

CEGASA

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Anexo 3:

Protocolo comunicaciones Modbus TCP/IP

Registro de revisiones

VERSIÓN	FECHA	DESCRIPCIÓN
Octubre 2025	3/10/2025	Actualización registros

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A3.1 OBJETIVO

El presente documento tiene por objeto definir el protocolo Modbus implementado en los Sistemas de Baterías de CEGASA. Este protocolo sigue la norma IEEE 1547-2018, estándar SunSpec 800x.

A3.2 DESCRIPCIÓN GENERAL

El estándar de SunSpec 800X para baterías de litio ofrece una guía para definir las variables de monitorización y control sistemas de almacenamiento de energía basados en baterías de litio. Estas variables las agrupa en distintos modelos, cada uno orientada a un ámbito de la aplicación.

Para definir los modelos, SunSpec realiza la siguiente clasificación de componentes dentro de un sistema de almacenamiento basado en litio:

Terminology

Battery manufacturers have different terms for the components that make up a lithium-ion battery energy storage system. This specification and the associated model use the following terms:

Term	Definition
Cell	A single energy or charge-storing unit
Module	A single enclosed unit consisting of a set of cells
String	Set of battery modules connected in series
Bank	Set of battery strings connected in parallel

Con esta clasificación, establece una serie de modelos, tanto genéricos como particulares de la aplicación:

COMPONENTE	MODELO
Common	Modelo 1
Base	Modelo 802
Bank	Modelo 803
String	Modelo 804
Module	Modelo 805

Detallando cada modelo como se describe a continuación:

- **Base Model (802):** Este modelo proporciona puntos clave de monitoreo y control para todos los dispositivos de almacenamiento de baterías. Es el modelo principal que se utiliza para la comunicación con la batería.
- **Bank Model (803):** Este modelo proporciona puntos de monitoreo y control para un banco de baterías de litio. Incluye información resumida sobre las cadenas dentro del banco.
- **String Model (804):** Este modelo proporciona puntos de monitoreo y control para una cadena de baterías de litio específica. Incluye información resumida sobre los módulos dentro de la cadena.
- **Module Model (805):** Este modelo proporciona puntos de monitoreo y control para un módulo de batería de litio específico. Incluye información resumida sobre las celdas dentro del módulo.

Cada modelo en SunSpec está compuesto por dos partes: una parte fija y una parte variable.

La parte fija de cada modelo se refiere a los campos y parámetros que son comunes y se mantienen constantes para todos los dispositivos que implementan ese modelo. Estos campos representan la estructura básica y los atributos esenciales del modelo. Por ejemplo, en el Modelo 1 Common, los campos como Model ID, Model Length, Manufacturer, y Serial Number son parte de la parte fija, ya que estos campos son necesarios para identificar y describir el dispositivo.

La parte variable de cada modelo se refiere a los campos y parámetros que pueden variar entre diferentes dispositivos o implementaciones del mismo modelo. Estos campos representan información específica del dispositivo o configuraciones personalizadas. Por ejemplo, en el Modelo 1 Common, los campos como Options, Version y Device Address son parte de la parte variable, ya que pueden contener valores específicos del fabricante o configuraciones específicas del dispositivo.

La parte fija proporciona la estructura y los campos básicos necesarios para todos los dispositivos que implementan ese modelo, mientras que la parte variable permite la personalización y adaptación del modelo a las necesidades específicas de cada dispositivo o implementación.

Para el caso de baterías de Cegasa, la parte variable dependerá de la configuración concreta de cada aplicación, ya que el número de strings que puede contener cada sistema es variable. A continuación, se muestra una tabla con una definición de la estructura modbus para el caso de 9 strings.

Register	Description	Values
4x40001	'SunS' Identifier	32-bit Identifier : 0x53756e53
4x40003	Common Model	Model ID : 1 Model Length : 66 ⋮
4x40071	Battery Base Model	Model ID : 802 Model Length : 62 ⋮
4x40135	Lithium-ion Battery Bank Model	Model ID : 803 Model Length : $26 + (9 * 28) = 278^2$ ⋮
4x40415	End Model	Model ID : 0xFFFF Model Length : 0

Para la aplicación del estándar Sunspec para baterías Cegasa, se plantea utilizar dos aproximaciones.

