

**Wire Bonder Specific Equipment  
Model (SEM) Rev. 2.0**

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# Wire Bonder Specific Equipment Model (SEM) Rev. 2.0

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**Abstract:** This document updates and expands the SEMATECH Wire Bonder Specific Equipment Model (WBSEM). The model consists of equipment characteristics and behaviors that apply to such equipment and that are consistent with supporting SEMI standards, including the Generic Equipment Model (GEM) and Semiconductor Equipment Communications Standards 1 and 2 (SECS-I and SECS-II). The model is designed to facilitate the integration of wire bonding equipment into an automated semiconductor factory. This version of WBSEM includes simplification of the Process State Model, removal of Common SEM sections, updated Bond Map and Strip Map sections, and other changes. This document is part of a series of SEMATECH-developed Specific Equipment Models (SEMs); others include *SEMATECH Stepper Specific Equipment Model (SEM)*, Technology Transfer #95042782A-ENG; *SEMATECH Metrology Specific Equipment Model (MSEM)*, Technology Transfer #95042793A-ENG; *SEMATECH Inspection/Review Specific Equipment Model (ISEM)*, Technology Transfer #95042797A-ENG; and *SEMATECH Apply/Develop Track Specific Equipment Model (ADTSEM), Version 0.8*, Technology Transfer #95113021A-ENG.

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## **1 EXECUTIVE SUMMARY**

### **1.1 Purpose**

This document updates and expands the SEMATECH Wire Bonder Specific Equipment Model (WBSEM), which establishes a specific equipment model (SEM) for wire bonder equipment. This wire bonder SEM (WBSEM) consists of equipment characteristics and behaviors that apply to this class of equipment and that are required for implementation in addition to the fundamental requirements and additional capabilities of the Generic Equipment Model (SEMI E30). This version of WBSEM includes the following updates to the version 1.02:

- The Process State Model has been simplified.
- The Common SEM sections have been removed for inclusion in SEMI E30.
- The Bond Map and Strip Map sections have been updated.
- Edits have been made to require only High-speed Message Services (HSMS) (SEMI E37), with no restrictions on use of HSMS-SS or HSMS-GS.

The intent of this document is to facilitate the integration of wire bonder equipment into an automated semiconductor factory. This document accomplishes this by defining an operational model for wire bonder equipment, as viewed by a factory automation controller. This definition provides a standard host interface and equipment operational behavior.

### **1.2 Scope**

The scope of this document is limited to the definition of wire bonder equipment behavior as perceived by a Semiconductor Equipment Communications Standard 2 (SEMI E5) host that complies with the SEMI E30 model. It defines the view of the equipment through the SECS communications link, but does not define the internal operation of the equipment. It includes a specific processing state model as the basis for all equipment behavior of this class.

This document requires that the SEMI E30 fundamental requirements and additional capabilities have been implemented on the WBSEM equipment. This document expands the SEMI E30 standard requirements and capabilities in the areas of the processing state model, collection events, remote commands, data item variables, and Process Program management.

It is required that any WBSEM compliant equipment follow the communications state model in SEMI E30. In addition, WBSEM-compliant equipment shall support the High-speed SECS Message Services (HSMS) E37 communication standard for sending SEMI E5 messages over Transmission Control Protocol/Internet Protocol (TCP/IP).

### **1.3 Limitations**

It is required that any WBSEM compliant equipment follow the communications state model in SEMI E30. In addition, WBSEM-compliant equipment shall support the High-speed SECS Message Services (HSMS) communication standard for sending SEMI E5 messages over TCP/IP.

This SEM makes some demands and assumptions about how the wire bonder works in a linked mode. These requirements are as follows:

- Strip identification are available to the wire bonder
- Magazine identification are available to the wire bonder

## 2 REFERENCED DOCUMENTS

NOTE: As listed or revised, all documents cited shall be the latest publications of adopted standards.

### 2.1 SEMI Standards

SEMI E30	Generic Model for Communications and Control of SEMI Equipment
SEMI E5	Semiconductor Equipment Communications Standard 2 (SECS-II) Message Content
SEMI E4	SEMI Equipment Communications Standard 1 (SECS-I) Message Transfer
SEMI E37	SEMI High Speed Messaging Service Transfer (HSMS)
SEMI E37.1	SEMI High Speed Messaging Service Single Session
SEMI E32	SEMI Material Movement Management Standard (MMMS)

### 2.2 Other References

Harel, D., "Statecharts: A Visual Formalism for Complex Systems," *Science of Computer Programming*, 8 (1987) 231–274.

TUMMALA-89 Rao, R. Tummala, Eugene J. Rymaszewski, *Microelectronics Packaging Handbook*, New York: Van Nostrand Reinhold, 1988.

## 3 TERMINOLOGY

Terms used in this document include the following:

**Ball bonding:** The joining of wire (usually gold) to *bond pad* (or *lead finger*) by the formation of a ball by passing a hydrogen torch over the end of the gold wire, or by capacitance discharge and then applying a vertical load to the ball while ultrasonically exciting the wire [TUMMALA89].

**Bond diagram:** Usually termed *mount and bond diagrams* or *buildsheets*. These diagrams specify such characteristics as die orientation on *die pad*, leadfinger to *bond pad* wiring schematics, besides specifying *material* to be used usually at *die* bond and wirebond operations (also called *mount*, *bond diagram* and *buildsheet*).

**Bonding head:** See bonding stylus or bonding capillary.

**Die bond pad:** Relatively large metal areas on a *die* used for electrical contact with a package or probe pins.

**Bonding area:** The point of contact. The area of a *package* designated for the attachment of small diameter wires from the *bond pads* on the *die* to the *package*. These areas are often coined if the *strips* are stamped, in order to provide a flat surface for bonding.

**Bonding stylus:** Wire guide used in *ultrasonic bonding* to create *wedge bonds*, sometimes called bonding head [TUMMALA89].

**Bonding capillary:** Tubular wire guide used in *thermoccompression (T/C)* or *thermosonic (T/S)* bonding usually made of alumina, tungsten carbide, or other refractory material. Sometimes called bonding head [TUMMALA89].

**Build sheets:** See *bond diagram*.

**Capillary:** See bonding capillary.

**Chaining:** A mode of operation for the wire bonder that allows back to back processing of lots. The wire bonder will process these lots with exactly the same operating conditions, without performing the setup operation between the lots.

**Device:** The *combination of chip* (or *chips*) connected to the *substrate* to form a functional integrated circuit.

**Die (attach) pad:** The nominal area designated for die attaching to the package or strip.

**Electronic flame-off (EFO) v:** Capacitance discharge used to cut bond wire and form the ball at the end of the wire for *ball bonding*.

**Execution area:** The area from which a current copy of the Process Program instructions are executed.

**Indexing:** The controlled stepped movement of *strips* or *boats* through the *workholder* section of a wire bonder.

**Linked bonder:** A wire bonder that is mechanically interfaced to an adjacent equipment (i.e., *die bonder*, *automolder*, *automated material handler*) such that *strip* or *substrates* are transferred one unit or *magazine* at a time between the *wire bonder* and the adjacent equipment.

**Lead finger:** 1. In ceramic packages, an area of refractory metal that has been plated, usually gold, and is intended for wire bonding. 2. The area of *strips* designated for the attachment of bonding wires between the *bond pads* on the die and the *leadframe*. Also called *bonding finger* or *substrate connector lead*.

**Leadframe:** A sheet metal framework upon which a *chip* (sometimes *chips*) is attached, wire bonded, and then molded with plastic epoxy.

**Safe state:** A state where material, personnel, and equipment are not in danger. Specific identification of stage states are determined by the equipment manufacture.

**Strip:** A precut length of several leadframes laid out in a serial or matrix pattern (also called matrix *leadframes*).

mount and bond diagram: See *bond diagram*.

**Offline programming utility:** Utility to create, edit, and format Process Programs on a computer as opposed to creating Process Programs at the equipment.

**Pattern recognition system:** A system or subsystem that can identify substrate surface patterns based on alignment marks that appear on the integrated circuit layout.

**Reset:** The action of reassigning the value of a variable, such as wafer count.

**Slot:** A position in a *magazine* where a *strip* or *boat* may reside.

**Strip map:** A formatted data item mapping functionally good and bad *devices* on a *strip* or *boat* to ones and zeros respectively. Maps originating from upstream processes like die bond will indicate zeros corresponding to a strip to be skipped by the *wire bonder*.

**Standalone bonder:** A *wire bonder* that has processing material loaded and unloaded manually.

**Thermocompression (T/C) bonding:** Bonding accomplished by pressing the wire (usually gold) against the *bond pad* (or *lead finger*) at an elevated temperature. Practically all *wire loops* are formed using a *ball bond* at the first bond site and a *wedge bond* at the second. [TUMMALA89]

**Thermosonic (T/S) bonding:** A combination of the principle bonding features of *ultrasonic* and *thermocompression bonding*. Gold wire *ball-and-wedge bonds* are made, as in the *thermocompression* technique, but the *bonding capillary* is driven by a burst of ultrasonic power at each bond to augment metal joining, thus enabling lower-temperature bonding than regular *thermocompression bonding*. [TUMMALA89]

**Ultrasonic (U/S) bonding:** A process in which wire is guided to the bonding site, pressed onto the surface by a *bonding stylus*; when the wire is clamped and stable, it is cold-welded (see *wedge bond*) by a burst of ultrasonic vibrations from the *bonding stylus* [TUMMALA89]

**Wedge bonding:** The forming of a metallurgical cold weld between wire and *bond pad* (or *lead finger*) accomplished by a combination of pressure and ultrasonic excitation [TUMMALA89].

