BA200 Series Module Design Guide

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Chapter 4 Product Kits

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Preface

Intended Audience

This guide is written for hardware engineers who design modules for the BA200 Series of microsystem enclosures. It assumes knowledge of basic electronics concepts and terminology. It does not assume knowledge of the BA200 Series or other Digital products.

This guide is designed to accompany several Bulkhead Product Kits that allow engineers to design modules for the BA200 Series. It first explains concepts specific to the BA200 Series. Knowledge of these concepts and the appropriate use of the kits is interrelated. This guide describes each of the kits.

This guide shows how to do the following:

- Modify modules that do not connect to external I/O devices
- Modify modules that connect to external I/O devices
- Design new modules for the BA200 Series enclosures
- Mount I/O connectors on bulkheads
- Mount I/O connectors on modules.

Organization

This document is organized into five chapters and two appendices.

- Chapter 1 presents an overview of the BA200 Series. It shows how the BA200 Series differs from other microsystem enclosures. This chapter explains how BA200 Series enclosures are designed to minimize the Electromagnetic Interference (EMI) emitted by a module. It explains the role of bulkheads in reducing EMI.
- Chapter 2 describes how to adapt modules designed for other enclosures and how to create new modules for BA200 Series enclosures. It describes how to choose the proper bulkheads for modules with or without external I/O. It also shows how to create new module layouts for BA200 Series enclosures.
- Chapter 3 describes the manufacturing issues associated with BA200 Series modules. This chapter shows where to drill pin holes on the modules for different kinds of connectors. It also explains how to drill holes on the bulkheads for connectors, switches and LEDs.
- Chapter 4 describes the Bulkhead Product Kits currently available from Digital. It provides a complete parts list for each kit.
- Chapter 5 provides examples of how to select the appropriate bulkhead for a particular application.
- Appendix A provides a description of the power supply of BA200 Series enclosures.
- Appendix B provides a description of the backplane of BA200 Series enclosures.
- A glossary of terms is included in the back of this guide. The first use of each glossary entry is italicized within the chapters of this guide.

Related Documents

This guide does not describe the MicroVAX or MicroPDP-11. For more information on these systems, see the *MicroPDP-11 Maintenance Addendum* or the *MicroVAX Systems Maintenance Guide*. The following documents may be ordered from Digital:

Technical Manual	Order Number
MicroPDP-11 Systems Maintenance Guide	AZ-FI11A-MC
MicroPDP-11 Maintenance Addendum	EK-00000-AC
Industrial MicroPDP-11/53 Installation	EK-134AA-IN
Industrial MicroPDP-11/53 Operation	EK-135AA-OP
Industrial MicroPDP-11/53 Troubleshooting	EK-136AA-TS
Industrial MicroPDP-11/53 Technical Information	EK-137AA-TM
Industrial MicroPDP-11/83 Installation	EK-O32AA-IN
Industrial MicroPDP-11/83 Operation	EK-O76AA-OP
Industrial MicroPDP-11/83 Troubleshooting	EK-110AA-TS
Industrial MicroPDP-11/83 Technical Information	EK-O78AA-TM
Industrial PDP Maintenance Addendum	EK-152AA-MA
MicroVAX Systems Maintenance Guide	EK-001AA-MG
Factory Systems Site Prep Guide	EK-O74AA-SP
Factory Systems Customer Services	EK-O31AA-SV

Terminology

This guide uses the following terms as they are here defined.

Term	Meaning
BA200 Series	A line of microsystem enclosures that house the MicroVAX or MicroPDP-11. The BA213 and BA214 are examples of the BA200 Series.
Bulkhead	A cover or handle that helps contain electrical noise that a system generates.
Cover	A bulkhead that is not attached to a module.
Handle	A bulkhead that is attached to a module.
Module	A printed circuit board. The term *BA200 module* signifies a module that is designed specifically for a BA200 Series enclosure.

These and other terms are defined in the glossary. The first use of each glossary entry is italicized within the chapters of this guide.

Measurements

All physical dimensions listed in this guide are shown in inches unless otherwise indicated.

Chapter 1
Basic Concepts of the BA200 Series Enclosures

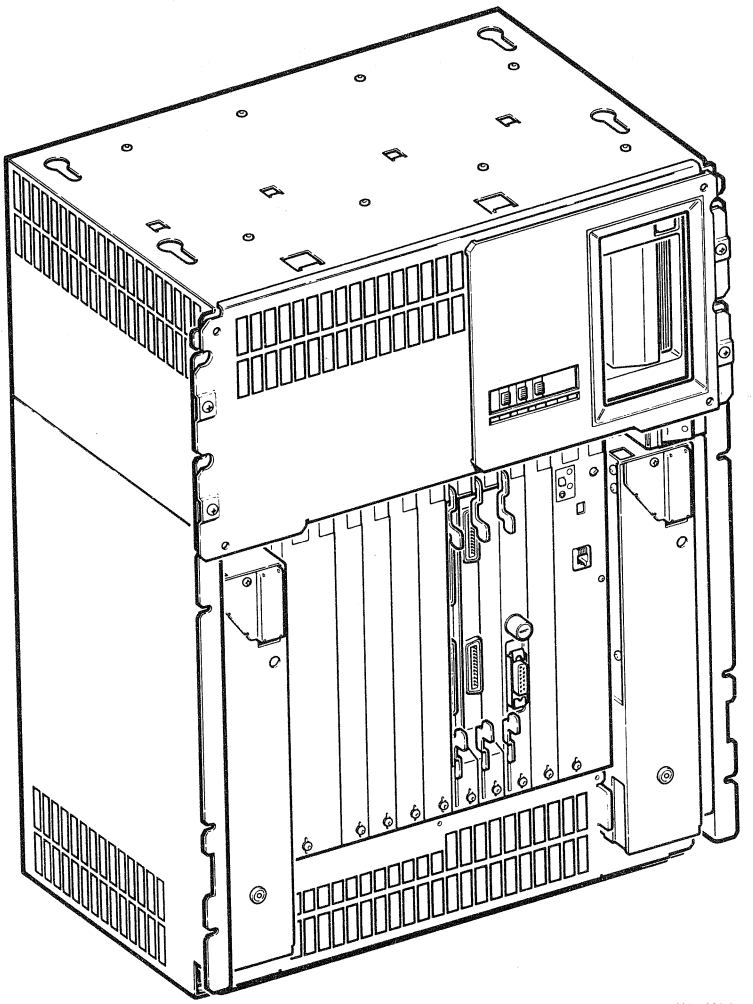
The *BA200 Series* is a family of microsystem enclosures. Each of the enclosures has a six- or twelve-slot *Q22-bus* backplane and one or two modular power supplies.

1.1 Description

BA200 Series enclosures can be mounted vertically, in a rack or on the wall. For example, the BA213 mounts vertically inside a cabinet such as Digital's H994 cabinet, using a BA213-RA rackmount kit.

The BA200 Series card cage is designed so that all *modules*, cables, and options can be accessed from the front (Figure 1–1). The module *bulkheads* are designed for easy system access and maintenance, and provide containment of *electromagnetic interference (EMI)* emissions.

Figure 1–1: BA213 Enclosure: Example of BA200 Enclosure



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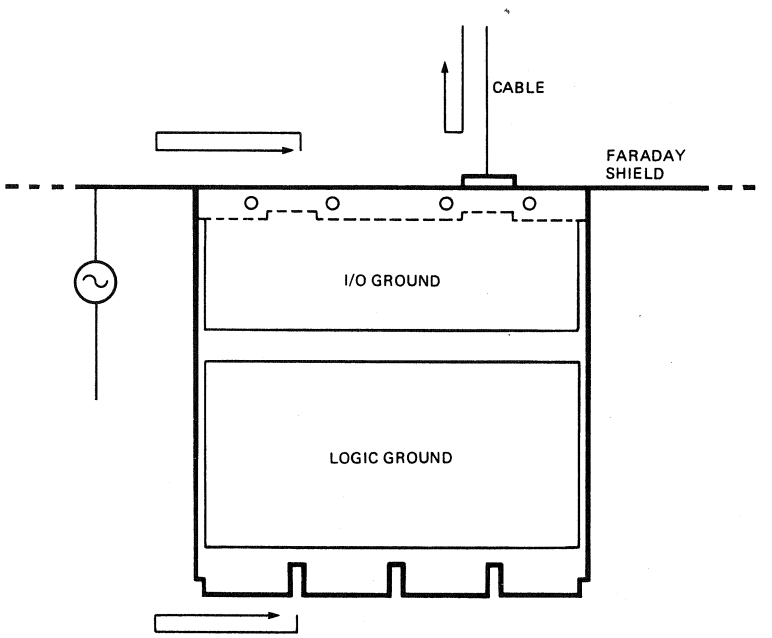
1.2 Electrical Current Flow Within the BA200 Series

BA200 Series enclosures have design features that reduce EMI emissions from the system. These features are best explained through an understanding of electrical current paths within the enclosure. Figure 1–2 shows three current paths within the enclosure: (1) the current that passes along the I/O cable; (2) the current flow through the module logic board; (3) the current flow through the electrical shield. The recommended strategy for reducing EMI within the card cage is to isolate the sources of current from one another.

Figure 1–2: Current Paths Within a BA200 Series Enclosure

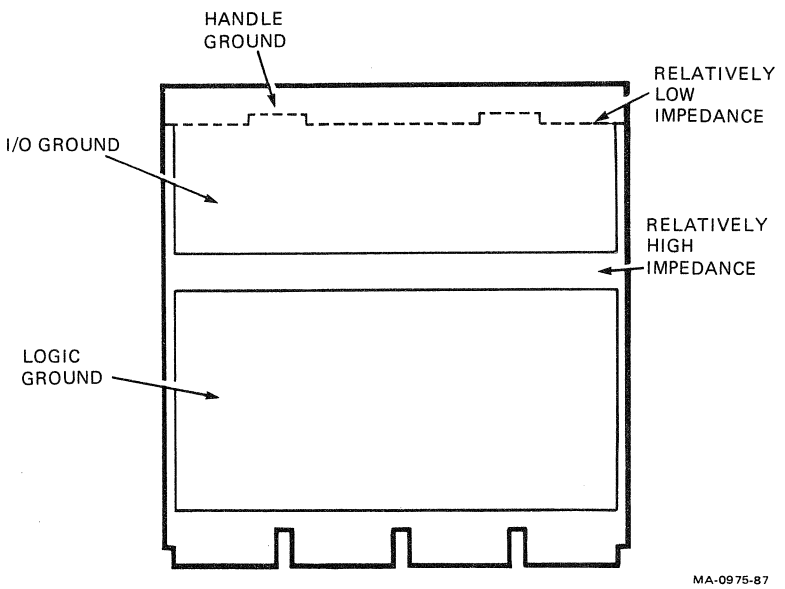


1.2.1 Isolating Sources of Current

The logic and I/O grounds must be isolated before the sources of current can be isolated. Leaving a high impedance path between the logic and I/O grounds isolates the grounds. A low impedance path between the I/O ground and the handle ground must also be left. Figure 1-3 shows where the etches on a module should be placed. Note where paths of high and low impedance are located.

There are additional strategies that isolate the sources of current in a BA200 Series enclosure. These strategies are discussed in Chapter 2.

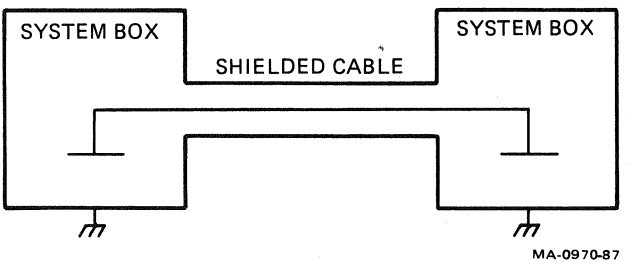
Figure 1-3: Etch Grounding of a BA200 Module



1.3 How the BA200 Series Provides EMI Shielding

In addition to reducing EMI, the BA200 Series enclosures help contain *noise* generated by the system. The traditional method of providing overall EMI shielding is the Faraday shield, shown in Figure 1–4. This design helps ensure that noise generated by the antenna effect or any other effect will remain within the enclosure.

Figure 1–4: Faraday Shield



The bulkhead design uses the concept of the Faraday Shield to form a grounded electrical shield that complies with EMI regulations by (1) keeping frequencies generated by the system inside the enclosure, and (2) keeping radio frequencies out of the enclosure. The bulkheads supplied in the Bulkhead Product Kits (see Chapter 4) provide one way of ensuring that a module is properly shielded.

The design of the BA200 Series bulkheads allows for the attachment of I/O *connectors*, LEDs, and switches to the bulkhead. Openings can be made in the bulkhead for these items provided they follow the constraints described in Chapter 4. Deviations from these constraints require the use of a filtered connector.

The BA200 Series bulkheads also reduce EMI emissions by eliminating the need for internal cabling. Internal cables are a common source of EMI emissions.

1.4 What is a Bulkhead?

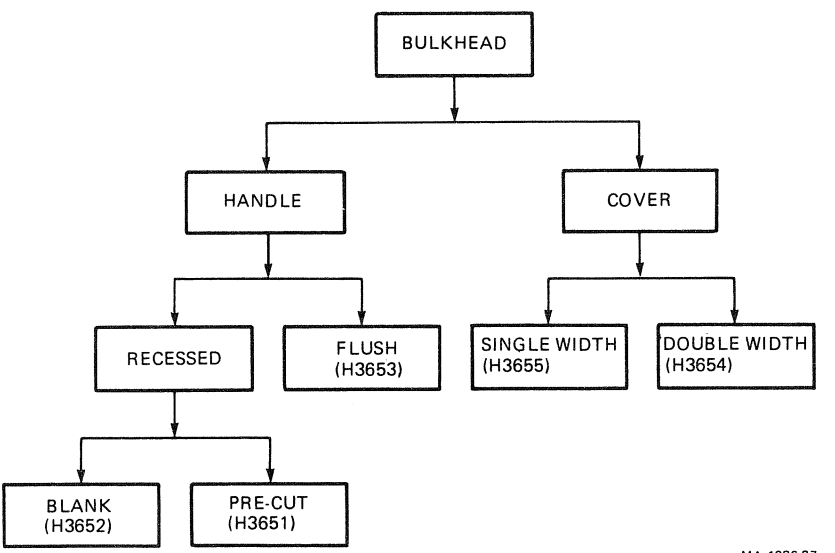
A *bulkhead* is a *handle* that is attached to a module or a *cover* that is not attached to a module. A bulkhead provides EMI emissions containment for a slot in a card cage. Bulkheads attached to modules can be either *recessed* or *flush*. Bulkheads that are not attached to modules can be either *single* or *double* width.

This guide identifies the four kinds of bulkheads as follows:

- Recessed handle
- Flush handle
- Single cover
- Double cover

Figure 1-5 shows the types of bulkheads used in a BA200 Series enclosure.

