# **SERCOS Protocol Analyzer**

Takahisa Sakuma

Shin Nagata

Yoshiaki Kobayashi

# 1. Introduction

Since 1996, our company has been developing the system adopting SERCOS interface and producing components, and developing the SERCOS products, an international standard.

We have so far been commercializing a group of SERCOS products, such as a controller "S-MAC PC", an objected-oriented full-software motion control language "AML" along with servo drivers with SERCOS I/F, such as "PV2W", "PQ" Type R, "PQ" Type M, "PE-W" and "PZ-W", in addition a SERCOS I/O unit "SRU10D". This time we have developed the SERCOS analyzer, which analyzes the SERCOS interface protocol in order to facilitate the defect analysis on SERCOS systems and to reduce the start-up time of the SERCOS product. This SERCOS protocol analyzer is introduced in this document.

# 2. SERCOS Protocol Analyzer

# 2.1 Basic Configuration

Fig.1 shows a basic system configuration used this SERCOS protocol analyzer. A basic configuration consists of the target unit and the host analyzer software that controls the unit. Fig.2 shows the target unit.

With the SERCOS protocol analyzer software, the user analyze the real-time SERCOS communication data displayed on the screen of his/her pc, while the software is communicating with its target unit via RS-232C.



Fig.1 Basic Configuration of SERCOS Protocol Analyzer



Fig.2 Target Unit

## 2.2 Internal Configuration of Target Unit

Fig.3 shows the internal configuration of the target unit. This unit consists of an ASIC "SERCON816" which controls the SERCOS communication, a RAM (memory) to trace the communication data, a D/A converter to monitor the communication data with the oscilloscope, FPGA which manages SERCOS communication time and the transition of the external inputs, and a CPU to transmit the temporarily stored data in the RAM toward the management PC.



Fig.3 Internal Configuration of SERCOS Analyzer

# 2.3 Features

The main features of the SERCOS analyzer are as follows.

(1) Compact Size

The Target unit is compact and lightweight so it is ideal for field use. (W70×H138×D25) In addition, a RS232C interface is ready for connecting to PC to realize the general-purpose use.

(2) SERCOS baud rate and communication cycle

The SERCOS baud rate can be selected from 2, 4, 8, and 16MHz at the time of starting the software.

Moreover, the SERCOS cycle can be selected from 1msec or 2msec.

(3) Optical communication transmit level

The intensity of optical transmitting is selectable from 1 to 6 16MHz at the time of starting the software.

(4) Real-Time Monitoring

The cyclic data of axes, such as AT (Amplifier Telegram) and MDT (Mater Data Telegram), configured to monitor at starting the software can be checked for the command and feedback data by real-time monitoring.

(5) Manual tracing command

The communication data of an axis selected at the time of starting the software can be traced at a random timing. The traced data is displayed after it is uploaded into the personal computer. The total of the traced data can be displayed at one try is about 400 samplings of SERCOS communication cycle.

- (6) Automatic tracing command with trigger conditions Various kinds of trigger events can be set as trigger conditions, including SERCOS phase information, status data, control data, cyclic data, the transition of external inputs. When any trigger events meet the trigger conditions defined, the tracing data will be automatically displayed on the screen after completing the uploading process to the pc. The traced data can be displayed at one try is about 400 samplings of the SERCOS communication and the trigger point can be selected manually, 100 samples 200 samples or 300 samples. Additionally displayed traced data can
- (7) External Trigger Input

The target unit has four external inputs, which can be used to set the trigger conditions. As a result, the data which relates to events other than the SERCOS communication can be traced as well

be saved on PC as a text file with naming.

(8) DAC Monitor Function

The Target unit has a D/A converter to output SERCOS cyclic data including position command values or position feedback values. By connecting the unit to an oscilloscope or a data logger, the user can monitor the waveform of these data on the screen.

### 2.4 Basic Specification

Table 1 shows a basic specification of the SERCOS protocol analyzer.

Table 1	Basic Specification
---------	---------------------

Item	Specification		
Protocol	IEC61491(SERCOS)compatible		
Data Transfer Speed	Selectable from 2M, 4M, 8M and 16Mbps		
Host Interface	RS232C interface (9600bps )		
Monitoring Software	OS : Windows NT, Windows 98(95) (English, Japanese)		
Features	Real time monitoring,		
	Automatic tracing command with trigger conditions, and		
	Dumping and Saving function		
Power Supply	DC4.75 ~ 5.25V		
Temperature Range for Use	0 ~ 55		
Accessory	A pair of SERCOS optical fiber cable		
Option	DC adopter (for +5V power supply )		
	Power supply cable		

Note: The slave axis that can be analyzed at one try is up to one axis selected at starting the monitoring software.

