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DEVELOPMENT TOOLS

Bootloader Awareness Manual
GRUB

MANUAL

Bootloader Awareness Manual GRUB

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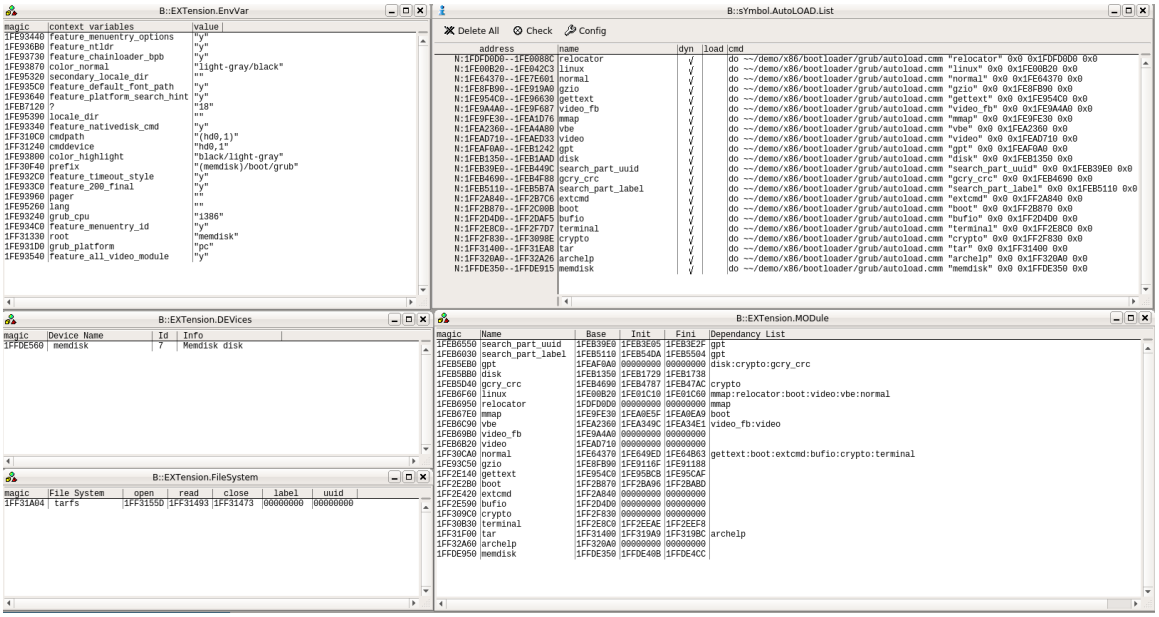
Version 06-Jun-2024

History

28-Aug-18 The title of the manual was changed from “Bootloader Debugger for *<x>*” to “Bootloader Awareness Manual *<x>*”.

Overview



The Bootloader Awareness for GRUB contains special extensions to the TRACE32 Debugger. This chapter describes the additional features, such as additional commands and debugging approaches.

Architecture-independent information:

- **"Training Basic Debugging"** (training_debugger.pdf): Get familiar with the basic features of a TRACE32 debugger.
- **"T32Start"** (app_t32start.pdf): T32Start assists you in starting TRACE32 PowerView instances for different configurations of the debugger. T32Start is only available for Windows.
- **"General Commands"** (general_ref_<*x*>.pdf): Alphabetic list of debug commands.

Architecture-specific information:

- **"Processor Architecture Manuals"**: These manuals describe commands that are specific for the processor architecture supported by your Debug Cable. To access the manual for your processor architecture, proceed as follows:
  - Choose **Help** menu > **Processor Architecture Manual**.
- **"OS Awareness Manuals"** (rtos_<*os*>.pdf): TRACE32 PowerView can be extended for operating system-aware debugging. The appropriate OS Awareness manual informs you how to enable the OS-aware debugging.
- **"UEFI Awareness Manuals"** (uefi_<*x*>.pdf): TRACE32 PowerView can be extended for UEFI-aware debugging. The appropriate UEFI manual informs you how to enable the UEFI-aware debugging.

