



SmarTek Systems, Inc.TM

14710 Kogan Drive
Woodbridge, VA 22193
703-680-6554
Sales 410-315-9727

SmarTek Acoustic Sensor - Version 1 (SAS-1)

Installation and Setup Guide

Part-F

SAS-1 Setup Using SAS Monitor and Setup Software

5 August 2005

Note: In all cases, do not work or position equipment over an active traffic lane. Working over active lanes presents a hazard to the installer and to travelers using the highway. Follow local authorized procedures when installing the SAS-1 unit and any associated components or subsystems.

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Connecting to SAS-1 via the SAS-CT and Establishing Communication

Connect the SAS-CT (RJ-45) to the PC comm port (DB-9) using the supplied serial cable. Check that power to the SAS-CT is present and the fuse is in place on the SAS-CT. Run the **SAS Monitor and Setup** program on the PC by clicking **Start/Programs/SmarTek Systems/SAS_Monitor_V6**. On the Introduction screen, click **Direct**. All SAS Monitor and Setup parameters are stored in a parameter file (**user_specified_name.smp**) with a user specified name and a “.smp” extension . Select the SAS Monitor parameter file (.smp) using the standard “Open File” dialog window which is displayed after selecting the **Direct** button. The SAS Monitor and Setup’s main display is shown in Figure 1.

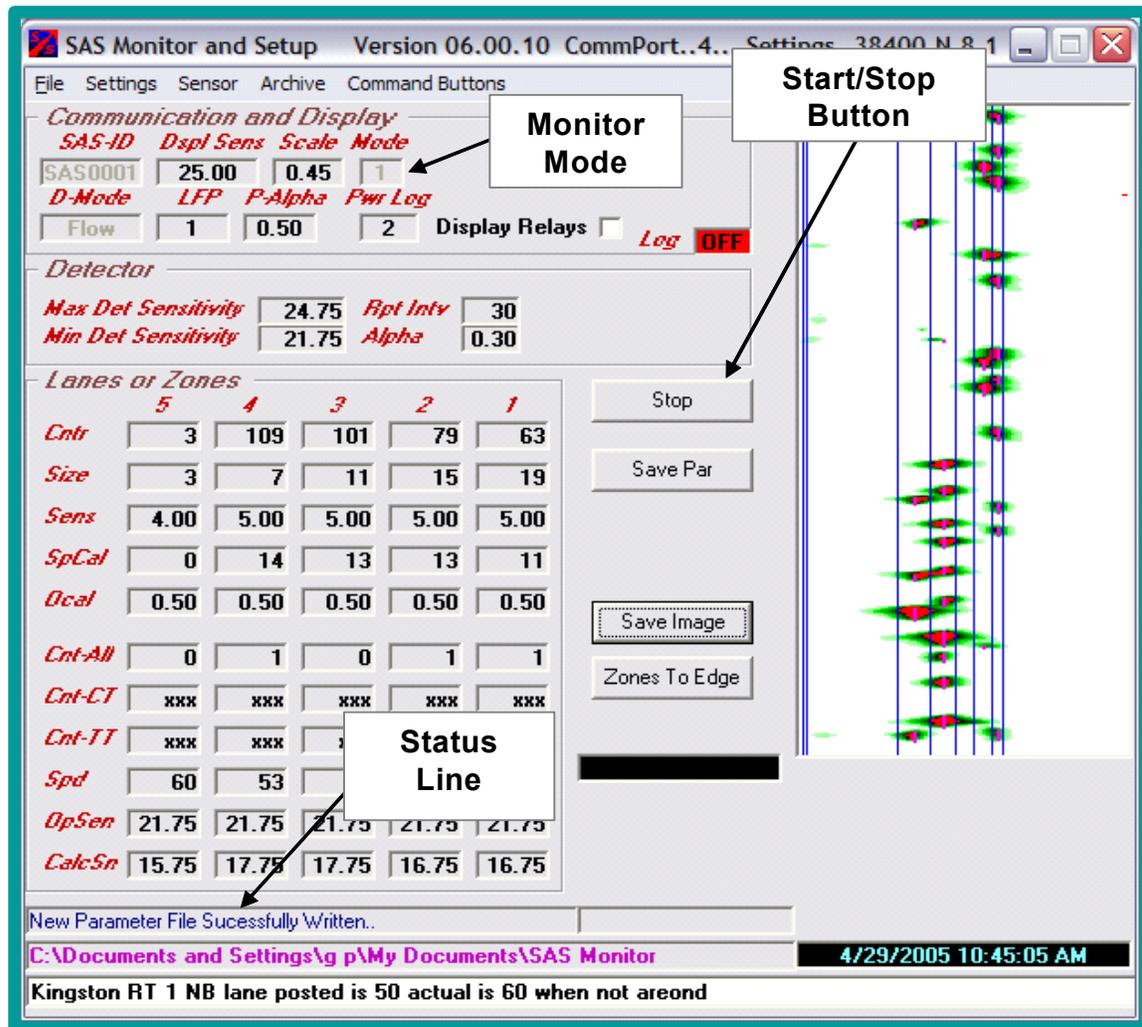


Figure 1 SAS Monitor and Setup Main Display

To change parameter values in the SAS Monitor and Setup Display, left click in the upper (increment) or lower (decrement) part of the parameter value display field. For most of the parameters, holding the Shift key down while clicking in the parameter field increases the increment/decrement amount.

Click the menu item **Settings/Comm Port/Setup Comm Port** to set the PC Comm Port parameters. The **Comm Port Number** for a laptop PC is typically 1 or 2 for native comm ports or may be some other number if a USB to Serial Comm Port converter is used. Set the Comm Port Number to the appropriate value corresponding to the serial comm port. The rest of the Comm Port parameters should be as follows:

Baud Rate	38400 (set to match the SAS-1 baud rate)
Data Bits	8
Parity	N
Stop Bits	1
HW Flow Control	Unchecked
SW Flow Control	Unchecked
Set DTR line high	Checked
Set RTS line high	Checked.

Note: If the SAS-1 baud rate is not known, click the **Settings/Comm Port/Find SAS Baud Rate** menu item to let SAS Monitor try to determine the SAS-1 baud rate. The progress/result of the SAS-1 baud rate search is displayed in the Status Line in the lower left part of the SAS Monitor and Setup Main display. After SAS Monitor and Setup successfully determines the SAS-1 baud rate, the user must change the SAS Monitor and Setup baud rate to match the SAS-1 baud rate as described above.

Click the menu item **Sensor/Get SAS ID**. This retrieves the SAS ID from the SAS-1. The SAS ID is a 7 character ID (SAS0001, SAS0002, etc.). The status line in the lower left portion of the main display will indicate success or failure of the operation. If the operation fails, click the **Stop** button and retry the operation.

Click the menu item **Sensor/Get SAS Parameters**. The SAS-1 responds by sending all parameters to SAS Monitor and Setup. The parameter values displayed are updated according to what came from the SAS-1. The status line in the lower left portion of the main display will indicate success or failure of the operation. If the operation fails, click the **Stop** button and retry the operation.

Set the Monitor Mode to 2 by clicking in the **Mode** value field to increment or decrement the value. Click the menu item **Sensor/Reset SAS**. The SAS-1 will respond with a banner (status line in the lower left portion of the main display) indicating the **software version number, the size of the non-volatile flash memory in the SAS-1, the presence or absence of a battery backed real time clock in the SAS-1, and the archive update period.**

Setting Default Operating Modes

To set the SAS-1 Default Operating Mode, left click the menu item **Sensor/Set SAS Default Mode**. The dialog window that appears provides for setting several parameters as described below.

