WDC Marvell

Contents

ACE Laboratory
for official users only

ACE Laboratory
for official users only

1. Drives supported by the WDC Marvell utility

Fig. 1.1.

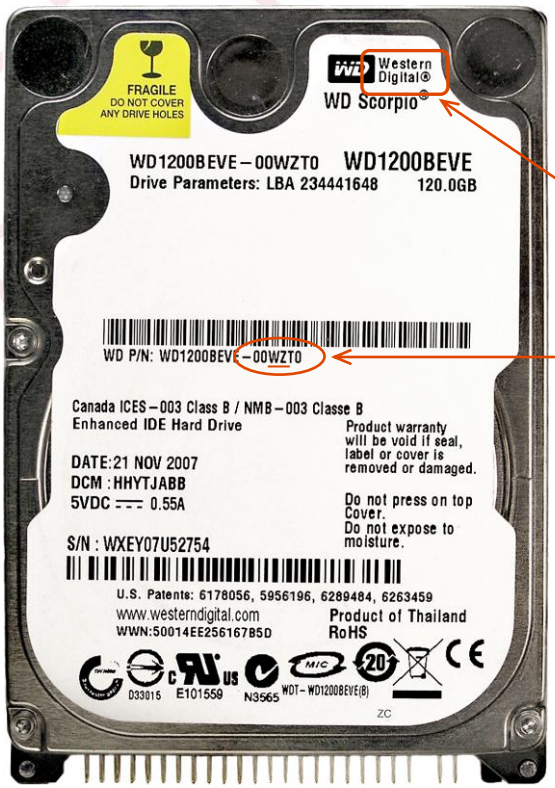


Fig. 1.2.

Fig. 1.3.

Family ID	Brand	RPM	Interface	Form factor	Cache
Mammoth					
EY, EZ, FA, FJ, HE, JS, JY	Caviar	7200	PATA	3.5	2M
FC, FM, HF, JT	Caviar	7200	PATA	3.5	8M
JE	Protege	5400	PATA	3.5	2M
Sabre					
JH, JK, KS, LN, MG	Caviar	7200	PATA	3.5	2M
JJ, JL	Caviar	7200	PATA	3.5	8M
JM, JP	Caviar	7200	SATA	3.5	2M
JN, JR	Caviar	7200	SATA	3.5	8M
JU	Protege	5400	PATA	3.5	2M
Hawk					
MH,ML,MV,MZ,NC,NF, NG,NK	Caviar	7200	SATA II	3.5	8M
MJ,MK,MW,MY,ND,NE, NH,NJ	Caviar	7200	SATA II	3.5	16M
NT, NV, NY, PA	Caviar	7200	SATA	3.5	16M
NU, NW, NZ, PB	Caviar	7200	SATA	3.5	8M
RP	Hawk	7200	SATA II	3.5	2M
Starling					
RD, RJ(2)	Caviar	7200	PATA	3.5	2M

Unauthorized copy of distribution
of these documents is prohibited

RE, RF, RK(2), RL(2)	Caviar	7200	PATA	3.5	8M
Scorpio					
HC	Scorpio	5400	PATA	2.5	2M
HD	Scorpio	5400	PATA	2.5	8M
KH	Scorpio	4200	PATA	2.5	2M
Buccaneer					
KE	Caviar	7200	PATA	3.5	2M
KF, KM	Caviar	7200	PATA	3.5	8M
KG	Protege	5400	PATA	3.5	2M
Orion					
KV	Scorpio	5400	PATA	2.5	2M
KW	Scorpio	5400	PATA	2.5	8M
Aquarius					
KZ, RM(FFS)	Scorpio	5400	SATA II	2.5	2M
LA, RN(FFS)	Scorpio	5400	SATA II	2.5	8M
Unicorn					
LR, LT, MR, MT	Caviar	7200	SATA II	3.5	2M
LS, LU, MS, MU	Caviar	7200	SATA II	3.5	8M
Zeus					
MN, MP	Caviar	7200	SATA	3.5	16M
VJ(w/NCQ)	WD RE	7200	SATA	3.5	16M
Raider					
PC	Caviar	7200	SATA II	3.5	2M
PD, PE	Caviar	7200	SATA II	3.5	8M
PF, PG	Caviar	7200	SATA II	3.5	16M
Sequoia					
PN	WD RE	7200	SATA II	3.5	16M
PR	Caviar	7200	SATA II	3.5	2M
PS	Caviar	7200	SATA II	3.5	8M
PT	Caviar	7200	SATA II	3.5	16M
PU	Caviar	7200	PATA	3.5	2M
PV	Caviar	7200	PATA	3.5	8M
SV	WD AV	7200	SATA II	3.5	2M
SW	WD AV	7200	SATA II	3.5	8M
SY	WD AV	7200	PATA	3.5	2M
SZ	WD AV	7200	PATA	3.5	8M
Jupiter					
RB, RC	Caviar	7200	SATA II	3.5	16M
TU	WD AV	7200	SATA II	3.5	16M
Aries					
RR, RU(FFS)	Scorpio	5400	SATA II	2.5	2M
RS, RV(FFS)	Scorpio	5400	SATA II	2.5	8M
RT, RW(FFS)	Scorpio	5400	SATA II	2.5	16M
Tornado					
TA, TP(3D)	WD AV	7200	SATA II	3.5	2M
TB, TR(3D)	WD AV	7200	SATA II	3.5	8M

Unauthorized copy of distribution
of these documents is prohibited

TC, TS(3D)	WD AV	7200	SATA II	3.5	16M
TH(3D)	Caviar	7200	SATA II	3.5	2M
TJ(3D)	WD RE	7200	SATA II	3.5	2M
TK(3D)	WD Caviar SE	7200	SATA II	3.5	8M
TL(3D)	WD RE	7200	SATA II	3.5	8M
TM(3D)	WD Caviar SE16	7200	SATA II	3.5	16M
TN(3D)	WD RE	7200	SATA II	3.5	16M
RY	WD Caviar SE	7200	SATA II	3.5	8M
RZ	WD RE	7200	SATA II	3.5	8M
SB	WD Caviar SE16	7200	SATA II	3.5	16M
SC	WD RE	7200	SATA II	3.5	16M
SD	Caviar	7200	SATA II	3.5	2M
SE	WD RE	7200	SATA II	3.5	2M
Tornado PATA					
TV, UF(3D)	Caviar	7200	PATA	3.5	2M
TW, UG(3D)	WD RE	7200	PATA	3.5	2M
TY	WD Caviar SE	7200	PATA	3.5	8M
TZ, UJ(3D)	WD RE	7200	PATA	3.5	8M
UA, UK(3D)	WD Caviar SE16	7200	PATA	3.5	16M
UB, UL(3D)	WD RE	7200	PATA	3.5	16M
UC, UM(3D)	WD AV	7200	PATA	3.5	2M
UD, UN(3D)	WD AV	7200	PATA	3.5	8M
UE, UP(3D)	WD AV	7200	PATA	3.5	16M
UH(3D)	Caviar	7200	PATA	3.5	8M
Hawk-2					
SG, TG	Caviar	7200	SATA II	3.5	8M
SH	Caviar	7200	SATA II	3.5	16M
McKinley					
SN(FFS), UR	Scorpio	5400	SATA II	2.5	2M
SP(FFS), US	Scorpio	5400	SATA II	2.5	8M
SR(FFS), UT	Scorpio	5400	SATA II	2.5	16M
Lynx					
UW	Scorpio	5400	PATA	2.5	2M
UY	Scorpio	5400	PATA	2.5	8M
Yosemite / STG Twin Lakes					
VK	WD RE	7200	SATA II	3.5	16M
VL	WD RE	7200	SATA II	3.5	8M
VM	WD RE	7200	SATA II	3.5	2M
VN	WD AV	7200	SATA II	3.5	16M
VP	WD AV	7200	SATA II	3.5	8M
VR	WD AV	7200	SATA II	3.5	2M
VS	WD Caviar SE16	7200	SATA II	3.5	16M
VT	WD Caviar SE	7200	SATA II	3.5	8M
VU	WD Caviar	7200	SATA II	3.5	2M
Tornado 2D					
VV	WD Caviar	7200	SATA II	3.5	2M

Unauthorized copy of distribution
of these documents is prohibited

VW	WD Caviar SE	7200	SATA II	3.5	8M
VY	WD Caviar SE16	7200	SATA II	3.5	16M
WC	WD AV	7200	SATA II	3.5	2M
WD	WD AV	7200	SATA II	3.5	8M
WE	WD AV	7200	SATA II	3.5	16M
B9	WD RE2	7200	SATA II	3.5	16M
C9	WD Caviar SE16	7200	SATA II	3.5	16M
Tornado 2PMR					
WF	WD Caviar	7200	PATA	3.5	2M
WG	WD Caviar SE	7200	PATA	3.5	8M
WH	WD Caviar SE16	7200	PATA	3.5	16M
WJ	WD AV	7200	PATA	3.5	2M
WK	WD AV	7200	PATA	3.5	8M
WL	WD AV	7200	PATA	3.5	16M
Cougar					
WY	WD Scorpio	5400	PATA	2.5	2M
WZ	WD Scorpio	5400	PATA	2.5	8M
Tornado 3D PMR/ Tornado 2R					
YE	WD Caviar	7200	SATA II	3.5	2M
YF	WD Caviar SE	7200	SATA II	3.5	8M
YG	WD Caviar SE16	7200	SATA II	3.5	16M
YH	WD AV	7200	SATA II	3.5	2M
YJ	WD AV	7200	SATA II	3.5	8M
YK	WD AV	7200	SATA II	3.5	16M
YL	WD RE2	7200	SATA II	3.5	2M
YM	WD RE2	7200	SATA II	3.5	8M
YN	WD RE2	7200	SATA II	3.5	16M
YP	WD Caviar	7200	PATA	3.5	2M
YR	WD Caviar SE	7200	PATA	3.5	8M
YS	WD Caviar SE16	7200	PATA	3.5	16M
YT	WD AV	7200	PATA	3.5	2M
YU	WD AV	7200	PATA	3.5	8M
YV	WD AV	7200	PATA	3.5	16M
YW	WD RE2	7200	PATA	3.5	2M
YY	WD RE2	7200	PATA	3.5	8M
YZ	WD RE2	7200	PATA	3.5	16M
C8	WD Caviar SE16	7200	SATA II	3.5	16M
Spider					
ZS	WD Caviar GP	5400	SATA II	3.5	2M
ZT	WD Caviar GP	5400	SATA II	3.5	8M
ZU	WD Caviar GP	5400	SATA II	3.5	16M
ZV	WD AV-GP	5400	SATA II	3.5	2M
ZW	WD AV-GP	5400	SATA II	3.5	8M
ZY	WD AV-GP	5400	SATA II	3.5	16M
ZZ	WD RE2-GP	5400	SATA II	3.5	16M
D0	WD Caviar GP	5400	SATA II	3.5	16M
Mars					

Unauthorized copy of distribution
of these documents is prohibited

A0	WD Caviar SE	7200	SATA II	3.5	8M
A1	WD AV	7200	SATA II	3.5	8M
A2	WD Caviar SE16	7200	SATA II	3.5	16M
A3	WD AV	7200	SATA II	3.5	16M
A4	WD Caviar SE32	7200	SATA II	3.5	32M
A5	WD AV	7200	SATA II	3.5	32M
A6	WD AV	7200	SATA II	3.5	32M
D4	WD RE3	7200	SATA II	3.5	16M
E8	WD Caviar Black	7200	SATA II	3.5	32M
E9	WD Caviar SE16	7200	SATA II	3.5	16M
F5	WD Caviar SE16	7200	SATA II	3.5	16M
F6	WD Caviar SE32	7200	SATA II	3.5	32M
F7	WD AV	7200	SATA II	3.5	32M
J7, J8	WD Caviar Black	7200	SATA II	3.5	32M
K1	WD Caviar Black	7200	SATA II	3.5	32M
Atlantis					
D2	WD Caviar SE16	7200	SATA II	3.5	16M
E7	WD Caviar SE32	7200	SATA II	3.5	32M
A7	WD Caviar SE16	7200	SATA II	3.5	16M
A8	WD Caviar SE	7200	SATA II	3.5	8M
A9	WD AV	7200	SATA II	3.5	16M
B0	WD AV	7200	SATA II	3.5	8M
B1	WD RE3	7200	SATA II	3.5	16M
B2	WD RE2	7200	SATA II	3.5	8M
C3	WD RE3	7200	SATA II	3.5	32M
C2	WD AV	7200	SATA II	3.5	32M
C1	WD Caviar SE32	7200	SATA II	3.5	32M
Pinnacle					
B3	WD Caviar SE16	7200	SATA II	3.5	16M
B4	WD Caviar SE	7200	SATA II	3.5	8M
B5	WD AV	7200	SATA II	3.5	16M
B6	WD AV	7200	SATA II	3.5	8M
B7	WD RE3	7200	SATA II	3.5	16M
E2	WD Caviar SE32	7200	SATA II	3.5	32M
F0	WD Caviar SE16	7200	SATA II	3.5	16M
F1	WD Caviar SE32	7200	SATA II	3.5	32M
F2	WD RE3	7200	SATA II	3.5	32M
H4	WD Caviar	7200	SATA II	3.5	2M
Hulk					
ZJ	WD Caviar GP	5400	SATA II	3.5	16M
ZK	WD RE2-GP	5400	SATA II	3.5	16M
C7	WD Caviar GP	5400	SATA II	3.5	16M
ZP	WD Caviar GP	5400	SATA II	3.5	8M
ZR	WD AV-GP	5400	SATA II	3.5	8M
ZL	WD AV-GP	5400	SATA II	3.5	16M
Kermit					
D6	WD Caviar GP	5400	SATA II	3.5	16M

Unauthorized copy of distribution
of these documents is prohibited

D7	WD Caviar GP	5400	SATA II	3.5	8M
E0	WD AV-GP	5400	SATA II	3.5	16M
E1	WD AV-GP	5400	SATA II	3.5	8M
Denali					
VB, VE, ZD	WD Scorpio	5400	SATA II	2.5	16M
UZ, VC	WD Scorpio	5400	SATA II	2.5	2M
VA, VD, ZC	WD Scorpio	5400	SATA II	2.5	8M
Saturn					
F3, F4	WD Scorpio Black	7200	SATA II	3.5	16M
Mercury					
ZA	WD Scorpio Blue	5400	SATA II		8M
ZB	WD Scorpio Blue	5400	SATA II		16M
Sequoia PMR					
VZ	WD Caviar	7200	SATA II	3.5	8M
WA	WD Caviar SE	7200	SATA II	3.5	8M
WB	WD Caviar SE16	7200	SATA II	3.5	16M
WM	WD AV	7200	SATA II	3.5	2M
WN	WD AV	7200	SATA II	3.5	8M
WP	WD Caviar	7200	PATA	3.5	2M
WR	WD Caviar SE	7200	PATA	3.5	8M
WS	WD AV	7200	PATA	3.5	2M
WT	WD AV	7200	PATA	3.5	8M
C0	WD RE2	7200	SATA II	3.5	16M
D1	WD Caviar SE	7200	SATA II	3.5	8M
Cypress					
G0, G1	WD Caviar SE	7200	SATA II	3.5	8M
G2	WD AV	7200	SATA II	3.5	8M
G3, G4	WD Caviar SE16	7200	SATA II	3.5	16M
K0, J9	WD Caviar	7200	SATA II	3.5	2M
Gekko					
G8	WD Caviar GP	5400	SATA II	3.5	16M
G9	WD Caviar GP	5400	SATA II	3.5	8M
H0	WD AV	5400	SATA II	3.5	8M
H1	WD AV	5400	SATA II	3.5	16M
Pinnacle PATA					
J2	WD Caviar SE16	7200	PATA	3.5	16M
J3	WD Caviar SE	7200	PATA	3.5	8M
J4	WD Caviar	7200	PATA	3.5	2M
J5	WD AV	7200	PATA	3.5	8M
Atlantis PATA					
H8	WD Caviar SE16	7200	PATA	3.5	16M
H9	WD Caviar SE	7200	PATA	3.5	8M
J0	WD AV	7200	PATA	3.5	16M
J1	WD AV	7200	PATA	3.5	8M

Unauthorized copy of distribution
of these documents is prohibited

2. Drive start

To read and write data, a HDD has to pass successfully the startup procedure that consists of several initialization stages (the subdivision is conventional, based on data recovery experience of the utility developers):

- Microcode loading from ROM to the electronic board RAM and its subsequent execution.
- Polling of connected magnetic heads.
- Spindle motor start and spin-up to the nominal rotational speed.
- System head positioning over the service area.
- Loading of additional microcode (ID=1xh overlays) from the service area.
- Calibration of all connected magnetic heads.
- Translator initialization.

Connect the HDD to PC-3000and switch on power supply to the HDD. At HDD power-up its initialization program starts automatically. Once a drive passes the above stages successfully, it reaches readiness and returns correct identification information (model name, capacity and serial number). Such startup procedure is considered normal; it means that all heads are functional and there are no seriously damaged surface areas. To access drive data, you have to run the WDC Marvell utility, then - Data Extractor. The data recovery task should be created with the enabled option for automatic copying to image[1]. After the task is started, it is recommended to use the «Service» → «Build heads map» menu to map the HDD heads. As soon as the heads map is created, you can determine the head corresponding to the majority of BAD sectors. You may also initiate copying using specified heads.

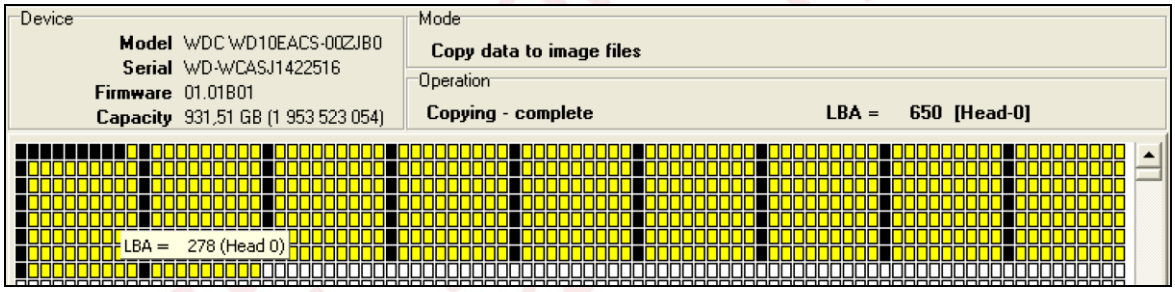


Fig. 2.1.

Now let us discuss the problems which may occur during drive startup and cause inaccessibility of user data.

Drives belonging to various families behave differently when powered on. Before you begin diagnostics, it is advisable to read the classification of Marvell WDC drives and learn their distribution between groups of families.

- Green colour in the figure below marks the drive families using classic format of module headers. We'll refer to them as MWD-CHS. MWD-CHS drive families use external boot ROM (see *Fig. 2.3*).
- Blue colour marks the drive families that use a new module header beginning with the «ROYL» signature but addressing the service area by PCHS coordinates. We'll refer to them as MWD-ROYL-CHS.

The families are not marked in green and blue colour marks the drive families that use a new module header beginning with the «ROYL» signature and addressing the service area by ABA coordinates. We'll refer to them as MWD-ROYL-ABA. In newer MWD-ROYL-ABA families it is built into the processor (though rare exceptions may be encountered), *see Figure 2.4.*

Boot-up code has its own version, which is always different from the firmware version returned in the identification data (HDD ID). E.g., version 05.04E05 may be returned in the HDD ID while the boot code version is 000500BH.

[1] – The copy may be created as image file (slower method) or as a sector-by-sector copy to another drive connected to standard system adapter (faster method).

Unauthorized copy of distribution
of these documents is prohibited

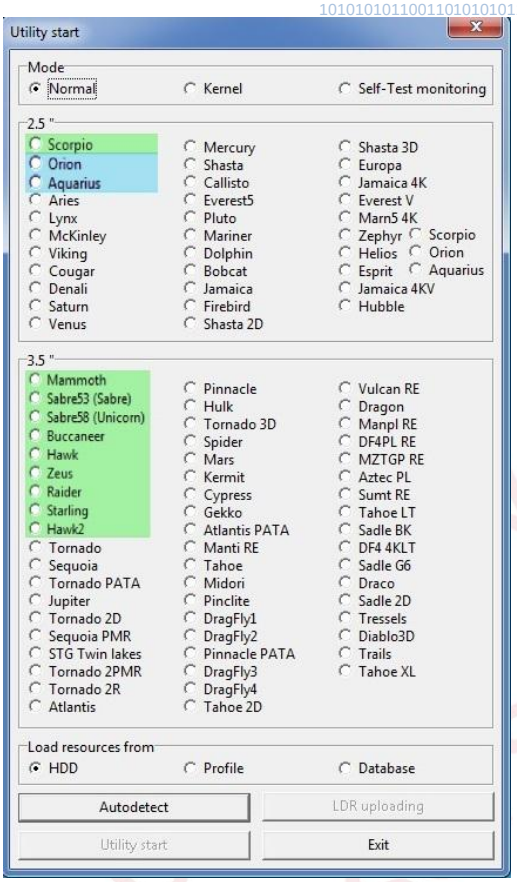


Fig. 2.2.

Fig. 2.3.

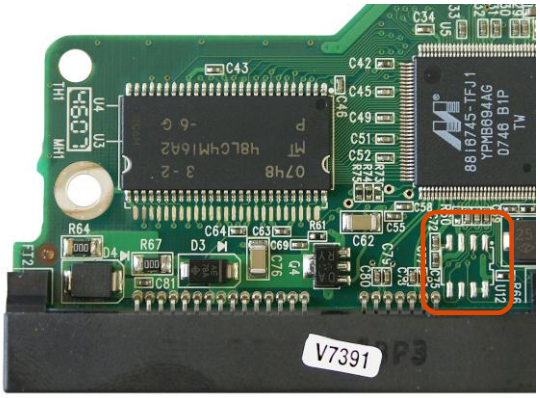


Fig. 2.4.

