Communication specifications for BOSK AMHS Conveyor SEM

On-line Communication specifications and Scenarios between ECS ↔ CCS

Version 1.11

Smart Manufacturing DT Unit

Revision histories

Date	Release version	Modifier	Comment
2023.09.08	Initial release (Draft version)	Smart Mfg. DT Unit msukchoi@sk.com	Initially created for BOSK formation stocker controller's online communication spec. and scenarios between ECS and CCS based on SEMI standard E5 SECS-II, E30 GEM, E88 StockerSEM and SKOY CCS spec.
2023.10.12	1.01	Smart Mfg. DT Unit msukchoi@sk.com	• Define conveyor carrier state model. • Add even logs based OY ECS in the scenarios to help for understanding.
2023.10.31	1.1	Smart Mfg. DT Unit msukchoi@sk.com	• Modify S1F4 Selected Equipment Status Data Structure (30 page) Rename S2F41 CIMSTOP, CIMRESET to UNITSTOP, UNITRESET (32, 34, 35, 64, 65 page) • Modify Carrier ID Rule (45 page)
2023.11.17	1.11	Smart Mfg. DT Unit msukchoi@sk.com	• Add TRANSFER command event after CarrierStackOut at the M/G or CarrierSplitOut at the D/P to prevent the carrier being moved. (52~57 page) • Add repeat CarrierStackOut or CarrierSplitOut event until TRANSFER command received to automatically recover without human intervention.

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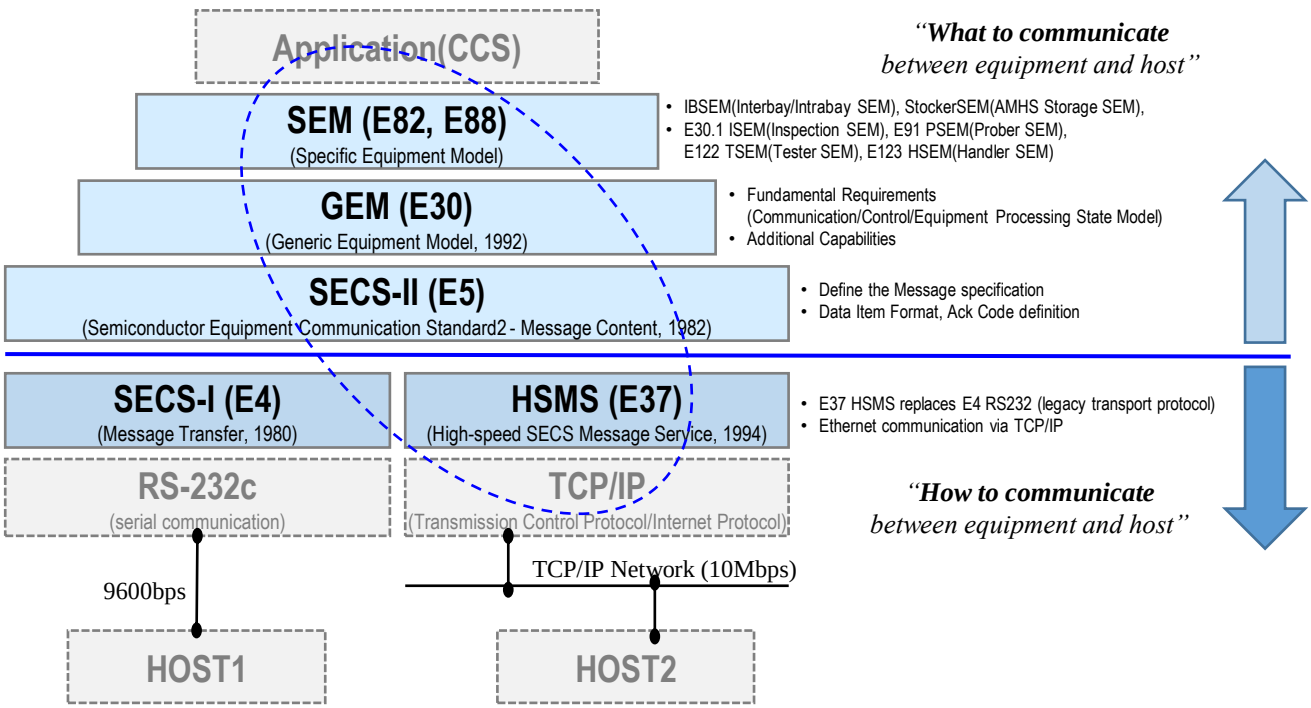
I. GEM(Generic Model for Communications and Control of Manufacturing Equipment)

1 Introduction of SEMI E30 GEM

1.1 Scope — The scope of the GEM standard is limited to defining the behavior of semiconductor equipment as viewed through a communications link. The SEMI E5 (SECS-II) standard provides the definition of messages and related data items exchanged between host and equipment. The GEM standard defines which SECS-II messages should be used, in what situations, and what the resulting activity should be. Figure 1 illustrates the relationship of GEM, SECS-II and other communications alternatives. The GEM standard does NOT attempt to define the behavior of the host computer in the communications link. The host computer may initiate any GEM message scenario at any time and the equipment shall respond as described in the GEM standard. When a GEM message scenario is initiated by either the host or equipment, the equipment shall behave in the manner described in the GEM standard when the host uses the appropriate GEM messages.

1.2 Intent : GEM defines a standard implementation of SECS-II for all semiconductor manufacturing equipment. The GEM standard defines a common set of equipment behavior and communications capabilities that provide the functionality and flexibility to support the manufacturing automation programs of semiconductor device manufacturers. Equipment suppliers may provide additional SECS-II functionality not included in GEM as long as the additional functionality does not conflict with any of the behavior or capabilities defined in GEM. Such additions may include SECS-II messages, collection events, alarms, remote command codes, processing states, variable data items (data values, status values or equipment constants), or other functionality that is unique to a class (etchers, steppers, etc.) or specific instance of equipment. GEM is intended to produce economic benefits for both device manufacturers and equipment suppliers. Equipment suppliers benefit from the ability to develop and market a single SECS-II interface that satisfies most customers. Device manufacturers benefit from the increased functionality and standardization of the SECS-II interface across all manufacturing equipment. This standardization reduces the cost of software development for both equipment suppliers and device manufacturers. By reducing costs and increasing functionality, device manufacturers can automate semiconductor factories more quickly and effectively. The flexibility provided by the GEM standard also enables device manufacturers to implement unique automation solutions within a common industry framework. The GEM standard is intended to specify the following:

- A model of the behavior to be exhibited by semiconductor manufacturing equipment in a SECS-II communication environment,
- A description of information and control functions needed in a semiconductor manufacturing environment,
- A definition of the basic SECS-II communications capabilities of semiconductor manufacturing equipment,
- A single consistent means of accomplishing an action when SECS-II provides multiple possible methods, and
- Standard message dialogues necessary to achieve useful communications capabilities.



** SEMI E30(GEM) describes how a semiconductor equipment shall communicate with a MES, usually called 'Host'. GEM is based on other lower level standards such as SECS-II which defined the message exchanged, SECS-I which defines communication by RS-232 or HSMS for communication via TCP/IP. For ease of reference, all these standards are often referred to as SECS/GEM.*

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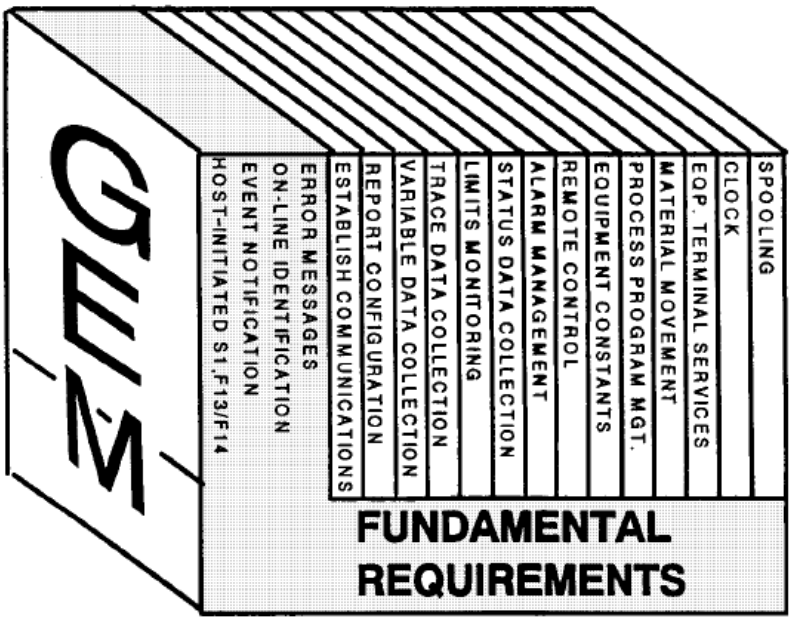
1.3 The GEM standard contains two types of requirements:
1) fundamental GEM requirements and
2) requirements of additional GEM capabilities.



Vertical text represents capabilities.

Some capabilities are also fundamental requirements.

Figure 12
GEM Requirements and Capabilities

Fundamental GEM Requirements
1) State Models
2) Equipment Processing States
3) Host-Initiated S1,F13/F14 Scenarios
4) Event Notification
5) On-line Identification
6) Error Message
7) Control (Operator-Initiated)
8) Documentation

GEM Capabilities
1) Establish Communications
2) Event Notification
3) Dynamic Event Report Configuration
4) Variable Data Collection
5) Trace Data Collection
6) Limits Monitoring
7) Status Data Collection
8) On-line Identification
9) Alarm Management
10) Remote Control
11) Equipment Constants
12) Process Recipe Management
13) Material Movement
14) Equipment Terminal Services
15) Error Messages
16) Clock
17) Spooling
18) Control (Operator-Initiated)
19) Control (Host-Initiated)

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2 Communication Requirements

It is required that any Conveyor SEM compliant equipment follow the Communications State Model in SEMI E30. In addition, Conveyor SEM compliant equipment shall support either SEMI E37 and SEMI E37.1 or SEMI E4.

2.1 Communication States

There are two major states of SECS communication, DISABLED and ENABLED. The system default state must be user-configurable at the equipment (e.g., via a jumper setting or non-volatile memory variable).
Once system initialization has been achieved, the operator shall be able to change the communication state selection at any time via equipment terminal functions or momentary switch. A two-position type switch must not be used due to possible conflict with the system default.
The ENABLED state has two substates, NOT COMMUNICATING and COMMUNICATING, described below. The equipment must inform the operator of the current communication state via continuous display at the equipment, including the NOT COMMUNI-CATING and COMMUNICATING sub-states.
In the event of a connection transaction failure, a user-configurable equipment constant EstablishCommunicationsTimeout is used to establish the interval between attempts to send an S1,F13 (Establish Communications Request) while in the NOT COMMUNICATING substate.
Figure 4 shows the relationship between the super-states and substates of the Communications State Model. A description of the events triggering state transitions and the actions taken is given in Table 1.

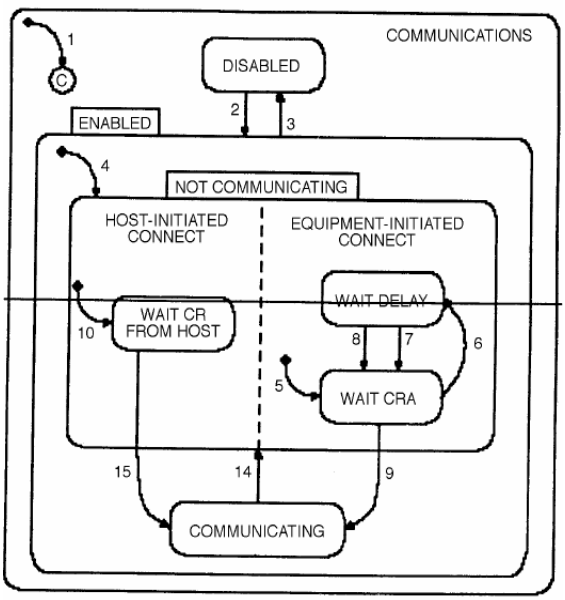

Figure 4
Communications State Diagram

1) The states of the **Communications State Model** are defined as follows:
① ***DISABLED***
In this state SECS-II communication with a host computer is non-existent. If the operator switches from ENABLED to DISABLED, all SECS-II communications must cease immediately. Any messages queued to send shall be discarded, and all further action on any open transactions and conversations shall be terminated.4 Handling of messages currently being transmitted is an issue for lower level message transfer protocols and is not addressed in this standard.
The DISABLED state is a possible system default.
② ***ENABLED***
ENABLED has two substates, ***COMMUNICA-TING*** and ***NOT COMMUNICATING***.
Whenever communications are enabled, either during system initialization or through operator selection, the substate of NOT COMMUNICATING is active until communications are formally established. Lower-level protocols (such as SECS-I) are assumed to be functioning normally in that they are capable of supporting the communication of SECS-II syntax.
The ENABLED state is a possible system default.

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③ ***ENABLED / NOT COMMUNICATING***

No messages other than S1,F13, S1,F14, and S9,Fx shall be sent while this substate is active. The equipment shall discard any messages received from the host other than S1,F13 or S1,F14 (Establish Communications Acknowledge). It shall also periodically attempt to establish communication with a host computer by issuing an S1,F13 until communications are successfully established. However, only one equipment-initiated S1,F13 transaction may be open at any time.

The NOT COMMUNICATING state has two AND substates, HOST-INITIATED CONNECT and EQUIPMENTINITIATED CONNECT, both of which are active whenever the equipment is NOT COMMUNICATING. These two substates clarify the behavior of the equipment in the event that both the equipment and the host attempt to establish communications during the same period of time5 .

④ ***NOT COMMUNICATING / EQUIPMENT-INITIATED CONNECT***

This state has two substates, WAIT CRA and WAIT DELAY. Upon any entry to the NOT COMMUNICATING state, whenever EQUIPMENT-INITIATED CONNECT first becomes active, a transition to WAIT CRA occurs, the CommDelay timer is set to "expired," and an immediate attempt to send S1,F13 is made.

NOT COMMUNICATING/EQUIPMENT-INITIATED CONNECT/WAIT CRA

An Establish Communications Request has been sent. The equipment waits for the host to acknowledge the request.

⑤ ***NOT COMMUNICATING / EQUIPMENT-INITIATED CONNECT/WAIT DELAY***

A connection transaction failure has occurred. The CommDelay timer has been initialized. The equipment waits for the timer to expire.

⑥ ***NOT COMMUNICATING / HOST-INITIATED CONNECT***

This state describes the behavior of the equipment in response to a host-initiated S1,F13 while NOT COMMUNICATING is active.

⑦ ***NOT COMMUNICATING / HOST-INITIATED CON-NECT/WAIT CR FROM HOST***

The equipment waits for an S1,F13 from the host. If an S1,F13 is received, the equipment attempts to send an S1,F14 with COMMACK = 0.

⑧ ***ENABLED / COMMUNICATING***

Communications have been established. The equipment may receive any message from the host, including S1,F13. When the equipment is COMMUNICATING, SECS communications with a host computer must be maintained. This state remains active until communications are disabled or a communication failure occurs. If the equipment receives S1,F13 from the host while in the COMMUNICATING substate, it should respond with S1,F14 with COMMACK set to zero. If the equipment receives S1,F14 from a previously sent S1,F13, no action is required. In the event of communication failure, the equipment shall return to the NOT COMMUNICATING substate and attempt to re-establish communications with the host.

It is possible that the equipment may be waiting for an S1,F14 from the host in EQUIPMENT-INITIATED CONNECT/WAIT CRA at the time an S1,F13 is received from the host in HOST-INITIATED CONNECT/WAIT CR FROM HOST. When this situation occurs, both equipment and host have an open S1,F13/S1,F14 transaction. Since communications are successfully established on the successful completion of any S1,F13/S1,F14 transaction, either of these two transactions may be the first to complete successfully and to cause the transition from NOT COMMUNICATING state to COMMUNICATING. In this event, the other transaction shall remain open regardless of the transition to COMMUNICATING until it is closed in a normal manner.

If the equipment has not yet sent 6 an S1,F14 to a previously received S1,F13 at the time when COMMUNICATING becomes active, the S1,F14 response shall be sent in a normal manner. A failure to send the S1,F14 is then treated as any other communication failure.

If the equipment-initiated S1,F13/S1,F14 is still open when the transition to COMMUNICATING occurs, subsequent failure to receive a [Reply] from the host is considered a communication fault by equipment. An S9,F9 should be sent when a transaction timer timeout occurs7 (see § 4.9 for definitions of communication faults and message faults, as well as detail on Stream 9 Error Messages).

2) **State Transitions** — Table 1 contains a full description of the state transitions depicted in Figure 4.

When the operator switches from the DISABLED state to the ENABLED state, no collection event shall occur, since no messages can be sent until communications have been established. The process of establishing communications serves to notify the host that communications are ENABLED. No other collection events are defined for the Communications State Model.

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3) COMMUNICATION State Transition Table

Transition #	Previous State	Trigger	New State	Actions	Comments
1	(Entry to COMMUNICATIONS)	System initialization	System Default	***None***	The system default may be set to DISABLED or ENABLED.
2	2 DISABLED	Operator switches from DISABLED to ENABLED.	ENABLED	***None.***	SECS-II communications are enabled.
3	ENABLED	Operator switches from ENABLED to DISABLED	DISABLED	***None***	SECS-II communications are prohibited.
4	(Entry to ENABLED)	Any entry to ENABLED state.	NOT COMMUNICATING	***None.***	May enter from system initialization to ENABLED or through operator switch to ENABLED.
5	(Entry to EQUIPMENTINITIATED CONNECT)	(Any entry to NOT COMMUNICATING)	WAIT CRA	***Initialize communications. Set CommDelay timer "expired." Send S1,F13.***	Begin the attempt to establish communications.
6	WAIT CRA	Connection transaction failure.	WAIT DELAY	***Initialize CommDelay timer. Dequeue all messages queued to send.***	If appropriate, dequeued messages shall be placed in spool buffer in the order generated. Wait for timer to expire.
7	WAIT DELAY	CommDelay timer expired.	WAIT CRA	***Send S1,F13***	Wait for S1,F14. May receive S1,F13 from Host.
8	WAIT DELAY	Received a message other than S1,F13.	WAIT CRA	***Discard message. No [Reply]. Set CommDelay timer "expired". Send S1,F13.***	Indicates opportunity to Establish communications.
9	WAIT CRA	Received expected S1,F14 with COMMACK = 0.	COMMUNICATING	***None.***	Communications are established.
10	(Entry to HOST-INITIATED CONNECT)	(Any entry to NOT COMMUNICA-TING)	WAIT CR FROM HOST	***None.***	Wait for S1,F13 from Host.
14	COMMUNICATING	Communication failure. (See SEMI E4 or SEMI E37 for a protocol-specific definition of communication failure.)	NOT COMMUNICATING	***Dequeue all messages queued to send.***	Dequeued messages may be placed in spool buffer as appropriate.
15	WAIT CR FROM HOST	Received S1,F13.	COMMUNICATING	***Send S1,F14 with COMMACK = 0.***	Communications are established.

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2.2 Control State Model

The CONTROL state model defines the level of cooperation between the host and equipment. It also specifies how the operator may interact at the different levels of host control. While the COMMUNICATIONS state model addresses the ability for the host and equipment to exchange messages, the CONTROL model addresses the equipment's responsibility to act upon messages that it receives.

The CONTROL model provides the host with three basic levels of control. In the highest level (REMOTE), the host may control the equipment to the full extent possible. The middle level (LOCAL) allows the host full access to information, but places some limits on how the host can affect equipment operation. In the lowest level (OFFLINE), the equipment allows no host control[8] and only very limited information.[9]
The control model and communications model (when implemented) do not interact directly. That is, no action or state of one model directly causes a change in behavior of the other. It is true, however, that when the communication state is NOT COMMUNICATING then most message transaction are not functional. When messages cannot be transmitted, the control capabilities and all other GEM capabilities are affected. Refer to Figure 5 as the CONTROL substates and state transitions are defined.

1) OFF-LINE

When the OFF-LINE state is active, operation of the equipment is performed by the operator at the operator console. While the equipment is OFF-LINE, message transfer is possible. However the use of messaging for any automation purpose is severely restricted. While the OFF-LINE state is active, the equipment will only respond to those messages used for the establishment of communications or a host request to activate the ON-LINE state. While OFF-LINE, the equipment will respond with an Sx,F0 to any primary message from the host other than S1,F13 or S1,F17. It will process and respond to S1,F13 and S1,F17. S1,F17 is used by the host to request the equipment to transition to the ON-LINE state. The equipment will accept this request and send a positive response only when the HOST OFF-LINE state is active (see transition 11 definition below).
While the OFF-LINE state is active, the equipment shall attempt to send no primary message other than S1,F13,10 S9,Fx,11 and S1,F1 (see ATTEMPT ON-LINE substate). If the equipment receives a [Reply] message from the host
other than S1,F14 or S1,F2, this message is discarded.
No messages enter the spool when the system is OFF-LINE. Spooling may be active when the Communications State of NOT COMMUNICATING is active. This might occur during OFF-LINE, but since the equipment will not attempt to send messages except as mentioned in the previous paragraph12, no messages will enter the spool.
OFF-LINE has three substates: EQUIPMENT OFF-LINE, ATTEMPT ON-LINE, and HOST OFF-LINE.

① *OFF-LINE / EQUIPMENT OFF-LINE*

While this state is active, the system maintains the OFF-LINE state. It awaits operator instructions to attempt to go ON-LINE.

② *OFF-LINE / ATTEMPT ON-LINE*

While the ATTEMPT ON-LINE state is active, the equipment has responded to an operator instruction to attempt to go to the ON-LINE state. Upon activating this state, the equipment attempts to send an S1,F1 to the host.
Note that when this state is active, the system does not respond to operator actuation of either the ON-LINE or the OFF-LINE switch.

③ *OFF-LINE / HOST OFF-LINE*

While the HOST OFF-LINE state is active, the operator's intent is that the equipment be ON-LINE. However, the host has not agreed. Entry to this state may be due to a failed attempt to go ON-LINE or to the host's request that the equipment go OFF-LINE from ON-LINE (see the transition table for more detail). While this state is active, the equipment shall positively respond to any host's request to go ON-LINE (S1,F17). Such a request shall be denied when the HOST OFF-LINE state is not active.

2) ON-LINE

While the ON-LINE state is active, SECS-II messages may be exchanged and acted upon. Capabilities that may be available to the host should be similar to those available from the operator console wherever practical.
The use of Sx,F0 messages is not required while the ON-LINE state is active. Their use is discouraged in this case. The only allowed use is to close open transactions in conjunction with message faults.

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④ *ON-LINE / LOCAL*

Operation of the equipment is implemented by direct action of an operator. All operation commands shall be available for input at the local operator console of the equipment.
The host shall have the following capabilities and restrictions when the LOCAL state is active:.

- The host shall be prohibited from the use of remote commands that cause physical movement or which initiate processing. During processing, the host shall be prohibited from the use of any remote command that affects that process.
- During processing, the host shall be prohibited from modifying any equipment constants that affect that process. Other equipment constants shall be changeable during processing. The host shall be able to modify all available equipment constants when no processing is in progress.
- The host shall be capable of initiating the upload and download of recipes to/from the recipe storage area on the equipment. The host shall be capable of selecting recipes for execution so long as this action does not affect any currently executing recipe.
- The host shall be able to configure automatic data reporting capabilities including alarms, event reporting, and trace data reporting. The host shall receive all such reports at the appropriate times.
- The host shall be able to inquire for data from the equipment, including status data, equipment constants, event reports, Process Recipe directories, and alarms.
- The equipment shall be able to perform Terminal Services as defined in GEM.

The host shall be allowed any other capabilities that were not specifically restricted in the above items as long as the LOCAL state is active. NOTE 1: Capabilities mentioned above which are not implemented on a specific equipment may be ignored in this context.

⑤ *ON-LINE / REMOTE*

For equipment which supports the GEM capability of remote control (see § 4.4), while the REMOTE state is active, the host shall have access, through the communications interface, to the necessary commands to operate the equipment through the full process cycle in an automated manner. The equipment does not restrict any host capabilities when REMOTE is active. The degree of control executed by the host may vary from factory to factory. In some cases, the operator maybe required to interact during remotely controlled processes. This interaction may involve set-up operations, operator assist situations, and others. This state is intended to be flexible enough to accommodate these different situations.
To support the different factory automation policies and procedures, it shall be possible to configure the equipment to restrict the operator in specific non-emergency procedures. These restrictions shall be configurable so that the equipment may be set up to allow the operator to perform necessary functions without contention with the host. The categories for configuration shall include (but are not limited to):

- change equipment constants (process-related),
- change equipment constants (non-process-related),
- initiate Process Recipe download,
- select Process Recipe,
- start Process Recipe,
- pause/resume Process Recipe,
- operator assist,
- material movement to/from equipment, and
- equipment-specific commands (on a command-by-command basis if needed).

NOTE 2: Capabilities mentioned above which are not implemented on a specific equipment may be ignored in this context.

No capabilities that are available to the operator when the LOCAL state is active should be unconditionally restricted when the REMOTE state is active. The supplier may provide for configurable restriction of operator capabilities not included in the list above if desired. No configurability is necessary for any operator functions not available to the host.
The control functions must be shared to some degree between the host and the local operator. At the very least, the operator must have the capability to change the CONTROL state, actuate an Emergency Stop, and interrupt processing (e.g., STOP, ABORT, or PAUSE). All of these capabilities except Emergency Stop may be access limited.
The host software should be designed to be compatible with the capabilities allotted to the operator.

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3) CONTROL State Transition Table

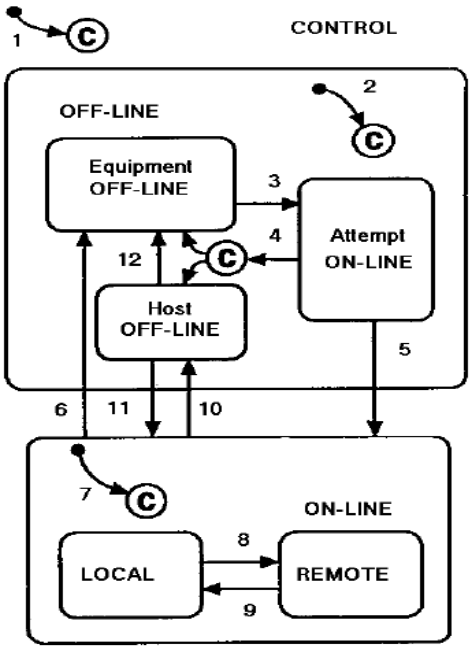

Figure 5
CONTROL State Model

Transition #	Previous State	Trigger	New State	Actions	Comments
1	(Undefined)	Entry into CONTROL state (system initialization).	CONTROL (Substate conditional on configuration).	***None***	Equipment may be configured to default to ON-LINE or OFF-LINE (see #1).
2	(Undefined)	Entry into OFF-LINE state.	OFF-LINE (Substate conditional on configuration.)	***S6,F11 Equipment OFF-LINE***	Equipment may be configured to default to any substate of OFF-LINE.
3	EQUIPMENT OFF-LINE	Operator actuates ON-LINE switch.	ATTEMPT ON-LINE	***None***	Note that an S1,F1 is sent whenever ATTEMPT ON-LINE is activated.
4	ATTEMPT ON-LINE	S1,F0.	New state conditional on configuration.	***None***	This may be due to a communication failure (see #2), [Reply] timeout, or receipt of S1,F0. Configuration may be set to EQUIPMENT OFF-LINE or HOST OFFLINE.
5	ATTEMPT ON-LINE	Equipment receives expected S1,F2 message from the host.	ON-LINE	***None***	Host is notified of transition to ON-LINE at transition 7.
6	ON-LINE	Operator actuates OFF-LINE switch.	EQUIPMENT OFF-LINE	***S6,F11 Equipment OFF-LINE***	"Equipment OFF-LINE" event occurs(see #3). Event [Reply] will be discarded while OFF-LINE is active.
7	(Undefined)	Entry to ON-LINE state.	ON-LINE (Substate conditional on REMOTE/LOCAL switch setting.)	***S6,F11 ControlState REMOTE*** *or* ***S6,F11 ControlState LOCAL***	"Control State LOCAL" or "Control State REMOTE" event occurs. Event reported based on actual ON-LINE substate activated.
8	LOCAL	Operator sets front panel switch to REMOTE.	REMOTE	***S6,F11 ControlState REMOTE***	"Control State REMOTE" event occurs.
9	REMOTE	Operator sets front panel switch to LOCAL.	LOCAL	***S6,F11 ControlState LOCAL***	"Control State LOCAL" event occurs.
10	ON-LINE	Equipment accepts "Set OFF-LINE" message from host (S1,F15).	HOST OFF-LINE	***S6,F11 Equipment OFF-LINE***	"Equipment OFF-LINE" event occurs.
11	HOST OFF-LINE	Equipment accepts host request to go ON-LINE (S1,F17).	ON-LINE	***None***	Host is notified to transition to ON-LINE at transition 7.
12	HOST OFF-LINE	Operator actuates OFF-LINE switch.	EQUIPMENT OFF-LINE	***S6,F11 Equipment OFF-LINE***	"Equipment OFF-LINE" event occurs.