Operating Mode – Flow, Azimuth Detect, Single Relay, Flow/Truck Type or Dual Loop Relay (with loop separation). *Set this to the desired power on mode for operation.*

Monitor Mode – Freeway (more dynamic detector settings) or Intersection (less dynamic detector settings with up to a 2 second detection on hold time). *Set this according to required operation (monitor Freeway traffic or Intersection Stop Line Presence).*

Internet Connectivity – Yes or No sets a timeout parameter switch in the SAS-1 to account for expected internet latency and delays when uploading new software to the SAS-1. *Set this to No unless using internet connectivity between the SAS-1 and the PC used for setup.*

Communication Mode – Periodic or Polled sets the message communication mode from the SAS-1. *Set this to Polled if the SAS-1 is to wait for a message request before sending data. Set this to Periodic if the SAS-1 is to send its data message every Report Interval.*

Report Interval – 1 second to 220 seconds. *Set this to the desired report interval to be used for collecting and estimating traffic flow measures (i.e. 20 sec, 30 sec, etc.).*

Radio Network Number – For wireless operation, this specifies the spread spectrum hopping pattern (or network number) needed to match the wireless base unit (roadside cabinet). Up to 64 network numbers may be used to eliminate interference between radio networks (consult with SmarTek Systems for detailed directions for setting this parameter, 0 to 63). The capability to change the SAS-1 Wireless Network Number using this dialog window is implemented in SAS-1 firmware version SAS_131 or higher. *For RS-422 hard wired home run configurations, set this to 0.*

After setting the Default Operating Mode parameter values, click the **OK** button. Click the **Yes** button after reading the warning message. At this point the updated Default Operating Mode parameters are sent to the SAS-1 and saved in non-volatile memory. The status line in the lower left portion of the main display will indicate success or failure of the operation.

SAS Monitor and Setup Display and Parameters

The area to the right on the SAS Monitor and Setup Display is used to show measurement/signal time history, while the area to the left (upper part) is used for common parameter display and modification. The area in the lower left part of the SAS Monitor and Setup Display is for lane by lane parameter display and modification and for showing the most recent traffic flow measurements on a lane by lane basis.

As can be seen in Figure 1, there are several parameters fields grouped in three frames and are described in the following paragraphs.

Communication and Display Parameters: These parameters are used to set or identify the SAS-1 data communication mode and the SAS Monitor and Setup display sensitivity.

SAS-ID - Identifies a specific SAS-1 unit for monitoring and setup. This ID must match the ID for the connected SAS-1 in order to communicate.

Dspl Sens - Controls the display of data on the TAI display. Higher values of Dspl Sens cause more acoustic data to be displayed. This parameter is only used for the SAS Monitor and Setup Traffic Acoustic Image (TAI) display. **A typical value for this parameter = 25.**

Scale - This is a scaling parameter for converting acoustic power measurements (intensity) into the levels of color (green) for the TAI display. Larger values of this parameter would cause each acoustic power measurement to be shown in a darker shade of green.

Mode - Sets the display mode for the SAS Monitor and Setup program. For each of the available modes, the SAS-1 is told to send specific measurements for display.

Mode=1 .. Traffic Acoustic Image Mode (real time acoustic power and detection indication). This mode is used to setup detection zones and to calibrate speed.

Mode=2 .. Multi-lane Flow Mode (vehicle volume, lane occupancy, and average speed per lane). This mode displays and logs traffic flow time history.

Mode=3 .. Azimuth Detection Measurements Mode (peak amplitude and angle per detection). This is a special mode used to display azimuth tracking measurements. This mode is not used in highway monitoring applications.

Mode=4 .. Multi-lane Flow Mode (total vehicle volume, commercial truck volume, tractor trailer volume, lane occupancy, and average speed per lane). This mode displays and logs traffic flow time history.

Mode=7 .. Polled Multi-Lane Flow Mode (vehicle volume, lane occupancy, and average speed per lane). This mode can log traffic flow time history for each SAS-1 polled. SAS Monitor and Setup can be set to poll up to 20 SAS-1 units.

Mode=10 . Programmable Button Response Display Mode using the visible message window. This mode is used to display the response of a device to programmable messages sent out by clicking the Programmable Buttons.

D-Mode - Default Operating Mode (not interactive) that the SAS-1 unit will fall back to on power up, reset, or loss of data carrier detect when using modem communications.

LFP - Lane Finder Period specifies the amount of time (in minutes) used to collect data and calculate the Lane Finder Function.

P-Alpha - Plot Alpha sets the amount of smoothing for the traffic flow measurements display used in Mode=2 and 4 operation of SAS Monitor and Setup (1.0 for no smoothing, .05 for significant smoothing).

Pwr Log – Power Logging Period specifies the amount of time (in minutes), that power data (TAI display data) is logged when enabled.

Log – Logging indicator shows whether traffic flow message logging is enabled. This flag shows “Off” in Red when message logging is disabled and “On” in Green when message logging is enabled.

Detector Parameters: These parameters are used by the SAS-1 unit to adjust vehicle detection sensitivity.

Max Det Sensitivity - Sets the SAS-1’s maximum detection sensitivity. Detection sensitivity increases (“detection threshold”decreases) with higher values. The SAS-1 vehicle detector sensitivity always operates between the Minimum Detection Sensitivity

(“upper detection threshold”) and the Maximum Detection Sensitivity (“lower detection threshold”). **A typical value for this parameter = 24.75.**

Min Det Sensitivity - Sets the SAS-1’s minimum detection sensitivity. Detection sensitivity increases (“detection threshold”decreases) with higher values. The SAS-1 vehicle detector sensitivity always operates between the Minimum Detection Sensitivity (“upper detection threshold”) and the Maximum Detection Sensitivity (“lower detection threshold”). **A typical value for this parameter = 22.00.**

Alpha - Sets the amount of averaging over time of acoustic power before vehicle detection (for no smoothing use 1.0, for heavy smoothing use 0.05). **A typical value for this parameter is 0.30.**

Rpt Intv - Sets the data collection and reporting interval (1 second to 220 seconds) of the SAS-1 unit when operating in the Flow Mode (Mode=2,4,7) or the Azimuth Detection Mode (Mode=3). The default operational value for the reporting interval is set using the Set Default Operating Mode Dialog Window.

Lanes or Zones Parameters: These parameters define each detection zone position and size with respect to 181 TAI display pixels and the 91 look directions for which power is measured in the SAS-1 unit. Calibration parameters for lane occupancy and average speed are also specified on a lane by lane basis.

Cntr - Sets the detection zone center position in terms of 181 TAI display pixels. The SAS-1 unit will convert this value to the appropriate look direction index value.

Size - Sets the detection zone size in terms of 181 TAI display pixels. The SAS-1 unit will convert this value to the appropriate range of look direction index values.

Sens - Specifies lane by lane detection sensitivity adjustment. A simple procedure for setting this parameter for each lane is described later in this document.

SpCal –Specifies the lane by lane adjustment factor used to calibrate the average speed for each lane. A effective tool for setting this parameter to calibrate speed for each lane is described later in this document.

Ocal - Specifies the lane by lane adjustment factor used to calibrate the lane occupancy for each lane (**typical value= 0.5**).

Making changes to SAS-1 parameters will cause a yellow parameter flag to be displayed. This flag is a reminder that some or all of the displayed parameters have been changed (only in SAS Monitor) and need to be sent to the SAS-1 and written to the SAS-1’s non-volatile memory.

SAS-1 Setup

The SAS-1 is best setup with active traffic in the lanes to be monitored.

