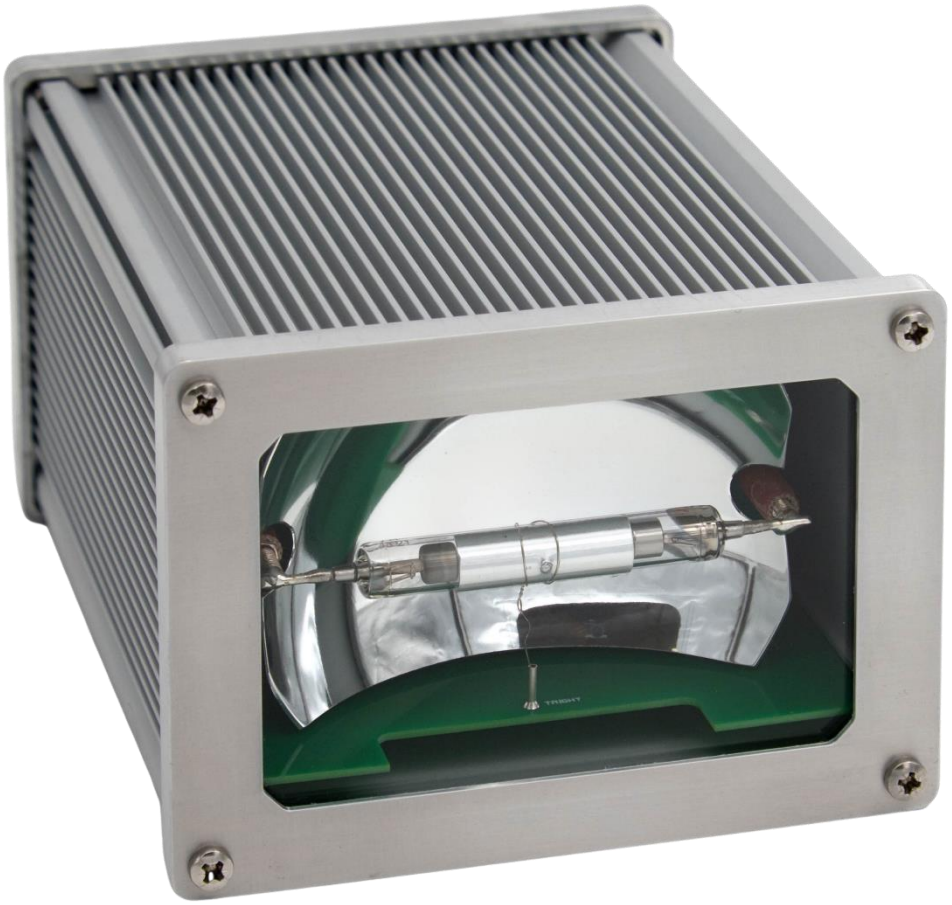
Sx-IP

IP67 versatile

Xenon Flash

MODBUS MANUAL

1.x software revisions



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2 MODBUS INTERFACE:

Sx-IP device is fully configurable through a RS485 Modbus interface with following parameters:

- RTU mode
- 19200bps
- Even parity

For Modbus protocol details refer to:

- MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3
- Modbus over serial line specification & implementation guide V1.02

Up to 247 Sx-IP devices can be connected on a single RS485 link.

Modbus interface gives write access to configurable parameters like:

- Modbus address
- Energy level
- I/O configuration
- Device status, counters and statistics

Modbus interface also gives read access to many device parameters like:

- Device information (serial number; date code; hardware and software revisions…)
- Device status (flash energy; internal temperature; detailed status and errors…)
- Counters and statistics (Flash counts, min/max temperature, flash health…)

Design notes :

Endianness can be a little confusing:

- *RS485 serial protocol is Little Endian (LSB first).*
- *Modbus protocol is Big Endian (MSB first).*
- *Sx-IP registers' implementation is Little Endian (MSB first)*

Serial protocol	**Modbus** protocol	**Sx-IP** 32bits **registers'** implementation
bits order in serial frame	Byte order in 16bits words	16bits words orders in the Modbus frame
Little Endian	**Big Endian**	**Little Endian**

As a result, Sx-IP answer to a Modbus 32bits registers' read request will be as follow:

Address		Function		Nb of bytes		LSB of 32bit word				MSB of 32bit word				CRC			
						MSB		LSB		MSB		LSB		MSB		LSB	
0	7	0	7	0	7	8	15	0	7	24	31	16	23	8	15	0	7

