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MSC2.5PN7.5

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Approval

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Section	Reason for Change	Issue
All	Initial draft	A
All 5.1 6.1	Header and Footer updated Part number corrected Baud rate changed to 9600 baud	B

Contents

1. Introduction

The MSC2.5PN7.5, high voltage power supply is for ESC (Electrostatic chuck) applications. The unit has an RS485/RS232 interface which allows monitoring and control of the unit and has a front panel display with buttons which also allows control and setup of the unit. This specification defines the protocol which runs over the serial link. This is based on the SCPI protocol, SCPI commands are ASCII text strings. Commands are a series of one or more keywords, many of which take parameters. In this specification, keywords are written CONFigure: The entire keyword can be used, or it can be abbreviated to just the uppercase portion. Responses to query commands are typically ASCII strings. However, for bulk data, binary formats are be used.

2. Scope

The purpose of this specification is to define the requirements for the protocol against which the firmware in the unit will be designed. The draft document is intended to communicate the intentions of the design team to other parts of the company, or customers, for feedback and comment. The issued specification will be used to verify the design and, where applicable, form the basis for datasheets and marketing documentation.

3. Glossary

ASCII	-	American Standard Code for Information Interchange
bps	-	Bits per second
PSU	-	Power Supply Unit
wrt	-	With Respect To
TBA	-	To Be Agreed
TBD	-	To Be Decided
SW	-	refers to PC Software AND/OR Firmware
HW	-	Hardware
fs	-	Full scale

4. Definition of terms

a) Within the scope of the specification the word “shall” is used as an imperative, i.e. the following text is a mandatory requirement.

b) Within the scope of the specification the word “will” is used to indicate that the following text shows a high priority, but non-mandatory, requirement. Deviations from such requirements will be permitted only by a change of specification.

c) Within the scope of the specification the word “should” is used to indicate that the following test is advisory. Deviations from such requirements will be permitted after justification but will not require a change in specification.

d) Within the scope of the specification the phrase “Normal Operating Conditions” is used to define conditions under which the unit will meet full rated performance.

e) Within the scope of the specification the phrase “Abnormal Operating Conditions” is used to define conditions under which the unit will continue to operate, but certain performance criteria may be degraded.

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5. Associated Documents

5.1. Internal Documents

81609-1 Specification for the MSC2.5PN7.5/1166

5.2. External Documents

None

6. Communications

6.1. Serial Communications

Both RS232 and RS485 serial communications is supported.
All software that addresses the RS-232 interface must adhere to the following parameters:

- Baud rate: 9600
- Parity: None
- Data Bits: 8
- Stop Bit: 1
- Handshake: None

Selecting between RS232 and RS485 is performed via the front panel menu.

6.1.1. RS232

The RS232 interface is compliant with the EIA RS232-C standard. It produces +/-5V on the transmit line and will accept +/-15V (up to +/-25V under fault conditions) on the receive input. The interface makes use of a standard 'command/response' communications protocol.

6.1.2. RS485

The RS485 interface is compliant with the EIA RS485 standard. The interface makes use of a standard 'command/response' communications protocol.

Programming of the PSU's RS485 Address is performed via the front panel menu.

6.2. Ethernet

The PSU also supports Ethernet TCP/IP communications. The default TCP/IP configuration is a detailed table below.

Default TCP/IP Configuration	
IP Address	192.168.18.50
IP Sub net mask	255.255.255.0
Port	9760

Note:
i) Only static IP addressing is supported.
ii) Only IPv4 addresses are supported.
iii) When Ethernet is connected to the LAN port, Serial comms is disabled.

6.3. SCPI Command Format

The unit processes SCPI commands.

https://en.wikipedia.org/wiki/Standard_Commands_for_Programmable_Instruments

The unit acts as a slave and only responds to messages sent by the host, it does not initiate any message transmission.

SCPI commands to the unit may either perform a set operation (e.g. setting the output voltage) or a query operation (e.g. reading a voltage). Queries are issued to the unit by appending a question-mark to the end of a command. Some commands can be used for both setting and querying.

Similar commands are grouped into a hierarchy or "tree" structure. For example, any instruction to read a measurement from an instrument will begin with "MEASure". Specific sub-commands within the hierarchy are nested with a colon (:) character. For example, the command to "Measure the DC voltage" would take the form MEASure:VOLTage:DC?

```
:MEASure
   :VOLTage
      :DC?
```

The command syntax consists of a mixture of upper- and lower-case letters. Capital letters refer to the abbreviation of the command. Use square brackets ({}), vertical bars (|), right angle brackets (<>), or square brackets ([]) to separate multiple variables in the command.

{}	:	Displays the variable in the command string.
|	:	Distinguish multiple variables within the command string.
<>	:	Used to indicate that the variable in <> must be specified.
[]	:	Indicates that the variable is optional in the command string.

Note: BEWARE, space characters (ASCII 32, 0x20, 20H) in commands are significant.

A colon (:) is used to separate command keywords and space characters are used to distinguish variables from command keywords. Commas (,) are used between multiple variables.

e. g. SOUR:VOLT 1kV,-1kV

The MSC unit uses the <new line> character, (ASCII 10, 0AH, 0x0A) to indicate the termination of the transmitted command string.

All numeric values are expressed in decimal numbers, decimal points, negative numbers, and unit usage are also allowed.

Boolean variables are used to indicate a variable in true (1) or false (0) form.

String variables are also allowed using quotation marks.

7. SCPI Commands

7.1. *CLS

This command clears all data structures within the unit. Its main function is to clear the Error/Event Queue.

Example:

Command: *CLS
Response: none

7.2. *IDN?

Returns the identification code of the Power Supply.

The identification code is formatted as shown below:

Example:

Command: *IDN?
Response: SHV, MSC2.5PN7.5,XXXXXXXXX,vYYrZZ

Where	SHV	Manufacturer (Spellman High Voltage)		
	MSC2.5PN7.5	Product Model Name		
	XXXXXXXXX	Serial Number		
	vYYrZZ	Firmware version		
		Where:	YY	Firmware Version
			ZZ	Firmware Revision

7.3. *RST

Reset the Power Supply. Restores factory default configuration.

Example:

Command: *RTS
Response: none

Data structures are not affected by *RST. The status event bits are cleared by *CLS and by reading the event register. The error/event queue is also cleared by *CLS.

7.4. SYSTem:ERRor?

Returns the last error message from the error queue in the power supply.

If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with *-350,"Error queue overflow"*. No additional errors are stored until errors are removed from the queue.

The error queue is cleared by the *CLS and when power is cycled. It is not cleared by a *RST. If there are no error in the buffer it returns the *+0, "No Error"* message.

Example:

Command: SYSTEM:ERROR?
SYST:ERR?

Response: Error message. e.g. *-104, "Data type error"*

7.5. SYSTem:VERSion?

Returns the version of SCPI being used by power supply.
SCPI version information is returned in the format.

Example:
The commands below are valid ways to request the SCPI version information.

Command: SYSTEM:VERSION?
SYST:VERS?

Response: YYYY.V

Where: YYYY Specifies the year.
V Specifies the SCPI version for that year.

e.g. V1999.0 ch4.1.1

7.6. SYSTem:LOCal

Places the PSU in local mode.

In local mode, except for the LOCAL button, all front panel buttons are disabled.

Example:
The commands below are valid ways to place the unit in local mode.

Commands: SYSTEM:LOCAL
SYST:LOC

Response: None

7.7. SYSTem:REMote

Places the PSU in remote mode.

In remote mode:

i) The front panel push buttons are disabled.
ii) The PSU can be returned to local mode by pressing the LOCAL button on the front panel.

Example:
The commands below are valid ways to place the unit in remote mode.

Command: SYSTEM:REMOTE
SYST:REM

Response: None

7.8. SYSTem:KLOCk

Disables the front panel buttons. This prevents users tampering with setting from the front panel. The instrument can only be controlled remotely.

Syntax: SYSTem:KLOCk {0|1|OFF|ON}
SYSTem:KLOCk?

Example:
The commands below are all valid methods of tuning on/off the front panel push buttons.

Commands:	SYSTem:KLOCk 1	} Turns the key lock ON
	SYSTem:KLOC ON	} (Disables front panel buttons)
	SYST:KLOC 0	} Turns the key lock OFF
	SYST:KLOC OFF	} (Enables front panel buttons)

Response: None

The commands below all request the current state of the key lock feature.

Command:	SYSTem:KLOCk? SYST:KLOC?
Response:	0 = Key lock is disabled/OFF. 1 = Key lock is enabled/ON.

7.9. SYSTem:BEEPer

This command allows the host computer to make the PSU generate a Beep.

Syntax: SYSTem:BEEP

Example:
The commands below both make the PSU emit a beep sound.

Commands:	SYSTEM:BEEPER SYST:BEEP

7.10. SYSTem:BEEPer:STATe

This command allows the system beeper to be enabled or disabled.

Syntax: SYSTem:BEEPer:STATe {0|1|OFF|ON}
SYSTem:BEEPer:STATe?

Example:
The commands below enable the beeper.

Commands: SYSTEM:BEEPER:STATE 1
SYSTEM:BEEPER:STATE ON
SYST:BEEP:STAT 1
SYST:BEEP:STAT ON

The commands below enable the beeper.

Commands: SYSTEM:BEEPER:STATE 0
SYSTEM:BEEPER:STATE OFF
SYST:BEEP:STAT 0
SYST:BEEP:STAT OFF

Response: None

The commands below all request the current state of the beeper.

Commands: SYSTEM:BEEPER:STATE?
SYST:BEEP:STAT?