Supported Architectures

Currently GRUB is supported for the following architectures:

- GRUB on Intel® x86/x64 architectures
- GRUB on Arm architectures

Configuration

The Bootloader Awareness for GRUB is configured by loading an extension definition file called “grub.t32” from the demo directory with the **EXTension.CONFIG** command.

Additionally, load the “grub.men” menu file (see “**GRUB specific Menu**”).

A full configuration for all supported architecture can look like this (the path prefix ~~ expands to the system directory of TRACE32):

```
; Load the GRUB symbols
Data.LOAD.Elf <path_to_grub_elf>/kernel.exec /NoCODE

; Load the Bootloader Awareness for GRUB:
EXTension.CONFIG ~~/demo/<arch>/bootloader/grub/grub.t32

; Load the additional menu:
MENU.ReProgram ~~/demo/<arch>/bootloader/grub/grub.men
```

Features

The Bootloader Awareness supports the following features.

Display of GRUB Resources

The extension defines new commands to display various resources. Information on the following GRUB components can be displayed

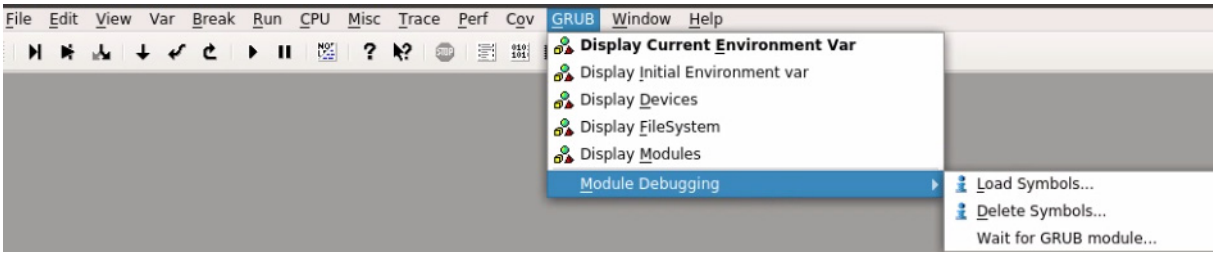
EXTension.MODule	Loaded modules
EXTension.DEVices	Boot devices
EXTension.EnvVar	GRUB environment variables
EXTension.FileSystem	Boot file systems

For a detailed description of each command, refer to chapter "**GRUB Commands**".

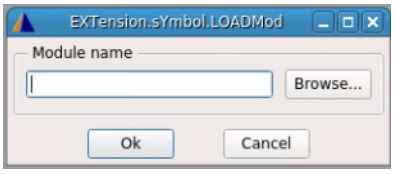
GRUB Specific Menu

The menu file “grub.men” contains a menu with GRUB specific menu items. Load this menu with the **MENU.ReProgram** command.

You will find a new menu called **GRUB**.

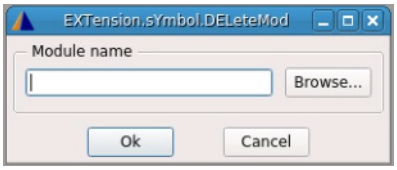


- The **Display** menu items launch the GRUB resource display windows.
- Selecting **GRUB** > **Module Debugging** > **Load Symbols** will open the following dialog.



You can enter the GRUB module name, with/without the “.mod” extension and click **OK**, or click the **Browse** button and select the GRUB module directly. The **EXTension.sYmbol.LOADMod** command will be executed with the selected module as parameter.

- Selecting **GRUB** > **Module Debugging** > **Delete Symbols** will open the following dialog.



You can enter the GRUB module name, with/without the “.mod” extension and click **OK**, or click the **Browse** button and select the GRUB module directly. The **EXTension.sYmbol.DELeteMod** command will be executed with the selected module as parameter.

- Selecting **GRUB** > **Module Debugging** > **Wait for GRUB module** will open the following dialog.

You can enter the GRUB module name you want to debug with or without the “.mod” extension and click **OK**, or click the **Browse** button and select the GRUB module directly. If the module is already loaded, the Bootloader Awareness will load its debug symbols. If the module is not yet loaded, TRACE32 will wait till GRUB loads this module, then TRACE32 will stop the application execution and load module debug symbols.