2.1 REGISTERS

Register address Dec	Hex	Register name	Register content	Access
0	0x00	SERIAL_NUMBER	Device serial number	R
1	0x01	DATE_CODE	MSB = year, LSB = week	R
2	0x02	HARDWARE_REV	MSB = Major code (1->A), LSB = minor code, 0x0454 -> rev.D.54	R
3	0x03	PRODUCT_ID	Product ID	R
37	0x25	MISS_FLASH_WEIGHT	Weight of a missed flash for flash health supervision	R/W
38	0x26	FLASH_HEALTH_TH	Threshold for the flash health supervision to trigger a failure	R/W
39	0x27	RESET_ON_FAILURE	Time (s) from a failure detection to automatic device reset Value 0 disable automatic device reset in case of failure	R/W
48	0x30	MODBUS_ADDR_PRESET	Modbus address setting, 1 to 247, 0 for hardware address selection	R/W
49	0x31	ENERGY_LEVEL_PRESETS	NRJ level setting, 1 to 16, 0 for hardware energy level selection 8bits LSB is primary energy level preset 8bits MSB is alternate energy level preset	R/W
51	0x33	TRIGGER_DELAY	Time from flash request to flash tube triggering (µs)	R/W
52	0x34	SYNC_SHIFT	Synchronization signal shift. -32766 to +32767 referenced to trigger flash tube ignition	R/W
53	0x35	SYNC_PULSE_TIME	Synchronization pulse duration 0 to 65535µs	R/W
62	0x3E	IO5_CONFIG	Input 5 configuration	R/W
63	0x3F	IO6_CONFIG	IO6 configuration	R/W
64	0x40	IO7_CONFIG	Output 7 (isolated output) configuration	R/W
256	0x100	STATUS	Status flags	R
257	0x101	ERRORS	Error flags	R
258	0x102	FAILURES	Failure flags	R
259	0x103	COM_ERRORS	Communication error flags	R
260	0x104	INTERNAL_ERRORS	Internal error flags	R
262	0x106	IO_STATE	Input / output actual state	R
269	0x10D	RESET_SOURCE	Source of the last device's reset	R
270	0x10E	MODBUS_ADDRESS	Modbus address (1~247)	R
271	0x10F	ENERGY_LEVEL	Energy level (1~16)	R
272	0X110	FLASH_TIME	Flash time (µs)	R
273	0x111	INPUT_VOLTAGE	Input voltage (mV)	R
274	0x112	TEMPERATURE	Internal temperature (°C)	R
276	0x114	HT_VOLTAGE	Flash capacitor voltage (V/10)	R
279	0x117	FLASH_ENERGY	Last flash energy (J/100)	R
280	0x118	AVERAGE_POWER	Average device power (W) (8s average)	R
282	0x11A	FLASH_ERROR_COUNT	Flash error count since last reset	R
283	0x11B	FLASH_HEALTH	Flash health indicator (0 if no error)	R
286	0x11E	MIN_INPUT_VOLTAGE	Minimum voltage seen on input since last reset (mV)	R
287	0x11F	TARGET_ENERGY	Flash target energy (J/100)	R
288	0x120	MIN_MAX_TEMP	LSB = Maximum temperature, MSB= Minimum temperature	R
289	0x121	START_COUNT_LSB	Number of device power-up	R

Register address Dec	Hex	Register name	Register content	Access
290	0x122	START_COUNT_MSB		R
291	0x123	TIME_COUNT_LSB	Device up-time since last power-up (minutes)	R
292	0x124	TIME_COUNT_MSB		R
293	0x125	TOTAL_TIME_COUNT_LSB	Total device up-time (minutes)	R
294	0x126	TOTAL_TIME_COUNT_MSB		R
295	0x127	FLASH_COUNT_LSB	Flash count since last power-up	R
296	0x128	FLASH_COUNT_MSB		R
297	0x129	TOT_ FLASH_COUNT_LSB	Total flash count	R
298	0x12A	TOT_ FLASH_COUNT_MSB		R
301	0x12D	TUBE_COUNT_LSB	Flash count since last flash tube replacement	R
302	0x12E	TUBE_COUNT_MSB		R

2.2 IMPLEMENTED STANDARD FUNCTIONS

2.2.1 FUNCTION 03: READ HOLDING REGISTERS

Example of serial number (0x0000) register read operation:

Request	**8 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x03	Function code	1 byte	0x03
Starting address	2 bytes	0x0000	Number of bytes	1 byte	0x02
Quantity of registers	2 bytes	0x0001	Register content	2 bytes	0x0001
CRC	2 bytes	0x840A	CRC	2 bytes	0x7984

Example of out of range (0x0320) register read operation:

Request	**8 bytes**		**Answer**	**5 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x03	Error code	1 byte	0x83
Starting address	2 bytes	0x0320	Exception code	1 byte	0x02
Quantity of registers	2 bytes	0x0001	CRC	2 bytes	0xC0F1
CRC	2 bytes	0x8584			

Example of multiple register read (0x0005 to 0x0008) operation:

Request	**8 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x03	Function code	1 byte	0x03
Starting address	2 bytes	0x0000	Number of bytes	1 byte	0x06
Quantity of registers	2 bytes	0x0003	Register content	6 bytes	0x0001 170E 0200
CRC	2 bytes	0x05CB	CRC	2 bytes	0x79A2

2.2.2 FUNCTION 06: PRESET SINGLE REGISTER

Example of energy level preset (0x0031) register write operation:

Request	**8 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x06	Function code	1 byte	0x06
Register address	2 bytes	0x0031	Register address	2 bytes	0x0031
Value to write	2 bytes	0x0005	Value to be write	2 bytes	0x0005
CRC	2 bytes	0x1806	CRC	2 bytes	0x1806

Example of out of range (serial number = 0x0000) register write operation:

Request	**8 bytes**		**Answer**	**5 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x03	Error code	1 byte	0x86
Register address	2 bytes	0x0000	Exception code	1 byte	0x02
Value to write	2 bytes	0x0001	CRC	2 bytes	0xC3A1
CRC	2 bytes	0x480A			

2.2.3 FUNCTION 05: WRITE SINGLE COIL

Write single coil function is used to send specific commands to the Sx-IP.

Command code		Command name	Purpose	Execution time
Dec	Hex			
1	0x01	RESET	Sx-IP software reset request	<10ms
2	0x02	INIT_DONE	Set the INIT_DONE flag	<10ms
3	0x03	CLEAR	Clear errors and fault counters	<10ms
4	0x04	FLASH	Software flash request	<10ms
5	0x05	SAVE_SETTINGS	Save setting registers' content	**Up to 2s**
6	0x06	CLR_FT_COUNT	Clear flash tube count (at flash tube replacement)	Up to 200ms

Example of clear command (0x0003):

Request	**8 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x05	Function code	1 byte	0x05
Coil address	2 bytes	0x0003	Coil address	2 bytes	0x0003
Value to be write	2 bytes	0xFF00	Value to be write	2 bytes	0xFF00
CRC	2 bytes	0x7C3A	CRC	2 bytes	0x7C3A

Example of unauthorized command (0x0011):

Request	**8 bytes**		**Answer**	**5 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x05	Error code	1 byte	0x85
Coil address	2 bytes	0x000B	Exception code	1 byte	0x03
Value to be write	2 bytes	0x0000	CRC	2 bytes	0x0291
CRC	2 bytes	0x3DCA			

Design notes:

The Sx-IP will answer a request only after completion of the process (after the execution delay).

For long processes like «Save setting», a suitable response timeout shall be set at client side.

2.2.4 SERIAL LINE DIAGNOSTIC COUNTERS

Serial line diagnostic counters are available as defined by the Modbus organization.

Example of Bus message counter read:

Request	**8 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x08	Function code	1 byte	0x08
Sub function code	2 bytes	0x000B	Sub function code	2 bytes	0x000B
Value to write	2 bytes	0x0000	Value to be write	2 bytes	0x24B2
CRC	2 bytes	0x91C9	CRC	2 bytes	0x0ABC

2.2.5 READ DEVICE IDENTIFICATION

Basic device identification is available as defined by the Modbus organization.