Response: 0 = Beeper is Disabled.
1 = Beeper is Enabled.

7.11. DISPlay[:STATe]

This command can be used to turn ON or OFF the unit's display.

Syntax: DISPlay[:STATe] {0|1|OFF|ON}
DISPlay[:STATe]?

Example:

The commands below turn the display OFF.

Commands: DISPLAY:STATE 0
DISPLAY:STAT OFF
DISPLAY 0
DISP OFF

Response: None

The commands below turn the ON.

Commands: DISPLAY:STATE 1
DISPLAY:STAT ON
DISPLAY 1
DISP ON

Response: None

The commands below request the current state of the display.

Commands: DISPlay:STATE?
DISPlay:STAT?
DISPLAY?
DISP?

Response: 0 = OFF
1 = ON

7.12. INSTrument:NSELect

This command is used to select the PSU on the RS485 bus that is about to be instructed to do something.

Syntax: INSTrument:NSELect {<N>}

Where N is the RS485 address of the PSU being addressed.
Valid range 1→31

Example:
The commands below are all valid ways of selecting PSU 5.

Commands: INSTRUMENT:NSELECT 5
INSTRUMENT:NSEL 5
INST:NSEL 5

Response: None

Note: When using RS232 or Ethernet communications this command does not need to be used.

7.13. SYSTem:COMMunicate:LAN:IPADdress

This command is used to set and request the TCP/IP address of the PSU.

Syntax: SYSTem:COMMunicate:LAN:IPADdress {<"xxx.xxx.xxx.xxx">}
SYSTem:COMMunicate:LAN:IPADdress?

Where "xxx.xxx.xxx.xxx" is the IP address to be used.

Example:
The commands below are all valid commands to set new IP address.

Commands: SYSTEM:COMMUNICATE:LAN:IPADDRESS "192.168.18.50"
SYSTEM:COMM:LAN:IPAD "192.168.18.50"
SYST:COMM:LAN: IPAD "192.168.18.50"

Response: None

The commands below are all valid examples of ways to request the current IP address.

Commands: SYSTEM:COMMUNICATE:LAN:IPADDRESS?
SYSTEM:COMM:LAN:IPAD?
SYST:COMM:LAN: IPAD?

Response: "192.168.18.50"

Notes:

i) Only IPv4 addressing is supported.
ii) Only static IP addressing is supported.

7.14. SYSTem:COMMunicate:LAN:SMASk

This command is used to set and request the TCP/IP sub net mask.

Syntax: SYSTem:COMMunicate:LAN:SMASk {<"xxx.xxx.xxx.xxx">}
SYSTem:COMMunicate:LAN:SMASk?

Where "xxx.xxx.xxx.xxx" is the sub net mask to be used.

Example:
The commands below are all valid commands to set a new sub net mask.

Commands: SYSTEM:COMMUNICATE:LAN:SMASk "255.255.255.0"
SYSTEM:COMM:LAN:SMASk "255.255.255.0"
SYST:COMM:LAN:SMASk "255.255.255.0"

Response: None

The commands below are all valid examples of ways to request the current sub net mask.

Commands: SYSTEM:COMMUNICATE:LAN:SMASK?
SYSTEM:COMM:LAN:SMAS?
SYST:COMM:LAN:SMAS?

Response: "255.255.255.0"

Notes:

i) Only IPv4 addressing is supported.
ii) Only static IP addressing is supported.

7.15. SYSTem:COMMunicate:LAN:PORT

This command is used to set and request the TCP/IP communication port number.

Syntax: SYSTem:COMMunicate:LAN:PORT {<N>}
SYSTem:COMMunicate:LAN:PORT?

Where N is valid in the range 0 to 65535.

Example:
The commands below are all valid ways to set the TCP/IP port number to 7960.

Commands: SYSTEM:COMMUNICATE:LAN:PORT 7960
SYSTEM:COMM:LAN:PORT 7960
SYST:COMM:LAN:PORT 7960

Response: None

The commands below are all valid ways to request the current TCP/IP port number.

Commands: SYSTEM:COMMUNICATE:LAN:PORT?
SYSTEM:COMM:LAN:PORT?
SYST:COMM:LAN:PORT?

Response: 9760

7.16. SYSTem:COMMunicate:LAN:MAC?

This command is used to request the PSU Ethernet MAC address.

Syntax: SYSTem:COMMunicate:LAN:MAC?

Example:
The commands below are all examples of how to request the Ethernet MAC address.

Commands: SYSTEM:COMMUNICATE:LAN:MAC?
SYSTEM:COMM:LAN:MAC?
SYST:COMM:LAN:MAC?

Response: "04:91:62:82:BF:7D"

Note: Every MAC address is unique.

7.17. SYSTem:DATE

This command is used to set and request the system date.

Syntax: SYSTem:DATE {<yy;mm;dd>}
SYSTem:DATE?

Where:

yy	Year – not including century.
mm	Month
dd	Day

Example:
The commands below are all examples of how to set the system date to March 30th 2020.

Commands: SYSTEM:DATE 20;03;30
SYST:DATE 20;03;30

Response: None

The commands below are all valid examples of how to request the current system date.

Commands: SYSTEM:DATE?
SYST:DATE?

Response: 20;03;30

7.18. SYSTem:TIME

This command can be used to set or request the system time.

Syntax: SYSTem:TIME {<hh;mm;ss>}
SYSTem:TIME?

Where:

hh	Hours
mm	Minutes
ss	Seconds

Example:
The examples below are all valid commands to set the time to 12:00:00. (Mid-day)

Commands: SYSTEM:TIME 12;00;00
SYST:TIME 12;00;00

Response: None

The examples below are all valid commands to request the current system time.

Commands: SYSTEM:TIME?
SYST:TIME?
Response: 12;00;00

Note: System time is 24 Hour.

7.19. OUTPut[:STATe]

Control and request the PSU output state.

Syntax: OUTPut[:STATe] {0|1|OFF|ON}
OUTPut[:STATe]?

Example:
The commands below, enable (turns on) the HV outputs on the PSU.

Commands: OUTPUT:STATE 1
OUTP ON

The commands below, disable (turns off) the HV outputs on the PSU.

Commands: OUTP:STATE 0
OUTP OFF

Response: None

The commands below, request the current state of the outputs.

Commands: OUTPUT:STATE?
OUTP?

Response: 0 = The outputs are currently enabled/turned ON.
1 = The outputs are currently disabled/turned OFF.

7.20. TOGGle

Control and request the PSU toggle (reversal) state.

Syntax: TOGGle {0|1|OFF|ON}
TOGGle?

Example:
The commands below set the polarity of the unit's outputs.

Commands: TOGGLE 1
TOGG ON

TOGGLE 0
TOGG OFF

Response: None

The commands below request the current toggle state.

Commands: TOGGLE?
TOGG?

Response: 0 = The outputs **ARE NOT** reversed.
1 = The outputs **ARE** reversed.

7.21. MEASure[:VOLTage]

Requests the measured voltage monitors.

Syntax: MEASure[:VOLTage][:DC]? [(@channel list)]

Example:
The commands below are all valid examples of ways to request the output Voltage monitors. *(Assumes the outputs are on and programmed to +2500V and -2500V)*

Commands:

a. Requests voltage on channel 1
   Command: MEASURE:VOLTAGE:DC? (@1)
   Response: V+2500

b. Requests voltage on channel 2
   Command: MEAS:VOLT:DC? (@2)
   Response: V-2500

c. Requests voltage on channels 1 and 2
   Command: MEAS:VOLT? (@1,2)
   Response: V+2500;V-2500

d. Requests voltage on channels 1 and 2
   Command: MEAS? (@1,2)
   Response: V+2500;V-2500

e. Requests voltage on channel 1
   Command: MEAS?
   Response: V+2500

7.22. MEASure:CURRent

Requests the measured current monitors.

Syntax: MEASure:CURRent[:DC]? [(@channel list)]

Example:
The commands below are all valid to request the current monitors.
(Examples assume the output currents are 1mA and 1mA)

a. Requests current on channel 1
   Command: MEASURE:CURRENT:DC? (@1)
   Response: A+1000

b. Requests current on channel 2
   Command: MEAS:CURR:DC? (@2)
   Response: A+1000

c. Requests current on channels 1 and 2
   Command: MEAS:CURR? (@1,2)
   Response: A+1000;A+1000

d. Requests current on channel 1
   Command: MEAS:CURR?
   Response: A+1000

7.23. STAT?

Requests the unit's complete status.

Syntax: STAT?

Example:

Command: STAT?
Response: CH1V;CH2V;CH1I;CH2I;OP;TOGGLE;REMOTE

Where:

CH1V	Channel 1 voltage
CH2V	Channel 2 voltage
CH1I	Channel 1 current
CH2I	Channel 2 current
OP	Output status (1 = On, 0 = Off)
TOGGLE	Toggled status (1 = Reversed, 0 = Not Reversed)
REMOTE	Local/Remote status (1 = Remote, 0 = Local)

e.g. V+2500;V-2500;A+1000;A+1;0;1;1

7.24. CONFigure:VOLTage

Sets and requests the output voltages. Using this command, set the channel polarities.