The **SAS ID** is of the form SASxxxx, where xxxx is a four digit number (i.e. SAS0001, SAS0002,....SAS0999, etc.). For installations where only one SAS-1 will be connected to a cabinet controller via a home run cable or wireless link, set the SAS ID to **SAS0001**. **For installations where multiple SAS-1s will be connected to a single cabinet controller via a single home run cable or a wireless link, set each SAS ID to consecutive values starting at**

SAS0001. For example, a traffic monitoring station with three SAS-1s connected to the roadside cabinet controller using a single home run cable, should have the **SAS IDs** set to **SAS0001, SAS0002, and SAS0003.** **Each SAS ID must be set before the units are “wired” together on the same home run cable or wireless link.** If multiple SAS-1 units are installed sharing the same home run cable and each have the same SAS ID, then communication with each SAS-1 is not possible. To correct this situation without physically disconnecting the SAS-1 units, change each SAS-1 ID, using the SAS Auto ID command described in Section G (Part-G, SAS-1 Detailed Communication Formats).

To set the SAS ID, click the menu item **Sensor/Change SAS ID.** An Information Dialog Window will popup asking for the new SAS ID. The new SAS ID may be incremented or decremented by **left clicking** in the upper or lower portion of the SAS ID field. After providing the new SAS ID, click **OK.** The Status line at the lower left of the display should indicate a positive response (OK) from the SAS-1 unit. The SAS-ID field will then be updated to the new ID value. If the positive “OK” response is not quickly received, click the **Stop Button** and repeat the Change SAS ID procedure just described.

To communicate to and begin the setup for a specific SAS-1 unit, click the menu item **Sensor/Get SAS ID** or click in the **SAS ID** field (Figure 1) to set the SAS ID field value to the appropriate value.

Click the menu item **Sensor/Get SAS Parameters.** Check and set (if necessary) the following parameters to their respective values as follows:

Dspl Sens	24.75 (higher values show more signal background)
Scale	0.45 (increase to make green acoustic response darker)
Mode	1 (Traffic Acoustic Image Mode-TAI)
Min Det Sensitivity	22.00 (higher values-more sensitive)
Max Det Sensitivity	24.75 (higher values-more sensitive)
Alpha	0.30 (toward 1.0 for less smoothing)
Sens (per lane)	4.00 (As initial value)
SpCal (per lane)	10 (As initial value)
Ocal (per lane)	0.50 (Larger value increase occupancy estimate)

If the **Start/Stop** button is showing **Stop**, then click the **Stop** button. Next click the **Save Par** button. After the **Save Par** button turns to the **Send Par** button, click it. At this point the detection sensitivity parameters have been sent to the SAS-1 unit. Click the menu item **Sensor/Write SAS Parameters.** **This saves the parameter values to the SAS-1’s non-volatile memory. For SAS-1 firmware version SAS_131 and higher, the Sensor/Write SAS Parameters step is not necessary.**

Set Detection Zone Position and Size for Multi-Lane Monitoring

The SAS Monitor and Setup program includes **Automatic Lane Finder** processing. This processing provides a more automated and quantitative approach for setting the zone or lane positions. The Lane Finder Function (LFF) will be calculated and displayed as a red plot in the

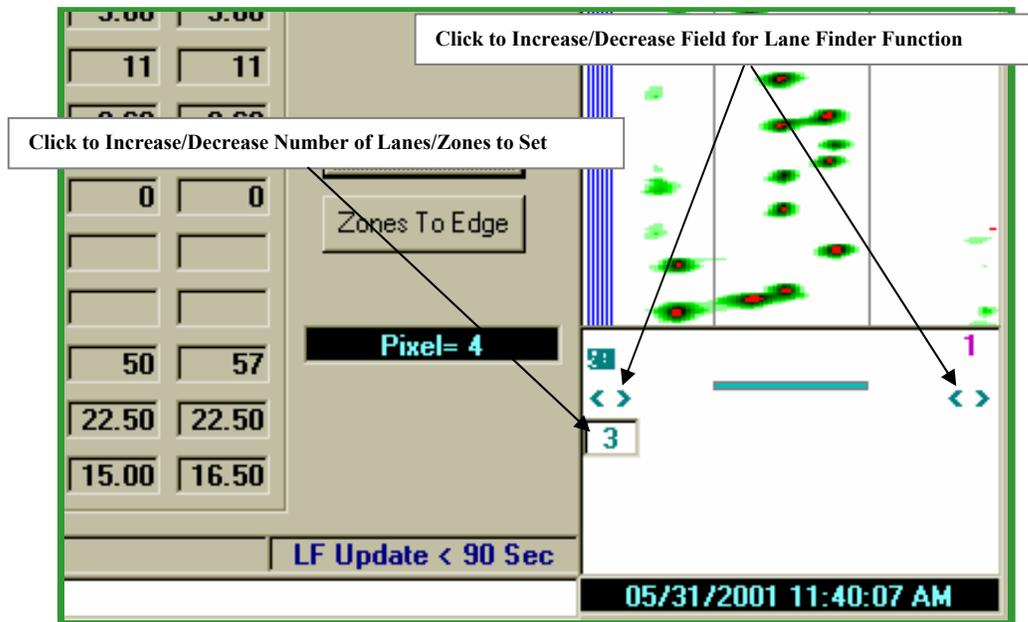


Figure 2 Begin Lane Finder Functions

Lane Finder Function display area below the TAI display. The peaks of the LFF show where each lane should be set, while the valleys indicate quiet space between lanes.

Set the Monitor **Mode** to **1** (Traffic Acoustic Image Display Mode).

If the **Start/Stop** button shows **Stop** then click the **Stop** button to stop the current display activity. Click the **Zones To Edge** button to move all detection zones to the edge of the display. Click the **Save Par** button and after it changes to **Send Par** click the **Send Par** button. Now click the **Start** button. Click in the upper or lower part of the Lane Finder Period (LFP) display field to set the Lane Finder Period to **3** (3 minutes). Select the **Settings/Lane Finder** menu item to show the Lane Finder Function display (Figure 2).

The TAI and Lane Finder displays should look like those shown in Figure 2. Click the <> symbols on the left or right side of the Lane Finder display to set the **Lane Finder Function Field**. This field is indicated by the horizontal bar between the <> symbols and the gray lines in the TAI display. The Lane Finder Function will only be computed within the area indicated by the horizontal bar (and the gray lines displayed in the TAI). This allows the user to select the specific set of look directions to be considered for automatic lane finding. The **Number Control** shown on the left side of the Lane Finder Function display indicates the maximum number of lanes to find (1 to 5). Clicking this control will increment or decrement the maximum number of lanes to find.

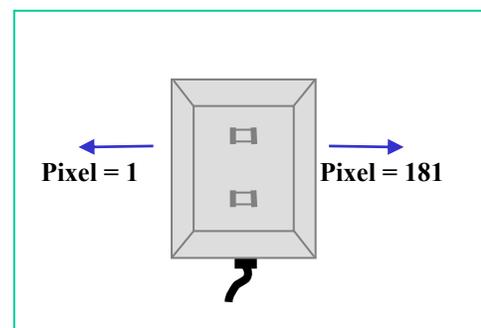


Figure 3 TAI Orientation

For this display, it is important to understand the point of reference. Move the mouse pointer slowly through the TAI display area from left to right. As the mouse pointer moves through, you should see the green readout to the left of the TAI display area change from **Pixel=1** to **Pixel=181**. If you were standing just behind the SAS-1 (same end as the strain relief) to your left would be Pixel=1 and to your right would be Pixel=181 (Figure 3). As vehicles pass by the SAS-1, they appear as the most recent update. Vehicles which passed by several seconds earlier, appear higher on the TAI display. Hence, the top of the display area shows the oldest vehicle acoustic signals, while the bottom shows the newest vehicle acoustic signals.

