



# Fault Monitoring & Management

## Application Note 303

### Fault Monitoring & Management with Stabiliti™ Series PCS

#### Purpose and Scope

CE+T America provides a robust means of monitoring and managing Power Converter System (PCS) faults via the Modbus interface. This Fault Application Note details the specific fault implementation and support logic found in the Stabiliti™ Series products. The PCS constantly checks internal and external conditions to ensure that the converter is operating properly and that external conditions are within allowed safe operating ranges. A fault occurs when a condition is encountered that is outside of a pre-defined safe operating range. This document describes the fault handling information and data that is provided to users via the Modbus interface along with detailed descriptions of each fault. Recommended site controller responses to reported faults and PCS operating states is also covered.

This application note should be used in conjunction with other product and safety documentation provided by CE+T America (“CEA”). The intended audience is engineering and lab personnel familiar with highvoltage/ high-power systems, and the general safety issues related to the wiring and use of 3-phase AC; battery systems; and PV energy sources utilized during the evaluation and qualification testing of power converters. Additionally, this document assumes that the reader is already familiar with the Stabiliti 30C or 30C3 Modbus Interface, and is comfortable using that interface to configure, monitor and command PCS operation.

Applies to Stabiliti™ 30C & 30C3 products with the following firmware versions:

FPGA	3.2 Build 106
Communications	3.2 Build 136

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## Fault System Overview

CE+T America PCS allow for a partly automated fault handling system which broadly operates as follows. When a fault limit is reached during operation, the PCS will halt operation and set a unique flag indicating the fault type in an Active Fault register and then start one of three internal reconnect count-down timers. Once the count-down timer reaches zero, the PCS will reconnect and resume operation as prior to the fault. Note that the fault must be clear at the end of countdown sequence in order for the PCS resume operation, and that any fault re occurrence during the countdown period will restart the countdown process. If a fault persists indefinitely, the PCS will be stuck in the countdown mode until the fault finally clears.

Once the fault condition has passed the PCS will clear the Active Fault flag and increment a counter on the associated Occurred Fault register. The PCS may also be operated in a manual mode which is typically meant for test or troubleshooting operation. If set to manual operating mode, the PCS will not automatically attempt to recover after a fault: the external system controller must issue a user\_start command via the Modbus interface.

## Faulty Severity Categories

Each fault is associated with one of the three count-down timers. In particular, faults associated with IEEE1547 over/under voltage & over/under frequency grid conditions are assigned to reconnect timer #0 which has a factory default of 320 seconds to conform with utility interconnection requirements. Timers #1 and #2 have 20 second factory defaults. Some faults are not transient by definition, such as with a blown GFDI fuse, and do not self-clear. These select lockdown faults are not assigned to a reconnect timer and typically require on-site service to clear. For all other cases, an external acknowledgement or reset of the fault is not required as is sometimes demanded by other equipment employing latching fault states.

There are 54 reported faults, which are all described in the Fault Descriptions section of this document. The fault severity level determines if the fault is simply recorded, or the converter response is to shut down.

The severities are as follows and are detailed further in the description of Modbus Register 9.

- Info: increments the fault counter only.
- Alert: increments the fault counter only.
- Alarm: fault is logged.
- Abort 0: fault is logged and PCS is stopped. Reconnect timer 0 is used for countdown and restart.
- Abort 1: fault is logged and PCS is stopped. Reconnect timer 1 is used countdown and restart.
- Abort 2: fault is logged and PCS is stopped. Reconnect timer 2 is used for countdown and restart.
- Lockdown: fault is logged, PCS stops processing power and requires on-site service and manual reset.

## Fault Data

When a fault does occur, registers 24 – 27 show which fault(s) have occurred since the last time that faults were cleared. In addition, registers 16 – 19 show which faults are currently active. To see more detailed information about a given fault that has occurred enter the number of the fault in question into register 0, then check registers 1 – 9 for specific fault details. In the case where a particular fault has occurred more than once since it was last reset, the values shown in register 1 – 9 represent the most recent occurrence. Available fault information includes the fault limit, fault value, fault counter, a timestamp, fault selector and status.