Notes:
i) Valid range of voltages that can be used is -2500V → +2500V.
ii) *Values set are saved to non-volatile memory and so values persist across power cycles.*

Syntax: Set Voltages: CONFigure:VOLTage[:LEVel] {<volt1>},{<volt2>}
Request voltages: CONFigure:VOLTage[:LEVel]? [(@ channel list)]

Example:
The commands below are valid examples of how to set different voltages.

a. Sets Channel 1 voltage to 500V and Channel 2 to -500V
Command: CONFIGURE:VOLTAGE:LEVEL 500,-500
Response: None

b. Sets Channel 1 voltage to -500V and Channel 2 to 500V
Command: CONF:VOLT -0.5kv,500
Response: None

c. Sets both Channel 1 and Channel 2 to 500V
Command: CONF:VOLT 500,0.5kv
Response: None

d. Sets both Channel 1 and Channel 2 to -500V
Command: CONF:VOLT -500,-500
Response: None

The commands below request output voltages.

a. Requests Channel 1 Voltage. (Assumes it is set to +500V)
Command: CONFIGURE:VOLTAGE:LEVEL? (@1)
Response: V+0500

b. Requests Channel 2 Voltage. (Assumes it is set to +500V)
Command: CONF:VOLT? (@2)
Response: V+0500

c. Requests Channel 1 & 2 Voltages. (Assumes both are set to +500V)
Command: CONF:VOLT? (@1,2)
Response: V+0500;V+0500

d. Requests Channel 1 Voltage. (Assumes it is set to +500V)
Command: CONF:VOLT?
Response: V+0500

7.25. CONFigure:CURRent

Sets and requests the output channel current limits.

Note: *Valid range of values are 0.3mA → 3.2mA.*

Syntax: CONFigure:CURRent[:LEVel] {<curr1>},{<curr2>}
CONFigure:CURRent[:LEVel]? (@channel list)]

Example:
The examples below are all valid ways to set the current limit on both channels to 0.5mA.

a. Command: CONFIGURE:CURRENT:LEVEL 0.0005,0.0005
Response: None

b. Command: CONF:CURR:LEV 0.0005,0.5mA
Response: None

c. Command: CONF:CURR 0.5mA,0.5mA
Response: None

The examples below are all valid ways to request the channel current limits.
(Assumes current limits for both channels are set to 0.5mA)

a. Requests the current limit on Channel 1.
Command: CONFIGURE:CURRENT:LEVEL?
Response: A+0500

b. Requests the current limit on Channel 1.
Command: CONF:CURR:LEV?
Response: A+0500

c. Requests the current limit on Channel 1.
Command: CONF:CURR?
Response: A+0500

d. Requests the current limit on Channel 1.
Command: CONF:CURR? (@1)
Response: A+0500

e. Requests the current limit on Channel 2.
Command: CONF:CURR? (@2)
Response: A+0500

f. Requests the current limit on Channel 1 & 2.
Command: CONF:CURR? (@1, 2)
Response: A+0500;A+0500

7.26. CONFigure:RAMP

This command sets or requests the ramp times.

Note: *The valid range of ramp times is 300mS → 9900mS.*

Syntax:		
	Set Ramp times	CONFigure:RAMP {UP|DOWN},{time}
	Request Ramp times	CONFigure:RAMP? [UP|DOWN]

Example:
The examples below assume the ramp times used are as below.

Ramp Up	300mS
Ramp Down	500mS

a. Sets the ramp up time set to 0.3 seconds.
   Command: CONFIGURE:RAMP UP,300
   Response: None

b. Sets the ramp down time set to 0.5 seconds.
   Command: CONF:RAMP DOWN,500
   Response: None

The commands below are all valid requests for the Ramp Up and Down times.

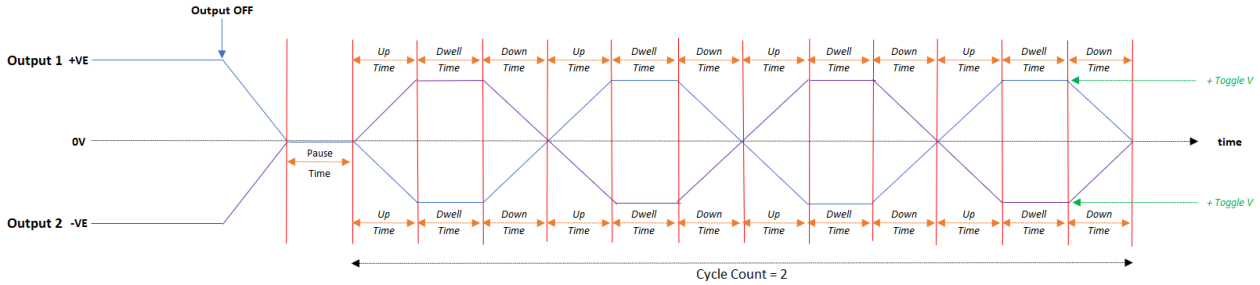
a. Returns the set ramp up value.
   Command: CONFIGURE:RAMP? UP
   Response: 300

b. Returns the set ramp down value.
   Command: CONF:RAMP? DOWN
   Response: 500

7.27. AToggle[:STATe]

This command is used to enable/disable and request the state of the Auto Toggle feature.

When enabled, the Auto Toggle feature executes as the outputs reach 0V after being turned off.



Syntax: Set Toggle State: AToggle[:STATe] {0|1|ON|OFF}
Request toggle State: AToggle[:STATe]?

Example:
The commands below enable and disable the Auto Toggle feature.

Command: ATOGGLE:STATE 0 } All valid examples of disabling
AT:STAT OFF } the Auto Toggle feature.
AT OFF }

ATOGGLE:STATE 1 } All valid examples of enabling
AT:STAT ON } the Auto Toggle feature.
AT ON }

Response: None

The commands below request the state of the Auto Toggle feature.

Command: ATOGGLE:STATE? } All valid examples of requesting the
AT:STAT? } current state of the Auto Toggle feature.
AT? }

Response: 0 = Auto Toggle feature is enabled/ON.
1 = Auto Toggle feature is disabled/OFF.

7.28. AToggle:COUNt

This command is used to set and request the number of Auto Toggle cycles generated.

Syntax: Set Toggle Cycle Count: AToggle:COUNt <count>
Request Toggle Cycle Count: AToggle:COUNt?

The valid range of <count> is 1 → 10 cycles.

Example:
All valid examples of setting the Auto Toggle cycle count to 5.

Commands: ATOGGLE:COUNT 5
ATOGGLE:COUN 5
AT:COUN 5

Response: None

All valid examples of requesting the Auto Toggle cycle count. (Assumes set at 5)

Commands: ATOGGLE:COUNT?
ATOGGLE:COUN?
AT:COUN?

Response: 5

7.29. AToggle:VOLTage

Set and requests the voltage that is to be used during the Auto Toggling.

Syntax: Set Toggle Voltage: AToggle:VOLTage[:LEVel] <voltage>
Request Toggle Voltage: AToggle:VOLTage[:LEVel]?

Example:
Valid examples of commands that set the Auto Toggle Voltage.

Commands: ATOGGLE:VOLTAGE:LEVEL 500
ATOGGLE:VOLTAGE:LEV 500
ATOGGLE:VOLT 500
AT:VOLT 500

Response: None

Valid examples of commands that request Auto Toggle Voltage.

Commands: ATOGGLE:VOLTAGE:LEVEL?
ATOGGLE:VOLTAGE?
AT:VOLT?

Response: 500

7.30. AToggle:TIME

This command allows the various Auto-toggle times to be set and requested.

Syntax: AToggle:TIME {PAUSE|UP|DOWN|DWELL},{<Time>}
AToggle:TIME? {PAUSE|UP|DOWN|DWELL}

Where:

PAUSE Pause time is the time between the outputs reaching 0V after being switched off and the Auto-toggle cycles starting.

UP Up time is the time taken to ramp the output from 0V to the specified Auto-toggle Voltage.

DOWN Down time is the time taken to ramp the output from the specified Auto-toggle Voltage to 0V.

DWELL Dwell time is the time spent at the Auto-toggle Voltage.

Time Time in mS.
(Valid Range is 300 mS → 9900 mS)

Example:
The commands below are valid examples of commands that set various Auto-toggle times to 300mS.

Commands: ATOGGLE:TIME PAUSE,300
AT:TIME UP,300
AT:TIME DOWN,300
AT:TIME DWELL,300

Response: None

7.31. SOURce:VOLTage:PROTection:TRIPped

This command can be used to determine if a shutdown was caused by a voltage related problem.

Syntax: SOURce:VOLTage:PROTection:TRIPped?

Example:
The commands below all perform the same function and return the voltage trip state.

Commands: SOURCE:VOLTAGE:PROTECTION:TRIPPED?
SOURCE:VOLTAGE:PROTECTION:TRIP
SOURCE:VOLTAGE:PROT:TRIP?
SOURCE:VOLT:PROT:TRIP?
SOUR:VOLT:PROT:TRIP?

Response: 0 = Not Tripped due to voltage related issue.
1 = Tripped due to voltage related issue.

7.1. SOURce:VOLTage:PROTection:CLEar

See command ‘DIAGnostic:FAULts:CLEAR’ for more information.

7.2. SOURce:TEMPerature:PROTection:TRIPped

This command can be used to determine if a shutdown was caused by an over temperature problem.

Syntax: SOURce:TEMPerature:PROTection:TRIPped?

Example:
The commands below perform the same function and return the over temperature trip state.

Commands: SOURCE:TEMPERATURE:PROTECTION:CLEAR
SOURCE:TEMPERATURE:PROTECTION:CLE
SOURCE:TEMPERATURE:PROT:CLE
SOURCE:TEMP:PROT:CLE
SOUR:TEMP:PROT:CLE

Response: 0 = Not Tripped due to temperature related issue.
1 = Tripped due to temperature related issue.

7.3. SOURce:TEMPerature:PROTection:CLEar

See command 'DIAGnostic:FAULts:CLEAR' for more information.

7.4. DIAGnostic:HWrevision

This command is used to request the hardware version of the PSU.

