RS-232 Serial Interface Specification

Apex Series Acceptors

Document Number: RS_232

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Interface Description

This document describes a serial interface that is used to communicate between the Apex Series bill acceptor and a host, such as a vending machine or amusement machine

This interface is compatible with the Mars™ Serial Interface.

This interface uses a bi-directional, three (3) wire system: a transmit line (TXD), a receive line (RXD) and a ground line. The bill acceptor or "slave," responds only to requests (or polls) from the "master" or vending machine. Therefore, the "master" gives the requests and the "slave" responds.

The polled system is designed for the master to request information from the slave at a periodic rate. The rate can be as slow as 5 seconds or as fast as 100 msec between each poll. The popular rate is fast since the overall system performance (bills per minute accepted) will be slower at slower polling rates. While feeding the bill into the acceptor, the acceptor will miss a few polls, because it is reading the bill and not servicing the serial interface (Typical for acceptors using this protocol).

Communication Data

- Baud rate- 9600
- 1 start and 1 stop bit
- 7 data bits (bit 0 = sent first (LSB))
- 1 parity bit (bit 7, even parity)

Inactive Timing- Timing is a key factor when sending polls. If the acceptor does not receive a poll after 5 seconds of the previous poll, the acceptor may:

1. Reject any bill held in escrow.
2. Stop accepting any new bill until the master initiates the poll sequence.

Message Format

Common format for a transmitted message, is as followed:

| STX | Length | MSG Type and Ack Number | Data Fields | ETX | Checksum |

Descriptions:

STX- 02H The start of a message is indicated by one byte.

Length- One byte representation of the number of bytes in each message (binary), including the STX, ETX and the Checksum.

MSG Type and Ack Number- One byte of data

MSG Type- (Bits 4, 5 and 6 of this byte)

1- For master to slave (acceptor) messages.

2- For slave (acceptor) to master messages.

Note: Numbers 4-7 are reserved for future use[1].

ACK Number- 0 or 1 (lower 4 bits of this byte, bits 0-3)

The Ack number is used to identify the messages sent by the master. While messages are being sent to the acceptor, the number alternates between 00 and 01H. Two consecutive messages with the same number can be received. When this occurs, the second message will be treated as a retransmission of the first message. When the message is sent from the slave (acceptor), this number is used to acknowledge the messages from the master. When the master sends a message to the bill acceptor, this number will set the "ACK Number" of the master's message, telling the master that the message was received correctly. If the message is received incorrectly, the acceptor will respond with the previous "Ack Number".

Data- Portion of the message, the data, consists of the multiple data fields in the next section titled **Data Fields for Messages Sent By the Master**. (Byte 0 is sent first, then Byte 1, etc..)

ETX- 03H End of the message byte.

Checksum- (one byte checksum). The checksum is calculated on all bytes (except: STX, ETX and the checksum byte itself). This is done by bitwise Exclusive OR-ing (XOR) the bytes.

[1] See section on extended RS-232 commands

Data Fields for Messages Sent By the Master

BYTE 0

BIT 0- $1 Accept Enable (Set to a "1" to accept a bill)
BIT 1- $2 Accept Enable (Not used on Apex series acceptors)
BIT 2- $5 Accept Enable
BIT 3- $10 Accept Enable
BIT 4- $20 Accept Enable
BIT 5- $50 Accept Enable
BIT 6- $100 Accept Enable

Note: Foreign currencies are in sequential order as note 1-7, for a total of seven (7) denominations accepted.

BYTE 1

BIT 0- Reserved for future use. (Set to 0)
BIT 1- SECURITY (Reserved for future use.)
BIT 2- ORIENTATION (Reserved for future use.)
BIT 3- ORIENTATION (Reserved for future use.)
BIT 4- Escrow (Set = 1 to enable escrow)
BIT 5- Stack (Set = 1 causes bill to be stacked)
BIT 6- Return (Set = 1 causes bill to be returned)

BYTE 2

BIT 0- 6 - Reserved for future use.

Data Fields for Messages sent by the Slave (Bill Acceptor)

BYTE 0

Bit 0- Idling (Set = 1 if acceptor is in idle state)
Bit 1- Accepting (Set = 1 if accepting a bill)
Bit 2- Escrowed (Set =1 if a bill is in escrow)
Bit 3- Stacking (Set = 1 if a bill is being stacked)
Bit 4- Stacked (Set = 1 if a bill was stacked, Idle (Bit 0) also set during this state)
Bit 5- Returning (= 1 if a bill is being returned)
Bit 6- Returned (Set = 1 if the bill has been returned, Idle (Bit 0) also set during this state)