Figure 1-5: Types of Bulkheads



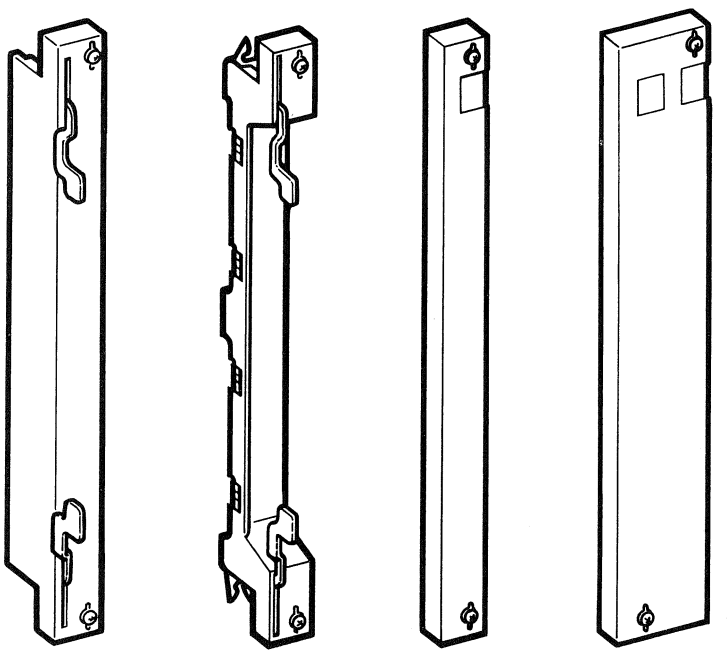
Note that bulkheads include both handles and covers. There are two types of handles - recessed and flush. Recessed handles are further classified as blank or pre-cut. There are two types of covers - single width and double width.

All covers are flush and blank, never recessed or pre-cut. All handles are single width.

Figure 1–5 shows the product kit numbers that contain the corresponding bulkheads. See Chapter 4 for more information on the product kits.

Figure 1–6 shows the bulkheads used by the BA200 series. Each bulkhead has two captive quarter-turn phillips screws to hold it in the card cage. Each handle has release levers to help install or remove the module from the card cage. Each handle also has a reserved area at its upper end for the module number.

Figure 1–6: Examples of BA200 Series Handles and Covers



1.5 Bulkhead Features

BA200 Series bulkheads are designed to provide the following:

- EMI emissions shielding
- Added rigidity to the module
- Space for I/O connectors
- A location for module identification and labeling for switches, LEDs and connectors
- A latching mechanism for module insertion and extraction
- Windows for module diagnostic LEDs and switches
- Low impedance bonding between I/O transceiver ground and chassis ground
- Space for interface/adaptive circuitry.

Chapter 2
Designing BA200 Series Modules

This chapter first describes how to modify modules that are used in other Digital enclosures. It explains the requirements for bulkheads that are different from those used in other Digital enclosures. Second, this chapter explains the proper layout for modules designed for BA200 Series enclosures, and offers guidelines for reducing EMI emissions.

Design considerations differ for modules with and without external I/O connectors. For example, it is easy to adapt for use in the BA200 Series, a module without external I/O connectors. Adapting a module with external I/O connectors requires more planning and designing an entirely new module requires even more planning.

This chapter is divided into three sections.

- Adapting Modules Without External I/O
- Adapting Modules With External I/O, LEDs, or Switches
- Designing New Modules

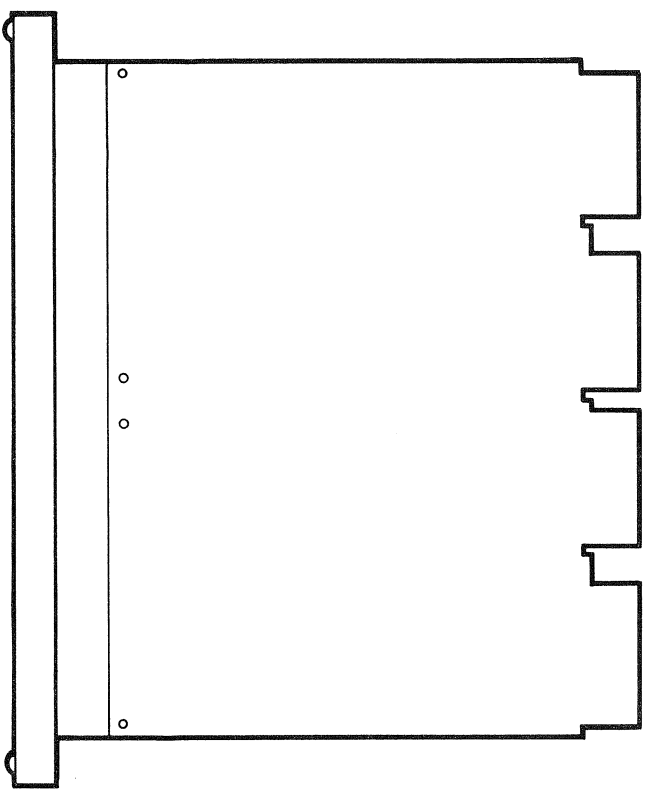
Whether adapting or creating a module, refer to Section B.1 in Appendix B. This appendix contains essential information on grant continuity and the BA200 Series backplane.

2.1 Adapting Modules Without External I/O

This section describes how to adapt existing modules from other computer enclosures for use in the BA200 Series enclosures. It is relatively easy to adapt modules without external I/O from other enclosures.

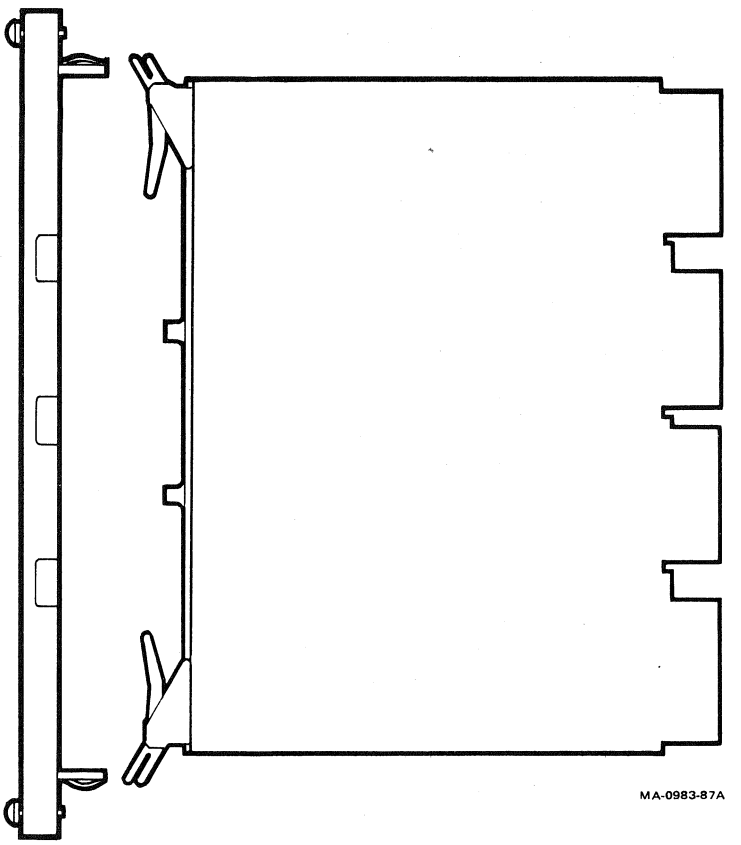
When adapting a non-I/O module for the BA200 Series, a cover or a handle must be used with the module. Using a handle makes installation and removal of the module easier. The non-I/O *quad-height module* must be riveted to a flush handle at four places. Figure 2–1 shows how a module is attached to a flush handle (Kit H3653). (See Chapter 4 for positioning drill holes.)

Figure 2–1: Flush Handle and Module



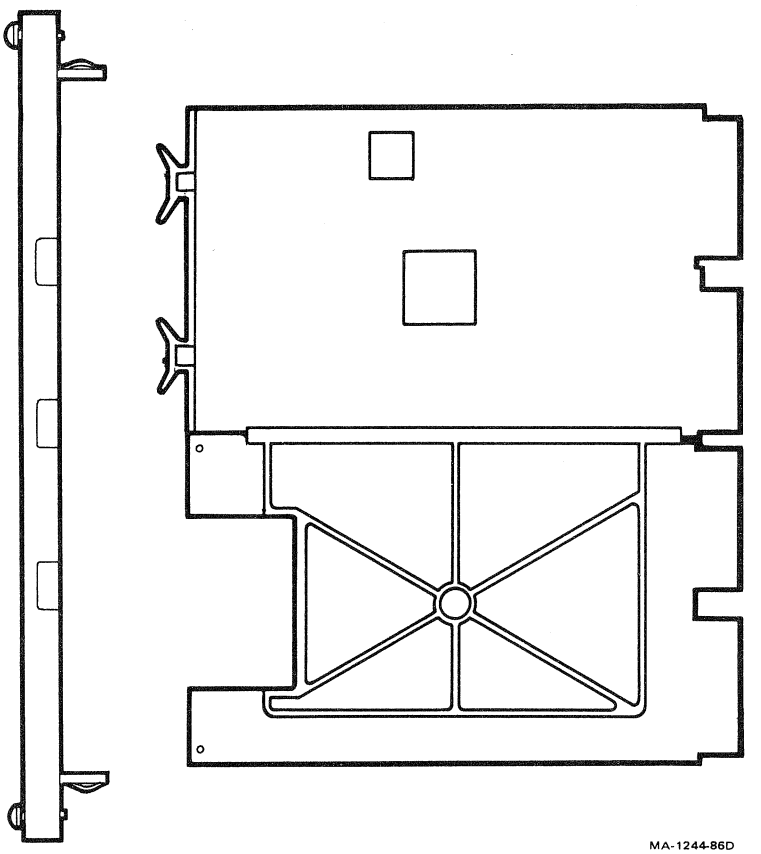
A cover can be used with a non-I/O module. A quad-height module without Q22-bus signals in rows C and D can be installed in the BA200 backplane. The slot can be covered with a BA200 Series cover. Figure 2–2 shows how a cover (Kit H3655) and a module are used.

Figure 2–2: Single Cover and Quad-Height Module



A single cover can be used with a *dual-height module* and dual filler panel (Kit H3656). Figure 2–3 shows how to use these components together.

Figure 2–3: Single Cover and Dual-Height Module



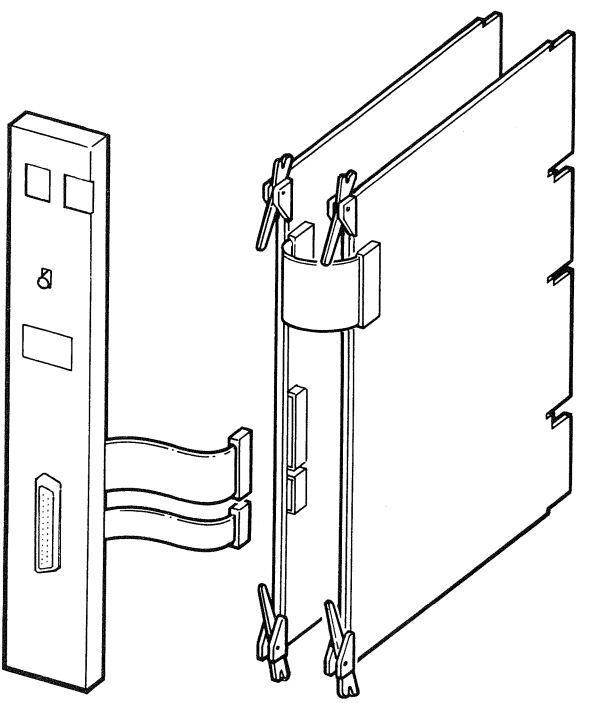
See Chapter 4 for more information on the covers and handles that can be used in the BA200 Series microsystem enclosures.

2.2 Adapting Modules With External I/O, LEDs, or Switches

Adapting a module with external I/O involves many of the same considerations as adapting a module without external I/O. However, there are additional issues that must be considered when adapting modules with external I/O. This section deals specifically with these concerns.

When adapting a module with one or more I/O connectors, a BA200 Series cover or a handle can be used. Depending on the module type, either a single cover (Kit H3655) or a double cover (Kit H3654) can be used. When a double cover is used (Kit H3654) with two modules requiring an I/O connector, a connector hole must be drilled in the cover. (See Chapter 3 for information on how to drill bulkheads.) Figure 2–4 shows how the double cover looks after a hole has been drilled.

Figure 2–4: Double Cover and Quad-Height Modules



2.2.1 Recessed Versus Flush Handles

When using a handle, determine whether to use a flush handle (Kit H3653) or a recessed handle (Kit H3652). The use of one or the other depends on the kind of I/O connectors the module requires. Connectors on BA200 Series bulkheads must adhere to certain clearances. Depending on whether a bulkhead is flush or recessed, its connectors and switches must fall within the clearances shown in Figure 2–5.

An existing module must be adapted with these clearances in mind. External cabling must not exceed 1.57 inches in depth (4.00 cm) on a flush handle or 2.6 inches (6.5 cm) in depth on a recessed handle. External cabling must be kept within these limits.

If the module requires a bulky external cable and connector, a recessed handle must be used to provide the necessary clearance. The recessed handle reduces the space between the connector on the module and the connector on the handle.

Figure 2–5 also shows the maximum clearances between a module and a cover. If circuitry or a connector is required on a cover, it **must not** exceed these clearances.

