



OpenCore

Reference Manual (0.6.~~1~~.2)

[2020.09.13]

Type: plist boolean

Failsafe: false

Requirement: 10.11 (not required for older)

Description: Patch various kexts (AppleUSBXHCI.kext, AppleUSBXHCIPCI.kext, IOUSBHostFamily.kext) to remove USB port count limit of 15 ports.

Note: This option should be avoided whenever possible. USB port limit is imposed by the amount of used bits in locationID format and there is no possible way to workaroud this without heavy OS modification. The only valid solution is to limit the amount of used ports to 15 (discarding some). More details can be found on AppleLife.ru.

7.9 Scheme Properties

These properties are particularly relevant for older macOS operating systems. For more details on how to install and troubleshoot such macOS installation refer to Legacy Apple OS.

1. FuzzyMatch

Type: plist boolean

Failsafe: false

Description: Use `kernelcache` with different checksums when available.

On macOS 10.6 and earlier `kernelcache` filename has a checksum, which essentially is `adler32` from SMBIOS product name and EfiBoot device path. On certain firmwares EfiBoot device path differs between UEFI and macOS due to ACPI or hardware specifics, rendering `kernelcache` checksum as always different.

This setting allows matching the latest `kernelcache` with a suitable architecture when the `kernelcache` without suffix is unavailable, improving macOS 10.6 boot performance on several platforms.

2. KernelArch

Type: plist string

Failsafe: Auto

Description: Prefer specified kernel architecture (`Auto`, `i386`, `i386-user32`, `x86_64`) when available.

On macOS 10.7 and earlier XNU kernel can boot with architectures different from the usual `x86_64`. This setting will use the specified architecture to boot macOS when it is supported by the macOS and the configuration:

- `Auto` — Choose the preferred architecture automatically.
- `i386` — Use `i386` (32-bit) kernel when available.
- `i386-user32` — Use `i386` (32-bit) kernel when available and force the use of 32-bit userspace on 64-bit capable processors. On macOS 64-bit capable processors are assumed to support `SSSE3`. This is not the case for older 64-bit capable Pentium processors, which cause some applications to crash on macOS 10.6. The behaviour corresponds to `-legacy` kernel boot argument.
- `x86_64` — Use `x86_64` (64-bit) kernel when available.

Below is the algorithm determining the kernel architecture.

- `arch` argument in image arguments (e.g. when launched via UEFI Shell) or in `boot-args` variable overrides any compatibility checks and forces the specified architecture, completing this algorithm.
- OpenCore build architecture restricts capabilities to `i386` and `i386-user32` mode for the 32-bit firmware variant.
- Determined EfiBoot version restricts architecture choice:
 - 10.4-10.5 — `i386` or `i386-user32`
 - 10.6 ~~10.7~~ — `i386`, `i386-user32`, or `x86_64`
 - 10.7 — `i386` or `x86_64`
 - 10.8 or newer — `x86_64`
- If `KernelArch` is set to `Auto` and `SSSE3` is not supported by the CPU, capabilities are restricted to `i386-user32` if supported by EfiBoot.
- Board identifier (from SMBIOS) based on EfiBoot version disables `x86_64` support on an unsupported model if any `i386` variant is supported. `Auto` is not consulted here as the list is not overridable in EfiBoot.
- `KernelArch` restricts the support to the explicitly specified architecture (when not set to `Auto`) if the architecture remains present in the capabilities.
- The best supported architecture is chosen in this order: `x86_64`, `i386`, `i386-user32`.