Example of Read Modbus ID request:

Request	**7 bytes**		**Answer**	**7 bytes**	
Device address	1 byte	0x01	Device address	1 byte	0x01
Function code	1 byte	0x2B	Function code	1 byte	0x2B
MEI type	1 byte	0x0E	MEI type	1 byte	0x0E
Read Dev Id code	1 byte	0x02	Read Dev Id code	1 byte	0x02
Object Id	1 byte	0x00	Conformity level	1 byte	0x82
CRC	2 bytes	0x7087	More follows	1 byte	0x00
			Next object Id	1 byte	0x00
			Nb of objects	1 byte	0x05
			Object Id	1 byte	0x00
			Object length	1 byte	0x07
			Object value	7 bytes	“PHOXENE”
			Object Id	1 byte	0x01
			Object length	1 byte	0x05
			Object value	4 bytes	“0953U”
			Object Id	1 byte	0x02
			Object length	1 byte	0x04
			Object value	4 bytes	“C.00”
			Object Id	1 byte	0x03
			Object length	1 byte	0x0B
			Object value	11 bytes	“phoxene.com”
			Object Id	1 byte	0x04
			Object length	1 byte	0x04
			Object value	4 bytes	“Sx-IP”
			CRC	2 bytes	0x4C10

Modbus identification information is then:

- Vendor Name = “PHOXENE”
- Product Code = “0953U”
- Vendor Url = “phoxene.com”
- ProductName = “Sx-IP”

3 SX-IP CONFIGURATION

3.1 MODBUS ADDRESS SELECTION

Modbus address can be selected from 1 to 247 by *MODBUS_ADDRESS_PRESET* register setting.

Alternatively; by writing 0 in the *MODBUS_ADDRESS_PRESET* register; the Modbus address can be selected from 1 to 16 using the configuration input IN1 to IN4.

MODBUS_ADDRESS_PRESET (R/W)

15 - - - 8	7 - - - 0
0x00	Modbus address preset

Value	Description
0	Modbus address is according to configuration inputs IN1 to IN4
1 to 247	Modbus address is set to the value
>247	Return exception. Modbus address is set to 1

Design notes:

Factory default Modbus address is '1'

3.2 ENERGY LEVEL SELECTION

Energy level can be selected from 1 to 16 setting the *ENERGY_LEVEL_PRESETS* registers.

PRIMARY_ENERGY_LEVEL_PRESET is the default energy level preset register.

ALTERNATE_ENERGY_LEVEL_PRESET can be selected instead of the primary level preset register reset register by a configuring a discrete input.

If the selected energy preset value is "0", the energy level is selected from 1 to 16 by the configuration inputs IN1 to IN4.

ENERGY_LEVEL_PRESETS (R/W)

15 - - - 8	7 - - - 0
Alternate energy level preset	Primary energy level preset

PRIMARY_ENERGY_LEVEL_PRESETS (R/W)

7 - - - 4	3 - - - 0
0x00	Primary energy level preset

Value	Description
0	If primary level selected: Energy level is according to configuration inputs IN1 to IN4
1 to 16	If primary level selected: Energy level is set to the value
>16	Return exception.

ALTERNATE_ENERGY_LEVEL_PRESETS (R/W)

7 - - - 4	3 - - - 0
0x00	Alternat energy level preset

Value	Description
0	If alternate level selected: Energy level is according to configuration inputs IN1 to IN4
1 to 16	If alternate level selected: Energy level is set to the value
>16	Return exception.

Design notes:

Alternate energy level can be useful to switch a device between two energy levels (for example day/night) using a discrete signal, without implementing Modbus communication.

3.3 INPUT 5 CONFIGURATION

Input 5 can be configured using *IO5_CONFIG* register.

IO5_CONFIG (R/W)

15	-	-	5	4	3	2	1	0
			Buffer	Mode				Edge

Bit 0: Edge

Value	Description
0	Input is active high (triggers on rising edges)
1	Input is active low (triggers on falling edges)

Bit 4-1: Mode selection

Value	Description
0000	**Unused**: Input has no effect
0001	**Flash request input**: Input triggers flashes
0010	**Alternate energy level:** Switch to alternate energy level (see §5.1.3)
Other values	**Not implemented**

Bit 5: Buffer

Value	Description
0	Input buffer is optimized for 12V levels (levels are 2.0V and 8.0V with Schmitt trigger)
1	Input buffer is 5V compatible (levels are 1.6V and 4.0V)

Design notes:

Input buffer configuration is updated at reset.

3.4 IO6 CONFIGURATION

IO6 can be configured using *IO6_CONFIG* register.

