ads-tec Energy GmbH

StoraXe System Master Controller

Master Interface Description

Modbus/TCP

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Change log

Version	Date	Editor	Changes
1	10.10.2012		Draft
2	23.10.2012	DrGv	Corrections from AiNr
3	30.11.2012	DrGv	Correct object name CosPhiReq PhaseModeReq Correct CosPhi unit Introduce QVReq + ComplexPowerReq Change IP Define readable address range Correct unit in mains frequency Redefine GridStReq in SysStReq Concatenate read addresses in grid management range Correct unit of RunTimeToFull / RunTimeToEmpty Rename OperationState in BatteryState Rename SafetyState in BatteryOperationState Signed SoF_P_Power, SoF_P_Energy Remove shutdown command, replaced by SysStReq Extend address/bit assignment in SysErrCode Extend address/bit assignment in BattErrCode Extend address/bit assignment in SysWarnCode Correct ModSet-states Extended comments
4	15.03.2013	DrGv, McSn	Register 12 bit description Register 33 range definition + default Register 34 default value Register 120 unit Register 217 added Register 218-238 bit description Register 230-233 bit description Register ID+20 bit description
5	12.09.2013	McSn, DrGv	Register 13+14 MaxRealPower Register 15+16 MaxReactivePower
6	05.03.2014	McSn	Register 125 description Register 126 changed unit to [%] and added description Extended Register ID + 11 changed unit to [%] Register 201 changed to version 6 Reg. 207 - 212: renamed to IN and corrected description
7	11.06.2014	McSn, PkGz	Changed Adresses to Registers → see ch. 2.3.1 Register 202 changed to version 7 Reg. 208 - 213: renamed to IN and corrected description Extended Register ID + 9 : SRS system temperature sensor 1 Extended Register ID + 10 : SRS system temperature sensor 2 Reg. 220: Added error bit 9 and bit 10 Reg. 232: Added error bit 1 and bit 2
8	30.04.2015	McSn, SnSb, FxFr	General description additions Reg. 18: High frequency resolution Reg. 36 - 47: Added P / Q reading for systems with independent power control Reg. 36 - 47: Added P / Q setting for systems with independent power control Reg. 128 - 129: RunTime2Full and RunTime2Empty removed Reg. 130 - 131: Added system temperatures of SXS controller Reg. 142: Removed non exclusive battery state “5 warning”

			Reg. 201: Added System operating state Reg. 202: changed to version 8 Reg. 227: Increased SRS amount to 16 Extended address range of StoraXe system management Reg. 244: Extended system state requests Reg. 245: Added register for auto sleep time out Reg. ID + 21: Extended error codes
9	09.12.2015	FxFr	Reg. 113-118: Added energy counters Reg. 134-137: Added energy counters Reg. 144: SOF functions are removed Reg. 151-154: SOF functions are removed Reg. 202: changed to version 9 Extended previously reserved system warning and system error bits
10	07.03.2016	SnPr	Reg. 133 Write Access: Watchdog Removed Fire extinguisher collective error, collective shutdown and collective fire from the error bits and added them as warnings.
11	14.09.2016	FxFr	Update of documentation for SRC1xxx firmware 1.3.1 Extended SRS Information is only available for SRS 1..10 Reg. 138: Added MinCellVoltage Reg. 139: Added MaxCellVoltage Reg. 143: Added state 0 Reg. 202: changed to version 11 Reg. 220-221: Added further inverter error bits Reg. 227: Flags only for SRS 1..10 Reg. 233: Added further warning bits Reg. 238: Update meaning of bits 2 and 3 Reg. ID+3: Removed SRS current 60s average Reg. ID+5: Added SRSMinCellVoltage Reg. ID+7: Added SRSMaxCellVoltage Reg. ID+21: Added further error bits Reg. ID+22: Added error bits Reg. ID+25: Added warning bits
12	06.02.2020	SnPr, OrBn	Update of documentation for SRC1xxx firmware 1.4.3 Add Modbus function 16 (write multiple registers) where required Update notes on data consistency for 32bit values Reg. 202: changed to version 12 Reg. 245: now unused Added BPMN Diagram Added new system state request / system state “deep sleep” Enhanced extended SRS registers IdleTimerStandby is now discontinued
	08.05.2020	SnPr	Added chapter regarding system behaviour on failures
13	19.05.2020	SnPr	Added chapter regarding system behaviour on failures Updated BPMN diagramm with sleep states Re-added Reg. 128 and 129 now with new temperature values. Added environmental sensors 0-8 at starting Reg. 500 Extended chapter regarding system behaviour on failures Added generic data exchange register Reg. 242 Added SoCmax register Reg. 128
13.1	04.08.2020	OrBn	Re-added Reg. “128 and 129” should read “129 and 132”. Rework “Environmental” (sensor pairs 0-7), added modbus range at 500. Clarified safety levels chapter “system behaviour on failures”.
13.2	23.09.2020	SnPr	Added Energy Registers 144 to 147

14	23.07.2021	KnHr, OrBn	Additional float interfaces for selected datapoints (powers, currents) Reg. 202: changed to version 14 Added NrOfSRSFaulty (140), VPNStatus (240) and GPIO Control/Status (245) Additional datapoints at SRS level (id + 4, id + 43 to 51) Added SystemEnergy registers 148 to 153 Added datapoints at power unit level (60000 to 60599) Added datapoint SystemControlState (154) Added datapoint SoCestim (119) Mark single phase registers as obsolete (36 to 47) Support up to 63 SRS error status bits (227 to 230) Clarified system lock and precharge fuse (239 SysErrCode4) Clarified calculation of max charge/discharge currents (93/102, 95/112) Fix example for extended SRS information: id for SRS 128 is 13700 Extend Feature Availability Matrix: Standby for APS supported
15	20.07.2022	KnHr	Added SysWarnCode3 bits 9 to 12 Renamed EnergyUntilFull to EnergyUntilFirstFull and EnergyUntilEmpty to EnergyUntilFirstEmpty. Introduced new EnergyUntilFull and EnergyUntilEmpty fields. Introduced normalized SoCs for energy and power based usecase (reg. 155-160) and added underlying calculation description.
16	19.09.2022	KnHr, OrBn	Added “Invalid” value für Temperature Sensor 1 & 2 (130, 131) Added “F_island_setpoint” and “U_Island_setpoint” (160,161) Added Trumpf-Hüttinger AC3025 to feature availability matrix
17	01.03.2023	OrBn	Added TimeToOff (31)

1. Introduction

The document in hand describes the master interface between an ads-tec StoraXe System Master Controller (“Master Controller”) and an external control system.

A StoraXe system consists of multiple Storage Rack Systems (SRS), each of them monitored by a Storage Rack Controller. The central System Controller centralizes the operating data of the SRS, thus the StoraXe system appears as a single battery to the outside and can be operated as such. The Master Interface enables to visualize, monitor and control a StoraXe system.

