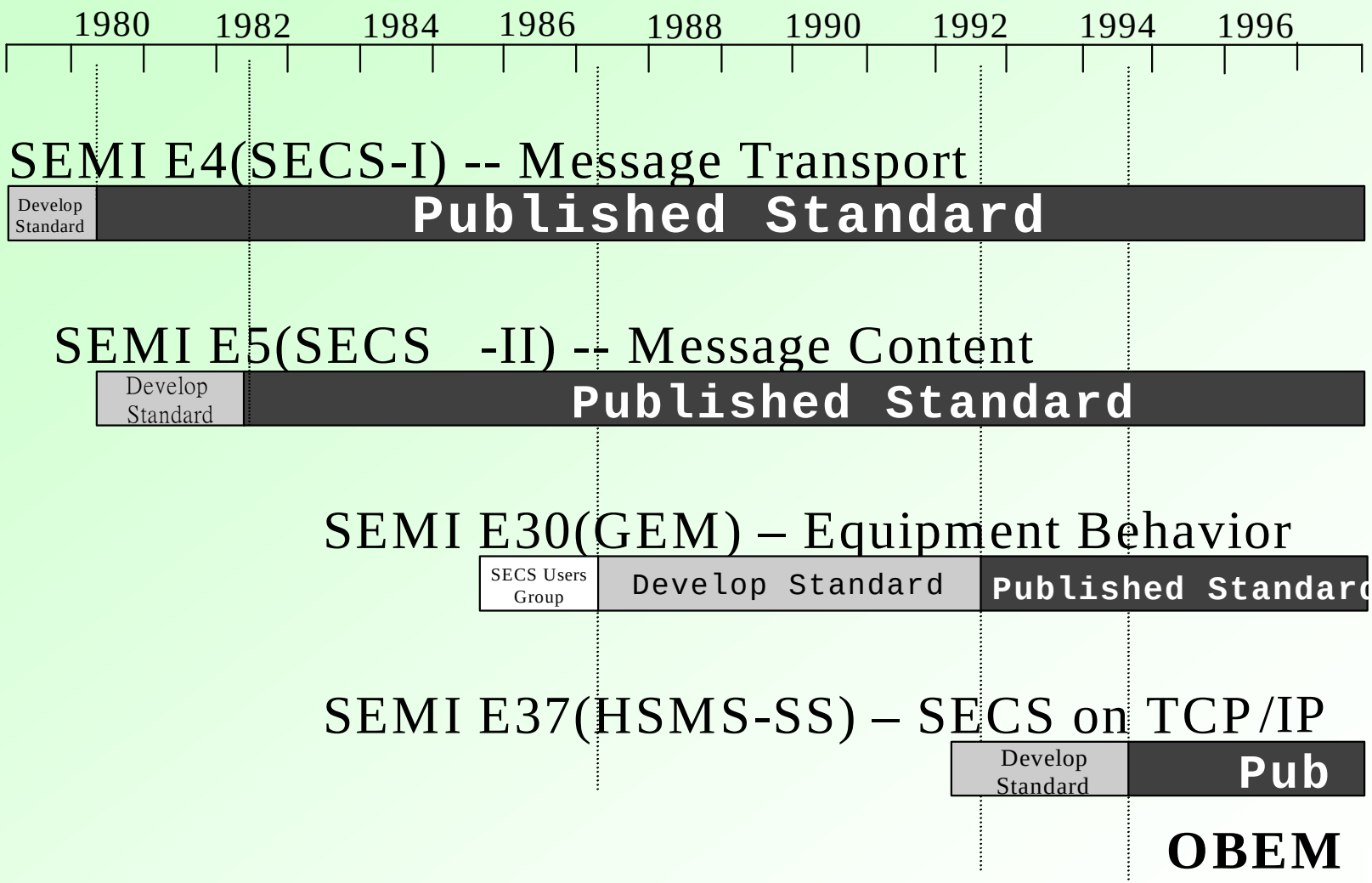
The SECS Standards and Examples

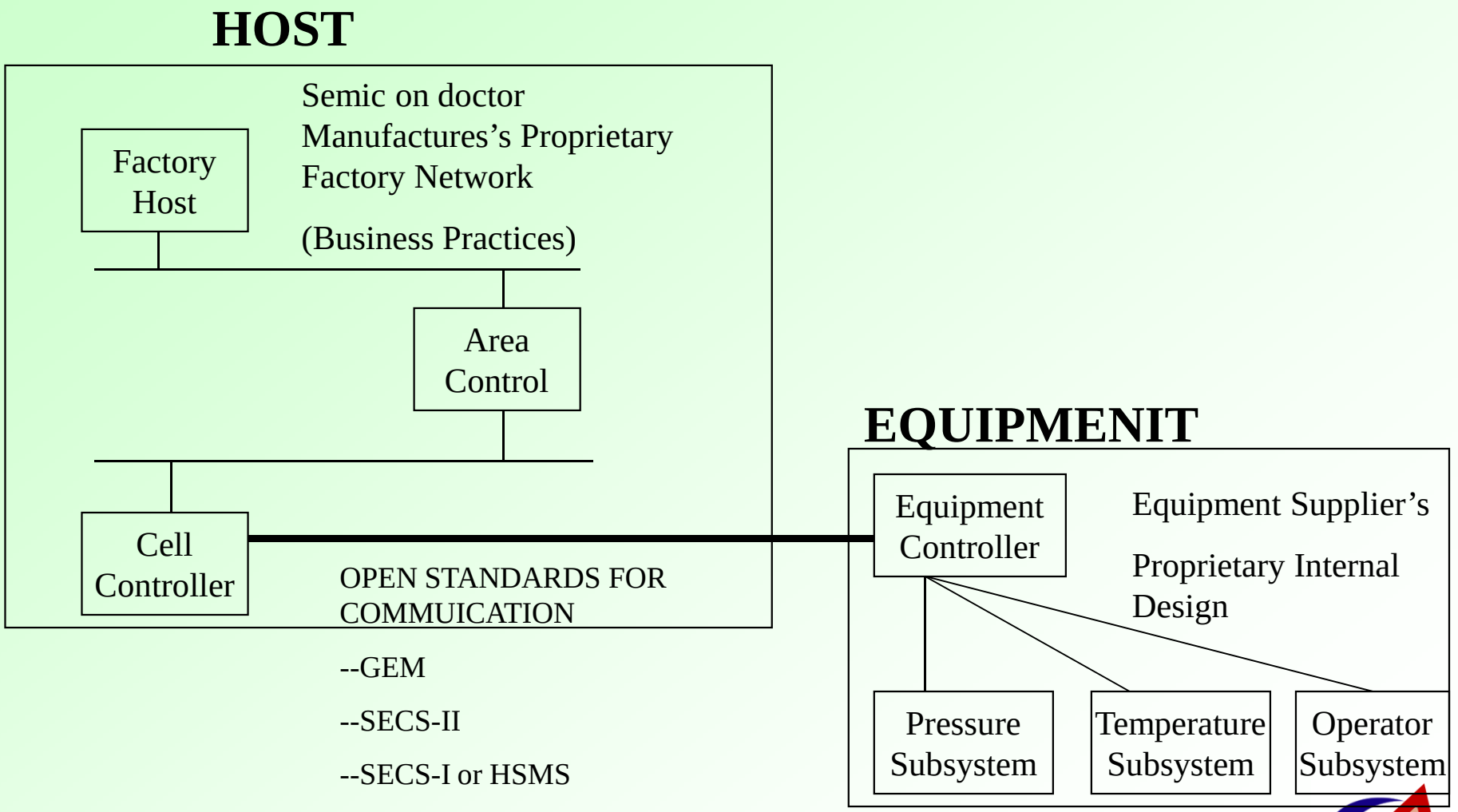
Abbreviations

- SECS - Semiconductor Equipment Communication Standard
- GEM - Generic Equipment Model
- HSMS - High Speed SECS Message Services
- CORBA - Common Object Request Broker Architecture
- CIM - Computer Integrated Manufacturing
- OBEM - Object-Based Equipment Model

SECS/GEM/HSMS HISTORY

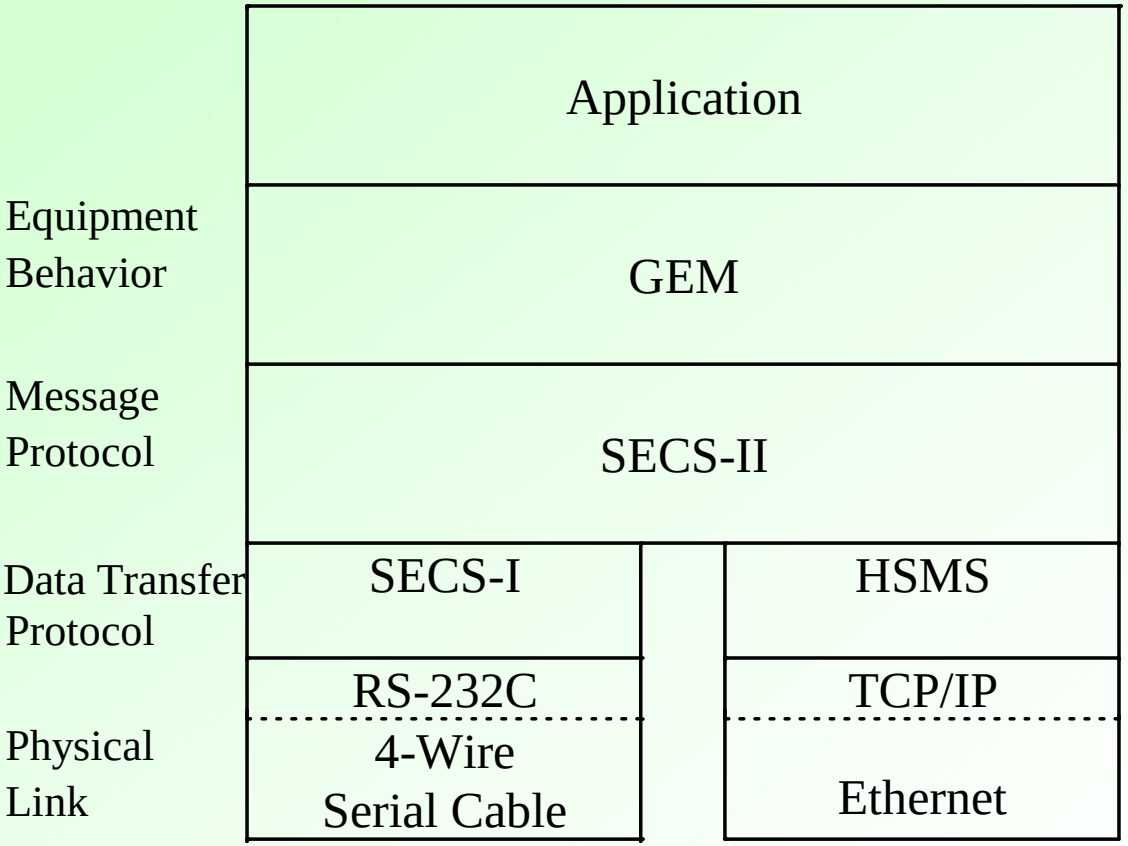


Conventional Factory Communications Proprietary Conventions vs. Open Standards



Introduction

Layered Protocol



Introduction (continued)

RS-232C

RS-232C protocol; one start bit, one stop bit, full duplex line, half duplex communication.

