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INTRODUCTION

The iLog datalogging feature allows valuable information to be recorded in the hearing aid on a continual basis. This information can include, for example, the habits of the hearing aid wearer, the types of environments they spend their time in, and important information about the hearing aid itself. iLog datalogging is designed to record data during the time between visits to the audiologist. This information is valuable to audiologists when fitting hearing aids for the patient.

If iLog datalogging is enabled on a hearing aid, iLog parameters are continually recorded when the hearing aid is turned on. Once these parameter values are read from the

device, they can be used to counsel the user and fine-tune the fitting. Information about the state of the hearing aid and its environment are recorded at set intervals to non-volatile memory. The feature can be enabled with IDS and information collection will begin the next time the hybrid is powered up. This information is recorded over time and can be downloaded for analysis.

Two versions of iLog are currently supported by IDS: iLog 1.0 and iLog 2.0. iLog 1.0 stores less information and is designed for hybrids with 256 kB of memory (GA3285). iLog 2.0 stores more information and is designed for hybrids with a larger memory capacity (SA3286).

iLog DATALOGGING METHODS

The datalogging information is recorded using two methods used in parallel: a short-term method and a long-term method. The short-term method is used to record detailed information about the user's hearing aid settings and environment (i.e. memory changes, VC settings, battery levels, etc.). The long-term method is used to record how much time was spent in each memory over the life of the hearing aid (or since the last time the log was cleared).

Short-Term Method

In the short-term datalogging method, data is recorded in a circular buffer. The parameters being logged are immediately recorded at device power up and checked thereafter at regular time intervals. In iLog 1.0, this interval is 15 minutes long. In iLog 2.0, the interval is set by the hearing aid manufacturer or audiologist, and can be anywhere from 4 seconds to 60 minutes. Adjusting the datalogging interval can extend the life of the buffer before it starts to get overwritten with new data. This feature could be particularly useful for a first time hearing aid wearer who may make a lot of adjustments in the first few days of wearing their hearing aid.

When the parameters are checked, data is only recorded if:

- Any of the parameters have changed.

- The timestamp value is at its maximum (63 in the case of iLog 1.0 and 255 in the case of iLog 2.0) and is about to wrap around to '1'. This is done in order to save space in memory for more useful log information. Parameters must be recorded when the timestamp value is about to wrap around in order to properly calculate the actual time that the hearing aid has been on.

The sizes of the circular buffer are:

- 183 entries (for iLog 1.0)
- 750 entries (for iLog 2.0)

The parameters recorded using the short-term method are as follows:

- Program Memory Selection
- Volume Control Setting
- Ambient Sound Level
- Battery Level
- Environment Classification (only for iLog 2.0)

The Ambient Sound Level has a threshold associated with it, set by the manufacturer or audiologist. This threshold controls how much the Ambient Sound Level must change to be considered a *significant change* by iLog and, therefore,

stimulate a new record entry. Ambient Sound Level can also be disabled, meaning that regardless of the amount the Ambient Sound Level has changed, it will never stimulate a new record entry. The reason for these adjustments to the logging of this parameter is that ambient sound level is likely to change very frequently, depending on the different environments that the patient is in. If all the changes to the ambient sound level were logged, the circular buffer would fill up extremely quickly and not very much useful information would be stored.

Long-term Method

The long-term datalogging method uses a counter for each memory which is updated at device power up and at regular intervals. The counters are updated at the same time

interval as that of the short-term method, except that they are always updated no matter whether there has been a change or not. When the counters are updated, the counter that corresponds to the hearing aid's current memory is incremented by one. There are four counters available, one for each of the four memories.

Based on the value stored in the counters, the following information can be calculated:

- Length of time the hearing aid has spent in each memory (since data log was last cleared)
- Total length of time the hearing aid has been powered on (since data log was last cleared)

NOTE: All circular buffer entries and counters are protected using checksum verification.