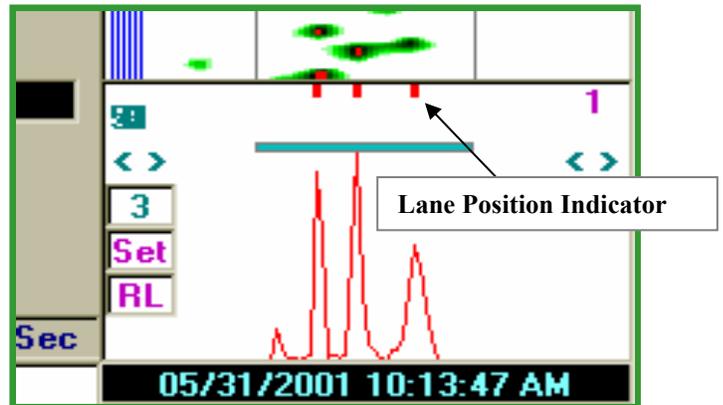


Figure 4 Lane/Zone Position Indicators

The total display time (vertical) is 30 seconds unless the SAS-1 baud rate is set to 19.2 Kbps or less in which case the total TAI display time is 60 seconds for 19.2 K bps or 120 seconds for 9600 bps. Once the display reaches the bottom, it clears and starts again at the top. If the TAI Scroll mode is active (click **Settings/Scroll Traffic Acoustic Image(TAI)**), the TAI display builds (or scrolls) from the bottom up continuously and does not clear. The Scroll mode is the preferred mode, however, it requires increased computer speed. This display continues until stopped by the installer.

The green vehicle acoustic power “blobs”, as they appear and fill the display, will form “columns”. An occasional lane switcher will appear to be “out of line”, however, each “column” of green vehicle “blobs” define each lane’s position. The process of setting the detection zone positions and sizes for the SAS-1 is based on where the “columns” of vehicle “blobs” are located. The SAS Monitor Lane Finder Function integrates the acoustic power data for the period specified in the **LPF** display field (set this to 2 or 5 minutes for heavy traffic and to 10 minutes or more for light traffic). At the end of the Lane Finder integration period, the Lane Finder Function is displayed (updated) showing the red function with peaks and nulls (Figure 4). Also displayed or updated are red indicators just below the TAI display area. These indicators show the lane or zone center positions found by the Lane Finder Function. The time remaining for a Lane Finder update is indicated in the field to the left of the Lane Finder Display area. Once the Lane Finder Function

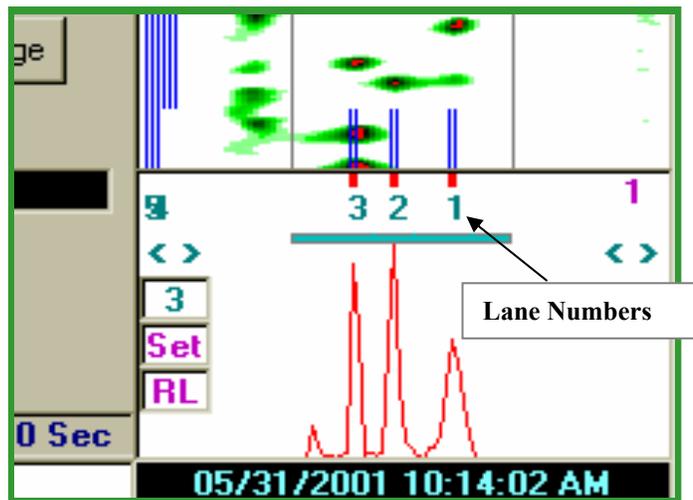


Figure 5 Setting the Lane/Zone Center

is updated, two additional controls are displayed on the left side of the Lane Finder Function display area.

The **Set** control is used to select all lane positions as identified by the Lane Finder's red indicators. Clicking this control will cause each lane center position to be set according to the each red indicator. The lane numbers will be selected starting with the magenta colored number shown in the upper right of the Lane Finder display area. This number is incremented by left clicking anywhere in the Lane Finder display area. The **RL** or **LR** control specifies numbering lanes from right to left (**RL**) or left to right (**LR**). Clicking on this control toggles the specified numbering direction (**RL** to **LR**). After clicking the **Set** control, the Lane Finder Function display should look like that of Figure 5. Additionally, each lane center (**Cntr**) display field and the position of the corresponding blue lines are updated to reflect the lane center values.

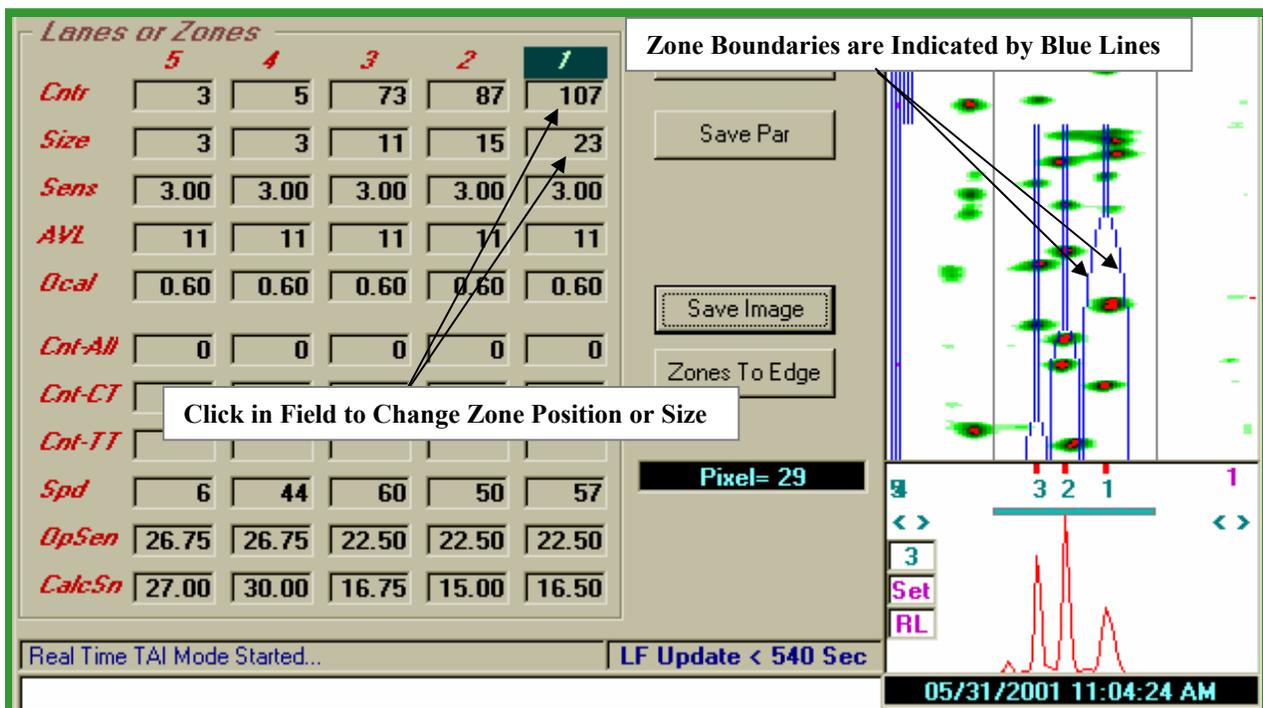


Figure 6 Setting the Lane/Zone Size

After the lanes have been set by clicking the **Set** control, each lane is indicated with the lane number shown below the red lane center indicators. At this point each lane center position has been found and set automatically. At this point, the installer should observe the TAI and Lane Finder Function displays for a short period of time to verify that the lane centers have been found and set correctly.

Clicking in the **Cntr** (lane center) and **Size** (lane size) fields for each lane will cause that lane's Blue Lines (indicate lane edges) to change on the TAI display. To increment or decrement a parameter value, left click in the parameter field. Each zone size can be adjusted until each pair of Blue Lines (detection zone edges) encompass each column of green acoustic power "blobs". Set the zone size by clicking in the **Size** field for each zone (lane) as shown in Figure 6. Once

satisfied with the zone settings (as viewed on the TAI display), click the **Stop, Save Par** , and the **Send Par** buttons. Click the menu item **Sensor/Write SAS Parameters** to save the new parameters to SAS-1's non-volatile memory. For SAS-1 firmware version SAS_131 or higher, the Write SAS Parameters step is not necessary to save the parameters to non-volatile memory in the SAS-1.

