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SECS-I AND HSMS CONVERTING METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a converting method between SECS-I protocol and HSMS protocol of SEMI (Semiconductor Equipment and Material International).

2. Description of the Related Arts

In semiconductor industry, a communication concept or standard has been introduced in manufacturing to increase productivity. This is a way to manage product equipments, such as manufacture equipment, measurement equipment, inspection equipment, and the like, in centralized on-line system by using a host computer. To effectively achieve communications between semiconductor product equipments, SEMI established various protocols or standards. The SEMI ISO standardizes that SEMI protocols have; to be technical accuracy and useful with participating experts of many fields, to adopt sufficiently other standards under international conference, to examine technical accuracy, consistency and opportuneness any time and so on.

One of the SEMI protocols, SECS (SEMI Equipment Communications Standard) has been widely used since 1980. SECS includes SECS-I and SECS-II, which are communication interface ways between the semiconductor manufacture equipments and the host computer. These ways, which communicate information through serial point-to-point line, contains prescription such as physical connection, signal size, data speed, and logic protocol to exchange messages or information between the equipments and the host computer.

The outline of the SECS-I is as follows:

Communication Protocol - Connector and voltage level are used under EIA

RS-232C protocol in USA or JIS C6361 protocol in Japan.

Date Constitution - 8 bits are regarded as 1 byte. One bit is allocated to each of start bit and stop bit, respectively.

Communication Method - It is an asynchronous bidirectional way in which monodirection transmission is made at one time. The direction of transmission is determined by special character and handshaking.

Transmission Unit - Data is transmitted in blocks, each of the blocks being 254 bytes and less. Each block includes a ten-byte message header and following text data. The header of each block stores information to specify a specific block of messages. The messages are constructed by a pair of reply and request, which consist of a transaction. SECS-I does not prescribe the format of text data within the messages. The text data is formatted as specified in SECS-II standard.

The SECS-I and SECS-II have several drawbacks. Since they use RS-232C as communication protocol, it is difficult to transmit a large message due to slow speed of communication. In addition, since they permit short-distance communications and therefore the equipments and the host computer should be near to each other, a control room is very badly planned in the clean room. Besides, the one-to-one connection between the equipment and the host computer makes it hard to add new equipment connected with the host computer.

FIG. 1 schematically illustrates, when the SECS-I protocol is applied, connections between a host computer 1 and equipments 2a, 2b, and 2c. As described above, the host computer 1 is connected to each equipment 2a, 2b, and 2c one by one through RS-232C cables 3a, 3b, and 3c, respectively.

After the SECS-I and II protocols, HSMS (High-speed SECS Message Service) standard of SEMI was developed in 1995. The HSMS is adopted to meet needs of higher speed or to overcome insufficiency of simple serial line. HSMS was fundamentally prescribed to be used in TCP/IP (Transmission Control Protocol/Internet Protocol) of high speed message transmission protocol. The HSMS is a proper communication protocol for message exchange between computers of semiconductor factory.

The HSMS standard achieves faster transmission speed than the SECS-I with RS-232, by using the TCP/IP network protocol which is widely used and, for instance, provided for local area network (LAN). The HSMS is able to logically break the communications link without any physical disconnect from the network medium, to test the communications link for connection integrity purposes, and to reject connection attempts from incompatible subsidiary standards. In addition, special considerations, such as network timeouts and handling multiple connections, are taken into account in the TCP/IP implementation.

FIG. 2 schematically shows connections between equipments with using the HSMS protocol. As shown in FIG. 2, a host computer 11 of the factory and several equipments 12a, 12b and 12c are connected with a main communication line 13 via branch lines 13a, 13b, 13c and 13d. While the equipments and host computer depicted in FIG. 1 are directly connected to each other one by one via the serial line 3a, 3b and 3c, the equipments and host computer illustrated in FIG. 2 are connected to the main line 13, i.e., a common TCP/IP communication line, via the branch lines 13a, 13b, 13c and 13d. Therefore, the HSMS allows long distance communication, remotely controlling the equipments, and easily transmits large messages by faster speed. Furthermore, a new equipment can be easily and simply added.

