

**MultiCluster-2**  
**Technical Documentation**

**Installation, expansion and  
maintenance manual**

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# 1. Introduction

## To The Multicluster-2 Series

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### 1.1 General Information

---

The MultiCluster-2 series consists of a family of units which can be combined and expanded, allowing the flexible construction of a multiprocessor system based on busless processing modules supplied by Parsytec. Since Transputer technology is employed in all components, systems based on the MultiCluster-2 series offer all the advantages of the Transputer family's microprocessors and peripheral chips:

- unlimited expansion possibilities
- adaptable computation power
- error tolerance

The user can therefore choose the number and topology of the integrated processors according to design requirements of his parallel computer. The total systems memory capacity can also be tailored to fit the planned systems needs by appropriately fitting the processors. As the system is modular, the designer has access to a wide range of intelligent interface controllers and a variety of I/O units.

The MultiCluster-2 series is situated at the centre of the Paracom product line. The well-known MultiCluster-1 series at the lower end only provides reconfiguration via jumper selection. The "high end" SuperCluster series, on the other hand, realizes all the possibilities a Transputer-based Supercomputer can offer. The MultiCluster-2 series provides the architectural framework necessary to configure medium size systems with up to 32 Transputers within one basic unit.

In addition, other computer families or I/O units can be connected to a MultiCluster-2 system by using plain or intelligent bus bridgehead modules:

VMEbus

SUN Microsystems

PC-class microcomputers

MACINTOSH II

Q-Bus

among others.

making it possible to combine computer and I/O systems with the MultiCluster-2 series units to form a total concept. Such a concept can then make full use of all the advantages of the MultiCluster-2 series in addition to the properties of the above listed systems.

# MultiCluster 2 Functional Diagram

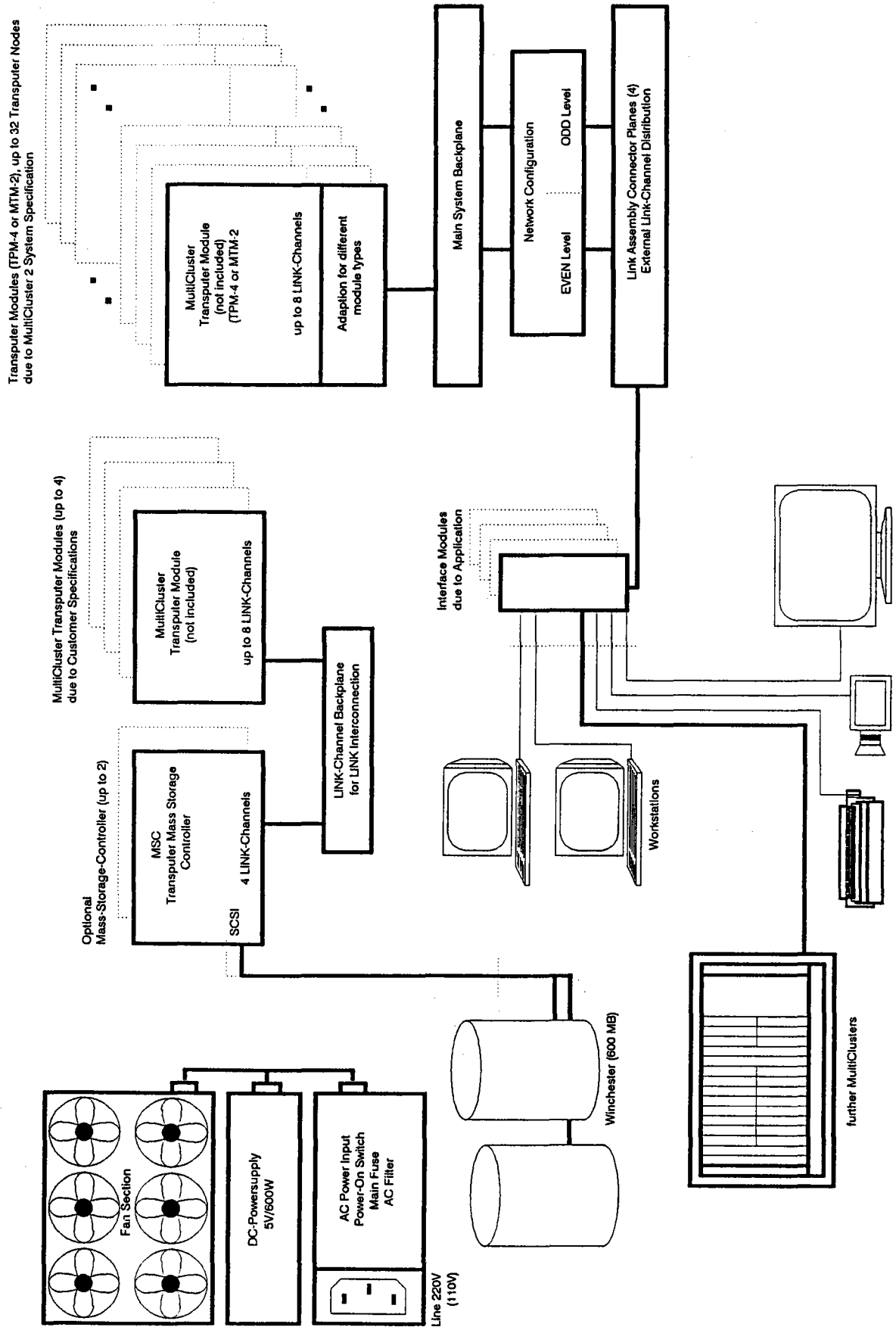


Figure 1.1: Block diagram of the functions and expansion possibilities within the MultiCluster-2 series

## **1.2 System Architecture**

---

All MultiCluster-2 units basically devices consist of the following three subsystems:

The Processing Subsystem (Transputer section)

The I/O Subsystem (expansion section)

The Configuration Subsystem (configuration section)

The names in parentheses correspond to the physical description level of this manual.



# MultiCluster 2 System Architecture

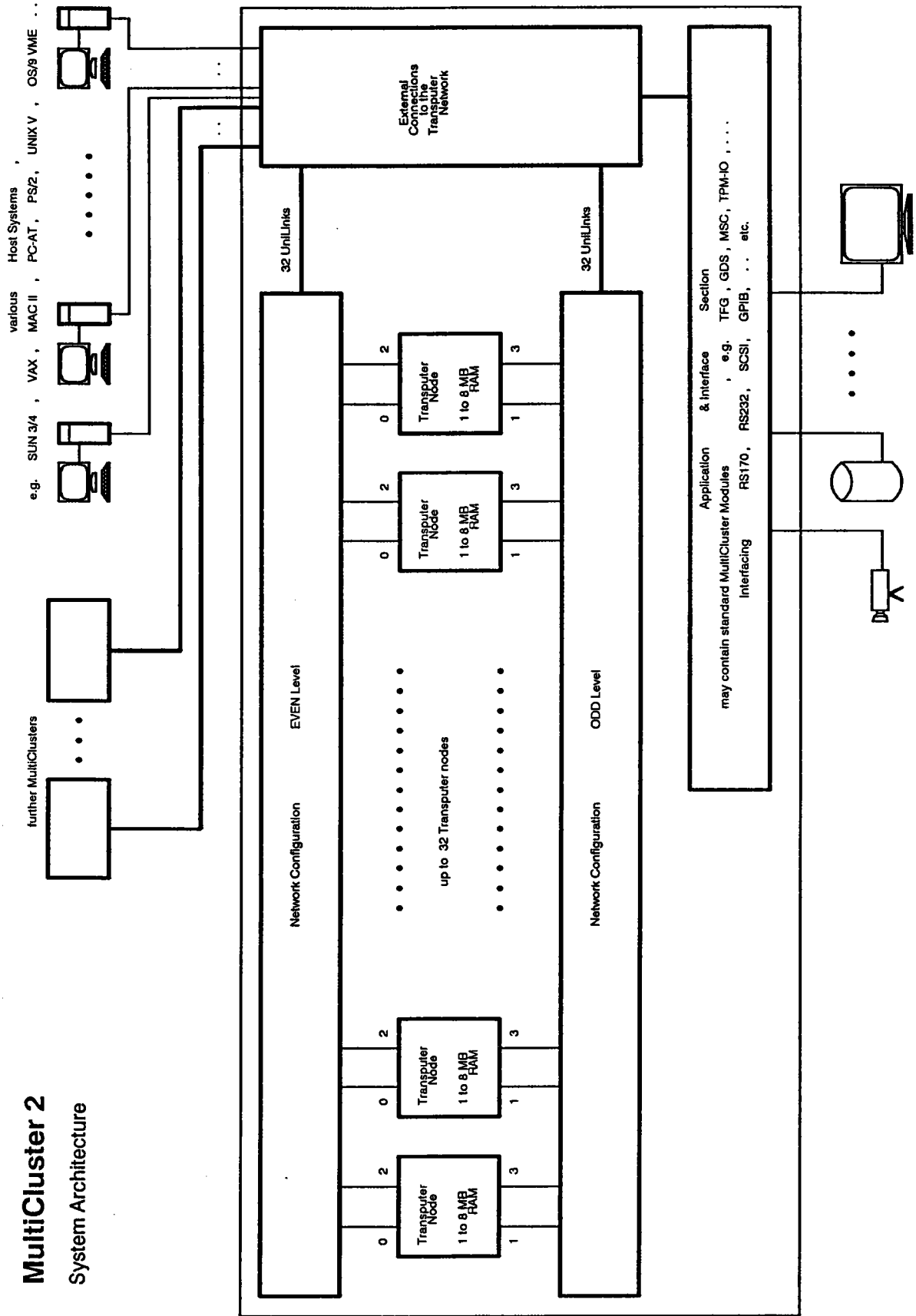


Figure 1.2: The general system architecture of the MultiCluster-2 series

### **1.2.1 The Processing Subsystem**

---

The processing subsystem offers 16 slots for busless modules and is able to support up to 32 Transputer nodes. A wide range of modules can be integrated in a MultiCluster-2 device including boards with one or two Transputers and various memory-sizes and processor speeds.

### **1.2.2 The I/O-Subsystem**

---

The I/O-subsystem is fully integrated into the reconfiguration scheme of the MultiCluster-2 series. It accepts up to six busless I/O controller boards including mass storage, graphics and video controllers as well as high performance I/O and special interface boards.

### **1.2.3 The Configuration Control Subsystem**

---

The network configuration units (NCUs) used in the SuperCluster series can also be integrated in the configuration control subsystem. Each network configuration unit has the capacity for 96x96 UniLinks. A UniLink consists of a communication link and an associated reset link in accordance to Parsytec's unique decentralised scheme for parallel systems control. The actual network configuration units are based on the advanced IMSC004 chip of Inmos. This chip has two major advantages in comparison to other switching elements: first, the internal refreshment of signals increases the reliability of communication; second, this chip guarantees the compatibility with the next Inmos switching element generation (the link speed will increase significantly). Two network configuration units provide full reconfigurability for two groups of up to 96 UniLinks each.

If a low-cost solution is desired, modules with simpler configurations can be used. These modules offer a certain number of fixed topologies determined by jumper settings; the network structure can then only be altered by changing the jumper configuration. Such a module can be used with a second "fixed topology modules" or combined with a network configuration unit. By doing so, one can build up to a fully reconfigurable system, step by step.

MultiCluster-2 series units are equipped with two spaces for configuration modules. The number of configuration modules needed depends upon the number of processors in the processing subsystem and the type of reconfigurability required by the user. The links are split into two groups, "odd & even", corresponding to their numeration on the Transputer pinout. Odd and even links are traced separately through the main link backplane to the slots of the configuration control subsystem.

## **1.2.4 Reconfigurability**

---

Three levels of reconfigurability are available, depending on the type of modules installed in the configuration section:

fixed topology

partial reconfigurability

full reconfigurability and physical partitioning

### **1.2.4.1 Fixed Topology**

A network configuration unit is not required in a MultiCluster-2 system with a fixed topology. The topology of the processor network is configured by four fixed topology modules plugged into the slots of the configuration sections. This offers a choice among a number of different standard network structures. This type of architecture is shown in figure 1.3.

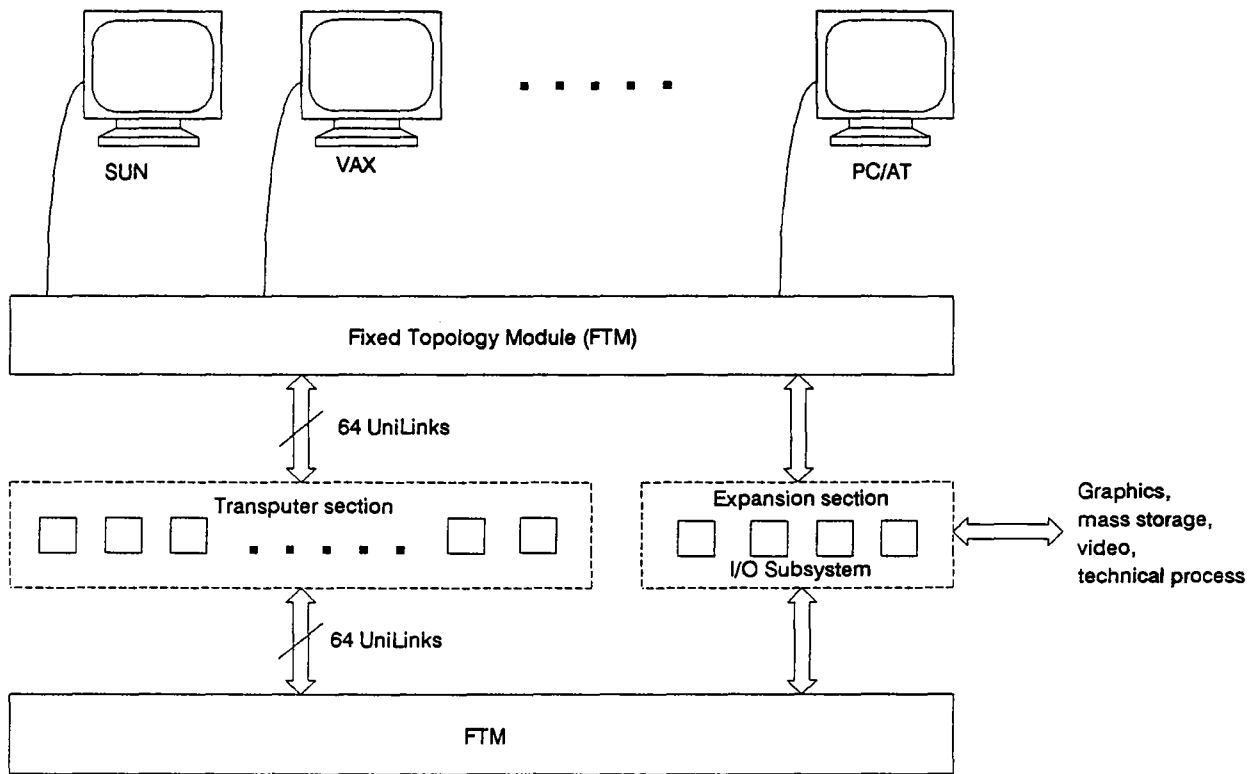


Figure 1.3: Model-32 with fixed topology

#### 1.2.4.2 Partial Reconfigurability

Partial reconfigurability is achieved by inserting a network configuration unit in one of the configuration section's slots, and a fixed topology module in the other. The network configuration unit configures all even-numbered Transputer UniLinks in the processing subsystem. The odd-numbered UniLinks are controlled by the fixed topology module in the second slot of the network configuration subsystem. Figure 1.4 demonstrates this type of architecture as used in MultiCluster-2 models. It should be noted that the use of the fixed topology module doesn't seriously restrict the range of possible topologies.

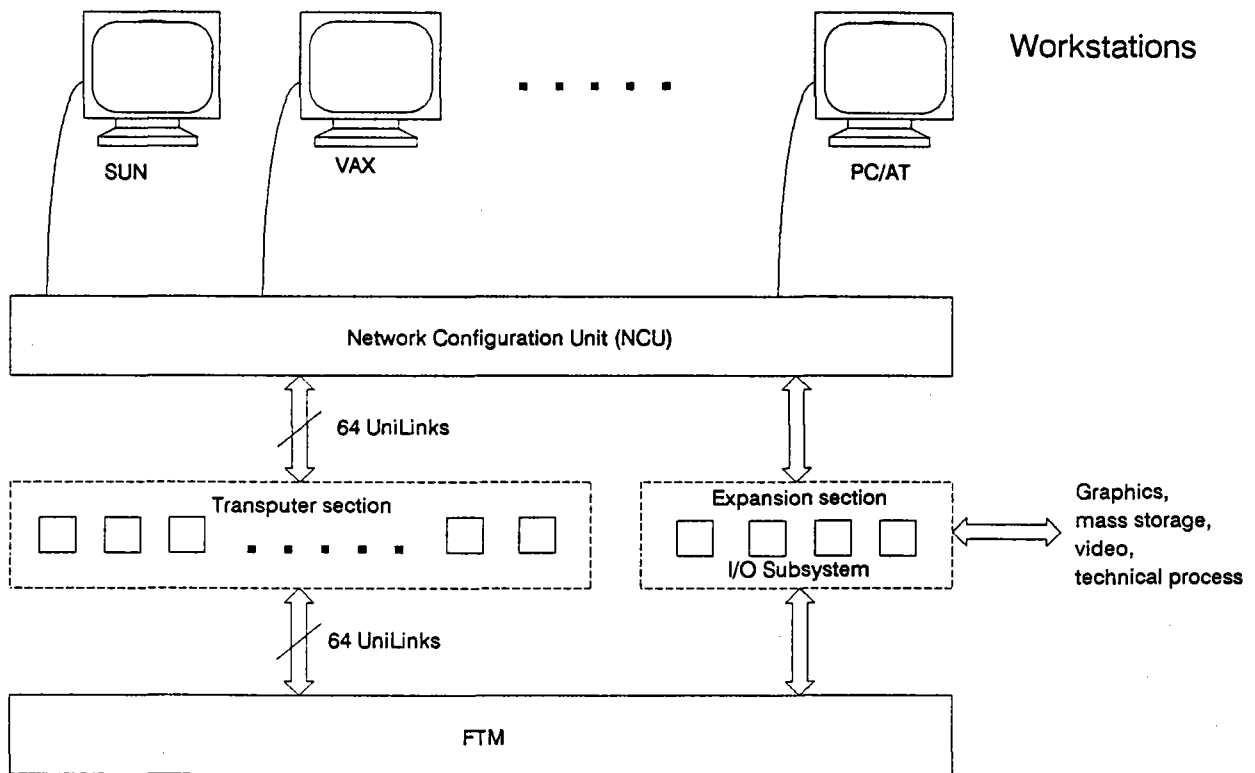


Figure 1.4: Model-32 with partial reconfigurability

### 1.2.4.3 Full Reconfigurability

A single network configuration unit provides a full crossbar function between sixteen Transputers. Achieving unlimited reconfigurability for sixteen processors, therefore, requires one network configuration unit. This comprises the smallest full-reconfigurable MultiCluster-2 system, whose architecture is shown in figure 1.5.

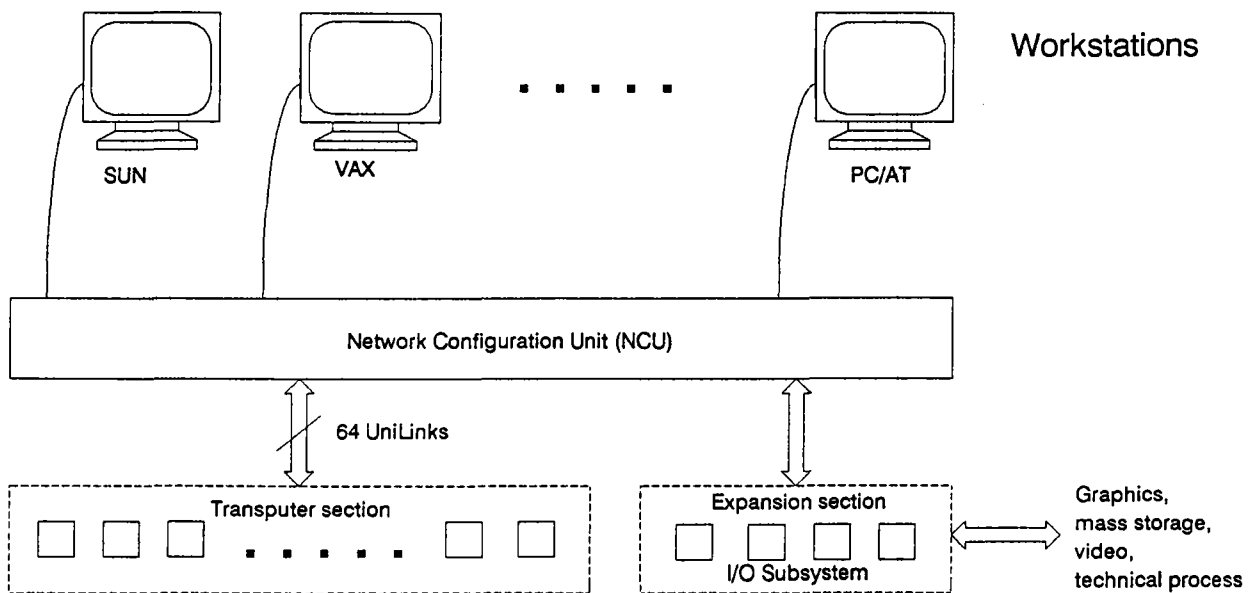


Figure 1.5: Model-16 with full reconfigurability

Two network configuration units are needed for full reconfigurability in MultiCluster-2 systems with more than sixteen Transputers. In this case, the UniLinks are divided into two groups. The even numbered UniLinks are controlled by one network configuration unit, the odd numbered UniLinks, by the other. This architecture provides full functionality for 17- to 32-processor MultiCluster-2 systems (see figure 1.6).

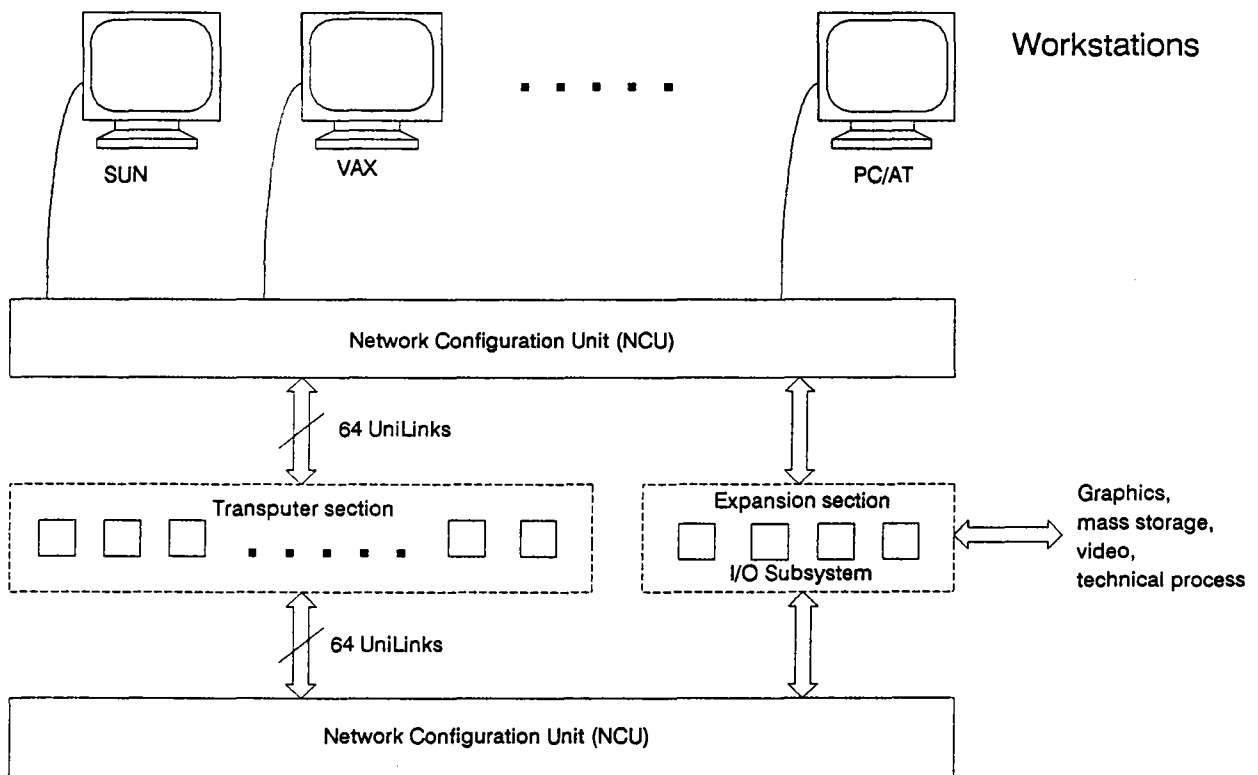


Figure 1.6: Model-32 with full reconfigurability

## 2. System Installation

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This chapter describes the unpacking and installation of a MultiCluster-2 unit and its environmental requirements. There are a few important conditions which have to be fulfilled before a MultiCluster-2 unit can be powered on for the first time.

### 2.1 Unpacking

---

1. Open the outer transport container by carefully cutting the tape or tearing it off.
2. Open the lids of the both the outer and inner transport container.
3. Grip the handholds on the left and right sides of the MultiCluster-2 cabinet.
4. Carefully lift the computer out of the container. Since a MultiCluster-2 unit weights up to 45 kg, this job should not be done alone (it's easier if somebody else holds the box etc.).

**CAUTION:** Never move a MultiCluster-2 unit while in operation!

#### 2.1.2 Environmental Requirements

---

A MultiCluster-2 unit is designed to operate under standard office conditions (0°C to 40°C, 30% to 80% RH).

The minimum space necessary to set up the MultiCluster-2 is 0,7 by 0,7 meters.

This is described in full detail in appendix A 3.3.

**NOTE:** Make sure that the external airflow to and from the internal cooling system is never blocked!

For more detailed information regarding this aspects, please refer also to appendix A.3.3.

#### 2.1.3 Power Requirements

---

The MultiCluster-2 needs a clean and stable computer AC line.

For detailed information regarding its power requirements refer to appendix A.1.

## **2.2 Connecting The Bootstation And/Or Additional Workstations**

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### **2.2.1 The Difference Between Workstations And Bootstations**

---

The minor difference between a workstation and a boot station is as follows.

#### **Workstations:**

A workstation is a computer which contains at least one Transputer module. It is connected with one UniLink cable to the user interface of a MultiCluster-2 computer. Workstations run MultiTool or a part of the Helios operating system and support the environment to edit and compile the parallel programs which have to be tested and run on a MultiCluster-2 unit.

#### **Bootstations:**

Normally, a bootstation is just a workstation with an additional facility to control the network configuration unit of a reconfigurable MultiCluster-2 unit. The bootstation sends the network configuration software to the network configuration unit. The boot process must be done after every cold start (power on) or warm start (restart) of a MultiCluster-2 device.

### **2.2.2 Common Aspects Of Bootstations And Workstations**

---

The 220 V supply for the MultiCluster-2 computer, the boot and the workstations should have the same line phase.

The default link speed used both within a MultiCluster-2 unit and supported externally is 20 Mbit/s. All external components connected to a MultiCluster-2 must also be run with this link speed. LNK 10 link cables should be used for connecting the boot and workstations to the MultiCluster-2 unit. The user interface and configuration link plugs are located on the rear panel of the MultiCluster-2 cabinet as seen in figure 2.1.

The user interface is the only place where users normally have to plug "in" or "out" cables for connecting their workstations. A bootstation additionally uses the plug labelled Configuration In, located in the centre of the rear panel's lower third.



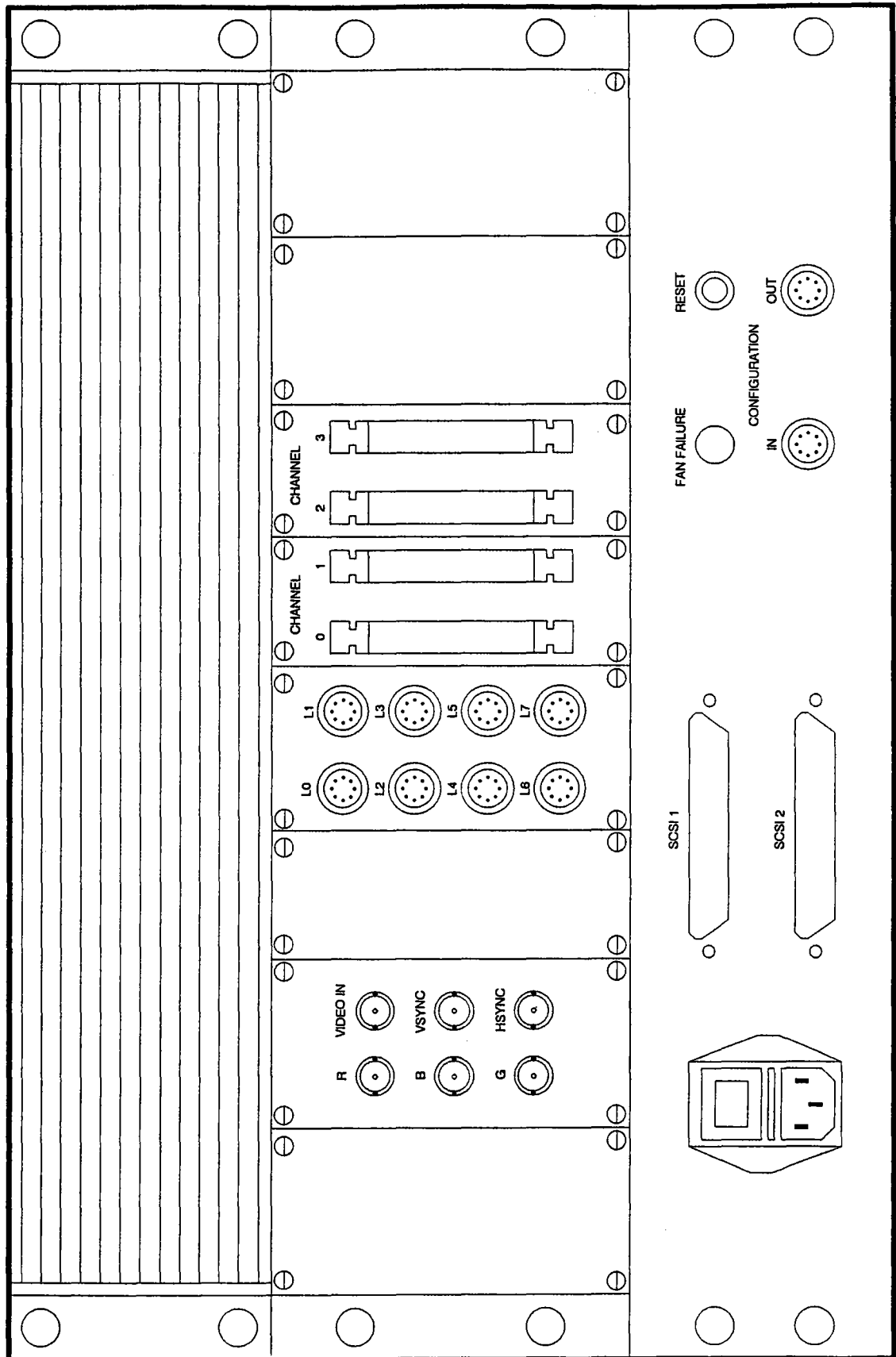


Figure 2.1: Rear view of a MultiCluster-2 cabinet showing the user interface and the configuration link plugs

## 2.2.3 Connecting A Bootstation

The bootstation downloads the link configuration software via the configuration link input to a MultiCluster-2's network configuration units. The process executing the boot phase requires a default wiring between the bootstation and the MultiCluster-2.

**Note:** A MultiCluster-2 computer or a system consisting of several MultiCluster-2 devices can only be connected to one bootstation!

**Note:** When using IMS-B004-boards as workstations apply the special boot sequence described in appendix E.

### 2.2.3.1 Pure Bootstations

Connect Link 3 of the integrated Transputer module to the plug labelled Configuration In on the rear panel of the MultiCluster-2 cabinet (see figure 2.2). Use figure 2.1 for orientation. Please refer to the documentation of your workstation's Transputer module to locate its Link 3 plug.

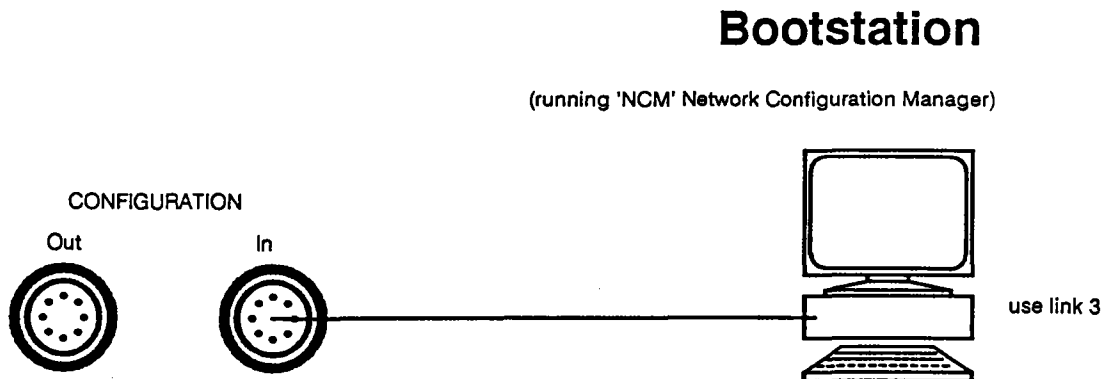


Figure 2.2: Wiring scheme for connecting a bootstation to a MultiCluster-2 computer.

### 2.2.3.2 Combined Boot/Workstation

A bootstation can also be used as a workstation. In this case, steps, additional to those described in chapter 2.2.3.1, have to be taken. Use an appropriate cable to connect the bootstation's Link 2 to any of the MultiCluster-2's user interface plugs (use figure 2.3 as reference). Plug L0 offers the easiest access when using a combined boot/workstation. This primary link connection represents the default cabling required by the software.

The following wiring scheme is strongly recommended when connecting the bootstation to your MultiCluster-2 unit. Connect bootstation Transputer module link 3 to the Configuration In plug. When working with a combined boot/workstation, connect link 2 of the Transputer module to any link Lx (x=0..7).

Bootstation	Boot/Workstation	
connect bootstation Transputer module link 3 to the	Configuration In	xor
	Configuration In	xor
	...	xor
	Configuration In	link 7
plug of your MultiCluster-2 unit		

Table 2.1: Wiring recommended for a MultiCluster-2 system bootstation

Link 0 of the bootstation's Transputer module is not used, since its reserved for interfacing between the host computer and the integrated Transputer module.

### 2.2.4 Connecting Workstations

A workstation offers the environment for developing the programs that will be run on a MultiCluster-2. They are connected by LNK-10 or similar cables to the user interface plugs.

Connect a cable from Link 2 of your host computer's integrated Transputer module in to any of the plugs of the user interface of the MultiCluster-2 unit (see figure 2.3). Refer to figure 2.1 for orientation. Use the documentation of the Transputer module used in your workstation to find its Link 2 plug.

Workstations

Workstations

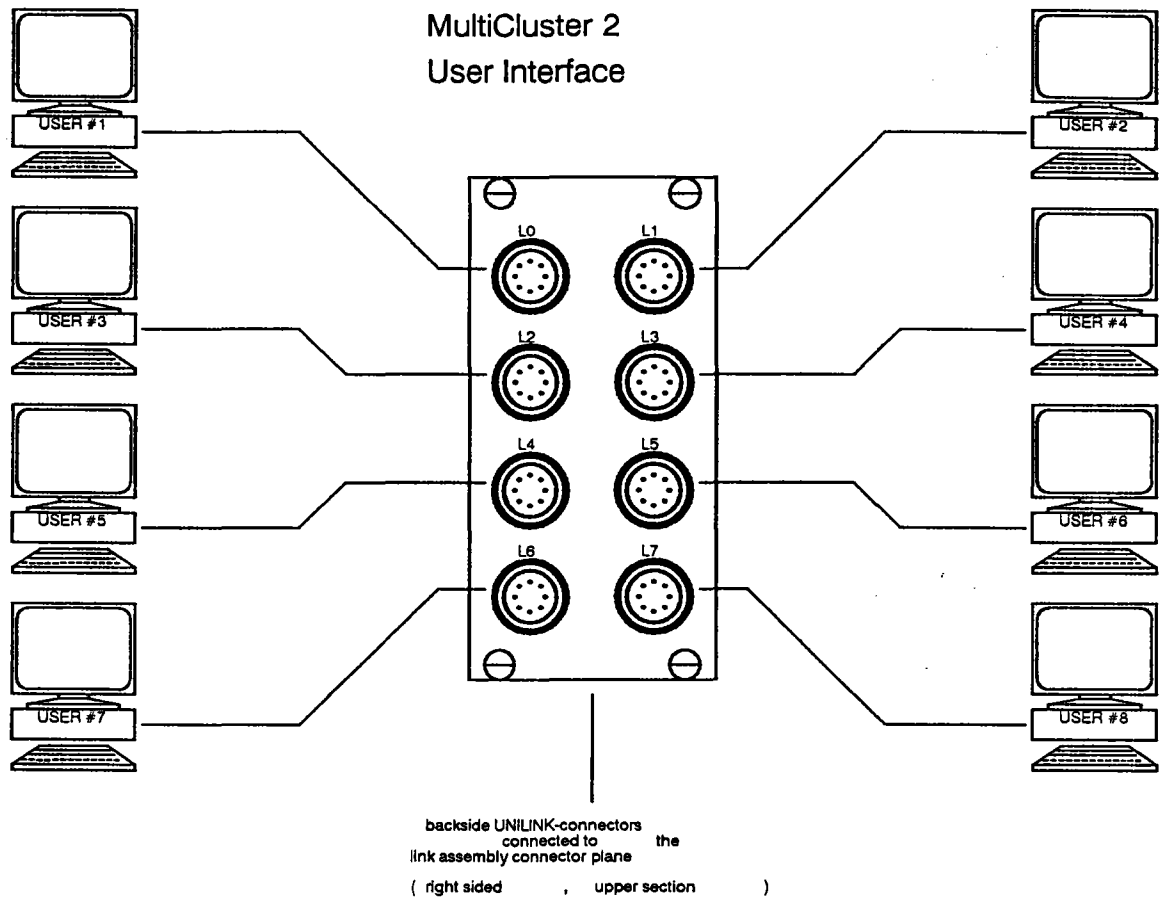


Figure 2.3: Wiring scheme for connecting workstations to a MultiCluster-2 computer.

---

connect workstation link 2 to the  
following user interface plug

---

workstation 0	Link 0
workstation 1	Link 1
workstation 2	Link 2
workstation 3	Link 3
workstation 4	Link 4
workstation 5	Link 5
workstation 6	Link 6
workstation 7	Link 7

---

Table 2.2: Wiring scheme recommended for workstations

Link 0 of the workstation's Transputer module is not used, as it is reserved for interfacing between the host computer and the integrated Transputer module.

### **2.2.5. IMS-B004 As Transputer-host For Boot And Workstations**

Because the reset and link schemes of the Inmos B004 are incompatible to those used by Parsytec, booting with this type of Transputer host follows a different sequence. The methods required are described in appendix E.

## **2.3. Starting A MultiCluster-2 Unit**

If all the requirements listed above have been met, you can finally start your MultiCluster-2 computer.

### **2.3.1. Switching On The Power**

1. Connect the MultiCluster-2 unit to a clean and stable 220 V AC line. Use the AC cord supplied with the unit. Plug it into the built-in AC-connector of the cabinet (see figure 2.1).
2. Switch the main power switch (located at the bottom of the rear panel) to the 'ON' position.
3. The power-on LEDs of all installed Transputer modules should be on now.
4. If the steps above were not successful, the fuses might be responsible. Please refer to appendix D (Replacing Fuses).

### **2.3.2. Booting The MultiCluster-2**

Booting can be performed in two ways. One method is to boot with the MultiTool programming environment installed in the bootstation. The other approach is to boot from the operating system level of the boot station. Booting a MultiCluster-2 means sending the configuration software to the network configuration units. Please refer to the appropriate sections of the your system software's installation manual.

## 2.4 Installing Video Devices

Video devices such as video cameras and RGB-monitors can be connected directly to your MultiCluster-2 unit if there are TFG- or GDS-boards installed in its expansion section.

