# BRUT

## Technical Manual

1991-12-09

Bildbehandling AB

AGEMA internal use only

# Preface

This manual is in the process of being written and is therefore incomplete in some areas. Any suggestions on improvements are gratefully accepted.

The reader of this manual needs at least a basic undertanding of normal BRUT operation and familiarity with the BRUT command set. In addition, the following manual should be easily at hand:

**Burst Recording Unit Reference Manual**

Any problems related to BRUT maintenance should be directed to:

Bildbehandling AB
P.O. Box 6117
S–580 06 Linköping
SWEDEN
Phone: +46 13 140000
Fax: +46 13 144069

# Contents

# 1. Functional Description

## 1.1 External Controls and Connectors

The front panel of the BRUT provides access to the I/O units. The BRUT may have just a floppy disk drive or a floppy and a tape drive. The tape drive can either be a 1/4" cartridge tape drive or a DAT. There is also a power indicator. The vents in the panel must never be blocked!

The rear panel holds all signal connectors, the mains inlet, and the mains voltage selector. The inlet integrates the power input, the power switch and the mains fuses. The fuses can be accessed after removing the mains plug and prying the fuse compartment open with a small screwdriver. Note that *both* fuses must be installed. There is also a mains fuse *inside* the power supply unit.

The voltage selector has two positions: 110–120 and 220–240 volts operation. Before operating the system for the first time **make sure the selector is properly set!!**

In the present BRUT system, the following signal connectors are being used:

- Scanner A connector. Power fuse on interface board. (SC, SRS, SWD)
- Scanner B connector. Power fuse on interface board. (DC, DRS, DWD)
- TTY connector for VT100 compatible terminal
- Control connector for the keyboard with a trackball. Power fuse on main board next to connector.
- Video connector, PC super–VGA compatible
- Trig input connector for trig input and alarm output
- Ethernet/Cheapernet BNC connector
- An optional TV input BNC connector

