Peloton Prism Communications Handling

Date: July 26, 2019

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General Notes:

Version 0.6.3 - Now NAK's all set commands if the system status is not 0xAA (OKAY). All but the set speed and set incline are also allowed when the system status is 0xDD (ESTOP).

Version 0.6.4 - Added checks to make sure the system is not already calibrating before starting a calibration. Also makes sure the system status is 0xAA (OKAY) before starting a calibration. The protocol NAK's those attempts.

Basic Packet Structure

The basic command structure is as follows:

Header	Command Id	Data length	Data	8 bit checksum	Trailer
0xDEAD	<CMD ID>	<LENGTH>	<DATA>	<CHECKSUM>	0xBEEF

<CHECKSUM> is the arithmetic sum of all bytes up by not including the checksum and the trailer.

Currently there are two basic types of command GET DATA and SET DATA. There are some specialty command to initiate the boot loader, start the automatic calibration, clear errors, and clear pending error. Not all GET DATA commands have an equivalent SET DATA command. All SET DATA commands have an equivalent GET DATA command.

Currently there are three types of command responses. It can either be data, an ACK, or NAK. An ACK signifies that the previous command was accepted. A NAK means that the previous command was not accepted. This can be either for invalid data values or improper packet format.

Header	Command Id	Data length	Data	8 bit checksum	Trailer
0xDEAD	0xXX	0xNN	NN data bytes	<CHECKSUM>	0xBEEF
0xDEAD	0xBB (ACK)	0x05	Time MSB Time 3rd Time 2nd Time LSB 0xXX	<CHECKSUM>	0xBEEF
0xDEAD	0xEE (NAK)	0x05	Time MSB Time 3rd Time 2nd Time LSB 0xXX	<CHECKSUM>	0xBEEF

Command List

Get MCB HW version

This command actually returns the version of the pseudo boot loader. This version will change is the boot loader changes or the hardware changes. The command returns 4 bytes. The last byte is always zero.

Command ID 0x00

Returns: 4 bytes

Bytes	Description
1	Major version
1	Minor version
1	Revision
1	0x00

Get MCB FW version

This command returns the current software version of the application. The command returns 4 bytes. The last byte is always zero.

Command ID 0x01

Returns: 4 bytes

Bytes	Description
1	Major version
1	Minor version
1	Revision
1	0x00

Get/Set Current speed

These commands are used to get or set the current speed in the selected units. The value is speed in MPH or KPH scaled to the nearest tenth. The units are controlled by the “set speed units” command. Currently the only supported units are English and Metric.

Get Command ID 0x02

Returns: Current speed in tenths of a unit

Set Command ID 0x06 Target speed in tenths of a unit

Returns: ACK if the speed is zero, greater than the minimum speed and less than the maximum speed, otherwise NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK’s when this happens.)

Get/Set Current Incline

These commands are used to get or set the percent grade. The value is the incline percent grade scaled to the nearest tenth.

Get Command ID 0x03

Returns: Current incline in tenths of a percent grade

Set Command ID 0x07 Target incline in tenths of percent grade

Returns: ACK if less than maximum incline, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set speed units

These commands are used to get or set the system units. When setting the units, the MCB will respond with an ACK if the unit value is correct or NAK if the unit value is not correct. The MCB will also respond with a NAK if the units did not change because they are the same.

Get Command ID 0x05

Returns: Units 0x01 English 0x02 Metric

Set Command ID 0x04 Units 0x01 English or 0x02 Metric

Returns: ACK if units are valid and different from the current units, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set "0" incline

These commands are used to get or set a new zero calibration point. The values is range checked and will return a NAK if the value is zero or greater than 1023. If the value is less than the maximum ADC value then the incline will not operate properly. You can retrieve the maximum ADC with the "get calibration data" command.

Get Command ID 0x09

Returns: 4 bytes

0x00
0x00
MSB zero incline
LSB zero incline

Set Command ID 0x08 Data <0x00><0x00><MSB zero incline><LSB zero incline>

Returns: ACK of value is greater than 0 but less than 1023, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set max incline

These commands are used to get or set the upper grade limit in tenths of a percent grade. The value is range checked to verify that is greater than or equal to 0.5% and less than or equal to 15.0%. The value should be in tenths of a percent grade.

Get Command ID 0x0B

Returns: Maximum incline in tenths of a percent grade

Set Command ID 0x0A Maximum incline in tenths of a percent grade

Returns: ACK if the incline greater than 0.5% and less than 15.0%, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set max speed

These commands are used to get or set the maximum speed limit. This is not the absolute maximum speed but the maximum that can be set through the protocol. The value is in tenths of MPH or KPH. The value is range checked using the current units for the limits.