IO6_CONFIG (R/W)

15	-	-	5	4	3	2	1	0
			Buffer	Mode				Edge

Bit 0: Edge

Value	Description
0	I/O is active high
1	I/O is active low

Bit 4-1: Mode selection

Value	Description
0000	**Unused**: High impedance with a weak pull-up to 5V for hardware revisions < C04 High impedance with 2K61 pull-up to 12V for hardware revisions ≥ C04
0001	**Flash request input**: Input triggers flashes
0010	**Alternate energy level:** Switch to alternate energy level (see §5.1.3)
1000	**Low:** I/O is hold at low level (not available with hardware revisions ≥ C04)
1001	**High:** I/O is hold at high level (not available with hardware revisions ≥ C04)
1010	**Synchronization output** (not available with hardware revisions ≥ C04)
Other values	**Not implemented**

Bit 5: Buffer

Value	Description
0	Input buffer is Schmitt trigger levels are 1.0V and 4.0V for hardware revisions < C04 levels are 2.0V and 8.0V for hardware revisions ≥ C04
1	Input buffer is TTL levels are 0.8V and 2.0V for hardware revisions < C04 levels are 1.6V and 4.0V for hardware revisions ≥ C04

Design notes:

Input buffer configuration is updated at reset.

3.5 ISOLATED OUTPUT:

Isolated output can be configured using *IO7_CONFIG* register.

IO7_CONFIG (R/W)

15	-	-	5	4	3	2	1	0
				Mode				Edge

Bit 0: Edge

Value	Description
0	Isolated output is active high (open state)
1	Isolated output is active low (close state)

Bit 4-1: Mode selection

Value	Description
0000	**Default open state**
1000	**Open:** IO7 is hold in open state
1001	**Closed:** IO7 is hold in closed state
1010	**Synchronization output**
Other values	**Not implemented**

3.6 RESET ON FAILURE

Reset on failure function can be adjusted by writing *RESET_ON_FAILURE* register.

Value	Description
0	Reset on failure is unactive
1 to 65535	Timeout in s from Failure apparition to automatic device reset

3.7 SAVING SETTINGS:

Registers' modifications change current setting but are not retained after a device reset.

In order to save current settings, the Modbus client shall issue a SAVE_SETTINGS command. Refer to §4.5.

4 SX-IP COMMANDS

Command requests are sent using Modbus write single coil instructions (refer to § 0).

4.1 RESET (0X01):

Request a software reset of the device.

4.2 INIT_DONE (0X02):

Set the INIT_DONE flag of the status register. INIT_DONE flag is cleared on reset.

This flag is intended to be set by the Modbus client after start-up then periodically read to check that the device has not been reset since last INIT_DONE command.

4.3 CLEAR (0X03):

Clear errors flags, failure flags and flash health value.

4.4 FLASH (0X04):

Software flash command.

4.5 SAVE_SETTINGS (0X05):

Save flash settings in a non-volatile memory. This operation can take up to 2s to complete. A suitable timeout shall be implemented on client side.

4.6 CLR_TUBE_COUNT (0X06):

Reset the flash tube counter. This command shall be sent after a flash tube replacement. This operation can take up to 200ms to complete. A suitable timeout shall be implemented on client side.

5 SX-IP READ ONLY REGISTERS

5.1 CURRENT REGISTERS:

5.1.1 IO_STATE (0X106) (R):

Device input state is available from the *IO_STATE* register. This register is mainly for debug purpose, in order to test that the Sx-IP is correctly interfaced.

IO_STATE (R)

15	-	-	6	5	4	3	2	1	0
			IO7	IO6	IO5	IN4	IN3	IN2	IN1

Bit 0: IN1 state

Value	Description
0	Input 1 is low (externally driven low)
1	Input 1 is high (internally pulled-up)

Bit 1: IN2 state

Value	Description
0	Input 2 is low (externally driven low)
1	Input 2 is high (internally pulled-up)

Bit 2: IN3 state

Value	Description
0	Input 3 is low (externally driven low)
1	Input 3 is high (internally pulled-up)

Bit 3: IN4 state

Value	Description
0	Input 4 is low (externally driven low)
1	Input 4 is high (internally pulled-up)

Bit 4: IN5 state

Value	Description
0	Input 5 is released (left open and internally pulled-up)
1	Input 5 is activated (externally driven low)

Bit 5: IN6 state

Value	Description
0	Input 6 is low
1	Input 6 is high (internally pulled-up)

Bit 6: OUT7 state

Value	Description
0	Isolated output (OUT7) is released (open)
1	Isolated output (OUT7) is active (closed)

5.1.2 MODBUS ADDRESS (0X10E) (R):

Modbus address is available from the *MODBUS_ADDRESS* register.