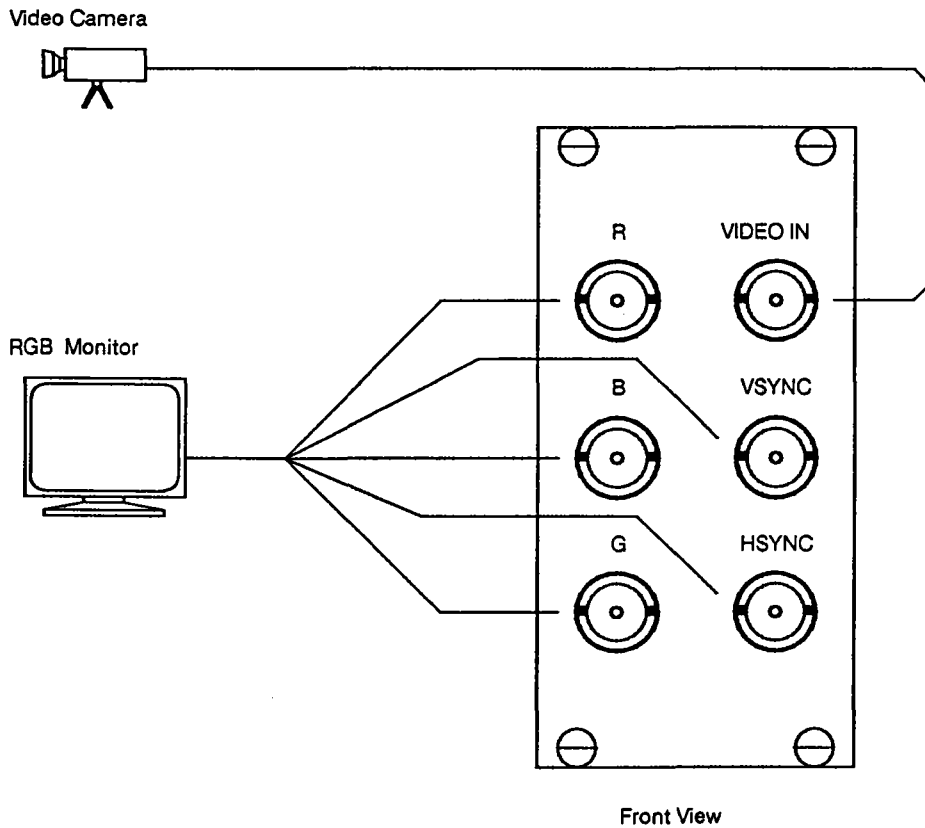


Figure 2.4: Wiring scheme for connecting Video Devices.

The video interface plugs are located on rear panel (see figure 2.1). Figure 2.4 shows how to connect video and graphics devices.

## 3. Hardware Description

---

Every MultiCluster-2 series computer consists of a number of separate functional elements (sections or units). These elements will always fulfil the same function when installed in a MultiCluster-2 unit. The most important elements are:

- upper and lower Transputer section
- upper and lower expansion section
- odd and even level configuration section
- internal wiring section
  - main backplane
  - left and right link assembly connector plane
  - expansion section backplane
  - internal connector planes of external interface section
- external interface section
  - system expansion interface
  - user interface
  - video interface
  - SCSI-Interface
  - configuration links
  - reset switch
- power supply unit
  - power control unit
  - main power switch
  - power socket
  - fuses
- ventilation unit
  - fans
  - fan failure LED
  - dust filter

The exact location and function of each of these elements will be explained in the following chapters. Several elements in turn consist of subsections and units which are installed in different parts of the cabinet.

### 3.1 The Front Panel Elements

---

Figure 3.1 shows a schematic front view of a fully equipped MultiCluster-2 unit. All normally accessible elements are depicted and listed below:

upper and lower Transputer section,  
 odd and even level configuration section,  
 upper and lower expansion section,  
 power supply unit,  
 fan unit.

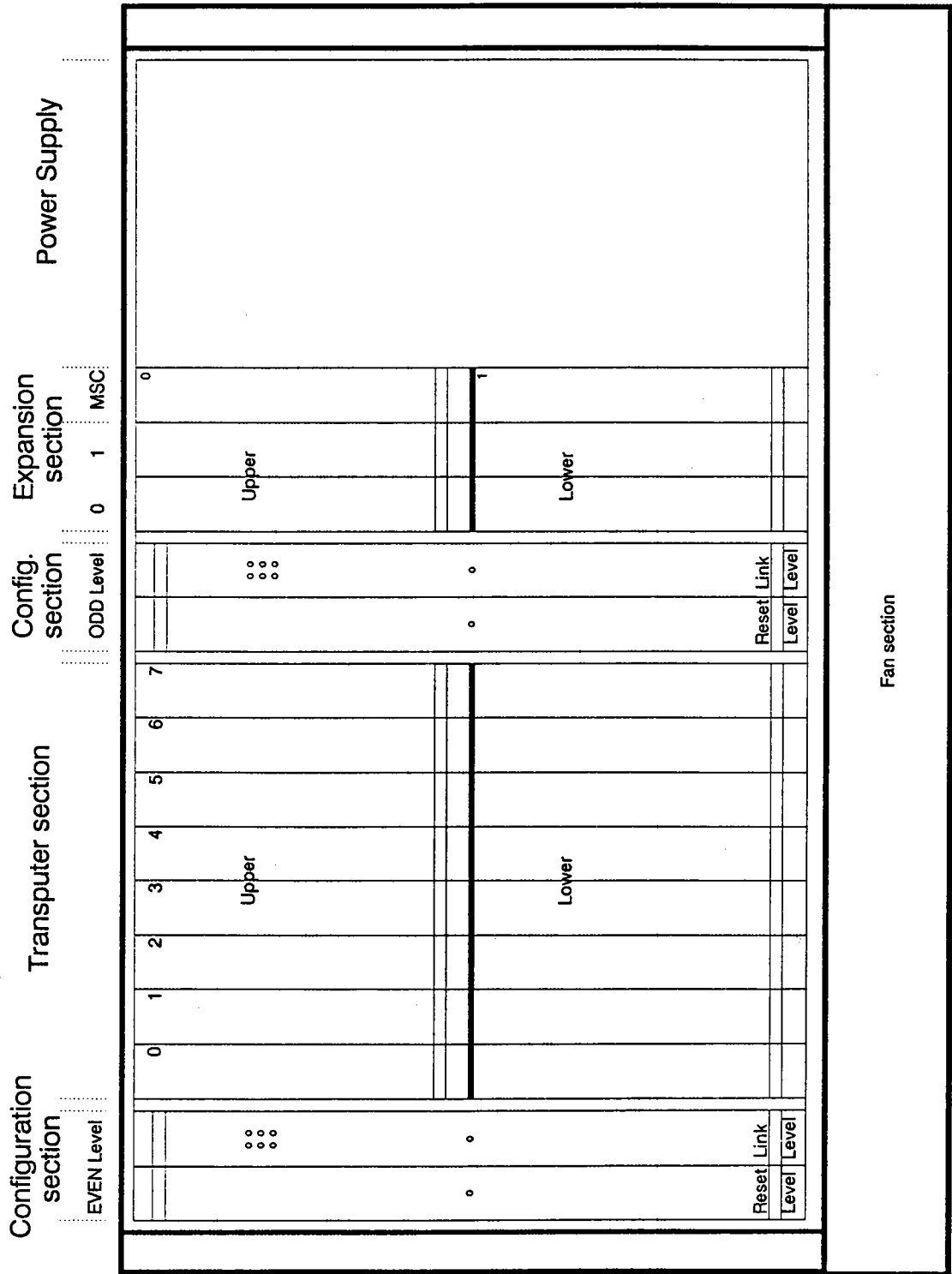


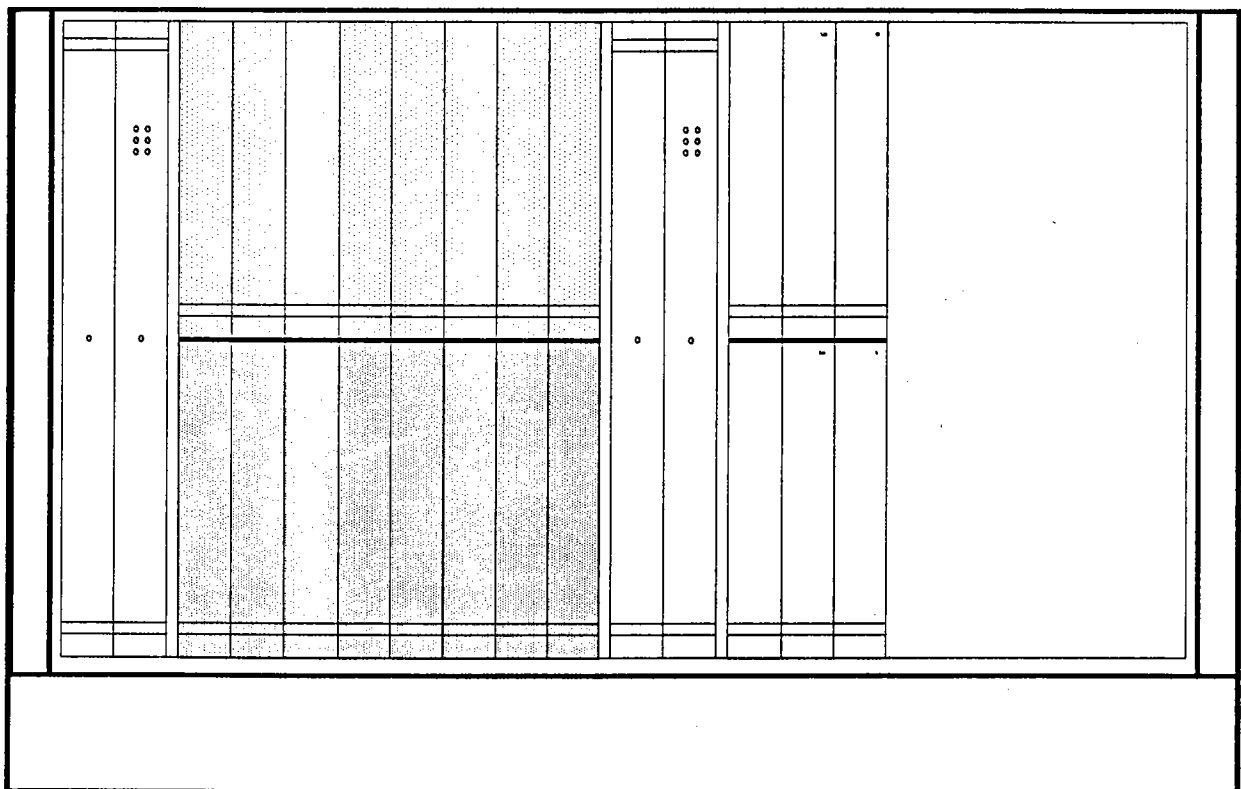
Figure 3.1: Front view of a typical MultiCluster-2 series unit.



All board-oriented installation or manipulation is done from the front of the cabinet. This includes installing & exchanging busless processing and I/O modules and adapting & altering configurations in MultiCluster-2 units with fixed topologies.

### 3.1.1 Upper And Lower Transputer Sections

The terms "upper" and "lower" used in this context only refer to the respective locations within the cabinet. Both Transputer sections are designed to accommodate busless Transputer modules, e.g. pure processor boards.





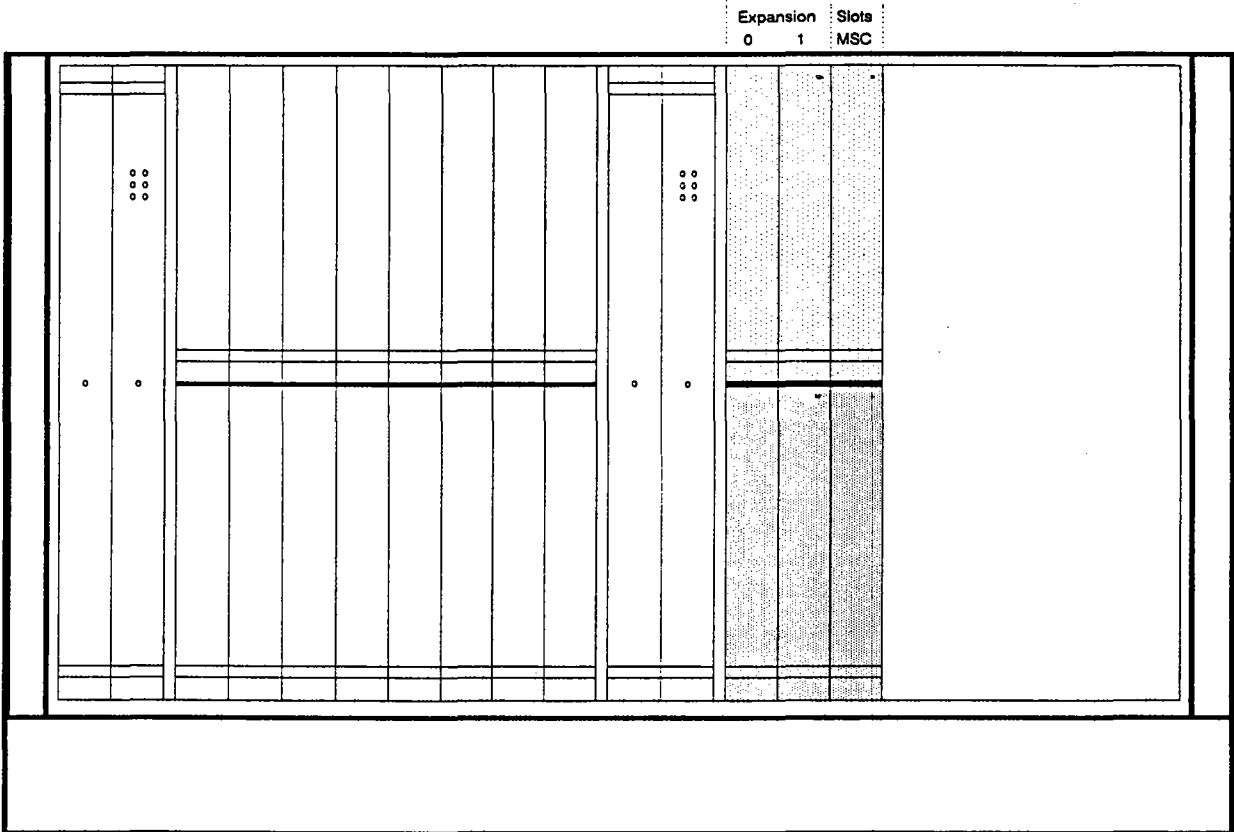
-  Upper Transputer section
-  Lower Transputer section

Figure 3.2: The positions of the two Transputer sections within the front panel of a MultiCluster-2 cabinet.

Each Transputer section can accommodate up to eight busless Transputer modules, representing a total capacity of 32 processing elements when using two-processor modules. The Transputer section concept is what makes a MultiCluster-2 unit's computation power so adaptable.

### 3.1.2 Upper And Lower Expansion Sections

The terms "upper" and "lower" used in this context only refer to the respective locations within the MultiCluster-2 cabinet. Both sections are designed to provide the infrastructure necessary for the integration of busless I/O modules (graphic monitor controller, mass storage controller etc.).





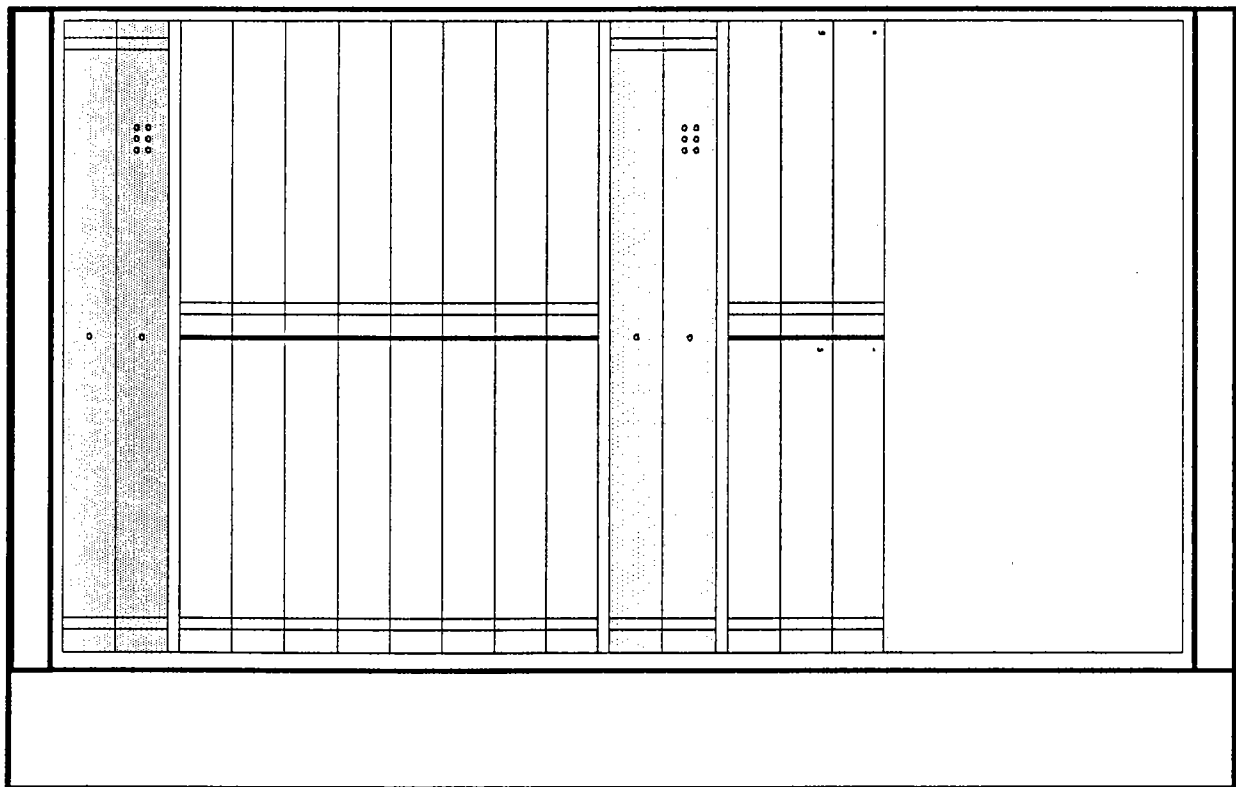
-  Upper expansion section
-  Lower expansion section

Figure 3.3: The positions of the two expansion sections within the front panel of a MultiCluster-2 cabinet.

The slot farthest to the right of each expansion section is reserved specifically for the installation of a mass storage controller. The remaining four slots (two in each section) would then allow the installation of two GDS boards a TFG and a TPS board, for instance.

### 3.1.3 Odd & Even Level Configuration Section

Both configuration sections consists of two slots designed for boards twice the normal height. The degree of reconfigurability your parallel computer offers is determined by the type of boards installed in the two configuration sections. The different MultiCluster-2 series models are consequently equipped with different combinations of configuration modules. The use of two fixed topology modules leads to a parallel computer whose topology can only be altered by shutting down the system and replugging bridges. On the other hand, if network configuration units are employed, the processor topology only depends on the software.





-  Even level configuration section
-  Odd level configuration section

Figure 3.4: The positions of the two configuration sections within the front panel of a MultiCluster-2 cabinet.

A combination, however, is also possible. In this case a fixed topology module is inserted in the odd level configuration section, and the even level section gets a network configuration unit.

### **3.1.3.1 Odd Level Configuration Section**

All odd numbered UniLinks are controlled from the configuration modules installed in this section regardless of the system's degree of reconfigurability (fixed topology vs. total reconfigurability). This level has no function, however, in the case of the MultiCluster-2 model-16 with total reconfigurability.

### **3.1.3.2 Even Level Configuration Section**

This configuration section consists of two slots designed for boards twice the normal height. In the MultiCluster-2 model-16, with total reconfigurability, all UniLinks are switched by the network configuration unit installed here. This is the only exception. In all other cases, only the even numbered UniLinks are switched in this section, regardless of the degree of reconfigurability your system has (fixed topology vs. total reconfigurability).

### **3.1.4 The Power Supply Unit**

The right side of the cabinet belongs to the power supply unit (see figure 3.1). This unit is designed to provide sufficient power to all elements and modules installed in a given MultiCluster-2 unit.

This power supply unit consists of a primary switched AC/DC converter offering a 5 volt output and capable of supplying a maximum of 600 watts and 120 amperes. The power supply unit is protected against open currents and sustained short circuits conditions

### **3.1.5 Ventilation Unit**

The ventilation unit is located in a horizontal drawer in the lower section of the front panel (see figure 3.1). It consists of six independently monitored fan systems and stretches back as far as the rear quarter of the MultiCluster-2 cabinet. Air is sucked in through the rear panel's air filter mat, past the wiring and modules, thereby cooling them, and then blown out through the ventilation slots at the bottom of the cabinet.

## 3.2 The Internal Wiring Section Elements

The internal wiring section consists of the following elements:

- main link backplane
- left and right link assembly connector planes
- expansion section backplane
- internal connector planes of the external interface section
- system expansion interface
- user interface
- video interface
- SCSI interface
- configuration link connectors

The exact location of all these elements is shown in figure 3.5. All UniLink connections between the expansion, Transputer, configuration and external interface sections are established in this part of the MultiCluster-2 unit.

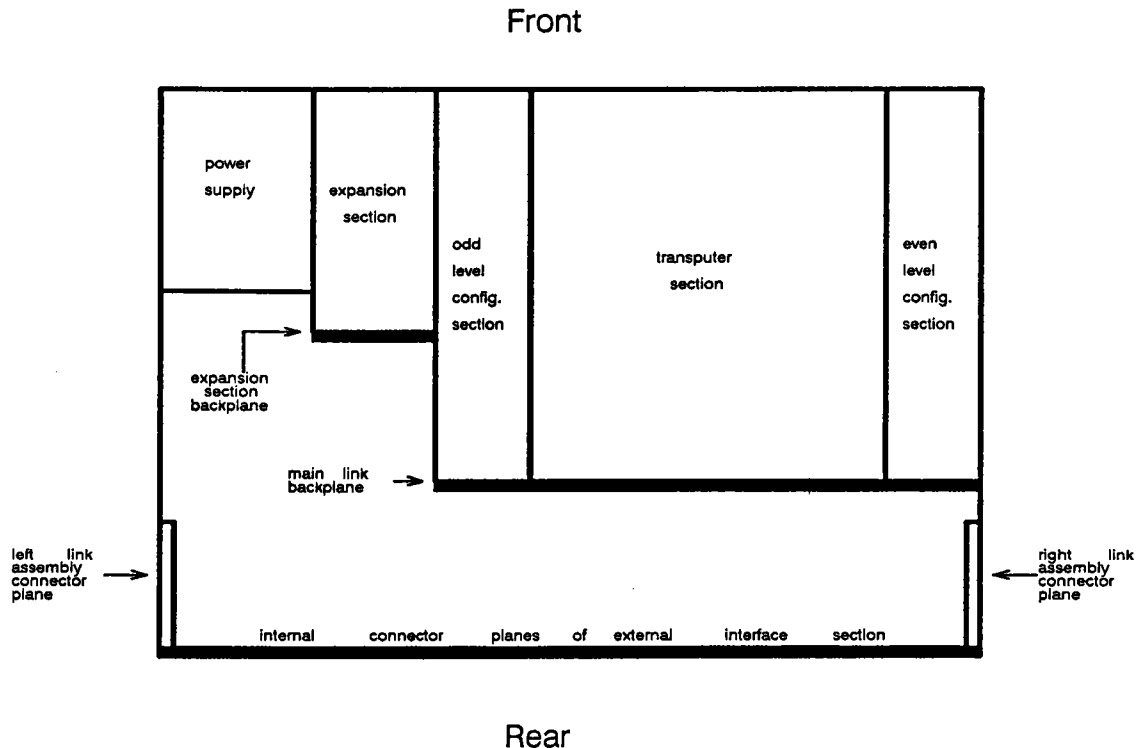


Figure 3.5: Shows the exact location of the internal wiring section elements within an open MultiCluster-2 cabinet (top view).

### 3.2.1 Main Link Backplane

As seen in figure 3.5, the main link backplane is in effect the rear panel of both Transputer and configuration sections. The connectors for processor and configuration modules are actually parts of the main link backplane (see figure 3.6). The processor module UniLinks are therefore connected directly to the configuration sections via the main link backplane. Configuration modules inserted into the configuration sections are not limited to these internal UniLinks, but can also make use of a number of external UniLinks to create the desired configuration. These external UniLinks, the MultiCluster-2 unit's connection to the outside world, run from the configuration module to the plugs to the rear of the main link backplane (its "connection" side).

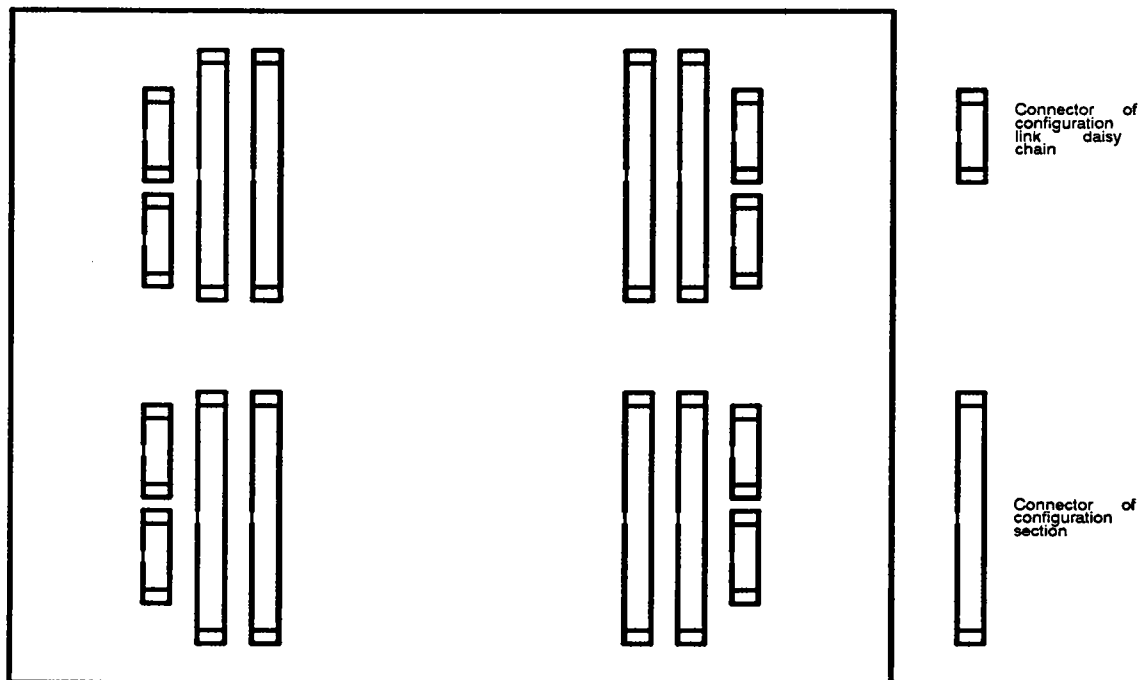


Figure 3.6: View of the rear of the main link backplane (the "connection" side).

External units are not plugged into a MultiCluster-2 unit via the main link backplane plugs. In this case, the connection includes the external interface section's link assembly connector planes and internal connector planes.

Additional MultiCluster-2 units are connected by plugging them into the system expansion interface, and from there into the main link backplane. This will result in a larger, reconfigurable computer network.

### 3.2.2 Link Assembly Connector Planes

The link assembly connector planes enable a flexible wiring of internal UniLinks to the unit's expansion section. They also provide an intermediate station between the user interface and the rear panel's external interface section (where the workstations are connected). Each link assembly connector plane combines eight separately wired UniLinks to one connector, thereby reaching the level of integration used in the main link backplane.

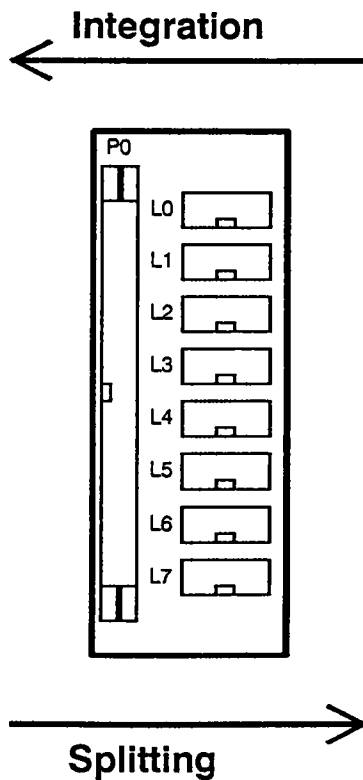


Figure 3.7: View of a link assembly connector plane's "connection" side.

A total of four link assembly connector planes are installed in the rear portion of a MultiCluster-2 unit, two on each side (one on top of the other - see figure 3.5). This makes it possible to combine up to 32 single UniLinks within four cables and connect these to the main link backplane.

### 3.2.3 Expansion Section Backplane

As one might imagine when reading the name, the expansion section backplane is the expansion section's rear panel (see chapter 3.2.1). The "connection" sides plugs are arranged in what amounts to a mirror image of the constellation seen on the slot side (see figure 3.8). The slot farthest to the right of each expansion section is reserved specifically for the installation of a busless mass storage controller. The remaining four slots, two on top & two below, can be used for the installation of other busless I/O modules (graphic monitor controller, video controller etc.).

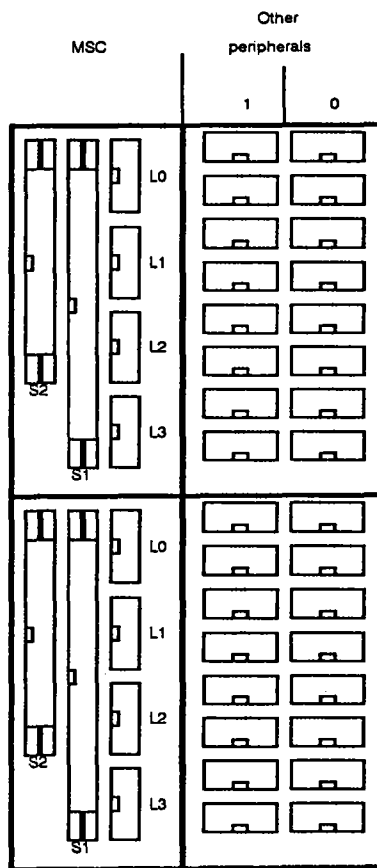


Figure 3.8: View of the expansion section plane's "connection" side.

Signals intended for specific external units are sent from the expansion section backplane directly to the appropriate rear panel plugs (SCSI signals, video signals etc.). Controller board processor UniLinks, on the other hand, are usually wired to the link assembly connector planes.



### **3.2.4 Internal Connector Planes Of The External Interface Section**

The internal connector planes consist of the internal connections of the following external interface section subsections:

- system expansion interface
- user interface
- video interface
- SCSI-Interface
- configuration links

All signals to the outside world first arrive at one of the internal connector planes. They will be introduced in full detail along with the external interface section (see chapter 3.3.3), since they're directly connected (wired) to the plugs.

## **3.3 The Rear Panel Elements**

The rear panel of a MultiCluster-2 unit contains the following important elements:

- the air filter and fan failure LED
- the power control unit
  - main power switch
  - power socket
  - fuses
- the external interface section
  - system expansion interface
  - user interface
  - video interface
  - SCSI-Interface
  - configuration links
  - reset switch

The rear panel of a MultiCluster-2 unit is shown in figure 3.9.

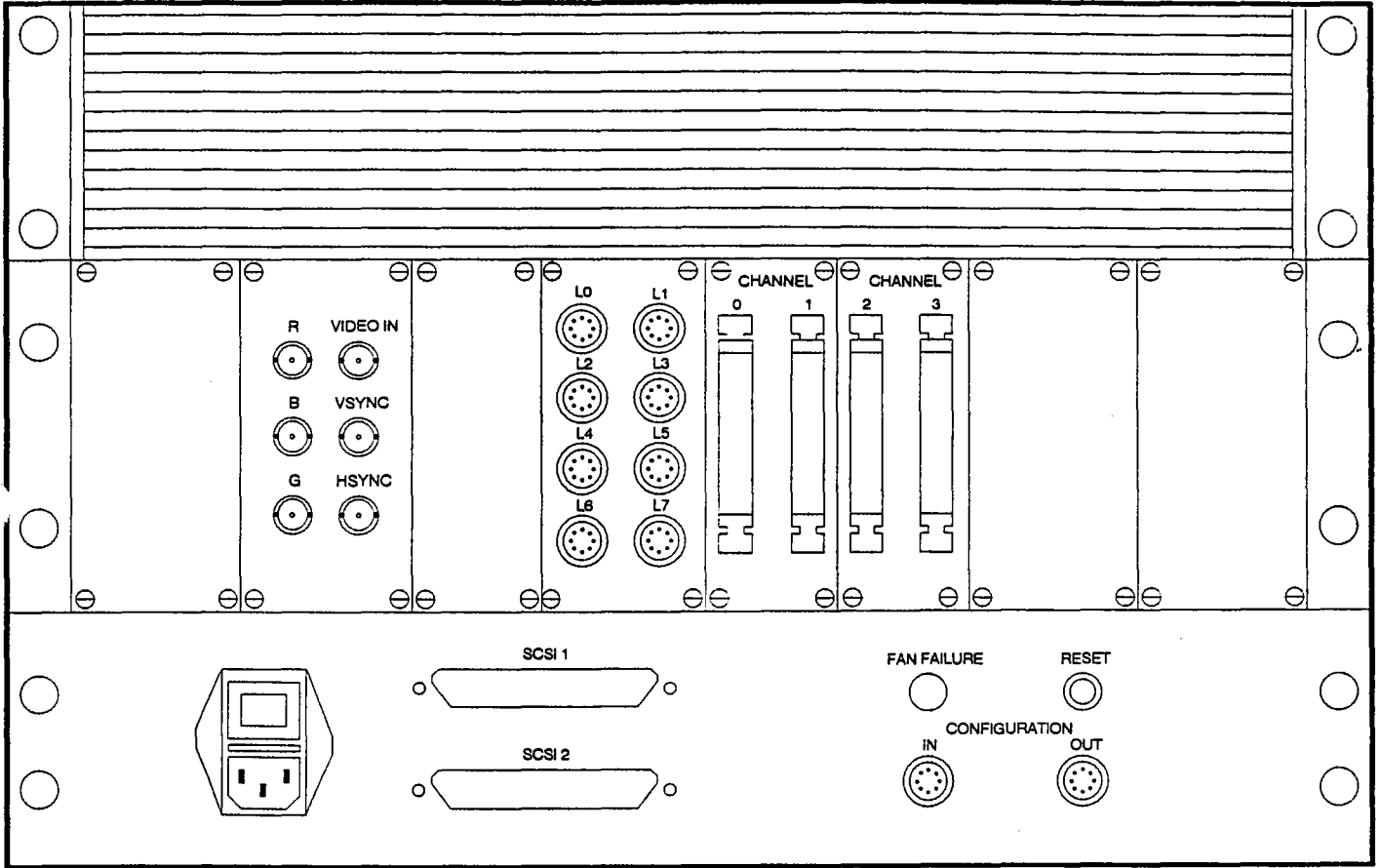


Figure 3.9: The standard layout of a MultiCluster-2 unit's rear panel.

A differing layout may result if special I/O modules are installed in the unit's expansion section. These difference , however, will only affect the structure of the external interface section.

### 3.3.1 Air Filter & Fan Failure LED

The cooling grid frame and air filter mat take up the entire upper third of the rear panel (see figure 2.10). Air is sucked in through the back of the unit and blown out the bottom by the ventilation unit's three fans, cooling all heat producing components in the process (see chapter 2.1.1.5).

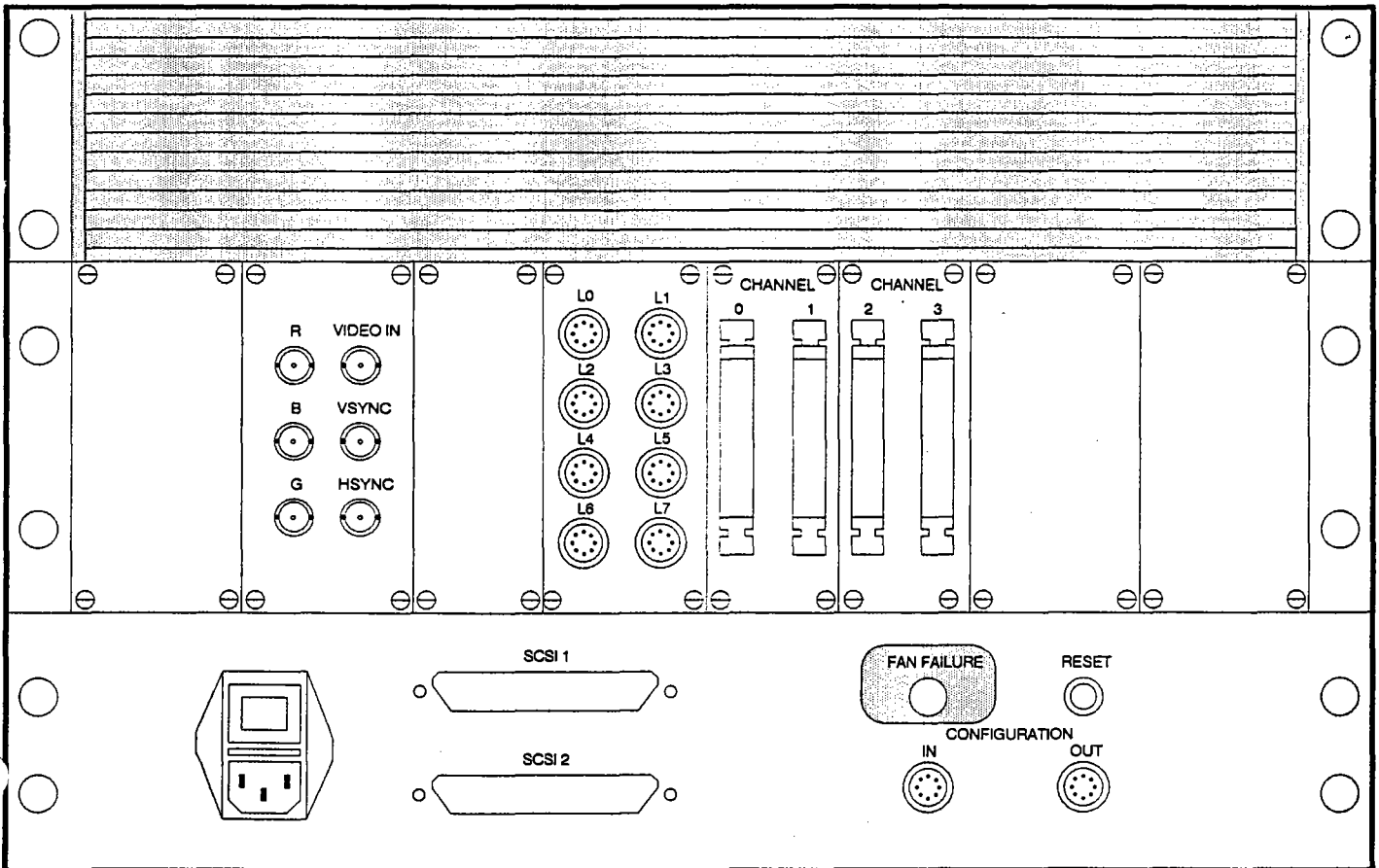


Figure 3.10: Position of the fan failure LED and the air filter on the rear panel.

Each of the three fans is constantly monitored. If any fan should malfunction, the red fan failure LED on the rear panel will light up. The position of the fan failure lamp is shown in figure 3.10.

### 3.3.2 Power Control Unit

The power control unit consists of the following elements:

- main power switch
- power socket
- fuses

These elements are all integrated in a single component, located in the lower left portion of the rear panel (viewed from the rear, see figure 3.11).

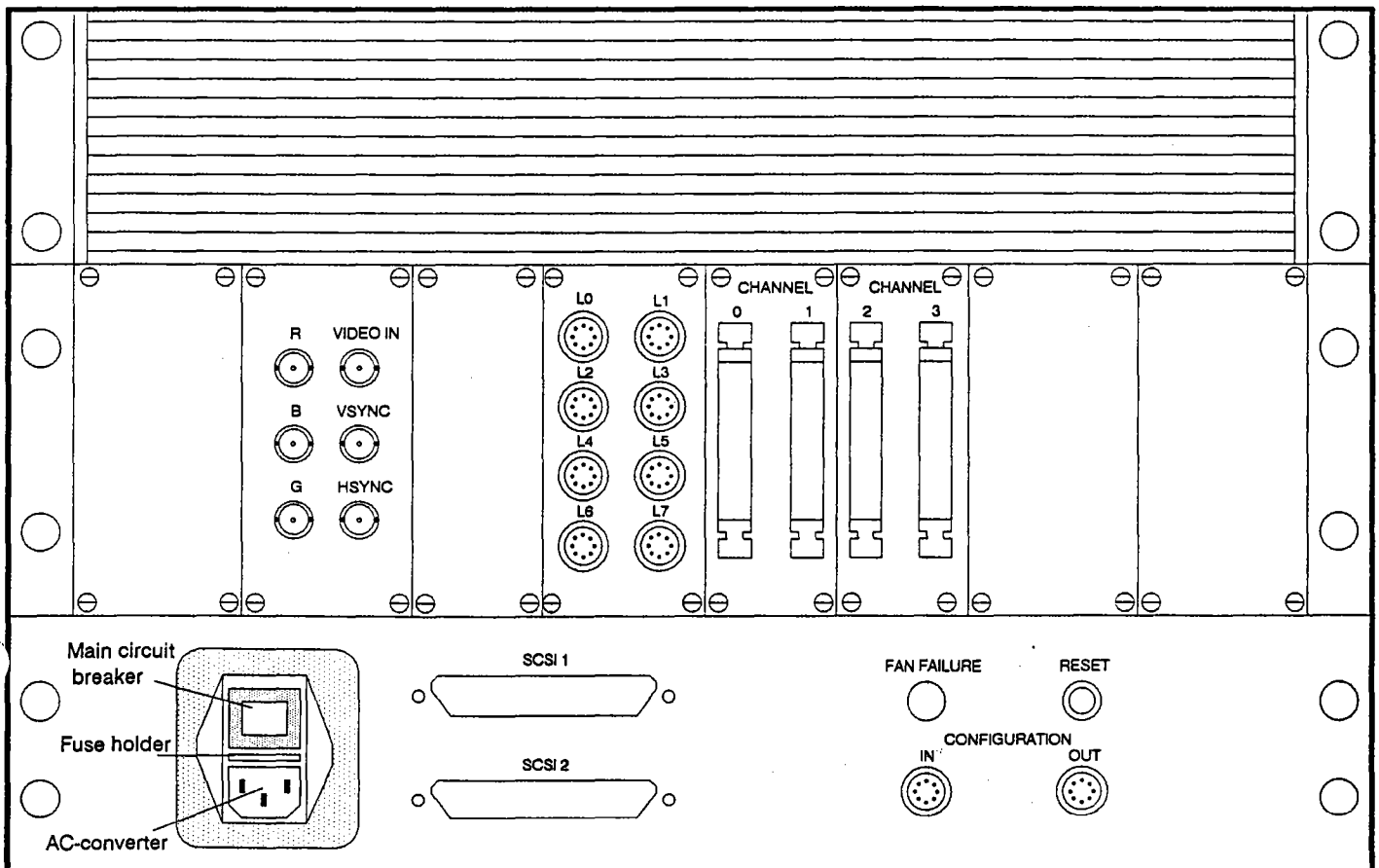


Figure 3.11: Position of the power control unit on the rear panel of a MultiCluster-2 unit.