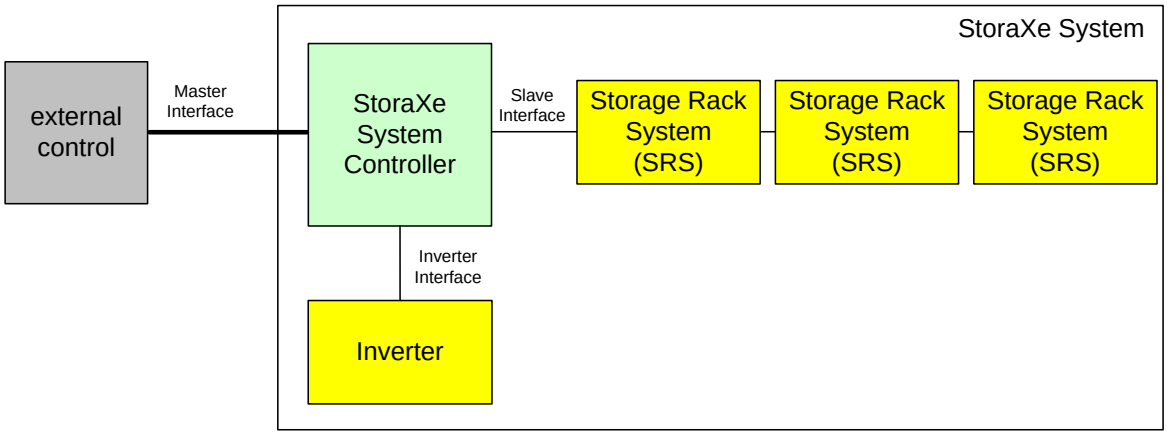

Figure 1: System overview single power unit system

The described interface in this document enables to poll operating data and permitted operating parameters.

In detail these are:

- Grid management
- Battery management
- StoraXe system management
- Extended SRS information
- Power unit information

The communication protocol relies on Modbus/TCP. The Master Controller (SRC1xxx device) is configured to the IP address 1.0.0.1 with subnet mask 255.255.255.0 (front side Ethernet port). These settings can be modified using the SRC1xxx web interface.

The interface description is valid for all ads-tec Storage Rack Systems with a Master Controller. The interface description is valid until a newer version is released. Depending on system architecture (inverter type, etc.) not all operating modes and error/warning information are available.

This interface description is only valid for SRC1xxx firmware versions 2.0.4 and higher, and valid until a newer version is released.

2. General System Information

2.1 Simplified behaviour model

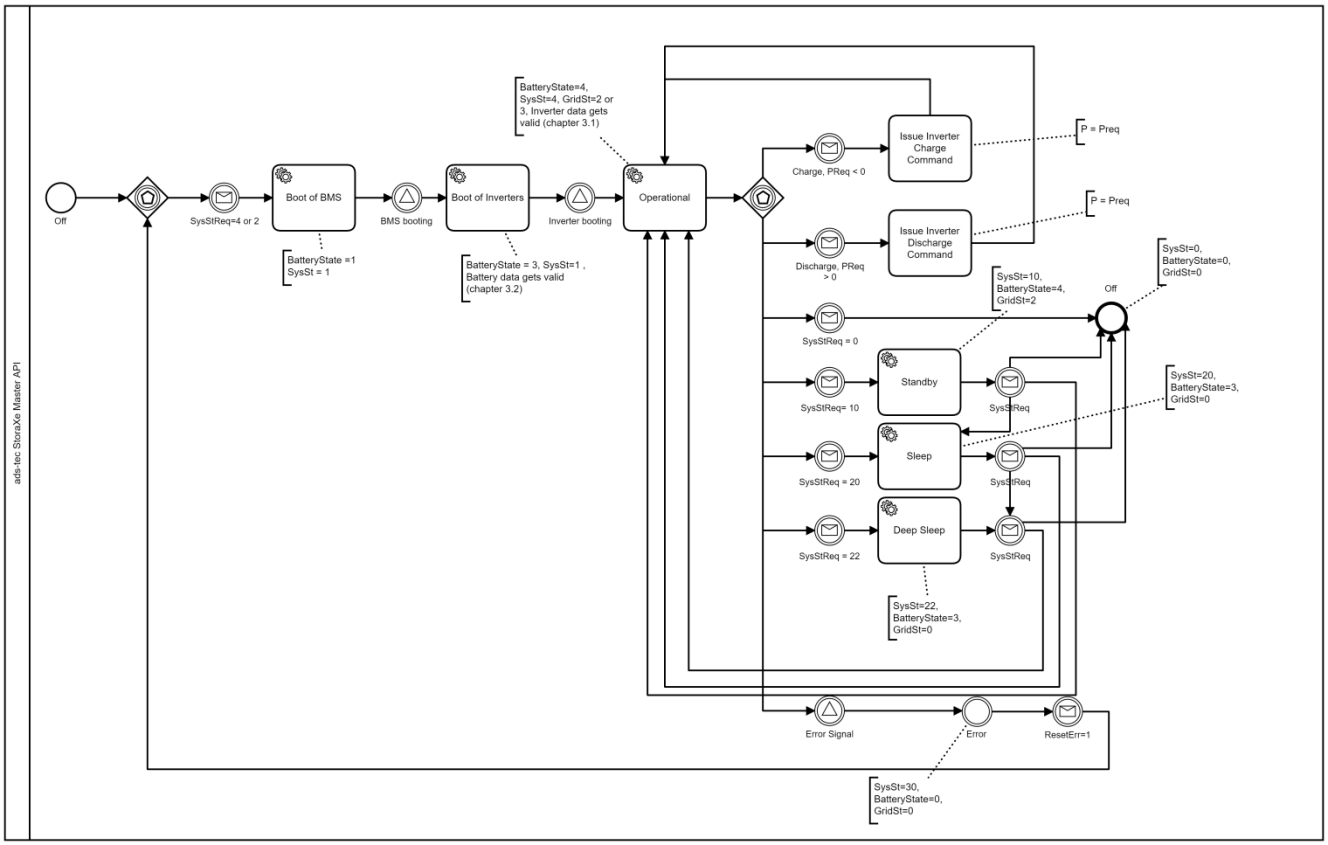

Figure 2: BPMN for operation

2.2 Feature Availability Matrix

2.2.1 Operation Modes

Depending on the systems inverter the following operation modes are available.

	WSTech BAT100/280/720	WSTech APS	WSTech BAT20	Kaco Blue Planet 50	Trumpf-Hüt-tinger AC3025
Island	(optional)	No	Yes	No	Yes
Auto	(optional)	Defaults to Grid	Yes	Defaults to Grid	Defaults to Grid
Sleep	No	No	Yes	No	Yes
Deep Sleep	Yes	Yes	Yes	Yes	Yes
Standby	Yes	Yes	Yes	No	Defaults to Grid
Grid	Yes	Yes	Yes	Yes	Yes

3. Modbus/TCP

3.1 Modbus Specification

The following section does not completely describe the Modbus specification. For further information please go to the Modbus website https://www.modbus.org/ .

3.2 Modbus function codes

The StoraXe system does not use all the function codes provided by Modbus, but narrows down to the following:

Code	Name	Data type	Description
02	Read discrete inputs	bool	Read status bit
03	Read holding register	uint16	Read back written value
04	Read input register	uint16	Read actual value
05	Write single coil	bool	Write bit
06	Write holding register	uint16	Write value
16	Write multiple register	uint16	Write values

3.3 Modbus registers

The available register range is divided into the following ranges:

Function	Register range
Grid management	1-69
Battery management	89-199
StoraXe System management	200-299
Environmental sensors	500-515
Extended SRS information	1000-12700
Power unit information	60000-60599

All registers in this document are in decimal notation.

