1261C Rosecrans Street
San Diego, CA 92106
PHONE: (619) 226-2534

TRANSPORT DATA SYSTEMS

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Automatic Vehicle Classifier

AVC Processor/Host Computer Interface Specification

REVISION STATUS

Rev.	Date	Description
A	5/27/99	Initial Issue
B	5/14/02	Added A11 and A12 message types – updated format
C	6/7/02	Added Exit Reason #2 for message type A04
D	7/9/02	Added A13 message type – Added width to A02 laser scanner message
E	11/25/02	Correct message lengths for A02 and A04 messages

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1.0 SCOPE

This document describes the Transport Data Systems (TDS) Automatic Vehicle Classification (AVC) serial communications interface.

1.1 Definitions, Acronyms, and Abbreviations

The following acronyms and terms are used in this document:

AVC Automatic Vehicle Classification

2.0 APPLICABLE DOCUMENTS

None

3.0 GENERAL DESCRIPTION

The TDS AVC system is a standalone vehicle classification system that consists of a light curtain (or overhead laser scanner), Doppler radar, and an AVC processing computer. The system software processes the sensor inputs to determine the classification of a vehicle as it passes through the sensors. The AVC processor is capable of transmitting the vehicle classification to a host computer in near real-time (less than 50 milliseconds after the vehicle exits the curtain) over a serial interface. This document defines all message formats for the AVC processor/host interface.

3.1 Functional Description

All communications between the AVC processor and the host computer originate at the AVC processor. Currently, there are no message types defined that originate at the host computer. The AVC processor will transmit a message to the host computer when a status change is detected. The types of status changes reported are outlined later in this document.

4.0 DETAIL REQUIREMENTS

4.1 Transfer and Data Format

The baud rate of the interface is configurable (range = 300 - 38400). A byte of data consists of 1 start bit, 8 data bits, and 1 stop bit. No parity bit is used. Data is transferred in ASCII format. All message transfers are initiated by “A”.

4.2 System Initialization Protocol

After an AVC system reset occurs, the AVC processor will transmit a “System Initialization Complete” message to the host computer, indicating that AVC system has completed a reboot sequence and is operational.

4.3 Message Format

Each message consists of a message ID, message data, and a message checksum. All fields will be ASCII text.

The message ID consists of 3 characters. The first character is always “A”. The following two characters identify the message type.

The message data varies in length depending on the message type. The message length for each message type is fixed. Individual message lengths range from 0 to 26 bytes.

The message checksum is the two’s complement of the sum of the message ID and all of the message data bytes. The check sum will be a 3-digit value ranging from 000 to 255. The message lengths identified in the message descriptions below include the checksum. The following example C code function determines the checksum, where pbuf points at the received message string (with the three checksum characters removed from the end of it):

```
unsigned char determine_checksum( unsigned char *pbuf )
{
  unsigned char check_sum = 0;

  while( *pbuf != '\0' )
  {
     check_sum += *(pbuf++);
  }

  /* two's complement */
  check_sum = ( 0xFFu - check_sum + 1 );
  return check_sum;
}
```

4.4 Message Types

Message ID	Message Description
A00	System Initialization Complete
A01	Valid Curtain Penetration
A02	Classification
A03	Rear Camera Trigger
A04	Exiting Lane
A05	Curtain Status
A06	Radar Status
A07	Curtain Beams Permanently Blocked
A08	Curtain Penetration During Radar Failure
A09	Curtain Exit During Radar Failure
A10	Back Out
A11	At Coin Machine
A12	Front Camera Trigger
A13	Heartbeat

AVC System Initialization Complete – 'A00'

Message Length – 6 bytes

This message indicates that the AVC processor has completed a reboot sequence.

Example: "A00095"

Valid Curtain Penetration – 'A01'

Message Length: 11 characters

Field Name	Size
Lane object ID	1
Reason	1
Speed	3

Lane Object ID: a lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object. The value ranges between B and F.

Reason: the reason is a number indicating the reason a lane object was assigned a speed. The reason will indicate if the penetrating object was seen/unseen by the radar. 0 indicates an unseen target. 1 indicates a target that was seen.