Introduction (continued)

SECS-I

Data transfer protocol; it is responsible for making sure that the data is transmitted correctly from Host to Equipment or Equipment to Host using RS-232C protocol.

SECS 1 is a low technology, low cost but in most cases adequate message transport protocol. It has been criticized as too slow by those people looking for excuses for not implementing SECS on the equipment or in the factory. It has been the limiting factor in implementing and using SECS in factories.

Introduction (continued)

SECS-I (continued)

Note:

The word “Host” is used to describe any type of computer on the other side of the “Equipment”. This Host can be a PC, workstation, mainframe, robot, or even another piece of Equipment.

Introduction (continued)

SECS-II

Message protocol; it provides the definition of messages and related data items exchanged between Host and Equipment.

This is the core specification. It defines specific messages and message formats for transfer of classes of manufacturing information. SECS-II can be used in any manufacturing environment. It can pulled from SECS-I and used in other message transports such as Ethernet.

Introduction (continued)

GEM

Equipment behavior; it defines which SECS-II messages should be used, in what situations, and what the resulting activity should be.

GEM is both a specification and a guide. It sets minimum capabilities for the SECS communication on the equipment and it defines that this communication is tied closely to equipment activities through a state diagram. The specification was developed by the semiconductor manufacturers as a directive to equipment manufacturers. It was asked for by the equipment manufacturers.

Introduction (continued)

TCP/IP (Transmission Control Protocol/Internet Protocol)

A method of communications which provides reliable, connection-oriented message exchange between computers within a network.

HSMS

Data transfer protocol; it defines a communication interface suitable for the exchange of messages between computers in a semiconductor factory using a TCP/IP environment.

Introduction (continued)

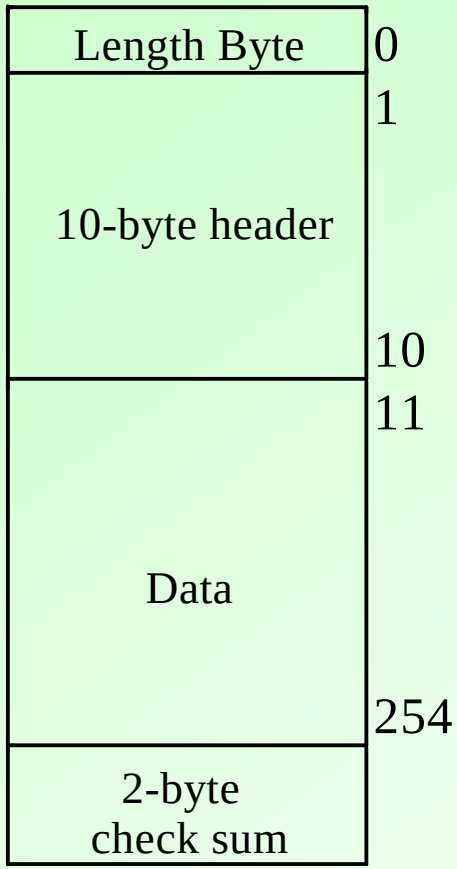
Usage

Most common applications of SECS protocol, in order of popularity:

- Data collection
- Alarm collection
- Recipe Management
- Wafer Mapping
- Remote Control
- Material Control

SECS is sometimes used for communication internal to a piece of equipment.

SECS-I



SECS BLOCK

Blocks:
A message is sent in blocks.

A block contains a 10-byte header and a 2-byte checksum.

Each block starts with a length byte which describes the length of the block not including the checksum.

The maximum length is 254 bytes. The minimum is 10 bytes (header only).

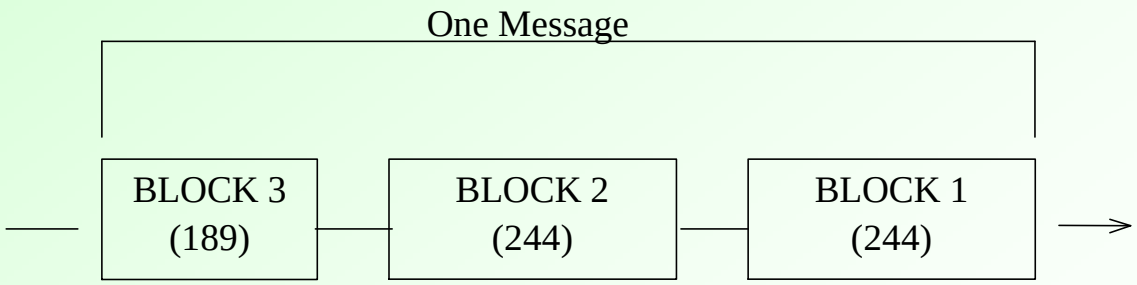
Each block may contain up to 244 bytes of data.

SECS-I (continued)

Blocks (continued):

A message with more than 244 bytes of data must have multiple blocks.

A message can contain up to 32,767 blocks (approximately 8 million bytes long).



Multi-Block Message (677 data bytes)

SECS-I (continued)

Block Protocol

The Sender can be either the host or the equipment.

Both Sender and Receiver start in the “idle” state.

The Sender of a SECS message first sends an ENQ.

If the Receiver of the ENQ is able to accept a message, the receiver will send an EOT.

Upon receipt of the EQT, the sender will send one block of data.

SECS-I (continued)

Block Protocol (continued)

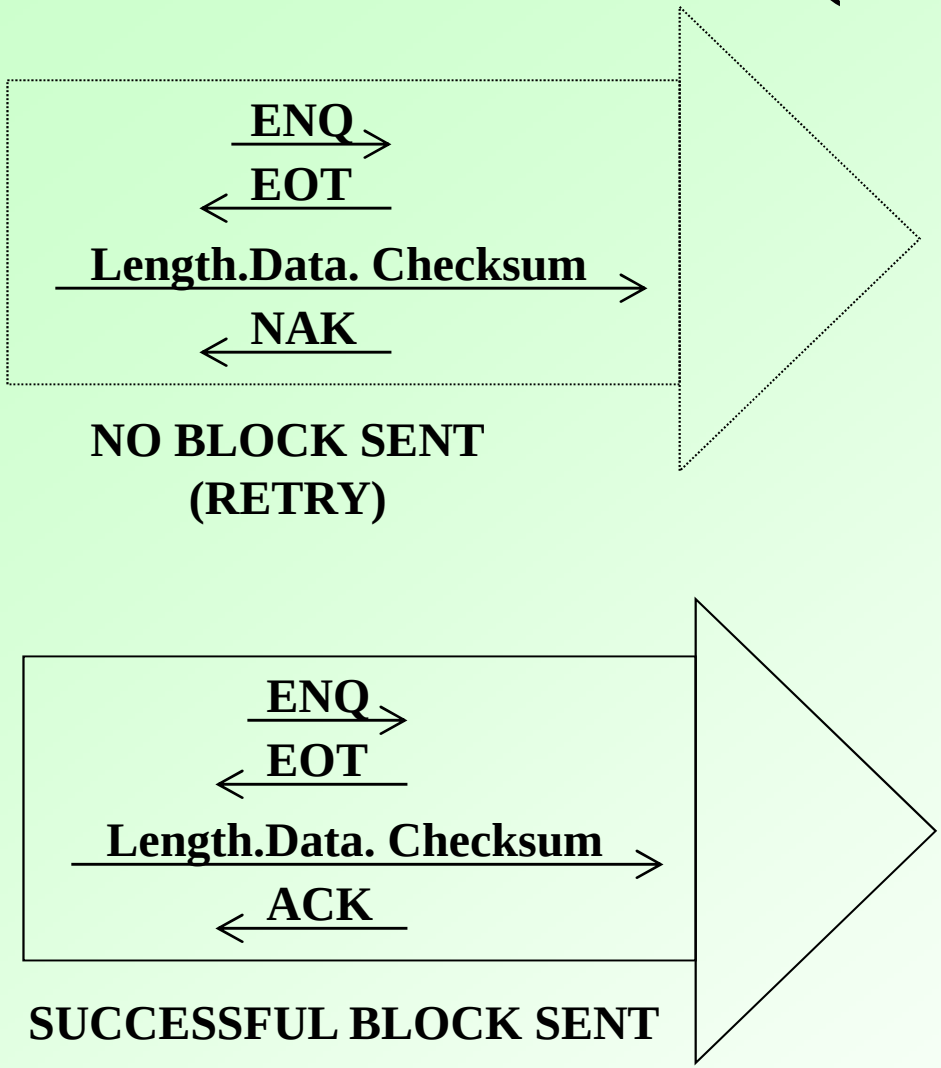
If received correctly, the Receiver will acknowledge with an ACK.

