Intelligent Computer Peripherals ®
ICP

Chapter L

GDTSETUP

In Detail

L. GDTSETUP in Detail

We refer to firmware as the operating system which controls the ICP Controller with all its functions and capabilities. The firmware exclusively runs on the ICP Controller and is stored in the Flash-RAM on the ICP Controller PCB. The controlling function is entirely independent of the PCI computer and the host operating system installed (for example UNIX), and does not "drain" any computing power or time from the PCI computer. According to the performance requirements needed, the ICP Controllers are available with two firmware variants. The firmware is either already installed on the controller upon delivery, or can be added as an upgrade: *RAIDYNE upgrade*.

- **Standard Firmware** (installed on the GDT6**1**xyRP controllers).
  In addition to simple controlling functions regarding SCSI hard disks or removable hard disks, this version allows disk chaining (several drives can be linked in order to form a single "large" drive), and the configuration of Array Drives of the types data striping (RAID 0) and disk mirroring or duplexing (RAID 1).
- **RAIDYNE Firmware** (installed on the GDT6**5**xyRP controllers). In addition to disk chaining, RAID 0 and RAID 1, RAIDYNE allows you to install and control Array Drives of the types RAID 4 (data striping with dedicated parity drive), RAID 5 (data striping with distributed parity) and RAID10 (a combination between RAID 0 and 1)

RAIDYNE is the name of the ICP disk-array operating system for the ICP Controllers. Unlike pure software solutions, RAIDYNE is totally independent of the host operating system, and can therefore be accessed under MS-DOS, Windows, OS/2, SCO-UNIX, Interactive UNIX, Novell NetWare, etc.. Special RAID drivers are not needed. The integration of a RAID Array Drive into the host operating system is carried out with the same drivers used for the integration of a single SCSI hard disk. All ICP Controllers are equipped with a hardware which is particularly well suited for Array Drives. RAIDYNE uses this hardware with extreme efficiency and therefore allows you to configure Array Drives that do not load the host computer (whereas all software-based RAID solutions more or less reduce the overall performance of the host computer.).

L.1 The four Levels of Hierarchy in the GDT Fimware

Both GDT firmware versions (Standard and RAIDYNE) are based on four fundamental levels of hierarchy. Each level has its "own drives" (= components). The basic rule is:

To build up a “drive“ on a given level of hierarchy, the “drives“ of the next lower level of hierarchy are used as components.

Level 1:
Physical Drives = hard disks, removable hard disks, some MO drives are located on the lowest level. They are the basic components of all "drive constructions" you can set up. However, before they can be used by the firmware, these hard disks must be "prepared", a procedure we call *initialization*. During this initialization each hard disk receives information which allows an univocal identification even if the SCSI-ID or the controller is changed. For reasons of data coherency, this information is extremely important for any drive construction consisting of more than one physical drive.

Level 2:

On the next higher level are the **Logical Drives**. Logical Drives are introduced to obtain a full independence of the physical coordinates of a physical device. This is necessary to easily change the whole ICP Controller and the channels, IDs, without loosing the data and the information on a specific Array Drive.

Level 3:
On this level of hierarchy, the firmware forms the **Array Drives**. Depending on the firmware installed, this can be

- Single Disks (one hard disk, some vendors call it JBOD - Just A Bunch Of Drives)
- Chaining Sets (concatenation of several hard disks)
- RAID 0 Array Drives
- RAID 1 Array Drives, RAID 1 Array Drives plus hot fix drive
- RAID 4 Array Drives, RAID 4 Array Drives plus hot fix drive
- RAID 5 Array Drives, RAID 5 Array Drives plus hot fix drive
- RAID 10 Array Drives, RAID 10 Array Drives plus hot fix drive

Level 4:
On the highest level of hierarchy, the firmware forms the **Host Drives**. In the end, only these Host Drives can be accessed by the host operating system of the computer. Drives C, D, etc. under MS-DOS, OS/2, etc. are always referred to as Host Drives by the firmware. The same applies to NetWare- and UNIX-drives. The firmware automatically transforms each newly installed Logical Drive and Array Drive into a Host Drive. This Host Drive is then assigned a Host Drive number which is identical to its Logical Drive or Array Drive number.
The firmware is capable of running several Host Drives of the most various kinds at the same time. An example for MS-DOS: drive C is a RAID 5 type Host Drive (consisting of 5 SCSI hard disks), drive D is a single hard disk, and drive E is a CD-ROM communicating with RAIDYNE through corelSCSI and the GDT ASPI manager.
On this level the user may split an existing Array Drive into several Host Drives.
After a capacity expansion of a given Array Drive the added capacity appears as a new Host Drive on this level. It can be either used as a separate Host Drive, or merged with the first Host Drive of the Array Drive.

Within GDTSETUP, each level of hierarchy has its own special menu:

Level 1	⇨	Menu: ***Configure Physical Device***
Level 2	⇨	Menu: ***Configure Logical Drive***
Level 3	⇨	Menu: ***Configure Array Drive***
Level 4	⇨	Menu: ***Configure Host Drive***

Generally, each installation procedure passes through these 4 menus, starting with level 1.

Therefore:

- First initialize the Physical Drives.
- Then configure the Logical Drives.
- Then configure the Array Drives (e.g. Array Drives with RAID 0, 1, 4, 5 and 10).
- Finally, configure the Host Drives.

L.1.1 Host Drive Types in RAIDYNE

The following summary gives you an overview of all Host Drive types you can create with the GDT firmware. **The ICP Controller can *simultaneously* control several Host Drives of most various types.**
For instance, MS-DOS drive C could be a Host Drive of the type disk (consisting of a single SCSI hard disk), MS-DOS drive D is a type RAID 5 Array Drive, MS-DOS drive E is a Host Drive of the type chain, and MS-DOS drive F is a CD-ROM which communicates with MS-DOS through corelSCSI and the GDT ASPI manager.

Available with Firmware variant	Type of Host Drive	Description of Host Drive	Installation on Level	Minimum number of SCSI devices
S, R	Disk	1:1 assignment: Host Drive to SCSI device	2	1
S, R	Chain	Concatenation of several SCSI devices	2	2
S, R	Mirror, RAID 1	Mirroring of Logical Drives	3	2
S, R	RAID 0	Data Striping	3	2
R	RAID 4	Data Striping with parity drive	3	3
R	RAID 5	Data Striping with striped parity	3	3
R	RAID 10	Combined RAID 0 and 1	3	4

S = Standard; R = RAIDYNE Firmware.

L.2 SCSI Devices Which can be Configured With GDTSETUP

SCSI devices which can be configured with GDTSETUP are called ***Direct Access Devices*** (SCSI devices such as hard disks or removable hard disks, or other devices behaving like a hard disk). SCSI devices other than SCSI hard disks or removable hard disks, or devices that do not behave like them, are called ***Not Direct Access Devices***. **They are not configured with GDTSETUP and cannot form cache or Host Drives.** These SCSI devices are either run through the ASPI interface (Advanced SCSI Programming Interface) (MS-DOS, Windows, Novell NetWare or OS/2), or they are directly accessed from the operating system (true for UNIX and Windows NT). For details on how to operate these devices, please refer to the corresponding chapters of this manual.

L.3 Loading GDTSETUP

Any installation or maintenance procedures regarding the ICP Controller are carried out with the configuration program **GDTSETUP**. The monitoring program **GDTMON** allows continuous monitoring and maintenance of the ICP Controller and the connected Array Drives. The GDTMON utility also include options to replace a defective drive with a new one (Hot Plug) and is available for most of the operating systems supported by the ICP Controllers. GDTSETUP allows you to set up single disks or complex Array Drives with simple and user-friendly installation procedures. Little previous knowledge is needed to be able to use GDTSETUP efficiently. It is only necessary to understand the hierarchy levels in the ICP

Controller firmware (which are the same for both firmware versions: Standard and RAIDYNE). For the user's convenience the GDTSETUP program is available in two different variants:

- GDTSETUP loaded from the ICP Controller's Flash-RAM after switching on the computer
- GDTSETUP loaded from disk under MS-DOS.

The header of the GDTSETUP program indicates with a letter after the version number, whether GDTSETUP was loaded from disk or from Flash-RAM:

"**R**" for GDTSETUP loaded from the Flash-RAM after switching on the computer
"**D**" for GDTSETUP loaded from Disk, i.e., under MS-DOS.

Loading GDTSETUP with <CTRL><G> from the Flash-RAM is very comfortable since no operating system is required to carry out the configuration and setup works.

On the other side, loading GDTSETUP from disk (i.e., under MS-DOS) becomes necessary for tasks like partitioning or enabling a totally disabled GDT BIOS (which includes GDTSETUP).

L.3.1 Special Keys in GDTSETUP

Cursor-keys ↑ and ↓
Used to select a menu option or command. If a Microsoft-compatible mouse and a mouse driver are installed, you can also make your choices with the mouse.

<ENTER> key
Confirms a choice, entry, warning or message in GDTSETUP.

<ESC> key
Exits the current menu.

<SPACE> bar
Multiple selections, or toggling between a number of preset options.

Function key <F2>
This key has different functions, depending on the menu you are in:

a. Toggle between Express or Enhanced Setup.
b. Display drive configuration.

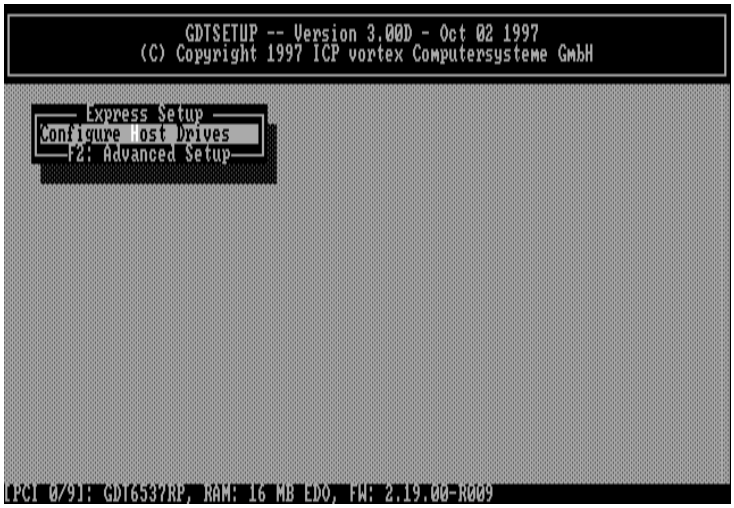
Function key <F3>
To *Lock* and *Unlock* removable media.

Function key <F10>
Refresh Information.

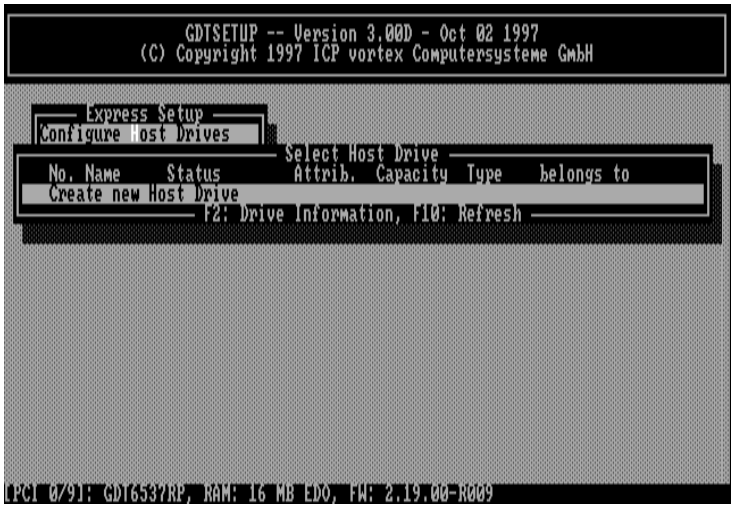
When GDTSETUP is loaded, the main menu appears as shown below:

L.4 Express Setup

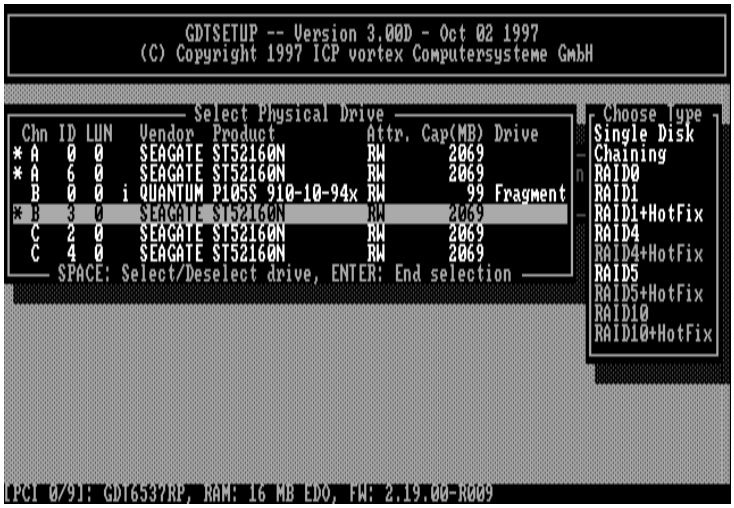
This function allows the easy setup of Array Drives and does not require any previous knowledge. If you choose this function, GDTSETUP carries out the complete installation entirely on its own, giving you, for example, a fully operational RAID 5 Array Drive with optimized settings (for instance, with all SCSI features of a given drive activated).



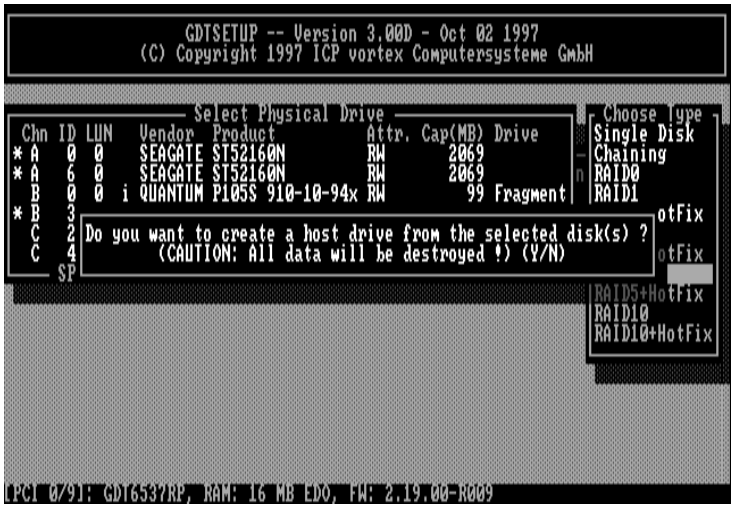
After selecting *Configure Host Drives* and *Create new Host Drive*, GDTSETUP scans the system for ICP Controllers and "free" hard disks (i.e., drives which are not yet logical drives or Host Drives or part of Array Drives).



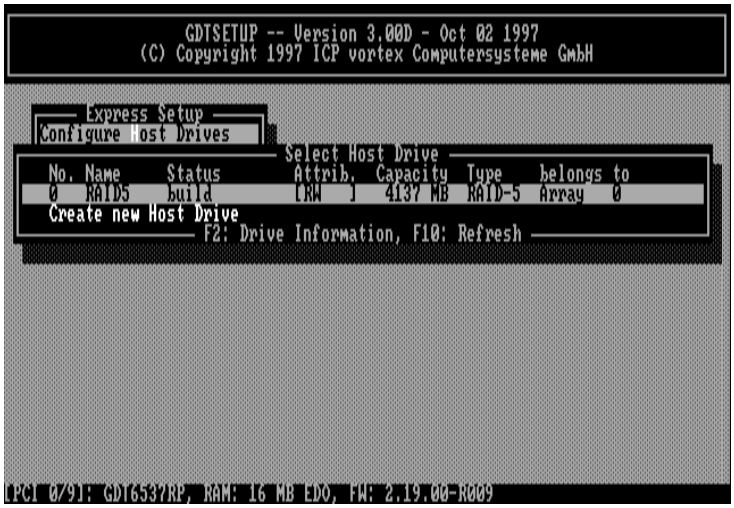
Select with the <Space> bar the hard disks you want to integrate into the new Host Drive. Depending on the number of selected drives in the *Choose Type* windows all possible Host Drive configurations are high-lighted.



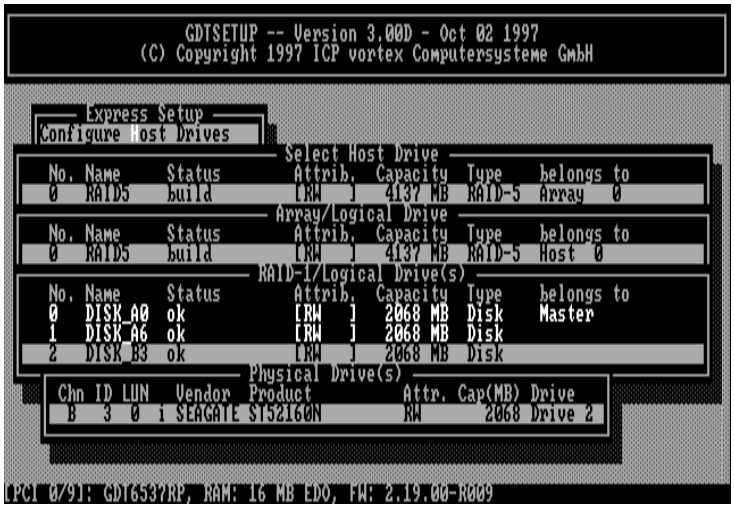
Press <ENTER> . You may select the desired Host Drive type. In our example select RAID5 and press <ENTER> .



