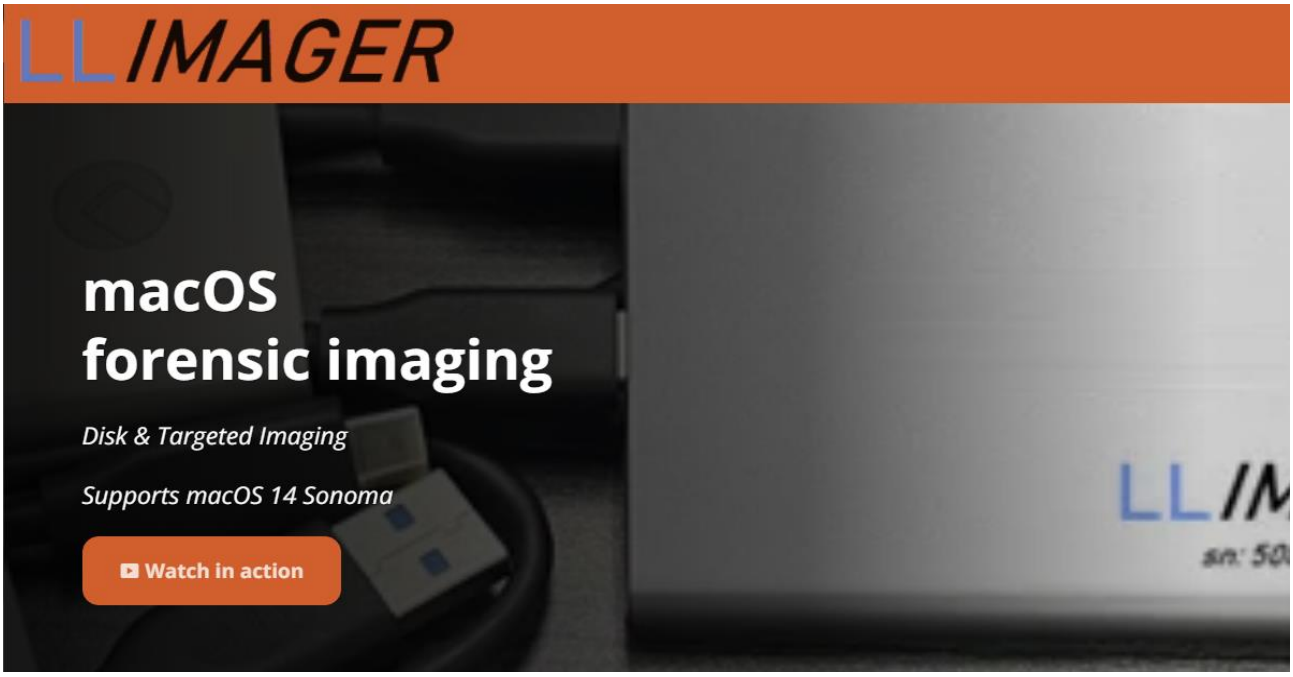

Version 4.0

User Manual

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Preface

Welcome to LL*IMAGER* 4.0, the cutting-edge solution for mac forensic imaging. As a complete rewrite, LL*IMAGER* 4.0 has been meticulously crafted to meet the demanding needs of digital investigators, e-discovery services providers, law enforcement professionals, and cybersecurity experts. Powered by Apple's Swift language, this new version combines robust functionality with an intuitive user interface, making it the go-to tool for acquiring and preserving digital evidence. Whether you're conducting criminal investigations, e-discovery, or incident response, LL*IMAGER* 4.0 empowers you to extract critical data from Mac systems with precision and efficiency.

LL*IMAGER* was created in response to emerging trends in macOS forensic imaging such as limited "dead box" options, and Apple's macOS security enhancements that tend to restrict access.

It was designed to meet the need for robust and comprehensive forensic imaging of Mac computers, capable of capturing targeted folders (logical images) and active space from all APFS synthesized volumes and HFS+ volumes.

LL*IMAGER* is user-friendly and easy enough for entry level digital forensics examiners. The application leverages built-in Mac utilities, providing a versatile solution compatible with a wide range of macOS versions, both past and present. This ensures the tool remains functional across diverse system configurations.

Terminology

Sparse image file: a native macOS image format that is dynamic and used within the Mac environment. The file grows as data is added to the image, taking up only as much disk space as stored in it.

DMG file: a native macOS disk image format like the sparse image but less versatile. It is used primarily to distribute software to Mac users. It is more compatible with other commercial software and can be imported into any modern forensic applications.

Device Identifier (ID): the term used herein refers to the unique identifier used by the operating system to identify a mounted storage device with a disk number (disk1, disk1s1, etc.). This can be located using the Disk Utility as seen highlighted in the following picture.

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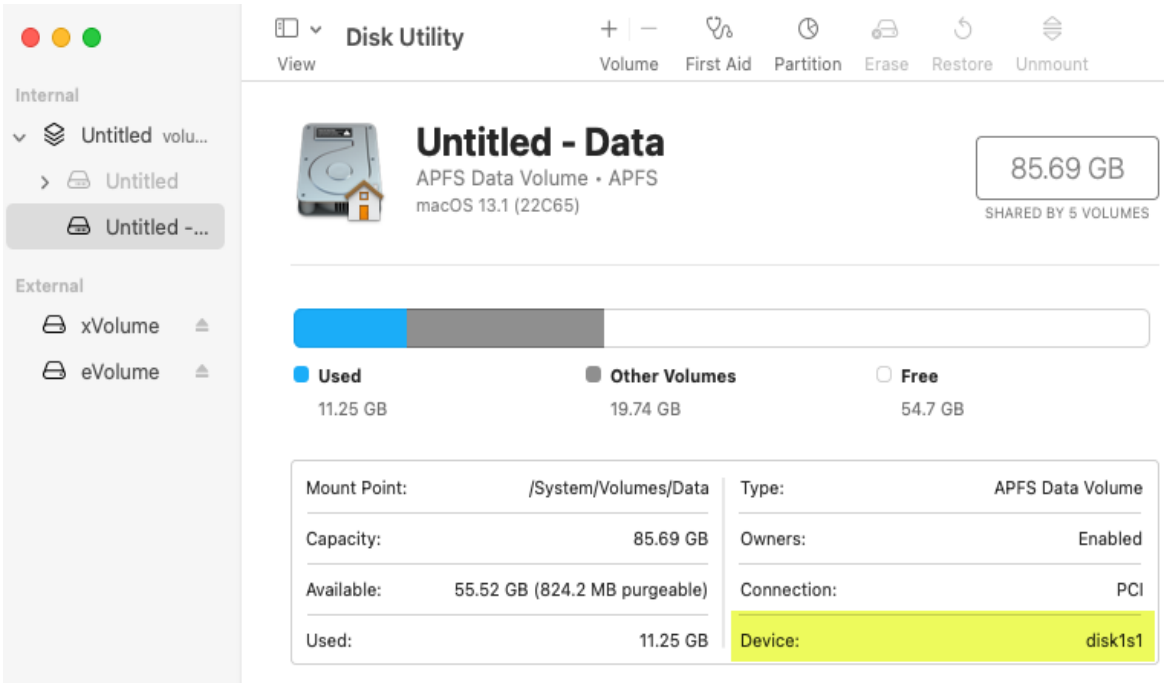

USB Label / Name: This is the name of a mounted partition, physical or virtual. It can be found using Finder, on the left side of the window. Note that a disk can have more than one partition, hence, each partition will be mounted with its own name.

LL*IMAGER* USB Drive: This is a USB drive with the two DMG files containing the executable file of the same name, and the license key file. The executable is "llimager.app".

Supported Mac Hardware

Live Image (booted from internal disk)

LL*IMAGER* works with Intel-based Macs and new Silicon processors including M3s.

Before You Start

The Mac native Apple Software Restore (ASR) utility is used for the imaging process, thus basically any Mac can be imaged from an admin authenticated session on the Mac computer, and there should be no issues with Apple data encryption, be it FileVault of T2 chipset, or Apple new hardware M1/M2/M3.

The imaging process will first create a sparse image container and use it as the destination of the disk's image. Once the imaging of the disk has completed, the sparse image will be used to create a compressed

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read-only DMG file that can be processed with popular forensic and e-discovery pre-processing applications[1].

The application does not provide an option to encrypt the DMG, as encrypted DMGs are not currently supported by many forensics' applications.

In the event a DMG image must be securely encrypted, the following options are recommended:

1. Usage of a hardware-encrypted external USB disk to save the unencrypted image.
2. Encrypt the DMG and place it on a normal unencrypted disk.
3. Copy the unencrypted image to a compatible encrypted container on a normal USB disk.

The image format is limited to those used by Apple, in our case, DMG. Other applications can be used to convert the DMG to other formats (e01, …).

Requirements

- **A local admin password** for the Mac computer to be imaged.
- **LL*IMAGER* must have "Full Disk Access" permission** (set this in: Settings > Privacy & Security > Full Disk Access)
- **LL*IMAGER* USB disk**: Containing a copy of the imager executable "llimager.app" and the required license file (llimager.lic).
- **Temporary Image USB disk (if used)**: Since LL*IMAGER* creates a temporary sparse Image, the optimal method of acquisition is to have a holding disk for it. The disk can either be the LL*IMAGER* USB or another dedicated USB drive. In both cases, enough free space is required, which should be equivalent *to the total used space plus 10% or larger*.
- **Destination USB disk**: external disks formatted with exFAT are recommended to be used as the destination of the disk image (for compatibility between Operating Systems). Of course, any Mac writeable partition format will work.
    - *The USB disk should have free space equal to or greater than twice the size of the source device's used space plus 10%.* If a separate Temporary Image USB disk is used, each should have free space equal to at least the size of the used space plus 10% of the source device. Use these guides as a rule:

Source Size	Source Space Used	Minimum Disk Size (when using One Destination Disk for Temp & DMG)	Minimum Disk Size (when using two Destination Disks for Temp & DMG)
500GB	50GB	110GB	55GB, 55GB
500GB	400GB	880GB	440GB, 440GB
2TB	120GB	264GB	132GB, 132GB

[1] Forensic applications change over time, and support for image types may vary. Test the image produced by LL*IMAGER* during the trial period to ensure compatibility with your application(s).

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- **The best practice with respect to optimal performance is to use two USB disks, one for the sparse image, and one for the final converted DMG. This will significantly reduce the time to convert the sparse image to the DMG file**.
- When using two USB disks, each must have a unique name.

Live System Boot

Boot the computer normally and login using an account with admin privileges. This is the most straight-forward option. An admin password is needed however to run the application.

Getting Started with LL*IMAGER*

Refer to the pertinent scenario below.

USB SSD/HDD Version

- Login as an admin into the target Mac computer and connect the LL*IMAGER* USB SSD drive that contains the copy of the imager (llimager.app, manual and license key file).
- Connect the destination disk(s) – refer to Requirements section for details on options and best practices.
- Open Finder to identify the destination USB volume names for the sparse image, and for the DMG by opening Finder.
- On the LL*IMAGER* USB SSD, navigate to /llimager and double click on “llimager.app” .
- Proceed to image.

User-Supplied USB SSD/HDD Version

- Login to any Windows computer.
- Prepare the USB SSD/HDD by:
  - Insert an SSD into a Windows computer and create an exFAT partition named “llimager” (case sensitive). This can be a relatively small partition, e.g., 30GB.
  - Create a folder named “llimager”, which when mounted on a mac, should result in /Volumes/llimager/llimager
  - Download the most current version of LL*IMAGER* from “llimager.com/download” and unzip into “/Volumes/llimager/llimager”
  - Copy the purchased license file (llimager.lic) into “/Volumes/llimager/llimager”.
  - Your disk is now properly loaded, and you can open the manual or download it from “llimager.com/resources/llimager-manual”

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- Login as an admin into the target Mac computer.
- Connect the user-supplied USB SSD drive that contains the copy of the imager (llimager.app, manual and license key file).
- Connect the destination disk(s) – refer to Requirements section for details on options and best practices.
- Open Finder to identify the destination USB volume names for the sparse image, and for the DMG by opening Finder.
- On your USB SSD, navigate to /llimager and double-click on "llimager.app".