If received incorrectly, the Receiver will acknowledge with a NAK.

Handshake Codes (bytes)

Name	Binary Code	Hex	Function
ENQ	00000101	05	Request to Send
EOT	00000100	04	Ready to Receive
ACK	00000110	06	Correct Reception
NAK	00010101	15	Incorrect Reception

SECS-I (continued)



If the Receiver responds with a NAK instead of an ACK, the Block Transfer Protocol will Retry sending the block. See below for information on the Retry Limit.

SECS-I (continued)

Timeouts

- T1 Inter-Character Timeout

  Limits the time between receipt of characters.

- T2 Protocol Timeout

  Limits the time between handshake bytes and between data and handshake bytes.

SECS-I (continued)

Timeouts (continued)

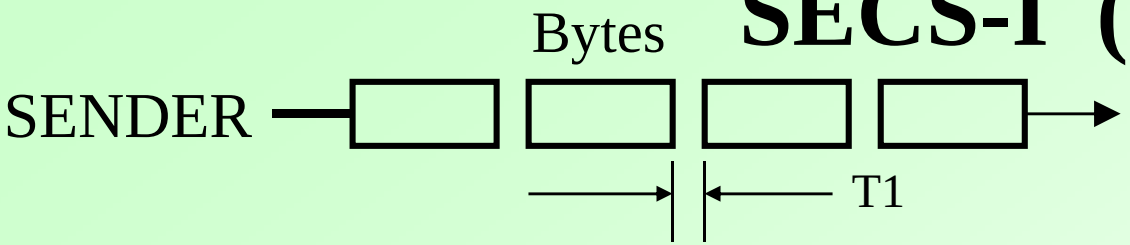
- T3 Reply Timeout

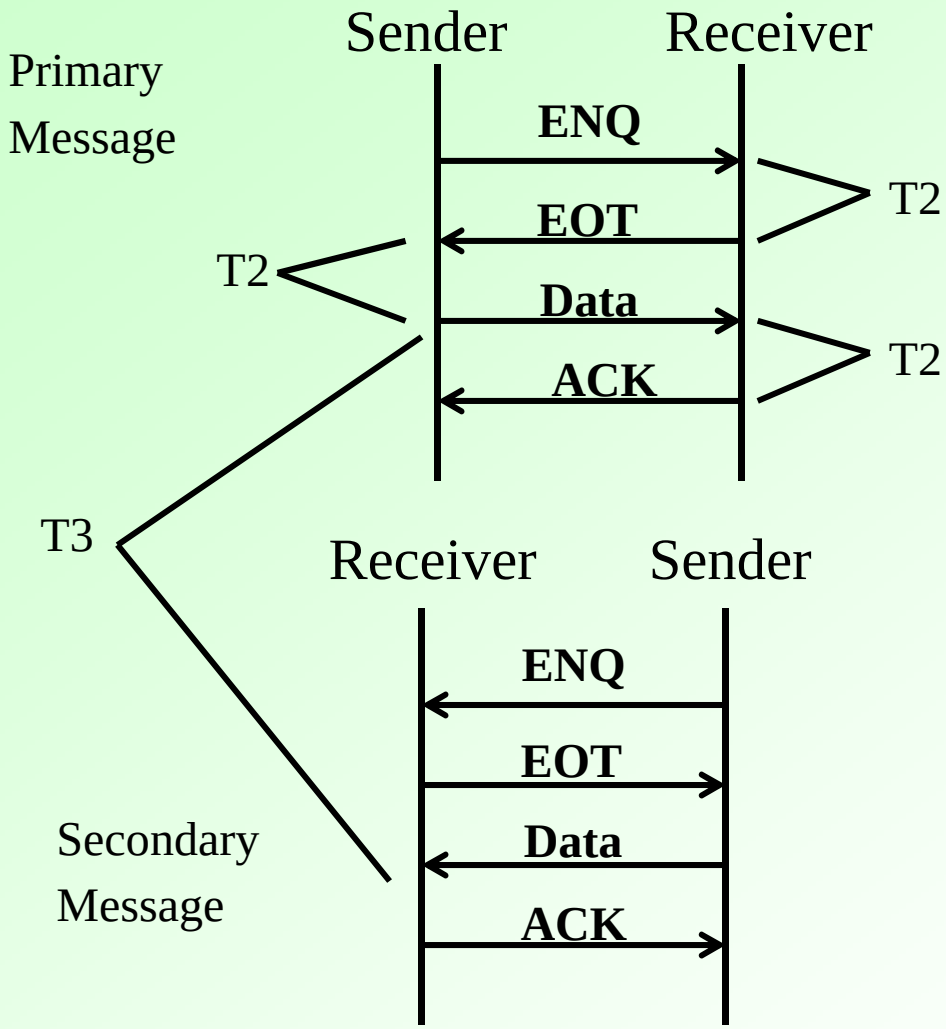
  Time that the sender of a primary message will wait until the receipt of the secondary message.

- T4 Inter-block Timeout

  Time interval that the receiver of a multi-block message will wait between blocks.

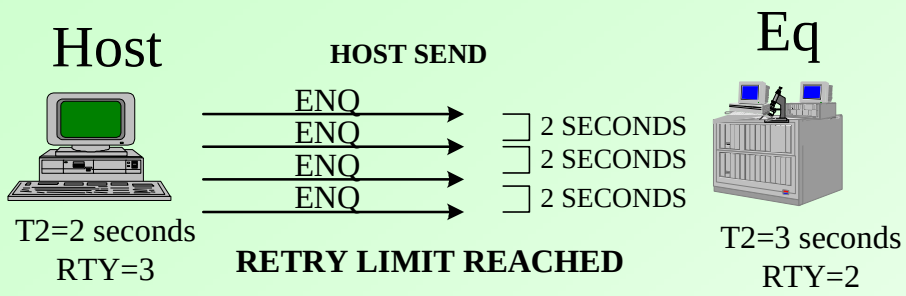
SECS-I (continued)

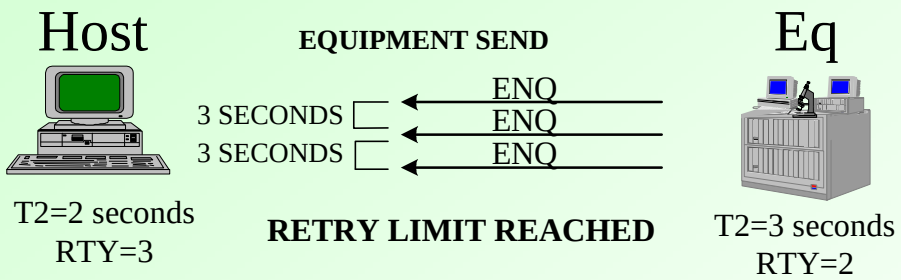




Block Transfer Protocol and Timeouts

SECS-I (continued)





❖ **RTY** Retry Limit

- During a Block Transfer send attempt, the Retry Limit is the maximum number of times the sender will attempt to retry sending a block before declaring a block send failure.

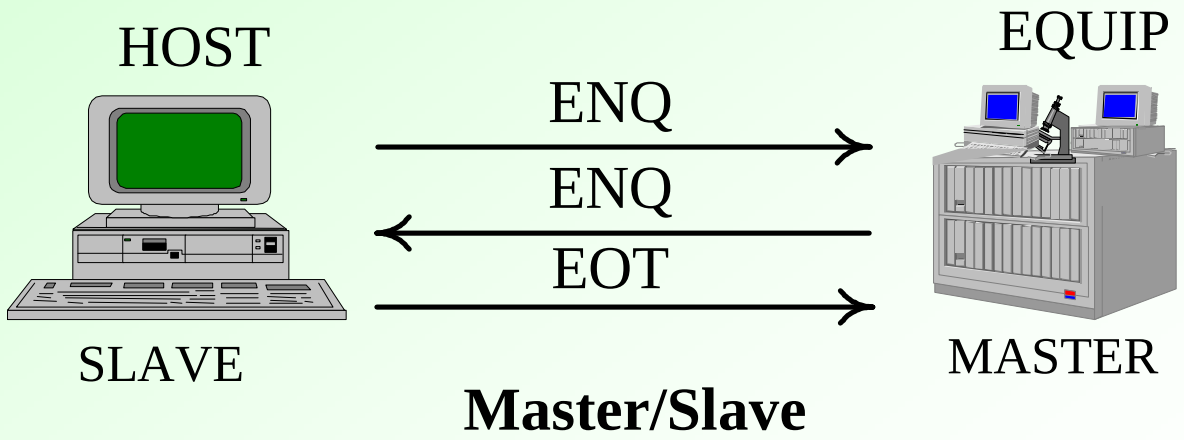
- For example, in case 1 (and shown in drawing below), the ENQ is retried repeatedly waiting for an EOT response before declaring a failure. Notice that the T2 timeout and Retry Count are different between the Host send case and the Equipment send case.

SECS-I (continued)

❖ Master/Slave

SECS operates at Full Duplex Line. Both Sender and Receive can be sending ENQs to each other simultaneously.

The Equipment is the Master and the Host is the Slave. The Host will give up control of the “line” to the Equipment and reply to the Equipment’s ENQ with an EOT.



Master/Slave

SECS-I (continued)

8	7 6 5 4 3 2 1	byte
R	Upper Device ID	1
	Lower Device ID	2
W	Upper Message ID	3
	Lower Message ID	4
E	Upper Block No.	5
	Lower Block No.	6
	System bytes	7
	System bytes	8
	System bytes	9
	System bytes	10

Upper means "most significant"
Lower means "least significant"

- **Header**

Every SECS block contains a 10-byte header.

The header provides information so that the Receiver can identify the block according to Equipment, message, and block number.

SECS-I (continued)

- **R-bit**

Reverse bit. Signifies the direction of the message.

R=0 Host → Equipment

R=1 Host ← Equipment

- **Device ID**

Each equipment must have a device ID.