- Una primera simplificada que únicamente contendrá los modelos 1 y 802.
- Una segunda aproximación más detallada contendrá los modelos 1, 802, 803

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Field Type	Register	Address Offset	Block Offset	Size	Name	Label	Value	Type	Units	Scale Factor	RW Access (RW)	Mandatory (M)	Static (S)	Description	Notes
Header	0	0		1	id[0]	Sunspec Identifier	0x5375	uint16				M	S	Sunspec Identifier - Su	
Header	1	1		1	id[1]	Sunspec Identifier	0x6e53	uint16				M	S	Sunspec Identifier - nS	
Model 1 Common Model															
Header	2	0		1	ID	Common Model ID	1	uint16				M	S	Model identifier	
Header	3	1		1	L	Common Model Length	66	uint16				M	S	Model length	
Fixed Block	4	2	0	16	Mn	Manufacturer	"CEGASA"	string32				M	S	Well known value registered with SunSpec for compliance	
Fixed Block	20	18	16	16	Md	Model		string32				M	S	Manufacturer specific value (32 chars)	
Fixed Block	36	34	32	8	Opt	Options		string16					S	Manufacturer specific value (16 chars)	
Fixed Block	44	42	40	8	Vr	Version		string16					S	Manufacturer specific value (16 chars)	
Fixed Block	52	50	48	16	SN	Serial Number		string32				M	S	Manufacturer specific value (32 chars)	
Fixed Block	68	66	64	1	DA	Device Address	0x01	uint16						Master CAN ID	
Fixed Block	69	67	65	1	Pad		0x8000	pad					S	Force even alignment	
Model 802 Energy Storage Base Model															
Header	70	0		1	ID	Energy Storage Base Model ID	802	uint16				M	S	Model identifier	
Header	71	1		1	L	Energy Storage Base Model Length	62	uint16				M	S	Model length	
Fixed Block	72	2	0	1	AHRtg	Nameplate Charge Capacity		uint16	Ah	AHRtg_SF	R	M	S	Nameplate charge capacity in amp-hours.	
Fixed Block	73	3	1	1	WHRtg	Nameplate Energy Capacity		uint16	Wh	WHRtg_SF	R	M	S	Nameplate energy capacity in DC watt-hours.	
Fixed Block	74	4	2	1	WChaRteMax	Nameplate Max Charge Rate		uint16	W	WChaDisChaMax_SF	R	M		Maximum rate of energy transfer into the storage device in DC watts.	
Fixed Block	75	5	3	1	WDisChaRteMax	Nameplate Max Discharge Rate		uint16	W	WChaDisChaMax_SF	R	M		Maximum rate of energy transfer out of the storage device in DC watts.	
Fixed Block	76	6	4	1	DisChaRte	Self Discharge Rate		uint16	%	DisChaRte_SF	R	O	S	Self discharge rate. Percentage of capacity (WHRtg) discharged per day.	