**Wire bonder:** Equipment that bonds wires (usually a gold or aluminum alloy), normally one at a time, to the *chip* and *leadframe* or *substrate* using *ultrasonic (U/S)*, *thermocompression (T/C)*, or *thermosonic (T/S)* bonding.

**Wire size:** Diameter of bonding wire used.

**Workholder:** Exchangeable jig or fixture that is used as the stable working platform for positioning and *clamping strip* or *boats* for the bonding process. These may be fixed or flexible to accommodate various *strip* and *boat* sizes.

## 4 STATE MODELS

This section defines the equipment-specific processing state model and other state models necessary to portray the expected operational states of the equipment. This enables host tracking and control in place of the local operator.

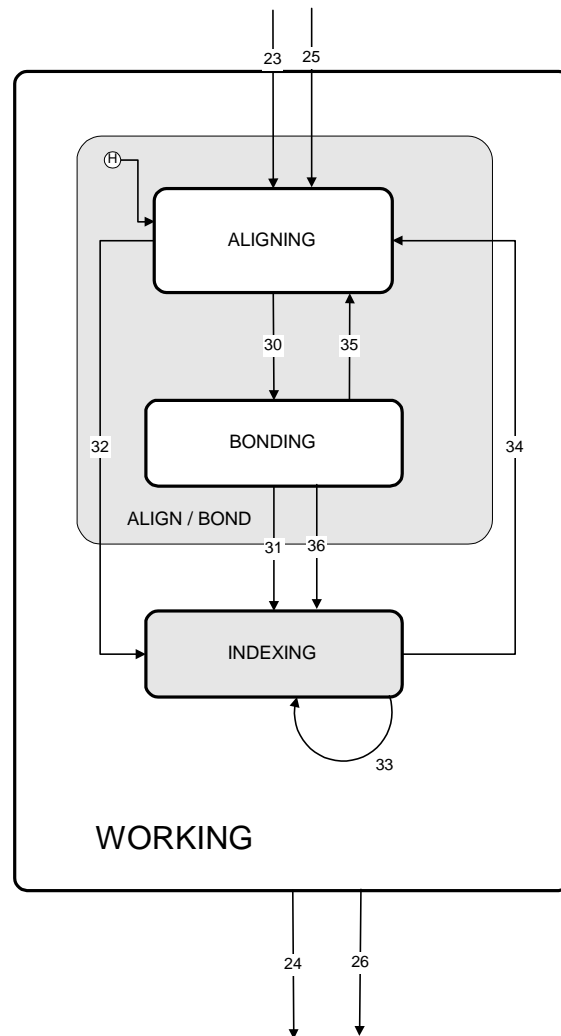
### 4.1 Processing State Model Requirements

- The Processing State models in this document are required for implementing a WBSEM-compliant wire bonder in addition to the required state models in E30. A state model consists of a state model diagram, processing state definitions, and a state transition table.

- A state model represents the host's view of the wire bonder, not necessarily the actual wire bonder operation.
- All WBSEM state model transitions shall be mapped sequentially into the actual equipment events that satisfy the requirements of those transitions. In certain implementations, the wire bonder may enter a state and have already satisfied all of the conditions required by the WBSEM state model for transition to another state. The wire bonder makes the required transition without any additional actions in this situation.
- Some equipment may need to include additional states. However, any additional states shall not change the WBSEM-defined state transitions. All expected transitions between WBSEM states shall occur.



### 4.2.1 Working State of Processing State Model



**Figure 2** WBSEM Working State Expanded

### 4.3 Processing State Definitions

#### ABORTED

All activity is suspended as a result of an ABORT command. Any alarm and abort conditions shall be cleared and verified by an operator before exit from this state.

#### ABORTING (PROCESSING ACTIVE substate)

The wire bonder has received an ABORT command. All activity is suspended. The wire bonder is taking appropriate action to bring itself and material to a “safe” state where possible. Device or lot data may be invalid or not available.

#### ALIGNING (WORKING substate)

The wire bonder aligns to the device to be bonded. Rotation of the strip/boat or bond head may be performed in this state to achieve the proper alignment.

ALARM PAUSED (PAUSE substate)

An alarm has occurred in the PROCESS or PROCESS PAUSE states and the wire bonder is waiting for the alarm to be cleared.

BONDING (WORKING substate)

Connections are made between the device and the leadframe.

CHECKING (PROCESS PAUSED substate)

The wire bonder verifies that the updates made to the Process Programs are valid. This is a similar procedure to that which is done in SETTING UP before the wire bonder is ready to transition to the READY state. At the completion of verification, an event is generated when the verification succeeds and the operator or host shall issue a RESUME command to the wire bonder before it will resume processing from the point where it was paused.

EXECUTING (PROCESS substate)

The wire bonder is processing material automatically and can continue to do so without external intervention. This state may include interaction with the host or operator.

IDLE

Awaiting a command. IDLE is free of ALARMS and error conditions.

IDLE with ALARMS

An alarm has occurred in the IDLE state and the wire bonder is waiting for all alarms to be cleared.

INDEXING (WORKING substate)

The bonder moves the leadframe strip to the next location where bonding may be performed if no additional devices are available. Then the leadframe strip is indexed off the workholder.

INIT

Wire bonder initialization is occurring.

LOAD (EXECUTING substate)

This is the state where the strip is transferred to the bonder's workholder and clamped in place.

PAUSE (PROCESSING ACTIVE substate)

The PROCESS state is suspended at the completion of the current device, wire bond, or next opportunity. Actions to put the wire bonder in a safe state will be performed. The wire bonder is awaiting a command (RESUME, PP-UPDATE, STOP, or ABORT), or for alarm(s) to be cleared.

PAUSED (PROCESS PAUSE substate)

The PROCESS state has been suspended and the wire bonder is waiting for a command (RESUME, PP-UPDATE, STOP, or ABORT). In this state, the operator may correct error conditions that do not affect the current Process Program selection. One corrective action allowed is for manual alignment of a strip by the operator.

PAUSING (PROCESS PAUSE substate)

The PROCESS state are suspended at the completion of the current device, wire, or next opportunity. The wire bonder cannot transition to PAUSED state until the current device is completed and the wire bonder is in a “safe state.”

PROCESS (PROCESSING ACTIVE substate)

This state is the parent of those substates that refer to the preparation and execution of a Process Program.

PROCESSING ACTIVE

This state is the parent of all substates where a Process Program exists.

PROCESS PAUSE (PAUSE substate)

The wire bonder is free of alarm conditions in the PAUSE state.

READY (PROCESS substate)

The wire bonder is ready to begin processing and is awaiting a START command from the operator or host.

SETTING UP (PROCESS substate)

The wire bonder is satisfying conditions so that processing and additional module initialization can begin. This includes the receipt of any Process Programs and material to be processed and their validation.

STOPPING (PROCESSING ACTIVE substate)

The wire bonder has completed a Process Program or has been instructed to stop processing and will do so gracefully at the next opportunity. All necessary cleanup completed within this state is cleared before exit from this state.

UNLOAD (EXECUTING substate)

The strip is being removed from the bonding workholder.

WORKING (EXECUTING substate)

The wire bonder is processing a specific leadframe strip.

#### 4.4 Processing State Transition Table

**Table 1 Processing State Transitions**

WBSEM #	Current State	Trigger	New State	Actions	Comments
1	INIT	All wire bonder initialization is complete with no alarms or error conditions.	IDLE	None	None
2	IDLE	A Process Program is selected.	SETTING UP	Wire bonder dependent.	Commit has been made to set up.
3	SETTING UP	All setup activity has completed and the wire bonder is ready to receive a START command.	READY	The wire bonder is waiting for a START command.	The selected Process Program is available for execution and material is present at the input port.
4	READY	The wire bonder executes a START command for a new lot.	LOAD	Transfers the next strip to the bonding workholder.	LOAD is an EXECUTING substate.
5	UNLOAD	The material unload is complete.	LOAD	Transfers the next strip to the processing location.	None
6	PROCESS	The wire bonder has received a STOP command.	STOPPING	The wire bonder completes the current strip in the WORKING state and unloaded it.	The wire bonder begins its cleanup procedure.
7	PROCESS	The wire bonder has received an ABORT command from operator, host, or self generated.	ABORTING	The wire bonder is put in a "safe" state.	Strip or lot data may be invalid or not available.
8	PROCESS	An alarm occurs.	ALARM PAUSED	PROCESS activity is suspended and the wire bonder is waiting for all alarms to be cleared.	ALARM PAUSED is a PAUSE substate.
9	PROCESS	The wire bonder has received a PAUSE command.	PAUSING	The PROCESS state is suspended at the completion of the current device, wire, or bond. Any necessary actions to put the wire bonder in a safe state shall be performed.	PAUSING is a PAUSE substate.
10	PROCESS PAUSE	The wire bonder has received a RESUME command.	Previous PROCESS State	Proceeds from the point where processing was previous suspended.	None
12	STOPPING	The wire bonder cleanup is complete and the wire bonder is free of alarms.	IDLE	None	None

<b>WBSEM #</b>	<b>Current State</b>	<b>Trigger</b>	<b>New State</b>	<b>Actions</b>	<b>Comments</b>
13	PAUSE	The wire bonder has received a STOP command.	STOPPING	The wire bonder proceeds with clean up.	Data is preserved and is valid.
14	PAUSE	The wire bonder has received an ABORT command.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or unavailable.
15	STOPPING	The wire bonder has received an ABORT command or an alarm.	ABORTING	Any unsafe condition is resolved if possible.	Data may be invalid or unavailable.
16	ABORTING	Unsafe conditions have been resolved where possible.	ABORTED	The wire bonder is waiting for alarm and ABORT conditions to be cleared.	The only state change allowed is to IDLE.
17	ABORTED	An operator has verified that all alarms and abort conditions have been cleared.	IDLE	None	The IDLE state is a "clean" state.
18	IDLE	An alarm is set.	IDLE with ALARMS	The wire bonder waits for all alarms to be cleared.	None
19	IDLE with ALARMS	All alarms have been cleared.	IDLE	None	The IDLE state is free of alarms.
20	PAUSING	The wire bonder has completed processing the current device in the WORKING state and achieved a safe condition.	PAUSED	The wire bonder is waiting for a command (RESUME, STOP, ABORT, or PP-UPDATE).	None
21	PROCESS PAUSE	An alarm is set by the wire bonder.	ALARM PAUSED	The wire bonder waits for all alarms to be cleared, or a STOP or ABORT command.	None
22	ALARM PAUSED	All alarms are cleared.	PAUSED	The wire bonder is waiting for a command (RESUME, STOP, ABORT, or PP-UPDATE).	None
23	LOAD	A strip has completed loading to the bonders workholder.	ALIGNING	The strip is being aligned.	None
24	WORKING	The processing of the current strip has completed normally.	UNLOAD	This strip is transferred from the bonders workholder.	"Normal" completion of the strip.
25	LOAD	The first strip of a lot is being loaded to the workholder.	ALIGNING	The strip is being aligned.	None
26	WORKING	The processing of the current strip has completed abnormally.	UNLOAD	This strip is transferred from the bonders workholder.	Error exit from WORKING.