Syntax: DIAGnostic:HWrevision?

Example:
The commands below are all valid examples of how to request the hardware revision.

Commands: DIAGNOSTIC:HWREVISION?
DIAGNOSTIC:HW?
DIAG:HW?

Response: HWRev A

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7.5. DIAGnostic:STATus?

This command is used to request the system status register.

Syntax: DIAGnostic:STATus?

Examples Commands:
The commands below are all valid examples of how to request the PSU status.

DIAGnostic:STATus?
DIAGnostic:STAT?
DIAG:STAT?

Response: XXXXXXXX

Where: XXXXXXXX is an 8-digit hexadecimal encoded 32-bit number.

Bit	Byte	Name	Meaning
0	0	Local/Remote	0 = LOCAL 1 = REMOTE
1		Output	0 = Output Disabled 1 = Output Enabled
2		Toggle	0 = Output Not Inverted 1 = Output Inverted
3		Toggle in Progress	0 = Toggle Not in Progress 1 = Toggle in Progress (Ramping from +ve to -ve or vice versa)
4		Auto Toggle in Progress	0 = Output is not Auto-Toggling 1 = Output is Auto-Toggling
5		Ramping Away from Zero	0 = Output is Ramping 1 = Output is Not Ramping
6		Ramping Towards Zero	0 = Output is Ramping 1 = Output is Not Ramping
7		spare07	-
8	1	Buzzer	0 = Buzzer is Disabled 1 = Buzzer is Enabled
9		Display	0 = Display is Disabled 1 = Display is Enabled
10		Key	0 = Front Panel Buttons Enabled 1 = Front Panel Buttons Disabled
11		State Machine State 0	Valid values are 0 → 31
12		State Machine State 1	
13		State Machine State 2	
14		State Machine State 3	
15		State Machine State 4	
16	2	Voltage Regulation Warning	0 = Voltage Regulation Warning Not Present 1 = Voltage Regulation Warning Present
17		spare17	-
18		spare18	-
19		spare19	-
20		Temperature Trip	0 = Temperature Trip Not Present 1 = Temperature Trip Present Over-temperature must be present for >= 10seconds before it is asserted. Temperature Thresholds are: ➢ POS HV Generator Temperature: 90ºC ➢ NEG HV Generator Temperature: 90ºC ➢ System Temperature: 70ºC
21		24V Rail Trip	0 = 24V Power Supply OK 1 =24V Power Supply Out of Specification The 24V power supply must be out of specification for >= 10 seconds before it is asserted. Voltage Thresholds are: ➢ Low limit: 21.6V ➢ High Limit 26.4V
22		spare22	-
23		Faults Latched	0 = Faults Not Present 1 = Faults Present When a fault occurs, the outputs are ramped to 0V
24	3	PWM	0 = HV Generator Pulse Width Modulation Signals Off 1 = HV Generator Pulse Width Modulation Signals Running
25		RS485TXInProgress	0 = PSU not transmitting on RS485 1 =PSU transmitting on RS485
26		spare26	-
27		spare27	-
28		Shutdown in Progress	0 = Output Not Shutting Down 1 = Output shutting down (Fault detected)
29		Shutdown Complete	0 = Shutdown Incomplete 1 = Shutdown Complete
30		OP CTRL MODE 0	Valid values are 0 → 2
31		OP CTRL MODE 1	

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7.6. DIAGnostic:FAULts:CLEAR

This command is used to clear any system fault conditions.
When faults are present, it is not possible to turn the output on.

Syntax: DIAGnostic:FAULts:CLEAR

Example:
The commands below are all examples of how to clear system fault conditions.

Commands: DIAGNOSTIC:FAULTS:CLEAR
DIAGNOSTIC:FAUL:CLEAR
DIAG:FAUL:CLEAR

Response: None
The front panel LED will stop flashing and any faults displayed on the status page will be removed.

Note: *Sending the commands below will also clear all faults.*

SOURce:VOLTage:PROTection:CLEar
SOURce:TEMPerature:PROTection:CLEar

7.7. DIAGnostic:MONitor:TEMPerature?

This command is used to request one of the three system health temperatures..

Syntax: DIAGnostic:MONitor:TEMPerature? {POS|NEG|SYSTem}

Where:

POS	Temperature of Positive HV Generator.
NEG	Temperature of Negative HV Generator.
SYSTem	Temperature of System ambient Sensor.

Example:
The commands below are all valid examples of requesting the system ambient temperature.

Commands: DIAGNOSTIC:MONITOR:TEMPEMPERATURE? SYSTEM
DIAGNOSTIC:MONITOR:TEMP? SYST
DIAGNOSTIC:MON:TEMP? SYST
DIAG:MON:TEMP? SYST

Response: C+26.75 *(Temperature is in Celsius)*

7.8. DIAGnostic:MONitor:VOLTage?

This command can be used to request both the current output voltages and the input supply voltage.

Syntax: DIAGnostic:MONitor:VOLTage? {OP1|OP2|VIN}

Where:	OP1	Returns OP1 monitor voltage.
	OP2	Returns OP2 monitor voltage.
	VIN	Returns the 24V supply voltage.

Example:
The commands below are all valid examples of how one might request the various voltage monitors.

Command: DIAGNOSTIC:MONITOR:VOLTAGE? OP1
Response: V+2506.612

Command: DIAGNOSTIC:MON:VOLT? OP2
Response: V-2507.612

Command: DIAG:MON:VOLT? VIN
Response: V+24.234

7.9. DIAGnostic:LOG?

When any noteworthy event occurs in the PSU, a new event entry is logged in its event buffer. This command is used to request the next available event log entry.

Note: The Event log is held in RAM and so does not persist across power cycles.

Syntax: DIAGnostic:LOG?

Example:
The commands below are valid examples of commands to request the next available log entry.

Commands: DIAGNOSTIC:LOG?
DIAG:LOG?

Response: If events are available, the response takes the form below:

<dd/mm/yyyy> <hh:mm:ss> <event text>

Where:

<dd/mm/yyyy>	Date the event was recorded.
<hh:mm:ss>	Time the event was recorded.
<event text>	Event message text.

In the event there are no events to be read, the PSU replies with:

Log Empty

A list of possible messages can be seen in the table below.

Log Messages	
Log Empty	CONFIG CHANGE AUTOTOGGLE COUNT
POWER UP	CONFIG CHANGE AUTOTOGGLE TIME PAUSE
LOCAL	CONFIG CHANGE AUTOTOGGLE TIME UP
REMOTE	CONFIG CHANGE AUTOTOGGLE TIME DOWN
BUTTONS LOCKED	CONFIG CHANGE AUTOTOGGLE TIME DWELL
BUTTONS UNLOCKED	CONFIG CHANGE AUTOTOGGLE DISABLED
BEEPER ENABLED	CONFIG CHANGE AUTOTOGGLE ENABLED
BEEPER DISABLED	CONFIG CHANGE SERIAL NUMBER
DISPLAY ENABLED	CONFIG CHANGE PWM FREQ
DISPLAY DISABLED	CONFIG CHANGE PWM DUTY
CONFIG CHANGE SERIAL TYPE RS232	EVENT CODE RTC CHANGE
CONFIG CHANGE SERIAL TYPR RS485	OP ENABLED
CONFIG CHANGE SERIAL ADDRESS	OP DISABLED
CONFIG CHANGE IP ADDRESS	OP TOGGLED
CONFIG CHANGE IP MASK	AUTO TOGGLE IN PROGRESS
CONFIG CHANGE IP PORT	AUTO TOGGLE STOPPED
CONFIG CHANGE DATE	REGULATION WARNING
CONFIG CHANGE TIME	24V RAIL FAULT
CONFIG CHANGE OP1 V	TEMPERATURE FAULT
CONFIG CHANGE OP1 CURRENT LIMIT	FAULTS CLEARED
CONFIG CHANGE OP2 V	SHUTDOWN STARTED
CONFIG CHANGE OP2 CURRENT LIMIT	SHUTDOWN COMPLETE
CONFIG CHANGE RAMP UP TIME	ALL DACS CRASHED TO ZERO
CONFIG CHANGE RAMP DOWN TIME	LOG CLEARED
CONFIG CHANGE AUTOTOGGLE VOLTAGE	FRAM ERASED

7.10. DIAGnostic:LOG:CLEAR

This command is used to clear the event log. All event log entries are deleted.

Syntax: DIAGnostic:LOG:CLEAR

Example:
The commands below are all valid examples of ways to clear the event log

Commands: DIAGNOSTIC:LOG:CLEAR
DIAG:LOG:CLEAR

Response: None

7.11. DIAGnostic:CRASH

This command is used to force the outputs to 0V.

Note: The outputs do NOT ramp to 0V they step to 0V.

Syntax: DIAGnostic:CRASH

Example:
The commands shown below are all valid examples of this command.

Commands: DIAGNOSTIC:CRASH
DIAG:CRASH

Response: None

7.12. DIAGnostic:UPLOAD

This command places the PSU in a mode where it is ready to accept new firmware.

Syntax: DIAGnostic:UPLOAD

Example:
The examples below are all valid examples of commands to place the PSU in upload mode.

Commands : DIAGNOSTIC:UPLOAD
DIAG:UPLOAD

Response: None – The PSU Display will display the message shown below.

```
>>  Awaiting  FW  <<
>>     Update     <<
```

In the event this command is sent to the PSU in error, operation can be recovered by cycling the power.

8. SCPI Error Codes

8.1. -104, Data type error
Invalid data type for parameter.

8.2. -108, Parameter not allowed
The command received more parameters than expected.
Extra or additional parameters have been sent in commands that do not require parameters.

