ScandiCAT ModbusTCP specification

Revision history

Rev no **00**	Author JG Sign	Reviewer Sign	Approver Sign	Description Initial
Rev no **01**	Author JG Sign	Reviewer Sign	Approver Sign	Description CosyLabs input
Rev no **02**	Author JG	Reviewer	Approver	Description New addressing scheme and some comments has been moved from the registry list to simplify import from xml
Rev no **03**	Author JG	Reviewer	Approver	Description New variables: Input word 8,120-124
Rev no **04**	Author JG Sign	Reviewer Sign	Approver Sign	Description New stuff…
Rev no **05**	Author FH Sign	Reviewer Sign	Approver Sign	Description Mirror variables added and some updated variables.
Rev no **06**	Author FH Sign	Reviewer Sign	Approver Sign	Description Added phase shifter variables.
Rev no **07**	Author FH Sign	Reviewer Sign	Approver Sign	Description Added variables for SolPS2, SolPS3, Collector power, Body Power.
Rev no **08**	Author FH Sign	Reviewer Sign	Approver Sign	Description Added variables for Collector TempDiff and Body TempDiff.

1. Introduction

1.1. The internal Modbus TCP server enables communication over an Ethernet connection (TCP/IP, 100Mbit or 1000Mbit, IPv4 or IPv6) using the Modbus protocol.

1.2. Modbus is an open standard in industrial communication which is maintained by the independent Modbus Organization. The official specification can be found here:
http://www.modbus.org/docs/Modbus_Messaging_Implementation_Guide_V1_0b.pdf

Here you find a good tutorial:
http://www.rtaautomation.com/modbustcp/

1.3. Refresh rate depends on how big CPU is used in the modulator and also the size/complexity of the modulator, large data such as log-files or waveforms will be slower.

1.4. This protocol is not intended for synchronous streaming of data, such communication can be handled via the optional EtherCAT interface.

1.5. **This document identifies only the most common ModbusTCP registers, your modulator may have more registers depending on size / complexity / other neworks / your preferences.**

1.6. The file Recources.xml should be used by your system as a look-up table for strings, and simplifies the understanding of the state machine related registers:

StateTarget
StateRead
EventLogg
MainEvent
FirstInterlockEvent

1.7. All registers are little-endian (Intel order)

1.8. The Modbus-TCP server is located at “C:\TwinCAT\TcModbusSrv” and uses the following configuration file “ScandiCAT ModbusTCP.xml” located in the same folder (the registry list below is imported from this xml)

1.9. Event log (Address 1000-1649)

Reading the eventLogg is optional (you can control the modulator without this)
Here the fifty last events of the modulator are made available in eight FIFO arrays
Usage: Poll Incr[0] every second, if Incr[0}<>IncrPrev (your local variable) copy the first index of each array to your own
event storage and continue to evaluate Incr[1], if Incr[1]<>IncrPrev continue to copy the next index of each array and so
on until Incr[n]=IncrPrev. Finally copy Incr[0] to IncrPrev. Optionally you could also add a check that new events
must be newer than the previous by comparing TimeStamp[n]<> TimeStampPrev (your local variable)

1.10. MainEvent (Address 1700-1712)

Reading the MainEvent is optional (you can control the modulator without this)
Actual modulator state in the event format, priority:
1. Errors (when not active first interlock is showed instead)
2. First interlock (when not active warning is showed instead)
3. Warning (when not active state is showed instead)
4. State

1.11. FirstInterlockEvent (Address 1715-1727)

Reading the FirstInterlockEvent is optional (you can control the modulator without this). This is a copy of the first interlock since previous reset, after reset this event type is set to 0 to indicate not active

1.12. ReadMatrix (Address 2000-2255)

Reading the ReadMatrix is optional (you can control the modulator without this)
In the following two arrays you can see the state of all units of the modulator.
See MatrixItems in GUI Resource.xml