Note: The SERCOS communication cycle is only 1msec or 2msec.

# 3. Outline of SERCOS Protocol Analyzer Software Operation

The outline of the SERCOS protocol analyzer software operation is explained next.

#### 1) Start of Tool

After the tool is installed, click "SERCOS Analyzer.EXE" in the installation folder. The main window of this tool appears as shown in figure 4.

Cyclic data monitor	2393	Interface Status				
Time: Address:	0 us	External Input s				
Phase:	- 20	Bit3-0:				
Time: Address:	0 us Staus:	-	-			
Info	Length (	WORD):	-			
Data00-07(0x) Data08-15(0x)				-		
Time:	0 us				=1	
Address:	Control:					
Info:	Length (	WORD):				
Data00-07(0x): Data08-15(0x)				-		

Fig.4 Main screen

2) Configuration

Select "Configure Analyzer" under the Tools menu and set an address of the axis, the SERCOS communication baud rate, and the optical communication transmit level.

#### 3) Start of Master Device

Start up the SERCOS system including the SER-COS master and SERCOS slave devices.

#### 4) Setting of Trigger Condition

Select "Trigger Setting" under the Tools menu and set different kinds of trigger events. Fig.5 shows the trigger setting screen.

AT Condition MDT Condition Cyclic data values External Input events AT Stutuse BI Pattan Bit15 Bit14 Bit13 Bit12 Bit11 Bit10 Bit09 Bit08 Bit07 Bit06 Bit05 Bit04 Bit03 Bit02 Bit01 Bit00 Checked value: 1, No checked value: 0 AT Status Enable Pattan Ready to Operate(Bit15) Change bitfor (20(Bit12) Change bitfor (20(Bit12) Bit18 Bit18 Bit11 Bit10 Bit09 Bit19 Bit19 Bit11 Bit10 Bit09 Bit11 Bit10 Bit19 Bit11 Bit10 Bit09 Bit11 Bit10 Bit19 Bit11 Bit10 Bit09 Bit11 Bit10 Bit09 Bit11 Bit10 Bit09 Bit11 Bit10 Bit09 Bit01 Bit09 Bit11 Bit10 Bit09 Bit01 Bit01 Bit01B	abled Communication Phase Communication Phase: CP0 ampling number after captured Sampling number: 200	Trigger Condition C AT or MDT C AT and MDT C Phase(Only)	C AT(Only) C MDT(Only) C Cyclic data value: C External events	
F Ready to Operate(Bitt 5)   F Ready to Operate(Bitt 5)     Change bit for C10(Bitt 3)   F Ready time status bit (Bitt06)     Change bit for C20(Bitt 2)   F Procedure command change bit(Bit05)     Change bit for C30(Bitt 1)   F Brockelure command change bit(Bit05)     Change bit for C30(Bitt 1)   F Brockelure command change bit(Bit05)     Change bit for C30(Bitt 2)   F Arbade Bitt(Bit05)     No checked item is disabled   Arb(Bit00)     Logic Condition for each bit   F	AT Stutas Bit Pattan F Bit15 F Bit14 F Bit13 F Bit12 F Bit07 F Bit06 F Bit05 F Bit04	EBit11 EBit10 F	BitO9 🗖 BitO8	
	Ready to Operate(Bit15) Change bit for C1D(Bit13) Change bit for C2D(Bit12) Change bit for C3D(Bit12) Change bit for C3D(Bit11) Actual operation mode(Bit09-08)	Real-time status bit Procedure commar Error(Bit02) Busy(Bit01)	1 (Bit06)	
	The section of the second s	C AND Condition of A	T checked Item	

Fig.5 Trigger condition setting screen

#### 5) Beginning of Analysis

Selecting "Start" under the Measure menu will start analyzing. When any trigger events set as the trigger conditions occur, a message is displayed on the screen of pc, then the user comes to know some trigger event has occurred. After that, the data uploading process to pc starts automatically, then the detailed data is to be displayed on the screen.

Fig.6 shows the display screen of the SERCOS communication protocol.