The power socket is set at the top of the power control unit, the main power switch at the bottom, with the fuse socket in-between.

### 3.3.3 External Interface Section

The external interface section consists of the connection elements necessary for joining a MultiCluster-2 unit to I/O systems or other MultiCluster-2 units in order to create larger and more complex system. The connection elements (or subsections) are as follows:

- system expansion interface
- user interface
- video interface
- SCSI-Interface
- configuration links
- reset switch

These subsections occupy the two lower thirds of the MultiCluster-2 cabinet's rear panel (see figure 3.12).

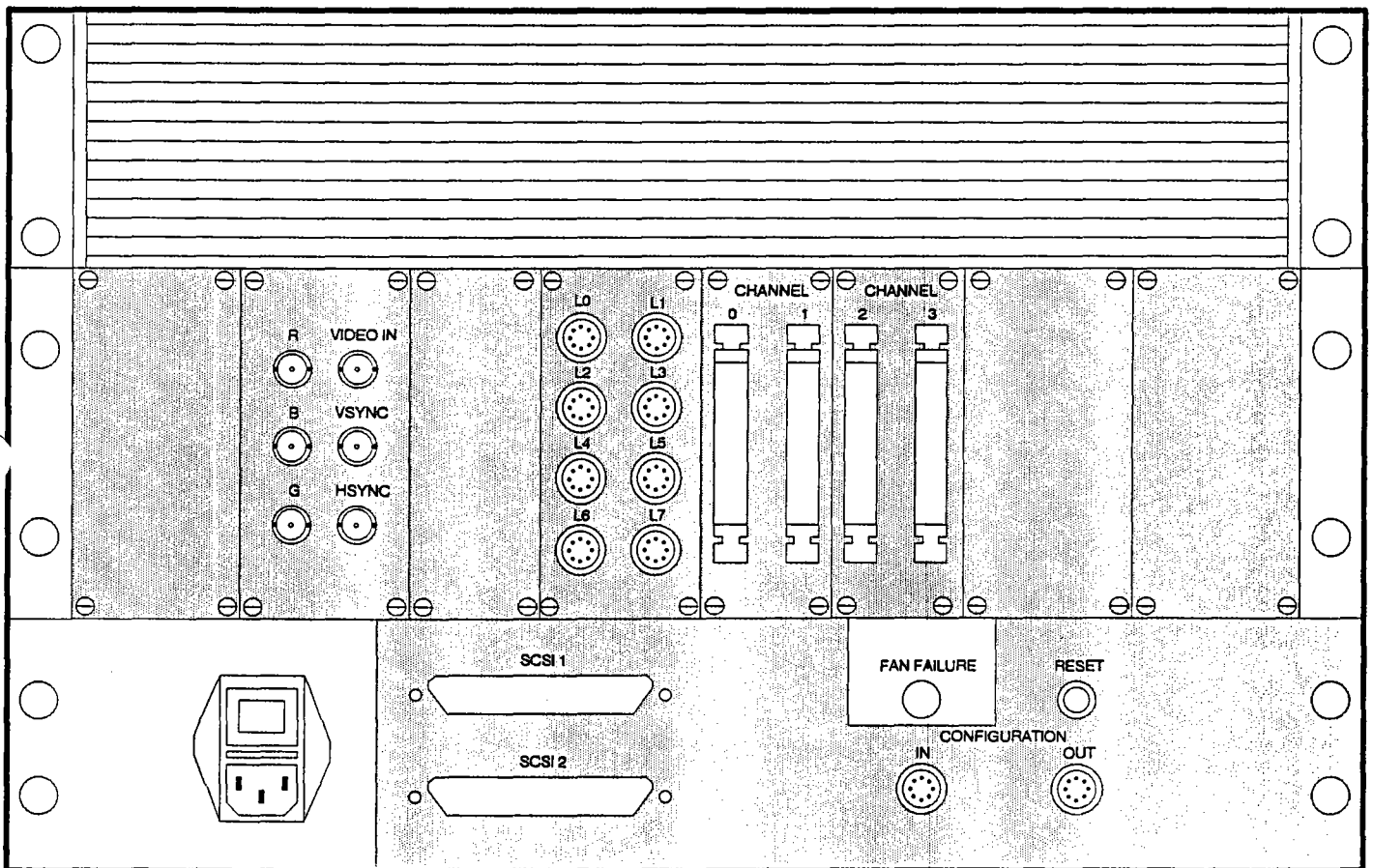


Figure 3.12: Position of the external interface section on the MultiCluster-2 cabinet's rear panel.

### 3.3.3.1 System Expansion Interface

The system expansion interface consists of four plugs used for connecting a MultiCluster-2 system to other MultiCluster-2 units (see figure 3.13). Distances of up to 10 meters can be bridged at peak transfer rates; transfer distances of up to 30 meters can be covered if the UniLink transfer rate is lowered.

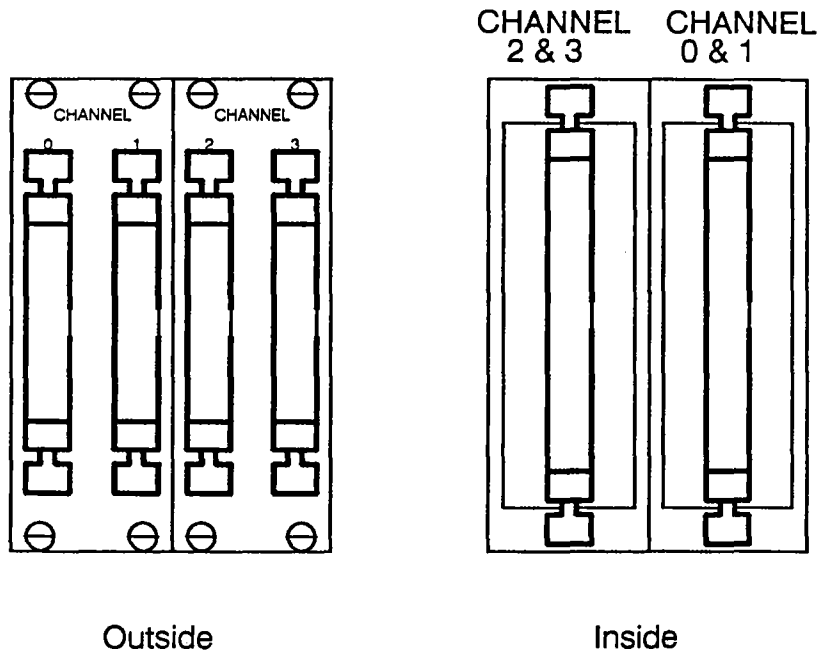


Figure 3.13: Views of the system expansion interface's "connection" side (inner side) and "plug" side (outer side).

The system expansion interface "connection" side's plugs are directly connected to the main link backplane.

### 3.3.3.2 User Interface

The user interface consists of eight lemosa plugs, arranged in two rows of four each (see figure 3.14). Workstations are connected to a MultiCluster-2 system via these plugs. The workstations can be located up to 10 meters away from the MultiCluster-2 unit if peak transfer rates are desired, although transfer distances of up to 30 meters can be covered if the UniLink transfer rate is lowered.

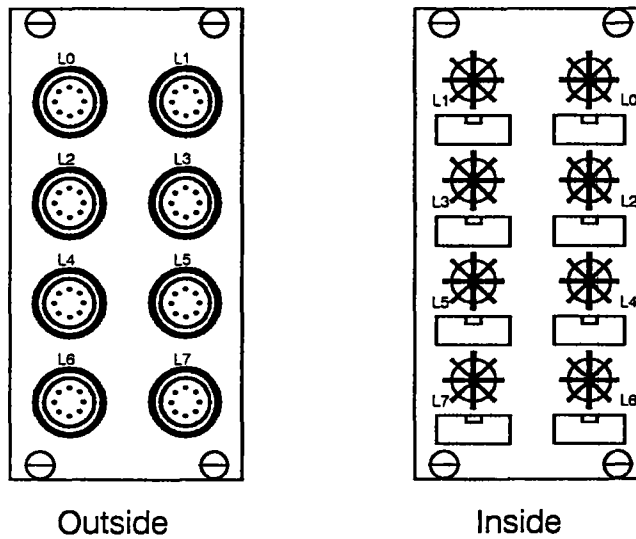


Figure 3.14: Views of the user interface's "connection" side (inner side) and "plug" side (outer side).

The corresponding "connection" side plugs are located on the inside of the MultiCluster-2 cabinet's rear panel (see figure 3.14). Wiring commences from here to one of the link assembly connector planes, and then on to the main link back plane.

### 3.3.3.3 Video Interface

The video interface consists of six coaxial plugs located on the MultiCluster-2 cabinet's rear panel (see figure 3.15). It can be used for the installation of colour graphic monitors or video cameras.

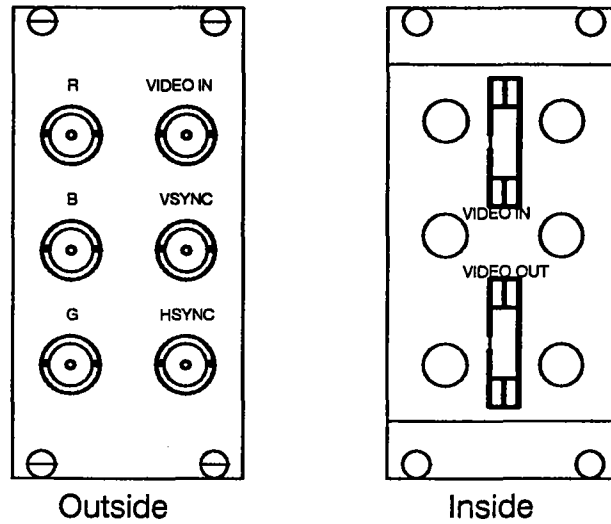


Figure 3.15: Views of the video interface's "connection" side (inner side) and "plug" side (outer side).

The video interface's "connection" side, located on the inside of the rear panel, is equipped with two plugs as seen in figure 3.15. The controller boards inserted in the expansion section are connected directly to these plugs.



### 3.3.3.4 SCSI Interface

The two rear panel SCSI interface plugs (see figure 3.16) are used to connect external mass storage units (a MultiCluster-2 system can only be equipped with an external mass storage). The appropriate mass storage controller in the expansion section is wired directly through the internal wiring section to one of these plugs.

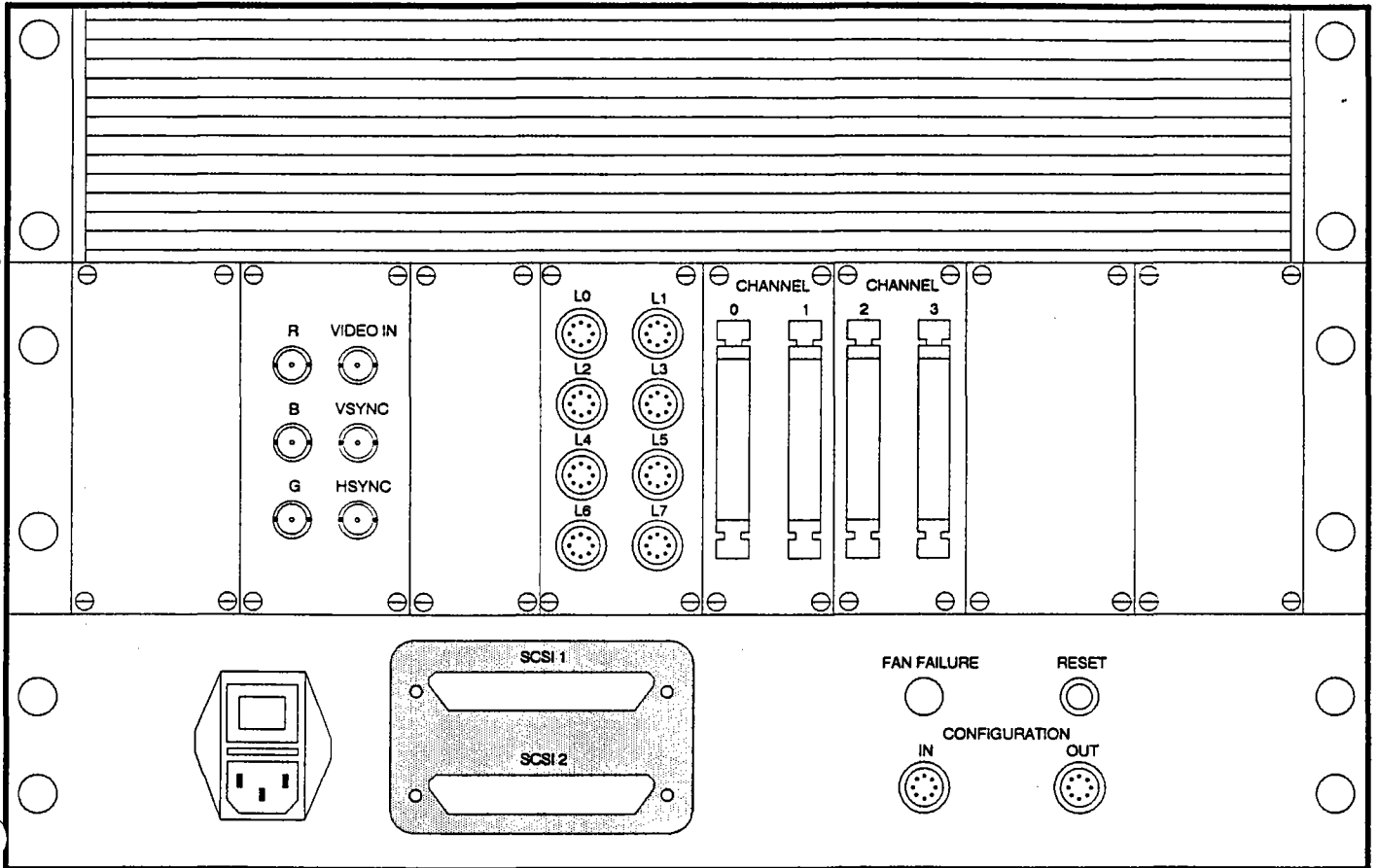


Figure 3.16: SCSI interface location

### 3.3.3.5 Configuration Link Interface

The rear panel's configuration link interface consists of two lemosa plugs labelled configuration "In" and "Out" (see figure 3.17). The designated bootstation is connected to the "In" plug. The bootstation sends the system and network configuration software to the network configuration unit. The configuration link interface is linked directly to the main link backplane. The configuration "Out" plug is only needed when several MultiCluster2 units are connected to form a larger system. In this case, the first unit's configuration "Out" plug is connected to the next unit's configuration "In" plug, and so on, down the configuration chain.

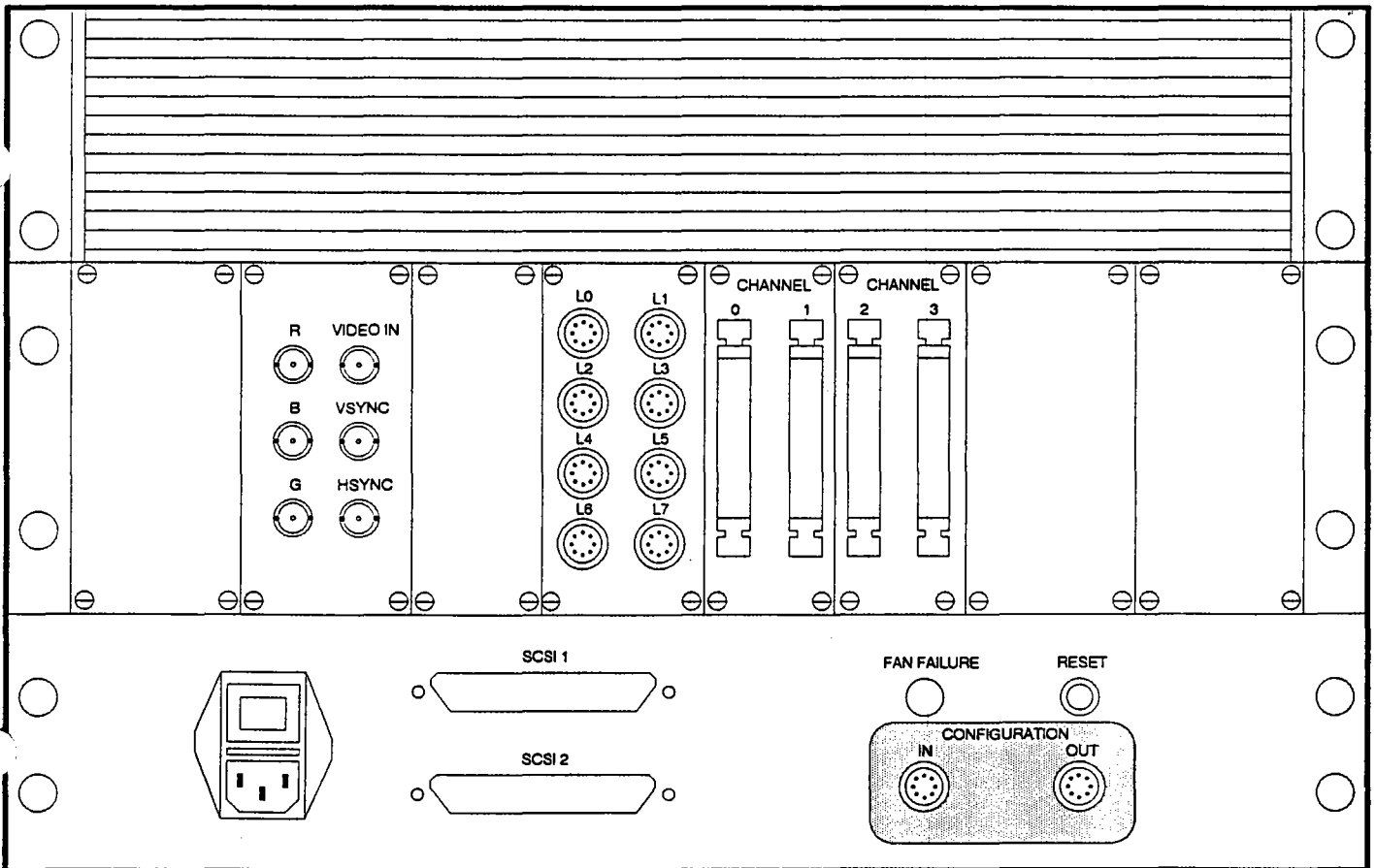


Figure 3.17: Location of Configuration Link Interface

### 3.3.3.6 Reset Switch

The reset switch located on the MultiCluster-2 cabinet's rear panel (see figure 3.18) generates a local power-on-reset which will not affect any connected external systems. It does not generate a link reset via the UniLinks and also the NCU are not resetted.

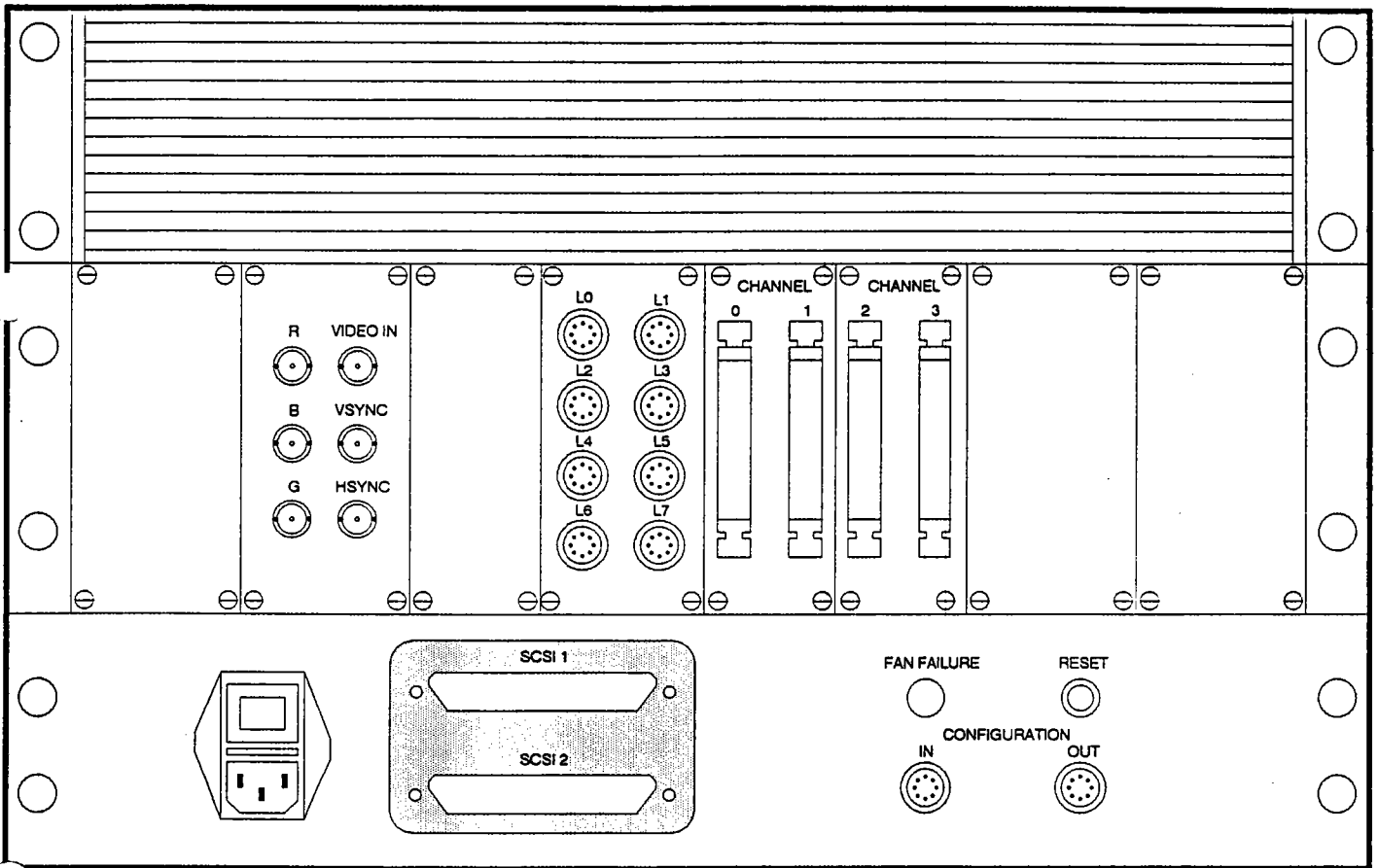


Figure 3.18: Location of Reset Switch

## **4. Internal Wiring And Plug Layout**

---

The MultiCluster-2 series consists of easily expandable, open units. The rear panel-user interface connections and the general internal wiring are designed for flexibility, simplifying the installation of different boards in different models. This chapter will explain the the more important pin layouts and connections. The individual model's default wiring will explained in detail in a separate documentation.

The internal wiring of a MultiCluster-2 unit consists of two major logical systems. First, the connections between the main link backplane and the expansion section, and second, the connections between the main link backplane and the user interface & the rear panel's system expansion section. Connections among the Transputer section's processors are established solely by the main link backplane and the configuration modules inserted in the configuration sections. Rewiring is not necessary when changing the system topology. If network configuration units are used in a MultiCluster-2 unit, its processor network can be altered on a soft ware basis. When using fixed topologies modules on the other hand, one can choose between a number of different topologies simply by switching the position of the jumpers located on the fixed topology modules (see chapter 6).

### **4.1 General Wiring**

---

Figure 4.1 depicts the general wiring scheme of all MultiCluster-2 models. The internal wiring of a MultiCluster-2 unit does not depend on the modules inserted in the Transputer and configuration sections. It will, however, vary depending on the type of modules inserted into the expansion section and the number connected workstations.

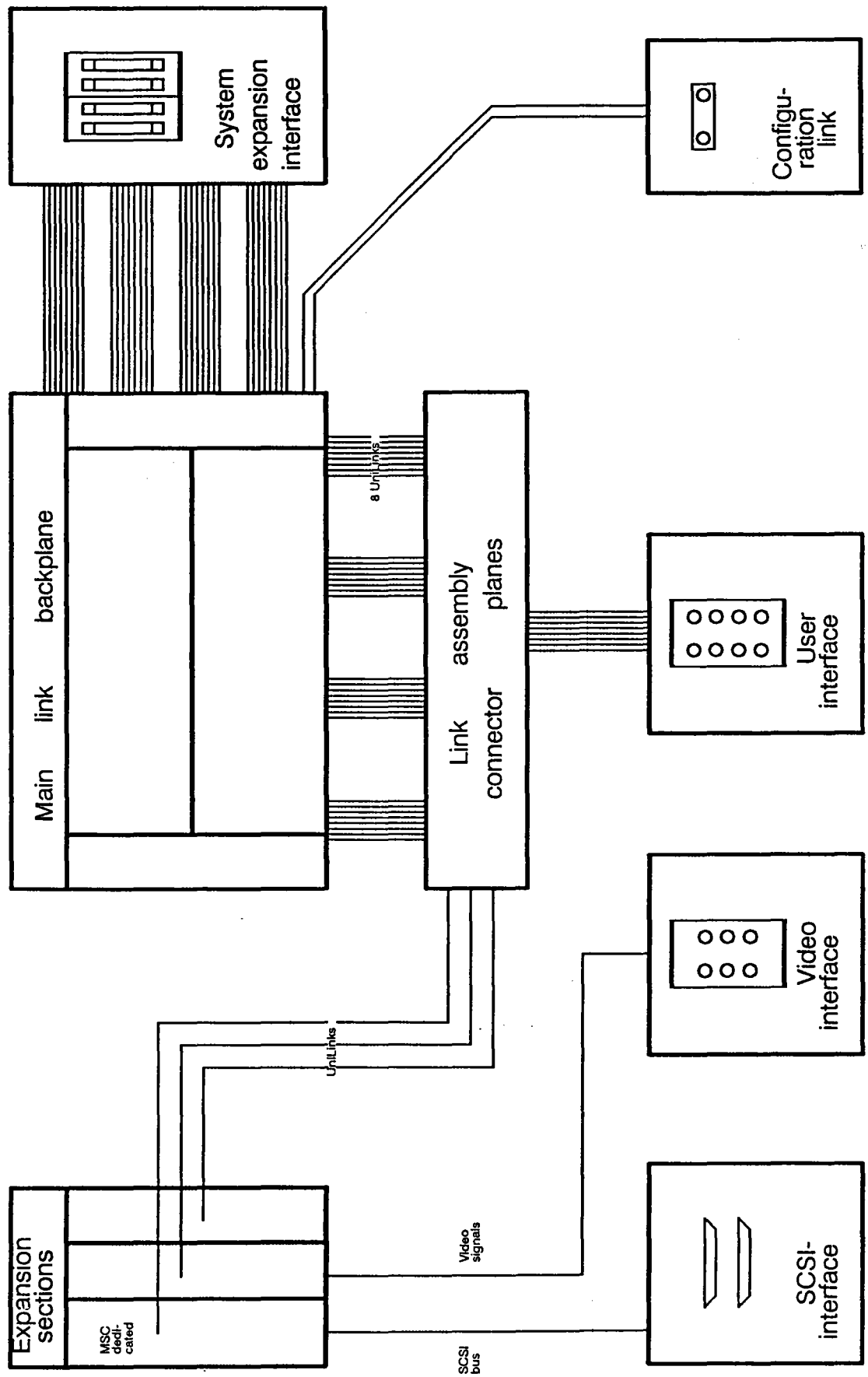


Figure 4.1: Internal wiring principals of a MultiCluster-2 unit.

Four cables lead directly from the main link backplane to the system expansion interface. They are relevant, for instance, when connecting several MultiCluster-2 units to achieve a larger total system. Four additional cables connect the main link back plane to the four link assembly connector planes. These, in turn, are the most important commutation channels for UniLinks from the expansion section's I/O modules and UniLinks arriving via the user interface (from other workstations). Cables to I/O units are led directly to the rear panel interface connectors, as they do not transmit UniLink signals and need not be connected to the link assembly planes.

## **4.2 Main Link Backplane Wiring And Plug Layout**

The main link backplane provides the infrastructure necessary for connecting all Transputer section processors to the two configuration modules inserted in the configuration sections. It also leads the configuration modules' external UniLinks to the plugs located on the main link backplane's "connection" side.

All configuration modules (fixed topology modules or network configuration units) have sufficient capacity for a total of 96 UniLinks. 64 UniLinks are reserved for up to 32 processor nodes installed in the Transputer section. The remaining 32 UniLinks are used to connect the processors to the outside world. A fully equipped MultiCluster-2 unit will require two configuration modules, as its 32 Transputer nodes present a total of  $32 \times 4 = 128$  UniLinks.

The processor nodes' UniLinks are connected to the two configuration units according to the following algorithm; all even numbered UniLinks (0,2) are led to one configuration unit, all odd numbered (1,3) UniLinks are led to the other. The configuration units are consequently named odd or even level configuration module (see figure 4.2).

All MultiCluster2 series "32" models are equipped with two configuration modules, regardless of the actual number of Transputer nodes. Model-16 with total reconfigurability on the other hand is only equipped with a single network configuration unit for handling up to 16 Transputers. This network configuration unit connects both the odd and even UniLinks of the system's Transputers among each other and to the outside world. This slightly different system structure is depicted in figure 4.3.

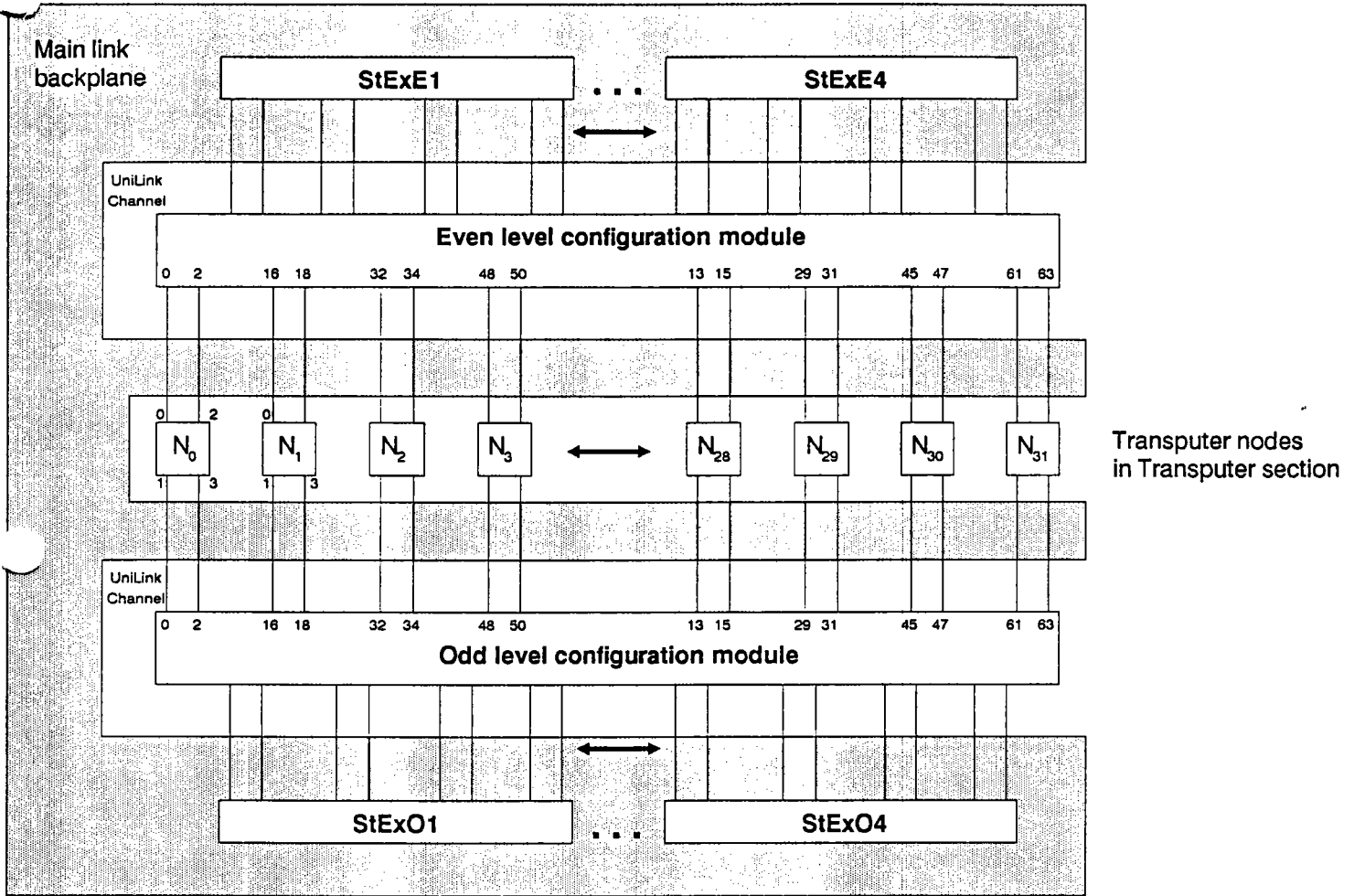


Figure 4.2: Numeration and correspondence of the configuration modules' UniLink channels to the Transputer-nodes of all MultiCluster-2 series "32" models.

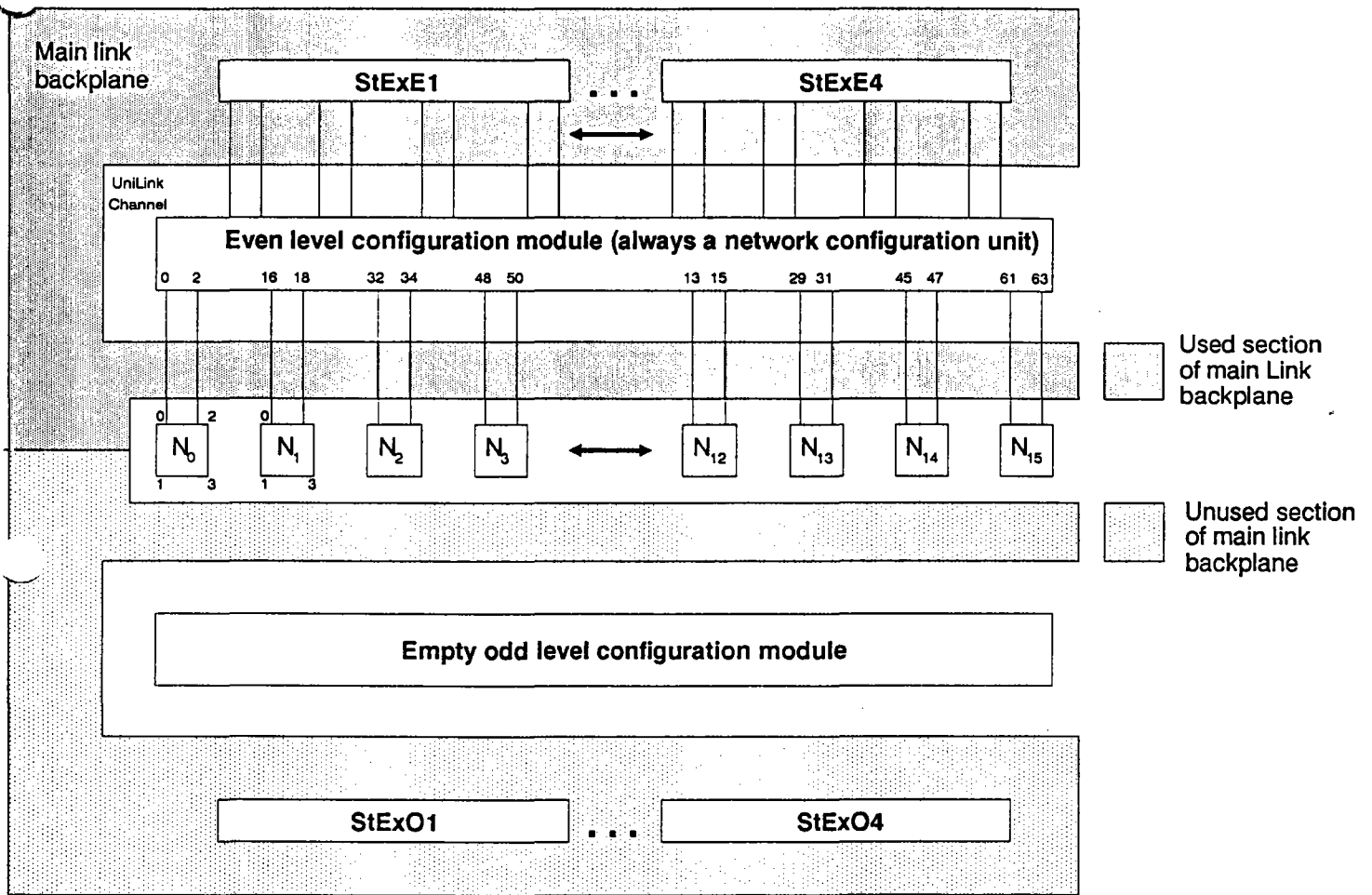


Figure 4.3: Numeration and correspondence of the configuration modules' UniLink channels to the Transputer-nodes of the MultiCluster2 series' Model-16.

The configuration module's 32 external UniLinks are connected to plugs located on its "connection" side (the side facing the rear of the cabinet) regardless of the MultiCluster-2 model. These UniLinks can then be connected to other sections of the MultiCluster-2 unit.



## 4.2.1 Main Link Backplane Plug Layout

The main link backplane's "connection" side is equipped with eight 64-way plugs. These plugs are connected to the configuration modules in the configuration sections via the link backplane (see figure 4.4).

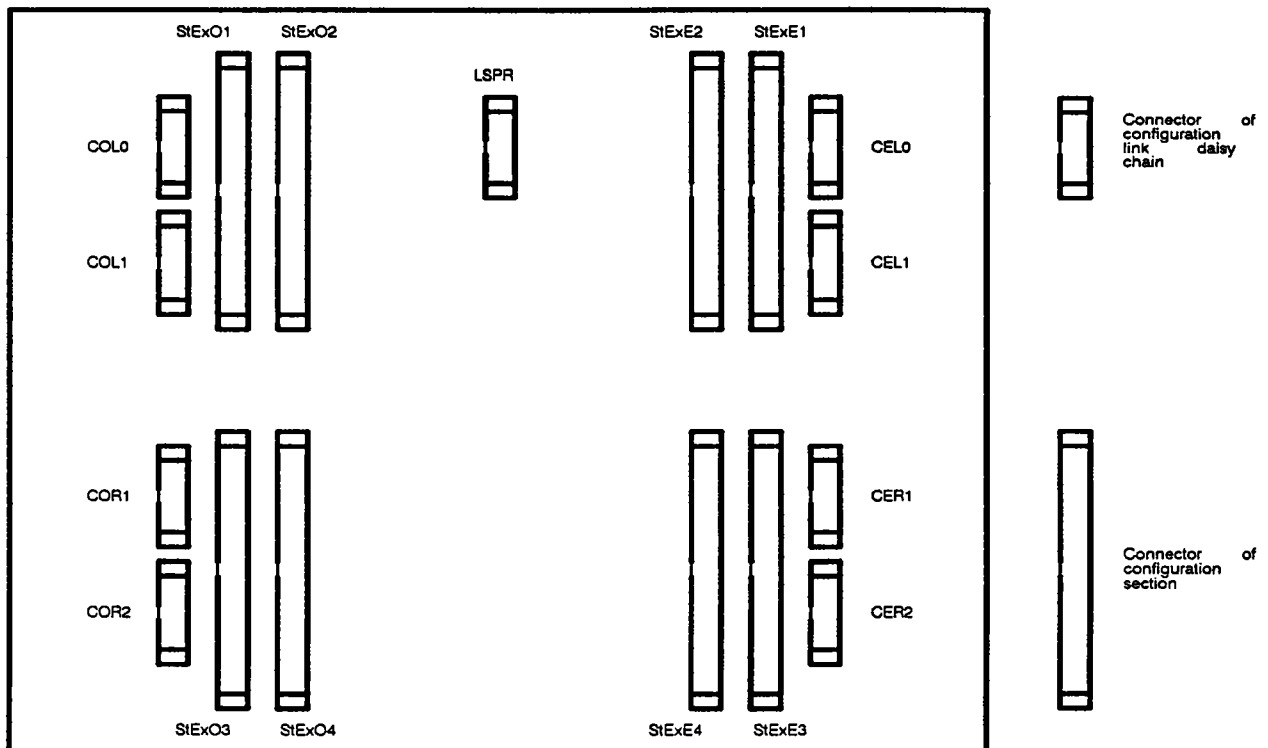


Figure 4.4: Locations and labels of the main link backplane "connection" side plugs.