- GSTT — GoptStop
- HDA — AudioDxe
- KKT — KeyTester
- MMDD — MmapDump
- OCPAVP — PavpProvision
- OCRST — ResetSystem
- OCUI — OpenCanopy
- OC — OpenCore main
- VMOPT — VerifyMemOpt

Libraries:

- AAPL — OcDebugLogLib, Apple EfiBoot logging
- OCABC — OcAfterBootCompatLib
- OCAE — OcAppleEventLib
- OCAK — OcAppleKernelLib
- OCAU — OcAudioLib
- OCAV — OcAppleImageVerificationLib
- OCA — OcAcpiLib
- OCBP — OcAppleBootPolicyLib
- OCB — OcBootManagementLib
- OCCL — OcAppleChunkListLib
- OCCPU — OcCpuLib
- OCC — OcConsoleLib
- [OCDC — OcDriverConnectionLib](#)
- OCDH — OcDataHubLib
- OCDI — OcAppleDiskImageLib
- ~~OCFSQ — OcFileLib, UnblockFs quirk~~
- OCFS — OcFileLib
- OCFV — OcFirmwareVolumeLib
- OCHS — OcHashServicesLib
- OCIA4 — OcAppleImg4Lib
- OCIC — OcImageConversionLib
- OCII — OcInputLib
- OCJS — OcApfsLib
- OCKM — OcAppleKeyMapLib
- OCL — OcDebugLogLib
- OCMCO — OcMachoLib
- OCME — OcHeciLib
- OCMM — OcMemoryLib
- OCPI — OcFileLib, partition info
- OCPNG — OcPngLib
- OCRAM — OcAppleRamDiskLib
- OCRTC — OcRtcLib
- OCSB — OcAppleSecureBootLib
- OCSMB — OcSmbiosLib
- OCSMC — OcSmcLib
- OCST — OcStorageLib
- OCS — OcSerializedLib
- OCTPL — OcTemplateLib
- OCUC — OcUnicodeCollationLib
- OCUT — OcAppleUserInterfaceThemeLib
- OCXML — OcXmlLib

8.5 Security Properties

1. AllowNvramReset
Type: plist boolean
Failsafe: false

- `OC_SCAN_ALLOW_DEVICE_SATA`
- `OC_SCAN_ALLOW_DEVICE_SASEX`
- `OC_SCAN_ALLOW_DEVICE_SCSI`
- `OC_SCAN_ALLOW_DEVICE_NVME`

14. `SecureBootModel`

Type: plist string

Failsafe: `Default`

Description: Apple Secure Boot hardware model.

Sets Apple Secure Boot hardware model and policy. Specifying this value defines which operating systems will be bootable. Operating systems shipped before the specified model was released will not boot. Valid values:

- **Default** — Recent available model, currently set to `j137`.
- **Disabled** — No model, Secure Boot will be disabled.
- `j137` — `iMacPro1,1` (December 2017) minimum macOS 10.13.2 (17C2111)
- `j680` — `MacBookPro15,1` (July 2018) minimum macOS 10.13.6 (17G2112)
- `j132` — `MacBookPro15,2` (July 2018) minimum macOS 10.13.6 (17G2112)
- `j174` — `Macmini8,1` (October 2018) minimum macOS 10.14 (18A2063)
- `j140k` — `MacBookAir8,1` (October 2018) minimum macOS 10.14.1 (18B2084)
- `j780` — `MacBookPro15,3` (May 2019) minimum macOS 10.14.5 (18F132)
- `j213` — `MacBookPro15,4` (July 2019) minimum macOS 10.14.5 (18F2058)
- `j140a` — `MacBookAir8,2` (July 2019) minimum macOS 10.14.5 (18F2058)
- `j152f` — `MacBookPro16,1` (November 2019) minimum macOS 10.15.1 (19B2093)
- `j160` — `MacPro7,1` (December 2019) minimum macOS 10.15.1 (19B88)
- `j230k` — `MacBookAir9,1` (March 2020) minimum macOS 10.15.3 (19D2064)
- `j214k` — `MacBookPro16,2` (May 2020) minimum macOS 10.15.4 (19E2269)
- `j223` — `MacBookPro16,3` (May 2020) minimum macOS 10.15.4 (19E2265)
- `j215` — `MacBookPro16,4` (June 2020) minimum macOS 10.15.5 (19F96)
- `j185` — `iMac20,1` (August 2020) minimum macOS 10.15.6 (19G2005)
- `j185f` — `iMac20,2` (August 2020) minimum macOS 10.15.6 (19G2005)

`PlatformInfo` and `SecureBootModel` are independent, allowing to enabling Apple Secure Boot with any SMBIOS. Setting `SecureBootModel` to any valid value but `Disabled` is equivalent to **Medium Security** of Apple Secure Boot. To achieve **Full Security** one will need to also specify `ApECID` value.