## System Controller Monitoring

CE+T America recommends the following practice for an external system controller to monitor faults. Details of each item are provided in later sections of this document.

1. Monitor the System Status register 298 for a snapshot view of the fault statuses and reconnect timer activity indicating a fault is active or a fault occurred and a reconnect count-down has begun.
2. Monitor the Active Faults registers 16-19 in real-time and automatically parse the bit fields to identify the fault ID. Continuously monitor Active Faults, log and timestamp once identified.
3. Monitor the Occurred Faults registers and automatically parse the bit field to identify the fault ID. When a fault occurs, iteratively query the fault data for all faults that have occurred. Log this fault data with a timestamp.
4. If the user encounters recurring active faults or repeating fault state oscillation, human intervention may be required. Consider implementing a system controller timeout to discontinue system start/ stop oscillation as a result of constantly repeating faults. Review the fault listing below for further explanation of fault causes and possible paths to fault resolution.
5. After a period of time logging faults and data the fault history can be cleared/reset by way of register 12, `fault_global_control`, in order to start fresh.

*Note: Many faults are transient in nature, and the triggering condition will pass quickly after the PCS has halted operation. As a result, the system controller may not capture every Active Fault flag as such transient faults occur. The only means to identify such faults is to query the Occurred Fault registers, and log fault counts. However, the user should recognize that an externally induced fault state may appear to clear but may be immediately triggered again, during or after the countdown process, which will reset the countdown state. This may result in an oscillating fault state, as described above.*

## Black Box Fault Recorder

The Stabiliti™ PCS includes a Black Box Fault Recorder system that automatically captures and saves operating data around the time of a fault. When a user is reporting failures, persistent or repetitive faults to CE+T America we require that the applicable Black Box fault log also be sent in order to better support our customers.

The Black Box data files are accessible through the PCS Ethernet connection over HTTP port 80. They are located in the 'faults' folder in the root directory of the PCS webserver as shown in the second image below. One FLT file is generated per day to capture any faults occurring that day and is named with the date in the form <MM-DD-YY.FLT>. Note that FLT files are binary formatted and only readable by CE+T America.

The FLT files may also be downloaded manually from the webserver with a web browser at the PCS IP address as shown in the following page.

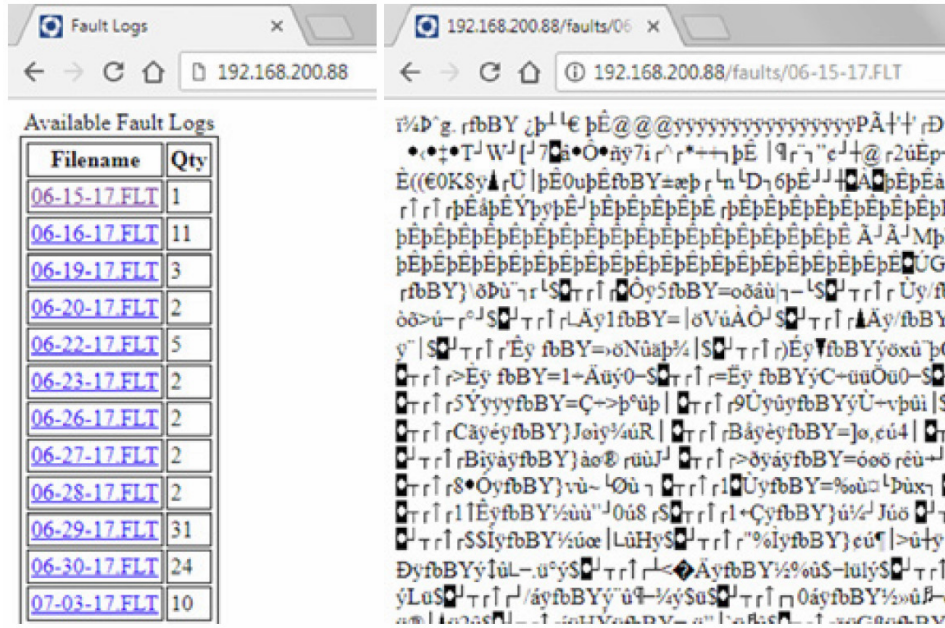


Figure 1. Black Box Fault Data File Access

## Front Panel Fault Display

The LCD front panel display of the PCS includes fault indicators and information.