The additional eight 10-way plugs are needed for the configuration link daisy chain, which will be explained in chapter 4.2.1.2.

### 4.2.1.1 External UniLink Connection Plugs

Each 64-way plug carries the signals from eight UniLinks, - the external UniLinks provided by each configuration module (32) for connecting the Transputer section processors to the outside world.

The four plugs labelled StExEn belong to the even level configuration section (St = Socket, Ex = External, E = Even level, n = 1,2,3,4) the four plugs labelled StExOn, to the odd level configuration section (O = Odd level).

Model	Model-32 with fixed topology channels	Model-32 with partial recon- figurability channels	Model-32 with full recon- figurability channels	Model-16 with full recon- figurability channels
StExE1	64 - 71	64 - 71	64 - 71	64 - 71
StExE2	free	80 - 87	80 - 87	80 - 87
StExE3	72 - 79	72 - 79	72 - 79	72 - 79
StExE4	free	88 - 95	88 - 95	88 - 95
StExO1	64 - 71	64 - 71	64 - 71	free
StExO2	free	free	80 - 87	free
StExO3	free	free	72 - 79	free
StExO4	free	free	88 - 95	free

Table 4.1: Correspondence of the two configuration section's UniLink channels to the main link backplane's "connection" side plugs.

### 4.2.1.2 Configuration Link Daisy Chain Wiring And Plugs

The other eight 10-way plugs belong to the configuration link daisy chain. When starting a MultiCluster-2 system, the system software is sent to the network configuration units' processors by the "daisy chain". This, however, is not necessary in MultiCluster-2 units with fixed topologies.

The following wiring scheme is implemented within the unit;

→ represents wiring

--- represents a direct connection within a board

Modell-32 with full reconfigurability:

configuration IN → CEL0---CEL1 → COL0---COL1 → configuration OUT

Modell-32 with partial reconfigurability

and

Modell-32 with fixed topology

and

Modell-16 with full reconfigurability:

configuration IN → CEL0---CEL1 → configuration OUT

The plugs CER1, CER2, COR1 and COR2 will be used in future software implementations.

The configuration link-protocol does not require a terminator. The daisy chain can remain open ended.

## **4.3 Link Assembly Connector Plane Wiring And Plug Layout**

---

In case of system expansion or possible repairs, any necessary rewiring can be easily done within the unit's four link assembly connectors. The 64-way flat ribbon cables carry eight external UniLinks from the configuration modules. Splice these cables into eight separate UniLinks each. The 64-way plugs are usually connected to the corresponding plugs located in the main link backplane, as described in chapter 4.2.2 and depicted in table 4.1.

### **4.3.1 Right Link Assembly Connector Planes Standard Wiring Scheme**

---

The term "right" refers to the position of two link assembly connector planes as seen from rear panel of the cabinet. The top link assembly connector plane (top board) is designated for the wiring to the user interface connection plugs. The workstations' LNK-10 cables can then be connected to its "plug" side located at the rear panel.

Figure 4.5 shows the correspondence between the even level configuration module channels and numeration of the user interface connectors.

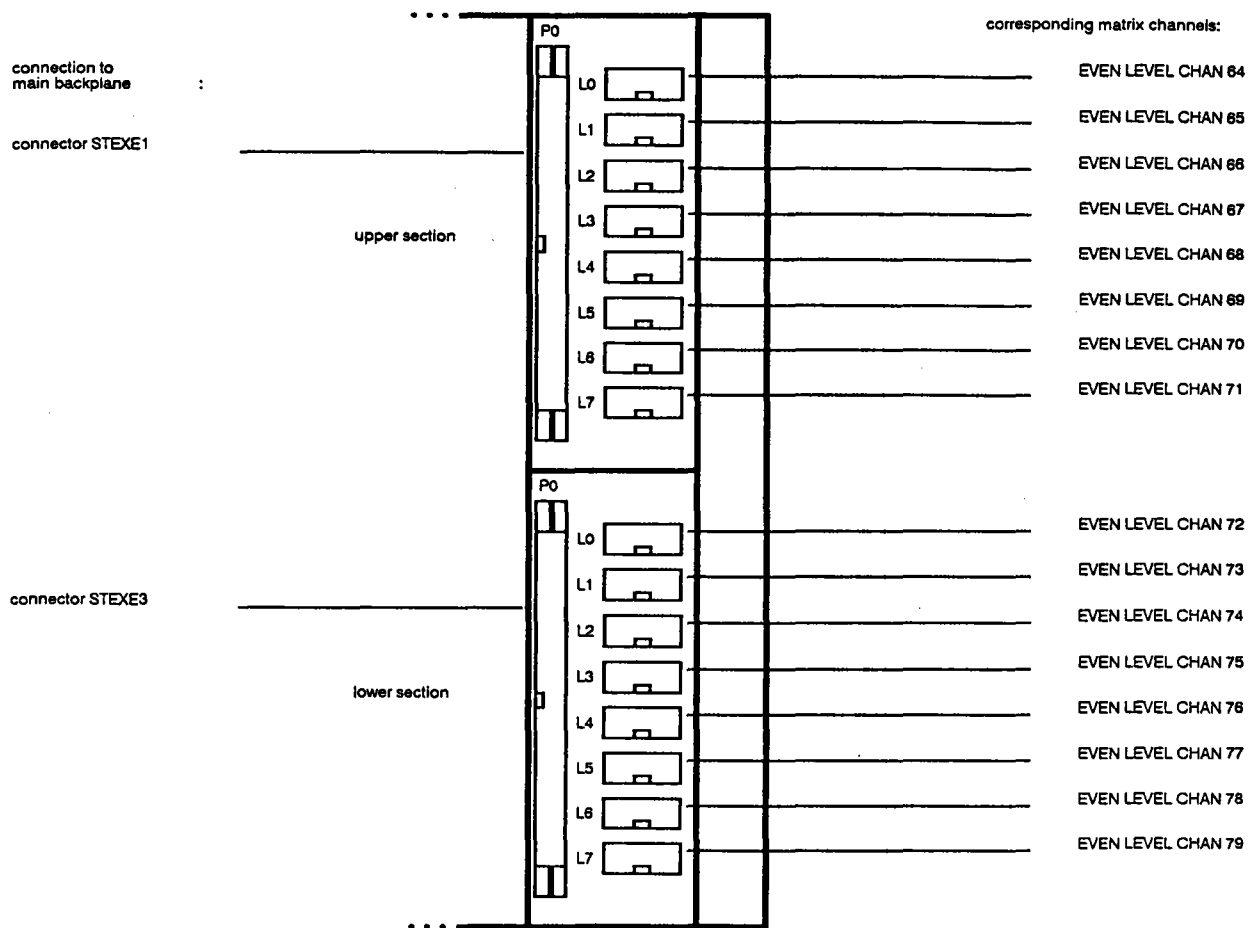


Figure 4.5: The correspondence between the UniLink plugs of the two right link assembly connector planes' and the even level configuration modules' channels in addition to the standard connections between the top board and the user interface.

Figure 4.5 also depicts the channel correspondence of the bottom link assembly connector plane's (the bottom board's) eight plugs. These plugs are reserved for special uses in "Model-32" MultiCluster-2 units. When integrating a Model-16 into a larger computer system, these plugs are used to connect it to the system via the system expansion interface.

### 4.3.2 Left Link Assembly Connector Planes Standard Wiring Scheme

The term "left" refers to the position of two link assembly connector planes as seen from rear panel of the cabinet. They are designated for the internal switching of external UniLinks from the odd level configuration modules to the I/O modules implemented in the MultiCluster-2 unit's expansion section. The upper link assembly plane corresponds to the upper expansion section, and as one would probably think, the lower to the lower. Figure 4.6 shows the standard correspondence between the UniLink plugs of the two left link assembly connector planes' and the odd level configuration modules' channels.

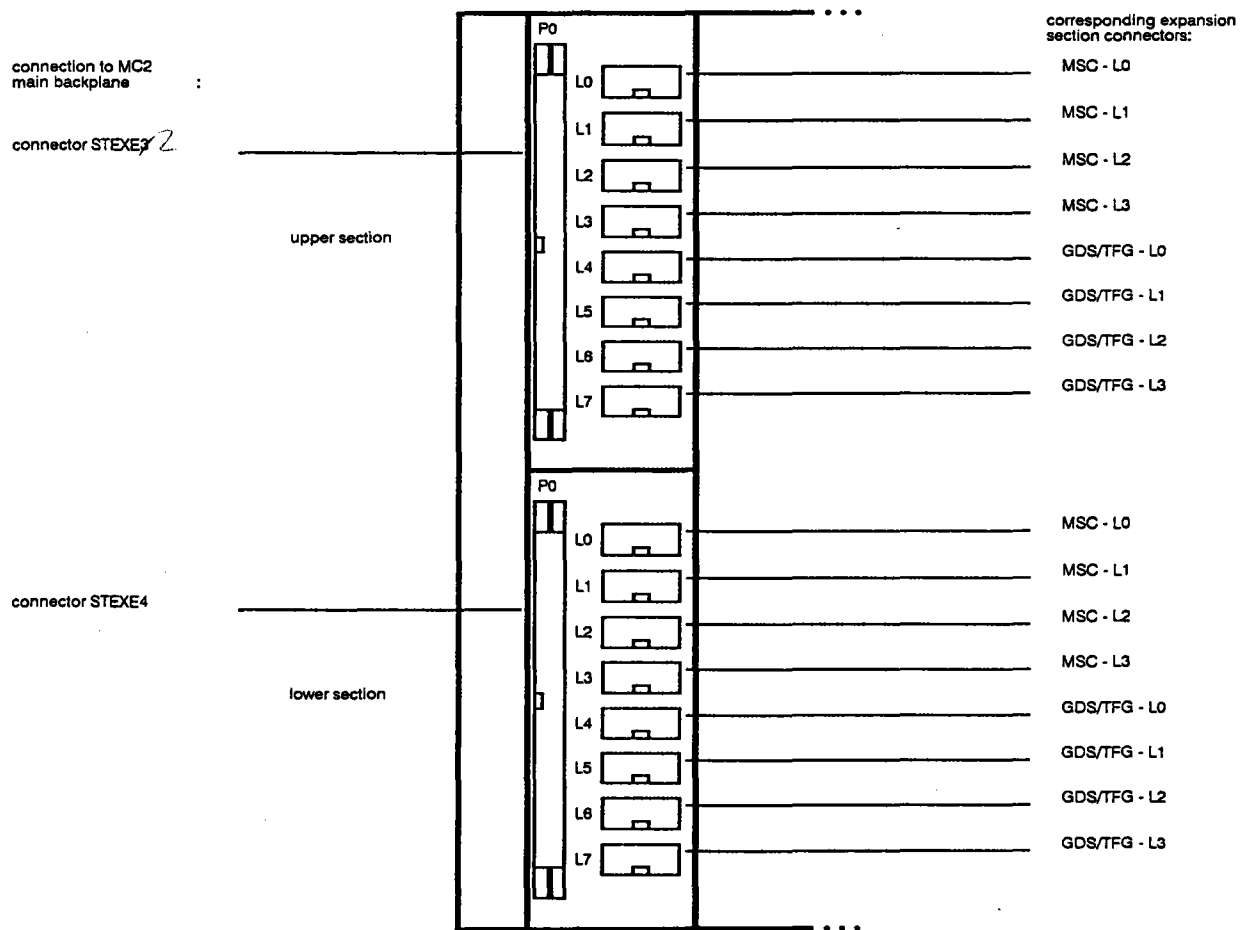


Figure 4.6: The correspondence between the UniLink plugs of the two left link assembly connector planes' and the odd level configuration modules' channels and the standard connections to the expansion section.

The exact correspondence of the both left link assembly connector planes' four lower plugs depends on the I/O modules used. This will be explained in the chapter concerning the expansion section.

## 4.4 Expansion Section Backplane Wiring And Plug Layout

The expansion section backplane consists of two identical expansion section backplane segments, corresponding to the upper and lower expansion sections. Figure 4.7 shows the expansion section's "connection" side in an opened MultiCluster-2 unit.

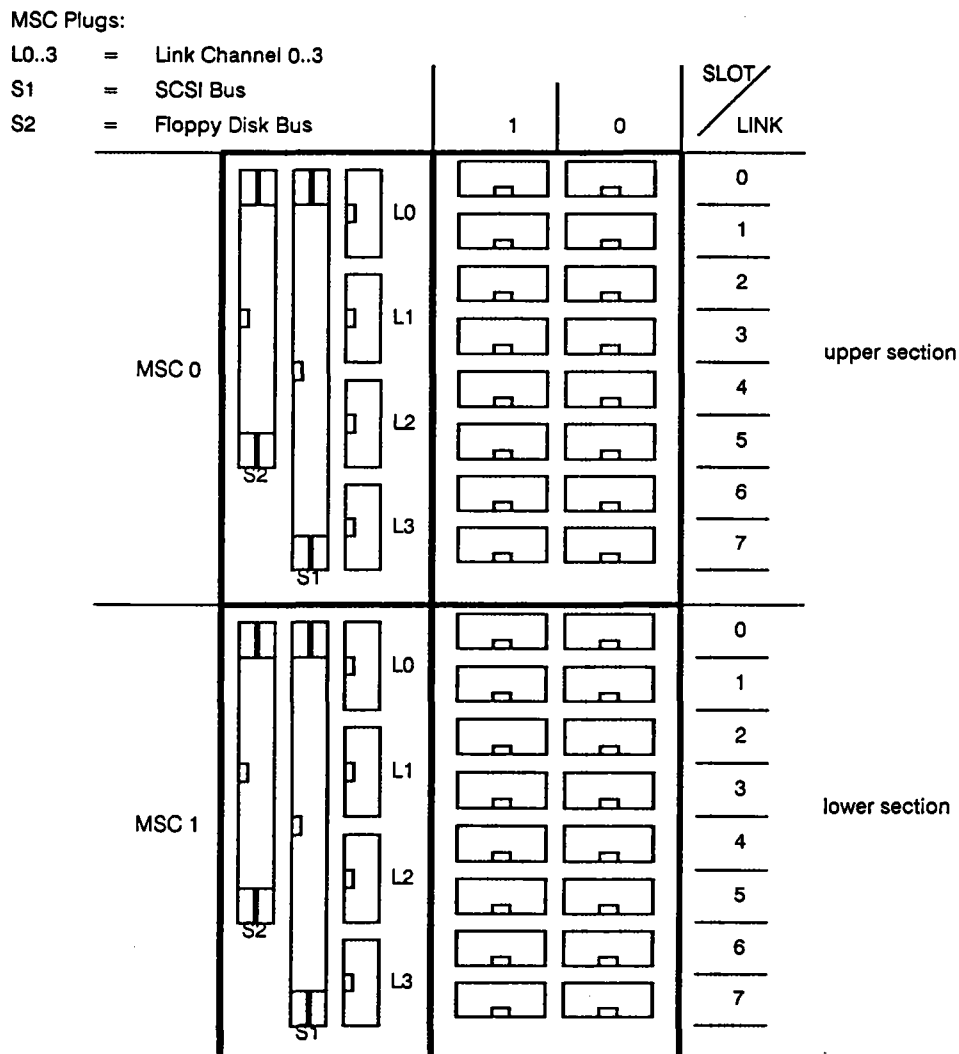


Figure 4.7: A MultiCluster-2 unit's expansion section slot layout as seen from its "connection" side.

The entire expansion section has the capacity to accommodate two intelligent, Transputer based mass storage controllers (one for each expansion section) in addition to four I/O controller boards. The slots designated for the mass storage

controllers are the leftmost as seen from the "connection" side (the slots farthest to the right, just next to the power unit, when viewed from the front).

The remaining four slots can be used for GDS-boards or other busless Transputer modules depending on the users specific needs.

A MultiCluster2 series unit is not equipped with a 12 Volt power supply. TFG-boards must therefore be accompanied by a TPSboard to supply the necessary current. Since installing a TFG-board requires two expansion section slots, only two such modules can be used in a MultiCluster-2 unit.

Each slot has eight 10-way plugs located on the expansion section backplane. The ten pins of each of these plugs will fulfil different functions depending on the type of board inserted in the corresponding slot (e.g. multi Transputer module (MTM/TPM-board) or graphic controller (GDS/TFG-board)). This will be explained in full detail in following chapters.

The UniLink signals of all modules inserted in the expansion section will, under normal circumstances, be routed to the left link assembly connector plane. The special controller boards interface signals, on the other hand, are sent (wired) directly to the appropriate MultiCluster-2 unit rear panel interface.









#### **4.4.1 MTM/TPM-Board Pin Layout**


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MTM/TPM-boards are usually only used in the Transputer section of a MultiCluster-2 unit. The exception to this rule, however, comes when you try to connect a workstation without the necessary intelligent Transputer based bus bridgehead modules. Plain bus bridgehead modules can then be used as an interface in the workstations, but the necessary remote Transputer intelligence has to be installed in the expansion section.

If a MTM/TPM-board is inserted in a slot, all Link Backplane plugs in a vertical row and belonging to the same slot will have identical pin layouts and functions. This is demonstrated in [table 4.2](#).

## MultiCluster link backplane non dedicated slots

locations of the 10-pin-connectors at the backplane	pin 1	pin 2	pin 3	pin 4	pin 7	pin 8	pin 9	pin 10	function of connector
con. #0 	reset in +	reset in -	link in +	link in -	reset out +	reset out -	link out +	link out -	RS 422 unilink
con. #1 									RS 422 unilink
con. #2 									RS 422 unilink
con. #3 									RS 422 unilink
con. #4 									RS 422 unilink
con. #5 									RS 422 unilink
con. #6 									RS 422 unilink
con. #7 									RS 422 unilink



pin positioning

Pins 5 and 6 are not used.  
Shaded area same pin layout as for con.#0.

Table 4.2: Pin layout and Function of the slot plugs, when using MTM- and TPM-modules.

Since a multi Transputer module only requires normal UniLinks and no special interface signals, all slot plugs have the same pin layout.



## 4.4.2 GDS/TFG-Board Pin Layout

If a Graphics-Display-Subsystem (GDS) or a Transputer-Frame-Grabber-Subsystem (TFG) is installed, the pin layout and function of the Link Backplane plugs 1,3,5 and 6 are altered (see table 4.3).

MultiCluster link backplane GDS/TFG-slot										
locations of the 10-pin-connectors at the backplane	pin 1	pin 2	pin 3	pin 4	pin 7	pin 8	pin 9	pin 10	function of connector	
con. #0	reset in	reset in	link in	link in	reset out	reset out	link out	link out	RS 422 unilink	
con. #1	GND	GND	GND	GND	SYNEXT	GND	PCEXT	BLKEXT	TFG SYNC output	
con. #2									RS 422 unilink	
con. #3	BLKEXT	PCEXT	XSYNC	SYNEXT	XPC	XBLK	GND	GND	TFG SYNC input	
con. #4									RS 422 unilink	
con. #5	GND	+12 V option	VIDEO option	-12 V option	VSYNC	GND	HSYNC	GND	TFG video input	
con. #6	GND	VSYNC	GND	RED	GREEN	BLUE	GND	HSYNC	GDS/TFG video output	
con. #7									RS 422 unilink	

pin positioning

Pins 5 and 6 are not used.  
 Shaded area same pin layout as for con.#0.

Table 4.3: Pin layout and Function of the plugs of a slot, when using a GDS or TFG-board.

Plugs 1,3 and 5 are only functional if a TFG-board is used. There are no valid signals in these positions when using a GDS-board.

**Note:** The plugs belonging to a slot in which a TPS-board (when using a TFG-board) is installed won't provide any thing useful, so forget hooking 'em up to anything!

## 5. System Addition And System Expansion

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**Warning:** Always remember to disconnect the cabinet from the line before installing or removing boards, or in that case, prior to any manipulations within a MultiCluster-2 cabinet! Wait till the work is done before reconnecting the line.

Use the "easy access" open front panel when installing or replacing boards from the expansion, configuration or Transputer sections. In some cases rewiring will be necessary. Appendix B describes the procedure for removing the cabinet lid, and, if it should be necessary, the cabinet floor.

When removing a board, first loosen the two fastening screws located at the top and bottom of the boards front panel. After this has been done, the board can be carefully pulled out (see figure 5.1).

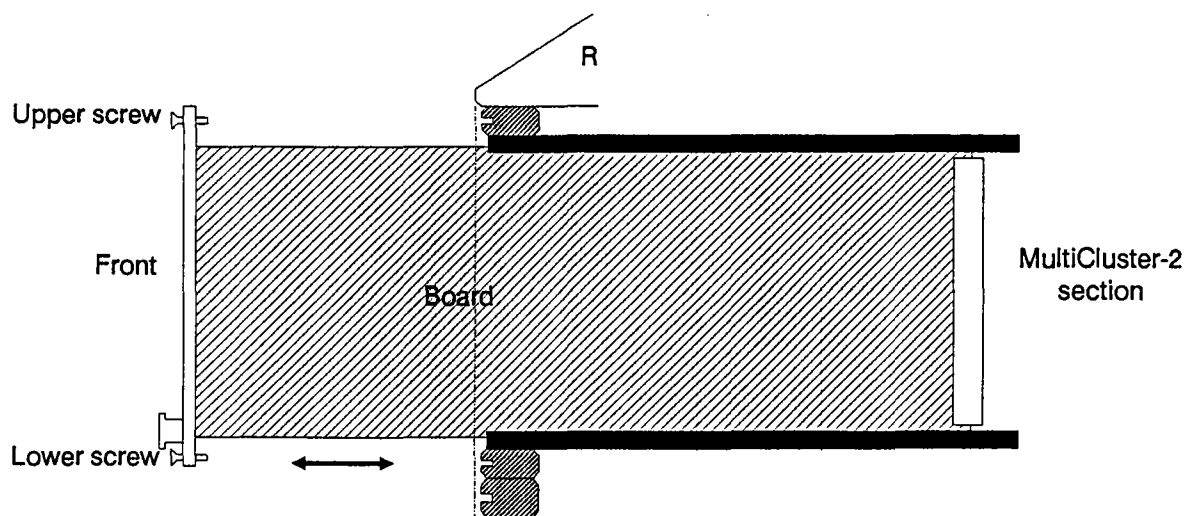


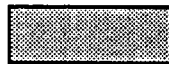
Figure 5.1: removing a board from a MultiCluster-2 unit.

If the board is equipped with removal levers, push the levers up or down accordingly. This will pull the board part-way out of the slot's connector. The board can then be carefully pulled out of the slot.

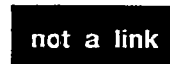
When installing an additional board, simply remove one of the slot covers by removing its fastening screws, insert the new board and tighten its fastening screws (see figure 5.1).

The correspondence between the processor UniLink channels of different board types and the expansion section backplane plug numeration is listed in table 5.1.

board conn.#	TPM-1 TPM-4	MTM-2-10 MTM-2-11 TPM-I/O	MTM-4-6	GDS	GDS-2
	Transputer / Link	Transputer / Link	Transputer / Link	Transputer / Link	Transputer / Link
0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
1		0 / 1	1 / 0		0 / 1
2	0 / 1	0 / 2	1 / 1	0 / 1	0 / 2
3		0 / 3	2 / 1		0 / 3
4	0 / 2	1 / 0	2 / 2	0 / 2	1 / 0
5		1 / 1	3 / 2		1 / 1
6	0 / 3	1 / 2	3 / 3	video out	video out
7		1 / 3	0 / 3	0 / 3	1 / 3



no valid signal



not a link connector

board conn.#	TFG	VTF	MSC	TPM-ETN	BBK-DR11
	Transputer / Link	Transputer / Link	Transputer / Link	Transputer / Link	Transputer / Link
0	0 / 0	T2-0 / 0	0 / 0	0 / 0	0 / 0
1	sync out		FD/SCSI		
2	0 / 1	T8 / 0	0 / 1	0 / 1	0 / 1
3	sync in		FD/SCSI		
4	0 / 2	def.by jump.	0 / 2	0 / 2	0 / 2
5	camera in		FD/SCSI		
6	video out	T2-1 / 0	0 / 3	0 / 3	0 / 3
7	0 / 3		FD/SCSI	Ethernet	

Table 5.1: The correspondence between the processors of different Transputer and controller board types and the expansion section backplane's plugs.

## 5.1 Installing Additional MTM-/TPM-Boards

---

Additional MTM/TPM-boards are usually installed in an existing MultiCluster-2 unit for one of two reasons. The first is a need for greater computing power. In this case, the additional boards are installed in the unit's Transputer section. The second reason arises when trying to connect a host system lacking its own Transputer intelligence. When working with a MultiCluster2 workstation only equipped with plain bus bridgehead modules, additional MTM/TPM-boards are installed in the unit's expansion section.

### 5.1.1 Installing Additional MTM-/TPM-Boards In The Unit's Transputer Section

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When inserting a MTM-/TPM-board into the unit's Transputer section, you will first have to attach a link converter board to make it long enough to connect. Figure 5.2 demonstrates the necessary steps if this has not already been done.

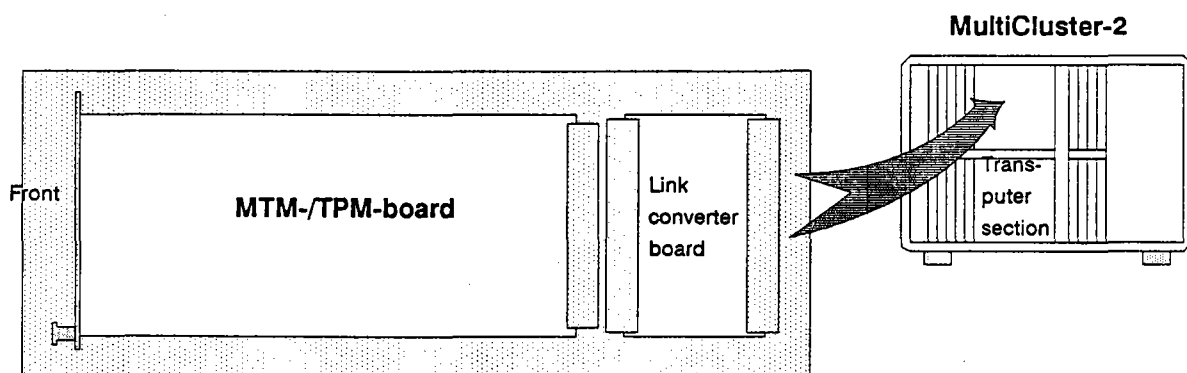


Figure 5.2: Fitting a MTM-/TPM-board with a link converter board to achieve the necessary size for Transputer section installation.

The link converter board jumpers might have to be rearranged before the "elongated" board can be inserted into the Transputer. As the name implies, the link converter board is not only suitable for adapting the size of a new board. Depending on the type of board inserted, the link converter board can also be used to determine how the Transputer modules' UniLink signals will be routed to the main link backplane.

### 5.1.1.1 Pure TPM-4 Operation

A pure TPM-4 operation occurs, when a Transputer section is only equipped with TPM-4-modules and an additional TPM-4 module is installed. In this case, all link converter board jumpers have to be set in the connector region labelled 16\*TPM. Figure 5.3 demonstrates the corresponding UniLink connections from the board to the main link backplane.

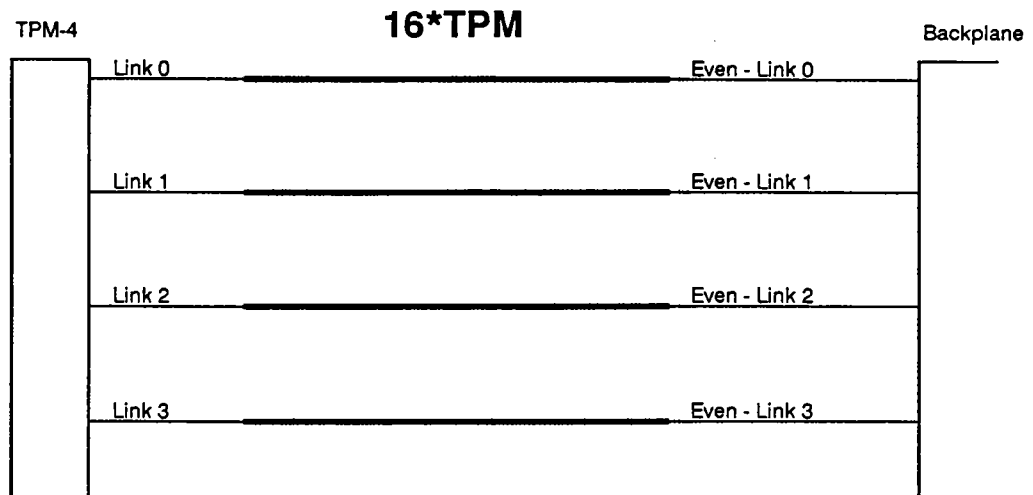


Figure 5.3: The link connections between a TPM-4-board installed in the Transputer section and the main link backplane during a pure TPM-4 operation.

### 5.1.1.2 Pure MTM-2 Operation

Analogously to a pure TPM-4 operation, a pure MTM-2 operation is characterized by a Transputer section only equipped with MTM-2 modules and an additional MTM-2 module being installed. In this case, all link converter board jumpers have to be set in the connector region labelled 16\*MTM-2. Figure 5.2 demonstrates the corresponding UniLink connections from the board to the main link backplane.

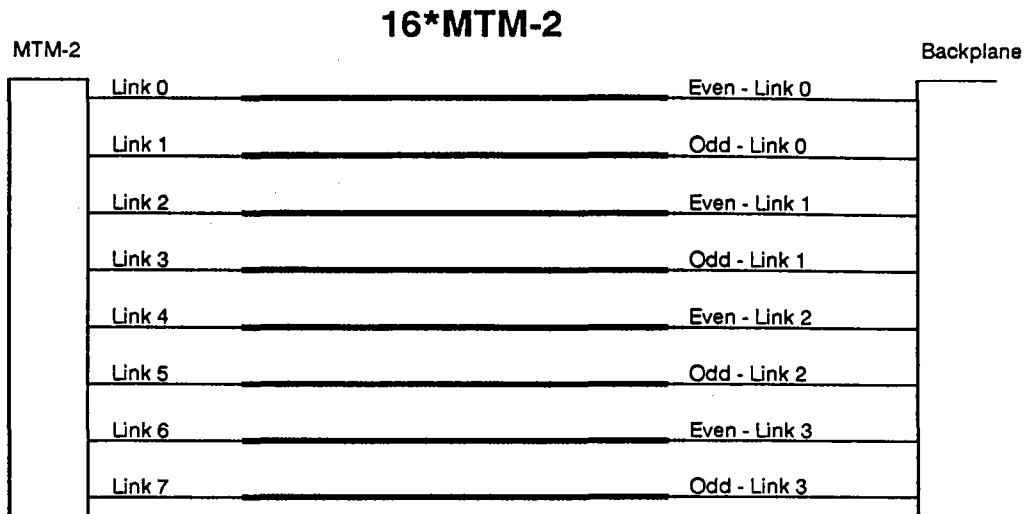


Figure 5.4: The link connections between a MTM-2-board installed in the Transputer section and the main link backplane during a pure MTM-2 operation.

### 5.1.1.3 Using A TPM-4 As A MTM-2-Board

Adding a TPM-4-board to a Transputer section with several MTM-2 modules already implemented requires the following rewiring. All link converter board jumpers have to be set in the connector region labelled TPM → 1/2MTM-2. Figure 5.5 shows how to rewire the slot's superfluous UniLinks to the main link backplane.

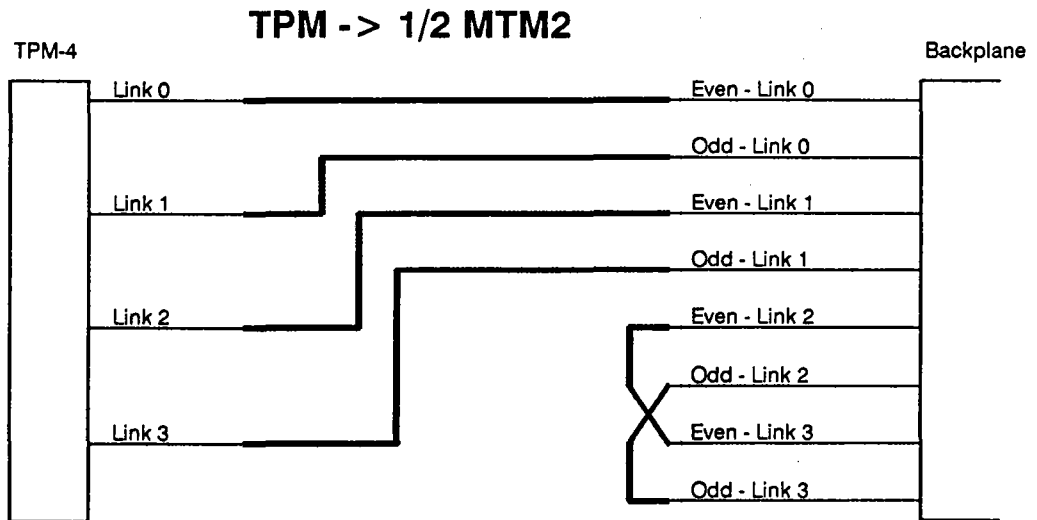


Figure 5.5: The link connections between a TPM-4-board installed in the Transputer section and the main link backplane when primarily using MTM-2-boards.

#### 5.1.1.4 Using A MTM-2 As A Double TPM-4-Board

If a Transputer section is primarily equipped with TPM-4 modules, additional MTM-2-boards have to be used like 2 TPM-4-boards. All link converter board jumpers have to be set in the connector region label 8\*MTM → 16\*TPM. Since a MTM-2-board is equipped with two Transputers, and therefore a total of eight UniLinks, four UniLinks have to be switched to another of the main backplanes's slots, thus simulating two TPM-4-boards. Figure 5.6 shows the how to wire the superfluous UniLinks to a second main link backplane slot.

**8\*MTM (-> 16\*TPM)**

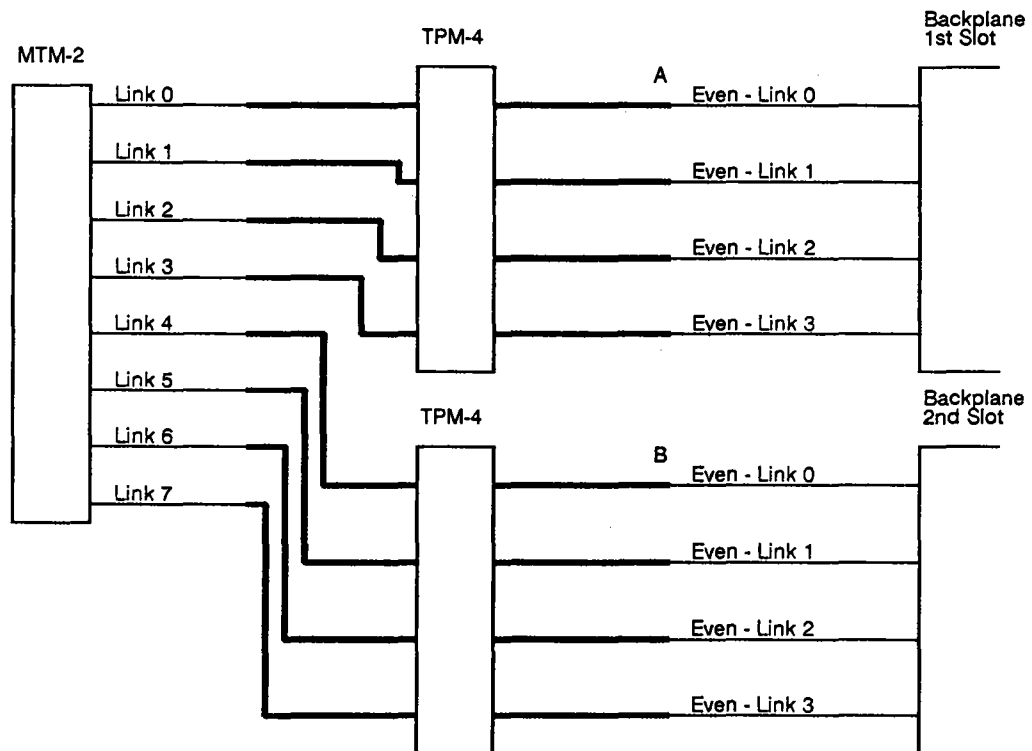


Figure 5.6: The link connections between a MTM-2-board installed in the Transputer section and the main link backplane when primarily using TPM-4-boards.

Connect a short flat ribbon cable to the appropriate plug located on the link converter board. Insert the board into the slot, and connect the other end of the cable to the connector of the neighbouring slot (see figure 5.7).

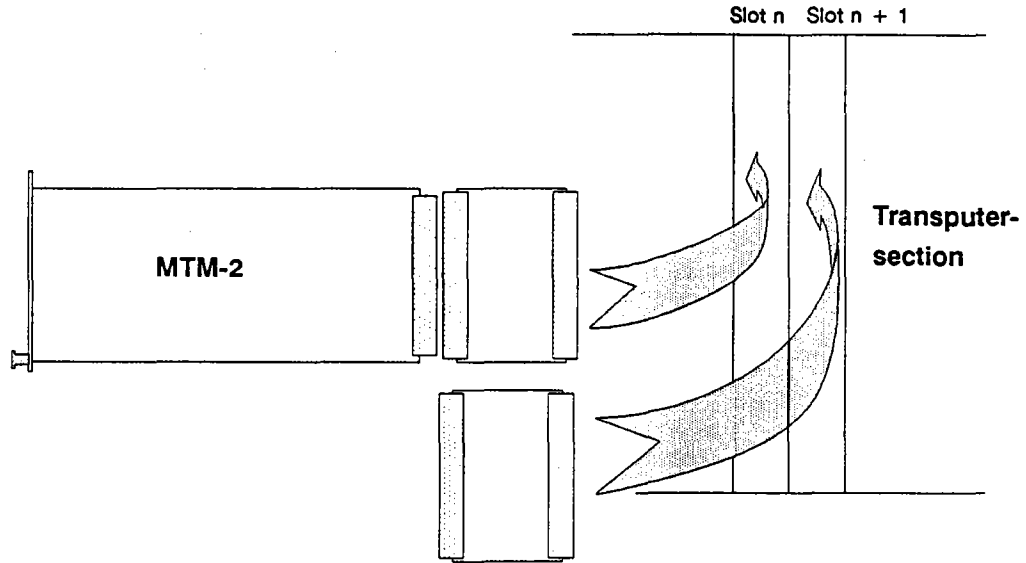


Figure 5.7: Installing a MTM-2-board as a double TPM-4 module.

The slot connectors are located pretty far inside the cabinet. To avoid awkward attempts at plugging in the cable, it is advisable to remove the cabinet lid to gain access to the upper Transputer section (respectively the floor for the lower Transputer section) as described in appendix B.

### 5.1.2 Installing Additional MTM-/TPM-Boards In The Unit's Expansion Section

Under normal circumstances, additional MTM-/TPM-boards are only installed in the unit's expansion section when using workstations without Transputer intelligence as a host. Figure 5.8 shows the general wiring scheme necessary in this case.

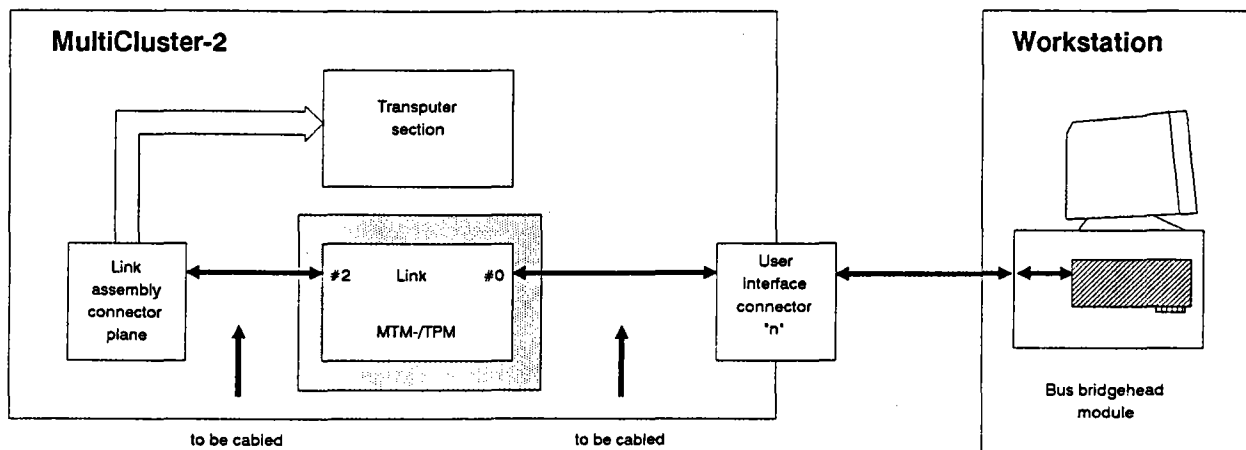


Figure 5.8: General wiring scheme when using a host without its own Transputer intelligence. The additional MTM-/TPM-boards installed in the MultiCluster-2 unit's expansion section supply the necessary intelligence.