8.3. -109, Missing parameter
The command received fewer parameters than expected. One or more variables required for the command have been omitted.

8.4. -113, Undefined header
Invalid command received. If a short form of command is used, make sure that the abbreviation is correct.

8.5. -222, Data out of range
A valid command was sent but it could not be executed because the data was outside the legal range defined by the device.

8.6. -350, Queue overflow
This code indicates that there is no room in the either the command or error queues.
When the error queue is full, because more than 10 errors have occurred, no additional errors will be saved until either all pending errors are read or a *CLS command is executed.

8.7. -410, Query INTERRUPTED
A command was received, but the output buffer contains data from the previous command.

8.8. -420, Query UNTERMINATED
Data is specified to be read, but no command has been received to send data to the output buffer.

8.9. -430, Query DEADLOCKED
A command was received and created too much data for the output buffer, and the input buffer is full. The command will continue to run, but all data will be lost.

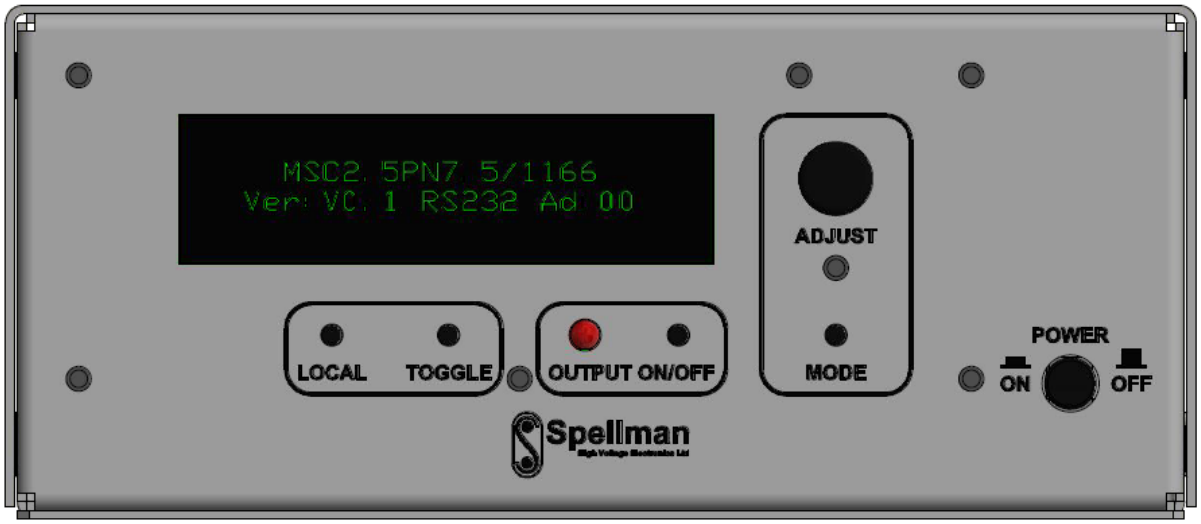
8.10. -440, Query UNTERMINATED after indefinite response
The *IDN? command must be used as the last query command in the command string. e.g. *IDN?;:SYST:ERR?

8.11. -515, Command not allowed in Remote
Commands were received from the Remote Status. e.g. VOLT 1000 in the Remote Status.

8.12. -522, Output buffer overflow
The output buffer is full.

8.13. -561, Output Enabled
Setup commands were received during output. e.g. Receive CONF:VOLT 1000 with OUTPUT ON

9. Front Panel



Device	Comment
Display (2 x 20 OLED display)	Used to display various system operating information pages system configuration.
LED	Red LED ➢ OFF Output is OFF. ➢ ON Output is ON. ➢ FLASHING There is a FAULT.
ADJUST (Rotary Encoder)	Used to navigate display pages and menu options
LOCAL Button	Returns PSU to LOCAL mode
TOGGLE Button	Turn output Toggle ON/OFF
ON/OFF Button	Turns output ON/OFF
MODE Button	Used when navigating menus to abort changes and exit menus.
POWER ON/OFF Button	Latching power button.

The following paragraphs discuss the contents of the display pages and the system menu.

Once powered-up, turning the Front Panel rotary encoder, cycles through the various display pages.

9.1. Power-Up Page

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1			M	S	C	2	.	5	P	N	7	.	5	/	1	1	6	6		
2	V	e	r	:	V	x	.	x	x		R	S	I	I	I		:		A	D

Where: `x.xx` Firmware version number.
`III` Serial interface (232 or 485).
`AD` Serial comms address.

9.2. Output Status Pages

The output display page shows different information when the outputs are disabled/enabled.

When the outputs are disabled, the following is displayed.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
1	O	P	1	:			O	u	t	p	u	t			O	F	F			L R	
2	O	P	2	:			O	u	t	p	u	t			O	F	F			N T	

Where: LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

When the outputs are enabled, the following is displayed.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
1	O	P	1	:	±	V	.	V	V	k	V		I	.	I	I	m	A		L R	
2	O	P	2	:	±	V	.	V	V	k	V		I	.	I	I	m	A		N T	

Where: V.VV Output Voltage.
I.II Output Current.
LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

Note: If LR displays the letter ‘A’ then the output is busy Auto-Toggling.

9.3. Fault/Warning Status Page

When no faults or warnings present, the following will be displayed.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
1	F	a	u	l	t	:					N	O	N	E						L R	
2	W	a	r	n	s	:														N T	

Where: LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

When faults or warnings are present, the following will be displayed.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	
1	F	a	u	l	t	:	S	,	T	,	x	x	,	y	y	,	z	z		L R	
2	W	a	r	n	s	:	R	E	G											N T	

Where: S +24V supply voltage.
T Over temperature.
xx *reserved*
yy *reserved*
zz *reserved*
REG Regulation.
LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

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9.4. Health Monitors Page

Displays the PSU health monitor values.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1	T	n	:	x	x	.	x	C			T	p	:	x	x	.	x	C		L R
2	T	s	:	x	x	.	x	C			V	i	:	y	y	.	y	V		N T

Where:	`Tn:xx.x`	POS HV generator temperature.
	`Tp:xx.x`	NEG HV generator temperature.
	`Ts:xx.x`	System temperature.
	`Vi:yy.y`	+24V Supply Voltage.
	`LR`	‘L’ = Local, ‘R’ = Remote.
	`NT`	‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

Note: Temperatures are displayed in Celsius.

9.5. Time/Date Page

Displays the current system Date and Time.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1	T	i	m	e	:				H	H	:	M	M	:	S	S				L R
2	D	a	t	e	:				D	D	/	m	m	/	Y	Y				N T

Where:	`HH`	Hour.
	`MM`	Minute.
	`SS`	Second.
	`DD`	Day.
	`mm`	Month.
	`YY`	Year. (Century is not displayed)
	`LR`	‘L’ = Local, ‘R’ = Remote.
	`NT`	‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

9.6. Unit Information Page

Displays unit Model number and Firmware version.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1			M	S	C	2	.	5	P	N	7	.	5	/	1	1	6	6		L R
2		F	i	r	m	w	a	R	e		V	e	r	:	x	.	x	x		N T

Where:	`x.xx`	Firmware version number.
	`LR`	‘L’ = Local, ‘R’ = Remote.
	`NT`	‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

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9.7. Unit Serial Number Page

Displays the unit serial number.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1	U	n	i	t		S	e	r	i	a	l		N	u	m	b	e	r		LR
2						N	N	N	N	N	N	N	N	N						NT

Where: NNNNNNNNN Nine-digit serial number.
LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

9.8. Serial Comms Configuration Page

Displays the Current Serial comms configuration.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1					S	e	r	i	a	l		C	o	m	m	S				LR
2			R	S	I	I	I		A	d	d	r	e	s	s	:	A	A		NT

Where: III Serial interface (232 or 485).
AA Serial comms address.
LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

9.9. TCP/IP Port # Page

Displays the TCP/IP port number.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1							E	t	h	e	r	n	e	t						LR
2					P	o	r	t		:		n	n	n	n	n				NT

Where: nnnnn TCP/IP Port number.
LR ‘L’ = Local, ‘R’ = Remote.
NT ‘N’ = Normal Output, ‘T’ = Toggled/Inverted Output.

9.10. Ethernet IP Address and Subnet Mask Page

Displays the TCP/IP Network configuration.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1	A	d	d	r	:	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x
2	M	a	s	k	:	y	y	y	.	y	y	y	.	y	y	y	.	y	y	y

Where: xxx IP Address octet.
yyy Subnet mask octet.

9.11. Configuration Menu Page

From this page it is possible to manually edit the PSU configuration.