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II. CONVEYOR SEM (Modified SEM based on StockerSEM)

1 Purpose

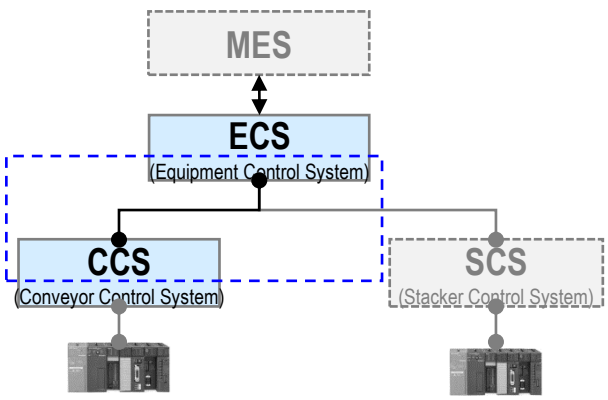
1.1 This standard establishes a Specific Equipment Model (SEM) for AMHS conveyor equipment (Conveyor SEM). The model consists of equipment characteristics and behaviors that are to be implemented in addition to the SEMI E30 fundamental requirements and selected additional capabilities. The intent of this standard is to facilitate the integration of Conveyor SEM equipment into an automated (e.g., semiconductor fabrication and flat panel display) factory.

This document accomplishes this by defining an operational model for Conveyor SEM equipment as viewed by a factory automation controller (Host). This definition provides a standard host interface and equipment operational behavior (e.g., control, state models, and data reports). Several topics require additional activity that are within the scope of this standard: queuing, parallel interface for carrier transfer [SEMI E23], conveyor controller architecture, and scheduling and transport of the transfer unit.

2 Scope

2.1 The scope of this standard is limited to the usage and description of AMHS conveyor equipment (Conveyors) as perceived by a SEMI Equipment Communications Standard 2 (SECS-II) host that complies with the GEM model (as specified in § 13). It defines the view of the equipment through the SECS communication link. It does not define the internal operation of the equipment. It includes a specific transfer command state model and conveyor controller state model as the basis for all equipment of this class.

2.2 This document assumes that the GEM fundamental requirements and selected additional capabilities (as specified in § 13) have been implemented on the Conveyor SEM equipment. It expands the GEM standard requirements and capabilities in the areas of state models (conveyor controller, transfer command, carrier and conveyor unit state models), collection events, alarm documentation, remote commands, data item variables, and material movement.



3 Limitations

3.1 *SEMI Standards Alignment*

The GEM [SEMI E30] model was used as the basis for Stocker SEM requirements definition in alignment with existing AMHS SEM Specifications.

3.2 *AMHS Conveyor Equipment Description*

① This standard is targeted at the different types/configurations of AMHS conveyor equipment. The term Conveyor SEM equipment refers to all the types of AMHS conveyor equipment. The equipment types may have fundamental mechanical differences.

② Conveyor *(configuration)*

A Conveyor is generally an AMHS automated transport device used to move carriers. The device is not required to provide temporary storage of carriers (e.g., when used as a device to connect multiple IBSEM devices or as a floor to floor lifter). Additionally, any number of physical interfaces may exist to connect the conveyor with external devices such as: Interbay and/or Intrabay Transport Systems, Process Equipment, other StockerSEM devices, Operator ports, etc.

4 Referenced Standards and Documents

4.1 *SEMI Standards*

SEMI E4 — SEMI Equipment Communications Standard 1 Message Transfer (SECS-I)
SEMI E5 — SEMI Equipment Communications Standard 2 Message Content (SECS-II)
SEMI E23 — Specification for Cassette Transfer Parallel I/O Interface
SEMI E30 — Generic Model for Communications and Control of Manufacturing Equipment (GEM)
SEMI E37 — High-Speed SECS Message Services (HSMS) Generic Services
SEMI E37.1 — High-Speed SECS Message Services Single Selected-Session Mode (HSMS-SS)
SEMI E84 — Specification for Enhanced Carrier Handoff Parallel I/O Interface

4.2 *Other References*

Harel, D., “Statecharts: A Visual Formalism for Complex Systems,” Science of Computer Programming 8 (1987)

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5 Terminology

5.1 Definitions

- ***alarm*** — an alarm is related to any abnormal situation on the equipment that may endanger people, equipment, or material being processed. Such abnormal situations are defined by the equipment manufacturer based on physical safety limitations. Equipment activities potentially impacted by the presence of an alarm shall be inhibited. (Note that exceeding control limits associated with process tolerance does not constitute an alarm nor do normal equipment events such as the start or completion of processing).
- ***capabilities*** — capabilities are operations performed by semiconductor manufacturing equipment. These operations are initiated through the communications interface using sequences of SECS-II messages (or scenarios). An example of a capability is the setting and clearing of alarms.
- ***collection event*** — a collection event is an event (or grouping of related events) on the equipment that is considered to be significant to the host.
- ***communication failure*** — a communication failure is said to occur when an established communications link is broken. Such failures are protocol specific. Refer to the appropriate protocol standard (e.g., SEMI E4 or SEMI E37) for a protocol-specific definition of communication failure.
- ***communication fault*** — a communication fault occurs when the equipment does not receive an expected message, or when either a transaction timer or a conversation timer expires.
- ***control*** — to control is to exercise directing influence.
- ***equipment model*** — an equipment model is a definition based on capabilities, scenarios, and SECS-II messages that manufacturing equipment should perform to support an automated manufacturing environment (see also Generic Equipment Model.).
- ***event*** — an event is a detectable occurrence significant to the equipment.
- ***GEM compliance*** — the term "GEM Compliance" is defined with respect to individual GEM capabilities to indicate adherence to the GEM standard for a specific capability. § 8 includes more detail on GEM Compliance.
- ***Generic Equipment Model*** — the Generic Equipment Model is used as a reference model for any type of equipment. It contains functionality that can apply to most equipment, but does not address unique requirements of specific equipment.
- ***host*** — SEMI E4 and SEMI E5 define Host as "the intelligent system that communicates with the equipment."
- message fault — a message fault occurs when the equipment receives a message that it cannot process because of a defect in the message.
- ***operational script*** — an operational script is a collection of scenarios arranged in a sequence typical of actual factory operations. Example sequences are system initialization power-up, machine setup, and processing.
- ***operator*** — a human who operates the equipment to perform its intended function (e.g., processing). The operator typically interacts with the equipment via the equipment supplied operator console.
- ***process unit*** — a process unit refers to the material that is typically processed as a unit via single run command, process program, etc. Common process units are wafers, cassettes, magazines, and boats.
- ***processing cycle*** — a processing cycle is a sequence wherein all of the material contained in a typical process unit is processed. This is often used as a measure of action or time.
- ***scenario*** — a scenario is a group of SECS-II messages arranged in a sequence to perform a capability. Other information may also be included in a scenario for clarity.
- ***SECS-I*** — SEMI Equipment Communications Standard 1 (SEMI E4). This standard specifies a method for a message transfer protocol with electrical signal levels based upon EIA RS232-C.
- ***SECS-II*** — SEMI Equipment Communications Standard 2 (SEMI E5). This standard specifies a group of messages and the respective syntax and semantics for those messages relating to semiconductor manufacturing equipment control.
- ***SMS*** — SECS Message Service. An alternative to SECS-I to be used when sending SECS-II formatted messages over a network.
- ***state model*** — a State Model is a collection of states and state transitions that combine to describe the behavior of a system. This model includes definition of the conditions that delineate a state, the actions/reactions possible within a state, the events that trigger transitions to other states, and the process of transitioning between states.
- ***system default*** — refers to state(s) in the equipment behavioral model that are expected to be active at the end of system initialization. It also refers to the value(s) that specified equipment variables are expected to contain at the end of system initialization.
- ***system initialization*** — the process that an equipment performs at power-up, system activation, and/or system reset. This process is expected to prepare the equipment to operate properly and according to the equipment behavioral models.
- ***user*** — a human or humans who represent the factory and enforce the factory operation model. A user is considered to be responsible for many setup and configuration activities that cause the equipment to best conform to factory operations practices.
- ***Automated Material Handling System*** — an automated system to store and transport materials within the factory.

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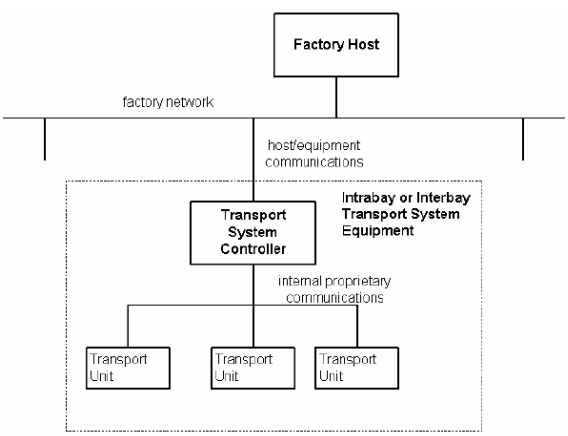
- ***automation*** — the capability of managing material and data within the factory.
- ***buffer*** — a set of one or more locations for holding carriers at the production equipment.
- ***buffer port*** — special buffer port location on a conveyor output shuttle. Contains carrier presence sensors so that the host can be notified when a carrier is situated at this position.
- ***carrier*** — a container with one or more fixed positions for holding substrates. Examples of carriers include FOUPs, open cassettes and unstacked or multi-stacked trays.
- ***carrier ID*** — a readable and unique identifier for the carrier.
- ***host*** — the factory computer system, or an intermediate system, that represents the factory and the user to the equipment. Refers system that controls or supervises the Transport Controller (TSC) throughout this document.
- ***independent port*** — a load port on the conveyor that is dedicated to input or output. It is considered that the carriers can only be transferred in one direction.
- ***Interbay Transport System*** — a transport system used to move work-in-process between stockers in different parts of the factory.
- ***Intrabay Transport System*** — a transport system dedicated to one or more bays in the factory and responsible for transferring carriers to and from production equipment. ITS consists of the physical units of the system (e.g., vehicles, nodes, docking stations), the low-level unit controllers, and a system-level controller. ITS excludes factory floor storage systems (stockers), but includes any short-term storage integral to the system, such as storage locations within an overhead track system that are accessible only to units of the particular ITS.
- ***load port*** — the interface location on the equipment where carriers are transferred.
- ***loading port*** — user or vehicle accessible port location on a conveyor output shuttle. Contains carrier presence sensors so that the host can be notified when a carrier is situated at this position.
- ***process equipment*** — equipment used to make semiconductor devices. This excludes metrology and material handling equipment.
- ***production equipment*** — equipment used to produce semiconductor devices, including wafer sorting, process, and metrology equipment and excluding material handling equipment.
- ***Conveyor Controller*** — conveyor Equipment Controller that communicates with the host and represents the system as the equipment.
- ***Conveyor track(or belt)*** — conveyor transfer agent specialized for the movement of carriers between tracks and input and output port locations.
- ***conveyor equipment*** — an individual conveyor viewed as a single piece of equipment, with distributed components and distributed control, as illustrated in Figure 1. The conveyor controller communicates with the host using HSMS and GEM and represents the system as an equipment. The factory may require more than one type of conveyor.
  - Communications with transport system equipment may require a low-level handshake with a transport unit directly involved in the transfer of material (such as a vehicle or a docking station on an overhead track).
  - Communications between the various conveyor units and controllers are proprietary to the supplier.
- ***conveyor unit*** — a physical component of the conveyor system, such as conveyor tracks(or belts), ID reader, tray exist sensor, shuttle port, magazine unit(stacking carriers) and dispenser unit(splitting carriers) etc.
- ***transfer agent*** — a component of equipment specialized to the movement of transfer objects from place to place within a factory. May be of different types with widely-differing characteristics. Examples are fixed-arm robots, robot arms on fixed tracks, overhead gantries or even systems containing a heterogeneous collection of other transfer agents. Humans may also act as transfer agents.
- ***transport system*** — the component of AMHS that moves material from one part of the factory to another.
- ***transport unit*** — a physical component of a transport system, such as a vehicle, node, or docking unit.
- ***Magazine(M/G) unit*** — a physical component of a transport system that stacks carriers.
- ***Dispenser(D/P) unit*** — a physical component of a transport system that splits the stacked carriers.



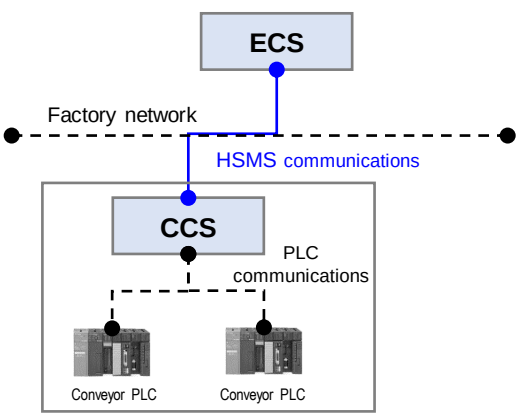


Figure 1
Example of Transport System Equipment

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5.2 Abbreviations and Acronyms

1) *AMHS* — Automated Material Handling System
2) ***D/P*** — Dispenser (split unit for splitting the stacked carriers)
3) ***M/G*** — Magazine (stack unit for carriers)
4) *TCP/IP* — Transmission Control Protocol/Internet Protocol
5) *TSC* — Transport System Controller (i.e., Conveyor Controller)

6. Overview and Assumptions

6.1 Destination Control (to Output Port or to Specific Track)

- The destination is controlled by Host when the carrier is input to the conveyor (i.e., the carrier enters the conveyor domain). The destination of the transfer command is required. It would be invalid for the Host to issue a transfer command to the TSC without including a valid destination.

6.2 Quantity Control in the Conveyor (Capacity Planning)

- The number of carriers in the conveyor is controlled by the Host. A list of carrier database entries in the specified conveyor's TSC database will be available to the Host upon request via a remote command.

6.3 Plural Sets of Input / Output Ports

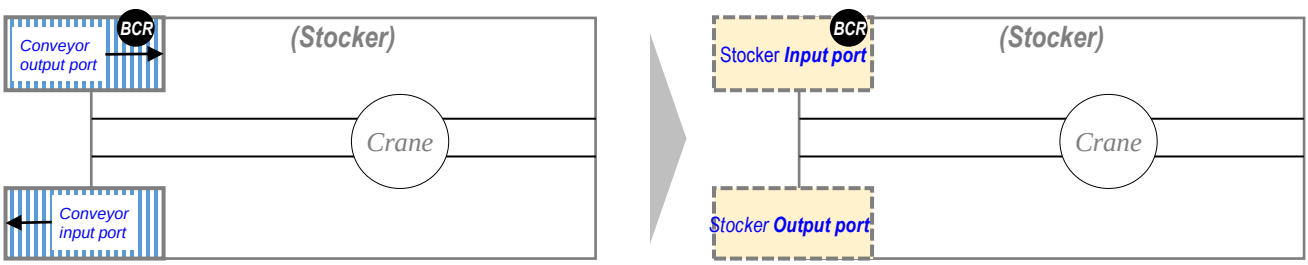
- Plural sets of Input / Output ports connected to the interbay or intrabay transport system must be considered. (This would be considered a Multi-loop type interface connection to the stocker.) Examples of plural sets of interfaces are as follows:

• Main Loop/Sub Loop,
• Right-handed rotation/Left-handed rotation, and
• Double Track (i.e., Stacked Track).

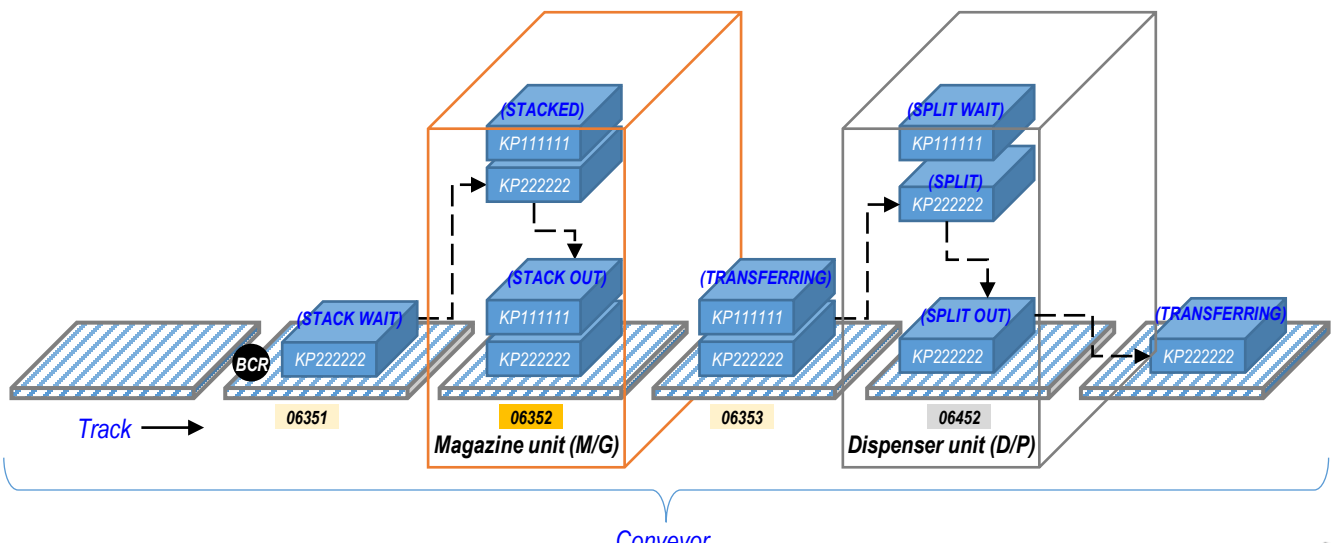
6.4 *Carrier ID Reader*

• Manual Input Port: Carrier ID Reader is mandatory.
• Automated Input Port: Carrier ID Reader is a customer option.
• Carrier ID Reader at any output port: Carrier ID Reader is a customer option.

- The intrabay automated input port is sometimes used as the manual Input Port. If one port is used for both an automated and a manual, the Carrier ID Reader is mandatory for this port. If there is a Carrier ID Reader, the scenario for a stocker transfer without a Carrier ID Reader is not applicable.



These out or in-going parts of conveyor, connected to a stocker, are "Physically" conveyor units, but "Logically" they should be regarded as stocker Input/Output port to handle 'Wait-In' or 'Wait-Out' event for a host to send a transfer command to SC(Stocker Controller). At the end of conveyor BCR also should be regarded as 'ID Read' at stocker input port.



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7 Communication Requirements

It is required that any Conveyor SEM compliant equipment follow the Communications State Model in SEMI E30. In addition, Conveyor SEM compliant equipment shall support either SEMI E37 and SEMI E37.1 or SEMI E4.

8 State Models

8.1 State Model Requirements

1) The state models included in this standard are a requirement for Conveyor SEM equipment. This standard requires implementation of all SEMI E30 state models (such as control, communication, on-line/off-line, etc. according to the GEM capabilities required per § 13). A state model consists of a state model diagram, state definitions, and a state transition table. All state transitions in this standard, unless otherwise specified, shall correspond to collection events.

2) A state model is the host's view of the equipment, and does not necessarily describe the internal equipment operation. All Conveyor SEM state model transitions shall be mapped into the appropriate internal equipment events that satisfy the requirements of those transitions. In certain implementations, the equipment may enter a state and have already satisfied all of the conditions required by the Conveyor SEM state model for transition to another state. The equipment makes the required transition without any additional actions in this situation.

3) Some equipment may need to include additional substrates other than those in this standard. Additional substrates may be added, but shall not change the Conveyor SEM defined state transitions. All expected transitions between Conveyor SEM states shall occur.

8.2 TSC(Transport System Controller) State Model

1) TSC State Model Requirements

The purpose of the Transport System state model is to provide information to the host regarding the overall status of the conveyor system. The TSC state model is valid when the SEMI E30 (GEM) state is ON-LINE. The TSC state model is not valid when the SEMI E30 (GEM) state is OFF-LINE. Since a conveyor may consist of many components (e.g., conveyor tracks, magazine/dispenser units, ID reader, etc.) it may be possible to continue ON-LINE operation when the operation mode of some conveyor components (as viewed by the TSC) is a manual state. The details of what happens when individual components of the conveyor enter a manual state are specific to the Conveyor SEM equipment supplier. When the SEMI E30 Control state changes from OFF-LINE to ON-LINE, the TSC State Model is started from the TSC INIT state.

2) TSC State Model

3) **TSC State Definitions**

① ***TSC INIT*** — TSC initialization of conveyor components is occurring. This is a non-operational state. No commands from the host will be acknowledged, queued or processed. The system will not move out of this state if there are carriers stacking on magazine units or splitting on dispenser units controlled by the TSC. Such units must be manually or automatically recovered before transitioning to the next state.

② ***PAUSING*** — A system PAUSE command has been received and is being processed. All carriers that are currently stacking or splitting will continue until the stack/split is complete. Carriers that are currently stacking or splitting may continue to complete but they must not begin a stack or split. TRANSFER commands are accepted and queued. All status requests will be processed. The RESUME command will also be processed.

③ ***PAUSED*** — No carriers are in the process of stacking or splitting on any of the conveyor units controlled by the TSC, but carriers may still be moving. TRANSFER commands are accepted and queued. All status requests will be processed. The RESUME command will also be processed.

④ ***AUTO*** — System is in the normal operational state. Commands are actively processed.

⑤ ***NO ALARMS*** — There are no alarms present in the system.

⑥ ***ALARMS*** — There are one or more alarms present in the system.

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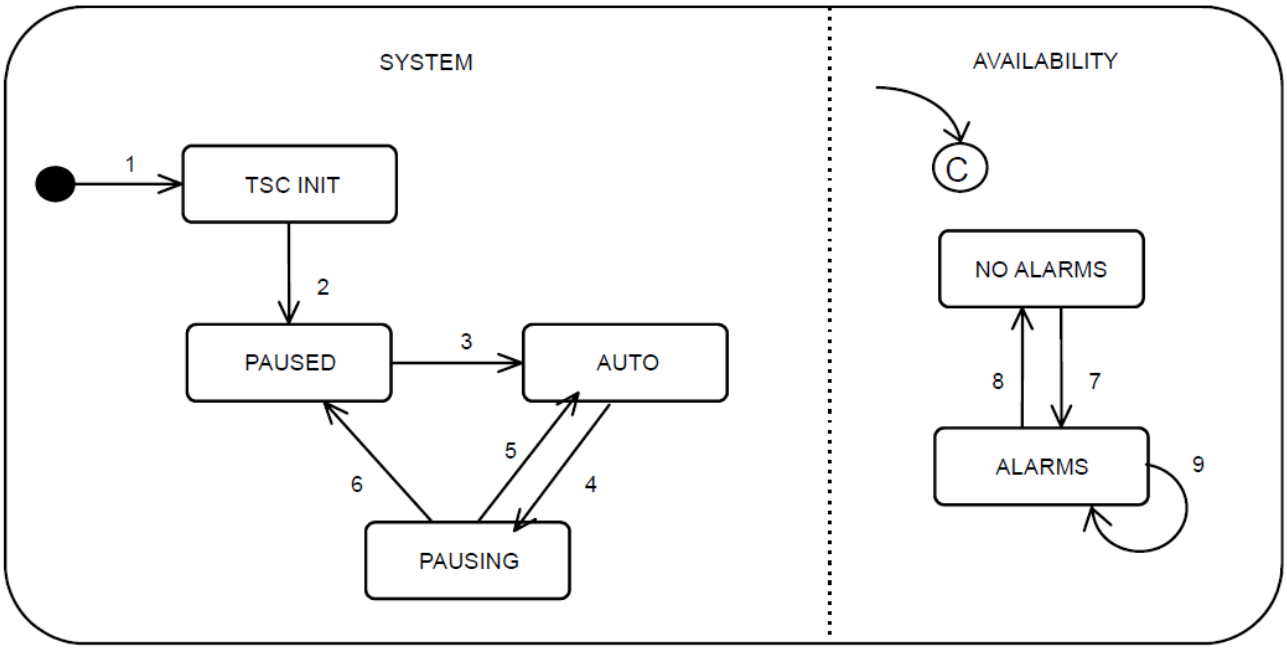

Figure 2

Generic TSC State Model Diagram

4) TSC State Transition Table

Transition #	Previous State	Trigger	New State	Actions	Comments
1	none	TSC Initiation.	TSC INIT	***S6F11 TSCAutoInitiated***	System runs through its startup sequence.
2	TSC INIT	System started up successfully. All loads and unloads are complete.	PAUSED	***S6F11 TSCPaused***	System ready.
3	PAUSED	TSC is resumed.	AUTO	***S6F11 TSCAutoCompleted***	System will now perform all commands based upon other internal conditions (Alarm, GEM ONLINE, etc.).
4	AUTO	TSC is requested to pause.	PAUSING	***S6F11 TSCPauseInitiated***	Carriers that are not moving remain there. Carriers that are moving must stop at the next logical stopping point.
5	PAUSING	TSC is resumed.	AUTO	***S6F11 TSCAutoCompleted***	System will now perform all commands based upon other internal conditions (Alarm, GEM ONLINE, etc.).
6	PAUSING	All carrier stacks and splits are completed. No new stacks or splits will occur.	PAUSED	***S6F11 TSCPauseCompleted***	System will accept and queue new commands but will not execute them.
7	NO ALARMS	Alarm Set.	ALARMS	***S6F11 AlarmSet***	System can process normally for transport components that are unaffected by the alarm.
8	ALARMS	Last remaining alarm cleared.	NO ALARMS	***S6F11 AlarmCleared***	
9	ALARMS	Alarm Set.	ALARMS	***S6F11 AlarmSet***	Alarm occurs when there is already an outstanding alarm.