Typical problems with Western Digital drives:

- Spindle motor does not start up.
- Original ROM is missing.
- Audible heads knocking at drive start.
- Incorrect HDD identification.
- Correct identification followed by an ABRT error at an attempt to read any sector.
- Indicators do not display the ready status.

Of course, these situations do not cover all possible problems, but they allow diagnostics and repair of most.

Warning! If HDD firmware has been deliberately altered (modules critical for operation have been overwritten with their counterparts from another HDD), there is no way to describe the entire variety of potential problems. In this description we assume that the drive in question started malfunctioning without additional intervention.

2.1. Spindle motor does not start up

Spindle motor start is audible and so it can be easily detected. If the spindle motor does not start, the situation can be caused by:

- Electronics board (PCB) malfunction
- Problem with the spindle motor coils
- Heads stuck in the HDD working area (in 2.5” HDD)
- Spindle motor seizure.

2.1.1. Electronics board malfunction

The simplest method for testing of the electronics board is its installation on a known good HDA belonging to a drive of the same family. A reverse check is also possible; in that case you will have to install a known good board on the HDA of the drive being repaired. Such swap is only possible provided that firmware versions and the heads maps are identical. If you do not have a compatible board, you can record the ROM contents of the HDD being restored to a board using a different version but belonging to the same drive family having saved its original ROM first.

Quite often drives suffer from a problem with the contact in the MHA connector. To fix the potential problem, use a rubber to clean the connector (*Figure 2.5*). Board malfunctions may also be manifested as problems with reading/writing of service area or user data area (e.g., the end of user data area may be readable for all heads while its beginning may not).

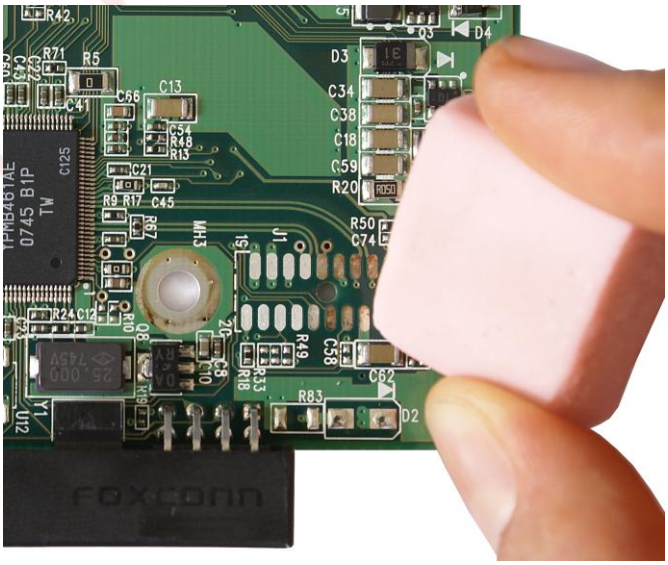


Fig. 2.5. Cleaning the MHA connector contacts.

Unauthorized copy of distribution
of these documents is prohibited

Board damage may prevent it from reaching readiness. In that case you may use the Kernel (Safe) mode jumpers. Kernel (Safe) mode can be enabled for 3.5" IDE (PATA) WD Caviar & Marvell HDD by setting three jumpers at the same time: CS, SLAVE, and MASTER (*Figure 2.6*). The spindle motor in that case does not spin up and the drive switches to a special mode (PSV Mode), which allows ROM reading/writing, editing of the heads map and other operations.

Fig. 2.6.

For 3.5" SATA WD HDD you will also have to set three jumpers, but their positions will be different: PM2, OPT1, and OPT2 (*Figure 2.7*). For WD Marvell-ROYL HDD the same three jumpers must be set, though one of them is named differently: PM2, OPT1, and FW.

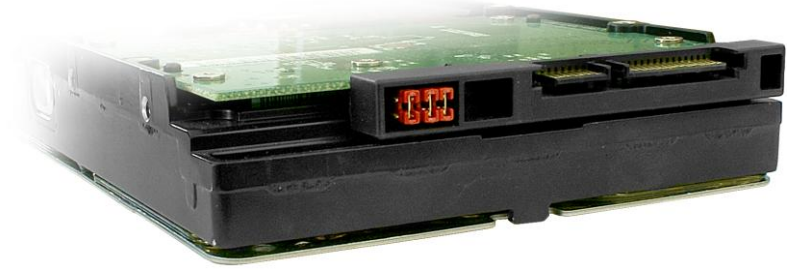


Fig. 2.7.

To enable Kernel (Safe) mode for 2.5" WD HDD, you have to set the jumpers on the PC-2" adapter (*Figure 2.8*).

Fig. 2.8.

There is also a universal method: place a strip of dense paper under the MHA connector so that the contacts are insulated but the spindle motor is connected (jumpers in that case can be left off). Then switch on the power supply for the drive. The HDD will enter Kernel mode in 1-2 minutes.

After the Kernel mode is enabled, the drive reaches a certain readiness state; the virtual indicators in that case are off. The utility does not read HDD ID immediately at its launch (*Figure 2.9*). To do that, you have to click «Yes». After that select the Kernel mode in the startup dialog and click the «Autodetect» button.

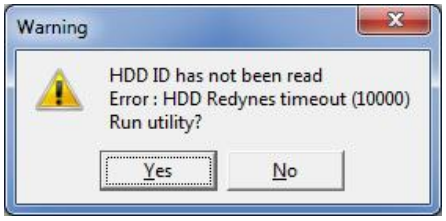


Fig. 2.9.

Warning! If you click «Autodetect» while the switch is left in the Normal mode, the automatic detection functionality will not work and an error message will be displayed.

If a malfunctioning board does not reach readiness in Kernel mode as well, the ROM chip should be resoldered to a normal board. For MWD-ROYL-ABA the procedure is impossible since the ROM is inside the processor; consequently, such boards cannot be repaired.

2.1.2. Problem with the spindle motor coils

To check the spindle motor, remove the board and measure the winding resistance in the points shown in the figures below *(Fig. 2.2 for 3.5" drives, Fig. 2.3 for 2.5" drives).*

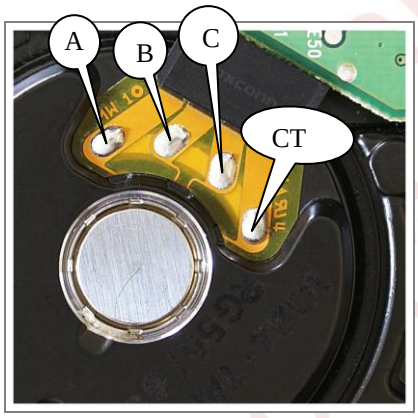


Fig. 2.2. Winding resistance measurement points for 3.5" HDD.

Resistance between the CT and A, B, C points must be 0.90 Ohm. Resistance between A and B, B and C, A and C must be 1.70 Ohm. Typically the problem appears when overheating causes winding disruption and its resistance becomes close to 0. Very high resistance means that the winding is broken.

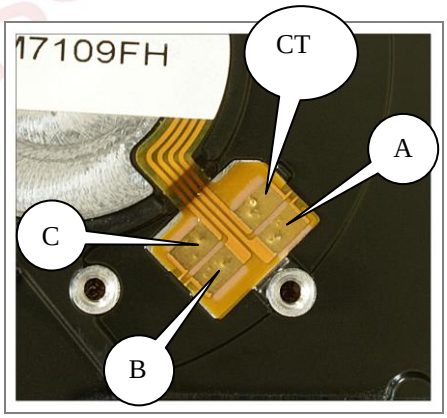


Fig. 2.3. Winding resistance measurement points for 2.5" HDD.

Resistance between the CT and A, B, C points must be 1.97 Ohm. Resistance between **A** and B, B and C, A and C must be 3.62 Ohm. Typically the problem appears when overheating causes winding disruption and its resistance becomes close to 0. Very high resistance means that the winding is broken.

2.1.3. Heads stuck in the drive working area

The problem typically occurs in 2.5" drives if a portable computer where they are installed falls (theoretically, heads may stick in 3.5" drives as well but in reality such cases are extremely rare since the spindle motor in those models is powerful enough to shift the heads from the position where they are stuck). To return the heads back to the parking rack, the drive has to be disassembled. Sometimes damaged (indented) HDA cover blocks the motion of the magnetic heads stack.

For official users only

2.1.4. Spindle motor bearing seizure

The problem can only be resolved by swapping the platter stack from a malfunctioning motor to a normal one. It is essential to preserve in such cases the orientation of magnetic disks relatively to each other with high precision. If magnetic disks are shifted or turned the firmware algorithm switching the magnetic heads will function incorrectly, and the HDD will begin knocking at an attempt to start.

2.2. Original ROM is missing

Such situation can be caused by a malfunctioning or damaged electronics board. Installing another board from the same drive family is insufficient to solve the problem. Correct drive start requires matching versions of firmware in drive ROM and overlays within the service data in its HDA, heads map and adaptive settings in ROM module ID=47h for all heads. Let use examine the ROM restoration algorithm further.

2.2.1. Step 1. Install a compatible board

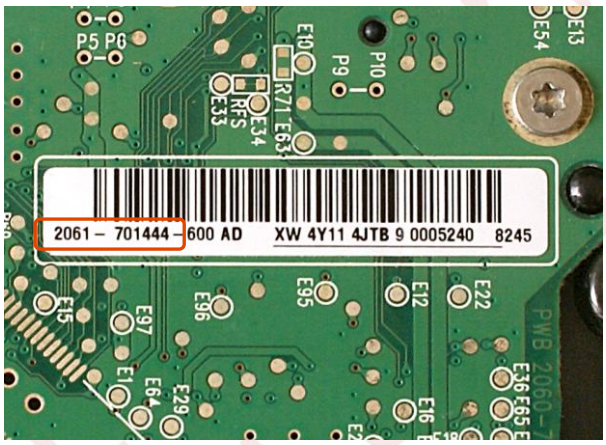


Fig. 2.4.

To restore the original ROM content, you have to install a functional board belonging to the same drive family. You can use the number on PCB label to make sure the right board is selected *(Fig. 2.4)*. Once a compatible board is installed, power is switched on and the utility is started, there are 4 possible variants of HDD behaviour.

Variant 1

The drive gets identified incorrectly returning its factory alias or «empty» HDD ID *(Fig. 2.5);* however, it does not stop the motor and after utility start allows to read the DIR module (ID = 01), as the start-up log indicates: «SA dir reading.....: Ok». In that case you may proceed to Step 2.

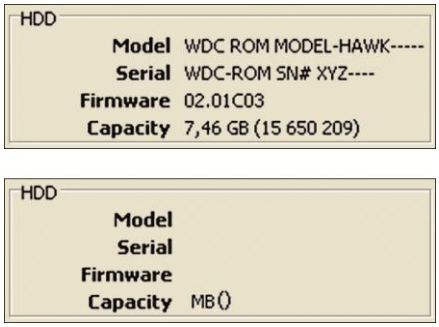


Fig. 2.5. Variations of WDC Marvell HDD identification in case of power-on initialization problems.

Variant 2

The drive gets identified incorrectly *(Fig. 2.5)*, it does not stop the motor and after utility start does not allow to read the DIR module (ID = 01), as the start-up log indicates: «SA dir reading : Unknown error. Code(0)». The

problem can be caused by a mismatch between adaptive data that is too large, or firmware incompatibility with the heads controller chip in the HDA[1]. Recording another ROM may help in such case. After recording start the drive again and monitor its behaviour. Continue the selection process until the drive starts acting as described in the variant 1 or 4.

Variant 3

The drive gets identified incorrectly *(Fig. 2.5)* stopping the motor at that. Such behaviour can be caused by a mismatch between the heads map defined in ROM module ID=0Ah and the actual configuration. E.g., it is possible if there is a HDD with one physical head 0 while the installed board is set up for one physical head which is configured, however, under number 1. Drive start then will demonstrate behaviour variant 3. In that case you may try editing the heads map in ROM having started the utility in Kernel mode.

Another reason causing such behaviour can be in a damaged preamplifier chip of the heads stack[2]. You can identify chip damage by two attempts to start the spindle motor (two slight audible clicks occur). For comparison: if magnetic heads are stuck to the surface or spindle motor seizure occurs (e.g., in 2.5" HDD upper rim of the spindle motor can be bent by an indented HDA cover) the firmware performs 5 attempts to start. Replacement of the magnetic heads assembly is necessary to solve the problem.

Variant 4

Sometimes (quite rarely) a drive may start without obvious problems and provide access to user data. Such behaviour is explained by a match between the firmware versions, adaptive settings close to the original configuration and all magnetic heads being functional and corresponding to the original map. In that case you may proceed to step 2 to restore the original ROM.

2.2.2. Step 2. Read modules

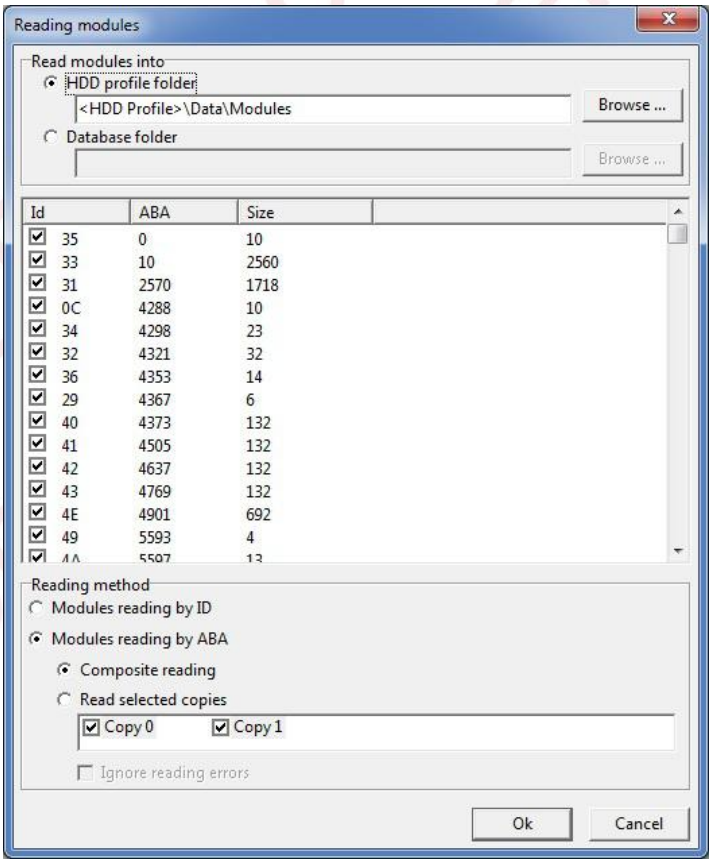


Fig. 2.6 Modules reading by ID.

[1] – Please note that incompatibility cases are very rare (practically encountered in the McKinley family only).

[2] – Quite often, damaged board electronics is combined with damaged electronic parts inside the HDA: heads controller chip, spindle motor coils, voice coil, etc.

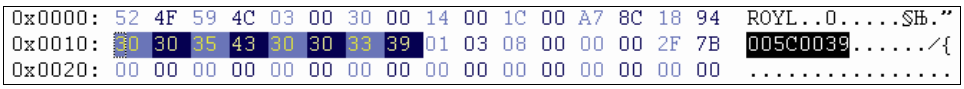
Unauthorized copy of distribution
of these documents is prohibited

To restore ROM, you have to read the following modules from the service area:

- ID=0109h (ROM image). It contains several modules (for example, the heads map with the default settings or firmware version module) but includes no adaptive settings module.
- ID=0102h (module containing the actual factory-defined heads map).
- ID=0103h (a copy of adaptive settings from module ID=047h).
- ID=0105h (a copy of the service area translator from ROM - module ID=030h).
- ID=0107h (a copy of module ID=00Bh that defines the map of modules present in ROM and the placement of service area copies).

You can initiate reading of the modules from the menu «Tests» → «Service information» → «Work with service area» → «Reading modules» (enable the option «Modules reading by ID» *(Fig. 2.6)*.

If the modules have been read successfully, proceed to Step 2. Assembly of a functional ROM will be impossible if reading of any module fails. You can try picking a ROM from another HDD or «compensate» for the missing modules using the guidelines below and proceed to Step 3.

Module	«Compensation» method
ID=0109h	Missing ID=0109h module can be compensated with the same module from another HDD using the same firmware version. You can check the version in the header of a suitable overlay (ID = llh, 12h, 14h, 15h, 17h, 19h, 21h, 29h). E.g., the figure below demonstrates the header of the ID=14h overlay, version number is 005C0039. Use the found firmware with the matching version to copy from it the missing module ID=0109h and proceed to Step 3.  *Fig. 2.7.*
ID=0102h	Missing ID=0102h module can be compensated with the same module from another HDD using the same map of real (physical) heads.
ID=0103h	Missing iD=0103h cannot be compensated entirely because of the unique data it contains. However, you can borrow the module ID=0103h from another drive of the same family using the same number of magnetic heads. After the ROM restoration procedure you may try selecting the proper ID=47h module if the readability of the user data area remains poor.
ID=0105h	Typically, a missing module can be replaced with one copied from any set of modules belonging to a HDD of the same drive family. That peculiarity follows from the fact that the service area very rarely contains hidden defects in locations critical for drive start.
ID=0107h	A missing module can be replaced with one copied from any set of modules belonging to a HDD of the same drive family.

2.2.3. Step 3. Rebuild ROM

To assemble the modules, use the «ROM build from SA data» menu item («Tests» → «Service information» → «Work with ROM» → «ROM build from SA data»). The utility will display an offer to select a profile or database. Choose the location where the modules required for rebuilding have been copied during Step 2. Assembled result will be stored in the «ROM - Build» *(Fig. 2.8)* subdirectory of the profile; it can be recorded to ROM immediately without proceeding to Step 4 (but that operation is only available in Kernel mode of the utility).

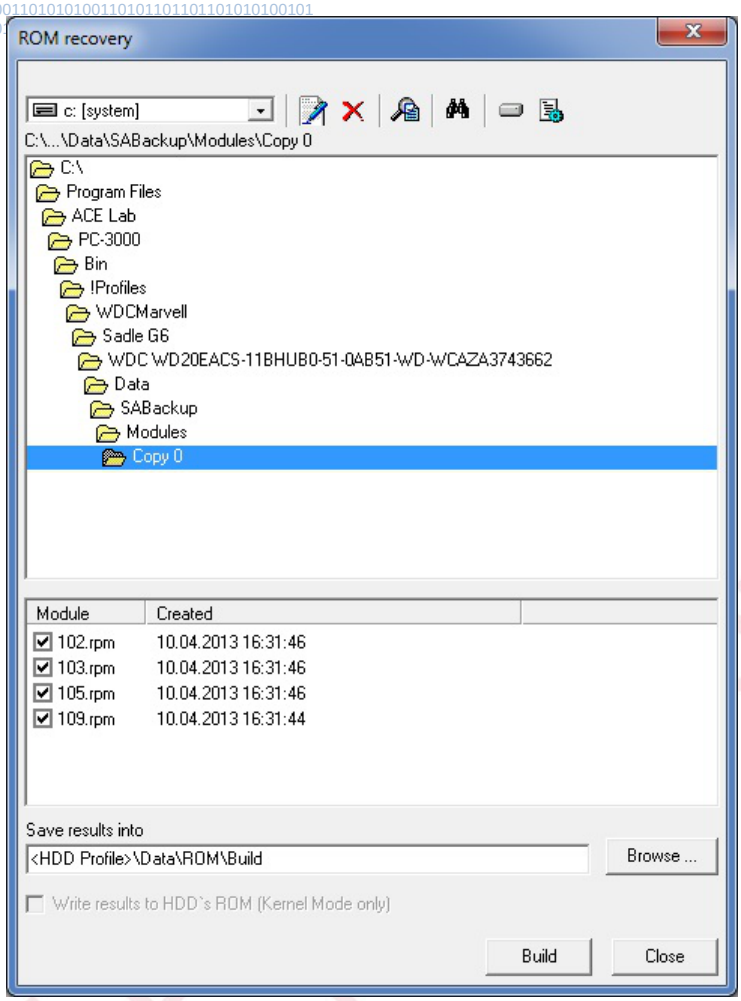


Fig. 2.8.

2.2.4. Step 4. Record assembled ROM and its modules

Recording should be performed in 2 stages: first write the ROM, then record the ROM modules while the HDD is still powered-on. To record the data, you have to perform the «Write ROM» and «Write ROM modules» operations respectively (in the «Tests» → «Service information» → «Work with ROM» menu).

2.3. Audible heads knocking at drive start

Similarly to problems with the spindle motor start, you should check the PCB first of all. If it is functional, then drive magnetic head(s) are damaged or the heads controller chip is malfunctioning. In that case you can use the PC-3000 Marvell WDC utility to perform the following operations:

- Diagnostics using the ROM Head map changing feature.
- RAM head map editing.
- HOT SWAP procedure.

Attention! Normal mode is useless for diagnostics of knocking drives (because after critical errors firmware blocks all operations with the service area and stops the motor); therefore only the Kernel mode is used. No jumper settings are necessary to use the Kernel mode.

Unauthorized copy of distribution
of these documents is prohibited

2.3.1. Diagnostics using the ROM Head map changing feature

You can use the feature for software disabling/enabling of magnetic heads in a drive to test the functionality of each individual head. That method does not allow access to the user data because sector format includes the appropriate number of a logical head corresponding to each sector. The method is available both in Kernel and in Normal utility modes, but using it in the Kernel mode is specifically recommended. After its selection the utility reads ROM and displays on-screen form, which you can use to edit the heads map.

Caution! Make a backup copy of ROM content and ROM modules prior to editing the map.