The device ID is set on the equipment.

It is possible to have more than one Device ID for equipment with multiple tubes (diffusion), chambers (cluster tools, implanters), and stations (coater/developer).

SECS-I (continued)

- **W-bit**

Wait bit.

Transaction: Pair of SECS messages.

Primary Message: First message sent in the transaction.

Secondary Message: Second message sent. Reply message.

W=1 Reply expected. Sent in primary messages only.

Most primary messages expect replies but not all.

W=0 Reply not expected. Always W=0 in secondary messages.

SECS-I (continued)

❖ Message IDs

Upper Message ID is called the Stream.

Lower Message ID is called the Function.

❖ E-bit

End bit.

E=0 More blocks expected.

E=1 Final block.

❖ Block Number

The Block No. is a two-byte number that counts the number of blocks in a message.

Block numbers start with 1.

SECS-I (continued)

❖ System Bytes

When a sender of a primary message expects a reply, the System Bytes allow the sender of the primary message (now the receiver of the reply message) to match the reply message to the appropriate primary message.

The System Bytes work the same for the Host or the Equipment sending the primary message.

SECS-I (continued)

- **System Bytes (continued)**

Responsibility of the Sender

The sender of a primary message must generate the system bytes.

The system bytes must not be the same as any other outstanding messages. This is called “Distinction”. Usually, system bytes are generated sequentially.

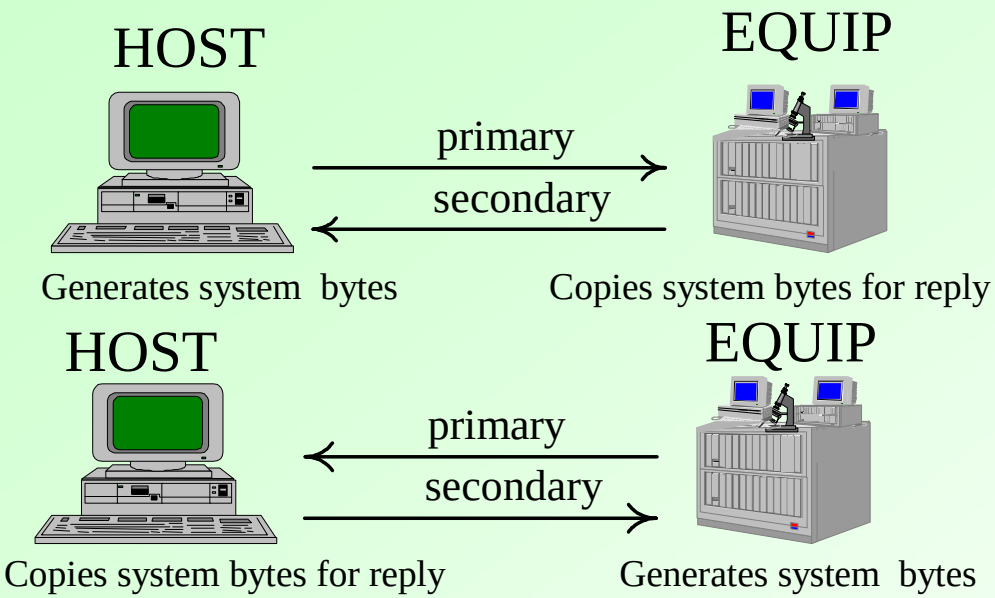
The system bytes may be different for different Device IDs.

All system bytes for a multi-block message must be the same.

Responsibility of the Receiver

Copy the system bytes from the primary message to the reply message.

SECS-I (continued)

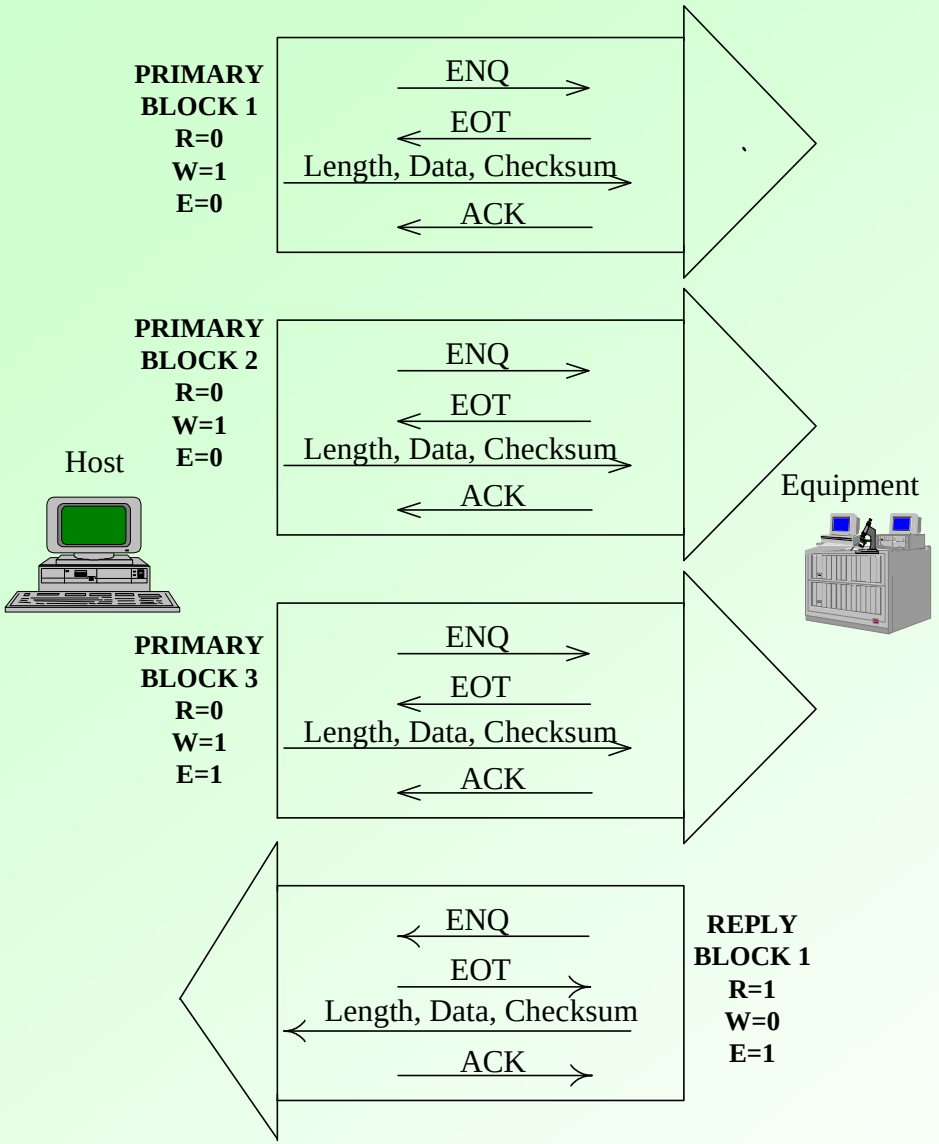


System Bytes

❖ Examples

In the first example left, the Host generates the system bytes in the primary message and the Equipment copies the system bytes into the secondary message reply to the Host. In the second example, the reverse happens.

SECS-I (continued)



BLOCK Transfer Protocol in Multi-block Message

- **Multi-block Messages**

  A message that is more than 254 bytes long must be sent as a multi-block message. Each block that is sent must contain the Block Transfer Protocol. Left is an example of a 3 block multi-block message sent from the Host to the Equipment with a single block reply.

SECS-I (continued)

Message Protocol

- **T3 Timeout**

  Reply Timeout: Time that the Sender of a primary message will wait until the receipt of the secondary message.

  W-bit must be equal to1.

  The Sender starts counting time whenever the last block of the primary message is successfully sent until the first block of the secondary message is received.

  If the T3 timeout is exceeded, the Message Protocol fails AT THE APPLICATION LEVEL. THERE IS NO RETRY.

SECS-I (continued)

Message Protocol (continued)

- **T4 Timeout**

  Inter-block Timeout: Time interval that the receiver of a multi-block message will wait between blocks.

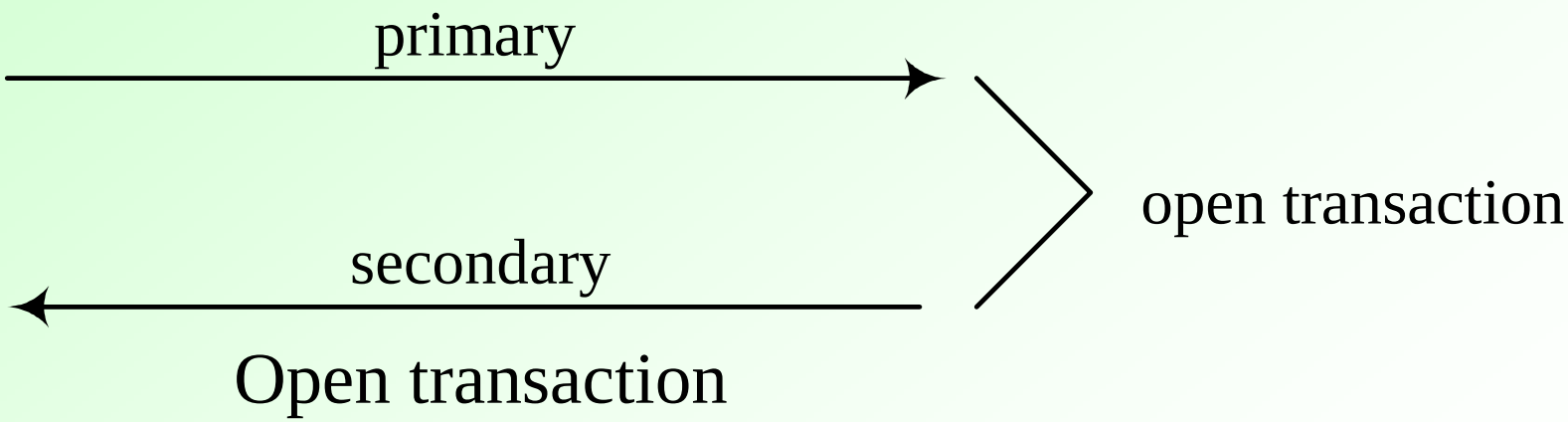
  The Sender start courting time whenever each block of the primary message is successfully received and the E-bit =0.