In order to function like a normal workstation, the added board's processor UniLinks have to be connected to both the MultiCluster-2 unit and the host computer. The connection to the Transputer section is achieved via the left link assembly connector plane. The host computer's UniLink cable, on the other hand, is simply connected to the user interface. Once its there, one can implement a direct connection to the host Transputer module in the expansion section.

### 5.1.2.1 Wiring To The Transputer Section

Connect UniLink #2 of the designated Transputer (as an interface processor to the workstation, see chapter 5.1.2) to the any of the left link assembly connector planes' free plugs via a 10-way link flat ribbon cable. At this point the MultiCluster-2 unit's standard wiring will take care of the rest. It makes no difference which processor is selected as host processor when using a two-processor module.

**Note:** Only UniLink #2 can be used to connect the host processor to the MultiCluster-2 unit's Transputer section.

The correspondence between the processor UniLinks of different MTM-/TPM-boards and the expansion section backplane plugs is listed in table 5.1.

### 5.1.2.2 Wiring To The User Interface

As described in chapter 5.1.2, the host Transputer (as an interface processor to the workstation, inserted into the expansion section) also has to be connected to the workstation. Connect UniLink #0 of the designated Transputer to the user interface by plugging one end of a 10-way link flat ribbon cable into the appropriate expansion section backplane plug. The other end is inserted into one of the user interface's "connection" side plugs labelled L0 to L7. The numeration of the Lemo-sa plugs located on the rear panel (in effect the "plug side" of the user interface) corresponds to the numeration used inside. The connection to the workstation is complete as soon as the station's LNK-10 cable is plugged into the correct Lemo-sa plug.

Use table 5.1 to locate the expansion section backplane plug corresponding to UniLink #0.

## 5.2 Adding I/O Boards

---

**Warning:** I/O boards may only be used in the MultiCluster-2 unit's expansion section. I/O boards inserted into the Transputer section may damage the configuration modules, or in turn be damaged.

The main link backplane only expects UniLink signals, and the configuration modules are only equipped to handle UniLink signals. I/O boards, on the other hand, have a number of interface signals unsuitable for the configuration modules, so never insert one into the Transputer section.

### 5.2.1 Adding GDS-Boards

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The rules listed in chapter 4.4 basically apply here too. A GDS-board is connected to the Transputer section processors via the left link assembly connector plane corresponding to its expansion section backplane. The designated link assembly connector plane plugs are shown in figure 4.6. The upper and lower expansion section backplane plugs 0,2,4 and 7 of segments 0 and 1 are reserved for this purpose (see table 5.1). The other four plugs either carry video signals or no information at all.

A monitor can be connected by wiring expansion section backplane plug 6 to video interface plug "video out" (located on the video interface's "connection" side, see figure 3.15) with a flat ribbon cable. The "video out" plug is linked to the rear panel coaxial plugs R, G, B, VSYNC and HSYNC (in effect the "plug side" of the video interface).

The monitor cable is then plugged into one of the video interface's "plug side" plugs (see figure 5.9).

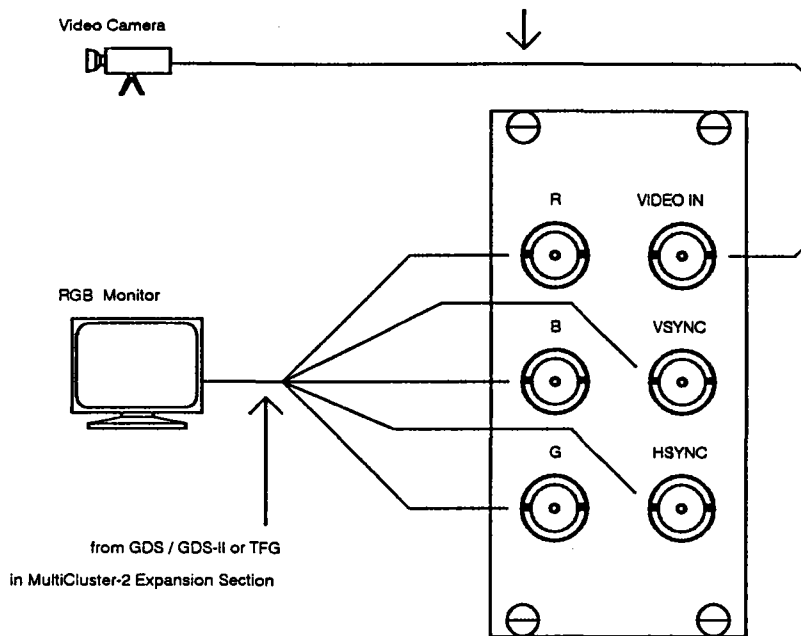


Figure 5.9: Plug side of the video interface on the MultiCluster-2 unit's rear panel with possible connections for different I/O constellations.

## 5.2.2 Adding A TFG-Subsystem

Again, the rules stated in chapter 4.4 apply when connecting a TFG-subsystem to the Transputer section. A TFG-subsystem is connected to the internal Transputer network via the left link assembly connector plane corresponding to its expansion section backplane. The designated link assembly connector plane plugs are shown in figure 4.6. Only the upper and lower expansion section backplane plugs 0,2,4 and 7 of segments 0 and 1 will provide UniLink signals from the TFG-board (see table 5.1). The other four plugs either carry video signals or no information at all.

A monitor can be connected by wiring expansion section backplane plug 6 to video interface plug "video out" (located on the video interface's "connection" side, see figure 3.15) with a flat ribbon cable. The "video out" plug is linked to the rear panel coaxial plugs R, G, B, VSYNC and HSYNC (in effect the "plug side" of the video interface).

When connecting a video camera, wire plug 5 of the appropriate expansion section backplane segment to the video interface's "connection" side "video in" plug with a flat ribbon cable (see figure 3.15). The "connection" side's "video in" plug is wired to the rear panel's coaxial "video in" plug (in effect the "plug side" of the video interface). Connect the video camera to this plug (see figure 5.9).

### **5.2.3 Adding A Mass Storage Controller**

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A MSC-board is connected to the internal Transputer network via the left link assembly connector plane corresponding to its expansion section backplane. The designated link assembly connector plane plugs are shown in figure 4.6. Figure 4.7 shows the expansion section backplane with the dedicated MSC connectors. The 20-way plugs L0 to L3 correspond to the MSC-Transputer links 0 to 3, which are wired (or have to be wired) to the left link assembly connector plane in standard configuration.

The SCSI busses are already wired from the plugs S1 of the MSC slots 0 and 1 to the SCSI connectors 0 and 1 of the external interface section (see figure 3.16).

## **5.3 Connecting Another MultiCluster-2 Computer**

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In order to connect a MultiCluster-2 unit to one or more other MultiCluster-2 units (in order to attain greater computing power), simply apply the external wiring depicted in figure 5.10. Use wiring scheme on the left if only one MultiCluster-2 unit is to be connected, otherwise, use the right scheme.

In addition to the UniLink connections between MultiCluster-2 units, one must also install a configuration link daisy chain. Connect bootstation link #1 with the first MultiCluster-2 unit's configuration section's "configuration in" plug (located on the rear panel). Then wire the first unit's "configuration out" plug to the next unit's "configuration in" plug. Continue this procedure till all MultiCluster2 systems are linked in a chain (see figure 5.11). The last link does not have to be rewired as terminators are not necessary in the MultiCluster-2 series.

## MultiCluster-2 System Expansion Interface

(Example)

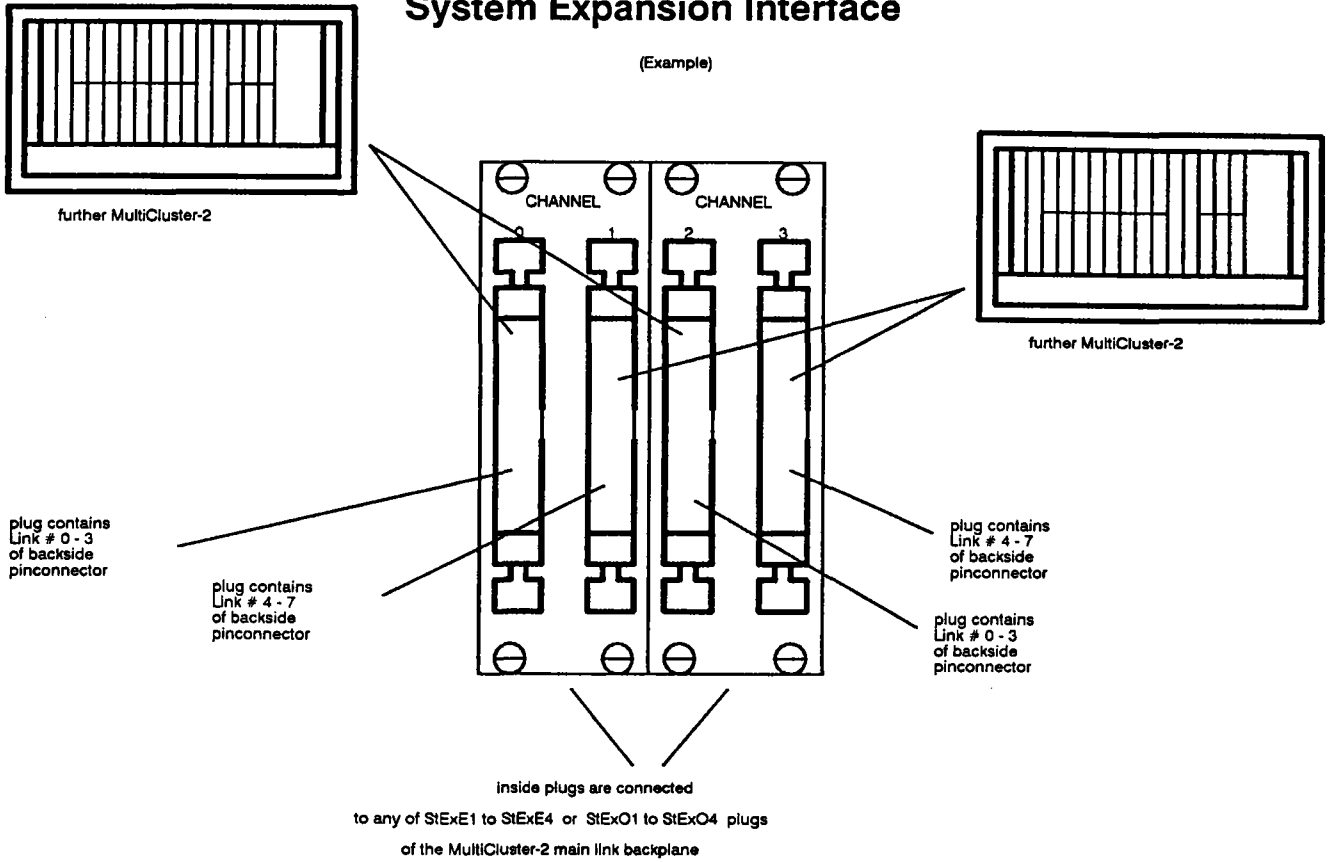


Figure 5.10: Possible connection schemes for adding systems to a MultiCluster-2 computer.

### Configuration Link Daisy Chain

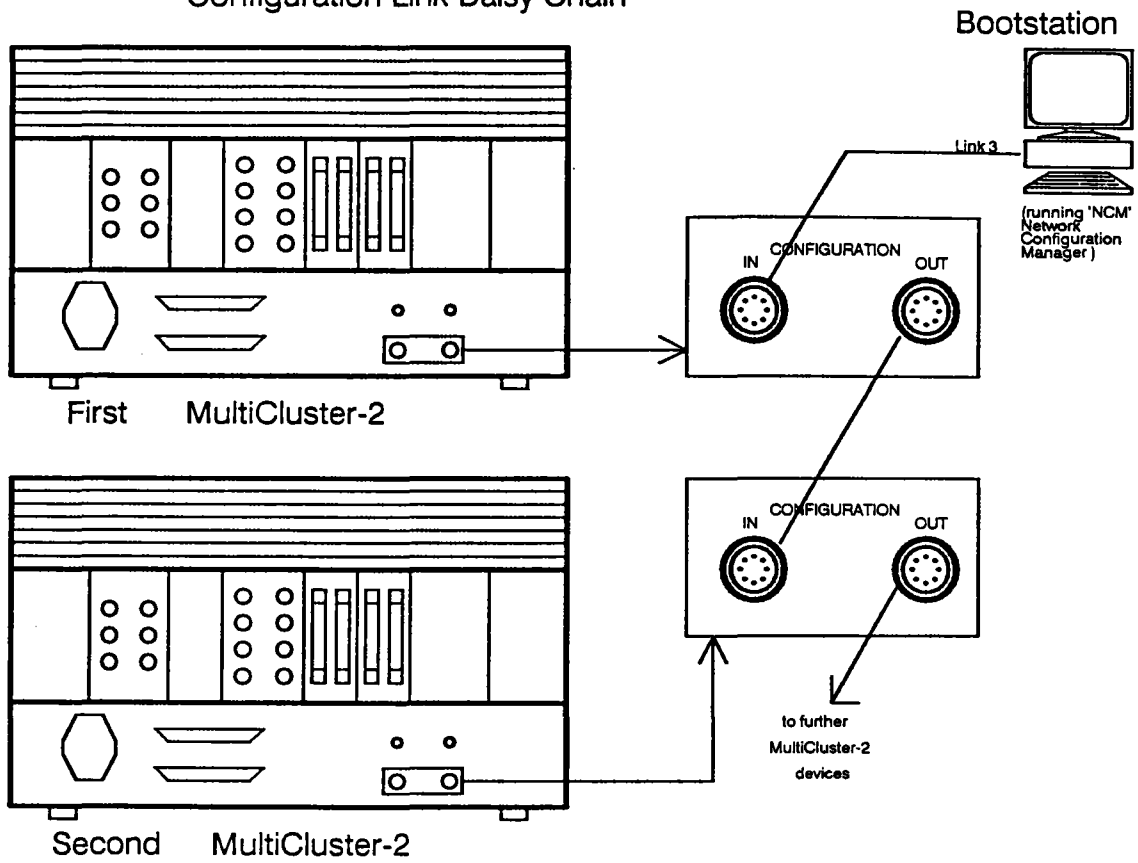


Figure 5.11: The configuration link daisy chain in a system consisting of several MultiCluster-2 computers.

## 6. Fixed Topology Modules

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The MultiCluster-2 series' concept lies between those of the smaller MultiCluster-1 series and the larger SuperCluster systems. Using fixed topology modules, a MultiCluster-2 unit is still more flexible than a MultiCluster-1 unit with its hard-wired configuration; the topology can be altered by rearranging the jumpers. Employing network configuration units in a MultiCluster-2 unit makes it possible to alter the system's topology on a software basis, just as in a SuperCluster system. This chapter will explain the topologies possible when fixed topology modules are installed.

Either two fixed topology modules or a fixed topology module paired with a network configuration unit are used in MultiCluster-2 units with total or partial fixed topology. Systems using a network configuration unit are more flexible and allow more topologies than systems only equipped with two fixed topology modules.

### 6.1 Topologies Available With A Pure Fixed Topology Model

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The two fixed topology modules installed in the configuration sections can switch up to 32 of the Transputer section's Transputer nodes to form a rectangular 4 x 8 array. Transputers in the columns of the array are connected by their even UniLinks, whereas all processors of the rows are connected by their odd links. The odd level configuration unit is therefore designated for switching rows, and the even level configuration unit for columns (see figure 6.1).

There are four free UniLinks on each side of the Transputer matrix. These can be rewired within the odd level configuration unit before the signals (all or in part, depending on the topology installed) reach the main link backplane's "connection" side.

The even level configuration section provides eight free UniLinks at both the top and bottom edges of the Transputer array. These UniLinks are not automatically routed out, but can also be rewired (by placing the jumpers accordingly) within the even level configuration section. Depending on the topology, all or only certain signals will then reach the main link backplane's "connection" side plugs.

Both boards are equipped with a number of pin connectors for this purpose. Each pin connector represents a different configuration. Since a topology has to be chosen and installed for both the link and the reset level (preferably the same, otherwise something won't work), a fixed topology module consists of two identical boards.

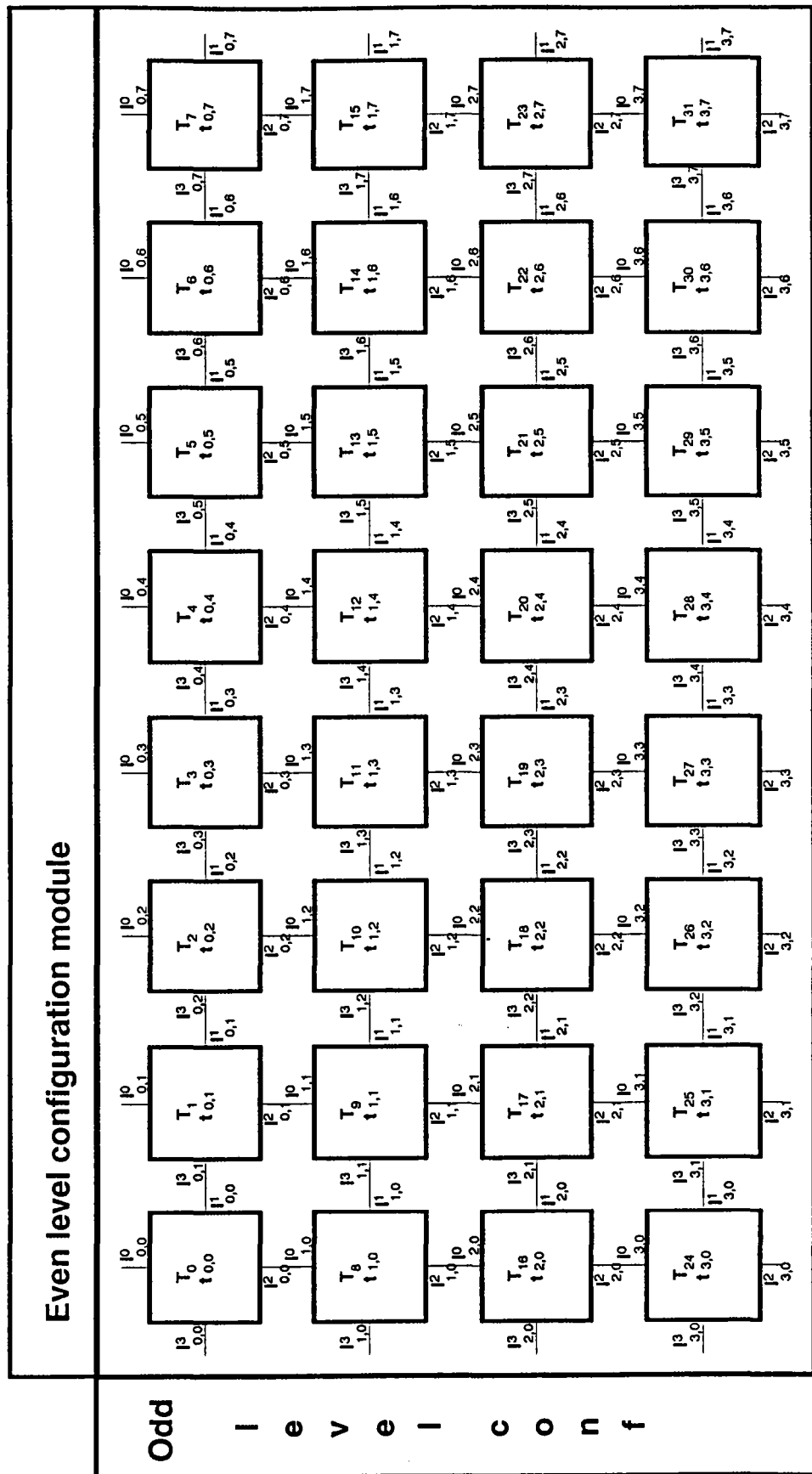


Figure 6.1: The basic connections and the link & node numerations of up to 32 Transputer nodes used by two fixed topology modules.



## 6.1.1 Choosing An Even Level Topology

There are four pin connectors in a vertical array on both boards of an even level fixed topology module. The connectors consist of 16 rows, at two pins each. Figure 6.2 shows the connector positions on an even level fixed topology module board.

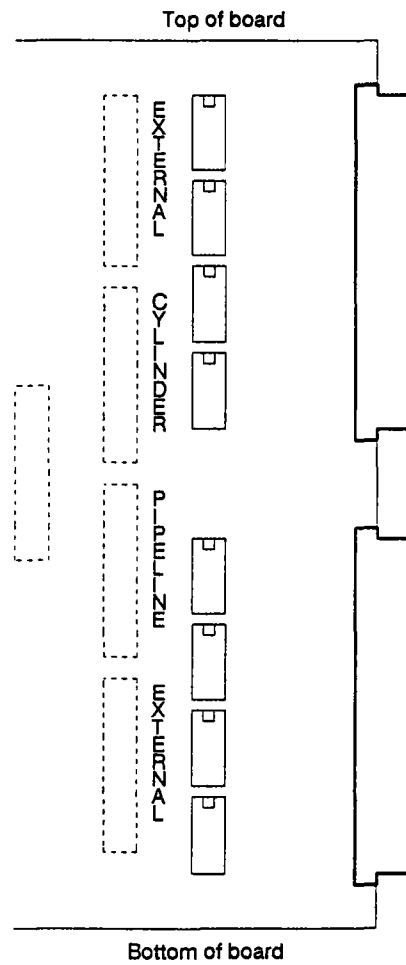


Figure 6.2: The configuration connector positions and functions on an even level fixed topology module board.

Each pin connector represents a certain wiring configuration of the even level UniLinks, therefore determining the processor matrix's column topology (see figure 6.1). The central topology of the processor matrix is not changed. It consists of a rectangular grid in which all processors can communicate with each other. By altering the wiring of the outermost Transputer nodes, however, the total graph can assume a different configuration. Possible configurations are as follows:

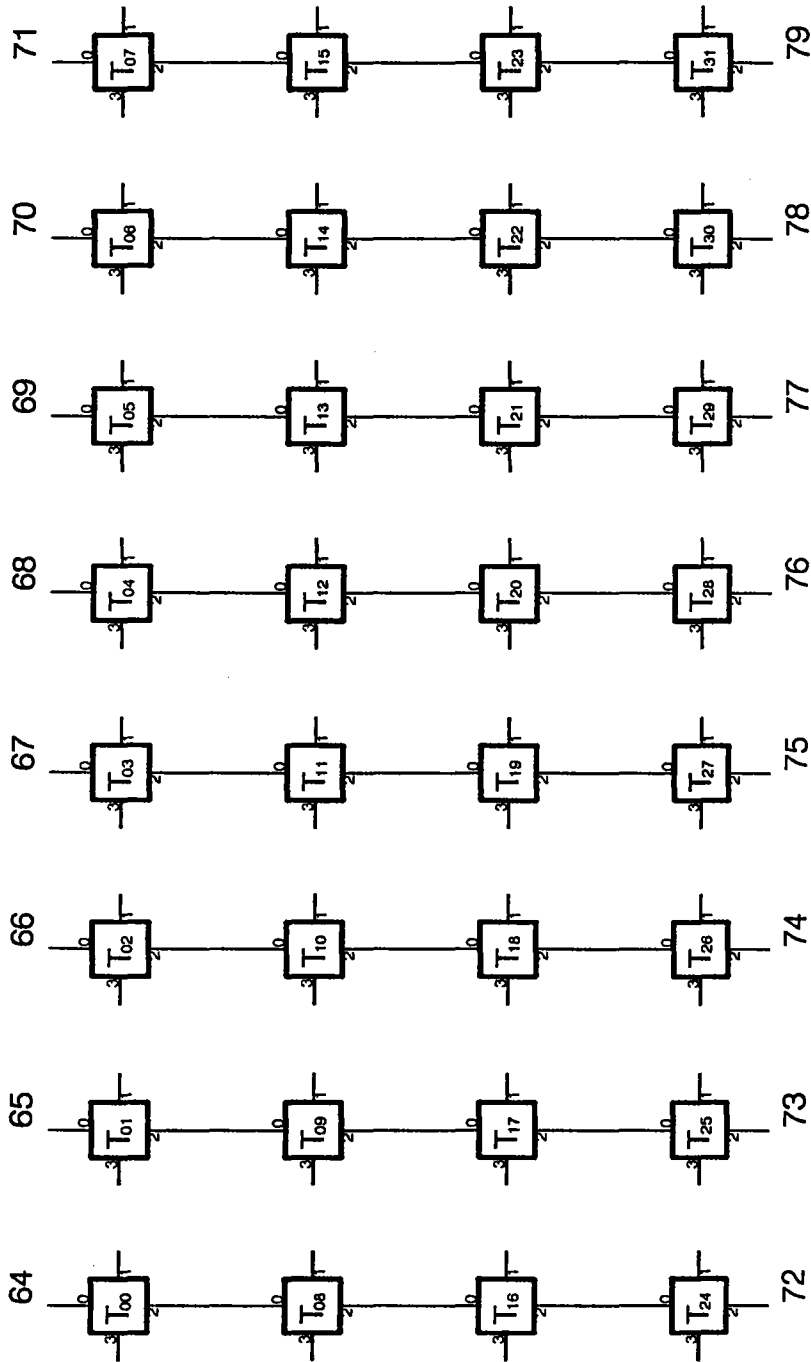
1. EXTERNAL,
2. PIPELINE/EXTERNAL,
3. PIPELINE,
- and
4. CYLINDER,

These will be explained in detail.

#### **6.1.1.1 The EXTERNAL Configuration**

The so-called EXTERNAL configuration routes all free UniLinks of the upper and lower rows to the outside world (see figure 6.3). If this configuration is chosen, signals are channelled to the main link backplane "connection" side plugs StExE1 and StExE2. This configuration provides maximal even level connectivity to the outside world.

# EXTERNAL



Channel numbers 64 to 71 refer to link numbers 0 to 7 of external connector StEXE1  
 Channel numbers 72 to 79 refer to link numbers 0 to 7 of external connector StEXE3

Figure 6.3: The processor matrix topology when using the EXTERNAL option on the even level fixed topology module.

In order to install an EXTERNAL configuration, connect the jumpers to the upper and lower pin connectors as shown in figure 6.4.

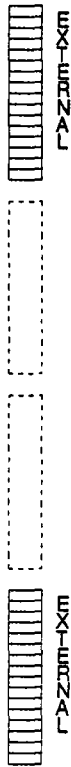


Figure 6.4: Even level fixed topology module jumper configuration when using the EXTERNAL option.

#### 6.1.1.2 The PIPELINE Configuration

The so called PIPELINE configuration connects all free UniLinks of the array's upper and lower row to form a continuous pipeline (see [figure 6.5](#)). None of the column UniLinks are connected to the outside world in this case; the result is minimal (zero) even level connectivity as opposed to the EXTERNAL configuration. If this configuration is implemented, all communication must be achieved via the odd configuration level.

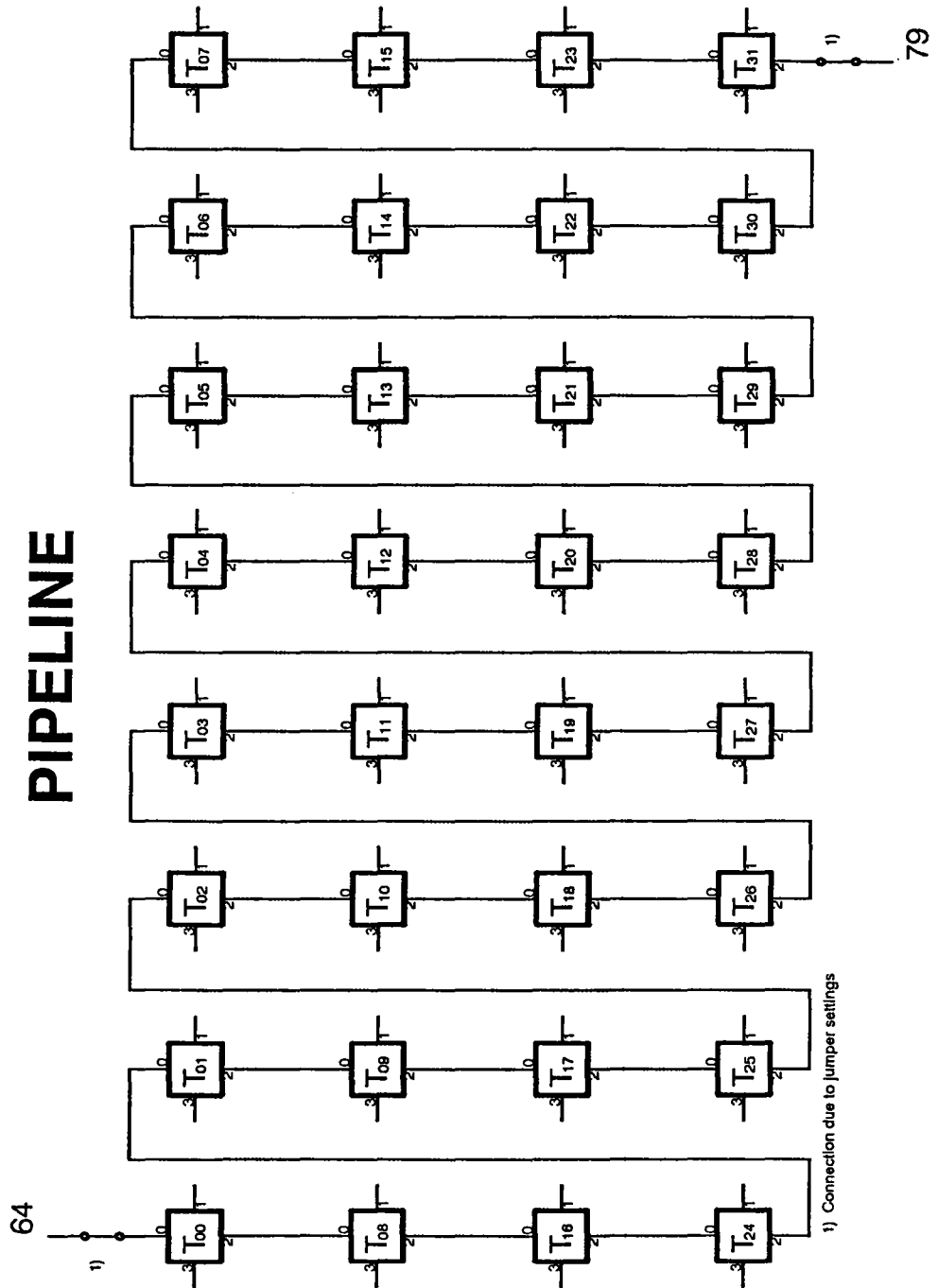


Figure 6.5: The processor matrix topology when using the PIPELINE option on the even level fixed topology module.

In order to install a PIPELINE configuration, connect the jumpers to the second pin connector from the bottom, as shown in figure 6.6.

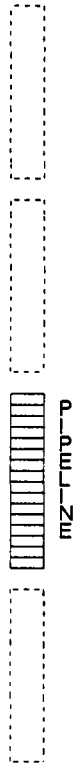


Figure 6.6: Even level fixed topology module jumper configuration when using the PIPELINE option.

### 6.1.1.3 The PIPELINE/EXTERNAL Configuration

In the combined PIPELINE/EXTERNAL configuration all but two of the array's upper and lower row's free UniLinks form a pipeline - the pipeline portion. The UniLinks at the beginning and end of the pipeline, however, are not connected to each other, but are routed to the outside - the external component (this is symbolized by the two jumpers in figure 6.5). The small amount of even level connectivity attained using this configuration should be compensated by a higher amount on the odd configuration level of the Transputer matrix.

When installing a PIPELINE/EXTERNAL configuration, connect two jumpers to the outer pins of each EXTERNAL pin connector (located at the top and bottom), and the rest to the second pin connector from the bottom. Figure 6.7 demonstrates the jumper configuration.

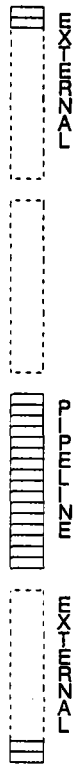


Figure 6.7: Even level fixed topology module jumper configuration when using the PIPELINE/EXTERNAL option.

#### 6.1.1.4 The CYLINDER Configuration

The CYLINDER configuration links all columns together to form rings (see figure 6.8). Together with the hard wired internal grid array, this results in a cylinder topology. As in the pure PIPELINE configuration, there are no outward connections from the columns - all communication must be achieved via the odd configuration level.

# Cylinder

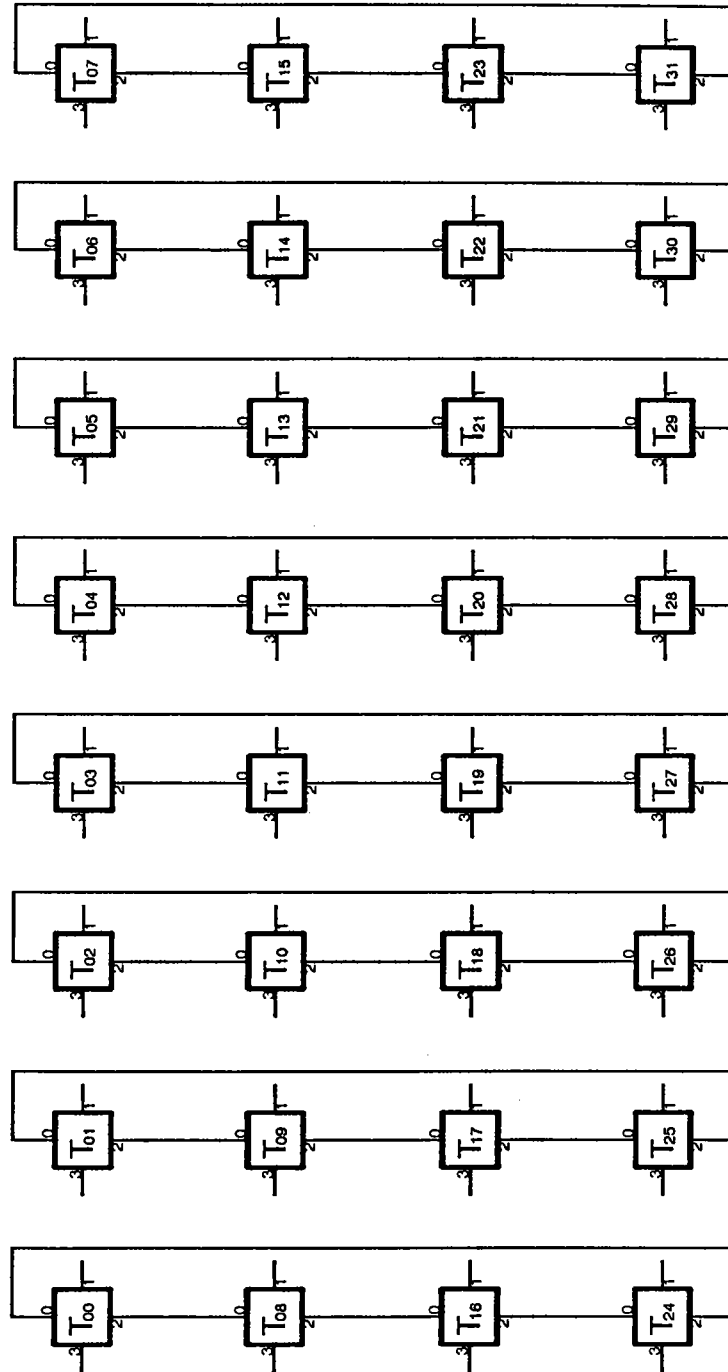


Figure 6.8: The processor matrix topology when using the CYLINDER option on the even level fixed topology module.



In order to install a CYLINDER configuration, connect all jumpers to the second pin connector from the top, as shown in figure 6.9.



Figure 6.9: Even level fixed topology module jumper configuration when using the CYLINDER option.

### 6.1.2 Choosing An Odd Level Topology

There are three pin connectors in a horizontal array on both boards of an odd level fixed topology module. The connectors consist of 16 rows, at two pins each. Figure 6.10 shows the connector positions on an even level fixed topology module board.

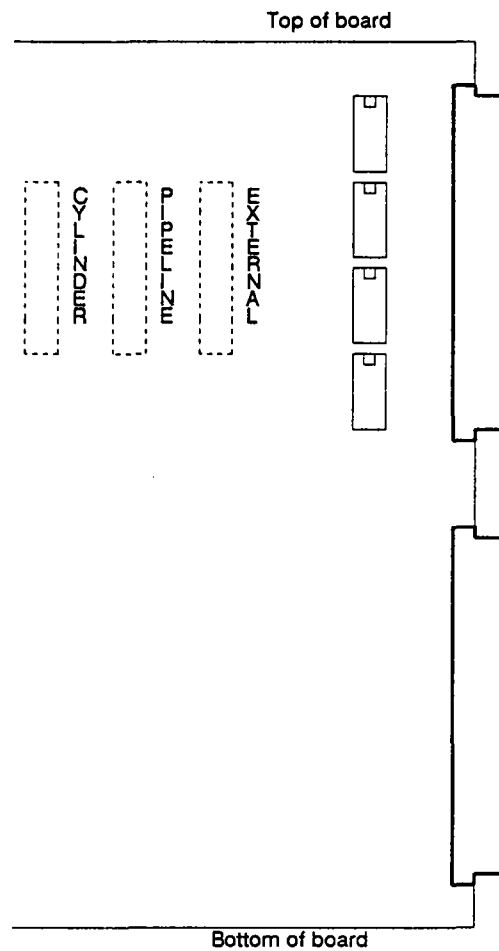


Figure 6.10: The configuration connector positions and functions on an odd level fixed topology module board.

Each pin connector represents a certain wiring configuration of the odd level Uni-Links, therefore determining the processor matrix's row topology (see figure 6.1). The central topology of the processor matrix is not changed. It consists of a rectangular grid in which all processors can communicate with each other. By altering the wiring of the outermost Transputer nodes (in this case the outer columns), however, the total graph can assume a different configuration. Possible configurations are as follows:

1. EXTERNAL,
2. PIPELINE/EXTERNAL,
3. PIPELINE,
- and
4. CYLINDER,

Though very similar to the even level topologies, these will also be explained in detail.

### 6.1.2.1 The EXTERNAL Configuration

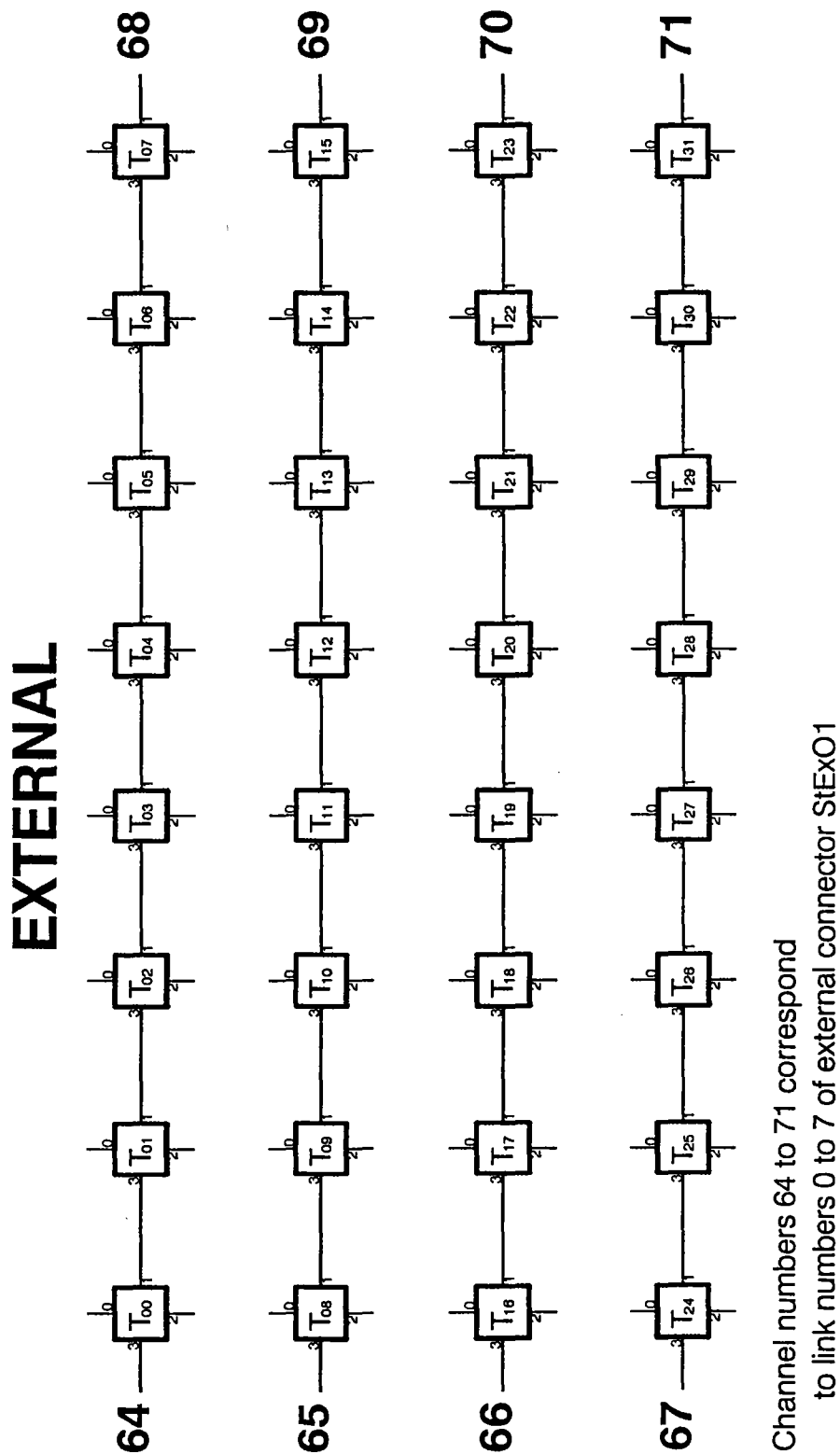


Figure 6.12: Odd level fixed topology module jumper configuration when using the EXTERNAL option.