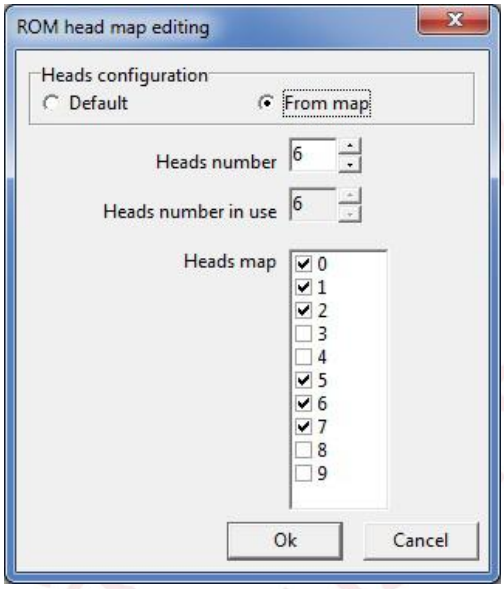


Fig. 2.9.

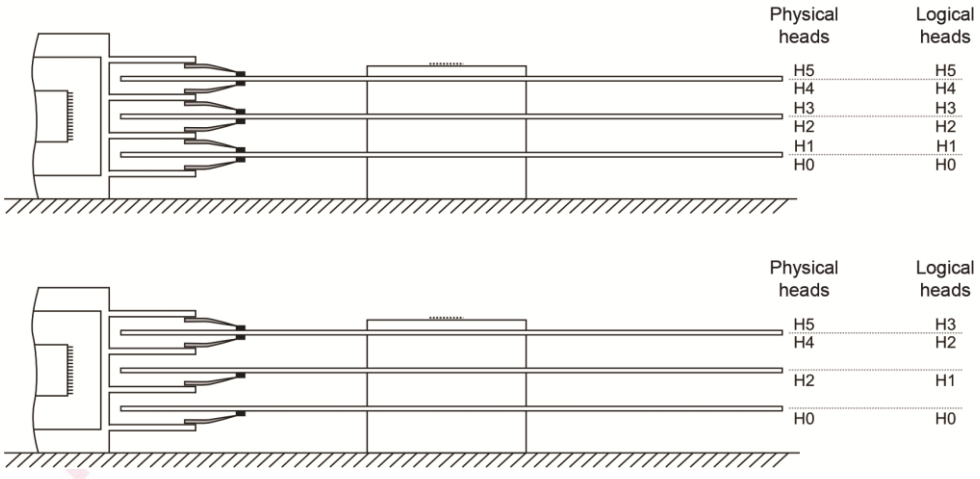


Fig. 2.10. Physical and logical heads numbering.

«Heads configuration» switch determines the heads map source. When the setting «From map» is selected, the utility reads the numbers of physical heads from the bit map byte in ROM (located in module ID=0Ah), while the «Default» parameter makes the utility identify the active physical heads by actual presence of connected heads. Please note, that the «Default» mode does not allow reading the map produced after the polling of existing heads (generally, you can view the generated map in RAM, but in this case the feature searching RAM for the map will find nothing).

2.3.1.1. Diagnostics of a knocking head

If a drive produces knocking sounds at the start, it may be useful to identify the head causing that sound (you may discover that any of the heads causes knocking, when enabled).

Diagnostics procedure:

1) Set the Safe mode jumpers (see section *2.1. Spindle motor does not start up)* and start the utility in Kernel mode.

2) Leave just one head enabled in the map and click «OK».

3) Switch the power off and remove the Safe mode jumpers.

4) Switch on the HDD power supply. If the drive continues knocking, register the current head as a malfunctioning one and repeat the procedure from step 1). If the drive does not knock and the enabled head can access the service area (logical heads 0 and 1), start the utility in Normal mode. Back up the data from the service area using the
«Reading modules» feature of the utility (menu «Tests» → «Service information» → «Work with service area» «Reading modules» (enable the option «Modules reading by ID»). Register such head as a normal one.

2.3.2. RAM head map editing

The method can be used to «trick» the drive calibration procedure through substitution of a normal head instead of a malfunctioning one (consequently, it works with drives using two or more heads). The feature is available both in Kernel and Normal modes (but using it in Kernel mode is recommended) from the «Service information» menu → «Work with ROM» → «RAM head map editing». Let us illustrate its use with some examples.

2.3.2.1. Examples of RAM head map editing

Example 1. HDD of the Zeus drive family

After power-on the HDD starts the spindle motor, produces 3 loud clicks with the heads stack and stops the motor. Status registers display an error *(Fig. 2.11).*

Fig. 2.11.

Launch the utility. It will return an entirely «empty» HDD ID *(Fig. 2.12).*

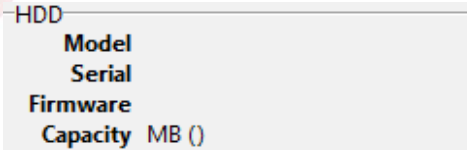


Fig. 2.12.

Perform «Autodetect» and enter the utility in Kernel mode. Select the «RAM head map editing» command. The corresponding dialog will appear *(Fig. 2.13).*

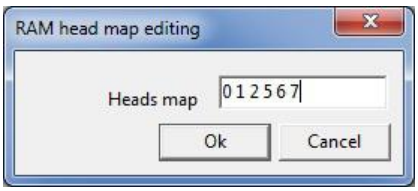


Fig. 2.13.

Unauthorized copy of distribution
of these documents is prohibited

Since you cannot know for sure, which physical head prevents the drive from starting (the map contains numbers of physical heads), try replacing all heads with the zero one *(Fig. 2.14).*

Fig. 2.14.

After the map is corrected, use the «Software Reset» command (the menu «Tools» → «HDD» → «Software Reset»). HDD will start the spindle motor and perform the initialization procedure using physical head 0 only. If it is functional, the drive will initialize successfully and return its correct HDD ID (you can check that by running the «Tools» → «HDD ID» command). If the head is malfunctioning, try changing all heads to number 1. Then again invoke «RAM head map editing» (without exiting the utility), define the original map and send a software reset signal. Now the drive is ready for data recovery.

Start «Data Extractor» and build the heads map («Service» menu → «Build heads map»). Once the heads map is created, you can recover the data using functional heads.

Example 2. HDD of the HULK drive family

A drive after power-on knocks for a long while and then reaches readiness having stopped the spindle motor. In that case you should perform diagnostics using modification of the heads map in ROM (see section *2.3.1. Diagnostics using the ROM Head map changing feature).* Let us assume that diagnostics has demonstrated that head 0 causes knocking while the remaining heads are functional. Then you have read all service area modules using head 1. You can check the integrity of the modules using the «Hardware modules checking» feature («Tests» menu → «Service information» → «Work with service area» → «Hardware modules checking»). Procedure:

1) Connect the drive with the original ROM where the map contains all heads.

2) At power-up the HDD spins up the spindle motor and stops it after a while.

3) Launch the utility. Switch the utility mode to Kernel, click the «Autodetect» button and perform «Utility start».

4) Select the «RAM head map editing» command («Tests» menu → «Service information» → «Work with ROM» → «RAM head map editing»).

5) Fill in the map as «1 1 2 3 4 5 6 7» *(Fig. 2.15):*

Fig. 2.15.

6) Use the «Software Reset» command («Tools» menu → «HDD» → «Software Reset»).

7) Read again HDD ID to check that the drive has been identified correctly. Start «Data Extractor» and build the heads map («Service» menu → «Build heads map»).

8) Once the heads map is created, you can recover the data using functional heads.

2.3.3. HOT SWAP procedure

The HOT SWAP procedure is necessary to restore logical access (i.e. an opportunity to read data using Data Extractor) in cases, when a head is malfunctioning (calibration procedure cannot finish because a drive is knocking and fails to initialize completely all the items it needs to operate via logical access), or when service area restoration is not possible (no opportunity to record modules).

For WDC Marvell the differences between two HDD belonging to the same family are as follows:

- ***Heads map***. Mismatch of the maps of drive heads stops initialization after a HDD powered on. When the power is switched on, the firmware attempts drive start and then stops the motor. Registers display the drive status *(e.g., Fig. 2.11)*. The same situation occurs when the service area has more associated heads than the heads map in ROM. You can avoid such situation if the heads maps are matching or if the donor drive certainly has more heads than the one being restored.
- ***Version of ROM and lxh overlays***, overlay 11 first of all. In that case a drive cannot start its firmware, then it will return either its factory alias or «empty» HDD ID *(Fig. 2.5)*.
- ***Adaptive settings in ROM module ID=47h***. In that case a HDD is also identified by its factory alias or «empty» HDD ID *(Fig. 2.5)*.
- ***Adaptive settings in the service area***, modules ID=4xh. When these modules do not match, a drive starts but does not allow reading of the user data area (no logical access).
- ***Zone allocation table***. Mismatching zone allocation table does not prevent a drive from starting, but the HDD will have no access to the user data area.
- ***Translator***. Translator mismatch prevents reading of the user data area.

Conclusion: successful «HOT SWAP» operation requires a donor drive with the same heads map as in the HDD being restored (or a larger one), compatible adaptive settings (which must allow reading both of the donor and the patient HDA) and the set of service area overlays. Compliance with these three conditions allows starting both a donor and a patient drive using the same board. To enable logical operation, you have to write to the donor drive the zone allocation table, adaptive settings stored in the service area modules and translator modules.

Attention! No jumper settings are necessary to start the utility in Kernel mode. WDC Marvell drives enter the Kernel mode automatically after a while (or immediately), having performed first initialization of the ROM modules (heads map, adaptive data, service area translator).

2.3.3.1. HOT SWAP procedure

Step 1. Copying modules from the patient's ROM and service area

First, you have to obtain a copy of the modules from the ROM and service area of the drive being restored (patient). If modules are accessible without problems, proceed to step 2. Reading modules (or, at least, tracks) from the patient is mandatory because otherwise no access to user data will be possible. Selecting suitable critical modules from another drive does not seem practically feasible. If copying the original service area data fails, the «HOT SWAP» procedure for restoration of access to user data will be impossible.

Methods for accessing the modules:

- Perform diagnostics using the ROM Head map changing feature (see section *2.3.1 Diagnostics using the ROM Head map changing feature)*, then read the modules.
- Save ROM image and ROM modules in Kernel mode. Then overwrite ROM with a copy from a drive using another version, restart the drive in Kernel mode and write again native ROM module ID=47h of the HDD being restored. As a result, version mismatch will occur and the drive will not complete the calibration procedure, but adaptive settings will be correct. Now you can read the service area using the «Read by ID» feature.

ACE Laboratory
for official users only

- Perform «HOT SWAP» without additional preparations (because at this stage you have just the patient's ROM) hoping to read successfully the service area tracks (modules will be unreadable altogether or many of them will be read incorrectly[1]). Use the «Reading service tracks» command («Tests» → «Service information» → «Work with service area» → «Reading service tracks»).

The method should only be used if the first two ways produce no result. It is less advisable because during work with tracks you have practically no way to control the integrity of modules; therefore it will be difficult to reveal after their recording to donor drive the real cause of problems with its start and proper identification.

Donor selection guidelines for heads replacement

Comparison of the MicroJog value can be employed for the heads replacement as well. During replacement you may either use an unchanged module ID=47h from the donor HDD, or generate a module containing average values for further use.

Step 2. Identification of the difference in the MicroJog[2] parameter in module ID=47h between the patient and the donor

Start the utility with the planned donor drive and select in the «Tools» menu the command «HDDs resources view and edit». Select in the displayed dialog the «ROM» tab, set the «ROM category data» selector to «ROM Module» and choose the module ID=47h. Now start the «Microjogs editor» *(Fig. 2.16)*.

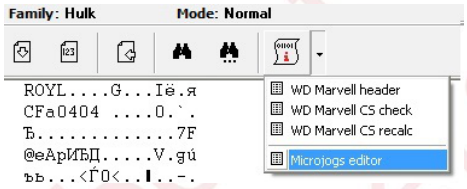


Fig. 2.16.

The dialog *(Fig. 2.17)* contains the MicroJog values in hexadecimal notation for each logical head[3] (see the footnote on page 21). Our experience tells that a discrepancy of 300 can already be too high so you have to choose a donor having as close values as possible. To estimate a donor drive fitness for a «HOT SWAP» operation, you should write to it a generated «average» module ID=47h and check whether the HDD starts using that module.

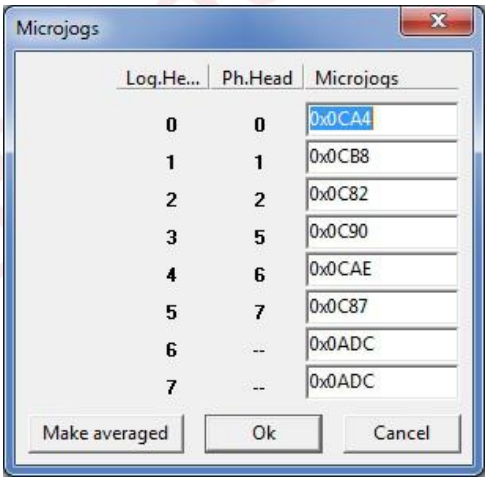


Fig. 2.17.

[1] – The step is determined by the fact that quite often different HDD use various locations of modules in the service area.

[2] – You can easily check how important the MicroJog parameter is, by changing its value in a completely functional HDD (e.g., to 100). As a result, the head used for such modification test will stop reading data although the drive will not start knocking when that head is accessed.

[3] – Please note that the value applies specifically to a logical head (not a physical one). E.g., if you disable in the heads map in ROM the 0 head, MicroJog values will be shifted for all heads and the value specified originally for head 0 will be used then for head 1 and so on. Deviations in drive operation will not be noticeable because the values are typically quite close.

Caution! Be sure to create a backup copy of the ROM and service area of the donor drive before any modification of its modules.

To generate the data, click the «Average» button and select the module ID=47h from the patient drive saved during step 1. The dialog window will display average values between the donor and patient parameters. Now click «Ok», recalculate the module checksum and write it back to the drive. Then restart the HDD and check its functionality with the modified parameters. If the drive does not start (returning factory alias or «empty» HDD ID, *Fig. 2.5)* or cannot read data from some head, you should look for another donor HDD. If the start succeeds, you may proceed to Step 3.

Step 3. Recording to donor HDD all modules from the patient

The procedure is performed in 2 steps:

- During the first step, write module ID=01 and restart the drive. After restart the HDD may fail to identify *(Fig. 2.5)*, but the functionality for module recording by ID will be available.
- During the second step, write the remaining modules. Record to the patient board the module ID=47h generated during step 2 (the donor board is very likely to have another ROM version). Install it to the donor drive and start it up. If the «average» adaptive data fit and the modules are not corrupted, the donor will start. If it fails to start, then the adaptive settings do not match (and you should look for another donor), or the modules from patient HDD are corrupted (then you can try repairing the modules, see section *3.2.2.5. Firmware overlays)*.

Step 4 (final)

Stop the spindle motor using the «Sleep» command («Tools» menu → «HDD» → «Sleep») and swap the powered board to the patient drive. Start «Data Extractor» and build the heads map («Service» menu → «Build heads map»). Once the heads map is created, you can recover the data using functional heads.

2.3.3.2. Examples of the HOT SWAP procedure

Example 1

Patient:

Model: WDC WD2500AAJS-00VWA0
Drive family: Tornado 2D
Heads map .....: 0,2,3

be used then for head 1 and so on. Deviations in drive operation will not be noticeable because the values are typically quite close.

Firmware version: 0058007M

Donor:

Model: WDC WD3200AAJS-0VWA0
Drive family: Tornado 2D
Heads map.....: 0,1,2,3
Firmware version.....: 00580076

Step 1: ROM and modules of the patient drive are readable, so now you should save them to a profile directory and proceed to step 2.

Step 2: Compare the values of adaptive settings in the donor and patient drives. Difference between the MicroJog values for head 0 is 26, for head 1-110, for head 2 - 72. For head 3 the difference is 958 because the patient drive has no such head and so the table of adaptive settings uses the default value. The smaller is the difference between MRJog values, the more compatible these magnetic heads will be. Starting with the difference of 300, reading problems with such head become quite noticeable.

Step 3: Now you have to record the modules of the patient drive to the donor drive. Recording should be performed in 2 stages. During the first stage we write just the module ID=01h *(Fig. 2.18)*.

Unauthorized copy of distribution
of these documents is prohibited

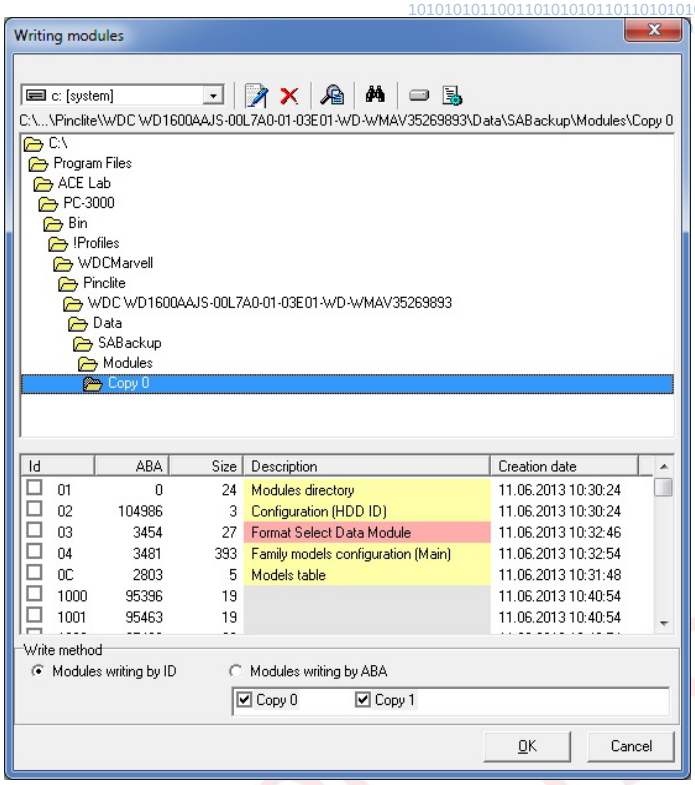


Fig. 2.18.

As the figure above demonstrates, recording is performed with the enabled «Modules writing by ID» option. After recording toggle the drive power supply off and on again and restart the utility. In this example the HDD will be identified properly after restart, but a situation is possible when a drive following the restart may be identified incorrectly *(Fig. 2.5)*. That is caused by firmware incompatibility. You can ignore the problem.

After the module ID=01h is recorded, the drive and utility are initialized using the sizes and coordinates of the modules matching the patient drive. Now you have to record all other modules (except for ID=01h) with the enabled option «Modules writing by ID».

If you turn the power off and on again after recording modules, the drive will not start. The peculiarity follows from the fact that the service area in patient drive contains a different overlay version. Let us assume that the overlay version matches the ROM version. In that case the situation will be even worse - the HDD at power-on will turn off the motor and fail to reach readiness (because the donor and patient drives have a different number of heads). To avoid these troubles, you should either record patient's ROM to the donor board or use the patient's native board.

Restart the drive. In this example the donor starts correctly using the adaptive settings module of the patient drive, i.e. the «average» ID=47h module is not required.

Example 2

Patient:

Model: WDC WD10EACS-00ZJB0
Drive family: Hulk
Heads map.....: 0,1,2,3,4,5,6,7
Firmware version: 005C0039

Donor:

Model: WDC WD10EACS-00ZJB0
Drive family: Hulk
Heads map ..... : 0,1,2,3,4,5,6,7
Firmware version .....: 005C0032

Step 1: The drive has a malfunctioning head; therefore it does not start, remains unable to reach readiness for a long time, after a while turns off all the bits in the status register.

- Launch the utility. HDD ID is not readable, ignore that and start the utility.
- Toggle the utility mode switch to Kernel and click the autodetect button. Now you can see that the HDD is ready. Start the utility.
- Read drive ROM and ROM modules to HDD profile.

To read the service area modules from patient drive, you should disable one of its heads (see section *2.3.1. Diagnostics using the ROM Head map changing feature)* or record the ROM from donor drive because it has a different version. Then restart the drive. If you are using the method that implies recording of another ROM, you should write in Kernel mode the module ID=47h saved from the patient's ROM and then restart the HDD again. Now after utility launch you can observe a situation similar to the one in the figure further. Read the drive modules to profile with the «Modules reading by ID» option enabled.

```
Techno mode key..................... : Ok

RAM:
Zone allocation table.................. : HDDs RAM reading error - Device Error Detected: "VSCE PERM OVL NOT LOADED"
SA SPT.............................. : 857

Head number reading................... : Ok
Heads number.......................... : 3

ROM:
Flash Dir reading..................... : Ok
ROM reading........................... : Ok
ROM Data size......................... : 192 Kb
ROM version........................... : 58.76D
ROM generation........................ : 58.76D
Link table version.................... : 01.0F.
Heads configuration................... : by map
Heads number.......................... : 4
Heads number in use................... : 3
Switched off heads.................... : Yes
Head map.............................. : 0,1,2

ROM Firmware version.................. : 00580076
Service area:
SA dir reading........................ : Ok
SA Copies avalabled................... : NONE

Configuration reading................. : No SA copy avalabled
```

Fig. 2.19.

Step 2: Similarly to the first example, compare the adaptive settings. The difference in the settings for the heads ranges from 777 to 1095. After the module ID=47h is written to the donor ROM, the donor drive cannot start, but if you record the module with average values, the donor HDD will start. It means that the donor drive has successfully passed the check for suitability. Proceed to step 3.

Step 3: Procedure during this step is identical to the operations examined in the Example 1.

2.4. Incorrect HDD identification

If a drive returns during utility start its factory alias or «empty» HDD ID *(Fig. 2.5)*, or fails to report on readiness for a long time, it is assumed that the drive is identified incorrectly. The disk in such cases rotates normally and the heads do not knock at the start. Such behaviour can be caused by one of the following reasons:

- ROM version mismatch.
- ROM contains a module with the adaptive settings (ID=47h) belonging to another HDD.
- One of magnetic heads is damaged beyond passing the calibration procedure but still causes no knocking.
- Spindle motor or heads controller (preamplifier) chip is malfunctioning.