  If the T4 timeout is exceeded, the Message Protocol fail AT THE APPLICATION LEVEL. THERE IS NO RETRY.

SECS-I (continued)

Message Interleaving

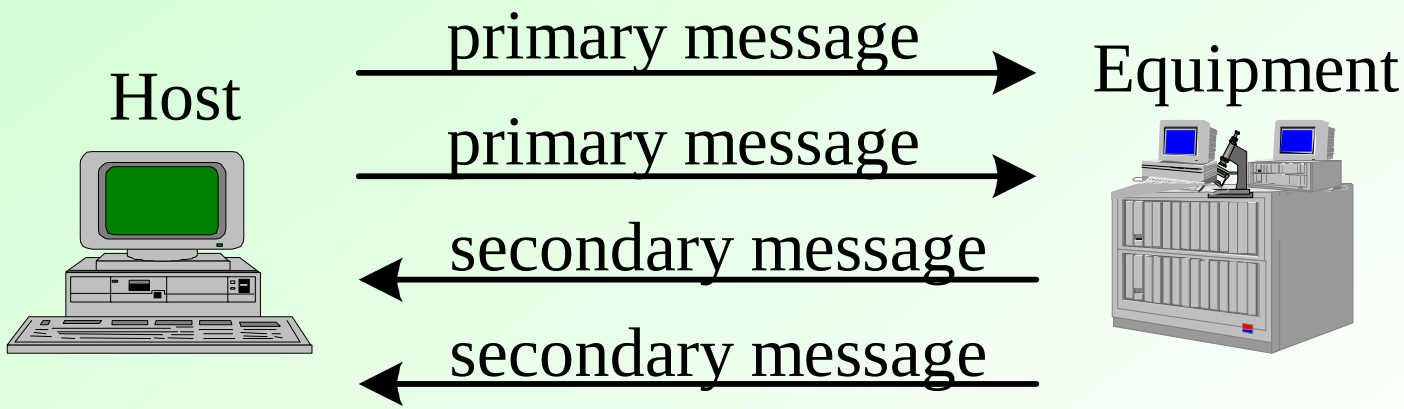
Open Transaction: After a primary message is sent and before the secondary message has been received.



SECS-I (continued)

Message Interleaving (continued)

Message interleaving occurs whenever there is more than one open transaction.



Message Interleaving

SECS-I (continued)

Protocol Parameters Summary

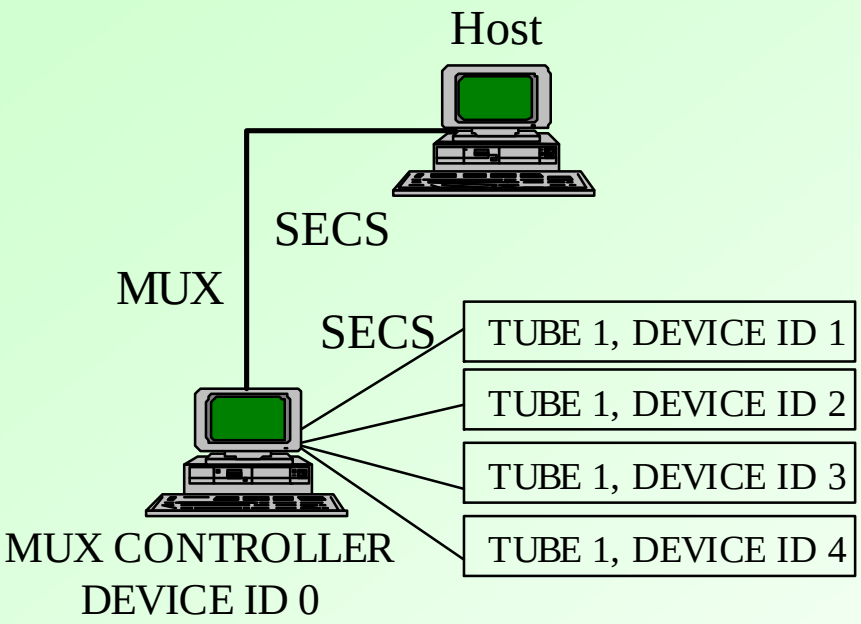
- **Timeouts**

T	Name	Typical Values	Range	Resolution
T1	Inter-Character	.5	0.1-10	0.1
T2	Protocol	2	0.2-25	0.2
T3	Reply	45	1-120	1
T4	Inter-Block	10	1-120	1

Note:

When setting up the Host and the Equipment, the timeouts should generally be set to the same values on the Equipment and Host.

SECS-I (continued)



Diffusion Furnace with
Multiple Devive IDs

Protocol Parameters Summary

- **Device ID**

  We recommend that the Device ID always be set to zero except in the cases where multiple equipment are on the same RS-232 connection. In these cases, set the Device ID to 0, 1, 2, 3…

  For a few equipment, the Device ID is fixed (rare).

SECS-I (continued)

Protocol Parameters Summary

- **BAUD**

Baud rate is usually 9600. Reduce baud rate for T1 timeouts or general communication problems.

- **RTY**

Retry count is typically 3. Increase if equipment fails to complete block protocol. The normal case for this is failure of EOT response to ENQ.

SECS-II

SECS-II provides a set of data structure rules and message structure guidelines that allow an equipment manufacturer to provide communication services to its Equipment.

The data structure (individual items) rules are quite strict. Deviations are rare. The message structure (lists and items) guidelines are a set of recommendations for particular messages that can be used to allow specific kinds of message communication. These guidelines allow for tremendous flexibility for the equipment manufacturer to allow communication with their equipment.

First, we will explore the data structure rules.

SECS-II

Data Structure Rules

❖ SECS Lists and items

- All data in a SECS Message is contained in items.
- An item is one or more data values of the same data format.
- There are 15 item data formats recognized by SECS-II.
- A SECS message contains at least one item.
- If a SECS message contains more than one item, the items are grouped in a list.
- A list may contain items and other list.

SECS-II (continued)

❖ Item Header

Byte Number	Bit Number 8 7 6 5 4 3 2 1	Description
1	format code (octal) | NLB	Format byte
2	most significant length byte	length byte 1, 2, or 3
3		
4	least significant length byte	

SECS-II (continued)

❖ Item Header (continued)

- Item format codes are provided in the SECS standard as octal numbers (6 bits).
- The Number of Length Bytes (NLB, 2 bits) informs the receiver whether the next 1, 2, or 3 bytes are to be used for the length of the item.
- For example, if the length of a message were 258 bytes, the length bytes of the message would be 0102 Hex. This takes 2 bytes to describe the message length. Therefore, the NLB=2.

NLB	Max. length of bytes
1	255
2	64k
3	7.99 million

Maximum Item Lengths for NLB

SECS-II (continued)

❖ Item Format Codes

Binary Bit 876543	Octal	Hex NLB=1	Meaning
000000	00	01	LIST
001000	10	21	Binary
001001	11	25	Boolean
010000	20	41	ASCII
010001	21	45	JIS-8
011000	30	61	8-byte integer (signed)
011001	31	65	1-byte integer (signed)
011010	32	69	2-byte integer (signed)
011100	34	71	4-byte integer (signed)
100000	40	81	8-byte floating point
100100	44	91	4-byte floating point
101000	50	A1	8-byte integer (unsigned)
101001	51	A5	1-byte integer (unsigned)
101010	52	A9	2-byte integer (unsigned)
101100	54	B1	4-byte integer (unsigned)

- The Hex column shows the code if the NLB=1 (01 binary).
- Except for recipes and data files, all items are generally less than 256 bytes long and NLB=1.
- For integers, data are sent with most significant byte first.

SECS-II (continued)

❖ Lists

- A list is a group of items.
- The format code for a list is 0 octal with one length byte.
- The format code for a list in hex is therefore 01.
- The length byte in a list (following the format code 01) is the number of items in the list.

SECS-II (continued)

Example Messages

Applied Materials AME 8300

Host gemerated transaction

Stream 1 Function 3
Stream 1 Function 4

S1F3 Host to Equipment

byte	Hex	Value	Description
1	00		R-bit=0; Host-> Equip
2	00	Device ID = 0	
3	81	Stream 1	W-bit=1; Reply Exected
4	03	Function 3	
5	80		E-bit=1; Last Block
6	01	Block # =1	
7	XX		
8	XX		
9	XX	System Bytes	
10	XX		
11	69	Item 1 Format	2-byte signed integers
12	0A	Item 1 Length	10 bytes; 5 SVIDs
13	00		
14	02	SVID1 = 2	Gas Flow 1
15	00		
16	10	SVID2 = 16	Hexcode DC Bias
17	00		
18	11	SVID3 =17	RF Forward Power
19	00		
20	60	SVID4 = 96	Current Recipe
21	00		
22	01	SVID5 = 1	Turbo Purge

Note:
In message left, data is sent in one item. This is legal since all data is the same format.