Detection Zone/Lane Positions and Sizes may also be set or reset manually by clicking in the **Cntr** and **Size** field for each lane. Before manually positioning each zone, click the **Zones To Edge** button. Click the **Stop, Save Par, Send Par** and the **Start** buttons. This immediately sets the zone positions to the left edge of the display and sets the zone size to 3 pixels. With all the Blue Lines starting at the TAI display edge, it is easier to set the position and size of each zone. Once satisfied with the zone positioning (as viewed on the TAI display), click the **Stop** button, click the **Save Par** button, and then click the **Send Par** button. This sends the newly adjusted detection zone parameters and any others which might have been changed to the SAS-1 unit. Click the menu item **Sensor/Write SAS Parameters** to save the new parameter values to SAS-1's non-volatile memory. For SAS-1 firmware version SAS_131 or higher, the Write SAS Parameters step is not necessary to save the parameters to non-volatile memory in the SAS-1.

Click the **Start** button to start the TAI display and check the position of the columns of green "blobs" with respect to the new lane positions (as in Figure 1). Also **check the magenta detection markers** to see if all vehicles are detected (a magenta marker for each green "blob"). Each magenta detection marker is placed in the lane or zone center for which the vehicle detection was assigned.

In addition to the automated Lane Finder for finding and setting the lane center positions, another approach is supported in SAS Monitor. This approach uses the Lane Finder Function as a guide to choosing the lane centers. To choose each lane to be set, move the mouse cursor to the Lane Finder Function display area and left click. Left click a few times and note the lane number label in the Lanes or Zones frame. After selecting the lane to be set (Lane number should be highlighted with a green box), right click while pointing to a peak in the LFF function. The lane position is set to the same position of the LFF peak. Note the change in the Blue Lane Lines on the TAI display. Continue this process to set the positions of all zones (lanes). Set the zone size by clicking in the **Size** field for each zone (lane). Once satisfied with the zone settings (as viewed on the TAI display), click the **Stop, Save Par** , and the **Send Par** button. Click the menu item **Sensor/Write SAS Parameters** to save the new parameters to SAS-1's non-volatile memory. For SAS-1 firmware version SAS_131 or higher, the Write SAS Parameters step is not necessary to save the parameters to non-volatile memory in the SAS-1.

Set Detection Sensitivity for Each Lane

For the SAS-1 to effectively adjust to changing traffic conditions, the detection sensitivity for each lane must be set. Lane sensitivity (**Sens** parameter) must be set during **Free Flow** traffic conditions. If the **Start/Stop** button on the main SAS Monitor and Setup display shows "Stop", click the **Stop** button to stop the current display activity.

Click the **Sensor/Show SAS Lane Power vs Time** menu item to open the SAS Lane Power vs Time Plot Display Window (Figure 7). To select each lane for setup:

- Click the **Pause** button,
- Click the **Lane Selection** option ,
- Click the **Continue** button.

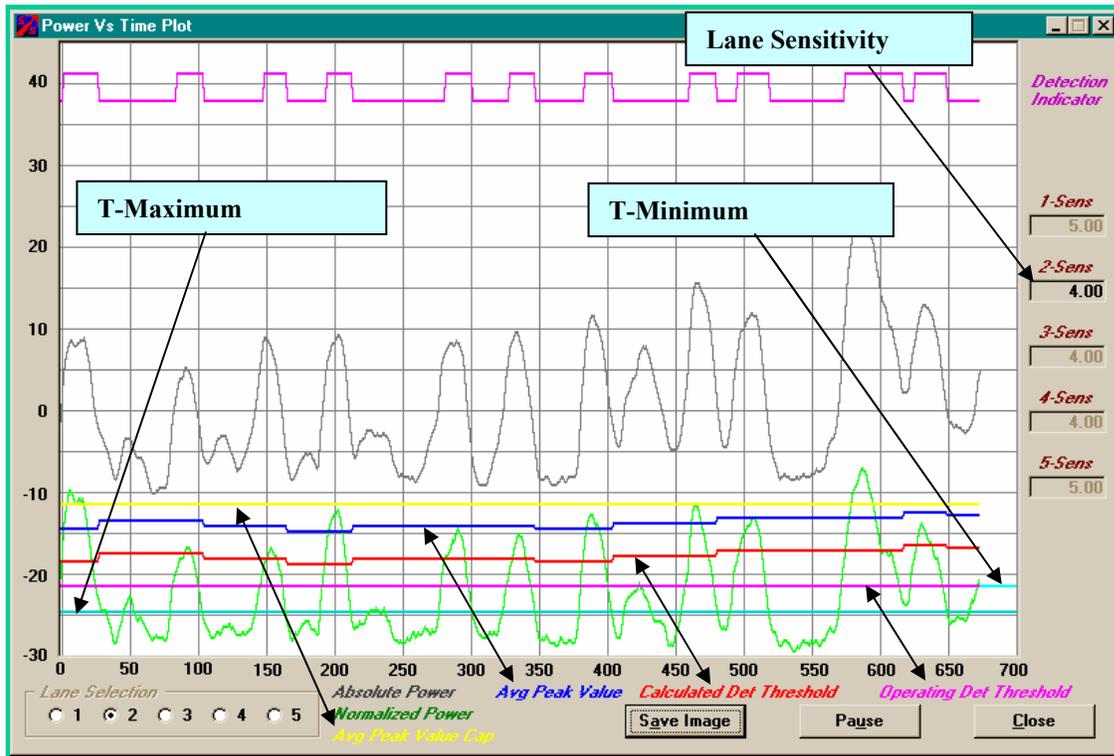


Figure 7 Setting Detection Sensitivity for Each Lane

After selecting a lane for setup, adjust the lane sensitivity by left clicking in the upper or lower part of the Lane Sensitivity field (**1-Sens**, **2-Sens**, etc. to the right of the plotting area). This will cause the **Red Trace (Calculated Detection Threshold)** to move up or down in 0.25 db increments. Adjust the Lane Sensitivity for each lane until the **Red Trace** is approximately 3 to 5 db above the **Cyan Trace** for the Minimum Sensitivity Threshold (T-Minimum Sensitivity). The **Red Trace** will track below the **Blue Trace (Avg Peak Value)** by the amount of the Lane Sensitivity. Typical values for Lane Sensitivity are 4 to 6 db.

Click the **Close** button to close the SAS Lane Power vs Time Plot Window. On the SAS Monitor and Setup main display click the **Save Par** , and the **Send Par** button.

Calibrate Speed Estimates for Each Lane

Set Detection Sensitivity for Each Lane

After setting up the SAS-1 detection zones/lanes and the lane by lane detection sensitivity, the speed estimate for each lane can be calibrated. If the **Start/Stop** button on the main SAS Monitor and Setup display shows “Stop”, click the **Stop** button to stop the current display activity. Now click in the upper or lower part of the **Mode** display field to set the SAS Monitor display to **Mode 1** (TAI display) and then click the **Start** button to start the TAI display. Click the **Settings/Speed Calibration Window** menu item. This opens the Speed Calibration Window shown in Figure 8.

The plotting area in the Speed Calibration Window shows the speed histogram plot for each lane. The plotting area has 10 mph grid lines from 0 mph to 100 mph. Move the mouse pointer in the plotting area from side to side and observe the speed readout above the histogram plotting area. As the TAI display runs, speed histogram data is continuously collected. Click on the **Auto SpCal Estimate Check Box** to enable the speed histogram plots and automatic SpCal estimation. Let the TAI display run for several minutes in order to collect a significant number of speed samples for each monitored lane. The raw speed histogram data is plotted in **Red**. The data plotted in **Blue** shows the “smoothed” histogram data.