Figure 2–5: Clearances For BA200 Series Bulkheads

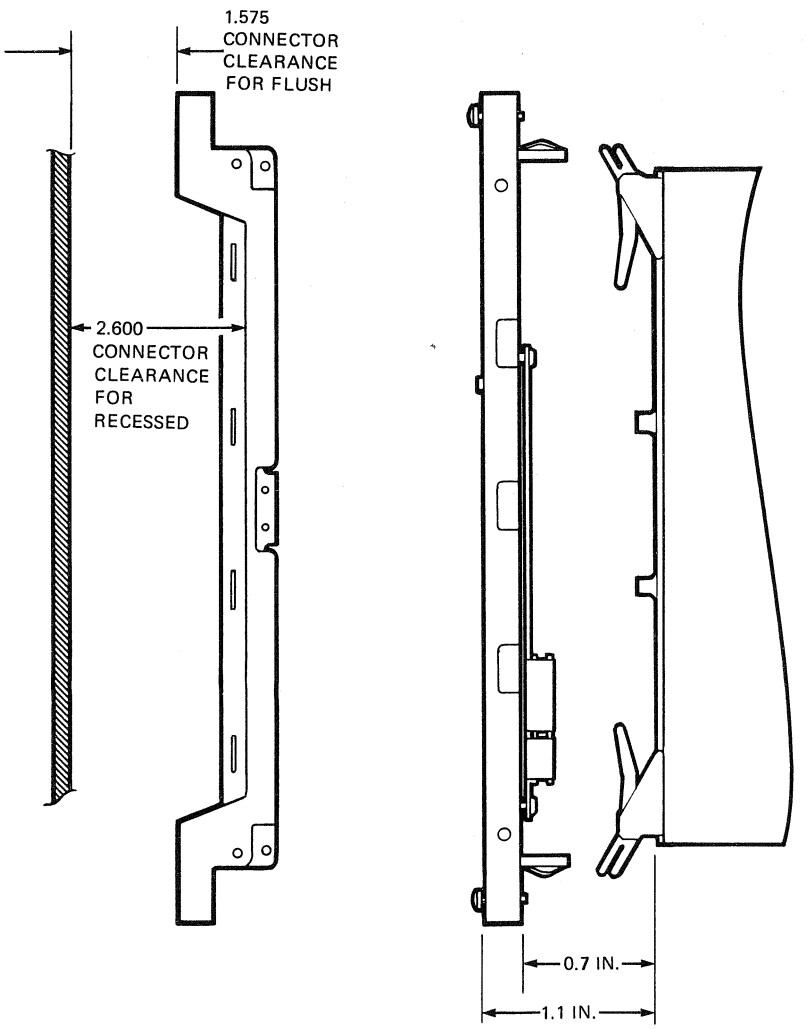
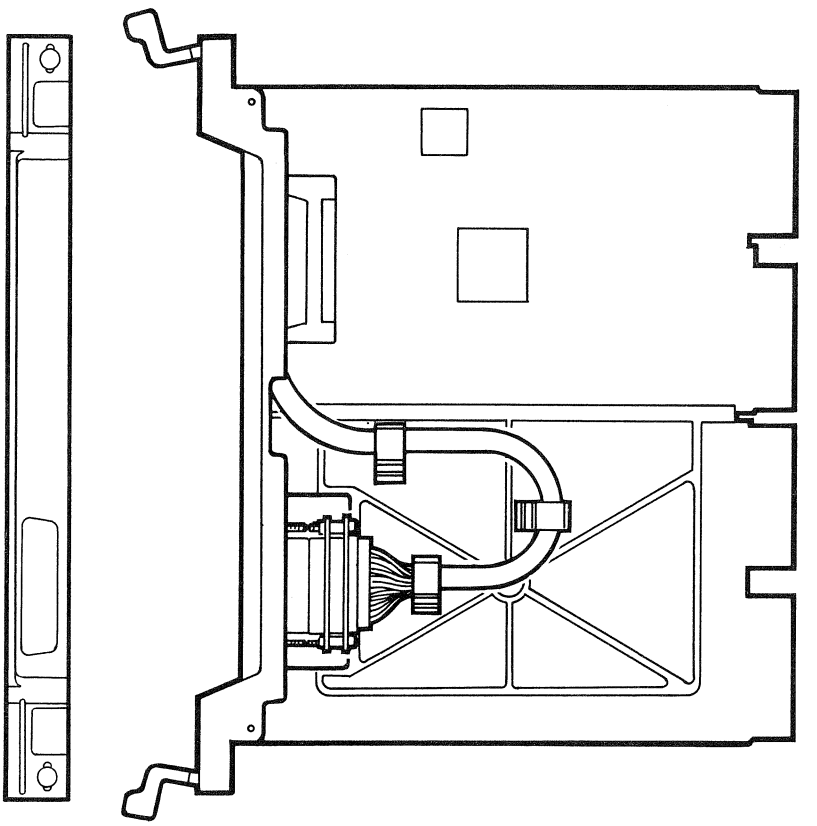


Figure 2-6 shows one way of making a module with a recessed handle easier to manufacture and maintain. When long internal cables are needed, use Ultra-Flex type cables instead of ribbon cables. Ultra-Flex cables do not interfere with air-flow inside the enclosure. Ultra-Flex is also more rugged and withstands more scratching from adjacent modules.

Figure 2-6: Recessed Handle



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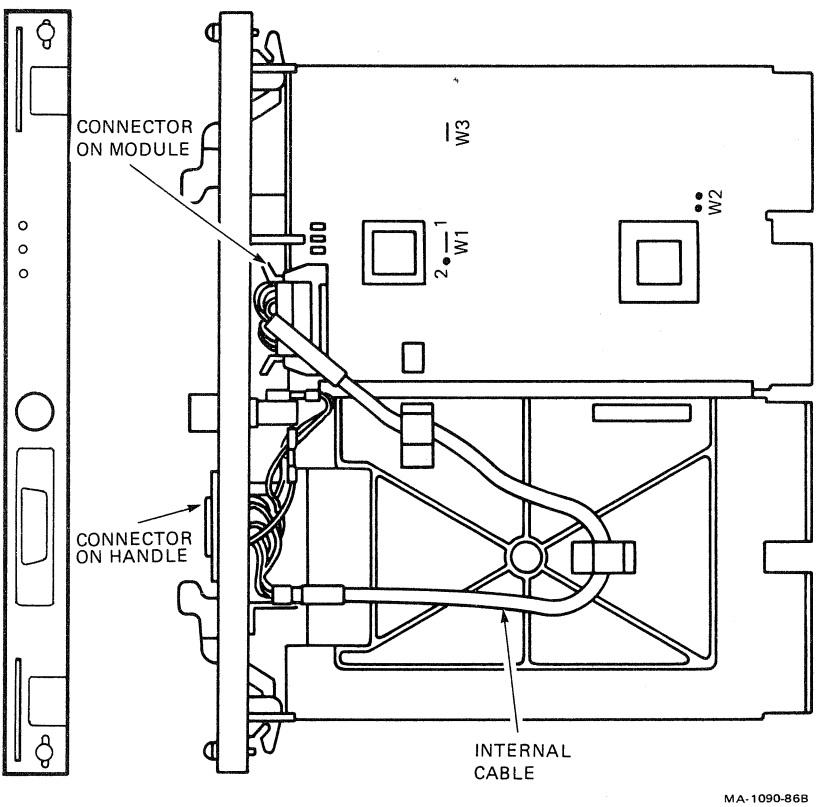
A flush handle allows enough clearance for attaching the internal cable from the module I/O connector to the bulkhead I/O connector. This allows easy manufacturing and maintenance. The use of a flush bulkhead, however, limits the clearance for external cabling to 1.57 inches (4.00 cm). This type of bulkhead should be used only for modules that need small or lower profile external I/O cables. Figure 2-7 shows how a flush handle is used with a small external cable.

Figure 2-7: Flush Handle



2.3 Designing New Modules

This section is helpful in designing a new module or creating a new layout for an existing module. This section is also helpful in modifying the layout of a module with external I/O.

As described in Chapter 1, the design strategy for the BA200 Series enclosures relies on containment of radiations and emissions rather than overall shielding with a Faraday shield. The recommended design strategy also depends on reducing or eliminating radiations and emissions. Table 2–1 lists and describes the kinds of noise that an effective design will reduce or eliminate.

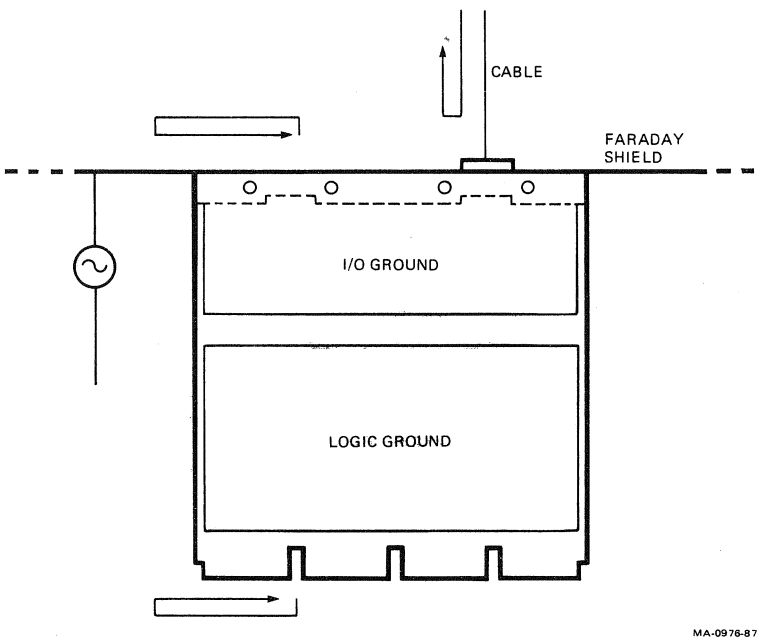
Table 2–1: Sources of Noise

Noise Source	Description
Power supply noise	This appears in the supply voltage/ground and may get propagated to the I/O lines via the driver or receiver. The solution is to decouple the driver/receiver power input to the low impedance path to the ground plane.
Signal rise time	This can be a noise source if the signals are fast enough. The solution is to control the slew rate of an integrated circuit to an acceptable value.
Antenna effect	This is the noise picked up by the etch runs from the driver and receiver to the I/O connector. The solution is to keep these etch runs short.
Common mode noise	This is caused by signal reference/return being something other than a perfectly low impedance to the chassis. This causes high frequency noise that appears in the communication driver and receiver lines. The solution is to tie the reference/return of the driver and receiver to a low impedance plane that is also tied by a low impedance path to the chassis.

2.3.1 Reducing EMI Generation

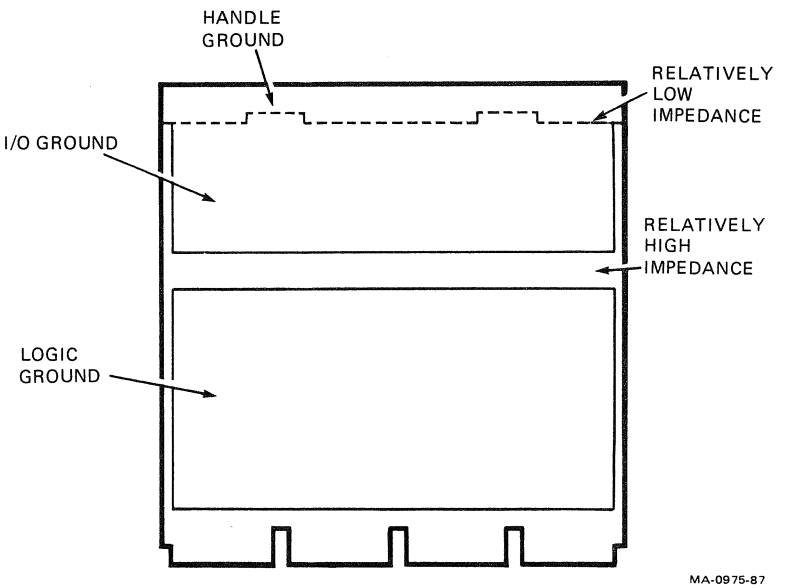
One of the goals of BA200 Series module design is to reduce EMI. One way of achieving this is to isolate the current sources. To isolate the current sources, the electrical current paths within the enclosure need to be understood. Figure 2-8 shows three current paths within the enclosure: (1) the current that passes along the I/O cable; (2) the current flow through the module logic board; (3) the current flow through the electrical shield. The recommended strategy for reducing EMI within the card cage is to isolate the sources of current from one another.

Figure 2-8: Current Paths Within a BA200 Series Enclosure



The logic and I/O grounds must be isolated from each other before the sources of current can be isolated. Leave a high impedance path between the logic and I/O grounds to isolate the grounds. Also, leave a low impedance path between the I/O ground and the handle ground. Figure 2–9 shows where the etches on a module should be placed. Note where paths of high and low impedance are located.

Figure 2–9: Etch Grounding of a BA200 Module



There are additional strategies that isolate the sources of current in a BA200 Series enclosure. The following guidelines should be observed when laying out a module:

- Do **not** use a solder mask for the ground etch along the handle on *Side 2*. When a mask is not used, increased contact area with the handle is provided to ensure the lowest impedance path between I/O and chassis ground.
- Do **not** use a solder mask on *Side 1* around the connector mounting area. When a mask is not used, increased contact area is provided to form the lowest impedance path.
- Use any unused area between the module and the bulkhead handle as a ground etch. Make multiple *feedthrough holes* between Side 1, Side 2 and the inner layer chassis ground plane.
- Place decoupling capacitors for the drivers, receivers, and protection devices between the handle ground strip and the power pins.
- Try to keep the I/O etch from extending more than *1.5 inches* from the transceiver chip to the I/O connectors. Do **not** extend the I/O etch more than 3 inches from the transceiver chip. This ensures that I/O is isolated from logic circuitry.
- Do not run the etch from the I/O area to the logic area except in order to utilize the transceiver circuits.
- Do not run high frequency lines across the area on the ground.
- If a module is being debugged with an extender module, provide a method for the I/O ground to connect to the logic ground.

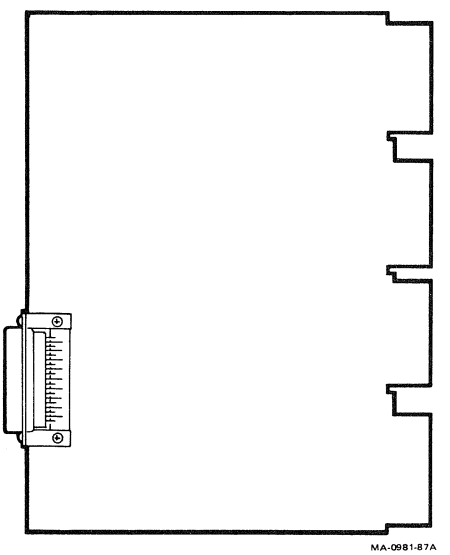
2.3.2 Choosing and Placing I/O Connectors

As emphasized in Chapter 1, a module should be designed to minimize EMI as much as possible. The type and location of I/O connectors helps reduce the amount of EMI produced in the module.

2.3.2.1 Preferred Interconnect Design

To further reduce EMI, select I/O connectors that reduce or eliminate internal cabling. *Right angle* printed circuit board (PCB) mount-type connectors do not require internal cabling. Figure 2–10 shows a right angle connector located on a module.

Figure 2–10: Right Angle Connector on Module



A right angle PCB mount-type connector reduces noise reception and transmission by reducing the length of etch runs and internal cables. In addition, this type of connector increases reliability because it is attached directly to the bulkhead.

2.3.3 Filters

BA200 Series modules that are properly laid out and referenced may not require a filtered connector. However, the drivers and receivers may require a filter for *electrostatic discharge (ESD)*. The use of a filtered connector is recommended in older designs.

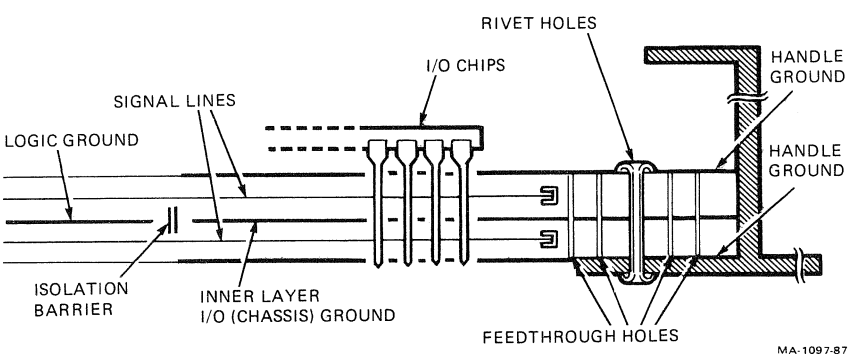
A filtered connector helps reduce the effects of ESD and helps form the shield for keeping internally generated noise in the enclosure and externally generated noise out. Typically, a filter with one feedthrough capacitor per line is sufficient. In addition, make sure that all I/O connectors, LEDs, and switches are close enough to the I/O etch.