To pinpoint the cause, you have to check the electronics board first of all and make sure that it's using native ROM (you can try restoring it and comparing the result). Diagnostics using modification of the heads map in ROM allows detection of the heads preventing normal drive start.

!!! In addition to the drive restoration methods described above, there are two more.

Interrupting the service area data loading at the overlay start stage

Essentially, the method implies that the ROM version should not match the overlay version in the service area. To accomplish that, record a ROM from another drive of the same family, but using a different version. After ROM

recording, you should write the native ROM modules ID=0Ah and ID=47h because ROM contains the heads map and adaptive settings. Procedure:

- Back up the original ROM and the modules it contains.
- Record another ROM having a different version.
- Record the original ROM modules ID=0Ah and ID=47h.

As a result, you can accomplish readability of drive modules by ID. In that state you can also perform hardware integrity verification of the modules («Tests» menu → «Service information» → «Work with service area» → «Hardware modules checking»). To access data, you may employ editing of the heads map in RAM or the HOT SWAP method.

Starting a HDD if the heads map in RAM is not found

Sometimes searching for drive heads cannot find their map in RAM but the service area remains readable without noticeable problems and another HDD using the same firmware version can find the heads map in RAM. You can check the service area readability by disabling one of the heads or recording another ROM version (using the methods described above).

The concept of this approach implies «substituting on-the-fly» an incompatible ID=11h with a compatible one. To start such drive, the following steps are required:

- Obtain access to the service area (e.g., by editing the heads map in ROM).
- Record the module ID=11h from a drive using another firmware version. During this stage you are very likely to encounter a situation where the length of the original module and the one being recorded do not match. You will have to use the hex editor to decrease (or increase) the module you are recording and recalculate its checksum.
- Return the original ROM to ensure the heads map is complete.
- After HDD restart the heads map will be present in RAM and available.
- Now record the original module ID=11h and while the HDD is still on, edit the heads map in RAM. Send the «Software Reset» command («Tools» menu → «HDD» → «Software Reset»).

2.5. Correct HDD identification followed by an ABRT error at an attempt to read any sector

The situation means that the firmware is initialized incompletely. Initialization may be prevented by problems while loading a critical module or calibration of a magnetic head. In that case you should create first a backup copy of drive ROM and service area, then try the following methods (arranged by the implementation complexity):

- Switch the heads map configuration from the «From map» option to the «Default» setting.
- Recalculate the translator («Tests» menu → «Service information» → «Work with service area» → «Translator regeneration»).
- Edit the heads map in RAM (the method is described in section *2.3.2. RAM head map editing)*. The difference is in the fact that you do not need the Kernel mode of the utility to perform the procedure.
- HOT SWAP (see *section 2.3.3*. HOT SWAP procedure).
- Combination of two firmware versions (the method is described in *section 3.2.5*. Firmware overlays).

2.6. Indicators do not display the ready status

HDD starts the motor producing regular recalibration sound, but virtual indicators do not display the ready status. Such behaviour can be caused by incorrect settings of the HDD configuration jumpers (for normal operation all jumpers must be disabled) or by a PCB malfunction (e.g., one of the pins in the IDE connector may be broken off). You should check whether the electronics board is connected properly and functional.

ACE Laboratory
for official users only

3. HDD WDC: firmware structure

HDD firmware consists of two parts. The first portion is stored in drive ROM, it only allows operations with the service area after a drive is powered on. The second portion is stored in the service area and its successful start allows access to the user data.

3.1. ROM and its modules

The utility supports reading and recording of an entire ROM. Read image already contains ROM modules as well, but reading the ROM modules separately makes sense for convenience. To view and edit the data in ROM, you can use the «HDD`s resources view and edit» command from the «Tools» menu, having selected the «ROM» tab *(Fig. 3.1)*.

Warning! Each of ROM parts is protected with a separate checksum, so an attempt to recalculate the checksum for the whole ROM image will cause its corruption.

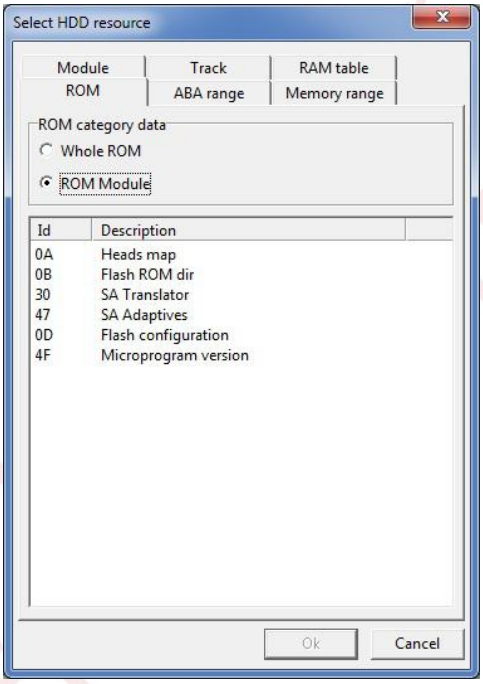


Fig. 3.1.

You can open the entire ROM image in hex editor «WD Marvell ROM map» plug-in, which allows viewing the map of code blocks stored in ROM *(Fig. 3.2)*.

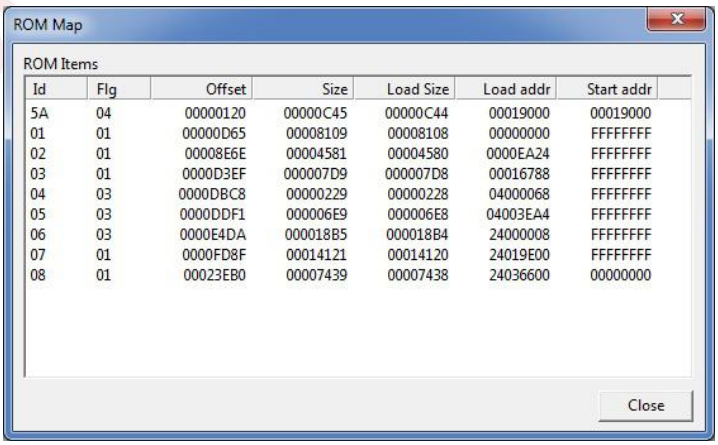


Fig. 3.2.

Unauthorized copy of distribution
of these documents is prohibited

3.1.1. Module 0Ah

The module contains the heads map which must correspond to the heads in use, otherwise the HDD will not start and will not provide access to user data. To edit the map, select the «Tests» menu → «Service information» → «Work with ROM» → «ROM Head map changing».

3.1.2. Module 47h

Information in that module (boot adaptive data) is used to configure the electronic components for work with the service area. The module is critical for drive start and unique for every HDD. The utility allows work with the module in the «Microjogs editor» plug-in for the hex editor.

Warning! Module checksum must be recalculated after modification of the values.

3.1.3. Module 30h

The module contains the coordinates of defective sectors within the service area (SA translator). Typically it contains no defects, but you may encounter exceptions.

3.1.4. Module 0Bh

The module contains the map of module locations in ROM. It is usually the same for all HDD within the same family.

3.1.5. Module 0Dh

Contains the firmware version and various flags (present in drives beginning with the Unicorn family).

3.1.6. Module 4Fh

The module is present in drives beginning with the Pinnacle family. It is likely to contain just the firmware version. The module is informational; its content does not affect logical access.

3.2. Service area modules critical for HDD start

Service area of a HDD is subdivided into modules, i.e. portions of binary code with a header, unique identifier and checksum. Some modules are necessary for HDD operation while others are used in the manufacturing process.

3.2.1. Module 01

Modules table. It contains the list of all modules including their sizes and coordinates. There are several structure types, which such modules may use. Hex editor features a plug-in for viewing of the module data *(Fig.3.3)*.

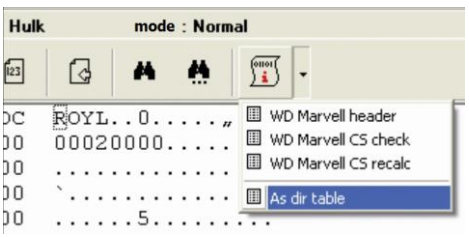


Fig.3.3.

The command for ID-based operations works in accordance with the DIR module loaded to RAM, i.e. if you try recording a module with a different length, the command will return an error. That is why you have to record first just the DIR module, restart the drive and then write the remaining modules in cases of complete replacement of drive modules using only the command for ID-based operation.

ACE Laboratory
for official users only

Service area peculiarities in MWD drives

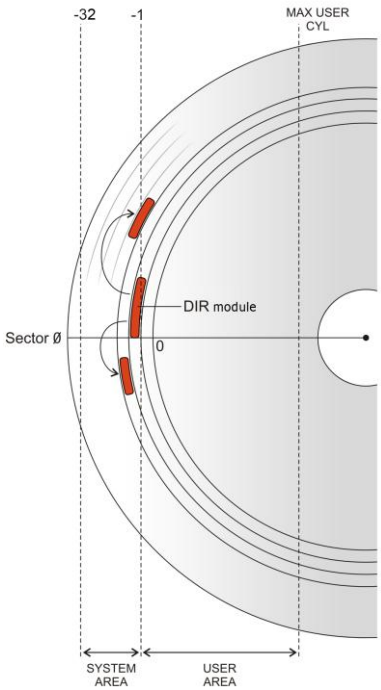


Fig. 3.4.

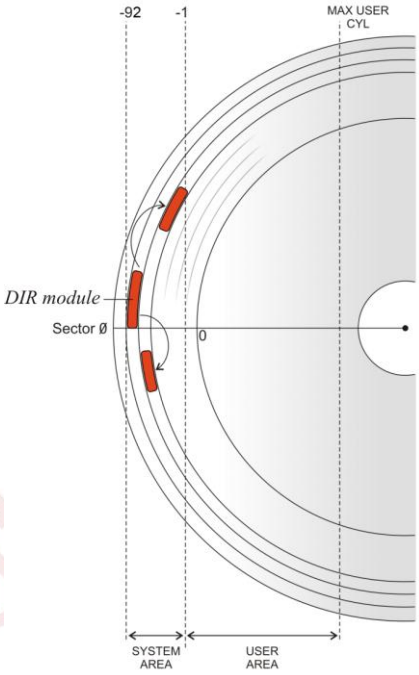


Fig. 3.5.

Service area in MWD-CHS и MWD-ROYL-CHS drive families consists of tracks that are assigned negative numbers. They are marked in the range from -1 to -32 in the figure to the left. Only first -20 tracks are used out of that range, others are not formatted. Service area has two identical copies recorded for logical heads 0 and 1. If one of the heads gets damaged (e.g., a head fails reading) the HDD starts using another one. If both copies contain corrupted portions, the drive's firmware is unable to use just normal data from both copies at once. In HDD equipped with one head the second copy of the service area is recorded for the same head but on other service tracks. Data in the service area are arranged as a small file system. The DIR (ID=01) module is stored in a fixed location (Cyl= -1, sector = 1). It contains CHS coordinates of all the modules in use.

Fig.3.5 demonstrates a different situation. Tracks with negative numbers are marked from -1 to -92. In the MWD-ROYL-ABA group of families the SA tracks are combined into a long sequence of sectors from cylinder -92 to -1 called a region and addressed by ABA sectors. The region usually begins with module DIR (ID=01) containing the locations of modules relative to the number of the ABA sector beginning the region (there are exceptions to this rule in some HDD). Two identical service area copies are recorded in two first regions corresponding to the logical heads 0 and 1. Regions for other heads are not used. Drives use for defects relocation within regions a system that is very similar to the one employed for the user data area. ROM contains the ID=30h SA translator module while the service area contains a defects table ID=35h. Please note that a portion of track -1 is not formatted (an attempt to read cylinder -1 will return errors while reading) and the area is intended to act as reserve space when sectors shift because of the defects relocated within a region.

Modules within the service area can be subdivided into 3 groups:

- Modules containing program code. Their version matches the ROM version.
- Modules containing hardware settings (mostly settings of the read/write heads) and the settings of the surface data format (e.g., zone allocation table, translator table, etc.)
- Modules employed during HDD manufacture only. They do not affect drive operation during logical access to the device.

Unauthorized copy of distribution
of these documents is prohibited

The utility supports reading and recording of the entire service area region. To do that, use the «HDD's resources view and edit» feature from the «Tools» menu (the «ABA range» tab). You can use the mode to record the whole service area for heads other than the system ones without disrupting the operation logic of the service area translator[1].

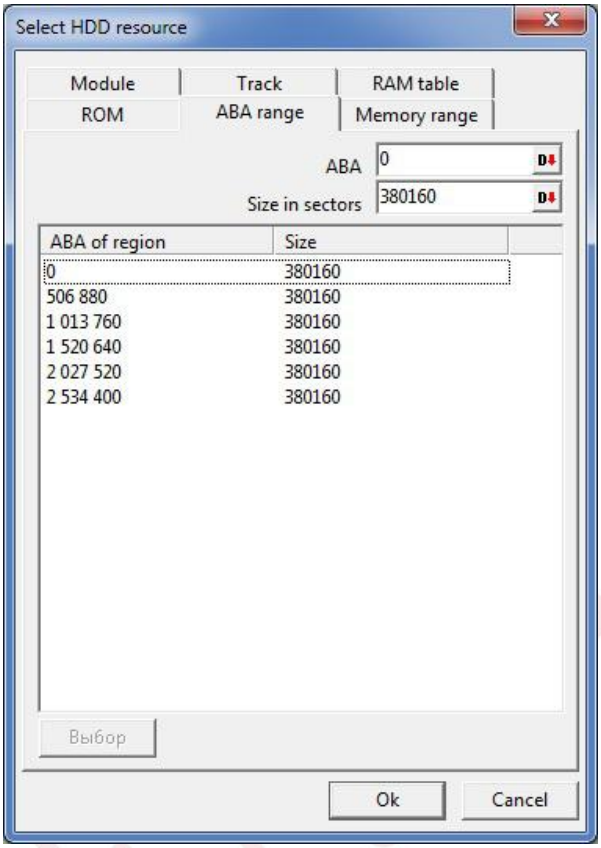


Fig. 3.6.

3.2.2. Module 02

Drive configuration module. It contains the HDD ID (model, serial number) and some other settings. Sometimes you may encounter a malfunction resetting the module to the default values; then such drive returns «WDC-ROM SN# XYZ----» instead of its serial number. Hex editor features a plug-in for viewing of the module data *(Fig.3.7)*.

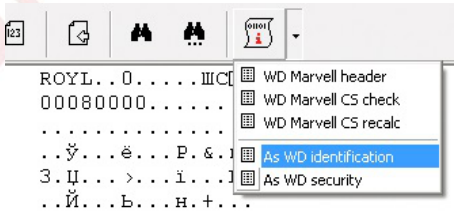


Fig. 3.7.

3.2.3. Module 03

This module is present in some drives only. It was introduced in the Zeus drive family. Before that the zone allocation table was built in the firmware and remained permanent for each specific firmware version. Now that the recording density depends upon the quality of magnetic heads installed in each individual drive, practically every HDD has its own zone allocation table. If the original table and the table recorded in service area do not match, a drive will either freeze during start or it will be unable to read the user data. If the module gets lost, restoring it or picking from another drive does not seem possible.

[1] – If you transfer the service area to another head using tracks, the hidden defects may not be taken into account and so the HDD may fail to start.

3.2.4. Module 0Ch

The module contains a list of all possible models of that drive. In HDD using the module ID=03 this one also contains its map, so the 0Ch module should only be recorded together with the module ID=03. In case of mismatch the drive will function incorrectly (sometimes it may even stop the spindle and switch to Kernel mode).

3.2.5. Firmware overlays

Firmware overlays include the modules ID = 11h, 12h, 14h, 15h, 17h, 19h, 21h, and 29h. All of them contain additional firmware code (with the version indicated in module header, Fig. 2.7*)*. ROM must have the same version. If the module ID=11h does not match or gets corrupted, the affected drive will be identified incorrectly *(Fig. 2.5)*. Other overlays are not so critical for drive start, but they are important for logical access.

Quite often just the ID=11h overlay gets damaged. To fix it, it is sufficient to record the same version of the module but finding an identical version is often quite difficult so you may have to use for restoration some other firmware (for example, one of those available from the PC-3000 database). Version replacement is possible but not in all cases. Certain versions may be incompatible with data modules, and that may prevent, for example, access to user data (i.e. all modules in the service area are intact, the drive starts and returns HDD ID correctly, but an attempt to access its surface returns ABRT errors). You can check whether such incompatibility exists by regenerating the drive translator. If recalculation ends with an error, then data structures are incompatible.

The algorithm for combining two firmware versions in a donor drive:

1) Use any method to obtain access to the modules of the drive being restored (operation similar to the description in section 2.3.3. HOT SWAP procedure). We'll refer to the saved modules as «firmware», and to original modules of the donor drive - as «firmware B».

2) Record to the donor HDD the ROM modules ID=0Ah and ID=47h from firmware A. Then record from firmware A the modules ID=03 and ID=0Ch.

3) Restart the utility. The donor drive must start correctly.

4) Record the modules containing P-List (ID=33h) and T-List (ID=36h).

5) Restart the utility. The donor drive must start correctly.

6) Recalculate the translator («Tests» menu → «Service information» → «Work with service area» → «Translator regeneration»). The procedure is necessary to check the compatibility of the data structure and the firmware, i.e. translator regeneration may complete with an error indicating data structure incompatibility. In that case you have to find another firmware for merging.

If the procedure succeeds, the donor drive will have a ready combined firmware: data-critical modules from firmware A + all other modules from firmware B.

3.2.6. Module 31 h

Module containing the translator data. Although it is unique for each HDD, its content may be restored using the data in the P-List (ID=33h) module during the translator regeneration procedure («Tests» → «Service information→ «Work with service area» → «Translator regeneration»).

3.2.7. Module 32h

List of sectors suspected for defects. Typically it is empty.

3.2.8. Module 34h

Module containing the G-List defects list.

3.2.9. Module 36h

Module containing the list of defective tracks. It is also used to reserve space for substitution of G-List defects.

Unauthorized copy of distribution
of these documents is prohibited

3.2.10. Modules 40h - 43h

Modules containing adaptive settings. Depending upon the zone allocation profile selected during manufacture, the appropriate module corresponding to that profile is used.

3.2.11. Module 49h

Module containing the «Mag Cal» adaptive settings.

3.2.12. Module 4Ah

Module containing the «MR Head Linearity» adaptive settings.

3.2.13. Module 4Dh

Module containing adaptive settings.

3.2.14. Module 50h - 53h

Acoustic profile. It is used with the command changing the HDD «noise level».

3.3. Modules employed during HDD manufacture only

Modules belonging to this category do not affect access to user data, but they can be used for HDD repair.

3.3.1. Module 33h

P-List defects list. The list is used to generate the drive translator during the «Tests» → «Service information» → «Work with service area» → «Translator regeneration» or «Tests» → «Format» procedure.

3.3.2. Module 28h

Module containing the factory program for internal drive testing (Self Test). To start it and monitor the results, the utility features «Tools» → «Self Test» functionality.

Module ID, hex	Description	Module ID, hex	Description
E6	Log module for the performed factory self test commands	E1	Log module for surface defects \ head 1
		E9	PE Data \ head 1
E7	Factory self test settings module	E2	Log module for surface defects \ head 2
EE	RRODataLog	E9	PE Data \ head 2
FA	ButterflyLog	E3	Log module for surface defects \ head 3
2D	DebugLog	EB	PE Data \ head 3
37	GainCallD GainCal Data File	E4	Log module for surface defects \ head 4
B5	WRROLogID WRRO Log File	EC	PE Data \ head 4
B8	TestClampDatalD	E5	Log module for surface defects \ head 5
35	RP List File \ defect list for the service area	ED	PE Data \ head 5
		F0	Log module for surface defects \ head 6
46	User ARCO File	F2	PE Data \ head 6
B8	SPT Communication File	F1	Log module for surface defects \ head 7
108	IBI packet	F3	PE Data \ head 7
E0	Log module for surface defects \ head 0	8000 – 805B	Life cycle simulation test logs
E8	PE Data \ head 0		

4. Factory self test for Marvell-based WDC HDD

4.1. Factory self-test: script editor mode

The mode can be invoked from the menu «Tools» → «Utility extensions» → «Self Test». It displays the script for the factory self-testing procedure, which consists of the sequence of tests to ran and their settings. The script is stored in module ID=28h and consists of 4 parts, each part begins from a DC test.

- ***1 part*** calibrates the drive, ie a variety of actions that test performance heads to read/write data. The work is not with the entire surface, but in some places. The test set DC pause for approximately 5 minutes.

Idx	TestId	Name	FncId	Params	Next	Err	Fatal
1	00DC	Test Xmit Blink	0001	0000000F 00000001 0000000A 00000000	2	STOP	STOP
2	00B1	Simple test	0000	00000000 00000000 00000000 00000000	3	24	STOP
3	00C4	Calibrator	0001	00000046 00000032 00000055 00000052	4	25	STOP
4	00B1	Simple test	0000	00000000 00000000 00000000 00000000	6	24	STOP
5	EEEE	Comment	EEEE	00000000 00000000 00000000 00000000	STOP	STOP	STOP

- ***2 part*** implements the surface test by physical parameters, hides defects found and forms a translator.