- Ground Fault Indicator ‘G’ – When this fault indicator is solid color red, there is a Ground Fault within the system. This indicator is dedicated to Fault #0 and Fault #1 as described below.
- Fault Indicator ‘F’ – When this fault indicator is solid color red, there is an active fault or a fault that has resulted in a lockdown of the system.

Fault information is provided in the 3rd grouping of text down from the top of the display. The most recent fault is indicated first. For faults that occurred simultaneously, the fault with lowest ID number will be displayed. Second, active Fault Sets 0-3 are displayed in hexadecimal format along with an indicator of how many faults are currently active. An example image is provided in the following image along with its interpretation.

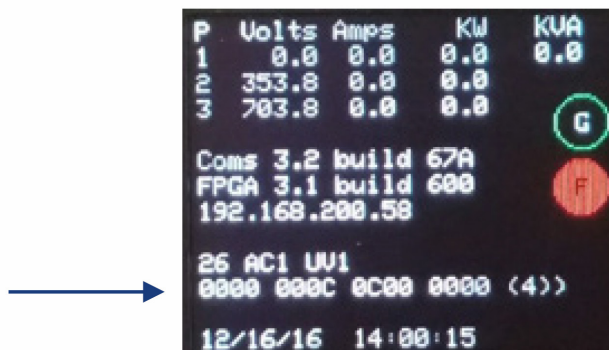


Figure 2. Sample front panel fault display

Figure 1 Interpretation

26 AC1 UV1: Most recent fault

0000	000C	0C00	0000	(4)
<i>Fault Set 3</i>	<i>Fault Set 2</i>	<i>Fault Set 1</i>	<i>Fault Set 0</i>	<i>four active faults</i>
<i>None Active</i>	<i>34 &amp; 35 Active</i>	<i>26 &amp; 27 Active</i>	<i>None active</i>	

Note that this set of four faults are the standard response to a loss of AC supply (utility grid).

## Register Map

Below is a detailed description of the Modbus holding registers that pertain to fault status and fault data reporting. In each case a chart shows the usage of the 16 bits for each Modbus Register. Also refer to the Modbus Map provided by CEA for your version of firmware. Access levels include Read & Write (RW), Read-Only (RO) and Write Only (WO) which indicates the PCS will clear a command after it is written.

Addr.	Addr.	Name	R/W	Type	Units	Min	Max	Default
0	0x0000	fault_index	RW	uint16		0	63	
1	0x0001	fault_limit	RO	uint16				
2	0x0002	fault_value	RO	uint16				
3	0x0003	fault_count	RO	uint16				
4	0x0004	fault_untime_0	RO	uint16				
5	0x0005	fault_untime_1	RO	uint16				
8	0x0008	fault_selector	RO	uint16				
9	0x0009	fault_status	RO	uint16x				
12	0x000C	fault_global_control	WO	uint16x		0	1	
16	0x0010	fault_active_0	RO	uint16x	bitfield			
17	0x0011	fault_active_1	RO	uint16x	bitfield			
18	0x0012	fault_active_2	RO	uint16x	bitfield			
19	0x0013	fault_active_3	RO	uint16x	bitfield			
24	0x0018	fault_occurred_0	RO	uint16x	bitfield			
25	0x0019	fault_occurred_1	RO	uint16x	bitfield			
26	0x001A	fault_occurred_2	RO	uint16x	bitfield			
27	0x001B	fault_occurred_3	RO	uint16x	bitfield			
256	0x0100	reconnect_timer_set_0	RW	uint16	s			320
257	0x0101	reconnect_timer_set_1	RW	uint16	s			20
258	0x0102	reconnect_timer_set_2	RW	uint16	s			20
288	0x0120	reconnect_timer_stat_0	RO	uint16	s			
289	0x0121	reconnect_timer_stat_1	RO	uint16	s			