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Fixed Block	77	7	5	1	SoCMax	Nameplate Max SoC		uint16	%	SoC_SF	R	O		Manufacturer maximum state of charge, expressed as a percentage.	
Fixed Block	78	8	6	1	SoCMin	Nameplate Min SoC		uint16	%	SoC_SF	R	O		Manufacturer minimum state of charge, expressed as a percentage.	
Fixed Block	79	9	7	1	SocRsvMax	Max Reserve Percent		uint16	%	SoC_SF	RW	O		Setpoint for maximum reserve for storage as a percentage of the nominal maximum storage.	
Fixed Block	80	10	8	1	SoCRsvMin	Min Reserve Percent		uint16	%	SoC_SF	RW	O		Setpoint for maximum reserve for storage as a percentage of the nominal maximum storage.	
Fixed Block	81	11	9	1	SoC	State of Charge		uint16	d%	SoC_SF	R	M		State of charge, expressed as a percentage.	Measurement.
Fixed Block	82	12	10	1	DoD	Depth of Discharge		uint16	d%	DoD_SF	R	O		Depth of discharge, expressed as a percentage.	Measurement.
Fixed Block	83	13	11	1	SoH	State of Health		uint16	d%	SoH_SF	R	O		Percentage of battery life remaining.	
Fixed Block	84	14	12	2	NCyc	Cycle Count		uint32		NCyc_SF	R	O		Number of cycles executed in the battery.	
Fixed Block	86	16	14	1	ChaSt	Charge Status		enum16			R	O		Charge status of storage device. Enumeration.	
Fixed Block	87	17	15	1	LocRemCtl	Control Mode		enum16			RW	M		Battery control mode. Enumeration.	Maps to DRCC.LocRemCtl in IEC 61850.
Fixed Block	88	18	16	1	Hb	Battery Heartbeat		uint16			R	O		Value is incremented every second with periodic resets to zero.	Increments from 0 to 100 and resets to zero
Fixed Block	89	19	17	1	CtrlHb	Controller Heartbeat		uint16			RW	O		Value is incremented every second with periodic resets to zero.	
Fixed Block	90	20	18	1	AlmRst	Alarm Reset		uint16			RW	M		Used to reset any latched alarms. 1 = Reset.	Battery should reset to 0 when reset is complete.
Fixed Block	91	21	19	1	Typ	Battery Type	0x0004	enum16			R	M	S	Type of battery. Enumeration.	Maps to DBAT.BatTyp in 61850.
Fixed Block	92	22	20	1	State	State of the Battery Bank		enum16			R	M		State of the battery bank. Enumeration.	Must be reconciled with State in IEC 61850.
Fixed Block	93	23	21	1	StateVnd	Vendor Battery Bank State		enum16			R	O		Vendor specific battery bank state. Enumeration.	
Fixed Block	94	24	22	2	WarrDt	Warranty Date	0x8000	uint32			R	O	S	Date the device warranty expires.	Number of days since 1/1/2000.
Fixed Block	96	26	24	2	Evt1	Battery Event Bitfield 1		bitfield32			R	M		Alarms and warnings. Bit flags.	

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Fixed Block	98	28	26	2	Evt2	Battery Event Bitfield 2	0x8000	bitfield32			R	M		Alarms and warnings. Bit flags.	Reserved for future use.
Fixed Block	100	30	28	2	EvtVnd 1	Vendor Event Bitfield 1		bitfield32			R	M		Vendor defined events.	
Fixed Block	102	32	30	2	EvtVnd 2	Vendor Event Bitfield 2	0x8000	bitfield32			R	M		Vendor defined events.	
Fixed Block	104	34	32	1	V	External Battery Voltage		uint16	V	V_SF	R	M		DC Bus Voltage.	Maps to ZBAT.V in IEC 61850.
Fixed Block	105	35	33	1	VMax	Max Battery Voltage		uint16	V	V_SF	R	O		Instantaneous maximum battery voltage.	If not implemented, must implement AChaMax and ADisChaMax.
Fixed Block	106	36	34	1	VMin	Min Battery Voltage		uint16	V	V_SF	R	O		Instantaneous minimum battery voltage.	If not implemented, must implement AChaMax and ADisChaMax.
Fixed Block	107	37	35	1	CellVM ax	Max Cell Voltage		uint16	V	CellV_SF	R	O		Maximum cell voltage value	Measurement.
Fixed Block	108	38	36	1	CellVM axStr	Max Cell Voltage String		uint16			R	O		Maximum cell voltage string index	
Fixed Block	109	39	37	1	CellVM axMod	Max Cell Voltage Module Cell		uint16			R	O		Maximum cell voltage module and cell indexes	Bit 0:7 = module index; bit 8:15 = cell index
Fixed Block	110	40	38	1	CellVMi n	Min Cell Voltage		uint16	V	CellV_SF	R	O		Minimum cell voltage value	Measurement.
Fixed Block	111	41	39	1	CellVMi nStr	Min Cell Voltage String		uint16			R	O		Minimum cell voltage string index	
Fixed Block	112	42	40	1	CellVMi nMod	Min Cell Voltage Module Cell		uint16			R	O		Minimum cell voltage module and cell indexes	Bit 0:7 = module index; bit 8:15 = cell index
Fixed Block	113	43	41	1	CellVAv g	Average Cell Voltage		uint16	V	CellV_SF	R	O		Average cell voltage for all cells in the bank.	Calculation based on measurements.
Fixed Block	114	44	42	1	A	Total DC Current		int16	A	A_SF	R	M		Total DC current flowing to/from the battery bank.	Measurement.
Fixed Block	115	45	43	1	AChaM ax	Max Charge Current		uint16	A	A_SF	R	O		Instantaneous maximum DC charge current.	Calculation which is always unsigned (i.e. magnitude only). If not implemented, must implement VMax and VMin.
Fixed Block	116	46	44	1	ADisCh aMax	Max Discharge Current		uint16	A	A_SF	R	O		Instantaneous maximum DC discharge current.	Calculation which is always unsigned (i.e. magnitude only). If not implemented, must implement VMax and VMin.