2.3.4 Design Example

Figure 2–11 shows a module that was planned using the guidelines in this section. It shows a design that isolates the different sources of current in the enclosure.

- All I/O chips and protection devices reference the I/O (transceiver) ground.
- Logic ground is separated from the I/O (transceiver) ground.
- The module I/O connector, handle ground, and I/O ground are all connected to the handle. The large area of etch overlapped by the handle provides a low impedance path to I/O ground.

Figure 2–11: Cross Section of Handle



Chapter 3
Attaching Connectors, LEDs and Switches to Modules

Chapter 2 showed how to modify or create a module for the BA200 Series enclosures. Chapter 4 describes the Bulkhead Product Kits that are available for BA200 Series modules. This chapter shows how to use the kits with modules that are modified or created for the BA200 Series enclosures.

This chapter also continues the discussion presented in Chapter 1 on the BA200 Series twofold design strategy - (1) *containing noise* within the enclosure, and (2) reducing EMI as much as possible. The material presented in this chapter is consistent with these goals.

The use of the Bulkhead Product Kits differs for modules with and without external I/O connectors. For example, it is relatively easy to use a single cover (H3655) to cover an empty slot or a module without external I/O. Preparing a bulkhead for a module with an I/O connector, a LED or a switch requires more planning. Selecting and preparing a bulkhead for an entirely new module requires even more planning.

This chapter is divided into two sections.

- Modules Without External I/O
- Modules With External I/O, LEDs, or Switches

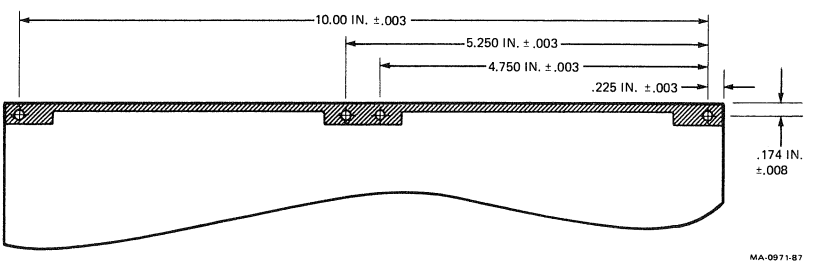
3.1 Modules Without External I/O

A module without external I/O does not require a pre-cut bulkhead. A cover or a handle can be used on a module without external I/O. If the module has a LED or switch, then the bulkhead that is used must be drilled. Section 3.3 explains how to drill a bulkhead. If the module does not require a drilled bulkhead, then a bulkhead from one of the kits can be used without modifications.

The physical dimensions of a module designed for the BA200 Series are identical to the quad-height module used in the standard Q22-bus card cage. If a single cover (H3655) or a double cover (H3654) is used, the module does not have to be drilled. If a handle is used, the module must have four eyelets for its mounting. Punch these with an eyelet machine at proper line pressure.

Figure 3–1 shows the dimensions of a module and rivet holes. It also shows where to drill the holes. Each of the rivet holes must be .142 +.000/-.005 inches in diameter.

Figure 3–1: Module Dimensions



3.2 Modules With External I/O, LEDs or Switches

There are basically two approaches for mounting connectors on bulkheads. The Bulkhead Assembly Kit (H3651) provides a pre-cut recessed handle and several adapter plates for different kinds of connectors. Using the Bulkhead Assembly Kit eliminates the need for drilling holes for several classes of connectors. The other approach requires that one of the other bulkheads (H3652 - H3655) be cut out for an I/O connector.

3.2.1 Using the H3651 Bulkhead Product Kit

This section describes how to use the Bulkhead Assembly Kit on a BA200 Series module. It shows how to mount adapter plates onto the pre-cut recessed handle that is supplied in the Bulkhead Assembly Kit (H3651). Table 3–1 lists the five kinds of plates that can be mounted on the pre-cut recessed handle supplied in the Bulkhead Assembly Kit.

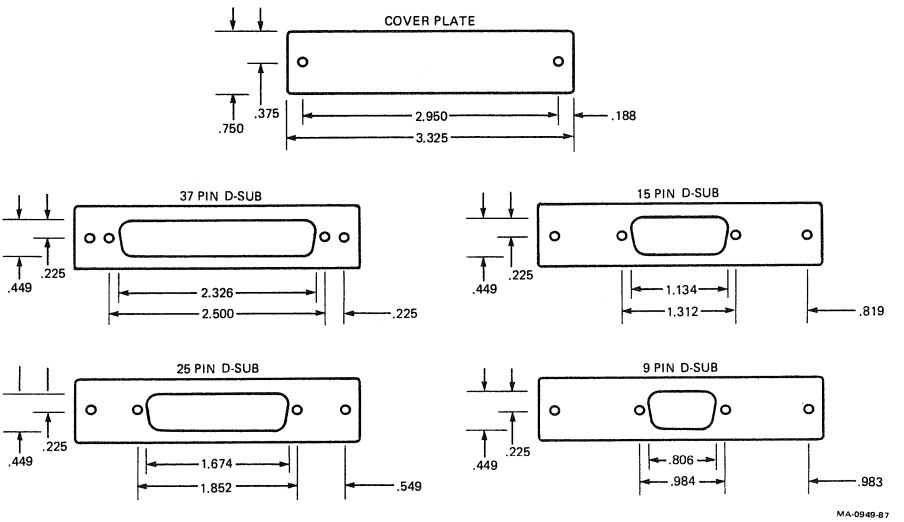
Table 3–1: Adapter Plates for the BA200 Series

Plate	Purpose
9-pin connector	Use for a 9-pin D-sub connector.
15-pin connector	Use for a 15-pin D-sub connector.
25-pin connector	Use for a 25-pin D-sub connector.
37-pin connector	Use for a 37-pin D-sub connector.
Cover	Use to cover an empty hole in the handle.

Without an adapter plate, a 50-pin IEEE connector can be used on the recessed handle.

Figure 3–2 shows the adapter plates that are included in the Bulkhead Assembly Kit (H3651).

Figure 3–2: Adapter Plates in Bulkhead Assembly Kit



3.2.1.1 Mounting Connectors

Mount the adapter plate that the I/O connector requires. Each adapter plate in the kit has screw holes that line up with holes on the recessed handle. To reduce EMI, the module I/O connectors should be located at their proper positions on the module. The following illustrations show how the different adapter plates are mounted on the recessed handle, and where the module I/O connectors should be placed on the module. Connectors of different sizes can be placed on the same module. The illustrations also show where holes for mounting right angle connectors need to be drilled on the module.

Figure 3–3 shows two 9-pin adapter plates mounted on a recessed handle. Adapter plates like these two help contain the electronic noise that is generated inside the enclosure.

Figure 3–3: Recessed Handle With Adapter Plates

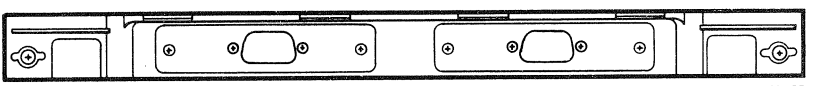


Figure 3–4 shows where to drill holes on a module with two 9-pin connectors. (Use the same dimensions and one of the locations if only one 9-pin connector is needed, or if a 9-pin connector and another connector described in this section are needed.)

Figure 3–4: Dimensions and Locations of 9-Pin Connector Holes

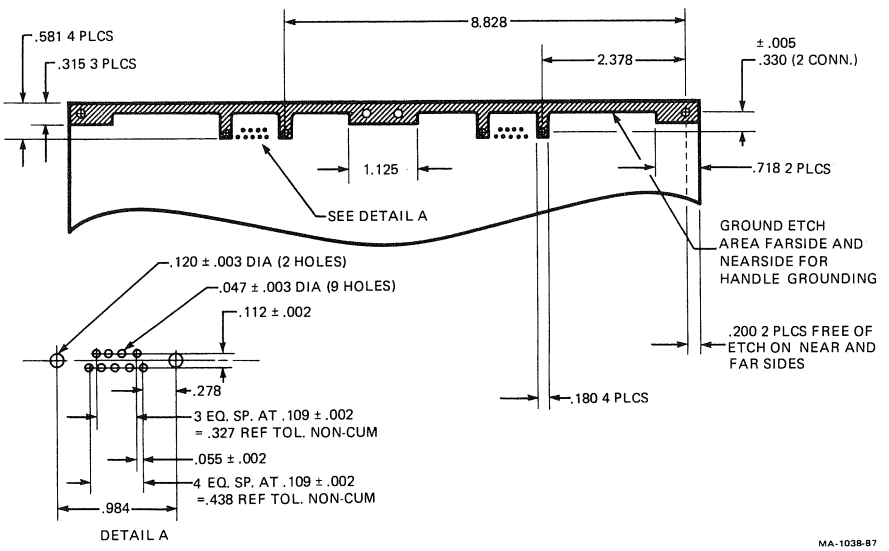


Figure 3–5 shows a recessed bulkhead with two 15-pin adapter plates attached to it. Figure 3–5 also shows the dimensions and locations of the holes that must be drilled on the module.

Figure 3–5: 15-Pin Adapter Plates and Holes

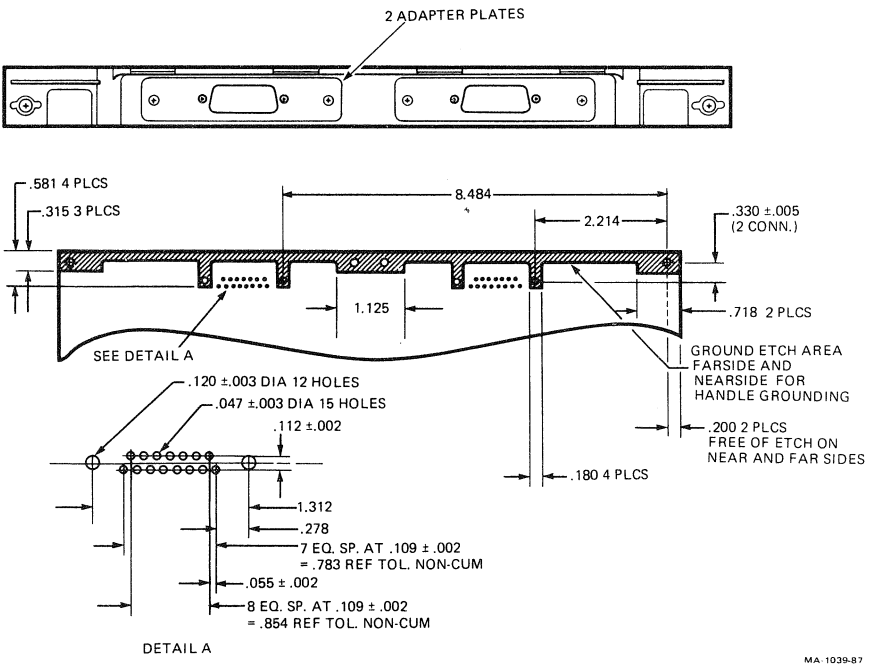


Figure 3–6 shows where to drill holes for modules requiring two 25-pin connnectors.

Figure 3–6: 25-Pin Adapter Plates and Holes

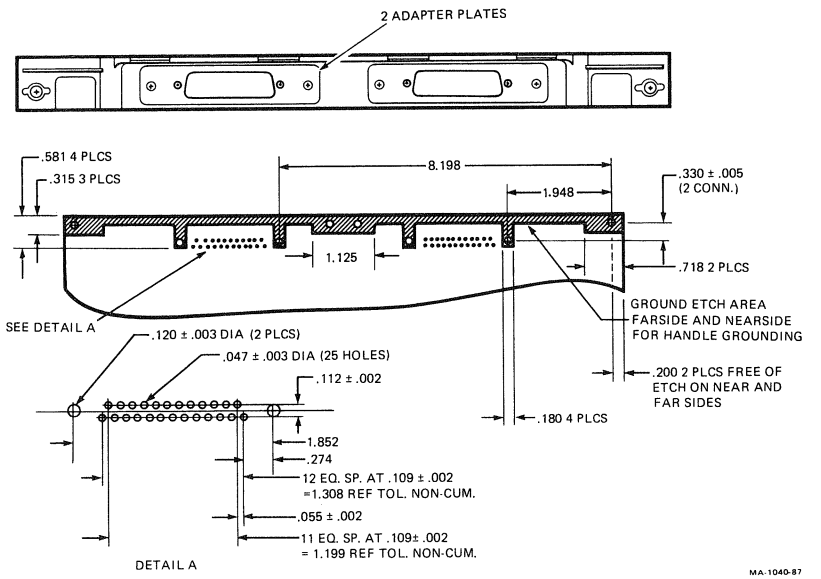


Figure 3–7 shows a recessed handle that has two 37-pin adapter plates mounted on it. It also shows where to drill pin holes for the two 37-pin connectors.