The so-called EXTERNAL configuration routes all free UniLinks of the outer columns to the outside world (see figure 6.11). If this configuration is chosen, signals are channelled to the main link backplane "connection" side plug StExO1. This configuration provides maximal odd level connectivity to the outside world.

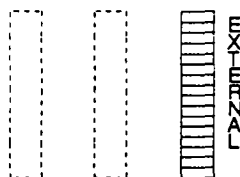


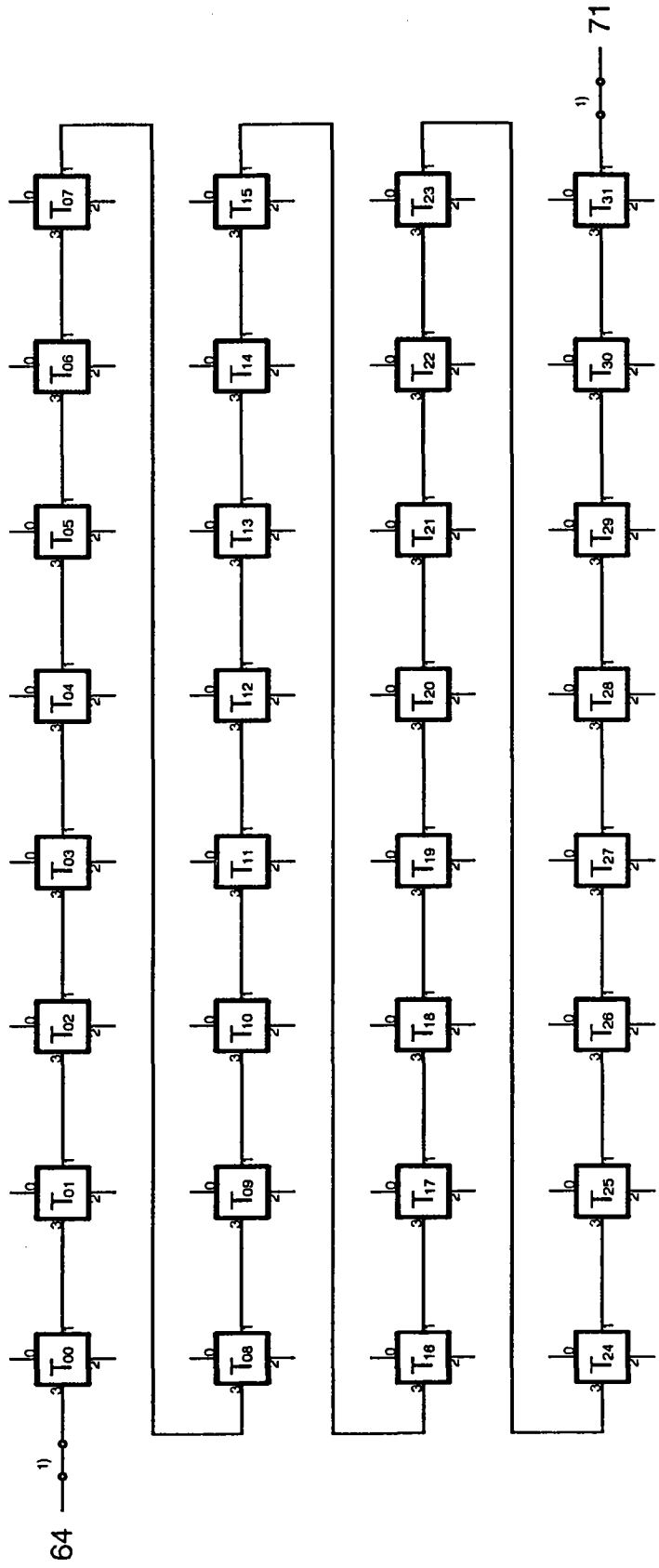
Figure 6.11: The processor matrix topology when using the EXTERNAL option on the odd level fixed topology module.

In order to install an EXTERNAL configuration, connect the jumpers to the right pin connector as shown in figure 6.12.

### 6.1.2.2 The PIPELINE Configuration

The so called PIPELINE configuration connects all free UniLinks of the array's outer columns to form a continuous pipeline (see figure 6.13). None of the row UniLinks are connected to the outside world in this case; the result is zero odd level connectivity as opposed to the EXTERNAL configuration. If this configuration is implemented, all communication must be achieved via the even configuration level.

# PIPELINE



1) Connection due to jumper settings

Figure 6.13: The processor matrix topology when using the PIPELINE option on the odd level fixed topology module.

In order to install a PIPELINE configuration, connect the jumpers to the odd level fixed topology module's middle pin connector, as shown in figure 6.14.

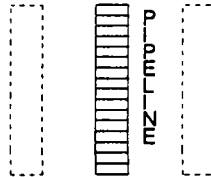


Figure 6.14: Odd level fixed topology module jumper configuration when using the PIPELINE option.

### 6.1.2.3 The PIPELINE/EXTERNAL Configuration

In the combined PIPELINE/EXTERNAL configuration all but two of the array's outer column's free UniLinks form a pipeline - the pipeline portion. The UniLinks at the beginning and end of the pipeline, however, are not connected to each other, but are routed to the outside - the external component (this is symbolized by the two jumpers in figure 6.13). The small amount of odd level connectivity attained using this configuration should be compensated by a higher amount on the even configuration level of the Transputer matrix.

When installing a PIPELINE/EXTERNAL configuration, connect two jumpers to the outer pins of EXTERNAL pin connector (located to the right), and the rest to the middle pin connector. Figure 6.15 demonstrates the jumper configuration.

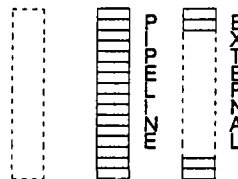


Figure 6.15: Odd level fixed topology module jumper configuration when using the PIPELINE/EXTERNAL option.

### 6.1.2.4 The CYLINDER Configuration

The CYLINDER configuration links all rows together to form rings (see figure 6.16). Together with the hard wired internal grid array, this results in a cylinder topology. As in the pure PIPELINE configuration, there is zero outward connectivity in this level, and all communication must be achieved via the other (in this case the even) configuration level.

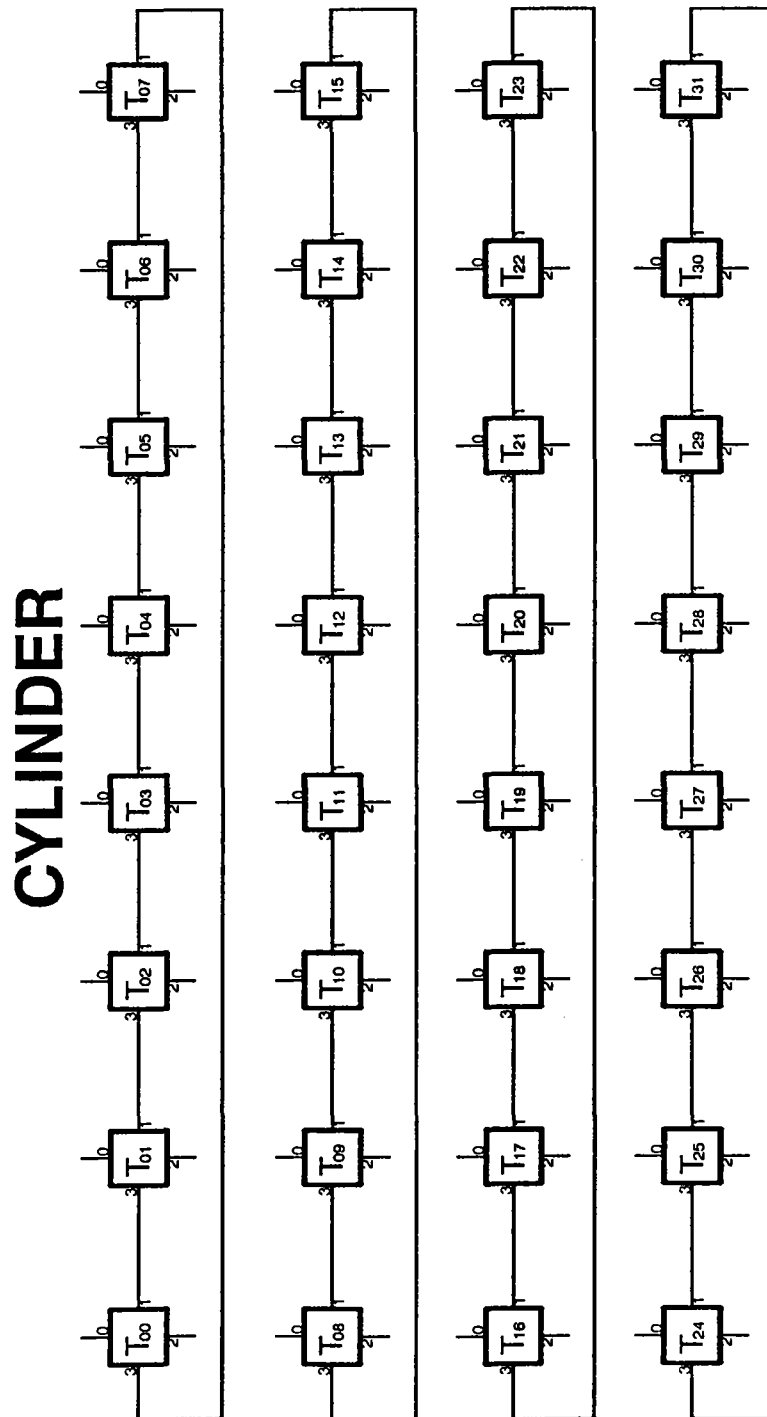


Figure 6.16: The processor matrix topology when using the CYLINDER option on the odd level fixed topology module.

In order to install a CYLINDER configuration, connect all jumpers to the left pin connector, as shown in figure 6.17.

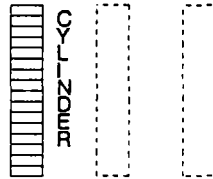


Figure 6.17: Odd level fixed topology module jumper configuration when using the CYLINDER option.

### 6.1.3 Combining Topologies

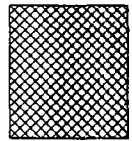
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The system's final topology is the result of the topologies installed in the odd and even configuration levels (rows & columns). Since there are four topologies to choose from, one can install a total of 16 different system topologies, not all of which, however, are practicable.

Table 6.1 lists the different combinations of odd and even level topologies. The shaded topologies are theoretically possible, but not very useful, since none of the UniLinks are accessible from the outside (e.g. nothing goes in or out). The following chapters will introduce and explain all possible topologies.



		Even level configuration (Columns)			
Odd level configuration (Rows)		EXTERNAL	PIPELINE + EXTERNAL	PIPELINE	CYLINDER
EXTERNAL	Figure 6.18 <b>Regular grid</b> Rectangular array accessible from all four borders	Figure 6.19 <b>Skewed lying cylinder</b> Rectangular array with pipelined columns, accessible by row links $l^3_{1,0}$ and $l^1_{1,7}$ and columns $l^0_{0,0}$ and $l^2_{3,7}$	Figure 6.20 <b>Skewed lying cylinder</b> Rectangular array with pipelined columns, accessible by row links $l^3_{1,0}$ and $l^1_{1,7}$	Figure 6.21 <b>Lying cylinder</b> Rectangular array with columns as rings, accessible by row links $l^3_{1,0}$ and $l^1_{1,7}$	
PIPELINE + EXTERNAL	Figure 6.22 <b>Skewed standing cylinder</b> Rectangular array with pipelined rows, accessible by column links $l^0_{0,1}$ and $l^2_{3,1}$ and columns $l^3_{0,0}$ and $l^1_{3,7}$	Figure 6.23 <b>Doubly distorted torus</b> Rectangular array with pipelined rows and columns, accessible by four links $l^0_{0,0}$ , $l^3_{0,0}$ , $l^1_{3,7}$ , $l^2_{3,7}$	Figure 6.24 <b>Doubly distorted torus</b> Rectangular array with pipelined rows and columns, accessible by links $l^3_{0,0}$ and $l^1_{3,7}$	Figure 6.25 <b>Distorted torus</b> Rectangular array with pipelined rows and columns, accessible by links $l^3_{0,0}$ and $l^1_{3,7}$	
PIPELINE	Figure 6.26 <b>Skewed standing cylinder</b> Rectangular array with pipelined rows, accessible by column links $l^0_{0,1}$ and $l^2_{3,1}$	Figure 6.27 <b>Doubly distorted torus</b> Rectangular array with pipelined rows and arrays, accessible by links $l^0_{0,0}$ and $l^2_{3,7}$	Figure 6.28 <b>Doubly distorted torus</b> In introspective meditation	Figure 6.29 <b>Distorted torus</b> In introspective meditation	
CYLINDER	Figure 6.30 <b>Standing cylinder</b> Rectangular array with rows as rings, accessible by column links $l^0_{0,1}$ and $l^2_{3,1}$	Figure 6.31 <b>Distorted torus</b> Rectangular array with rows as rings and pipelined columns, accessible by links $l^0_{0,0}$ and $l^2_{3,7}$	Figure 6.32 <b>Distorted torus</b> In introspective meditation	Figure 6.33 <b>Torus</b> In introspective meditation	



Not usable combination of even and odd level configurations

Table 6.1: All possible topology combinations using fixed topology modules in both odd and even level configuration sections.

### 6.1.3.1 EXTERNAL (Odd) & EXTERNAL (Even)

This configuration combination achieves a maximal amount of connectivity on both levels. As seen in figure 6.18, a total of 24 UniLinks are accessible to external units, such as workstations, i/o units or additional MultiCluster-2 units.

**odd: EXTERNAL**  
**even: EXTERNAL**

**Regular grid**  
**with maximum external accesses**

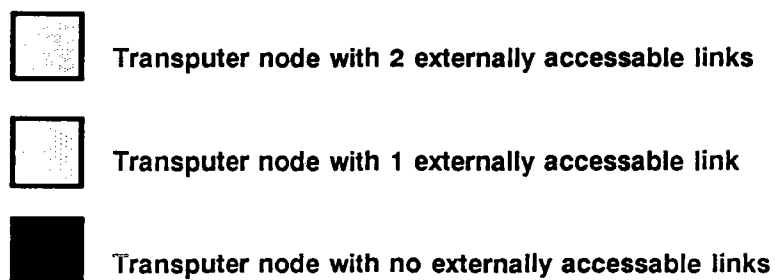
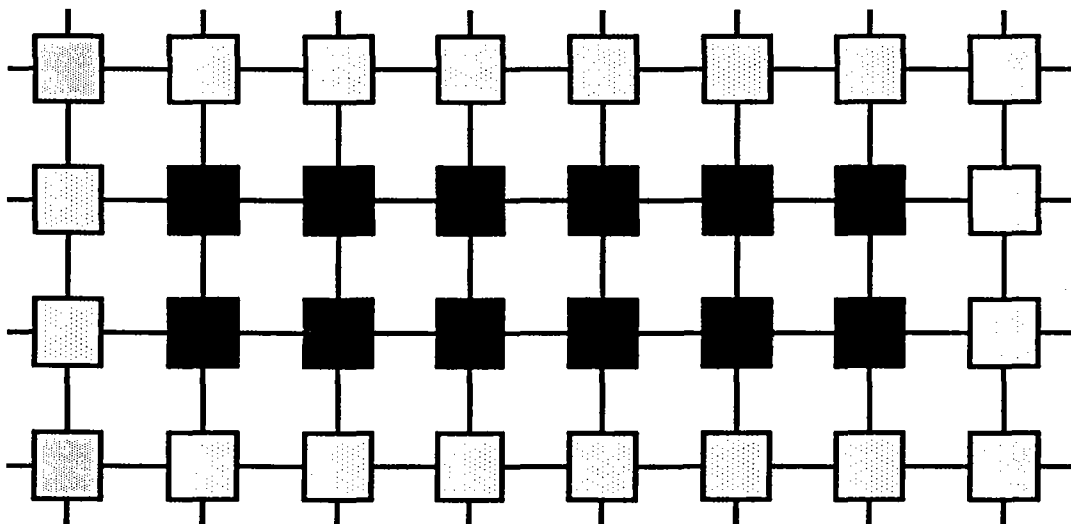


Figure 6.18: Topology resulting from combining the EXTERNAL option on the odd with the EXTERNAL option on the even level.

As none of the free UniLinks are rerouted back into the array, the resulting topology is in fact the rectangular grid primarily wired by the two fixed topology modules. The free column UniLinks have the following coordinates:

$I^0_{0,j} = [\text{eChs } 64-71]$  and  $I^2_{3,j} = [\text{eChs } 72-79]$  for  $j=0..7$ ,

the free row UniLinks, the coordinates:

$I^3_{i,0} = [\text{oChs } 64-67]$  and  $I^1_{i,7} = [\text{oChs } 68-71]$  for  $i=0..3$ .

### 6.1.3.2 EXTERNAL (Odd) & PIPELINE/EXTERNAL (Even)

This combination results in the equivalent of twisted, horizontal cylinder (a spiral wrapped around a cylinder). The structure and position of the free UniLinks are shown in figure 6.19.

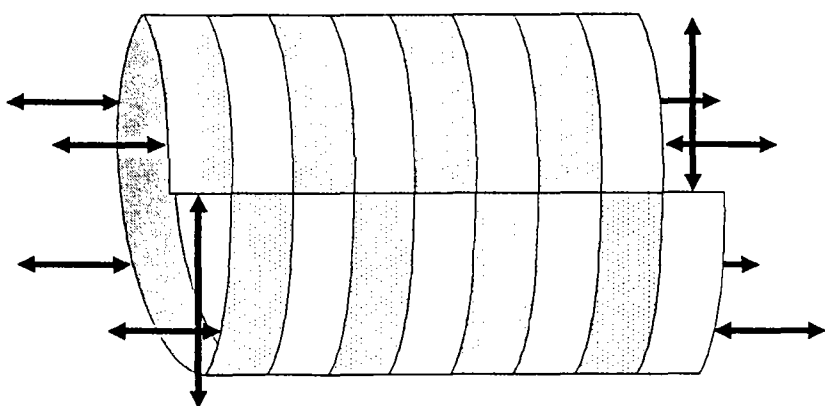
Using this combination, a total of ten UniLinks remain accessible from the outer world; the four free UniLinks of each outer column in addition to the "beginning" and "end" of the pipeline. The free column UniLinks have the following coordinates:

$I^0_{0,0} = [\text{eCh } 64]$  and  $I^2_{3,7} = [\text{eCh } 79]$

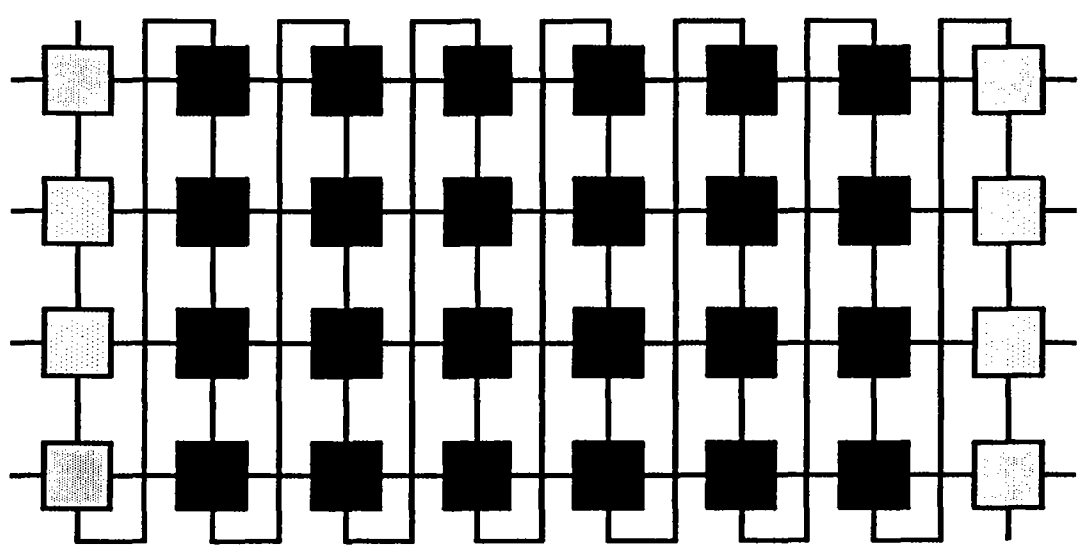
the free row UniLinks, the coordinates:

$I^3_{i,0} = [\text{oChs } 64-67]$  and  $I^1_{i,7} = [\text{oChs } 68-71]$  for  $i=0..3$ .

odd: EXTERNAL  
 even: PIPELINE + EXTERNAL



**Skewed lying cylinder**






-  Transputer node with 2 externally accessible links
-  Transputer node with 1 externally accessible link
-  Transputer node with no externally accessible links

Figure 6.19: Topology resulting from combining the EXTERNAL option on the odd with the PIPELINE/EXTERNAL option on the even level.

### 6.1.3.3 EXTERNAL (Odd) & PIPELINE (Even)

This configuration is similar to that described above; more or less a twisted (or spiral wrapped), horizontal cylinder. In this case, however, the spiral's end is connected back to its beginning. The structure and position of the free UniLinks are shown in figure 6.20.

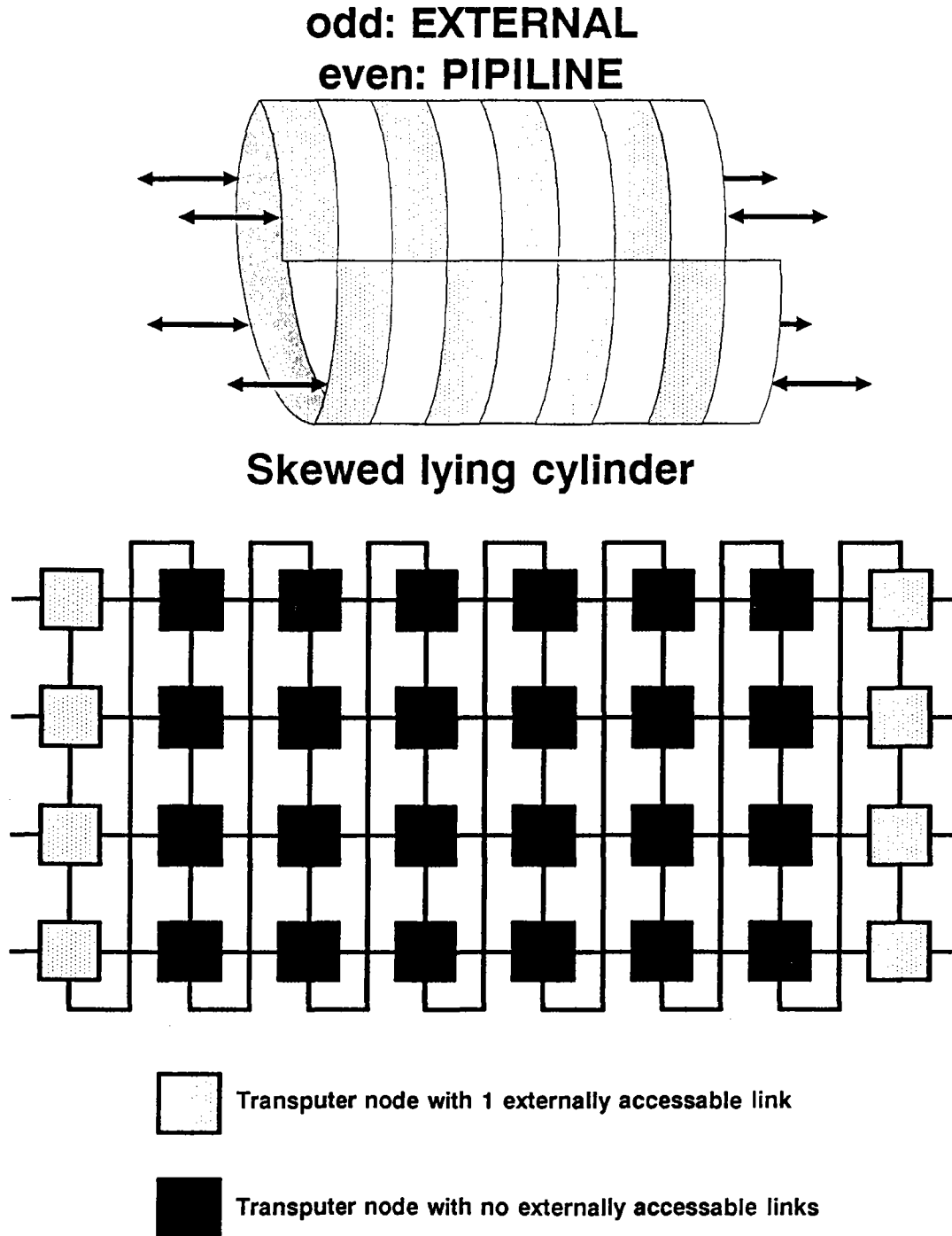


Figure 6.20: Topology resulting from combining the EXTERNAL option on the odd level with the PIPELINE option on the even level.

As stated above, the spiral's end are connected in this configuration, leaving only the four free UniLinks at each end the cylinder (the free UniLinks of the outer columns). The remaining eight accessible row UniLinks have the following coordinates:

$l^3_{i,0} = [\text{oChs } 64-67]$  and  $l^1_{i,7} = [\text{oChs } 68-71]$  for  $i=0..3$ .

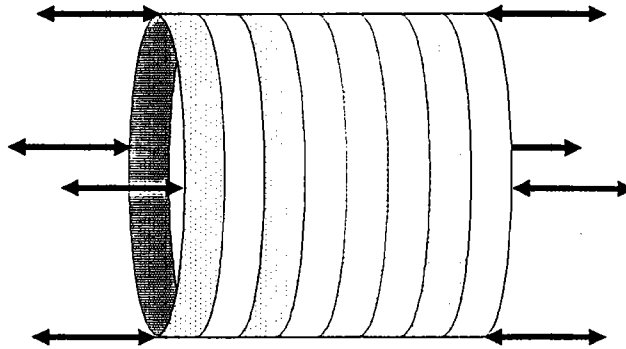
#### **6.1.3.4 EXTERNAL (Odd) & CYLINDER (Even)**

This configuration results in a topology equivalent to a simple horizontal cylinder. Structure and position of the free UniLinks are shown in figure 6.21.

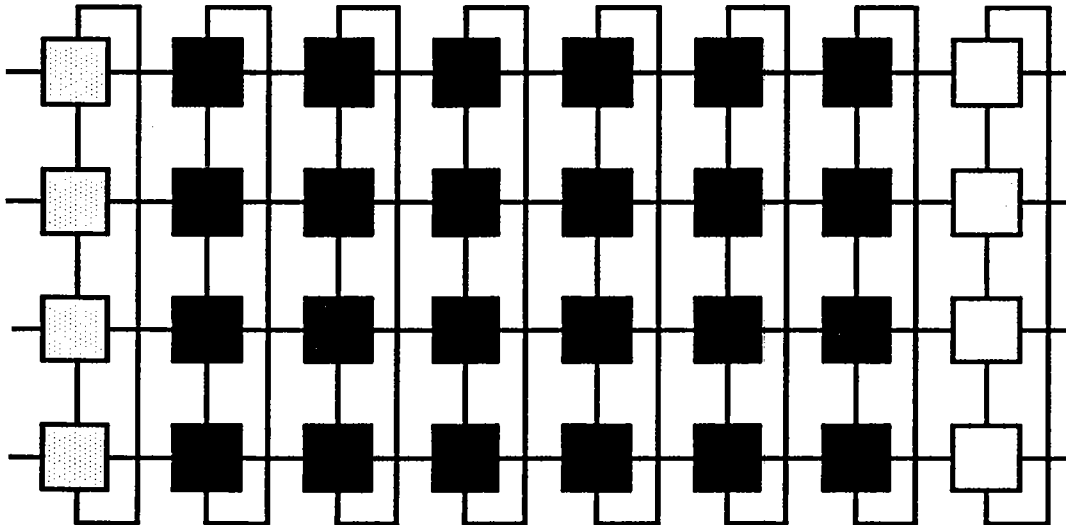
As seen in the drawing, the free UniLinks of the outer columns remain accessible. The remaining eight accessible row UniLinks have the following coordinates:

$l^3_{i,0} = [\text{oChs } 64-67]$  and  $l^1_{i,7} = [\text{oChs } 68-71]$  for  $i=0..3$ .

odd: EXTERNAL  
even: CYLINDER



Lying cylinder



Transputer node with 1 externally accessible link



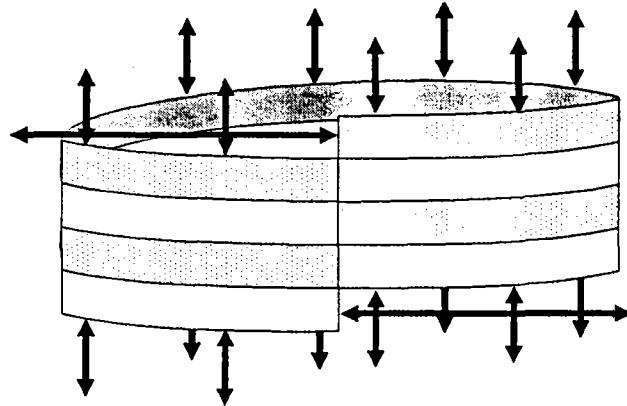
Transputer node with no externally accessible links

Figure 6.21: Topology resulting from combining the EXTERNAL option on the odd level with the CYLINDER option on the even level.

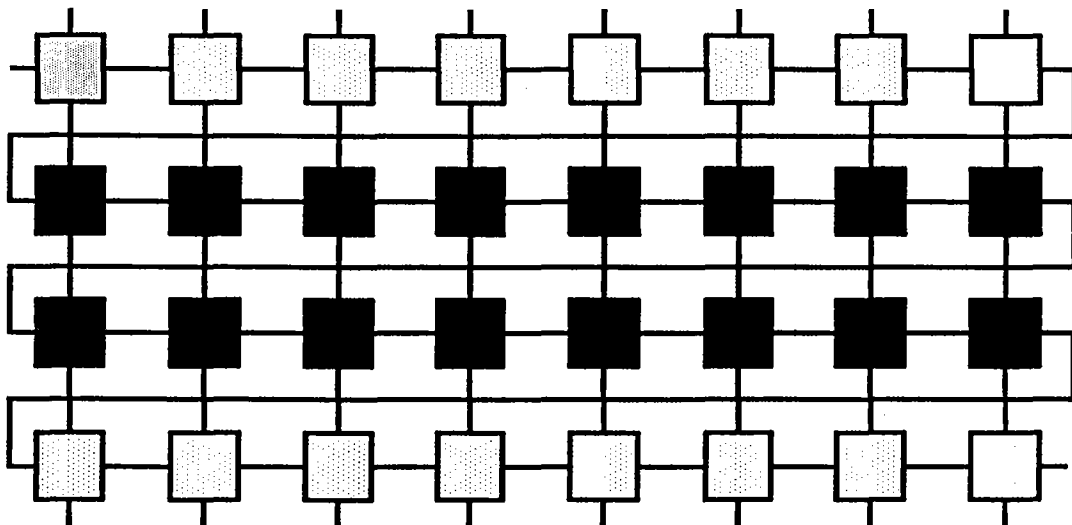
### 6.1.3.5 PIPELINE/EXTERNAL (Odd) & EXTERNAL (Even)

The combination of PIPELINE/EXTERNAL in the odd level with EXTERNAL on the even level results in a twisted, squat, vertical cylinder (comparable to E & P/E). The structure and position of the free UniLinks are shown in figure 6.22.

**odd: PIPELINE + EXTERNAL**  
**even: EXTERNAL**



**Skewed standing cylinder**



Transputer node with 2 externally accessible links



Transputer node with 1 externally accessible link



Transputer node with no externally accessible links

Figure 6.22: Topology resulting from combining the PIPELINE/EXTERNAL option on the odd level with the EXTERNAL option on the even level.



A total of 18 UniLinks are accessible in this configuration, as the accessible "rim" of the resulting figure is wider than it was in the case of the E & P/E option. External systems can be connected to the eight free UniLinks of the top and bottom rows as well as to the ends of the pipeline as seen in figure 6.22. The free column UniLinks have the following coordinates:

$I^0_{0,j} = [\text{eChs } 64-71]$  and  $I^2_{3,j} = [\text{eChs } 72-79]$  for  $j=0..7$

the two free row UniLinks, the coordinates:

$I^3_{0,0} = [\text{oCh } 64]$  and  $I^1_{3,7} = [\text{oCh } 71]$ .

**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

### 6.1.3.6 PIPELINE/EXTERNAL (Odd) & PIPELINE/EXTERNAL (Even)

The combination of these two configuration results in what could best be described as a twice twisted torus. Figure 6.23 depicts the topology and the remaining free UniLinks.

The two pipeline spirals are open ended, leaving a total of four free UniLinks for connecting external systems. The two remaining free column UniLinks have the coordinates:

$I^0_{0,0} = [\text{eCh } 64]$  and  $I^2_{3,7} = [\text{eCh } 79]$

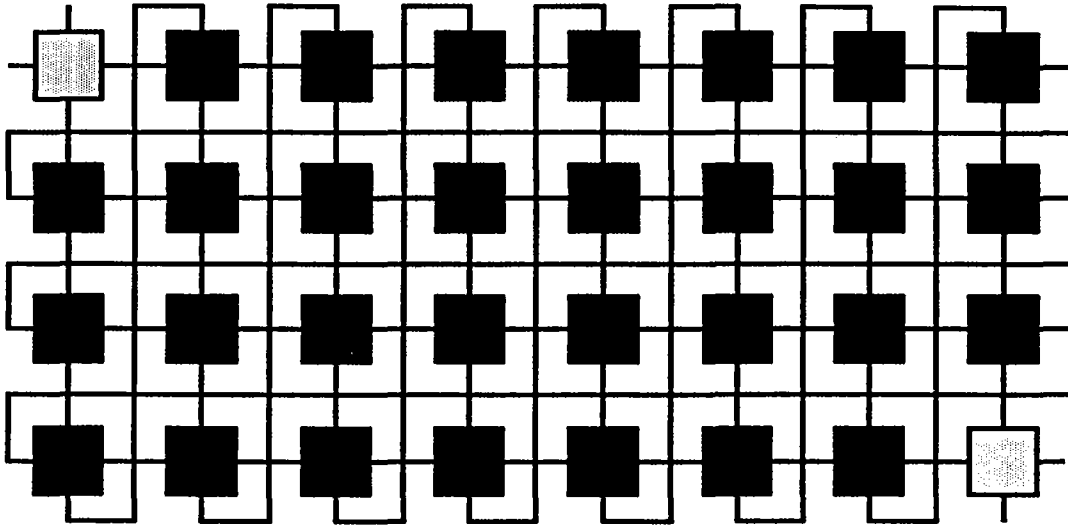
the two remaining free row UniLinks, the coordinates:

$I^3_{0,0} = [\text{oCh } 64]$  and  $I^1_{3,7} = [\text{oCh } 71]$ .

**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

**odd: PIPELINE + EXTERNAL**  
**even: PIPELINE + EXTERNAL**

**Doubly distorted torus**



**Transputer node with 2 externally accessible links**



**Transputer node with no externally accessible links**

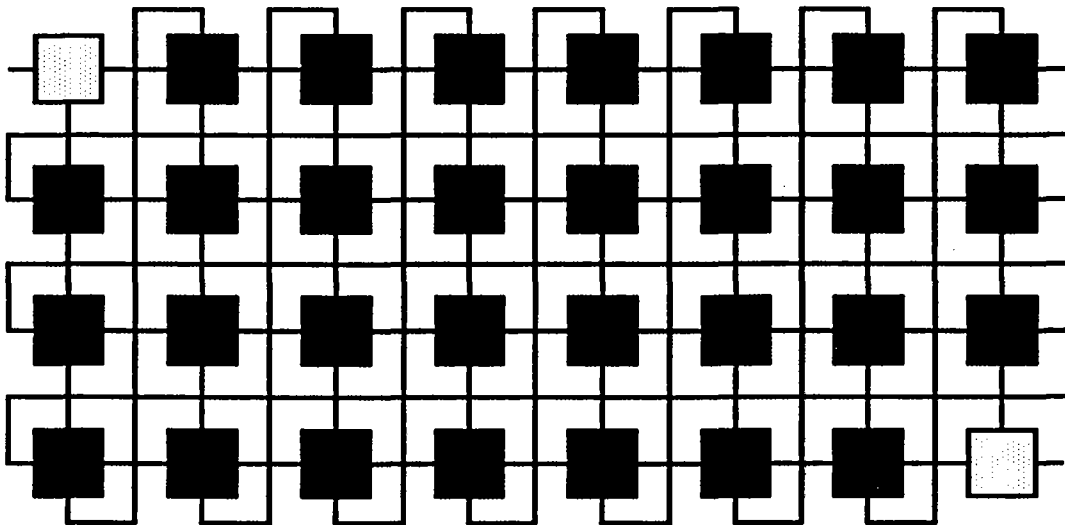
Figure 6.23: Topology resulting when combining the PIPELINE/EXTERNAL option on the odd level with the PIPELINE/EXTERNAL option on the even level.

### 6.1.3.7 PIPELINE/EXTERNAL (Odd) & PIPELINE (Even)

This also results in a twice twisted torus. The even UniLinks of the columns are linked to each other bottom to top, thus spiralling endlessly around the torus. The odd UniLinks, on the other hand, form an open spiral. The topology is shown in figure 6.24.

**odd: PIPELINE + EXTERNAL**  
**even: PIPELINE**

**Doubly distorted torus**



Transputer node with 1 externally accessible link



Transputer node with no externally accessible links

Figure 6.24: Topology resulting when the PIPELINE/EXTERNAL option on the odd level is combined with the PIPELINE option on the even level.

Figure 6.24 also hints at the topology's small connectivity. There are only two accessible UniLinks in this configuration, - the beginning and end of the row pipeline spiral with the coordinates:

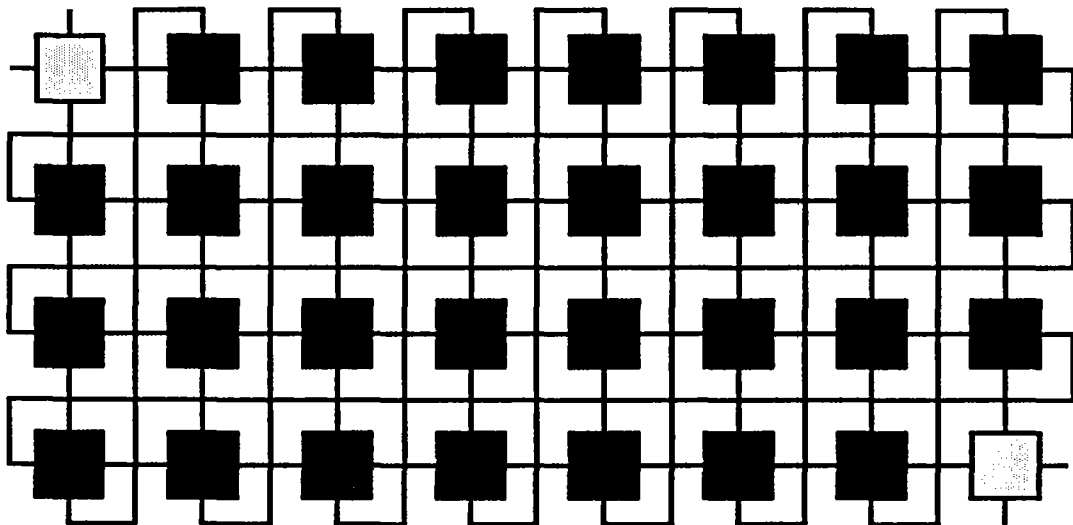
$$l^3_{0,0} = [\text{oCh } 64] \text{ and } l^1_{3,7} = [\text{oCh } 71].$$

**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

### 6.1.3.8 PIPELINE/EXTERNAL (Odd) & CYLINDER (Even)

Again, a twisted torus is the result, with the even links connected to form rings and the odd links spiralling in the open pipeline configuration as seen in figure 6.25.