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8.3 TRANSFER Command State Model

1) TRANSFER Command State Model Requirements
The TRANSFER command state model serves as the SEMI E30 Processing State Model. The purpose of the TRANSFER command state model is to provide information to the host regarding the control of the TRANSFER command. The TRANSFER command allows the host to manage carrier movement and scheduling. The control of each TRANSFER command must independently support the TRANSFER command state model.

2) TRANSFER Command State Model Diagram
The TRANSFER command state model is detailed for Conveyor SEM equipment in Figure 4.

3) TRANSFER Command State Definitions
① ***QUEUED*** — TSC has acknowledged and queued the TRANSFER command. TRANSFER command has not been initiated.
② ***ACTIVE*** — The carrier is involved in the physical aspect of the TRANSFER command. It is denoted by the time spanned by command initiation to command completion.
③ ***TRANSFERRING*** *(ACTIVE sub-state)* — The transfer command is actively being executed by the conveyor.
④ ***PAUSED*** *(ACTIVE sub-state)* — The Transfer command is not actively being executed by the conveyor. This may be due to an internal equipment error that does not immediately terminate the Transfer command unsuccessfully. This would allow the Host or Operator the opportunity to retry the transfer.
⑤ ***CANCELING*** — The TRANSFER command cancel procedure is being performed to terminate a transfer command which never entered the ACTIVE state (currently QUEUED). This state is entered via a CANCEL remote command.
⑥ ***ABORTING*** — The TRANSFER command abort procedure is being performed to terminate a transfer command which has entered the ACTIVE state. This state can only be entered via an ABORT remote command. An unsuccessful transfer command completion will ultimately result from this state.

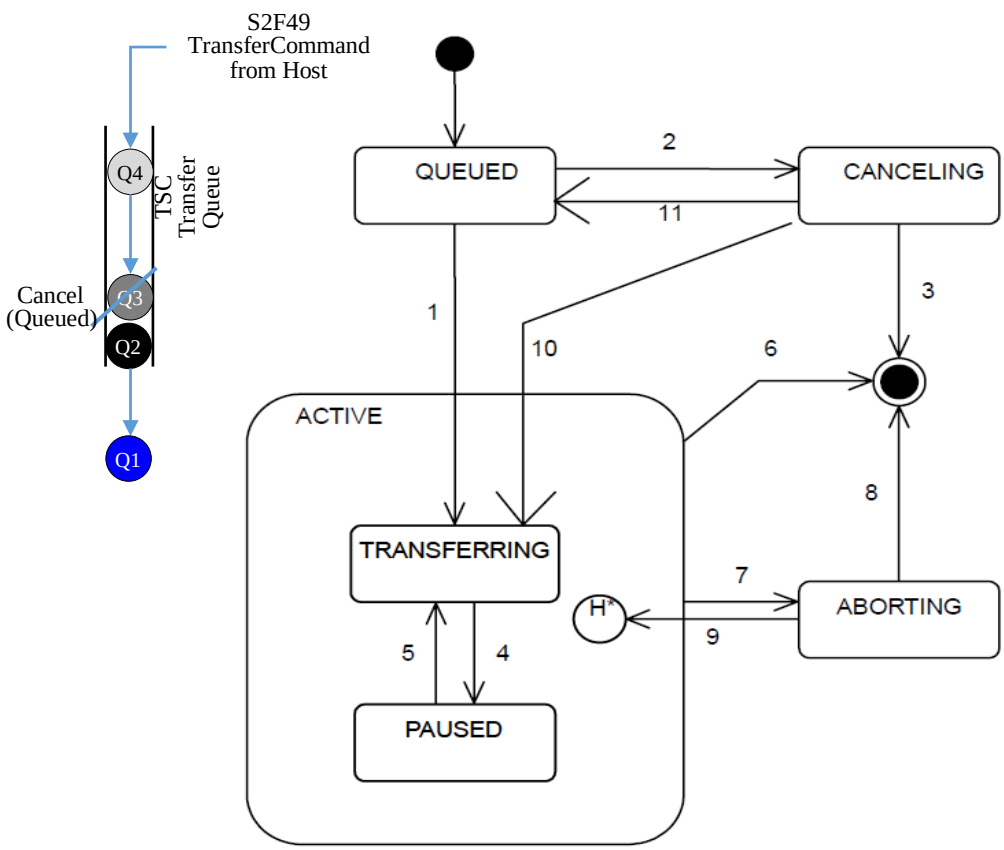

Figure 4
Generic TRANSFER Command State Model Diagram

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4) TRANSFER Command State Transition Table

Transition #	Previous State	Trigger	New State	Actions	Comments
1	QUEUED	The TRANSFER command has been initiated by the TSC.	TRANSFERRING	***S6F11 TransferInitiated***	
2	QUEUED	Host sends CANCEL command for a specified TRANSFER command to TSC.	CANCELING	***S6F11 TransferCancel-Initiated***	TRANSFER command is to be removed from the TRANSFER command queue.
3	CANCELING	The cancel procedure for the TRANSFER command has completed by the conveyor and the TSC.	None	***S6F11 TransferCancel-Completed***	The carrier will still be situated at the transfer source location. The carrier may now be included in a future transfer.
4	TRANSFERRING	The TSC pauses execution of the TRANSFER command due to an anomaly condition.	PAUSED	***S6F11 TransferPaused for a specific CommandID***	It is an important distinction to make that the TRANSFER command is paused and not just the transfer agent. The Transport System state will be ALARM.
5	PAUSED	The TSC resumes execution of the TRANSFER command since the anomaly condition has been cleared.	TRANSFERRRING	***S6F11 TransferResumed for a specific CommandID***	If this was the only remaining conveyor alarm, the Transport System Controller state will transition to NO ALARMS.
6	ACTIVE	The TRANSFER command has completed by the conveyor and TSC (either successfully or unsuccessfully).	None	***S6F11 TransferCompleted*** *sent to Host with appropriate ResultCode* ***ResultCode = 0 if successful ResultCode is nonzero if unsuccessful***	Carrier(s) could be located at any location or port located along the path of the transfer, if the TRANSFER command completed unsuccessfully. Supplier Option — The location of the carrier(s) associated with an unsuccessful transfer command must be a legal SourcePort for a new TRANSFER command.
7	ACTIVE	Host sends ABORT command for a specified TRANSFER command to TSC.	ABORTING	***S6F11 TransferAbort-Initiated***	
8	ABORTING	The abort procedure for the TRANSFER command has completed by the conveyor and TSC.	None	***S6F11 TransferAbort-Completed***	Carrier could be located at any location or port located along the path of the ACTIVE transfer. Supplier Option — The location of the carrier associated with the aborted transfer command must be a legal SourcePort for issuing a new TRANSFER command.
9	ABORTING	TRANSFER command cannot be aborted.	ACTIVE	***S6F11 TransferAbort-Failed***	TRANSFER command could not be aborted due to the physical state of the equipment. Such conditions must be documented by the Conveyor SEM equipment Supplier.
10	CANCELING	Transport system is unable to cancel the TRANSFER command because the transfer is now ACTIVE.	TRANSFERRING	***S6F11 TransferInitiated***	
11	CANCELING	Transport system is unable to cancel the TRANSFER command and it is still queued.	QUEUED	***S6F11 TransferCancel-Failed***	

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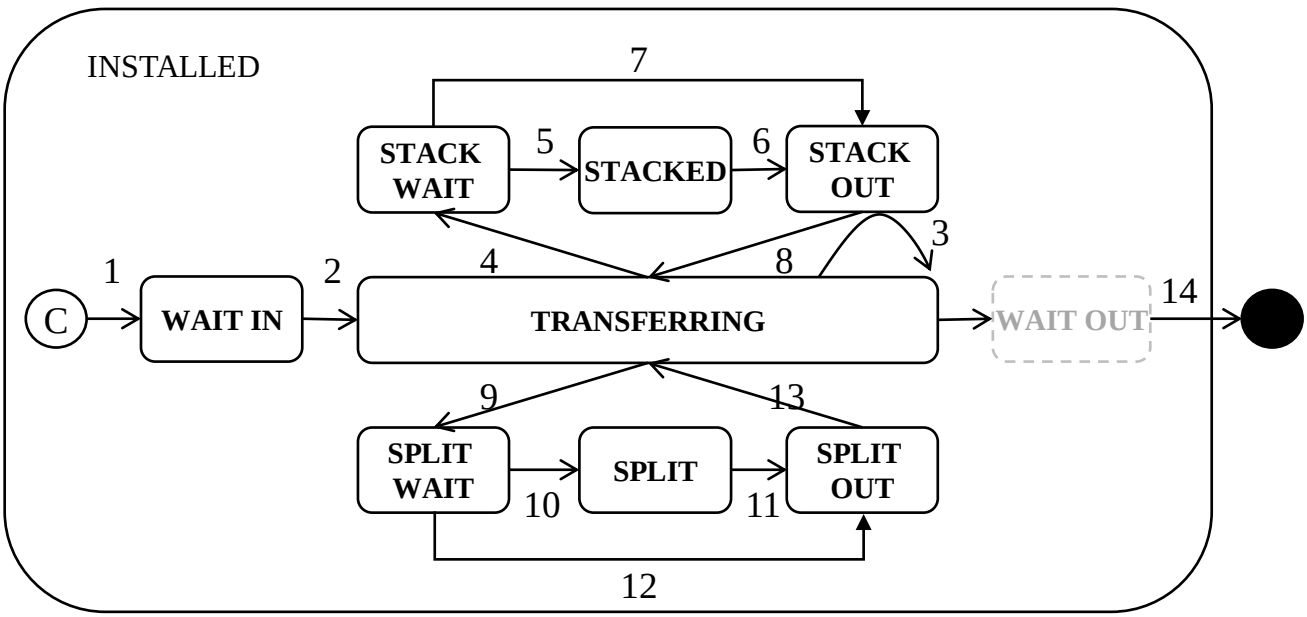
8.4 Conveyor Carrier State Model

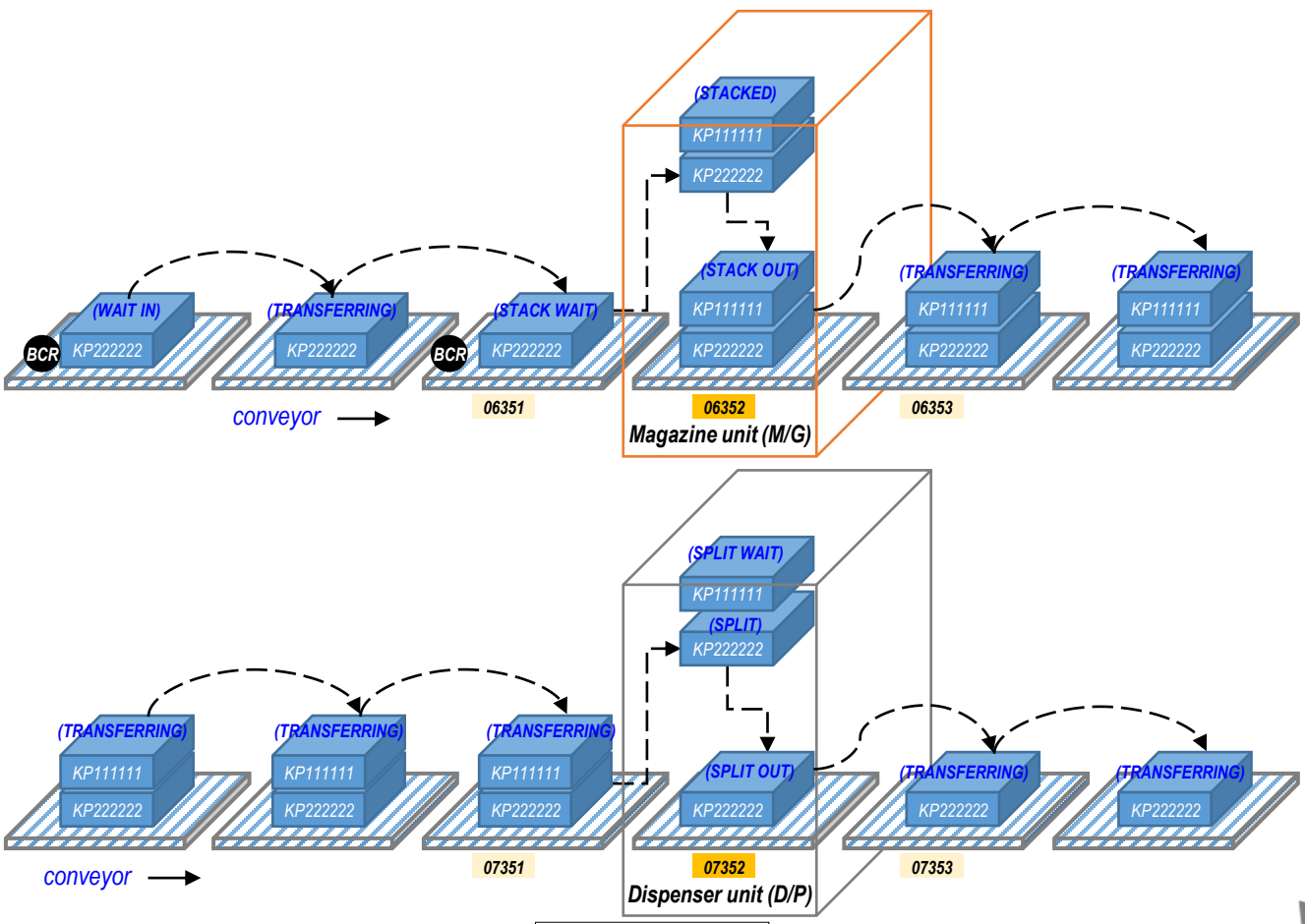
1) Conveyor Carrier State Model Requirements

The purpose of the conveyor carrier state model is to provide information to the host regarding carrier tracking (the Host will not control carriers) while the carrier is in the domain of the conveyor. The carrier is in the domain of the conveyor when it is on the conveyor or transport to the stocker interface port (manual, interbay, or intrabay). The equipment shall track each carrier in compliance with the Conveyor Carrier State Model.

2) Conveyor Carrier State Model



Conveyor Carrier State Model Diagram



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3) Conveyor Carrier State Definitions

① ***INSTALLED*** — Carrier in conveyor database.

② ***WAIT IN*** *(INSTALLED sub-state)* — Carrier enters the domain of the conveyor.

③ ***TRANSFERRING*** *(INSTALLED sub-state)* — Carrier 'moving' between locations in the conveyor.

④ ***STACK WAIT*** *(INSTALLED sub-state)* — Carrier is ready to be multiple-stacked in front of M/G(Magazine) unit and no further movement or action should be taken on this carrier prior to a remote command STACK, REPLACE or BYPASS.

⑤ ***STACKED*** *(INSTALLED sub-state)* — The carrier is stacked at a Magazine unit as a result of completing a STACK remote command..

⑥ ***STACK OUT*** *(INSTALLED sub-state)* — The stacked carrier is ready to be transferred to next conveyor track.

⑦ ***SPLIT WAIT*** *(INSTALLED sub-state)* — Carrier is ready to be split in the D/P(Dispenser) unit and no further movement or action should be taken on this carrier prior to a remote command SPLIT or FORCEOUT.

⑧ ***SPLIT*** *(INSTALLED sub-state)* — The carrier is split at a D/P(Dispenser) unit as a result of completing a SPLIT remote command..

⑨ ***SPLIT OUT*** *(INSTALLED sub-state)* — The split carrier is ready to be transferred to next conveyor track.

4) Conveyor Carrier State Transition Table

Transition #	Previous State	Trigger	New State	Actions	Comments
1	None	Carrier arrives at a Wait In position of the conveyor.	WAIT IN	***S6F11 CarrierWaitIn***	
2	WAIT IN	Carrier has advanced (automatically) on the tracks.	TRANSFERRING	***S6F11 CarrierTransferring***	
3	TRANSFERRING	Carrier has advanced (automatically) on the tracks.	TRANSFERRING	***S6F11 CarrierTransferring***	
4	TRANSFERRING	Carrier has been lifted at a Stack Wait position of the M/G(Magazine) unit.	STACK WAIT	***S6F11 CarrierStackWait***	
5	STACK WAIT	Carrier has been Stacked at the M/G unit.	STACKED	***S6F11 CarrierStacked***	Could be due to a STACK or REPLACE remote command.
6	STACKED	Carrier has been dropped and ready to be moved on the track beyond the M/G.	STACK OUT	***S6F11 CarrierStackOut***	Could be due to a REPLACE remote command.
7	STACK WAIT	Carrier has been dropped and ready to be moved on the track beyond the M/G.	STACK OUT	***S6F11 CarrierStackOut***	Could be due to a BYPASS remote command.
8	STACK OUT	Carrier has advanced (Not automatically) on the tracks beyond the M/G unit.	TRANSFERRING	***S6F11 CarrierTransferring***	Need to be confirmed by MES (to ensure stacking information)
9	TRANSFERRING	Carrier has been lifted at a Split Wait position of the D/P(Dispenser) unit.	SPLIT WAIT	***S6F11 CarrierSplitWait***	
10	SPLIT WAIT	Carrier has been Split at the D/P unit.	SPLIT	***S6F11 CarrierSplit***	Could be due to a SPLIT remote command.
11	SPLIT	Carrier has been dropped and ready to be moved on the track beyond the D/P.	SPLIT OUT	***S6F11 CarrierSplitOut***	
12	SPLIT WAIT	Carrier has been dropped and ready to be moved on the track beyond the D/P	SPLIT OUT	***S6F11 CarrierSplitOut***	Could be due to a FORCEOUT remote command.
13	SPLIT OUT	Split carrier has advanced (Not automatically) on the tracks beyond the D/P unit.	TRANSFERRING	***S6F11 CarrierTransferring***	Need to be confirmed by MES (to ensure split information)
~~14~~	~~TRANSFERRING~~	~~Carrier has arrived at an Output port and is removed from the conveyor domain.~~	~~None~~	~~***S6F11 CarrierRemoved***~~	~~This generally occurs when delivering directly to process equipment at a port with no sensors controlled by the TSC.~~

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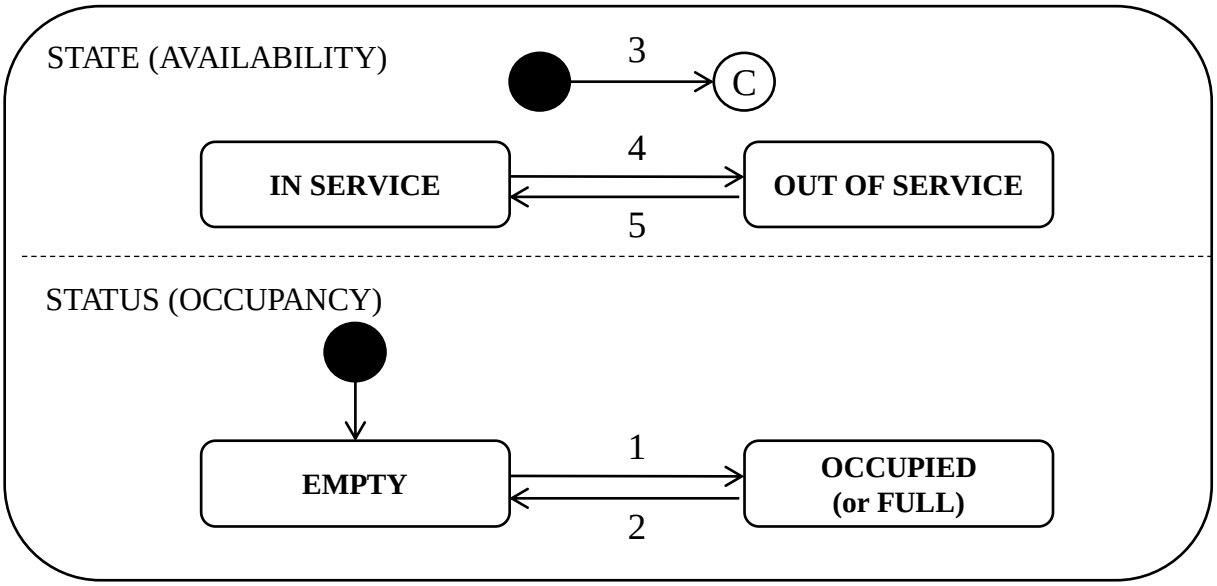
8.5 Conveyor Unit State/Status Model

1) Conveyor Unit State/Status Model Requirements
The purpose of the conveyor unit state model is to provide information to the host for use of conveyor unit information and metric tracking (i.e., the Host will not control the conveyor unit).

2) Conveyor Unit State/Status Model



Conveyor Unit State/Status Model Diagram

3) Conveyor Unit State/Status Definitions
① ***EMPTY*** — The conveyor unit does not have any carrier (The location is Empty).
② ***OCCUPIED (or FULL)*** — The conveyor unit has been occupied by any carrier (The location is Full).
③ ***IN SERVICE*** — The unit is able to perform the movement or stacking/splitting of carriers.
④ ***OUT OF SERVICE*** — The unit is not able to perform the movement or stacking/splitting of carriers. If a command is issued by the Host, it shall not be rejected solely because the unit is in this state. In other words, the state of the unit is not a valid reason to reject a command from the Host.

4) Conveyor Unit State/Status Transition Table

Transition #	Previous State	Trigger	New State	Actions	Comments
1	EMPTY	The conveyor unit does not have any carrier. (The location is Empty)	OCCUPIED	***S6F11 UnitStatusChanged***	
2	OCCUPIED	The conveyor unit has been occupied by any carrier. (The location is Full)	EMPTY	***S6F11 UnitStatusChanged***	
3	None	System reset.	OUT OF SERVICE or IN SERVICE	***S6F11 UnitStateChanged***	The new state is based on the current status of the conveyor unit or the state prior to system reset.
4	IN SERVICE	The equipment has determined that the conveyor unit should not be used for transfers or stacks/splits.	OUT OF SERVICE	***S6F11 UnitStateChanged***	This could be the result of an alarm condition.
5	OUT OF SERVICE	The equipment has determined that the conveyor unit can be utilized for transfers or stacks/splits.	IN SERVICE	***S6F11 UnitStateChanged***	

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III. SECS-II (SEMI Equipment Communications Standard 2 Message Content)

1 Purpose

The SEMI Equipment Communications Standard Part 2 (SECS-II) defines the details of the interpretation of messages exchanged between intelligent equipment and a host.

2 Scope

2.1 SECS-II gives form and meaning to messages exchanged between equipment and host using a message transfer protocol, such as SECS-I.

1) SECS-II defines the method of conveying information between equipment and host in the form of messages. These messages are organized into categories of activities, called streams, which contain specific messages, called functions. A request for information and the corresponding data transmission is an example of such an activity.

2) SECS-II defines the structure of messages into entities called items and lists of items. This structure allows for a self-describing data format to guarantee proper interpretation of the message.

3) The interchange of messages is governed by a set of rules for handling messages called the transaction protocol. The transaction protocol places some minimum requirements on any SECS-II implementation.

3 Terminology

3.1 Definitions

- ***block*** —a physical division of a message used by the message transfer protocol.
- ***conversation*** — a sequence of related messages.
- ***conversation timeout*** — an indication that a conversation has not completed properly.
- ***device ID*** — a number between 0 and 32767 used in identifying the particular piece of equipment communicating with a host.
- ***equipment*** — the intelligent system which communicates with a host.
- ***function*** — a specific message for a specific activity within a stream.
- ***host*** — the intelligent system which communicates with the equipment.
- ***interpreter*** — the system that interprets a primary message and generates a reply when requested.
- ***item*** — a data element within a message.
- ***item format*** — a code used to identify the data type of an item.
- ***list*** — a group of items.
- ***message*** — a complete unit of communication.
- ***message header*** — information about the message passed by the message transfer protocol.
- ***multi-block message*** — a message sent in more than one block by the message transfer protocol.
- ***originator*** — the creator of a primary message.
- ***packet*** — a physical division of a message used by the message transfer protocol.
- ***primary message*** — an odd numbered message. Also, the first message of a transaction.
- ***reply*** — the particular secondary message corresponding to a primary message.
- ***secondary message*** — an even-numbered message. Also the second message of a transaction.
- ***single-block message*** — a message sent in one block by the message transfer protocol.
- ***stream*** — a category of messages.
- ***transaction*** — a primary message and its associated secondary message, if any.
- ***transaction timeout*** — an indication from the message transfer protocol that a transaction has not completed properly.

4 The Message Transfer Protocol

4.1 Messages — The message transfer protocol is used to send messages between equipment and host. The message transfer protocol must be capable of sending a primary message, indicating whether a reply is requested; and, if a reply is requested, it must be capable of associating the corresponding secondary message or reply message with the original primary message. The term originator will refer to the creator of the original primary message. The term interpreter will refer to the entity that interprets the primary message at its destination and generates a reply when requested.

4.2 Blocking Requirements — The message transfer protocol must support the following SECS-II message blocking requirements.

1) Single-Block Messages — SECS-II requires that certain messages be sent in a single block or single packet by the message transfer protocol. Those messages defined in this standard as single-block SECS-II messages must be sent in a single-block or packet. The method used by the application software to tell the message transfer protocol that a particular message must be sent as a single block is not covered as part of this standard. For compatibility with SECS-I, the maximum length allowed for a single-block SECS-II message is 244 bytes. The minimum requirement for the message transfer protocol is to be able to send single-block SECS-II messages.

2) Multi-Block Messages — For compatibility with SECS-I, SECS-II messages that are longer than 244 bytes are referred to as multi-block messages. Also, certain SECS-II messages are allowed to be multi-block messages even

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if they otherwise meet the single-block length requirements. Certain older implementations may impose application specific requirements on block sizes for certain incoming messages. Beginning with the 1988 revision of the standard, new applications may not impose application-specific requirements on incoming block sizes. Applications implemented before 1988 may impose such requirements.

4.3 Message Header — The message transfer protocol must provide the following information, called the message header, with every message. Only the content of the message header is defined by this standard. The exact format of the message header passed between the application and the message transfer protocol is not covered as part of this standard.

1) Device ID — The message transfer protocol must be capable of identifying the device ID (0–32767) which indicates the source or destination of a message.

2) Stream and Function — The message transfer protocol must be capable of identifying to SECS-II a minimum 15 bit message identification code. In SECS-II, messages are identified by a stream code (0–127, 7 bits) and a function code (0–255, 8 bits). Each combination of stream and function represents a distinct message identification.

3) Reply Requested — The message transfer protocol must be capable of identifying whether a reply is requested to a primary message.

4.4 Transaction Timeout — It is presumed that the message transfer protocol will notify SECS-II in the event of failure to receive an expected reply message within a specified transaction timeout period.

NOTE : In SECS-I, a transaction timeout occurs if either the reply timeout (T3) is exceeded before the first block of a reply message is received or if the inter-block timeout (T4) is exceeded before an expected block of a multi-block message is received.

4.5 Multiple Open Transactions — This standard allows, but does not require, the support of more than one concurrent open transaction.

5 Streams and Functions

5.1 *Streams* — A stream is a category of messages intended to support similar or related activities.

5.2 *Functions* — A function is a specific message for a specific activity within a stream. All the functions used in SECS-II will follow a numbering convention corresponding to primary and secondary message pairs. All primary messages will be given an odd-numbered function code. The reply message function code is determined by adding one to the primary message function code. The even-numbered function following a primary message which requests no reply is reserved and is not to be used. Function code 0 is reserved in all streams for aborting transactions as described in § 10.4.