Symbol Autoloader

The Bootloader Awareness contains a “Symbol Autoloader”, which automatically loads symbol files corresponding to executed GRUB modules. The autoloader maintains a list of address ranges, corresponding to GRUB modules and the appropriate load command. Whenever the user accesses an address within an address range specified in the autoloader (e.g. via **List**), the debugger invokes the command necessary to load the corresponding symbols to the appropriate addresses (including relocation). This is usually done via a PRACTICE script.

In order to load symbol files, the debugger needs to be aware of the currently loaded components. The command **sYmbol.AutoLOAD.CHECK** defines *when* these module data structures are read by the debugger (only on demand or after each program execution).

sYmbol.AutoLOAD.CHECK [**ON** | **OFF** | **ONGO**]

The loaded components can change over time as processes are started and stopped and libraries are loaded or unloaded. The command **sYmbol.AutoLOAD.CHECK** configures the strategy when to “check” the kernel data structures for changes in order to keep the debugger’s information regarding the components up-to-date.

without parameters	The **sYmbol.AutoLOAD.CHECK** command *immediately* updates the component information by reading the kernel data structures. This information includes the component name, the load address used to fill the autoloader list (shown via **sYmbol.AutoLOAD.List**).
ON	The debugger *automatically* reads the component information *each time the target stops executing* (even after assembly steps), because the debugger has to assume that the component information might have changed. This significantly slows down the debugger, which is inconvenient and often superfluous, e.g. when stepping through code that does not load or unload components.
ONGO	The debugger checks for changed component info like with **ON**, but *not when performing single steps*.
OFF	No automatic read is performed. In this case, the update has to be triggered manually when considered necessary by the user.

NOTE:	The autoloader covers only modules that are already loaded. Modules that are not yet loaded are not covered.

When configuring the Bootloader Awareness, set up the symbol autoloader with the following command:

sYmbol.AutoLOAD.CHECKCoMmanD "*<action>*"

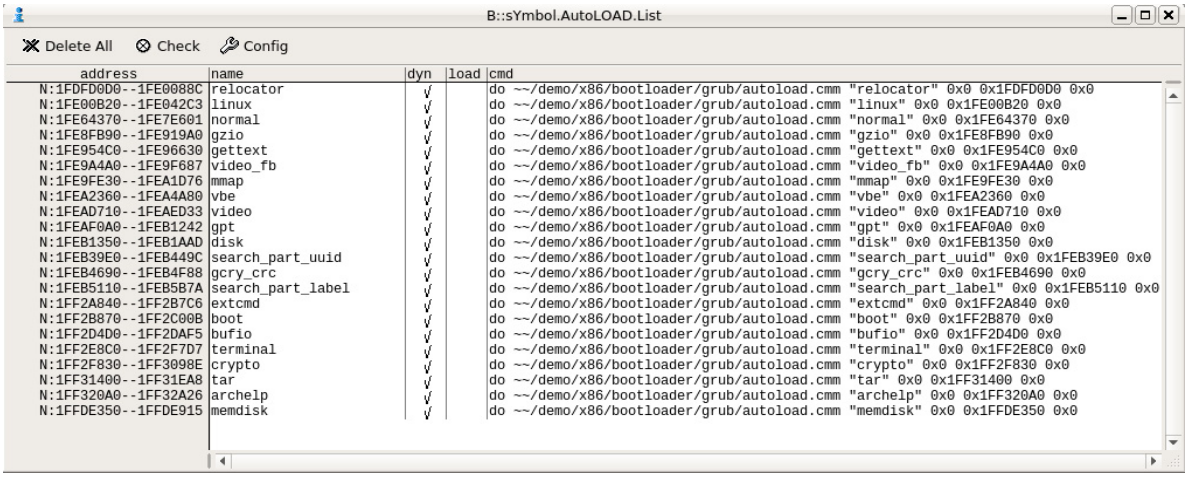
<action> to take for symbol load, e.g. "`DO autoload.cmm `"

The command **sYmbol.AutoLOAD.CHECKCoMmanD** is used to define which action is to be taken for loading the symbols corresponding to a specific address. The defined action is invoked with specific parameters (see below). With GRUB, the pre-defined action is to call the script ~~/demo/*<arch>*/bootloader/grub/autoload.cmm.