**odd: PIPELINE + EXTERNAL**  
**even: CYLINDER**  
**Distorted torus**



Transputer node with 2 externally accessible links



Transputer node with no externally accessible links

Figure 6.25: Topology resulting from combining the PIPELINE/EXTERNAL option on the odd level with the CYLINDER option on the even level.

The cylinder configuration, like the pipeline configuration described above, presents no access. The coordinates of the PIPELINE/EXTERNAL free UniLinks (the same as in P/E & P) are:

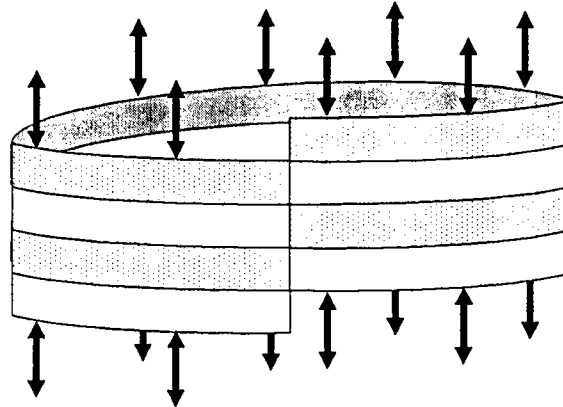
$$l^3_{0,0} = [\text{oCh } 64] \text{ and } l^1_{3,7} = [\text{oCh } 71].$$

**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

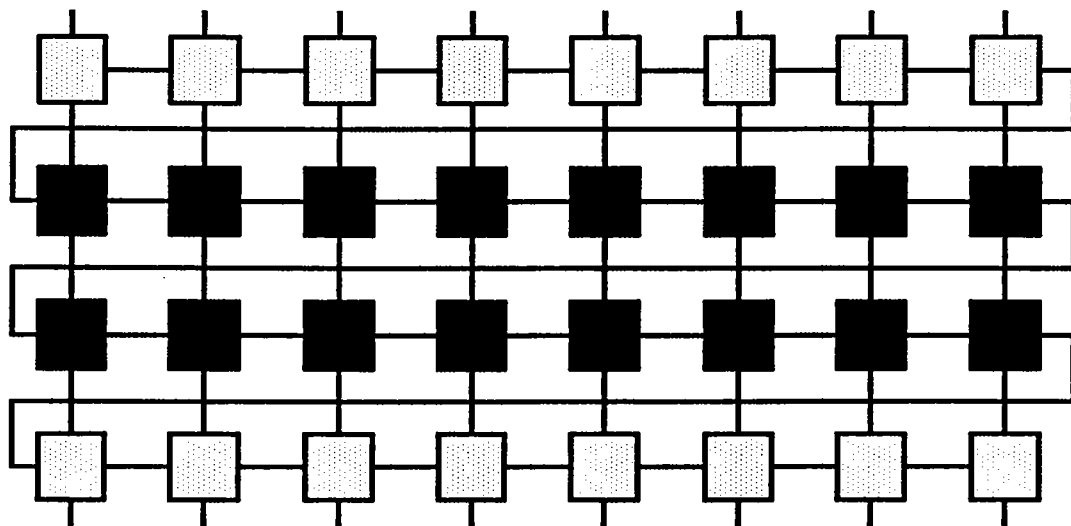
### 6.1.3.9 PIPELINE (Odd) & EXTERNAL (Even)

This combination delivers the topology of a twisted, squat, vertical cylinder (see also E & P). The spiral is closed, leaving no accessible UniLinks. The structure and position of the free UniLinks are shown in figure 6.20.

**odd: PIPELINE**  
**even: EXTERNAL**



**Skewed standing cylinder**



Transputer node with 1 externally accessible link



Transputer node with no externally accessible links

Figure 6.26: Topology resulting from combining the PIPELINE option on the odd level with the EXTERNAL option on the even level.

The free "rim" of the resulting figure is wider than it was in the case of the reversed (E & P) option. All columns are configured to EXTERNAL leaving a total of 16 accessible UniLinks in this configuration. The free column UniLinks have the coordinates:

$$l^0_{0,j} = [\text{eChs } 64-71] \text{ and } l^2_{3,j} = [\text{eChs } 72-79] \text{ for } j=0..7.$$

**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

### 6.1.3.10 PIPELINE (Odd) & PIPELINE/EXTERNAL (Even)

As in the case of P/E & P this configuration also results in a twice twisted torus. The odd UniLinks of the columns are linked to each other bottom to top, thus spiralling endlessly around the torus. The even UniLinks, on the other hand, form an open spiral. The topology is shown in figure 6.27.

**odd: PIPELINE**  
**even: PIPELINE + EXTERNAL**

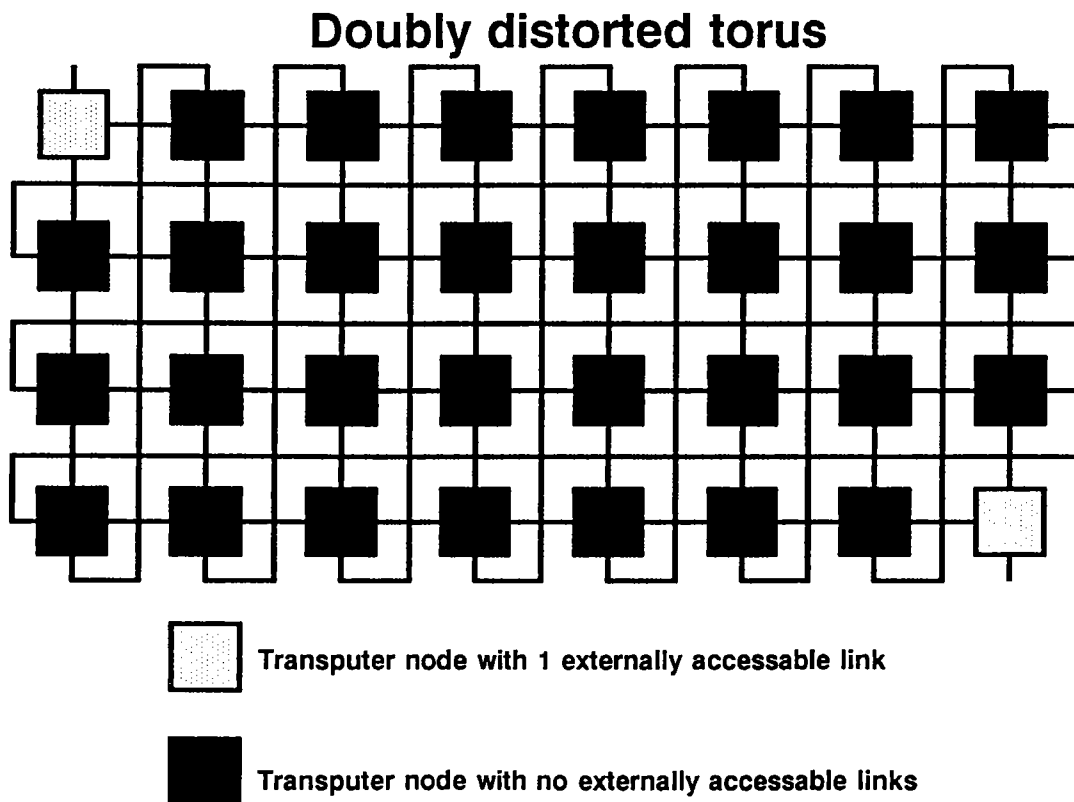


Figure 6.27: Topology resulting from combining the PIPELINE option on the odd level with the PIPELINE/EXTERNAL option on the even level.

There are only two UniLinks free for connecting external systems in this configuration, - the beginning and end of the column pipeline spiral. The corresponding coordinates are:

$$l^0_{0,0} = [\text{eCh } 64] \text{ and } l^2_{3,7} = [\text{eCh } 79].$$

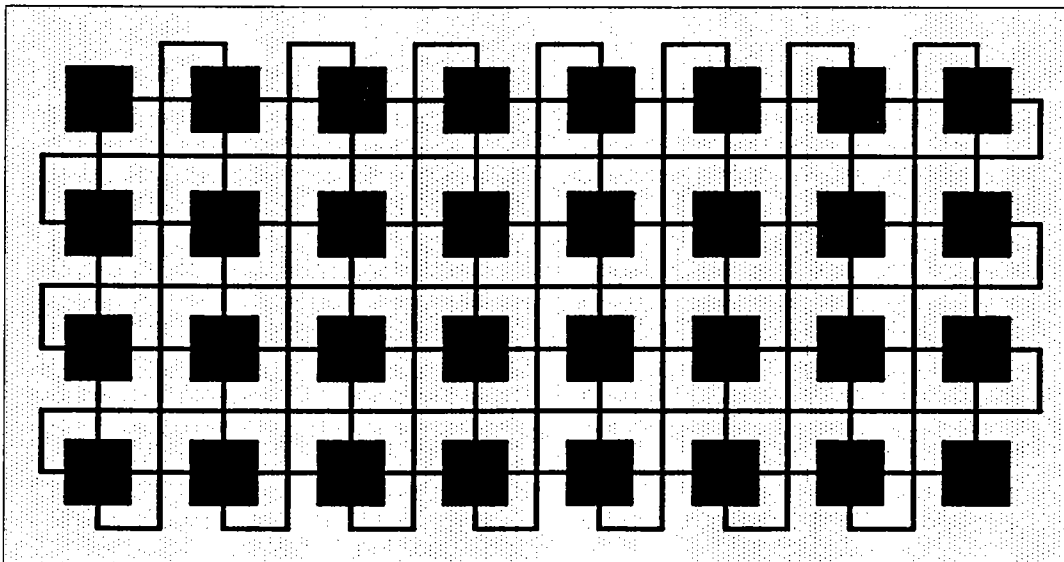
**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

### 6.1.3.11 PIPELINE (Odd) & PIPELINE (Even)

As demonstrated in figure 6.28, this configuration will lead to a twice twisted torus. As there are no free UniLinks available in this configuration it is effectively blind, deaf, dumb, and therefore useless for computing.

**odd: PIPELINE**  
**even: PIPELINE**

**Not accessible doubly distorted torus**



 Transputer node with no externally accessible links

Figure 6.28: Topology resulting from combining the PIPELINE option on the odd level with the PIPELINE option on the even level.

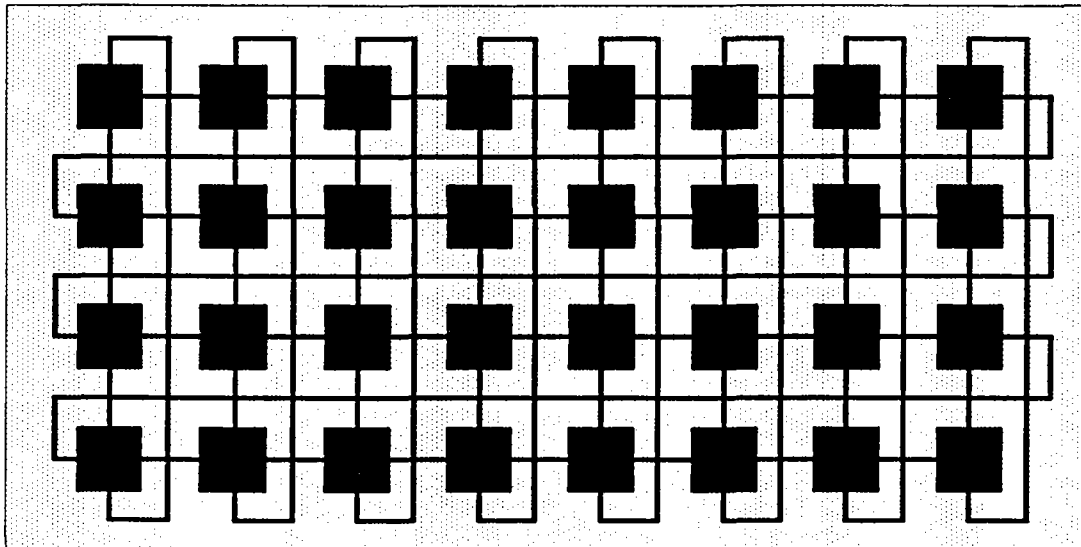
**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.

### 6.1.3.12 PIPELINE (Odd) & CYLINDER (Even)

Similar to the situation described above, this configuration also leads to torus with a single twist. It also represents a closed topology with no means of access (see figure 6.29).

odd: PIPELINE  
even: CYLINDER

Not accessible distorted torus



■ Transputer node with no externally accessible links

Figure 6.29: Topology resulting from combining the PIPELINE option on the odd level with the CYLINDER option on the even level.

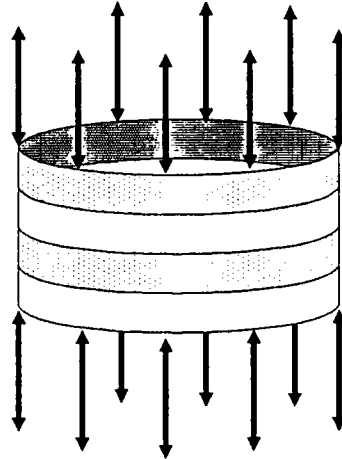
**Warning:** Don't use this configuration together with TPM-4 modules installed in mode "TPM-4 → 1/2MTM-2". Link communication is not possible at 20 Mbit/sec link speed.



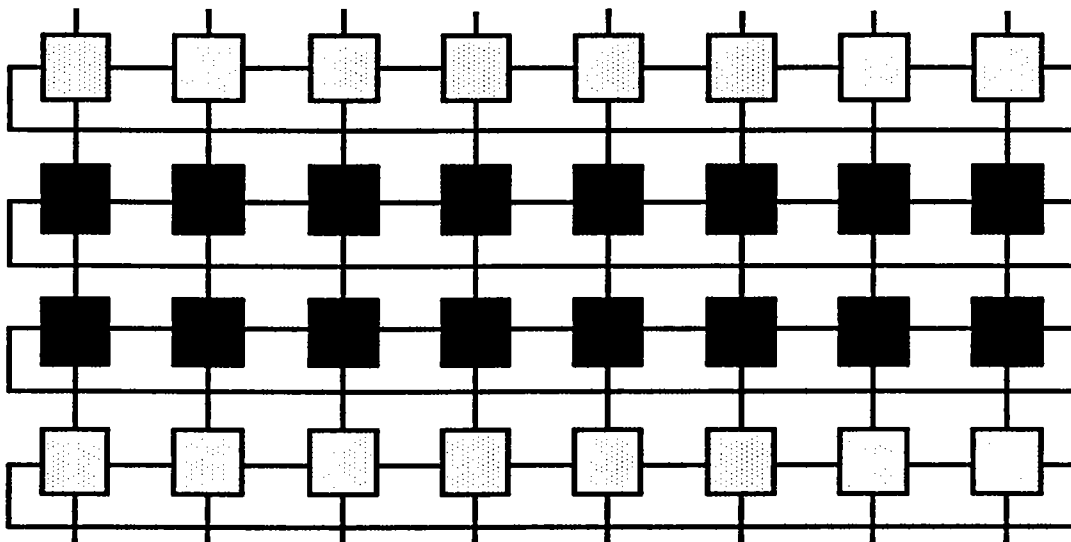
### 6.1.3.13 CYLINDER (Odd) & EXTERNAL (Even)

Combining the CYLINDER option on the odd level and the EXTERNAL option on the even level will result in the topology of the squat, vertical cylinder (see also E & C) shown in figure 6.30.

**odd: CYLINDER**  
**even: EXTERNAL**



**Standing cylinder**



Transputer node with 1 externally accessible link



Transputer node with no externally accessible links

Figure 6.30: Topology resulting from combining the CYLINDER option on the odd level with the EXTERNAL option on the even level.

As opposed to the E & C combination, this configuration presents a wider free rim. All column UniLinks at the top and bottom are accessible for a total of 16. The coordinates are:

$$l^0_{0,j} = [\text{eChs } 64-71] \text{ and } l^2_{3,j} = [\text{eChs } 72-79] \text{ for } j=0..7.$$

#### 6.1.3.14 CYLINDER (Odd) & PIPELINE/EXTERNAL (Even)

Choosing the CYLINDER option on the odd level and PIPELINE/EXTERNAL option on the even level delivers a twisted torus (see P/E & C). The odd links are connected to form rings and the even links spiral in the open pipeline configuration as seen in figure 6.31.

**odd: CYLINDER**  
**even: PIPELINE + EXTERNAL**

### Distorted torus

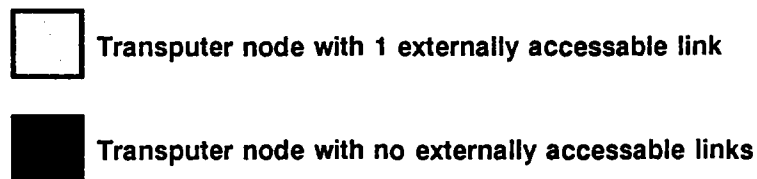
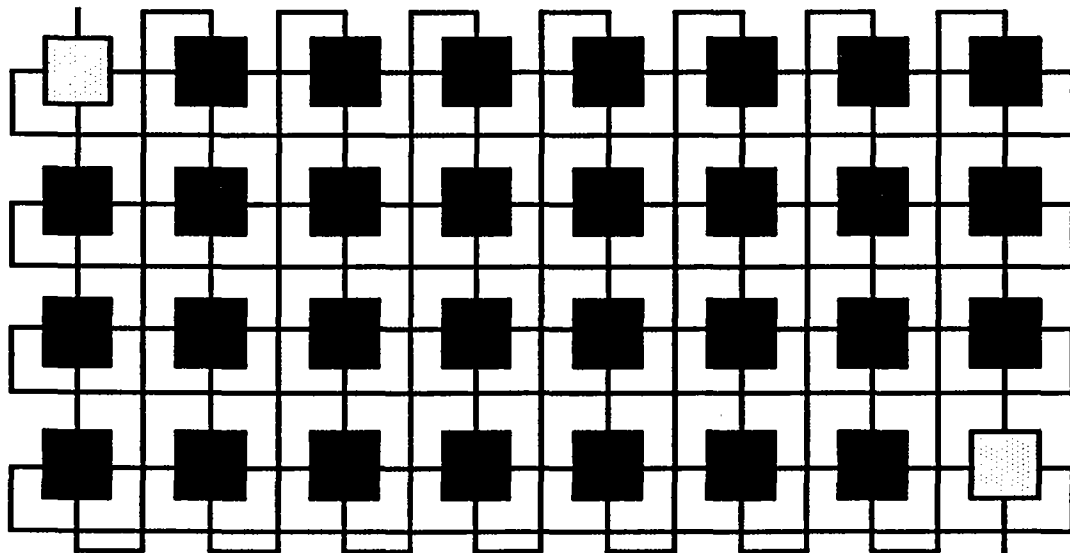


Figure 6.31: Topology resulting from combining the CYLINDER option on the odd level with the PIPELINE/EXTERNAL option on the even level.

The cylinder configuration presents no access. The coordinates of the PIPELINE/EXTERNAL free UniLinks are:

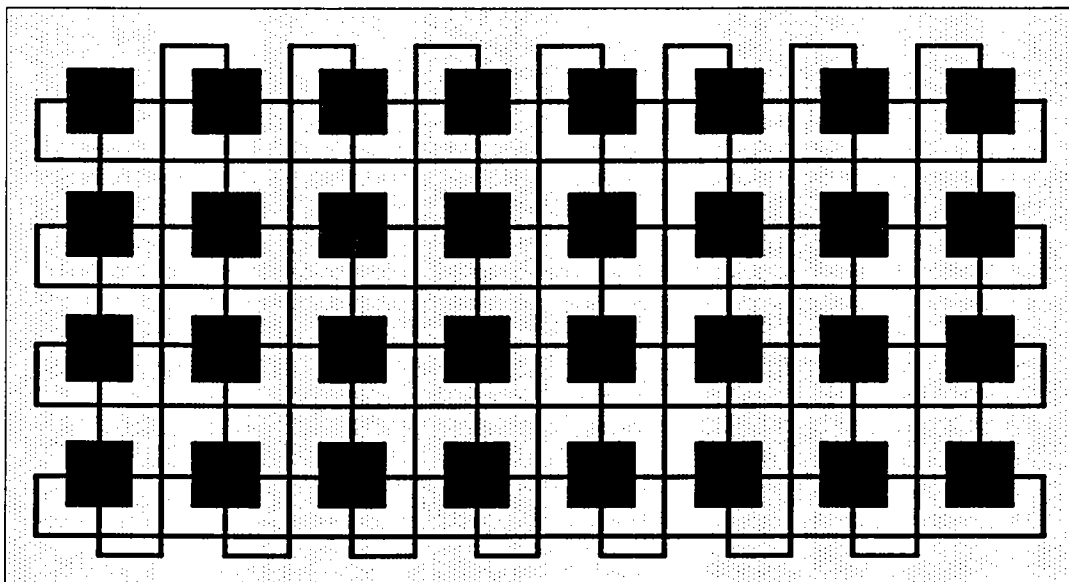
$$l^0_{0,0} = [\text{eCh } 64] \text{ and } l^2_{3,7} = [\text{eCh } 79] \text{ for } j=0..7.$$

### 6.1.3.15 CYLINDER (Odd) & PIPELINE (Even)

Analogous to the P & C configuration described above, this results in a closed topology (a twisted, closed torus) with no means of access (see figure 6.32) and is therefore not suitable for use.

**odd: CYLINDER**  
**even: PIPELINE**

**Not accessible distorted torus**



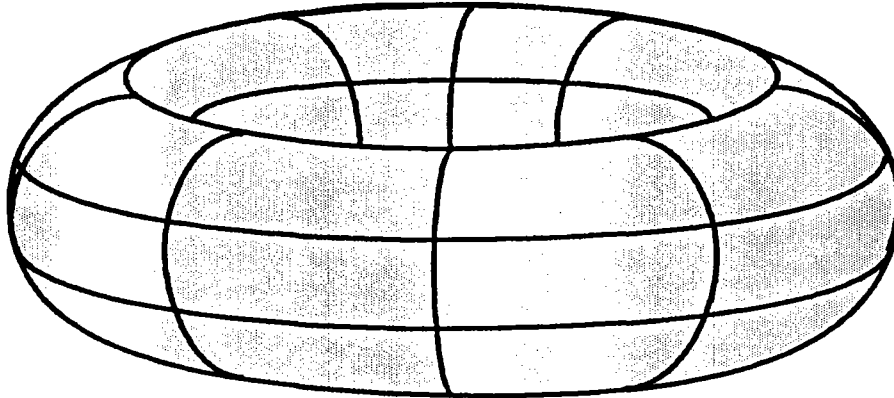
**Transputer node with no externally accessible links**

Figure 6.32: Topology resulting from combining the CYLINDER option on the odd level with the PIPELINE option on the even level.

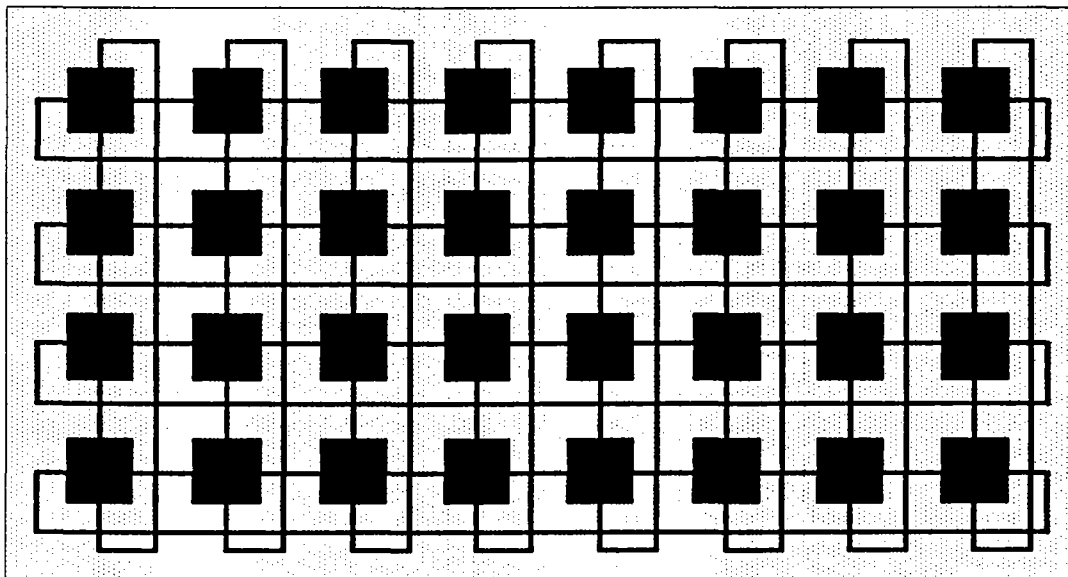
### 6.1.3.16 CYLINDER (Odd) & CYLINDER (Even)

Using the CYLINDER option on both configuration levels will not deliver a practicable processor topology. The resulting symmetrical torus is a closed figure with no means of access to the outside world as shown in figure 6.33.

**odd: CYLINDER**  
**even: CYLINDER**



**Not accessible torus**



 Transputer node with no externally accessible links

Figure 6.33: Topology resulting from combining the CYLINDER option on the odd level with the CYLINDER option on the even level.

In graph theory, the torus topology has several advantages in comparison to a rectangular grid: both the maximal distance and the mean distance between two given nodes are much smaller. As one can see in figure 6.33, the torus topology is not accessible under normal circumstances. A similar accessible topology can, however, be simulated using a grid or the free rims of a cylinder.

This will be explained using the topology described in chapter 6.1.3.13 (a vertical, open ended cylinder) as an example. By connecting the top of each column to its own bottom with an additional, external UniLink one can achieve a torus topology consisting of 40 Transputers. In this case, as opposed to the normal C & C situation, the eight additional external Transputers have two accessible UniLinks each. Up to 16 UniLinks can then be used for connecting external systems. The external processor nodes can then be programmed via software multiplexer in such a way that the eight UniLinks (which close the ring to a torus) resemble double links.

## 6.2 Topologies Available With Partially Reconfigurable MultiCluster-2 Models

---

A partially reconfigurable MultiCluster-2 unit is equipped with a fixed topology module in its odd level configuration section and a network configuration unit in its even level configuration section. A fixed topology module consists of two identical boards since a topology has to be chosen and installed for both the link and the reset level. A network configuration unit also consists of two boards for the very same reason. The positions of the odd and even level configuration section are depicted in figure 6.34. Figure 6.34 also shows where the network configuration unit's component boards have to be installed.

In a partially reconfigurable unit, the network configuration unit controls the connections of the Transputer section's even numbered Transputer UniLinks. The 32 Transputers are therefore no longer automatically linked together to form eight columns as they were in fixed topology units. The difference in wiring is obvious when comparing figure 6.35 to figure 6.1. Since the even level network configuration unit offers an additional 32 external UniLinks, the total number of possible external connections is significantly higher.

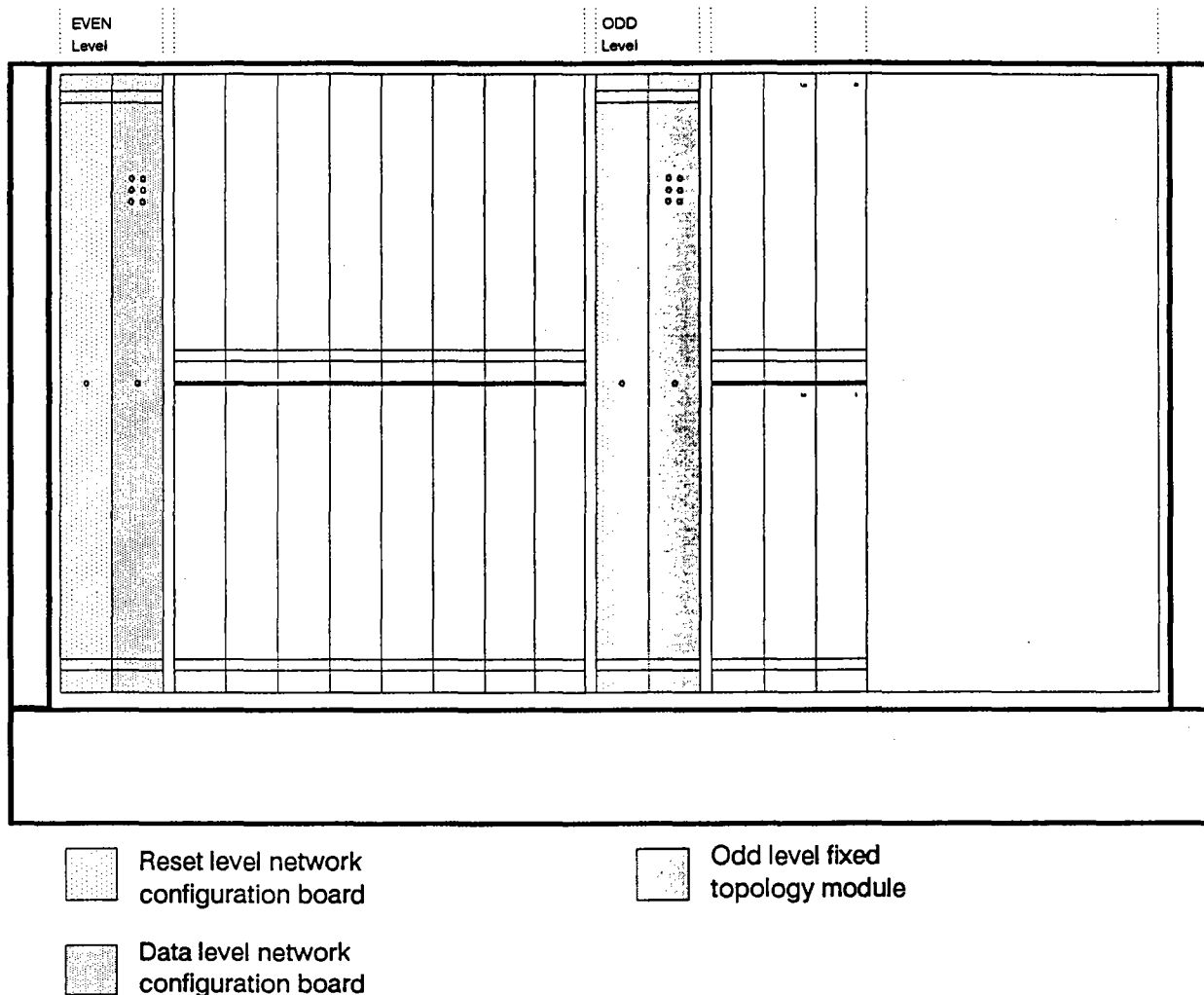


Figure 6.34: Location of the even level network configuration unit and the odd level fixed topology module of a partially reconfigurable MultiCluster-2 model.

The two odd level fixed topology modules installed in the odd level configuration section still connect the 32 Transputer nodes to form four pipelines at eight processors each (see figure 6.35). The possible odd level configurations and their installation are explained in chapter 6.1.2.

If a network configuration unit is installed, the number of possible topologies is greatly increased, without reducing the connection possibilities for external systems. Furthermore, topologies can be altered on a software basis at any time without having to shut the system down. The details of software configuration management should be explained in your system software manual.

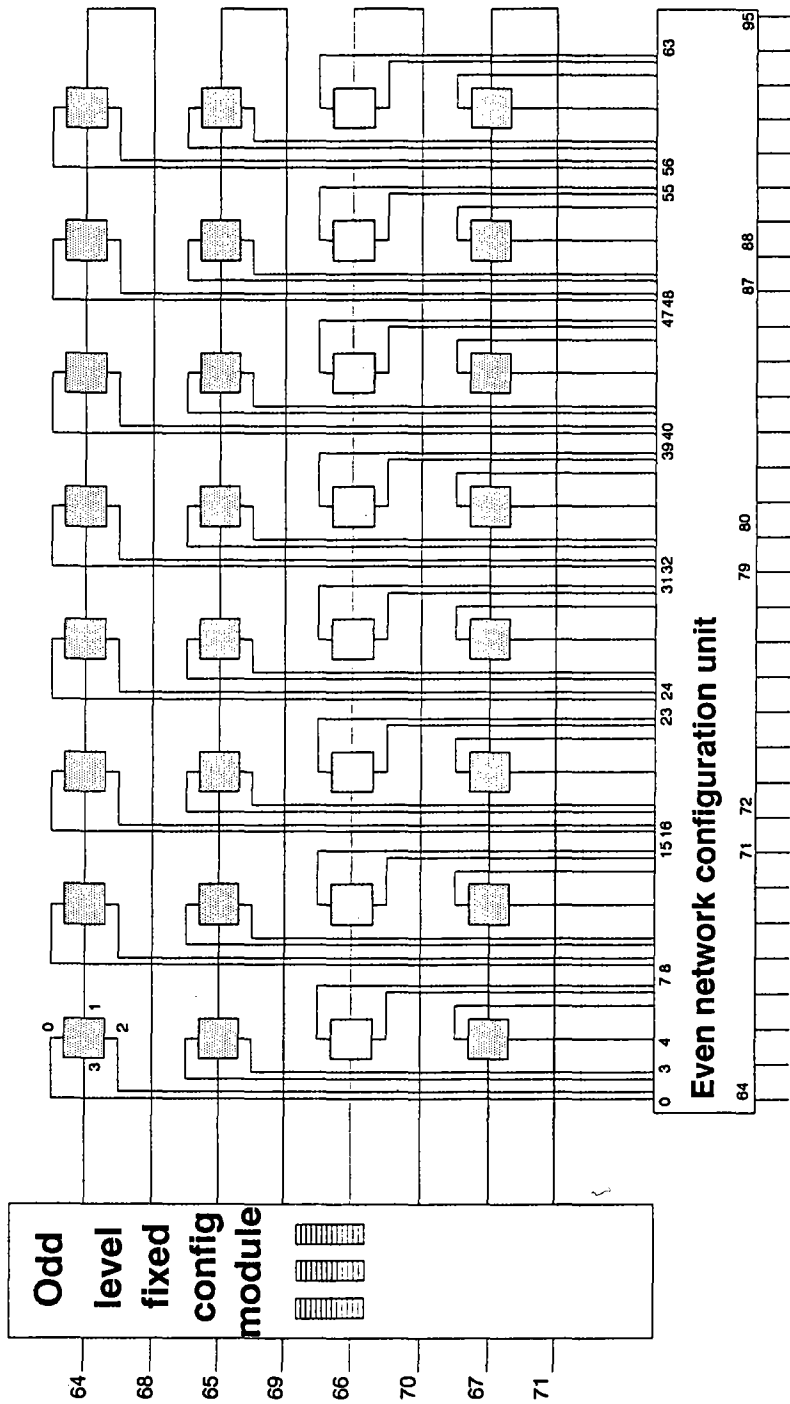


Figure 6.35: The connections between the possible 32 Transputers installed in the Transputer section of a partially reconfigurable MultiCluster-2 unit.

## 6.3 Changing The Configuration Of Fixed Topology Modules

---

When altering the topology on a fixed topology module, always shut down the MultiCluster-2 unit and disconnect it from the line. Never remove or insert a board when a MultiCluster-2 unit is running! After the unit has been disconnected from the line, loosen the fixed topology module's screws as described in chapter 5. Carefully remove the boards of the appropriate fixed topology module. Their exact position within the MultiCluster-2 cabinet is shown figure 6.36.

Lay the boards face upward on a flat surface. The pin connectors should be on the right, if figures 6.2 and 6.10 are used for orientation. Rearrange the jumpers according to the required topology as described in chapter 6.1. The jumpers of both boards making up a fixed topology module must have the same constellation.

Reinsert the fixed topology modules in their appropriate configuration sections and tighten their screws (see figure 6.36). When this is done you can reconnect the MultiCluster-2 unit to the line, start it up and test the new configuration.

**Warning:** Both boards of any fixed topology module must have the same jumper constellation. This will ensure that the link and the reset levels are paired.



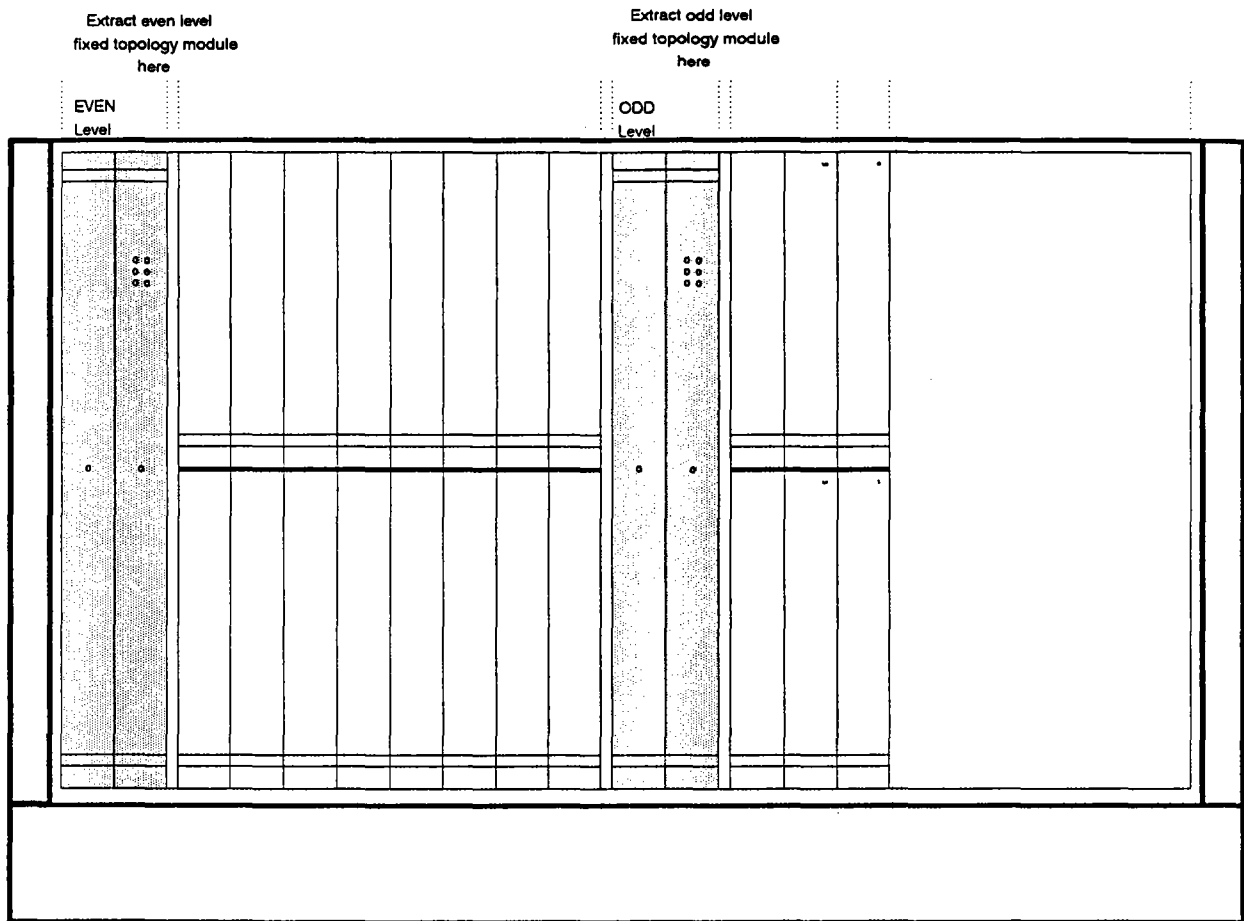


Figure 6.36 The positions of the fixed topology modules within a MultiCluster-2 cabinet.

# **Appendix A. Physical Requirements**

This appendix describes the power, environmental and physical requirements most important for the trouble-free operation of a MultiCluster-2 system.

## **A.1 Power Requirements**

### **A.1.1 General Requirements**

A MultiCluster-2 system can be run on 187-264 VAC or 95-132 VAC, 47-63 Hz.

### **A.1.2 Power Consumption**

The power consumption of a MultiCluster-2 unit depends on the number and type of computation and I/O modules inserted. The value listed on the cabinet's rear panel (600 W) represents the maximal power consumption attainable.

## **A.2 Environmental Requirements**

The specific operation and storage requirements depend on the environmental conditions your MultiCluster-2 system will encounter.