Idx	TestId	Name	FncId	Params	Next	Err	Fatal
6	00DC	Test Xmit Blink	0001	0000000F 00000003 0000000A 00000000	7	STOP	STOP
7	00DA	Test TS Write	0001	00000000 00000000 00000000 00000000	8	8	STOP
8	00DD	Test Gain Cal	0001	00000000 00000000 00000000 00000000	9	9	STOP
9	00DB	Test TS Read	0001	00000003 00000001 00000000 00000000	10	10	STOP
10	00D5	Test Cluster	0001	00000000 00000000 00000000 00000000	11	11	STOP
11	00D4	Test Tlist	0001	00000000 00000000 00000000 00000000	12	12	STOP
12	00D3	Test Calc PSN	0001	00000000 00000000 00000000 00000000	13	13	STOP
13	00D2	Test Plist	0001	00000000 00000000 00000000 00000000	15	15	STOP
14	EEEE	Comment	EEEE	00000000 00000000 00000000 00000000	STOP	STOP	STOP
15	00D6	Test RRO	0001	00000000 00000000 00000000 00000000	16	16	STOP
16	00D7	Test PE Scan	0001	00000000 00000000 00000000 00000000	17	17	STOP

- ***3-rd part*** produces quality testing by passing the logical parameters. If the translator was not formed in second part, then the test will not work, and will stop at the beginning of this part of the test - DC. If during testing defects yet to be found, they move into the G-List.

Idx	TestId	Name	FncId	Params	Next	Err	Fatal
17	00DC	Test Xmit Blink	0001	0000000F 00000004 0000FFFF 00000001	18	STOP	STOP
18	00BB	SPT Write All	0001	00000000 00000000 00000000 00000000	19	26	STOP
19	00B9	TList wrk	0001	00000000 00000000 00000000 00000000	20	27	STOP
20	00BA	SPT Read All	0001	0000FFFF 00000000 00000000 0000000A	21	28	STOP
21	00C4	Calibrator	0001	00000040 00000001 0000003F 00008402	22	29	STOP
22	00C4	Calibrator	0001	00000041 00000001 0000003F 00008402	23	30	STOP

- ***4 part*** in the event-free passage is never executed. It contains a list of test-errors.

Idx	TestId	Name	FncId	Params	Next	Err	Fatal
23	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000000	STOP	STOP	STOP
24	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000002	STOP	STOP	STOP
25	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000004	STOP	STOP	STOP
26	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000006	STOP	STOP	STOP
27	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000007	STOP	STOP	STOP
28	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 00000008	STOP	STOP	STOP
29	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 0000000A	STOP	STOP	STOP
30	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 0000000B	STOP	STOP	STOP
31	00DC	Test Xmit Blink	0001	0000000F 00000002 0000FFFF 0000000D	STOP	STOP	STOP

Fig. 4.1.

Unauthorized copy of distribution
of these documents is prohibited

Of course, we can find scripts with the other layout tests, but the essence of the division into stages does not change.

On many drives are additional scripts factory self-tests that are in modules 3B, 3C, 3D, 3E, 3F. We can view their contents with Hex-editor feature «Self test script».

4.2. Editing the test control record

The test control record consists of the following settings:

- ***Test ID*** - test number. It also matches the ID of an appropriate service area module containing the program code for the test.
- ***Fnc Id*** - test function number.
- ***Args*** - a set of arguments for the test.
- ***Next*** - step number where the test should proceed in case of successful completion.
- ***Error*** - step number where the test should proceed in case of error.
- ***Fatal*** - step number where the test should proceed in case of a fatal error (emergency termination).

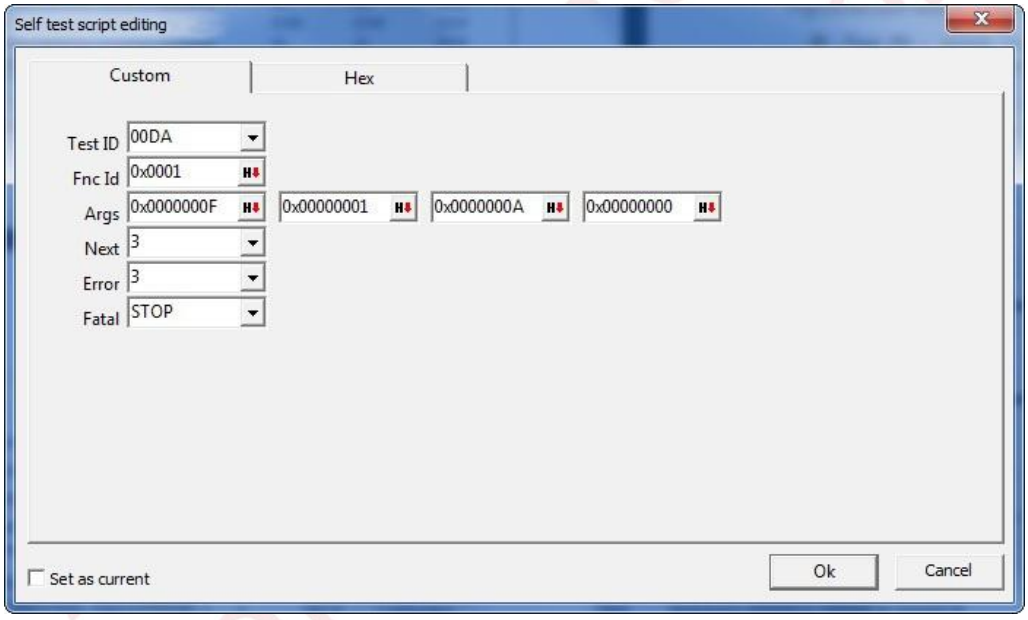


Fig. 4.2.

All bytes of the test control record are editable in the «Hex» tab. Step number marked as «STOP» is a step number variable set to 0xFFFF or -1 in int-notation.

4.3. Starting the factory self-testing procedure

Warning! Start of the factory self-testing routine will cause destruction of user data.

Before the procedure begins, the utility displays the start settings shown below *(Fig. 4.3)*. First DC test usually expects for several minutes after start (the duration depends upon drive family and the test settings in script) before it actually begins working.

Unauthorized copy of distribution
of these documents is prohibited

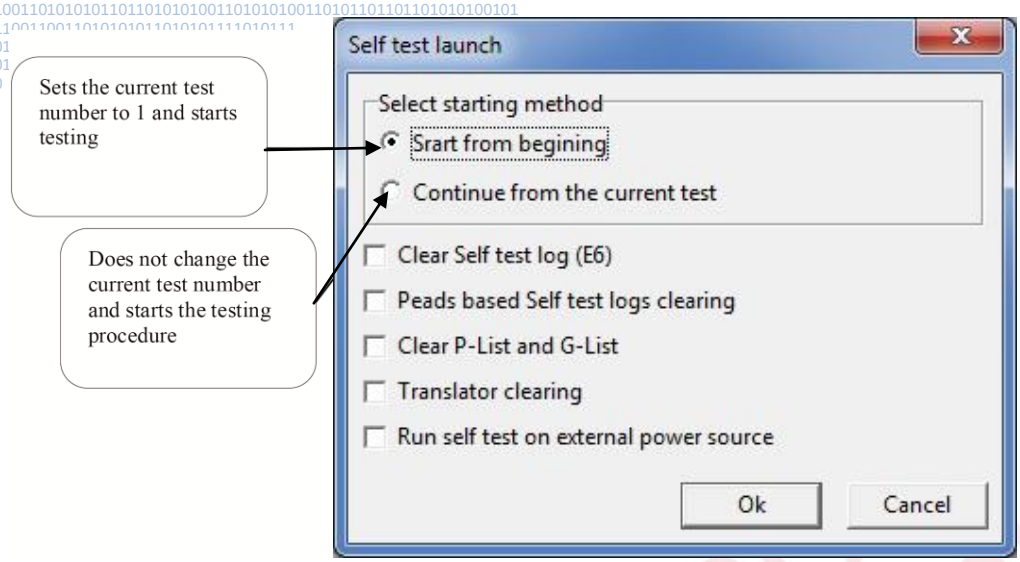


Fig. 4.3.

You can perform factory self-testing using a separate power supply unit. To do that, enable the option to «Run self test on external power source». After completion of preparatory steps you can disconnect the HDD and connect it to a separate power supply. In that case you will be unable to identify the moment when the testing sequence completes. Moreover, if you connect SATA cable during the procedure, scanning will be interrupted. Therefore, scan completion should be anticipated after the longest possible time the procedure is supposed to take (in practical experience, approximately 12 hours). When you connect the HDD back to the PC-3000 suite, a software reset signal must be sent to the drive because otherwise it will continue operating in factory mode. E.g., you can configure the utility to start with a reset command using the «Run utility with parameters» item from the additional menu of the utility start button *(see Figure 4.4):*

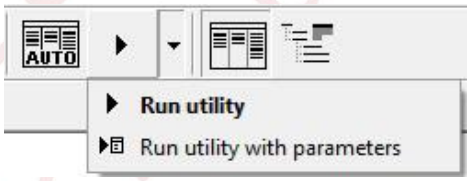


Fig.4.4

Starting with the Lynx family, 2.5” drives must be warmed up to 50° C to ensure successful completion of the C4 test, which begins the script. Once the test starts, heating can be stopped. The test starts approximately in a minute after a drive reaches 50°. Sample diagram of a Lynx drive that has successfully completed factory self-testing:

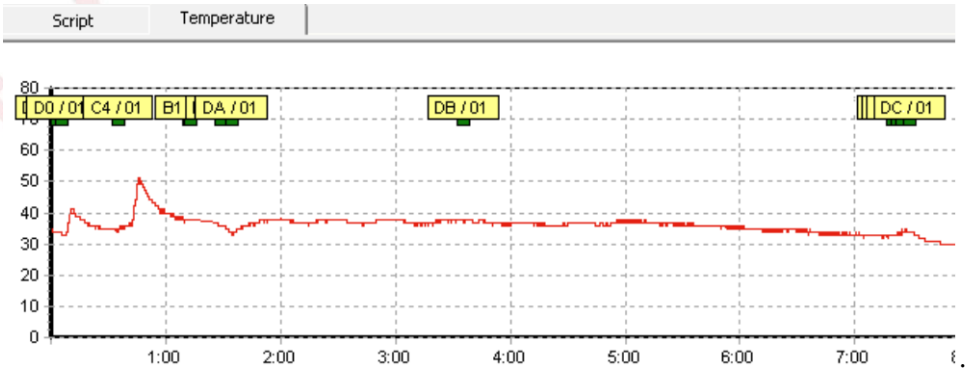


Fig. 4.5

Unauthorized copy of distribution
of these documents is prohibited

4.4. Monitoring current status

When status monitoring of factory self-testing is started, the «Operation» panel displays the following information *(Fig. 4.4):*

Fig. 4.6.

Here (left to right): ID of the current test, function number in the current test, cylinder, head, PCB temperature, read/write heads temperature.

Clicking the arrows below the displayed parameter values brings up 15 preceding values.

Actual factory testing is performed in thermostatic conditions at 50.

Since a drive does not return the current step number from the self-testing script, unambiguous detection of the current test position in script is only possible if the test's ID is used within the script just once.

4.5. Stopping the factory self-testing procedure

To stop self-testing, select the command to «Interrupt status monitoring» from the right-click context menu. The corresponding dialog will appear *(Fig. 4.7):*

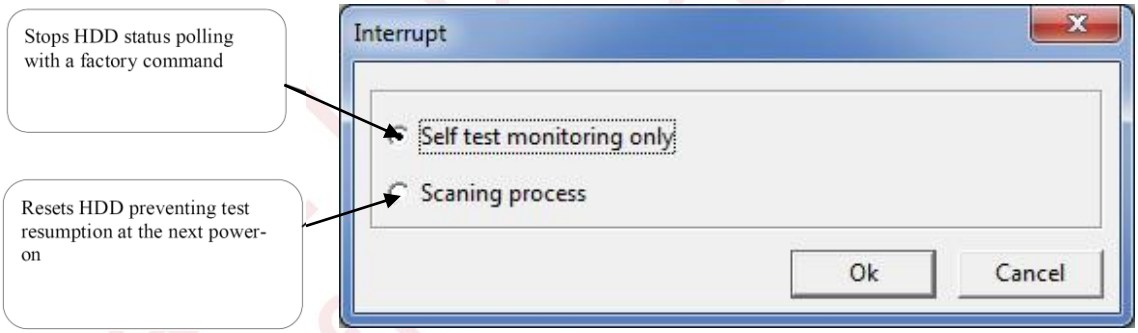


Fig. 4.7.

Switching the power off and on does not make a HDD exit the factory self-testing mode; after the power is switched on, the HDD ID will not be returned and the factory mode key sent to the HDD while starting the utility will just make such drive freeze. An alternative way to make a HDD exit the self-test mode is to send the software reset command from the menu «Tools» → «HDD» → «Software Reset».

Attention! When factory self-diagnostics stops, turn the drive off and on again. Failure to do so will cause the drive to respond with an «ABRT» error to all attempts to access the user data area.

4.6. Analysis of factory self-test results

To estimate the efficiency of factory self-diagnostics, you have to analyze the logs and P-List content.

Self test log

```
------------------------------------------------------------------------
Test ID       : Total Count   : Ok Count      : Total time    : Ok time
------------------------------------------------------------------------
00F7          : 1             : 1             : 0:18:00       : 0:18:00
00D1          : 1             : 1             : 15:51:07      : 15:51:07
00DD          : 1             : 1             : 0:02:31       : 0:02:31
00DB          : 1             : 1             : 16:47:24      : 16:47:24
00D5          : 1             : 1             : 0:10:55       : 0:10:55
00D4          : 3             : 3             : 0:07:12       : 0:02:09
00D3          : 1             : 1             : 0:01:15       : 0:01:15
00D2          : 1             : 1             : 0:07:15       : 0:07:15
3402          : 1             : 1             : 0:10:15       : 0:10:15
00D7          : 1             : 1             : 0:21:25       : 0:21:25
00BB          : 1             : 1             : 0:00:00       : 0:00:00
00B9          : 1             : 1             : 13:28:12      : 13:28:12

------------------------------------------------------------------------
Head          : Defects number
------------------------------------------------------------------------
2             : 549 / 53331
3             : 411 / 53331
4             : 504 / 53331
5             : 1441 / 53331
6             : 471 / 53331
7             : 347 / 53331
```

Fig. 4.8.

Scanning is completed successfully if the space allocated for defects is not exhausted and the drive successfully builds the P-List module. In case of completion failure the log will be filled entirely for one or more heads indicating a malfunction of the head. To accomplish successful scan completion, disable the malfunctioning heads and repeat the self-testing procedure.

While opening the scan log modules in hex editor, you can use the plug-in for module viewing as a defects list (*Figure 4.9.*). Defect logs differ from P-List, because during P-List generation close defective sectors get «combined» and multiple defective sectors are converted into a defective track.

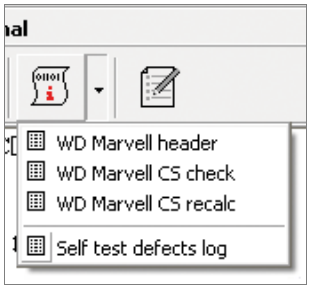


Fig. 4.9.

Unauthorized copy of distribution
of these documents is prohibited

4.7. Search the DB for compatible resources

Quite often you have to check the versions of modules available in your database. You can do that using the following methods.

4.7.1. Method involving utility start

You can export a specific firmware version from the database by selecting «Tests» → «Service information» → «Work with DB» → «HDD resources export». The Search button opens the search settings dialog where you can review the list of all versions in the DB (*see Figure 4.11.)*

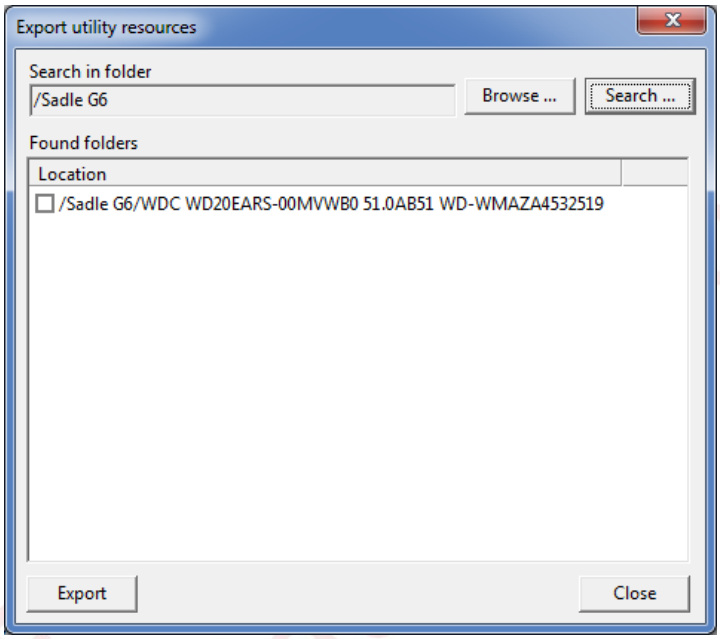


Fig. 4.10.

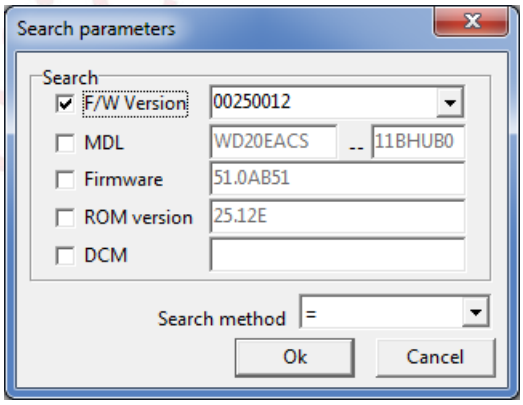


Fig. 4.11.

4.7.2. Method involving the universal DB editor

Start the DB editor in the utility selection mode from the «Tools» → «Database» menu. Select the necessary manufacturer and drive family in the tree and click the Search button. The search dialog will appear *(Figure 4.12).* In that case the suite will search for modules matching ID=02 and Firmware version 000500AS.

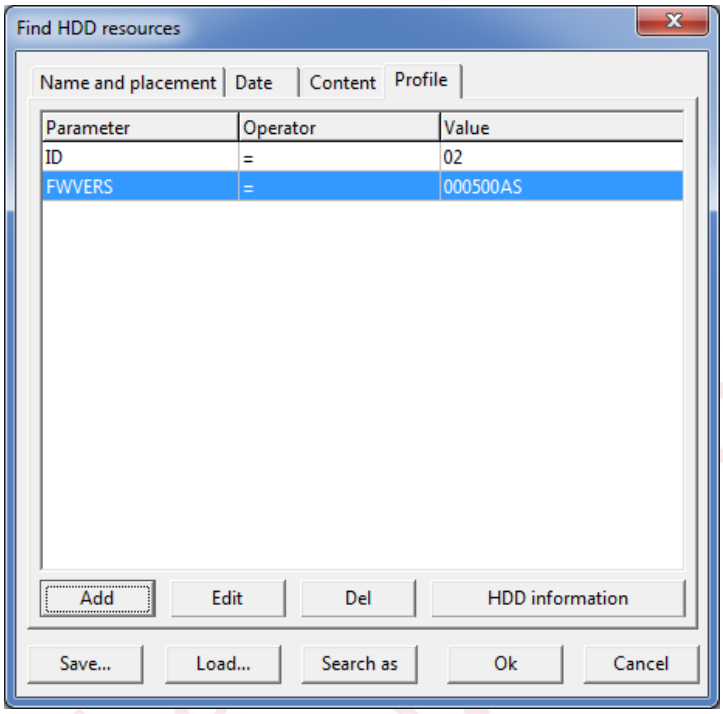


Fig. 4.12. Adding a search parameter.

4.8. Automatic password removal

If a HDD is password-protected, a suggestion to disable the protection will appear when the utility starts *(Figure 4.13)*

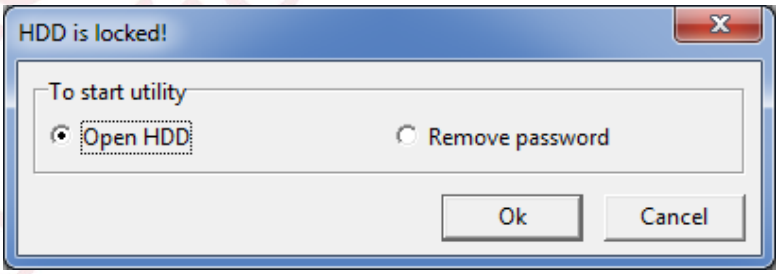


Fig. 4.13.