NOTE:	The action parameter needs to be enclosed in quotation marks (for the parser it is a string).

Note that *defining* this action does not cause its execution. The action is executed on demand, i.e. when the address is actually accessed by the debugger e.g. in the **List** or **Trace.List** window. In this case, the autoloader executes the <*action*> appending parameters indicating the name of the component and the load address.

To check the currently active components, use the command **sYmbol.AutoLOAD.List**. Together with the component name, the **sYmbol.AutoLOAD.List** window shows details like the load address, and the command that will be executed to load the corresponding object files with the symbol information. Only components shown in this list are handled by the autoloader.

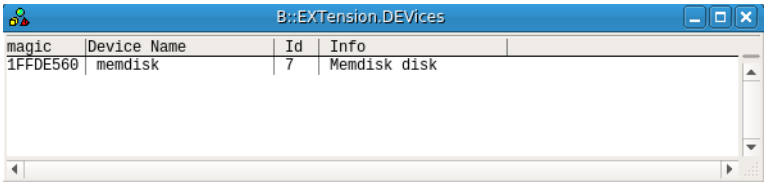


address	name	dyn	load	cmd
N:1FDFD0D0--1FE0088C	relocator	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "relocator" 0x0 0x1FDFD0D0 0x0
N:1FE00B20--1FE042C3	linux	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "linux" 0x0 0x1FE00B20 0x0
N:1FE64370--1FE7E601	normal	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "normal" 0x0 0x1FE64370 0x0
N:1FE8FB90--1FE919A0	gzio	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "gzio" 0x0 0x1FE8FB90 0x0
N:1FE954C0--1FE96630	gettext	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "gettext" 0x0 0x1FE954C0 0x0
N:1FE9A4A0--1FE9F687	video_fb	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "video_fb" 0x0 0x1FE9A4A0 0x0
N:1FE9FE30--1FEA1D76	mmap	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "mmap" 0x0 0x1FE9FE30 0x0
N:1FEA2360--1FEA4A80	vbe	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "vbe" 0x0 0x1FEA2360 0x0
N:1FEAD710--1FEAED33	video	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "video" 0x0 0x1FEAD710 0x0
N:1FEAF0A0--1FEB1242	gpt	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "gpt" 0x0 0x1FEAF0A0 0x0
N:1FEB1350--1FEB1AAD	disk	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "disk" 0x0 0x1FEB1350 0x0
N:1FEB39E0--1FEB449C	search_part_uuid	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "search_part_uuid" 0x0 0x1FEB39E0 0x0
N:1FEB4690--1FEB4F88	gcry_crc	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "gcry_crc" 0x0 0x1FEB4690 0x0
N:1FEB5110--1FEB5B7A	search_part_label	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "search_part_label" 0x0 0x1FEB5110 0x0
N:1FF2A840--1FF2B7C6	extcmd	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "extcmd" 0x0 0x1FF2A840 0x0
N:1FF2B870--1FF2C00B	boot	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "boot" 0x0 0x1FF2B870 0x0
N:1FF2D4D0--1FF2DAF5	bufio	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "bufio" 0x0 0x1FF2D4D0 0x0
N:1FF2E8C0--1FF2F7D7	terminal	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "terminal" 0x0 0x1FF2E8C0 0x0
N:1FF2F830--1FF3098E	crypto	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "crypto" 0x0 0x1FF2F830 0x0
N:1FF31400--1FF31EA8	tar	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "tar" 0x0 0x1FF31400 0x0
N:1FF320A0--1FF32A26	archelp	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "archelp" 0x0 0x1FF320A0 0x0
N:1FFDE350--1FFDE915	memdisk	√		do ~~/demo/x86/bootloader/grub/autoload.cmm "memdisk" 0x0 0x1FFDE350 0x0

EXTension.DEVices — Display GRUB boot devices

Format: **EXTension.DEVices**

Displays the boot device ID and Info.