CSV FILES

The iLog data can be displayed using the iLog Application (included with ARKbase). The iLog Application needs a CSV (Comma Separated Values) file containing the iLog data in order to display it. This CSV file can be constructed by the fitting software and has the format described below. The iLog Application needs to have the name of the CSV file passed to it as an argument when it is started. Once open, the iLog Application can open other, previously created CSV files.

CSV File Format

The CSV file contains all of the iLog data recorded in the device. Because iLog only records data at startup, when parameters have changed, and when the timestamp value is about to wrap around, these are the only entries that should appear in the CSV file.

The CSV file has the following sections:

- Version line
- Short-term data
- Long-term data

Version Line

The version line is the first line of the CSV file.

For iLog 1.0, this line is:

--Version 1.0--

For iLog 2.0, this line is:

--Version 2.0--

Short-Term Data

The short-term data appears in consecutive lines, each line corresponding to a data log entry for a particular point in time. Each line consists of these five or six values, in the order below, separated by commas:

1. Timestamp
2. Battery Level
3. Memory
4. VC Level
5. Ambient Level
6. EC (iLog 2.0 only)

Because log entries are only made when recorded parameters have changed, it can be assumed that the values in between the log entries (during the time of the missing time stamps) are the same as the earlier log entry.

The details of the values on each line are described below.

Timestamp

The timestamps for iLog 1.0 and iLog 2.0 are different.

iLog 1.0

The timestamp value is an integer from 0 to 63. In iLog 1.0, the interval between two consecutive numbers, i.e. from 0 to 1, is always 15 minutes.

At power on, the datalogging routine will always log a new entry with a timestamp of '0' to represent a new session. If any of the parameters being tracked are found to have changed since the last time they were checked, a new entry will be created with a timestamp representing the number of time intervals since the timestamp value was reset or the hybrid was powered on. If the device's timestamp reaches '63', a log entry will be created with the timestamp of '63' and the next timestamp increment will be '1'. The timestamp is *not* '0', as might be expected, because a timestamp of '0' always represents the device being powered up.

iLog 2.0

The timestamp value is an integer from 0 to 255. Each increment of the timestamp represents a time interval. This interval is set by the hearing aid manufacturer or the audiologist, and can be anywhere from 4 seconds to 60 minutes.

At power on, the datalogging routine will always log a new entry with a timestamp of '0' to represent a new session. If any of the parameters being tracked are found to have changed since the last time they were checked, a new entry will be created with a timestamp representing the number of time intervals since the timestamp value was reset or the hybrid was powered on. If the device's timestamp reaches '255', a log entry will be created with the timestamp of '255' and the next timestamp increment will be '1'. The timestamp

is *not* '0', as might be expected, because a timestamp of '0' always represents the device being powered up.

Battery Level

The Battery Level resolution is higher in iLog 2.0 than in iLog 1.0. The differences are explained below.

iLog 1.0

The battery level is an integer value from 0 to 3 with the value corresponding to these ranges:

- 3 = 1.3 V or higher
- 2 = 1.2 V – 1.29 V
- 1 = 1.1 V – 1.19 V
- 0 = Less than 1.1 V

iLog 2.0

The battery level is an integer value from 0 to 15 (decimal) with the value corresponding to these ranges:

- 15 = 1.468 – 1.502
- 14 = 1.444 – 1.467
- 13 = 1.421 – 1.443
- 12 = 1.397 – 1.420
- 11 = 1.373 – 1.396
- 10 = 1.350 – 1.372
- 9 = 1.326 – 1.349
- 8 = 1.303 – 1.325
- 7 = 1.279 – 1.302
- 6 = 1.256 – 1.278
- 5 = 1.232 – 1.255
- 4 = 1.208 – 1.231
- 3 = 1.185 – 1.207
- 2 = 1.156 – 1.184
- 1 = 1.135 – 1.155
- 0 = Less than 1.135 V

For both iLog 1.0 and iLog 2.0, datalogging ceases if the battery level drops below 1.13 V. This restriction is in place to prevent memory corruption. Burning datalog values to memory with low or unstable voltage levels is not safe. It will start again once the patient has replaced the battery.