  WARNING: if you receive an error message, "llimager.app is damaged and can't be opened" or "The application "LLIMAGER" can't be opened" you have run into a mac quarantine issue and you need to reload the software from a Windows computer; see FAQ #1 on our website.

- Proceed to image.

Trial Versions

- Login to a Windows computer.
- Download the trial from "llimager.com/trial-1" on to the internal disk and after receiving the license file (llimager.lic) from e-Forensics, you are ready to proceed.
- Prepare your USB Flash or SSD by:
  - Insert Flash/SSD into a Windows and create a small exFAT partition named "llimager" (case sensitive)
  - Create a folder named "llimager", which should result in /Volumes/llimager/llimager
  - While in Windows, download the most current version of LL*IMAGER* from "llimager.com/download" and unzip into "/Volumes/llimager/llimager"
  - Copy the trial license file (llimager.lic) into "/Volumes/llimager/llimager".
  - Your trial version disk is now properly loaded, and you can open the manual or download it from "llimager.com/resources/llimager-manual"
- Login as an admin into the target Mac computer.
- Connect your USB Flash/SSD drive that contains the trial copy of the imager (llimager.app, manual and license key file).

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- Connect the destination disk(s) – refer to Requirements section for details on options and best practices.
- Open Finder to identify the destination USB volume names for the sparse image, and for the DMG by opening Finder.
- On your USB Flash/SSD, navigate to /llimager and double-click on “llimager.app”.
- WARNING: if you receive an error message, “llimager.app is damaged and can't be opened” or “The application “LLIMAGER” can’t be opened” you have run into a mac quarantine issue and you need to reload the software from a Windows computer; see FAQ #1 on our website.
- Proceed to image.

NOTE: What to do if a window pops up with the message “llimager cannot be opened because it is from an unidentified developer” or any other message related to security restrictions.

Temporarily disable Gatekeeper and try running the app again. Once the imaging is completed, exit the application, and re-enable Gatekeeper. To disable, or re-enable Gatekeeper, open a Terminal window, and use one of the following commands accordingly to disable/enable, an admin password is required:

sudo spctl --master-disable

sudo spctl --master-enable

LL*IMAGER* Menu

The application starts by requesting a password from a user with admin rights, followed by a best practices checklist. The password will be used throughout the usage of the app in any of the task’s selection where it is required.

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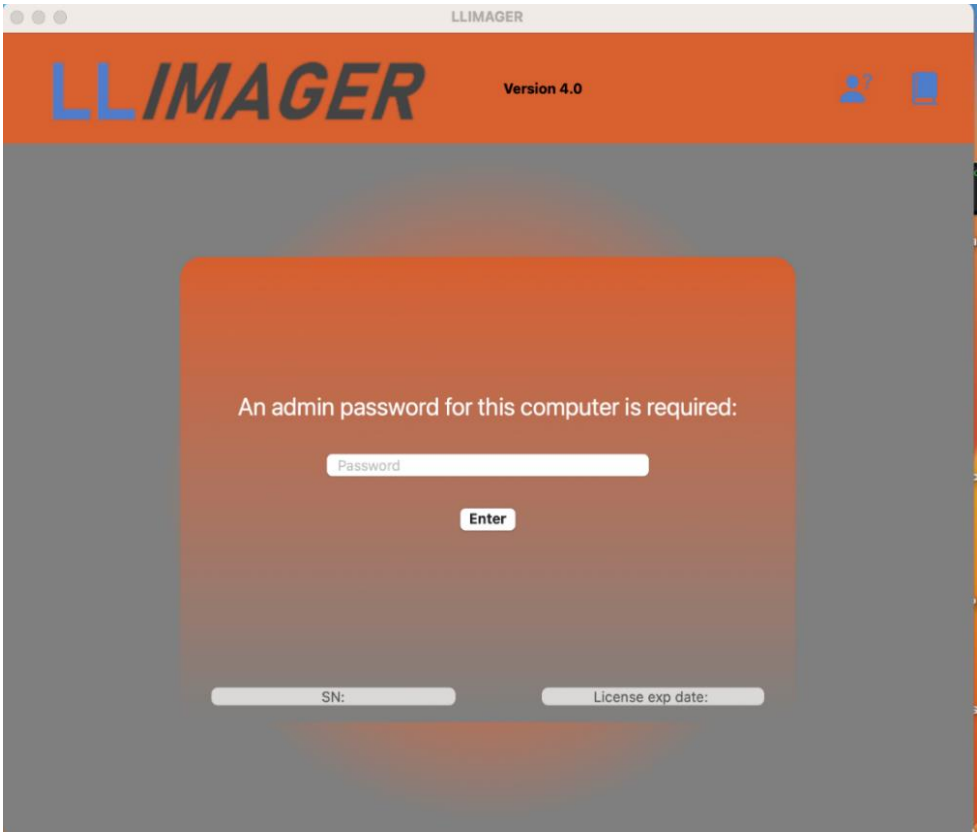

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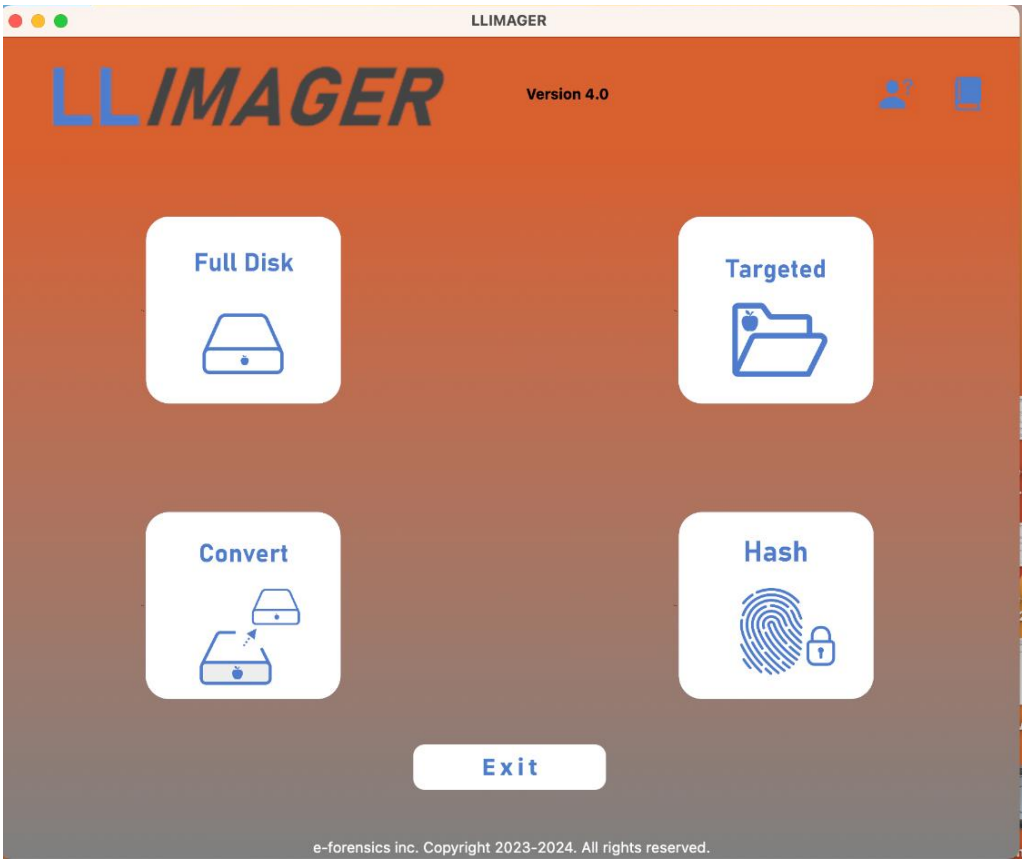
The Main Menu:



Full Disk - This option allows the entire process of imaging the computer's hard disk volumes' active space, saving the image to a Mac sparse image container and then conversion of the image to a compressed DMG file, and calculating the hash value of the DMG file. During the process, there will be an option to fully automate the process by creating the final DMG or to just generate the sparse file.

Targeted - This option allows the imaging of targeted files/folders on the computer's hard disk, saving the image to a compressed read-only DMG file, and calculating the hash value of the DMG file.

Convert - This option allows the process of converting a sparse image file to a compressed DMG file, and to calculate the hash value of the DMG file.

Hash - This option allows you to calculate the hash value of the sparse image, DMG or any file type.

Exit - This option will exit the application.

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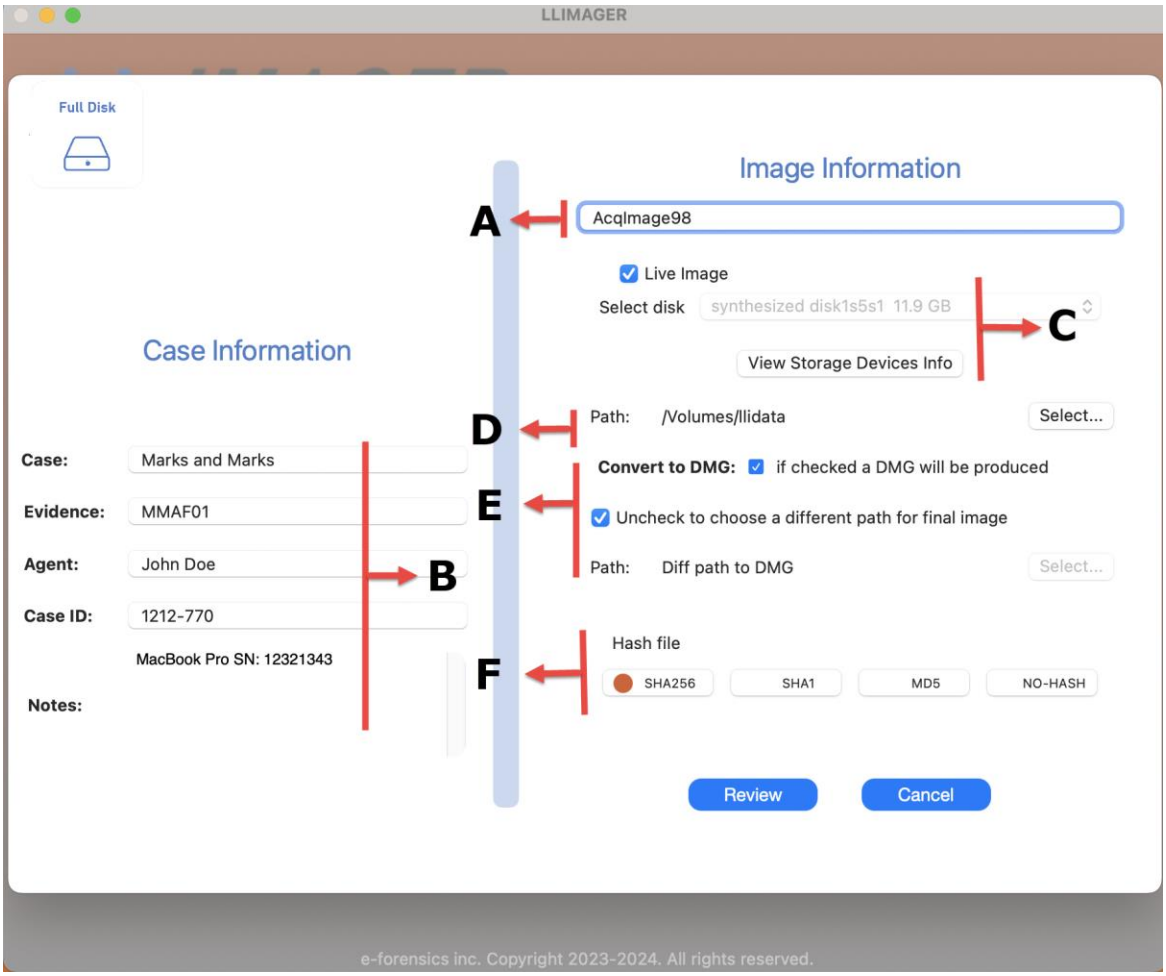
Menu Option (Full Disk)

Identify and input information about the device to be imaged, and the destination USBs where the image will be saved (see figure below). Additionally, provide information related to the case, name of the image and folders to use to save the file, select to convert or not to DMG, and choose to hash, and type of hash. The following picture shows the requested information.