With the **Auto SpCal Estimate** checked, SAS Monitor and Setup collects speed histogram data as each vehicle is detected. The mean value (peak of the blue plot) of each speed histogram is found and marked (black mark). From this value, the Specified Free Flow Speed, and the Current SpCal value, the **New SpCal** value for each lane is calculated. These values are displayed in the New SpCal field for each lane.

To transfer the automatically calculated New SpCal value for each lane to the SpCal fields on the main SAS Monitor and Setup display, click the **Set SpCal** button for each lane. Note that when these fields are updated, the Yellow Parameter Flag becomes visible. To complete the speed calibration procedure, the updated SpCal values need to be sent to the SAS-1. Click the **Stop** button to stop the TAI display. Click the **Save Par** button. After the **Save Par** button turns to

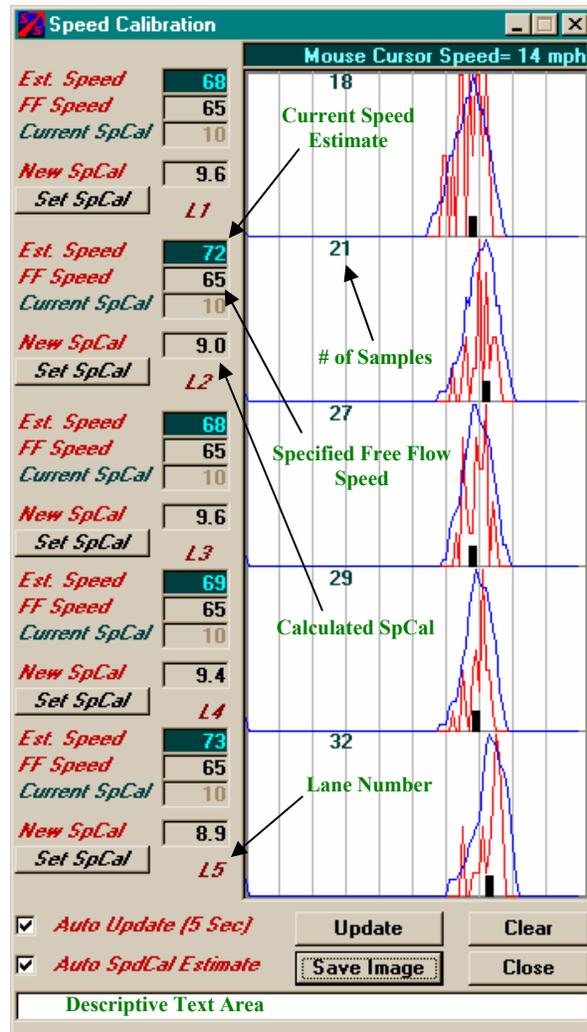


Figure 8 SAS-1 Speed Calibration

the **Send Par** button, click it. At this point, the updated SpCal parameters have been sent to the SAS-1 unit and saved in non-volatile memory.

To **manually calibrate** the speed estimates for each lane perform the following steps:

Enter the known free flow speed (mph) for each lane by clicking in the upper or lower part of the **FF Speed** field.

Capture the current speed estimate for each lane by positioning the mouse pointer in the center (horizontal center) of each smoothed histogram plot (**Blue Trace**) and left clicking. This estimate is shown in the **Est Speed** field. Repeating this step will update the value in the **Est Speed** field.

Click in the **New SpCal** field to compute and display a new SpCal value for use by SAS-1. The new value computed is displayed in the **New SpCal** field. Note that when the New SpCal value is computed and displayed, the **Set SpCal** button becomes visible for that lane.

Click the **Set SpCal** button for each lane to update the SpCal field on the main SAS Monitor and Setup display. Note that when these fields are updated, the Yellow Parameter Flag becomes visible. To complete the speed calibration procedure, the updated SpCal values need to be sent to the SAS-1. Click the **Stop** button to stop the TAI display. Click the **Save Par** button. After the **Save Par** button turns to the **Send Par** button, click it. At this point, the updated SpCal parameters have been sent to the SAS-1 unit and saved in non-volatile memory.

Click the **Start** button in the SAS Monitor and Setup main display to start the TAI display. Click the **Update** button in the Speed Calibration Window to update the speed histogram plots. Update the speed histogram plots for several minutes to verify that the speed calibration is satisfactory. If the speed calibration for each lane is acceptable then close the Speed Calibration Window. If the speed calibration is not acceptable, repeat the procedure.

Verify Default Operating Mode and Parameters

The SAS-1 is now be set to operate in one of two modes real time modes. In the **Multi-Lane Flow Mode**, the SAS-1 computes and reports vehicle count, lane occupancy, and average speed for each detection zone (lane). In the **Multi-Detection Zone Relay Mode**, the SAS-1 outputs a bit serial relay message for up to 5 lanes with 1 or 2 relays per lane. To set, reset, or verify the SAS-1 unit default operating mode, click **Sensor/Set SAS Default Operating Mode**. In the popup menu select or verify the operating mode and the corresponding parameters including report interval. Click the **OK** button and then click the **Yes** button after reading the warning message in the information window.

Setting Up the SAS-1 Archive Header Records

The SAS-1 Archive Header Records contain parameters used for continuously archiving traffic flow data and for controlling some basic SAS-1 behavior.

The SAS Monitor and Setup software provided by SmarTek Systems includes tools to setup or edit the SAS-1 parameters and information stored in the Archive Header Records, retrieve the SAS-1 archived data, and convert the archived data file to a growing list of end user formats. The paragraphs to follow describe how to setup the SAS-1 Archive Header Records and use the SAS-1 as a Vehicle Counter Station.

From the SAS Monitor and Setup main display, open the SAS-1 Header Editor by clicking the **Archive/Edit SAS Archive Header** menu item. The editor (Figure 9) opens with all fields filled in with default values. These values may be edited or an existing archive header file may be opened to use previously edited values. To open an existing header file (.hhx), click the **File/Open Archive Header File** menu item. Select and open the desired file using the standard Windows Open File Dialog Window.

SAS-1 Archive Header Editor

File

Update Period Field **Specified Avg Peak Power Cap**

Specified Prevailing Speed

File Names and Update Period
Update Per (minutes)

File Name Data Archive to be Saved as in the PC (8 Characters xxxxxxxx.ahx)

Associated Header File used for Specific Conversion (8 Characters yyyyyyyy.hdr)

Calibration Parameters for Vehicle Type and Prevailing Speed

Lane Number	5	4	3	2	1	
<i>Calibration for Short Truck (Feet)</i>	47	47	47	47	47	<i>Speed Adjust Increment (mph)</i> <input type="text" value="1"/>
<i>Calibration for Tractor Trailer (Feet)</i>	70	70	70	70	70	<i>No Detect TimeOut (Sec)</i> <input type="text" value="120"/>
<i>Prevailing FreeFlow Speed (mph)</i>	65	65	65	65	65	
<i>Peak Power Avg Cap Per Lane (db)</i>	10.00	10.00	10.00	10.00	10.00	

Code Settings

Station Location and Description (Text)

Station ID Number *State (FIPS Code)* *County Code*

Functional Class Code *Classification Count Method*

Posted Rt Category *Posted Rt No.* *Foot Notes*

Concurrent Rt Category *Concur Rt No.* *No. of Lanes*

	SAS Zone 5	SAS Zone 4	SAS Zone 3	SAS Zone 2	SAS Zone 1
<i>Direction of Travel</i>	E-W or SE-NW				
<i>Lane of Travel</i>	4th fr R-M	3rd fr R-M	2nd fr R-M	1st fr R-M	Right-Most

Figure 9 Editing the SAS-1 Archive Header

Edit each parameter by either clicking in the upper or lower part of the value field or by typing in the text fields. The lower part of the editor window consists of the set of standard federal reporting codes. The upper part consists of parameters used by the SAS-1 to calibrate commercial truck and tractor trailer classification/counting and the archive update period. One field in the upper right area specifies the file name (.ahx) that the retrieved SAS-1 data archive will be stored as in the \SAS_Monitor_V6\ Arch_Data\ sub-folder. The other field in the upper

right area specifies the file name of an associated Header file (**.hdr**) that may be used when the SAS-1 Archive Data File (**.ahx**) is converted to a specified end user format. Both of these file names must be eight (8) characters or less and must be valid names relative to Windows file name rules.