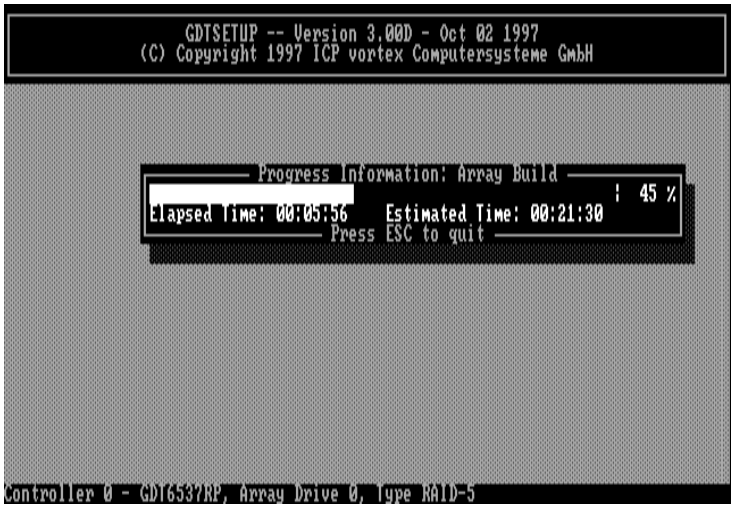
That's it!
As you can see from the next picture, the RAID5 Array Drive has been fully automatically configured. It is in the build state.



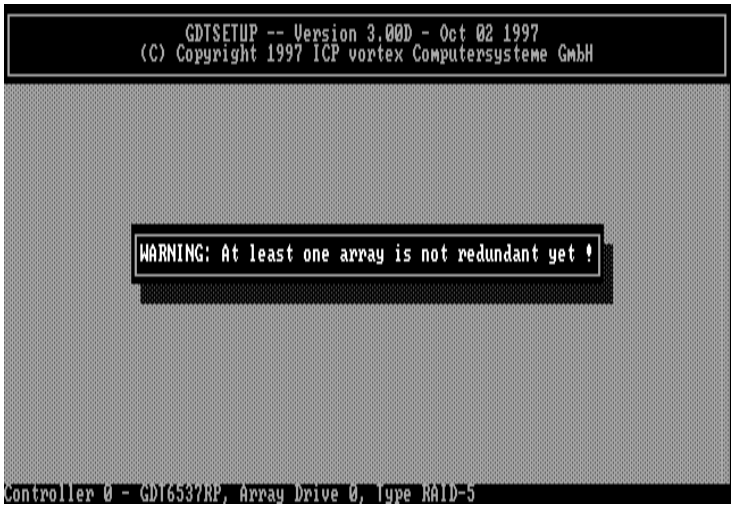
Press several times <F2> to get detailed information on the Array Drive's configuration and components.



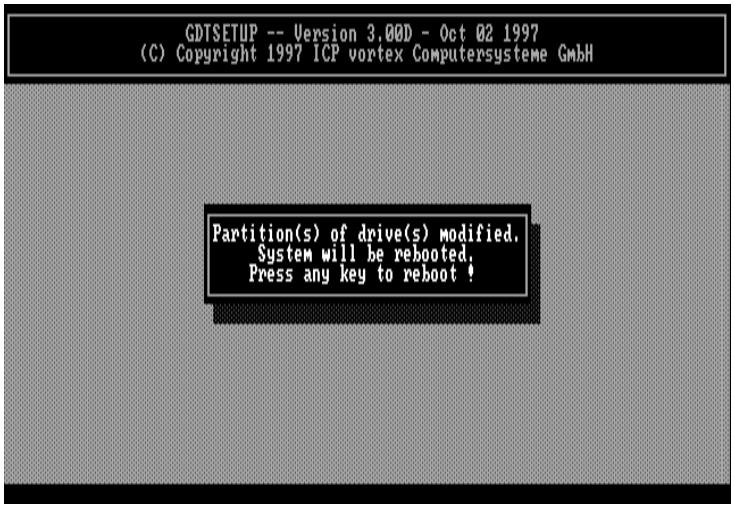
Press several times <ESC> to leave GDTSETUP. A new screen comes up giving you detailed progress information on the build process.



As you can see, the build process for the 4GB Array Drive takes approximately 22 minutes. If you press <ESC> GDTSETUP warns you that the array is not yet redundant.

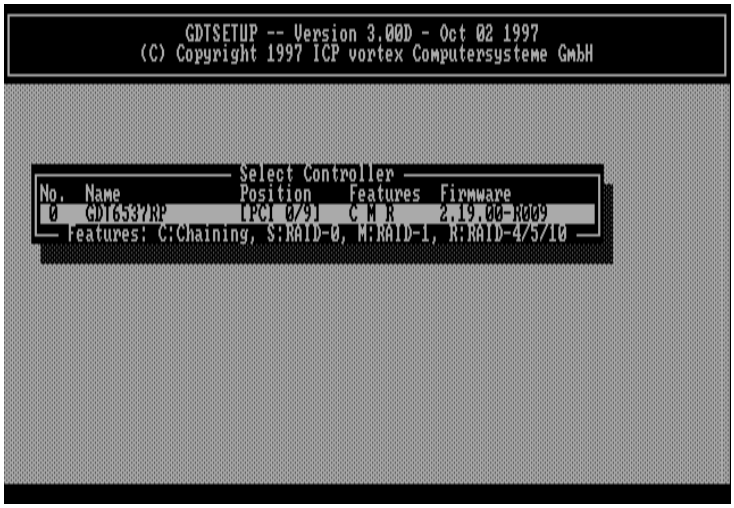


Pressing again <ESC> brings up the following screen, telling you the system needs a reboot to recognize the new Host Drive(s).



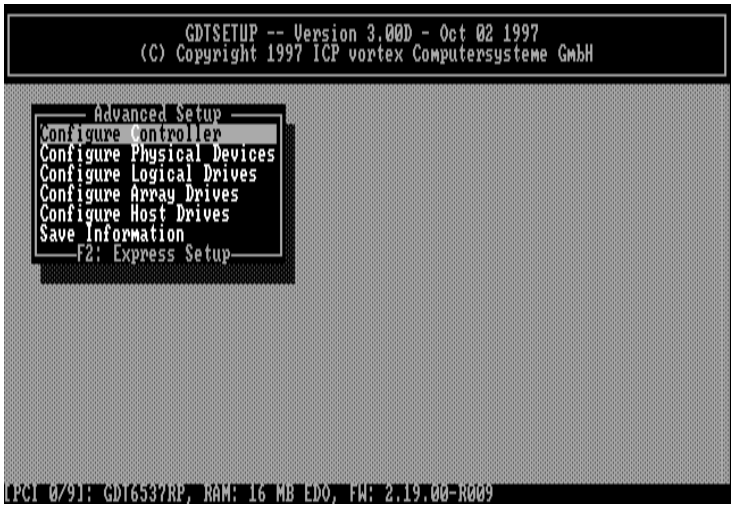
L.5 Select Controller

If there are more GDT RP Series controllers in the PCI computer, *Select Controller* lets you select the controller where you can apply all of the following GDTSETUP choices to. The currently selected controller is displayed on the lower left side of the screen. Below "Position", the PCI Slot number is displayed. The available features of the ICP Controller depend on the firmware installed. After a cold boot of the PCI computer, the controllers are recognized and initialized in the order of this list.

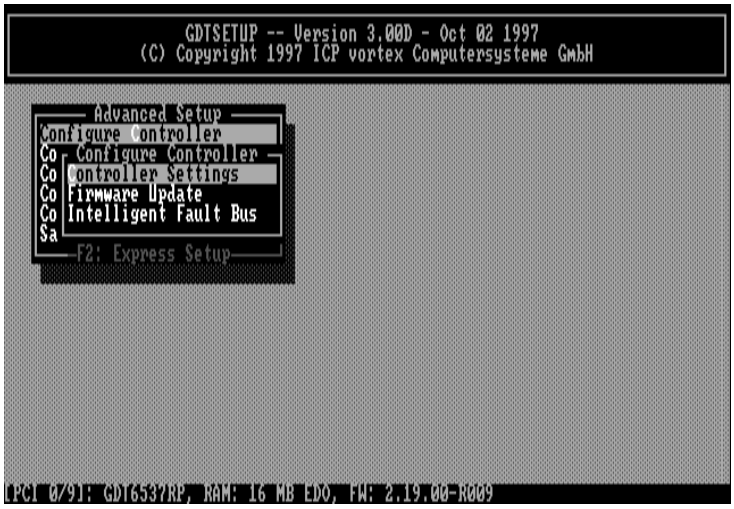


L.6 Configure Controller

After pressing <ENTER> and <F2> the *Advanced Setup* allows to select the *Configure Controller* menu option.

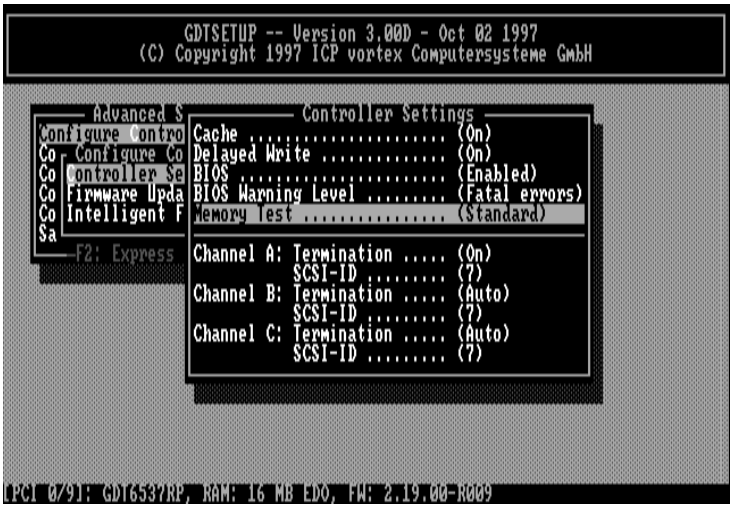


Press <ENTER> .



L.6.1 Controller Settings

(To change a setting, move the cursor keys ↑ and ↓ to the field and press <ENTER> .
Note: In order to obtain the full performance of your ICP Controller, it is very important that the *Delayed Write* function is ***On***, too. If you find a different setting, we recommend changing it now.



Function	***Possible Settings***	***Factory Setting***
Cache On (*)	On, Off	On
Delayed Write On (*)	On, Off	On
BIOS	Enabled, Disabled	Enabled
BIOS Warning Level	All messages, Fatal errors	Fatal errors
Memory Test	No Test, Standard, Double Scan, Intensive	Standard
SCSI-ID	0,1,2,3,4,5,6,7	7
SCSI Termination	On, Off, Auto	On

(*) Can also be changed with the GDTMON online utility.

L.6.2 Firmware Update

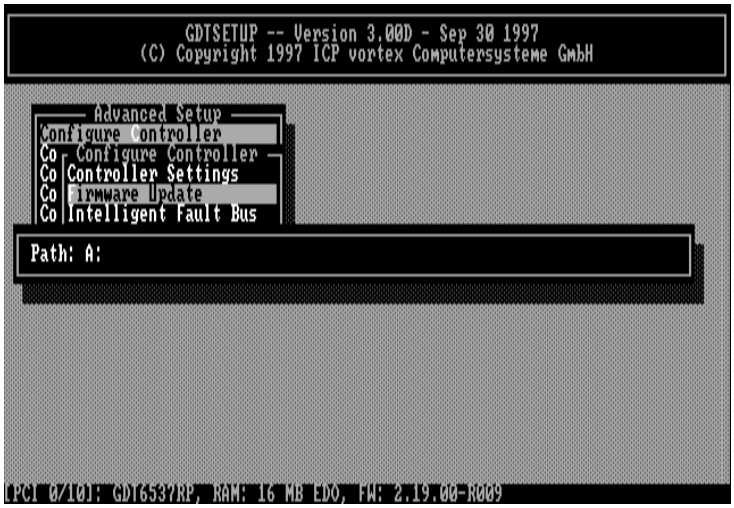
The firmware, the BIOS and the GDTSETUP program of the ICP Controller are stored in a Flash-RAM which is part of the ICP Controller hardware. In contrast to EPROMs, Flash-RAMs can be re-programmed many times and without the complicated UV-light erasing procedure. Thus, both software modules can be easily updated without having to remove the controller from its PCI slot. Firmware and BIOS are part of the ***GDT_RPFW*** file. The file has an extension (e.g. GDT_RPFW.009) which indicates the version stepping. The latest version of the this file can be downloaded either from our 24h BBS (+49-(0)-7131-5972-15) or from our Website http://www.icp-vortex.com. We recommend that you also download the packed files which contain the latest programs/drivers for the operating system used on your system. Observe the following order when carrying out the updating procedure:

1. Get the latest GDT_RPFW file for the ICP Controller (download it from our BBS, or our Website, or ask for an upgrade disk if you do not have a modem). The file does NOT need to be expanded !

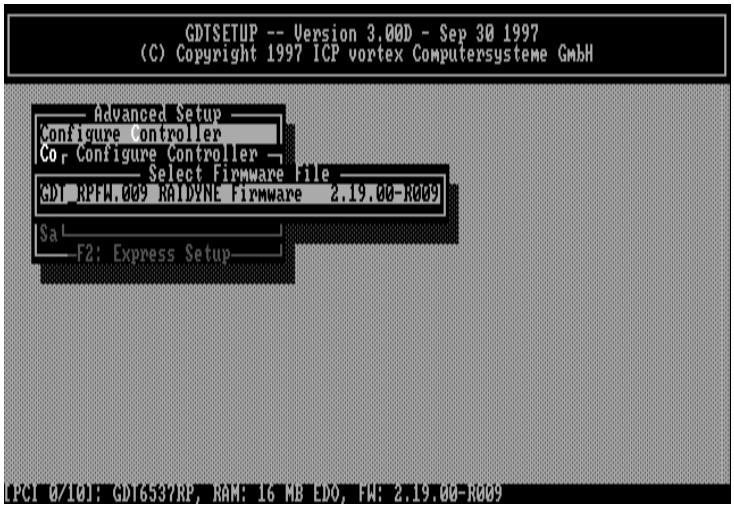
2. Format a 3.5" HD disk (1.44MB) and copy the GDT_RPFW file on this disk.

3. After loading GDTSETUP (from Flash-RAM or from disk under MS-DOS) select the desired ICP Controller for the firmware update and press the <F2>-key to enter the Advanced Setup.

4. Select *Configure Controller* and thereafter *Firmware Update*. Insert the disk with the firmware file into drive A. GDTSETUP loaded from the Flash-RAM will display a list of the valid files found on the disk. If you have loaded GDTSETUP from disk you have to enter the path "A:", first.



The update process starts as soon as the desired GDT_RPFW file has been selected. Strictly observe the messages and instructions of GDTSETUP. It is extremely important that the system is not switched off or reset during the update process. It is very likely that this would cause the ICP Controller to become inoperable.



The new versions of the GDT Firmware, the BIOS and GDTSETUP are available after the next cold-boot.

L.6.3 Intelligent Fault Bus

The GDT RP Series Controllers support two types of intelligent subsystems:

1. Subsystem which are accessed via the Intelligent Fault Bus (IFB, which is similar to the DEC™ fault bus). E.g. Storage Works ™.
   The IFB is based on an asynchronous bus on the SCSI connector and requires appropriate hard/software in the subsystem.

2. Subsystems which are accessed via SAF-TE (SCSI Accessed Fault Tolerant Enclosures). SAF-TE is based on the simple idea, that the GDT RP Series controller and the subsystem "talk" to each other via the SCSI bus. The subsystem requires a so-called SEP (SAF-TE Enclosure Processor) per channel and an appropriate firmware. The GDT RP Series controller includes in its firmware modules which provide a full SAF-TE implementation. (See next pages: *Configure Physical Devices*).

What are the benefits of intelligent subsystems ?

1. The GDT RP Series controller controls the LEDs. LED indication of the various states of the hard disk within the Array Drive. E.g., your are shown which drive has failed, or which drive is currently being rebuilt.

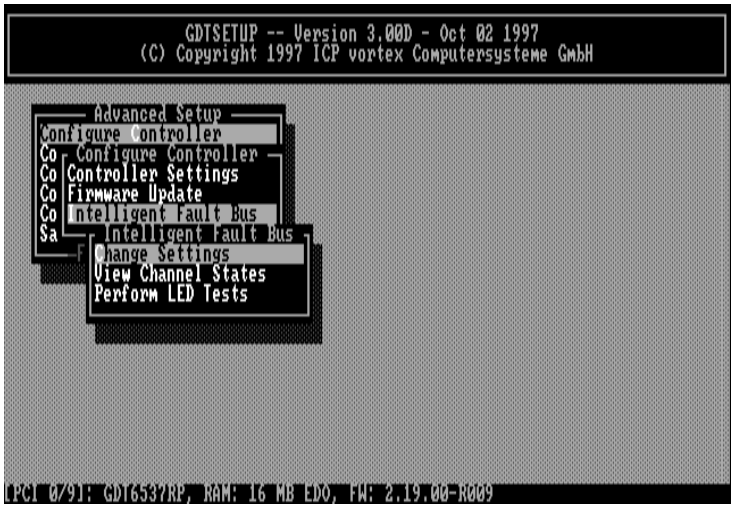
2. Controlled Hot Plug "Auto Hot Plug". No risk of SCSI bus disturbances and electrical problems. E.g., exchange of a drive is very simple: unplug it and plug in a new one.

3. Messaging of the states of the intelligent subsystems temperature, power supply condition, fan speed etc. to the GDT RP Series controller.

Of course the intelligent subsystem must be designed to implement all these features. The key point is the communication between the subsystem and the GDT RP Series controller. Some subsystems seem to have a lot of LEDs, redundant power supplies, etc., but are not intelligent at all. They stand there and keep all information for themselves.