2. ModbusTCP registers

Registers mapping						
InputRegisters						
Start Address	**End Address**	**Type**	**Unit**	**General**	**Function**	**VarName**
0	0	Int16		Modbus-TCP protocol identification number	Id number of protocol (can be different for different customers)	.gp_iModbusProtocolId
1	1	Int16		Modbus-TCP protocol revision number	Rev number of protocol (updated each time this document changes)	.gp_iModbusProtocolRev
2	2	Uint16		The previously received Modbus-TCP watchdog value	Copied from the ModbusTcpWatchdog holding register, can be used by the master to monitor this communication	SR_SlowCall.IFB_ExtComSts.uiModbusTcpWatchdogPrev
3	3	Int16		The actual state of the modulator	(* See Strings\State in GUI Resource.xml *) This is the actual state of the MSM (Main State Machine), example: StateTarget and StateRead are both "Trig" (13) A solenoid interlock is tripped, this interlock was configured to interlock the "Hv" state (9), therefore StateTarget is immediately set to the target level below which is "StandBy" (5). Now all units immediately go to "StandBy" and report their state to the MSM, when the MSM find that all units are at "StandBy" it sets the iStateRead to "StandBy". At the same time StatusBits.HvInlkExist is set to TRUE Also two events are added to the EventLogg, first the interlock event and then the state event (“StandBy”) Additionally the interlock event is copied to FirstInterlockEvent in case multiple interlocks occur in sequence this first interlock copy will not be overwritten until a reset is received)	.g_iStateRead
4	4	Uint16		A word containing 16 status bit's	Bit0: StbInlkExist Bit1: HvInlkExist Bit2: TrigInlkExist Bit3: WarningExist Bit4: OutsideLimits Bit5: Error Bit6: Spare Bit7: Spare Bit8: Spare Bit9: Spare Bit10: Spare Bit11: Spare Bit12: Spare Bit13: Spare Bit14: Spare Bit15: Spare	.g_wStatusBits
5	5	Int16		The current access level	See Strings\Message 0-3 in GUI Resource.xml	.g_iAccessLevel
6	7	Single		Remaining time of the delay	Filament warm-up timer	SR_SlowCall.IFB_SlowKly.IFB_Delay[1].rTimeRemaining
8	9	Single		Pulse repetition frequency	Pulse repetition frequency read value	SR_FastCall.IFB_FastTi.IFB_PrfRead.atq_rPrfRead
20	20	Single		Modulator target state	Currently used setvalue	.g_iStateTarget
21	22	Single	V	Voltage setvalue of all Ccps	Currently used setvalue	.gp_rVoltSet
23	24	Single	A	Filament current setvalue	Currently used setvalue	SR_FastCall.IFB_FastKly.IFB_FastFilPS.IFB_CurrSet.p_rSet1
25	26	Single	µs	Pulse width setvalue of all SU's	Currently used setvalue	.gp_rPlswthSet
100	101	Single	V	Voltage read value of Capacitor Charging Power Supply no 1	Scaled readvalue	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[1].IFB_VoltRead.atq_rRead
102	103	Single	V	Voltage read value of Capacitor Charging Power Supply no 2	Scaled readvalue	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[2].IFB_VoltRead.atq_rRead
104	105	Single	V	Voltage read value of Capacitor Charging Power Supply no 3	Scaled readvalue	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[3].IFB_VoltRead.atq_rRead
106	107	Single	V	Voltage read value of Capacitor Charging Power Supply no 4	Scaled readvalue	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[4].IFB_VoltRead.atq_rRead
108	109	Single	V	Voltage read value of Capacitor Charging	Scaled readvalue	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[5].IFB_VoltRead.atq_rRead