Get Command ID 0x0D

Returns: Maximum speed in tenths of the current unit

Set Command ID 0x0C Data Maximum speed in tenths of a unit

Returns: ACK of the value is greater than the minimum speed but less than the maximum speed for the current units, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set speed ratio

These commands are used to get or set the value used to convert from RPM to units. The only illegal value is zero and that will cause a NAK response. Otherwise the response is an ACK.

Get Command ID 0x0F

Returns: Speed ratio in RPM per unit

Set Command ID 0x0E Speed ratio in RPM per unit

Returns: ACK if greater than zero or a NAK on zero. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Start automatic calibration

This command starts the process to calibrate speed and incline process. The process can be aborted by removing the ESTOP. Both the speed and incline are calibrated at the same time.

Command ID 0x10

Data	Function
0x00	Calibrate both
0x01	Calibrate speed
0x02	Calibrate incline

Returns: ACK if not already calibrating and a NAK if it was calibrating. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get calibration status

This command returns the status of the calibration process. The response is a bit masked value that status of the speed and inclines calibration. The calibration status is saved during the calibration. The calibration status is reset when the units change but a re-calibration is usually not required.

Command ID 0x11

Returns: Calibration status

Code	Description
0x00	no calibration
0x?E	speed calibration
0xE?	incline calibration
0x?1	speed done
0x1?	incline done
0x11	both done

Get calibration data

This returns the calibration data for the maximum and minimum PWM and the maximum and minimum ADC values. This command is still functional but please use the get calibration parameters command ID 0x2A for additional information.

Command ID 0x12

Returns: 8 bytes Calibration data

Value	Size
Maximum PWM	2 bytes
Minimum PWM	2 bytes
Maximum ADC	2 bytes

Minimum ADC	2 bytes

Get/Set max acceleration

This command sets the time in seconds that it takes to go from 0 to maximum speed or from maximum speed to zero. This value must be greater than 20 seconds and less than 60 seconds.

Get Command ID 0x14

Returns: Acceleration time in seconds

Set Command ID 0x13 Acceleration time in seconds

Returns: ACK if the acceleration time is greater than 20 but less than 60 seconds, otherwise a NAK. . (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set max incline change allowed

This command sets the maximum incline change in tenths of a percent grade. This command sets a value but it is currently not used anywhere. There was no description as to how it is supposed to operate.

Get Command ID 0x16

Returns: Maximum incline change in tenths of a percent grade

Set Command ID 0x15 Maximum incline change

Returns: ACK if less than maximum incline, otherwise a NAK . (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get/Set MCB serial number

These commands are used to get or set the MCB serial number. The serial number is 16 data bytes and stored n EEPROM.

Get Command ID 0x1A

Returns: 16 bytes MCB serial number

Set Command ID 0x1 16 bytes MCB serial number

Returns: ACK

Get/Set chassis serial number

These commands are used to get or set the chassis serial number. The serial number is 16 data bytes and stored in EEPROM.

Get Command ID 0x1B

Returns: 16 bytes Chassis serial number

Set Command ID 0x18 16 bytes Chassis serial number

Returns: ACK

Write to memory

This command stores the calibration values as well as the MCB and chassis serial number to the EEPROM. This command is not really necessary but it won't hurt either.

Command ID 0x19

Returns: ACK

Read odometer

This command returns the 32 bit value in tenths of unit. The units can be either MPH or KPH. Currently this value is not saved in the EEPROM.

Command ID 0x1C

Returns: 4 bytes

MSB odometer
3rd odometer
2nd odometer
LSB odometer

Get seconds from power up

This command returns the 32 bit value in seconds from power up.

Command ID 0x1D

Returns: 4 bytes

MSB time
3rd time
2nd time
LSB time

Get system status

This command returns the system status byte.

Command ID 0x1E

Returns: System status

Value	Description

0xAA	all good
0x11	speed calibration
0x22	incline calibration
0x33	both calibration
0xBB	soft error
0xCC	hard error
0xDD	ESTOP

Get error states

This command returns the last 4 error codes. The most current code is always first. Each error code is 1 byte. The error processing section provides additional details on the error codes.

Command ID 0x1F

Returns: 4 bytes

error code 1
error code 2
error code 3
error code 4

Get error time

This command returns the last 4 error times. The most current time is always first. Each error time is 32 bits.