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
1					C	o	n	f	i	g	u	r	a	t	i	o	n			
2	P	u	s	h	=	E	d	i	t	,		M	O	D	E	=	E	x	i	t

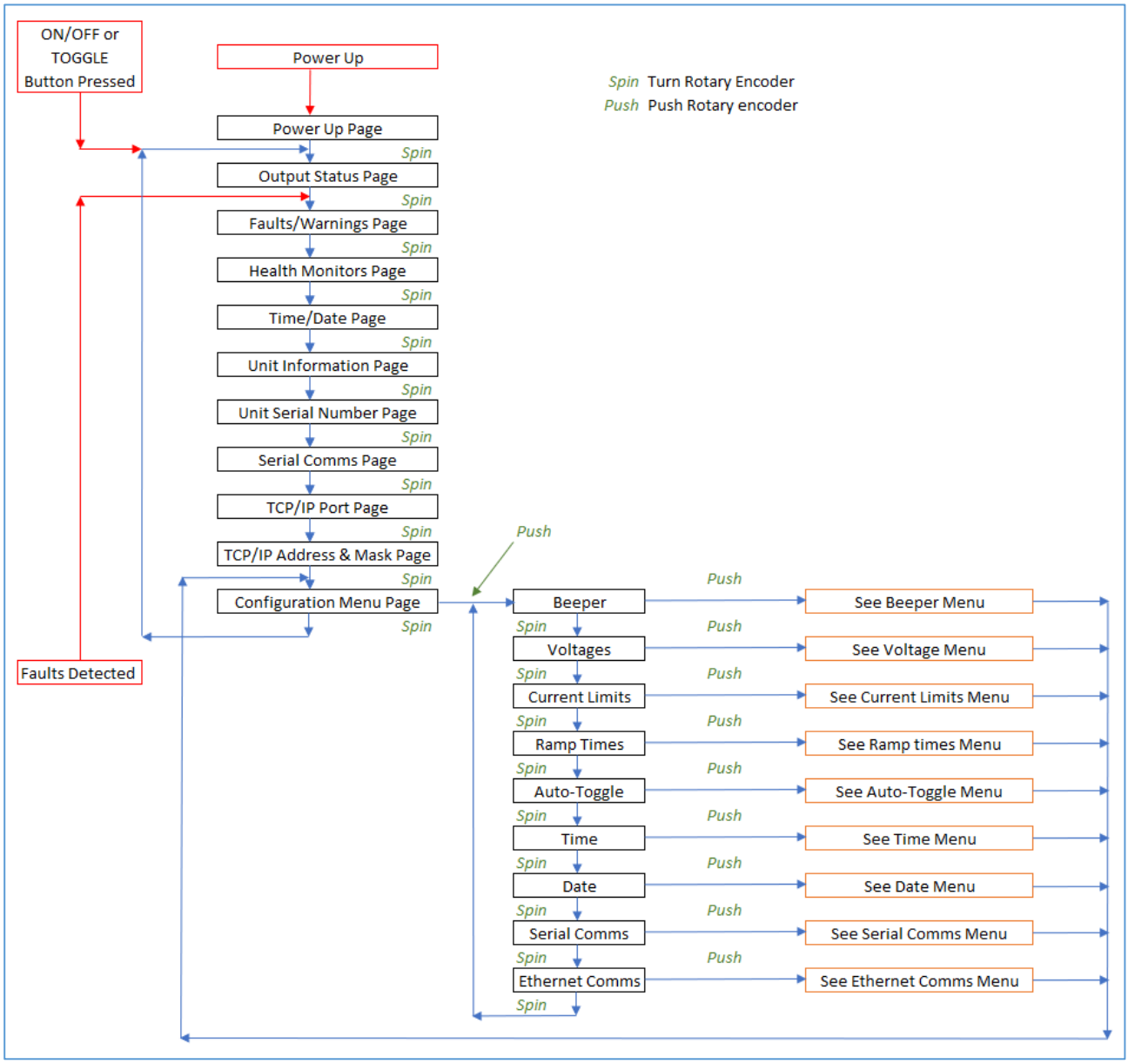
To Edit the current configuration, Push or Press the rotary encoder wheel.
You have now entered the configuration menu. The Press the ‘Mode’ button to exit this page.

Notes:

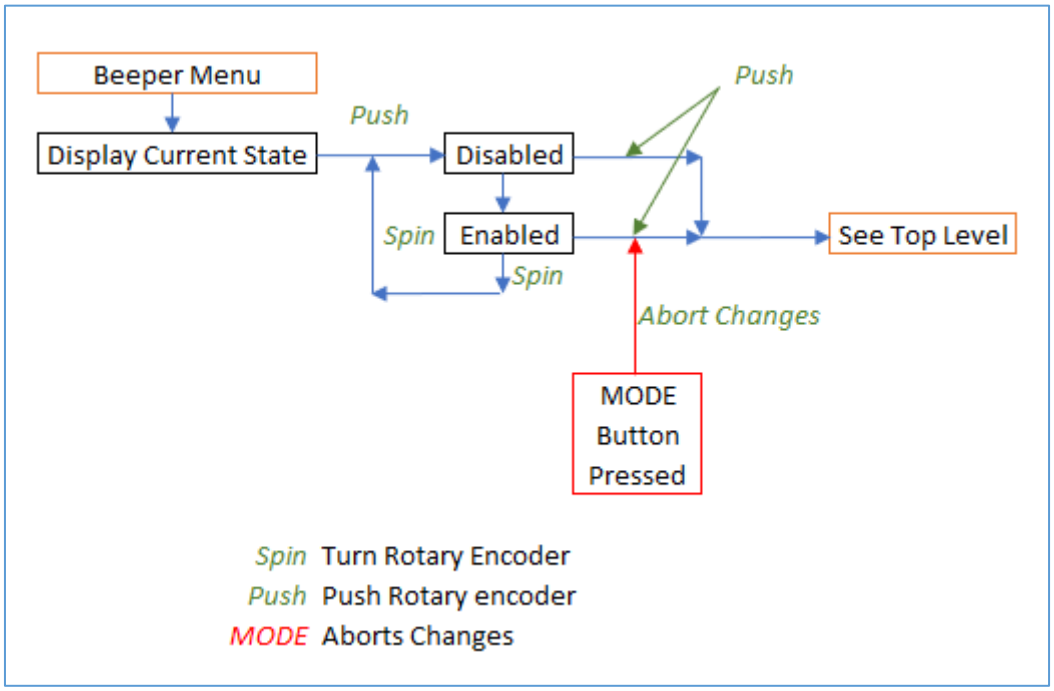
i) When the outputs are enabled or in Remote mode this will not be displayed.
ii) While this page is displayed the Host cannot communicate with the PSU.
iii) Entering the configuration menu stop the PSU communicating with the host.