<b>WBSEM #</b>	<b>Current State</b>	<b>Trigger</b>	<b>New State</b>	<b>Actions</b>	<b>Comments</b>
27	PAUSED	A PP-UPDATE command was received.	CHECKING	Validation of the new Process Program variable parameters begins.	Host or operator is required to issue a RESUME command before processing will continue.
28	CHECKING	An error was detected in new parameter setting being validated in the CHECKING state.	PAUSED	None	None
29	LOAD	The last strip of a lot has completed bonding and CHAINING is OFF.	SETTING UP	The wire bonder shall begin setting up a queued job or wait for another SELECT command.	None
30	ALIGNING	Alignment to a device is complete.	BONDING	Bonding of a device is started.	None
31	BONDING	Bonding of a device has completed normally or abnormally.	INDEXING	Index to next location.	None
32	ALIGNING	An error has occurred in aligning process and skip device is required.	INDEXING	Index to next location.	None
33	INDEXING	A device is being skipped.	INDEXING	Index to next location.	
34	INDEXING	Indexing of the strip is complete.	ALIGNING	New device is required.	None
35	BONDING	Additional alignment is required before bonding can continue.	ALIGNING	The wire bonder establishes a new reference location for the next group of bonds	None
36	BONDING	An error has occurred in bonding process and skip device is required.	INDEXING	Index to next location.	None

## 5 COLLECTION EVENT LIST

The objective is to define the list of collection events required by the WBSEM.

### 5.1 Requirements

- All SEMI E30-required events are required by the WBSEM. Since the Processing models are required by the WBSEM, all their state transitions are required Events.
- All SEMI E30-required events associated with the SEMI E30 Control, Communications, Alarm, and Spooling State models are required.

This section of the WBSEM lists only those collection events that are **not** associated with a change of state or those requiring specific data value (DVVALs) or reports defined in the WBSEM. Note: DVVALs are variables that are valid upon the occurrence of a specific collection event and may or may not be valid at other times, depending on the equipment. An attempt to read a data variable when it is invalid will not result in an error, but the data reported may not have relevant meaning.

- Common Collection Events – Collection events common to, and required on, all equipment of the class being addressed.
- Configuration-Specific Collection Events – Collection events associated with a specific configuration of the equipment class being addressed (i.e., lead inspection for wire bonding).

### 5.2 Collection Event Tables

Table 2 contains required events and associated reports. Table 3 contains required events and associated data variables.

**Table 2 Processing State Transitions That Require Report Levels**

Transition	From State	To State	Required Report
SETUP COMPLETE (3)	SETTING UP	READY	Setup Report
LOAD (23/25)	LOAD STRIP	WORKING	Strip Report
DEVICE COMPLETE (31)	BONDING	INDEX	Device Report
STRIP COMPLETE (24/26)	WORKING	UNLOAD	Strip Report

**Table 3 Other Required Collection Events**

Collection Event Name	Required DVVALs
BondCntIntervalEvent	BondCountInterval, TimeStamp
BondComplete	BondReport
ChainingStatusChange	ChainingStatus
CountThresholdReached	BondCount, DeviceCount, SkipCount, ToolCount or StripCount, Time
DeviceCntIntervalEvent	DeviceCountInterval
DeviceSkipped	DeviceReport
DiskThreshold	DiskThreshold, DiskID
DiskThresholdReached	DisknStatus
LastStripInLot	BondCnt, DeviceCnt, ToolCnt, Time_Stamp
LastStripInMag	BondCnt, DeviceCnt, ToolCnt, Time_Stamp
LinkStatusChange	LinkBonderStatus
LotComplete	LotID, LotProcessingTime
ScannerFailed	ScannerType, ScannerError, ScannerID
SkipCntIntervalEvent	SkipCntInterval
StripCntIntervalEvent	StripCountInterval
StripInspectionStart	LeadframeID
ToolCntIntervalEvent	ToolCountInterval
ToolingChange	WorkholderID
WireLow	Time
WireSpoolChange	Wiretype

## 6 DATA ITEM VARIABLES

This section defines the list of data item variables required by the WBSEM. Values of these variables are available to the host via collection event reports and host status queries.

### 6.1 Requirements

- All generic variable data items defined in SEMI E30 are required by all WBSEM equipment.
- All variable names in WBSEM are not case-sensitive.
- Variable data items required by WBSEM are categorized as follows:
  - Common Variables (CV) – variables common to all wire bonders.
  - Configuration-Specific Variables (CSV) – variables associated with a specific configuration of the above equipment class.

Any supplier defined variables shall be documented as those defined by WBSEM. All the supplied defined variables shall be specified as follows.

Variable Name	Category	Description	Class	Format	Comments
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Where

<variable name>:	a unique name for the data item variable.
Category:	defined as Common (CV) or Configuration Specific Variable (CSV).
Description:	<if class=DVVAL, description shall contain statement of when data is valid>. <If format = ASCII then a length is required. It is assumed to be left justified unless otherwise noted >.
Class:	<ECV, SV, or DVVAL>.
Format:	<SML notation>.
Comments:	any additional information pertinent to the variable name.

## 6.2 Data Item Variable Types

Equipment Constants (ECVs) can be changed by the host using S2F15. The operator may be able to change some values, but the equipment does not change the values on its own. The value of an equipment constant may be queried by the host at any time, using the S2F13/14 transaction. The ECVs reside in nonvolatile memory of the equipment. Equipment constants remain in effect until they are overwritten by manual entry or by a NEW EQUIPMENT CONSTANT SEND.

Equipment constants have various uses in WBSEM, including the following:

- Equipment offsets that match the performance of several pieces of equipment that would otherwise perform differently due to inherent manufacturing differences. Examples are machine focus offsets.
- Setting the configuration of the equipment to allow for different material specifications, equipment options, material flows, frequency of automatic functions, etc. Examples are ultrasonic-current-setpoints.
- Managing optional machine features. Examples are constants that tell the system whether optional features, such as automated inspection and scanners are present or enabled.

Status Variables (SVs) are valid at all times. An SV may not be changed by the host, but may be changed by the equipment or operator. The value of status variables may be queried by the host at anytime using the S1F3/4 or S6F19/20 transactions.

Data Variables (DVVALs) are variables that are valid only upon the occurrence of specific collection events. An attempt to read a data variable at the wrong time will not generate an error, but the data reported may not have relevant meaning.

**Table 4 Data Item Variable Table**

Variable Name	Category	Description	Class	Format	Comments
BondCount	CV	Number of bonds since last reset.	SV	U4	Valid in all states
BondCountInterval	CV	Event generated when number of bonds is completed.	ECV	U4	Valid in all states
BondForce	CV	Bond-force energy	DVVAL	F8	Valid in BONDING state
BondForceSetpoint	CV	Bond-force setpoint ( setpoint)	ECV	F8	Valid in all states
BondHeadLocation	CV	X, Y, Z axis bond head location with respect to pattern recognition reference point.	DVVAL	L,3 XLoc YLoc ZLoc	Valid in WORKING state
ChainingStatus	CV	1=ON, 0= OFF	SV	U4	Valid in all states
CurrentLead	CV	Current lead being bonded.	DVVAL	U4	Valid in BONDING state
DeviceCount	CV	Number of devices since last reset	SV	U4	Valid in all states
DeviceCountInterval	CV	Event generated when number of devices is completed.	SV	U4	Valid in all states
DeviceProcessTime	CV	Time to process last device.	SV	U4	Valid in all states
DiskStatus	CV	(3 = Full, 2 = Enable Read/Write, 1 = Enable Read, 0 = Disable)	SV	U4	Valid in all states
EquipSerialID	CV	Identification of equipment.	SV	A1-16	Valid in all states
Light PoleStatus	CSV	Color/status Ex: Red/flash	SV	A1-16	Valid in all States
LinkBonderStatus	CSV	(3 = Input/Output linked, 2 = Input linked, 1 = Output linked, 0 = Wire bonder not linked )	SV	U4	Valid in all substates
LotID	CV	Lot identification	EC	A1-24	Valid in all states
LotProcessingTime	CV	The time the current lot has been processing.	DVVAL	A1-8	Valid in PROCESSING substate
MagazineID	CV	Magazine Identification Number	EC	A1-24	Valid in all states
MagazineList	CV	List of current Magazines loaded	SV	L,n MagazineID	
QueueStatus	CV	PPID queued to be run.	SV	A1-80	Valid in all states
ReaderErrorType	CSV	Type of error detected by the material reader.	SV	A1-24	Supplier defined
ScannerError	CSV	Error text from scanner.	SV	A1-24	Valid in all states
ScannerID	CSV	Unique ID of scanner.	SV	U4	Valid in all states
ScannerName	CSV	Unique name given to a scanner	SV	A1-24	Valid in all states
ScannerStatus	CSV	(2 = not available, 1 = enabled, 0 = disabled)	ECV	U4	Valid in all states
ScannerType	CSV	(type magazine, strip)	SV	A1-24	Valid in all states