See the below description of each section.

A – Related to the image. Name assigned to the image files (sparse and DMG)

B- Related to the case. Case name, evidence number, agent, case ID and notes.

C – Related to the *device to be imaged*. Requires the selection of the device ID to be imaged. The app will verify the device and display the volume name, and the GB size of the device.

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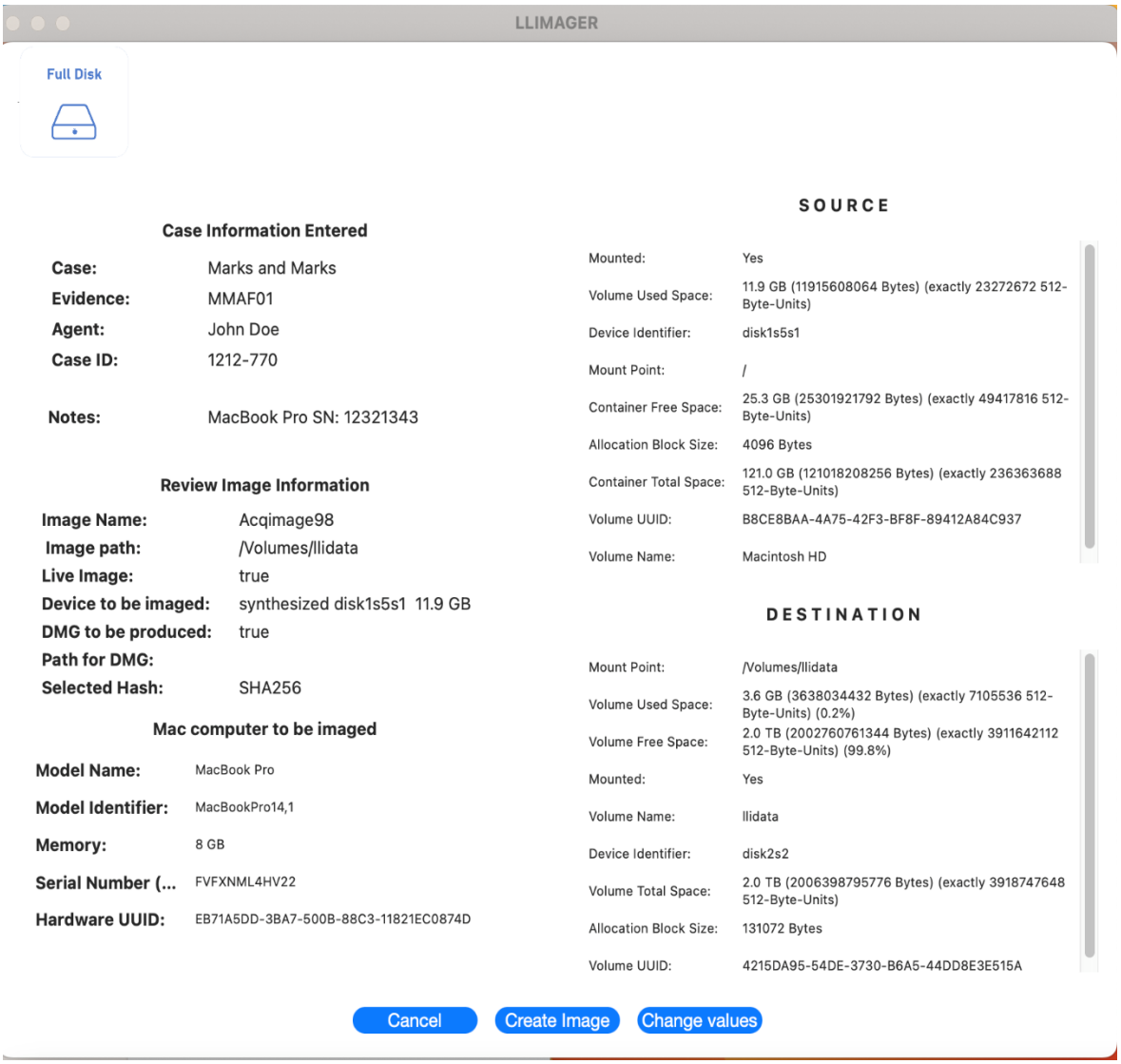
D – Related to the *destination of the sparse image and DMG file*. Requires the selection of the USB label (partition) to be used to save the files. The app will verify the device and display the device ID.

E – Select to convert or not to DMG, and to save to the same disk as the sparse or to a different disk.

F – Related to *hashing of the DMG* file. Specify if hashing should be done and type.

Note, there are power saving settings on the computer that may interfere and break the imaging process, these settings are temporarily disabled during the image.

After completing the selections, click on Review and a summary of the information provided will be displayed. See the following picture:



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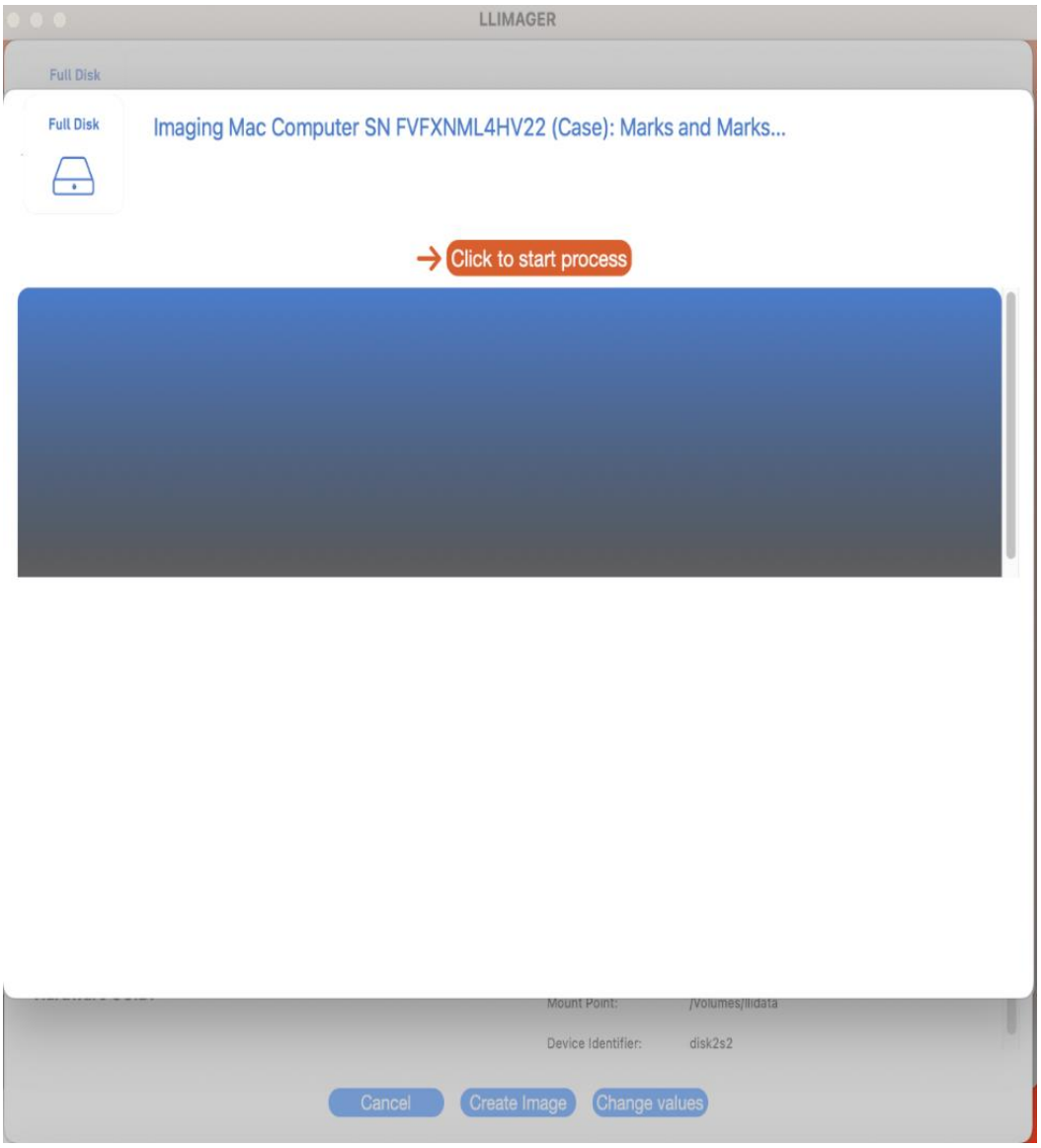
After validating and accepting the information, click on “Create Image” and the following will appear:



Click on “Click to start process” and as the process commences, a progress screen indicating that the sparse image is being generated will appear -- see below:

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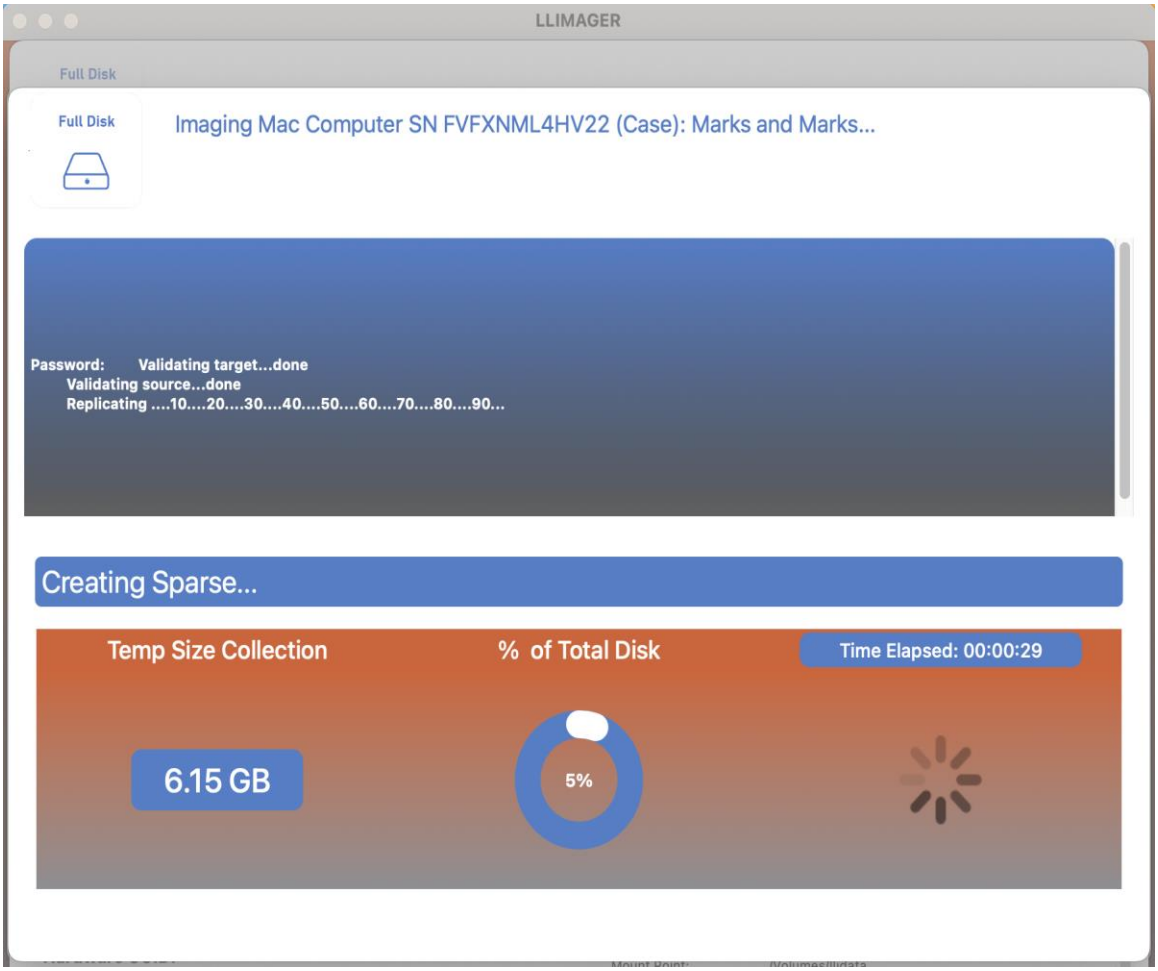

Once the sparse image is completed, if "Convert to DMG" was selected, LL*IMAGER* will proceed to create the DMG.