Up to 125 register can be read and up to 123 registers can be written as one block with one single Modbus/TCP request. Example:

Registers 89…147 with function code 04 (read input register) can be read as one block.

Undefined registers are present, readable and writeable. The returned value however may be arbitrary.

According to Modbus Application Protocol V1.1b (28.12.2006), register addresses start at zero, e.g. registers 1-16 are addressed in the Modbus protocol data unit with addresses 0-15.

Modbus uses a ‘big-Endian’ representation (high byte first). This means for example that for 16-bit register value 0x1234 the left byte ‘0x12’ is the high byte and ‘0x34’ the low byte. Accordingly, for 32bit values the high word is addressed first, and the low word is at address +1.

Floating point values are 32bit values according to IEEE-754, occupying two consecutive registers, high word first. Example:

Float value: 9,99E+2

Address x: 0x4479

Address x + 1: 0xC000

32bit datapoints (float, int32, uint32) are documented by their start address (x) only.

3.4 Float versus integer interface

For historical reasons, some datapoints are accessible as integer as well as float values. If there is no overflow both interfaces are functionally equivalent. Example:

16bit Integer Register 14: MaxRealPowerCharge [100W] is limited to 2^16 * 100W -1 = 6553500W (6,5535MW).

32bit Float Registers 56 + 57: MaxRealPowerCharge [W] may represent all valid IEEE-754 values.

Please note that not all real values have an exact IEEE-754 representation.

Important: For setpoints like RealPowerReq either float (reg. 48 + 49) or integer access (reg. 32) may be used. Float and integer access must never be mixed.

3.5 Reaction speed

All values are updated at least with a refresh rate of 1 Hz. Within this time interval all defined registers (except for extended SRS registers, depending on SRS count) can be read.

3.6 Connections

Multiple Modbus/TCP connections are allowed at the same time. However, write access from multiple clients is not recommended as it can lead to uncoordinated behavior.

3.7 Marking new datapoints

New registers from Version 13 on are marked with an icon. The number in the icon reflects the interface version of the datapoint.

Example:

V14: 

V15: 

V16: 

V17: 

4. Interface description

4.1 Grid management

4.1.1 Grid status

Name	Func.	Reg.	Description
GridSt	4	1	Grid State 0 = Off 1 = Island mode 2 = Online 3 = Error
RealPower	4	2	Real power [100W] in a two's complement
RealPower	4	52	Real power [W] 32bit float.
Power flow in direction of the battery is negative (e.g., 16bit value 0xFF88 corresponds to -12kW battery charging)			
ReactivePower	4	3	Reactive power [100var] in a two's complement
ReactivePower	4	54	Reactive power [var] 32bit float.
Capacitive reactive power is negative			
CosPhi	4	4	Power factor in 0.01-steps as absolute values 0 ... 100 unsigned
PhaseMode	4	5	Direction of power factor 0 = capacitive 1 = inductive
Frequency	4	6	Grid frequency [0.01Hz] unsigned
ACVoltageL1	4	7	Voltage L1 [0.1V] unsigned
ACVoltageL2	4	8	Voltage L2 [0.1V] unsigned
ACVoltageL3	4	9	Voltage L3 [0.1V] unsigned

ACCurrentL1	4	10	Current L1 [100mA] unsigned
ACCurrentL1	4	64	Current L1 [A] unsigned 32bit float. 14
ACCurrentL2	4	11	Current L2 [100mA] unsigned
ACCurrentL2	4	66	Current L2 [A] unsigned 32bit float. 14
ACCurrentL3	4	12	Current L3 [100mA] unsigned
ACCurrentL3	4	68	Current L3 [A] unsigned 32bit float. 14

AC-currents in reg. 10 to 12 (64 to 68) are unsigned and are considered as absolute current value. The direction of power flow can be determined from the signed value in reg. 2 (52).

FIslandSetpoint	4	70	Latest island frequency setpoint only applicable in island mode [mHz] unsigned 16
UIslandSetpoint_high	4	71	Latest island voltage setpoint only applicable in island mode [mHz] 32 bit unsigned 16
UIslandSetpoint_low	4	72	…

RequestError	4	13	Indicates that a request was not accepted bit 0: SysStReqErr bit 1: RealPowerReqErr bit 2: ReactivePowerReqErr bit 3: CosPhiReqErr bit 4: QVReqErr (reserved) bit 5: ComplexPowerReqErr (reserved) bit 6-15: reserved
			The read-out value from reg. 13 indicates an out-of-range request. In this case the corresponding bit is set.
MaxRealPowerCharge	4	14	Maximum real power charging in abs. values [100W] unsigned.
MaxRealPowerCharge	4	56	Maximum real power charging [W] unsigned 32bit float. 14
			The maximum real power charge from reg. 14 (56) bases on max. charge power in Reg. 124 (97) and inverter efficiency.
MaxRealPowerDischarge	4	15	Maximum real power discharging in abs. values [100W] unsigned.
MaxRealPowerDischarge	4	58	Maximum real power discharging [W] unsigned 32bit float. 14
			The maximum real power discharge from reg. 15 (58) bases on max. discharge power in Reg.125 (99) and inverter efficiency.
MaxReactivePowerInd	4	16	Maximum reactive power for inductive mode abs. values [100var] unsigned.
MaxReactivePowerInd	4	60	Maximum reactive power for inductive mode [var] unsigned 32bit float. 14
			The maximum reactive power (inductive) from reg. 16 (60) is dynamically calculated from the max. apparent power of the inverter (see datasheet) and the actual real power in Reg. 2 (52).
MaxReactivePowerCap	4	17	Maximum reactive power for capacitive mode in abs. values [100var] unsigned.
MaxReactivePowerCap	4	62	Maximum reactive power for capacitive mode [var] unsigned 32bit float. 14
			The maximum reactive power (capacitive) from reg. 17 (62) is dynamically calculated from the max. apparent power of the inverter (see datasheet) and the actual real power in Reg 2 (52).

4.1.1.1 Extended grid status for inverters with independent three phase power control (obsolete)

Name	Func.	Reg.	Description
FrequencyHiRes	4	18	Grid frequency in higher resolution [mHz] unsigned
The frequency is measured by the inverter. Not all inverters support this resolution.			
PL1_high	4	36	Real power phase L1, high word [W] in a two's complement Power flow in direction of the battery is negative
PL1_low	4	37	Real power phase L1, low word [W]
PL2_high	4	38	Real power phase L2, high word [W] in a two's complement Power flow in direction of the battery is negative
PL2_low	4	39	Real power phase L2, low word [W]
PL3_high	4	40	Real power phase L3, high word [W] in a two's complement Power flow in direction of the battery is negative
PL3_low	4	41	Real power phase L3, low word [W]
Reading registers 36...41: Always read as one job to ensure data consistency.			
QL1_high	4	42	Reactive power phase L1, high word [var] in a two's complement Capacitive reactive power is negative
QL1_low	4	43	Reactive power power phase L1, low word [var]
QL2_high	4	44	Reactive power power phase L2, high word [var] in a two's complement Capacitive reactive power is negative
QL2_low	4	45	Reactive power power phase L2, low word [var]
QL3_high	4	46	Reactive power power phase L3, high word [var] in a two's complement Capacitive reactive power is negative
QL3_low	4	47	Reactive power power phase L3, low word [var]
Reading registers 42...47: Always read as one job to ensure data consistency.			