5.3 Stream and Function Allocation — Some of the stream and function code combinations are reserved for this standard, while others are available for user definition. The stream and function codes reserved for this standard are as follows:

• In Stream 0, Functions 0–255.
• In Streams 1–63, Functions 0–63.
• In Streams 64–127, Function 0.

1) The stream and function codes available for user definition are as follows:

• In Streams 1–63, Functions 64–255.
• In Streams 64–127, Functions 1–255.

2) The stream and function code assignment can also be represented by the diagram shown in Figure 1.

3) The reserved codes assigned by this standard are listed in § 10. It is recognized that there will be user needs beyond the specific definitions given in this standard. In these situations, the streams and functions reserved for user definition should be used subject to the guidelines for minimum compliance outlined in § 8.

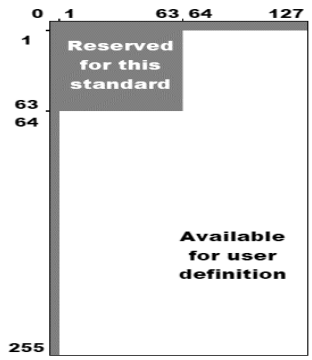

Figure 1
Stream and Function Allocation

6 Transaction and Conversation Protocols

6.1 Intent — For an implementation to be in compliance with SECS-II, it must meet the minimum transaction requirements outlined in this section. The conversation protocols serve to further define the use and interaction between transactions.

6.2 Transaction Definition — A transaction forms the basis for all information exchanges in SECS-II. A transaction consists of either a primary message for which no reply is requested, or a primary message which requests a reply together with its corresponding secondary message. Secondary messages cannot request a reply.

6.3 Transaction Level Requirements — The following are the requirements to comply with the SECS-II protocol at the transaction level:

1) Respond to S1F1 with S1F2 as described in § 10.5.

2) For any received message that cannot be processed by the equipment, send the appropriate error message on Stream 9. As described in § 10.13, S9F1, F3, F5, F7, or F11 are possible.

3) Format any other supported messages according to § 10.

4) Upon detection of a transaction timeout at the equipment, send S9F9 to the host.

5) Upon receipt of function 0 as a reply to a primary message, terminate the related transaction. No error message should be sent to the host by the equipment.

6.4 Conversation Protocols — A conversation is a series of one or more related transactions used to complete a specific task. A conversation should include all transactions necessary to accomplish the task and leave both the originator and interpreter free of resource commitments at its conclusion.

1) Conversation Timeout — A conversation timeout is used to indicate that a conversation has not completed properly. A conversation timeout is application-dependent, and the methods used for detecting conversation timeouts are not covered as part of this standard. A conversation timeout will terminate further action on the conversation, and will allow for the clearing of any committed resources. Upon detection of a conversation timeout at the equipment, S9F13 should be sent to the host.

2) Types of Conversations — There are seven types of conversations which characterize all information exchanges in SECS-II:

① A primary message with no reply is the simplest conversation. This message must be a single-block SECS-II message. The originator must assume that the interpreter responds to the message. This conversation is used where the originator can do nothing if the message is rejected.

② If the interpreter has data that the originator wants, the data are requested with a primary message and the data returned to the originator as a reply message. It is assumed that the originator requesting the data is prepared to receive the amount of data returned. This is the request/data conversation.

③ If the originator wishes to send data in a single-block SECS-II message to the interpreter, then the originator sends the data and expects an acknowledgment from the interpreter. This is the send/acknowledge conversation.

④ If the originator has a multi-block SECS-II message to send for a particular exchange, then the originator must receive permission from the interpreter prior to sending the data. The first transaction requests permission to send, and the interpreter either grants or denies permission. If permission is granted, the originator sends the data and the interpreter replies appropriately. This is the inquire/grant/send/acknowledge conversation. Between the inquire and the send, the interpreter may commit some resources in preparation for the data. Consequently, a conversation timeout may be set by the interpreter at a time dependent upon the application, at which time the interpreter will free its resources and send an S9,F13 error message to the originator. Note that under the definition of S9,F13 in this standard, only the equipment should generate an error message to the host under these conditions.

⑤ There is a conversation related to the transfer of unformatted data sets between equipment and host. This conversation is described in detail in Stream 13 (see § 10.17).

⑥ There is a conversation related to the handling of material between equipment. This conversation is described in detail in Stream 4 (see § 10.8).

⑦ The originator may request information from the interpreter which requires some time to obtain (e.g., operator input is required). The first transaction requests the information and the interpreter responds in one of three ways: ⓐ the information is returned, ⓑ the interpreter indicates that the information cannot or will not be obtained, or ⓒ the interpreter indicates that the information will be obtained and returned in a subsequent transaction, as specified for this conversation. For case ©, the interpreter will initiate the subsequent transaction when the information is available.

2.1) Case 3 is the request/acknowledge/send/acknowledge transaction.

2.2) The originator of the request/acknowledge/ send/acknowledge conversation may commit some resources in anticipation of the send/acknowledge transaction. Consequently, a conversation timeout may be set by the originator at a time dependent on the application. On timeout, the originator will free its resources and restart the conversation with the ‘request’, or send an S9,F13 error message. Note that under the definition of S9,F13 in this standard, only the equipment should generate an error message to the host under these conditions.

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7 Data Item Dictionary

Name	Format	Description	Values	Where used
ABS	10	Any binary string		S2F25,F26
ACCESSMODE	51	Load Port Access Mode Possible values are	0 = Manual 1 = Auto	S3F27
ACKC5	10	Acknowledge code, 1 byte	0 = Accepted >0 = Error, not accepted (1-63 Reserved)	S5F2,F4
ACKC6	10	Acknowledge code, 1 byte	0 = Accepted >0 = Error, not accepted (1-63 Reserved)	S6F10,F12
ALCD	10	Alarm code byte	bit 8 = 1 means alarm set bit 8 = 0 means alarm cleared bit 7-1 is alarm category 0 = Not used 1 = Personal safety 2 = Equipment safety 3 = Parameter control warning 4 = Parameter control error 5 = Irrecoverable error 6 = Equipment status warning 7 = Attention flags 8 = Data integrity >8 = Other categories (9-63 Reserved)	S5F1,F6
ALED	10	Alarm enable/disable code, 1 byte	bit 8 = 1 means enable alarm bit 8 = 0 means disable alarm	S5F3
ALID	3(), 5()	Alarm identification		S5F1, F3, F5, F6
ALTX	20	Alarm text limited to 40 characters		S5F1, F6
ATTRDATA	0, 10, 20, 3(), 4(), 5(), 11	Contains a specific attribute value for a specific object		S1F20; S3F17,F18; S13F14,F16;
CEID	20, 3(), 5()	Collected event ID		S6F11, F13
CEPACK	0, 51	Command Enhanced Parameter Acknowledge. If a specific value of CPNAME is defined to have a CEPVAL that is a LIST, then CEPACK shall have the same structure as the corresponding list format of CEPVAL as used in S2,F49. Otherwise CEPACK will be a 1 byte integer. Enumerated:	0 = No error 1 = Parameter name(CPNAME) does not exist 2 = Illegal value specified for CEPVAL 3 = Illegal format specified for CEPVAL 4 = Parameter name(CPNAME) not valid as used 5-63 Reserved	S2F50
CEPVAL	0, 10, 11, 20, 21, 3(), 4(), 5()	Command Enhanced Parameter Value. A specific application of CEPVAL shall always be identified with a specific value of CPNAME. A CEPVAL has the following forms: a single (non-list) value (e.g., CPVAL), a list of single items of identical format and type, or a list of items of the form.	L,2 1. CPNAME 2. CEPVAL	S2F49
CKPNT	54	Checkpoint as defined by the sending system		S13F3, F6
COMMACK	10	Establish Communications Acknowledge Code, 1 byte	0 = Accepted 1 = Denied, Try Again (2-63 Reserved)	S1F14
CPACK	10	Command Parameter Acknowledge Code, 1 byte	1 = Parameter Name(CPNAME) does not exist 2 = Illegal Value specified for CPVAL 3 = Illegal Format specified for CPVAL >3 = Other equipment-specific error 4-63 Reserved	S2F42
CPNAME	20, 3(), 5()	Command Parameter Name		S2F41,F42, F49,F50
CPVAL	10, 11, 20, 21, 3(), 5()	Command Parameter Value.		S2F41, F49

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Name	Format	Description	Values	Where used
DATAID	20, 3(), 5()	Data ID		S2F33, F49; S3F15,F17;
DVVAL	10, 11, 20, 21, 3(), 4(), 5()	Data value		S6F3, F8, F9
HCACK	10	Host Command Parameter Acknowledge Code, 1 byte	0 = Acknowledge, command has been performed 1 = Command does not exist 2 = Cannot perform now 3 = At least one parameter is invalid 4 = Acknowledge, command will be performed with completion signaled later by an event 5 = Rejected, Already in Desired Condition 6 = No such object exists 7-63 Reserved	S2F42, F50
MDLN	20	Equipment Model Type, 6 bytes max	Same data as returned by S1,F2	S1F2, F13, F14
OFLACK	10	Acknowledge code for OFF-LINE request	0 = OFF-LINE Acknowledge 1-63 Reserved	S1F16
ONLACK	10	Acknowledge code for ON-LINE request	0 = ON-LINE Accepted 1 = ON-LINE Not Allowed 2 = Equipment Already ON-LINE 3-63 Reserved	S1F18
RCMD	20, 31, 51	Remote command code or string		S2F41, F49
RPTID	20, 3(), 5()	Report ID		S2F33, F35; S6F11
SOFTREV	20	Software revision code 6 bytes maximum		S1F2, F13, F14
SV	10,11, 20,21, 3(), 4(), 5()	Status variable value		S1F4; S6F1
SVID	20, 3(), 5()	Status variable ID	Status variables may include any parameter that can be sampled in time such as temperature or quantity of a consumable.	S1F3, F11, F12; S2F23
SVNAME	20	Status Variable Name		S1F12
TEXT	10, 20, 22, 3(), 5()	A single line of characters		S10F1, F3, F5, F9
TIACK	10	Time Acknowledge Code, 1 byte	0 = OK 1 = Error, not done (2-63 Reserved)	S2F32
TID	10	Terminal number, 1 byte	0 = Single or main terminal >0 = Additional terminals at the same equipment	S10F1, F3, F5,F7
TIME	20	Time of day, 12 or 16 bytes	If 12 bytes the format is YYMMDDhhmmss If 16 bytes the format is YYYYMMDDhhmmsscc	S2F18, F31
TIMESTAMP	20	A text string indicating the time of an event, which encodes time in the following format:	YYYYMMDDhhmmsscc	S5F9, F11, F15; S15F41, F44; S16F5
V	10, 11, 20,21, 3(), 4(), 5()	Variable data		S6F11, F13, F16, F20, F22
VID	20, 3(), 5()	Variable ID		S2F33, F45, F46, F47, F48; S6F13, F18, F22; S17F1

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8 Variable Item Dictionary

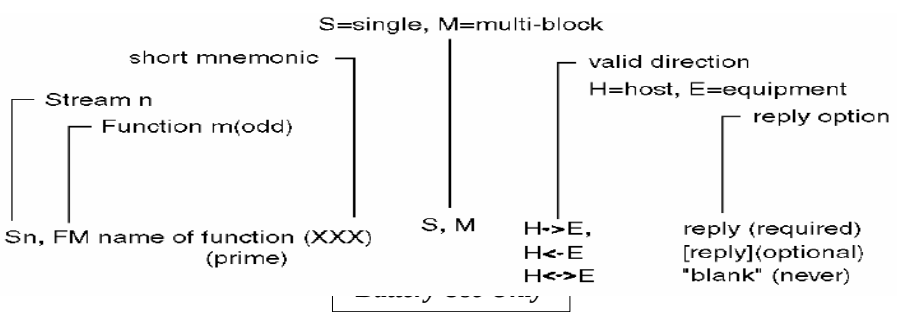
— This section defines variable data items which are available to the Host for data collection purposes.
Name: A unique mnemonic name for this variable data item. This name is provided for reference only.
Class: The data type classification (SV, ECV, or DVVAL) of the item. Status values (SVs) always contain valid information, while data values (DVVALs) may only be valid upon the occurrence of a particular event. All equipment constants (ECVs) are settable by the Host.
Format: The allowable item format codes which can be used for this variable data item, as in Data Item Dictionary
Description: A description of the variable data item, with the meanings of specific values. Also, specify validity for item of class DVVAL.

Table 4 Variable Item Dictionary

Name	Format	Description	Values	Class
AlarmID	3(),5()	This variable is valid only upon the setting or clearing of an alarm condition and contains the current alarm identification (ALID), regardless of whether that alarm is enabled for reporting		DVVAL
AlarmsEnabled	0	Contains the list of alarms (ALIDs) enabled for reporting (via Stream 5)	$L_{,n}$ n = # of alarms enabled 1.<$ALID_1$> … n.<$ALID_n$>	SV
AlarmsSet	0	Contents of this variable is a list of alarms (ALIDs) currently in the UNSAFE (alarm set) state, regardless of whether the alarms are enabled for reporting	$L_{,n}$ n = # of alarms enabled 1.<$ALID_1$> … n.<$ALID_n$>	SV
CLOCK	20	The value of the equipment's internal clock. This is a format requirement only and does not imply precision or accuracy	Format: YYYYMMDDhhmmsscc	SV
ControlState	10, 51	This status variable contains the code which identifies the current control state of the equipment. When reported related to a control state transition, its value should represent the state current after the transition.	1 = OFF-LINE / EQUIPMENT OFFLINE 2 = OFF-LINE / ATTEMPT ON-LINE 3 = OFF-LINE / HOST OFF-LINE 4 = ON-LINE / LOCAL 5 = ON-LINE / REMOTE 6-63 Reserved	SV
EqpName		Text string containing a user-assigned name for equipment. 1–80 characters. Information in the data item EQNAME is a subset of EqpName.		ECV
EstablishCommunications- Timeout	52	The length of time, in seconds, of the interval between attempts to send S1F13 when establishing Communications		ECV
EventsEnabled	0	Contains the list of events (CEIDs) enabled for reporting (via Stream 6)	$L_{,n}$ n = # of events enabled 1.<$CEID_1$> …. n.<$CEID_n$>	SV

9 Message Detail

9.1 Intent — This section defines a number of specific functions in different streams which can be used as a basis for communication between host and equipment. The functions are defined in the form of transaction message pairs according to the transaction level requirements specified in § 8.
9.2 The functions are described in a standard form which involves specification of the number, name, single or multiple block, direction of communication, nature of reply required, description, variable definition, and the detailed structure of the message in terms of lists and items. Double lines separate streams, and single lines separate transactions to aid readability.
1) The abbreviations used in each transaction are as follows:



9.3 Stream 1 Equipment Status

1) Function 0 exists in all streams and has the same special meaning in each stream. A function 0 message closes a transaction, so that the originator will not have to wait for a transaction timeout to proceed. Function 0 is sent in lieu of the expected secondary message when the interpreter cannot, because of a transmission error or some other reason, respond with the expected [Reply]. It is not a requirement that the interpreter send function 0 to close a transaction.

2) Stream 1 Equipment Status — This stream provides a means for exchanging information about the status of the equipment, including its current mode, depletion of various consumable items, and the status of transfer operations.

Messages	Name	Direction	Description
SxF0	Abort Transaction	H◁▶E	Used in lieu of an expected [Reply] to abort a transaction. Function 0 is defined in every stream and has the same meaning in every stream.
S1F1	Are You There Request (R)	H◁▶E, reply	Establishes if the equipment is on-line. A function 0 response to this message means the communication is inoperative. In the equipment, a function 0 is equivalent to a timeout on the receive timer after issuing S1,F1 to the host.
S1F2	On Line Data (D)	H◁▶E	Data signifying that the equipment is alive. L,2 1.<A[64] MDLN> //Model number of the equipment 2.<A[64] SOFTREV> //Software Revision
S1F3	***Selected Equipment Status Request (SSR)***	H▶E, reply	A request to the equipment to report selected values of its status. L,n 1. <$SVID_1$> ... n. <$SVID_n$>
S1F4	Selected Equipment Status Data (SSD)	H◁ E	The equipment reports the value of each SVID requested in the order requested. The host remembers the names of values requested. L,n 1. <SV_1> ... n. <SV_n>
S1F13	***Establish Communications Request (CR)***	H◁▶E, reply	The purpose of this message is to provide a formal means of initializing communications at a logical application level both on power-up and following a break in communications. It should be the following any period where host and Equipment SECS applications are unable to communicate. An attempt to send an Establish Communications Request (S1,F13) should be repeated at programmable intervals until an Establish Communications Acknowledge(S1,F14) is received within the transaction timeout period with an acknowledgement code accepting the establishment. L,2 1. <MDLN> 2. <SOFTREV>
S1F14	Establish Communications Request Acknowledge (CRA)	H◁▶E	Accept or deny Establish Communications Request (S1,F13). MDLN and SOFTREV are on-line data and are valid only if COMMACK = 0. L,2 1. <COMMACK> 2. L,2 1. <A[64] MDLN> //Model number of the equipment 2. <A[64] SOFTREV> //Software Revision
S1F15	***Request OFF-LINE (ROFL)***	H▶E, reply	The host requests that the equipment transition to the OFF-LINE state.
S1F16	OFF-LINE Acknowledge (OFLA)	H◁ E	Acknowledge or error <OFLACK>
S1F17	***Request ON-LINE (RONL)***	H▶E, reply	The host requests that the equipment transition to the ON-LINE state
S1F18	ON-LINE Acknowledge (ONLA)	H◁E	Acknowledge or error <ONLACK>

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3) Selected Equipment Status Request/Data Example (S1F3 SSR, S1F4 SSD)

Messages	Name	Direction	Description
S1F3	***Selected Equipment Status Request (SSR)***	H▶E	<L 4 <U2 [1] 1> //VID = 1, ControlState <U2 [1] 2> //VID = 2, TSCState <U2 [1] 3> //VID = 3, ActiveUnits <U2 [1] 4> //VID = 4, ActiveAlarms >

Messages	Name	Direction	Description
S1F4	***Selected Equipment Status Data (SSD)***	H◁E	<L,**4** <U2[1] /* ControlState */> <U2[1] /* TSCState */> <L,n /* ActiveUnits */ <L,3 <A[64] /* UnitID */> <U2[1] /* UnitState */> <U2[1] /* UnitStatus */> > > <L,n /* ActiveAlarms */ <L,3 <U4[1] /* AlarmID */> <A[64] /* UnitID */> <A[200] /* AlarmText */> > > >

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9.4 Stream 2 Equipment Control and Diagnostics

Messages which deal with control of the equipment from the host. This includes all remote operations and equipment self-diagnostics and calibration but specifically excludes the control operations which are associated with material transfer (see Stream 4), loading of executive and boot programs (Stream 8), and all file and operating system calls (Streams 10, 13). See also continuations in Stream 17.

Messages	Name	Direction	Description
S2F31	***Date and Time Set Request (DTS)***	H▶E, reply	Useful to synchronize the equipment time with host time base.
S2F32	Date and Time Set Acknowledge (DTA)	H◁E	Acknowledge the receipt of time and date.
S2F41	***Host Command Send (HCS)***	H▶E, reply	The Host requests the Equipment perform the specified remote command with the associated parameters. L,2 1. <RCMD> 2. L,n # of parameters 1. L,2 1. <CPNAME$_1$> parameter 1 name 2. <CPVAL$_1$> parameter 1 value ... n. L,2 1. <CPNAME$_n$> parameter n name 2. <CPVAL$_n$> parameter n value
S2F42	Host Command Acknowledge (HCA)	H◁ E	Acknowledge Host command or error. If command is not accepted due to one or more invalid parameters (i.e., HCACK = 3), then a list of invalid parameters will be returned containing the parameter name and reason for being invalid. L,2 1. <HCACK> 2. L,n # of parameters 1. L,2 1. <CPNAME$_1$> parameter 1 name 2. <CPACK$_1$> parameter 1 value ... n. L,2 1. <CPNAME$_n$> parameter n name 2. <CPACK$_n$> parameter n value
S2F49	***Enhanced Remote Command***	H▶E	The host requests an object to perform the specified remote command with its associated parameters. If multi-block, it shall be preceded by the S2,F39/S2,F40 Multi-Block Inquire/Grant transaction. L,4 1. <DATAID> 2. <OBJSPEC> 3. <RCMD> 4. L,m # of parameter groups 1. L,2 1. <CPNAME$_1$> command parameter 1 name 2. <CEPVAL$_1$> command-enhanced parameter 1 value 2. L,2 1. <CPNAME$_2$> command parameter 2 name 2. <CEPVAL$_2$> command-enhanced parameter 2 value …. m. L,2 1. <CPNAME$_m$> command parameter m name 2. <CEPVAL$_m$> command enhanced parameter m value
S2F50	Enhanced Remote Command Acknowledge	H◁E	The equipment acknowledges Enhanced Remote Command or reports any error(s). If the command is not accepted due to one or more invalid parameters, (i.e. HCACK = 3), then a list of invalid parameters will be returned containing the parameter name and reason for being invalid. L,2 1. <HCACK> 2. L,n # of parameter groups 1. L,2 1. <CPNAME$_1$> 2. <CEPACK$_1$> …. n. L,2 1. <CPNAME$_n$> 2. <CEPACK$_n$>

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1) Remote Command Example (S2F41)

Messages	Name	Direction	Description
S2F41	***Host Command Send (HCS)*** **** PAUSE or RESUME***	H▶E, [Reply]	<L,2 <A[64] RCMD> *PAUSE/RESUME <L0
S2F41	***Host Command Send (HCS)*** **** STACK, REPLACE, BYPASS, FORCEOUT or SPLIT***	H▶E, [Reply]	<L,2 <A[64] RCMD> //* 'STACK/REPLACE/BYPASS/FORCEOUT/SPLIT' <L,2 <L,2 <A[64] CPNAME> //'CARRIERID' <A[64] CPVAL> //CarrierID (ex. HP12345) <L,2 <A[64] CPNAME> //'CARRIERLOC' <A[64] CPVAL> //Carrier Current Loc.(ex. 10101)
S2F41	***Host Command Send (HCS)*** **** OPCALL***	H▶E, [Reply]	<L,2 <A[64] RCMD> /'/OPCALL' <L,3 <L,2 <A[64] CPNAME> //'CARRIERID' <A[64] CPVAL> //CarrierID <L,2 <A[64] CPNAME> //'MESSAGE' <A[64] CPVAL> //op call message <L,2 <A[64] CPNAME> //'CODE' <A[64] CPVAL> //ErrorCode # Error code 0 : only information 1 : MES dest error 2 : Route error
S2F41	***Host Command Send (HCS)*** **** UNITSTOP, UNITRESET, or BCRRETRY***	H▶E, [Reply]	<L,2 <A[64] RCMD> //'UNITSTOP, UNITRESET or BCRRETRY' <L,1 <L,2 <A[64] CPNAME> //'UNITID' <A[64] CPVAL>/unit id

Battery Use Only

2) Remote Command Example (S2F49, TRANSFER command)

Messages	Name	Direction	Description
S2F49	***Enhanced Remote Command***	H▶E	<L 4 <U2 [1] DATAID '0'> <A [0] OBJSPEC ''> <A [8] RCMD 'TRANSFER'> <L 2 <L 2 <A [11] 'COMMANDINFO'> <L 2 <L 2 <A [9] 'COMMANDID'> <'H_YD00338_09081640291943'> > <L 2 <A [8] 'PRIORITY'> <U2 [1] 50> > > <L 2 <A [12] 'TRANSFERINFO'> <L 3 <L n <A [9] 'CARRIERID'> <'YD00338'>(1단 캐리어 ID) > <L 2 <A [6] 'SOURCE'> <'05017'> > <L 2 <A [4] 'DEST'> <'05021,05201,05206'> //source, stopover,dest > > > > >

Messages	Name	Direction	Description
S2F50	Enhanced Remote Command Acknowledge (ERCA)	H◁E	1) No Error <L,2 <B[1] HCACK> // '0x00' or '0x04' <L0
			The equipment acknowledges Enhanced Remote Command or reports any error(s). If the command is not accepted due to one or more invalid parameters, (i.e. HCACK = 3), then a list of invalid parameters will be returned containing the parameter name and reason for being invalid. L,2 1. <HCACK> 2. L,n # of parameter groups 1. L,2 1. <$CPNAME_1$> 2. <$CEPACK_1$>

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* Remote Commands

1 The purpose of this section is to identify remote commands, command parameters, and valid commands versus states pertinent to the SEM.

2 Requirements

• The equipment shall support the SEMI E30 (according to the GEM capabilities) required remote commands.
• All the remote commands defined by Conveyor SEM are required to be implemented as specified.
• The alphanumeric strings defined by Conveyor SEM for RCMD and CPNAME are required.
• A completed table must be generated where an "X" is placed in the table for each state that a given command is valid.
• If additional remote commands are supported then a "remote commands versus valid states" matrix must be generated for these additional commands.
• For additional commands, a table must be generated similar to the remote command descriptions summary.

3 Remote Commands Description

1) ***STACK*** — This command is used to stack carriers at the M/G(Magazine) unit.
2) ***REPLACE*** — This command is used to replace carriers at the M/G unit (The old carrier lifted up in the air drops down first, and the newly arrived carrier to be lifted later).
3) ***BYPASS*** — This command is used to bypass the carrier at the M/G unit (The old carrier lifted up in the air will be still remained).
4) ***SPLIT*** — This command is used to separate the multiple-stacked carriers at the D/P(Dispenser) unit.
5) ***FORCEOUT*** — This command is used to forcefully drop the lifted-up carriers down at the D/P unit. It might be the newly arrived carrier's LOT is differ from the lifted one, or pre-defined time-out occurs. Or operators manually let the carrier to move.
6) ***PAUSE*** — This command puts the TSC in the PAUSING state.
7) ***RESUME*** — This command puts the TSC in the AUTO state.
8) ***OPCALL*** — This command is used to call operator to handle some anomaly conditions like information mismatch, host destination wrong, or route error.
9) ***UNITSTOP*** — This command puts the specific UNIT of CIM (TSC) to be OUT OF SERVICE state.
10) ***UNITRESET*** — This command puts the OUT OF SERVICE UNIT of CIM (TSC) to be IN-SERVICE state.
11) ***BCRRETRY*** — This command is used to retry BCR reading for unknown carrier.
12) ***TRANSFER*** — This is a SECS-II Enhanced Remote Command instead of a SECS-II Host Command Send (S2,F49 instead of S2,F41). See the examples in § 15.1 for details.

This command is used to perform the entire transfer command for the carrier to be transferred between conveyor locations. The execution of this command will include allocation of resources, acquiring the carrier, moving the carrier to the destination, queuing the carrier at an alternate destination (if needed), depositing the carrier, and returning the resources for other use. The number of carriers in the TRANSFER command is always equal to one (i.e., the size of the transfer unit is always equal to one carrier).

RCMD	Stream Function	CPNAME	
PAUSE	S2F41	None	Once received by the TSC, the TSC will queue any TRANSFER commands until the TSC receives and successfully executes the RESUME command. Once in the AUTO state the TSC will process the TRANSFER commands in its queue
RESUME	S2F41	None	Returns the PAUSE TSC to the AUTO state.
STACK	S2F41	"CARRIERID" "CARRIERLOC"	Stack carriers at the M/G unit.
REPLACE	S2F41	"CARRIERID" "CARRIERLOC"	Replace carriers at the M/G unit.
BYPASS	S2F41	"CARRIERID" "CARRIERLOC"	Bypass a carrier at the M/G unit.
SPLIT	S2F41	"CARRIERID" "CARRIERLOC"	Split the stacked carriers at the D/P unit.
FORCEOUT	S2F41	"CARRIERID" "CARRIERLOC"	The lifted-up carrier forcefully drop down at the D/P unit.