After the DMG conversion is completed, LL*IMAGER* will proceed to hash the DMG if "Hash file" was selected -- see below:

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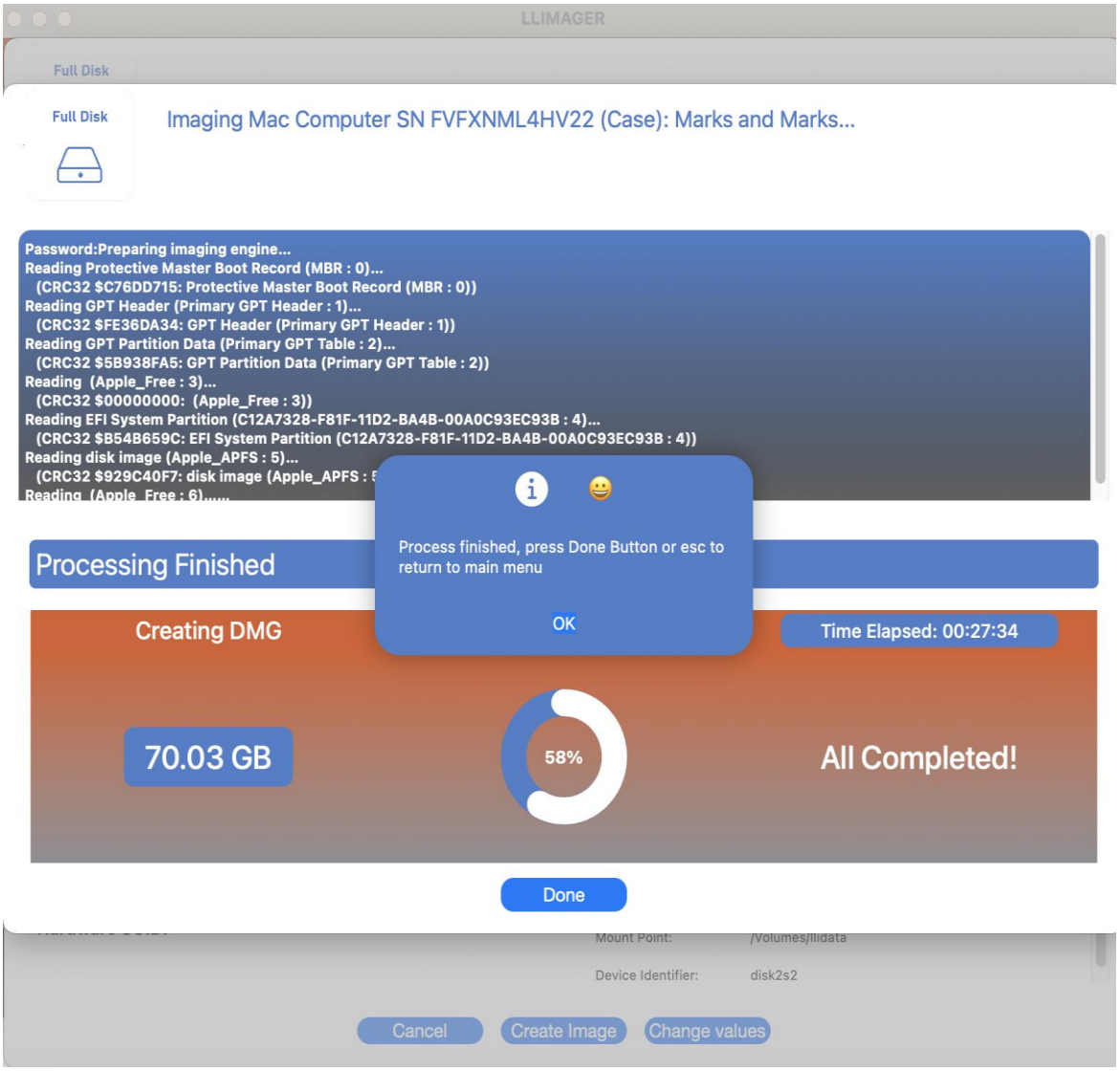

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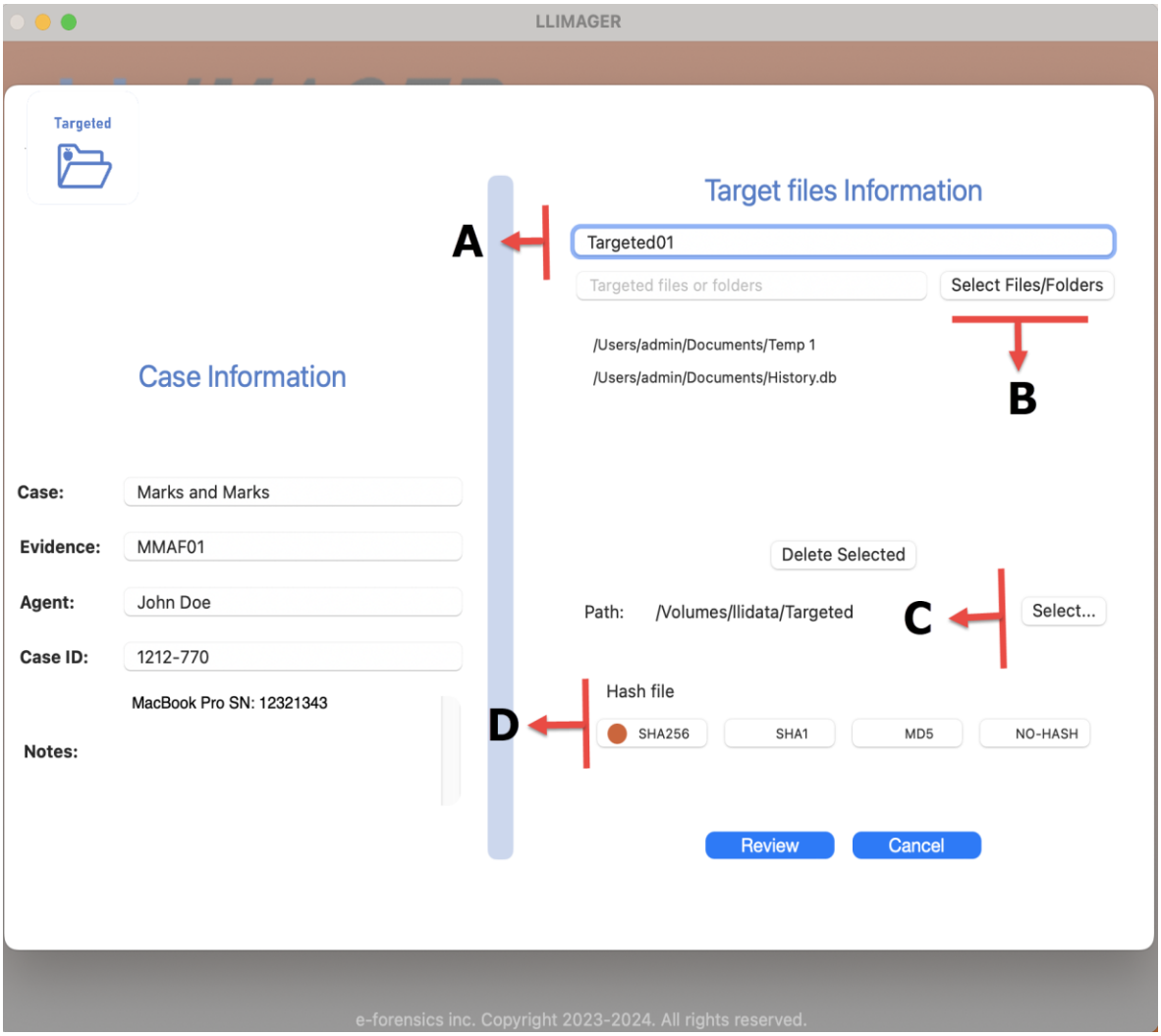
Menu Option (Targeted)

Input the image destination name and location of the destination logical DMG file. Additionally, choose to hash and type of hash. The following picture shows the requested information.



See below for a description of each section.

A – Specify the name of the image.

B – Related to the *source files/folders*. Requires selection of the source files/folders to acquire.

C – Related to the *destination of the DMG* file. Requires selection of path where the DMG will be saved.

D – Related to *hashing of the DMG* file. Specify if the DMG will be hashed then specify the type of hash.

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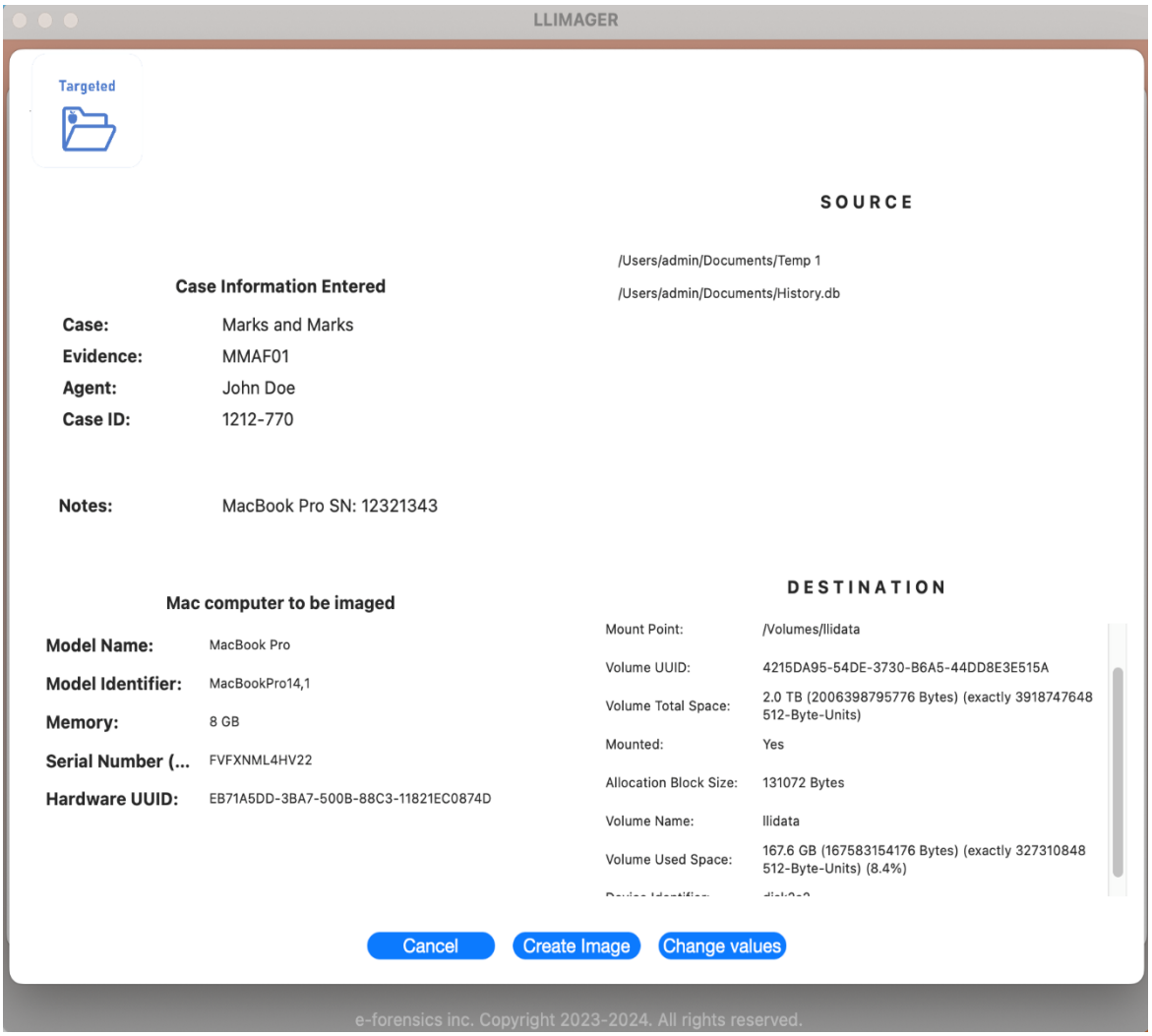
After completing the selections, a summary of the information provided; see below.