Command ID 0x20

Returns: 16 bytes

error time 1
error time 2
error time 3
error time 4

Clear error entry

This command is used to clear a single error entry. This command only clears the desired error entry from list but does not clear the pending error. Values 1 through 4 will get an ACK. Any other value will get a NAK.

Command ID 0x21

Data	Description
0x01	Clears entry 1
0x02	Clears entry 2
0x03	Clears entry 3
0x04	Clears entry 4

Returns: ACK if data is 1 through 4, otherwise a NAK

Get thermistor data

Not applicable always returns a NAK.

Command ID 0x22

Returns: NAK

Get person present

This command returns status of the person present input.

Command ID 0x23

Returns: Person present

Value	State
0	no person
1	person

Get/Set pulses per revolution

This command returns the number of pulse per revolution. The number of pulses counted during each revolution of the encoder wheel.

Get Command ID 0x24

Returns: Pulses per revolution

Set Command ID 0x25 Pulses per revolution

Returns: ACK if pulses per revolution is greater than 0 and less than 100, otherwise a NAK. (Version 0.6.3 now makes sure that system status is 0xAA before accepting the set command. The software NAK's when this happens.)

Get current RPM

This command returns the RPM of the encoder. This is a 16 bit value. This is not the motor RPM since the encoder is mounted on the roller and not the motor shaft.

Command ID 0x26

Returns: 2 bytes

MSB RPM
LSB RPM

Clear pending errors

This command clears any pending errors. Clearing an individual error does not clear the pending status. Fatal errors will not be cleared by this command.

Command ID 0x27

Returns: ACK

Enable ErP mode

This command causes the MCB to power itself down while leaving the +24 VDC available to the smart card and table. This command only works if the belt is stopped and the incline is not moving. The smart card must toggle the ErP wakeup pin to restore normal operation or a full power cycle. While in ErP mode, the MCB is not powered and cannot respond to communications.

Command ID 0x28

Returns: ACK and power off the MCB or NAK if the treadmill is moving.

Get Running Parameters

This command causes the MCB to return several parameters at once. This includes the system status, target speed, current speed, target grade, and current grade among others.

Command ID 0x29

Returns: length 20 bytes

Bytes	Description
1	System status
1	Calibration status
1	Person present
1	Units
1	Target speed
1	Current speed
2	Current RPM
1	Target incline
1	Current incline
2	Current incline ADC
4	Running time
4	Odometer

Get Calibration Parameters

This command causes the MCB to return all the calibration parameters. These include both the speed and incline calibration data.

Command ID 0x2A

Returns: length 52 bytes

Bytes	Description
1	Speed calibration done
1	Maximum speed
1	Half maximum speed
1	Minimum speed
2	Maximum PWM
2	Half maximum PWM
2	Minimum PWM
1	Incline calibration done
1	Maximum incline
1	Minimum incline
2	Maximum incline ADC
2	Minimum incline ADC
1	Pulses per revolution
1	Speed ratio
1	acceleration time
16	MCB serial number
16	Chassis serial number

Get Error Parameters

This command causes the MCB to return all the stored error codes and times. The errors are returned in order of newest first to oldest last.

Command ID 0x2B

Returns: length 20 bytes

Bytes	Description
1	Error code 1
4	Error time 1
1	Error code 2
4	Error time 2
1	Error code 3
4	Error time 3
1	Error code 4
4	Error time 4

Get Filtered Current (depreciated)

This command returns the measured RMS current. This value is returned as a byte that is scaled in tenths of an Amp.

Command ID 0x2C

Returns: Filtered RMS current

Get Averaged Current (depreciated)

This command returns the averaged RMS current. This value is returned as a byte that is scaled in tenths of an Amp.

Command ID 0x2D

Returns: Average RMS current

Reset Calibration Defaults

These commands reset the speed and/or incline calibration values back to their defaults.

Command ID 0x2E

Data	Function
0x00	Reset both
0x01	Reset speed
0x02	Reset incline

Returns: ACK unless the speed is greater than zero then it returns a NAK.

Get MCB ID

This command returns the value of the MCB ID. Currently the MCB ID is to distinguish between the 110 VAC and 220 VAC variations.

Command ID 0x2F

Returns: 0x00 for 110 VAC and 0x03 for 220 VAC

Get/Set Extra Serial Number 1

These commands are used to get or set the serial number. The serial number is 16 data bytes and stored n EEPROM.

Get Command ID 0x30

Returns: 16 bytes Serial number extra 1

Set Command ID 0x31 16 bytes Serial number extra 1

Returns: ACK

Get/Set Extra Serial Number 2

These commands are used to get or set the serial number. The serial number is 16 data bytes and stored n EEPROM.