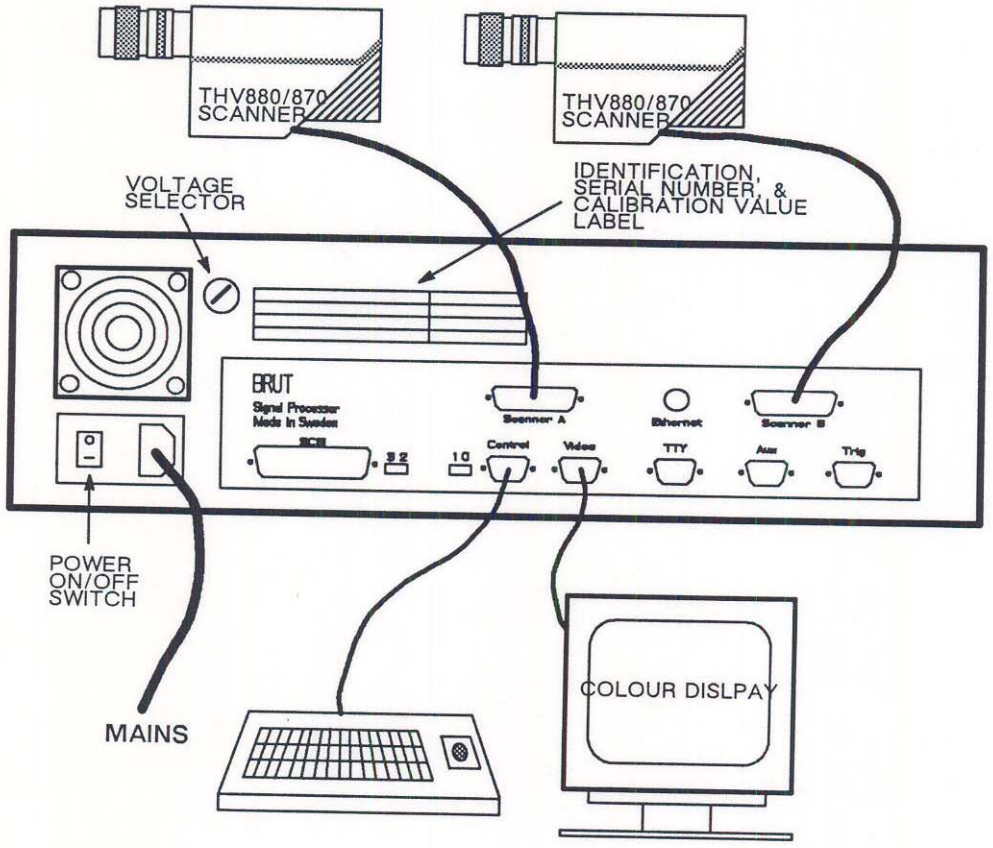



Figure 1: BRUT Rear view

## 1.2 Subunit Overview

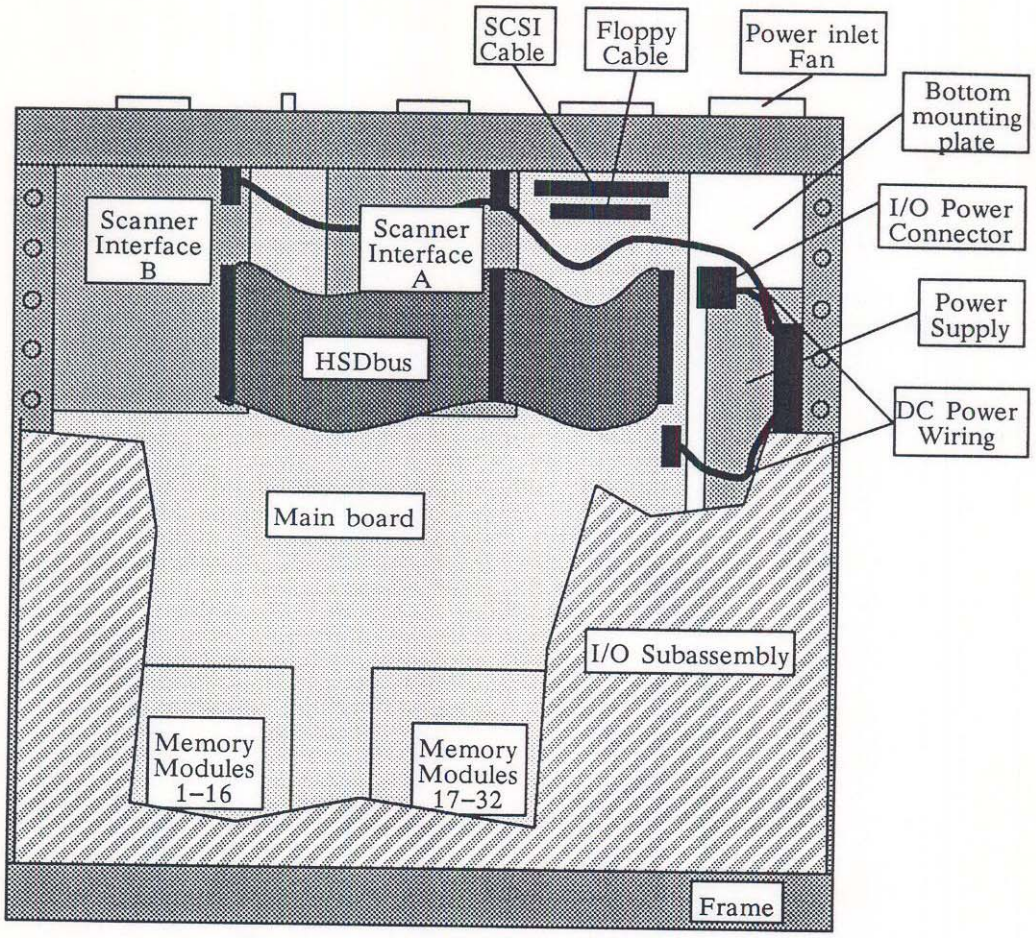



Figure 2: BRUT Subunits (I/O subassembly cables not shown)

The BRUT is composed of a number of physical subunits, all mounted inside the *enclosure*. The enclosure consists of *frame, bottom mounting plate, top cover, bottom cover, front panel,* and *rear panel*. The *I/O subassembly* is mounted on top of the frame under the top cover.

The bottom mounting plate holds the *main board* and the *power supply*. The *scanner interfaces* are mounted 40 mm above the main board. All signal connectors, both on the main and the scanner interface boards, are bolted to the *connector panel* which in turn is fastened to the rear panel. The connector panel is part of the main board and should never be removed from it.

Also mounted to the rear panel are the *power inlet,* the *voltage switch,* and the *fan*. The BRUT type designation, serial number, and calibration constants are found on the label in the upper center part of the rear panel.

The front panel only has the power LED attached to it.

The I/O subassembly holds all I/O units. The tape drive and the floppy disk drive are mounted to the plate with the two *I/O mounting brackets*. The small 105 Mbyte and the large 1.3 Gbyte hard

disks are mounted in a similar fashion. Note that the units are mounted *under* the plate as seen in installed position.

The cabling inside the BRUT consists of AC and DC power wiring and signal cables. The *mains power wiring* runs from the mains inlet and the voltage selector to the power supply. The *DC power wiring* connects the power supply to the main board, the scanner interfaces, the fan, and and the I/O subassembly. There is also wiring between the front panel power LED and the main board. The signal cables are ribbon type. There is one for the HSDbus between the scanner interfaces and the main board, one cable between the floppy unit and the main board, and one between the SCSI units (tape and winchester disk) and the main board.