Value	Description
1 to 247	Current Modbus address

5.1.3 ENERGY LEVEL (0X10F) (R):

Energy level is available from the *ENERGY_LEVEL* register.

Value	Description
1 to 16	Current Energy level

5.1.4 FLASH TIME (0X110) (R):

Flash time is available from the *FLASH_TIME* register.

Value	Description
0 to 65536	Flash duration

5.1.5 INPUT VOLTAGE (0X111) (R):

Input voltage is available from the *INPUT_VOLTAGE* register.

Value	Description
0 to 2000	Input voltage in hundredths of volts

5.1.6 TEMPERATURE (0X112) (R)

Internal temperature is available from the *TEMPERATURE* register.

Value	Description
-50 to 120	Temperature in °C

5.1.7 HT VOLTAGE (0X114 (R):

Flash voltage is available from the *HT_VOLTAGE* register.

Value	Description
0 to 3000	Input voltage in tenths of volts

5.1.8 FLASH ENERGY (0X117) (R):

Last flash energy is available from the *FLASH_ENERGY* register.

Value	Description
0 to 50000	Last flash energy in hundredths of Joules

5.1.9 AVERAGE POWER (0X118) (R):

Average output power calculated on a 8s sliding period is available from the *AVERAGE_POWER* register.

Value	Description
0 to 100	Average power in Watts

5.1.10 FLASH ERROR COUNT (0X11A) (R):

Count of missed flashes since last reset is available from the *FLASH_ERROR_COUNT* register.

Value	Description
0 to 65536	Number of missed flashes

FLASH_ERROR_COUNT register is cleared on reset.

5.1.11 FLASH HEALTH (0X11B) (R):

FLASH_HEALTH register is a flash fault rate indicator. It is mainly designed for flash tube health supervision.

This indicator is increased by 100 on a missed flash, decreased by 1 on a successful flash.

A flash failure triggers if the value reach 1000. Basically, It allows 10 missed flashes every 10000 flashes.

Value	Description
0 to 65536	Flash fault rate

FLASH_HEALTH register is cleared on reset.

Design notes:

Flash health evolution laws and failure thresholds are factory configured. It can be adapted to client needs.

5.1.12 MIN INPUT VOLTAGE (0X11E) (R):

MIN_INPUT_VOLTAGE register records the minimum input voltage seen since last reset.

Value	Description
0 to 45055	Minimum input voltage in mV

5.1.13 TARGET ENERGY (0X11F) (R):

TARGET_ENERGY register indicates the actual target flash energy.

Value	Description
0 to 65536	Target flash energy in in hundredths of Joules

5.1.14 MIN & MAX TEMPERATURE (0X64) (R):

Sx-IP records minimal and maximal temperatures. These values are available from the *MIN_MAX_TEMP* register.

15 - - - 8	7 - - - 0
Minimum temperature	Maximum temperature

MAX_TEMP (0x64 LSB) (R)

7 - - - - - - - - 0
Maximum temperature

Value	Description
-50 to 120	Maximum temperature in °C

MIN_TEMP (0x64 MSB) (R)

7 - - - - - - - - 0
Minimum temperature

Value	Description
-50 to 120	Minimum temperature in °C

5.1.15 START COUNTER (0X69, 0X6A) (R):

Sx-IP records the number of device power-up events (software reset are not accounted) This 32bits counter available from the *START_COUNT_LSB* and *START_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Start count MSB (0x6A)	Start count LSB (0x69)
Start count	

Value	Description
0 to 2^{32}	Number of device power-up (over device life)

5.1.16 TIME COUNTER (0X6B, 0X6C) (R):

The power-up time (since last power-up) is available from *TIME_COUNT_LSB* and *TIME_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Time count MSB (0x6C)	Time count LSB (0x6B)
Time count	

alue	Description
0 to 2^{32}	Power-up time in minutes since last power-up

5.1.17 TOTAL TIME COUNTER (0X6D, 0X6E) (R):

Sx-IP records the total power-up time (over device life). This 32bits counter is available from *TOTAL_TIME_COUNT_LSB* and *TOTAL_TIME_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Total time count MSB (0x6E)	Total time count LSB (0x6D)
Total time count	

Value	Description
0 to 2^{32}	Total power-up time in minutes since last (over device life)