SECS-II (continued)

S1F4 Equipment to Host

byte	Hex	Value	Description
1	80		R-bit=1 Host <- Equipment
2	00	Device ID = 0	
3	01	Stream 1	W-bit=0 No Reply
4	04	Function 4	
5	80		E-bit = 1 Last Block
6	01	Block #	First Block
7	xx		
8	xx		
9	xx	System Bytes	same as primary
10	xx		
11	01	List	
12	05	5 Items	
13	69	2-byte signed	Item1 format
14	02		Item1 length
15	00		SV1
16	40	64 sccm	Gas Flow 1
17	69		Item 2 format
18	02		Item 2 length
19	01		SV2
20	00	256 volts	Hexode DC Bias
21	69		Item 3 format
22	02		Item 3 length
23	02		SV3

S1F4 Equipment to Host (continued)

byte	Hex	Value	Description
24	00	512 watts	RF forward power
25	41		Item 4 format
26	10	16 bytes	Item 4 length
27	41	A	
28	42	B	
29	43	C	SV 4
30	44	D	Current Recipe="abcdef"
31	45	E	
32	46	F	
33	20	blank	
34	20	·	
35	20	·	
36	20	·	
37	20	·	
38	20	·	
39	20	·	
40	20	·	
41	20	·	
42	20	blank	
43	69	Item 5 format	
44	02	Item 5 length	
45	00		SV5
46	53	83 cc	Turbo Purge

SECS-II (continued)

Example

S6F9 Equipment to Host PFCD=1

byte	Hex	Value	Description
1	80		R-bit = 1 Host <- Equip
2	00	Device ID = 0	
3	86	Stream 6	W-bit = 1 Reply Expected
4	09	Function 9	
5	80		E-bit = 1 Last Block
6	01	Block # =1	
7	XX		System Bytes
8	XX		
9	XX		
10	XX		
11	01	List	
12	04	4 Items	
13	21		Item 1 format (binary)
14	01		Item 1 length
15	01	PFCD = 1	
16	69	2-byte signed	Item 2 format
17	02		Item 2 length
18	00		
19	06	DATAID = 6	Load C Pumpdown Started
20	21		Item 3 format
21	01		Item 3 length
22	01	CEID = 1	
23	01	List	Item 4
24	00		zero Items

SECS-II (continued)

Example

S6F10 Host to Equipment

byte	Hex	Value	Description
1	00		R-bit = 0 Host -> Equip
2	00	Device ID = 0	
3	06	Stream 6	W-bit = 0 No Reply
4	0A	Function 10	
5	80		E-bit = 1 Last Block
6	01	Block # =1	
7	XX		System Bytes
8	XX		
9	XX		
10	XX		
11	21	binary	Item 1 Format
12	01	1 byte	Item 1 Length
13	00	ACK6 = 0	acknowledge code (OK)

SECS-II (continued)

❖ Streams

- Streams are categories of messages.
- Most equipment manufacturers use only Streams 1-15.
- If the equipment manufacturer cannot find a Stream that meets their needs, the SECS standard allows an equipment manufacturer to create their own Streams. The Streams will be start with number 64.

Stream 1	Equipment Status
Stream 2	Equipment Control and Diagnostics
Stream 3	Material Status
Stream 4	Material Control
Stream 5	Exception Reporting (Alarms)
Stream 6	Data Collection
Stream 7	Process Program Management (Recipes)
Stream 8	Control Program Transfer (never used)
Stream 9	System Errors (SECS Communication)
Stream 10	Terminal Services
Stream 11	Host File Services(Deleted)
Stream 12	Wafer Mapping
Stream 13	Unformatted Data Set Transfers
Stream 14	Object Services
Stream 15	Receipe Management

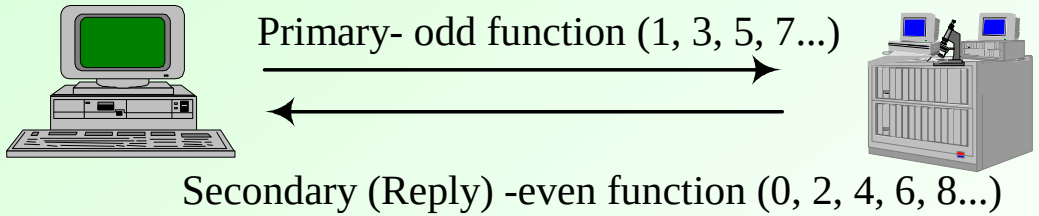
SECS-II (continued)

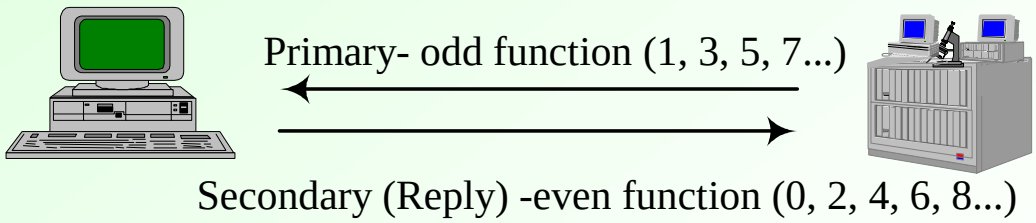
❖ Functions

- Functions are specific messages within a stream.
- Each equipment manufacturer determines which streams and functions are appropriate for their equipment model.
- Two equipment may use the same stream and function but contain different data.

SECS-II (continued)

- A primary message always contains an odd numbered function.
- A secondary (reply) message always contains an even numbered function.
- Remember that a primary message may come from either the Host or the Equipment.





SECS-II (continued)

❖ SECS 2 Messages – Notations

There are two popular abbreviations for SECS 2 messages. One comes from SEMI. You will find this one in most equipment documents. Another comes from GW Associates. You will use this one if you use SECSIMpro or SECSMON from GW Associates. This one is called SML.

SECS-II (continued)

❖SEMI

Data Item Dictionary

The Data Item Dictionary in the SEMI E5 document contains a list of recommended variable names. These names are for equipment companies to use in their equipment SECS documentation. On the host computer side, you should use the variable names given by the equipment documentation.

Examples:

Two of the most common variable names used in SECS are SV and SVID. They are shown below as they appear in the SEMI E5-91 Standards.

SECS-II (continued)

SV Format: 10, 11, 20, 21, 3(), 4(), 5()

Status variable value

Where used: S1F4, S6F1

SVID Format: 20, 3(), 5()

Status variable ID

Status variables may include any parameter that can be sampled by time such as temperature or quantity of consumable.

Where used: S1F3, F11, F12; S2F3

SECS-II (continued)

❖ SEMI SECS Notation

Every message has a style that is used:

Sn, Fm name of function (xxx)	S,M	direction	reply
Description: Structure: Exception:			

Message Detail Style

SECS-II (continued)

❖ SEMI SECS Notation (continued)

The entries in the form are described below:

Abbreviated Entry	Expanded entry and description	Example
Sn	Stream n where n= the stream number	*S1* (Stream 1)
Fm	Function m where m= the function number	*F3* (Function 3)
name	Every function has a name	Selected Equipment Status Request
(xxx)	Mnemonic-abbreviated notation for message	SSR
S, M	Single Block or Multi-Block	S
Direction	Host to Equipment, Equipment to Host, or both	H->E
Reply	Reply expected, [reply] = optional	reply
Description:	Explanation of purpose of message	
Structure:	List and item structure (see below)	
Exception:	To the structure (see below)	

SECS-II (continued)

❖ Message Structure

The following abbreviations are used:

L, n	List of n elements
< variable name>	Item
< var name 1, …, var name n>	Item with more than one variable

An element can be either an item or another list.

Most items contain one variable.

It is legal in some messages to have more than one variable as long as every variable has the same format.

SECS-II (continued)

Example

The following structure examples are the messages that were used in the Applied Materials 8300 etcher example.

SECS-II (continued)

S1F3

S1F3 Selected Equipment Status Request (SSR) *S, H → E, reply*

L, 5
1. <SVID1>
.
.
5. <SVID5>

The following structure has been acceptable for previous year's SEMI standards. This allows the list of SVIDs to appear in one item. This is how the Applied Materials 8300 sends the S1F3 message.

< SVID1, …, SVID5>

Exceptions: Zero length list means report all SVIDs.

SECS-II (continued)

S1F4

S1F4 Selected Equipment Status Data (SSD) *M, H ←E*

L, 5
1. <SV1>
.
.
5. <SV5>

Exceptions: Zero length item means SVID doesn't exist

SECS-II (continued)

S6F9

S6F9 Formatted Variable Send (FVS) *M, H ⟵ E, [reply]*

L, 4

1. <PFCD>
2. <DATAID>
3. <CEID>
4. L,0

S6F10

S6F10 Formatted Variable Acknowledge (FVA) *S, H ⟶ E*

<ACKC6>

SECS-II (continued)

❖ SML

SML was created by GW Associates. It was designed for use with the SECSIM product.

There are four main differences between the SML and the SEMI abbreviations:

1. SML contains no variable names. Actual data is used.
2. Items within lists are not numbered in SML as they are in SEMI (1,2,3,…n).
3. In SML, actual data is used so the lists have specific length (not length of n or m).
4. Lists in SML use the <> syntax as well as items.

SECS-II (continued)

❖ SML Syntax

SECS messages are specified as follows:

[msgname:] SnFm W items.

- msgname (message name) is optional and defaults to the Stream and Function.
- W is used whenever a reply is expected on a primary message.
- The “items” is actually the message structure.
- Message always ends in a period.
- Each item is created as follows:

<format [count/numlb] values >

count: number of values (optional)

numlb: NLB- number of length bytes (optional)

SECS-II (continued)

The formats have the following abbreviations:

SML	Description
A	ASCII
J	JIS-8
B	Binary
l1	One-byte Signed Integer
l2	Two-byte Signed Integer
l4	Four-byte Signed Integer
l8	Eight-byte Signed Integer
U1	One-byte Unsigned Integer
U2	Two-byte Unsigned Integer
U4	Four-byte Unsigned Integer
U8	Eight-byte Unsigned Integer
F4	Four-byte Floating Point
F8	Eight-byte Floating Point
BOOLEAN	True/False
L	List

SECS-II (continued)

The examples used previously would have the following SML notation:

S1F3

StatusRequest: S1F3 W

<I2[5] 2 16 17 96 1>.

Notice that this message contains the SVIDs in one item, not a list of items.

The Applied Materials 8300 requires this structure.

S1F4

StatusData: S1F4

```
<L
  <I2       64>   *Gas Flow 1
  <I2       256>  *DC Bias
  <I2       512>  *RF Forward Power
  <A[16]    'abcdef      '>
  <I2       83>   *Turbo Purge
>.
```

SECS-II (continued)

S6F9

EventReport: S6F9 W
<L
<B 01> *PFCD
<I2 6> *DATAID
<B 01> *CEID
<L[0] > *zero length list
>.