Enabling Apple Secure Boot is more demanding to incorrect configurations, buggy macOS installations, and unsupported setups. Things to keep in mind:

- Just like on T2 Macs you will not be able to install any unsigned kernel drivers and several signed kernel drivers including NVIDIA Web Drivers.
- The list of cached drivers may be different, resulting in the need to change the list of **Added** or **Forced** kernel drivers. For example, `I080211Family` cannot be injected in this case.
- System volume alterations on operating systems with sealing, like macOS 11, may result in the operating system being unbootable. Do not try to disable system volume encryption unless you disable Apple Secure Boot.
- If your platform requires certain settings, but they were not enabled, because the obvious issues did not trigger before, you may get boot failure. Be extra careful with `IgnoreInvalidFlexRatio` or `HashServices`.
- Operating systems released before Apple Secure Boot landed (e.g. macOS 10.12 or earlier) will still boot until UEFI Secure Boot is enabled. This is so, because from Apple Secure Boot point they are treated as incompatible and are assumed to be handled by the firmware just like Microsoft Windows is.
- On older CPUs (e.g. before Sandy Bridge) enabling Apple Secure Boot might cause slightly slower loading by up to 1 second.
- Since `Default` value will increase with time to support the latest major release operating system, it is not recommended to use `ApECID` and `Default` value together.

Sometimes the already installed operating system may have outdated Apple Secure Boot manifests on the **Preboot** partition causing boot failure. If you see the “OCB: Apple Secure Boot prohibits this boot entry, enforcing!” message, it is likely the case. When this happens you can either reinstall the operating system or copy the manifests (files with `.im4m` extension, like `boot.efi.j137.im4m`) from `/usr/standalone/i386` to `/Volumes/Preboot/<UUID>/System/Library/CoreServices`. Here `<UUID>` is your system volume identifier. [On](#)

- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:HW_BID`
Hardware BoardProduct (e.g. `Mac-35C1E88140C3E6CF`). Not present on real Macs, but used to avoid extra parsing of SMBIOS tables, especially in `boot.efi`.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:HW_MLB`
Hardware BoardSerialNumber. Override for MLB. Present on newer Macs (2013+ at least).
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:HW_ROM`
Hardware ROM. Override for ROM. Present on newer Macs (2013+ at least).
- `7C436110-AB2A-4BBB-A880-FE41995C9F82:prev-lang:kbd`
ASCII string defining default keyboard layout. Format is `lang-COUNTRY:keyboard`, e.g. `ru-RU:252` for Russian locale and ABC keyboard. Also accepts short forms: `ru:252` or `ru:0` (U.S. keyboard, compatible with 10.9). Full decoded keyboard list from `AppleKeyboardLayouts-L.dat` can be found [here](#). Using non-latin keyboard on 10.14 will not enable ABC keyboard, unlike previous and subsequent macOS versions, and is thus not recommended in case you need 10.14.
- `7C436110-AB2A-4BBB-A880-FE41995C9F82:security-mode`
ASCII string defining FireWire security mode. Legacy, can be found in `IOFireWireFamily` source code in `IOFireWireController.cpp`. It is recommended not to set this variable, which may speedup system startup. Setting to `full` is equivalent to not setting the variable and `none` disables FireWire security.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:UIScale`
One-byte data defining `boot.efi` user interface scaling. Should be `01` for normal screens and `02` for HiDPI screens.
- `4D1EDE05-38C7-4A6A-9CC6-4BCCA8B38C14:DefaultBackgroundColor`
Four-byte BGRA data defining `boot.efi` user interface background colour. Standard colours include `BF BF BF 00` (Light Gray) and `00 00 00 00` (Syrah Black). Other colours may be set at user's preference.