After validating and accepting the information, click on “Create Image” and the following will appear:

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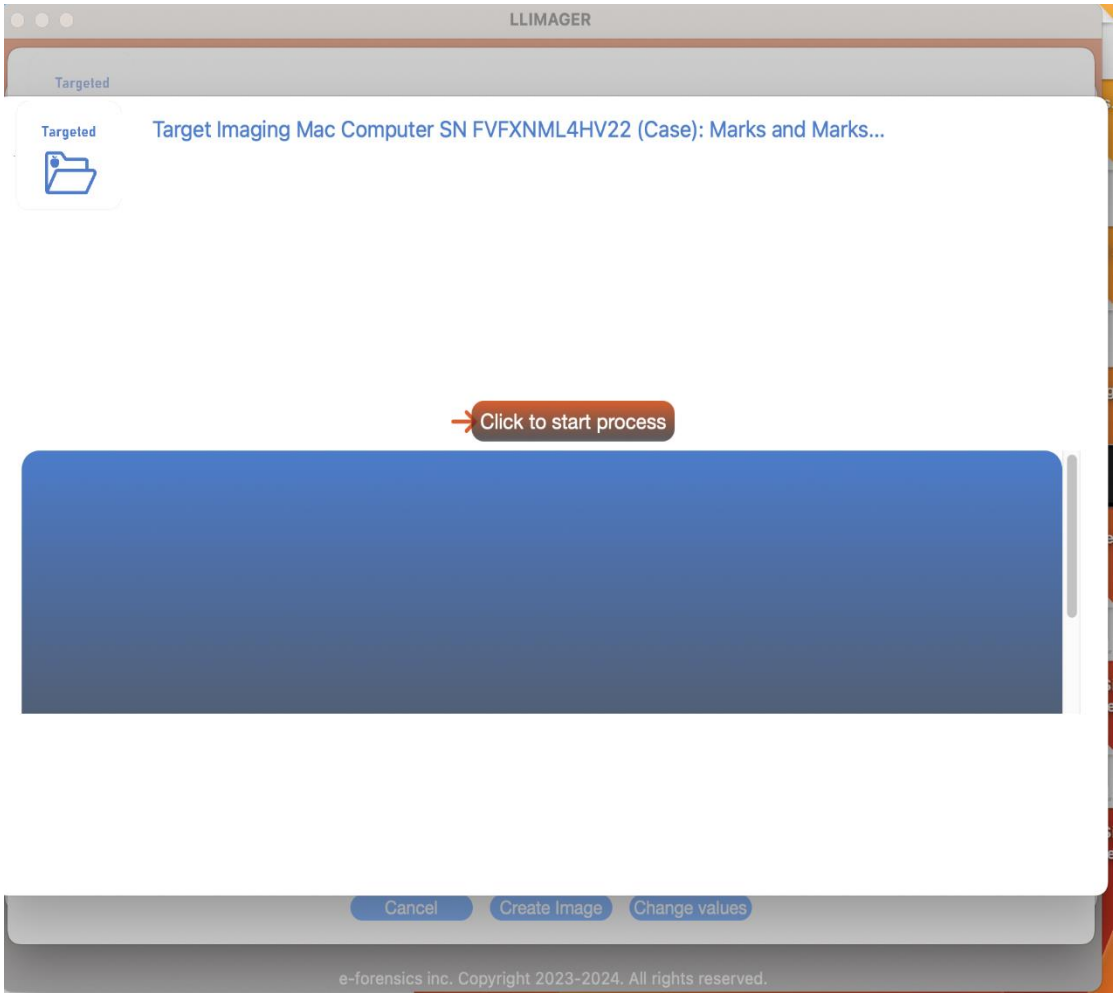

Click on “Click to start process” and as the process commences, a progress screen indicating that the DMG logical image is being generated will appear -- see below:

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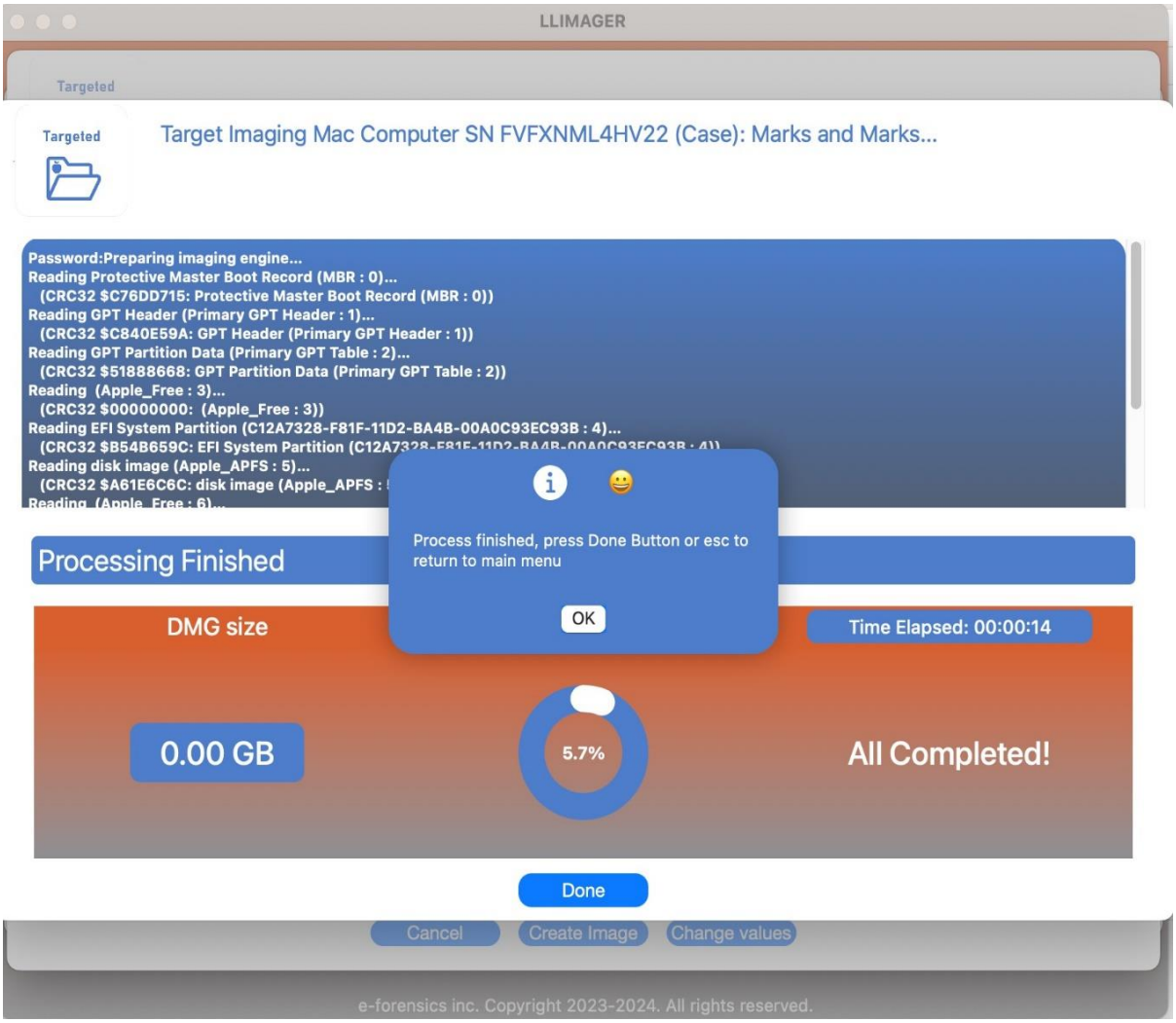

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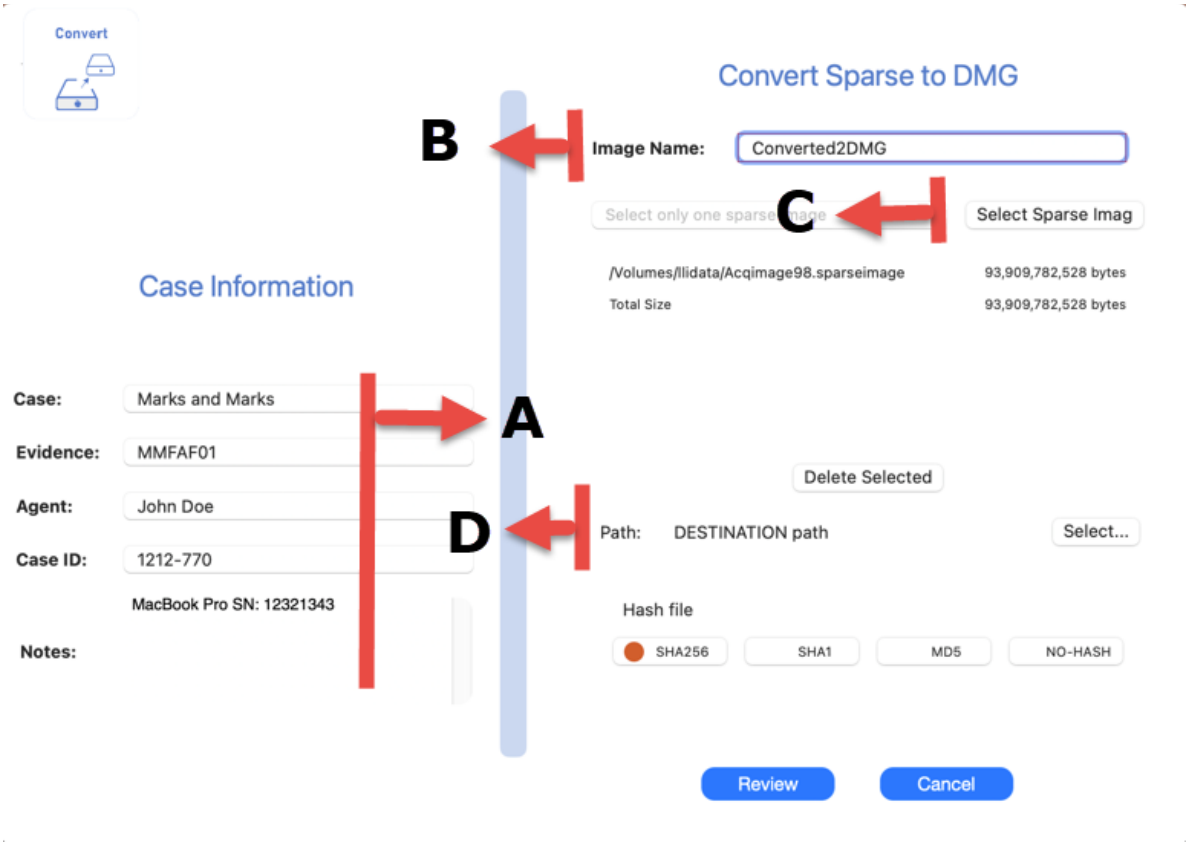
Menu Option (Convert)

This feature is available to convert the temp files, (spare image) to a DMG.