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Fixed Block	117	47	45	1	W	Total Power		int16	W	W_SF	R	M		Total power flowing to/from the battery bank.	Measurement.
Fixed Block	118	48	46	1	ReqInv State	Inverter State Request		enum16			R	O		Request from battery to start or stop the inverter. Enumeration.	Used in special states such as manual battery charging.
Fixed Block	119	49	47	1	ReqW	Battery Power Request		int16	W	W_SF	R	O		AC Power requested by battery.	Used in special states such as string balancing.
Fixed Block	120	50	48	1	SetOp	Set Operation		enum16			RW	M		Instruct the battery bank to perform an operation such as connecting. Enumeration.	
Fixed Block	121	51	49	1	SetInvState	Set Inverter State		enum16			RW	M		Set the current state of the inverter.	Information needed by battery for some operations.
Fixed Block	122	52	50	1	AHRtg_SF		0	sunssf			R	M	S	Scale factor for charge capacity.	
Fixed Block	123	53	51	1	WHRtg_SF		2	sunssf			R	M	S	Scale factor for energy capacity.	
Fixed Block	124	54	52	1	WChadisChamax_SF		2	sunssf			R	M	S	Scale factor for maximum charge and discharge rate.	
Fixed Block	125	55	53	1	DisCharge_SF		-1	sunssf			R	O	S	Scale factor for self discharge rate.	
Fixed Block	126	56	54	1	SoC_SF		-1	sunssf			R	M	S	Scale factor for state of charge values.	
Fixed Block	127	57	55	1	DoD_SF		-1	sunssf			R	O	S	Scale factor for depth of discharge.	
Fixed Block	128	58	56	1	SoH_SF		-1	sunssf			R	O	S	Scale factor for state of health.	
Fixed Block	129	59	57	1	V_SF		-1	sunssf			R	M	S	Scale factor for DC bus voltage.	
Fixed Block	130	60	58	1	CellV_SF		-3	sunssf			R	M	S	Scale factor for cell voltage.	
Fixed Block	131	61	59	1	A_SF		-1	sunssf			R	M	S	Scale factor for DC current.	
Fixed Block	132	62	60	1	NCyc_SF		-1	sunssf			R	M	S	Scale factor for number of cycles	
Fixed Block	133	63	61	1	W_SF		2	sunssf			R	O	S	Scale factor for power.	
Model 803 Lithium-Ion Battery Bank - Fixed block															
Header	134	0		1	ID	Lithium-Ion Battery Bank Model ID	803	uint16				M	S	Model identifier	
Header	135	1		1	L	Lithium-Ion Battery Bank Length	666	uint16	29A			M	S	Model length	Model 803 length = 26 + RB * 32, with RB = 20