Addr.	Addr.	Name	R/W	Type	Units	Min	Max	Default
290	0x0122	reconnect_timer_stat_2	RO	uint16	s			
298	0x012A	system_status	RO	uint16x	bitfield			
316	0x013C	gfdi_header	RO	uint16				
318	0x013E	imi_data	RO	uint16				
319	0x013F	gfdi_data	RO	uint16				

#### Address 0: Fault Index

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Reserved									Fault Index						

Access: RW  
 Default: NA  
 Format: Unsigned 16-bit value, 7-bit integer  
 Limits: 0 to 63

Description: The fault index is written by a user to select which fault information they would like to be provided in the following registers 1 – 9.

#### Address 1: Fault Limit

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault Result (16-bit signed value)															

Access: R  
 Default: NA  
 Format: Signed 16-bit integer  
 Limits: NA

Description: If the fault is associated with a value going beyond a given limit, the limit that was exceeded is shown here.

#### Address 2: Fault Result

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault Result (16-bit signed value)															

Access: R  
 Default: NA  
 Format: Signed 16-bit integer  
 Limits: NA

Description: The actual measured value that exceeded the fault limit and triggered the fault flag.

**Address 3: Fault Count**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault Count (16-bit signed value)															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

Description: The number of times a fault of this type has occurred since the last time that faults were reset.

**Address 4: Fault UNIX Timestamp 0**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault UNIX timestamp bits 15:0															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

Description: Bits 15:0 of the 32-bit UNIX timestamp of the most recent occurrence of this fault type.

**Address 5: Fault UNIX Timestamp 1**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault UNIX timestamp bits 31:16															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

Description: Bits 31:16 of the 32-bit UNIX timestamp of the most recent occurrence of this fault type.

**Address 6-7: Reserved**

**Address 8: Fault Selector**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Reserved												Selector			

Access: R  
 Default: NA  
 Format: Unsigned 16-bit value, bit field  
 Limits: NA

**Description:** In some cases, such as line over-voltage, a fault may have multiple sources. In those cases, this register will represent which source caused the fault. See the Fault Descriptions section of this document for the meaning of the selector for a given fault.

**Address 9: Fault Status**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Reserved										Status		Severity			

Access: R  
 Default: NA  
 Format: Unsigned 16-bit value, bit field  
 Limits: NA

**Description:**

b0-b2: The severity of the fault.

0x000 = Info: increments the fault counter only.

0x001 = Alert: increments the fault counter only.

0x010 = Alarm: fault is logged.

0x011 = Abort 0: fault is logged and unit is stopped. Reconnect timer 0 is used for restart.

0x100 = Abort 1: fault is logged and unit is stopped. Reconnect timer 1 is used for restart.

0x101 = Abort 2: fault is logged and unit is stopped. Reconnect timer 2 is used for restart.

0x110 = Lockdown: fault is logged, unit stops processing power and requires a reset.

0x111 = Reserved

b3-b4: The status of the fault.

0x01 = No fault

0x10 = Active

0x11 = Occurred

**Address 12: Fault Global Reset**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Reserved														Reset	



Access: WO  
 Default: 0x0000  
 Format: Unsigned 16-bit value, bit field  
 Limits: 0 to 1

Description: Write a 1 to reset (clear) all fault counters and history. Register self-clears, will always read back 0.

**Address 16-19: Fault Active Set 0-3**

Address	Set	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
16	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
17	1	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
18	2	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
19	3	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48

Access: R  
 Default: NA  
 Format: Unsigned 16-bit value, bit field  
 Limits: NA

**Description:**

b0 – b15: 1 = fault currently active, 0 = fault not currently active.

Address 16 is for faults 0 - 15.

Address 17 is for faults 16 - 31.

Address 18 is for faults 32 - 47.

Address 19 is for faults 48 - 63.

Faults 55, 56, and 58 through 63 are currently not defined and reserved for future use.

**Address 24-31: Fault Occurred Sets 0-3**

Address	Set	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
24	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
25	1	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
26	2	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
27	3	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48

Access: R  
 Default: NA  
 Format: Unsigned 16-bit value, bit field  
 Limits: NA

**Description:**

b0 – b15: 1 = Fault occurred since last reset, 0 = fault has not occurred since last reset.