				Power Supply no 5		
120	120	Word		Interlock status bits of Capacitor Charging Power Supply no 1	Bit0 "Mains interlock" Bit1 "PwmPulseCount interlock" Bit2 "IsaqCom interlock" Bit3 "SoftStart interlock" Bit4 "Igbt interlock" Bit5 "PhaseLoss interlock" Bit6 "TransformerTemp interlock" Bit7 "RectifierTemp interlock" Bit8 "IgbtTemp interlock" Bit9 "OverVoltage interlock" Bit10 "OverCurrent interlock" Bit11 "OptoFiberDarkTimeout"	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[1].IFB_DigitalInputWord.wTempWord
121	121	Word		Interlock status bits of Capacitor Charging Power Supply no 2	Bit0 "Mains interlock" Bit1 "PwmPulseCount interlock" Bit2 "IsaqCom interlock" Bit3 "SoftStart interlock" Bit4 "Igbt interlock" Bit5 "PhaseLoss interlock" Bit6 "TransformerTemp interlock" Bit7 "RectifierTemp interlock" Bit8 "IgbtTemp interlock" Bit9 "OverVoltage interlock" Bit10 "OverCurrent interlock" Bit11 "OptoFiberDarkTimeout"	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[2].IFB_DigitalInputWord.wTempWord
122	122	Word		Interlock status bits of Capacitor Charging Power Supply no 3	Bit0 "Mains interlock" Bit1 "PwmPulseCount interlock" Bit2 "IsaqCom interlock" Bit3 "SoftStart interlock" Bit4 "Igbt interlock" Bit5 "PhaseLoss interlock" Bit6 "TransformerTemp interlock" Bit7 "RectifierTemp interlock" Bit8 "IgbtTemp interlock" Bit9 "OverVoltage interlock" Bit10 "OverCurrent interlock" Bit11 "OptoFiberDarkTimeout"	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[3].IFB_DigitalInputWord.wTempWord
123	123	Word		Interlock status bits of Capacitor Charging Power Supply no 4	Bit0 "Mains interlock" Bit1 "PwmPulseCount interlock" Bit2 "IsaqCom interlock" Bit3 "SoftStart interlock" Bit4 "Igbt interlock" Bit5 "PhaseLoss interlock" Bit6 "TransformerTemp interlock" Bit7 "RectifierTemp interlock" Bit8 "IgbtTemp interlock" Bit9 "OverVoltage interlock" Bit10 "OverCurrent interlock" Bit11 "OptoFiberDarkTimeout"	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[4].IFB_DigitalInputWord.wTempWord
124	124	Word		Interlock status bits of Capacitor Charging Power Supply no 5	Bit0 "Mains interlock" Bit1 "PwmPulseCount interlock" Bit2 "IsaqCom interlock" Bit3 "SoftStart interlock" Bit4 "Igbt interlock" Bit5 "PhaseLoss interlock" Bit6 "TransformerTemp interlock" Bit7 "RectifierTemp interlock" Bit8 "IgbtTemp interlock" Bit9 "OverVoltage interlock" Bit10 "OverCurrent interlock" Bit11 "OptoFiberDarkTimeout"	SR_FastCall.IFB_Ccps.IFB_CcpsUnit[5].IFB_DigitalInputWord.wTempWord
200	201	Single	A	Current readvalue of the filament power supply	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastFilPs.IFB_CurrRead.atq_rRead
202	203	Single	V	Voltage readvalue of the filament power supply	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastFilPs.IFB_VoltRead.atq_rRead
300	301	Single	nA	Current readvalue of the ion pump controller 1	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastIonPS[1].IFB_CurrRead.atq_rRead
302	303	Single	kV	Voltage readvalue of the ion pump controller 1	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastIonPS[1].IFB_VoltRead.atq_rRead
400	401	Single	A	Current readvalue of solenoid power supply 1	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[1].IFB_CurrRead.atq_rRead
402	403	Single	V	Voltage readvalue of solenoid power supply 1	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[1].IFB_VoltRead.atq_rRead
404	405	Single	A	Current readvalue of solenoid power supply 2	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[2].IFB_CurrRead.atq_rRead
406	407	Single	V	Voltage readvalue of solenoid power supply 2	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[2].IFB_VoltRead.atq_rRead

408	409	Single	A	Current readvalue of solenoid power supply 3	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[3].IFB_CurrRead.atq_rRead
410	411	Single	V	Voltage readvalue of solenoid power supply 3	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_FastSolPS[3].IFB_VoltRead.atq_rRead
500	501	Single	A	Current Transformer readvalue	Scaled read value of the pulse current amplitude	SR_FastCall.IFB_FastTank.IFB_Digi.IFB_CtRead.atq_rRead
502	503	Single	kV	Capacitive voltage-divider readvalue	Scaled read value of the pulse voltage amplitude	SR_FastCall.IFB_FastTank.IFB_Digi.IFB_CvdRead.atq_rRead
504	505	Single	µs	Full Width Half Maximum readvalue	Scaled read value of the pulse width at 50% height of the current pulse	SR_FastCall.IFB_FastTank.IFB_Digi.IFB_FwhmRead.atq_rRead
600	601	Single	ºC	Oil temperature readvalue	Scaled readvalue	SR_SlowCall.IFB_SlowTank.IFB_OilTemperature.atq_rRead
602	603	Single	mm	Oil level readvalue	Scaled readvalue of the oil level (0mm at Klystron min specification)	SR_SlowCall.IFB_SlowTank.IFB_OilLevel.atq_rRead
700	701	Single	ºC	Collector inlet water temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[1].atq_rRead
702	703	Single	ºC	Collector outlet water temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[2].atq_rRead
704	705	Single	ºC	Body inlet water temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[3].atq_rRead
706	707	Single	ºC	Body outlet water temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[4].atq_rRead
708	709	Single	ºC	Body temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[5].atq_rRead
710	711	Single	ºC	Solenoid temperature	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempSensors[6].atq_rRead
740	741	Single	ºC	Collector temperature difference between outlet and inlet.	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempDiffCollector.atq_rRead
742	743	Single	ºC	Body temperature difference between outlet and inlet.	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_TempDiffBody.atq_rRead
750	751	Single	kW	Collector power	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_FlowPowerCollector.atq_rRead
752	753	Single	kW	Body power	Scaled readvalue	SR_SlowCall.IFB_Cool.IFB_FlowPowerBody.atq_rRead
800	801	Single	º	Phase shifter read value	Scaled readvalue	SR_FastCall.IFB_FastKly.IFB_PhaseShifter.rAngleRead
1000	1049	Uint16		Event logg increment array	Incremented for each new event, this enables GUI to see if new events has ocurred	.g_aEventsIncr
1050	1099	Uint16		Event logg type array	0=State, 1=Warning, 2=Interlock, 3=Error, 4=Parameter, 5=Message	.g_aEventsType
1100	1299	Uint64		Event logg time-stamp array	TYPE T_FILETIME : STRUCT dwLowDateTime : DWORD; dwHighDateTime : DWORD; END_STRUCT END_TYPE The T_FILETIME structure is a 64-bit value representing the number of 100-nanosecond intervals since January 1, 1601 (UTC). (Since modbus doesn't support Uint64 you have to read four words per timestamp)	.g_aEventsTime
1300	1399	Uint32		Event logg trig id array	The current trig id/count	.g_aEventsTrigId
1400	1449	Uint16		Event logg index array	Shows which item that generated this event, see Matrixltems in GUI Resource.xml	.g_aEventsIndex
1450	1499	Uint16		Event logg text number array	See GUI Resource.xml\Strings, Type determines sub-element	.g_aEventsTextNo
1500	1549	Uint16		Event logg data type array	0=No data, 1=Real, 2=Bool, 3=Int, 4=Uint, 5=Word, 6=Dint, 7=Udint, 8=Dword	.g_aEventsDataType
1550	1649	Uint32		Event logg data array	Here data for the event can be entered, if DataType indicates NoData then this value is random	.g_aEventsData
1700	1712	Struct		Main event struct	This can be used to present the actual state of the modulator, you see State, Warnings, FirstInterlock and Error messages STRUCT	.g_stMainEvent