Figure 3–7: 37-Pin Adapter Plates and Holes

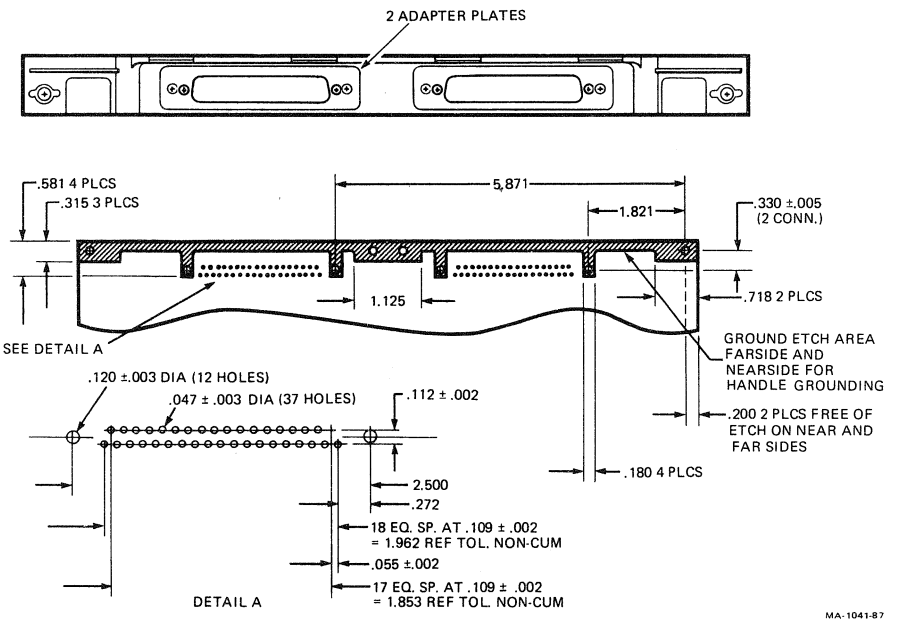
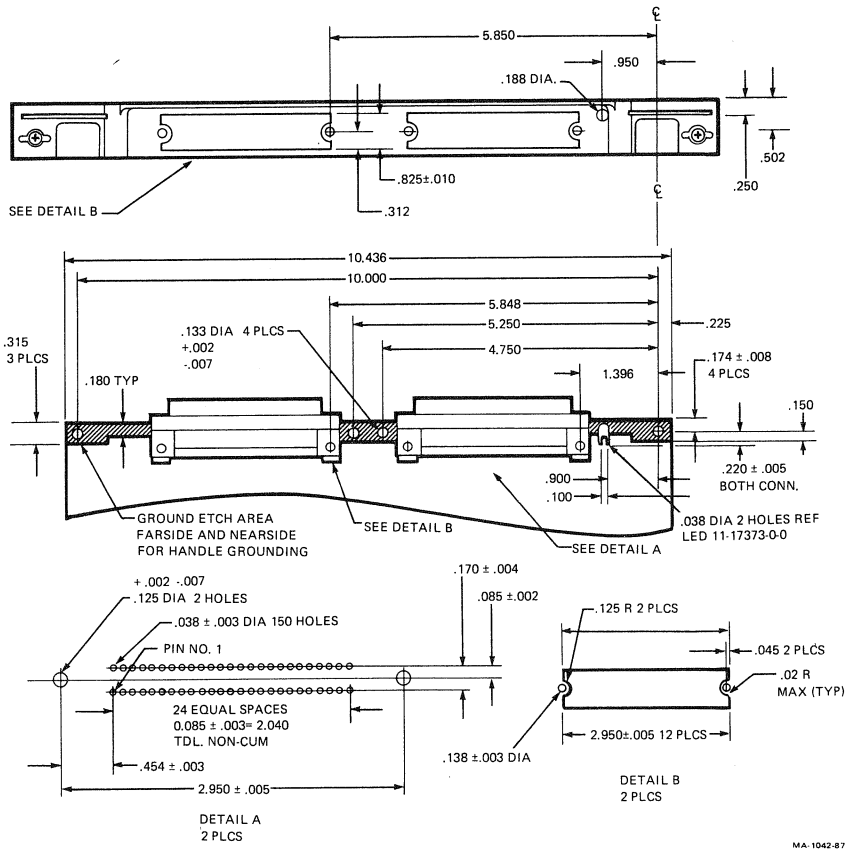


Figure 3–8 shows where to drill holes for two 50-pin connectors.

Figure 3–8: Holes for Two 50-Pin Connectors



3.2.2 Using Other Bulkhead Product Kits (H3652 - H3655)

The use of connectors other than those discussed in the previous section requires cutting holes in the bulkhead. This section describes how to drill holes on the bulkhead for connectors, LEDs, and cables. It also discusses any touch-up that is needed to contain noise within the enclosure.

3.2.2.1 Drilling the BA200 Series Bulkheads

As discussed in Chapter 2, holes can be drilled in the BA200 Series bulkheads for I/O connectors, LEDs, and cables. When a BA200 Series bulkhead is drilled, use any standard drilling or punching machine. (The bulkheads are made of a zinc/aluminum alloy and may require cutting oils on their surface.)

Because a bulkhead my be scratched or nicked during drilling, protect the surfaces during rework with a masking tape, such as 3-M 209 or 213 tapes that are supplied by 3-M Industrial Tape Division. Apply the tape just prior to rework. Marks for dimensions of any holes can be made on the tape. Remove the tape after rework.

3.2.2.2 Cleaning the Bulkheads

After drilling or cutting out a bulkhead, remove any cutting oils that may have been used for the rework. Use a solvent, such as alcohol, that will not destroy the plating. Wipe the surfaces with care because the chromate conversion coating on the plated surface has very little abrasion resistance. Do **not** wipe the surface of the plating with any **abrasive** material.

3.2.2.3 Retouching the Bulkheads

A bulkhead may need touch-up before it can be used in a BA200 Series enclosure. Some damage to plated surfaces can result from poor handling practices. This damage is most often cosmetic, in the form of scratches. Because of its finish, it is unlikely that the surface can be repaired to its original form.

After a bulkhead is drilled, the side walls of the holes or cutouts are unplated. The unplated sidewalls do not present a functional problem because the cutout will be loaded with a connector or switch. The side walls should not be used to make a shield contact.

Although no touch-up is required, a touch-up paint such as Krylon Silver can be used. Using a Q-Tip, apply the paint to the side walls of the cutouts. The paint is a good electrical insulator. Be careful not to paint the surfaces around the cutout. Paint on the surfaces around the cutout would interfere with contact with the installed connector. The plating on all the bulkheads is zinc with a "blue bright" zinc chromate. Use this plating if any rework is necessary.

3.3 Additional Considerations

This section describes labeling and installation considerations.

3.3.1 Labeling the Bulkheads

Each single bulkhead has two indented areas, one near its top and the other near its bottom. A double cover has four indented areas, two near its top and two near its bottom. In both cases, the area at the top is reserved for the module name. The area at the bottom is reserved for the revision number. After a module is designed or modified, label it for future reference.

To create labels like those used by Digital, the materials described in Table 3–2 are required.

Table 3–2: Materials Required for Bulkhead Labels

Material	Type
Base	2 mil computer imprintable polyester, 3M-7880, Flexcon PM-200-W MT/C.
Adhesive	1 mil permanent pressure sensitive acrylic.
Liner	Easy release liner.

The label should be black on a white background. Table 3–3 shows the established design format for bulkhead labels.

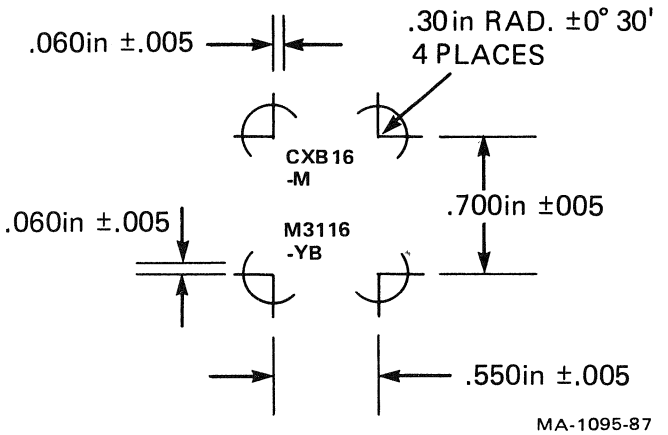
Table 3–3: Design Format for Bulkhead Labels

Row	Information	Example[1]
1	Option number	CXB16
2	Option variation	-M
3	Module number	M3116
4	Module variation	-YB

[1]Examples in this table refer to Figure 3-9.

Figure 3–9 shows the dimensions of a bulkhead label. Note that the information on the label appears on the rows shown in Table 3–3.

Figure 3–9: Dimensions of a Bulkhead Label

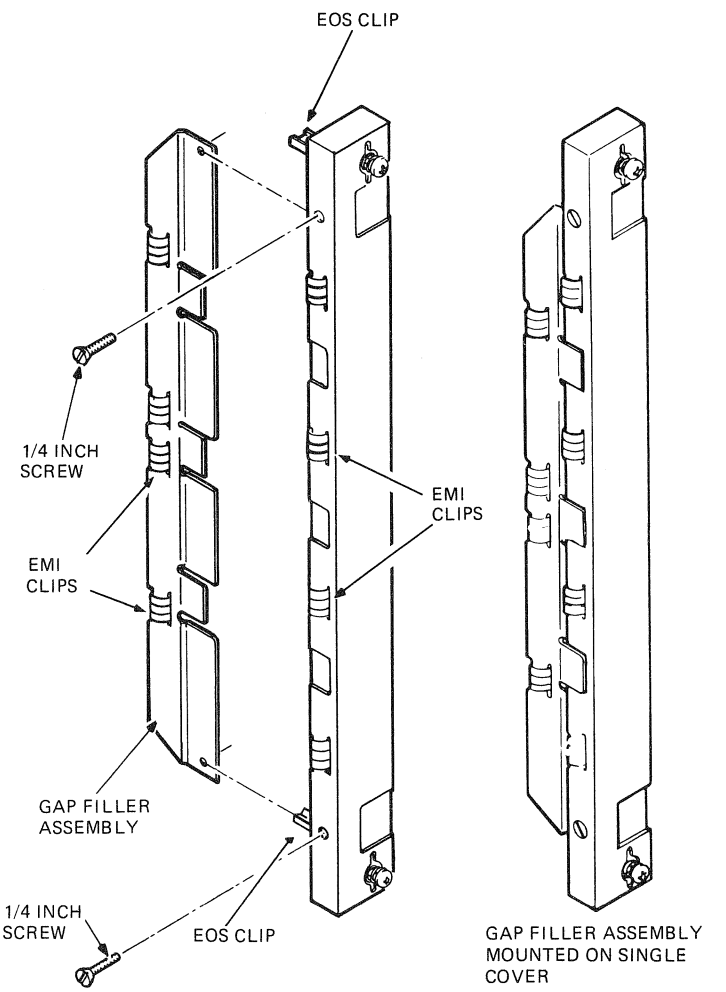


3.3.2 When To Use a Gap Filler

When installing a flush handle or cover to the left of a recessed handle, a gap filler (Kit 3657) must be attached to the flush handle to help contain EMI. Without the gap filler, circuitry on the recessed handle module is exposed. The gap filler (Kit 3657) has four sets of finger stock that provide an effective chassis ground between the handles. Attaching the gap filler is relatively easy. Flush handles and covers have screw holes at the top and bottom of each side for the installation of the gap filler. Figure 3–10 shows how the screw holes line up between the gap filler and a flush handle.

A gap filler must also be attached to a cover on either side of a recessed handle. Figure 3–10 shows how a gap filler is mounted on a cover.

Figure 3–10: Gap Filler and Flush Cover



3.3.3 Before Installing a Module

To help comply with EMI regulations, bulkheads are equipped with transient protection EOS and EMI clips. These clips provide ground through the module bulkhead. Before installing a module, perform the following procedure to help guarantee that the clips are in good condition:

1. Ensure that there is no residue or corrosion on the EOS and EMI clips located on the module bulkhead. If there is residue, remove it with isopropyl alcohol or other approved mild cleaners. Also, ensure that the EOS and EMI clips on the gap filler assembly are free of residue and corrosion.

2. Ensure that the EOS and EMI clips on the bulkhead are in an arch shape. When depressed slightly, they should return to their original shape.

3. If any clip is missing, broken, distorted or corroded, replace it with EOS clip P/N 12-26922-01 or EMI clip P/N 12-26340-01.

3.3.4 When To Use a Grant Card

As stated in Section 2.1, the backplane on BA200 Series enclosures has a Q22-bus on AB slots only. When designing a quad-height module, make sure that all Q22-bus signals are on AB fingers of the board. If there is an empty slot between the slots that are used, insert a *grant card (M9047)* into the slot. A grant card assures signal continuity in the backplane.

Chapter 4
Product Kits

This chapter provides descriptions of the different BA200 Series Bulkhead Product Kits available from Digital. (None of these kits provide the hardware or tools necessary for riveting modules, or for drilling or plating bulkheads.)

Digital sells the following Bulkhead Product Kits:

- H3650 - Bulkhead Evaluation Kit
- H3651 - Bulkhead Assembly Kit
- H3652 - Recessed Handle
- H3653 - Flush Handle
- H3654 - Double Cover
- H3655 - Single Cover
- H3656 - Dual Filler Panel
- H3657 - Gap Filler Kit

Before beginning to assemble any of the kits, identify each of the parts it contains. If a part is missing, contact your Digital Sales Representative.

4.1 H3650 - Bulkhead Evaluation Kit

The Bulkhead Evaluation Kit is for individuals who do not know which kind of bulkhead to use with a module. This kit contains each of the other kits that are available from Digital, as Table 4–1 shows. This kit is intended to help engineers determine the Bulkhead Product Kit best suited for their application.

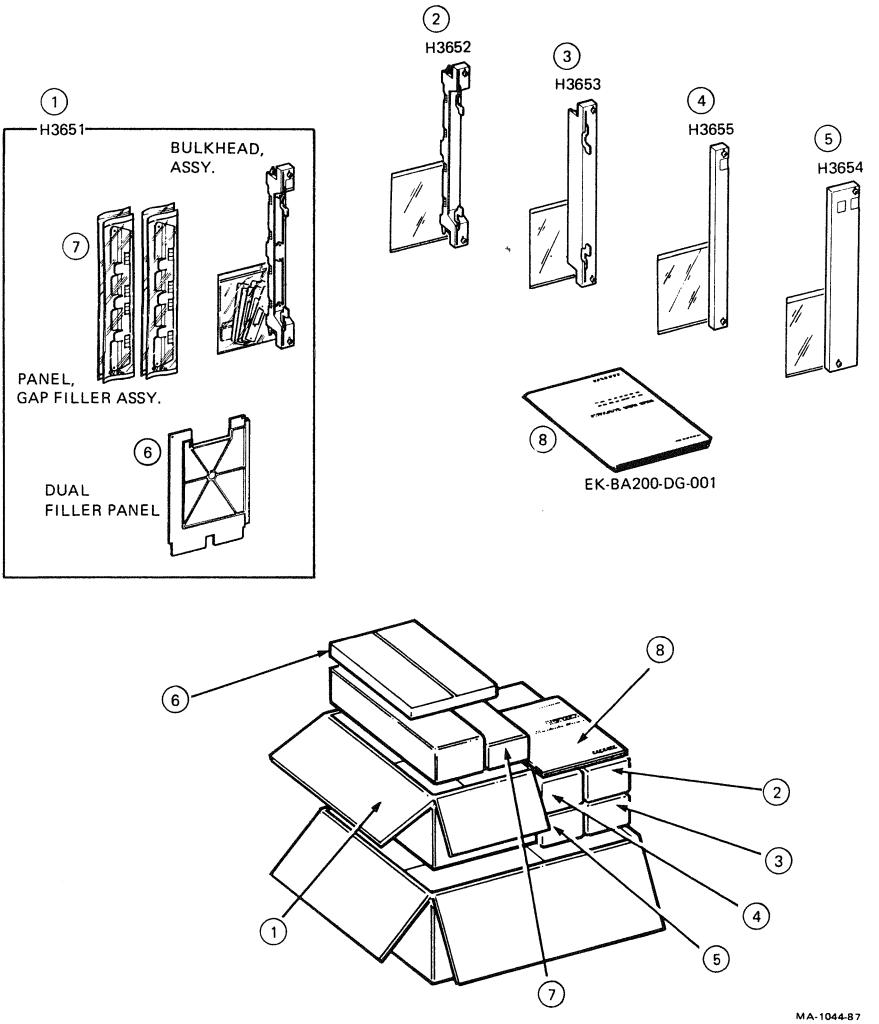
Table 4–1: Bulkhead Evaluation Kit - H3650

Part	Description	Quantity
[1]	H3651 - Bulkhead Assembly Kit	1
[2]	H3652 - Recessed Handle	1
[3]	H3653 - Flush Handle	1
[4]	H3654 - Double Cover	1
[5]	H3655 - Single Cover	1
[6]	H3656 [1]- Dual Filler Panel	1
[7]	H3657 [1]- Gap Filler Kit	1
[8]	BA200 Series Module Design Guide (EK-BA200-DG)	1

[1]These kits are not included separately in the H3650. They are included in the H3651.