Memory Value

The Memory value is an integer value from 0 to 3:

- 0 = memory A
- 1 = memory B
- 2 = memory C
- 3 = memory D

Volume Control Level

The Volume Control level is a decimal number (with one decimal place) with a value from 0 to -47.1 dB, where the value corresponds to the actual volume control level.

Ambient Sound Level

The Ambient Sound Level is an integer with a value from 55 to 100 dBSPL. The value corresponds to the actual ambient sound level.

iSceneDetect (Environmental Classification) Value

Only iLog 2.0 stores the iSceneDetect (Environmental Classification) value. The iSceneDetect value is an integer from 0 to 14 (decimal), with the value corresponding to the environmental modes below:

- 0 = Quiet Mode
- 2 = Speech In Quiet Mode
- 4 = Music Mode
- 8 = Noise Mode
- 10 = Speech In Noise Mode
- 14 = Off
- Odd value = Wind Mode (i.e. 1, 3, 5, 7, 9, 11, 13)

Long-Term Data

The long-term section of the CSV file consists of one line for iLog 1.0 and two lines for iLog 2.0.

Both iLog 1.0 and iLog 2.0 have a line that consists of four numbers separated by commas. These numbers represent the values in the long-term counters. They are integers between 0 and 1048575.

The last line of the iLog 2.0 CSV file is a number indicating the time interval between iLog checks. This is the number that was programmed into the device. The time (in seconds) can be calculated from this number using the formula:

$$\text{Interval Time (in seconds)} = (X + 1) * 4.096$$

Where 'X' is the number in the CSV file.

The Interval Time can be anywhere from 4.096 seconds to 60 minutes.

The values that are currently available to SA3286 libraries are as follows (all times approximate):

- 0 = 4 s
- 2 = 12 s
- 6 = 30 s
- 14 = 1 min
- 28 = 2 min
- 72 = 5 min
- 146 = 10 min
- 219 = 15 min
- 292 = 20 min
- 438 = 30 min
- 658 = 45 min
- 878 = 60 min

The Log interval value read from the product will be an integer in the range of 0 to 11. In order to convert from this integer to the values that should be written in the CSV file, the conversion table below should be used. This could be implemented in code using a case statement or something similar.

- 0 => 0
- 1 => 2
- 2 => 6
- 3 => 14

- 4 => 28
- 5 => 72
- 6 => 146
- 7 => 219
- 8 => 292
- 9 => 438
- 10 => 658
- 11 => 878

iLog CSV File Example

The text below from the line “--Version 2.0--” to the line “219” is the text that appears in a typical CSV file. It can be seen from the snippet of the file below that:

- The device was started 2 times
- The interval time is = (219 + 1)*4.096 seconds = 901.12 seconds = 15.02 minutes = ~ 15 minutes
- At the first startup, we can see that:
 - ◆ The Battery Level is between 1.47 and 1.5 Volts
 - ◆ The device is using memory B
 - ◆ The Volume Control Level is -25.9 dB
 - ◆ The Ambient Sound Level is 55 dBSPL
 - ◆ iSceneDetect is in Off Mode
- The second line shows that after 765 minutes (51*15) or 12 hours and 45 minutes, the Volume Control Level

was changed to -8.5 dB and the memory was changed to ‘C’. All the other parameters stayed the same.

- ◆ Because there were no entries before this entry we can deduce that between Time 0 and Time 12 hours and 45 minutes, the parameters were the same as they were at Time 0.

```
--Version 2.0--
0,15,1,-25.9,55,14
51,15,2,-8.5,55,14
52,15,0,-1.2,55,2
53,15,1,-1.2,55,14
255,15,0,-1.2,55,2
4,15,0,-1.2,55,2
5,15,1,-1.2,55,14
6,15,1,-38.6,61,14
7,15,1,-1.2,76,14
9,14,2,-1.2,67,14
0,14,3,-5,55,14
11,14,3,-11,55,14
12,14,0,-1.8,55,4
255,14,3,-11,55,14
...
0,9,2,-11,55,14
2,9,0,-11,55,2
5558,4462,270,376
219
```