However, if the equipments cannot accept the above-described effective HSMS, the HSMS becomes useless. At present, there are few equipment supporting the HSMS due to the short history of the HSMS.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a method for converting SECS-I and RS-232C protocol into HSMS and TCP/IP protocol, and vice versa, in order that existing equipments for SECS-I support are used as equipments for HSMS support.

The foregoing and other objects are achieved by a method of converting

SECS-I/HSMS for applying to devices in which SECS-I messages received through RS-232C are converted into HSMS messages and then output through TCP/IP, and/or inversely HSMS messages received through the TCP/IP are converted into SECS-I messages and then output through the RS-232C, the method comprising the steps of: identifying whether SECS-I messages are received from outside through the RS-232C; converting the SECS-I messages into HSMS messages when the SECS-I messages are received, and then outputting the HSMS messages through the TCP/IP; identifying whether SECS-I messages to output exist in the devices when the SECS-I messages are not received; outputting the SECS-I messages through the RS-232C when the SECS-I messages exist in the devices, or identifying whether HSMS messages are received from outside through the TCP/IP when the SECS-I messages do not exist in the devices; converting the HSMS messages into SECS-I messages when the HSMS messages are received, and then outputting the SECS-I messages through the RS-232C; identifying whether HSMS messages to output exist in the devices when the HSMS messages are not received; and outputting the HSMS messages through the TCP/IP when the HSMS messages exist in the devices, or, when the HSMS messages do not exist in the devices, returning to the step of identifying whether SECS-I messages are received from outside through the RS-232C.

In another aspect of the present invention, a method of converting a message format between SECS-I message and HSMS message by using a SECS/HSMS converting device is provided. The converting device comprises a SECS processor, a first SECS buffer, a SECS/HSMS converting department, a first HSMS buffer, a HSMS processor, a second HSMS buffer, a HSMS/SECS converting department, and a second SECS buffer. The SECS processor controls sending the SECS-I message received through RS-232C to the first SECS buffer or controls sending the SECS-I message stored at the second SECS buffer to external through the RS-232C. The first SECS buffer stores the SECS-I message received from the SECS processor. The SECS/HSMS converting department converts the SECS-I message received from the first SECS buffer into the HSMS message. The first HSMS buffer stores temporarily

the HSMS message converted by the SECS/HSMS converting department. The HSMS processor sends the HSMS message received from TCP/IP to the second HSMS buffer or sends the HSMS message stored at the first HSMS buffer to external through the TCP/IP. The second HSMS buffer stores temporarily the HSMS message received from the HSMS processor. The HSMS/SECS converting department converts the HSMS message into the SECS-I messages. And, the second SECS buffer transmits the SECS-I message received from the HSMS/SECS converting department to the SECS processor by block units. The converting method comprises the steps of: (S1) identifying whether the SECS processor receives the SECS-I message from external through the RS-232C or not; (S2) determining whether a block of the SECS-I message is the last block if the SECS-I message is received; (S3) storing repeatedly the block at the first SECS buffer if the block of the SECS-I message is not the last block; (S4) sending the SECS-I message of whole blocks to the SECS/HSMS converting department if the block is the last block, converting the SECS-I message into the HSMS message, and storing the HSMS message at the first HSMS buffer; (S5) reading the second SECS buffer to identify whether the SECS-I message exists in the second SECS buffer if the SECS processor does not receive the SECS-I message at the step (S1); (S6) transmitting the blocks of the SECS-I message to the SECS processor if the SECS-I message exists in the second SECS buffer, and clearing the second SECS buffer if the block is the last block; (S7) determining whether the HSMS message exist in the second HSMS buffer if the SECS-I message does not exist in the second SECS buffer; (S8) sending the HSMS message to the HSMS/SECS converting department if the HSMS message exists in the second HSMS buffer, converting the HSMS message into the SECS-I message, and storing the SECS-I message at the second SECS buffer; (S9) identifying whether the HSMS message is received to the HSMS processor through the TCP/IP from external or not; (S10) storing the HSMS message at the second HSMS buffer if the HSMS message is received; (S11) reading the first HSMS buffer to identify whether the HSMS message exists in the first HSMS buffer if the HSMS message is not received; and (S12) returning to the step of (S1) and performing the routine for the SECS-I message if the

HSMS message does not exist, or sending the HSMS message to external through the TCP/IP by the HSMS processor if the HSMS message exists.