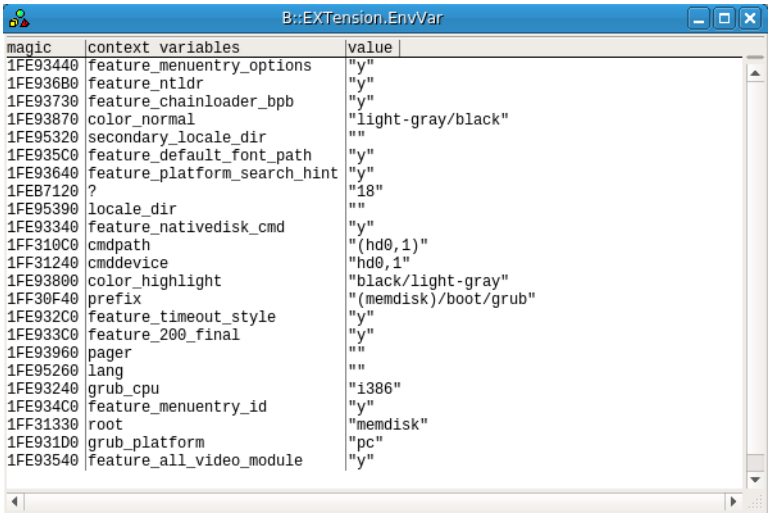


“magic” is a unique ID, used by the Bootloader Awareness to identify the boot devices in memory. The “Id”, “Device Name” and “Info” fields are referenced in the GRUB source code <grub_master>/include/grub/disk.h

EXTension.EnvVar — Display GRUB environment variables

Format: **EXTension.EnvVar**

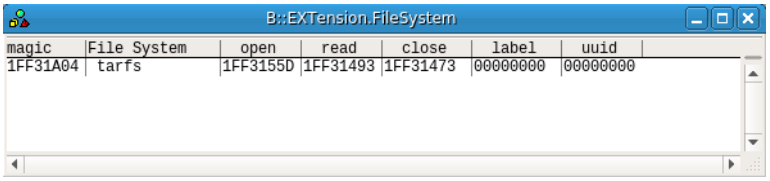
Displays the GRUB environment variables, the so-called “context”.



“magic” is a unique ID, used by the Bootloader Awareness to identify the address of each environment variable in memory. “context variables” lists the existing variable names, and “value” lists the values of the variables.

Format: **EXTension.FileSystem**

Displays the GRUB boot file system.

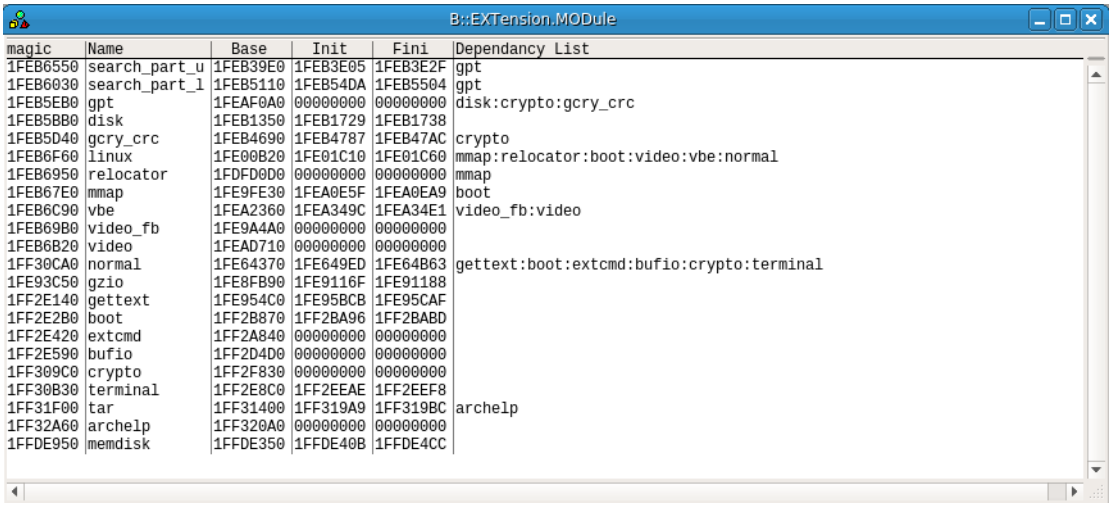


"magic" is a unique ID, used by the Bootloader Awareness to identify a boot file system in memory. The "open", "read" and "close" fields are mouse sensitive. Double-clicking will open a **List** view window of the corresponding function.