## 1.3 Block diagram

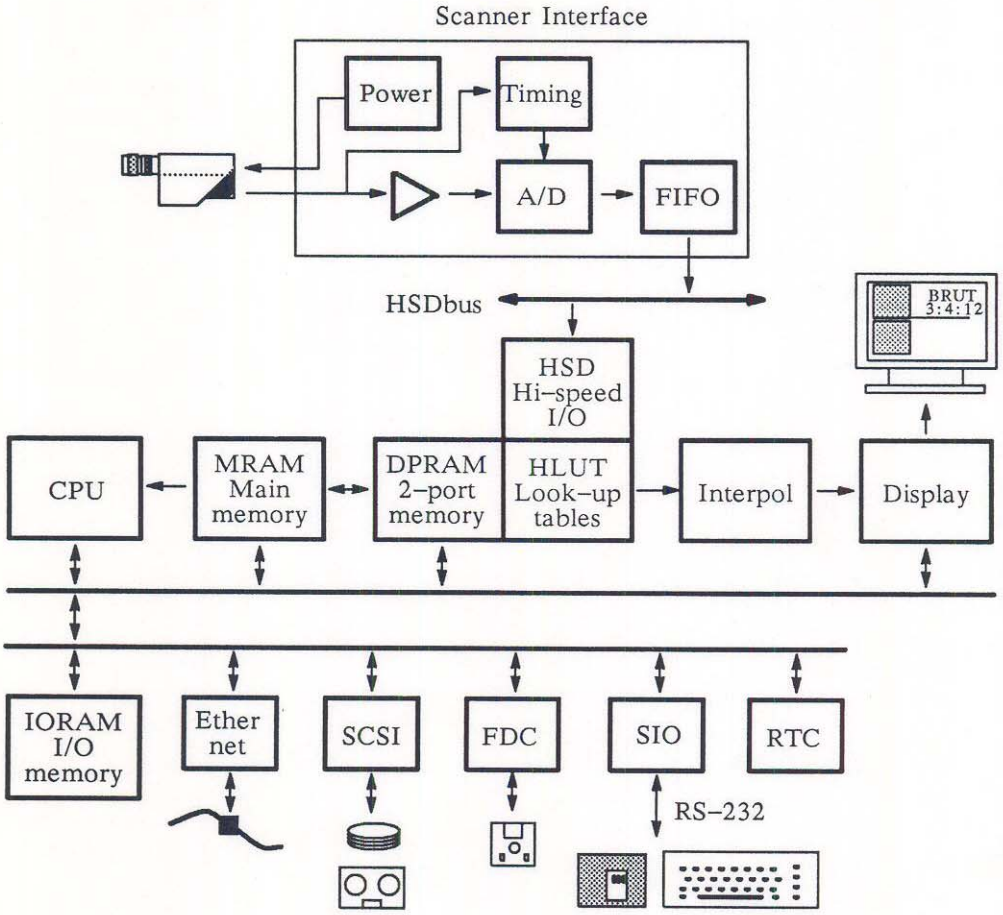



Figure 3: BRUT Block diagram

### Main Board

The BRUT architecture is most conveniently described by a number of distinct functional units, see Figure 4. Most of these are found on the main board while the scanner interfaces and I/O units are separate entities. On the main board there are six major functional blocks: the *central*

*processor*, in charge of all control and general computations, the *memory system*, including the main memory (MRAM) and interfacing to the high–speed channel, the *medium–speed I/O system* with standard computer interfaces, the *high–resolution display* which accepts data in real–time from the *interpolator*, and finally the *high–speed data channel* incorporating signal processing capabilties.

The CPU is the AMD 29000, a 32–bit RISC processor with separate instruction and data buses. In the BRUT application it yields 20 MIPS peak and approximately 6 MIPS sustained performance. The program and data are stored in the main memory (MRAM) which also serves as recording medium (RAMdisk). A single PROM device holds the initial bootstrap routines used on power–up.

The main memory forms the heart of the BRUT architecture. A combination of somewhat unconventional data paths and the CPU's unique capabilty for burst data transfers, enables very high speed data transfers into and out of MRAM. The HSD section is completely self–contained and communicates with the CPU through DPRAM. Three distinct, bidirectional data streams run between MRAM and DPRAM. One stream communicates directly with external devices such as scanner interfaces via the HSDbus while the other two feed the signal processing parts. The communication mechanism is based on double–buffering. The signal processing part is composed of a multiplier–accumulator and a set of lookup tables (HLUT). The tables are used for the level–range conversion, mapping 12–bit IR–pixels into 8–bit values fed to the interpolator. They are also used to correct and linearize data being input over the HSDbus. The HSDbus is 16 bits wide and fully synchronous, the timing determined by the main board, presently 16 MHz. It utilizes a block–oriented master–slave protocol with centralized arbitration. Up to eight different data sources/sinks can use the bus concurrently.

One characteristic of the system is the unusually fast HSD channel for I/O. Another is the complete set of standard computer interfaces such as SCSI, Ethernet, and RS–232. In order to minimize the overhead on data transfers, these medium–speed I/O units reside on a separate bus with its own local data memory for disk and Ethernet DMA. This ensures that the main data bus is devoted to high speed burst transfers while the I/O bus trots away at its own moderate pace. Besides the SCSI and Ethernet interfaces (the latter with on–board transceiver), the I/O system also incorporates eight lines of serial I/O, a floppy disk controller, and a real–time clock. There are also two digital inputs and two digital outputs dedicated to external trig signals.