Most fields in the Archive Header Records correspond to standard required information for traffic data collection and reporting, **however, there are some parameters which affect the performance and behavior of the SAS-1.**

The **Calibration Parameters for Vehicle Type, Prevailing Speed, and Average Peak value Cap** are used to calibrate how the SAS-1 counts three types of vehicles, how SAS-1 reports speed during long periods with no vehicle detections, and how the SAS-1 limits the maximum value of the Average Peak Power used for calculating the current detection threshold for each lane.

For each observation period, the SAS-1 can provide vehicle count data for **Long Trucks** (tractor trailers), **Short Trucks** (commercial trucks, trash trucks, dump trucks, etc.), and All Vehicles (including trucks). The Calibration parameters for the Short and Long Trucks control how the SAS-1 decides whether to include a detection in one of the two truck count categories. Increasing the value of the Short or Long Truck Calibration parameter makes it harder for the SAS-1 to count a specific detections as a truck. For example, if the SAS-1 appears to be over counting Long Trucks in one or more monitored lanes, the Long Truck Calibration value for the lanes in question should be increased. Properly setting the Long and Short Truck calibration values for a specific site requires a reasonable amount of observation and comparison of the count data against ground truth.

The SAS-1 reports and archives average vehicle speed for each lane. When there are no detections during an observation period or over several observation periods (very rural areas or late night times), there becomes a question of what to report for speed. Possible choices are to report the speed as 0 mph (could trip incident detection algorithms), or report the last measured value (could be several minutes old and does not reflect current conditions) , or report a specified no data value (would likely not be compatible with most system software). SAS-1 processing provides a means of tailoring the speed reported for the above no detection conditions using three parameters (Prevailing Freeflow Speed by Lane, Speed Adjust Increment, and No Detect TimeOut) stored in the Archive Header Records. If a time passes (**No Detect TimeOut**) without a detection, the SAS-1 will begin adjusting the last valid speed estimate toward (up or down) the specified **FreeFlow Speed** using the **Speed Adjustment Increment**. Setting the Speed Adjustment Increment to 0 in effect disables the speed adjustment. Setting the No Detect TimeOut to a large value in effect disables the speed adjustment or minimizes its affect. **For SAS-1 firmware revision SAS_142 and higher, Archive Header Records must be set up with reasonable values for these parameters and the header records sent to the SAS-1.**

The SAS-1 keeps track of the Average Peak Value for detections on a per lane basis. This ongoing calculation is used to compute the automatically adjustable detection threshold in each lane. The actual limiting value for the **Average Peak Value** in each lane is the Average Peak Value Cap parameter specified in the Archive Header Record plus the threshold value associated

with the Minimum Detection Sensitivity. A typical value for the **Average Peak Value Cap** parameter would be 10 db as shown in Figure 9. It is unlikely that this parameter value would ever need to be any value other than 10 db for each lane.

To save the edited Archive Header File (.hhx) to the \SAS_Monitor_V6\ Arch_Data\ sub-folder, click the **File/Save Archive Header File** menu item. Specify the desired file name using the standard Save File Dialog Window.

Sending the SAS-1 Archive Header Records to the SAS-1

To send a specific archive header file (.hhx) to the SAS-1, click the **Sensor/Send Header Records to SAS** menu item in the SAS Monitor and Setup main display. Click the **Yes** button in response to the question “You are going to send a new header record to SAS-1...Continue?”.

Select and open the desired file using the standard Windows Open File Dialog Window. This starts the process of sending the archive header records to the SAS-1. The status of the process is shown in the status line in the lower left part of the SAS Monitor and Setup main display. If the process is not successful, the **Start/Stop** button will show “Stop”. Click the **Stop** button and retry the send process by clicking the **Sensor/Send Header Records to SAS** menu item.

Sending the archive header file (.hhx) to the SAS-1 will reset and clear any existing data in the SAS-1 archive non-volatile storage space (existing archive data will be lost).

Setting the SAS-1 Date and Time

To set the date and time in the SAS-1, click the **Sensor/Set SAS Date and Time** menu item. Click the **Yes** button in response to the question “You are setting SAS Date and Time...Continue?”. The status of the process is shown in the status line in the lower left part of the main SAS Monitor and Setup display.

Setting the SAS-1 Date and Time will reset and clear any existing data in the SAS-1 archive non-volatile storage space (existing archive data will be lost).

This completes the basic setup for real time SAS-1 operation. It is now ready to be connected to the Cabinet Controller, SAS Relay Interface, or some other system interface such as a CDPD modem or network device server.

Collecting the Traffic Data

The SAS-1 has the capability to archive traffic flow measurements for five lanes for up to several weeks. The amount of archive time depends on the size of the installed non-volatile memory (**1 Mbit, 2 Mbit, or 4 Mbit**) and the selected update period (**5, 10, 15, 20, 30, or 60 minutes**). The SAS-1 continually updates the archive data, independent of its default mode of

operation. The archive storage is circular so that when the archive grows to the maximum size, the oldest measurement data is discarded to make room for the most recent.

The SAS-1 will collect traffic flow data for all 5 lanes and update the archive as specified by the **Update Period** parameter in the **Archive Header File** (5, 10, 15, 20, 30, or 60 minutes).

After sending a header file to the SAS-1 or setting the SAS-1 date and time, data archiving begins after the next full data write period. For example, let the archive period be set at 15 minutes and the Set Date and Time command be sent to the SAS-1 at 1:01:55 PM. The first archive record would be captured at 1:30:00 PM (data from 1:15 to 1:30) and the SAS-1 would write the archive records at 2:15:00 PM. The SAS-1 captures 4 intervals of data before writing the data to non-volatile flash memory. The time stamp for each written record corresponds to the end of the data interval.

Retrieving the Archive Data from the SAS-1

To retrieve the archive data from the SAS-1, click the **Sensor/Get SAS Archive Data** menu item. The progress of the retrieval process is shown in the status line at the lower left area of the SAS Monitor and Setup main display. If the process is not successful, the **Start/Stop** button will show “Stop”. Click the **Stop** button and retry by clicking the **Sensor/Get SAS Archive Data** menu item.