EXTension.MODule Display GRUB loaded modules

Format: **EXTension.MODule**

Displays the GRUB loaded modules (module name, base address, Init function address, Fini function address, and module dependency list).



"magic" is a unique ID, used by the Bootloader Awareness to identify a module. The "magic" field is mouse sensitive. Double-clicking it will show a variable view of the module GRUB data structure.

Double-clicking "Init" or "Fini" fields will open a **List** window of the Init / Fini module function.

The **EXTension.sYmbol** command group helps to load and unload the symbols of a given GRUB module. The commands are described below.

EXTension.sYmbol.DELeteMod Delete module debug symbols

Format:	**EXTension.sYmbol.DELeteMod** "*<module_name>*"

Deletes the module debug symbols from the Bootloader Awareness.

<module_name>	For a parameter description, see **EXTension.sYmbol.LOADMod**.

EXTension.sYmbol.LOADMod Load module debug symbols

Format:	**EXTension.sYmbol.LOADMod** "*<module_name>*"

Loads GRUB module debug symbols with the right offset using the Symbol Autoloader feature.

<module_name>	The *<module_name>* parameter can be a full path to the module and can be entered with or without the file name extension ".mod". If the full path to a module is entered as a parameter, the used path is automatically set as the default path for the GRUB modules. If just a module name is used as a parameter, the Bootloader Awareness will load the module from the previously set path. For more details, refer to **EXTension.sYmbol.ModPATH** and **TASK.Y.MODP(modpath)**.

Example 1:

```
EXTension.sYmbol.LOADMod "normal"
```

Example 2:

```
EXTension.sYmbol.LOADMod "normal.mod"
```

Example 3:

```
EXTension.sYmbol.LOADMod "/path/to/normal.mod"
```

EXTension.sYmbol.ModPATH — Set GRUB module directory path

Format:	**EXTension.sYmbol.ModPATH** "*<module_path>*"

Sets the entered module path as a default search for GRUB module when trying to load GRUB module debug symbol.

<module_name>	For a parameter description, see **EXTension.sYmbol.LOADMod**.

GRUB PRACTICE Functions

There are special definitions for GRUB specific PRACTICE functions.

TASK.MOD.MAGIC() Magic of GRUB module

[build 96505 - DVD 09/2018]

Syntax: **TASK.MOD.MAGIC("***<module_name>***")**

Returns the magic of a given loaded GRUB module.

Parameter Type: String.

Return Value Type: Hex value.

TASK.MOD.NAME() Name of GRUB module

[build 96505 - DVD 09/2018]

Syntax: **TASK.MOD.NAME(***<module_magic>***)**

Returns the module name of a given module magic number.

Parameter Type: Decimal or hex or binary value.

Return Value Type: String.

TASK.MOD.BASE() Base address of GRUB module

[build 96505 - DVD 09/2018]

Syntax: **TASK.MOD.BASE("***<module_name>***")**

Returns the base address of a loaded GRUB module name.

Parameter Type: String.

Return Value Type: Hex value.

TASK.MOD.INIT() Init address of GRUB module

[build 96505 - DVD 09/2018]

Syntax: **TASK.MOD.INIT("***<module_name>***")**

Returns the address of the “init” function of a loaded GRUB module.

Parameter Type: String.

Return Value Type: Hex value.

TASK.MOD.SIZE() Size of GRUB module

[build 96505 - DVD 09/2018]

Syntax: **TASK.MOD.SIZE("***<module_name>***")**

Returns the size of a loaded GRUB module.

Parameter Type: String.

Return Value Type: Hex value.

TASK.Y.MODP(modpath) Get path for GRUB modules

[build 96505 - DVD 09/2018]

Syntax: **TASK.Y.MODP(modpath)**

Returns the previously set module path using command **EXTension.sYmbol.ModPATH**

Return Value Type: String.

Example:

```
LOCAL &modpath
&modpath=TASK.Y.MODP(modpath)
IF "&modpath"==""
(
  PRINT %WARNING "no module path set, use EXTension.sYmbol.ModPATH"
)
```