4.1.2 Grid management

Name	Func.	Reg.	Description
RealPowerReq	3;6	32	Requested real power [100W] in a two's complement
RealPowerReq	3;6	48	Requested real power [W] 32bit float. 14
			If the requested power in reg. 32 (48) is permitted, the inverter will adjust this real power on the grid side. • *A positive value indicates discharging batteries and power flow to grid direction.* • *A negative value indicates charging batteries with power flow from the grid.*
ReactivePowerReq	3;6	33	Requested reactive power [100var] in a two's complement.
ReactivePowerReq	3;6	50	Requested reactive power [var] 32bit float. 14
			Capacitive requested reactive power is negative.
CosPhiReq	3;6	34	Power factor cos(phi) in 0.01-steps as absolute values 0 ... 100 Default: 100 (corresponds to cos(phi) = 1.0)
			The actual lower limit of CosPhiReq in reg. 34 depends on the inverter hardware. Requests outside of allowed range results in warnings in SysWarnCode1 (Reg. 231, bit 13 and bit 14)
PhaseModeReq	2;5	35	Direction of requested power factor 0 = capacitive (default); 1 = inductive
			The requested phase mode (reg. 35) determines the direction of the requested CosPhi in reg. 34, and thus the phase shift on the grid side. An additionally requested reactive power (reg. 33 (50)) will be set as a static offset to the reactive power from the CosPhi request.

4.1.2.1 Extended grid management for inverters with independent three phase power control (obsolete)

Name	Func.	Reg.	Description
PL1req_high	3;6;16	36	Requested real power phase L1, high word [W] in a two's complement Power flow in direction of the battery is negative
PL1req _low	3;6;16	37	Requested real power phase L1, low word [W]
PL2req_high	3;6;16	38	Requested real power phase L2, high word [W] in a two's complement Power flow in direction of the battery is negative
PL2req_low	3;6;16	39	Requested real power phase L2, low word [W]
PL3req_high	3;6;16	40	Requested real power phase L3, high word [W] in a two's complement Power flow in direction of the battery is negative
PL3req_low	3;6;16	41	Requested real power phase L3, low word [W]
Registers 36..41 only valid for inverters with independent three phase power control. Always access with Modbus function 16 to ensure data consistency.			
QL1req_high	3;6;16	42	Requested reactive power phase L1, high word [var] in a two's complement Capacitive reactive power is negative
QL1req_low	3;6;16	43	Requested reactive power phase L1, low word [var]
QL2req_high	3;6;16	44	Requested reactive power phase L2, high word [var] in a two's complement Capacitive reactive power is negative
QL2req_low	3;6;16	45	Requested reactive power phase L2, low word [var]
QL3req_high	3;6;16	46	Requested reactive power phase L3, high word [var] in a two's complement Capacitive reactive power is negative
QL3req_low	3;6;16	47	Requested reactive power phase L3, low word [var]
Registers 42..47 only valid for inverters with independent three phase power control. Always access with Modbus function 16 to ensure data consistency.			

4.2 Battery management

4.2.1 Battery status

Name	Func.	Reg.	Description
EndOfChargeVoltage	4	101	End-of-charge voltage [0.1V] unsigned This voltage must not be exceeded.
MaxChargeCurrent	4	102	Actual maximum charge current [0.1A] unsigned This value depends on the battery state of charge. The charge current must not exceed this value. Charging has to be stopped if this value is set to current = 0 A.
MaxChargeCurrent	4	93	Actual maximum charge current [A] unsigned 32bit float. 14 This value depends on the battery state of charge. The charge current must not exceed this value. Charging has to be stopped if this value is set to current = 0.0 A.
EndOfDischargeVoltage	4	111	End-of-discharge voltage [0.1V] unsigned The voltage must not fall below this value.
MaxDischargeCurrent	4	112	Actual maximum discharge current [0.1A] unsigned This value depends on the battery state of charge. The discharge current must not exceed this value. Discharging has to be stopped if this value is set to current = 0 A.
MaxDischargeCurrent	4	95	Actual maximum discharge current [A] unsigned 32bit float. 14 This value depends on the battery state of charge. The discharge current must not exceed this value. Discharging has to be stopped if this value is set to current = 0.0 A.
Current limits are calculated by multiplying the lowest current of all operational batteries with the number of connected batteries.			
EnergyCounter_high	3;4	113	Battery energy throughput (high word) Sum of absolute values of charged and discharged DC energy [kWh] unsigned.
EnergyCounter _low	3;4	114	Battery energy throughput (low word)
EnergyCounter is the total energy (DC side) which did flow through the battery modules (independently of the direction). This value is not available directly after system startup (value is 0kW then), but valid at most after one hour of successful operation in island or line-commutated mode after last system start. Afterwards the value is updated once per day. Always read as one job to ensure data consistency. *Example: If system was charged since installation with 90kWh and discharged with 85kWh this counter will report 175kWh.*			

EnergyExportedAC_high	3;4	115	Exported energy into the grid (AC side, high word) [kWh] unsigned
EnergyExportedAC_low	3;4	116	Exported energy into the grid (AC side, low word)
EnergyImportedAC_high	3;4	117	Imported energy from grid (AC side, high word) [kWh] unsigned
EnergyImportedAC_low	3;4	118	Imported energy from grid (AC side, low word)
EnergyExportedAC and EnergyImportedAC count the energy on the AC side as separate counters depending on the power direction. Always read as one job to ensure data consistency.			
SoCestim	4	119	Estimated State of charge [%] signed
When system is off: Estimation is based upon self-discharge rating and system-off time, -1 if unknown			
SXSVoltage	4	121	Actual measured system voltage [0.1V] unsigned
SXSCurrent	4	122	Actual measured system current [0.1A] in a two's complement
SXSCurrent	4	89	Actual measured system current [A] 32bit float. 14
SXSAverageCurrent	4	123	Average current over the last three seconds in [0.1A] in a two's complement
SXSAverageCurrent	4	91	Average current over the last three seconds in [A] 32bit float. 14
Charge currents are negative			
MaxChargePower	4	124	Actual maximum charge power [100W] unsigned
MaxChargePower	4	97	Actual maximum charge power [W] unsigned 32bit float. 14
MaxDischargePower	4	125	Actual maximum discharge power [100W] unsigned
MaxDischargePower	4	99	Actual maximum discharge power [W] unsigned 32bit float. 14
The power in reg. 124 (97) and 125 (99) is dynamically calculated during operation and relates to the whole system. The maximum charge power is reduced, if the system is almost fully charged. In this case charging at maximum charge current would exceed the end-of-charge voltage.Accordingly the maximum discharge power is reduced, if the system is almost fully discharged			
.			