In still another aspect of the present invention, a record media in which the above-described methods are recorded is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the present invention will be readily understood with reference to the following detailed description taken in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and, in which:

FIG. 1 is a schematic diagram showing connections between host computer and equipments in factory applying SECS-I;

FIG. 2 is a schematic diagram showing connections between host computer and equipments in factory applying HSMS;

FIG. 3 is a schematic diagram illustrating a system for performing a converting method according to the present invention;

FIG. 4 is a block diagram illustrating a converting device for performing the converting method according to the present invention; and

FIG. 5 is a flow chart of the converting method according to the present invention.

FIGS. 6A and 6B illustrate formats of SECS message and HSMS message, respectively.

FIGS. 7A and 7B illustrate header fields of the SECS message and the HSMS message, respectively.

FIGS. 8A and 8B conceptually illustrate a converting method of the header fields and that of the message format, respectively, from the SECS message to the HSMS message.

FIGS. 9A and 9B conceptually illustrate a converting method of the header

fields and that of the message format, respectively, from the HSMS message to the SECS message.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described below with reference to the accompanying drawings.

FIG. 3 is a schematic diagram, which illustrates a system for performing a method of converting between SECS-I and HSMS according to the present invention. An equipment 100, which is based on SECS-I 101 and RS-232C 102, is connected to a SECS-I/HSMS converting device 300 via a RS-232C cable 103. On the other hand, a host computer 200 based on HSMS 201 and TCP/IP 202 is connected to the SECS-I/HSMS converting device 300 via a communication line 203 such as LAN.

In such a way, the equipment 100 for the conventional SECS-I is connected to the host computer 200 for HSMS by the converting device 300 through a relatively short serial line such as the RS-232C cable 103. To maximize advantage of the present invention, it is preferable that the RS-232C cable 103 is relatively short and the communication line 203 such as LAN is relatively long. Hereinafter, the SECS-I will be abbreviated as SECS.

FIG. 4 is a block diagram, which schematically illustrates elements of the SECS/HSMS converting device 300 depicted in FIG. 3. As shown in FIG. 4, the converting device 300 includes a SECS processor 301, a first SECS buffer 303, a SECS-HSMS converting department 304, a first HSMS buffer 305, a HSMS processor 307, a second HSMS buffer 309, a HSMS-SECS converting department 311, and a second SECS buffer 313.

Specifically, the SECS processor 301 controls to send SECS message received through RS-232C to the first SECS buffer 303, or to output SECS message stored in the second SECS buffer 313 to outside through RS-232C. The first SECS buffer 303 receives SECS message from the SECS processor 301 and then stores the SECS

message. As described above, since the SECS message consists of several blocks and is exchanged by each block unit, the SECS message received from the SECS processor 301 is transmitted, in blocks, to the first SECS buffer 303. The first SECS buffer 303 merges all blocks of the transmitted SECS message and then outputs the merged message. The SECS-HSMS converting department 304 converts the outputted SECS message into HSMS message. This converting method will be described later.

The first HSMS buffer 305 temporarily stores the converted HSMS message. Then, the first HSMS buffer 305 sends the stored HSMS message to the HSMS processor 307 so as to output the HSMS message to outside. The HSMS processor 307 controls to send HSMS message received through TCP/IP communication line to the second HSMS buffer 309, or to send the HSMS message received from the first HSMS buffer 305 to outside through the TCP/CP. The second HSMS buffer 309 receives the HSMS message from the HSMS processor 307 and then temporarily stores the HSMS message. The HSMS-SECS converting department 311 converts the HSMS message into SECS message. This converting method will be also described later.