The downloaded archive data is stored in the **\Arch_Data** sub-folder with the filename specified in the Archive Header File (.ahx) and a date and time stamp prefix as follows:

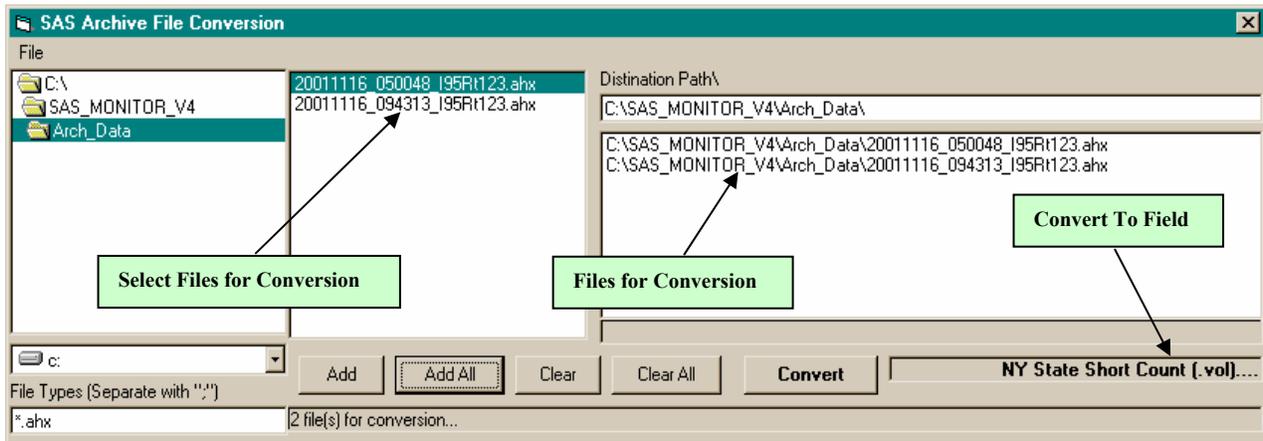


Figure 10 SAS-1 Archive Data File Conversion

yyyymmdd_hhmmss_Archive0.ahx

Converting the Archive Data from the SAS-1 to Another Format

To convert the SAS Archive Data File (.ahx) to a spread sheet ready file or another specified end user format, click the **Archive/Decode SAS Archive** menu item. This opens the SAS Archive File Conversion Window (Figure 10).

Click on the file for conversion in the middle pane to select the file. Click the **Add** button to add the selected file to the conversion list in the right pane. Click the **Add All** button to select and add all files to the conversion list. To clear a file(s) from the list for conversion, click on the file to select it and then click the **Clear** button. To clear all files from the conversion list, click on the **Clear All** button.

Click in the upper or lower part of the **Convert To** field to select the file format that each Archive Data File (.ahx) will be converted to. Several choices are available, including an ASCII version ready for import into a spreadsheet. To start the conversion process, click the **Convert** button. The number of files remaining for conversion is shown in the bottom line of the SAS Archive File Conversion Window. When the number of files is 0, the process is complete.

The converted files are stored in the \Arch_Data\ sub-folder. In addition to the selection in the **Convert To** field, the Archive Data Files (.ahx) are converted to a “space” delimited spread sheet ready file with the file name as follows:

yyyymmdd_hhmmss_Archive0.atx

Note: When converting to a specific end user file format, a separate associated header file (.hdr) may be required. The format for these files and the parameters they contain depend on the end user specified conversion. If the associated header (.hdr) files are required, they must be prepared in advance and located in the \Arch_Data\ sub-folder.

Menu Options Lists

The following is a complete list of menu options in the SAS Monitor and Setup software.

File Menu

Log Flow Measurements - Enables/Disables creation of a spreadsheet ready text measurement file in the \Arch_Data\ sub-folder (SASxxxx.log). When enabled new data is appended to older data in the file.

Enable Manual Measurements - Enables the collection and logging of manual vehicle counts. This capability uses a special parallel port interface (with buttons) for counting vehicles.

Enable Power Log - Enables/Disables disk logging of the acoustic power. The file is binary and is used by SmarTek Systems for analysis, development, demonstration, and debugging.

Save SAS Monitor Parameter File As.. - Open a "Save File As" dialog window for saving current SAS Monitor and Setup parameters in a new file specified by the user.

Exit - Terminates SAS Monitor and Setup.

Settings Menu

Comm Port/Set Up Comm Port - Opens a dialog window to set the PC Comm Port parameters.

Comm Port/Find SAS Baud Rate – Starts SAS Monitor and Setup process to try to determine SAS-1 baud rate. The progress/results of this operation are shown in the Status Line in the lower left part of the main display.

Modem - Opens a dialog window to set the modem parameters.

Create Sensor Polling List - Opens a dialog for creating a multi-sensor polling list. This list is used with special SAS Monitor and Setup modes for analysis, demonstration, and testing.

Visible Message Window - Enables/Disables a text window for observation of the SAS-1 messages.

Manual Vehicle Speed Measurement – Enables manual vehicle speed measurements using a push button interface and measured landmarks (time from point A to B is converted to speed).

White Plot Background - Toggles between a white background or black background measurement display.

Flow Mode Beep - Enables/Disables a audible beep upon traffic flow message arrival.

Scroll Traffic Acoustic Image – Enables/Disables TAI scrolling from bottom up for continuous display instead of the painting down from the top and refreshing when displayed data reaches the bottom. The scroll TAI mode requires a Pentium running at 300 MHz or better to work well.

Lane Finder - Enables/Disables the Automatic Lane Finder Function Display.

Speed Calibration Window – Opens the Speed Calibration Window for use while running SAS Monitor and Setup in Mode 1 (TAI display mode)

Communication Truck Roll Over T-Box – Opens the communication/parameter setup window for the Truck Roll Over application using the SAS-1. This is a special application using the SAS-1.

Sensor Menu

Get SAS ID – Retrieves the SAS ID for the connected SAS-1.

Get SAS Parameters - Retrieves current SAS-1 parameter settings and displays them in appropriate SAS Monitor and Setup parameter fields.

Get SAS Date and Time - Gets the Date and Time from the SAS-1 and displays it in the status line at the bottom left of the SAS Monitor Display.

Get SAS Archive Data - Retrieves the SAS archive and stores it in the \Arch_Data\ sub-folder under the application folder.

Write SAS Parameters- Instructs the SAS-1 unit to save its current parameters to nonvolatile memory.

Show SAS Spectrum Show – Opens a spectrum display to show real time signal spectrum for each of the eight SAS-1 microphone strips.

Show SAS Lane Power vs Time – Opens an acoustic power vs time display for each SAS detection zone.

Set SAS Default Operating Mode - Opens a dialog window for setting the SAS-1 default operating mode.

Set SAS Date and Time - Sets the SAS-1's real time clock to the Date and Time of the PC running SAS Monitor and Setup.

Send Header Records to SAS - Sends New Archive Header records to the SAS-1.

Send New Executable Code to SAS - Sends the SAS-1 new executable software.

Change SAS ID - Opens a dialog window for changing the SAS-1 unit's ID.

Change SAS Baud Rate - Opens a dialog window for setting the SAS-1 unit communication baud rate. Once this value is changed, the SAS Monitor and Setup Comm Port baud rate must be changed to match. If the SAS-1 baud rate is set to 19.2 K bps, the SAS-1 TAI data stream is decimated 2 to 1 to lower the data rate to better match the lower baud rate. If the SAS-1 baud rate is set to 9600 bps or less, the SAS-1 TAI data stream is decimated 4 to 1 to lower the data rate to better match the lower baud rate.

Reset SAS - Sends a command to the SAS-1 to execute a software reset. SAS responds with a banner containing configuration information. This information is displayed in the status line at the bottom left of the SAS Monitor Display (when the SAS Monitor Mode is set to 2 or 3). The information includes the software revision number, presence or absence of a battery backed real time clock, the presence and size of the flash memory chip, and the archive update period.

Note that setting the SAS-1 Date and Time or sending an Archive Header to the SAS-1 will reset the SAS-1 archive pointer. This will result in the loss of any archive data that was previously logged. After either of these actions or upon SAS-1 power on or reset, data archiving begins after the next full data write period (4 captured records).

Archive Menu

Decode SAS Archive – Opens a dialog window for selecting SAS-1 archive files (.ahx) for conversion to spread sheet ready text files (.atx).

Edit SAS Archive Header - Opens an editor window for editing SAS-1 archive header parameters including commercial and tractor trailer truck lengths and the archive update period.

Command Buttons Menu

Programmable Command Buttons – Displays 30 command buttons (29 are programmable) on the right side of the SAS Monitor and Setup main display.

Set Up Buttons – Open a setup window to specify each programmable button name and it's corresponding command string.