Name	Func.	Reg.	Description
SXSSOCMIN	4	126	State of Charge SOC [%] unsigned
			Reg. 126 represents the minimum state of charge of all cells within the battery system based on a full depth of discharge (DoD) of 100 %. Typical operating range of systems with DoD = 80% is limited to approx. 6 ≤ SOC ≤ 90%.
SXSSOH	4	127	State of Health SOH [%] unsigned
			Reg. 127 represents capacity fading of the cells in relation to the design capacity. Typical end of life definition is defined as 80% of the design capacity which corresponds in this case to SOH = 80%.
SXSSOCMAX	4	128	State of Charge SOC [%] unsigned
			Reg. 128 represents the maximum state of charge of all cells within the battery system based on a full depth of discharge (DoD) of 100 %.
Transformer Temp	4	129	Transformer winding temperature [°C] in a two's complement *(if physically present on the system)*
SysTemp1	4	130	System temperature of sensor 1 [°C] in a two's complement *Value 999 if no sensor is connected*
SysTemp2	4	131	System temperature of sensor 2 [°C] in a two's complement *Value 999 if no sensor is connected*
Inverter IGBT Temp	4	132	Out of all IGBTs, the maximum IGBT temperature out of all available inverters, [°C] in a two's complement *(if provided by the specific inverter model)*
Togglebit	4	133	bit 0 in this register toggles with every read access. It can be used as "still alive" monitor of the StoraXe system controller.
EnergyExportedDC_high	3;4	134	Exported energy into the grid (DC side, high word) [kWh] unsigned
EnergyExportedDC_low	3;4	135	Exported energy into the grid (DC side, low word)
EnergyImportedDC_high	3;4	136	Imported energy from grid (DC side, high word) [kWh] unsigned
EnergyImportedDC_low	3;4	137	Imported energy from grid (DC side, low word)
			EnergyExportedDC and EnergyImportedDC count the energy on the DC side as separate counters depending on the power direction. Always read as one job to ensure data consistency.
MinCellVoltage	4	138	Minimum cell voltage [mV] unsigned
MaxCellVoltage	4	139	Maximum cell voltage [mV] unsigned

NrOfSRSFaulted	4	140	Number of SRS systems in error. 14
NrOfSRS	4	141	Number of SRS systems connected to DC-Bus (dynamically)
BatteryState	4	142	0 = off 1 = start-up 2 = balancing 3 = ready 4 = operating 6 = error
BatteryOperatingState	4	143	0 = off/undefined 1 = discharge 2 = charge 3 = idle
EnergyUntilFirstEmpty_high	4	144	Stored Energy which can be discharged from the system by nominal power on the AC side until the system is empty or cannot deliver the nominal power any more. (high word) [Wh] unsigned
EnergyUntilFirstEmpty_low	4	145	Stored Energy which can be discharged from the system by nominal power on the AC side until the system is empty or cannot deliver the nominal power any more. (low word) [Wh] unsigned This Energy amount is calculated by using a calibrated Wh value per percent SoC based on the capacity test results. As the amount of energy is dependent of the power and temperature of the system this value can only give an estimation based on the operating conditions during the calibration. The value will be calculated based on the number of SRS currently operational.
EnergyUntilFirstFull_high	4	146	Energy which can be charged into the system on nominal power on the AC side until the system is full or cannot deliver the nominal power any more. (high word) [Wh] unsigned
EnergyUntilFirstFull_low	4	147	Energy which can be charged into the system on nominal power on the AC side until the system is full or cannot deliver the nominal power any more. (low word) [Wh] unsigned This Energy amount is calculated by using a calibrated Wh value per percent SoC based on the capacity test results. As the amount of energy is dependent of the power and temperature of the system this value can only give an estimation based on the operating

			conditions during the calibration. The value will be calculated based on the number of SRS currently operational.
SystemEnergyMin	4	148	Energy Content based on SoCmin [Wh] unsigned 32bit float. [14]
SystemEnergy	4	150	Energy Content based on SoC [Wh] unsigned 32bit float. [14]
SystemEnergyMax	4	152	Energy Content based on SoCmax [Wh] unsigned 32bit float. [14]
SystemControlState	4	154	System control blocker reasons as bitfield If field is zero unlimited control is possible Bit 0: Read Only Mode active. No control possible. Bit 1: Manual Mode active. No control possible. Bit 15: System error present. Only partial control possible (Error Reset necessary)
EnergyUntilEmpty_high	4	155	Energy which can be discharged from the system until all power units are empty. This field differs to EnergyUntilFirstEmpty (Reg. 144/145) in case of multiple power units. The EnergyUntil-FirstEmpty equals to zero if the first powerunit is empty and system will not be able to discharge with full power. [15]
EnergyUntilEmpty_low	4	156	…
EnergyUntilFull_high	4	157	Energy which can be charged into the system until all power units are full. This field differs to EnergyUntilFirstFull (Reg. 146/147) in case of multiple power units. The EnergyUntilFirstFull equals to zero if the first powerunit is full and system will not be able to charge with full power. [15]
EnergyUntilFull_low	4	158	...
SoCPowerNormalized	4	159	State of charge [%] calculated from EnergyUntilFirstFull and EnergyUntilFirstEmpty signalizing the first powerunit to be full or empty respecting operational SoC constraints. This value is calculated as following: $\mathrm{SoCPowerNormalized} = \frac{\mathrm{EnergyUntilFirstEmpty}}{\mathrm{EnergyUntilFirstFull} + \mathrm{EnergyUntilFirstEmpty}}$ [15]
SoCEnergyNormalized	4	160	State of charge [%] calculated from EnergyUntilFull and EnergyUntilEmpty signalizing all powerunits to be full or empty respecting operational SoC constraints. This value is calculated as following: $\mathrm{SoCEnergyNormalized} = \frac{\mathrm{EnergyUntilEmpty}}{\mathrm{EnergyUntilFull} + \mathrm{EnergyUntilEmpty}}$ [15]

4.3 StoraXe-System Management

4.3.1 StoraXe system status

Name	Func.	Reg.	Description
SysState	4	201	System operating state 0 = off 1 = balancing 2 = auto 3 = island mode 4 = line-commutated / grid 10 = standby 20 = sleep 22 = deep sleep 30 = error
			Reg. 201 reflects the system operating state. If "auto" is selected in Reg. 244 during system start, the system reports "auto" until the system finished startup procedure and attempts AC connection. Afterwards the actual system state (island or line-commutated) is reflected.
Interface Version	4	202	Always returns interface version: 14
SN1	4	203	2 ASCII char of StoraXe System serial number, MSB sent first
SN2	4	204	2 ASCII char of StoraXe System serial number, MSB sent first
SN3	4	205	2 ASCII char of StoraXe System serial number, MSB sent first
SN4	4	206	2 ASCII char of StoraXe System serial number, MSB sent first
SN5	4	207	2 ASCII char of StoraXe System serial number, MSB sent first
IN1	4	208	2 ASCII char of StoraXe System item number, MSB sent first
IN2	4	209	2 ASCII char of StoraXe System item number, MSB sent first
IN3	4	210	2 ASCII char of StoraXe System item number, MSB sent first
IN4	4	211	2 ASCII char of StoraXe System item number, MSB sent first
IN5	4	212	2 ASCII char of StoraXe System item number, MSB sent first
IN6	4	213	2 ASCII char of StoraXe System item number, MSB sent first

SXSFWVersion 1	4	214	SXS-FW Version 1
SXSFWVersion 2	4	215	SXS-FW Version 2
SXSFWVersion 3	4	216	SXS-FW Version 3
SXSFWRevision	4	217	SXS-FW Revision
SXSCFGVersion	4	218	SXS-Configuration Version