Address 24 is for faults 0 -15.

Address 25 is for faults 16 - 31.

Address 26 is for faults 32 - 47.

Address 27 is for faults 48 - 63.

Faults 55, 56 and 58 through 63 are currently not defined and reserved for future use.

**Address 256: Reconnect Timer 0 Set**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: RW

Default: 320

Format: Unsigned 16-bit integer

Limits: NA

**Description:**

The `reconnect_timer_set_0` register defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 0. This soft reconnect time is only used when the PCS in auto-control mode following an Abort 0 fault clearance. This register is in units of 1 second.

**Changing the duration of reconnect timer #0 may invalidate your utility interconnection agreement.**

**Address 257: Reconnect Timer 1 Set**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: RW

Default: 20

Format: Unsigned 16-bit integer

Limits: NA

**Description:**

The `reconnect_timer_set_1` register defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 1. This soft reconnect time is only used when the PCS in auto-control mode following an Abort 1 fault clearance. This register is in units of 1 second. CE+T America recommends this set-point not be set less than 3 seconds.

**Address 258: Reconnect Timer 2 Set**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: RW  
 Default: 20  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The reconnect\_timer\_set\_2 register defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 2. This reconnect time is only used when the PCS in auto-control mode following an Abort 1 fault clearance. This register is in units of 1 second. CE+T America recommends this set-point not be set less than 3 seconds.

**Address 288: Reconnect Timer 0 Status**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The reconnect\_timer\_stat\_0 register reads back the current state of the reconnect\_timer\_0 timer in the PCS. This reconnect timer defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 0. This reconnect time is only used when the PCS in auto-control mode following an Abort 0 fault clearance. This register is in units of 1 second.

**Address 289: Reconnect Timer 1 Status**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The reconnect\_timer\_stat\_1 register reads back the current state of the reconnect\_timer\_1 timer in the PCS. This reconnect timer defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 1. This reconnect time is only used when the PCS in auto-control mode following an Abort 1 fault clearance. This register is in units of 1 second.

**Address 290: Reconnect Timer 2 Status**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Time (s)															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The reconnect\_timer\_stat\_2 register reads back the current state of the reconnect\_timer\_2 timer in the PCS. This reconnect timer defines soft reconnect time after a disconnect triggered by a fault of severity level Abort 2. This soft reconnect time is only used when the PCS in auto-control mode following an Abort 2 fault clearance. This register is in units of 1 second.

**Address 298: System Status**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fault Active					Reserved						Reconnect Timers			Reset	

Access: R  
 Default: NA  
 Format: Unsigned 16-bit value, bit field  
 Limits: NA

**Description:**

Provides information on fault activity and the reconnect timers statuses as follows:

- b0: 1 = PCS is in Power ON Self-Test mode (POST).
- b1: 1 = Reconnect timer #0 is active, an Abort 0 category fault occurred.
- b2: 1 = Reconnect timer #1 is active, an Abort 1 category fault occurred.
- b3: 1 = Reconnect timer #2 is active, an Abort 2 category fault occurred.
- b11: 1 = Lockdown is active, a Lockdown category fault is active or occurred.
- b12: 1 = PCS fault of severity level Abort 0 is active.
- b13: 1 = PCS fault of severity level Abort 1 is active.
- b14: 1 = Fault of severity level Abort 2 is active.
- b15: 1 = GFDI fault or IMI fault detected.

**Address 316: GFDI Header**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Firmware version															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The `gfdi_header` register reads back the installed firmware version identifier for the GFDI/IMI fault detection PCS sub-system.

**Address 318: IMI Data**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Impedance															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit hexadecimal value  
 Limits: NA

**Description:**

The `imi_data` register reads back the computed impedance detected between the DC-COM node and earth ground. This impedance is calculated once every 30 secs. If the computed impedance is below a built-in threshold of 4kΩ, the PCS system asserts an IMI fault.