BYTE 1

Bit 0- Cheated (Set = 1 if acceptor suspects cheating)
Bit 1- Bill rejected (Set = 1 if a bill was rejected)
Bit 2- Bill jammed (Set = 1 if a bill is jammed)
Bit 3- Stacker full (Set = 1 if the stacker is full)
Bit 4- Bill cassette present (Set = 1 if cassette is present)
Bit 5- Reserved for future use (Set to 0)
Bit 6- Reserved for future use (Set to 0)

BYTE 2

Bit 0- Power up (Set = 1 if acceptor is initializing)
Bit 1- Invalid command (Set = 1 if an invalid command was received)
Bit 2- Failure (Set = 1 if acceptor has failed)
Bit 3-5 Bill value field

000 = None/unknown bill or note
001 = \$1 or 1st note type
010 = \$2 or 2nd note type
011 = \$5 or 3rd note type
100 = \$10 or 4th note type
101 = \$20 or 5th note type
110 = \$50 or 6th note type
111 = \$100 or 7th note type

Bit 6- Reserved for future use.

BYTE 3

Reserved for future use.

BYTE 4

Model number (00-7FH)

BYTE 5

Revision of firmware (00-7FH)

Description of Bill Acceptor States and Events

Pyramid Technologies has implemented an extended RS-232 command set to meet customer needs. These extended commands are backwards compatible but are only available on supported firmwares. Please contact sales@pyramidacceptors.com for more information on supported firmware.

Message Format

Common format for a transmitted message, is as followed:

| STX | Length | **MSG Type and Ack Number** | Data Fields | ETX | Checksum |

Descriptions:

MSG Type and Ack Number- One byte of data

MSG Type- (Bits 4, 5 and 6 of this byte)

1- For master to slave (acceptor) messages.

2- For slave (acceptor) to master messages.

6- Set bit to force acceptor to reset (Master only)

ACK Number- 0 or 1 (lower 4 bits of this byte, bits 0-3)

To issue a reset command

A hard reset can be performed on the Apex Series bill acceptor by setting bit 6 in the message type byte of message sent by the master.

Additionally, each of the three data bytes must be set to 0x7F. Your reset message would then look like one of these depending on your ACK number.

```
02 08 61 7f 7f 7f 03 16
```

-OR-

```
02 08 60 7f 7f 7f 03 17
```

Remember, the ACK number toggles the first bit of the message type byte. This command is not acknowledged by the unit. Please allow up to three seconds for the unit to begin responding normally after reset.

Description of Bill Acceptor States and Events

The bill acceptor will pass through a series of “States” during bill processing. The acceptor will always be in a “State.” If the acceptor is waiting for a bill insertion, it will report an “Idle” state to the master. If the acceptor is reading a bill, it will be reporting an “Accepting” state to the master. Only one state can be set at a time. The acceptor may also have a reported “Event” taking place. For example, if the acceptor has just stacked a bill in the “Stacking Mechanism”, it will report a “Stacked” event and since it is now waiting for another bill insertion, it will also report an “Idle” state within the same message. It is possible for a multiple event to be set in a message. Events are temporary. For example, when a message sent by the acceptor has been received by the master and a new message is then sent by the master, with a new MSG/ack number, the acceptor should clear the previous event bit that is set when it sends its next response.

Acceptor States

Idle- The bill acceptor has not processed a bill and is waiting for a bill to be inserted. There are no problems with the acceptor if this state is reported.

Accepting- In this state, a bill is being received through the acceptor. The bill has not reached the “Escrow” position yet (The position where the acceptor stops it’s motor and checks the validity of the bill.).

Escrowed- The bill is valid and in sitting inside the bill acceptor. The “Escrow State” reports the bill value field and will indicate the denomination of the bill. If the bill is invalid, the state of escrow would never be reported. When the acceptor first powers up and a bill is found to be in escrow, the acceptor would report in an escrow state with the “Bill Value Field” set to 000 (unknown value). The master would then send a return message to the acceptor. The acceptor finishes with a returned event, then it goes back to the idle state.

Stacking- The acceptor remains in this state as it transports the bill from the escrow position toward a secure position past all the bill acceptors internal sensors, as well as the stacking mechanism sensors. The acceptor will not change states until the bill is stacked or jammed. During power up if a bill is not in the escrow position, this state bit and the power up bit will be reported.

Returning- This state is set for the purpose of returning a bill to the patron. The master orders the bill to be returned because it responded to an Escrowed message and did not want to accept this bill. A “Returning” message and a “Rejected” message are quit different. A returning message means that the master did not want the acceptor to take a particular bill of valid currency. A rejected message is sent because the acceptor found the bill to be not valid.

Bill Jammed- The acceptor can not stack a bill or return the bill due to an error. The acceptor will keep sending this message until it has stopped trying to complete the operation (stack or return). If the jammed bill is removed, the acceptor will automatically exit this state.