InvErr1	4	219	Inverter error code as bit field bit 0: Island mode related bit 1: Grid error bit 2: Undertemperature bit 3: Overtemperature bit 4: Overcurrent bit 5: Undervoltage bit 6: Overvoltage bit 7: Underpower bit 8: Overpower bit 9: Hardware bit 10: Software bit 11: Configuration bit 12: Contactors bit 13: Intermediate circuit bit 14: Battery related bit 15: Emergency stop
InvErr2	4	220	Inverter error code as bit field bit 0: Insulation bit 1: Grid frequency bit 2: Communication bit 3: Error while charging bit 4: Error while discharging bit 5: Error while precharging bit 6: Short circuit bit 7: No Grid bit 8: Date/Time related bit 9: Grid rotation error bit 10: Heartbeat / Togglebit error bit 11: PWM / Pulse error bit 12: Supply voltage error bit 13: Update running/failed bit 14: NA protection (“Netz- und Anlagenschutz”) bit 15: Cooling/Fan
InvErr3	4	221	Inverter error code as bit field bit 0: Fuse bit 1 - 15: reserved

InvErr4	4	222	Inverter error code as bit field bit 0 - 15: reserved
BatErrCode1	4	227	Battery error code as bit field bit 0: SRS1 error status != 0 bit 1: SRS2 error status != 0 bit 2: SRS3 error status != 0 bit 3: SRS4 error status != 0 bit 4: SRS5 error status != 0 bit 5: SRS6 error status != 0 bit 6: SRS7 error status != 0 bit 7: SRS8 error status != 0 bit 8: SRS9 error status != 0 bit 9: SRS10 error status != 0 bit 10: SRS11 error status != 0 bit 11: SRS12 error status != 0 bit 12: SRS13 error status != 0 bit 13: SRS14 error status != 0 bit 14: SRS15 error status != 0 bit 15: SRS16 error status != 0
If an error status bit is set, the extended SRS information can provide additional error information.			
BatErrCode2	4	228	Battery error code as bit field bit 0 - 15: SRS17 – 32 error status != 0
BatErrCode3	4	229	Battery error code as bit field bit 0 - 15: SRS33 – 48 error status != 0
BatErrCode4	4	230	bit 0-14: SRS49 – 63 error status != 0 bit 15: obsolete

Name	Func.	Reg.	Description
SysWarnCode1	4	231	StoraXe System warnings as bit field bit 0 - 7: reserved bit 8: One or more SRS failed bit 9: Requested real power can't be fulfilled bit 10: Requested reactive power can't be fulfilled bit 11: reserved bit 12: reserved bit 13: Requested cos phi below inverter limit bit 14: Requested cos phi above inverter limit bit 15: reserved
			A warning bit is set, as soon as one SRS reports a warning. In this case one parameter is close to an error limit. The maximum charge / discharge currents are limited. The operator has to expect a battery disconnection from the DC power bus if these limits are further exceeded.
SysWarnCode2	4	232	StoraXe System warnings as bit field bit 0: Maximum apparent power in island mode exceeded bit 1: Waiting for full charge conditions to be fulfilled bit 2: Roof fan Failure bit 3: Container door open bit 4: Zero power force bit 5: Fire extinguisher blocked by hand lever bit 6: Fire extinguisher pre-alarm bit 7: Transformer temperature sensor over temperature warning bit 8: Watchdog is disabled bit 9: Fire extinguisher aggregated error bit 10: Fire extinguisher aggregated shutdown bit 11: Door 2 open bit 12: Transformer thermo couple error bit 13: Transformer over temperature bit 14: Transformer over temperature warning bit 15: System paused
SysWarnCode3	4	233	StoraXe System warnings as bit field bit 0: Transformer winding protection, apparent power is limited bit 1: Air conditioning system generic warning bit 2: Air conditioning system generic error bit 3: Fire extinguisher collective error bit 4: Fire extinguisher collective shutdown

			bit 5: Fire extinguisher collective fire bit 6: Inverter filter fuse defect bit 7: Inverter overtemperature bit 8: Inverter undertemperature bit 9: Inverter is forced to zero power due to overtemperature 15 bit 10: reserved bit 11: toggle byte is hanging 15 bit 12: USV or power supply is disfunctional 15 bit 13 - 15: reserved
SysWarnCode4	4	234	StoraXe System warnings as bit field bit 0 - 15: reserved
SysErrCode1	4	236	StoraXe System Error as bit field bit 0: Battery in error state (BatteryState == Error) bit 1: Inverter in error state bit 2 - 7: reserved bit 8: SRS string voltage difference too high bit 9: SRS timeout bit 10: SRS did not respond to contactor command bit 11: Unexpected contactor status of SRS bit 12 - 14: reserved bit 15: Inverter/Grid not ready
			Annotation: • *bit 0 in reg. 236 indicates that a bit is set in register BatErrCode Reg. 227ff.* • *bit 1 in reg. 236 indicates that a bit is set in register InvErr Reg. 219 ff.*
SysErrCode2	4	237	StoraXe System Error as bit field bit 0: Number of SRS incorrect bit 1: reserved bit 2: reserved bit 3: SRS communication problem bit 4: Missing SXS configuration bit 5: Inverter offline bit 6: Forced system shutdown bit 7: N/PE error bit 8: CO sensor bit 9: Water sensor bit 10: Emergency button

			bit 11: CO_2 extinguisher: Alarm bit 12: (reserved) bit 13: (reserved) bit 14: (reserved) bit 15: CO_2 extinguisher: actuated
SysErrCode3	4	238	StoraXe System Error as bit field bit 0: Transformer over temperature bit 1: Transformer temperature sensor error bit 2: SRS toggle bit error bit 3: Watchdog timeout bit 4 - 15: reserved
SysErrCode4	4	239	StoraXe System Error as bit field bit 1 - 13: reserved bit 14: System locked due to welded contactor detection bit 15: at least one SRS precharge fuse failed or SRS not connected to DC bus

4.3.2 StoraXe system management

Name	Func.	Reg.	Description
VPNStatus	3;6	240	If a VPN connection is established this value reads 1, else 0. 14
ModSet (obsolete)	2;5	241	Actual mode: (obsolete) 0 = Modbus: System locally controlled over the local interface 1 = System remotely controlled through Big-LinX
DataExchange	3;6	242	Generic data exchange register which can be written and read by the external controls. Written data will be stored until reboot.
ResetErr	5	243	Reset Error (Acknowledge error for reset)
			Each time this bit is set to 1, the StoraXe system controller acknowledges all present errors and tries to go into the system state according to SysStReq Reg. 244.
SysStReq	3;6	244	Requested system state 0 = off 1 = balancing 2 = auto 3 = island mode 4 = line-commutated 10 = standby 20 = sleep 22 = deep sleep
TimeToOff	3;6	31	Time [s] After this time SysSt changes from 10 (standby) to 0 (off). Setting this value to 0 disables this (default). 17

Reg. 244 enables to request for a new system state. The balancing-state initiates parallel string balancing between multiple connected strings to balance their string voltages. This state is automatically called when switching from "0 = off" to state 2, 3, 4, 10, 20 or 22 and is not necessary for normal operation.

For systems with island and emergency power option the standard operating state is "2 = auto". The system states "3 = island mode" and "4 = line-commutated" allow to manually select the system state. In auto state, the system operates line-commutated and automatically switches to island state in case of a mains power failure.