Get Command ID 0x32

Returns: 16 bytes Serial number extra 2

Set Command ID 0x33 16 bytes Serial number extra 2

Returns: ACK

Get Version Parameters

This command returns both the flash boot loader version and the application version is a single command. It also returns the MCB ID, extra serial number 1, and extra serial number2.

Command ID 0x34

Returns length of 41 bytes

Bytes	Description
1	Boot loader major version
1	Boot loader minor version
1	Boot loader revision
1	0x00
1	Application major version
1	Application minor version
1	Application revision
1	0x00
1	MCB ID
16	Extra serial number 1
16	Extra serial number 2

Get Motor Type

This command returns the motor type. The MCB does not have a mechanism actually read the motor type. It is the user's responsibility to make sure this value is correct. This value only effects the initial speed calibration by picking default calibration values that based on the average values collected from hundreds of motors.

Command ID 0x35

Returns motor type as a single byte

Value	Description
0	Default motor or Turdan
1	Turdan motor

2	McMillan motor

Set Motor Type

This command is used to set the motor type. The MCB does not have a mechanism actually read the motor. It is the user's responsibility to make sure this value is correct. This value only effects the speed calibration by picking default calibration values that based on the average values collected from hundreds of motors.

Command ID 0x36

Data	Description
0	Default motor or Turdan
1	Turdan motor
2	McMillan motor

Returns an ACK if the motor type is accepted or a NAK if the motor type is not available.

Get Device ID

This command returns the device id. This is a 4-byte value that indicates the processor type that is installed on the MCB. This value is unique to the processor and not necessarily the manufacturer. Currently there are two processors supported.

Command ID 0x37

Returns four bytes that uniquely identify the processor.

Value	Description
414	ST STM32F103xE or Gigadevices GD32F103xE
442	ST STM32F030xC

Switch to OTA mode

This command forces the processor to execute the ST internal boot loader. If the safety key is removed or the belt is moving or the elevation is moving, the software will return a NAK.