Figure 4–1 shows the different components of the Bulkhead Evaluation Kit.

Figure 4–1: Contents of Bulkhead Evaluation Kit (H3650)



4.2 H3651 - Bulkhead Assembly Kit

The Bulkhead Assembly Kit contains a recessed handle that is plated and pre-cut with holes that accommodate two standard 50-pin connectors.

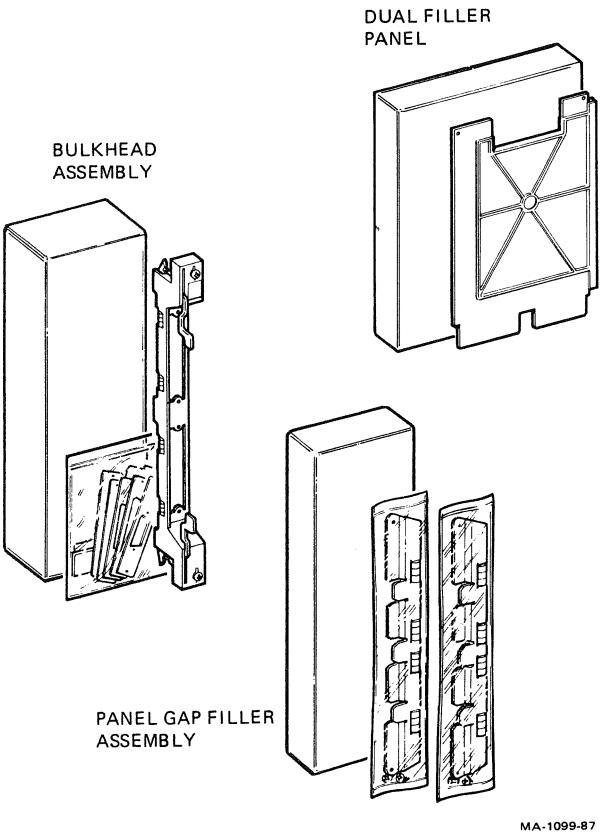
The kit also includes adapter plates for standard 9-, 15-, 25-, and 37-pin D-sub connectors. If only one connector is to be used, the kit has a cover plate for the remaining hole. The kit also contains a gap filler (H3657), and a dual filler panel (H3656), if they are needed. Table 4–2 lists the contents of the kit.

Table 4–2: Bulkhead Assembly Kit - H3651

Key	Description	Quantity
1	Handle, recessed, pre-cut	1
2	Gap filler assy kit (H3657)	1
3	Dual filler panel (H3656)	1
4	Cover	1
5	Adapter plate, 9-pin connector	2
6	Adapter plate, 15-pin connector	2
7	Adapter plate, 25-pin connector	2
8	Adapter plate, 37-pin connector	2
9	Insulator strip	2
10	Label kit	1
11	Screw pph 4-40 x 0.25	4
12	Nut, 4-40	4
13	Washer, lock internal tooth #4	4

Figure 4–2 shows the contents of the Bulkhead Assembly Kit.

Figure 4–2: Contents of Bulkhead Assembly Kit (H3651)



4.3 H3652-H3655 : Other Bulkhead Product Kits

These kits are designed for individuals who have special I/O needs. The kits contain handles or covers that are already plated and assembled but which have not been drilled.

Unlike the H3651, these kits do not include the dual filler panel (H3656) or the gap filler (H3657). If they are needed, these kits must be ordered separately. (See Section 4.4 and Section 4.5.)

Table 4–3 describes the four basic variations of the bulkheads.

Table 4–3: BA200 Covers and Handles

Contents	Part Number	Description
Recessed Handle	H3652	The handle is riveted to the module. This style is the preferred handle for all BA200 modules with external I/O connectors.
Flush Handle	H3653	Used when a recessed handle would interfere with the module circuitry or I/O connector. The flush handle is also riveted to the module. [1]
Double Cover	H3654	Used to cover two backplane slots. [1]
Single Cover	H3655	Covers one backplane slot. [1]

[1] If this type of cover is installed next to a module with a recessed handle, you must attach a gap filler (H3657) to maintain EMI compliance.

4.3.1 H3652 - Recessed Handle

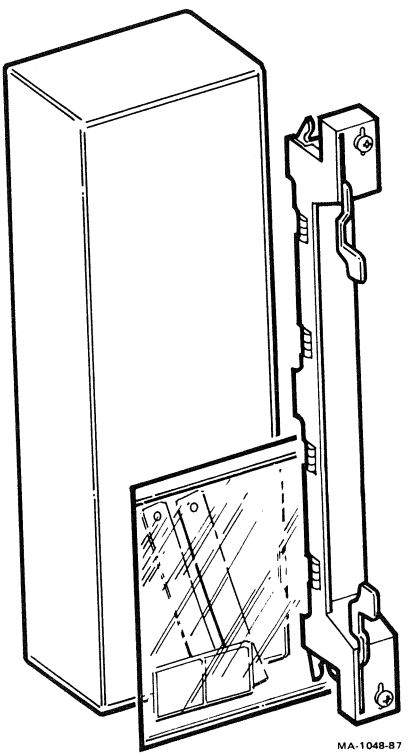
This kit contains a recessed handle. Table 4–4 lists the contents of the H3652 kit.

Table 4–4: Recessed Handle - H3652

Part	Description	Quantity
1	Recessed handle	1
2	Insulator strip	2
2	Label kit	1

Figure 4–3 shows the contents of the kit.

Figure 4–3: Recessed Handle Kit Contents (H3652)



4.3.2 H3653 - Flush Handle

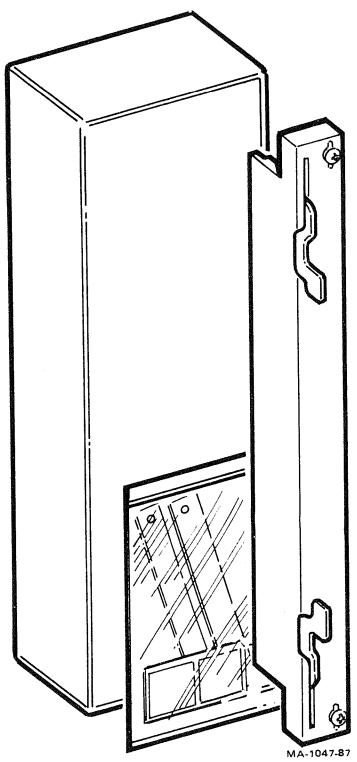
This kit contains a flush handle. Table 4–5 lists the contents of the H3653 kit.

Table 4–5: Flush Handle - H3653

Part	Description	Quantity
1	Flush handle	1
2	Insulator strip	2
3	Label kit	1

Figure 4–4 shows the contents of the kit.

Figure 4–4: Flush Handle Kit Contents (H3653)



4.3.3 H3654 - Double Cover

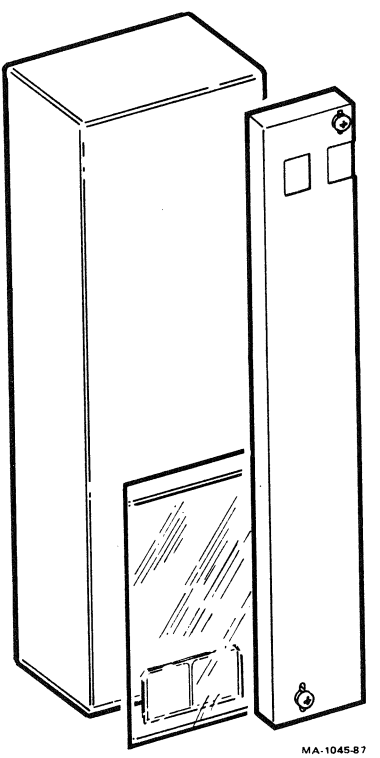
This kit contains a double cover. Table 4–6 lists the contents of the H3654 kit.

Table 4–6: Double Cover - H3654

Part	Description	Quantity
[1]	Double cover	1
[2]	Label kit	2

Figure 4–5 shows the contents of the kit.

Figure 4–5: Double Cover Kit Contents (H3654)



4.3.4 H3655 - Single Cover

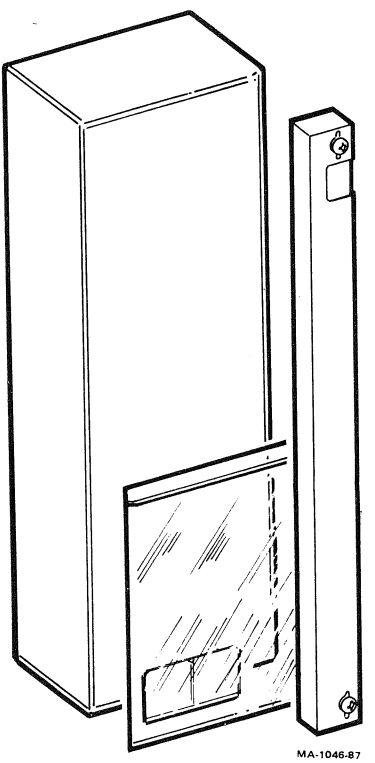
This kit contains a single cover. Table 4–7 lists the contents of the H3655 kit.

Table 4–7: Single Cover - H3655

Part	Description	Quantity
1	Single cover	1
2	Label kit	1

Figure 4–6 shows the contents of the kit.

Figure 4–6: Single Cover Kit Contents (H3655)



4.4 H3656 - Dual Filler Panel

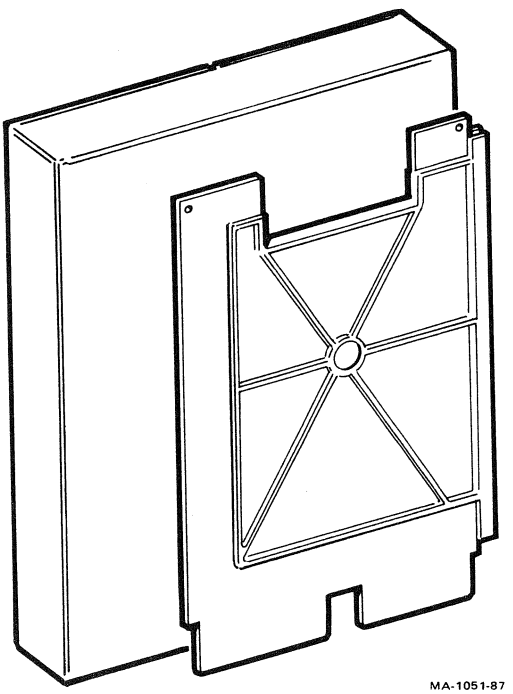
This panel is placed on the backplane for support when using dual-height modules. The panel functions as physical support only, and has no electrical characteristics. A dual filler panel must be used with a dual-height module in order to ensure proper air flow. Table 4–8 lists the contents of the H3656 kit.

Table 4–8: Dual Filler Panel - H3656

Part	Description	Quantity
[1]	Dual filler panel	1

Figure 4–7 shows the contents of the kit.

Figure 4–7: Dual Filler Panel Kit Contents (H3656)



4.5 H3657 - Gap Filler Kit

This kit contains the gap filler assembly. The gap filler is needed when a recessed bulkhead is placed to the right of a flush handle, or on either side of a cover in a BA200 Series enclosure.

The gap filler supplied is plated and ready to be installed. Its use helps the enclosure comply with EMI regulations.

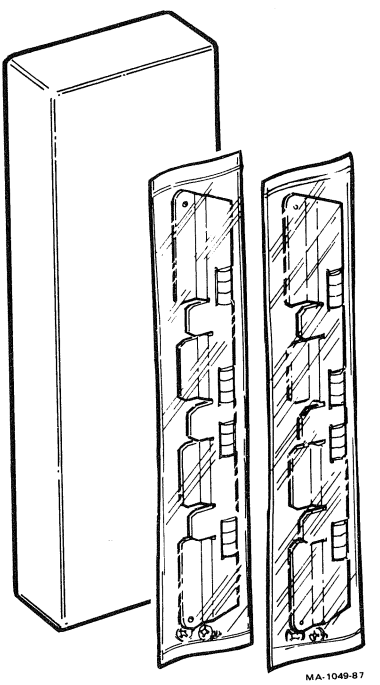
Table 4–9 lists the contents of the H3657 kit.

Table 4–9: Gap Filler Kit - H3657

Part	Description	Quantity
[1]	Gap filler assembly	2

Figure 4–8 shows the contents of the kit.

Figure 4–8: Gap Filler Kit Contents (H3657)



Chapter 5
Using Product Kits

The examples in this chapter explain how to use available product kits in the design of modules for BA200 enclosures. Each example provides a product description that is followed by a suggested approach for solving the module design problems.

5.1 Using Space Behind the Double Cover

This first example shows how to use the space behind the double cover to attach circuitry and save space on the module.

5.1.1 Product Description

The product consists of two quad-height modules connected by a private bus, in this case a ribbon cable from one module to the other. The product communicates to the external world by a serial line. The product also requires a baud rate switch and a two-digit seven segment display that the user or field service can access.

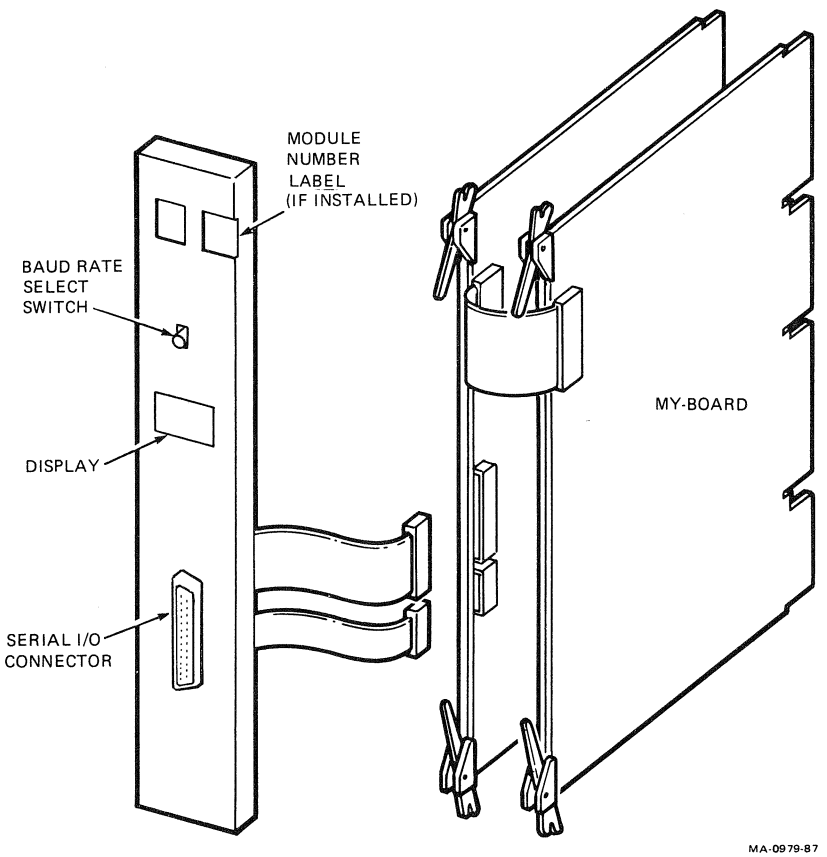
5.1.2 Approach

One approach is to attach the segment display, switch, and serial line connector to a small PCB that gets mounted directly on the bulkhead. Such an approach offers the advantage of placing the drivers close to the display and the transceivers close to the connector, thus reducing noise problems and freeing additional space on the module.