The display section is centered around a multiport image memory. It is accessed by the video output circuitry as well as the CPU and the interpolator data input channel. The video output is fully software programmable for any display format with a pixel rate of up to 80 MHz. The memory is organized as 512 lines by 1024 pixels or 640 by 768, software programmable. Each pixel comprises 12 bits, eight of which are used for image data and the remaining four for the graphical overlays. A two–level lookup table converts the pixel stream into 3 x 8 bits before D/A conversion into red, green, and blue video signals.The image portion of the display memory may also be updated by the interpolator. The interpolation method used is either nearest–neighbor or bilinear. The zoom factor is programmable between four times reducation up to 64 times magnification.

**Scanner Interface**

The scanner interface is composed of four main blocks. The *A/D converter* digitizes the scanner video and converts it into a 12–bit digital pixel. The pixels are put into the *communication FIFO* which collects three full lines of 140 pixels each before shipping them off to the main board via the HSDbus. The *timing generator* synthesizes the sampling clock for the A/D conversion and indicates the active portion of the video signal. Finally, the *power supply* keeps the scanner cool (870 only) and running.

The video input circuitry encompasses a differential signal receiver and a two–position programmable attenuator. The latter provides the Gain X2 function of the BRUT system giving higher resolution at the cost of a reduced upper temperature limit. After passing an anti–aliasing filter, the signal is fed to the monolithic A/D converter. In addition to the principal functions, there is also a calibration mechanism for the analog video input circuitry and the A/D converter. This is activated under software control during the scanner interface calibration procedure.

The timing of the A/D conversion is based on the scanner line syncs. A phase–locked loop synthesizes the sample clock from the sync pulses. A programmable sequencer keeps track of the position in the image and enables data transfers to the main board. The transfers of three–line packets over the HSDbus is initiated automatically when a packet is completed in the FIFO.

The 870/880 series scanners require a host of supply voltages. These are all generated on the board from the BRUT 12–volt supplies. For the 870 unit, the TE–cooler power is also generated by the board.

# 2. System Setup

## 2.1 System Parameters

Essentially all system parameters are part of the BRUT software and are set to fixed default values at every system startup. There is however a small number of parameters that are system unique and for the matter of convenience should be retained when power is shut–off. The realtime clock features a small memory area in addition to the time and date functions which is used for that purpose. In the present software version (3.1) the following parameters are retained:

- Ethernet address
- Scanner interface calibration values
- Date and time

The scanner calibration values, date, and time are automatically read and updated by the BRUT software and need to further explanation. The Ethernet address however is set from the BRUT monitor program and requires a few extra steps. The Ethernet address of the system is a unique six byte (48 bit) entity. It is set before delivery of the system, although for testing purposes it is sometimes convenient to change it to a different value.

**Setting the Ethernet address**

1. Determine the new six byte Ethernet address. It is normally written with each byte separated by colons. Example: 8:0:20:0:0:1
2. Power–up the system and type ctrl–C before it has booted. This brings you to the BRUT monitor.
3. At the monitor prompt, type **q 10**.
   Argus> **q 10**
4. At the address prompt, start typing the address bytes each separated with CR. After the last CR, type .CR (period CR).
   10: 23 ? **8**
   11: 11 ? **0**
   12: 98 ? **20**
   13: 02 ? **0**
   14: 22 ? **0**
   15: 78 ? **1**
   16: 10 ? **.**
   Argus>
5. The Ethernet address should then be checked. This is done by typing **b** at the monitor prompt. The message output contains the Ethernet address in the colon notation. (This can be done with or without the Ethernet cable connected.)

## 2.2 Scanner Interface

The scanner interface has two things that must be checked when a new board is installed into the system. The first is the board address and the second the video input calibration.

**Board address**

The scanner interfaces communicate with the main board over the HSDbus. Since there is usually more than one interface on the bus, the board address must be selectable. The address decides whether the board appears to software as the Channel A or the Channel B board.

The board address is determined by jumper S12 and two jumpers in the S6 field. Also, the HSDbus must be terminated at the leftmost board (normally channel B). This is ensured by resistor networks R56 and R57 and jumper S10. The leftmost and *only* the leftmost board must *always* be terminated.

Channel A:

Jumper S12 and two jumpers at "4" in S6

Channel B:

No S12 jumper, two jumpers at "5" in S6

Termination (normally on channel B):

Insert R56, R57 and S10. Note the orientation of R56 and R57.