9.5 Other Variables

The following variables may be useful for certain configurations or troubleshooting:

- `7C436110-AB2A-4BBB-A880-FE41995C9F82:boot-args`
Kernel arguments, used to pass configuration to Apple kernel and drivers. There are many arguments, which may be found by looking for the use of `PE_parse_boot_argn` function in the kernel or driver code. Some of the known boot arguments include:
 - `acpi_layer=0xFFFFFFFF`
 - `acpi_level=0xFFFF5F` (implies `ACPI_ALL_COMPONENTS`)
 - `arch=i386` (force kernel architecture to `i386`, see `KernelArch`)
 - `batman=VALUE` (`AppleSmartBatteryManager` debug mask)
 - `batman-nosmc=1` (disable `AppleSmartBatteryManager` SMC interface)
 - `cpus=VALUE` (maximum number of CPUs used)
 - `debug=VALUE` (debug mask)
 - `io=VALUE` (IOKit debug mask)
 - `keepsyms=1` (show panic log debug symbols)
 - `kextlog=VALUE` (kernel extension loading debug mask)
 - `nv_disable=1` (disables NVIDIA GPU acceleration)
 - `nvda_drv=1` (legacy way to enable NVIDIA web driver, removed in 10.12)
 - `npci=0x2000` (legacy, disables `kIOPCIConfiguratorPFM64`)
 - `lapic_dont_panic=1`
 - `slide=VALUE` (manually set KASLR slide)
 - `smcdebug=VALUE` (`AppleSMC` debug mask)
 - `-amd_no_dgpu_accel` (alternative to WhateverGreen's `-radvesa` for new GPUs)
 - `-nehalem_error_disable`
 - `-no_compat_check` (disable model checking [on 10.7+](#))
 - `-s` (single mode)
 - `-v` (verbose mode)
 - `-x` (safe mode)

There are multiple external places summarising macOS argument lists: [example 1](#), [example 2](#).

- `7C436110-AB2A-4BBB-A880-FE41995C9F82:bootercfg`
Booter arguments, similar to `boot-args` but for `boot.efi`. Accepts a set of arguments, which are hexadecimal 64-bit values with or without `0x`. At different stages `boot.efi` will request different debugging (logging) modes

(e.g. after `ExitBootServices` it will only print to serial). Several booter arguments control whether these requests will succeed. The list of known requests is covered below:

- `0x00` – `INIT`.
- `0x01` – `VERBOSE` (e.g. `-v`, force console logging).
- `0x02` – `EXIT`.
- `0x03` – `RESET:OK`.
- `0x04` – `RESET:FAIL` (e.g. unknown `board-id`, hibernate mismatch, panic loop, etc.).
- `0x05` – `RESET:RECOVERY`.
- `0x06` – `RECOVERY`.
- `0x07` – `REAN:START`.
- `0x08` – `REAN:END`.
- `0x09` – `DT` (can no longer log to `DeviceTree`).
- `0x0A` – `EXITBS:START` (forced serial only).
- `0x0B` – `EXITBS:END` (forced serial only).
- `0x0C` – `UNKNOWN`.