Input the DMG file name and location of the destination logical DMG file. The following picture shows the requested information.



See below for a description of each section.

A – Specify case related information

B – Related to the name to give the DMG file.

C – Related to the source sparse image to be converted.

D – The path where the destination DMG will be stored.

After completing the selections, clock on Review for summary of the information provided; see below.

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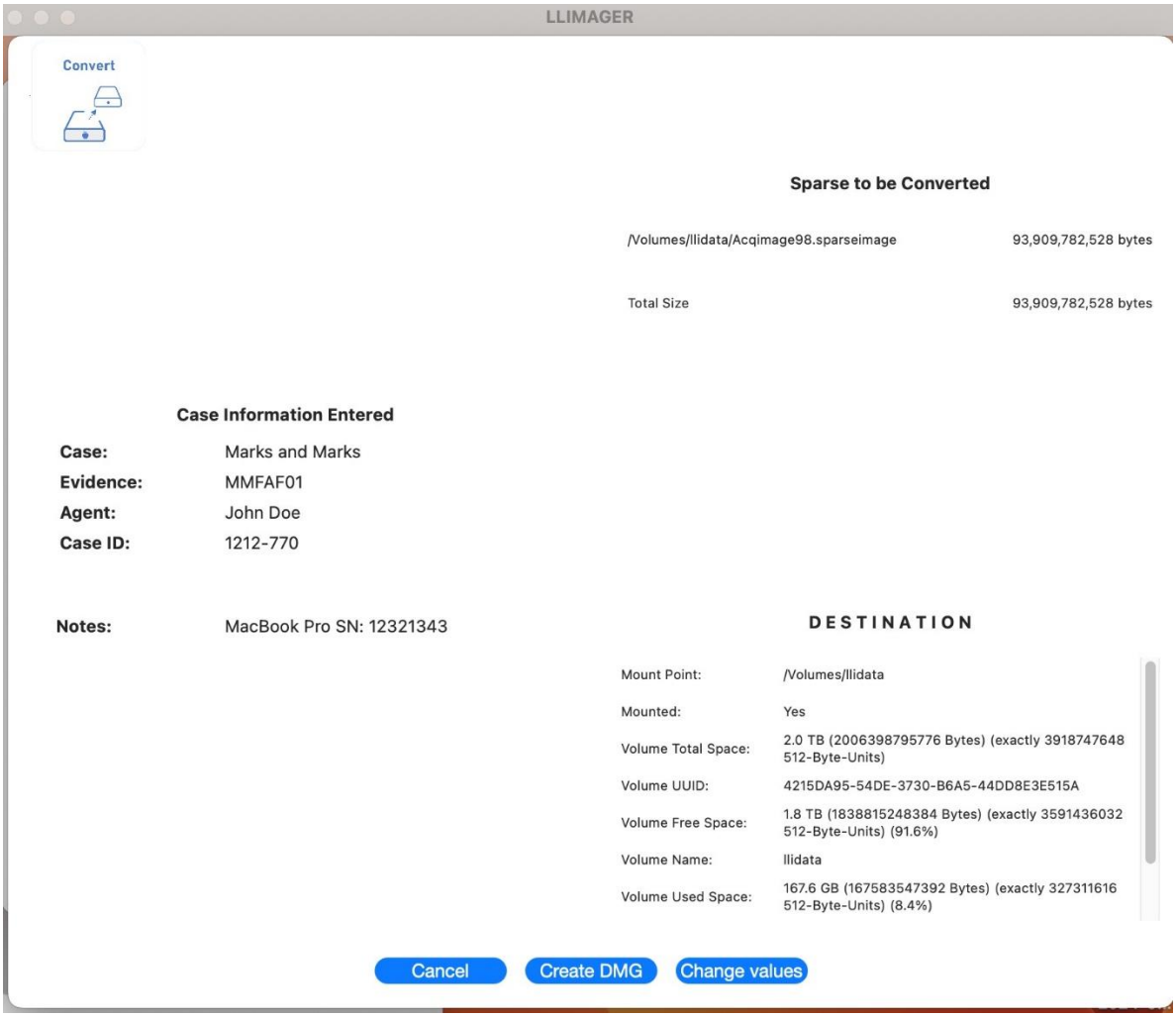

Upon completing the review, click “Create DMG” and the following screen will appear, and click on “Click to start process”):

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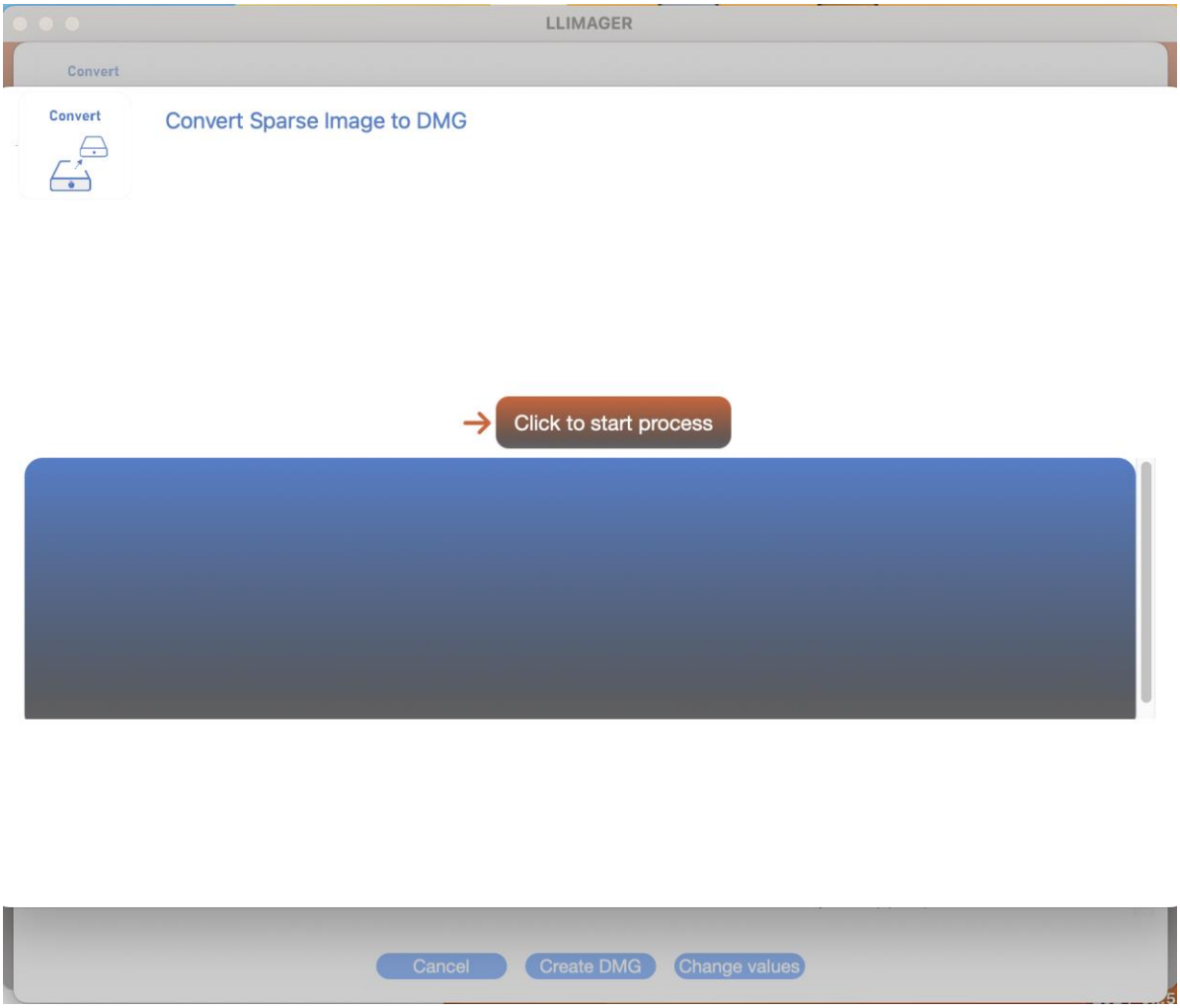

Upon completion, the following will appear:

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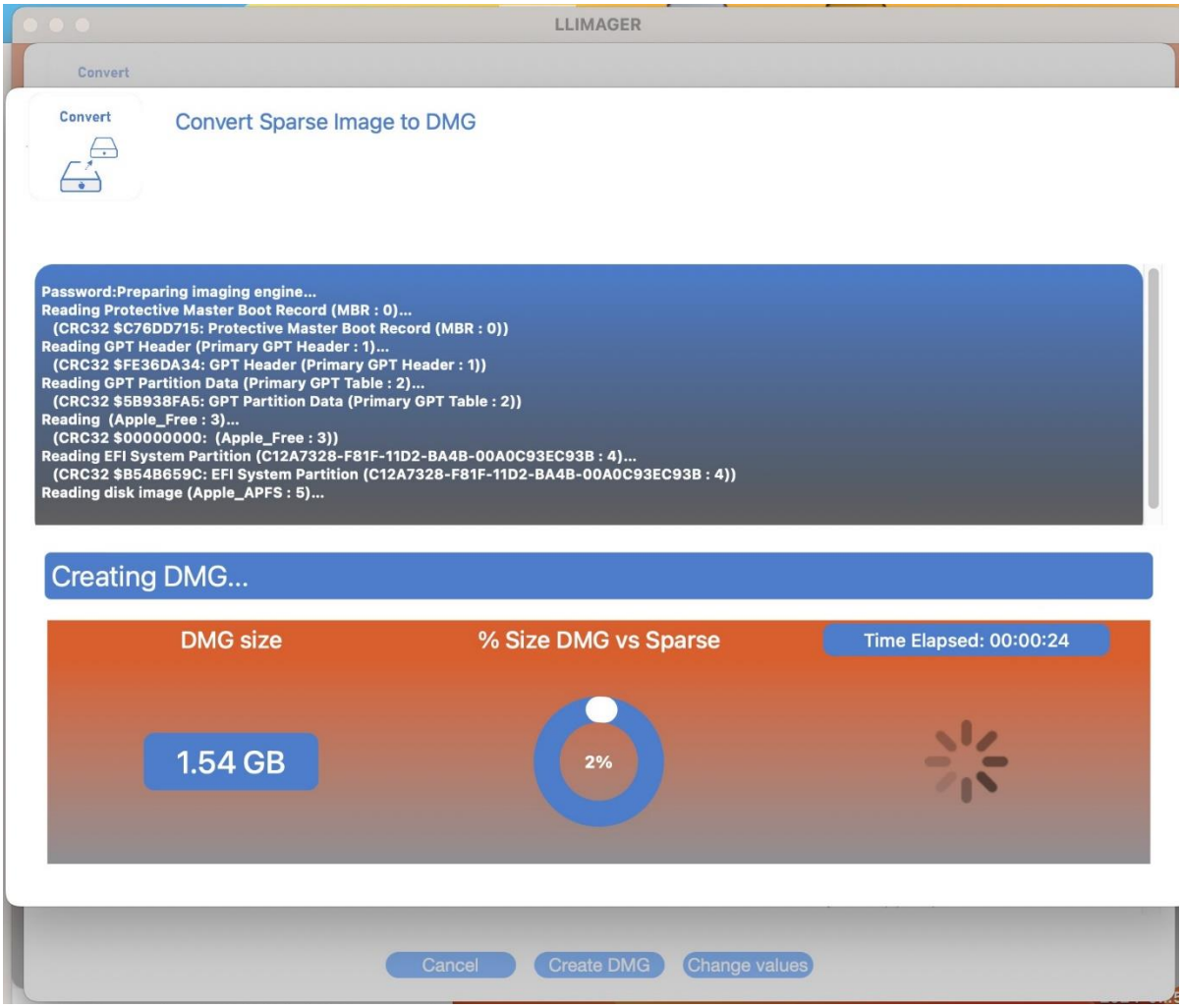