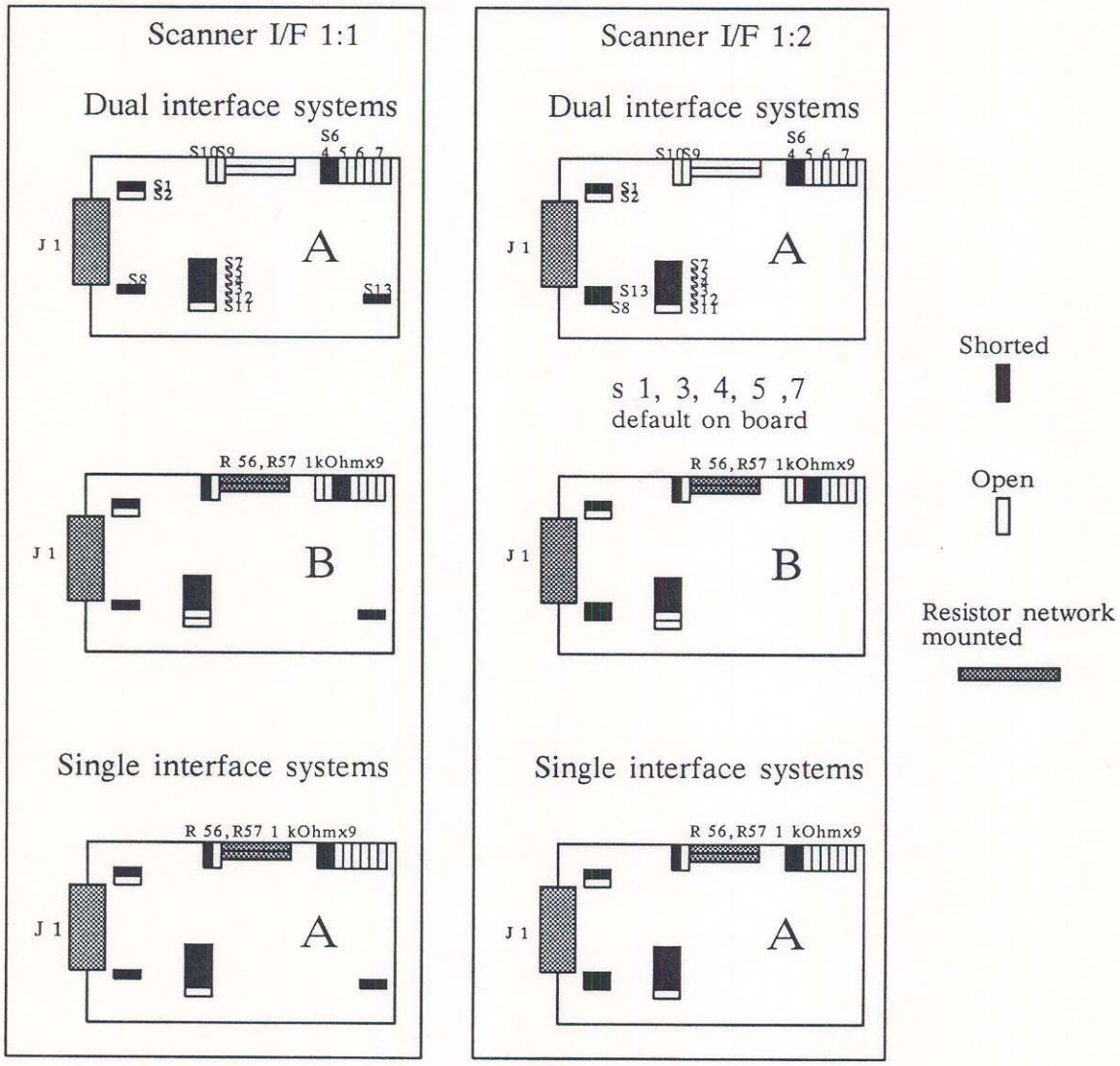



Figure 4: Interface board jumpers and terminations

### Board Calibration

The scanner interface contains sensitive analog circuitry which must be calibrated after any analog parts have been replaced. In general it is a good idea to calibrate an interface board whenever it is installed into the BRUT. The calibration procedure is part of the BRUT software which provides a step by step walk–through on the terminal screen.

Refer to Appendix A of the BRUT Reference Manual for a description of the calibration procedure. Note that jumper S8 must be installed during calibration.

### Date and time

Setting correct time and date can be done from the BRUT software with the DATE and TIME commands. When the system boots it outputs current date and time and *day of week*. The day of week might need adjustment. This is done from the BRUT monitor with the command

```
Argus> n 1
```

The system will respond by asking about date, day of week, and time.

# 3. Unit Assembly – Disassembly

## 3.1 General

The following set of tools is required for the assembly/disassembly of the BRUT and subunits.

- 5 mm socket wrench
- 7 mm socket wrench
- Pointed pliers
- No 2 Pozidrive screwdriver
- No 1 Pozidrive screwdriver
- 5 mm normal screwdriver
- 5.5 mm socket wrench (only needed for main board removal)

**Do NOT use adjustable wrenches or non-metric (yuck!) tools!**
The above set with the proper tools can be purchased from Bildbehandling AB.

ALWAYS disconnect power before removing or installing any parts of the BRUT.

## 3.2 Scanner Interface

The scanner interfaces are removed and reinstalled using the following procedure.