In 10.15 debugging support was mostly broken before 10.15.4 due to some kind of refactoring and introduction of a new debug protocol. Some of the arguments and their values below may not be valid for versions prior to 10.15.4. The list of known arguments is covered below:

- `boot-save-log=VALUE` — debug log save mode for normal boot.
 - * `0`
 - * `1`
 - * `2` — (default).
 - * `3`
 - * `4` — (save to file).
- `wake-save-log=VALUE` — debug log save mode for hibernation wake.
 - * `0` — disabled.
 - * `1`
 - * `2` — (default).
 - * `3` — (unavailable).
 - * `4` — (save to file, unavailable).
- `breakpoint=VALUE` — enables debug breaks (missing in production `boot.efi`).
 - * `0` — disables debug breaks on errors (default).
 - * `1` — enables debug breaks on errors.
- `console=VALUE` — enables console logging.
 - * `0` — disables console logging.
 - * `1` — enables console logging when debug protocol is missing (default).
 - * `2` — enables console logging unconditionally (unavailable).
- `embed-log-dt=VALUE` — enables `DeviceTree` logging.
 - * `0` — disables `DeviceTree` logging (default).
 - * `1` — enables `DeviceTree` logging.
- `kc-read-size=VALUE` — Chunk size used for buffered I/O from network or disk for prelinkedkernel reading and related. Set to 1MB (0x100000) by default, can be tuned for faster booting.
- `log-level=VALUE` — log level bitmask.
 - * `0x01` — enables trace logging (default).
- `serial=VALUE` — enables serial logging.
 - * `0` — disables serial logging (default).
 - * `1` — enables serial logging for `EXITBS:END` onwards.
 - * `2` — enables serial logging for `EXITBS:START` onwards.
 - * `3` — enables serial logging when debug protocol is missing.
 - * `4` — enables serial logging unconditionally.
- `timestamps=VALUE` — enables timestamp logging.
 - * `0` — disables timestamp logging.
 - * `1` — enables timestamp logging (default).
- `log=VALUE` — deprecated starting from 10.15.
 - * `1` — `AppleLoggingConOutOrErrSet/AppleLoggingConOutOrErrPrint` (classical `ConOut/StdErr`)
 - * `2` — `AppleLoggingStdErrSet/AppleLoggingStdErrPrint` (`StdErr` or serial?)
 - * `4` — `AppleLoggingFileSet/AppleLoggingFilePrint` (`BOOTER.LOG/BOOTER.OLD` file on EFI partition)

- **TryOverwrite** — **Overwrite** if new size is \leq than the page-aligned original and there are no issues with legacy region unlock. **Create** otherwise. Has issues with some firmwares.
- **Create** — Replace the tables with newly allocated `EfiReservedMemoryType` at `AllocateMaxAddress` without any fallbacks.
- **Overwrite** — **Overwrite** existing `gEfiSmbiosTableGuid` and `gEfiSmbiosTable3Guid` data if it fits new size. Abort with unspecified state otherwise.
- **Custom** — Write SMBIOS tables (`gEfiSmbios(3)TableGuid`) to `gOcCustomSmbios(3)TableGuid` to workaround firmwares overwriting SMBIOS contents at `ExitBootServices`. Otherwise equivalent to **Create**. Requires patching `AppleSmbios.kext` and `AppleACPIPlatform.kext` to read from another GUID: "EB9D2D31" - "EB9D2D35" (in ASCII), done automatically by `CustomSMBIOSGuid` quirk.

Note: A side effect of using **Custom** approach is making SMBIOS updates exclusive to macOS, avoiding a collision with existing Windows activation and custom OEM software but potentially breaking Apple-specific tools.

6. Generic

Type: plist dictionary

Description: Update all fields. This section is read only when **Automatic** is active.

7. DataHub

Type: plist dictionary

Optional: When **Automatic** is true

Description: Update Data Hub fields. This section is read only when **Automatic** is not active.

8. PlatformNVRAM

Type: plist dictionary

Optional: When **Automatic** is true

Description: Update platform NVRAM fields. This section is read only when **Automatic** is not active.

9. SMBIOS

Type: plist dictionary

Optional: When **Automatic** is true

Description: Update SMBIOS fields. This section is read only when **Automatic** is not active.