Variable Name	Category	Description	Class	Format	Comments
DeviceSkipCount	CV	Number of skipped devices since last reset.	SV	U4	Valid in all states
DeviceSkipCountInterval	CV	Event generated when number of devices is skipped.	ECV	U4	Valid in all states
StripBondTime	CV	Time it took to process last strip	SV	U4	Valid in all states
StripCount	CV	Number of strips since last reset.	SV	U4	Valid in all states
StripCountInterval	CV	Event generated when number of strips is completed.	SV	U4	Valid in all states
Stripid	CV	Strip identification.	SV	A1-24	Valid in EXECUTING state
StripMapStatus	CV	(0 = disabled, 1 = upload and download, 2 = download only, 3 = upload only)	ECV	U4	Valid in all states
ToolCount	CV	Number of bonds since last reset on a tool (i.e., capillary).	SV	U4	Valid in all states
ToolCountInterval	CV	Event generated when number of bonds is completed.	ECV	U4	Valid in all states
UltrasonicControlMode	CSV	Ultrasonic current or ultrasonic, voltage.	SV	A1-24	Valid in all states
UltrasonicCurrent	CSV	Ultrasonic current	DVVAL	U4	Valid in BONDING state
UltrasonicCurrentSetpoint	CSV	Ultrasonic current set point (setpoint)	ECV	U4	Valid in all states
UltrasonicVoltage	CSV	Ultrasonic voltage	DVVAL	U4	Valid in BONDING state
UltrasonicVoltageSetpoint	CSV	Ultrasonic voltage set point (setpoint)	ECV	U4	Valid in all states
WireType	CV	Material ID of the wire mounted on the bonder.	SV	A1-24	Valid in all states
WorkholderSetTemp	ECV	Workholder temperature (setpoint)	ECV	U4	Celsius - Setpoint
WorkholderTemp	CV	Temperature	SV	U4	Valid in all states
WorkholderType	CV	Workholder identification	SV	A1-24	Valid in all states

### 6.3 Data Item Variable Reports

The reports below are required as “canned” or preconfigured reports by WBSEM. WBSEM does not require the equipment to guarantee the accuracy of data identified in these reports outside the PROCESSING ACTIVE state defined in the WBSEM process state model.

### 6.3.1 Setup Report

Table 5 contains variables that shall be available at the setup complete event.

**Table 5 Variables Required for Setup Complete Event**

Variable Name	Notes
LotId	
WorkholderType	
WireType	
BondForceSetpoint	Optional equipment-specific
UltrasonicCurrentSetpoint	Optional equipment-specific
Ultrasonic Voltage Setpoint	Optional equipment-specific
WorkholderSetTempn	

### 6.3.2 Bond Report

Table 6 contains variables that shall be available and reported while in the WORKING state.

**Table 6 Variables Required for BONDING State**

Variable Name	Notes
WorkholderTemp	
BondForce	
UltrasonicCurrent	Optional equipment-specific
Ultrasonic Voltage	Optional equipment-specific
CurrentLead	
LeadframeID	
DevicePosition	
BondHeadPosition	

### 6.3.3 Strip Report

Table 7 contains variables that shall be available and reported at the completion of a device.

**Table 7 Variables Required at Device Completion**

Variable Name	Notes
LotID	
MagazineID	
StripID	

### 6.3.4 Device Report

Table 8 contains variables that shall be available and reported at the completion of a device.

**Table 8 Variables Required at Device Completion**

Variable Name	Notes
DevicePosition	
DeviceStatus	
StripID	Optional

## 7 PROCESS PROGRAM MANAGEMENT

Process Program management provides a means to transfer Process Programs, check their validity and accuracy, and share their management between the host computer and a specific piece of equipment.

### 7.1 Requirements

The WBSEM requires that the SEMI E30 capabilities of Process Programs management be fully supported for this class of equipment. The WBSEM also requires that the Process Program have a structure that enables the equipment end-user or customer to build Process Programs with default conditions and/or settings that can be overridden for a specific run. The concepts of Process Program management and the overall structure of such programs are discussed below.

In general, the WBSEM requires that the equipment manufacturer provide support for the following minimum set of requirements:

- Minimum, maximum, and default parameter values shall be defined for all Process Programs.
- Verification shall be provided, so that when a Process Program is downloaded to the equipment, the program syntax is verified by the equipment manufacturer.
- Validation shall be provided, such that the downloaded Process Program parameters are checked by type and range before execution.
- Equipment should provide the functionality to manually or interactively modify the parameters sent in the Process Program.
- An error message shall be generated from the wire bonder if the Process Program parameters are outside the range of the machine calibration.
- At any time when the Process Program is active in the execution area, it may be saved as a new Process Program with updated variable parameters.

The WBSEM requires that a Process Program shall contain the necessary run time-specific information and/or instructions that are required for the wire bond equipment to complete a specific bond operation. However, the WBSEM does not intend to enforce specific data structure or format, since format will differ among equipment manufacturers. Rather, the objective is to provide direction to the equipment manufacturer on the overall design, structure, and content of a Process Program.

## **7.2 Process Program Structure**

A wire bond Process Program shall have three distinct and identifiable sections:

- Bond map information section
- Machine-specific configuration parameters
- Vision-specific information

When combined, these sections constitute a complete Process Program. It is emphasized that the WBSEM does not enforce the exact content of each section. However, it does provide the minimum required information for each section.

### **7.2.1 Bond Map Information**

The “Bond Map Information” is considered to be a header table or file. This section is commonly referred to in this document as the “configuration table.” The configuration table provides pointers or references to a list of other tables or files that pin point the exact bond sites, a list of tables of files that indicate the alignment sites, and finally one or more wire list tables or files.

### **7.2.2 Machine-Specific Configuration Parameters**

Each brand or type of wire bonder may have one or more machine-specific configuration parameters. Examples of such parameters would be lighting-specific information, box sizes, and workholder information. Even though supplier-specific, these parameters play a vital role in the overall generation or creation of a Process Program.

### **7.2.3 Vision-Specific Information**

In this section, the equipment manufacturer provides vision-specific information about one or more types of wire bonders. For example, such parameters might include program alignment images. These parameters likewise would differ among equipment manufacturers. WBSEM only requires that these parameters be available.

The WBSEM chose to separate these sections for the sake of clarity and completeness. However, a specific format or specific data types are not enforced for each section.

## **7.3 Methods of Process Program Creation**

The method by which an equipment manufacturer creates a Process Program may be unique to that manufacturer. However, it is recommended that, at minimum, the customer be given one of the following options for the creation of a Process Program.

### **7.3.1 Offline Development**

Using this method, the customer is given a set of software tools (Process Program compilers, decompilers, and debuggers) that enable it to generate or create a Process Program using the above-mentioned information (bond map information, machine-specific configuration parameters, and equipment vision-specific details). The newly generated Process Program is then downloaded onto a specific wire bonder (using S7FX) and can be selected and executed locally by the operator, or remotely by the host computer. If this process is used, the supplied software tools should closely mimic or simulate a wire bonder so that a user can create a complete Process

Program. In many situations, minor adjustments to the Process Program may be needed on the equipment before it is ready for execution.

### **7.3.2 Online Development**

The second option would enable the user to download the above-mentioned tables or files (the bond map, vision-specific, and the machine-specific information) onto the equipment and create the actual Process Program on the equipment. To accomplish this, the WBSEM requires that the equipment supplier support Stream 13 Unformatted Data Set Transfers (S13FX).

## **8 REMOTE COMMANDS**

This section identifies remote commands, command parameters, and valid commands.

### **8.1 Requirements**

Requirements for remote commands are as follows:

- The equipment shall support the SEMI E30-required remote commands.
- If additional remote commands are supported, then the “Remote Command versus Valid States” matrix shall be generated for these additional commands. Place an “X” in the table for each state that a given command is valid.
- For additional commands, generate a table similar to the remote command descriptions summary.
- The alphanumeric strings defined by WBSEM for remote commands (RMCD) and command parameter (CPNAME) are required.

### **8.2 Remote Command Descriptions**

#### ABORT-LOT

This command terminates the current lot prior to its completion. ABORT-LOT makes no guarantee about completion of the current leadframe. Levels of ABORT-LOT maybe specified.

#### ABORT-STRIP

This command terminates the current strip being processed prior to its completion. ABORT-STRIP does not guarantee completion of the current substrate. Levels of ABORT-STRIP may be specified.

#### CHAINING

This command directs the wire bonder to use the currently executing Process Program and its operating parameters to process the next lot. When the last strip of the current lot has completed, the next lot shall be processed with the current operating conditions on the wire bonder. The CHAINING-OFF command is required to terminate this behavior.

#### CHAINING-OFF

This command simply cancels the CHAINING command. The next lot requires the setup procedure to be performed.

### PAUSE

This command transitions the wire bonder to the PAUSING process state where the current wire/device/strip completes processing.