S6F10

EventAck: S6F10
<B 0> *acknowledge

SECS-II (continued)

Specific Message Information

❖ Messages common to most equipment

- Every equipment model supports a different set of messages transactions.
- SECS message transactions (Stream and Function) that are different from one equipment to another often have different structures and always have different data.
- There are some messages that are exactly the same for many equipments, especially newer equipment models. These messages have the exact same structure.
- The data may not be exactly the same but the data format is the same. This allows the host application to be written such that the messages can be identical from one equipment to another.
- The following frequently used message transactions are present in most semiconductor equipment worldwide.

SECS-II (continued)

S1F1 Are You There Request (R) S, H⟷E, reply

S1F2 On Line Data S, H⟷E

- Can be initiated by both the Host and Equipment.
- All equipment supports this transaction as a reply.
- Some equipment use this transaction as a request to determine Host availability.
- Use by the Host to determine if the Equipment “is on line” (communicating).
- Contains the model number and software revision, which is useful for determining if you have the proper SECS documentation for the equipment.

SECS-II (continued)

Special applications of S1F1/F2 by Host

- Normally used whenever the Host first connects to the equipment.
- Used by the Host to continuously monitor “On Line Status”. (Heartbeat.)

Special applications of S1F1/F2 by the Equipment

- An equipment which uses this message often ignores primary messages until the equipment receives the proper response to its S1F1.

S1F1

Structure: Header Only

S1F2

Structure: L, 2

1. <MDLN> *Model Number
2. <SOFTREV> *Software Revision

Exception: Host sends a zero-length list to the equipment

SECS-II (continued)

S2F25 Loopback Diagnostic Request (LDR) S, H⟷E, reply

S2F26 Loopback Diagnostic Data (LDD) S, H⟷E

- The initiator of the transaction sends a binary string of data and expects the receiver to reply with the exact same string.
- Used to determine reliability of the communication.
- Can be initiated by either the Host and Equipment.
- Many equipments support this transaction as a reply.
- A few equipment use this transactions as a request.

S2F25

Structure: <ABS>*binary string

S2F26

Structure: <ABS>*echo same binary string

Exception: Host sends a zero-length list to the equipment

SECS-II (continued)

S5F1 Alarm Report Send (ARS) **S, H⟵E, [reply]**

S5F2 Alarm Report Acknowledge (ARA) **S, H⟶E**

- Initiated by the Equipment only. Never a Host initiation.
- The reply is optional in the SEMI standards but most equipments expect a reply.
- Possible exceptions to commonality among various equipment :

1. The Alarm Code (ALCD) is bit encoded and most equipment do not usually contain all bit encoded information.
2. Some equipment sends more than 40 characters for ALTX.

```
S5F1
    Structure: L, 3
                    <ALCD> *Alarm Code
                    <ALID> *Alarm ID
                    <ALTX> *Alarm Text
S5F2
    Structure: <ACKC5> *Acknowledge
```

SECS-II (continued)

S7F1 Process Program Load Inquire **S, H ⟷ E, reply**

S7F2 Process Program Load Grant **S, H ⟷ E**

S7F3 Process Program Send **M, H ⟷ E, reply**

S7F4 Process Program Acknowledge **S, H ⟷ E**

- These two transactions are used to download a process recipe to the equipment.
- The H ⟷ E shows that this recipe can be uploaded using this same sequence but this is rarely supported. Uploading is almost always Host initiated.
- In the first transaction, the Host asks the Equipment if it is OK to download. The name of the recipe and its length is provided so that the equipment can determine if it already has this recipe and if it has enough memory to store it.

SECS-II (continued)

- In the second transaction, the Host downloads the recipe as a string of binary data.
- One of the exceptions to the commonality among equipment is the PPID length.
- Most equipments use 16 bytes. Some equipments do not allow trailing blanks on a recipe name shorter than 16 bytes.

S7F1

Structure: L, 2
1. <PPID> *Recipe name, ASCII
2. <LENGTH>

S7F2

Structure: <PPGNT> *Grant

S7F3

Structure: L, 2
1. <PPID>
2. <PPBODY> *binary string (recipe)

S7F4

Structure: <ACKC7>

SECS-II (continued)

Stream 9

- Stream 9 contains error messages that are always initiated by the Equipment to inform the host of a communication error.
- Stream 9 messages never have a reply.
- Stream 9 functions are:

Function	Description
1	Unrecognized Device ID
3	Unrecognized Stream Type
5	Unrecognized Function Type
7	Illegal Data
9	Transaction Timer Timeout
11	Data Too Long
13	Conversation Timeout

SECS-II (continued)

Stream 9 (continued)

- Function 9 is used whenever the equipment sends a primary message and does not receive a reply within the equipment's T3 timeout.
- Function 13 is used whenever the Host is send a two transaction conversation (for example S7F1, 2 – S7F3, 4). If the second transaction is not received within a reasonable (defined by equipment) time after the first transaction, the Equipment will send the Function 13 message.
- Except for Function 13, all Stream 9 messages send one 10-byte binary item which is the header of the message sent by the host that caused the equipment a communication problem.
- Function 13 sends a list of two items.

SECS-II (continued)

❖ Special Messages

Stream 6

Stream 6 messages are used:

1. By almost all metrology equipment to report measurement data.
2. Increasingly by process equipment to report data and events.

Stream 6 messages are special because they:

1. Are initiated by the equipment.
2. Often have more than one data structure for the same Stream and Function.

SECS-II (continued)

Common problems and Complications

- **Cabling**

  Pins 2 and 3 crossed. Standard debug tool is null modem.

- **System Bytes**

  Some old equipment makes errors handing system bytes.

  At least two equipment (older models of the Hitachi 6000 SEM and Tencor 4500) always send zero for system bytes.

SECS-II (continued)

Common problems and Complications(continued)

- **Timeouts**

  “Tune” timeouts on Host and Equipment so that match.

  Make sure that the T2 timeout is not close to the T3 or T4 timeout.

  General rule is (Host T2)* (Host RTY) < Equipment T3 and vice versa.

- **Message Interleaving**

  Not supported by some equipment. Must guard in application.

- **Short Blocks**

  For multi-block messages, some equipments send blocks, other than the last block, shorter than 254 bytes.

SECS-II (continued)

Example

Host Initiated Messages for K&S 1488 turbo Wire Bonders

Primary		Reply (Secondary)	
		SnF0	Abort transaction
S1F1	are you there request	S1F2	online data
S1F5	formatted status request	S1F6	formatted status data
S1F13	establish communications request	S1F14	establish communications request acknowledge
S2F15	new equipment constant send	S2F16	new equipment constant
S2F21	remote command send	S2F22	remote command acknowledge
S2F25	loopback diagnostic request	S2F26	loopback diagnostic data
S5F3	enable/disable alarm send	S5F4	enable/disable alarm acknowledge
S5F5	list alarms request	S5F6	list alarms data
S7F1①	process program load inquire	S7F2	process program load grant
S7F3 ①	process program send	S7F4	process program acknowledge
S7F5 ①	process program request	S7F6	process program data
S10F3	terminal display, single		

(*) Message defined by Kulicke and Soffa; not part of the SECS-II standard.

①: Note equipment must be in Host-Initiated Transfer Mode

SECS-II (continued)

Equipment Initiated Messages for K&S 1488 turbo Wire Bonders

Primary		Reply (Secondary)	
S1F1	are you there request	S1 F2	online data
S1F13	establish communications request	S1F14	establish communications request acknowledge
*S1F65	send operator ID		
*S1F69	going offline		
S2F25	loopback diagnostic request	S2F26	loopback diagnostic data
*S3F65	identify material	*S3F66	identify material acknowledge
S5F1	alarm report send	†S5F2	alarm report acknowledge
S6F3	discrete variable data send	† S6F4	discrete variable data acknowledge
S7F1	process program load inquire	S7F2	process program load grant
S7F3	process program send	S7F4	process program acknowledge
S7F5	process program request	S7F6	process program data
*S7F107	process program name request	*S7F108	process program name
S9F1	unrecognized device id		
S9F3	unrecognized stream type		
S9F5	unrecognized function type		
S9F7	illegal data		
*S10F65	physical setup text requests	*S10F66	physical setup text
*S64F65	material parameter flags request	*S64F66	material parameter flags

(*) :Message defined by Kulicke and Soffa; not part of the SECS-II standard.

(†): Not required by the equipment, ignored if sent.

SECS-II (continued)

❖ Message Details

- **Stream 1, Equipment Status**

S1F1 Are You There Request (R) *S, H* ⟷ *E, reply*

Description: This message establishes if the other end of the communication link is online.

Structure: Header Only.

Timing: The equipment sends this message in the following situations.

1. Automatically upon power-up.
2. Whenever the operator directs the equipment to go online.

The host may send this message at any time.

Note: The equipment can be configured to use S1F13 to establish communication instead of S1F1. See S1F13, and communication scenarios on pp. 7-8.

SECS-II (continued)

S1F2 On line Data (D) *S, H* ⟷ *E*

Description: This message contains data signifying that the receiver of a S1F1 message is online.

Structure: L, 2

1.<MDLN>

2.<SOFTREV>

Content: The equipment returns the following data.

1. The model type of the equipment.

2. The software revision currently installed.

The host returns no data in this message.

SECS-II (continued)

S1F5 Formatted Status Request (SSR) *S, H* ⟶ *E, reply*

Description: This message requests a pre-defined report from the equipment.

Structure: <SFCD>

Timing: This message can be sent at any time when the equipment is online.

S1F6 Formatted Status Data (SSD) *M, H* ⟵ *E*

Description: This message is the reply to the Formatted Status Request message.

Structure: Described in Report definitions below.

Content: The content of this message varies with the report which was requested.