Command ID 0xFF

Returns: ACK unless the treadmill is moving, then it will return a NAK

Error Processing

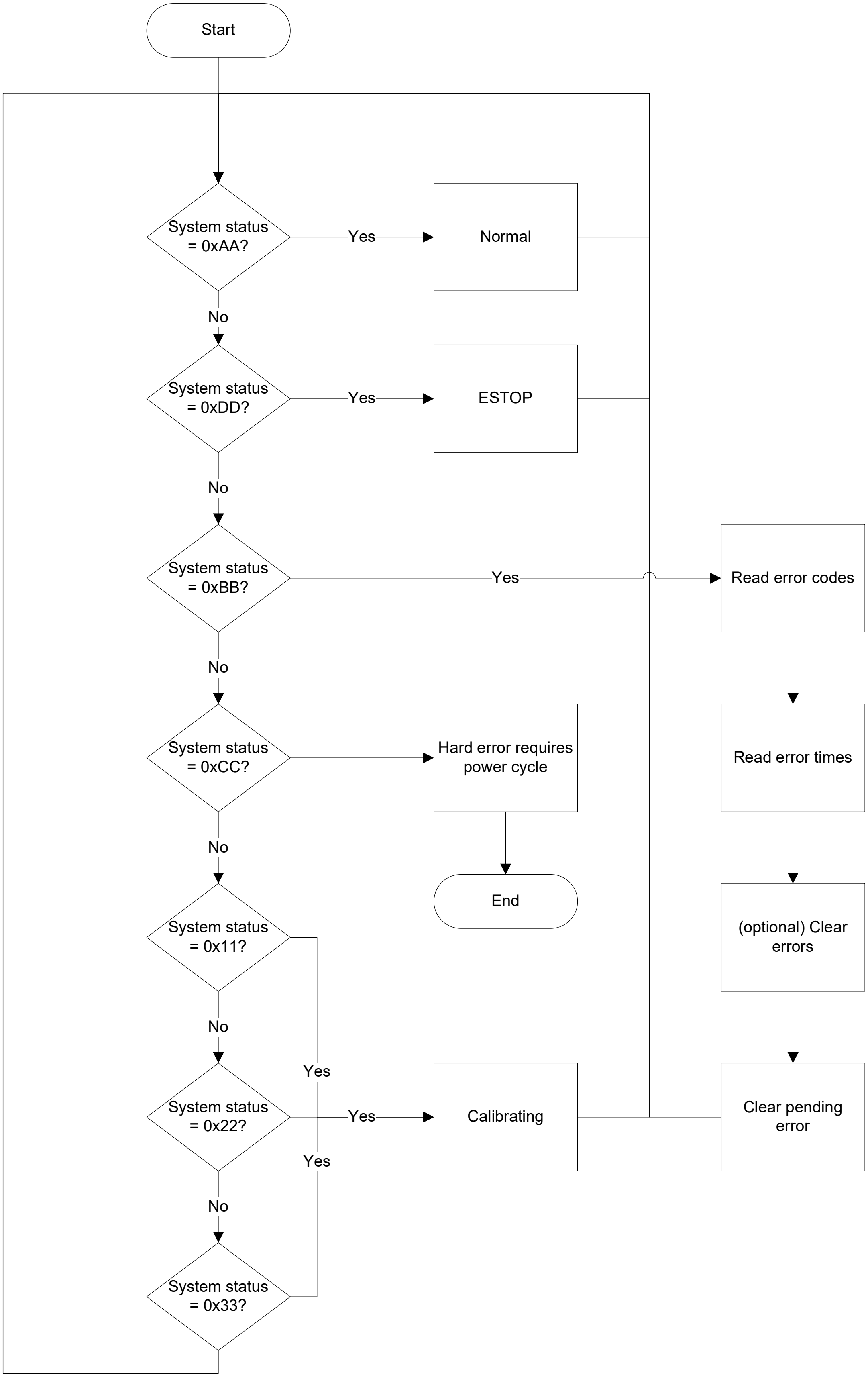
The MCB can detect many different errors. There are two classifications for errors. The first is a soft or resettable error. The second is hard (fatal) error that requires a power cycle. The following is a list of errors and whether they are resettable or fatal.

```
ERROR_NOERROR,                   // 00 - yes
ERROR_SPEED_SENSOR_FAIL,         // 01 – yes resettable
ERROR_ABNORMAL_ARMATURE_VOLTAGE, // 02 - no provision
ERROR_UNDERVOLATAGE_PROTECTION,  // 03 - no provision
ERROR_OVERVOLTAGE_PROTECTION,    // 04 - no provision
ERROR_DC_MOTOR_OPEN,             // 05 - no provision
ERROR_DC_MOTOR_OVER_ACCEL,       // 06 - yes resettable
ERROR_ELEVATION_DIR,             // 07 - yes resettable
ERROR_ELEVATION_CAL_FAIL,        // 08 – yes resettable
ERROR_SPEED_CAL_FAIL,            // 09 – yes resettable
ERROR_MOSFET_FAIL,               // 0A - todo fatal
ERROR_EEPROM_FAIL,               // 0B - yes fatal
ERROR_PWM_ERROR,                 // 0C - no provision
ERROR_DC_MOTOR_SHORT_POWER,      // 0D - no provision
ERROR_DC_MOTOR_SHORT_RUNNING,    // 0E - no provision
ERROR_INCLINE_ANTILOCK,          // 0F - no provision
ERROR_ELEVATION_SENSOR_FAIL,     // 10 - yes resettable
ERROR_DC_MOTOR_OVERSPEED,        // 11 - yes resettable
ERROR_ELEVATION_RUNAWAY,         // 12 - yes resettable
ERROR_BUSENABLE,                 // 13 - yes fatal
ERROR_LOOPSPERSECOND_LOW,        // 14 - yes fatal
```

The protocol has 5 commands that deal with error processing.

1. 0x1E – get system status – returns the system status. This value can be used to determine if the system has a pending non-fatal error or a pending fatal error. This value will also tell whether the treadmill is calibrating or in ESTOP.
2. 0x1F – get error states – returns the last four error codes. The first code is the most recent and so on.
3. 0x20 – get error times – returns the matching four error times as 32 bit values. The first time is the most recent and so on.
4. 0x21 – clear error – clears the error number specified in the data field.
5. 0x27 – clear pending error – clears the system of any pending non-fatal errors.

The errors are stored in a circular queue that keeps only the last 4 errors. It is really not necessary to clear an error entry because the errors are always sent with the most recent being first and the fourth is the oldest. You will need to clear pending error function to clear the MCB status and return it back to normal. If the error that is pending is a fatal error then it will not be reset by the command. Fatal errors can only be reset with a power cycle.



Start
System status = 0xAA?
Yes
Normal
No
System status = 0xDD?
Yes
ESTOP
No
System status = 0xBB?
Yes
Read error codes
No
System status = 0xCC?
Hard error requires power cycle
Read error times
No
End
System status = 0x11?
(optional) Clear errors
No
Yes
System status = 0x22?
Yes
Calibrating
Clear pending error
Yes
No
System status = 0x33?