5.1.18 FLASH COUNTER (0X6F, 0X70) (R):

Flash count (since last power-up) is available from *FLASH_COUNT_LSB* and *FLASH_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Flash count MSB (0x70)	Flash count LSB (0x6F)
Flashes count	

Value	Description
0 to 2^{32}	Flash count last (since last power-up)

5.1.19 TOTAL FLASH COUNTER (0X71, 0X72) (R):

Sx-IP records the total flash count (over device life). This 32bits counter is available from *TOTAL_FLASH_COUNT_LSB* and *TOTAL_FLASH_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Total flash count MSB (0x72)	Total flash count LSB (0x71)
Flashes count	

Value	Description
0 to 2^{32}	Total flash count last (over device life)

5.1.20 FLASH TUBE COUNTER (0X75, 0X76) (R):

Flash tube count record the total flash count of the flash tube. This 32bits counter is available from *FT_COUNT_LSB* and *FT_COUNT_MSB* registers.

31 - - - 16	15 - - - 0
Flash tube count MSB (0x76)	Flash tube count LSB (0x75)
Flash tube count	

Value	Description
0 to 2^{32}	Flash tube count (since last Flash tube count clear)

Flash tube count can be cleared after flash tube replacement by sending a CLR_FT_COUNT command (refer to §4.6).

5.2 STATUS REGISTER:

STATUS register provides most important device status information.

STATUS (0x100) (R)

Bit	Flag name	Description
0	CONFIGURED	Set after device configuration has been loaded from memory
1	INITIALIZED	Set using INIT_DONE command
2	READY	Sx-IP is ready to flash (internal 100ms refresh rate)
3	COM_ERROR	An error occurs on the Modbus link (details available from *COM_ERRORS* register)
4	ERROR	Global error flag
5	FAILURE	Global failure flag
8	ALT_ENERGY_LEVEL	Alternate energy level is selected (night mode)

Design notes:

Ready flag has internal 100ms refresh rate. It can be used to check that the device is ready in steady state operation but is not relevant in burst or periodic operations.

5.3 ERRORS AND FAILURES FLAGS REGISTERS:

ERRORS, *FAILURES*, *INT_ERRORS* and *COM_ERRORS* register provides detailed error information.

5.3.1 ERRORS (0X101) (R)

Bit	Flag name	Description
0	VIN_OUT_OF_RANGE	Input voltage is not in the required range
2	WAS_NOT_READY	A flash request occurs while the device was not ready (cleared on next flash)
5	FLASH_ERROR	Last flash was missed or out of expected energy range
6	FAN ERROR	Internal fan is not spinning at expected speed
7	OVERTEMP	Internal temperature exceed 80°C (2°C hysteresis)
8	INTERNAL_ERROR	An internal error occurs (details available from *INT_ERRORS* register)
9	CONFIG_ERROR	Some value in settings is not supported
10	SEQUENCE_ERROR	Actual settings do not allow to build a flash sequence

5.3.2 FAILURES (0X102) (R)

Bit	Flag name	Description
0	INT_SUPPLY_START_FAILURE	Sx-IP device was not able to rise internal supplies.
1	INT_SUPPLY_LOST	Failure due to internal supply loss
2	INT_ID_FAILURE	Sx-IP device was not able to start due to a memory corruption
3	INT_CONF_FAILURE	Sx-IP device was not able to start due to a memory corruption
4	INT_COM_FAILURE	Failure due to internal communication errors
5	FLASH_FAILURE	Set when flash error occurrences exceed defined health parameters
6	FAN_FAILURE	Internal fan was in error for 10s

5.3.3 COM_ERRORS (0X103) (R)

Bit	Flag name	Description
0	RS485_FRAME_ERROR	A received frame was not correct (uart level)
1	RS485_PARITY_ERROR	A received frame comes with bad parity
2	RS485_FIFO_OVERFLOW	More characters were received that the FIFO can hold
3	RS485_BUFFER_OVERFLOW	A character was received before last frame was processed
5	MODBUS_FRAME_ERROR	A frame was received with unexpected size
6	MODBUS_CRC_ERROR	A frame was received with a bad CRC.

5.3.4 INTERNAL_ERRORS (0X104) (R)

Bit	Flag name	Description
0	INT_SUPPLY_ERROR	Internal supply out of range error
1	MEMORY_ERROR	Memory is corrupted or contains unexpected value(s)
2	**INT_COM_ERROR**	**Internal communication error**

6 ADVANCED FUNCTIONNALITIES

6.1 HEALTH MONITORING

Sx-IP device has a build in configurable health monitoring function.