SECS-II (continued)

S1F6 (continued)

SFCD 1: Combined Reports

Description: This report is a combination of other reports.

Structure: L, 18

1. Report for <SFCD> =2
2. Report for <SFCD> =4
3. Report for <SFCD> =5
4. Report for <SFCD> =6
5. Report for <SFCD> =7
6. Report for <SFCD> =8
7. Report for <SFCD> =9
8. Report for <SFCD> =10
9. Report for <SFCD> =11
10. Report for <SFCD> =12
11. Report for <SFCD> =13
12. Report for <SFCD> =14
13. Report for <SFCD> =15
14. Report for <SFCD> =16
15. Report for <SFCD> =17
16. Report for <SFCD> =18
17. Report for <SFCD> =19
18. Report for <SFCD> =20

SECS-II (continued)

S1F6 (continued)

SFCD 2: Production Counter Report

Description: This report contains the number of devices which have been successfully processed and the number of devices which have been skipped. When the equipment is powered-up these counters are set to zero. Each subsequent device which is processed automatically is then counted into one of the two categories. These counters continue to accumulate until the equipment is powered off or the operator resets them.

Structure:	L, 4			
		1.	Device processed	Format: 54
		2.	Reserved for earlier compatibility	Format: 31
		3.	Reserved for earlier compatibility	Format: 31
		4.	Devices skipped	Format: 54

. . . .

SECS-II (continued)

S1 F13 Establish Communications Request (CR) *S, H* ⟷ *E, reply*

Description: This message is the alternate means for initializing communication. The equipment will send this message at power up and following a communication break, and will repeat sending the message at programmable intervals until communication is established. The host responds to a S1F13 message with either a S1F13 or S1F14, and communication is established or restored.

Structure: As per SEMI SECS-II Specification

Note: This method of establishing communication, and the value of the interval timer, is set at the equipment console. The timer can be set for 1-250 seconds. The default is disabled, with the S1F1/S1F2 scenario used for initialization, and S5F1 for reconnection.

SECS-II (continued)

S1 F14 Establish Communications Request Acknowledge (CRA) S, H ⟷ E

Description: This message is sent by either the host or the equipment in response to a S1F13 attempt to establish communication.

Structure: As per SEMI SECS-II Specification

Note: This method of acknowledging the establish communication request is enabled at the equipment console.

SECS-II (continued)

Stream 5, Exception Reporting

Stream 5 messages are used to report the occurrence and status of equipment alarms.

S5 F1 Alarm Report Send (ARS) *S, H←——E*

Description: This message reports a change in the status of an alarm. See Appendix B: Alarm Identification Codes for alarm code explanations.

Structure: L, 3

1.<ALCD>
2.<ALID>
3.<ALTX>

Timing: This message is sent when the equipment is in Auto mode and an equipment operation alarm status changes. Alarms associated specifically with loss of communication will be sent upon resumption of communication, independently of the equipment mode of operation.

Content: This message contains the identity, its severity and its status for the alarm.

SECS-II (continued)

S5 F2 Alarm Report Acknowledge (ARA) $S, H \longrightarrow E$

Description: This message acknowledges the receipt of an alarm report. This message is not required by the equipment. The equipment will ignore this message if it is sent.

Structure: <ACKC5>

SECS-II (continued)

S5 F3 Enable/Disable Alarm Send (EAS) *S, H → E, reply*

Description: This message allows the host to enable or disable the reporting of a selected alarm or for all alarms.

Structure: L, 2
1.<ALED>
2.<ALID>

Timing: This message may be sent whenever the host and the equipment are online.

Content: This message contains the alarm identification code and the desired enable/disable status.

Exceptions: A zero length item for ALID means all alarms.

SECS-II (continued)

S5 F4 Enable/Disable Alarm Acknowledge (EAA) *S, H⟵E*

Description: This message indicates whether an alarm enable/disable request message was accepted.

Structure: <ACKC5>

Timing: This message is sent in response to a S5 F3 message which has the reply required bit set.

SECS-II (continued)

❖ **Alarm Identification Codes for K&S 1488 turbo Wire Bonders**

Detailed information about equipment alarm identity codes is listed in the following. Alarms may be of two types:

Error Alarm Code 5: These alarms will be set upon an error condition and cleared if the error condition is corrected, or if the machine is put in E-Stop or Master Mode by the operator.

SECS-II (continued)

❖Alarm Identification Codes for K&S 1488 turbo Wire Bonders (continued)

Warning — Alarm Code 6: These alarms will be set upon a warning condition and cleared one of three ways:

1. Cleared immediately if the warning does not stop the machine.
2. If the warning stops machine, cleared after the operator acknowledges the warning.
3. Cleared when the machine is put in E-Stop or Master Mode by the operator.

- Note that ALID 9000 is never cleared.
- Some alarms are only found in an earlier version of bonder software (identified by [3.19]); some are available only for specific 1488 turbo configurations or options (such as [FLEX] or [2803.2810]). Note: “Spares” are reserved for future use.

SECS-II (continued)

Alarm Description	ALARM ALID	ALARM CODE
System Error Group		
•Internal SYSERR	1	5
PRS Subsystem Error Group:		
•PRS equipment failure	16	5
•First eyepoint failure	17	6
•Second eyepoint failure	18	6
•LTOL failure	19	6
•Maximum number of PRS skips	20	5
•VLL find error-lead edge not found	21	5
•VLL width error-lead width out of tolerance	22	5
•VLL not taught-no lead taught	23	5
•Spare PRS Alarm	24-25	5
Bonding Error Group:		
•EFO equipment failure [3.19]	32	5

SECS-II Example

Host (Equipment Manager or Cell Controller)

STEP 1

Device 2 START

Timer on

S1F1 Polling successful

Sending S1F2

SdrResponse: S1F2

STEP 2

Sending S1F1

status=Status OK

S1F2 Polling successful

STEP 3

S5F1 Polling successful

ALCD: 1

ALID: 17

ALTX: Equipment on fire

SdrResponse: S5F2

STEP 4

Sending S1F5 [SFCD=2]

status=Status OK

S1F6 Polling successful

Processed# : 23456

Skipped#: 19876

SECS-II Example (continued)

Equipment (SECSIM) STEP 1

13:08:05 BEGIN LOG FILE 11/26/97

13:08:05 Sending S1F1

S1F1 W.

13:08:05 SENT 05 (ENQ)

13:08:05 RECD 04 (EOT)

13:08:05 SENT 0A 80 00 81 01 80 01 00 00 00 01 01 84

13:08:05 RECD 06 (ACK)

13:08:05 MESSAGE SENT

13:08:05 RECD 05 (ENQ)

13:08:05 SENT 04 (EOT)

13:08:05 RECD 18 00 00 01 02 80 01 00 00 00 01 01 02 41 03 53 49 42 41 05 30 38 5F 32 38
03 21

13:08:05 SENT 06 (ACK)

13:08:05 RECEIVED SECONDARY REPLY MESSAGE

S1F2

<L [2/1]

<A [3/1] 'SIB' >

<A [5/1] '08_28' >

>.

SECS-II Example (continued)

Equipment (SECSIM) STEP 2

13:08:17 RECD 05 (ENQ)

13:08:17 SENT 04 (EOT)

13:08:17 RECD 0A 00 00 81 01 80 01 00 00 00 15 01 18

13:08:17 SENT 06 (ACK)

13:08:17 RECEIVED PRIMARY MESSAGE

S1F1 W.

13:08:17 Sending S1F2

```
S1F2
 <L [2/1]
     <A [6/1]  '1484XQ' >
     <A [6/1] '702414' >
 >.
```

13:08:17 SENT 05 (ENQ)

13:08:17 RECD 04 (EOT)

13:08:17 SENT IC 80 00 01 02 80 01 00 00 00 15 01 02 41 06 31 34 38 34 58 51 41 06 37 30 32 34 31 34 04 56

13:08:17 RECD 06 (ACK)

13:08:17 MESSAGE SENT

SECS-II Example (continued)

Equipment (SECSIM) STEP 3

13:08:27 Sending S5F1

```
S5F1      W
 <L [3/1]
        <B [1/1]  01 >
       <U2 [1/1] 17 >
        <A [17/1] 'Equipment on fire' >
   >.
```

13:08:27 SENT 05 (ENQ)

13:08:27 RECD 04 (EOT)

13:08:27 SENT 26 80 00 85 01 80 01 00 00 00 02 01 03 21 01 01 A9 02 00 11 41 11 45 71 75
69 70 6D 65 6E 74 20 6F 6E 20 66 69 72 65 09 39

13:08:27 RECD 06 (ACK)

13:08:27 MESSAGE SENT

13:08:27 RECD 05 (ENQ)

13:08:27 SENT 04 (EOT)

13:08:27 RECD 0D 00 00 05 02 80 01 00 00 00 02 21 01 00 00 AC

13:08:27 SENT 06 (ACK)

13:08:27 RECEIVED SECONDARY REPLY MESSAGE

```
S5F2
     <B [1/1]  00 >.
```

SECS-II Example (continued)

Equipment (SECSIM) STEP 4

13:08:36 RECD 05 (ENQ)
13:08:36 SENT 04 (EOT)
13:08:36 RECD 0D 00 00 81 05 80 01 00 00 00 16 21 01 02 01 41
13:08:36 SENT 06 (ACK)
13:08:36 RECEIVED PRIMARY MESSAGE
S1F5 W
<B [1/1] 02>.
13:08:36 Sending S1F6

```
S1F6
<L [4/1]
    <U4 [1/1]  23456 >
      <I1 [1/1] 0 >
      <I1 [1/1] 0 >
     <U4 [1/1]  19876 >
  >.
```

13:08:36 SENT 05 (ENQ)
13:08:37 RECD 04 (EOT)
13:08:37 SENT IE 80 00 01 06 80 01 00 00 00 16 01 04 B1 04 00 00 5B A0 65 01 00 65 01 00
B1 04 00 00 4D A4 05 45
13:08:37 RECD 06 (ACK)
13:08:37 MESSAGE SENT