INTERFACING WITH THE DEVICE

Reading and Clearing the Data Log

In IDS, selecting **Tools > Read Data Log** causes:

- The iLog data log to be read
- A CSV file to be created with the read data
- The iLog App to be launched and loaded with the CSV file

To read the data log, the IDS subroutine ReadDataLog() is called. Reviewing the code in this subroutine can help software developers interested in incorporating this functionality into their own fitting software. The source code for this subroutine can be found in the IDS source code, located in the ARKsdk package.

Selecting **Tools > Clear Data Log** causes the iLog data log to be cleared, including both the short-term circular buffer and the long-term counters. To clear the data log, the IDS subroutine ClearDataLog() is called. Software developers interested in incorporating this functionality into

their own software should consult this procedure in the source code, which can also be found in the IDS source code in ARKsdk.

Enabling and Setting iLog Parameters

In IDS, the iLog parameters are controlled from the **Settings** tab. The **DataloggingEnable** parameter controls whether iLog is enabled or not. The **LogAmbientLevel** parameter controls whether or not changes in the Ambient Sound Level stimulate iLog to make a new entry in the data log. If the LogAmbientLevel parameter is enabled, the **AmbientThreshold** parameter controls the threshold required to stimulate a new iLog entry. For iLog 2.0, the **LogInterval** parameter controls the interval of the datalogging as mentioned in section Long-Term Data on page 3.

These settings will only take effect once they have been burned in and the part is rebooted.

iLog APPLICATION

The iLog Application supports both iLog 1.0 and iLog 2.0. In the iLog Application, the data is displayed graphically in such a way that it can be used by the audiologist to counsel the user and fine-tune the fitting. This iLog Application can be easily incorporated into other applications by launching the iLog executable (ensuring to pass the name of the CSV file as an argument) from the calling application.

Figure 1 shows a screenshot of the iLog Application. The Memory Select tab shows the Memory Select statistics – what percentage of time the hearing aid has been in each memory. This data is retrieved from the long-term data logs. The Memory [A,B,C,D] tabs show the volume control level and ambient sound level measurements for each memory when that particular memory was in use. This data is

provided by the short-term data logs. It is important to note that the time scale of these graphs only represents the time when that memory was being used, not to the entire time the hearing aid was on.

The **Environment** tab shows a pie chart that displays iSceneDetect statistics – what percentage of the time the hearing aid was in each iSceneDetect mode or whether iSceneDetect was off. The **Battery Level** tab shows the measured battery levels the entire time the hearing aid was on. The Battery Level resolution will be higher (the measurement increments will be smaller) for iLog 2.0 than iLog 1.0 because iLog 2.0 contains more Battery Level intervals.

The **All Memories** tab shows a combination of parameters so that they can easily be compared to each other. It shows the iSceneDetect Mode, Selected Memory, Ambient Level, and Volume Control, all on the same time scale. The time scale represents the entire time the hearing aid was on.

For all the X–Y graphs, it is easy to zoom in and out of the graphs in order to view the measurements in more detail. To zoom in on the time scale (x-axis), the user clicks on the graph and drags horizontally, selecting the time they wish to zoom in on. To zoom out, the user right-clicks on the graph and selects **Un-Zoom**. Also, on the X–Y graphs, the user can right-click at any time and select **Show Sessions** to display vertical lines indicating the points at which memory switches occurred.

The iLog viewer has the ability to save the current iLog datalogs using the **Save to File** button. A previously stored datalog can be loaded using the **Load from File** button.

The iLog application can be customized to display different colours for the various pie charts and lines on the graphs, etc. The config.xml file that is located in the same directory as IDS can be modified to add the RGB values of the desired colours that the user wishes to have displayed. The config.xml file must be stored in the same directory as iLog.exe.