The intelligent subsystem can also be integrated into the server enclosure. I.e., there is a backplane which includes the circuitry and mechanical environment to perform the Auto Hot Plug.

After selecting the *Intelligent Fault Bus* menu you are offered three options:

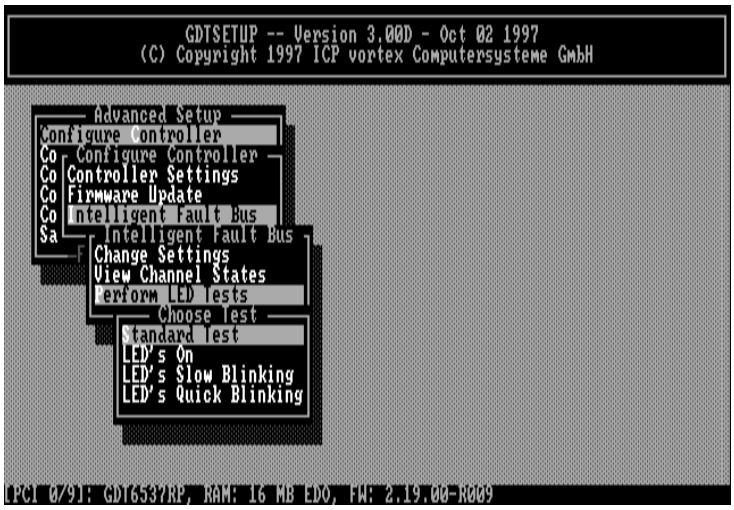


- *Change Settings*
- *View Channel States*
- *Perform LED Tests*

The GDT RP Series controllers support in the standard delivery the Intelligent Fault Bus (IFB) on channel A. The *Fault Bus Module* is a small PCB which plugs as a daughter board onto the main PCB of the GDT RP Series controller. Once it is installed, all further channels are also IFB equipped.

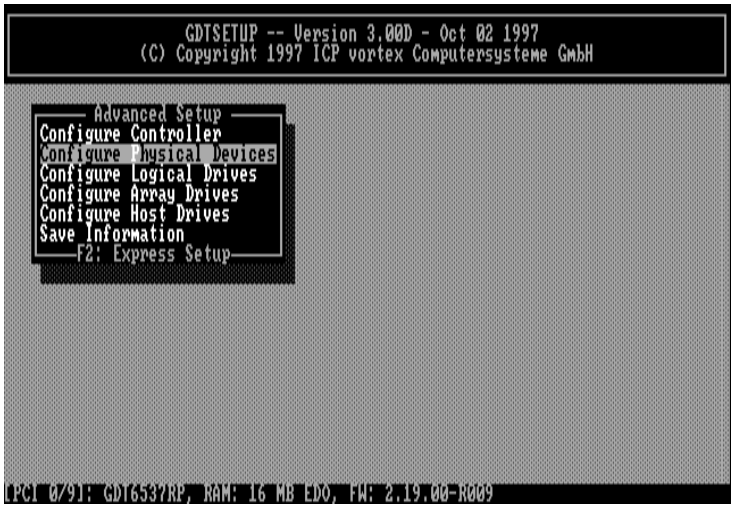
This screen shows you the states of the Fault Bus and the description of the LED blink-codes.

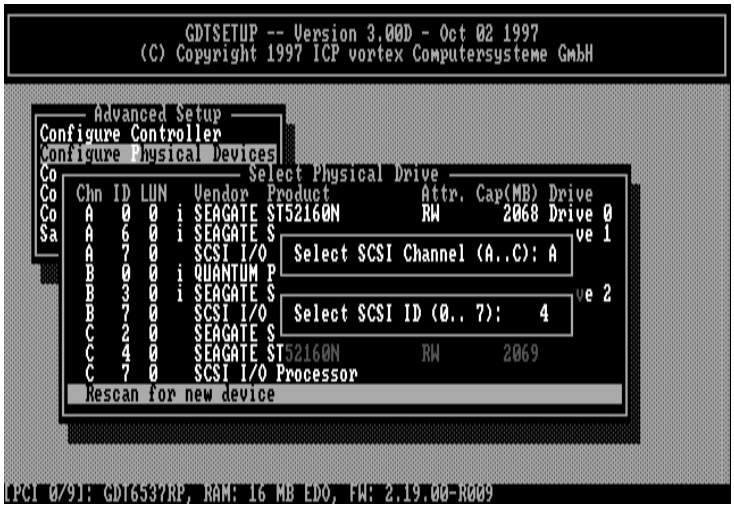
With the *Perform LED Tests* menu, you can check if the LEDs and blink-codes are properly controlled and displayed.



L.7 Configure Physical Devices

This menu allows you to prepare hard disks and removable hard disks for use with the ICP Controller (hierarchy level 1). You can scan the SCSI bus again for a given SCSI-ID (this may become necessary when another SCSI device is being connected during the operating session).

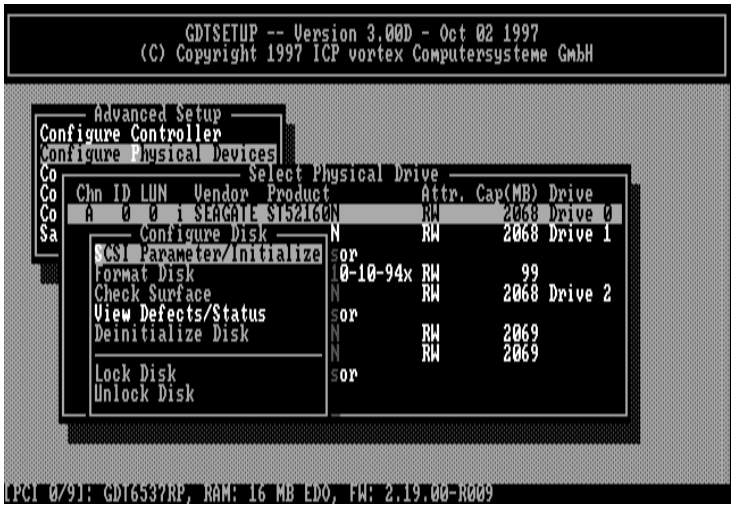




This screen tells you:

- the SCSI channel
- which SCSI-ID a drive has (the entry *SCSI I/O processor* stands for the according SCSI channel of the ICP Controller. Its default setting is ID 7, as explained in chapter B)
- the state of initialization ("i" = initialized)
- the SCSI names of the drives
- the state, [RW] = Read + Write, [RO] = Read only, [RM] = Removable
- the gross capacity
- if component of a Logical Drive

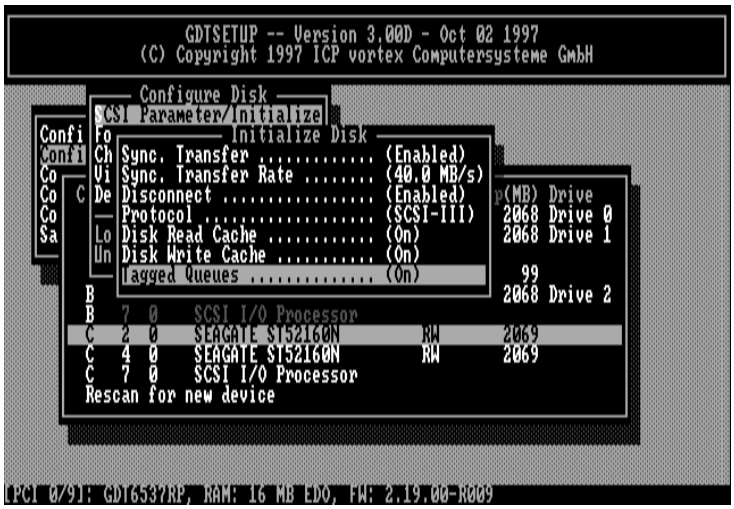
Use the cursor keys ↑ and ↓ to highlight the drive you wish to initialize. When a SCSI device is selected with <ENTER>, a new screen is displayed.



You may select the high-lighted menu options. The other options are either not appropriate to the type of device (removable hard disk), or currently blocked because of security reasons (e.g., the drive belongs to an Array Drive)

L.7.1 SCSI Parameter / Initialize

This option can destroy all data on the hard disk.
If a hard disk is not yet initialized, you have to initialize it first. GDTSETUP copies ICP specific configuration blocks on the hard disk, a primary block and a mirrored secondary block.



1. Sync. Transfer: Enabled (Disabled)

The SCSI-bus knows two methods of data transfer: asynchronous and synchronous transfer. Each SCSI device must be able to perform the first type of transfer, the second one is optional. The advantage of the synchronous transfer consists in a higher data transfer rate, since the signal transfer times on the possibly long SCSI-cable have no influence on the transfer rate anymore. Two SCSI-bus participants which want to exchange data between each other have to check if and how (i.e., with which parameters) a synchronous data transfer between them is possible. Therefore, the mere setting does not automatically enable synchronous data transfer; this mode is only effective if both devices support it and after they have checked their capability of communicating with each other in this mode.

2. Sync. Transfer Rate

This is the synchronous data transfer rate in MB/se. Ultra SCSI allows on a 8 Bit bus 20MB/s and on a 16 bit bus 40MB/s.
If a given SCSI-cable does not allow 10.0 MB/s (= FAST-SCSI), the data transfer rate can be reduced to a value that allows a trouble-free data transfer. The reason for such a restriction is not necessarily a "bad" SCSI-cable. Lowering the transfer rate may also become necessary when you set up a special configuration with a very long SCSI-cable whose length simply does not allow 10.0 MB/s.
Even if you set the maximum speed to 10, 20 or 40 MB/s, this does not mean that the SCSI device actually supports this transfer rate.

3. Disconnect: Enabled (Disabled)

The concept of the SCSI-bus allows several participants (8 IDs with 8 LUNs each). All these participants ought to be able to use the bus in a manner that causes the least reciprocal disturbance or obstruction. A participant should therefore vacate the bus if he does not need it. For reasons of performance, it is particularly important to guarantee a high degree of action overlapping on the SCSI-bus. This high degree of overlapping becomes possible when a SCSI device is enabled to be disconnected, thus leaving the bus to be used by another participant. If there is only one SCSI device connected to the SCSI-bus, "Disconnect" should be disabled.

4. Protocol (SCSI-II, SCSI-III)

If a drive supports a particular SCSI specification (II, or III) you should always use the highest protocol level the drive supports.

5. Disk Read Cache: On (Off)

This is the read ahead cache of the hard disk. Because of performance reasons it should always be enabled (On).

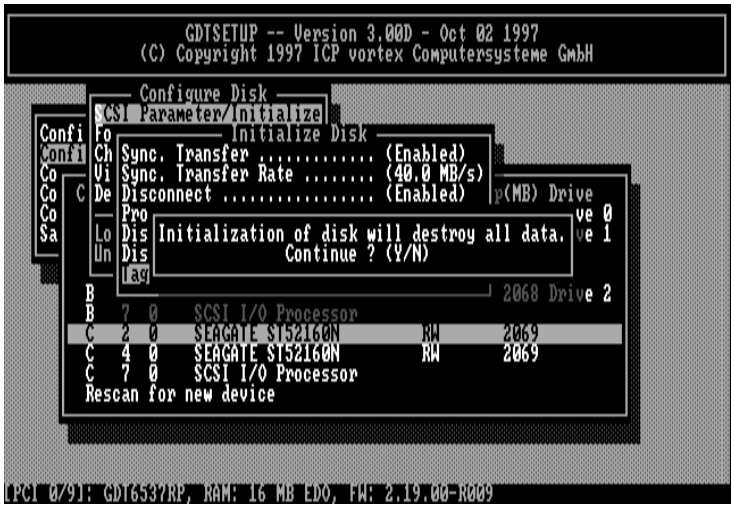
6. Disk Write Cache: On (Off)

This is the delayed write cache of the hard disk. Because of performance reasons it should always be enabled (On), except during the installation of operating systems like Windows 95 and Windows NT.

7. Tagged Queues: On (Off)

Tagged Queues is a SCSI feature which allows the drive to execute more than one command at a time.

If you leave this configuration form with <ESC> and you have made changes , GDTSETUP displays a security request.



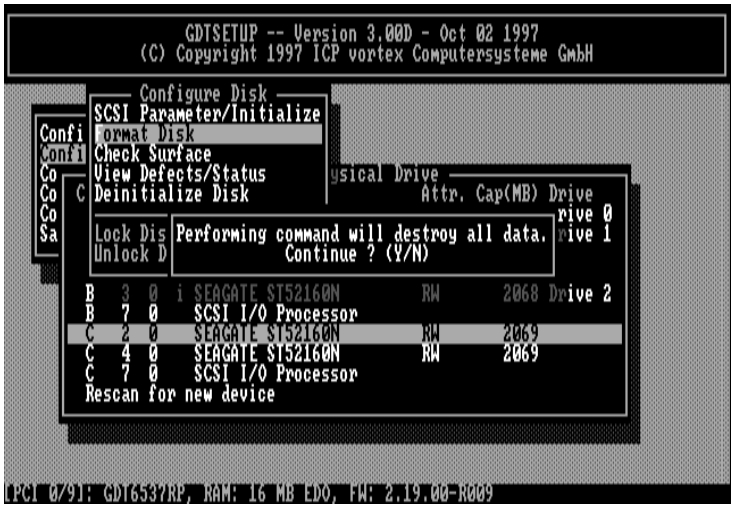
The warning of the destruction of all data implies different evaluations, depending on the device's current state and the options you selected:

1. *First Initialization of the SCSI Device*
   In this case, the warning must be taken seriously. If the drive was previously connected to a different controller (e.g. NCR etc.) and still contains important data, this data will be lost now.

2. *The SCSI Device was already initialized*
   If only internal parameters such as Disconnect, Synchronous Transfer, and SCSI Options have been changed, the data on the drive remains intact. Only the function state of the device changes.

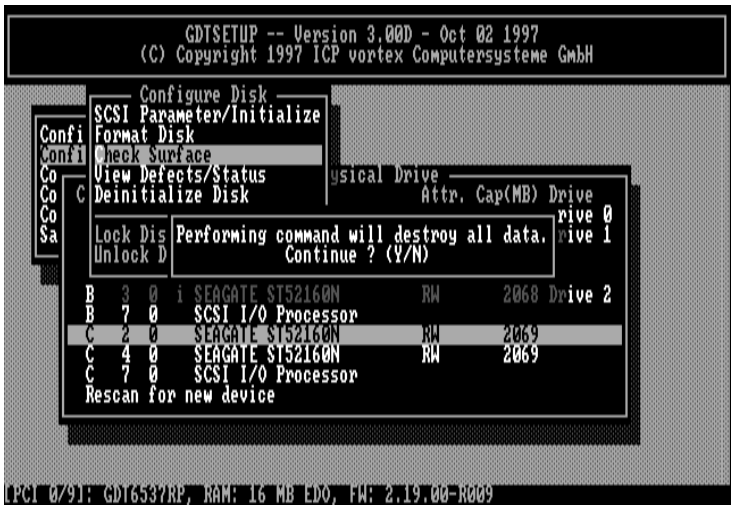
L.7.2 Format Disk

This option destroys all data on the hard disk.
All manufacturers of SCSI hard disks deliver their products already formatted and surface-tested. For new hard disks it is neither necessary, nor advisable to perform the Format Disk. This procedure is only indicated if you have doubts on the hard disk's condition.
The time required for the Format Disk of a hard disk depends on the hard disk itself. It can take quite a long time (up to days !). Often it seems that nothing happens and that the system hangs (no LED indication). If you put your ear on the hard disk you can hear the actuator stepping (with some drives one step per minute or longer). **Never interrupt a Format Disk procedure.** This may lead with a very high probability to a non-functioning hard disk. Before the actual formatting, GDTSETUP asks you whether the "Grown Defect" table of the hard disk should be deleted. Some users believe that this makes a hard disk with a lot of grown defects like new. This is wrong. As soon as the bad sectors are accessed again, a re-assign will happen, generating a new grown defect.



L.7.3 Check Surface

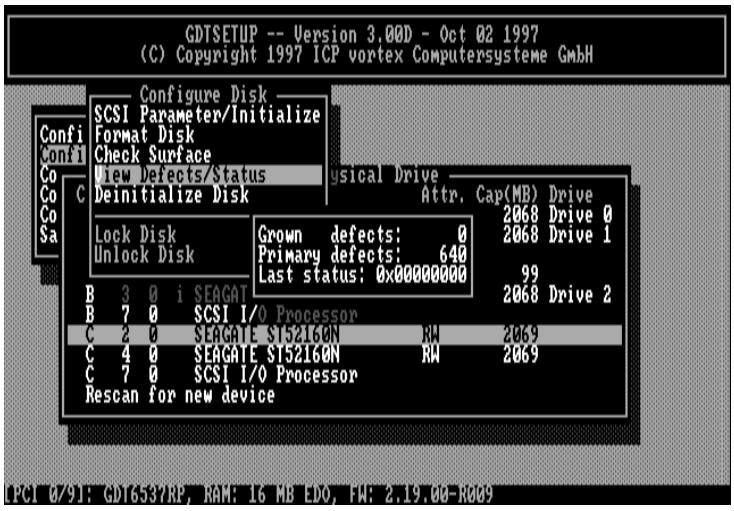
This option destroys all data on the hard disk.
This option allows the checking of the surfaces of the hard disk media. The GDT RP Series Controller writes and reads certain data patterns and checks them for correctness.



After confirming the security request, a progress information is displayed. You can interrupt the Check Surface option by pressing <ESC>.

L.7.4 View Defects/ Status

This option allows you to check the number of media defects the selected hard disk has.



Grown defects. Number of media defects that have occurred in addition to the media defects the hard disk already had upon delivery.

Primary defects. Number of media defects that the hard disk already had upon delivery.