Unauthorized copy of distribution
of these documents is prohibited

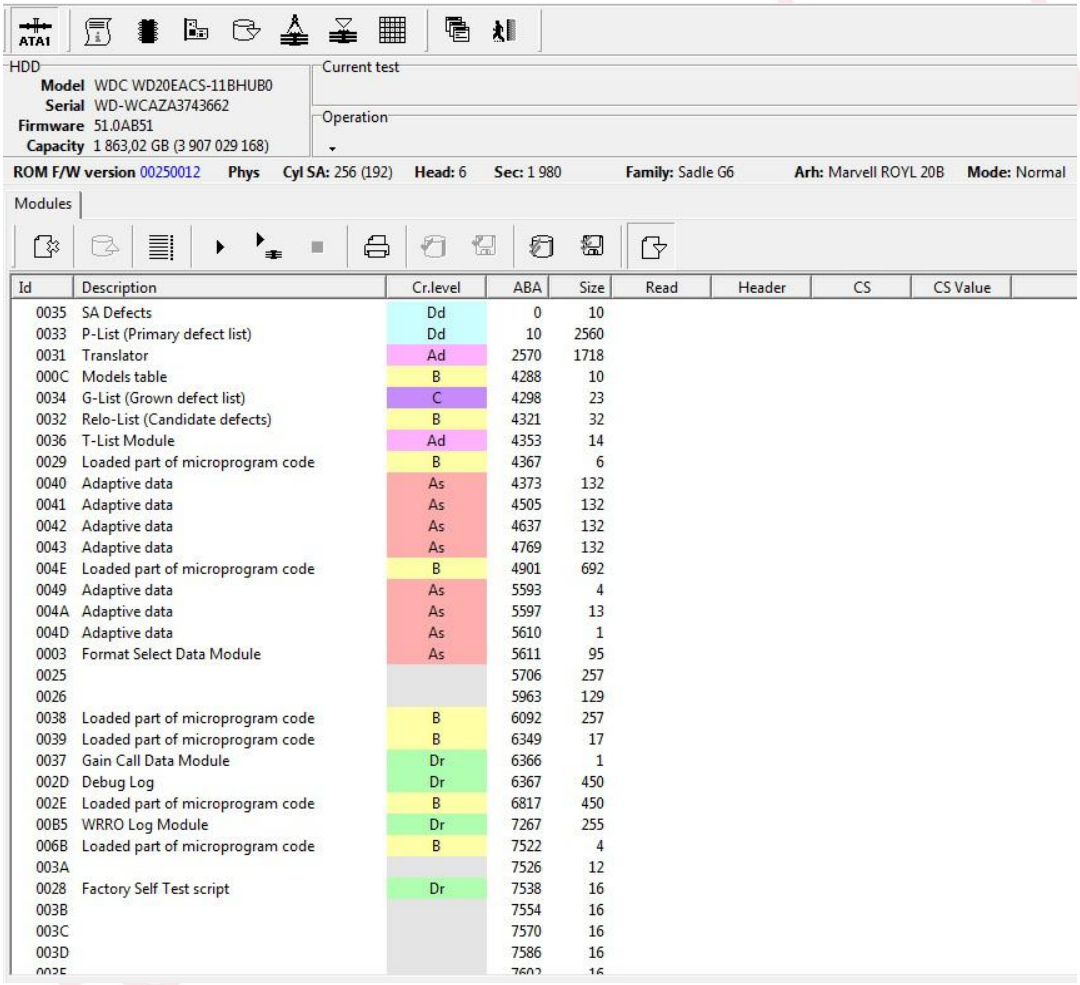
4.9. DIR editing

DIR editing is useful while solving two tasks: module relocation from an area containing defects to free space and triggering of selective loading from the service area in order to skip specific data. The mode can be invoked from the «Tools» → «Utility extensions» → «Dir editor». A module can be relocated to a free cylinder or an area in ABA range.

The utility in this mode reads and writes DIR using the command working with modules based on their ID.

4.10. Version control

During start the utility compares the versions of ROM and the 11th overlay. If they don't match, version will be highlighted in red *(Figure 4.16)*. Typically, version mismatch is the reason causing incorrect HDD start. In new drive families version mismatch is a quite frequent situation; however, such drives still start correctly. It means that the versions are compatible, they are just designated differently.



Id	Description	Cr.level	ABA	Size	Read	Header	CS	CS Value
0035	SA Defects	Dd	0	10				
0033	P-List (Primary defect list)	Dd	10	2560				
0031	Translator	Ad	2570	1718				
000C	Models table	B	4288	10				
0034	G-List (Grown defect list)	C	4298	23				
0032	Relo-List (Candidate defects)	B	4321	32				
0036	T-List Module	Ad	4353	14				
0029	Loaded part of microprogram code	B	4367	6				
0040	Adaptive data	As	4373	132				
0041	Adaptive data	As	4505	132				
0042	Adaptive data	As	4637	132				
0043	Adaptive data	As	4769	132				
004E	Loaded part of microprogram code	B	4901	692				
0049	Adaptive data	As	5593	4				
004A	Adaptive data	As	5597	13				
004D	Adaptive data	As	5610	1				
0003	Format Select Data Module	As	5611	95				
0025			5706	257				
0026			5963	129				
0038	Loaded part of microprogram code	B	6092	257				
0039	Loaded part of microprogram code	B	6349	17				
0037	Gain Call Data Module	Dr	6366	1				
002D	Debug Log	Dr	6367	450				
002E	Loaded part of microprogram code	B	6817	450				
00B5	WRRO Log Module	Dr	7267	255				
006B	Loaded part of microprogram code	B	7522	4				
003A			7526	12				
0028	Factory Self Test script	Dr	7538	16				
003B			7554	16				
003C			7570	16				
003D			7586	16				

Fig. 4.14. Window appearance in the mode.

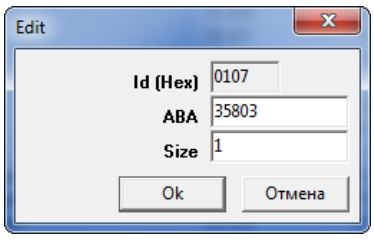


Fig. 4.15. Location editing dialog.

```
ROM Firmware version..................... : 00250012

Service area:
SA dir reading (ID)...................... : Ok
SA Access................................ : Copy 0,Copy 1

Configuration reading.................... : Ok
Master Password.......................... : "WDCWDCWDCWDCWDCWDCWDCWDCWDCW."
User Password............................ : has not been set

SA Firmware version...................... : 00110019
```

Fig. 4.16.

4.11. Disabling heads

You can disable drive heads from the «Tests» → «Disable head» menu.

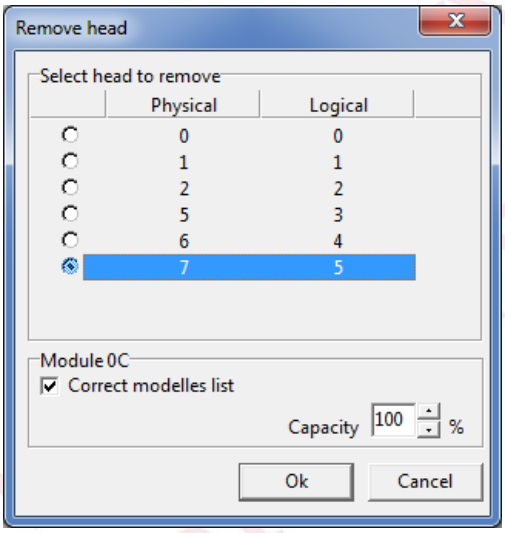


Fig. 4.17.

Capacity setting allows you to correct the LBA space remaining after the head is disabled. The step is required by the fact that the utility cannot precisely calculate the resulting capacity after the head is disabled. If the subsequent translator regeneration completes with an error, you will have to record the original set of modules and repeat the disabling procedure but this time decrease the «Capacity» percentage.

After a head is disabled, the translator must be regenerated without the data from defect lists:

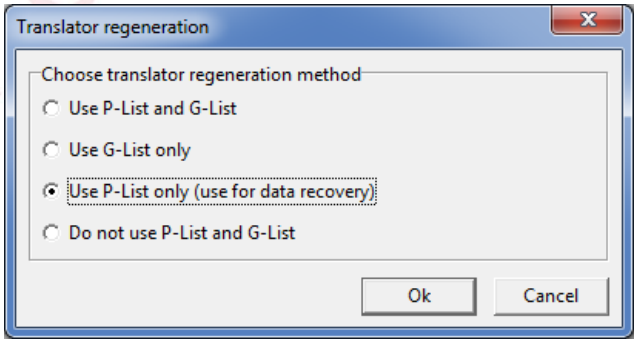


Fig.4.18.

Once the drive is restarted, it must be formatted using the P-List data. If the system head has been disabled (logical head 0 or 1), you have to read all modules using their ID and write them using their ID as well. This operation will create a copy of the service area under another head that previously had no system purpose, or in a backup copy area in cases, when there is just one head left.

Unauthorized copy of distribution
of these documents is prohibited

5. WD Marvell ROYL-20B architecture

Table 1. Drive families using the 20B architecture.

Drive family	Drive family code	Form factor
Pinnacle	B3, B4, B5, B6, B7, E2, F0, F1, F2, H4	3.5
Tahoe	M9, N0, N1, N2, N3, V0, V1	3.5
Midori	L0, L1, L2, K9	3.5
Pinclite	L6, L7, L8, L9, M0, M1, N9, J2, J3, J5, R1	3.5
DragFly1	M7, M8, N7, S9, U7	3.5
DragFly2	M2, M3, M4, M5, P6, U8	3.5
Pinnacle PATA	J3	3.5
DragFly3	Z5, P8, P9, R0	3.5
DragFly4	S1, S2, S8, T3, U1, U2, R6, H5, H7, P3	3.5
Tahoe 2D	E3, Z8	3.5
Dragon	J99	3.5
Tahoe LT	1C, YZC, UU3	3.5
Sadle G6	MVW	3.5
Shasta	K6, A02, A1J, A1N, A28	2.5
Mariner	A05, A06, A1C, A0L, A0R	2.5

WDM-ROYL HDDs with the module ID=20Bh in ROM use basically different structure of the service area. Therefore, these drives require other restoration methods. We'll refer to them collectively as WDM-ROYL-20B. Please note that in some families (e.g., Pinnacle) you may encounter firmware of the new WDM-ROYL-20B generation, as well as regular WDM-ROYL.

The main peculiarity of the new firmware generation is the fact that ABA location of the DIR (ID=01) module is no longer fixed. In all WDM-ROYL HDDs DIR always starts with ABA = 0. The module's location is specified in module ID=0Bh or in ID=20Bh. WDM-ROYL-20B firmware always contains both these modules. The opportunity for modification of the DIR module location can be used to make a freezing drive start up. However, experience has shown that sometimes this method may cause a HDD to corrupt its DIR after successful start. Therefore, it is recommended to rather perform drive diagnostics and restoration using the method described in *section 1.1*.

Another difference exists with regard to the head map editing in RAM. WDM-ROYL-20B drives require a loader, otherwise the heads map cannot be found in RAM. This peculiarity results from the fact that the command used to work with RAM is no longer present in the ROM code. It is now located in the overlay ID=11h (loader).

When the utility starts, it displays the DIR location from the active module in ROM. In the example below DIR is located in ROM modules, thus indicating the new generation of WDM-ROYL-20B firmware:

ROM Modules:
Flash ROM dir reading…… Ok
Flash ROM dir (ext) reading…… Ok (Active)
Modules directory address……... 377 657 (24)

In this case, however, DIR location is fixed, thus indicating the regular WDM-ROYL firmware:

Flash ROM dir reading…… Ok
Flash ROM dir (ext) reading…… Ok (Active)
Modules directory address……... 377 657 (24)

Please note that enabling heads in ROM one by one, to identify the normal and malfunctioning heads, is no longer possible. When a HDD detects a mismatch between the number of connected heads and the number specified in the zone allocation table, it fails to start, acting just as if the enabled head is malfunctioning.

The variations in the operation logic of WDM-ROYL and WDM-ROYL-20B firmware means that there are considerable differences in the manifestation of HDD malfunctions and appropriate repair methods. The main problem with the new firmware generation is the freezing or slow response during start. PCB donor selection is also considerably more complicated as WDM-ROYL-20B drives contain no copies of the ROM modules. However, a copy of the ROM code is still present (module ID=109h).

The problem of slow response manifests itself in three ways:

1) Freezing. A drive freezes in BSY state. After approximately 1 minute it stops the spindle and turns off the status and error registers.

2) Slow operation, but after a soft reset the drive starts to function normally. This is typical of 3.5" drives.

3) Slow operation, but a soft reset causes a drive to freeze completely. This is typical of 2.5" drives.

5.1. Gaining access to the service area of WDM-ROYL and WDM-ROYL-20B

The method described further is based on editing of the service area regions which prevents the drive starting from the service area after it is powered on. Such blocking may be required to bypass firmware problems and to access drive heads which have reading issues.

Step-by-step HDD start procedure is as follows:

1) Set the Kernel mode jumpers, wait until the drive switches to Kernel mode, or insert a piece of paper between the preamplifier connector and the electronics board.

2) Start the utility, ignore the HDD ID read error, detect the drive family automatically and enter the Kernel mode. Backup ROM content to a file. Select «Tests» → «Work with ROM» → «SA regions editor». To block staring from SA, add a single sector to the initial ABA of regions 0 and 1. To edit a region, double click it in the table of regions, or use the shortcut menu. Save the module and restart the drive.

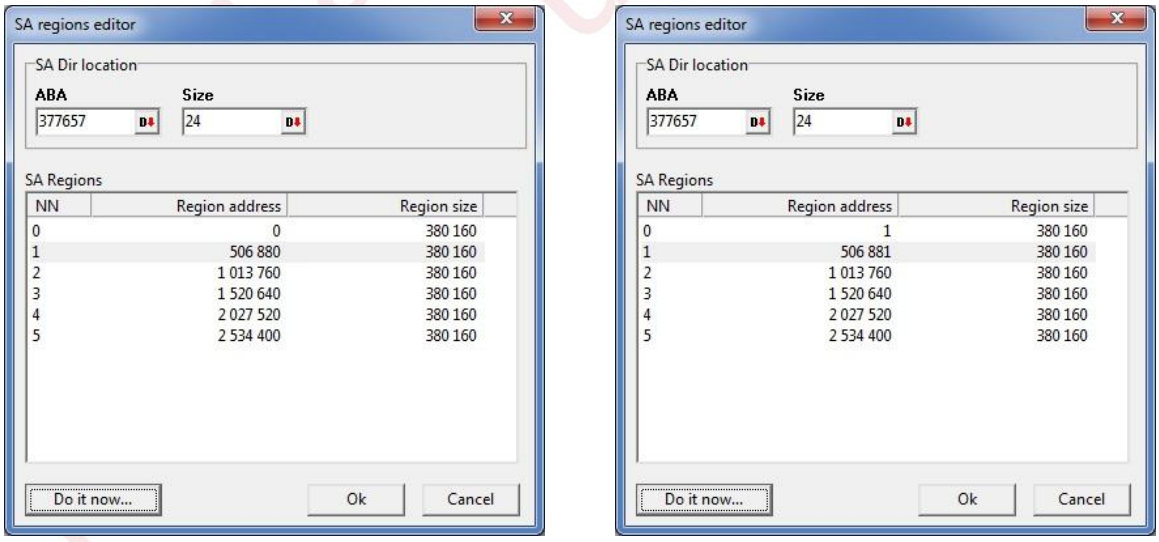


Fig.5.1

Attention! The editor in Normal utility mode can be invoked from the menu «Tests» → «Service information» → «Work with ROM» → «SA regions editor».

3) When powered on, the drive starts without loading anything from the service area. However, all items necessary for data reading from its service area will be initialized: adaptive data, service area translator, the platter will be rotating and the heads will be unparked.

4) Start a loader matching the ROM version to obtain access to the service area via ABA. Many drive families allow SA reading using CHS coordinates without using a loader to start. You can take the opportunity to find module ID=11h and then use it as a native loader. To perform CHS-based search,

Unauthorized copy of distribution
of these documents is prohibited

start the utility in Normal mode and select «Tools» → «Utility extensions» → «Module search in SA». In the displayed mode window, use the toolbar to «Start search».

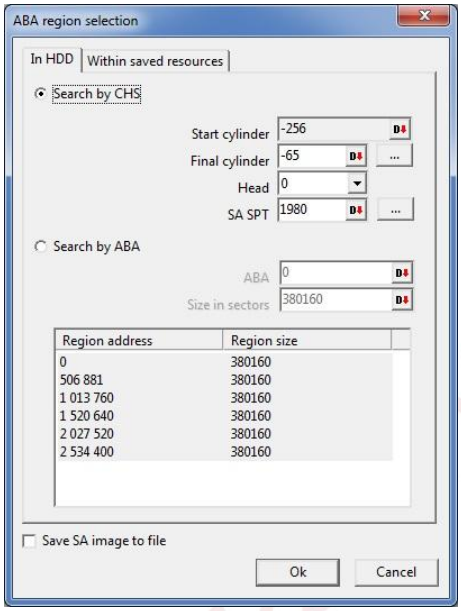


Fig.5.2. Search settings dialog.

In the displayed settings window, toggle the selection to «Search by CHS». The SA SPT will then be substituted incorrectly because it has not been identified during utility start. To identify SA SPT automatically, click the «…» button. After the search the utility displays the list of found modules. Select one of them and use the shortcut menu to «Save module 11».

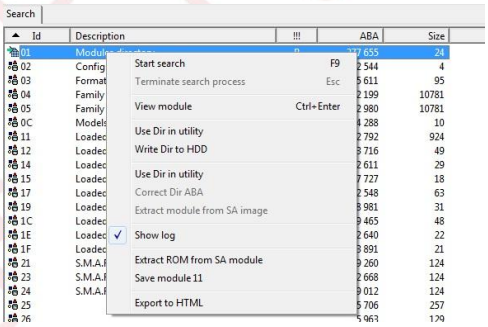


Fig. 5.3. Module search result and the shortcut menu.

Attention! Peculiarities of loader start. Why is setting the Kernel mode jumpers and starting a loader not possible? Setting of the jumpers prevents initialization of the appropriate executive electronic components along with the content of ROM modules. When a drive enters Kernel mode on its own upon a fatal error, it usually performs the initialization procedure and its service area becomes accessible after loader start. Sometimes, if loader start is activated internally in Kernel mode, it may freeze. The situation can be reproduced easily: disable a head in ROM or scramble the checksum for module ID=03h in both copies and restart the drive. It will enter Kernel mode and respond to loader start either by freezing, or return back to kernel mode.

5) After loader start the service area will be available via ABA. The HDD itself has not loaded the DIR module. Therefore, the module search procedure should be performed in the service area. To perform the module search procedure, use the menu «Tools» - «Utility extensions» - «Module search in SA». Click the «Start search» button. Once the search is completed, click the «Use Dir in utility» toolbar button. It will enable correct operation of many features available in the utility. The DIR application operation does not write anything to the drive.

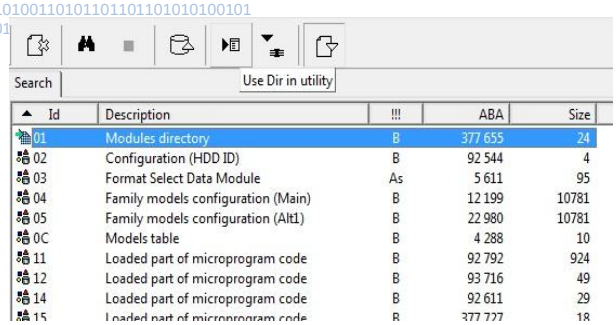


Fig. 5.4. Results of ABA-based module search in the service area.

Once the DIR data is applied in the utility make a backup copy of the service area modules. Backing up ROM contents together with the modules is not advisable because the SA regions in ROM are modified. Therefore, you should use the ROM backup copy made during the step 1, i.e. before all modifications.

6) Having saved the entire service area, you can now attempt to identify the causes of malfunction. Running the «Solve "slow responding" problem» procedure usually helps to restore the functionality of the service area.

Fig. 5.5. «Solve "slow responding" problem» settings.

Prior to starting the procedure, make sure that recording to the service area functions correctly. To test this you can use the heads test or modify, in the hex editor, an unnecessary modulesuch as ID=62h, by writing it and then reading it. If the changes are recorded writing functionality is working correctly. A drive may fail to start properly for other reasons than firmware issues, such as a problem in module 03 or slow operation of a system read/write head.

Examples of the methods described above are provided below:

5.1.1. Example of restoration of a freezing Dragfly1 500GB

Procedure:

- Start the drive in Kernel mode.
- Use the regions editor to shift the beginning of regions 0 and 1 by 1 sector.
- Start the loader of an appropriate ROM version. An incomplete match is possible, in which case the last character in the version number may differ.

Unauthorized copy of distribution
of these documents is prohibited

- Enter the utility in Normal mode and start the module search in the service area. Select searching by ABA and specify region 0 as the area to search.
- In the module search mode, click the «Use Dir in utility» button.
- Make a backup copy of the service area modules using reading by ABA from specified copies.
- Run the «Solve "slow responding" problem» procedure configured to use ABA access.
- Restore the original location coordinates of the modified regions and restart the drive - the drive should now be working.

5.1.2. Pinnacle 20B restoration example

Power on the HDD. The drive has a blank HDD ID (very occasionaly it contains the model and serial number from ROM module 0D, but incorrect capacity).

- Identify the drive family.
- Enter the Kernel mode.

Try to retrieve content from module ID=90h using the menu «Tests» - «Work with service area» - «View module 90 information». Thus, you can check whether the disk surface is readable and identify the original ROM version for the drive. Compare the version with the ROM version. If it matches then the board is most likely native for the drive. If you have an appropriate loader version available, start it. If you have no matching loader version you may use a donor board or perform a module search using the menu «Tools» → «Utility extension» → «Module search in SA» with the «Search by CHS» option enabled.

Method when using a donor board.

To use a donor PCB you have to find the closest board version to the original, otherwise you are likely to encounter another processor type or adaptive data in module ID=47h that differ too much for a successful substitution. E.g., you have board v. 00050084 and install board version 0005008T as a replacement. The drive starts, reads module ID=90h, but an attempt at module search reveals that the service area is barely readable.

Record only module ID=47h from ROM 00050084 to the ROM of 0005008T. If there is no native ID=47h module available you have to pick a board capable of reading the service area. In fact, if information from module ID=90h has been read successfully, it will contain the version of module ID=47h. If you find a ROM with exactly the same version of the module ID=47h, the drive is very likely to start with that module.

After board v. 0005008T is installed and module ID=47h is recorded, start the loader.

Start the utility in Normal mode and perform a module search in region 0 or 1 of the service area using ABA access. Apply the list of found modules as DIR in the utility. This step allows saving of all found data using the «module reading» command.

Intermediate result:

A suitable loader is available and all functional modules from the service area are saved.

Now you have to identify the exact cause of the malfunction. As an example we shall use a case with an erased DIR module and BAD blocks in the location of ID=11h and ID=12h overlays.

DIR recording by ID has failed for the Pinnacle drive family. Therefore, DIR location specified in module ID=20Bh was used to read 24 sectors with the command to read/write sectors by ABA, and then load DIR as a file from another similar drive.

After a restart the drive can already read DIR during the normal utility start. We then discover that the non-native DIR resulted in shifted locations of the firmware modules. To address the problem, previously saved modules can be recorded using the appropriate ID. Writing may fail for some modules because of an invalid size. This means that the recorded DIR may contain a smaller module size than its actual size of the drive being restored. The problem can be bypassed using the menu «Tools» → «Utility extensions» → «DIR editor». Simple modifications of module sizes may cause them to intersect with other modules. Therefore, we have to find, in the SA, empty space (typically, from 50000 to 80000 ABA), move all incorrectly sizes modules to this location and correct their sizes. Save the modified DIR, restart the drive and the utility. Write the modules (it is advisable to write modules by ID).