### LAST-MAGAZINE

This command instructs the wire bonder to treat the current magazine being processed on the bonder as the last magazine of the lot. This forces the subsequent magazine to be considered the first magazine of the next lot. If the magazine-ID is sent down with the command, then the bonder uses the magazine-ID to determine when the end-of-lot event is generated.

### LAST-STRIP

This command instructs the wire bonder to treat the current strip on the workholder as the last strip of the lot. This forces the subsequent strip to be considered the first strip of the next lot. If the strip-ID is sent down with the command, then the bonder uses the strip-ID to determine when the end-of-lot event is generated.

### NEW-LOT

This command instructs the wire bonder to begin tagging material to the new lot ID after it completes the last strip of the current lot being processed. This command is intended to be used when CHAINING is active and more than one lot are processed with the current processing conditions.

### PP-SELECT

This command instructs the wire bonder to copy the indicated Process Program from nonvolatile storage to the wire bonder's Process Program execution area. Process Program variable parameters can be specified in this command to modify the default values for these variable parameters in the Process Program.

### PP-UPDATE

This command is used when Process Program variable parameters require modification during a run. Only those parameters contained in this command are affected. This command can only be sent in the PAUSED state.

### Q-DESELECT

This command deselects a queued Process Program.

### RESUME

This command resumes processing from the point where the process was PAUSED. This command are recognized only if the wire bonder is in the PAUSED state.

### Q-SELECT

This command "queues" a request to replace the currently executing Process Program with a new one at the completion of the lot currently being processed. The Process Program and its variable parameters are verified upon the receipt of this command. Only one queued Process Program selection is allowed on WBSEM-compliant equipment (Note: if CHAINING is enabled, the Q-SELECT command is not valid).

## RESET-TOOL-COUNTS

This command initializes various equipment attributes, such as number of number of strips (since last reset), number of bonds (since last reset), etc.

## START

This command is available only to the host or operator when a Process Program has been selected and the wire bonder is in the READY processing state. The START command instructs the wire bonder to initiate processing.

## STOP

This command completes the current strip, stops in a safe condition, and returns to the IDLE processing state. STOP has the intent of bringing about a normal termination after completion of the current strip.

**Table 9 Remote Command Descriptions**

Command Name	Parameter*			
	Name	Opt/Req	Description	Format
ABORT-STRIP	SKIP	OPT*	Index to the next strip and continue.	A[7]
	CLEANUP	OPT*	The wire bonder finishes bonding the current device, remove the strip, and enter the ABORTING state.	A[7]
	HALT	OPT*	The wire bonder finishes bonding the current device, leave everything in place, and enter the ABORTING state.	A[7]
ABORT-LOT	CLEANUP	OPT*	The wire bonder finishes bonding the current strip, remove all strips and magazines that belong to the lot, and enter the ABORTING state.	A[7]
	HALT	OPT*	The wire bonder finishes the current strip, leave everything in place, and enter the ABORTING state.	A[7]
CHAINING	NO PARAMS			
CHAINING-OFF	NO PARAMS			
LAST-STRIP	Strip-ID	OPT	ID of the last strip in the lot, defaults to current strip.	ASCII
	Next-Lot-ID	OPT	This CPNAME is required if CHAINING is active and it contains the ID of the next lot to be processed. If CHAINING is OFF then the Q-SELECT command contains the next lot ID.	ASCII
	Mag-List	OPT	One or more magazines to be processed with this program.	ASCII List
	Strip-List	OPT	One or more strips to be processed with this program.	ASCII List

Command Name	Parameter*			
	Name	Opt/Req	Description	Format
LAST-MAGAZINE	Magazine-ID	OPT	ID of the last magazine in the lot, defaults to current magazine.	ASCII
	Mag-List	OPT	One or more magazines to be processed with this program.	ASCII List
	Strip-List	OPT	One or more strips to be processed with this program.	ASCII List
	Next-Lot-ID	OPT	This CPNAME is required if CHAINING is active and it contains the ID of the next lot to be processed. If CHAINING is OFF, then the Q-SELECT command contains the next lot ID.	ASCII
NEW-LOT	Lot-ID	REQ	ID of New LOT	ASCII
PAUSE	Device	OPT*	Stop after bonding the current device or before starting another next device.	ASCII
PP-UPDATE	PP-Name	REQ	The name of the Process Program to be used.	A[1-80]
PP-SELECT	PP-Name	REQ	The name of the Process Program to be used.	A[1-80]
	Auto-Start	OPT	Start the bonder automatically after READY.	ASCII
	Lot-ID	REQ	Lot to be processed with this program.	ASCII
	Mag-List	OPT	One or more magazines to be processed with this program.	ASCII List
	Strip-List	OPT	One or more strips to be processed with this program.	ASCII List
Q-DESELECT	NO PARAMS			
Q-SELECT	PP-Name	REQ	The name of the Process Program to be used.	A[1-80]
	Auto-Start	OPT	Start the bonder automatically after READY.	ASCII
	Lot-ID	REQ	Lot to be processed with this program.	ASCII
	Mag-List	OPT	One or more magazines to be processed with this program.	ASCII List
	Strip-List	OPT	One or more strips to be processed with this program.	ASCII List
RESET-TOOL- COUNTS	Counter	REQ	All = All Counters Tooln = Tool-Counter Bond = Bond-Counter Strip = Strip-Counter	ASCII List
RESUME	NO PARAMS		None	None
START	NO PARAMS		None	None
STOP	NO PARAMS		None	None

### 8.3 Process Program Variable Parameters Name Table

All CPNAMES in the process program variable parameters table below may be updated through the use of the PPUPDATE command during the execution of a Process Program. The equipment supplier provide this information in their documentation.

**Table 10 Process Program Variable Parameters**

<b>CP Name</b>	<b>Description</b>	<b>Units</b>	<b>Range</b>	<b>Format</b>
BONDFORCE-ADD	Increment BONDFORCE			
BONDFORCE-SET	Set the BONDFORCE			
ILLUMINATION-ADD	Increment ILLUMINATION			
ILLUMINATION-SET	Set ILLUMINATION			
SEARCH-HEIGHT-ADD	Increment SEARCH HEIGHT			
SEARCH-HEIGHT-SET	Set SEARCH HEIGHT			

### 8.4 Remote Commands and Associated Host Command Parameters

Table 11 illustrates the relationship between remote commands and states of the WBSEM processing state model. An “X” indicates that a command is valid for use in this state. If a remote command is attempted during a nonvalid state, the equipment would reject the remote command.

**Table 11 Remote Commands versus Process States**

COMMAND													
ABORT-LOT													
ABORT-STRIP													
CHAINING													
CHAINING-OFF													
LAST-MAGAZINE													
LAST-STRIP													
NEW-LOT													
Q-DESELECT													
Q-SELECT													
PAUSE													
PP-SELECT													
PP-UPDATE													
RESUME													
START													
STOP													
<b>PROCESSING STATE</b>													
IDLE					X			X					
PROCESSING ACTIVE													
<b>PROCESS</b>													
SETTING UP	X					X	X	X	X			X	X
READY	X	X				X	X	X	X			X	X
<b>EXECUTING</b>													
LOAD	X					X	X	X		X	X		X
WORKING	X					X	X	X		X	X		X
UNLOAD	X					X	X	X		X	X		X
<b>PROCESS PAUSE</b>													
PAUSING	X												X
PAUSED	X		X	X			X	X	X	X	X	X	X
CHECKING	X												
ALARM PAUSED	X						X	X					X
ABORTED								X					

## 9 SCENARIOS

This sections documents WBSEM-specific scenarios that shall be performed by this class of equipment. Throughout the scenarios below, the stream and functions SF141/SF142 are used to represent the advance remote command recently accepted into E30.

### 9.1 Normal Run (Error—Free Run Scenario)

Next is an error-free run of a single lot, with no additional lots queued.

Commands	Host	Equipment	Comments
Multi-Block-Inquire	S2F39 >		
		< S2F40	Pos Ack (2)
PP-SELECT	S2F141 >		
		< S2F142	Pos Ack (2)
		< S6F11	Transition to SETTING UP
Pos Ack	S6F12 >		
		< S6F11	Exchange Loaded Event
Pos Ack	S6F12 >		
		< S6F11	Setup procedure complete. Transition to READY. (3)
Pos Ack	S6F12 >		
	START	S2F41 >	
		< S2F42	Pos Ack
		< S6F11	Strip received from input port. Transition to LOAD state.
Pos Ack	S6F12 >		
	S12F69>	Strip Map Send	
		<S12F70	Update existing map
		< S6F11	Strip loaded into workholder. Transition to WORKING. (23)
Pos Ack	S6F12 >		
			<i>[WHILE] not last bond ALIGN → BOND</i>
		< S6F11	Complete bond align event. (30)
Pos Ack	S6F12 >		
		< S6F11	Complete single bond event. (35).
Pos Ack	S6F12 >		
			<i>[ENDWHILE].</i>
		< S6F11	Complete last bond event. (31) [Bond Report]
Pos Ack	S6F12 >		
		< S6F11	Single device completed, index to next. Transition to INDEX state. [Device Report]
Pos Ack	S6F12 >		
			<i>[WHILE] not last device WORKING → ALIGN → BOND → INDEXING</i>
		< S6F11	Transition to ALIGN state. (29)
Pos Ack	S6F12 >		
			<i>[ENDWHILE].</i>