Last status: The Last Status gives detailed information on the last failure of a hard disk. The information is only present until the next hard reset of the system and may help for deeper failure analysis or tracing.

The following listed messages are part of the SCSI documentation. Format: ***0x????70yz*** (???? = additional device specific messages)

0x????7000h NO SENSE. Indicates that there is no specific sense key information to be reported for the designated logical unit. This would be the case for a successful command or a command that received CHECK CONDITION or COMMAND TERMINATED status because one of the filemark, EOM, or ILI bits is set to one.

0x????7001h RECOVERED ERROR. Indicates that the last command completed successfully with some recovery action performed by the target. Details may be determinable by examining the additional sense bytes and the information field. When multiple recovered errors occur during one command, the choice of which error to report (first, last, most severe, etc.) is device specific.

0x????7002h NOT READY. Indicates that the logical unit addressed cannot be accessed. Operator intervention may be required to correct this condition.

0x????7003h MEDIUM ERROR. Indicates that the command terminated with a non recovered error condition that was probably caused by a flaw in the medium or an error in the recorded data. This sense key may also be returned if the target is unable to distinguish between a flaw in the medium and a specific hardware failure (sense key 4h).

0x????7004h HARDWARE ERROR. Indicates that the target detected a non-recoverable hardware failure (for example, controller failure, device failure, parity error, etc.) while performing the command or during a self test.

0x????7005h ILLEGAL REQUEST. Indicates that there was an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands (FORMAT UNIT, SEARCH DATA, etc.). If the target detects an invalid parameter in the command descriptor block, then it shall terminate the command without altering the medium. If the target detects an invalid parameter in the additional parameters supplied as data, then the target may have already altered the medium. This sense key may also indicate that an invalid IDENTIFY message was received (6.6.7).

0x????7006h UNIT ATTENTION. Indicates that the removable medium may have been changed or the target has been reset. See 7.9 for more detailed information about the unit attention condition.

0x????7007h DATA PROTECT. Indicates that a command that reads or writes the medium was attempted on a block that is protected from this operation. The read or write operation is not performed.

0x????7008h	BLANK CHECK. Indicates that a write-once device or a sequential access device encountered blank medium or format-defined end-of-data indication while reading or a write-once device encountered a non-blank medium while writing.
0x????7009h	VENDOR-SPECIFIC. This sense key is available for reporting vendor specific conditions.
0x????700Ah	COPY ABORTED. Indicates a COPY, COMPARE, or COPY AND VERIFY command was aborted due to an error condition on the source device, the destination device, or both. (See 8.2.3.2 for additional information on this sense key.)
0x????700Bh	ABORTED COMMAND. Indicates that the target aborted the command. The initiator may be able to recover by trying the command again.
0x????700Ch	EQUAL. Indicates a SEARCH DATA command has satisfied an equal comparison.
0x????700Dh	VOLUME OVERFLOW. Indicates that a buffered peripheral device has reached the end-of-partition and data may remain in the buffer that has not been written to the medium. A RECOVER BUFFERED DATA command(s) may be issued to read the unwritten data from the buffer.
0x????700Eh	MISCOMPARE. Indicates that the source data did not match the data read from the medium.
0x????700Fh	RESERVED.

L.7.5 Deinitialize Disk

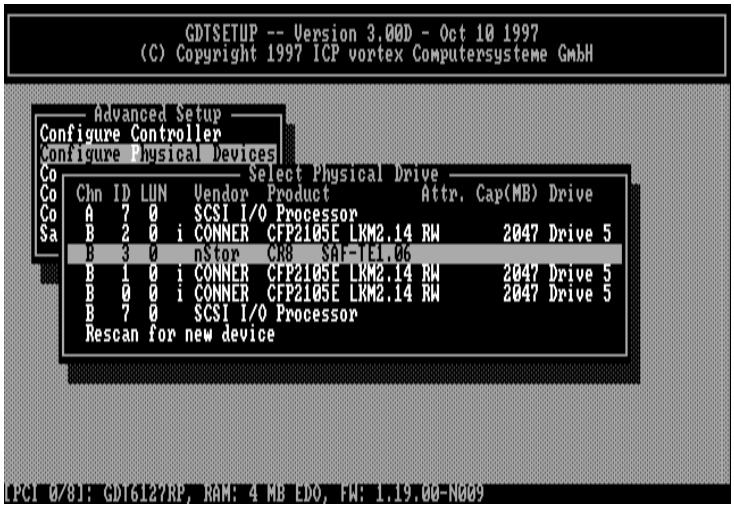
This menu option allows you to de-initialize a SCSI hard disk which has previously been initialized for use with the ICP Controller. By doing so, the specific GDT information present on the device is canceled. Obviously, the deinitialization cannot restore data that was lost during initialization.

L.7.6 Lock / Unlock Disk

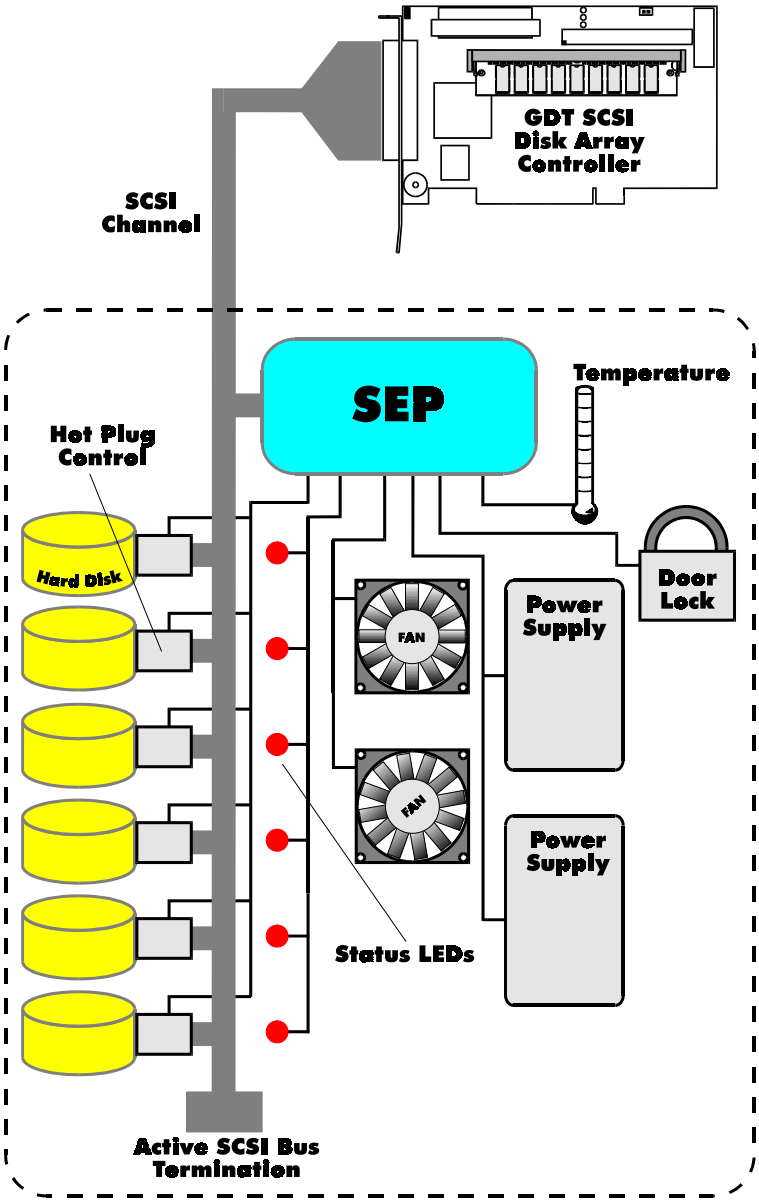
This option is only high-lighted when you have selected a removable hard disk (e.g., Syquest, Iomega). Before you can initialize a cartridge you have to lock it. Before removing it you have to unlock it.

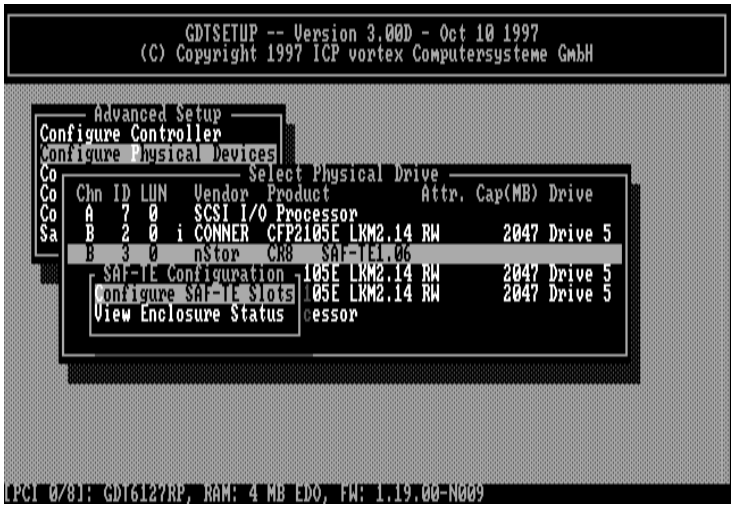
L.7.7 Configuration of SAF-TE Subsystems

Before you can use the Auto Hot Plug with a SAF-TE subsystem, you first have to configure the subsystem (more precisely it's intelligence, the so-called SEP - SAF-TE Enclosure Processor).
In the following list of devices, the entry "nStor CR8 SAF-TE1.06" represents the SEP of the connected SAF-TE subsystem. Each SCSI channel requires its own SEP.

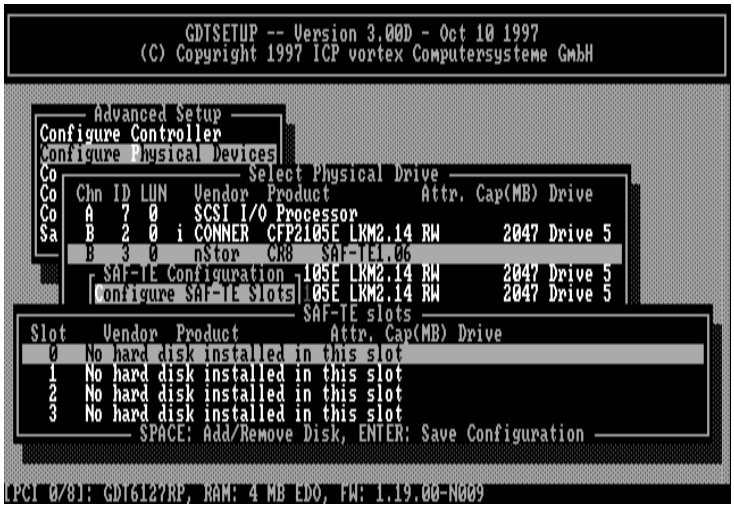


The next page shows a block diagram of a SAF-TE subsystem.

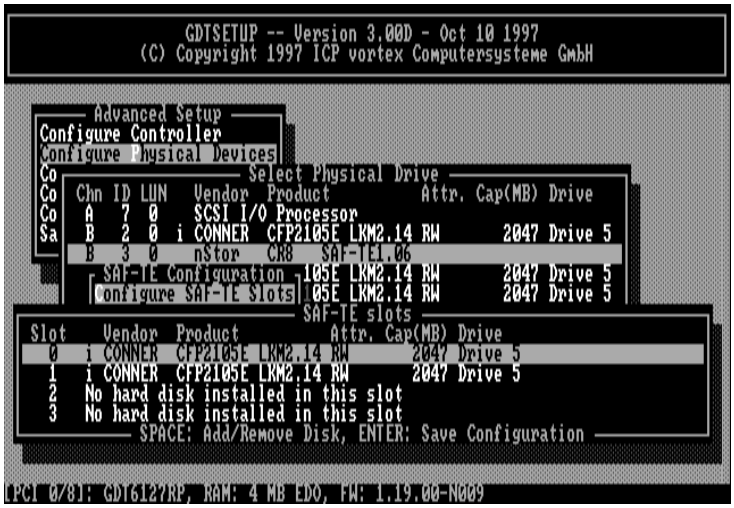

GDT SCSI
Disk Array
Controller
SCSI
Channel
SEP
Temperature
Hot Plug
Control
Hard Disk
FAN
FAN
Power
Supply
Power
Supply
Door
Lock
Status LEDs
Active SCSI Bus
Termination



After selecting the SEP press <ENTER> . You can either configure the SAF-TE Slots (i.e., the drive bays in the subsystem), or view the enclosure's status.

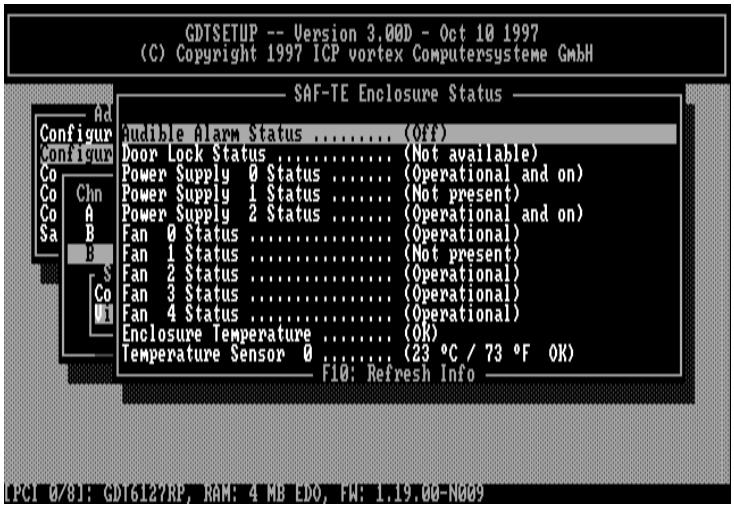


With the <SPACE>-bar you can assign hard disks to a SAF-TE slot. Once you have finished the assignment press <ENTER> to save the new configuration.



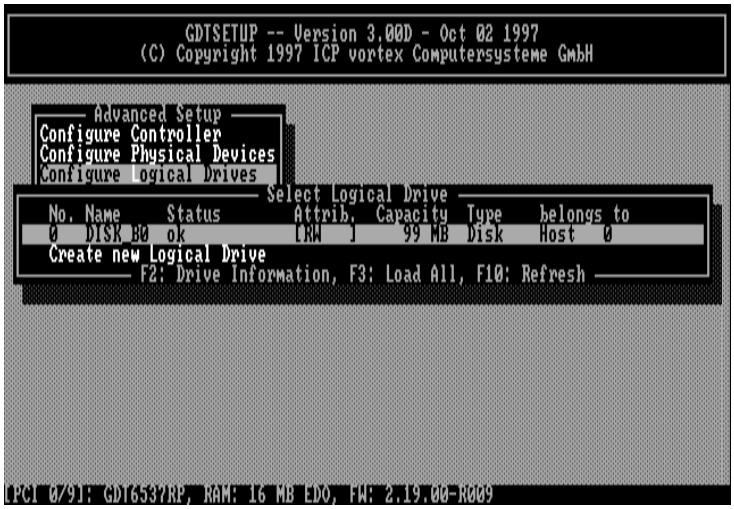
In this example 2 of the 4 available slots in the subsystem are occupied with hard disks.

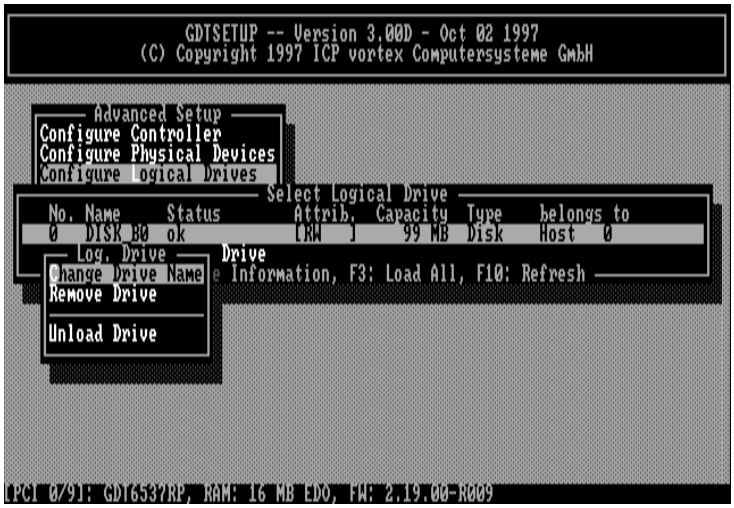
The following screen shows you the enclosure's status. Features which are marked with (Not available) are not implemented in the subsystem/SEP.



L.8 Configure Logical Drives

Logical Drives (hierarchy level 2) are installed in this main menu option.
Selecting *Configure Logical Drives* leads you to the screen shown next. As you can see, there is already one Logical Drive in the list. The drive's name has been assigned automatically and contains the channel description and the SCSI-ID after the underscore ("_"). This can serve as a reminder when you install a complex system with many drives (naturally you can change the name). After having selected a Logical Drive, you can carry out various operations.



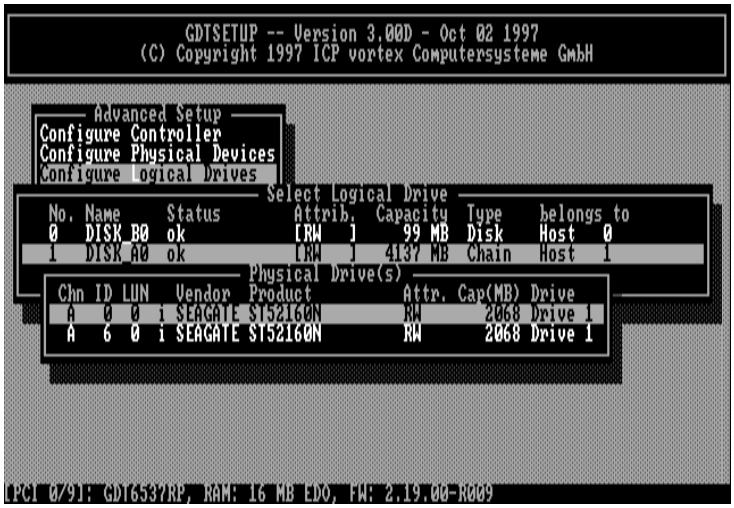


Change Drive Name. Here you can enter a name for the selected drive.