State "10 = standby" puts the system in a stand-by operating state:

When switching to system state "standby", the system starts (if it is not already running in state = 2, 3 or 4), boosts the DC link and then connects to AC grid. Subsequently, the system stops boosting the DC link from the batteries and supplies the DC link over a bridge rectifier from AC grid. This state conserves battery power, reduces strain on the battery and thus enhances the battery lifetime. Furthermore this state allows to quickly switching back to normal operating states 2, 3 or 4.

The system state "sleep" enables to reduce the stand-by power and still being able to power up quickly. The battery string operates in this state while the inverter controller is sleeping. The DC contactors between battery and inverter are closed in order to boost the DC link quickly.

System state "deep sleep" completely switches off the inverter, and opens the DC contactors between battery and inverter, thus allowing to monitor battery life data like temperatures or voltages. Care should be taken about battery SOC as this state consumes battery power.

Not all specified states are available for all systems, e.g. depending on the inverter features/type.

IdleTimerStandby (obsolete)	3;6	245	Time [s] until system automatically switches to system state standby if real power and reactive power requests are set to zero. Deactivate this feature by setting this value to 0. Default: 0

Reg. 245 enables to set a timer which automatically sets the system to system state "standby", if power request are zero and system state = line-commutated and SysStReq is not sleep and IdleTimerStandby > 0. The system goes back into previously selected system state if a new power request ≠ 0 is set.

Setting an idle timer in system state "auto" may influence the system behavior in case of a grid failure, as the system cannot automatically switch to backup power supply in standby mode.

Not available for all systems, e.g. depending on the inverter features/type.

GPIOControl	3;6	246	Control rear digital SRC1xxx outputs [14] Bits D0 to 5 (D6/7 reserved) correspond to outputs A2…A4: Bitpattern 01 = reset output Bitpattern 10 = set output Bitpatterns 00/11 = don't care Examples set A3 only: 00 00 10 00 (0x0008) reset A2 only: 00 00 00 01 (0x0001)

Outputs are (re-) set only on write access, readback is valid only after write access.

Watchdog	3;6	133	Time [s], if 0 the watchdog is disabled, use a value between 1 and 900 to enable the watchdog.

This register enables a watchdog countdown. The register has to be filled with the number of seconds until the watchdog will stop the system with a "Watchdog timeout" error. It is recommended to re-write the register at least 10 seconds before the countdown reaches 0.

Use this feature to automatically shutdown in case of communication loss between the central control and the battery system.

The default value is 0, thus the warning bit "Watchdog disabled" will be present. The warning will go away after the watchdog has been enabled.

To disable the watchdog again write a value of 0.

4.4 System management

4.4.1 Environmental

Up to 8 sensor pairs for temperature and relative humidity of the air are supported by the interface. Typically one pair of values will be used by one StoraXe container or system.

Name	Func.	Reg.	Description
rel. humidity sensor 0	4	500	rel. humidity of sensor 0 [0.1%]
temperature sensor 0	4	501	temperature of sensor 0 [0.1°C] in a two's complement
rel. humidity sensor *N*	4	500+*N**2	rel. humidity of sensor *N* [0.1%]
temperature sensor *N*	4	500+*N**2+1	temperature of sensor *N* [0.1°C] in a two's complement
..			
rel. humidity sensor 7	4	514	rel. humidity of sensor 7 [0.1%]
temperature sensor 7	4	515	temperature of sensor 7 [0.1°C] in a two's complement

4.5 Extended SRS Information

An extended interface delivers additional data of all connected Storage Rack System (SRS) for information purposes and for error diagnostics. The register set ID of a given SRS starts at 1000 plus an offset of 100 registers for each SRS, e.g.:

SRS-Number	ID
1	1000
2	1100
3	1200
…	…
128	13700

This ID allows getting information about every SRS. The following information can be polled within the SRS-specific register range:

Name	Func.	Reg.	Description
	4	ID + 0	reserved
SRSVoltage	4	ID + 1	Actual measured SRS voltage [0.1V] unsigned
SRSCurrent	4	ID + 2	Averaged SRS current [3 s, 0.1 A] in a two's complement Charge current is negative
	4	ID + 3	reserved
SRSAvgCellVoltage	4	ID + 4	Average cell voltage in SRS [mV] unsigned
SRSMinCellVoltage	4	ID + 5	Minimum cell voltage in SRS [mV] unsigned
SRSMinCellTemp	4	ID + 6	Minimum cell temperature in SRS [°C] in a two's complement
SRSMaxCellVoltage	4	ID + 7	Maximum cell voltage in SRS [mV] unsigned
SRSMaxCellTemp	4	ID + 8	Maximum cell temperature in SRS [°C] in a two's complement
SRSSysTemp1	4	ID + 9	SRS temperature sensor 1 [°C] in a two's complement
SRSSysTemp2	4	ID + 10	SRS temperature sensor 2 [°C] in a two's complement
SRSSOC	4	ID + 11	State of charge SOC [%] unsigned Minimum SOC in SRS
SRSSOH	4	ID + 12	State of Health SOH [%] unsigned Minimum SOH in SRS
			Reg. ID + 12 represents capacity fading of the cells in relation to the design capacity. Typically, battery end of life is defined as 80% of the initial "design" capacity which corresponds in this case to SOH = 80%.
SRSContactorState	4	ID + 20	Indicates state of contactors of the SRS: 0 = contactors open 1 = pre-charge 2 = full charge
SRSErr1	4	ID + 21	SRS error code as bit field bit 0: Overcurrent bit 1: Overvoltage bit 2: Undervoltage bit 3: Undertemperature bit 4: Overtemperature bit 5: Self-test error

			bit 6: DC-power cable missing bit 7: External stop from I/O bit 8: Incompatible SRB in SRS bit 9: SRB fan bit 10: Broken wire detection bit 11: Current sensor bit 12: Second Level Safety bit 13: Third Level Safety bit 14: Contactor bit 15: Service required (non-resettable error)
SRSErr2	4	ID + 22	SRS error code as bit field bit 0: Roof fan bit 1: SRR isolation error bit 2: SRR emergency stop bit 3: SRS triggered “yellow light” error bit 4: Watchdog timeout bit 5: Minimum SOC timeout bit 6: Minimum SOC timeout (non-resettable error) bit 7 - bit 14: reserved bit 15: Other errors
SRSErr3	4	ID + 23	SRS error code as bit field bit 0 - bit 15: reserved
SRSErr4	4	ID + 24	SRS error code as bit field bit 0 - bit 15: reserved
SRSWarn1	4	ID + 25	SRS warn code as bit field bit 0: reserved bit 1: Derating to prevent overvoltage bit 2: Derating to prevent undervoltage bit 3: Derating due to underemperature bit 4: Derating due to overtemperature bit 5: “Yellow light” bit 6: Watchdog disabled bit 7 - bit 15: reserved
SRSWarn2	4	ID + 26	SRS warn code as bit field bit 0 - bit 15: reserved
SRSWarn3	4	ID + 27	SRS warn code as bit field