Speed: the speed (ft/sec or dm/sec) of the vehicle when it penetrated the curtain.

This message is sent from the curtain thread when a vehicle has sufficiently penetrated the curtain. Sufficient penetration is defined as more than 12 beams blocked and a length greater than 4 feet.

Example: "A01B1020089"

Classification - 'A02'

Message length: 26 bytes for Curtain Configuration
29 bytes for Laser Scanner Configuration

Field Name	Size
Lane object ID	1
Class key #	2
Class ID	4
Sub Class ID	2
Total Axles	2
Max Speed	3
Max Height	3
Length	3
Width (Laser Scanner Only)	3

Lane Object ID: A lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object.
Class key #: the line number of the classification in the avc.dat file (used for debug only).

Class ID: the customer classification of the vehicle.

Subclass ID: the customer subclass value of the vehicle (always 00 if not required).

Total axles: the total number of axles for the entire vehicle.

Max speed: the maximum velocity (ft/sec or dm/sec) of the vehicle while it was in the curtain.

Max height: the maximum height of the vehicle in inches or cm.

Length: the length of the vehicle in feet or dm.

Width: the width of the vehicle in inches or cm (laser scanner configuration only)

This message is sent at the time that the vehicle (>4 feet long) exits the curtain.

Curtain example: "A02E040072000201005201810 4"
Laser Scanner example: "A02E040072000201005201809 6201"

Rear Camera Trigger – 'A03'

Message Length: 7 bytes

Field Name	Size
Lane object ID	1

Lane Object ID: A lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object.

This message is sent when the rear of the vehicle is at a preset distance downstream from the light curtain. The rear camera trigger point is located at the position indicated in the AVC configuration file.

Example: “A03B026”

Exiting Lane – ‘A04’

Message Length: 8 bytes

Field Name	Size
Lane object ID	1
Exit reason	1

Lane Object ID: A lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object.

Exit reason:

- 0 - vehicle exited the lane normally.
- 1 - vehicle track was lost after being classified and overtaken by next vehicle.
- 2 – vehicle was classified and then backed out of the lane.

This message is sent in the following situations:

- Vehicle’s rear bumper reaches a point 5 feet from the radar. Exit reason = 0.
- Vehicle never reaches lane exit point before rear of vehicle is overtaken by the front of a trailing vehicle. Exit reason = 1.
- Vehicle that has been classified (A02 sent) stops before reaching the lane exit point and then backs up through the light curtain in the reverse direction. Exit reason = 2.

Example: “A04B0233”

Curtain Status – ‘A05’

Message Length: 7 bytes

Field Name	Size
Status	1

Status: indicates curtain communication status. 0 indicates no communications. 1 indicates normal communications.

This message is transmitted when the curtain communications status changes. A050 is always transmitted immediately at startup. A051 will follow when normal communications with the curtain have been established.

Example: “A051041“

Radar Status – 'A06'

Message Length: 7 or 11 bytes

Field Name	Size
Status	1
Status word (only sent for status = 2)	4

Status:

- 0 – radar not communicating.
- 1 - normal communication.
- 2 - radar is reporting an internal error (message length = 11 bytes).
- 3 - radar misalignment – not detecting vehicles at the curtain.
- 4 - radar misalignment – not detecting vehicles at the camera trigger point.

Status word: This value is transmitted when the radar status is 2. The 4 characters represent the hex value of the radar's built-in-test word. The built-in-test word is for diagnostic purposes only. The range of status word values is from '0001' to 'FFFF' depending on what type of internal failure the radar has detected.

Example message – "A062F301077" - indicates that the radar has detected an internal failure of type F301.

This message is transmitted when the radar communication status changes. A060 is always transmitted immediately at startup. A061 will follow when communications have been established.

Example messages are:
"A060041"
"A061040"

The message 'A063' is transmitted to indicate that the zero velocity alarm threshold has been exceeded. The zero velocity alarm indicates that an unacceptable percentage of vehicles are penetrating the curtain without having been detected by the radar. This alarm provides an indication of radar misalignment. Example message: "A063038".