1. Disconnect the scanner.
2. Remove top cover.
3. Disconnect the HSDbus and power connectors from the interface board.
4. Remove the two screws holding the scanner connector to the rear panel. Use a 5 mm socket wrench on the screws and pointed pliers to hold the nuts at the back of the connector. *Be careful not to drop the nuts into the BRUT!*
5. Remove the two nuts holding the board. Use a 7 mm socket wrench.
6. Remove the board.
7. Check the channel select straps of the new board, see Section 2.2.
8. Install the new board. Make sure that the outer metal shield of the scanner connector is in place and properly oriented.
9. Insert and tighten the connector screws and nuts. Use the 5 mm wrench and pointed pliers.
10. Tighten board nuts with the 7 mm wrench.
11. Reconnect power and HSDbus connectors. Make sure the power connectors are properly aligned to the sockets.
12. Start the system and calibrate the new scanner interface, see Section 2.2.
13. Mount top cover.

## 3.3 I/O Subassembly

The I/O subassembly consists of a large aluminum mounting plate and two mounting brackets for the tape and floppy disk drives. The hard disk, whether it is a small or a large one, is mounted in another pair of brackets.

The procedure for removing and installing the I/O subassembly is as follows:

1. Remove top cover.
2. Disconnect the power connector at the power supply and disconnect the floppy and SCSI cables from the main board.
3. Dismount the front panel after removing four or eight Pozidrive screws. Be careful not to strain the wire to the panel LED.
4. Remove three or four Pozidrive screws securing the plate to the frame. On older systems you need to use a 7 mm socket wrench to hold the nuts.
5. Carefully lift the subassembly from the frame and place it upside down (I/O units facing upwards) on the table.

## 3.4 I/O Units

1. Disconnect the power and ribbon cable from the unit(s) to be replaced.
2. Put the I/O subassembly with the Winchester disk facing downwards and remove four screws holding it to the plate.
3. Remove four screws on each of the tape drive and the floppy disk unit to separate them from the mounting brackets.
4. Check the switch settings of the new unit(s) to be installed, see appendix A.

## 3.5 Memory Modules

The BRUT comes equipped with a varying amount of main memory. The main memory holds the BRUT program and also serves as recording medium. The BRUT is normally equipped with the minimum amount: 8 Mbytes. RAM oriented systems have at least 16 Mbyte. Memory size is always a multiple of 4 Mbyte.

The amount of memory can be changed at any time but should be avoided since excessive removal/installation of memory modules imposes stress on the board and sockets. Be very careful when you install and remove the modules as the sockets are easily destroyed. The memory modules *must* be upgraded in multiples of four and the following procedure should be used. *Note that normal ESD precautions must be taken!*

1. Remove top cover.
2. Remove I/O subassembly
3. Locate the two main memory areas at the front of the main board. Modules are added from back to front, with no empty slots. The first 16 modules are installed in the leftmost area and further modules in the rightmost.
4. Take the module by the edges and insert it into the socket.
5. Before reinstalling anything, turn the system on and check the PROM monitor printout. If the displayed memory size differs from the expected value, turn power off and check that all modules are properly seated.
6. Reinstall I/O subassembly and top cover.

## 3.6 Power Supply

The power supply hardly ever needs to be replaced, but in some rare cases eg with the voltage selector in the wrong position, the internal fuse must be replaced. Only replacing the fuse however does *not* require the disconnection of the wires as described in the following procedure.

1. Remove top cover and I/O subassembly.
3. Remove bottom cover. Do *not* turn the BRUT upside down, but lift the BRUT from the cover after removing the screws.
4. With the BRUT slightly over the edge of the table, remove the two outmost screws holding the power supply cover.
2. Remove all wires to the power supply. *Be careful to note where they are connected!*
5. Remove the power supply by removing three screws in line that secure the unit to the plate.
6. Install the replacement. Note that the voltage selector wires must be connected *before* installing the power supply cover.
7. Tighten all screws properly then put the BRUT back on the bottom cover.
8. Reinstall all wiring.
9. Disconnect the power from *all boards and I/O units*. Turn the power on and check polarity and voltages in the loose connectors.
10. If 9. is OK, with power *off*, reinstall all power connectors.
11. Put it all back together.

## 3.7 Main Board

The main board is more than the heart of the system, it is also the brain. Unfortunately, replacing a brain is tougher than it seems and *should be avoided as far as possible*.

1. Remove top cover and I/O subassembly.
2. Remove the scanner interfaces.
3. Remove eight Pozidrive screws holding the connector panel to the rear panel. Note the ground lug with washer and nut on one of the screws. Use a 5.5 mm wrench to remove the nut.
4. Remove eight Pozidrive screws holding the rear panel to the frame. The power supply wiring can remain connected but be sure not to strain the connections.
5. Remove all nuts holding the main board down. Use a 7 mm socket wrench.
6. Lift the board straight up then lift it out of the frame with the front edge first.
7. Do *not* separate the connector panel from the board. They are always handled as one unit.
8. When reinstalling the board, don't forget the ground wire from step 3.