After all corrections are complete it turns out that overlays 11 and 12 are written to areas containing BAD blocks. These should be treated similarly to the modules with incorrect sizes. We move them to free space in the SA in DIR editor. Restart the drive and the utility. Write the modules and the drive should begin to function.

5.2. Specifics of operations with system heads

Situations where one of the system heads is malfunctioning occur quite often. The peculiarity of system heads is the fact that they are used to access copies of the service area. Problems occur when heads are disabled (for repair) or combined in RAM (for data recovery). The SA regions editor helps to avoid this problem. To bypass this issue, specify the locations of the zero and first regions corresponding to the zero and first copies of the service area associating them with the same head. E.g.:

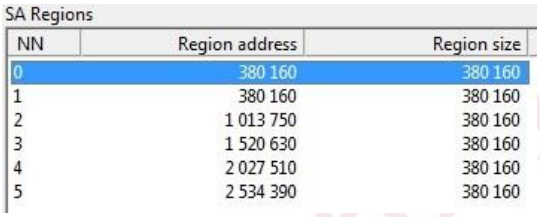


Fig.5.6.

In this example the service area will be accessed using logical head 1 only. This approach helps bypass access attempts via malfunctioning logical head 0 in the case of head disabling or combination.

5.3. Solution for slow response problem

The problem manifests itself as very slow reactions to any command sent to a hard disk drive.

3.5" HDD

To fix the problem send a soft reset, at which point the drive starts working properly. To send the reset signal, select the utility to start with additional options using the utility launch configuration button.

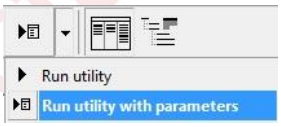


Fig.5.7.

Use the additional options to enable a soft reset signal during start.

Fig.5.8.

Enter the utility in normal mode and select the «Solve "slow responding" problem».

2.5'' HDD

The situation is more complicated with 2.5" drives. In fact, a soft reset causes such HDDs to freeze completely. The problem needs to be solved in an alternative manner. In the settings of PC-3000 suite, set the «HDD Timeout» to 100 sec.

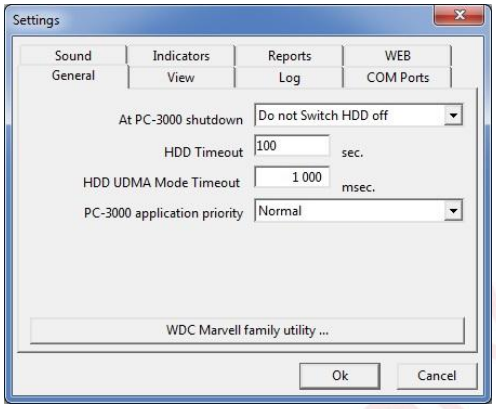


Fig.5.9.

Start the utility and wait until it reads the HDD ID. Perform automatic identification, switch the utility to Kernel mode and start it. Enter the utility and run «Tests» → «Work with service area» → «Solve "slow responding" problem».

You may also try using a different start method: lift the PCB of the 2.5" drive, wait until it reaches readiness, then lower the board and send the soft reset signal.

6. Board installation

What happens when another board with a matching number is installed on a WD drive instead of its native PCB?

Fig. 6.1. PCB identification number.

Configuration discrepancy occurs, namely:

- Mismatch of firmware version in ROM and the service area
- Adaptive settings in ROM module ID=47h are either incompatible with the preamplifier in the had, or differ considerably from the appropriate values. When the settings are compatible with the preamplifier and differ only marginally, SA reading/writing is possible.
- Different head maps may exist in ROM (ROM module ID=0Ah)
- Differences between the service area translators (ROM module ID=30h)
- Differences in the location of SA regions and their sizes (module ID=0Bh or ID=20Bh)
- Differences in the location of the DIR module (ID=0Bh or ID=20Bh)

In drive restoration we can distinguish between two different cases of installations of a non-native board. We'll refer to them as simple and complex cases.

ACE Laboratory for official users only

6.1. Simple case

If you find a board matching the original PCB of a malfunctioning HDD, both in family code (in Fig. 10 - 2061-701444) and the additional code (in Fig. 10 - 600), the probability of a successful HDD start and correct identification is quite high. In situations where a drive fails to start (indicated by an empty HDD ID) you have to try using another board (important note: another physical board should be used, not just different ROM versions written to the same board), or classify this as a complex case. Enter the utility in Normal mode and select restoration of the module ID=47h. Restore the module (it will be recorded as 47-new.ben file). Write the restored file of module ID=47h to ROM. Restart the HDD, at which point the drive should work correctly. This case is simple as all mismatches in the PCB configurations have been resolved.

6.2. Complex case

Step-by-step restoration procedure:

Step 1.

Install a functional board (the selected board should be as similar to the original one as possible as installation of a PCB with a non-matching ROM version is likely to damage the heads stack). Just as in the simple cases, the PCB code must match completely and matching of the additional code is recommended *(Fig. 6.1)*.

During board selection pay attention to the content of the ROM module ID=30h.

```
0x000: 52 4F 59 4C 01 00 1E 00 30 00 02 00 A4 3B F4 4C  ROYL....0...¤;ôL
0x010: 30 30 31 36 30 30 30 30 08 14 31 00 00 00 00 00  00160000..1.....
0x020: 34 00 00 00 3C 00 00 00 00 00 00 00 01 00 00 00  4...<...........
0x030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
0x040: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
```

Fig. 6.2. Sample ROM module ID=30h containing no hidden defects.

```
0x000: 52 4F 59 4C 01 00 1E 00 30 00 02 00 06 36 E7 4A  ROYL....0....6çJ
0x010: 30 30 31 36 30 30 30 30 08 14 31 00 00 00 00 00  00160000..1.....
0x020: 34 00 00 00 3C 00 00 00 01 00 00 00 01 00 00 00  4...<...........
0x030: 00 00 00 00 00 01 01 01 01 01 01 01 05 00 00 00  ................
0x040: 97 03 0B 00 00 00 00 00 00 00 00 00 00 00 00 00  —...............
0x050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
```

Fig. 6.3. Sample ROM module ID=30h containing hidden defects.

Module ID=30h should preferably not contain any hidden defects. *Figure 6.2* shows a sample module without hidden defects, whilst Figure 12 shows a sample module containing relocated defects. As this comparison of module content demonstrates, hidden defects are indicated by non-zero bytes beginning with the address 35h. If ID=30h contains hidden defects, a portion of the SA in the drive being restored may be unreadable.

After a functional board is installed and power is switched on, the drive must not stop rotation of the spindle motor. If the motor stops the board is either not a close enough match, or there are other damaged components other than the board: heads and/or preamplifier chip of the heads stack.

Step 2.

Start the loader from the HDD from which the board has been borrowed. This will allow SA access using ABA. In newer drives starting with a loader is required, otherwise you will be unable to write modules by ID (e.g., in Dragfly1 and later).

Step 3.

Try to read module ID=90h by selecting «Work with service area» → «View module 90 information» with the utility in kernel mode.

Unauthorized copy of distribution
of these documents is prohibited

```
Total heads.............................. : 8
Used heads............................... : 8
Mdl 47 version........................... : FJ.0013
ROM Version version...................... : 00W60054 (W6.54)
Mdl 11 Version........................... : 00W60054 (W6.54)
```

Fig. 6.4. Results of successful ID=90h reading output to log.

Readability of the data in module ID=90h allows us to conclude that the service area is readable and allows us to find out the original firmware version, along with the version of module ID=47h in the malfunctioning or lost original board.

Step 4.

Location of the DIR module may differ between the ROM from the original board and the ROM existing in the newly installed board. Therefore, neither the HDD nor the utility is «aware» of the current location of the modules in the service area. To address the problem you have to search for all the SA modules. Try to find them using the menu «Tools» → «Module search in SA» and then proceed to «Use Dir in utility». Then, make a backup copy of the SA modules.

Step 5.

Take a look at module 35. Does it contain defects? If it does, the SA translator in ROM should be recalculated using that module in order to generate a valid ROM module 30. The obtained module 30 should be saved and the module search run once again.

Step 6.

Restore the native ROM from module 109. The search window contains a special button for ROM saving.

Step 7.

Restore module 47 using the «Module 47 recovery» feature.

Step 8.

Enter the ABA location of module 01 in the ROM module 20B. Also check the size of the SA regions. Sometimes a 20B module from module 109 contains a considerably smaller region size compared to previous value.

During board selection you will have to perform ROM recording. Since ROM in many boards is built into the processor and there is no way to reprogram it in the case of damage or code mismatch, connecting an external ROM is appropriate. In the case of code-related problems in an external ROM, you can always unsolder and reprogram it.

6.3. External ROM installation

Western Digital PCBs exist in two configurations: models with an external serial FLASH ROM and models with built-in ROM inside the processor. All boards using internal ROM support installation of an external ROM, marked on all PCBs as U12. Merely installing a ROM programmed with a proper firmware version is insufficient. Together with the ROM installation you have to configure the board to load from the ROM chip using one or more resistors (depending on the drive family and ROM size). Configuration is accomplished using resistors R37, R38, R73, R74 and R75. *Figure 4* illustrates the scheme for connecting the resistors to the processor and control points. If a board contains no resistor mark you can find it by tracking the connection to a known control point.

ACE Laboratory
for official users only

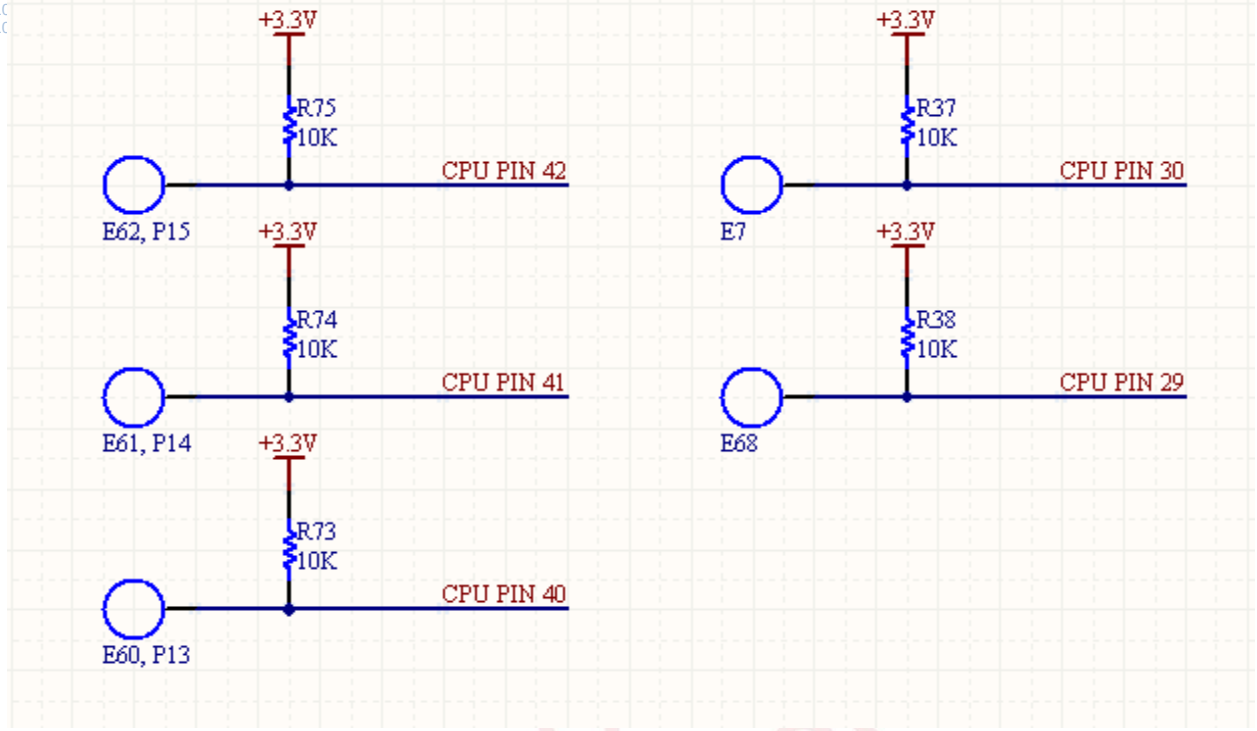


Fig. 6.5. Connection scheme for ROM configuration resistors.

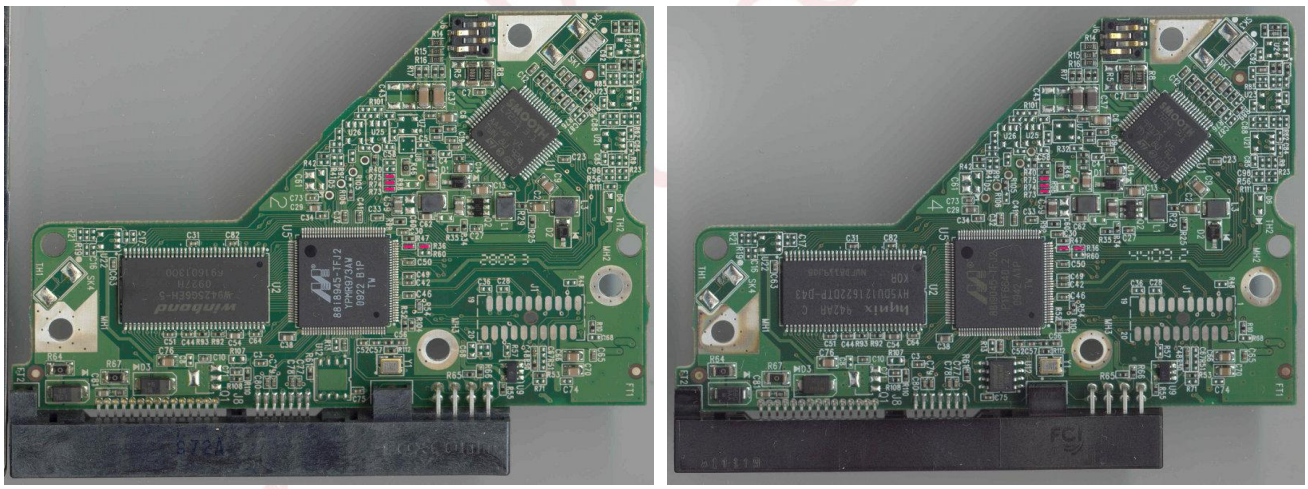


Fig .6.6. Location of the configuration resistors on a Dragfly2 PCB.

Unauthorized copy of distribution
of these documents is prohibited

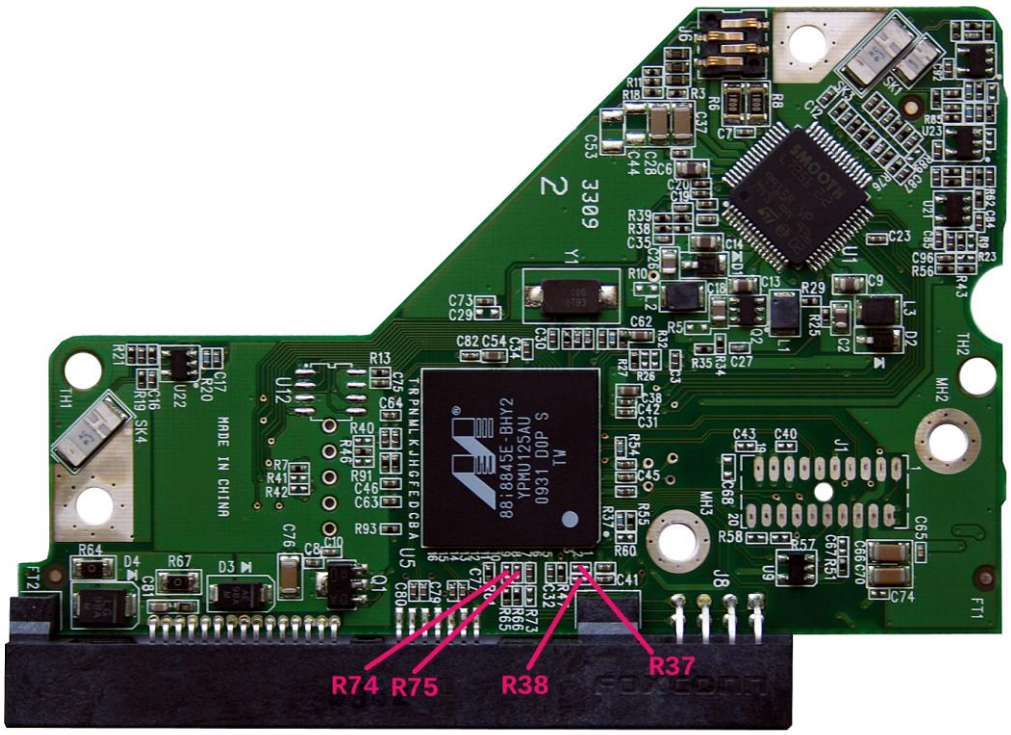


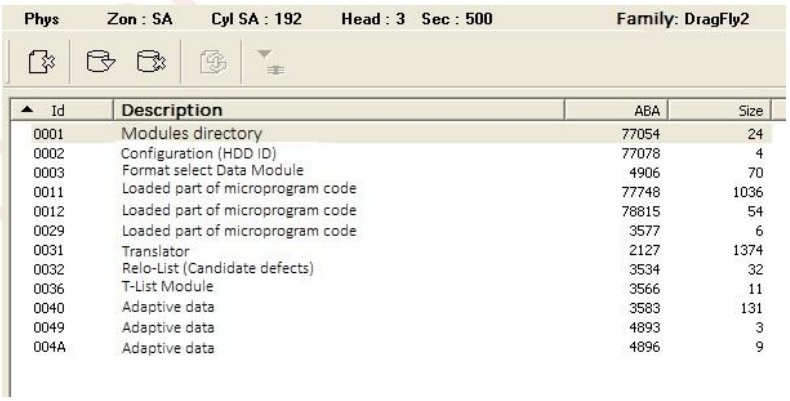
Fig.6.7. Location of the configuration resistors on a Mars PCB.

7. Minimum set of HDD modules for logic-based operation

We shall examine HDDs of the DRAGFLY2, WD7500AADS-00M2B0 drive families

During data recovery from damaged drives you often have to find out which modules are necessary to allow access to user data, and which modules are optional. The answer to this question depends on the specific HDD WDM model as the firmware logic largely depends on the firmware version.

Please see the DIR below which contains the minimum set of modules in the Dragfly2 drive family, ensuring drive operation with logical access:



Id	Description	ABA	Size
0001	Modules directory	77054	24
0002	Configuration (HDD ID)	77078	4
0003	Format select Data Module	4906	70
0011	Loaded part of microprogram code	77748	1036
0012	Loaded part of microprogram code	78815	54
0029	Loaded part of microprogram code	3577	6
0031	Translator	2127	1374
0032	Relo-List (Candidate defects)	3534	32
0036	T-List Module	3566	11
0040	Adaptive data	3583	131
0049	Adaptive data	4893	3
004A	Adaptive data	4896	9

Fig.7.1.

In this case many features, both standard (like S.M.A.R.T.) and factory (like format), will not work as the necessary overlays are missing.

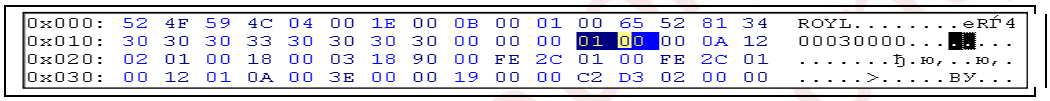
To identify the minimum set of modules necessary for work with logical access in the current version of the WDM utility of the PC-3000 suite, you must use the «DIR editor» tool. There are two methods of modifying module records:

deleting them from DIR and changing the ABA location, for example, by deducting 1. Unfortunately the current implementation of the editor only allows modification of one module at a time, so completing the task will require some patience.

The other method which is based on changing the location by - 1 is more convenient than the removal methodas you can easily start using the module again at a later stage by adding 1 to its location. The removal method also requires preserving backup copies of the corresponding modules in order to use them, if necessary. Before recording the modified DIR module, invoke the «Modules directory» mode and switch the power off/on without exiting the utility. When the drive reaches readiness you can check that logic-based access is available using the «Sector editor» tool. To ensure correct operation of the modified DIR, read any module from the modules directory by double-clicking it.

During experimentation a situation may arise where the drive stops the spindle and enters the kernel mode when powered up. This is due to an error in the logical sequence of the loading of firmware module 03. To return the drive to a functional state:

1) In Kernel mode of the utility establish which of the flash dir modules is active: 0B or 20B (using the «View and edit HDD resources» tool). You can identify the module using the value of the byte at offset 1Bh. If it is 01, the module is active (in use). If it is 00, the module is unused.



2) Use the appropriate HEX editor command, modify the ABA location of the DIR module by -1 and save the module.

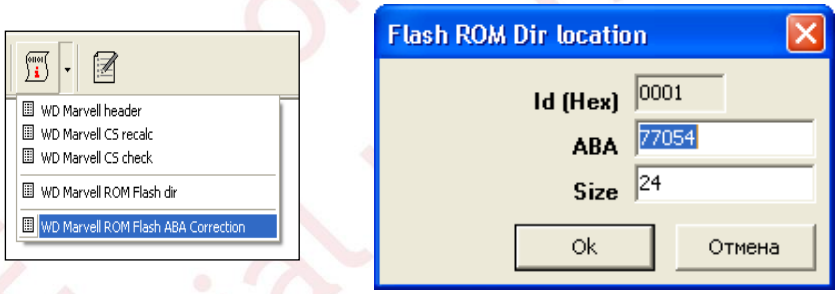


Fig.7.2.