The converted SECS message is transmitted in blocks to the second SECS buffer 313. The second SECS buffer 313 receives the SECS message from the HSMS-SECS converting department 311, and then transmits it to the SECS processor 301 in blocks.

FIG. 5 is a flow chart of a program for operating the SECS/HSMS converting device 300. With reference to FIG. 5, the SECS/HSMS converting method of the present invention is described hereinafter.

(S1) First of all, the device identifies whether the SECS processor 301 receives a SECS message from external through RS-232C, or not. The SECS message is transmitted by block unit, and then stored in order at the first SECS buffer 303.

(S2) If a SECS message is received, the device determines whether the block of the SECS message is the last block or not.

(S3) If the block is not the last one, the block is stored at the first SECS buffer

309. This step is repeated until the last block is received.

(S4) If the block is the last one, the SECS message of whole block is sent to the SECS-HSMS converting department 304, and then converted into a HSMS message. The converted HSMS message is stored at the first HSMS buffer 305. The converting method will be described later with reference to another drawing.

(S5) If the SECS processor 301 does not receive a SECS message at the above step (S1), the device reads the second SECS buffer 313 so as to identify whether another SECS message exists in the second SECS buffer 313.

(S6) If a SECS message exists in the second SECS buffer 313, the block of the SECS message is transmitted to the SECS processor 301. If the block is the last one, the second SECS buffer 313 is cleared.

(S7) If no SECS message exists in the second SECS buffer 313, the device determines whether a message is in the second HSMS buffer 309.

(S8) If any message is in the second HSMS buffer 309, the device sends the message to the HSMS-SECS converting department 311 since the message in the second HSMS buffer 309 is a HSMS message. The HSMS message is then converted into a SECS message and stored at the second SECS buffer 313.

After the above steps are done, a specific routine for HSMS messages follows.

(S9) The device identifies whether a HSMS message is received to the HSMS processor through the TCP/IP line from external, or not. Unlike the SECS messages, the HSMS messages are transmitted collectively without block concept.

(S10) If there is a message received from external, this message is stored at the second HSMS buffer 309. Next, this HSMS message is converted into a SECS message and then stored at the second SECS buffer 313. This step is associated with the above-described step (S8).

(S11) If no message is received, the device reads the first HSMS buffer 305 and identifies whether there is a HSMS message to send. As described above, the HSMS message in the first HSMS buffer 305 is one into which the SECS message sent from the SECS processor 301 is converted.

(S12) If no message is in the first HSMS buffer 305, it should return to the

first and then perform the routine for the SECS messages. If any message is in the first HSMS buffer 305, the HSMS processor 307 sends this message to external through the TCP/IP.

The basic format of each message is described in detail with reference to FIGS. 6A and 6B. FIG. 6A represents the format of the SECS message, and FIG. 6B does the format of the HSMS message. Each block of the SECS message consists of four kinds of fields, i.e., length byte, header, body and checksum. The HSMS message consists of length byte, header and body. Unlike the SECS message, the HSMS message includes several bodies containing useful text of the message. From now, the length byte, header, body and checksum are abbreviated as L, H, B and C, respectively.

FIGS. 7A and 7B show the only H field of the message. FIGS. 7A and 7B represent the H of the SECS message and the HSMS message, respectively. The H of the SECS message is totally ten bytes, which consists of a two-byte Device ID field specifying a kind of equipments, a one-byte Stream field, a one-byte Function field, a two-byte Block No. field designating a block number, and a four-byte System Byte field. The H of the HSMS message is also totally ten bytes, which consists of a two-byte Session field, a one-byte Stream field, a one-byte Function field, a one-byte P-type field, a one-byte S-type field, and a four-byte System Byte field. The P-type field is a spare field, being always "0". In the S-type, "0" indicates that a message is data, and "1" does that a message is of control. The Session field corresponds to the Device ID field of the SECS message header.