### **A.2.1 Temperature And Humidity During Operation**

Temperature :	0 to +40°C
Gradient :	20°C per hour
Humidity :	20% to 80% RH (non condensating at 35°C)
Gradient :	30% per hour

## **A.2.2 Temperature And Humidity During Transport And Storage**

---

Temperature :	-20 to +60°C
Gradient :	20°C per hour
Humidity :	95% RH (non condensating at 35°C)
Gradient :	30% per hour

## **A.2.3 Vibration And Shock During Operation**

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Vibration :	0.2 G, range 2 to 300 Hz magnitude 0.5 mm p-p
Shock :	2 G, 10 ms maximum

## **A.2.4 Vibration And Shock During Transport And Storage**

---

Vibration :	0.5 G, range 5 to 300 Hz
Shock :	15 G, 10 ms maximum

## **A.3 Further Physical Parameters**

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### **A.3.1 Weight**

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An empty MultiCluster-2 cabinet weighs approx. 33 kg. The final weight depends on the number and type of processor and expansion modules inserted into the cabinet, but will seldom exceed 45 kg.

### **A.3.2 Dimensions**

---

When installing a MultiCluster-2 cabinet, please remember that in addition to the dimensions listed below, enough room must be left around the cabinet to guarantee adequate ventilation (see appendix: A.3.3).

Height :	340 mm
Width :	500 mm
Depth :	540 mm

### A.3.3 Space Requirements And Installation Conditions

The space requirements listed below represent the absolute minimum necessary in order to protect the unit from overheating. We advise leaving more space, as this not only widens the safety margin, but also makes installing and altering the wiring a heck of a lot easier.

#### A.3.3.1 Open Installation

In order to maintain a sufficient air flow and cooling, leave at least 10 cm between the MultiCluster-2 cabinet's rear panel and any other object (see figure A.1).

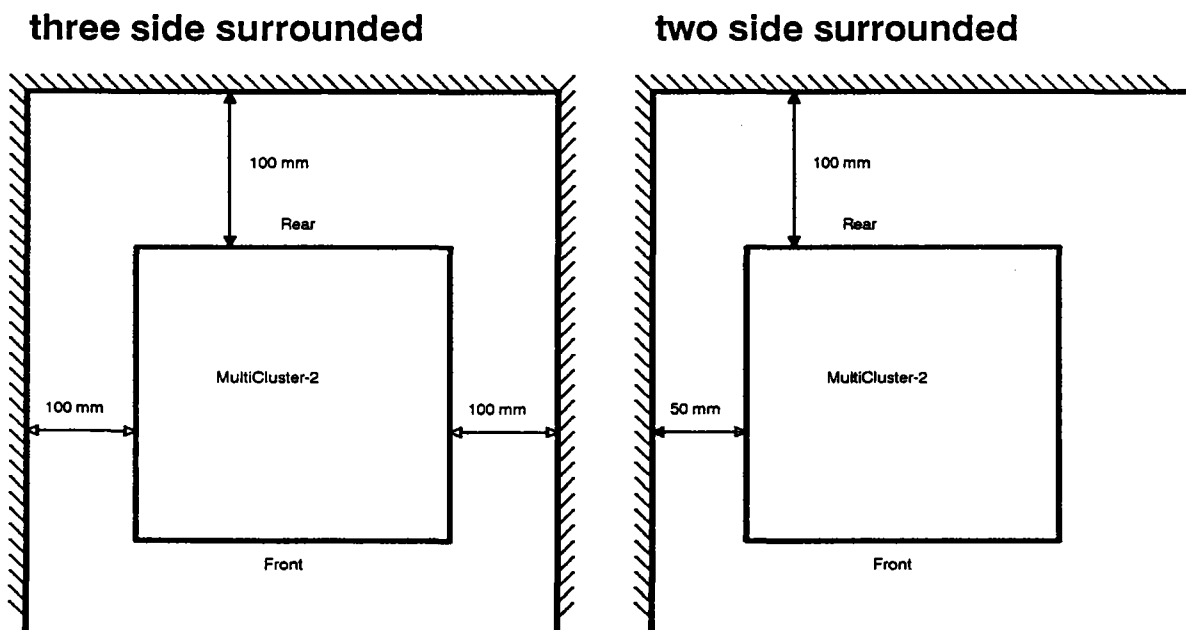


Figure A.1: Minimal space requirements when installing MultiCluster-2 cabinet

### **A.3.3.2 Installation On Shelves**

When installing a MultiCluster-2 cabinet in a closed shelf i.e. only the front panel is exposed, leave at least 10 cm to all sides of the MultiCluster-2 cabinet. Make sure the flow of cool air is never blocked, otherwise, the unit may overheat.

### **A.3.3.3 Installation In Cabinets**

MultiCluster-2 units should never be installed in closed cabinets, as adequate ventilation cannot be guaranteed.

**Warning:** During installation, always be certain that the MultiCluster-2 cabinet's ground clearance is at least 3 cm. As the warm air is blown out the bottom of the cabinet, any obstruction can reduce the air flow. Be especially careful not to set the unit on any surface smaller than the area encompassed by the unit's four feet, as this would block off the lower ventilation grid entirely and cause serious damage to your unit.

# Appendix B. Opening And Closing MultiCluster-2 Cabinets

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The MultiCluster-2 cabinet should only be opened for the installation of new processor or I/O boards, or for routine maintenance.

For the protection of both the user and the MultiCluster-2 system, always switch off the unit and disconnect it from the line before opening the MultiCluster-2 cabinet.

**Warning:** Metallic parts dropped into a running MultiCluster-2 system may cause serious damage.

## B.1 Removing The Cabinet Lid

---

First, remove the four cabinet housing screws, two on each side, as shown in figure B.1 (Remember to keep all screws and small metallic parts in a safe place). Then carefully lift the cabinet lid from your unit and disconnect the ground wire. After finishing the necessary work, reconnect the ground wire before replacing the cabinet lid and screws. When this has been done, reconnect the power line.

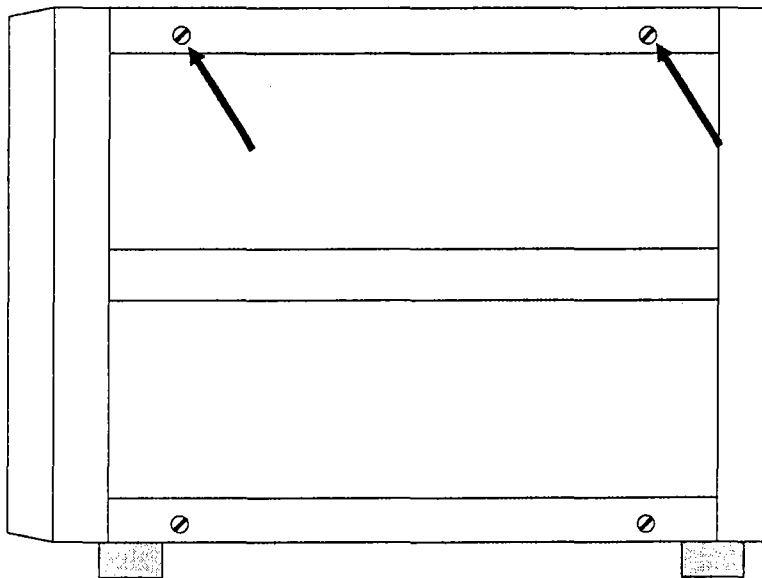


Figure B.1: There are two housing screws on each side of the MultiCluster-2 cabinet which must be removed before taking off the cabinet lid or floor.

## **B.2 Removing The Cabinet Floor**

Removing the cabinet floor is requires the same steps as removing the cabinet lid. In this case, however, one should turn the unit upside down.

# Appendix C. General Maintenance

In order to guarantee steady and sufficient cooling, the MultiCluster-2 cabinet's built-in ventilation unit requires periodic inspections. These include regular checks of the unit's function and of the unit's filter mat in intervals depending on the dust contamination of the surrounding area.

## C.1 Checking The Fans

The MultiCluster-2 cabinet's ventilation units are located at the bottom of the cabinet and can be found at the lower portion of the front panel, just below the module expansion slots (see figure C.1). Each of the six fans is constantly monitored, and a red LED on the rear panel will signal any malfunction (see figure C.2).

If the LED lights up, the unit must be shut down as soon as possible, regardless of the consequences (the software, however, can be salvaged first). If one of the fans has failed completely, this leads to an insufficient air flow. Defective fans have to be replaced as soon as possible.

There are two ways to check the function of unit's six fans.

The first way is by removing the MultiCluster-2 unit's lid, as described in appendix B, and while observing all safety precautions reconnect the power supply. One can observe the six fans and, if they are all functional, replace the unit's lid.

The alternative is to carefully pull the ventilation unit partway out after removing the four fastening screws located on the front panel of the MultiCluster-2 cabinet (see figure C.1). One can then check whether or not the six ventilation fans are running properly. The ventilation unit can then be reinserted, and the screws replaced.

**Note:** Defective ventilation units may only be replaced by Parsytec technicians.



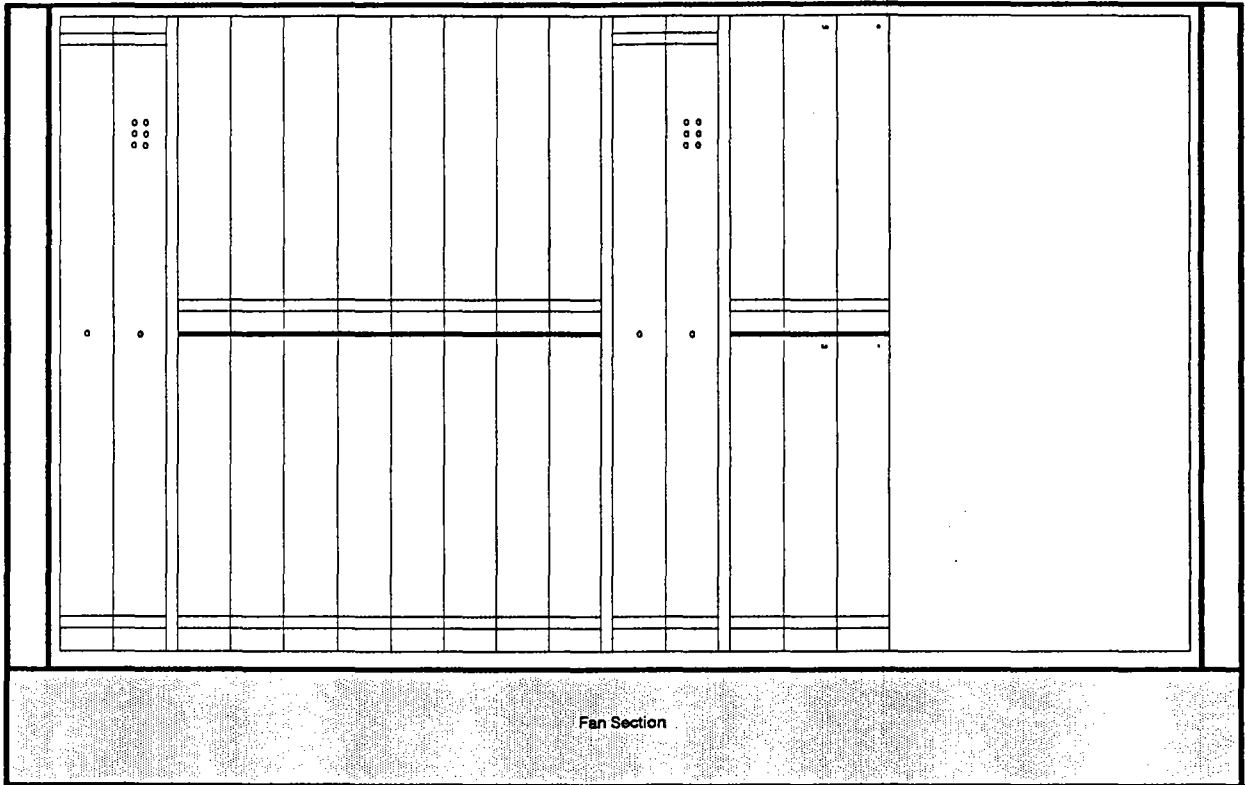


Figure C.1: Position of the fan section within the front panel of a MultiCluster-2 unit

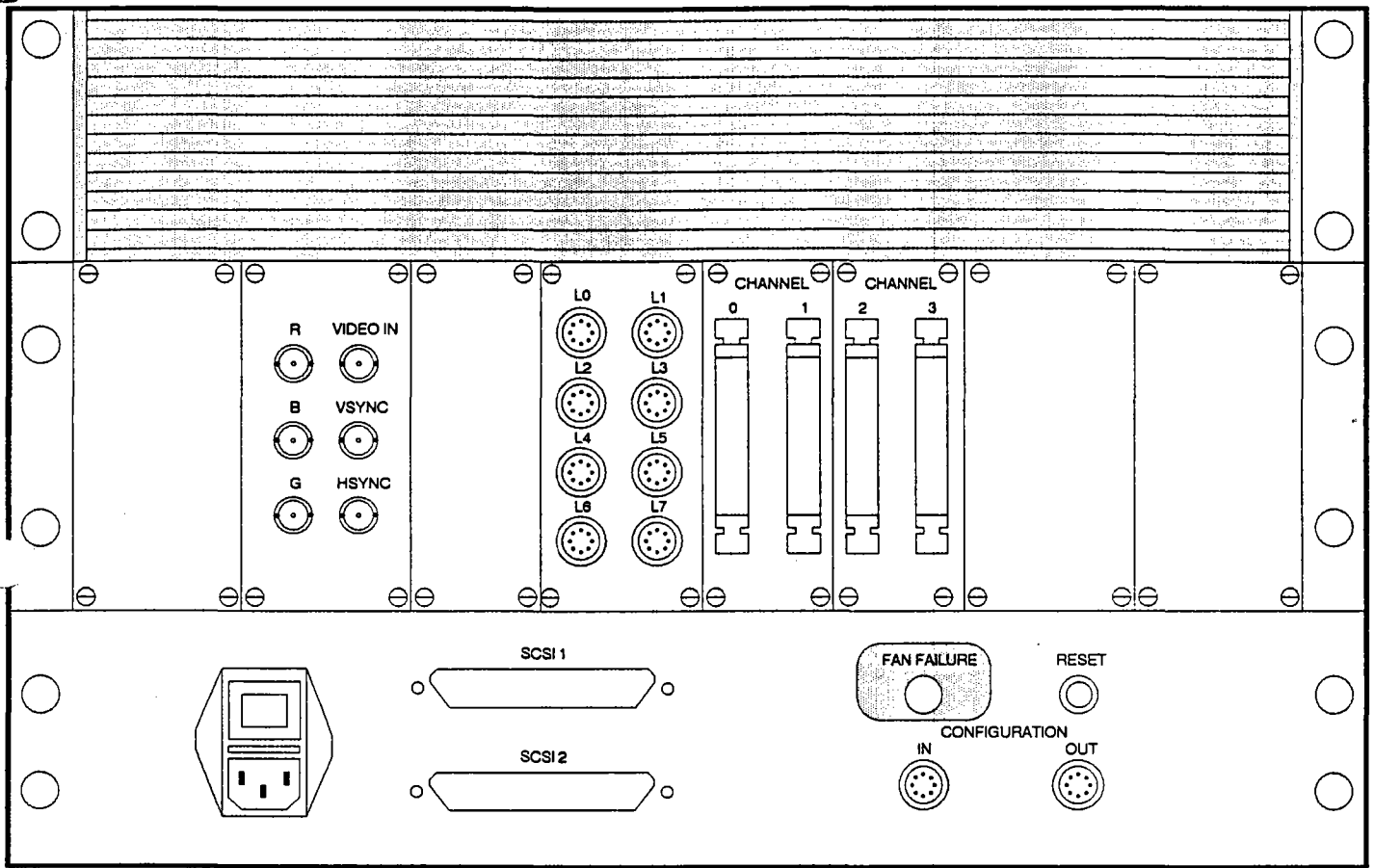


Figure C.2: Position of the filter mat in the rear panel of a MultiCluster-2 unit

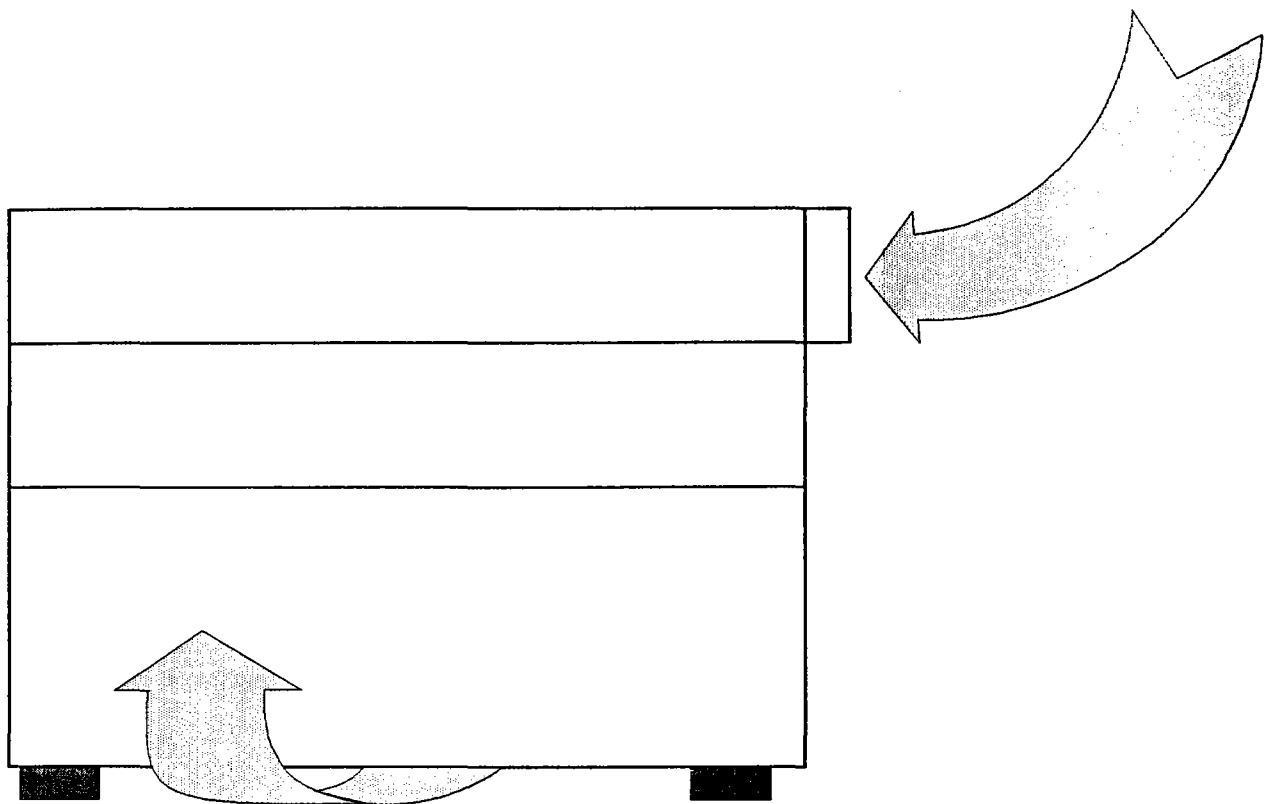


Figure C3: Air flow in a MultiCluster-2

## C.2 Replacing The Air Filter Mat

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The air filter mat should be examined periodically to avoid excessive dust deposits. The intervals between inspections vary depending on the dust contamination of the surrounding area. Excessive dust deposits will block the air flow necessary for cooling. The air filter mat is located to the rear of the MultiCluster cabinet, just behind the black, horizontal cooling grid (see figure C.2).

In order to replace the air filter mat, first remove the two fastening screws of one of the two cooling grid frames. When this has been done, remove the grid frame, the grid and the air filter mat. The frame can be refastened immediately. After a clean filter mat has been inserted, the cooling grid can be pressed between the two frames until it snaps into place.

# Appendix D. Replacing Fuses

Although it is unlikely, the MultiCluster-2 unit's two fuses may burn out and have to be replaced. The required procedure is described in the following chapter. If both fuses burn out frequently, one should try to discover the reason for these failures before reconnecting the MultiCluster-2 unit's power supply (high voltage peaks are the most frequent cause).

The main fuses of a MultiCluster-2 cabinet are located in the rear panel, just between the main power switch and the power socket (see figure D.1). As a safety precaution, always remember to disconnect the unit from the line before replacing the fuses. Pull out the fuse halter. Remove both fuses and check them with an ohmmeter. If the fuses are stuck, carefully pull them out with a pair of tweezers. Replace the faulty fuse or fuses by fitting one or two replacements into the halter. The fuses must have the following specifications:

250 volt, slow acting, 5 ampere (220/240 VAC)

or

125 volt, slow acting, 10 ampere (110 VAC)

depending on AC-Voltage.

Replace the fuse halter, reconnect the unit from the line and switch the unit back on.

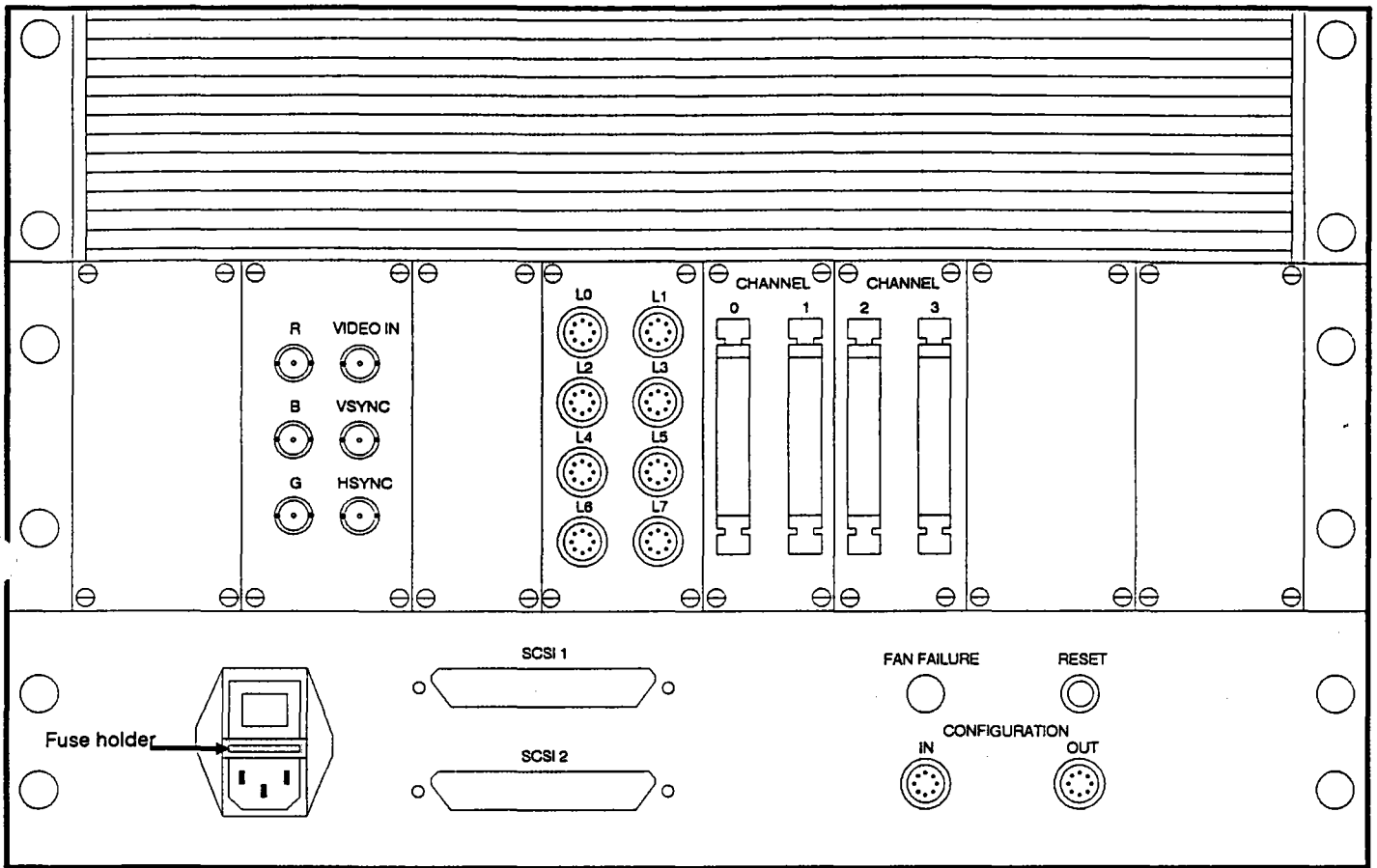


Figure D.1: Position of the fuse halter in the MultiCluster-2 cabinet's rear panel

# Appendix E. Using IMS-B004 Boards In Boot And Workstations

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The reset schemes and the physical link specifications used by Inmos and Parsytec are not compatible. A somewhat different wiring is therefore necessary when connecting a MultiCluster-2 unit to workstations with this type of host. Booting a MultiCluster-2 unit from a bootstation with an IMS-B004 as host also requires additional manipulations. The locations of the plugs mentioned in this appendix are explained in chapter 2.1.3.3.

## E.1 General Requirements When Using IMS-B004 Boards

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A link converter box has to be inserted between the signal lines in order to adapt the two link standards. This converter box is able to adapt four UniLinks to four Inmos reset and link signal lines. When connecting the IMS-B004 plug to the Link Converter Box, use the LNK-INMOS link cable especially designed for this purpose. The wiring from the converter box to the MultiCluster-2-unit should be done with the standard LNK10 cable required for all link level (UniLink) connections to a MultiCluster-2 unit.

Figure E.1 shows the necessary IMS-B004 board plugs and the wiring between the workstation, the Link Converter Box and the MultiCluster-2 unit.

**Note:** Always use the Link 2 and the subsystem plug of an IMSB004 board based workstation as the primary link channel to a MultiCluster-2 unit. Using other plugs will require Software adaptations if you get it to work at all.

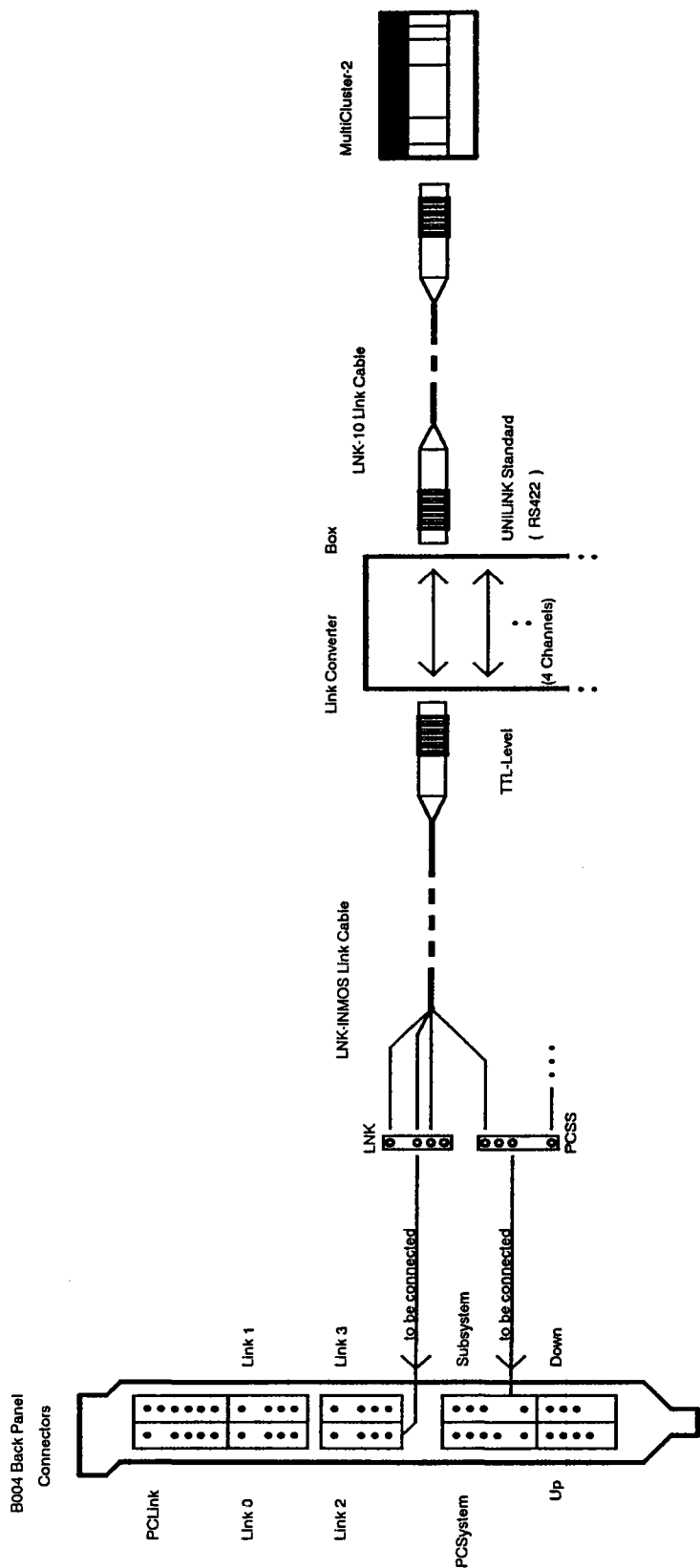


Figure E.1: Wiring when using an IMS-B004 board as a bootstation and/or several boards of this type as workstations.

## E.2 Using An IMS-B004 Board In A Pure Bootstation

Use the wiring described in appendix E.1 and shown in figure E.1. The bootstation has to be connected to the Configuration Link In plug at the external interface section of the MultiCluster-2 unit (see figure E.2). Use the booting method described in your operating system manual. After booting, all connected workstations should be able to use the MultiCluster-2 hardware in the normal manner. For information on using a combined boot/workstation see appendix E.3!

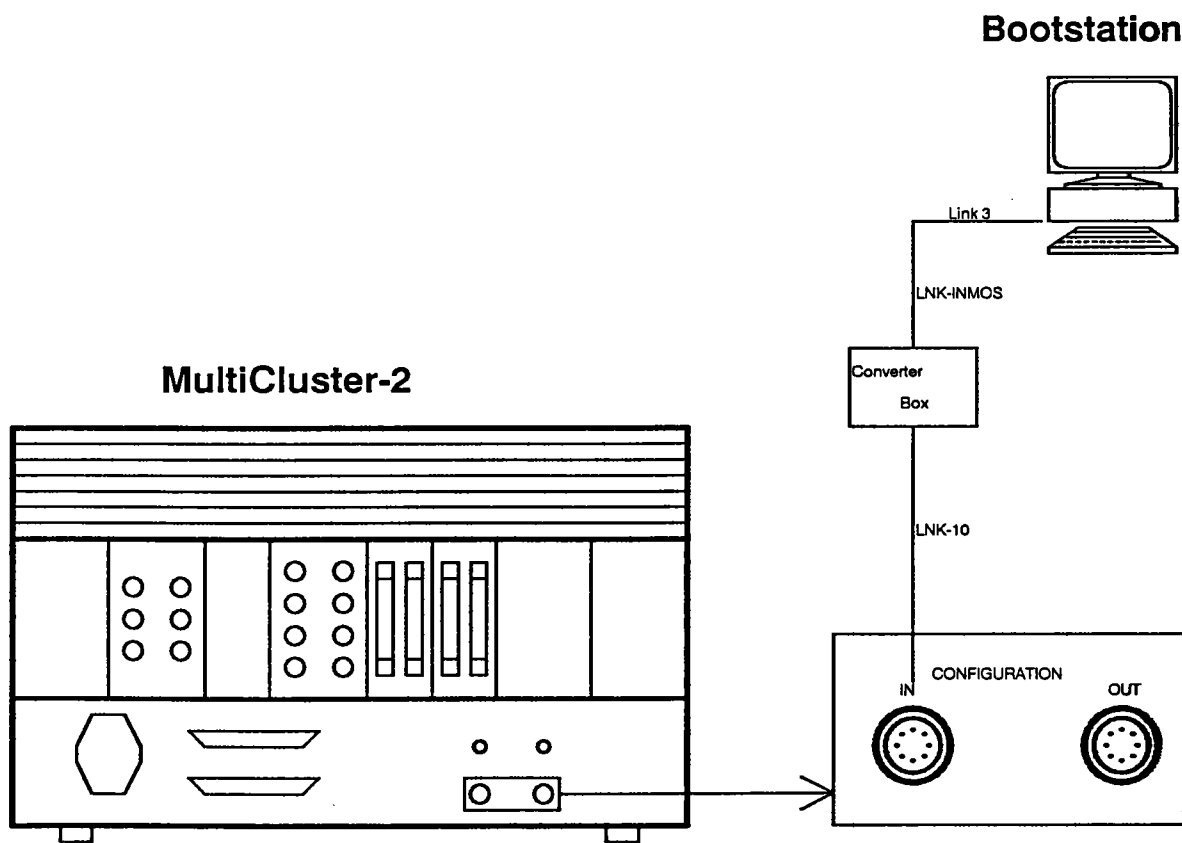


Figure E.2: Wiring of a pure bootstation based on an IMS-B004 board.



## E.3 Using An IMS-B004 Board In A Combined Boot/Workstation

Use the wiring for B004-based workstations described in appendix E.1 and shown in figure E.1. The procedure for booting from a combined boot/workstation is described in appendix E.2. After booting has finished, unplug the LNK-10 link cable from the Configuration In plug and plug it into a free Lx (x=0..7) plug of the user interface panel (see figure E.3). The user interface is a part of the external interface section.

**Note:** Plug L0 offers the easiest access when using a combined boot/workstation.

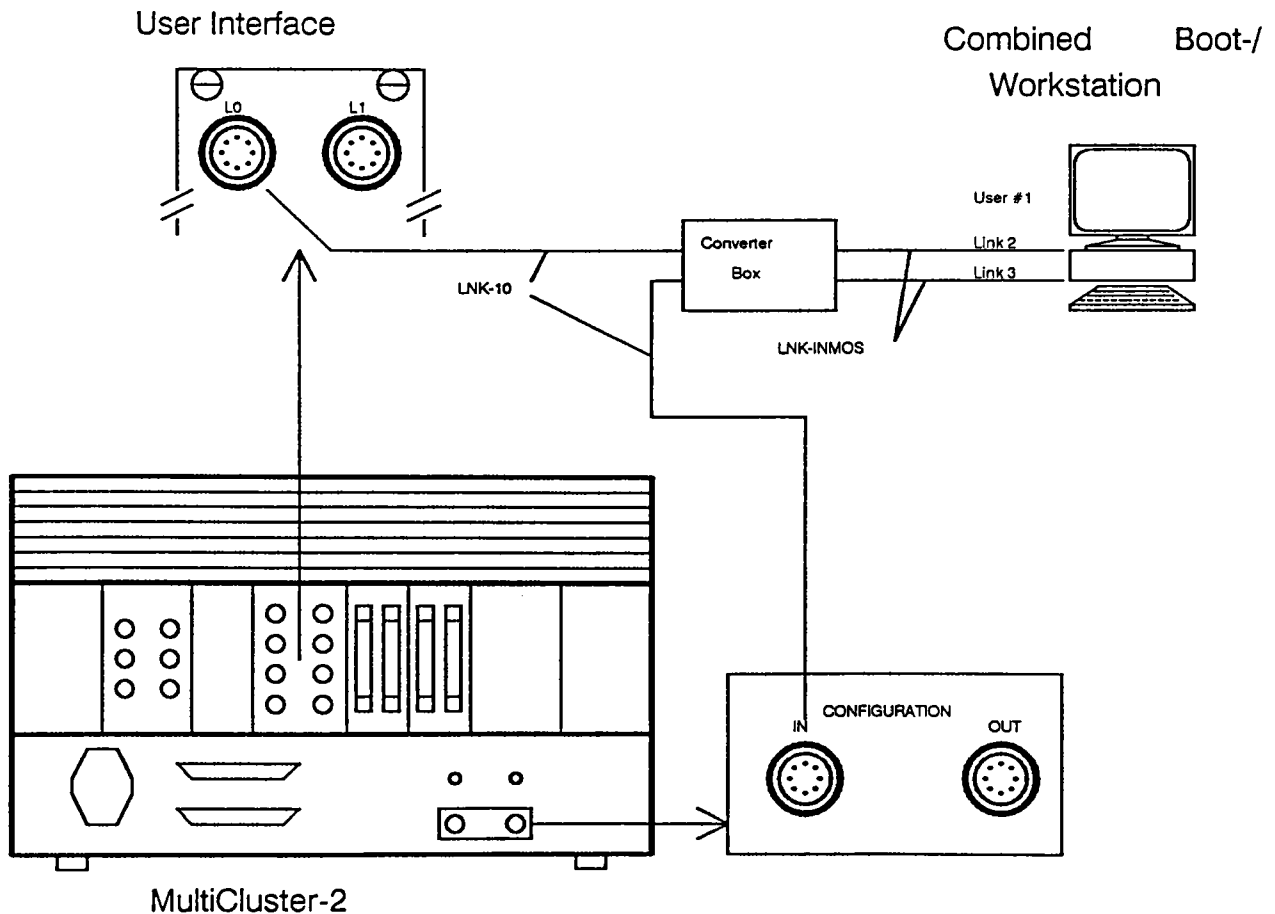


Figure E.3: Second step of the dynamic boot and wiring sequence of a combined boot/workstation based on an IMS-B004 board.

## **E.4 Using IMS-B004 Boards In Pure Workstations**

If a work stations is equipped with an IMS-B004 board, then apply the wiring described in appendix E.1 to connect it to your MultiCluster-2 unit. The steps mentioned in appendices E.2 and E.3 are not necessary. The LNK-10 link wires leading from the workstations to the MultiCluster-2 unit should be plugged into the Lx (x=0..7) plugs of the user interface panel (see figure E.3)

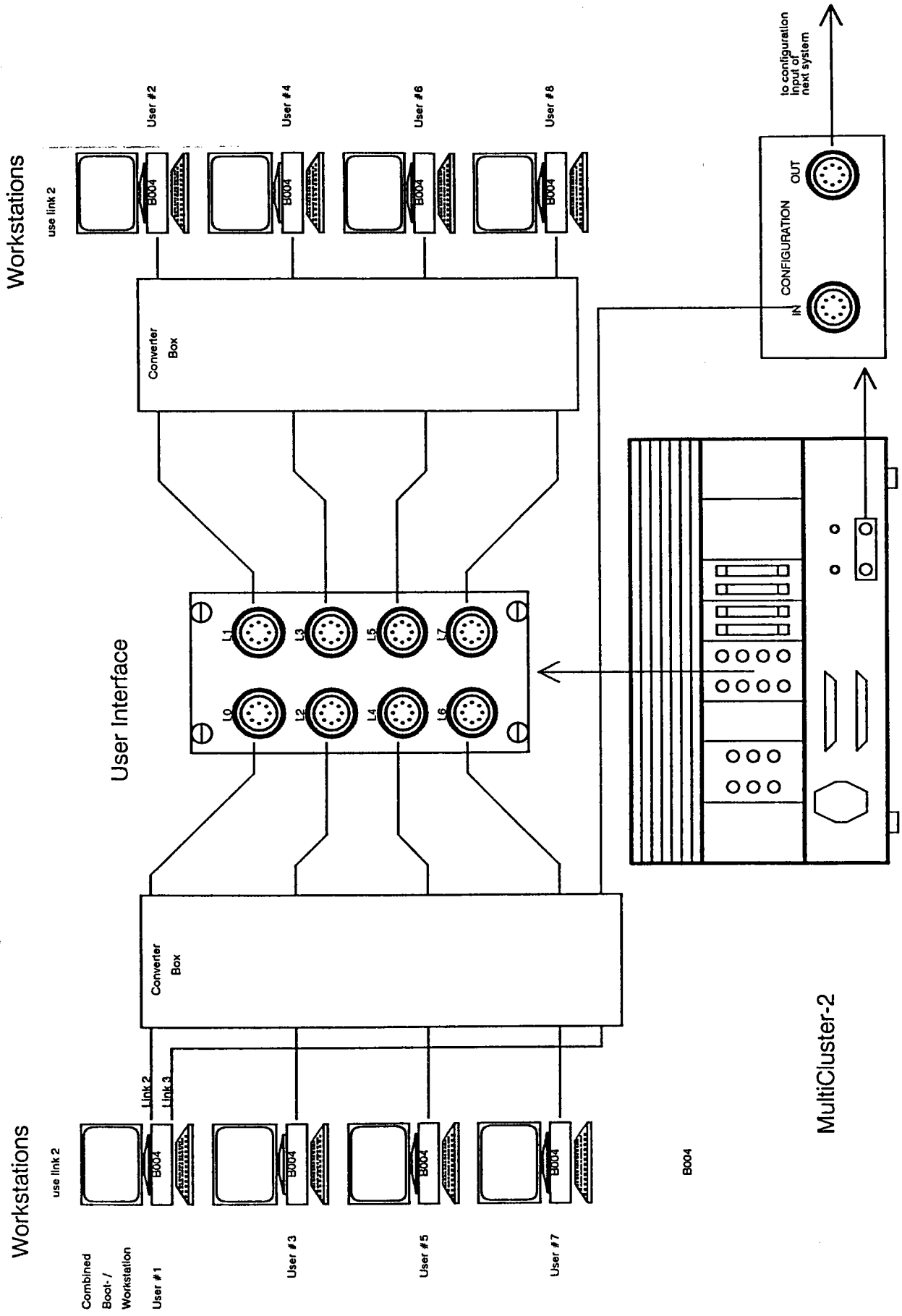


Figure E.4: Summary of the steps necessary when using IMS-B004 boards as pure boot or workstations.