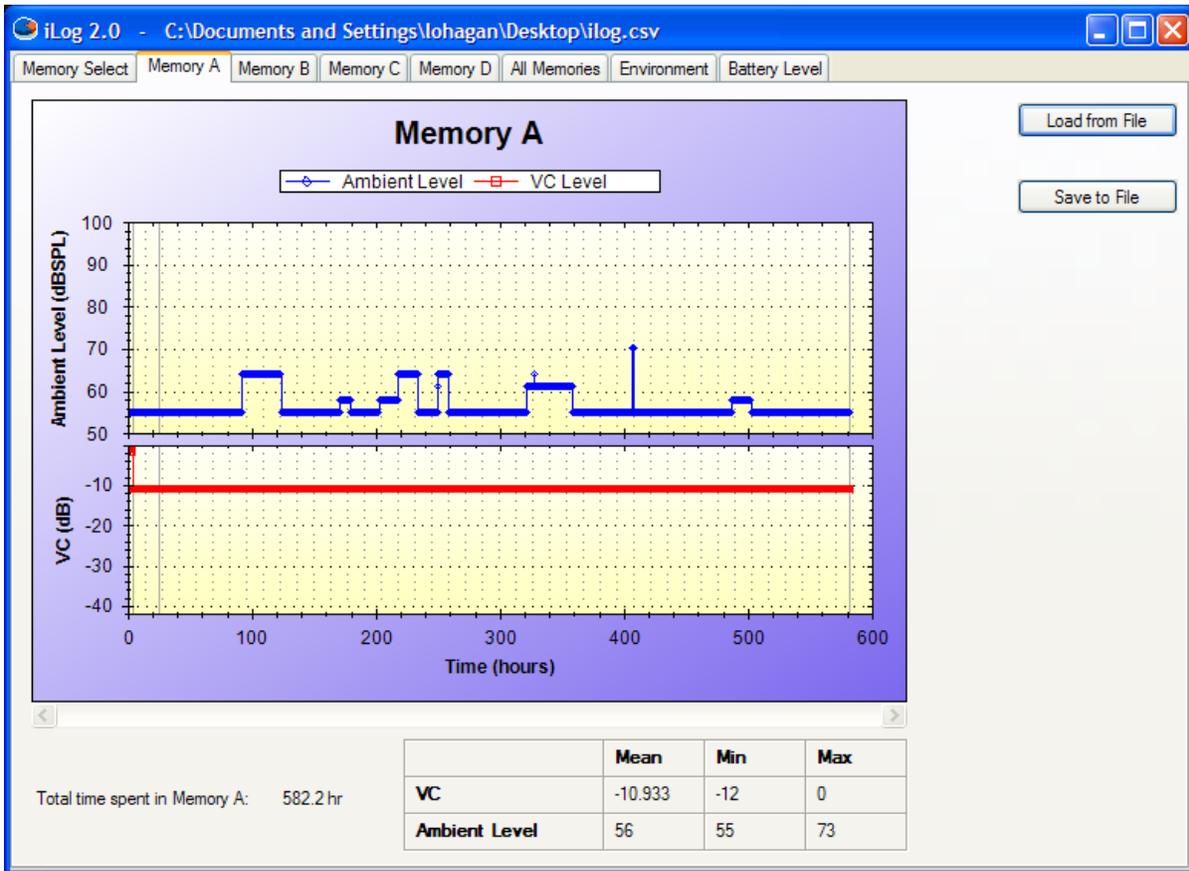


Figure 1. Screenshot of iLog 2.0 Application

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Users running Windows XP or 2000 must install the .NET Framework 2.0 from Microsoft in order to use the iLog Application. The .NET 2.0 Framework can be installed from the following address:

<http://www.update.microsoft.com/microsoftupdate/v6/default.aspx?ln=en-us>

Click the **Custom** button and select **.NET Framework 2.0**. If the .NET Framework 2.0 is already installed, it will not appear on that list.

NOTE: The iLog Application is not supported on Windows 98 or earlier.

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