**Address 319: GFDI Data**

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Fuse state															

Access: R  
 Default: NA  
 Format: Unsigned 16-bit integer  
 Limits: NA

**Description:**

The `gfdi_data` register reads back a non-zero value if the PCS ground fault fuse is intact, or closed. If the fuse opens (blows) due to a system DC ground fault, the GFDI fault detection sub-system will write a value of 0 to the `gfdi_data` register indicating detection of the ground fault.

## Fault Description

The faults that can occur in the Stabiliti Series are listed here along with a brief description.

Faults in the **Abort 0** category are associated with utility interconnection trip limits and the AC input should be investigated for troubleshooting.

Faults in the **Abort 1** category are associated with external PCS faults. To troubleshoot, review the fault description and investigate the applicable external condition.

Faults in the **Abort 2** category are associated with internal PCS faults. Typically, there are no actions an operator may take to troubleshoot these faults. Such faults may occur occasionally. If such a fault begins to occur consistently under a particular condition, please contact [tech.support@cetamerica.com](mailto:tech.support@cetamerica.com) for troubleshooting assistance.

*When contacting CE+T America for fault handling support, please provide all the available fault information provided by the PCS through the Modbus interface and Black Box Recorder as described in this document.*



*Note: A tabulated listing of all the faults may be found at the end of this document in the Quick Reference section.*

**Fault Number: 0**

Description: GFDI fault (grounded DC)

Selector Values:

0x01 = GFDI fault detected

0x10 = Loss of communication

Severity: 0x110 = Lockdown

**Fault Number: 1**

Description: IMI fault (floating DC)

Selector Values: NA

Severity: 0x110 = Lockdown

**Fault Number: 2**

Description: Power module heatsink temperature fault

Selector Values:

0x00 = Over temperature

0x01 = Under temperature

Severity: 0x100 Abort 1

**Fault Number: 3**

Description: Control board temperature fault

Selector Values:

0x00 = Over temperature

0x01 = Under temperature

Severity: 0x100 Abort 1

**Fault Number: 4**

Description: 24V auxiliary supply under voltage

Selector Values: NA

Severity: 0x100 Abort 1

**Fault Number: 5**

Description: Fan fault

Selector Values:

0x00 = Fan not spinning

0x01 = Bad tach reading

Severity: 0x110 = Lockdown

**Fault Number: 6**

Description: DC differential over voltage

Selector Values:

0x00 = Port 2

0x01 = Port 3

Severity: 0x100 Abort 1

**Fault Number: 7**

Description: DC differential under voltage

Selector Values:

0x00 = Port 2

0x01 = Port 3

Severity: 0x100 Abort 1

**Fault Number: 8**

Description: Link over voltage

Selector Values: NA

Severity: 0x101 Abort 2

**Fault Number: 9**

Description: Link starving

Selector Values: NA

Severity: 0x101 Abort 2



**Fault Number: 10**

Description: Link over current

Selector Values: NA

Severity: 0x101 Abort 2

**Fault Number: 11**

Description: IGBT VCES over voltage 1

Selector Values:

0x00 = Link positive to phase A

0x01 = Link positive to phase B

0x10 = Link positive to phase C

Severity: 0x101 Abort 2

**Fault Number: 12**

Description: IGBT VCES over voltage 2

Selector Values:

0x00 = Link negative to phase A

0x01 = Link negative to phase B

0x10 = Link negative to phase C

Severity: 0x101 Abort 2

**Fault Number: 13**

Description: IGBT VCES over voltage 3

Selector Values:

0x00 = Link positive to DC port 2

0x01 = Link positive to DC port 3

0x10 = Link positive to DC common

Severity: 0x101 Abort 2

**Fault Number: 14**

Description: IGBT VCES over voltage 4

Selector Values:

0x00 = Link positive to DC port 2

0x01 = Link positive to DC port 3

0x10 = Link positive to DC common

Severity: 0x101 Abort 2

**Fault Number: 15**

Description: AC A-B hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 16**

Description: AC B-C hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 17**

Description: AC C-A hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 18**

Description: DC2 input hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 19**

Description: DC2 output hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 20**