Commands	Host	Equipment	Comments
		< S6F11	Strip Complete event. (24/26) [Strip Report]
Pos Ack	S6F12 >		
		<S12F69	Strip Map Send
	S12F70>		Update existing map <i>[IF] not last strip</i> <i>INDEXING → LOAD</i>
		< S6F11	Load next strip. (5)
	S12F69>		Strip Map Send
		<S12F70	Update existing map
Pos Ack	S6F12 >		<i>[ELSE]</i>
		< S6F11	Last strip unload from workholder. (5). Transition to LOAD STRIP state.
Pos Ack	S6F12 >		<i>[ENDIF]</i> <i>[IF] STOP COMMAND</i>
		< S6F11	Transition to STOPPING. (6)
Pos Ack	S6F12 >		
		< S6F11	Transition to IDLE. (12)
Pos Ack	S6F12 >		<i>[ELSE]</i>
		< S6F11	Transition to SETUP. (29)
Pos Ack	S6F12 >		<i>[ENDIF]</i>

## 9.2 PAUSE and PP-UPDATE Scenario

Commands	Host	Equipment	Comments
Start	S2F41 >	< S2F42 < S6F11	Pos Ack Strip Index from input port. Transition to LOAD state.
Pos Ack	S6F12 >	< S6F11	Device load into workholder Transition to WORKING.
Pos Ack	S6F12 >		
<i>Alignment, bonding, and indexing is as per normal run. These are omitted here.</i>			
Pos Ack	S6F12 >	< S6F11	Complete device event.
Pos Ack	S6F12 >	< S6F11	Single device completed, index to next. Transition to INDEXING state.
Pos Ack	S6F12 > [WHILE] not last device 1) WORKING → INDEXING 2) INDEXING → WORKING [ENDWHILE].		
PAUSE (DEVICE)	S2F41 >	< S2F42	Pos Ack
		< S6F11	Single device completed.
Pos Ack	S6F12 > [ENDIF]	< S6F11	Transition to PAUSING state. (9)
Pos Ack	S6F12 >		
Multi-Block-Inquire	S2F39 >	<S2F40	Pos Ack (2)
PP-UPDATE	S2F141 >		
The PP-UPDATE updated certain values in the old Process Program.			
		< S2F142	Pos Ack
		< S6F11	Transition to CHECKING state. (27)
Pos Ack	S6F12 > [IF] updates are valid; Return to previous process state thru history on RESUME command. [ELSE] Returned to PAUSED state. The Process Program remain unchanged.		
Host to resolve the problem			
	[ENDIF]		
RESUME	S2F41 >	< S2F42 <S6F11	Pos Ack Transition thru history back to the PROCESS state (10) where the PAUSE was received.
Pos Ack	S6F12 >		

### 9.3 CHAINING Scenario

Commands	Host	Equipment	Comments
			Chaining mode is ON. There are two lots of same device to be run. Q-Select identified magazine list for both lots.
START	S2F41 >	< S2F42 < S6F11	Pos Ack Strip index from input port. Transition to LOAD state.
Pos Ack	S6F12 >		
Strip setup data send	S12F65 >	< S12F66	Strip Setup Data ACK
Strip Map	S12F69 >	< S12F70 < S6F11	Strip Map ACK Device load into workholder. Transition to WORKING.
Pos Ack	S6F12 >		
<i>Alignment, bonding, and indexing is as per normal run. These are omitted here.</i>			
		<i>[IF] not last strip INDEXING → LOAD</i>	
		< S6F11	Load next strip. (5)
Pos Ack	S6F12 >		
Strip Map	S12F69 >	< S12F70	Strip Map ACK
		<i>[ELSE]</i>	
LAST STRIP	S2F41 >	< S2F42 < S6F11	Pos Ack Unload completed Last Strip of Lot from workholder. (24)
Pos Ack	S6F12 >		
		<i>[ENDIF]</i>	
		< S6F11	
Pos Ack	S6F12 >		
<i>Since CHAINING is ON, there is no need for setup to be performed.</i>			
		< S6F11	Device load into workholder. Transition to WORKING. (25)
Pos Ack	S6F12 >		
<i>Alignment, bonding, and indexing is as per normal run until last strip.</i>			
		<S6F11	Last strip unload from workholder. (25) End of lot. Transition to STOPPING state.
Pos Ack	S6F12 >		
		<i>[IF] STOP</i>	
		< S6F11	Transition to STOPPING. (6)
Pos Ack	S6F12 >		
		< S6F11	Transition to IDLE. (12)
Pos Ack	S6F12 >		
		<i>[ELSE]</i>	
		< S6F11	Transition to SETUP. (29)
Pos Ack	S6F12 >		
		<i>[ENDIF]</i>	

## 9.4 QSELECT Scenario

Commands	Host	Equipment	Comments
			There are two lots of different devices to be run. Strip Map is turned off. PP-SELECT contained MAG_LIST.
CHAINING-OFF	S2F41 >		Force Q-SELECT to be acted on.
		< S2F42	Pos Ack
START	S2F41 >		
		< S2F42	Pos Ack
		< S6F11	Strip index from input port. Transition to LOAD state.
Pos Ack	S6F12 >		
		< S6F11	Device load into workholder. Transition to WORKING.
Pos Ack	S6F12 >		
<i>Alignment, bonding, and indexing is as per normal run. These are omitted here.</i>			
<i>Sometime during the WORKING state</i>			
Multi-Block-Inquire	S2F39 >		
		< S2F40	Pos Ack (2)
Q-SELECT	S2F141 >		
MAG_LIST included.		< S2F142	Pos Ack. Next program parameter selected.
			<i>[WHILE] not last strip INDEXING → LOAD</i>
		<S6F11	Load next strip. (5)
Pos Ack	S6F12 >		
	<i>[ENDWHILE]</i>		
	<i>E]</i>	< S6F11	Last strip unload from workholder. (25) End of lot.
Pos Ack	S6F12 >		
<i>Since CHAINING is OFF and Q-SELECTED, the wire bonder will transition to SETTING UP using the Process Program and parameter from Q-SELECT.</i>			
		< S6F11	Transition to READY state after parameter setup. Awaits for START command.
Pos Ack	S6F12 >		
START	S2F41 >		
		< S2F42	Pos Ack
		< S6F11	Transition to LOAD state. (4)
Pos Ack	S6F12 >		
		< S6F11	Device load into workholder. Transition to WORKING. (2)
Pos Ack	S6F12 >		
<i>Wire bonder carries on as per normal.</i>			

## **10 ADDITIONAL SEMI E30 CAPABILITIES**

The purpose of this section is to specify any SEMI E30 additional capabilities that are required to be supported by this class of equipment.

### **10.1 Requirement**

The following SEMI E30 additional capabilities required by WBSEM are as follows:

- Establish Communications
- Dynamic Event Report Configuration
- Variable Data Collection
- Status Data Collection
- Alarm Management
- Remote Control
- Equipment Constants
- Process Program management
- Equipment Terminal Services
- Clock
- Spooling
- Control (Host Initiated)

## **11 RELATED INFORMATION**

The following application notes are not an official part of this SEMI standard. These notes are presented as possible methods for WBSEM implementations and are included only as reference material.

### **11.1 Bond Map**

The purpose of this section is to provide a method and specific formats to define, identify and communicate coordinate systems, site locations, and other wire bond machine specific data used by WBSEM equipment.

### **11.2 Intent**

The WBSEM required formats are intended to minimize the number and type of site location format transformations needing support by both equipment suppliers and users.

### **11.3 Scope**

All WBSEM required site location formats involve the use of a WBSEM-defined Cartesian coordinate system. All coordinates defined in a bond map must be defined in microns. The scope of the detailed bond map description in this section is specific to wire bond equipment but general enough in methodology so that all types of wire bond equipment can use the format successfully.

## 11.4 Definitions

<b>Bond Map:</b>	A group of ASCII text tables used to describe a bond process for wire bond equipment.
<b>Equipment:</b>	The wire bonder equipment.
<b>XYcoordinate:</b>	A coordinate position on the XY plane of the bond map or equipment.
<b>XYzero:</b>	A selected site on the device used for initial referencing of the bond map by the equipment. Example: Center point of rotation on equipment. Example: A corner of a die paddle on a leadframe.
<b>OffsetToXYzero:</b>	A distance, defined in the bond map, between the XYzero and a MapOrigin.
<b>MapOrigin</b>	The 0,0 origin of an AlignmentSiteList or BondSiteList.
<b>Table:</b>	A list of specific data used for a bond map.
<b>TableType:</b>	Defines what the context of a bond map table will be; Bond Map TableTypes: <ol style="list-style-type: none"> <li>1. Configuration</li> <li>2. BondSiteList</li> <li>3. AlignSiteList</li> <li>4. WireList</li> </ol>
<b>TableName:</b>	A unique name given to any bond map table for external reference by other tables.
<b>Configuration:</b>	A TableType which contains the information required to indicate which tables compose the bond map, and the offset of XYcoordinates defined in the tables to the XYzero.
<b>BondSite:</b>	An XYcoordinate where a bond will occur.
<b>BondSiteList:</b>	A table of BondSites.
<b>BondSiteNumber:</b>	The sequence number of a BondSite.
<b>AlignSite:</b>	An XYcoordinate used alone or in conjunction with others to increase the accuracy of the alignment. Align sites can be primary, secondary, manual, or automatic and can have machine specific data attached to aid in alignment.
<b>AlignSiteList:</b>	A table of AlignSites.
<b>AlignSiteNumber:</b>	The sequence number of an AlignSite.
<b>AlignParmName:</b>	References a value containing an equipment specific parameter pertaining to the alignment site (such as primary, secondary, manual, automatic, box size, illumination, etc.).

**WireList:** List of BondSites used to create wires. Wire lists are selected in the order indicated in the Configuration Table, and from within each list the wires are selected in the order 1..N. If applicable for the bond process, wires are grouped into segments.

**WireNumber:** The sequence number of a wire.

**WireParmName:** References a value containing an equipment specific parameter pertaining to the wire or bond (such as bond force, loop type, etc.).