It allows to detect when a device regularly miss flashes, that is relevant of a flash tube end of life.

6.1.1 HEALTH MONITORING ALGORITHM

The algorithm is:

- Each missed flash *FLASH_HEALTH* register is incremented by *MISS_FLASH_WEIGHT*.
- Each succeeded flash *FLASH_HEALTH* register is decremented by 1 (if not zero).
- If *FLASH_HEALTH* reach *FLASH_HEALTH_TH*, a flash failure is triggered

Design notes:

From software revision 1.06, setting FLASH_HEALTH_TH to zero inhibits triggering a flash failure.

For software revisions up to 1.05, flash failure triggering can be avoided by setting FLASH_HEALTH_TH to 0xFFFF and by keeping MISS_FLASH_WEIGHT small enough so the number of missed flashes for FLASH_HEALTH to reach FLASH_HEALTH_TH is very high

6.1.2 HEALTH MONITORING SET-UP

Health monitoring algorithm allows to adjust the health monitoring based on two parameters:

- The maximum allowed consecutive missed flashes; subsequently called **CMF**
- The maximum allowed missed flash rate; subsequently called **MFR**

Health monitoring registers' value can be calculated using following equations:

MISS_FLASH_WEIGHT = 1 / MFR

FLASH_HEALTH_TH = (CMF + 1) * *MISS_FLASH_WEIGHT*

Calculation example:

Let's assume that we want the flash failure to trigger if the missed flash rate rise above 1% or if more than two consecutive flashes are missed:

- Expected CMF = 2 consecutive flashes
- Expected MFR = 1%

MISS_FLASH_WEIGHT = 1 / 1% = 100

FLASH_HEALTH_TH = (2+ 1) * 100 = 300

7 TROUBLESHOOTING

7.1 FAILURES MANAGEMENT

Failures makes Sx-IP unable to operate.

In case of failure, Sx-IP will try to resume by a software reset every 5s (configurable refer to §3.6) .

7.2 ERRORS MANAGEMENT

Errors are usually not blocking.

Most errors (fan error, internal errors, communication errors) are for information. These errors do not cause degradation of the device performances.

Over-temp error clears READY flag so the device becomes unable to flash.

Fan error will cause a failure if it lasts for 10s.

Vin out of range error is maintained for 10s every time the input voltage is detected out of range.

If the input voltage remains out of range for more than several milliseconds, it may cause multiple errors and failures due to internal supplies fall.

7.3 ERRORS AND FAILURES WORKAROUND

Error flag	Causes	Workaround
Vin out of range	Input voltage has been detected out of range during the last 10s.	Check power supply volage, current capacity and voltage drop in cables Supervise the *MIN_VOLTAGE* register
Was not ready	A flash request occurs while the device was not ready.	Check that the delay between two flash requests is compatible with the flash configuration
Over-temp	Internal temperature exceed 80°C	Reduce average power (flash energy and/or cadence) Reduce ambient temperature. Protect the flash housing from direct sunlight. Increase air-flow around the flash housing
COM error	An error occurs on the Modbus link	Detailed error flags are available in *COM_ERROR* register
RS485 Frame error	Received frame is not correct	Check serial parameters (baudrate, nb bits, stop bits) Check RS485 link quality (common mode voltage…)
RS485 parity error	Received frame parity is not correct	Check serial parameters (baudrate, nb bits, stop bits) Check RS485 link quality (common mode voltage…)
RS485 FIFO overflow	More characters were received that the FIFO can hold	Check frame length Check frame cadence (was the last frame answered ?)
RS485 buffer overflow	A character was received before last frame was processed	Check frame cadence (was the last frame answered ?)
Modbus Frame error	Frame length is not as expected	Check Modbus client frame construction
Modbus CRC error	The frame CRC is not valid	Check Modbus client CRC algorithm Check Modbus client frame construction
Sequence error	Actual settings do not allow to build a flash sequence	Check sync pulse parameters
Flash failure	Device fails to flash and/or flash energy is not in expected range.	Check / replace the flash tube Contact Phoxene
Fan error	Internal fan has been detected	Nothing to do
Fan failure	Internal fan failure	Contact Phoxene
Config error	Some value in settings is not supported	Check setting values, contact Phoxene
Internal error	An internal error occurs	Contact Phoxene