The ideal bulkhead for this approach is a double cover (Kit H3654). The double cover provides space to mount the PCB and eliminates the need for two covers.

A good way to connect the bulkhead circuitry to the modules is to use a small (for example, 4 inch) ribbon cable that is soldered on the bulkhead PCB and is connected to the module by a Berg connector. See Figure 5-1. When the connector type on the module has been set, the modules are ready for layout. Refer to Chapter 2 for information on module layout.

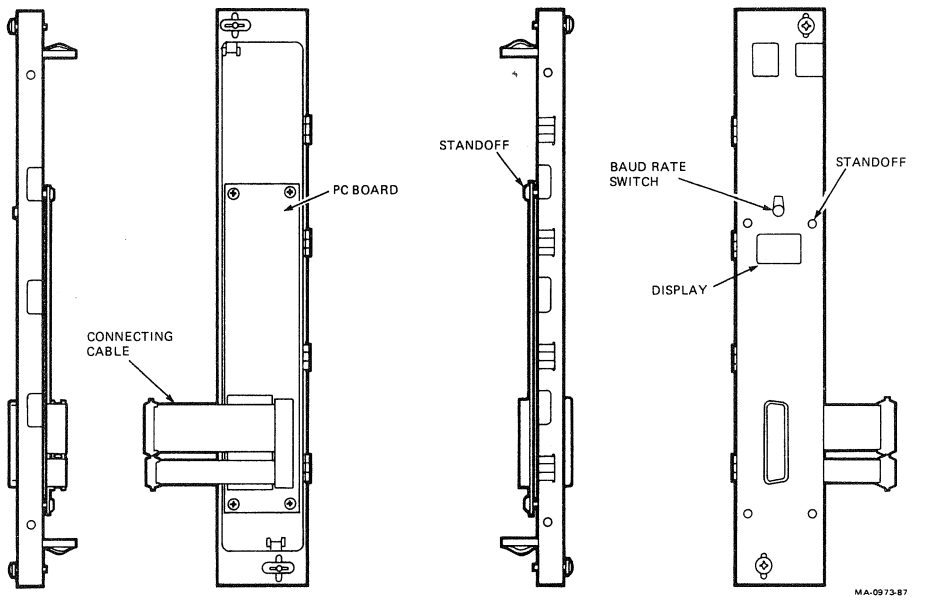
Figure 5-1: Double Cover and Modules



Mount the PCB onto the double cover by using standard drilling and riveting techniques. To do this, drill four holes for the standoffs on the cover, as shown in Figure 5–2. Drill holes for access to the Baud Rate switch, display, and serial connector. See Chapter 3 for information on how to drill holes on the bulkhead.

After drilling, touch up the cover to prevent corrosion (see Chapter 3) and assemble it. Screw the PCB onto the cover.

Figure 5–2: Double Cover and Printed Circuit Board



5.2 Adapting Modules

This second example shows how to adapt a module to a BA200 Series enclosure and save unnecessary cutting and assembling, and touch-up work. For information on adapting existing modules, see Chapter 2.

5.2.1 Product Description

The product consists of a quad-height module with a 37-pin I/O connector.

5.2.2 Approach

The most economic approach is to use the H3651 kit. This kit provides a pre-cut recessed handle. Use a right angle PCB mount 37-pin D-sub connector on the module. Then rivet the module to the handle. Use an adapter plate to insert the connector through the handle. Cover the unused hole in the bulkhead with a cover plate.

Figure 5–3 shows the quad-height module with the right angle 37-pin D-sub connector.

Figure 5–3: Quad-Height Module

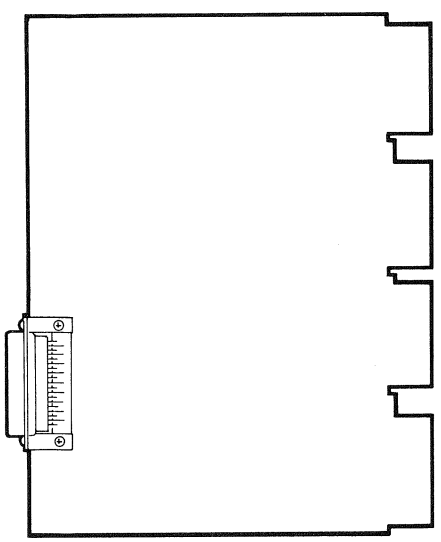
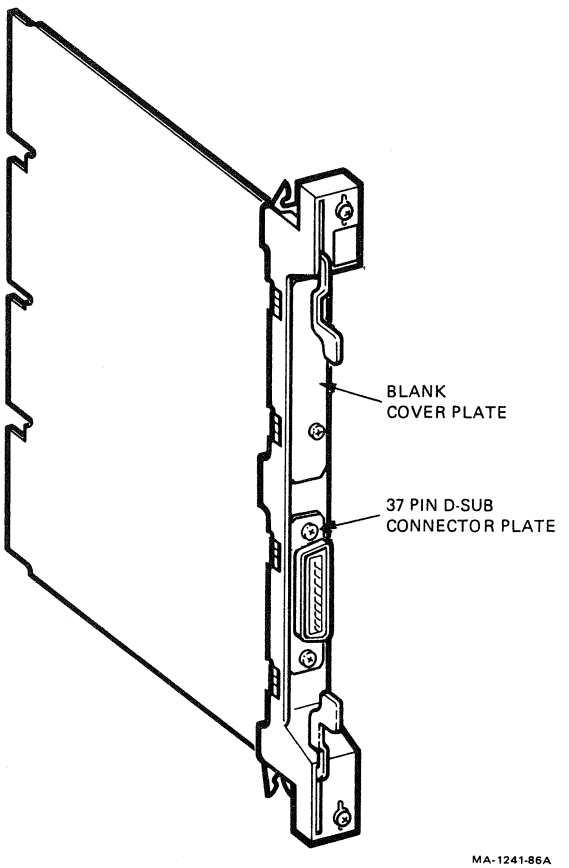


Figure 5-4 shows the recessed handle and quad-height module.

Figure 5-4: Recessed Handle and Quad-Height Module



Rivet the module to the bulkhead so that when it is installed in a BA200 Series enclosure, its fingers fit in the A and B Q22-bus sockets. If the recessed handle is placed to the right of a flush handle, or on either side of a cover, attach a gap filler onto the flush handle or cover. (See Section 4.5.)

5.3 Designing With Non-Standard I/O Connectors, Switches and LEDs

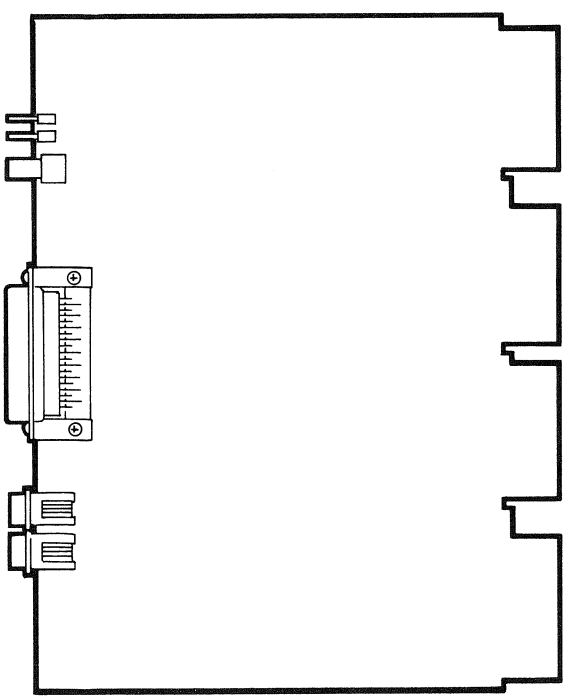
This third example shows how to use a product kit with a module that requires non-standard I/O connectors, switches, and LEDs.

5.3.1 Product Description

The product consists of one quad-height combination communication module with a serial line right angle D-sub connector, two MMJ connectors, one selection switch and two LEDs. Figure 5–5 shows the module.

Note that a right angle D-sub connector was used in the module design. This type of connector is designed to extend through the hole that will be drilled in the handle.

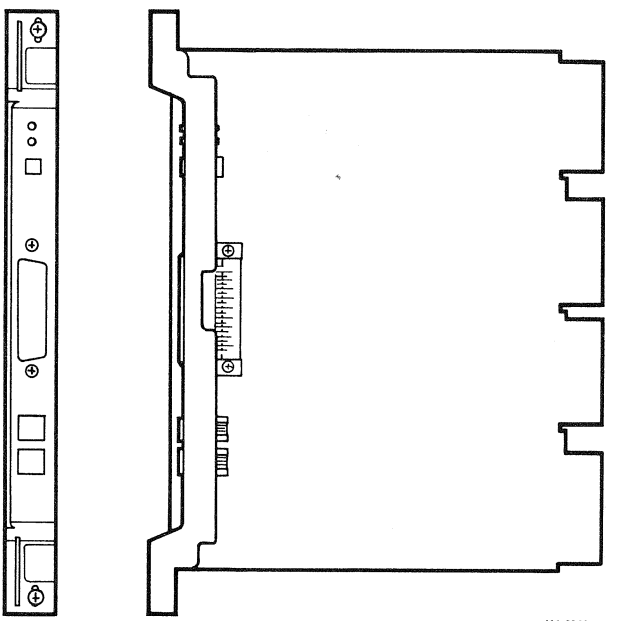
Figure 5–5: Quad-Height Communication Module



5.3.2 Approach

One approach is to use a recessed handle (H3652) because holes can be drilled into this handle to fit the MMJ connectors and because the right angle D-sub connector will extend through the pre-cut connector hole. Figure 5–6 shows the recessed handle after it has been drilled to accommodate the MMJ connectors and the right angle D-sub connector.

Figure 5–6: Handle of Module



In Figure 5–6, note that the LEDs and selection switch are positioned at the top of the board so that the serial and MMJ connector cables do not interfere with access to them. The serial connector is positioned above the MMJ connectors and away from the bottom of the handle because the right angle serial connector cable is very rigid and inflexible at its base. The serial connector would be obstructed by the bottom protrusion of the recessed handle if it were positioned too close to the bottom of the handle.

The module label has been silk-screened onto the handle. See Chapter 3 for more information on labeling modules.

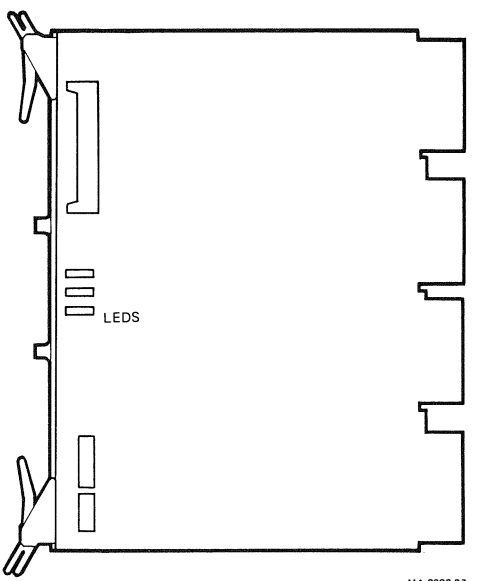
5.4 Adapting a Module With I/O and LEDs

This fourth example shows how to use a product kit to adapt an existing module with I/O and LEDs.

5.4.1 Product Description

The product is a communications module with three LEDs and an I/O ribbon cable connector located at the edge of the module. Figure 5–7 shows the module.

Figure 5–7: Module With Three LEDs, Fuse and Ribbon Cable

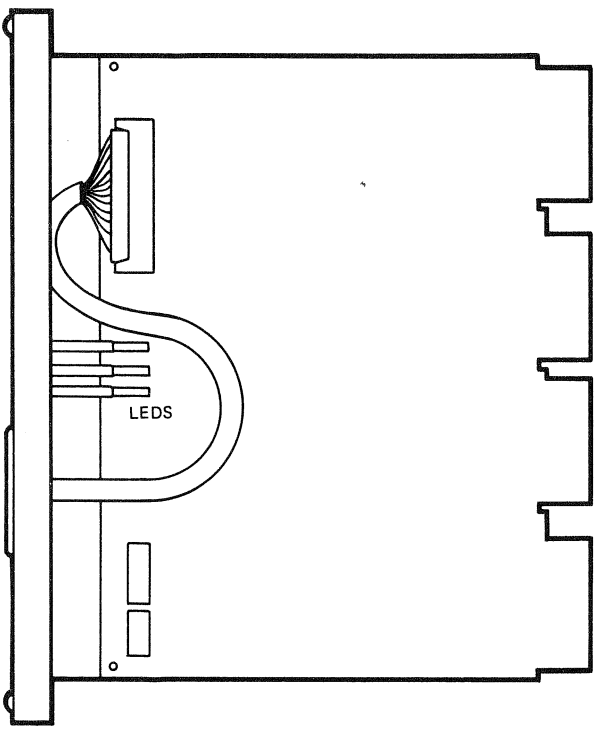


5.4.2 Approach

One approach, in order to avoid re-layout of the module, is to choose a flush handle (H3653), and route an Ultra-Flex cable from the I/O connector on the board to a connector hole on the handle. An Ultra-Flex cable is used to route the cable to the handle because it covers less surface area of the board and allows better air flow. Holes must also be drilled into the handle (H3653) for the LEDs. Note also that the module handle (H3653) must be drilled in order for it to fit on the module.

Since this approach uses a flush handle, there will be some clearance between the handle and the LEDs located on the board. In this case, pipes should be added to the LEDs so that their light can be seen despite the clearance. Figure 5–8 shows the handle.

Figure 5–8: Module Riveted to Handle



5.5 Adapting a Module Without External I/O

This fifth example shows how to adapt a module without external I/O.