Description: DC3 input hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 21**

Description: DC3 output hard switch

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2



**Fault Number: 22**

Description: Link state timer check

Selector Values: NA

Severity: 0x101 Abort 2

**Fault Number: 23**

Description: Bad link start

Selector Values: 0x00, 0x01, 0x10, 0x11

Severity: 0x101 Abort 2

**Fault Number: 24**

Description: Invalid method/settings

Selector Values:

0x00 = Invalid port1 method/setting

0x01 = Invalid port2 method/setting

0x10 = Invalid port3 method/setting

Severity: 0x101 Abort 2

**Fault Number: 25**

Description: Island detected

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 26**

Description: AC under voltage level 1 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 27**

Description: AC under voltage level 2 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 28**

Description: AC under voltage level 3 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 29**

Description: AC under voltage level 4 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 30**

Description: AC over voltage level 1 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 31**

Description: AC over voltage level 2 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 32**

Description: AC over voltage level 3 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 33**

Description: AC over voltage level 4 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 34**

Description: AC under frequency level 1 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 35**

Description: AC under frequency level 2 trip

Selector Values: NA

Severity: 0x011 Abort 0





**Fault Number: 36**

Description: AC under frequency level 3 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 37**

Description: AC under frequency level 4 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 38**

Description: AC over frequency level 1 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 39**

Description: AC over frequency level 2 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 40**

Description: AC over frequency level 3 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 41**

Description: AC over frequency level 4 trip

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 42**

Description: Watchdog timeout

Selector Values: 0x00, 0x01

Severity: 0x101 Abort 2

**Fault Number: 43**

Description: Emergency stop active

Selector Values: NA

Severity: 0x011 = Abort 0

**Fault Number: 44**

Description: Sensing fault

Selector Values: NA

Severity: 0x101 Abort 2

**Fault Number: 45**

Description: Arc fault

Selector Values: NA

Severity: 0x011 Abort 0

**Fault Number: 46**

Description: Comms processor initiated shutdown

Selector Values: NA

Severity: 0x101 Abort 2

**Fault Number: 47**

Description: Surge detect

Selector Values:

0x00 = Phase A

0x01 = Phase B

0x10 = Phase C

Severity: 0x100 Abort 1

**Fault Number: 48**

Description: AC switch breakdown voltage exceeded

Selector Values:

0x00 = Phase A to phase B

0x01 = Phase B to phase C

0x10 = Phase C to phase A

Severity: 0x101 Abort 2

**Fault Number: 49**

Description: DC switch breakdown voltage exceeded

Selector Values:

0x00 = DC2

0x01 = DC3

Severity: 0x101 Abort 2



**Fault Number: 50**  
 Description: Precharge timeout  
 Selector Values: NA  
 Severity: 0x101 Abort 2

**Fault Number: 51**  
 Description: AC to link primary high voltage  
 Selector Values:  
     0x000 = Positive to ground  
     0x001 = Negative to ground  
 Severity: 0x101 Abort 2

**Fault Number: 52**  
 Description: AC line to line instantaneous over voltage  
 Selector Values:  
     0x000 = Phase A to phase B  
     0x001 = Phase B to phase C  
     0x010 = Phase C to phase A  
 Severity: 0x100 Abort 1

**Fault Number: 53**  
 Description: License fault  
 Selector Values: NA  
 Severity: 0x101 Abort 2

**Fault Number: 54**  
 Description: Grid\_Ack timeout  
 Selector Values: NA  
 Severity: 0x100 Abort 1

**Fault Number: 57**  
 Description: AC line to ground instantaneous over voltage  
 Selector Values:  
     0x000 = Phase A to ground  
     0x001 = Phase B to ground  
     0x010 = Phase 3 to ground  
 Severity: 0x100 Abort 1

## Faults Quick Reference - Figure A

### Hexadecimal Reference

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Binary	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

### Address 16-19: Fault Active Sets 0-3

Address	Set	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
16	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
17	1	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
18	2	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
19	3	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48

### Address 24-31: Fault Occurred Sets 0-3

Address	Set	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
24	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Address	Set	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
25	1	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
26	2	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32
27	3	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48