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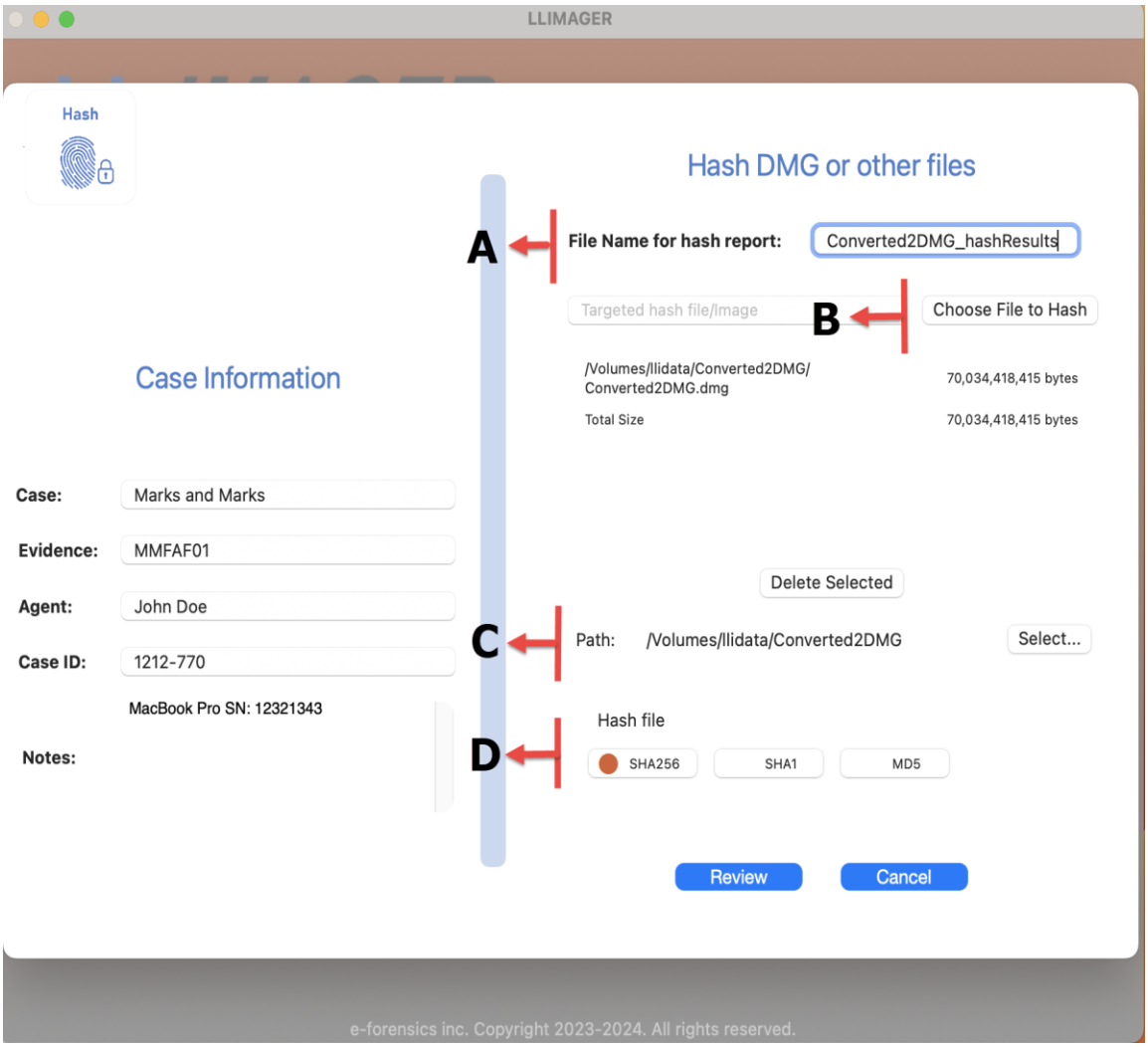
Menu Option (Hash)

The hash option is used to calculate the hash of a file, be it sparse image, DMG or any other type, and the following picture shows the fields and selection options:



See below for a description of each section.

A – Specify the name of the hash report file.

B – Related to the *source files/folders*. Requires selection of the source files to hash.

C – Related to the *destination of the hash report* file. Requires selection of path hash report destination folder.

D – Related to *hashing type.* Specify the type of hash.

After completing the selections, a summary of the information is provided; see below.

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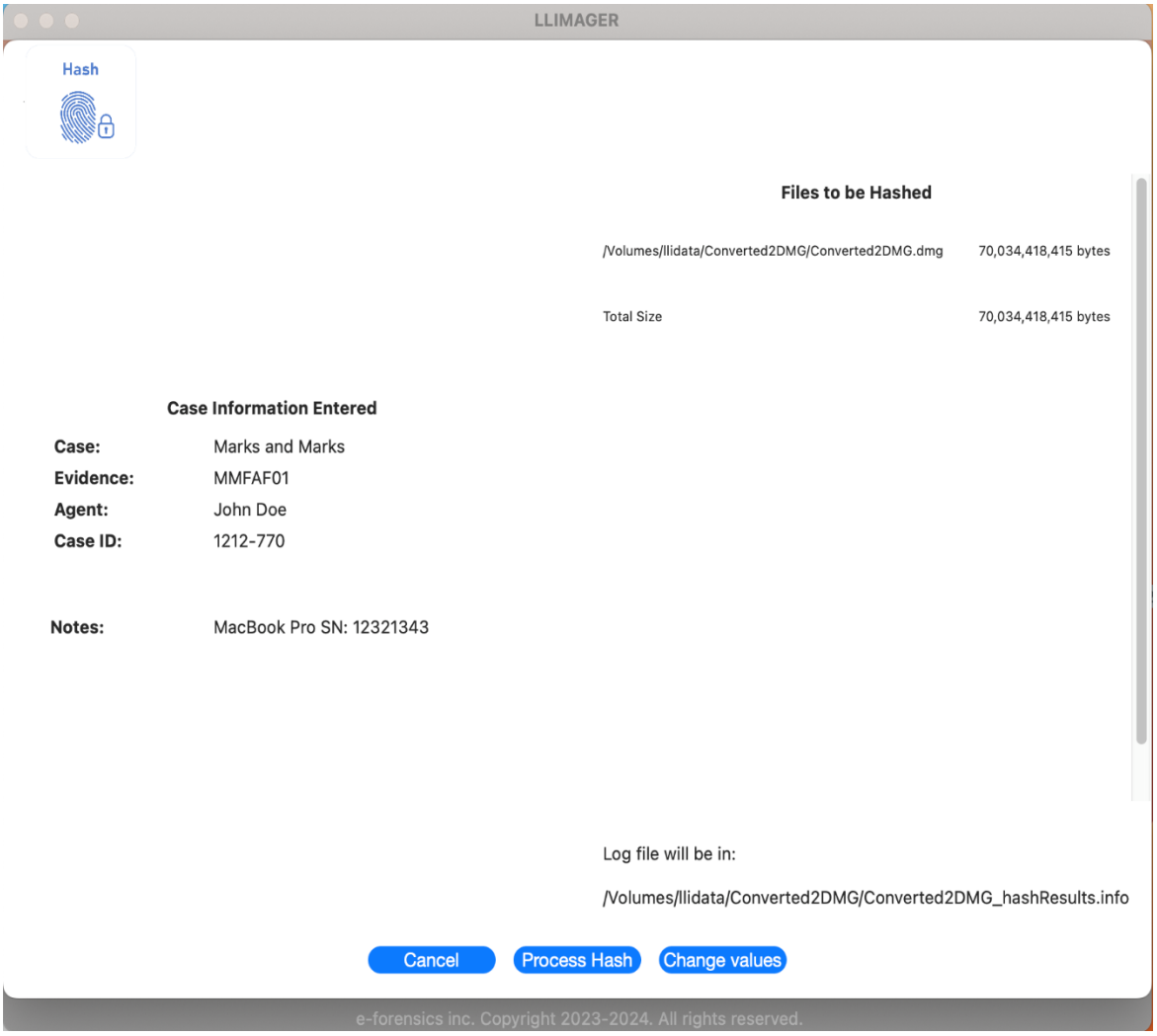

Proceed to click on “Process Hash” and the following will appear:

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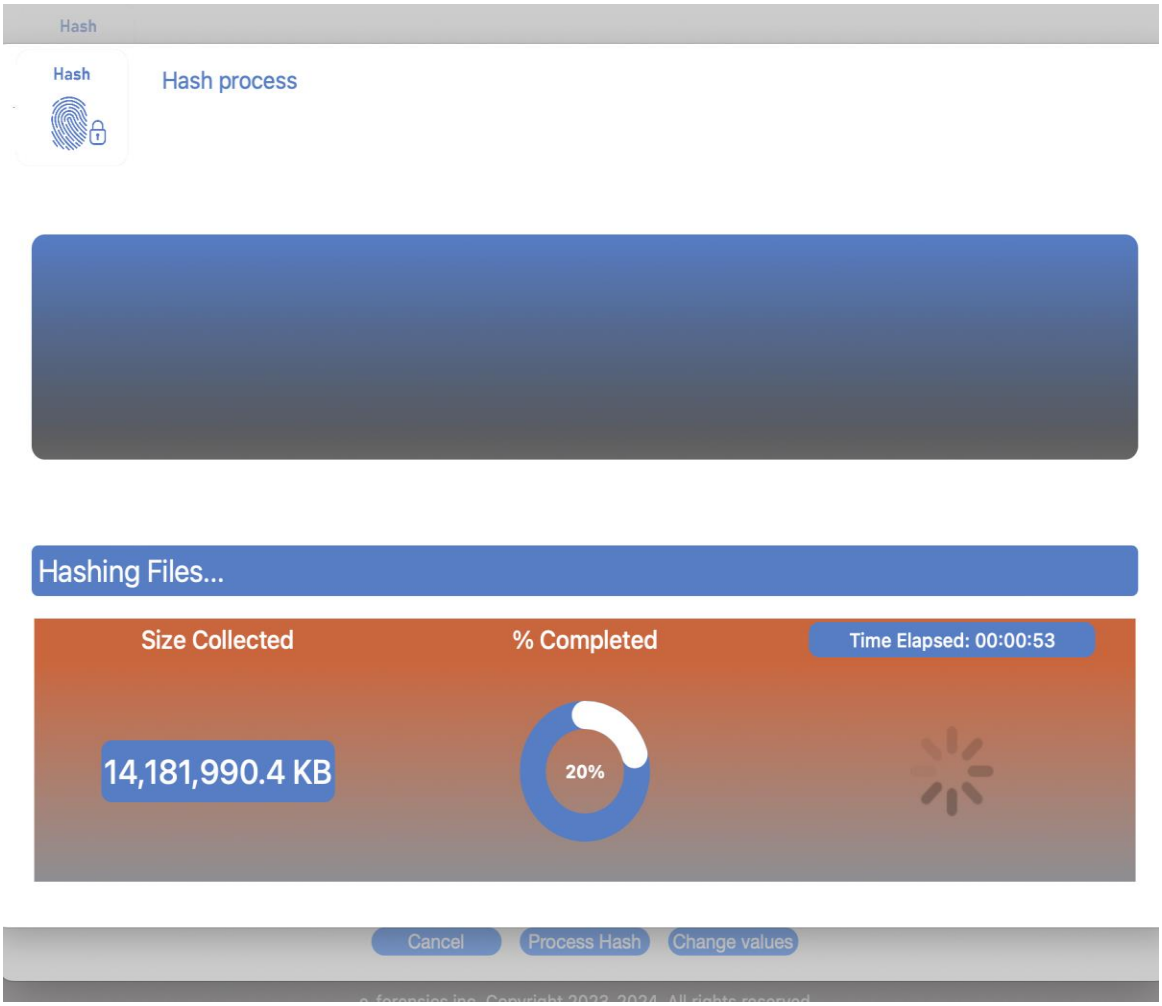