10. Front Panel Configuration Menu Flow

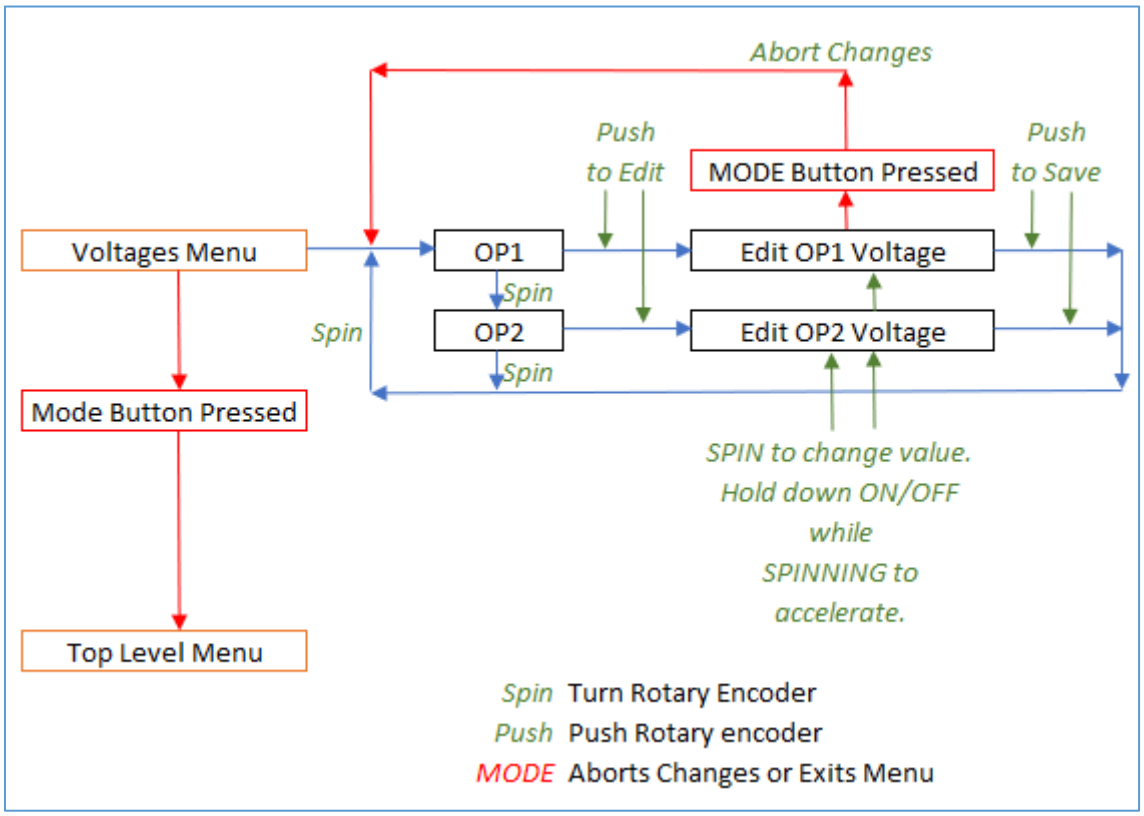
10.1. Top Level Menu



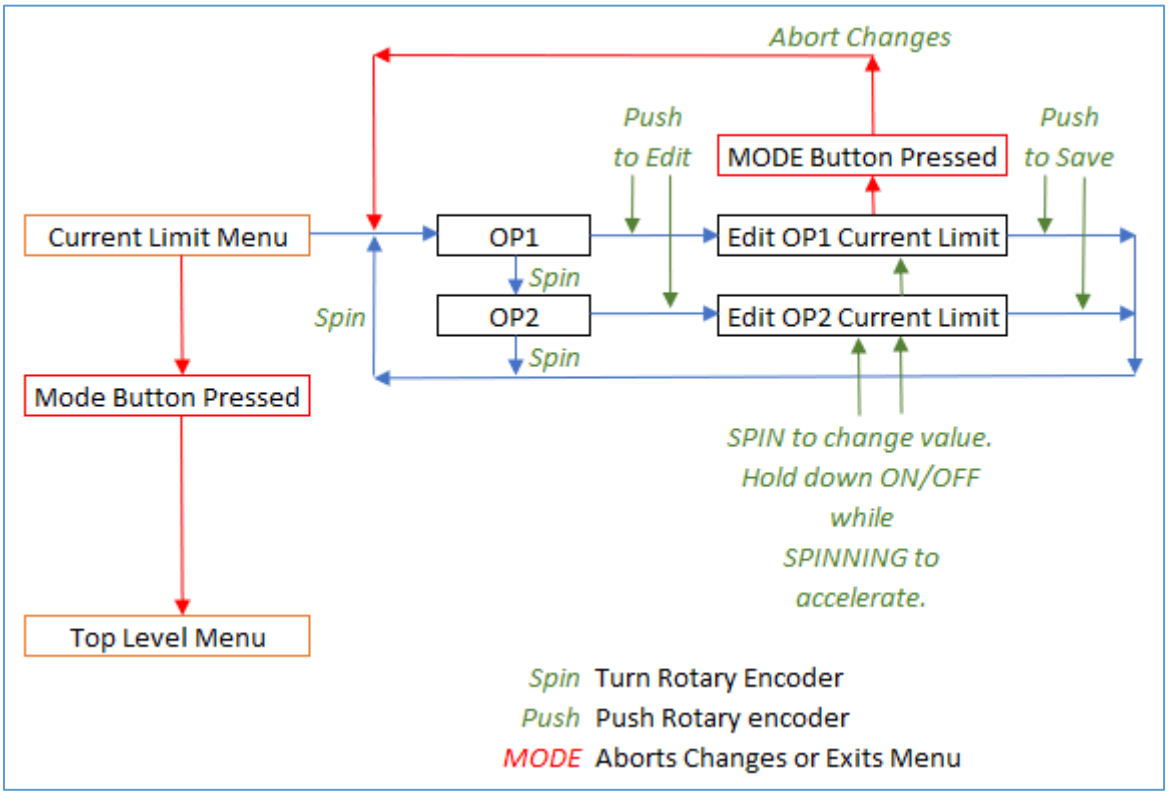
10.2. Beeper Menu



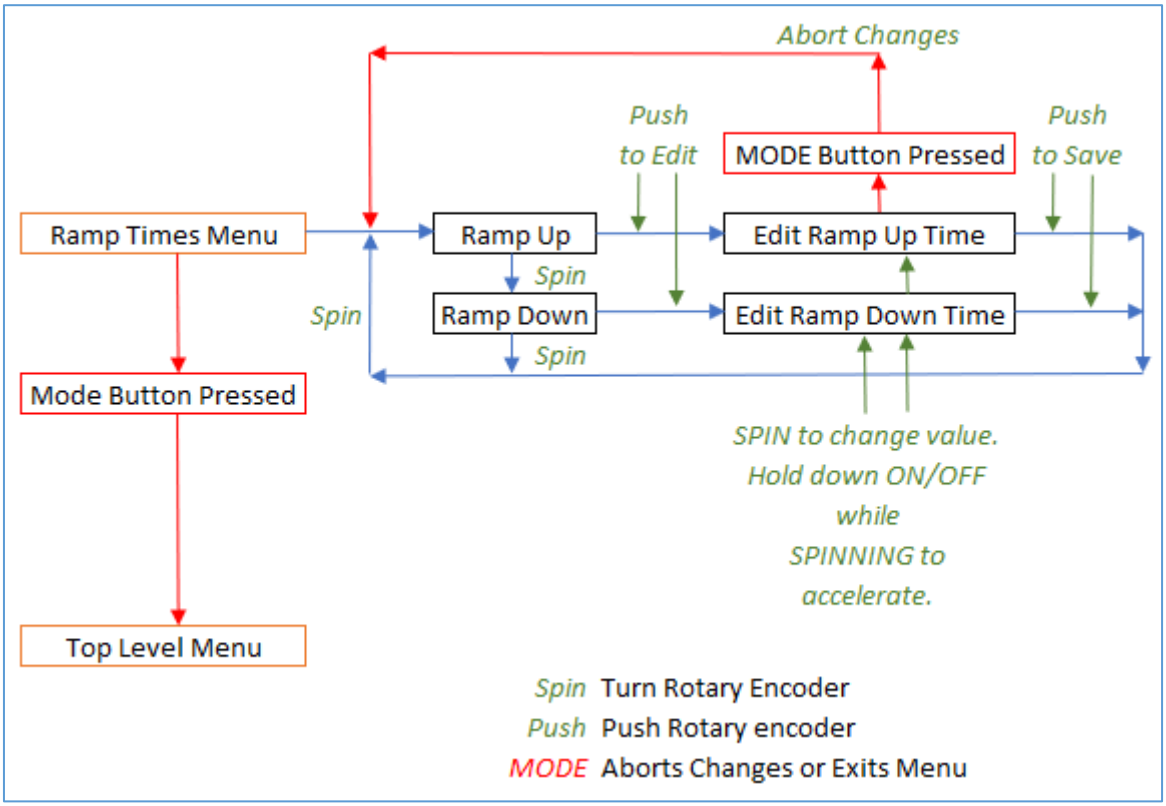
10.3. Voltage Menu



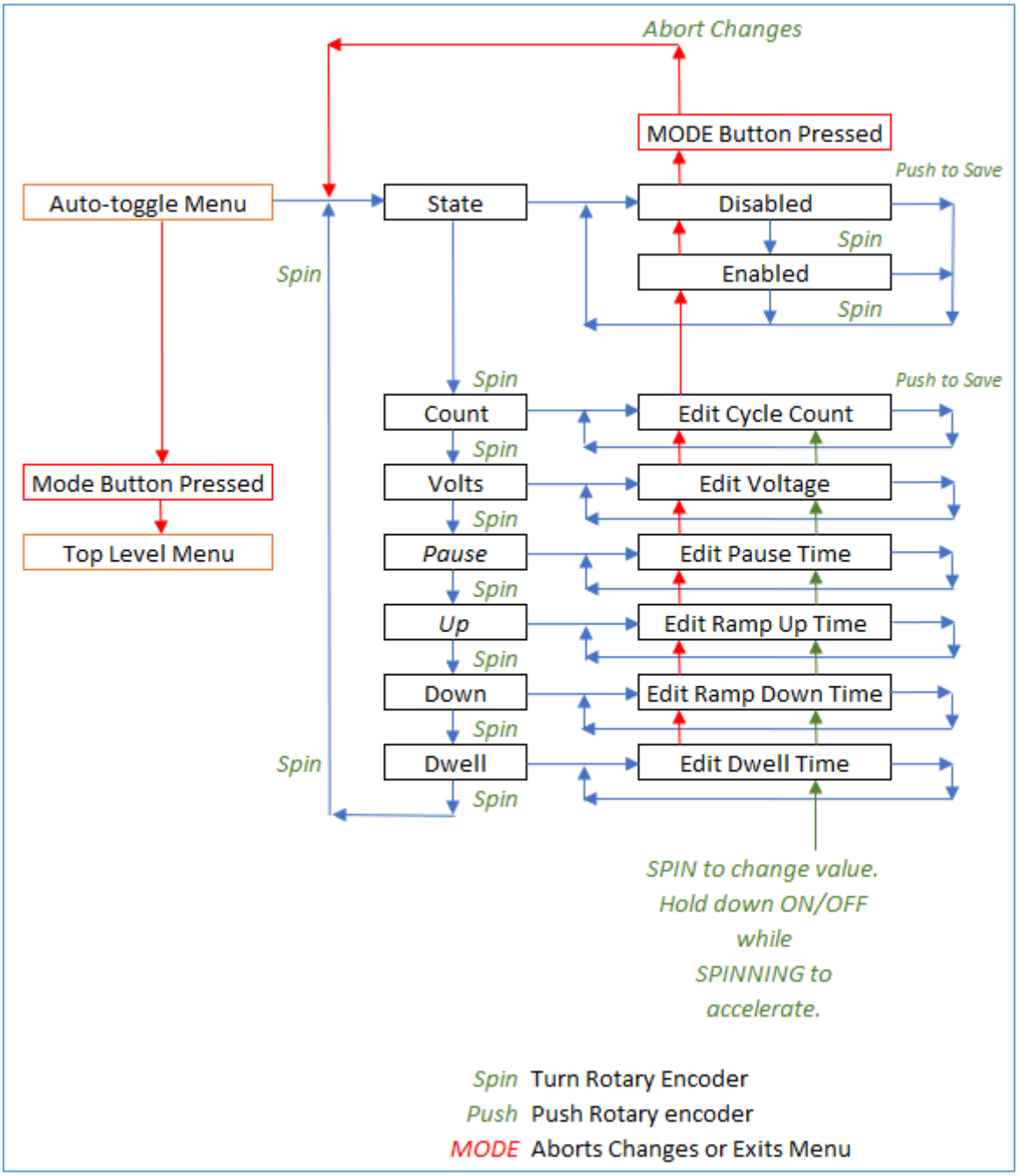