Now, a converting method of the SECS and HSMS messages will be described in detail. FIGS. 8A and 8B conceptually show the converting method from the SECS message to the HSMS message. Specifically, FIG. 8A shows the header conversion method and FIG. 8B does the format conversion method. As shown in FIG. 8A, the Device ID, Stream, Function, and System Byte fields of the SECS header are copied as they are, and converted into the Session, Stream, Function, and System Byte of the HSMS header, respectively. On the other hand, the higher and lower Block No. fields of the SECS header are converted into the P-type and S-type fields of the

HSMS header being set by "0", respectively. While the H of the SECS message is converted into that of the HSMS message, as described above, the B in every block of the SECS message is merged in that of the HSMS message, as seen from FIG. 8B.

Next, FIGS. 9A and 9B conceptually show the converting method from the HSMS message to the SECS message. Specifically, FIG. 9A shows the header conversion method and FIG. 9B does the format conversion method. As shown in FIG. 9A, the Session, Stream, Function, and System Byte fields of the HSMS header are copied as they are, and converted into the Device ID, Stream, Function, and System Byte of the SECS header, respectively. On the other hand, the Block No. field of each SECS header is converted by assigning a block number in order of divided blocks of the SECS message. Further, if a block of the SECS message is the last block, a given bit in the Block No. field is set by "1". In preferred embodiment, the above bit set by one is a Most Significant Bit (MSB) which is located at the foremost bit in the higher Block No. field. The B in each block of the SECS message is made by extracting the B of the HSMS message, as seen from FIG. 9B.

The mutual converting method of the SECS-I and HSMS is implemented by computer program according to the above operation. This program may be applied to be stored at many kinds of record media, such as EPROM, mask ROM, CDROM and so on.

As described above, by SECS-I/HSMS converting method of this invention, it could make it support HSMS although it is equipment, which made for support of traditional SECS-I. So it has advantages of HSMS; it can increase control distance between equipment due to WAN, is easy to transmit a large message with high speed and to extend new equipment. Therefore, ir is not needed unnecessary investment for new equipment, and production cost may be reduced.

Although preferred embodiments of the present invention have been described in detail hereinabove, it should be understood that many variations and/or modifications of the basic inventive concepts herein taught which may appear to those skilled in the art will still fall within the spirit and scope of the present invention as defined in the appended claims.

WHAT IS CLAIMED IS :

1. A method of converting SECS-I/HSMS for applying to devices in which SECS-I messages received through RS-232C are converted into HSMS messages and then output through TCP/IP, and/or inversely HSMS messages received through the TCP/IP are converted into SECS-I messages and then output through the RS-232C, said method comprising the steps of:

identifying whether SECS-I messages are received from outside through the RS-232C;

converting the SECS-I messages into HSMS messages when the SECS-I messages are received, and then outputting the HSMS messages through the TCP/IP;

identifying whether SECS-I messages to output exist in the devices when the SECS-I messages are not received;

outputting the SECS-I messages through the RS-232C when the SECS-I messages exist in the devices, or identifying whether HSMS messages are received from outside through the TCP/IP when the SECS-I messages do not exist in the devices;

converting the HSMS messages into SECS-I messages when the HSMS messages are received, and then outputting the SECS-I messages through the RS-232C;

identifying whether HSMS messages to output exist in the devices when the HSMS messages are not received; and

outputting the HSMS messages through the TCP/IP when the HSMS messages exist in the devices, or, when the HSMS messages do not exist in the devices, returning to said step of identifying whether SECS-I messages are received from outside through the RS-232C.