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Fixed Block	136	2	0	1	NStr	String Count		uint16			R	M		Number of strings in the bank.	
Fixed Block	137	3	1	1	NStrCo n	Connected String Count		uint16			R	M		Number of strings with contactor closed.	
Fixed Block	138	4	2	1	ModTm pMax	Max Module Temperature		int16	C	ModTmp_S F	R	M		Maximum temperature for all modules in the bank.	
Fixed Block	139	5	3	1	ModTm pMaxSt r	Max Module Temperature String		uint16			R	O		String containing the module with maximum temperature.	
Fixed Block	140	6	4	1	ModTm pMaxM od	Max Module Temperature Module		uint16			R	O		Module with maximum temperature.	
Fixed Block	141	7	5	1	ModTm pMin	Min Module Temperature		int16	C	ModTmp_S F	R	M		Minimum temperature for all modules in the bank.	
Fixed Block	142	8	6	1	ModTm pMinStr	Min Module Temperature String		uint16			R	O		String containing the module with minimum temperature.	
Fixed Block	143	9	7	1	ModTm pMinM od	Min Module Temperature Module		uint16			R	O		Module with minimum temperature.	
Fixed Block	144	10	8	1	ModTm pAvg	Average Module Temperature		uint16	C	ModTmp_S F	R	O		Average temperature for all modules in the bank.	
Fixed Block	145	11	9	1	StrVMA x	Max String Voltage		uint16	V	V_SF	R	O		Maximum string voltage for all strings in the bank.	Measurement.
Fixed Block	146	12	10	1	StrVMA xStr	Max String Voltage String		uint16			R	O		String with maximum voltage.	Measurement.
Fixed Block	147	13	11	1	StrVMI n	Min String Voltage		uint16	V	V_SF	R	O		Minimum string voltage for all strings in the bank.	
Fixed Block	148	14	12	1	StrVMI nStr	Min String Voltage String		uint16			R	O		String with minimum voltage.	
Fixed Block	149	15	13	1	StrVAV g	Average String Voltage		uint16	V	V_SF	R	O		Average string voltage for all strings in the bank.	
Fixed Block	150	16	14	1	StrAMA x	Max String Current		int16	A	A_SF	R	O		Maximum current of any string in the bank.	Maps to DRCC.LocRemCtl in IEC 61850.
Fixed Block	151	17	15	1	StrAMA xStr	Max String Current String		uint16			R	O		String with the maximum current.	
Fixed Block	152	18	16	1	StrAMI n	Min String Current		int16	A	A_SF	R	O		Minimum current of any string in the bank.	
Fixed Block	153	19	17	1	StrAMI nStr	Min String Current String		uint16			R	O		String with the minimum current.	Battery should reset to 0 when reset is complete.
Fixed Block	154	20	18	1	StrAAV g	Average String Current		int16	A	A_SF	R	O		Average string current for all strings in the bank.	Maps to DBAT.BatTyp in 61850.

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Fixed Block	155	21	19	1	NCellBal	Battery Cell Balancing Count	0x8000	uint16			R	O		Total number of cells that are currently being balanced.	Must be reconciled with State in IEC 61850.
Fixed Block	156	22	20	1	CellV_SF		-3	sunssf			R	M		Scale factor for cell voltage.	
Fixed Block	157	23	21	1	ModTm_p_SF		-1	sunssf			R	M		Scale factor for module temperatures.	Number of days since 1/1/2000.
Fixed Block	158	24	22	1	A_SF		-1	sunssf			R	M		Scale factor for string currents.	
Fixed Block	159	25	23	1	SoH_SF		-1	sunssf			R	O		Scale factor for string state of health.	Reserved for future use.
Fixed Block	160	26	24	1	SoC_SF		-1	sunssf			R	M		Scale factor for string state of charge.	
Fixed Block	161	27	25	1	V_SF		-1	sunssf			R	O		Scale factor for string voltage.	
String	1	Model 803 Lithium-Ion Battery Bank - Repeating block													
Repeating Block	162	28	0	1	StrNMod	Module Count		uint16			R	M	S	Count of modules in the string.	
Repeating Block	163	29	1	1	StrConFail	Connection Failure Reason		enum16			R	M		Current status of the string.	See EnumValues_BitFlags
Repeating Block	164	30	2	2	StrSt	String Status		bitfield32			R	O		String connection failure code	See EnumValues_BitFlags
Repeating Block	166	32	4	1	StrSoC	String State of Charge		uint16	%	SoC_SF	R	M		Battery string state of charge, expressed as a percentage.	Measurement.
Repeating Block	167	33	5	1	StrSoH	String State of Health		uint16	%	SoH_SF	R	O		Battery string state of health, expressed as a percentage.	Measurement.
Repeating Block	168	34	6	1	StrA	String Current		int16	A	A_SF	R	M		String current measurement.	Measurement.
Repeating Block	169	35	7	1	StrCellVMax	Max Cell Voltage		uint16	V	CellV_SF	R	M		Maximum voltage for all cells in the string.	Measurement.
Repeating Block	170	36	8	1	StrCellVMaxMod	Max Cell Voltage Module		uint16			R	O		Module containing the maximum cell voltage.	
Repeating Block	171	37	9	1	StrCellVMin	Min Cell Voltage		uint16	V	CellV_SF	R	M		Minimum voltage for all cells in the string.	Measurement.