Remove Drive. This menu option lets you remove a single Logical Drive from the list of available Logical Drives. (Note: Logical Drives belonging to a RAID 0, 1, 4, 5 or 10 Host Drive cannot be removed. To do so, the corresponding Host Drive has to be removed first.)

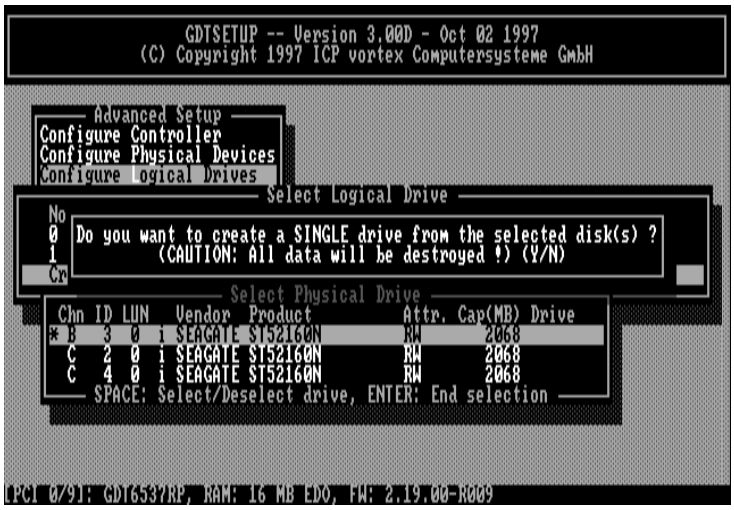
Unload Drive. Unlock the media of the removable hard disk, which belongs to the Logical Drive.

The <F2>-key gives you a list of all the SCSI devices this Logical Drive consists of. If it is a Logical Drive of the type ***Disk,*** it only consists of one single SCSI device. If a Logical Drive consists of more SCSI devices, it is of the type ***Chain*** (concatenation of several SCSI devices).



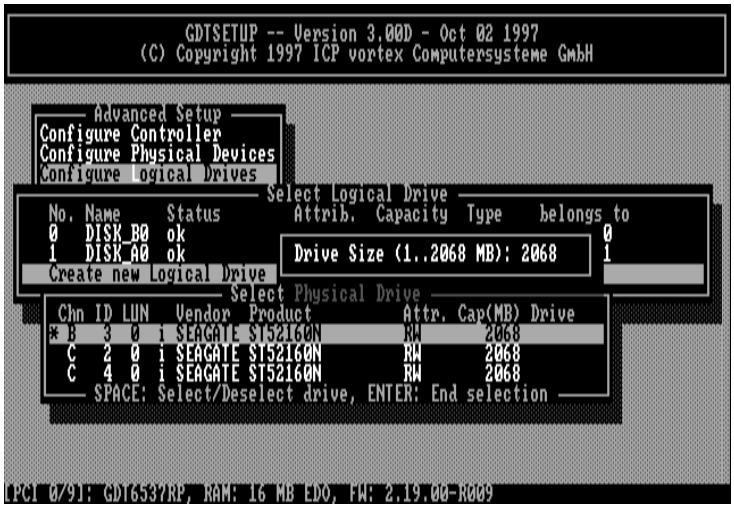
L.8.1 Installing a Logical Drive of the Type Disk

Mark the selected SCSI device with the <SPACE>-bar (pressing the <SPACE>-bar again undoes your choice) and confirm your choice with <ENTER>.

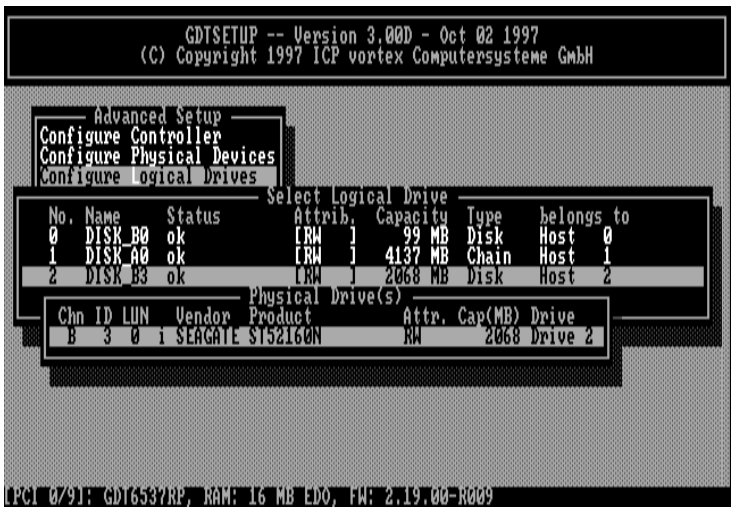


A security request appears. If you confirm with <*Y*>, GDTSETUP allows you to limit the size of the Logical Drive. This becomes interesting when you configure later on an Array Drive with several identical Logical Drives and you want to make sure that you get appropriate

spare hard disks in the future. It would be bad luck if the new hard disk would have 2060MB, only. It simply wouldn't fit into the Array Drive. If you limit the capacity to e.g., 2000MB from the beginning, you can be sure that all future 2GB hard disk will have at least 2000MB and thus can be used as spare hard disk.

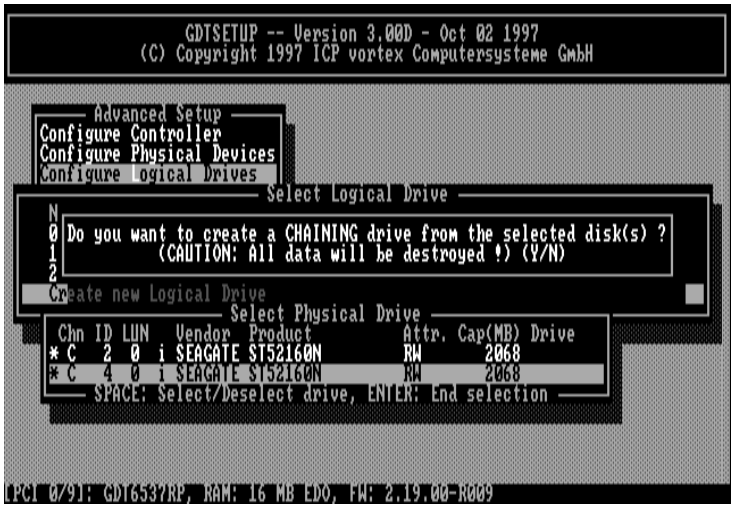


After pressing <ENTER> the list appears again, but with a new entry. The <F2>-key shows the hard disk forming the new Logical Drive.

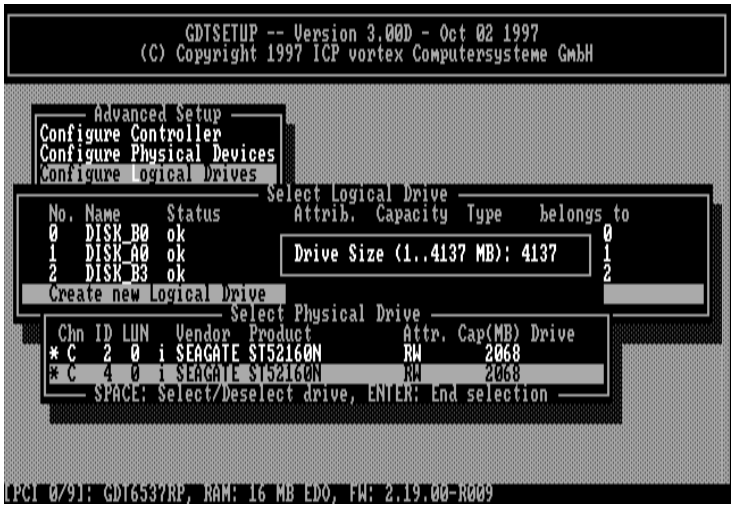


L.8.2 Installing a Logical Drive of the Type Chain

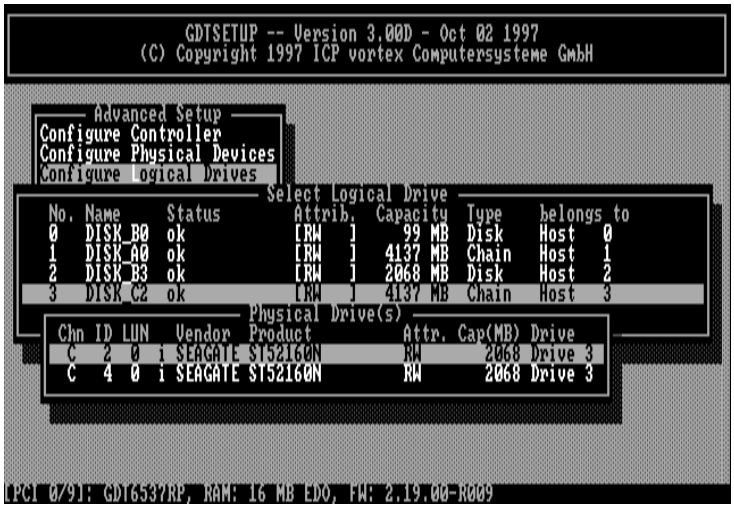
In some literature Disk Chaining is also called *Disk Spanning*. You can picture the functioning mechanism of a type *Chain* Logical Drive as follows: all SCSI devices forming the Logical Drive are linked together one by one in the exact same order in which they have been selected with the <SPACE>-bar. This concatenation can be compared with a chain. If, for example, the Logical Drive consists of 4 SCSI devices with 2000MB each, the Logical Drive will have a capacity of 8000MB. When data is written to this Logical Drive, the first SCSI device is filled first, then the second, and so on.
Although it is not advisable, Logical Drives of the type Chain, can also be components of Array Drives.
Select the SCSI devices with the <SPACE>-bar and then confirm with <ENTER>.



A security request appears. If you confirm with <*Y* >, GDTSETUP allows you to limit the size of the Logical Drive. This becomes interesting when you configure later on an Array Drive with several identical Logical Drives and you want to make sure that you get appropriate spare hard disks in the future. It would be bad luck if the new hard disk would have 4100MB, only. It simply wouldn't fit into the Array Drive. If you limit from the beginning the capacity to e.g., 4000MB, you can be sure that all future 4GB hard disk will have at least 4000MB and thus can be used as spare hard disk.



After pressing <ENTER> the list appears again, but with a new entry. The <F2>-key shows the hard disk forming the new Logical Drive.

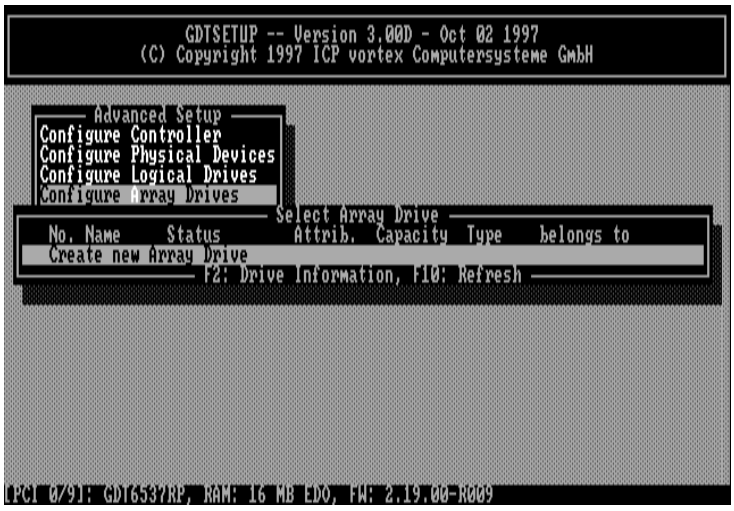


L.9 Configure Array Drives

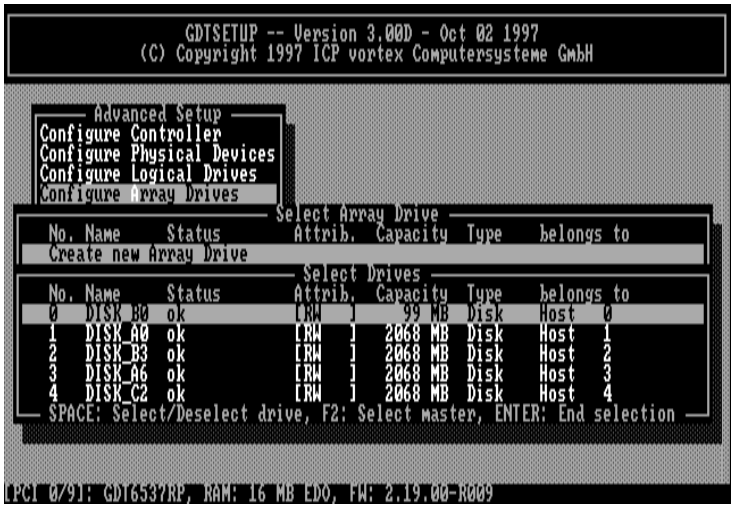
This main menu option allows you to configure Array Drives (level of hierarchy 3).
Array Drives with the following listed RAID levels can be configured within this menu.

- RAID 0 pure data striping without redundancy
- RAID 1 disk mirroring
- RAID 4 data striping with dedicated parity drive
- RAID 5 data striping with striped parity
- RAID 10 RAID 0 combined with RAID 1

The ICP Controller can manage up to 35 Array Drives (with different RAID levels) simultaneously. Obviously, the physically existing number of hard disks will limit the number of parallel used Arrays.

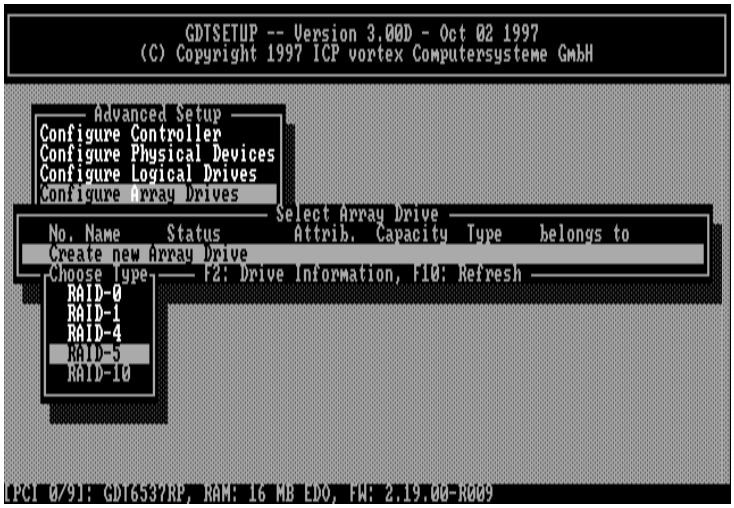


After pressing <ENTER>, GDTSETUP lists all free Logical Drives, which are free (not yet part of Array / Host Drives).

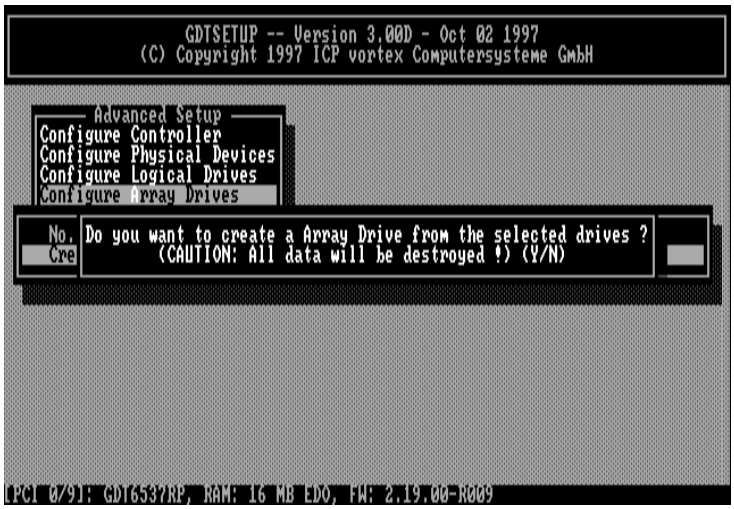


Move the selection-bar to the second entry and select Logical Drives No. 1,2 and 3.

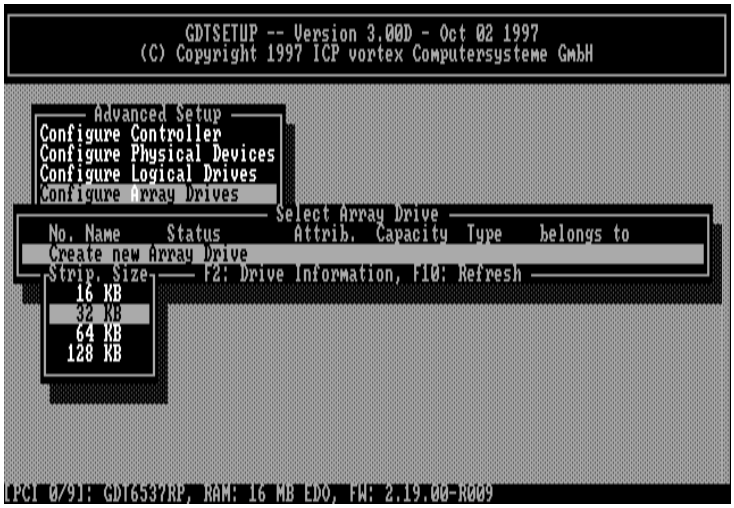
The "M" means Master. For a striping array (RAID 0, 4, 5, 10), this is the first Logical Drive in the array. For a RAID 1 (mirroring) array this is the Logical Drive which contains the valid data and which should be copied to the second Logical Drive. After pressing <ENTER> GDTSETUP displays a list of possible RAID levels. The number of previously selected Logical Drives determines the high-lighted levels. In our case RAID 10 is not selectable, since it requires at least 4 Logical Drives.