2. A record media wherein the method of claim 1 is recorded.

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3. A method of converting a message format between SECS-I message and HSMS message by using a SECS/HSMS converting device which comprises a SECS processor, a first SECS buffer, a SECS/HSMS converting department, a first HSMS buffer, a HSMS processor, a second HSMS buffer, a HSMS/SECS converting department, and a second SECS buffer, wherein the SECS processor controls sending the SECS-I message received through RS-232C to the first SECS buffer or controls sending the SECS-I message stored at the second SECS buffer to external through the RS-232C, wherein the first SECS buffer stores the SECS-I message received from the SECS processor, wherein the SECS/HSMS converting department converts the SECS-I message received from the first SECS buffer into the HSMS message, the first HSMS buffer stores temporarily the HSMS message converted by the SECS/HSMS converting department, the HSMS processor sends the HSMS message received from TCP/IP to the second HSMS buffer or sends the HSMS message stored at the first HSMS buffer to external through the TCP/IP, the second HSMS buffer stores temporarily the HSMS message received from the HSMS processor, the HSMS/SECS converting department converts the HSMS message into the SECS-I messages, and the second SECS buffer transmits the SECS-I message received from the HSMS/SECS converting department to the SECS processor by block units, said method comprising the steps of:

(S1) identifying whether the SECS processor receives the SECS-I message from external through the RS-232C or not;

(S2) determining whether a block of the SECS-I message is the last block if the SECS-I message is received;

(S3) storing repeatedly the block at the first SECS buffer if the block of the SECS-I message is not the last block;

(S4) sending the SECS-I message of whole blocks to the SECS/HSMS converting department if the block is the last block, converting the SECS-I message into the HSMS message, and storing the HSMS message at the first HSMS buffer;

(S5) reading the second SECS buffer to identify whether the SECS-I message exists in the second SECS buffer if the SECS processor does not receive the

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SECS-I message at said step (S1);

(S6) transmitting the blocks of the SECS-I message to the SECS processor if the SECS-I message exists in the second SECS buffer, and clearing the second SECS buffer if the block is the last block;

(S7) determining whether the HSMS message exist in the second HSMS buffer if the SECS-I message does not exist in the second SECS buffer;

(S8) sending the HSMS message to the HSMS/SECS converting department if the HSMS message exists in the second HSMS buffer, converting the HSMS message into the SECS-I message, and storing the SECS-I message at the second SECS buffer;

(S9) identifying whether the HSMS message is received to the HSMS processor through the TCP/IP from external or not;

(S10) storing the HSMS message at the second HSMS buffer if the HSMS message is received;

(S11) reading the first HSMS buffer to identify whether the HSMS message exists in the first HSMS buffer if the HSMS message is not received; and

(S12) returning to said step of (S1) and performing the routine for the SECS-I message if the HSMS message does not exist, or sending the HSMS message to external through the TCP/IP by the HSMS processor if the HSMS message exists.

4. The method of claim 3, wherein each block of the SECS-I message includes length byte fields, header fields, body fields and checksum fields, wherein the header fields of the SECS-I message include device fields, stream fields, function fields, block No. fields and system byte fields, wherein the HSMS message includes length byte fields, header fields and body fields, and wherein the header fields of the HSMS message include session fields, stream fields, function fields, P-type fields, S-type fields and system byte fields.

5. The method of claim 4, wherein the converting the SECS-I message into the HSMS message in said step (S4) comprises copying the device ID fields of

the SECS-I message into the session fields of the HSMS message, copying the stream fields of the SECS-I message into the stream fields of the HSMS message, copying the function fields of the SECS-I message into the function fields of the HSMS message, setting the P-type and S-type fields of the HSMS message by zero, and copying the system fields of the SECS-I message into the system fields of the HSMS message.

6. The method of claim 4, wherein the converting the HSMS message into the SECS-I message in said step (S8) comprises copying the session fields of the HSMS message into the device ID fields of the SECS-I message, copying the stream fields of the HSMS message into the stream fields of the SECS-I message, copying the function fields of the HSMS message into the function fields of the SECS-I message, assigning a block number to the block No. fields in order of divided blocks of the SECS-I message and setting a given bit in the block No. fields of the last block by one, and copying the system fields of the HSMS message into the system fields of the SECS-I message.

7. A record media wherein the converting method between the SECS-I/HSMS messages recited in claim 3 is recorded.

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