# 4. Troubleshooting

## 4.1 General

The general strategi for BRUT field repair is to handle the problems at the subunit level but not at any further detail. Defect subunits are returned to Bildbehandling for repair. This chapter presents a number of steps that can be used to isolate a problem to a specific subunit. All procedures require at least rudimentary operation of the main board ie terminal communication and ability to boot programs from floppy disk. You should use a terminal connected to the TTY connector of the BRUT during troubleshooting.

After the properly connected BRUT is powered–up, the following should happen:

1. The green power–on LED on the front panel is illuminated. Any connected scanners start spinning up the motors.
2. The following message is output on the terminal:
   PROM–boot
   PROM sum XXXXXXXX, YYYYYYYY
   BRUT MONITOR – version – X.X

   XX Mbytes of DRAM
   <date and time>
   Autobooting from floppy disk.
3. The video monitor presents the multi–colored BRUT logo.
4. The system starts booting from floppy–disk (if a floppy is inserted) or from the hard disk (if there is a boot file present).
   The progress of the boot procedure is indicated by a revolving bar.
5. If booting was successful, the following is output on the terminal:
   <BRUT startup greeting with system S/N and program version number>
   ...
   Use '?' to get .....
   BRUT>
6. The monitor shows the BRUT screen.
7. The BRUT is operational. Check keyboard operation, tape drive, and disk.

If any of these steps should fail, the following may be used to guide the troubleshooting. Note that no detailed procedure is given and that a general knowledge of the BRUT system and internals is required.

**Before and during booting:**

*Power–on LED dark:*

Check fuses in mains inlet, check DC voltages inside BRUT, check fuse inside power supply, check power supply with some and all subunits disconnected, check LED.

*Scanners don't start properly:*

Check scanner cable and connectors, check fuse FS1 on scanner interface, check scanner, check scanner supply voltages in scanner connector (refer to BRUT Reference Manual), check DC voltages +12V and –12V inside BRUT, check resistors R41 – R47. They are on the reverse side for interfaces rev 1:1 while on the top side on rev 1:2.

*No terminal output at all:*

Check terminal settings (9600 baud, 8 bits, no parity), check cable between BRUT and terminal (refer to BRUT Reference Manual), check terminal.

*Terminal output different from 2.:*

Contact Bildbehandling AB.

*No logo or incorrect BRUT logo during booting:*

Check monitor type (super–VGA compatible), check monitor cable.

*System does not boot:*

See Section 4.4.

**After booting, during BRUT program startup:**

*Scanner interface not detected or calibrated:*

See Section 4.2.

*Disk not found:*

ie startup message declares RAM storage available only. See Section 4.3.

**With BRUT program running:**

*Tape not accessible:*

ie TAPE commands give error messages. See Section 4.3.

*System crashes:*

See Section 4.5.

*Abnormal IR–image:*

See Section 4.2.

*Mouse does not work, terminal does:*

Check mouse, check mouse power +5V between pins 6 and 7. If no +5V, check mouse fuse F1 on main board underneath scanner interface A.

## 4.2 Scanner Interfaces

The scanner interfaces communicate with the main board over the HSDbus. Since they share the same communication channel, a problem with one board may disturb operation of the other. The cause of an interface communication problem may also be on the main board, although less likely. The following procedure may be used to determine whether the problem is in an interface or in the main board.

1. Restore a previously recorded correct sequence from tape into the system. If the BRUT is equipped with a Winchester disk a correct sequence already on the disk may be used. Run in PLAYBACK mode and examine the image. Given that the restored sequence is correct, the main board is faulty if the displayed IR–image looks abnormal.
2. Disconnect one interface board at a time and check the other. Note that *both* power and signal connectors must be disconnected. Also remember that the single interface being tested must have the HSDbus terminated, see Section 2.2.
3. In a dual system, reverse the address of the boards, A to B and vice versa, see Section 2.2. See if the problem follows the board.

## 4.3 SCSI Devices (Tape and Disk units)

The cartridge tape drive and the Winchester disk drive both utilize the SCSI bus interface to communicate with the main board. The following procedure may be used to locate a SCSI unit problem.

1. If both units are non–operational, test the units one by one by disconnecting the SCSI cable from the unit not being tested.
2. The disk is recognized by the BRUT software on system startup *only*. The system therefore must be restarted between tests.
3. Use the TAPE LIST command to verify tape access and the DISK LIST command to verify disk presence.
4. If the commands in 3. gave no error messages, test the TAPE DUMP and TAPE RESTORE commands and RECORD/PLAYBACK on the disk.
5. If some commands are OK and others not, the problem is in the I/O unit. Or if one unit works and the other not.
6. If both units, disk and tape, are dead and DC power and signal cables have been checked, the problem is most likely on the main board.
7. Some revisions of the main board use a small adapter for the SCSI controller chip. The controller is located in the upper righthand corner of the board. Check that the adapter is properly seated in its socket.

## 4.4 Floppy Disk Unit

In the absense of Ethernet and host computer the floppy disk drive is crucial to the bootstrapping of the BRUT. The following steps may be executed to track down a floppy disk boot problem.