			bit 0 - bit 15: reserved
SRSWarn4	4	ID + 28	SRS warn code as bit field bit 0 - bit 15: reserved
SRC-SN1	4	ID + 31	2 ASCII char of SRC serial number, MSB sent first
SRC-SN2	4	ID + 32	2 ASCII char of SRC serial number, MSB sent first
SRC-SN3	4	ID + 33	2 ASCII char of SRC serial number, MSB sent first
SRC-SN4	4	ID + 34	2 ASCII char of SRC serial number, MSB sent first
SRC-SN5	4	ID + 35	2 ASCII char of SRC serial number, MSB sent first
SRS-CfgVersion	4	ID + 38	Version of SRS configuration
SRC-FW1	4	ID + 39	SRC firmware version 1
SRC-FW2	4	ID + 40	SRC firmware version 2
SRC-FW3	4	ID + 41	SRC firmware version 3
SRC-FWR	4	ID + 42	SRC revision of firmware
SRSIChargeMax	4	ID + 43	SRS max charge current [100mA] unsigned 14
SRSIDisChargeMax	4	ID + 44	SRS max discharge current [100mA] unsigned 14
SRSPChargeMax	4	ID + 45	SRS max charge power [100W] unsigned 14
SRSPDisChargeMax	4	ID + 46	SRS max discharge power [100W] unsigned 14
SRSAvgCellTemp	4	ID + 47	Average cell temperature in SRS [°C] unsigned 14
SRSSOCmax	4	ID + 48	SRS maximum SOC [%] unsigned 14
SRSUModMin	4	ID + 49	SRS minimum module voltage [100mV] unsigned 14
SRSUModAvg	4	ID + 50	SRS average module voltage [100mV] unsigned 14
SRSUModMax	4	ID + 51	SRS maximum module voltage [100mV] unsigned 14

4.6 System status at power unit level

4.6.1 Power unit information

One system may consist of up to 12 power units, each equipped with batteries and one inverter. Power unit information start at register 60000, with an offset of 50 registers for each unit:

Power unit	ID
1	60000
2	60050
3	60100
…	…
12	60550

Available information for each power unit:

Name	Func.	Reg.	Description
	4	ID+0	reserved
NrOfSRS	4	ID+1	Number of SRS contacted to this unit. [14]
NrOfSRSFaulted	4	ID+2	Number of SRS not contacted to this unit. [14]
Voltage	4	ID+3	Unit DC voltage [100mV]. [14]
Current	4	ID+4	Unit DC current [A] 32bit float. [14]
SOCAvg	4	ID+6	Average SoC [%]. [14]
SOCMin	4	ID+7	Minimum SoC [%]. [14]
SOCMax	4	ID+8	Maximum SoC [%]. [14]
SOHMin	4	ID+9	Minimum SoH [%]. [14]
IChgMax	4	ID+10	Max charge current [A] unsigned 32bit float. [14]
IDisChgMax	4	ID+12	Max discharge current [A] unsigned 32bit float. [14]

PChgMax	4	ID+14	Max charge power [W] unsigned 32bit float. 14
PDisChgMax	4	ID+16	Max discharge power [W] unsigned 32bit float. 14
InvTempMax	4	ID+18	Highest inverter temperature [°C], two's complement. 14
InvTempMin	4	ID+19	Lowest inverter temperature [°C], two's complement. 14
BatTempMax	4	ID+20	Highest battery temperature [°C], two's complement. 14
BatTempMin	4	ID+21	Lowest battery temperature [°C], two's complement. 14
InvErr1	4	ID+22	Inverter error codes 1. 14
InvErr2	4	ID+23	Inverter error codes 2. 14
InvErr3	4	ID+24	Inverter error codes 3. 14
InvErr4	4	ID+25	Inverter error codes 4. 14
For inverter error bits please refer to registers 219 to 223.			

5. System behavior on error conditions

Index	Component	Type of failure	Behaviour	Signaling bits	Actions
1.1	StoraXe Battery Module (SRB)	Physical 1st order violation of battery module safety parameters regarding voltage temperature or current.	Enforced opening of the DC contactors of the whole SRS segment independent of the current. Other parallel SRS segments which are not physically affected will continue with operation.	SRSErr1 bits 0-4	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger a acknowledge. The segment will be started and the contacts will be closed if the voltage of the SRS segment matches the other parallel connected SRS segments. If the voltage does not match the systems waits until the condition occurs. From an operating point of view one could charge or discharge the SRS in operation until the voltage level

					is reached to speed up this recovery process.
1.2	StoraXe Battery Module (SRB)	Physical 2nd or 3rd order violation of battery module safety parameters regarding voltage temperature or current.	Enforced opening of the DC contactors of the whole SRS segment independent of the current. Other parallel SRS segments which are not physically affected will continue with operation.	SRS-Err1. bit 12 and bit 13	ads-tec service must be contacted.
2.1	StoraXe Battery String Controller SRC2000	Loss of Ethernet communication with the main controller (SRC1420) or loss of supply voltage of the SRC2000.	Enforced opening of the DC contactors when the watchdog timeout is reached.	SRSErr2 bit4	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger an acknowledge.
2.2	StoraXe Battery String Controller SRC2000	Failure of DC contactors to close	String will go to error state instead of operation. All other not affected strings wlll operate normally.		ads-tec service must be contacted.
2.3	StoraXe Battery String Controller SRC2000	Failure of DC contactors to open	String will go to error state instead of off. All other not affected strings on the same power unit will also go to error. Attached inverter will be switched off. If installed DC contactors of attached inverter will be opened.		ads-tec service must be contacted.
3.1	Inverter	Generic failure of single power unit to operate.	Attached strings will get switched off and their DC contactors opened. Other unaffected power units will continue to operate.	Corresponding InvErr bit is set.	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger an acknowledge. The power unit in failure will be restarted to match the operating state of the whole system.
3.2	Inverter	Transformer winding temperature sensor above warning threshold and bellow error threshold	System will continue to operate according with full power according to the requests. It is up to the controller to take into	Corresponding Warning bit is set.	External controller can reduce power requests or activate additional cooling.

			regard the warning and reduce the power requests.		
3.3	Inverter	Transformer winding temperature sensor above error threshold	All attached inverters of the transformer will enter error state. All DC contactors and AC contactors will be opened. If there are multiple transformers in the systems then other not affected parts will continue to operate.	Corresponding error bits are set.	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger an acknowledge.
3.4	Inverter	Transformer winding temperature sensor failure	*Tbd*	Corresponding warning bits are set.	*Tbd*
4.1	HVAC	Generic failure to operate	System will continue to operate as normal until cell temperature reached the operating window as described at 1.1	Corresponding SXS warning bit is set	Reason for warning must be removed.
5.1	CO2 extinguishing system	Extinguishing system is actuated	System will go to error state. All inverters and batteries will shut down. If there are multiple extinguishing systems the behavior of the complete setup is defined by the electrical circuits on a per project basis.	Corresponding error bits are set	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger an acknowledge.
5.2	CO2 extinguishing system	Extinguishing system detects fire	System will go to error state. All inverters and batteries will shut down. If there are multiple extinguishing systems the behavior of the complete setup is defined by the electrical circuits on a per project basis.	Corresponding error bits are set	Reason for failure must be removed. ResetErr bit can be set by the external controller to trigger an acknowledge.

6. Abbreviations

BLX	Big-LinX
IP	Internet protocol
SOC	State of Charge
SOH	State of Health
SRC	Storage Rack Controller
SRS	Storage Rack System
SXS	StoraXe System

7. Approval

Position	Name	Signature
CTO	Dr. Thorsten Ochs	