For this example we select RAID-5 and press <ENTER> .

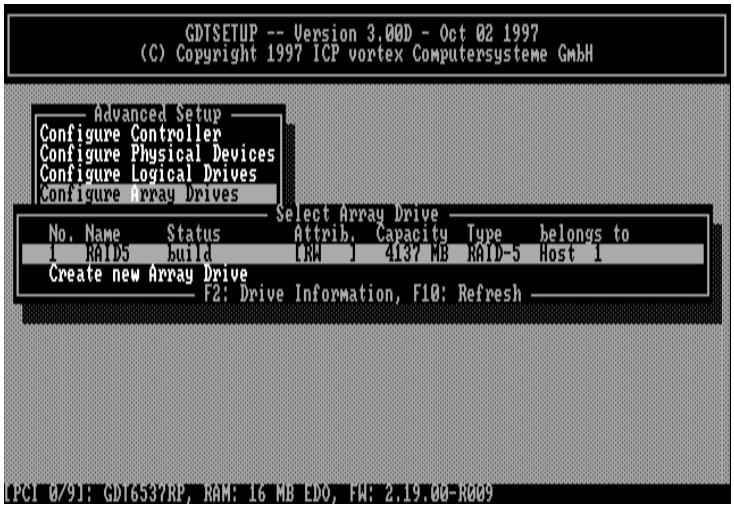


This security request has to be taken seriously. If you confirm with <Y> all data are lost. GDTSETUP will ask you for the Stripe Size. This is the size of the stripes into which the data is divided. Valid values are 16KB, 32KB, 64KB or 128KB. The default is 32KB which we leave for this example and therefore press <ENTER>. (Note: 32KB stripe size is suggested because in various performance tests it has proved to be the best value.).

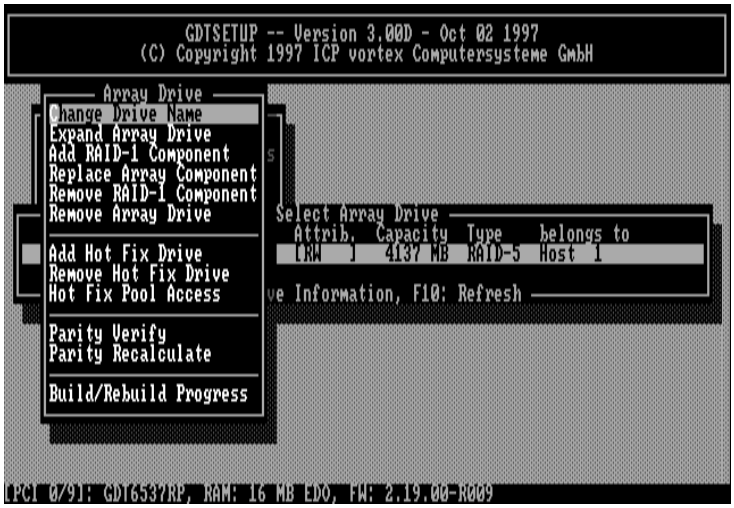


If necessary you can limit the Array Drive's capacity. For this example we take the complete capacity.

The Array Drive has entered the *build* state, i.e., the parity information is currently generated.



After completion of the build process, the Array Drive's state is *ready*, i.e., fault tolerant. If you select the new Array Drive, you are offered various menu option:



L.9.1 Notes on the Configuration of RAID 0, 1, 4, 5 and 10 Arrays Drives

(1) Use preferably Logical Drives of the type *disk* to build an Array Drive.
Of course, RAID Array Drives can be configured with Logical Drives of the type *chain*, too, but the aspects of security should be taken into consideration as well. For regular RAID Array Drives, type *disk* Logical Drives are used.

(2) The Logical Drives of an Array Drive should have the same storage capacity.
In order not to waste valuable storage capacity, you should only use Logical Drives that have the same storage capacity for an Array Drive.

(3) Use different SCSI channels when setting up Logical Drives for Array Drives.
Alternate between SCSI channels A and B (and C, D, and E if available) when setting up SCSI devices for Logical Drives. This configuration method has a considerable impact on a Array Drive's performance. Always keep in mind that the data is written in stripes to the Logical Drives. If the next drive to be accessed is connected to a different SCSI channel, independent and overlapping accesses are possible.

(4) The Hot Fix drive provides the utmost security.
One of the reasons for which **R**AID Array Drives are used definitely lies with the **r**edundancy they provide, that is, the data security you still have even in the event of a hard disk failure, thus resting assured against loss of data and time. For the purpose of the following considerations, we define the term ***time without redundancy*, TWR**. Set apart the time needed to set up the Array Drive (state *build*), the time without redundancy should be kept as short as possible. Let us assume that one of the hard disks of a RAID 5 Array Drive fails. The Array Drive is without redundancy. TWR starts to run. Any superfluous prolongation of the TWR (because you have to get a replacement hard disk, or because you did not realize the failure immediately since you didn't hear the ICP Controller's alarm signal, or because nobody checked the file server) increases the risk of data loss which will occur if a second hard disk should fail. Therefore, new redundancy should be created as soon as possible and in an entirely automated manner. Integrating a Hot Fix drive as an immediately available and auto-replacing hard disk is the only way to keep the TWR as short as possible. Only a Hot Fix drive can ensure optimal Array Drive security and constant data availability. Of course a Hot Fix drive is not mandatory. If you control the Array Drive at regular intervals and immediately replace a defective hard disk (by shutting down the system or Hot Plug), you can do without a Hot Fix drive.

(5) States of a RAIDYNE Array Drive
An Array Drive under the RAIDYNE operation system can assume seven different operational modes. An Array Drive is fully operational when in the *ready* state. All redundant information is present, that is, a hard disk can fail without impairing the functionality of the Array Drive. This is the normal state of an Array Drive.

idle ready fail build rebuild expand error

***Idle* state.** This mode is characterized by the fact that the redundancy information of the Array Drive has never been entirely created. An Array Drive assumes this state after its first configuration and you exit GDTSETUP. If an error should occur while the array is in the *build* state, the array returns to the *idle* state (exception: if during the *build* state the dedicated drive of RAID 4 fails, the state changes to *fail*).

***Build* state.** After the Array Drive has been configured for the first time, it changes from the *idle* to the *build* state as soon as you quit GDTSETUP. While the array is in the *build* state, redundancy information is calculated and stored to the hard disks of the array.

***Ready* state.** The disk array is fully operational when in the *ready* state. All redundant information is present, that is, a hard disk can fail without impairing the functionality of the disk array. This is the normal state of a disk array. The state *ready/expand* indicates that the RAID level and/or capacity are currently migrated/expanded.

***Fail* state.** The Array Drive changes to the *fail* state whenever a Logical Drive fails. Redundancy information is still present, thus allowing the remaining hard disks to continue to work. This state should be eliminated as soon as possible by replacing the defective hard disk. If a so-called Hot Fix drive has previously been assigned to an Array Drive with GDTSETUP, the controller will automatically replace the defective drive and start the reconstruction of the data and the redundancy information. Under these circumstances the *fail* state is only temporary and will be eliminated by the controller itself.

***Rebuild* state.** The Array Drive will assume this state after the automatic activation of a Hot Fix drive or after a manual replacement carried out with GDTSETUP. The data and the redundant information are reconstructed and stored to the new drive.

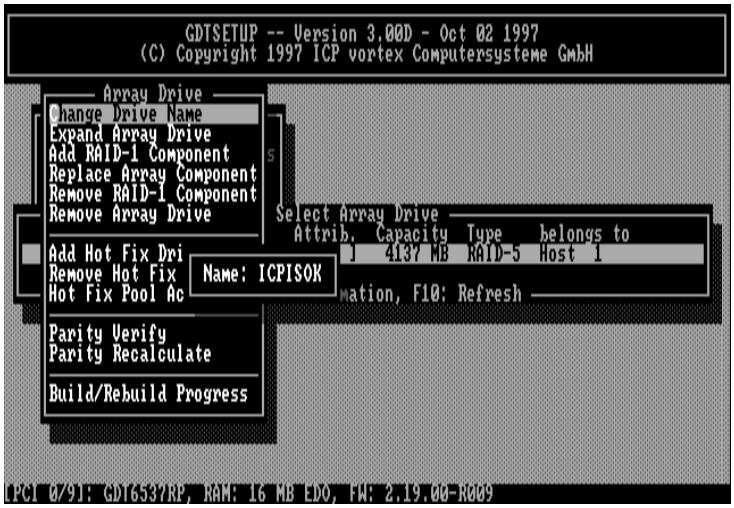
Expand state. If the capacity or RAID level of an existing Array Drive is changed, the Array Drive changes its state into *expand*. As soon as the expansion or migration is completed, the state changes back to *ready*.

***Error* state.** If a second hard disk should fail while the Array Drive is in the *fail* or *rebuild* state, it is not possible to continue the working session without restrictions. The Array Drive is still available for I/Os, but data loss and error messages on the host level are possible.

The state diagram on the last page of chapter C of this User's Manual shows the various states and transitions.

Some of these sates may become the addendum ***patch*** (e.g. *build/patch*, *ready/patch*).
This word indicates that the original Array Drive went through a significant procedure. I.e., the parity information was recalculated anew.
Or, the Array Drive has been patched from the error state into the fail state. This may become extremely helpful in a situation where two Logical Drives of an Array Drive fail at the same time, but only one of the two Logical Drives is really defective and the other was blocked out, since it was connected with the same SCSI channel as the defective one. The Array Drive's state is error and normally all data would be lost. RAIDYNE and GDTSETUP include some functions, which allow the patch of this Array Drive from the error state into the fail sate. Before the actual patch, the defective drive has to be physically removed from the Array Drive. Such a patch-procedure is a real sheet-anchor and should only be used after a detailed consultation with a trained support person (a printout of the *Save Information* file is extremely helpful).

L.9.2 Change Drive Name



This command allows you to change the name of an Array Drive. The name serves to identify an Array Drive in GDTSETUP. This can be very helpful for configurations where several Host Drives of various types are operated by a single controller.

L.9.3 Expand Array Drive

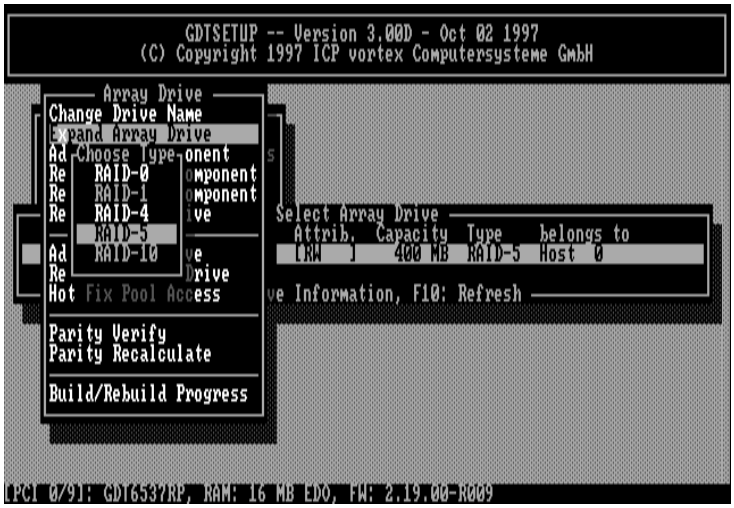
The *Expand Array Drive* option, which is also available online within GDTMON, includes two functions:

1. *Migration* of the RAID level of a given Array Drive
   RAID 0 -> RAID 4 and vice versa
   RAID 0 -> RAID 5 and vice versa

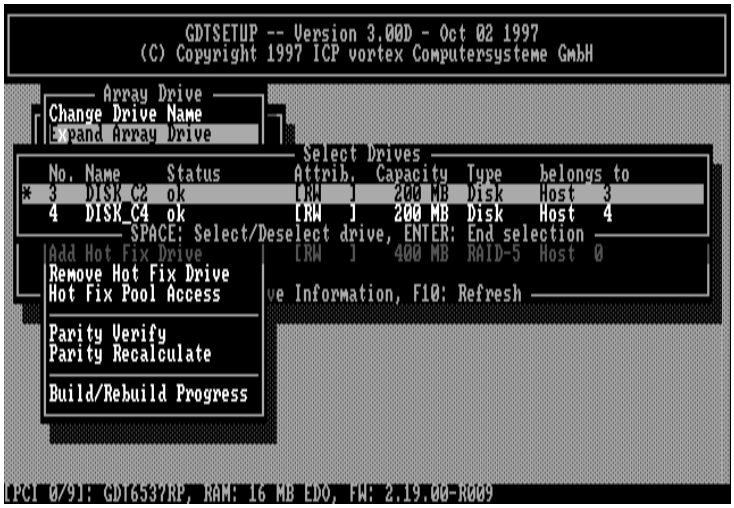
2. *Expansion* of the capacity of a given Array Drive

To initiate a migration or expansion with a RAID 4/5 Array Drive, the state must be *ready*.
The data on the Array Drive remain intact and are not affected by the expansion.
The additional capacity is introduced as new Host Drive (see next pages).
If a Logical Drive fails during the expansion, the expansion process continues until the expansion is finished. The Array Drive changes into the *fail* state.

In the following example the capacity of a given 400MB RAID 5 Array Drive is expanded.

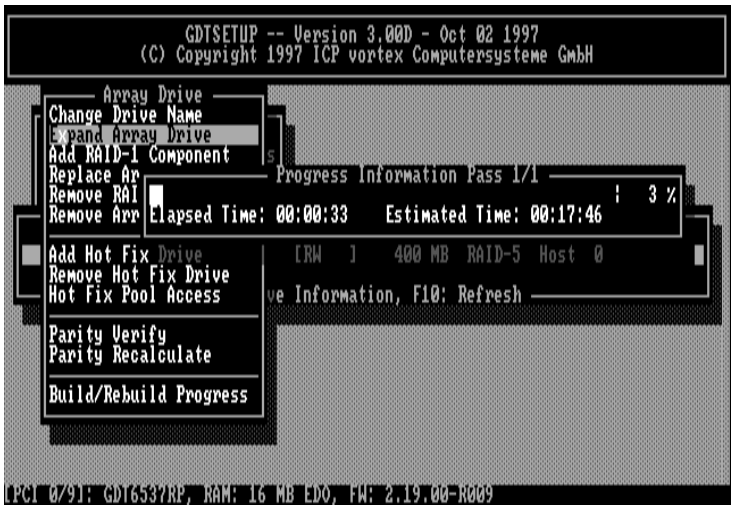


GDTSETUP displays a list with Logical Drives which are free and can be added to the existing Array Drive.

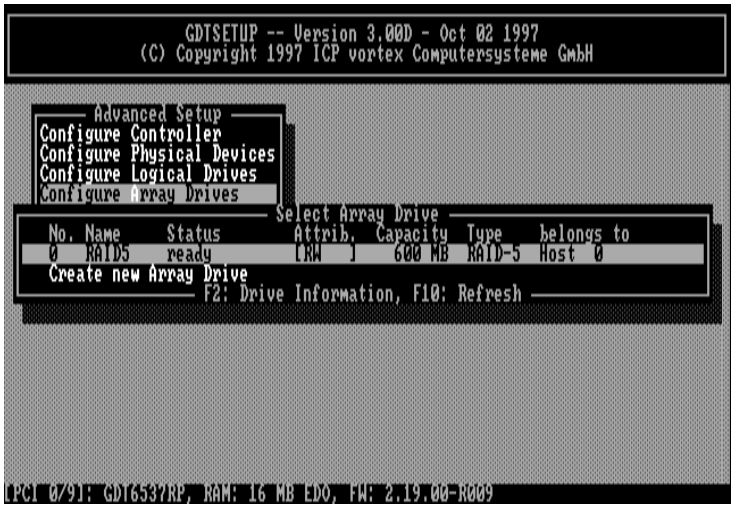


Here we select the first Logical Drive. We could have also added the first and the second Logical Drive to expand the Array Drive's capacity in one step from 400MB to 800MB.

After the acknowledgement of the security request, the expansion process starts.

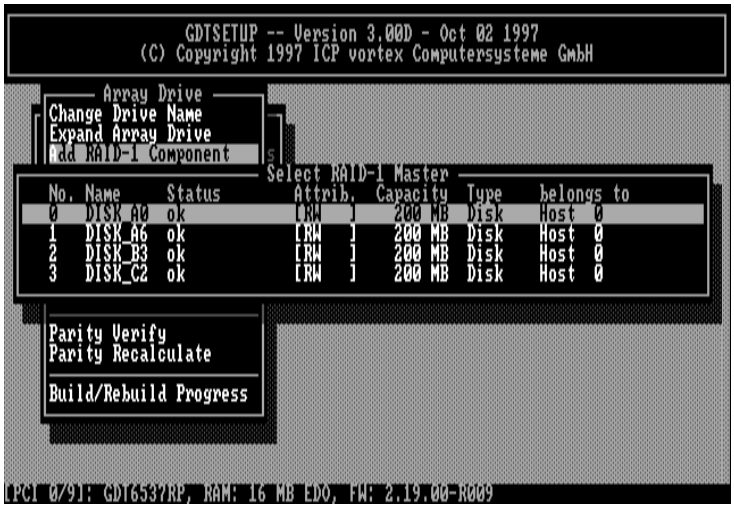


After completion of this process the new capacity is displayed. It is added as another Host Drive (see next pages).