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RCMD	Stream Function	CPNAME	
OPCALL	S2F41	"CARRIERID" "MESSAGE" "CODE"	Call operators to solve some anomaly conditions
UNITSTOP	S2F41	"UNITID"	Change a specific UNIT of CIM to be OUT-OF-SERVICE.
UNITRESET	S2F41	"UNITID"	Change the OUT-OF-SERVICE'd UNIT to be IN SERVICE.
BCRRETRY	S2F41	"UNITID"	Remote command for barcode reading again.
TRANSFER	S2F49	"COMMANDID" "CARRIERINFO"	

Remote Command Parameters

CPNAME	Description	Range	Format
CARRIERID	Unique ID of the carrier.		A[1-64]
CARRIERLOC	Unique carrier location within the conveyor.		A[1-64]
COMMANDID	Unique command identifier created by the Host.		A[1-64]
MESSAGE	Message for op call		A[1-64]
CODE	Error code about op call		A[1-64]
UNITID	CIM unit id		A[1-64]
COMMANDINFO	L,2 COMMANDID PRIORITY		L,2
PRIORITY	Remote command priority.	0 is not valid. 1 is the LOWEST priority, 99 is the highest priority.	U2
SOURCE	Unique source location identifier.		A[1-64]
DEST	Destination location identifier.	Must be a valid ZoneName. Must be a loading port for a move to an output shuttle (DEST = LP).	A[1-64]
TRANSFERINFO	L,3 CARRIERID SOURCE DEST	SOURCE may intentionally be left blank by the Host. If this is true, the conveyor must determine the carrier's current location by checking its database for the specified CARRIERID.	L,3

Battery Use Only

9.5 Stream 5 Exception Handling

This stream contains messages regarding binary and analog equipment exceptions. Exceptions are classified into two categories: errors and alarms. Messages S5,F1 through S5,F8 of this section provide basic alarm messages. The messages S5,F9 through S5,F18 provide extended capabilities for Exception Handling. When using messages F1–F8, alarms may be divided into categories as follows:

1. personal safety — Condition may be dangerous to people.
2. equipment safety — Condition may harm equipment.
3. parameter control warning — Parameter variation outside of preset limits — may harm product.
4. parameter control error — Parameter variation outside of reasonable control limits — may indicate an equipment malfunction.
5. irrecoverable error — Intervention required before normal use of equipment can resume.
6. equipment status warning — An unexpected condition has occurred, but operation can continue.
7. attention flags — A signal from a process program indicating that a particular step has been reached.
8. data integrity — A condition which may cause loss of data; usually related to Stream 6.

For messages F1—F8, it will be the equipment's responsibility to categorize the alarm. Some alarm conditions may cause more than one type of alarm to be issued. For example, a parameter control error on over temperature may also trip a protective device that makes the alarm irrecoverable without some intervention.

Messages	Name	Direction	Description
S5F1	Alarm Report Send (ARS)	H◁E, [Reply]	This message reports a change in or presence of an alarm condition. One message will be issued when the alarm is set and one message will be issued when the alarm is cleared. Irrecoverable errors and attention flags may not have a corresponding clear message. L,3 1. <ALCD> 2. <ALID> 3. <ALTX>
S5F2	Alarm Report Acknowledge (ARA)	H▶E	Acknowledge or error
S5F3	Enable/Disable Alarm Send (EAS)	H ▶ E, [Reply]	This message will change the state of the enable bit in the equipment. The enable bit determines if the alarm will be sent to the host. Alarms which are not controllable in this way are unaffected by this message. L,2 1. <ALED> 2. <ALID>
S5F4	Enable/Disable Alarm Acknowledge (EAA)	H◁E	Acknowledge or error <ACKC5>
S5F5	List Alarms Request (LAR)	H▶E, reply	This message requests the equipment to send binary and analog alarm information to the host. <$ALID_1$, . . . ,$ALID_n$>
S5F6	List Alarm Data (LAD)	H◁E	This message contains the alarm data known to the equipment. There are "m" alarms in the list. <L,m < L,3 // m=1 <B[1] $ALCD_1$> <U2 $ALID_1$> <A[64] $ALTX_1$> <L,3 // m=2 …. <L,3 <B[1] $ALCD_m$> <U2 $ALID_m$> <A[64] $ALTX_m$>

Battery Use Only

9.6 Stream 6 Data Collection

This stream is intended to cover the needs of in-process measurements and equipment monitoring.

Messages	Name	Direction	Description
S6F11	Event Report Send (ERS)	H◁E, reply	The purpose of this message is for the equipment to send a defined, linked, and enabled group of reports to the host upon the occurrence of an event (CEID). If S6,F11 is Multi-block, it must be preceded by the S6,F5/S6,F6 Inquire/Grant transaction. L,3 1. <DATAID> 2. <CEID> 3. L,a 1. L,2 1. <RPTID$_1$> 2. L,b 1. <V$_1$> …. b. <V$_b$> …. a. L,2 report a 1. <RPTID$_a$> 2. L,c #Vs this report 1. <V$_1$> …. c. <V$_c$>
S6F12	Event Report Acknowledge (ERA)	H▶E	Acknowledge or error <ACKC6>

CEID	Event Name	RPTID
1	**Equipment OFF-LINE** <L,3 <U2[1] DATAID> <U2[1] CEID> //CEID = 1(OFFLINE) < L,1 <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
2	**ControlState LOCAL** <L,3 <U2[1] DATAID> <U2[1] CEID> //CEID = 2(LOCAL) < L,1 <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
3	**ControlState REMOTE** <L,3 <U2[1] DATAID> <U2[1] CEID> //CEID = 3(REMOTE) < L,1 <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
4	**TSCAutoInitiated** <L,3 <U2[1] DATAID> <U2[1] CEID> //CEID = 4(Auto Initiated), 5(Auto Completed), 6(Pause Initiated), 7(Pause Completed), or 8(Paused) < L,1 <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
5	**TSCAutoCompleted** <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
6	**TSCPauseInitiated** <L,2 <U2[1] RPTID> //RPTID = 1 <L,0	1
7	**TSCPauseCompleted**	1
8	**TSCPaused**	1

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CEID	Event Name	RPTID
11	**UnitStateChanged** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 11 <L,2 <A[64] UnitID> //PortID, TrackID [VID 23] <U2[1] UnitState> //1=InService, 2=OutOfService [VID 25]	11
12	**UnitStatusChanged** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 12 <L,2 <A[64] UnitID> //PortID, TrackID [VID 23] <U2[1] UnitStatus> //1=Empty, 2=Occupied [VID 26]	12
13, 14	**UnitAlarmSet(CEID=13), UnitAlarmCleared (CEID=14)** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 13 <L,3 <U4[1] AlarmID> <A[64] UnitID> <A[200] AlarmText>	13
~~21, 23, 24, 25, 26, 27, 28, 29, 30~~	~~**TransferInitiated(CEID=21), TransferPaused(23), TransferResumed(24), TransferAbortInitiated(25), TransferAbortCompleted(26), TransferAbortFailed(27), TransferCancelInitiated(28), TransferCancelCompleted(29), TransferCancelFailed(30)**~~ ~~<L,3~~ ~~<U2 [1] DATAID>~~ ~~<U2 [1] CEID>~~ ~~< L,1~~ ~~<L,2~~ ~~<U2 RPTID> //RPTID = 21~~ ~~<L,4~~ ~~<A[64] CommandID>~~ ~~<A[64] CarrierID>~~ ~~<A[64] CarrierLoc>~~ ~~<A[64] Dest>~~	~~21~~
~~22~~	~~**TransferCompleted (CEID=22)**~~ ~~<L,3~~ ~~<U2 [1] DATAID>~~ ~~<U2 [1] CEID>~~ ~~< L,1~~ ~~<L,2~~ ~~<U2 RPTID> //RPTID = 22~~ ~~<L,4~~ ~~<A[64] CommandID>~~ ~~<A[64] CarrierID>~~ ~~<A[64] CarrierLoc>~~ ~~<U2 [1] ResultCode>~~	~~22~~
31	**CarrierIDRead (CEID=31)** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 31 <L,4 <A[64] CarrierID> // Parent Carrier ID <A[64] CarrierLoc> //[VID 23] <U2 [1] IDReadStatus> //[VID 28] <L,n <A[64] ChildCarrierID>	31

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CEID	Event Name	RPTID
32, 33, 34	**CarrierWaitIn(CEID=32), CarrierTransferring(33), CarrierMoveFailed(34)** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 32 <L,2 <A[64] CarrierID> <A[64] CarrierLoc>	32
41,42,43, 51,52,53	**CarrierStackWait(CEID=41), CarrierStacked(42), CarrierStackOut(43), CarrierSplitWait(51), CarrierSplit(52), CarrierSplitOut(53)** <L,3 <U2 [1] DATAID> <U2 [1] CEID> < L,1 <L,2 <U2 RPTID> //RPTID = 41 <L,3 <A[64] CarrierID> <A[64] CarrierLoc> //PortID, TrackID, M/G UnitID, D/P UnitID [VID 23] <L,n //Child Carrier ID List <A[64] ChildCarrierID>	41

Battery Use Only

9.7 Stream 9 System Errors

This stream provides a method of informing the host that a message block has been received which cannot be handled or that a timeout on a transaction (receive) timer has occurred. The messages indicate either a Message Fault or a Communications Fault has occurred but do not indicate a Communications Failure has occurred.

1) Communications Failure — A Communications Failure occurs in a SECS-I environment when, and only when, the RTY limit is exceeded.

NOTE : In the event of a Communications Failure, no Stream 9 message is sent.

2) Communications Fault — A Communications Fault occurs when the equipment does not receive an expected message (when a transaction timer or a conversation timer has expired).

3) Message Fault — A Message Fault occurs when the equipment receives a message which it cannot process because of a fault that arises from the content, context, or length of the message.

Messages	Name	Direction	Description
S9F1	Unrecognized Device ID (UDN)	H◁E	The device ID in the message block header did not correspond to any known device ID in the node detecting the error. <MHEAD>
S9F3	Unrecognized Stream Type (USN)	H◁E	The equipment does not recognize the stream type in the message block header. <MHEAD>
S9F5	Unrecognized Function Type (UFN)	H◁E	This message indicates that the function in the message ID is not recognized by the receiver. <MHEAD>
S9F7	Illegal Data (IDN)	H◁E	This message indicates that the stream and function were recognized, but the message format was incorrect. This message may be used to indicate that a message received by the equipment did not conform to § 10.3.1.3 “Compliance to Message Definitions” or that data within the received message was not an allowed data type. If the Message Definition allows for multiple formats for items or for multiple data types, this message may be used to indicate that the equipment does not support a format or type that was used in the instance of the message. Equipment suppliers are encouraged to document which data formats and data types are supported when multiple formats or types are allowed for items within a message. Similarly, if the message for a custom stream and function is not formatted according to the rules in § 10.3.1.3 for the Message Definition provided by the equipment supplier, this message may be used to indicate the message format was incorrect.
S9F9	Transaction Timer Timeout (TTN)	H◁E	This message indicates that a transaction (receive) timer has timed out and that the corresponding transaction has been aborted. It is up to the host to respond to this error in an appropriate manner to keep the system operational.
S9F11	Data Too Long (DLN)	H◁E	This message to the host indicates that the equipment has been sent more data than it can handle.
S9F13	Conversation Timeout (CTN)	H◁E	Data were expected but none were received within a reasonable length of time. Resources have been cleared. L,2 1. <MEXP> 2. <EDID>

9.8 Stream 10 Terminal Services

The functions of this stream is to pass textual messages between operator terminals attached to processing and/or testing equipment and the host. The equipment makes no attempt to interpret the text of the message, but merely passes it from terminal keyboard to the host or from the host to the display of the terminal. Management of human response times to information displayed on terminals is the responsibility of the host.

Messages	Name	Direction	Description
S10F3	Terminal Display, Single (VTN)	H▶E, [Reply]	Data to be displayed. L,2 1. <TID> 2. <TEXT>
S10F4	Terminal Display, Single Acknowledge (VTA)	H◁E	Acknowledge or error <ACKC10>

Battery Use Only

9.9 CEID : Control State Transition Event (GEM spec.)

CEID	Event Name	Transition	
		Current State	New State
1	*Equipment OFF-LINE*	LOCAL or REMOTE	OFFLINE
2	*ControlState LOCAL*	OFFLINE or REMOTE	LOCAL
3	*ControlState REMOTE*	LOCAL	REMOTE

9.10 CEID : TSC State Transition Event (Stocker SEM spec.)

CEID	Event Name	Transition	
		Current State	New State
4	*TSCAutoInitiated*	(None)	TSC INIT
5	*TSCAutoCompleted*	PAUSED or PAUSING	AUTO
6	*TSCPauseInitiated*	AUTO	PAUSING
7	*TSCPauseCompleted*	PAUSING	PAUSED
8	*TSCPaused*	TSC INIT	PAUSED
11	*UnitStateChanged (InService / OutOfService)*	(None)	(None)
12	*UnitStatusChanged (Empty / Full)*	(None)	(None)
13	*UnitAlarmSet*	NO ALARM	ALARMS
14	*UnitAlarmCleared*	ALARMS	NO ALARM

9.11 CEID : TRANSFER Command Transaction Event (Stocker SEM spec.)

CEID	Event Name	Transition	
		Current State	New State
21	***TransferInitiated***	QUEUED	TRANSFERRING
22	***TransferCompleted***	ACTIVE	(None)
23	***TransferPaused***	TRANSFERRING	PAUSED
24	***TransferResumed***	PAUSED	TRANSFERRING
25	***TransferAbortInitiated***	ACTIVE	ABORTING
26	***TransferAbortCompleted***	ABORTING	(None)
27	***TransferAbortFailed***	ABORTING	ACTIVE
28	***TransferCancelInitiated***	QUEUED	CANCELING
29	***TransferCancelCompleted***	CANCELING	(None)
30	***TransferCancelFailed***	CANCELING	QUEUED

Battery Use Only

9.12 CEID : Carrier State Transition Event (Stocker SEM spec.)

CEID	Event Name	Transition	
		Current State	New State
31	*CarrierIDRead*	(Non-Transition Event)	
32	*CarrierWaitIn*	(None)	WAIT IN
33	*CarrierTransferring*	WAIT IN	TRANSFERRING
34	*CarrierMoveFailed*	TRANSFERRING	(None)

9.13 CEID : Carrier Stack/Split State Transition Event

CEID	Event Name	Transition	
		Current State	New State
41	*CarrierStackWait*	TRANSFERRING	STACK WAIT
42	*CarrierStacked*	STACK WAIT	STACKED
43	*CarrierStackOut*	STACKED or STACK WAIT	STACK OUT
51	*CarrierSplitWait*	TRANSFERRING	SPLIT WAIT
52	*CarrrierSplit*	SPLIT WAIT	SPLIT
53	*CarrierSplitOut*	SPLIT or SPLIT WAIT	SPLIT OUT

Battery Use Only

10. Variable Data Items

10.1 The purpose of this section is to define the list of variable data item requirements for StockerSEM equipment. Values of these variables will be available to the host via collection event reports and host status queries.

10.2 Requirements

- All variable data items and data item restrictions defined in SEMI E30 are required on Stocker SEM equipment (according to the GEM capabilities required per § 13).
- All variable data items in the Stocker SEM Variable Data Item Dictionary for specific equipment classifications are required for Stocker SEM equipment. The data item restrictions are also required.
- Some SVs in the Variable Data Item Dictionary are referenced by an "i" subscript (e.g., $CarrierID_i$). The "i" subscript denotes a specific instance of the SV. This is necessary since there is usually more than one instance of such an SV active in the system at the same time (e.g., if there are 20 carriers active at the same time then "i" could range from 1–20 for $CarrierID_i$). Variable Data Items containing the "i" subscript should not have Variable IDs assigned to them.
- All variable data items with a format of ASCII (A) shall be limited to printable characters in the decimal range of 32–126, with the exception of the following non-permitted characters: "*" (decimal 42), "\"(decimal 92).

Variable data items are documented in the Stocker SEM Variable Data Item Dictionary using the following format:

① **Variable Name**: A unique name for the variable data item.
② **Type**: CV – meaning common variables, variables that are general to all vehicles.
CSV – meaning configuration specific variables.
③ **Description**: If class is DVVAL, then the description shall contain a statement of when data is valid in terms of Stocker SEM events.
④ **Class**: The data type of the item.
⑤ **Format**: <SECS Message Language (SML) mnemonic>acceptable formats are SEMI E5 lists, ASCII, floating point, unsigned integer or signed integer. A description of "ANY", indicates that only the above formats are acceptable and is left to the supplier to decide.

10.3 Variable Data Item Types

1) ***Equipment Constants (ECV)*** — The value can be changed by the host using S2F15. The operator may have the ability to change some or all of the values. The value of an equipment constant may be queried at any time by the host using the S2F13/14 transaction or Stream 6 reports.
2) ***Status Variables (SV)*** — The values are valid at all times. A SV may not be changed by the host or operator, but may be changed by the equipment. A host or operator command may change an equipment status thus changing a SV. The value of status variables may be queried by the host at any time using the S1F3/4 or Stream 6 reports.
3) ***Data Variables (DVVAL)*** — These are variables which are valid upon the occurrence of a specific collection event, and may or may not be valid at other times depending upon the equipment. An attempt to read a variable data item when it's invalid will not result in an error, but the data reported may not have relevant meaning.
4) ***Variable Data (V)*** — This is a class of variable data which includes all the previously defined types of variables.

10.4 Variable Data Item Dictionary

VID	Variable Name	Class	Format	Values	Comments
1	ControlState	SV DVVAL	U2	1 = EQUIPMENT OFFLINE 2 = ATTEMPT ON-LINE 3 = HOST OFF-LINE 4 = ON-LINE LOCAL 5 = ON-LINE REMOTE	This status variable contains the code which identifies the current control state of the equipment. When reported related to a control state transition, its value should represent the state current after the transition.
2	TSCState	SV	U2	1 = TSC INIT 2 = PAUSED 3 = AUTO 4 = PAUSING	TSC State(SYSTEM)

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VID	Variable Name	Class	Format	Values	Comments
3	ActiveUnits	SV	Ln 1.<UnitInfo$_1$> … n.<UnitInfo$_n$>		List current status of all unit information in the TSC database.
4	ActiveAlarms	SV	Ln 1.<AlarmInfo$_1$> … n.<AlarmInfo$_n$>		List current status of all alarm information in the TSC.
11	UnitInfo	SV DVVAL	L3 1.<A[64] UnitID> 2.<U2 UnitState> 3.<U2 UnitStatus>		
12	AlarmInfo	SV DVVAL	L3 1.<U4 AlarmID> 2.<A[64] UnitID> 3.<A[128] AlarmText>		
~~13~~	~~CommandInfo~~	~~SV DVVAL~~	~~L2 1.<A[64] CommandID> 2.<U2 Priority>~~	~~Priority 1 ~ 99 0 is not valid. 1 is the LOWEST priority, 99 is the highest priority~~	~~Remote command priority~~
~~14~~	~~TransferInfo~~	~~SV DVVAL~~	~~L5 1.<A[64] CarrierID> 2.<A[64] CarrierLoc> 3.<A[64] Source> 4.<A[64] Dest> 5.<U2 TransferState>~~	~~1 = Queued 2 = Transferring 3 = Paused 4 = Canceling 5 = Aborting~~	~~Carrier information associated with a particular transfer command.~~
21	CommandID	DV	A[1-64]	H(Host)_CarrierID_TimeStamp U(UI)_CarrierID_TimeStamp C(CIM)_CarrierID_TimeStamp	Used to subsequently refer to a specified remote command (e.g., to cancel a remote command). If a command is generated by the Transport System Controller, the CommandID must begin with the string 'C(CIM)_' followed by any arbitrary sequence identifier.
22	CarrierID	SV DVVAL	A[1-64]		Unique ID of the carrier. If an Id is created by the equipment (not obtained via an id reader, the host interface, or the user interface) it must be of the following format: UNKNOWNEqpNameSeq Where: UNKNOWN are the exact characters "UNKNOWN" EqpName is the value of the EqpName ECV (truncated if required) Seq is a unique sequence identifier determined by the vendor.
23	UnitID (or CarrierLoc)	DV	A[1-64]		ID of the Unit (TrackID, PortID, M/G or D/P unit ID)
25	UnitState	SV DVVAL	U2	1 = InService 2 = OutOfService	Unit: Port, Track(Belt), M/G(Magazine) unit, D/P(Dispenser) unit
26	UnitStatus	SV DVVAL	U2	1 = Empty 2 = Occupied(Full)	
28	IDReadStatus	DVVAL	U2	0 = Success 1 = Reading Failure	Result Code of an ID read event.
33	Source	DVVAL	A[1-64]		
34	Dest	DVVAL	A[1-64]		Must be the name of the port or virtual destination.

Battery Use Only

Appendix#1 ID Rules

1) Command ID

- Prefix(H/U/C)_ + Carrier ID_ + TimeStamp(yyyyMMddHHmmssfff)

Commander	Prefix	Example
MES or ECS	H (Host)	H_CARRIER_0120160904093931123
ECS UI	U (UI)	U_CARRIER_0120160904093931123
CCS	C (CIM)	C_CARRIER_0120160904093931123

2) Carrier ID

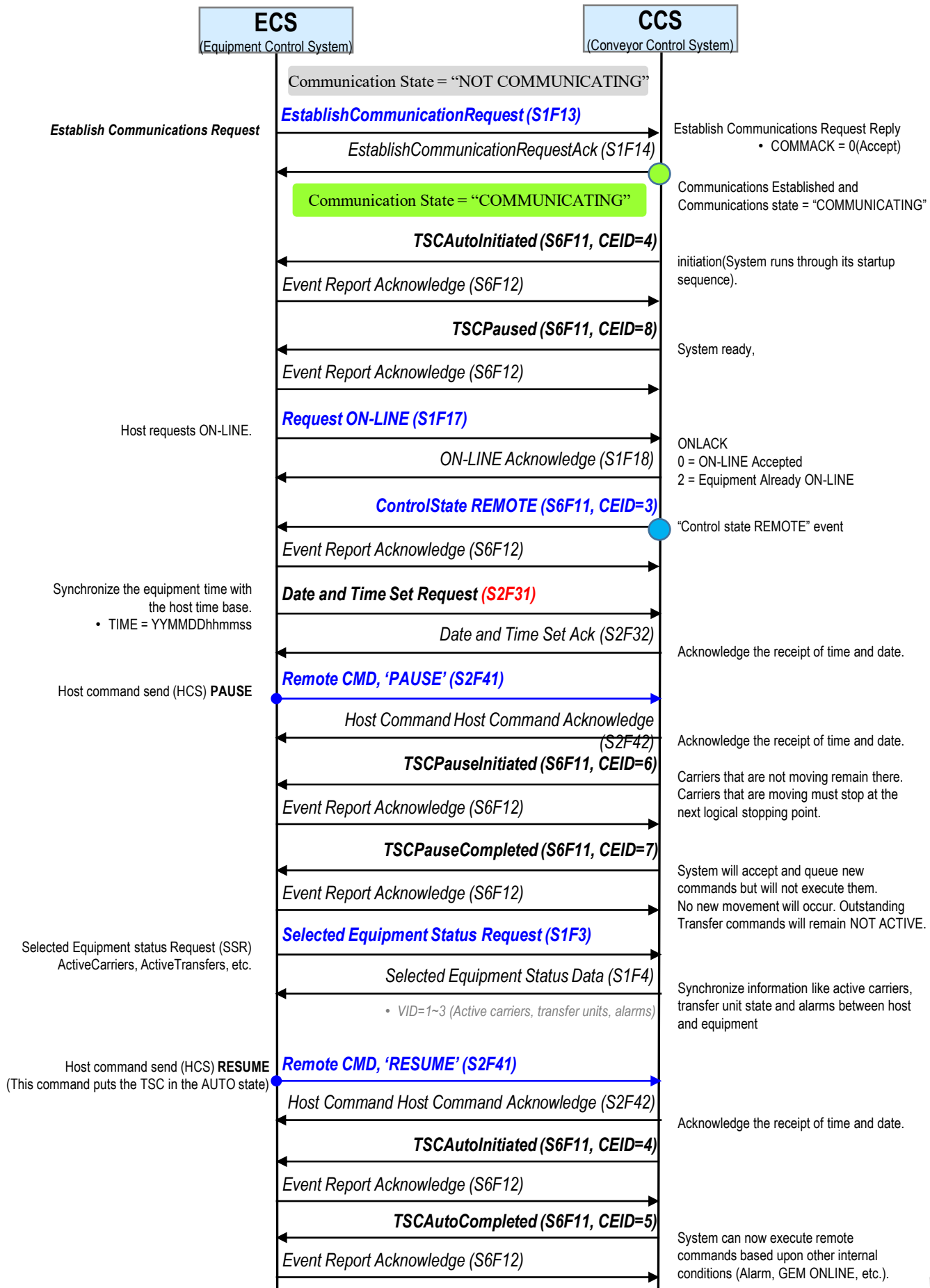
Case	ID create rule	Example
ID Read Failure	UNK_ + CurrentLocation(Track No) + TimeStamp(yyyyMMddHHmmssfff)	UNK_102345(Track No)_~~2023~~11011620~~999~~ (27 character, but could be 20 character omitting yyyy, fff)
Duplication	DUP_ + CarrierID + TimeStamp(yyyyMMddHHmmssfff)	DUP_KP123456_~~2023~~11011620~~999~~ (MMddHHmmss) (28 character, but could be 23 character omitting yyyy, fff)