1. Try a different boot floppy. Make sure it is write–protected in case the drive has gone wild.
2. Check that the power and signal cables are properly connected, both to the drive and the power supply/main board.
3. Try a different drive. Make sure all switches are properly set.
4. Still no success: main board is probably bad.

## 4.5 System Crashes

System crashes ie when the BRUT suddenly aborts normal operation and usually reboots itself is a symptom of either a hardware or a software error. Another reason can be poor quality of the mains power with heavy transients causing the system to crash.

In general, it is almost impossible to tell in field whether a crash was caused by a hardware or software problem. When a system repeatedly crashes, the trace outputs should be registered and the listing passed on to the systems engineers at Bildbehandling. For this to be possible, the reboot–after–crash function must be disabled otherwise the terminal screen will be cleared when the system reboots. This is done by the following steps:

1. Power–up the system with *no* floppy inserted and copy down the monitor version when shown.
2. Type ctrl–C.
3. Insert the boot floppy.
4. At the monitor prompt, type **f <CR>**
5. The system boots with some extra messages output and starts normal operation
6. Copy down the BRUT program version number, shown when the program starts.

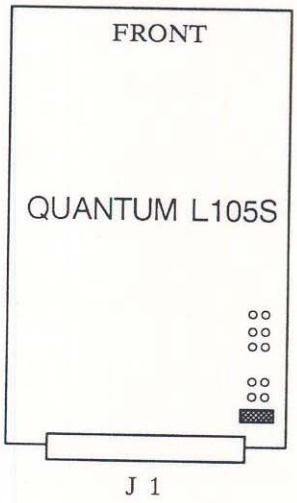
7. When the system crashes, the trace messages will be output and the system stop at the monitor prompt.

8. Copy down the following lines:
   *** Trap # XXXX
   ops: XXXXXX
   pc: XXXXXXXX, XXXXXXXX, XXXXXXXX
   cha: XXXXXXXX, chc: XXXXXXXX, chd: XXXXXXXX
   The rest is unimportant

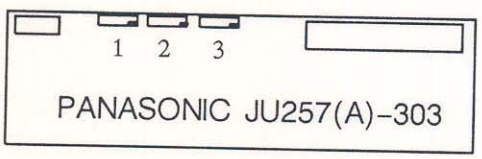
# Appendix A

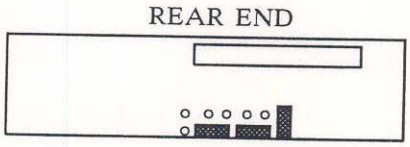
## Jumper settings in I/O units

### Hard disks

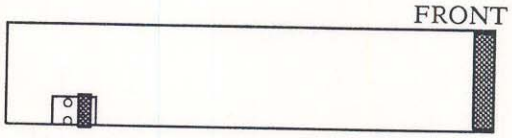




### Floppy disk drives

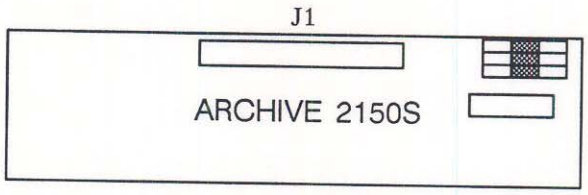


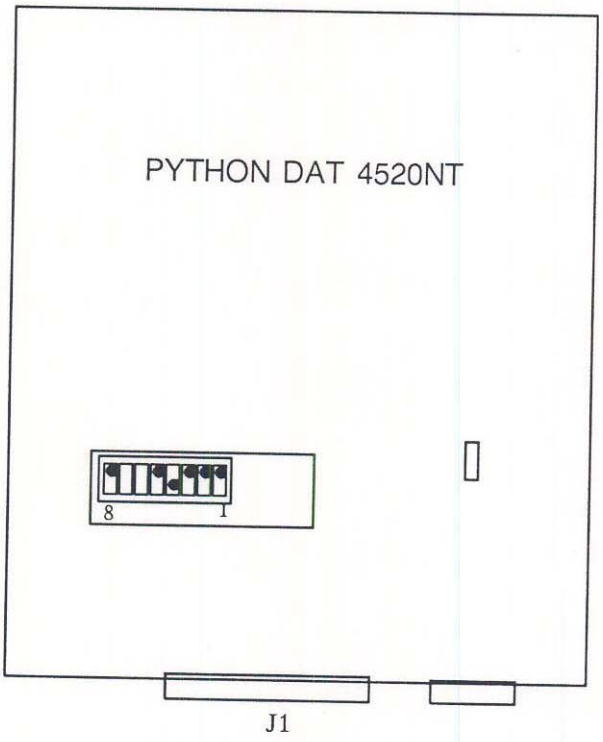




PANASONIC JU 257-121P



# Tape drives




S1–3= SCSI ID = 0 OFF
S 4 = SCSI 2 = 1 ON
S 5 = Par disable = 0 OFF
S 6–7 future use
S 8 = Power on self test = 0 OFF