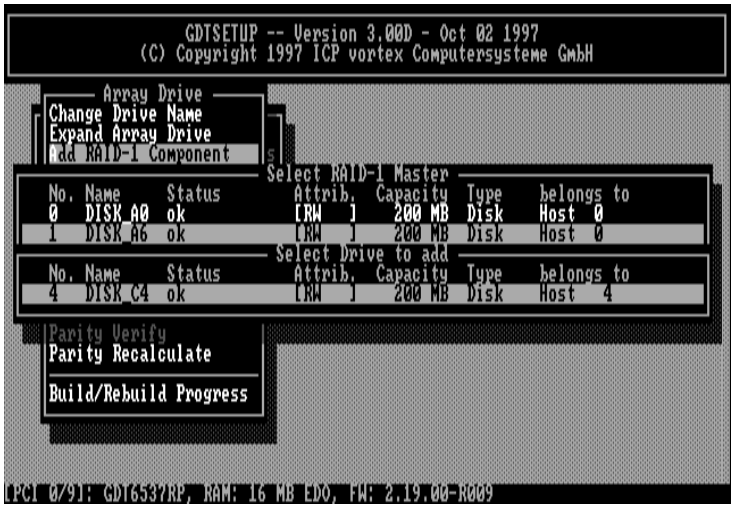


L.9.4 Add RAID-1 Component

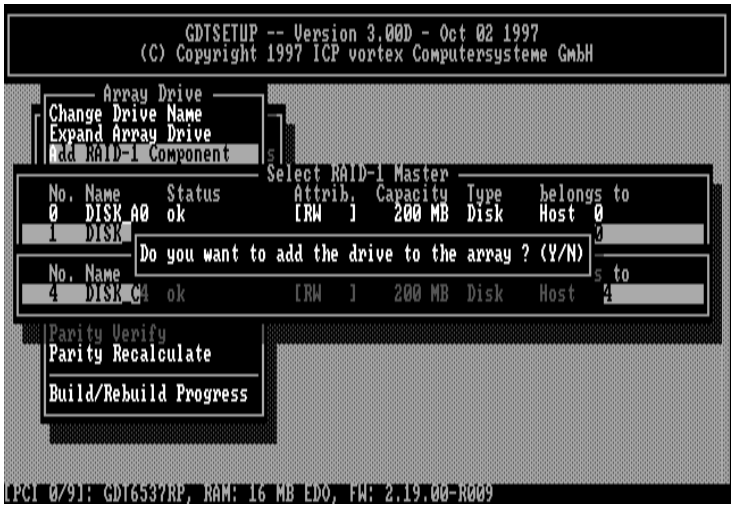
In certain "emergency" cases this is a very powerful and helpful option. This function allows you to add to a Logical Drive which is member of an Array Drive, another Logical Drive as a mirror drive (RAID-1).
Example: You have configured an Array Drive with 4 Logical Drives. One Logical Drive has failed and the Array Drive went into the fail state. Another failure would cause data loss. Unfortunately, you find another Logical Drive, which is shortly before failing (e.g., you hear a strange noise from it, or it's grown defect counter explodes). If you now initiate a hot plug it is very likely that this critical Logical Drive will also fail. This would result in a disaster. To avoid that problem, you can mirror in a first step a new good Logical Drive to the critical one. When the copying is finished you remove the critical Logical Drive (see over-next paragraph) and then carry out a hot plug procedure.



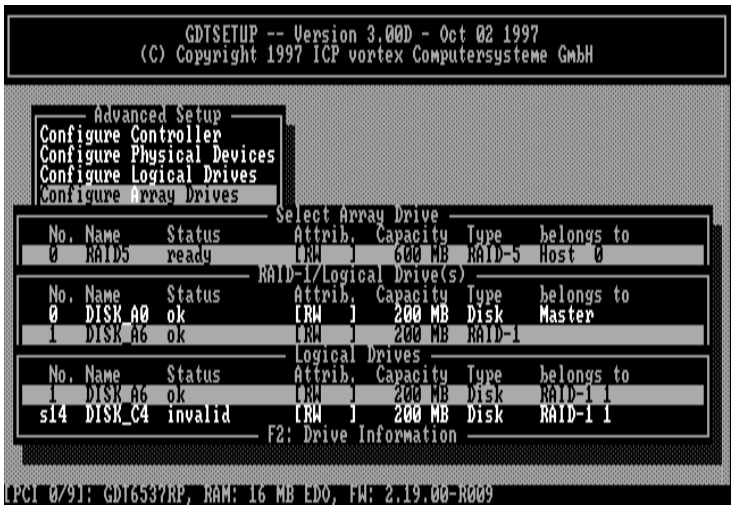
In this example the Array Drive is *ready*. Here you can select the RAID-1 Master. This is the Logical Drive which data are mirrored to the new Logical Drive.



Logical Drive DISK_C4 is added as a RAID-1 component to DISK_A6.



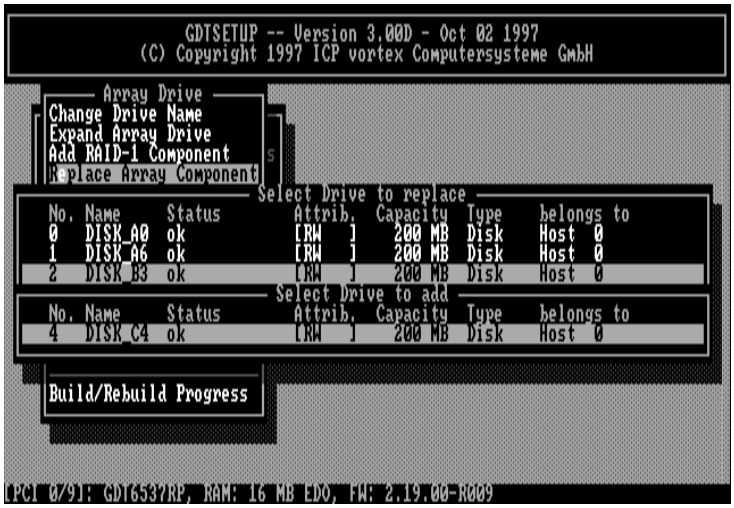
Press <F2> to get detailed information of the Array Drive. If you think this flexibility through to the end, you could add another RAID-1 Logical Drive to each Logical Drive which is component of a RAID 4/5 Array Drive (double redundancy, but also double cost).



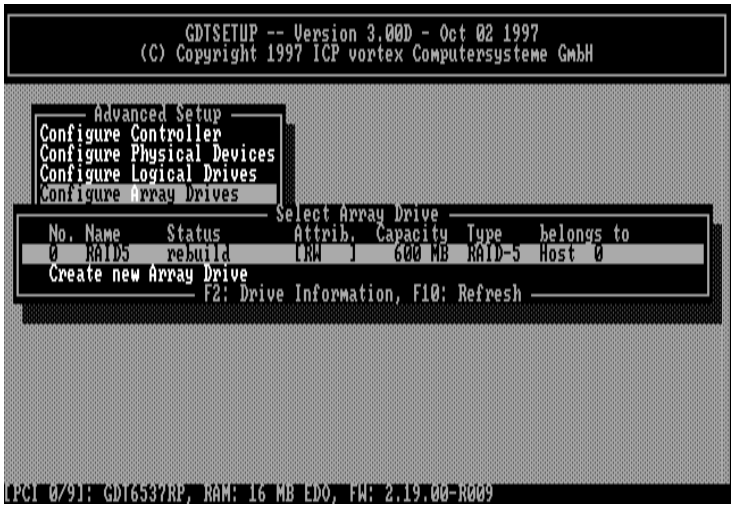
L.9.5 Replace Array Component

If a Logical Drive of an Array Drive without a Hot Fix drive should fail (or is very likely to fail, soon), you should replace the defective hard disk with a new one as soon as possible

because the Array Drive is without redundancy. The replacement Logical Drive has to have at least the same capacity as the failed one. The replacement is carried out either interactively with GDTSETUP or online with the GDTMON utility program (see Chapter K).
Before you replace the failed Logical Drive, you have to power off the computer system. Then, after having installed the replacement hard disk as a new Logical Drive, you can add it to the Array Drive. After selecting the Logical Drive which needs to be exchanged, GDTSETUP offers a list of existing Logical Drives which can be used as replacement units.

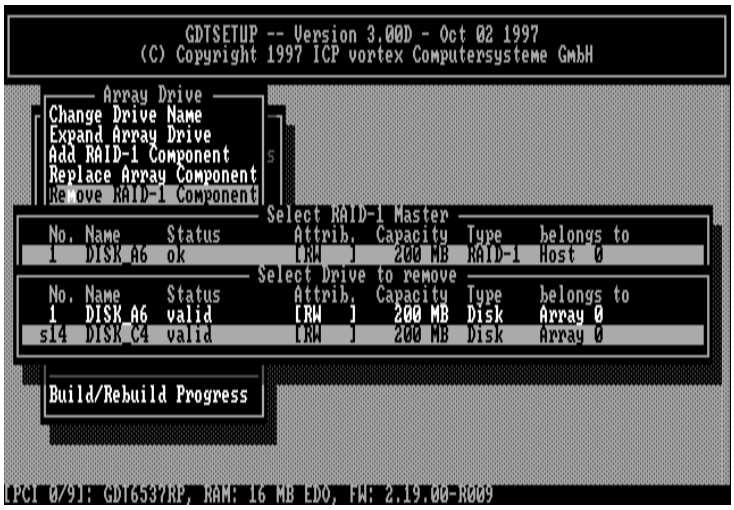


The Array Drive's state is changing into *rebuild* and the missing data is automatically reconstructed on the new Logical Drive.

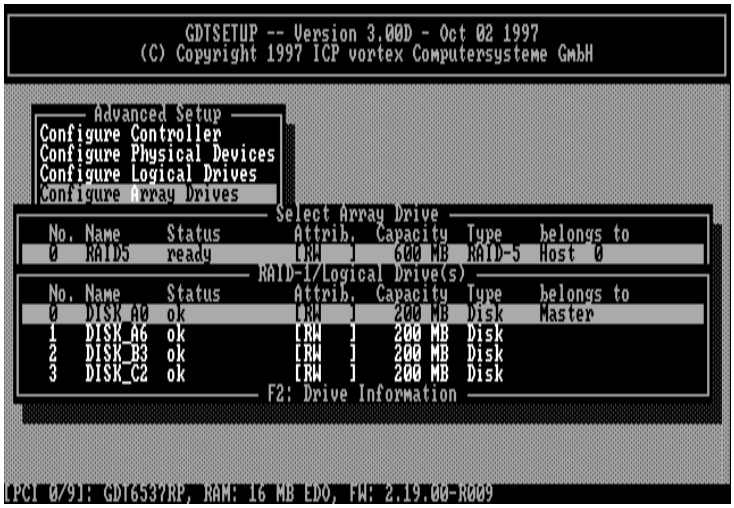


L.9.6 Remove RAID-1 Component

This option corresponds with the *Add RAID-1 Component* option. It allows you to remove a previously configured RAID-1 combination.



Press <F2> to get details. As you can see, all Logical Drives have the type *Disk*, again.



L.9.7 Remove Array Drive

This command allows you to remove an existing Array Drive. **All the data of the Array Drive will be lost !** Before you confirm the security request with <Y>, you should be sure about this choice.

Note: if an Array Drive has been removed, it can only be rebuilt without data loss if it is re-constructed in the exact same order it had been built before, and only if the components of

the Array Drive, that is the Host Drives, have not been modified in any kind whatsoever in the meantime.

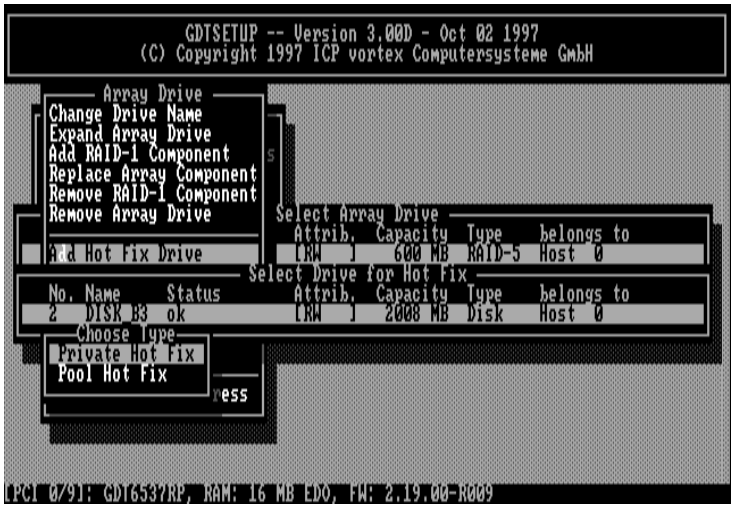
L.9.8 Add Hot Fix Drive

This submenu option allows you to add a Hot Fix drive to an existing RAID 1, RAID 4, RAID 5, or RAID 10 Array Drive.
There are two different types of Hot Fix drives: *Private* and *Pool* Hot Fix drives.
A *Pool* Hot Fix Drive is a spare drive within the so-called Hot Fix Pool. A drive in a Hot Fix Pool is available for several Array Drives as a Hot Fix drive. Thus, several Array Drives can share one Hot Fix drive. Of course, once this drive has been used by one of the Array Drives, it is no longer available for the others.
A P*rivate* Hot Fix drive is dedicated to one RAID 1, RAID 4, RAID 5 or RAID 10 Array Drive.

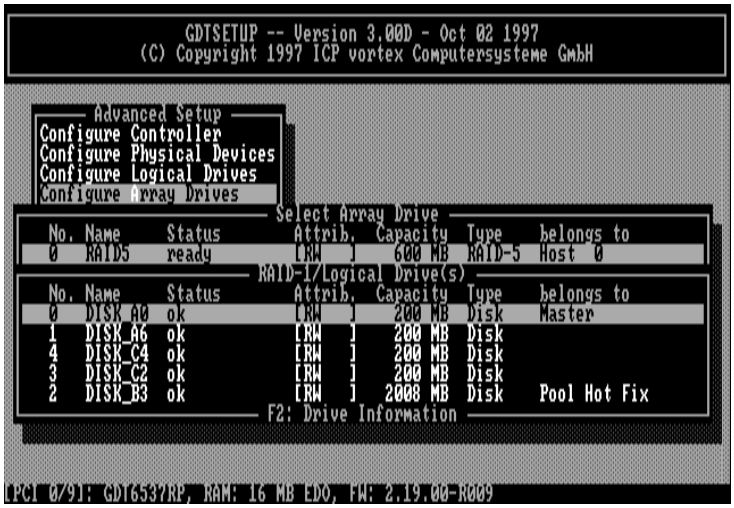
Only drives that meet the following requirements are suitable as Hot Fix drives:

1. The Logical Drive that is to become a Hot Fix drive must not be an active component of another Array Drive.

2. The Logical Drive that is to become a Hot Fix drive must have a storage capacity greater than or equal to the storage capacity of the smallest Logical Drive of the Array Drive. Example: A type RAID 5 Array Drive consists of the following components:
   Logical Drive 0 2000MB
   Logical Drive 1 1500MB
   Logical Drive 2 1100MB
   Logical Drive 3 2000MB
   This Array Drive has a usable storage capacity of 3300MB. A Hot Fix drive for this array must have at least 1100MB of storage capacity. (Note: in order not to waste valuable storage capacity, it is strongly recommended that all Logical Drives forming an Array Drive have the same storage capacity.)



Example of an Array Drive configuration with a Hot Fix drive (press the <F2>-key to display the following screen). The Array Drive configuration sheet, shows the active Array Drive members including the Pool Hot Fix drive.



What happens after a drive failure ?

The controller will substitute a failed Logical Drive with a Hot Fix drive only if the Array Drive was in the *ready* state before the failure, or, in other words, a Hot Fix drive can only be activated if the corresponding Array Drive had a state of data redundancy at the moment of failure.

1. After a short while, the controller's alarm turns on.
   (Note: the alarm is activated only when the Array Drive is being accessed.)
2. The controller activates the *fail* operation mode. In this mode, the Array Drive remains fully operational. The data located on the failed drive is generated by means of the redundancy information stored on the other drives, without causing any decrease in performance.
3. The controller starts the motor of the Hot Fix drive.
4. The controller integrates the Hot Fix drive into the Array Drive and starts to reconstruct the data and redundancy information. The Array Drive is now in the *rebuild* operation mode.

Obviously, no other hard disk may fail until all data has entirely been reconstructed on the Hot Fix drive, because up to that moment, the system is operating without redundancy.

Notes: In some literature, Hot Fix drives are also called *Hot-Spare* drives.
You can add or remove Hot Fix drives also with the GDTMON utility program (see Chapter K).

L.9.9 Remove Hot Fix Drive

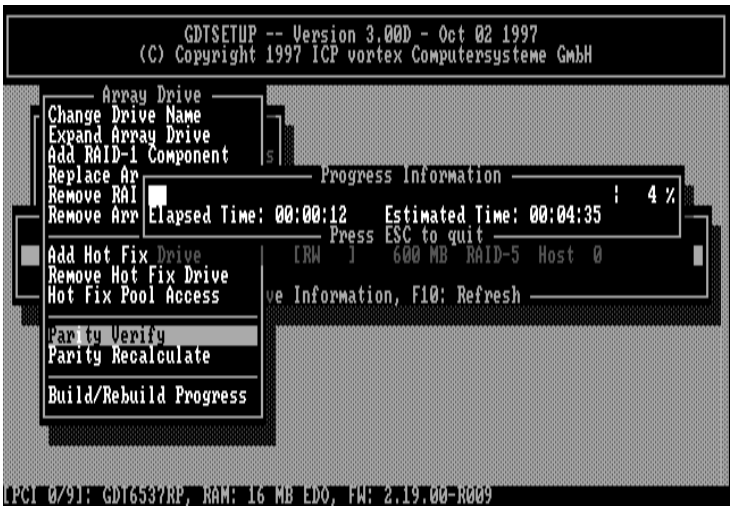
This option allows you to remove a Hot Fix Drive from an existing Array Drive. Naturally, the Hot Fix drive must not be used up so far.