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Repeating Block	172	38	10	1	StrCellVMinMod	Min Cell Voltage Module	uint16			R	O		Module containing the minimum cell voltage.	
Repeating Block	173	39	11	1	StrCellVAvg	Average Cell Voltage	uint16	V	CellV_SF	R	M		Average voltage for all cells in the string.	Calculation based on measurements.
Repeating Block	174	40	12	1	StrModTmpMax	Max Module Temperature	int16	C	ModTmp_SF	R	M		Maximum temperature for all modules in the bank.	Measurement.
Repeating Block	175	41	13	1	StrModTmpMaxMod	Max Module Temperature Module	uint16			R	O		Module with the maximum temperature.	
Repeating Block	176	42	14	1	StrModTmpMin	Min Module Temperature	int16	C	ModTmp_SF	R	M		Minimum temperature for all modules in the bank.	Measurement.
Repeating Block	177	43	15	1	StrModTmpMinMod	Min Module Temperature Module	uint16			R	O		Module with the minimum temperature.	
Repeating Block	178	44	16	1	StrModTmpAvg	Average Module Temperature	int16	C	ModTmp_SF	R	M		Average temperature for all modules in the bank.	Calculation based on measurements.
Repeating Block	179	45	17	1	StrDisReason	Disabled Reason	enum16			R	O		Reason why the string is currently disabled.	See EnumValues_BitFlags
Repeating Block	180	46	18	2	StrCont	Contactors Status	bitfield32			R	O		Status of the contactor(s) for the string.	See EnumValues_BitFlags
Repeating Block	182	48	20	2	StrEvt1	String Event Bitfield 1	bitfield32			R	M		Alarms, warnings and status values. Bit flags.	See EnumValues_BitFlags
Repeating Block	184	50	22	2	StrEvt2	String Event Bitfield 2	bitfield32			R	O		Alarms, warnings and status values. Bit flags.	Reserved for future use.
Repeating Block	186	52	24	2	StrEvtVnd1	Vendor String Event Bitfield 1	bitfield32			R	O		Vendor defined events.	
Repeating Block	188	54	26	2	StrEvtVnd2	Vendor String Event Bitfield 2	bitfield32			R	O		Vendor defined events.	
Repeating Block	190	56	28	1	StrSetEna	Enable/Disable String	enum16			RW	O		Enables and disables the string.	See EnumValues_BitFlags. Should reset to 0 upon completion.

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Repeating Block	191	57	29	1	StrSet Con	Connect/Disconnect String		enum16			R	O		Connects and disconnects the string.	See EnumValues_BitFlags. Should reset to 0 upon completion.
Repeating Block	192	58	30	1	Pad1	Pad		pad			R	M	S	Pad register.	
Repeating Block	193	59	31	1	Pad2	Pad		pad			R	M	S	Pad register.	
End Block															
Header	802	0		1	EoM[0]		0xFFFF	uint16			R	M	S	End block	
Header	803	1		1	EoM[1]		0xFFFF	uint16			R	M	S	End block	

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