File(E) View(V)	/er300 - [Dump List] Tools(T) - Measure(M) - Window(W) W D) - D				 
581	1 54 us (AT	001	89	L 8801 2020 0000 0000	a control
582	158 us [HDT	255	89	8987 895F 8888 8889	1
583	47846774  ns		81	04 Ext INPUT:0x00	
584	54 us IAT	0.01	89	8801 2020 0000 0000	
585	158 us MDT	255	89	0007 005F 0000 0000	
586 I	47847774  ns	ti i	81	84 Ext INPUT:8x88	
587 I	54 us IAT	001	89	8881 2828 8888 8888	
588	158 us   HDT	255	89	8887 885F 8888 8888	
589 j	47848774  ns	ti i	81	04 Ext INPUT:0x00	
590 j	54 us jAT	001	89	8801 2020 0000 0000	
591 j	158 us   HDT	255	89	0007 005F 0000 0000	
592	47849774  ns	ti i	81	84 Ext_INPUT:8x88	
593	54 us   AT	001	89	8801 2020 0000 0000	
594	157 us   HDT	255	89	0007 005F 0000 0000	
595	47050774ns	ti i	81	84 Ext_INPUT:0x00	
596	54 us   AT	001	89	8801 2020 0000 0000	
597	158 us   MDT	255	89	0007 005F 0000 0000	
598	47851774  ns		81	84 Ext_INPUT:0x00	
599	54 us  AT	001	89	8801 2020 0000 0000	
600	158 us   HDT	255	89	0007 005F 0000 0000	
601 ***	47052774ns		01	04 Ext_INPUT:0x01	
6 82	53 us  AT	881	89	8801 2020 0000 0000	
6 8 3	157 us   MDT	255	89	8887 885F 8888 8888	
684	47053773  ns		01	04 Ext_INPUT:0x01	
6 85	54 us  AT	001	89	8801 2020 0000 0000	
686	158 us   HDT	255	89	0007 005F 0000 0000	
607	47054773  ns		81	04 Ext_INPUT:0x01	
6 8 8	54 us  AT	001	89	8801 2020 0000 0000	
6 8 9	158 us   HDT	255	69	0007 005F 0000 0000	
610	47055773ns		81	04 Ext_INPUT:0x01	
611	54 us  AT	881	89	8801 2020 0000 0000	
612	158 us   MDT	255	89	0007 005F 0000 0000	
613	47056773  ns	ti i	81	84 Ext INPUT:0x01	

Fig.6 Display screen of the SERCOS communication protocol

#### 6) Saving of Traced Data

The displayed traced data can be named and saved on the PC as a text file.

# 4. Application Example

The following is the application of remote maintenance in which a SERCOS protocol analyzer is used. There is a problem in how to acquire necessary information by remote maintenance. We were concerned that preparing analog I/O or digital I/O and wiring to connect for data acquisition would bring about a great increase in the cost of equipment and time. The SERCOS analyzer, on the other hand, was used inserting in a SER-COS Ring. No special wiring is needed except the use of an external input trigger, which resulted in a remarkable reduction in wiring. Individual data that flows in a SERCOS Ring such as drivers and I/O can be selected and monitored though the system configuration of the SERCOS analyzer is concise. Additionally, this placed no requirements on other equipment. This time, we would like to introduce the usage of a remote maintenance tool utilizing the features of this SERCOS analyzer.

#### **Range of Remote Maintenance**

The SERCOS analyzer is structured on the assumption of operating it face to face meaning: it is necessary that a operator specify an axis he/she wants to acquire, analyze the meaning of the bit row of the acquired axis data, and take the required action for it. The only exception is when the trigger condition is validated, the event is voluntarily started. Therefore, the range of remote maintenance becomes the following.

- The event of voluntary trigger condition from the SERCOS analyzer is validated is the only factor monitored by remote maintenance.
- The analysis and setting of data are handled with Remote Monitoring and Remote Handling.
- The target unit of the SERCOS analyzer is left as is and Configuration & Monitor Tool Software support remote starting RS232C.
- Sending a warning mail at the event of when trigger condition validated. Data is analyzed and set by remote access with the PPP connection.

Fig.7 shows the example of applying remote maintenance.



Fig.7 Example of Applying Remote Maintenance

# 5. Conclusion

The SERCOS protocol analyzer including an application example was introduced above. The network in the field of motion control is surely becoming widespread its range of the application expands. We will continuously make an effort for enhancements of these peripheral tool and the improvements of ease of use in the future.

We would be most pleased if this tool helps create the solutions to problems that can occur in the use of the network.

\*SERCOS is the abbreviation of SErial Realtime COmmunications System

#### References

(1) Yasuhiro Kyuma, Shin Nagata and others : "Servo Amplifier Supporting SERCOS"

SANYO DENKI Technical Report No.5、 pp.38-41(1998-5)

(2) Hiroshi Yoshikawa : Development and Characteristics of Advanced Motion Language(AML),

SANYO DENKI Technical Report No.7、pp.28-36(1999-5) IGS: 「SERCOS interface I/O-Functions」



# Yoshiaki Kobayashi

Joined company in 1981 Control Systems Division Worked on design and development of S-MAC components

# Shin Nagata

Joined company in 1983 Control Systems Division, 1st Solution Dept. Worked on design and development of S-MAC components



# Takahisa Sakuma

Joined company in 1991 Control Systems Division, Solution Dept. Worked on design and development of S-MAC components