Addr.	Addr.	Name	R/W	Type	Units	Min	Max	Default
0	0x0000	fault_index	RW	uint16		0	63	
1	0x0001	fault_limit	RO	uint16				
2	0x0002	fault_value	RO	uint16				
3	0x0003	fault_count	RO	uint16				
4	0x0004	fault_untime_0	RO	uint16				
5	0x0005	fault_untime_1	RO	uint16				
8	0x0008	fault_selector	RO	uint16				
9	0x0009	fault_status	RO	uint16x				
12	0x000C	fault_global_control	WO	uint16x		0	1	
256	0x0100	reconnect_timer_set_0	RW	uint16	s			320
257	0x0101	reconnect_timer_set_1	RW	uint16	s			20
258	0x0102	reconnect_timer_set_2	RW	uint16	s			20
288	0x0120	reconnect_timer_stat_0	RO	uint16	s			
289	0x0121	reconnect_timer_stat_1	RO	uint16	s			
290	0x0122	reconnect_timer_stat_2	RO	uint16	s			
298	0x012A	system_status	RO	uint16x	bitfield			
316	0x013C	gfdi_header	RO	uint16				
318	0x013E	imi_data	RO	uint16				
319	0x013F	gfdi_data	RO	uint16				

### Faults Quick Reference - Figure B

Fault	Description	Severity	Fault	Description	Severity
0	GFDI Fault	Lockdown	28	AC under voltage level 3 trip	Abort 0
1	IMI Fault	Lockdown	29	AC under voltage level 4 trip	Abort 0
2	Power module heatsink temperature fault	Abort 1	30	AC over voltage level 1 trip	Abort 0
3	Control board temperature fault	Abort 1	31	AC over voltage level 2 trip	Abort 0
4	24V auxiliary supply under voltage	Abort 1	32	AC over voltage level 3 trip	Abort 0
5	Fan fault	Lockdown	33	AC over voltage level 4 trip	Abort 0
6	DC differential over voltage	Abort 1	34	AC under frequency level 1 trip	Abort 0



Fault	Description	Severity	Fault	Description	Severity
7	DC differential under voltage	Abort 1	35	AC under frequency level 2 trip	Abort 0
8	Link over voltage	Abort 2	36	AC under frequency level 3 trip	Abort 0
9	Link starving	Abort 2	37	AC under frequency level 4 trip	Abort 0
10	Link over current	Abort 2	38	AC over frequency level 1 trip	Abort 0
11	IGBT VCES over voltage 1	Abort 2	39	AC over frequency level 2 trip	Abort 0
12	IGBT VCES over voltage 2	Abort 2	40	AC over frequency level 3 trip	Abort 0
13	IGBT VCES over voltage 3	Abort 2	41	AC over frequency level 4 trip	Abort 0
14	IGBT VCES over voltage 4	Abort 2	42	Watchdog timeout	Abort 2
15	AC A-B hard switch	Abort 2	43	Emergency Stop	Abort 0
16	AC B-C hard switch	Abort 2	44	Sensing fault	Abort 2
17	AC C-A hard switch	Abort 2	45	Arc Fault	Abort 0
18	DC2 input hard switch	Abort 2	46	Comms processor initiated shutdown	Abort 2
19	DC2 output hard switch	Abort 2	47	AC Surge detect	Abort 1
20	DC3 input hard switch	Abort 2	48	AC switch breakdown voltage exceeded	Abort 2
21	DC3 output hard switch	Abort 2	49	DC switch breakdown voltage exceeded	Abort 2
22	Link state timer check	Abort 2	50	Precharge timeout	Abort 2
23	Bad link start	Abort 2	51	AC to link primary high voltage	Abort 2
24	Invalid method/settings	Abort 2	52	AC line to line instantaneous over voltage	Abort 1
25	Island detected	Abort 0	53	License fault	Abort 2
26	AC under voltage level 1 trip	Abort 0	54	Grid_Ack timeout	Abort 1
27	AC under voltage level 2 trip	Abort 0	57	AC line to ground instantaneous over voltage	Abort 1

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