Battery Use Only

Normal Scenario

IV. NORMAL SCENARIO

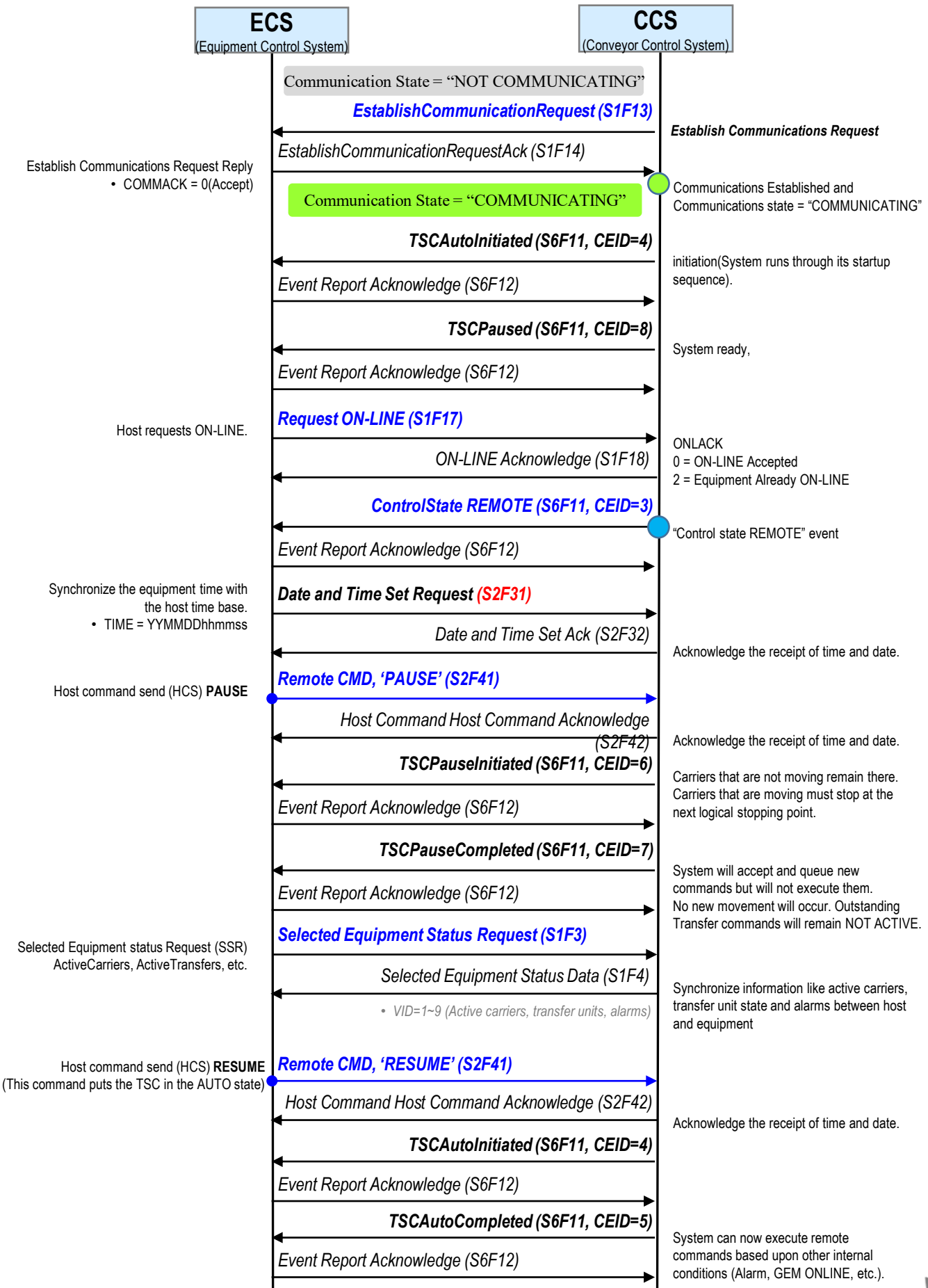
1.1 Initialization by Host(Reconciliation for synchronization between equipment and host)



Battery Use Only

IV. NORMAL SCENARIO

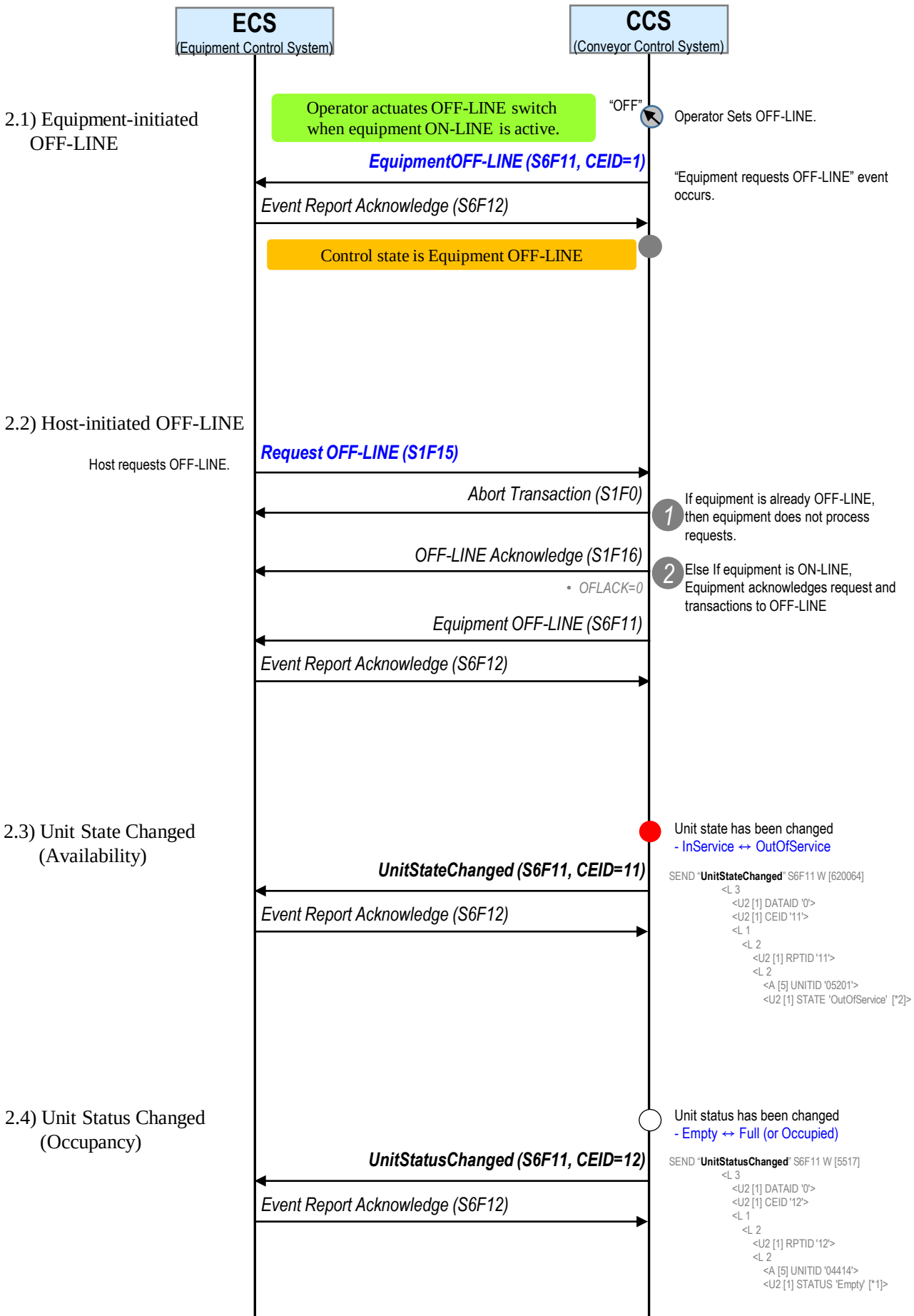
1.2 Initialization by Equipment



Battery Use Only

IV. NORMAL SCENARIO

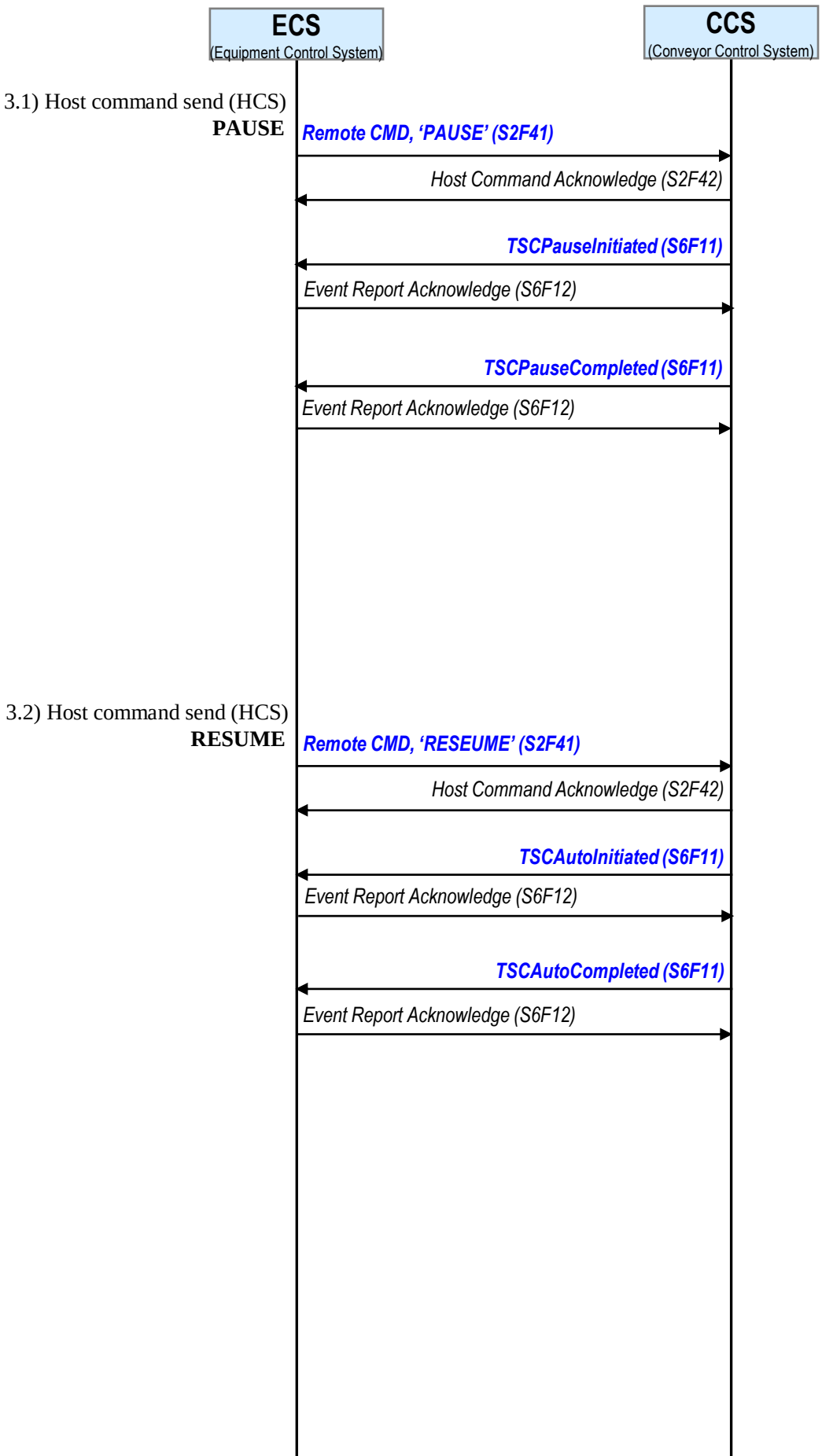
2 Control Mode Change



Battery Use Only

IV. NORMAL SCENARIO

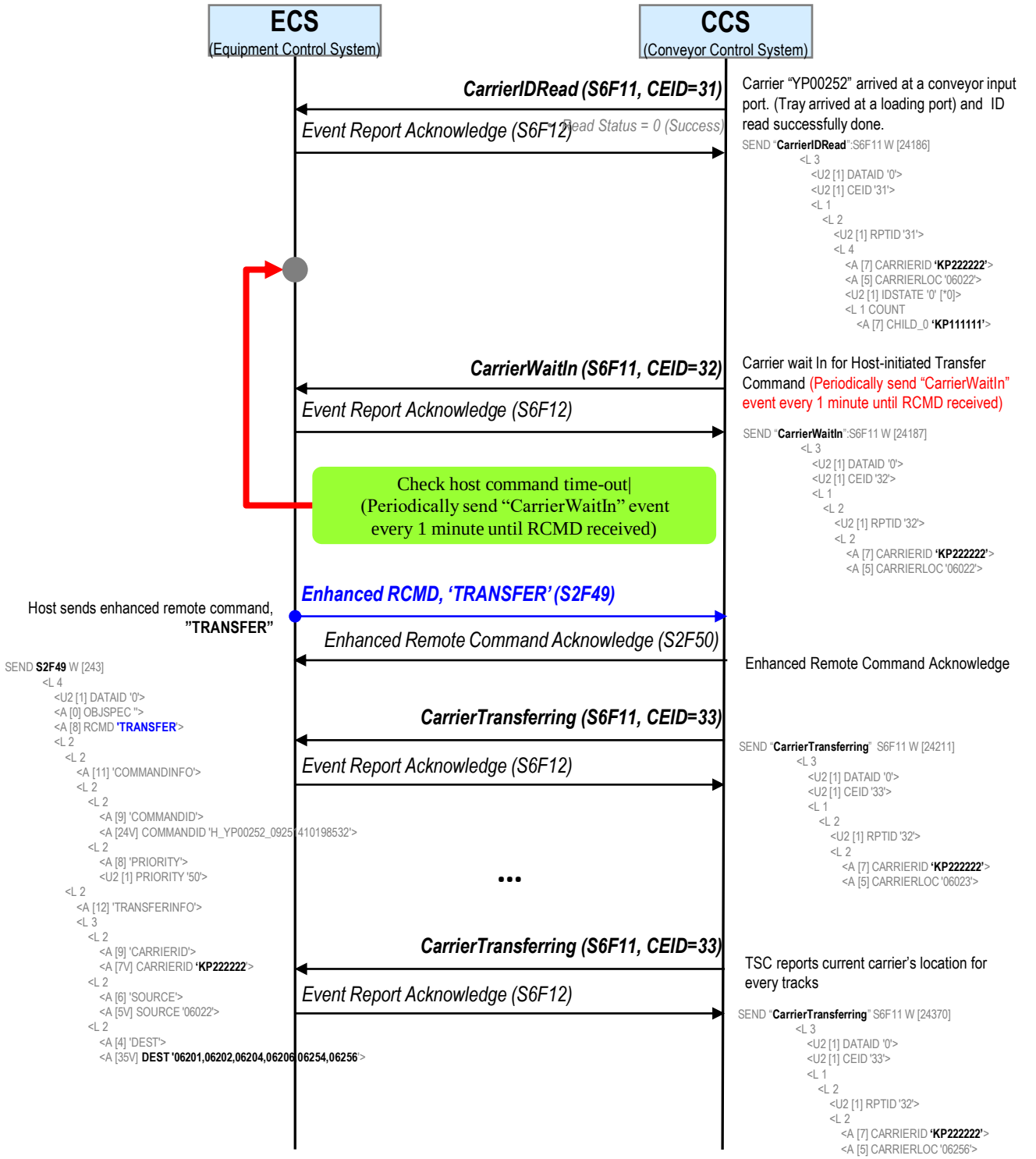
3 TSC Pause/Resume



Battery Use Only

IV. NORMAL SCENARIO

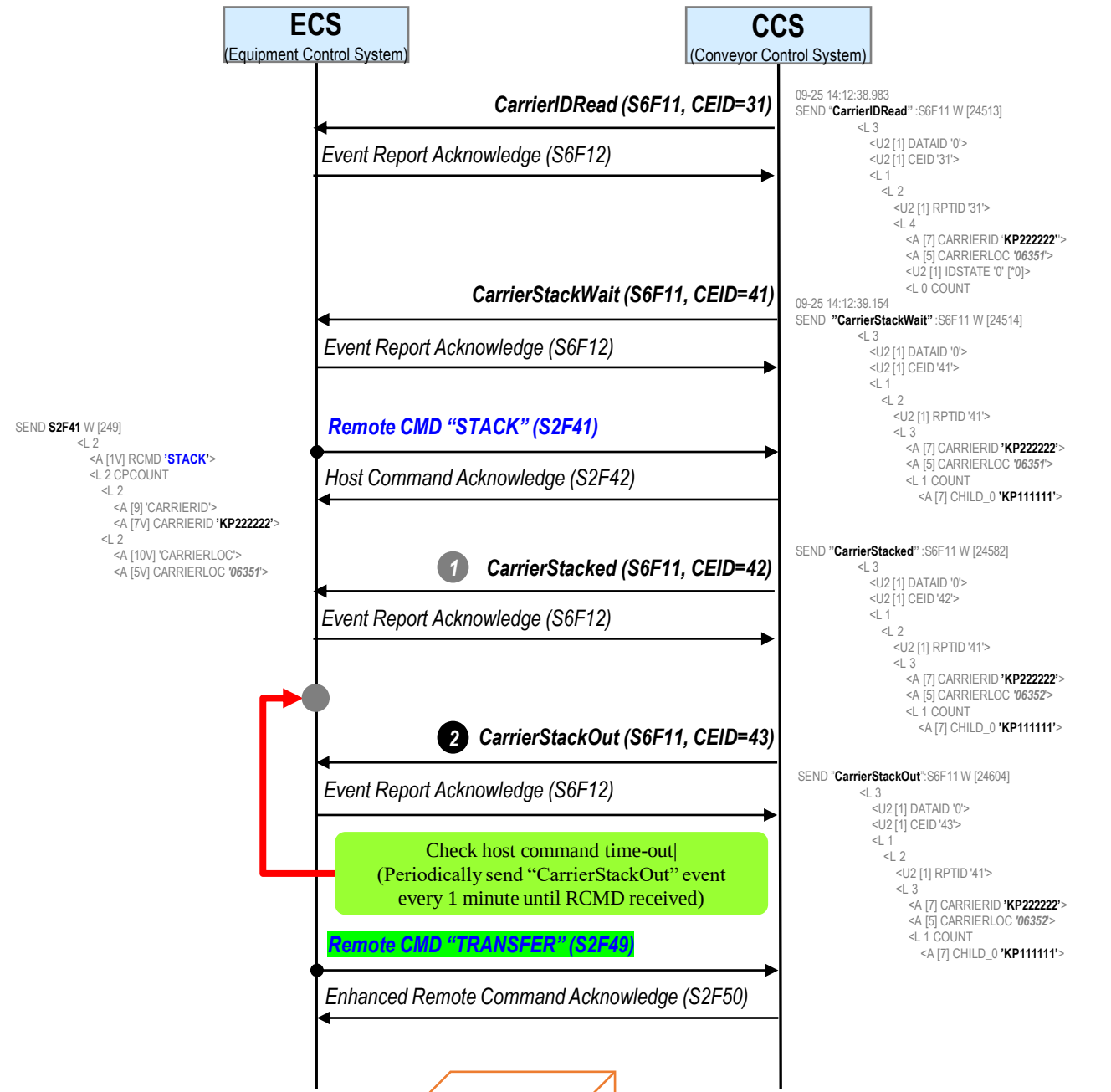
4 Normal Transfer

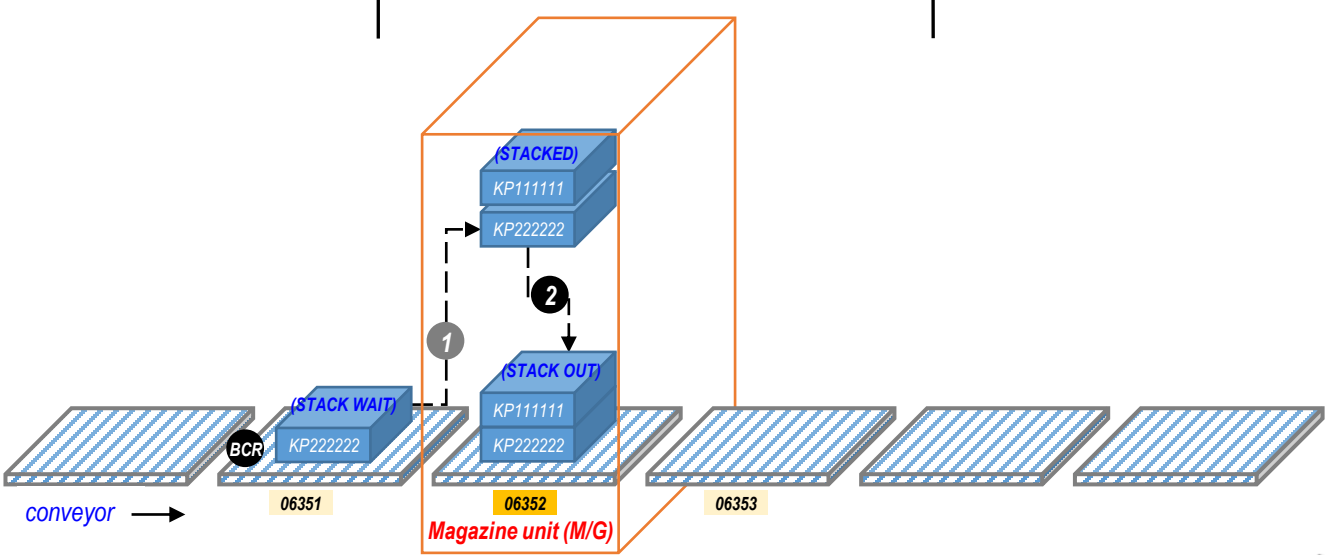


Battery Use Only

IV. NORMAL SCENARIO

5.1 STACK at the Magazine(M/G) unit (Double stacked)

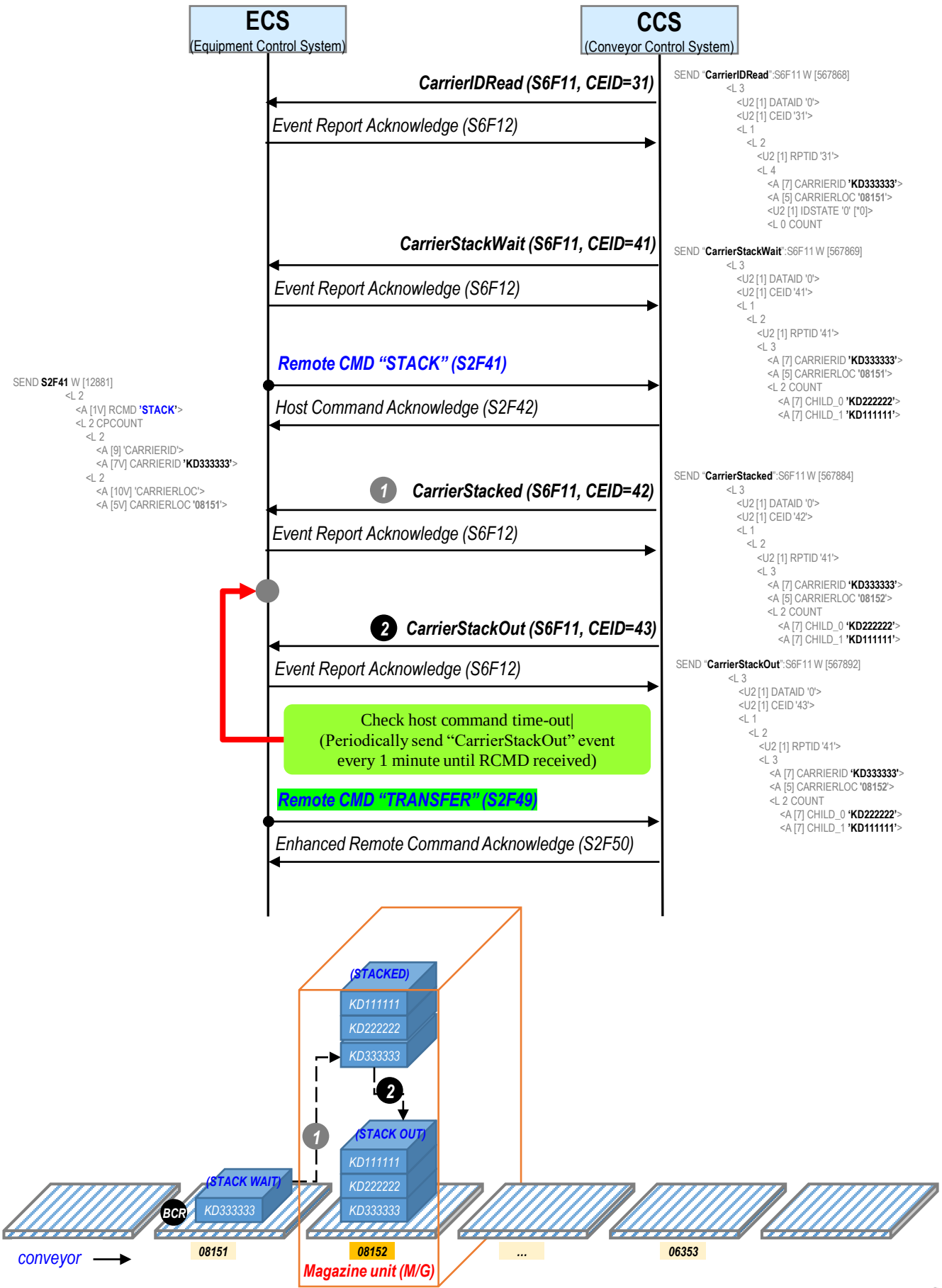




Battery Use Only

IV. NORMAL SCENARIO

5.2 STACK at the Magazine(M/G) unit (Triple stacked)

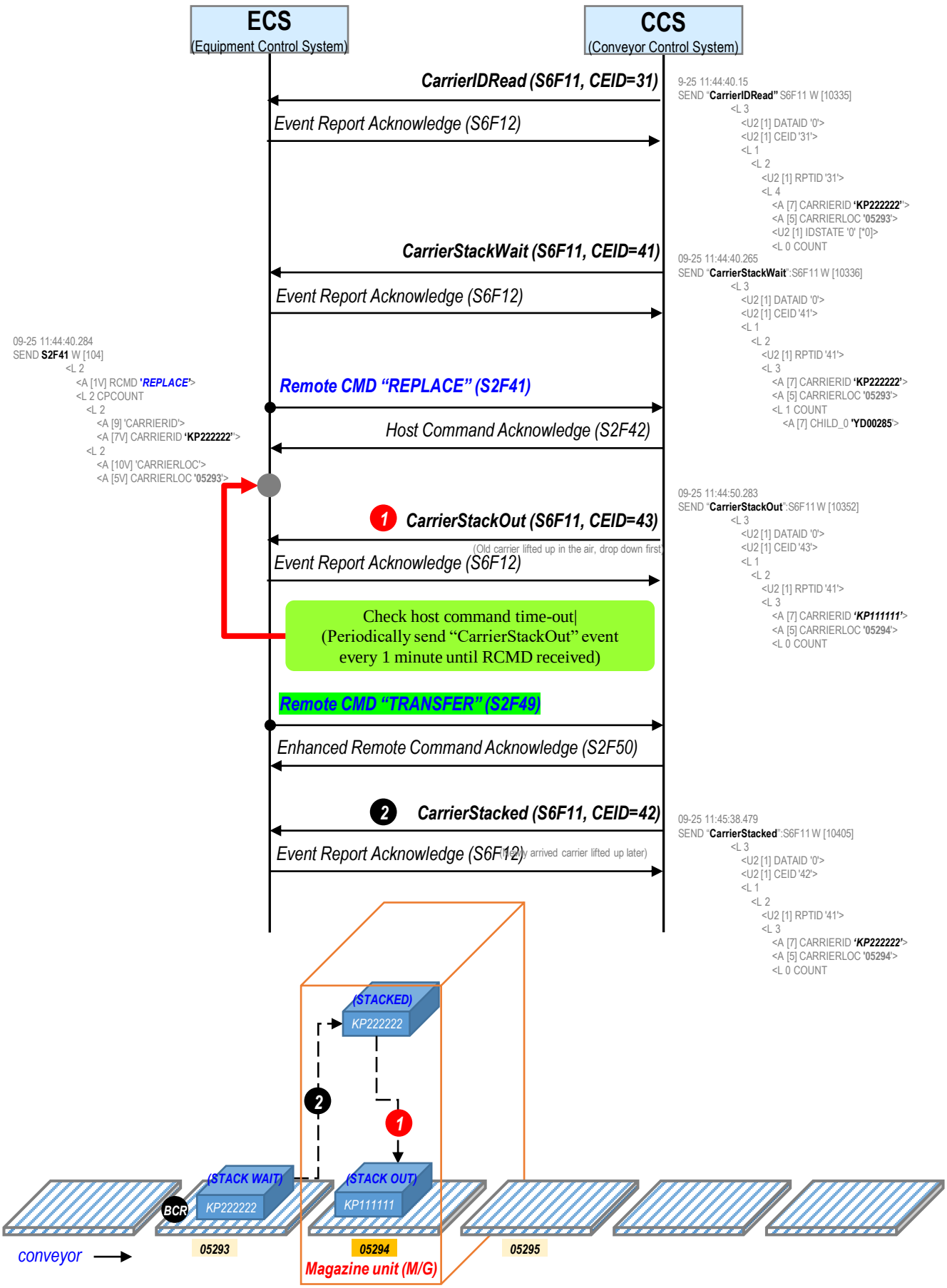


Battery Use Only

IV. NORMAL SCENARIO

6 REPLACE

(The old carrier lifted up in the air drops down first, and the newly arrived carrier to be lifted later).