The message 'A064' is transmitted to indicate that the 'unlocked at camera trigger' alarm threshold has been exceeded. This alarm indicates that an unacceptable percentage of vehicles have been outside the radar's detection field when they reached the camera trigger point. This alarm is not generated when the lane configuration does not include a camera. Example message: "A064037".

Curtain Beams Permanently Blocked – 'A07'

Message Length: 9 bytes

Field Name	Size
Beams permanently blocked	3

Beams permanently blocked: # of curtain beams that are being masked out due to blockage.

This message will be transmitted when the "permanently blocked" status of any beam changes. The status of a beam is determined to be "permanently blocked" if it has been blocked for more than 5 seconds when a vehicle profile reaches 100 feet. A "permanently blocked" beam is then masked from profiler/classifier operations until the beam status is determined to be unblocked. A beam is determined to be unblocked the first time it is reported as clear.

Example message: "A07003197" – Indicates 3 beams are "permanently blocked".

Curtain Penetration without Radar – 'A08'

Message Length: 6 bytes

This message is transmitted when a curtain penetration occurs during periods when velocity information is not available from the radar (i.e. radar failure or loss of radar communications). This message may be used in conjunction with A09 during such periods to separate vehicles until the faulty radar is repaired.

Example messages:
"A08087"
"A09086"

Example message sequence:
A01B1020089 Normal AVC operation
A02B0400720002010052018107
A03B026
A04B0233
~
A060041 Loss of radar coms – AVC switches to separator mode
A08087 Curtain penetration
A09086 Curtain exit
A08087 Curtain penetration
A09086 Curtain exit

Curtain Exit without Radar – 'A09'

Message Length: 6 bytes

This message is transmitted in conjunction with the A08 message (see example above). It indicates a curtain exit has occurred while the radar is not functioning. This allows the curtain to be used as a separator until the radar fault has been corrected.

Back Out - 'A10'

Message Length: 7 bytes

Field Name	Size
Lane object ID	1

Lane Object ID: A lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object.

This message is transmitted when a vehicle that was previously reported as a valid curtain penetration (A01), has backed out of the curtain before a classification was generated for the vehicle.

Message example: "A10C027"

Vehicle at Coin Machine - 'A11'

Message Length: 7 bytes

Field Name	Size
Lane object ID	1

Lane Object ID: A lane object ID is assigned to a lane object when it penetrates the curtain. The ID is used for all subsequent messages referring to the object.

This message type is used only when the lane configuration includes a coin machine. A message is sent when the front of a vehicle reaches the coin machine (location is configurable in the AVC configuration file). This message is used to associate coins with the correct vehicle.

Message example: "A11D025"

Front Camera Trigger – 'A12'

Message Length: 7 bytes

Field Name	Size

Lane object ID	1

This message is sent when the front of the vehicle is at the front camera trigger point downstream from the light curtain. The front camera trigger point is located at the position indicated in the AVC configuration file.

Example message: “A12F022”

Heartbeat – ‘A13’

Message Length: 6 bytes

This message indicates that the AVC process is running. The message is transmitted at the rate that is defined in the avc.conf file. The default rate is 10 seconds.

Message example: “A13091”

Message Sequencing Example

The first two fields of the message are the timestamp. The AVC messages are brackets by |.

Vehicle C passes through the lane and is classified:
[05/10][06:33:04:85]|A01C1019080|
[05/10][06:33:06:83]|A02C1005350005021111046103|
[05/10][06:33:07:63]|A03C025|
[05/10][06:33:08:34]|A04C024|

Vehicle F passes through the lane and is classified:
[05/10][06:33:08:99]|A01F1019077|
[05/10][06:33:09:61]|A02F0400720002019052015097|
[05/10][06:33:10:50]|A03F022|
[05/10][06:33:11:36]|A04F021|

Vehicle E
[05/10][06:33:11:81]|A01E1017080|
[05/10][06:33:12:44]|A02E0400720002018045015097|
[05/10][06:33:13:39]|A03E023|

Vehicle D enters curtain before Vehicle E has exited lane:
[05/10][06:33:13:83]|A01D1016082|
[05/10][06:33:14:16]|A04E022|
[05/10][06:33:14:68]|A02D0400720002019058017091|
[05/10][06:33:15:56]|A03D024|