10.4. Current Limits Menu



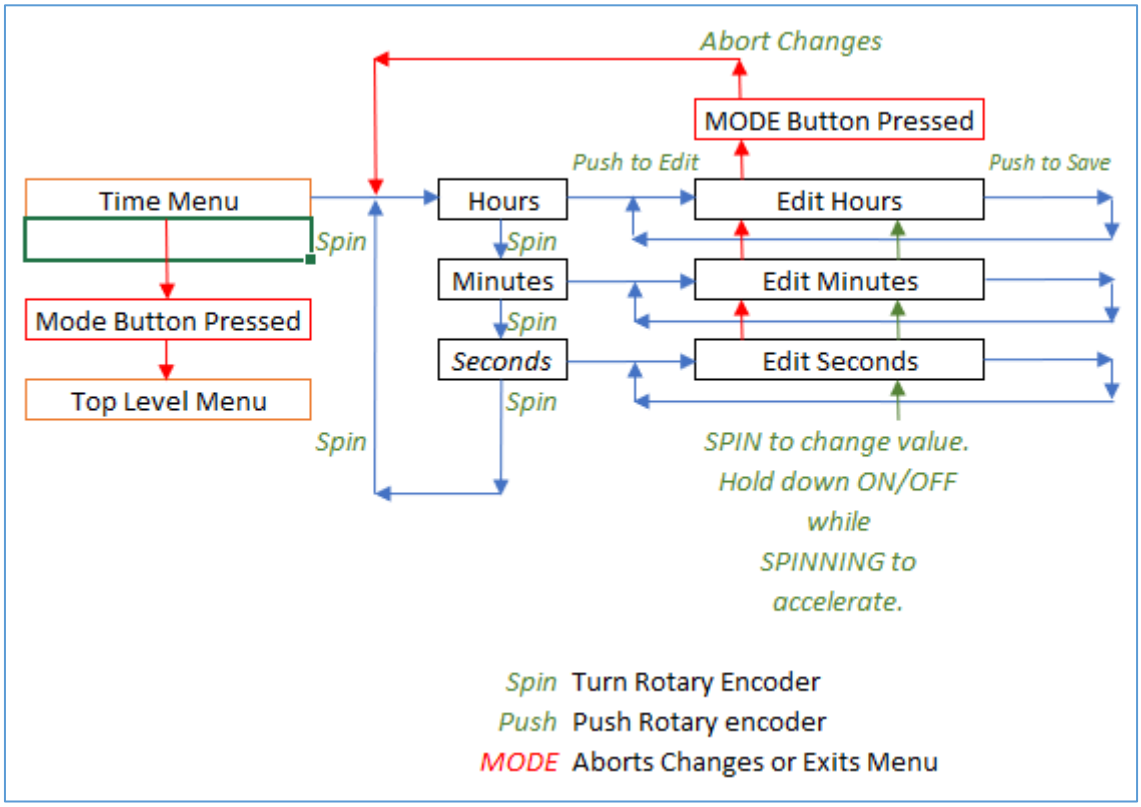
10.5. Ramp Time Menu



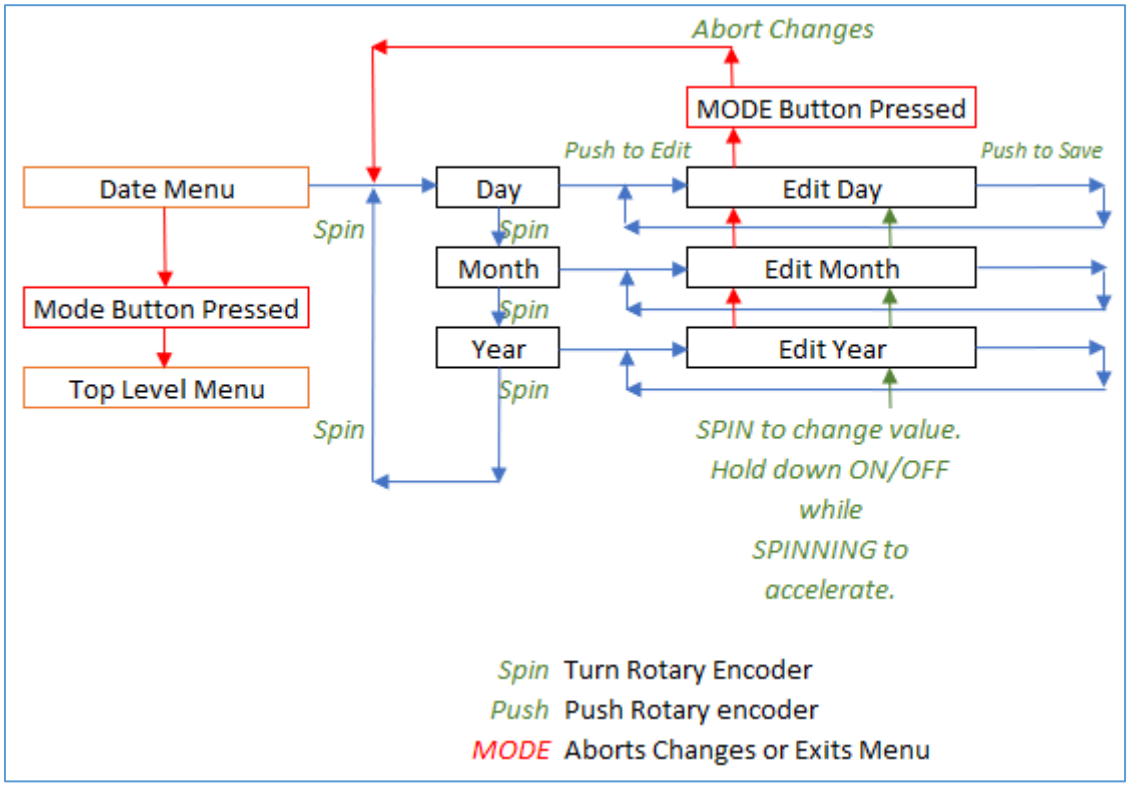
10.6. Auto-Toggle Menu



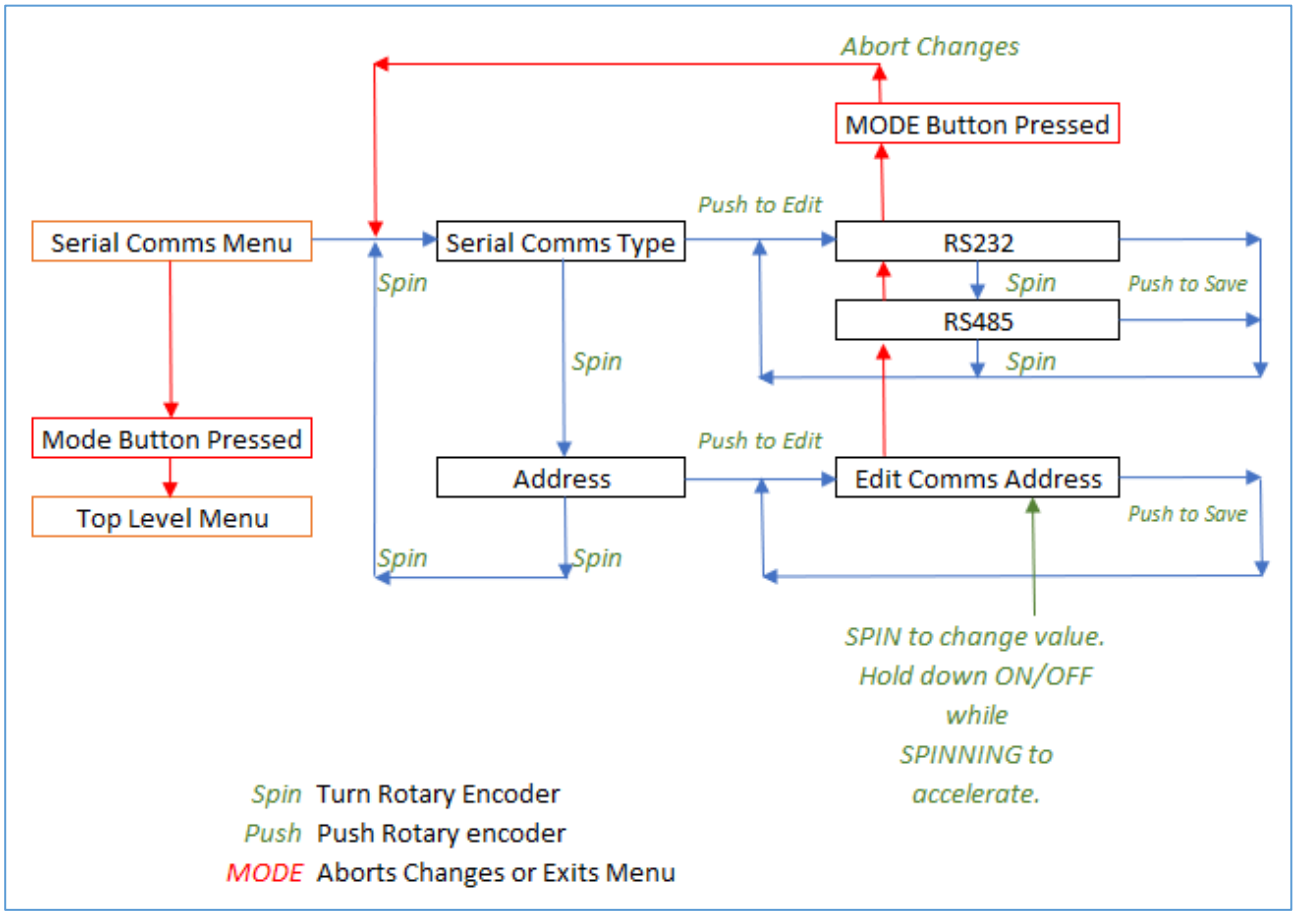
10.7. Time Menu



10.8. Date Menu



10.9. Serial Comms Menu



10.10. Ethernet Comms