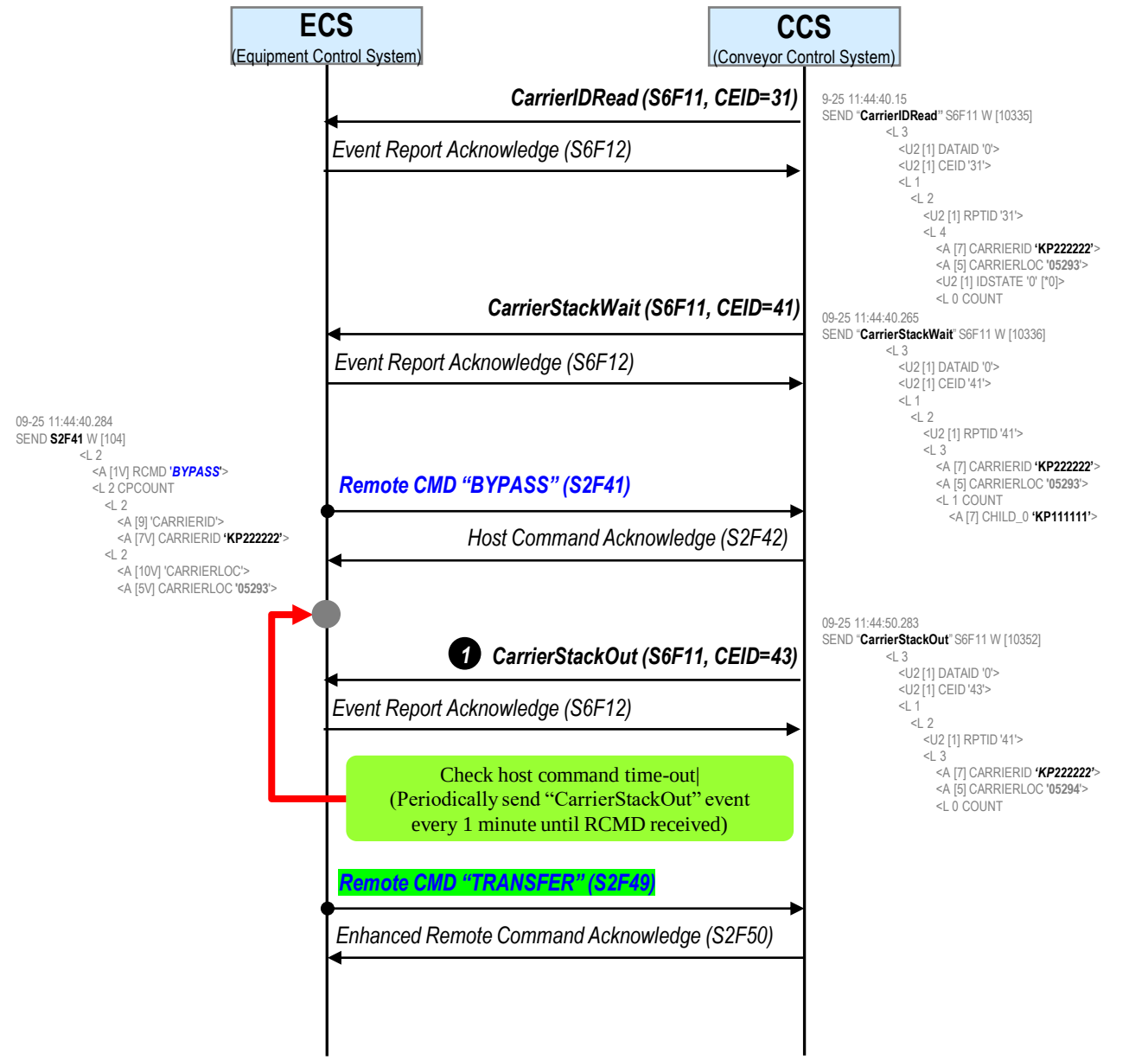


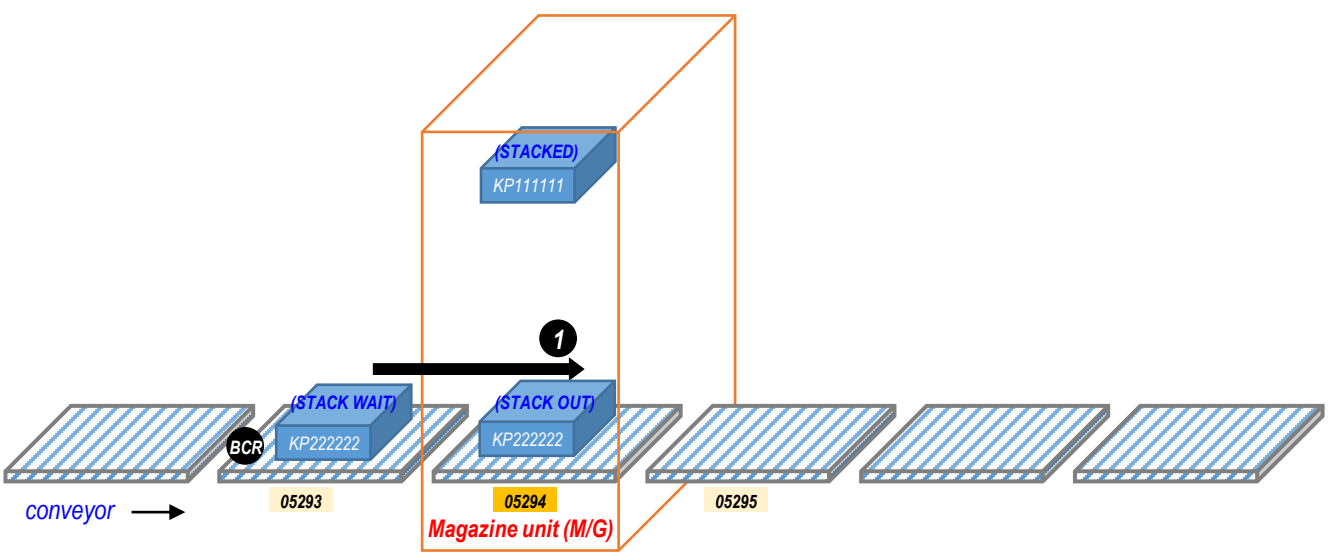
Battery Use Only

IV. NORMAL SCENARIO

7 BYPASS

(The old carrier lifted up in the air will be still remained).

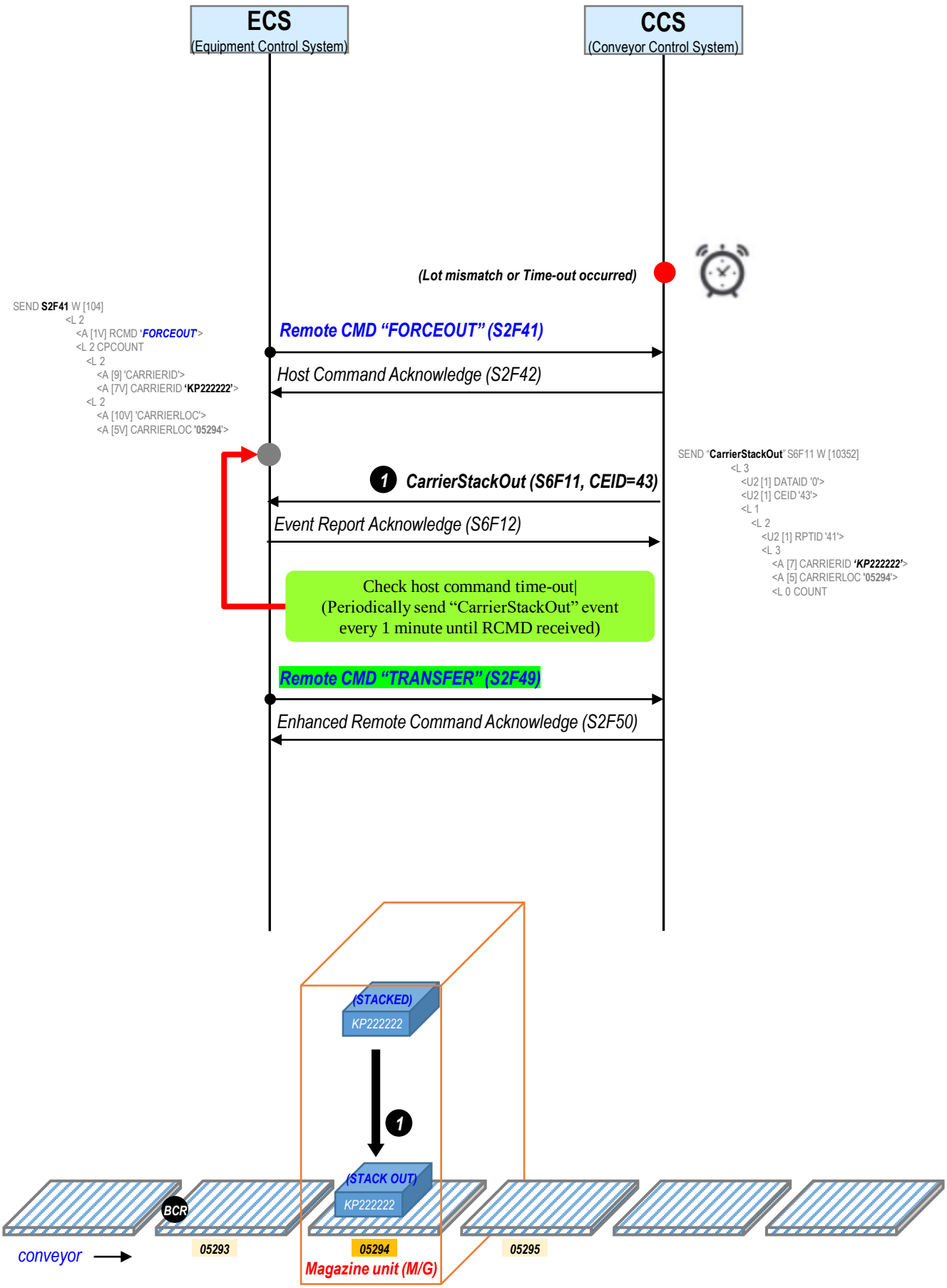




Battery Use Only

IV. NORMAL SCENARIO

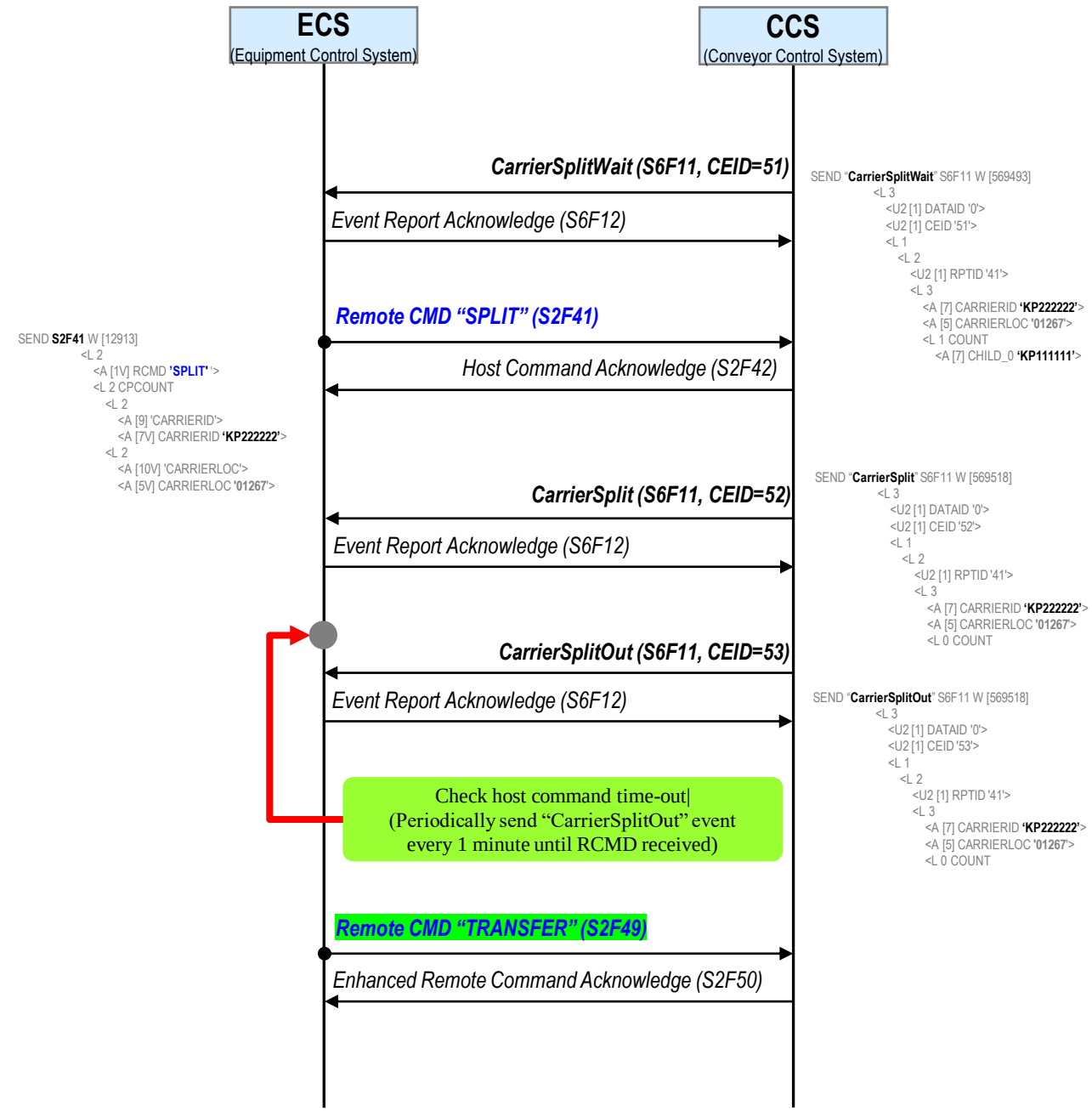
8 FORCEOUT (forcefully drop the lifted-up carriers down at the M/G unit. It might be the newly arrived carrier's LOT is differ from the lifted one, or pre-defined time-out occurs. Or operators manually let them to go)