Stacker Full- If this state has been reported, the acceptor can no longer accept any bills. Usually, this indicates that the cashbox is full.

Failure- If this state has been reported, the acceptor is implying that a condition exists that prevents the bill acceptor from accepting any more currency. For example, a sensor may have failed, then the acceptor will enter this state.

Acceptor Events

Note: Events are reported only once to the master.

Stacked- After the bill has been successfully stacked into the cashbox, this event is reported. The master will then issues the credit for the bill.

Returned- When the master tells the slave to return a bill (After an Escrowed message), this message is sent after the bill has been successfully returned to the patron. This bill was valid but for some reason, the master wanted it to be returned.

Cheated- If the acceptor perceives a bill as being manipulated, this event reports it. The bill may be returned to the patron, or be stacked with no credit issued. (Bill Value Field = 000)

Bill Rejected- A bill will be returned to the patron because the acceptor found it to be invalid.

Power Up- The acceptor had a power up sequence. The initialization stage will continue to be reported until the acceptor is finished. The event will keep occurring until the master has recognized it and the message is read at least once. This event, similar to a state, is certain to be reported once.

Other Message Information that is not a State or an Event

Bill Cassette Present- (controlled by the bill acceptor) When the cassette is present, this bit will be set to a logic high. If there is no cassette, the bit will be cleared. Therefore, the acceptor will not accept any bills. *Note: not used on stackerless units.*

Bill Value- Three (3) bits are used to illustrate the denomination of the bill in process. The bill value can equal 000, this states that the bill is unknown (Occurs during power up with a bill in escrow.).

Electrical Hookup RS-232 Mode (True RS-232 and TTL RS-232)

Note: To enable this mode on the acceptor, make sure the Configuration Card has been configured for "RS-232" mode.

In this mode, the user has a choice of True RS-232 levels or TTL levels.

TTL (5 VDC)

Levels are available in the 120 VAC model, 24 VAC and 12 VDC model of the Apex bill acceptor. Order our Acceptor I/O Harness, Generic (P/N 05AA0002). With this cable, you must manually connect the wires to your machine.

True RS-232

Levels are available only in the 12 VDC Model of the Apex bill acceptor. In the 12 VDC version, the harness has a DB-9 connector and hard drive connector installed to ease customer installation.

Order RS-232 Communication Harness (P/N 05AA0009) to have this ability if you use RS-232.

If you use USB, order USB Communication Harness(P/N 05AA0023).

This RS-232 mode uses a three wire interface. This interface uses a Transmit Line (TXD), a Receive Line (RXD) and DC ground (Gnd).

This RS-232 Interface is compatible with the interface used on Mars™ GL5™ style acceptors. It is a polled interface where the host machine is the Master and the bill acceptor is the Slave.

Note: Mars is a Trademark of Mars Electronics International.

TTL RS-232 Mode Power and I/O Connections (Refer to Figure 1 for Pinouts)

Pin Function and Location	**Apex 12VDC Version**	**Apex 120VAC Version**
DC Ground- Pin 4 (Black wire) on the 18-pin connector	DC communication ground and DC power ground	DC communication ground.
+12VDC- Pin 11 (Red wire) on the 18-pin connector	12VDC acceptor power	Do not use this pin for 120 VAC version!
120 VAC Hot- Pin 4 (Black wire) on the 9-pin connector	Do not use this pin for 12 VDC Version	120VAC hot.
120 VAC Neutral- Pin 6 (White wire) on the 9-pin connector	Do not use this pin for 12 VDC Version	120 VAC neutral.
TXD Line- Pin 5 (Green wire) on the 18-pin connector	TXD- Apex Transmit Line. Connect to Receive line on your equipment	TXD- Apex Transmit Line. Connect to Receive line on your equipment.
RXD Line- Pin 16 (White/Red wire) on the 18-pin connector	RXD- Apex Receive Line. Connect to Transmit line on your equipment	RXD- Apex Receive Line. Connect to Transmit line on your equipment.

True RS-232 Mode Power and I/O Connections

Pin Function and Location	**Apex 12VDC Version**
DC Ground- Pin 2 (Black wire) on the Hard Drive connector.	DC power ground.
+12VDC- Pin 1 (Yellow wire) on the Hard Drive connector.	12 VDC acceptor power.
Communication Ground- Pin 5 (Black wire) on the DB-9 connector.	DC communication ground.
TXD Line- Pin 3 (Green wire) on the DB-9 connector.	Connected to TXD line from your PC. (PC TXD line)
RXD Line- Pin 2 (White wire) on the DB-9 connector.	Connected to RXD line from your PC. (PC RXD line)