10.2 Generic Properties

1. SpoofVendor

Type: plist boolean

Failsafe: false

Description: Sets SMBIOS vendor fields to `Acidanthera`.

It is dangerous to use Apple in SMBIOS vendor fields for reasons given in `SystemManufacturer` description. However, certain firmwares may not provide valid values otherwise, which could break some software.

2. AdviseWindows

Type: plist boolean

Failsafe: false

Description: Forces Windows support in `FirmwareFeatures`.

Added bits to `FirmwareFeatures`:

- `FW_FEATURE_SUPPORTS_CSM_LEGACY_MODE` (0x1) - Without this bit it is not possible to reboot to Windows installed on a drive with EFI partition being not the first partition on the disk.
- `FW_FEATURE_SUPPORTS_UEFI_WINDOWS_BOOT` (0x20000000) - Without this bit it is not possible to reboot to Windows installed on a drive with EFI partition being the first partition on the disk.

3. ProcessorType **Type:** plist integer

Failsafe: Automatic

Description: Refer to SMBIOS ProcessorType.

4. SystemProductName

Type: plist string

Failsafe: MacPro6,1

Description: Refer to SMBIOS `SystemProductName`.

SMBIOS: System Enclosure or Chassis (Type 3) — Type

Description: Chassis type, refer to Table 17 — System Enclosure or Chassis Types for more details.

20. ChassisVersion

Type: plist string

Failsafe: OEM specified

SMBIOS: System Enclosure or Chassis (Type 3) — Version

Description: Should match BoardProduct.

21. ChassisSerialNumber

Type: plist string

Failsafe: OEM specified

SMBIOS: System Enclosure or Chassis (Type 3) — Version

Description: Should match SystemSerialNumber.

22. ChassisAssetTag

Type: plist string

Failsafe: OEM specified

SMBIOS: System Enclosure or Chassis (Type 3) — Asset Tag Number

Description: Chassis type name. Varies, could be empty or MacBook-Aluminum.

23. PlatformFeature

Type: plist integer, 32-bit

Failsafe: 0xFFFFFFFF

SMBIOS: APPLE_SMBIOS_TABLE_TYPE133 - PlatformFeature

Description: Platform features bitmask. Refer to AppleFeatures.h for more details. Use 0xFFFFFFFF value to not provide this table.

24. SmcVersion

Type: plist data, 16 bytes

Failsafe: All zero

SMBIOS: APPLE_SMBIOS_TABLE_TYPE134 - Version

Description: ASCII string containing SMC version in upper case. Missing on T2 based Macs. Ignored when zero.

25. FirmwareFeatures

Type: plist data, 8 bytes

Failsafe: 0

SMBIOS: APPLE_SMBIOS_TABLE_TYPE128 - FirmwareFeatures and ExtendedFirmwareFeatures

Description: 64-bit firmware features bitmask. Refer to AppleFeatures.h for more details. Lower 32 bits match FirmwareFeatures. Upper 64 bits match ExtendedFirmwareFeatures.

26. FirmwareFeaturesMask

Type: plist data, 8 bytes

Failsafe: 0

SMBIOS: APPLE_SMBIOS_TABLE_TYPE128 - FirmwareFeaturesMask and ExtendedFirmwareFeaturesMask

Description: Supported bits of extended firmware features bitmask. Refer to AppleFeatures.h for more details. Lower 32 bits match FirmwareFeaturesMask. Upper 64 bits match ExtendedFirmwareFeaturesMask.

27. ProcessorType

Type: plist integer, 16-bit

Failsafe: Automatic

SMBIOS: APPLE_SMBIOS_TABLE_TYPE131 - ProcessorType

Description: Combined of Processor Major and Minor types.

Automatic value generation tries to provide most accurate value for the currently installed CPU. When this fails please make sure to create an issue and provide sysctl machdep.cpu and dmidecode output. For a full list of available values and their limitations (the value will only apply if the CPU core count matches) refer to Apple SMBIOS definitions header here.