## 11.5 Description

TableType: Configuration

### CONCEPT:

The Configuration Table contains the information required to indicate which tables compose the bond map, and the offset of XYcoordinates defined in the tables to the XYzero.

### DEFINITION OF TABLE LINES

- 1.1–1.4 **BondSiteList Items:** BondSiteList tables and their OffsetToXYzero for this bond map.
- 1.5–1.8 **AlignmentSiteList Items:** AlignSiteList tables and their OffsetToXYzero for this bond map.
- 1.9–1.12 **WireList Items:** WireList tables for this bond map.
- 1.13 End of table.

### CONFIGURATION TABLE DEFINITION

#### ConfigurationName

	Item	TableName	OffsetToXYzero
1.1	BondSiteList	BondSiteListName	XYcoordinate
1.2	BondSiteList	BondSiteListName	XYcoordinate
1.3	:	:	:
1.4	BondSiteList	BondSiteListName	XYcoordinate
1.5	AlignSiteList	AlignSiteListName	XYcoordinate
1.6	AlignSiteList	AlignSiteListName	XYcoordinate
1.7	:	:	:
1.8	AlignSiteList	AlignSiteListName	XYcoordinate
1.9	WireList	WireListName	NA
1.10	WireList	WireListName	NA
1.11	:	:	NA
1.12	WireList	WireListName	NA
1.13	END		

**Table Type: BondSiteList****CONCEPT**

Each bond site on the device is assigned an XYcoordinate. The bond sites can be grouped in any way, for example, as indicated by layers in drawings (such as by die and package) or can be included in a single list. Each BondSiteList is given a unique BondSiteListName allowing it to be referenced externally. The bond sites are referenced from outside the table using: “BondSiteListName: BondSiteNumber”.

**DEFINITION OF TABLE LINES**

- 1.1–1.5 The BondSiteNumber allows the coordinates for the respective bond site to be referenced from outside the table.
- 1.6 End of table.
- 2.1–2.5 The BondSiteNumber allows the coordinates for the respective bond site to be referenced from outside the table.
- 2.6 End of table.
- 3.1–3.5 The BondSiteNumber allows the coordinates for the respective bond site to be referenced from outside the table.
- 3.6 End of table.

**BondSiteList TABLE DEFINITION****BondSiteListName**

	<b>BondSiteNumber</b>	<b>XYcoordinate</b>
1.1	1	XYcoordinate
1.2	2	XYcoordinate
1.3	:	:
1.4	:	:
1.5	n	XYcoordinate
1.6	END	

**BondSiteListName**

	<b>BondSiteNumber</b>	<b>XYcoordinate</b>
2.1	1	XYcoordinate
2.2	2	XYcoordinate
2.3	:	:
2.4	:	:
2.5	n	XYcoordinate
2.6	END	

**BondSiteListName**

	<b>BondSiteNumber</b>	<b>XYcoordinate</b>
3.1	1	XYcoordinate
3.2	2	XYcoordinate
3.3	:	:
3.4	:	:
3.5	n	XYcoordinate
3.6	END	

**Table Type: AlignSiteList****CONCEPT:**

Each align site on the device is assigned an XYcoordinate. Align sites typically are grouped in sets which contain one or more sites used in conjunction with each other to increase the accuracy of the alignment. Align sites can be primary, secondary, manual, or automatic. Each AlignSiteList is given a unique AlignSiteListName allowing it to be referenced externally. The align sites are referenced from outside the table using: “AlignSiteListName, AlignSiteNumber”.

An AlignParmName references a value containing an equipment specific parameter pertaining to the alignment site (such as primary, secondary, manual, automatic, box size, illumination, etc.).

**DEFINITIONS OF TABLE LINES**

- 1.1–1.5 The AlignSiteNumber allows the coordinates for the respective align site to be referenced from outside the table.
- 1.6 End of table.
- 2.1–2.5 The AlignSiteNumber allows the coordinates for the respective align site to be referenced from outside the table.
- 2.6 End of table.
- 3.1–3.5 The AlignSiteNumber allows the coordinates for the respective align site to be referenced from outside the table.
- 3.6 End of table.

**AlignSiteList TABLE DEFINITION****AlignSiteListName**

	<b>AlignSiteNumber</b>	<b>XYcoordinate</b>	<b>AlignParmName</b>	<b>AlignParmName</b>		<b>AlignParmName</b>
1.1	1	XYcoordinate	value	value		value
1.2	2	XYcoordinate	value	value		value
1.3	:	:	:	:	...	:
1.4	:	:	:	:		:
1.5	n	XYcoordinate	value	value		value
1.6	END					

:  
:  
:

**AlignSiteListName**

	<b>AlignSiteNumber</b>	<b>XYcoordinate</b>	<b>AlignParmName</b>	<b>AlignParmName</b>	<b>AlignParmName</b>
2.1	1	XYcoordinate	value	value	value
2.2	2	XYcoordinate	value	value	value
2.3	:	:	:	:	:
2.4	:	:	:	:	:
2.5	n	XYcoordinate	value	value	value
2.6	END				

:

:

:

**AlignSiteListName**

	<b>AlignSiteNumber</b>	<b>XYcoordinate</b>	<b>AlignParmName</b>	<b>AlignParmName</b>	<b>AlignParmName</b>
3.1	1	XYcoordinate	value	value	value
3.2	2	XYcoordinate	value	value	value
3.3	:	:	:	:	:
3.4	:	:	:	:	:
3.5	n	XYcoordinate	value	value	value
3.6	END				

**Table Type: WireList****CONCEPT:**

A WireList is used to link BondSites to create wires. Wire lists are selected in the order indicated in the Configuration Table, and from within each list the wires are selected in the order 1..N. If applicable for the bond process, wires are grouped into segments.

Each wire on the device is assigned a list of bond sites. Each WireNumber starts a new wire. The key word "TO" indicates that the wire is to be bonded to the next site. In the case of stitch bonds, more than two bond sites are listed.

Alignment lists to be used for the bond site are referenced for both X and Y. Typically the alignment list bethe same for X and Y, but in some cases an alternate list is preferred when a shift in one axis can be expected.

A WireParmName references a value containing an equipment specific parameter pertaining to the wire or bond (such as bond force, loop type, etc.).

**DEFINITIONS OF TABLE LINES**

- 1.1–1.9 The WireNumber defines the start (first bond) for each wire.  
Each “TO” keyword defines all subsequent bonds for each wire.
- 1.9 End of table.
- 2.1–2.9 The WireNumber defines the start (first bond) for each wire.  
Each “TO” keyword defines all subsequent bonds for each wire.
- 2.10 End of table.
- 3.1–3.9 The WireNumber defines the start (first bond) for each wire.  
Each “TO” keyword defines all subsequent bonds for each wire.
- 3.10 End of table.

## WireList TABLE DEFINITION

### WireListName

WireNumber	BondSiteList, BondSiteNumber	X AlignSiteList	Y AlignSiteList	WireParmName
1.1	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.2	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.3	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.4	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.5	:	:	:	:
1.6	:	:	:	:
1.7	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.8	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
1.9	END			

...

### WireListName

WireNumber	BondSiteList, BondSiteNumber	X AlignSiteList	Y AlignSiteList	WireParmName
2.1	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.2	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.3	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.4	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.5	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.6	:	:	:	:
2.7	:	:	:	:
2.8	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.9	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
2.10	END			

...

**WireListName**

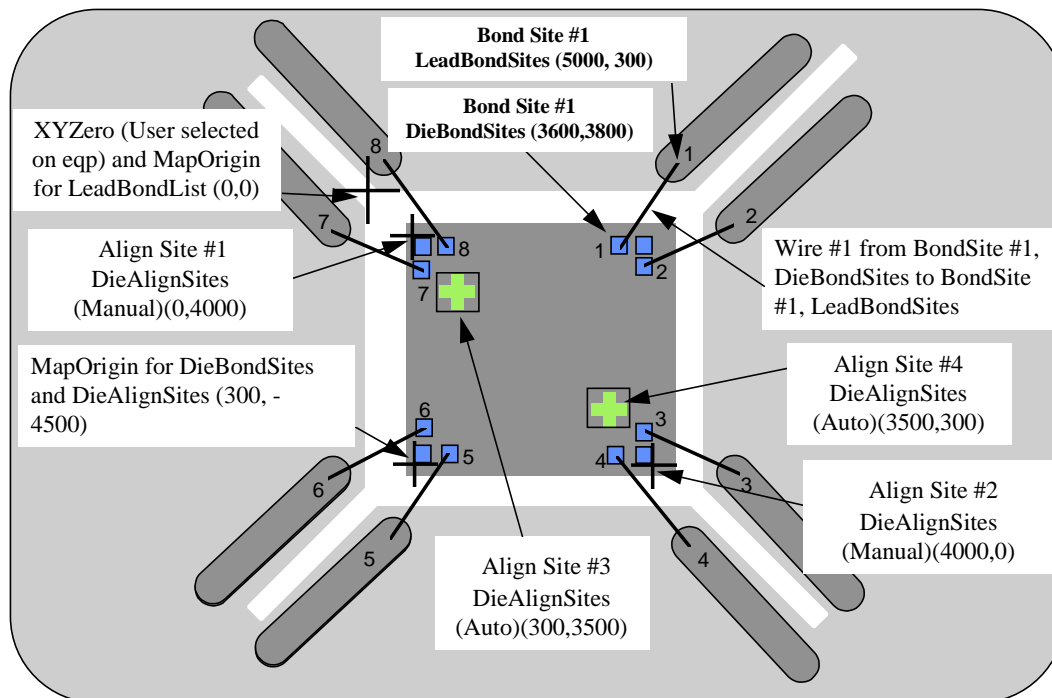
WireNumber	BondSiteList, BondSiteNumber	X AlignSiteList	Y AlignSiteList	WireParmName
3.1	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.2	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.3	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.4	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.5	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.6	:	:	:	:
3.7	:	:	:	:
3.8	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.9	BondSiteListName, BondSiteNumber	AlignSiteListName	AlignSiteListName	value
3.10	END			

### ***Bond Map Example***

The following example demonstrates how a bond map is constructed.