					Incr : Uint16; (addr: 1700) Type : Uint16; (addr: 1701) TimeStamp : Uint64; (addr: 1702) TrigId : Uint32; (addr: 1706) Index : Uint16; (addr: 1708) TextNo : Uint16; (addr: 1709) DataType : Uint16; (addr: 1710) Data : Uint32; (addr: 1711) END_STRUCT	
1715	1727	Struct		Main event struct	Displays the first interlock event since previous reset, the Type element will indicate active interlock whith the value 2 and inactive/resetted with the value 0 STRUCT Incr : Uint16; (addr: 1715) Type : Uint16; (addr: 1716) TimeStamp : Uint64; (addr: 1717) TrigId : Uint32; (addr: 1721) Index : Uint16; (addr: 1723) TextNo : Uint16; (addr: 1724) DataType : Uint16; (addr: 1725) Data : Uint32; (addr: 1726) END_STRUCT	.g_stFirstInterlockEvent
2000	2255	Uint16		State read array	In this array you can see the actual state of all items in the modulator, see Strings\State in GUI Resource.xml	.g_aReadMatrixStateRead
2300	2555	Uint16		Status bit's array	In this array you can see the unlatched status bit's of all items in the modulator, Bit0: Warning condition exists Bit1: Interlock condition exists	.g_aReadMatrixStatusBits

OutputRegisters						
Start Addr	**End Addr**	**Type**	**Unit**	**General**	**Function**	**VarName**
0	0	Uint16		Communication watchdog	Increment this value at least every second (depending on timeout setting in local GUI), used by the modulator to monitor this communication	SR_SlowCall.IFB_ExtComSts.uiModbusTcpWatchdog
1	1	Int16		Modulator target state	This is the target state of the MSM (Main State Machine), example: iStateTarget and iStateRead are both "Off" (1) You request the modulator to "Hv" state by writing 9 to StateTarget See Strings\State in GUI Resource.xml	.g_iStateTargetRem
2	2	Uint16		Command bit's Bit0: Reset Bit1: ECAT control (use .g_rVoltSetEcat)	A word containing 16 command bit's Bit0: Reset (remember to set it back to zero afterwards) Bit1: ECAT control (use .g_rVoltSetEcat)	.g_wCommandBitsRem
100	101	Single	V	Voltage setvalue of all Ccps	Scaled setvalue, range 0-1200VDC	.g_rVoltSetRem
200	201	Single	A	Filament current setvalue	Scaled setvalue, range 0-30ADC	SR_FastCall.IFB_FastKly.IFB_FastFilPS.IFB_CurrSet.ati_rSet1Rem
300	301	Single	µs	Pulse width setvalue of all SU's	Scaled setvalue, range 1-5µs	.g_rPlswthSetRem
800	801	Single	°	Phase shifter set value.	Scaled setvalue, range 0-540 degrees	SR_FastCall.IFB_FastKly.IFB_PhaseShifter.rAngleSetRem