28. MemoryFormFactor

Type: plist integer, 8-bit


```
Do you want to proceed? (Y/N): Y
OK; writing new GUID partition table (GPT) to \\.\physicaldrive0.
Disk synchronization succeeded! The computer should now use the new partition table.
The operation has completed successfully.
```

Listing 4: Relabeling Windows volume

How to choose Windows BOOTCAMP with custom NTFS drivers?

Third-party drivers providing NTFS support, such as NTFS-3G, Paragon NTFS, Tuxera NTFS or Seagate Paragon Driver break certain macOS functionality, including Startup Disk preference pane normally used for operating system selection. While the recommended option remains not to use such drivers as they commonly corrupt the filesystem, and prefer the driver bundled with macOS with optional write support (`command` or `GUI`), there still exist vendor-specific workarounds for their products: Tuxera, Paragon, etc.

12.4 Debugging

Similar to other projects working with hardware OpenCore supports auditing and debugging. The use of `NOOPT` or `DEBUG` build modes instead of `RELEASE` can produce a lot more debug output. With `NOOPT` source level debugging with GDB or IDA Pro is also available. For GDB check OpenCore Debug page. For IDA Pro you will need IDA Pro 7.3 or newer, refer to Debugging the XNU Kernel with IDA Pro for more details.

To obtain the log during boot you can make the use of serial port debugging. Serial port debugging is enabled in `Target`, e.g. `0xB` for onscreen with serial. To initialise serial within OpenCore use `SerialInit` configuration option. For macOS your best choice are CP2102-based UART devices. Connect motherboard `TX` to USB UART `RX`, and motherboard `GND` to USB UART `GND`. Use `screen` utility to get the output, or download GUI software, such as CoolTerm.

Note: On several motherboards (and possibly USB UART dongles) PIN naming may be incorrect. It is very common to have `GND` swapped with `RX`, thus you have to connect motherboard “`TX`” to USB UART `GND`, and motherboard “`GND`” to USB UART `RX`.

Remember to enable `COM` port in firmware settings, and never use USB cables longer than 1 meter to avoid output corruption. To additionally enable XNU kernel serial output you will need `debug=0x8` boot argument.

12.5 Tips and Tricks

1. How to debug boot failure?

Normally it is enough to obtain the actual error message. For this ensure that:

- You have a `DEBUG` or `NOOPT` version of OpenCore.
- Logging is enabled (1) and shown onscreen (2): `Misc` → `Debug` → `Target` = 3.
- Logged messages from at least `DEBUG_ERROR` (0x80000000), `DEBUG_WARN` (0x00000002), and `DEBUG_INFO` (0x00000040) levels are visible onscreen: `Misc` → `Debug` → `DisplayLevel` = 0x80000042.
- Critical error messages, like `DEBUG_ERROR`, stop booting: `Misc` → `Security` → `HaltLevel` = 0x80000000.
- Watch Dog is disabled to prevent automatic reboot: `Misc` → `Debug` → `DisableWatchDog` = `true`.
- Boot Picker (entry selector) is enabled: `Misc` → `Boot` → `ShowPicker` = `true`.

If there is no obvious error, check the available hacks in `Quirks` sections one by one. For early boot troubleshooting, for instance, when OpenCore menu does not appear, using `UEFI Shell` (bundled with OpenCore) may help to see early debug messages.

2. How to debug macOS boot failure?

- Refer to `boot-args` values like `debug=0x100`, `keepsyms=1`, `-v`, and similar.
- Do not forget about `AppleDebug` and `ApplePanic` properties.
- Take care of `Booter`, `Kernel`, and `UEFI` quirks.
- Consider using serial port to inspect early kernel boot failures. For this you may need `debug=0x108`, `serial=5`, and `msgbuf=1048576` boot arguments. Refer to the patches in `Sample.plist` when dying before serial init.
- Always read the logs carefully.