#### ***Description of Example Bond Map “SimpleMap”***

- Two manual alignment sites and two automatic alignment sites for the die.
- Eight bond sites (for bond 1) belocated on the die. These bond sites bealigned using the manual or automatic alignment sites defined on the die. This alignment allows for die shift or rotation.
- Eight bond sites (for bond 2) belocated on the leadframe. These bonds will occur at the defined values for x and y since no alignment occurs for the leadframe.
- Eight wires going from the die to the leadframe.



**Figure 3 Bond Map Example Diagram**

#### **List of Tables Required for Bond Map Example:**

- Configuration, ConfigurationName: SimpleMap
- BondSiteList, BondSiteListName: DieBondSites
- BondSiteList, BondSiteListName: LeadBondSites
- AlignSiteList, AlignSiteListName: DieAlignSites
- WireList, WireListName: DieToLeadWireList

**Bond Map Example Tables:****Table 12 Configuration—ConfigurationName: SimpleMap**

Bond Map Table	Table Name	OffsetToXYZzero
BondSiteList	DieBondSites	300, -4500
BondSiteList	LeadBondSites	0, 0 (no offset)
AlignSiteList	DieAlignSites	300, -4500
WireList	DieToLeadWireList	NA

**Table 13 Bond Site List #1—BondSiteListName: DieBondSites**

BondSiteNumber	XYcoordinate
1	3600, 3800
2	3800, 3600
3	3800, 300
4	3600, 100
5	200, 100
6	100, 200
7	100, 3600
8	200, 3800

**Table 14 Bond Site List #2—BondSiteListName: LeadBondSites**

BondSiteNumber	XYcoordinate
1	5000, 300
2	5500, -200
3	5500, -5000
4	5000, -5500
5	300, -5500
6	-200, -5000
7	-200, -200
8	300, 300

**Table 15 Align Site List #1—AlignSiteListName: DieAlignSites**

AlignmentSiteNumber	XYcoordinate	Type*	Illumination*	BoxSize*
1	0, 4000	Manual	12	NA
2	4000, 0	Manual	10	NA
3	300, 3500	Auto	10	50
4	3500, 300	Auto	10	48

**Table 16 Wire List #1—WireListName: DieToLeadWireList**

WireNumber	BondSiteList, BondSitenummer	X AlignSiteList	Y AlignSiteList	BondForce*	BondPower*	TailLength*
1	DieBondSites.1	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.1			50	300	57
2	DieBondSites.2	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.2			50	300	57
3	DieBondSites.3	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.3			50	300	57
4	DieBondSites.4	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.4			50	300	57
5	DieBondSites.5	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.5			50	300	57
6	DieBondSites.6	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.6			50	300	57
7	DieBondSites.7	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.7			50	300	57
8	DieBondSites.8	DieAlignSites	DieAlignSites	10	200	
TO	LeadBondSites.8			50	300	57

\*NOTE: Field name, dimension, and parameter definitions given below are for example only. They will vary dependent upon wire bonder type and manufacturer.

## 11.6 Strip Map Information

The following SEMI E5 messages are used to identify die location on a strip. This information can be passed around to the different assembly equipment and can help track bin values of die being assembled within a strip. If bin values are identified via a wafer map sent to the die bonder, and the strip is identified when the die is placed onto the strip, it is possible to carry that information through to the marking step and have the die package marked appropriately. In addition, bad die placed on a strip can be ignored by the assembly equipment and skipped over, improving the productivity of operations such as wire bonding.

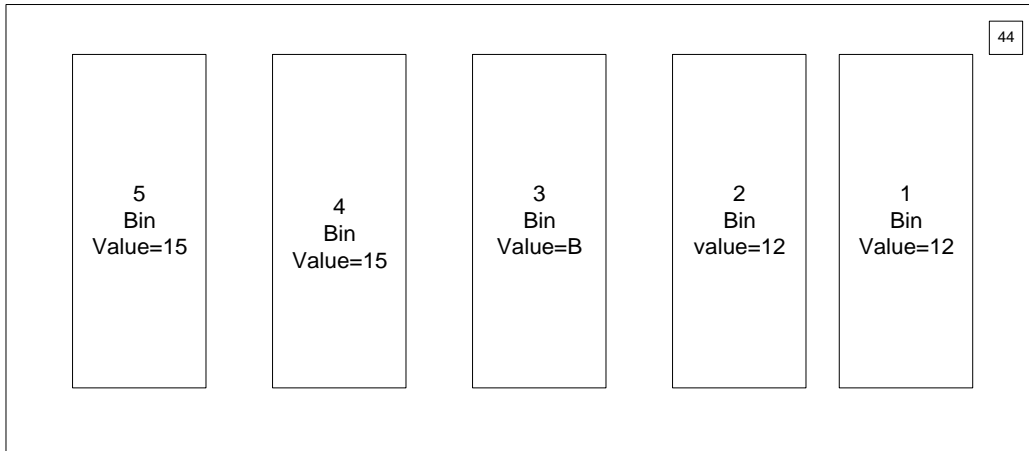
Assembly equipment also could update the maps of the strip when an error occurred on a specific die within the strip. This information would be passed up to the host that would edit and maintain the bin values for each of the die on a strip.

### 11.6.1 Description

The strip point of reference is the upper right hand corner of the strip. The list order of the values in the STRLT data item is row top-to-bottom and column right-to-left. Orientation of the strip is determined by an identification mark on the upper right-hand corner of the strip. The identification mark is used to ensure that the die always area assembled in the correct orientation of the strip.

In the data items sent in the S12F65 message are as follows:

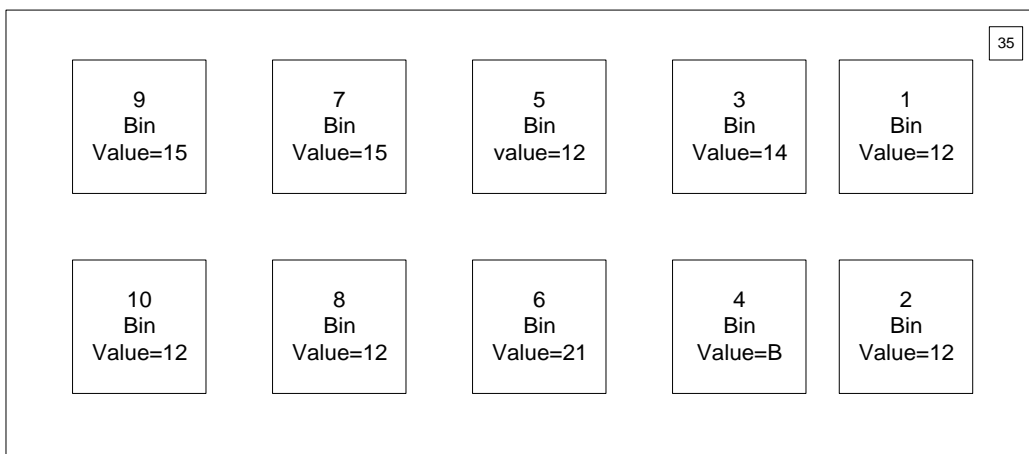
BDID - B  
 GDID - 12,13  
 STRID - 44  
 STRLT - 12,12,B,15,12



**Figure 4 Example: Map of Single Row Strip**

In Figure 5, the data items sent in the S12F65 message are as follows:

BDID - B  
 GDID - 12,13  
 STRID - 35  
 STRLT - 12,12,14,B,12,21,15,12,15,12



**Figure 5 Example: Map of Multiple Row Strip**

### 11.6.2 Definitions

Following are definitions of data variables used in messages to support the setup and updating of strip maps for backend assembly equipment.

- BDID* Value that identifies the character used to indicate a bad or no device on the strip (Format 20)
- GDID* A list of values that identifies the good device on the strip (Format 20)
- SCOL* Represents the number of columns of devices on the strip (Format 32)
- SROW* Represents the number of rows of devices on the strip (Format 32)
- STRID* The ID for the strip/leadframe (Format 20)
- STRILT* An array of bin values for each device on the strip with Row 1 and Column 1. The list order of the values in the STRILT data item is row top to bottom and column right to left (Format 20).
- SDACK* See SEMI E5-95.

### 11.6.3 Messages to Support the Capability

---

S12F65 Strip Setup Data Send (SSDS) S,H->E

Description: Used to send strip map setup information to the equipment.

Structure: L, 3

1. <BDID>
2. <GDID>
3. <SROW>
4. <SCOL>

S12F66 Strip Setup Data Acknowledge (SSDA) S,H->E

Description: Acknowledgement of receipt of strip map setup parameters.

Structure: <SDACK>

---

---

S12F67 Strip Setup Data Request (SSDR) S,H<->E

Description: Used to request strip map setup information.

Structure: Header only

S12F68 Map Setup Data (MSDA) S.H<->E

Description: Used to send the strip setup data to link the strip map with the physical strip/leadframe.

Structure: L, 3

1. <BDID>
2. <GDID>
3. <SROW>
4. <SCOL>

---

S12F69 Strip Map (SMAP) S,H<>-E

Description: Used to send the strip map data for the strip.

Structure: L, 2

1. <STRID>
2. <STRLT>

S12F70 Strip Map Data Acknowledge (SMDA) S.H->E

Description: Acknowledge or error.

Structure: <MDACK>

---



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