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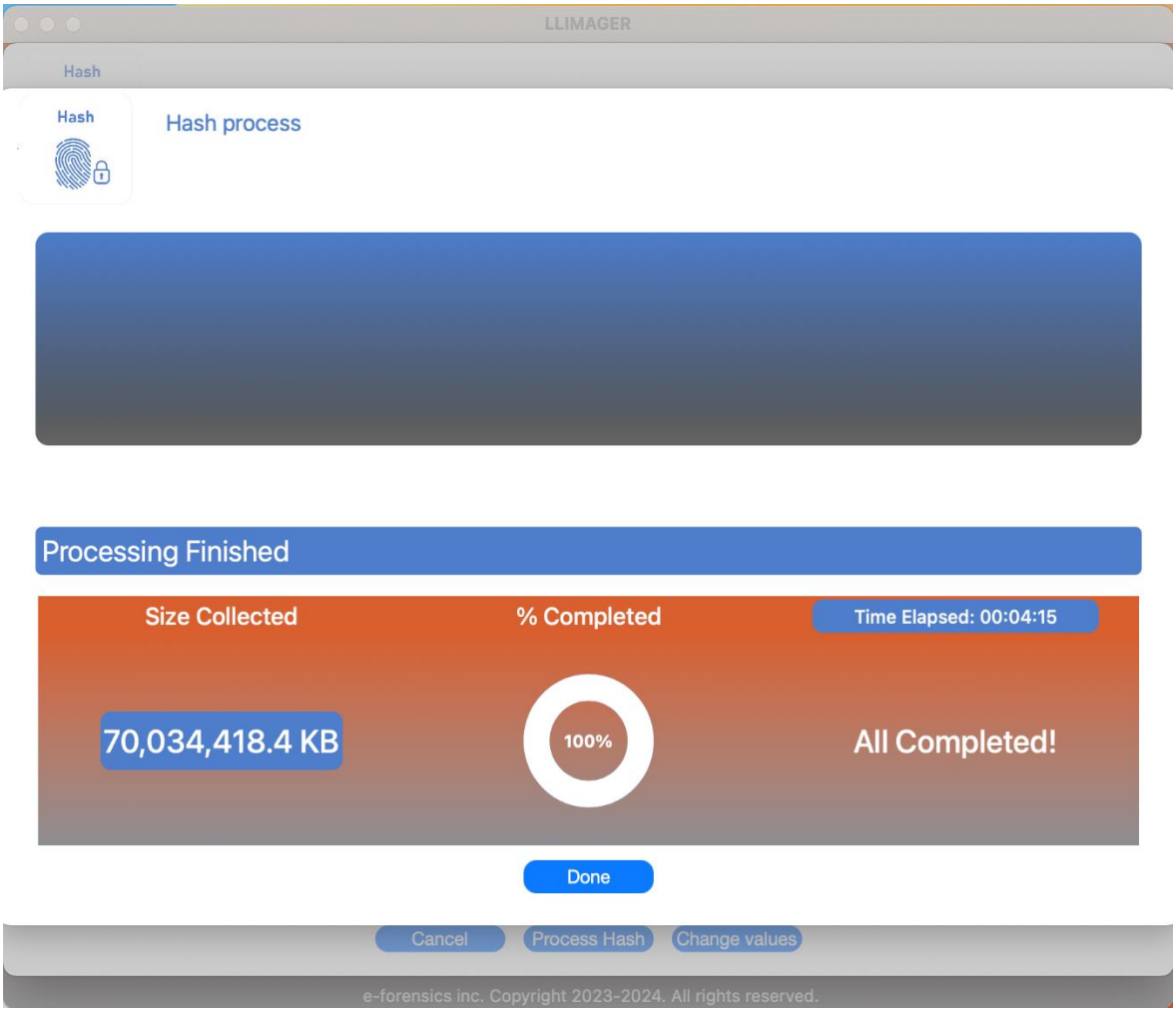

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Disk Acquisition Log Sample

The following is a sample of the disk acquisition log.

```
================================================================================================
LLimager V 4.0 -  Mac Computers Forensics Imager

ACQUISITION DETAIL

------------------------------------------------------------------------------------------------
    Case Summary

        Case Name:      Marks and Marks
        Evidence Name:  MMAF01
        Agent Name:     John Doe
        Case ID:        1212-770

        Case Notes:     MacBook Pro SN: 12321343

        Start Time:     2024-04-05 10:28:51

------------------------------------------------------------------------------------------------
    Hardware information

        Serial Number:  FVFXNML4HV22
        Model Name:     MacBook Pro
        Model Indent.:  MacBookPro14,1
        Memory:         8 GB
        Device UUID:    EB71A5DD-3BA7-500B-88C3-11821EC0874D

------------------------------------------------------------------------------------------------
    Source Disk Information

   Device Identifier:         disk1s5s1
   Device Node:               /dev/disk1s5s1
   Whole:                     No
   Part of Whole:             disk1

   Volume Name:               Macintosh HD
   Mounted:                   Yes
   Mount Point:               /

   Partition Type:            41504653-0000-11AA-AA11-00306543ECAC
   File System Personality:   APFS
   Type (Bundle):             apfs
   Name (User Visible):       APFS
   Owners:                    Enabled
```


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```
   OS Can Be Installed:       No
   Booter Disk:               disk1s2
   Recovery Disk:             disk1s3
   Media Type:                Generic
   Protocol:                  PCI-Express
   SMART Status:              Verified
   Volume UUID:               B8CE8BAA-4A75-42F3-BF8F-89412A84C937
   Disk / Partition UUID:     B8CE8BAA-4A75-42F3-BF8F-89412A84C937

   Disk Size:                 121.0 GB (121018208256 Bytes) (exactly 236363688 512-Byte-Units)
   Device Block Size:         4096 Bytes

   Volume Used Space:         11.9 GB (11915608064 Bytes) (exactly 23272672 512-Byte-Units)
   Container Total Space:     121.0 GB (121018208256 Bytes) (exactly 236363688 512-Byte-Units)
   Container Free Space:      25.3 GB (25298644992 Bytes) (exactly 49411416 512-Byte-Units)
   Allocation Block Size:     4096 Bytes

   Media OS Use Only:         No
   Media Read-Only:           Yes
   Volume Read-Only:          Yes (read-only mount flag set)

   Device Location:           Internal
   Removable Media:           Fixed

   Solid State:               Yes
   Hardware AES Support:      No

   This disk is an APFS Volume Snapshot.  APFS Information:
   APFS Snapshot Name:        com.apple.os.update-A17B27811581529D33626973A757590AE0168469175C377BE4B1C7BDFDED1E84
   APFS Snapshot UUID:        B8CE8BAA-4A75-42F3-BF8F-89412A84C937
   APFS Container:            disk1
   APFS Physical Store:       disk0s2
   Fusion Drive:              No
   APFS Volume Group:         890F1145-BA72-4388-B74E-D0E7C79835AB
   EFI Driver In macOS:       2142140009000000
   Encrypted:                 No
   FileVault:                 Yes
   Sealed:                    Broken
   Locked:                    No

   APFS Snapshots are defined upon this APFS Volume.  Snapshot list:
   Snapshot UUID:             B8CE8BAA-4A75-42F3-BF8F-89412A84C937
   Name:                      com.apple.os.update-A17B27811581529D33626973A757590AE0168469175C377BE4B1C7BDFDED1E84
   XID:                       58627287
   Snapshot UUID:             D56BC470-A1BF-436F-8F17-D82DA8C35346
   Name:                      com.apple.os.update-MSUPrepareUpdate
   XID:                       59597868

================================================================================================
```


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```
RESULTS


Sparse image process----------------------------------------

Start time:     2024-04-05 10:28:54
End time:       2024-04-05 10:39:12
Image size:     93.91 GB

Sparse image created:      /Volumes/llidata/Acqimage98.sparseimage

DMG image process-----------------------------------------

Start time:     2024-04-05 10:39:20
End time:       2024-04-05 10:56:29
Image size:     70.03 GB

DMG image created:      /Volumes/llidata/Acqimage98.dmg

Hash DMG process------------------------------------------

Start time:     2024-04-05 10:56:29
End time:       2024-04-05 11:00:36
SHA256 hash:    83b5601089817ea0fe72492e16d4e453cfbad051431ff93b40b03953f83c37e0


    ================================================================================================
```

Targeted Acquisition Log Sample

The following is a sample of the targeted folders acquisition log.

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```
================================================================================
LLimager V 4.0 -  Mac Computers Forensics Imager

ACQUISITION DETAIL
--------------------------------------------------------------------------------
    Case Summary

        Case Name:      Case Name
        Evidence Name:  Evidence
        Agent Name:     Agent
        Case ID:        Case ID

        Start Time:     2024-04-08 16:16:54

--------------------------------------------------------------------------------
    Hardware information

        Serial Number:  FVFXNML4HV22
        Model Name:     MacBook Pro
        Model Indent.:  MacBookPro14,1
        Memory:         8 GB
        Device UUID:    EB71A5DD-3BA7-500B-88C3-11821EC0874D

--------------------------------------------------------------------------------
    Targeted Files and Folders Information

/Users/admin/Documents/TestApp
/Users/admin/Documents/Temp 1
/Users/admin/Documents/History.db
================================================================================

RESULTS


Extract process --------------------

Start time:     2024-04-08 16:17:00
End time:       2024-04-08 16:17:01
Image size:     0.02 GB

DMG image process ------------------

Start time:     2024-04-08 16:17:06
End time:       2024-04-08 16:17:08
Image size:     0.00 GB

Hash DMG image process -------------

Start time:     2024-04-08 16:17:08
End time:       2024-04-08 16:17:08
SHA256 value:   3530a79062acab0bec2cecb124b8578a69fb1185dc9d870cc23cf819ad0961a5
```

Changelog

July 20, 2023: Commercial Version 3.5 (beta core)

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September 8, 2023: Commercial Version 3.7: Major cosmetic

September 15, 2023: Commercial Version 3.7.1: Minor updates to license key processing, and packaging executables into DMGs

October 2, 2023: Commercial Version 3.7.2: Added new feature to create logical image of targeted folders.

November 14, 2023: Manual documentation update regarding resolution of LLimager being damaged and can't open.

November 17, 2023: Update to EULA

December 8, 2023: Commercial Version 3.8: Major update

- Transparent management of System sleeping time.
- Removed the required input requesting confirmation to erase the sparse after selecting to run in Unattended mode.
- Updated messages during the process to make warning messages more notable.
- Updated the imaging of targeted folders.
- Changed the process to save all targeted folders into one DMG.
- Enhanced error trapping.
- Updates to the acquisition log file.
- Other minor changes to enhance performance.
- Manual documentation update regarding resolution of LLimager_M1 being damaged and can't open.

April 8, 2024: Complete rewrite to GUI using in Swift.

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