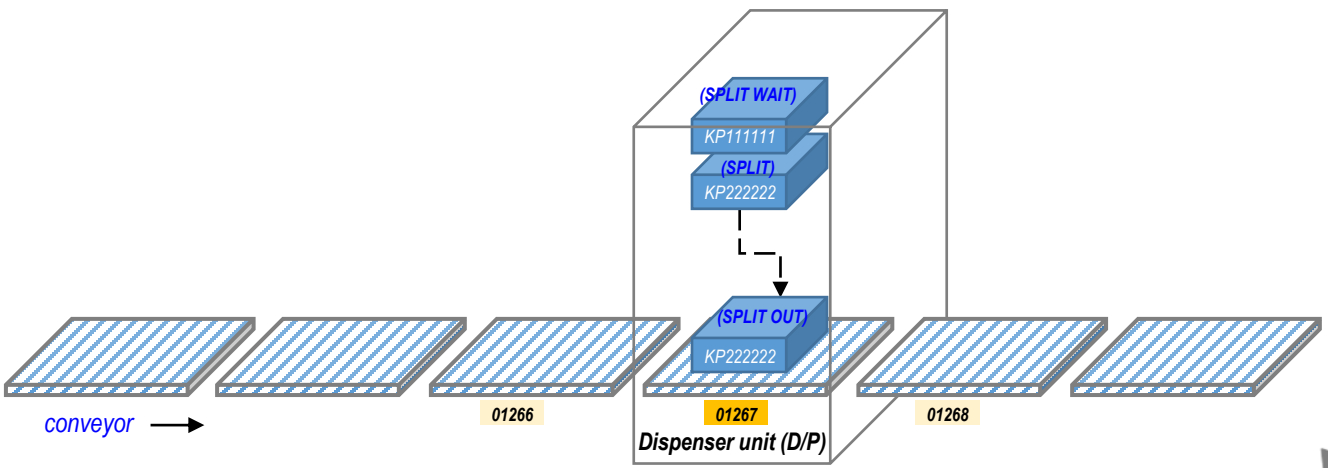


Battery Use Only

IV. NORMAL SCENARIO

9 SPLIT at the Dispenser(D/P) unit



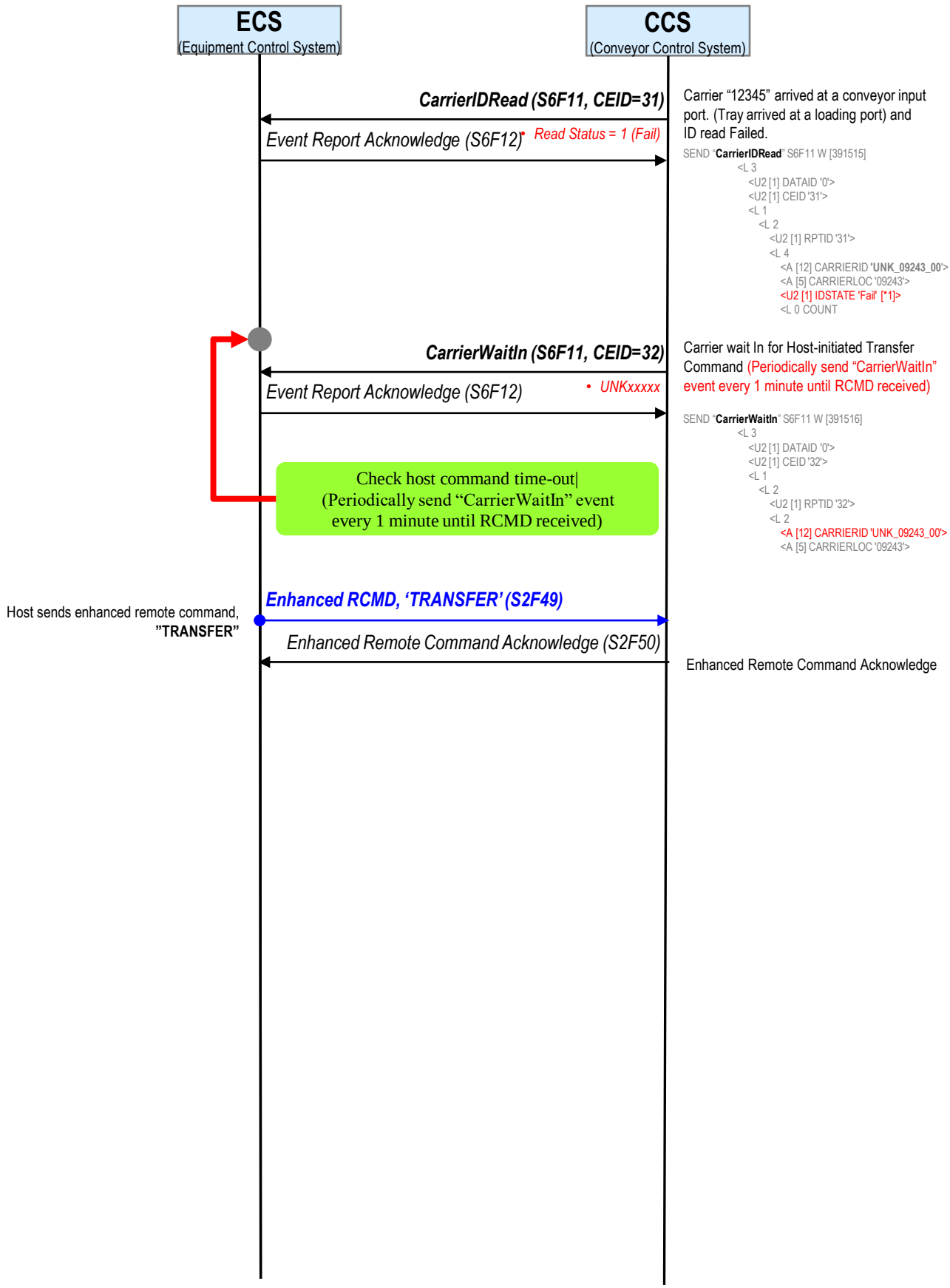


Battery Use Only

Abnormal Scenario

V. ABNORMAL SCENARIO

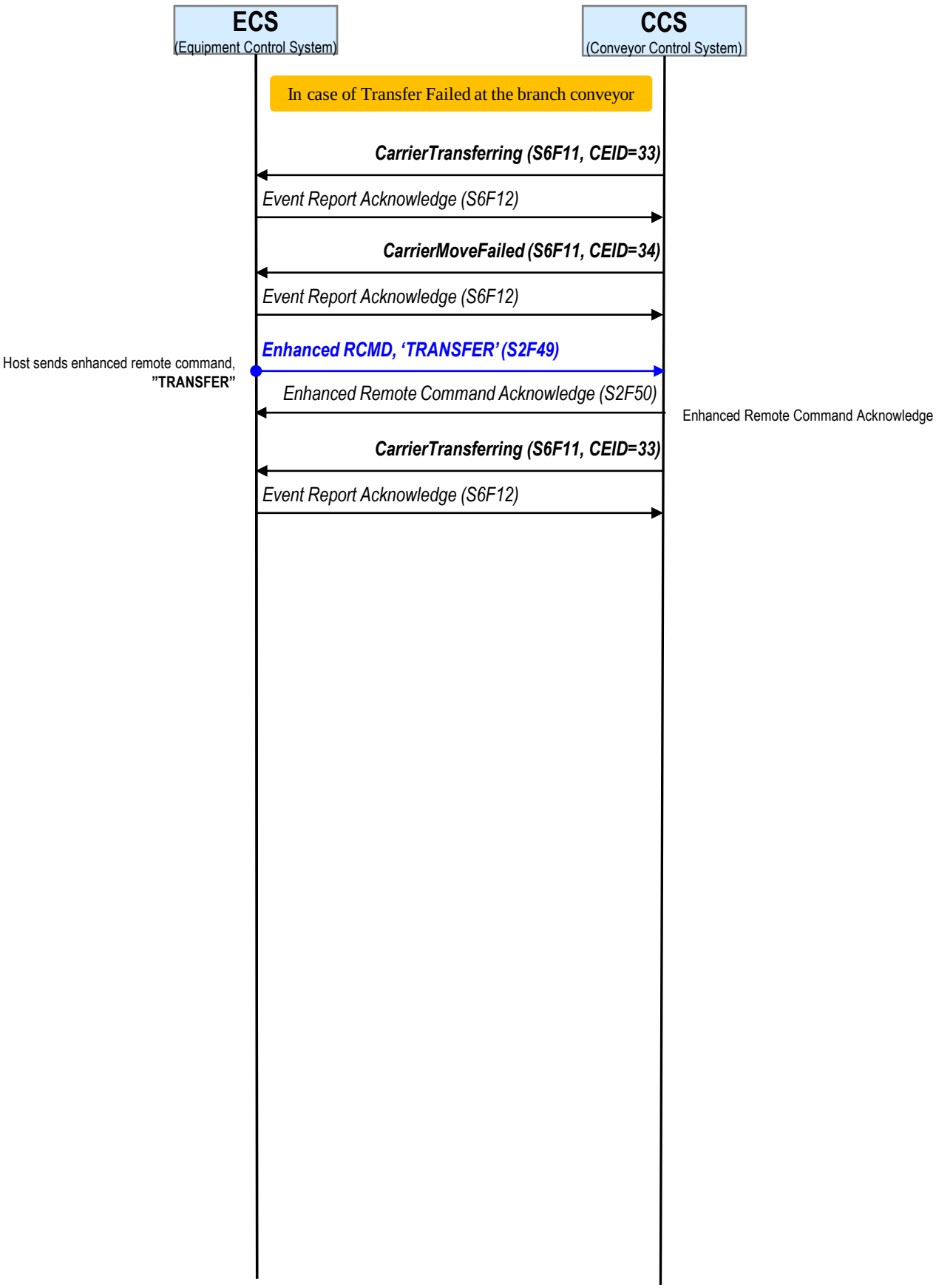
1 BCR Failed



Battery Use Only

V. ABNORMAL SCENARIO

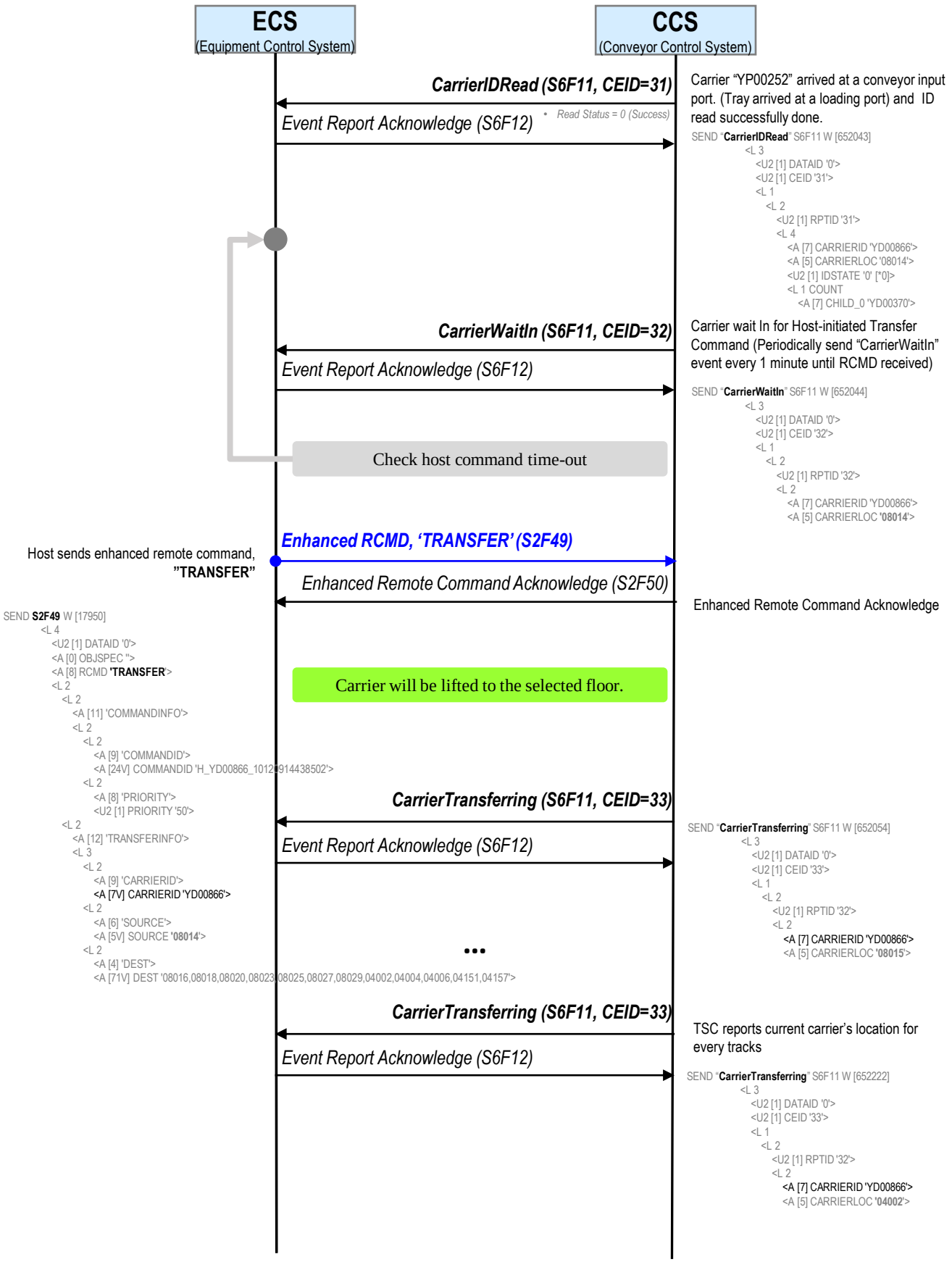
2 Circular Transfer



Battery Use Only

V. ABNORMAL SCENARIO

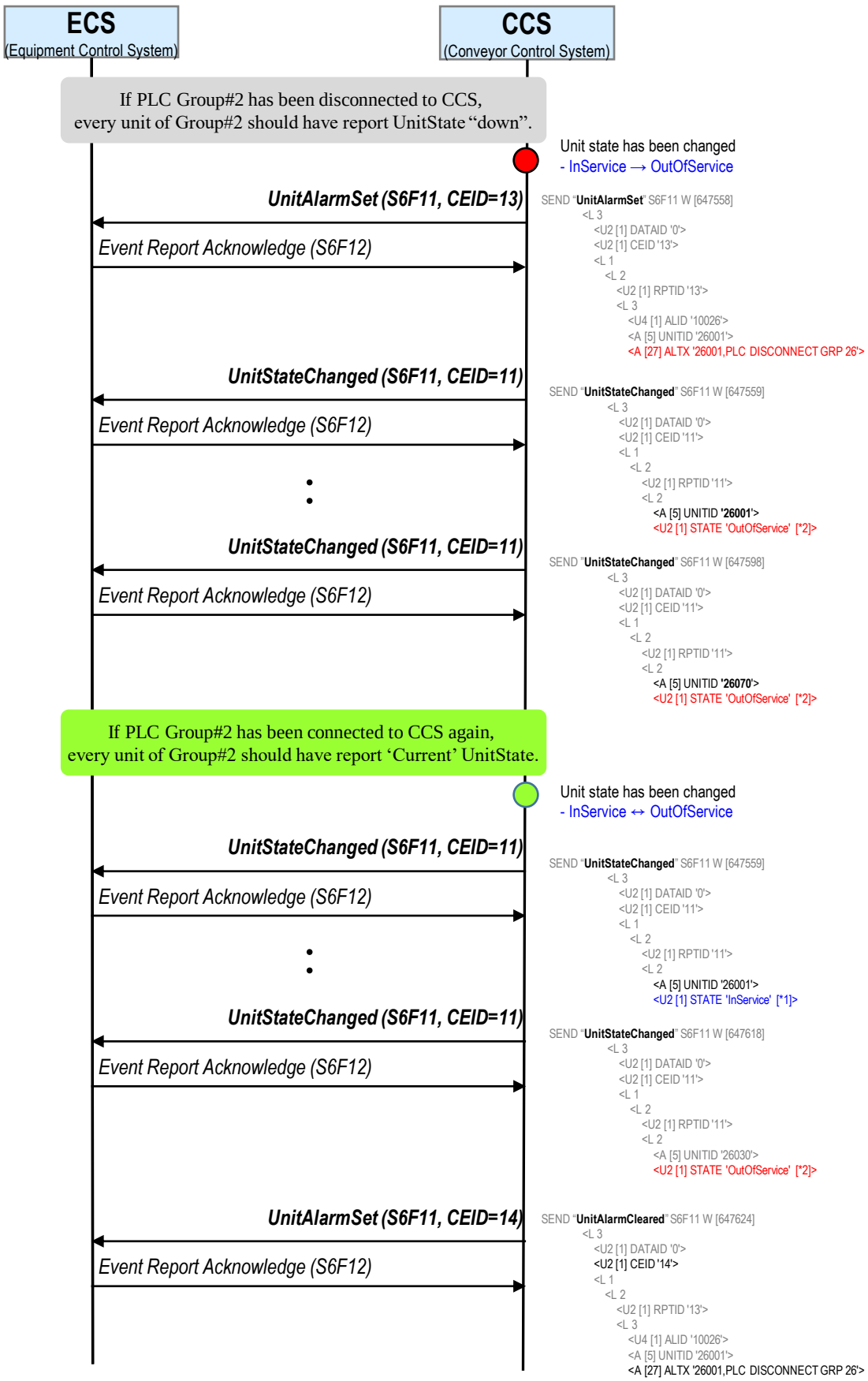
3 Floor Selection



Battery Use Only

V. ABNORMAL SCENARIO

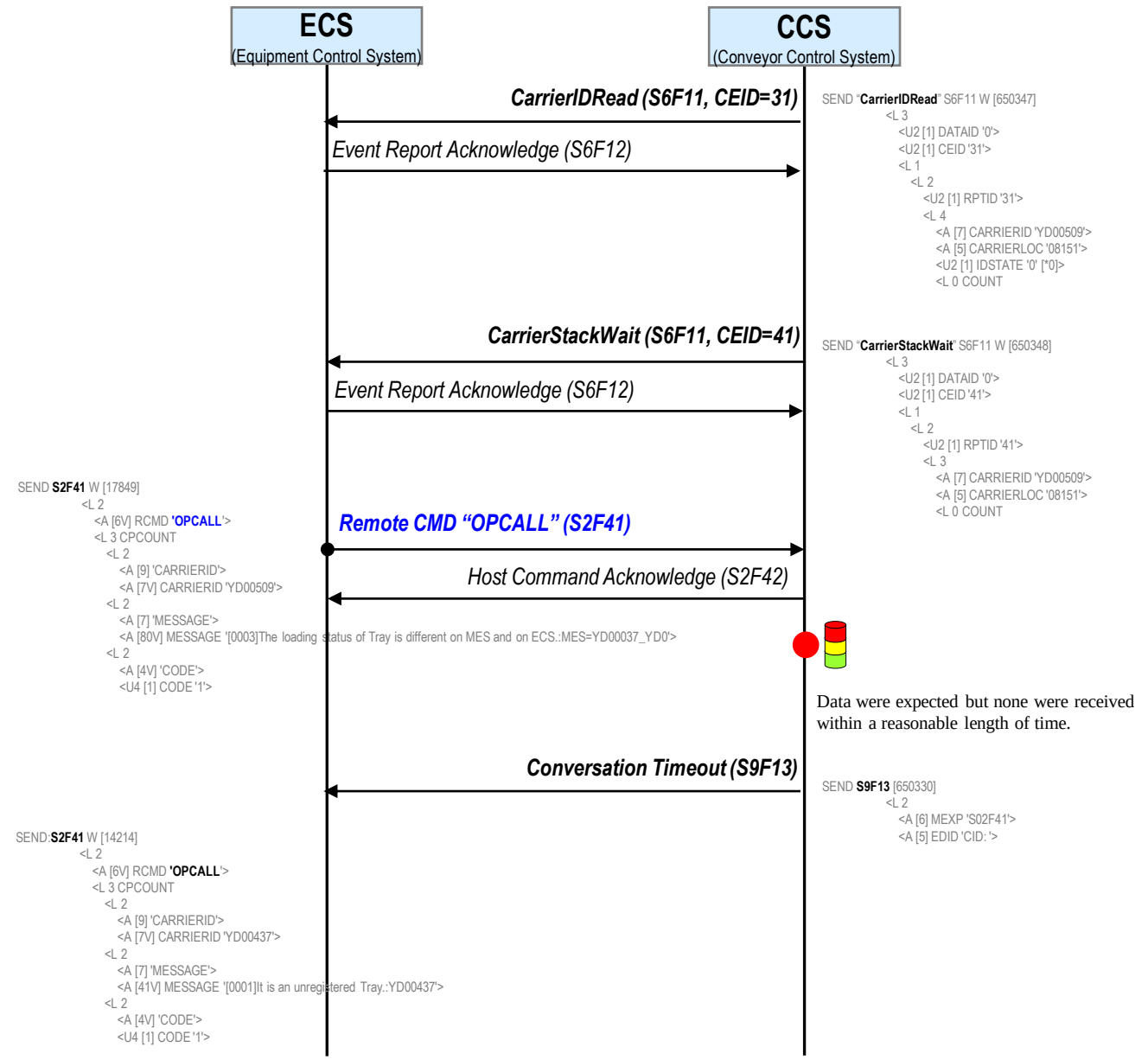
4 PLC Disconnected

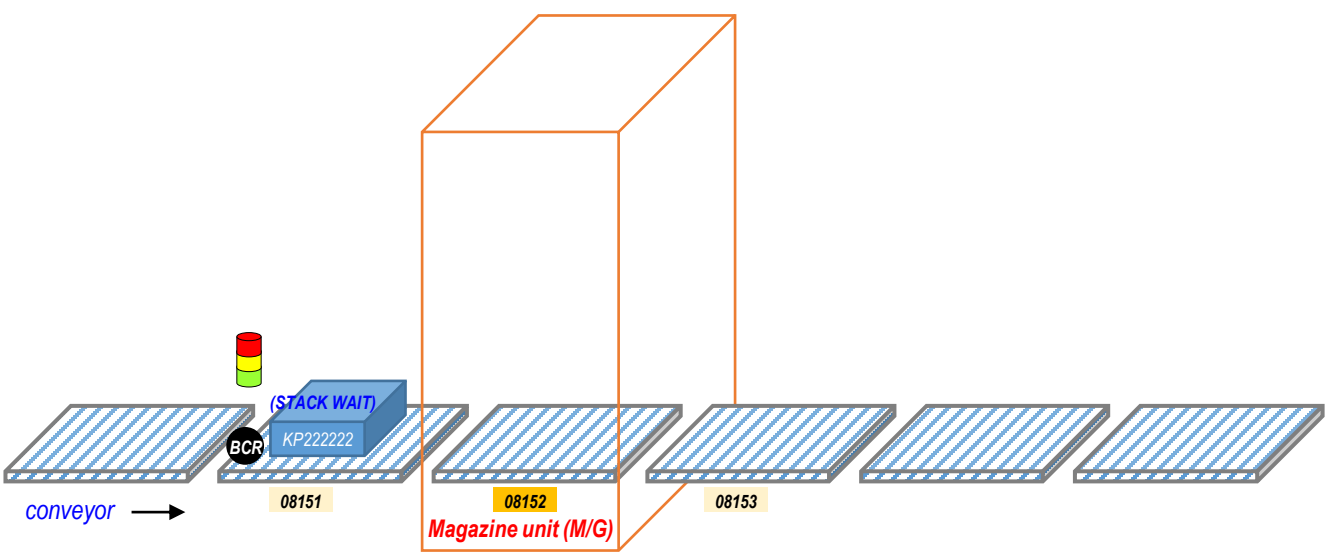


Battery Use Only

V. ABNORMAL SCENARIO

5 OPCALL (This command is used to call operator to handle some anomaly conditions like information mismatch, host destination wrong, or route error, etc.)



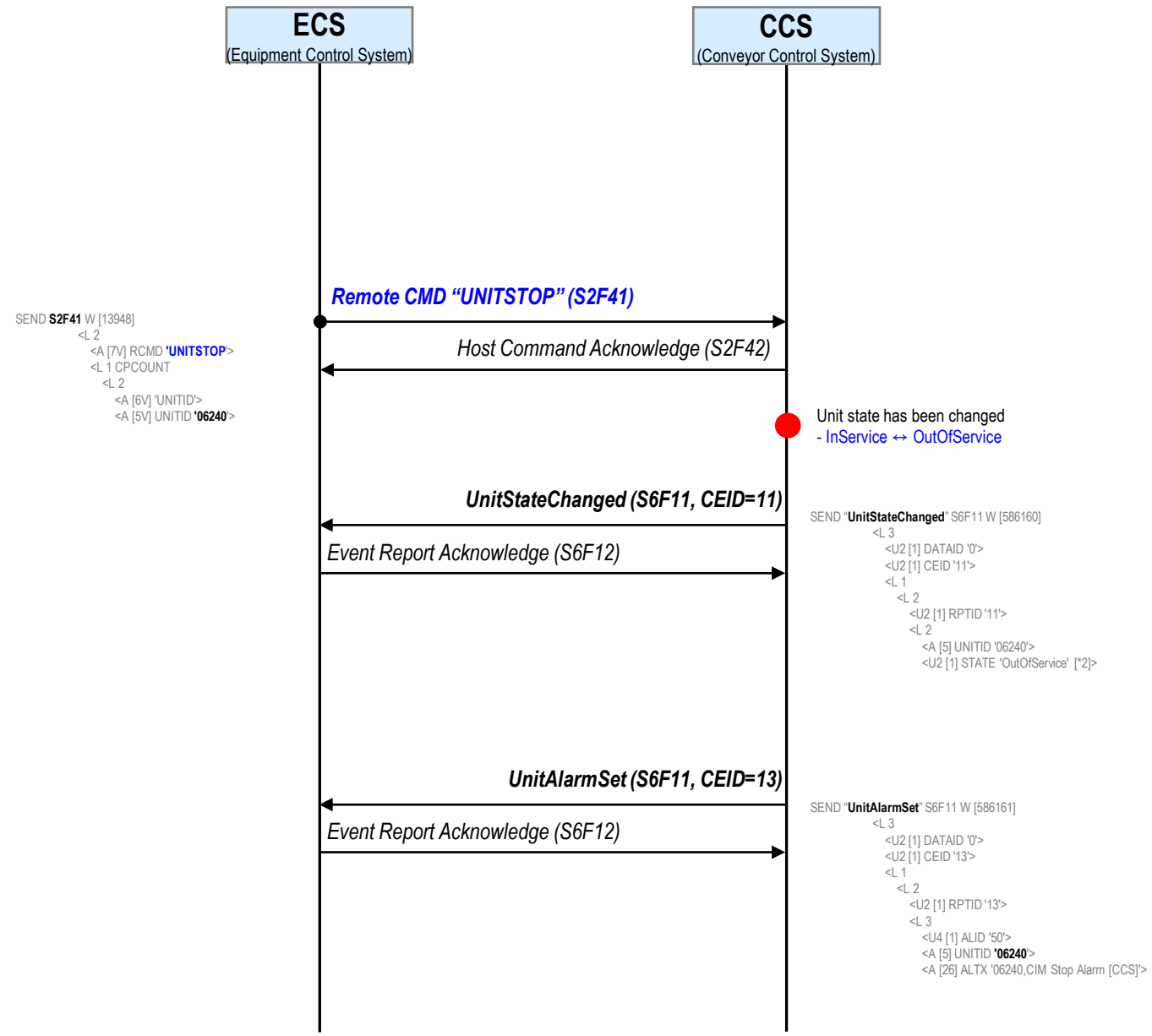


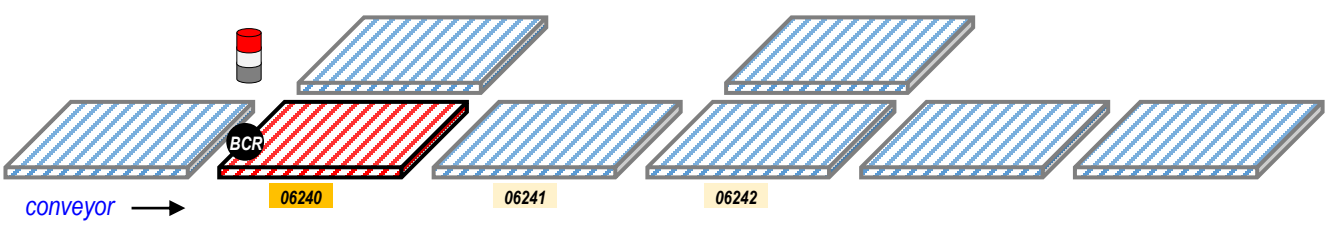
Battery Use Only

V. ABNORMAL SCENARIO

6 UNITSTOP

(This command puts the specific UNIT to be OUT OF SERVICE state.)



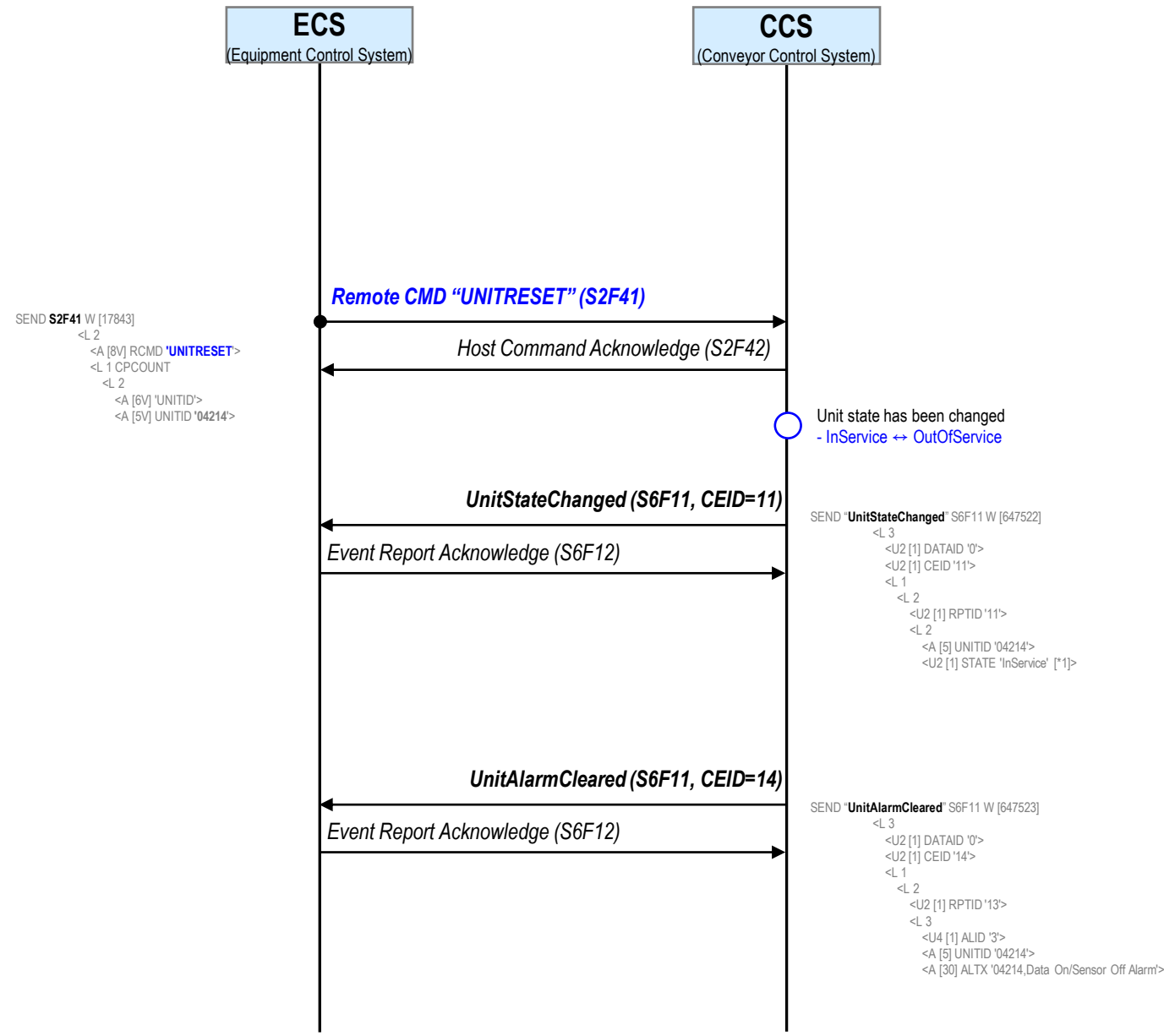


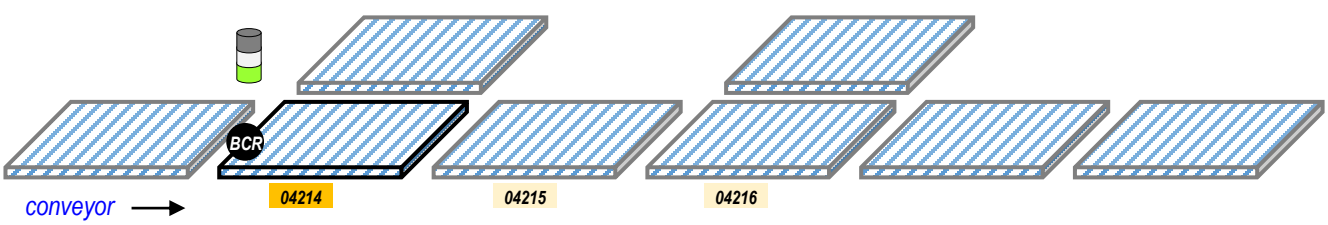
Battery Use Only

V. ABNORMAL SCENARIO

7 UNITRESET

(This command puts the OUT OF SERVICE'd UNIT to be In-Service state.)



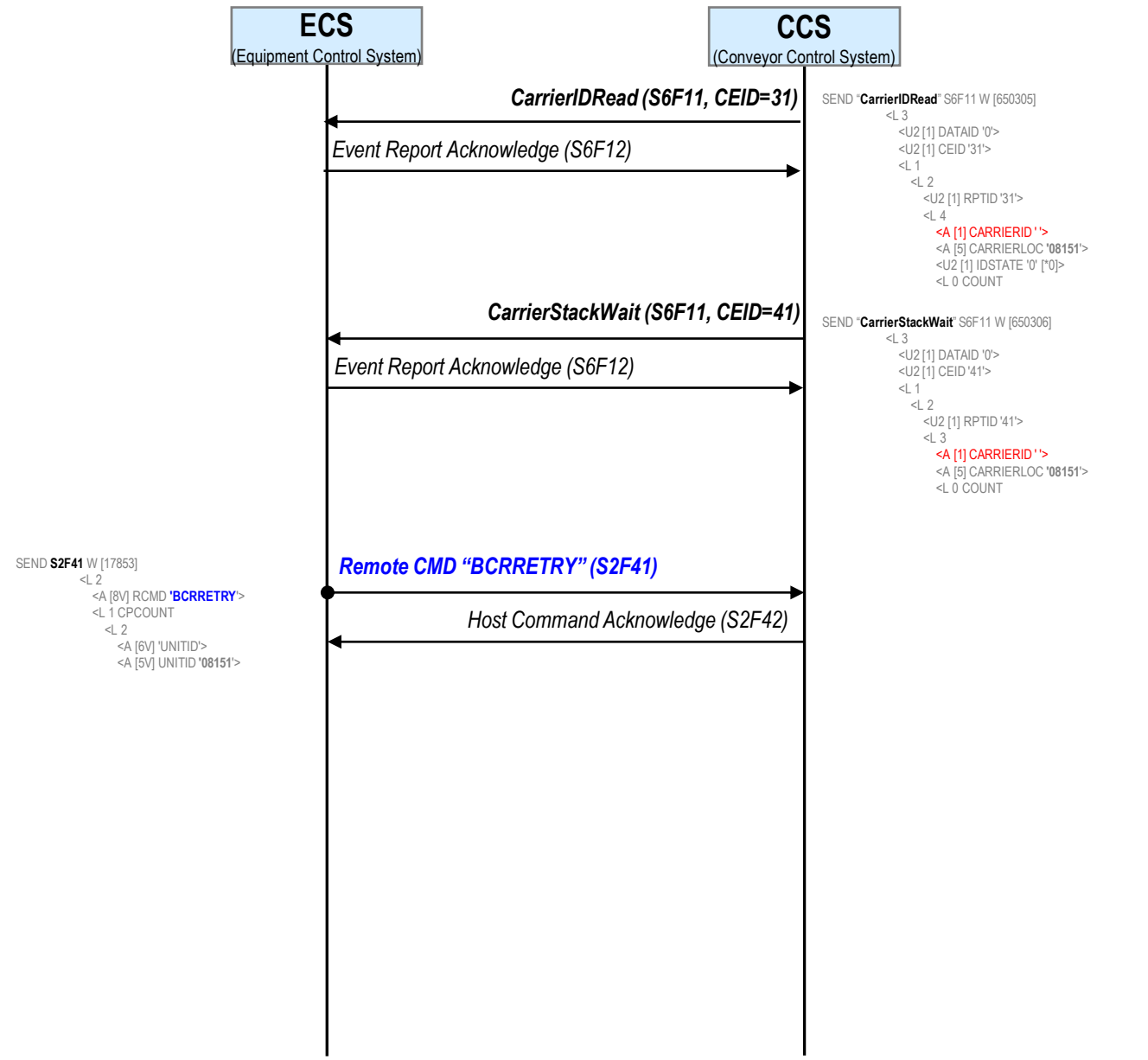


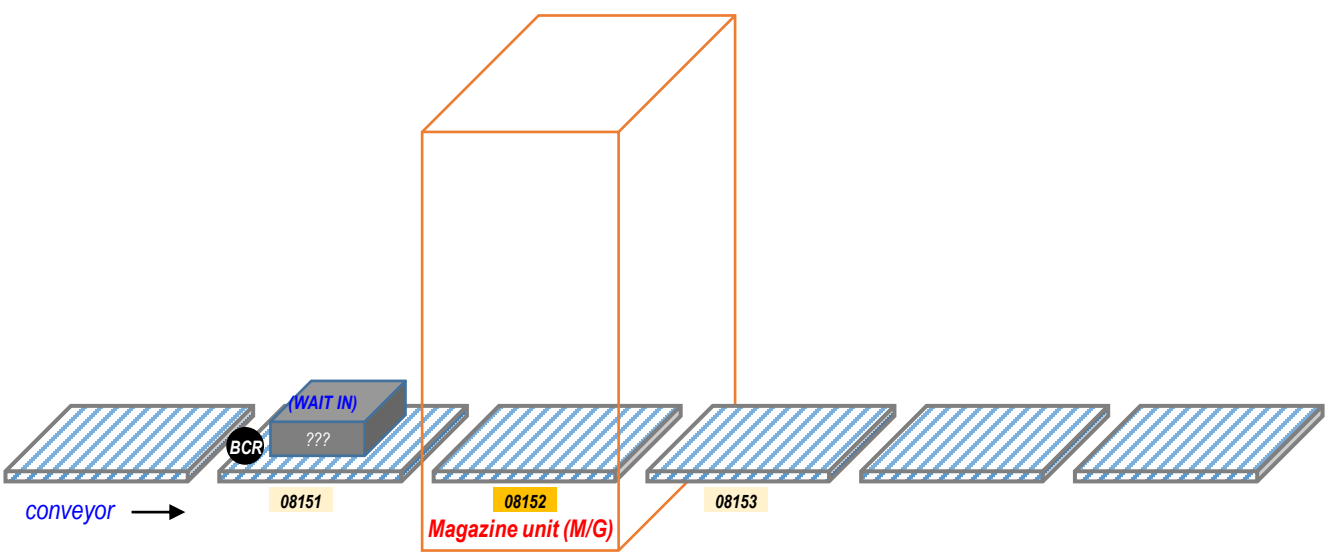
Battery Use Only

V. ABNORMAL SCENARIO

8 BCRRETRY

(This command is used to retry BCR reading for unknown carrier.)





Battery Use Only

End of Document