L.9.10 Hot Fix Pool Access

By selecting the *Hot Fix Pool Access* option, the access of a specific Array Drive to the Hot Fix pool can be enabled of disabled.

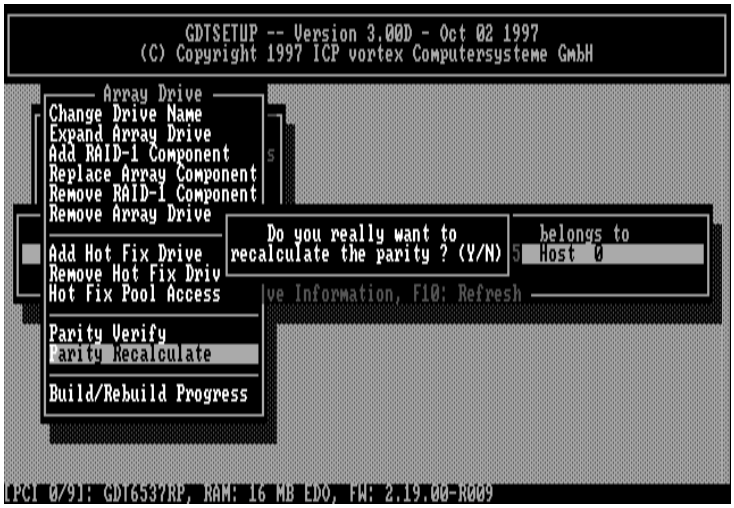
L.9.11 Parity Verify

The redundancy information which is calculated during an array *build* or *rebuild* is stored on a dedicated Logical Drive (RAID 4), or is distributed over all Logical Drives of the Array Drive (RAID 5). This information is often called *parity data*. The calculation is made with an exclusive OR function (XOR). If a Logical Drive of an Array Drive fails, its data can be recalculated by means of the data present on the other Logical Drives of the Array Drive and the parity data. The *Parity Verify* function allows you to check the consistency of an Array Drive's parity data.
(Note: The diagnosis program GDTMON allows an online parity verify, that is a verification during which the Array Drive continues to be fully operational. Further details are given in chapter K).
The verification may take quite a long time, but you can terminate it by pressing <ESC>.



L.9.12 Parity Recalculate

If the parity information of a given Array Drive is defective, this function may be used to recalculate it anew.

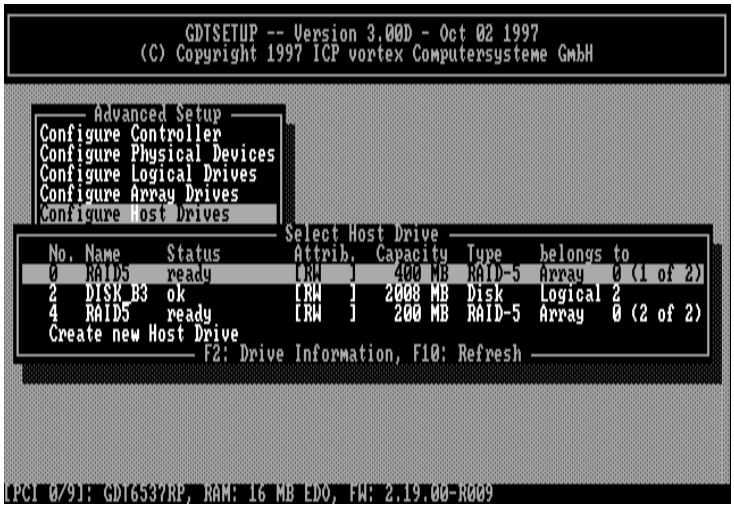


L.9.13 Build/Rebuild Progress

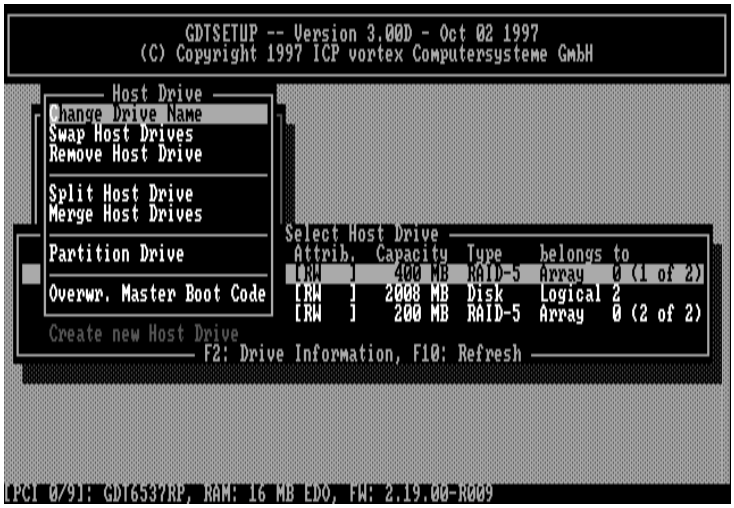
Whenever an Array Drive is in the *build* or *rebuild* state, you can select this option, to get progress information and estimates for the required time.

L.10 Configure Host Drives

This main menu option allows you to configure Host Drives (level of hierarchy 4).
As already mentioned before, these are the drives the Host Computer is aware of. Host Drives can consist of a single hard disk, or of many hard disk combined to a RAID 5 Array Drive.
As you can see from the following screen, there are two Host Drives in the list, which belong to the same physical Array Drive. Host Drive 4 (2 of 2) is the result of a previous capacity expansion. If you expanded the capacity of the Array Drive a second time, there would be three Host Drives in that list, belonging to one and the same Array Drive.
Since there is currently no operating system, which supports "growing hard disks", this expansion method is the only safe way to introduce new capacity.



After selection of a Host Drive press <ENTER>.

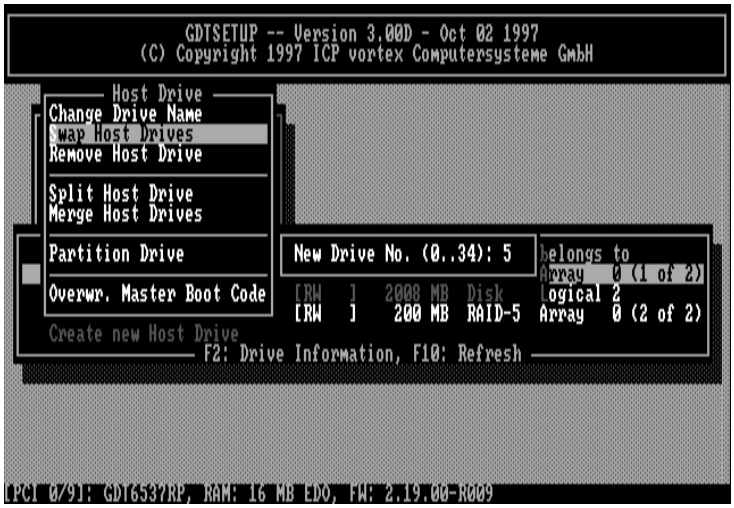


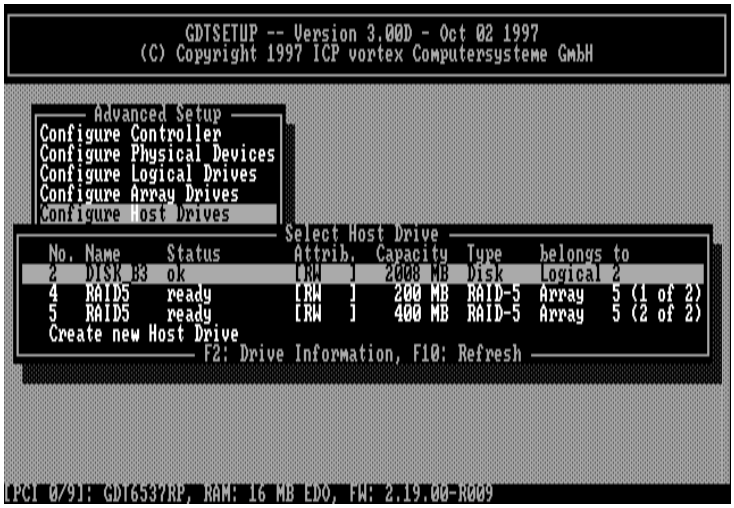
L.10.1 Change Drive Name

This command allows you to change the name of a Host Drive. The name serves to identify a Host Drive with GDTSETUP.

L.10.2 Swap Host Drives

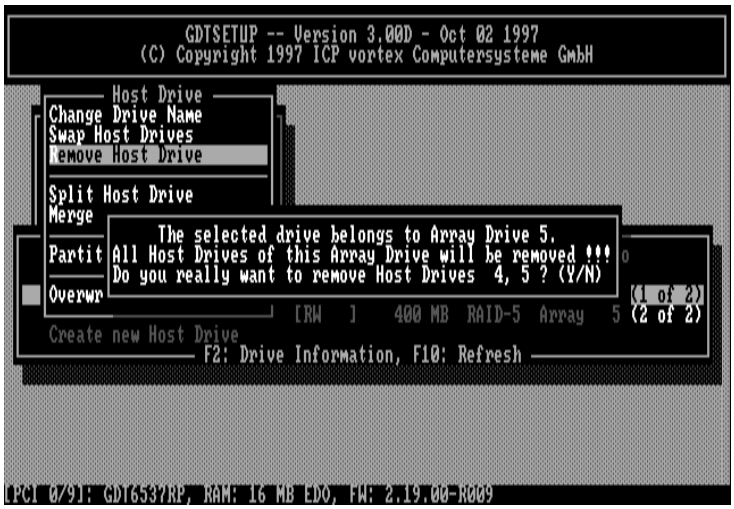
When the PCI computer is switched on, the Host Drives are initialized in the order of the Host Drive list, which means that the operating system is booted from the Host Drive having the lowest number. For reasons of flexibility, a Host Drive's position in the list can be changed. However, the position of the Host Drive from which the operating system is booted and the position of the Host Drive from which GDTSETUP (disk version) was started (both can be the same), cannot be changed. If you wish to change the position of these drives, you have to boot the operating system and GDTSETUP from a floppy disk or use the GDTSETUP version loadable from the Flash-RAM of the controller. To change the position of a Host Drive in the Host Drive list, highlight the Host Drive and confirm with <ENTER>. Then, type on the new position and press <ENTER> .





L.10.3 Remove Host Drive

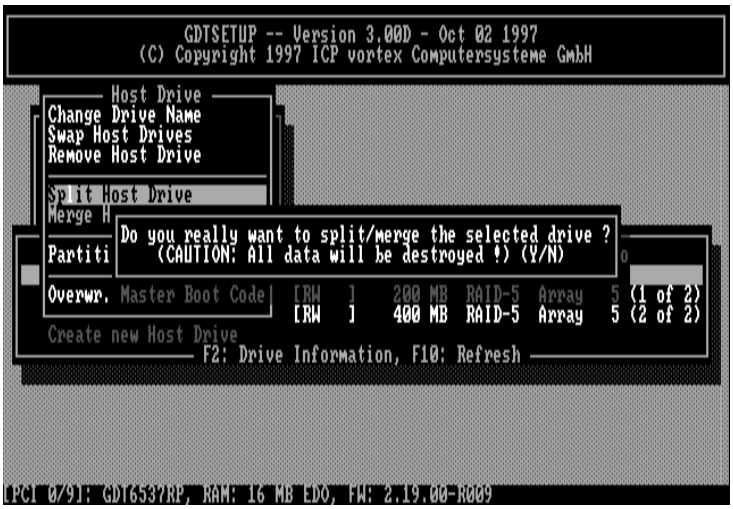
Removing a Host Drive is a serious action. ***All data will be lost after removal.***
If you want to remove a Host Drive belonging to an Array Drive for which several Host Drives exist (after capacity expansion, or after splitting), all other Host Drives will also be removed.

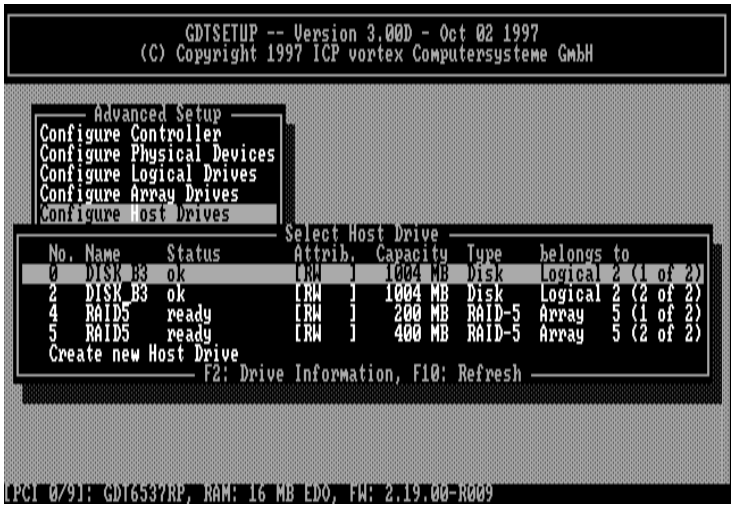


L.10.4 Split Host Drive

For some purposes it might of interest to split an existing Host Drive into two or several Host Drives. Each Host Drives looks to the operating system just like a single hard disk.

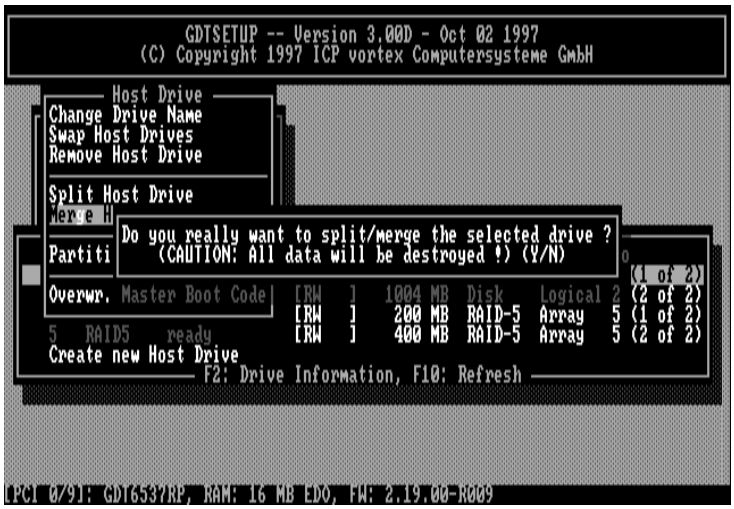
Since the new Host Drives have smaller capacities GDTSETUP has to write new header information on the two Host Drives. ***All data will be lost.***





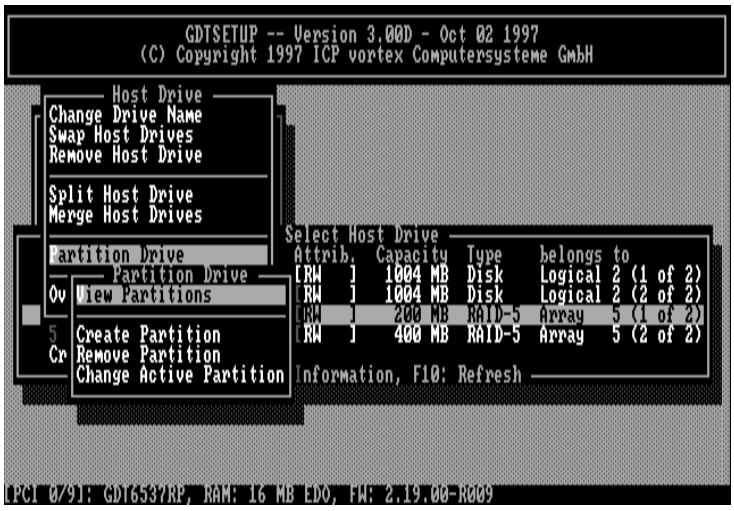
L.10.5 Merge Host Drives

This function reverses the *Split Host Drive* option. Only such Host Drives can be merged which belong to the same Array Drive or Logical Drive. Since the new Host Drives has a larger capacity GDTSETUP has to write a new header information on the new Host Drives. ***All data will be lost.***



L.10.6 Partition Host Drive

This option is not available, when loading GDTSETUP from the Flash-RAM of the controller. Before you can partition a new Host Drive it may become necessary to reboot the system, first.



The partitioning menu has similar functions as the MS-DOS program FDISK. You can create and delete a partition and also change the active partition. MS-DOS can only be booted from an active partition. Just like FDISK, GDTSETUP can handle primary partitions, extended partitions, and logical drives within the extended partitions.

L.10.7 Overwrite Master Boot Code

This option created a valid and consistent master boor record on the selected Host Drive and should be carried out on any new Host Drive on which Windows NT is installed.

L.11 Save Information

This main menu saves all relevant configuration information of the selected controller (controller settings, Physical Drives, Logical Drives, Array Drives, Host Drives, etc.) in an ASCII file. You can choose the filename and path. This file is very helpful for deeper support and is also a good basis for system documentation.

L.12 Leaving GDTSETUP

Always end GDTSETUP by leaving the program in the regular way (do not warm boot with CTRL-ALT-DEL or cold boot by pressing the RESET button). Certain information is only transferred to the controller when you leave GDTSETUP in the regular way.

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