3) Toggle the power off/on. Wait until the drive reaches readiness and check that the disk is rotating. Identify the drive family automatically and start the LDR file from the utility start-up menu.

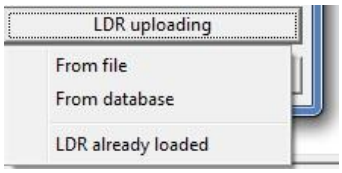


Fig.7.3.

After starting with the LDR switch the selector to «Use resources from» to «Profile» and specify the original DIR module before modification.

4) Write the correct DIR module to both copies or fix any other problems. Please note that ID-based recording will not be available as the DIR module is not loaded into HDD memory.

5) Restore the initial DIR location modified during step 2.

Unauthorized copy of distribution
of these documents is prohibited

8. Drive restore examples

8.1. Restoring a 2.5" Zephyr drive

Observations: When the power supply is switched on the drive enters the ready state, but freezes when it attempts to read HDD ID. The platters continue to rotate and no head knocking is audible. Supposedly we are dealing with a firmware freeze here. We proceed to the restoration.

Step 1

Fig.8.1. Inserting insulation.

Fig.8.2. Another variant of insulator insertion.

Unauthorized copy of distribution
of these documents is prohibited

The HDD will not react to any command in the «busy» state. To access the service area, you have to activate the kernel mode. There is no way to enable the kernel mode only by software means, but you can physically disconnect the PCB from the preamplifier and heads positioner by inserting insulating material between the electronics board and the HDA connector *(Fig.8.1*Fig.8.*)*. It is essential to leave the spindle motor contacts connected during the procedure to prevent the HDD from freezing during the motor start routine.

After inserting the insulator, switch on the power supply and, after approximately 20 seconds, the drive will reach the ready state, provided the electronic components are at least partially functional.

Launch the utility, click the «Autodetect» button and select «Utility start». The utility is started in Kernel mode. Now read the HDD ROM and save it to a profile. Open «Work with ROM» → «SA regions editor». The editor will display the content of the active module in the ROM map (ID=0Bh or ID=20Bh). Click the «Do it now…» button and select «Block SA access» in the displayed menu. Click «OK», switch off the HDD power supply, remove the insulator and attach the PCB back onto the HDA.

Step 2

Switch on HDD power supply. Similarly to the previous step, start the utility in Kernel mode. Select the menu item «Work with service area», and view information from module ID=90h. As you can see in the utility log, information cannot be retrieved, i.e. the service area is unreadable. To restore the drive to the original condition, switch the HDD power off and on and select «Tests» → «Set kernel mode». Then select «Work with RAM» → «LDR file loading». During this step please keep in mind that you need to have a firmware copy from a HDD with the same ROM version stored as a record in the firmware database of your PC-3000 suite, or as a file. Select loading from database and click the search button. The firmware version will be substituted in the search settings. Select the found resource and click «LDR uploading». After a while the utility will display the message: «LDR has been uploaded successfully».

Step 3

Exit the utility and reopen it. Click the «Autodetect» button and start the utility in Normal mode. After a few initialization steps you will see a dialog requesting the SA parameters *(Fig. 8.3)*.

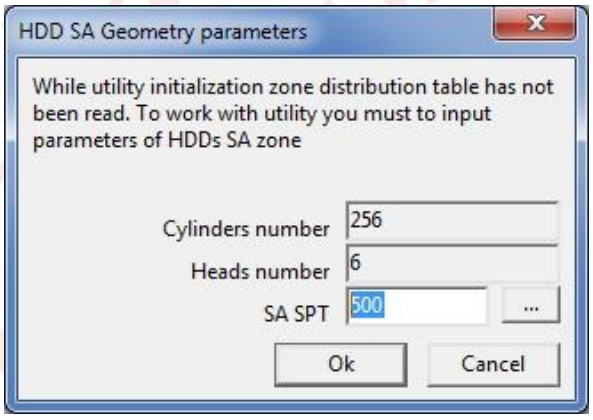


Fig. 8.3. SA parameters dialog.

Click the «…» button to detect the number of sectors in the service area. If the utility succeeds in reading the data, the actual number of sectors will appear in the SA SPT line instead of the default value of 500. Click «OK», the utility will complete the initialization procedure. Read the service area by selecting «Tests» → «Service information» → «HDD resources backup». Deselect the «tracks» option, as reading them takes quite a while and these items are not required during restoration. Typically, if a drive freezes because of one or more malfunctioning heads, the backup copying procedure completes successfully and copies all modules.

Step 4

Check the service information structure. In the example used, all modules are displayed as intact after the test. HDD freezing is then related to problems in the automatic subsystem which searches for defects and stores them in module ID=32h. To address the problem, select «Service area» → «Solve “slow responding” problem». During the start of the procedure the utility will display the following settings window *(Fig. 8.4)*. The solution consists of disabling shadow scanning of the disk surface and clearing of already found surface defects.

Unauthorized copy of distribution
of these documents is prohibited

To make SA modification safer you can change just the zero copy, selecting the command to write using ABA and leaving only copy 0 selected. Then, click «OK» and monitor the progress of the procedure via the log.

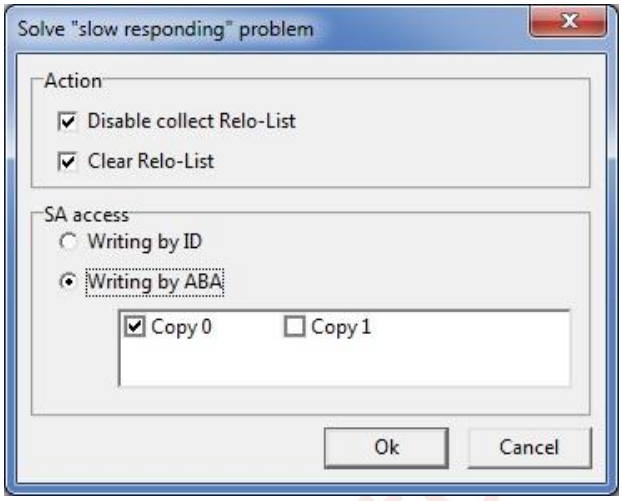


Fig. 8.4. Settings window for the slow response problem solution.

Step 5

Now you have to allow access to the service area, which was blocked in the first step. Select «Work with ROM» → «SA regions editor», select region 0, press [F2] and restore its original location by deducting 1. Click «OK». Thus, the drive will only see copy zero of the SA containing the necessary corrections. In the example being used, drive restart resulted in it starting up correctly, providing an opportunity to copy user data. As was discovered later, the drive had been damaged approximately in the middle of the user data area, this being the cause of problems as the subsystem was hiding defects on the fly.

8.2. Restoring a 3.5" Sadle G6 drive

Observations: at power-on the drive fails to report on readiness. Approximately one minute after power was switched on the DRD & DSC register lights go out and the spindle motor stops. No heads knocking is audible. A malfunction of one or more heads is assumed.

Step 1

Start the utility, having disabled HDD ID reading. The utility start mode switch will automatically be set to Kernel mode. Click «Autodetect», the utility recognizes the drive as Sadle G6 and starts up. During start up it returns the error «Debug Stop Code: HOST DEBUGSTOP RESET TIMEOUT». Read the HDD ROM and save it to a profile. Select the menu «Work with ROM» → «SA regions editor». The editor will display the contents of the active module in ROM map (ID=0Bh or ID=20Bh). Click the «Do it now…» button and select «Block SA access» in the displayed menu. Click «OK» and switch off the HDD power supply. After a short while switch the power back on and restart the utility.

Step 2

Start the utility in Kernel mode and select «Work with RAM» → «LDR file loading». During this step please keep in mind that you need to have a firmware copy from a HDD with the same ROM version stored as a record in the firmware database of your PC-3000 suite, or as a file. Select loading from database and click the search button. The firmware version will be substituted in the search settings. Select the found resource and click «LDR uploading». After a while the utility will display the message: «LDR has been uploaded successfully». After the procedure select «Tools» → «HDD» → «Recalibration». An error will be returned during the calibration process, but the goal will be achieved: access to the service area will be available. To verify this, select the menu item «Work with service area», and view information from module ID=90h. The first two access attempts will trigger an error, but the third attempt will return the information about the number of heads and versions of some essential modules, meaning that the service area is accessible.

ACE Laboratory
for official users only

Step 3

Leave the power on, exit the utility and reopen it. Toggle the utility start switch to Normal, and in the menu displayed after clicking the «LDR uploading» button, select the «LDR already loaded» option. Launch the utility.

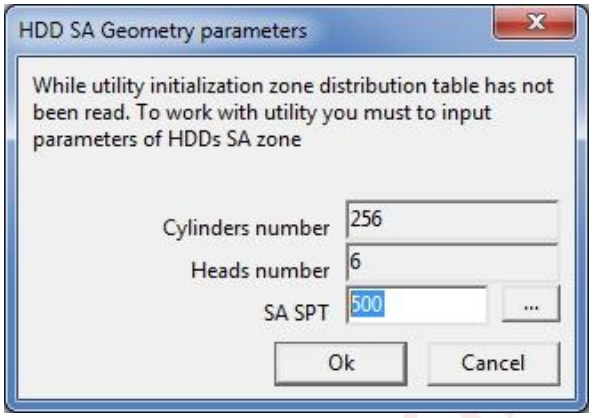


Fig. 8.5. SA parameters dialog.

After a few initialization steps you will see a dialog requesting the SA parameters *(Fig.8.5)*. Click the «…» button to detect the number of sectors in the service area. If the utility succeeds in reading the data, the actual number of sectors will appear in the SA SPT line instead of the default value of 500. Click «OK», the utility will complete the initialization procedure. The log indicates that the Dir module is not readable by ID, but is still accessible via direct reading of the service area sectors. Read the service area by selecting «Tests» → «Service information» → «HDD resources backup». Deselect the «tracks» option, as reading them takes quite a while and these items are not required during restoration.

Step 4

Check the service information structure. In example used, all essential modules are displayed as intact after the test. HDD freezing is then related to problems in the automatic subsystem which searches for defects and stores them in module ID=32h. To address the problem, select «Work with service area» → «Solve “slow responding” problem». During the start of the procedure the utility will display the following settings window *(Fig. 8.6)*.

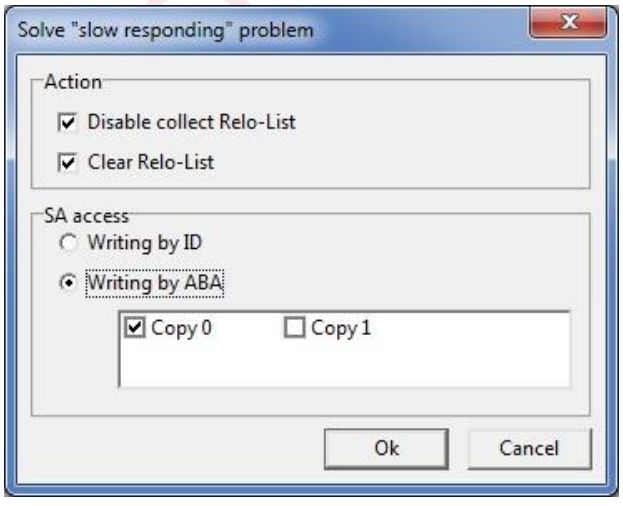


Fig. 8.6. Settings window for the slow response problem solution.

The solution consists of disabling shadow scanning of the disk surface and clearing of already found surface defects.

To make SA modification safer, you can change just the zero copy, selecting the command to write using ABA and leaving only copy 0 selected. Click «OK» and monitor the progress of the procedure via the log.

ACE Laboratory for official use only

Unauthorized copy of distribution
of these documents is prohibited

Step 5

Now you have to allow access to the service area, which was blocked in the first step. Select «Work with ROM» → «SA regions editor», select region 0, press [F2] and restore its original location by deducting 1. Click «OK». Thus, the drive will only see copy zero of the SA containing the necessary corrections. In the example being used, drive restart resulted in it starting up correctly, providing an opportunity to copy user data. As was discovered later, the drive had been damaged approximately in the middle of the user data area, this being the cause of problems as the subsystem was hiding defects on the fly.

8.3. Restoring a 3.5" Sadle BK drive

Observations: at power-on the drive fails to report on readiness. Approximately one minute after power was switched on the DRD & DSC register lights go out and the spindle motor stops. No heads knocking is audible. A malfunction of one or more heads is assumed.

Step 1

Start the utility, having disabled HDD ID reading. The utility start mode switch will automatically be set to Kernel mode. Click «Autodetect», the utility recognizes the drive as Sadle BK and starts up. During start up it returns the error «Debug Stop Code: HOST DEBUGSTOP RESET TIMEOUT». Read the HDD ROM and save it to a profile. Select the menu «Work with ROM» → «SA regions editor». The editor will display the contents of the active module in ROM map (ID=0Bh or ID=20Bh). Click the «Do it now…» button and select «Block SA access» in the displayed menu. Click «OK» and switch off the HDD power supply. After a short while switch the power back on and restart the utility.

Step 2

Switch the drive's power supply on. Similarly to the previous step, start the utility in Kernel mode. Select the menu item «Work with service area», and view information from module ID=90h. As you can see in the utility log, information cannot be retrieved, i.e. the service area is unreadable. Searching for a LDR with the same version returned no results, so we have to try restoring the drive without it.

Step 3

Edit, in RAM, the module containing the map of regions. To do this you have first have to check the utility log generated during utility start to identify the active map module. The message «Flash ROM dir (ext) reading..... : Ok (Active)» means that the active module is ID=20Bh. Otherwise (just the message «Flash ROM dir reading..... : Ok» is returned) the active module is ID=0Bh *(Fig. 8.7.)*.

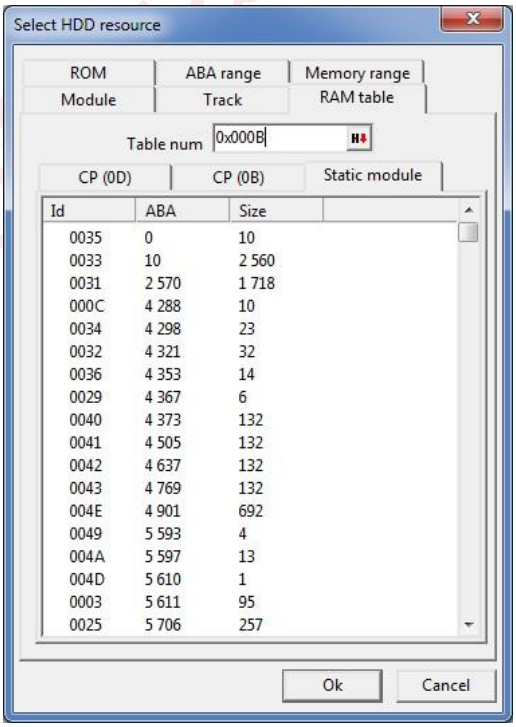


Fig.8.7. ID=0Bh module reading from RAM.

Use the «View and edit HDD resources» feature. Select the «RAM table» tab and input in the «Table num» entry line, the active Flash ROM dir (ID=0Bh or ID=20Bh). In this case it is the module ID=0Bh. Now use the hex editor extension «WD Marvell ROM Flash RGN correction» to change the initial region address back from 0 *(Fig.8.8).*

After completing the editing you have to save the changes to the HDD by clicking the «Write data to HDD» button.

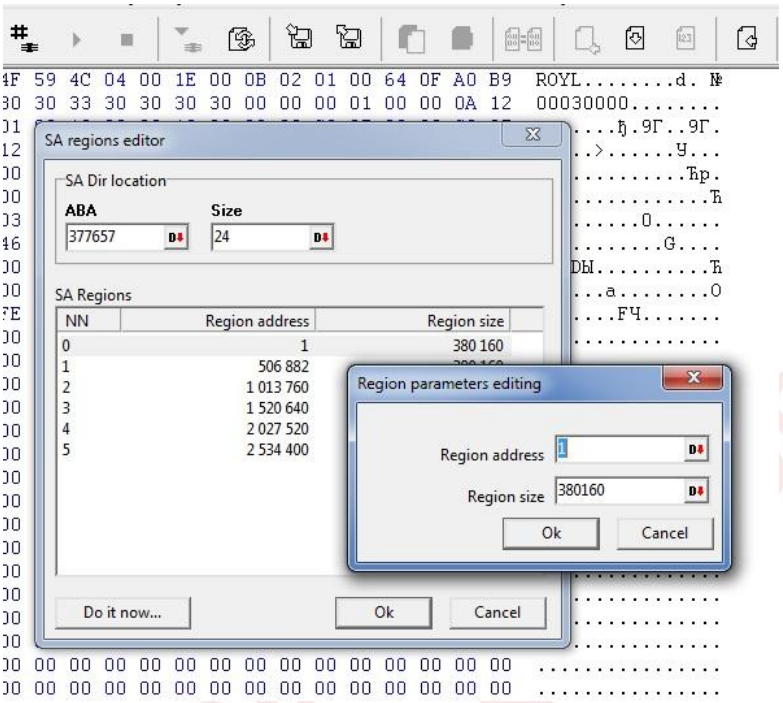


Fig. 8.8. Editing the regions map in RAM.

Step 4

Check the readability of modules ID=90h and ID=01h to ensure that the service area is accessible. Module ID=90h has a peculiarity: its physical location is always fixed and hardcoded in the firmware: cyl=-1, head=0 or 1, sector=0. It is also not included in the modules directory, thus being safe from corruption caused by software failures during drive operation or accidental overwriting of service area items. In this example, both modules are readable.

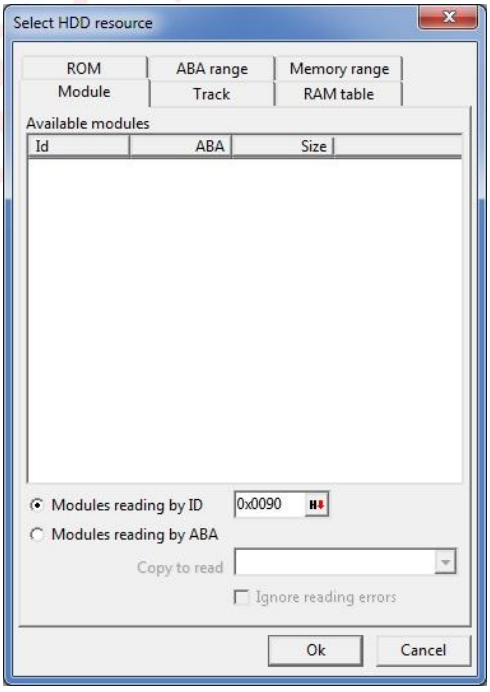


Fig. 8.9. Reading the module ID=90h using its ID location.

Unauthorized copy of distribution
of these documents is prohibited

Step 5

In the open hex editor window containing the module ID=01h, use the commands to «Select all» and «Copy». Select «View and edit HDD resources» → «RAM table» and input 01 in the «Table num» entry line *(Fig.8.)*. Insert, into the read data, the copied content of the module ID=01h and save the changes. Send the HDD recalibration command.

Step 6

Check to ensure that the previous step completed successfully. To do this, try to read modules using their ID, for example, module ID=02h (*Fig. 8.9*, just input 02 instead of 90). Restart the utility in Normal mode. Make a backup copy of the modules, accessing them by ID.

Attention! Operations via ABA or CHS are not available.

Step 7

Now we have the original LDR file (11.rpm) and starting from it can be attempted.

After loading of the file l the calibration command is sent. Typically, the calibration procedure completes with an error, but the disk continues to function. Operations via ABA and CHS are now available.

Step 8

Check the service information structure. In the example used, all essential modules are displayed as intact after the test. HDD freezing is then related to problems in the automatic subsystem which searches for defects and stores them in module ID=32h. To resolve the problem, select «Service area» → «Solve "slow responding" problem». During the start of the procedure the utility will display the following settings window *(Fig. 8.10)*.

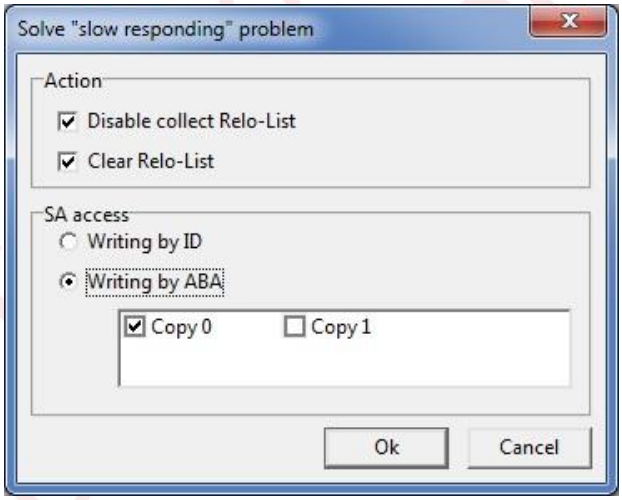


Fig. 8.10. Settings window for the slow response problem solution.

The solution consists of disabling shadow scanning of the disk surface and clearing of already found surface defects.

To make SA modification safer you can change just the zero copy, selecting the command to write using ABA and leaving only copy 0 selected. Then, click «OK» and monitor the progress of the procedure via the log.

Step 9

After a restart the drive still fails to start correctly. We start the LDR file (11.rpm) again. After starting with the loader we send the calibration command and discover that the drive has started up correctly. As confirmation we send a soft reset signal and gain reading access to the entire surface of the user area (LBA access).

We should note that not all Sadle G6 drives follow this behaviour pattern. Many drives return error 0101 when starting with a LDR file during step 7. However, if during step 5 a software reset command is sent instead of calibration, the drive will load, from the service area, the 11.rpm overlay and stop the loading procedure. This is because overlay initialization will trigger loading of the module ID=0Bh (or ID=20Bh) from drive ROM making the service area inaccessible for the drive again. However, the utility will be able to function without problems via ABA, providing you with a way to make the necessary corrections (e.g., address the slow response problem).