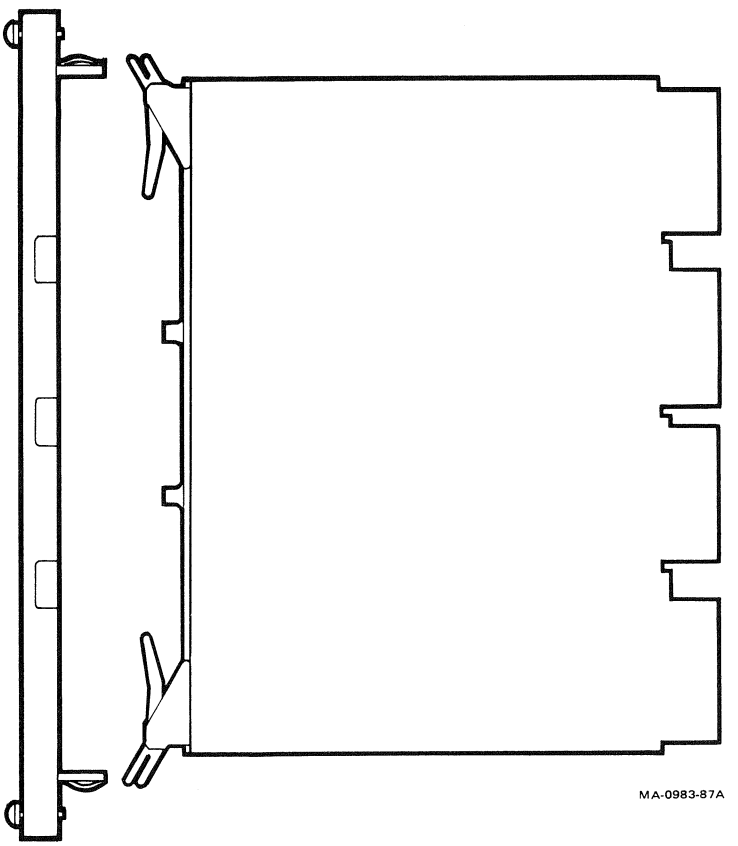
5.5.1 Product Description

The product is an existing memory board without I/O connectors.

5.5.2 Approach

The best approach is to choose a single cover (H3655). Because there are no I/O connectors, it is not necessary to drill holes into this cover. Figure 5–9 shows the single cover. Insert the module into the backplane and cover its slot with the single cover.

Figure 5–9: Single Cover and Module



5.6 Using a Dual Filler Panel

This sixth example shows how to use a dual filler panel in order to support a dual-height module.

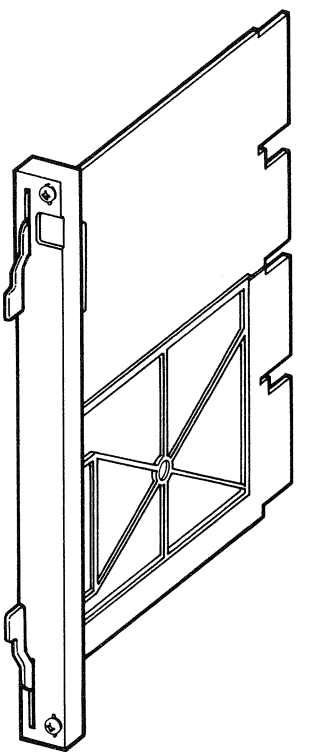
5.6.1 Product Description

The product is a dual-height module.

5.6.2 Approach

Because the product is a dual-height module, a dual filler panel must be riveted to a flush or recessed handle. Select the handle that is appropriate for the enclosure. The dual filler panel provides support to the module and allows for proper air flow within the enclosure. Figure 5–10 shows a dual-height module and dual filler panel riveted to a flush handle.

Figure 5–10: Flush Handle and Dual-Height Module



Appendix A
BA200 Series Power Supply (H7868)

The BA200 Series enclosures come with one or two modular power supplies. Each power supply plugs directly into the backplane via a 56-pin connector. Each power supply delivers the following maximum current.

7.0 amps at +12 Vdc
33.0 amps at +5 Vdc

The combined maximum current at +12 Vdc and +5 Vdc must not consume more than 230 watts of power for each supply.

In the BA213 enclosure, an ac line filter distributes ac input power to the two power supplies. The filter is under the left power supply area. Each power supply has a 12-hole (6-pin) ac input power connector at its base. The two power supplies provide power to the following areas.

Primary power supply	Backplane slots 1 through 6, two mass storage devices, and two dc fans under the card cage
Expansion power supply	Backplane slots 7 through 12, and a third and fourth mass storage device

Each power supply also has a power indicator, CPU Restart switch, and circuit breaker on the front.

The power supply enters and completes a shutdown sequence whenever the BPOK H signal is negated. When BPOK H is asserted high on the Q22-bus, the power system is in a state to allow normal system operation. Any of the following conditions negate BPOK H.

- Fan failure or other cause of overheating, triggering an over-temperature sense.
- An overcurrent condition
- Input voltage greater than 132 Vrms or less than 88 Vrms

In systems with two power supplies, BPOK H and BDCOK H are parallel. If one power supply starts to shut down and the other supply is still operating, BPOK H and BDCOK H are negated through a low from the power supply that is shutting down.

Appendix B
Backplane in the BA200 Series

This appendix describes the BA200 Series backplane. The first section describes the grant continuity in the BA200 Series backplane. The second section describes the physical characteristics of the backplane.

B.1 Grant Continuity and the BA200 Series Backplane

A module from a different enclosure must be compatible with the BA200 Series backplane grant continuity. Figure B–1 shows the backplane grant continuity of the BA123 enclosure. Note that slots 5 through 12 carry the Q22-Bus signal in rows C and D, and in rows A and B.

Figure B–1: BA123 Series Backplane Grant Continuity

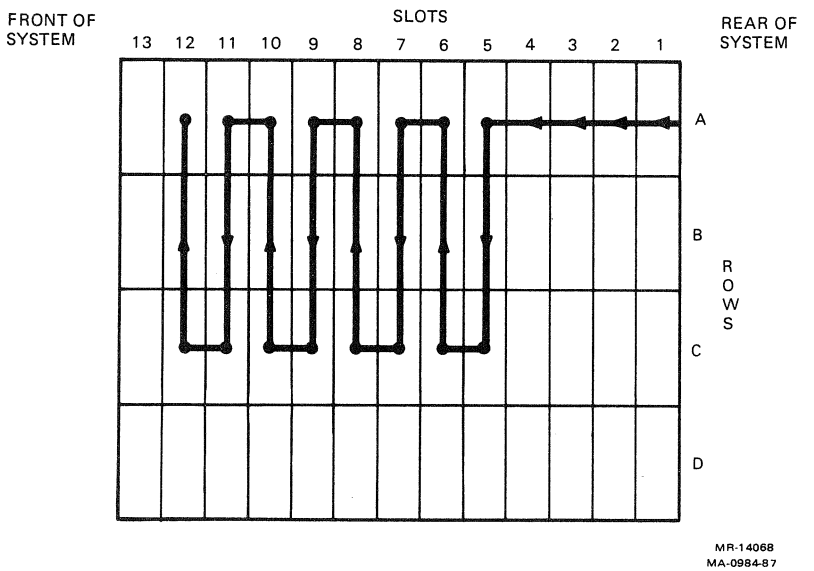
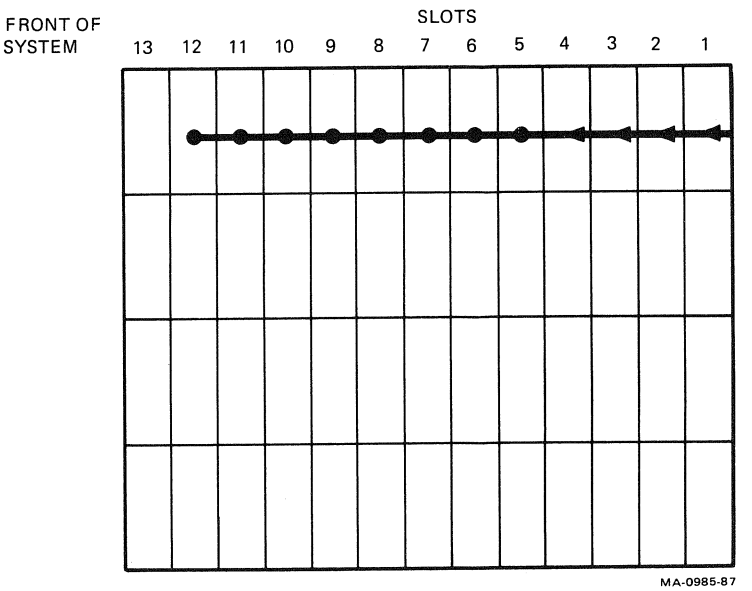


Figure B–2 shows the backplane grant continuity of the BA200 Series. Only rows A and B carry the Q22-bus signal in the BA200 backplane. This means that modules that carry Q22-bus signals in the C and D rows cannot be installed in the BA200 Series. If the module you want to adapt carries signals in the C and D rows, the module must be laid out again so that it carries Q22-bus signals only in the A and B rows. Section 2.3 contains information for designers who need to re-layout a module so that the C and D rows do not carry Q22-bus signals. This section also describes how to reduce the amount of EMI a module generates.

The design of the BA200 Series backplane also means that a dual-height module must be installed **only** in rows A and B. A plastic filler panel (Kit H3656) must be installed to provide extra support for a dual-height Q22-bus module in a BA200 backplane. The plastic filler panel plugs into the CD rows below the module. The plastic panel has a fitted groove along the top edge to support the dual-height module above it. The plastic panel also ensures proper air flow inside the enclosure.

Figure B–2: BA200 Series Backplane Grant Continuity



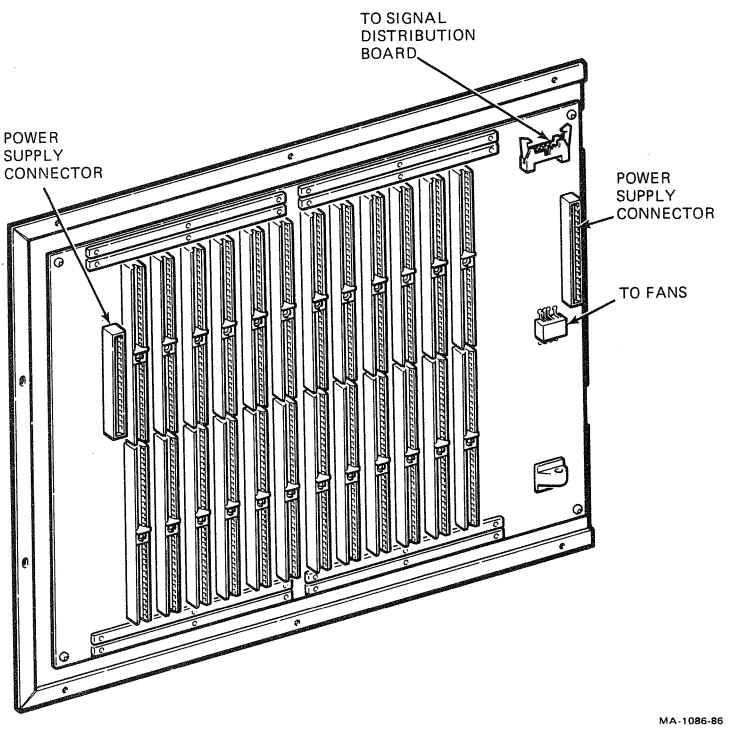
B.2 Description of the BA213 Backplane

The BA213 has a 12-slot, quad-height backplane (Figure B-3). The backplane is a 26.3 cm X 40.7 cm (11.9 in X 16 in) assembly with 24 press-pin connector blocks. The space between each backplane slot is 2.4 cm (0.95 in). The backplane's printed circuit board is a one-layer, two-sided etch board.

The backplane implements the Q22-bus on the AB rows of each slot. The CD rows of all slots are interconnected. In slots 1 through 3, this connection provides the microsystem memory interconnect.

The backplane is bounded and cannot be expanded. It supports 35 equivalent ac loads and 20 dc loads from all the modules installed in the backplane. An ac load is the amount of capacitance a module presents to a bus signal line. One ac load equals 9.35 picofarads (pf). A dc load is the amount of dc leakage a module presents to a bus signal line. One dc load is approximately 105 microamperes (μA). The backplane presents 5.6 ac loads to the Q22 bus.

Figure B-3: BA213 Backplane



There are two variations of the BA213 backplane, for systems with and without mass storage devices (see Table B–1). The two backplanes are not interchangeable. At present, all microsystem systems use the backplane that supports mass storage devices.

Table B–1: Backplanes

Backplane	Part Number	Description
Mass storage	70-23712-01	Connects to the signal distribution board via a ribbon cable. This cable carries the DCOK, POK, +5 Vdc and signal ground lines for the DC OK LED and disk activity lights on the front of the system. The 10-pin cable connector is on the upper-right of the backplane. The backplane also has two 56-pin edge board connectors. The primary connector near slot 1 supplies power to backplane slots 1 to 6. The expansion connector near slot 12 supplies power to backplane slots 7 to 12.
No mass storage	70-23712-02	Does not have connectors for the signal distribution board or a second power supply. Jumpers between slots 6 and 7 bring +5 and +12 Vdc to slots 7 to 12.

The backplane also has a 4-pin power connector on the right side for the two dc fans below the card cage.

B.2.1 Load Module (Systems with Two Power Supplies)

Some BA200 systems that use two power supplies need a quad-height load module (M9060-YA) installed in the backplane (one of slots 7 through 12).

- Systems with 3 or 4 mass storage devices, and with no Q22-bus modules in slots 7 through 12.
- Systems with 1 or 2 mass storage devices, and with Q22-bus modules in any of slots 7 through 12.

The load module loads the +5 Vdc output of the second power supply to the required continuous minimum current of 5 amps. If the minimum current of 5 amps is not reached, the power supply enters an error mode and shuts down the system. Install the load module after the last Q22-bus module.

Glossary

1.5 inch rule
The guideline for module layout that says that an I/O etch should not be longer than 1.5 inches.

BA200 Series
A line of system enclosures that include the BA213 and BA214.

BA200 Series Module
A module specifically designed to be used in one of the BA200 Series enclosures.

Bulkhead
Handle or cover over a module that provides the physical barrier or shield between the inside of the box and the outside world.

Connector
A device that connects an I/O cable to I/O signals on a module.

Cover
A bulkhead that is not attached to a module.

Double
A bulkhead that spans two BA200 Series enclosure slots.

Dual-height module
A module with two sets of fingers that utilize two sockets in a backplane row of four connectors.

EMI
Electromagnetic Interference such as power supply noise, noise generated from the antenna effect, and common mode noise.

ESD
Electro-Static-Discharge. ESD can destroy logic circuitry.

Feedthrough hole
A hole on a module that goes through all layers.

Flush
A handle that is flush against the BA200 enclosure exterior.

Grant card
A device inserted in a backplane to ensure a continuity of Q22-bus signals.

Handle
A bulkhead that is attached to a module.

Handle I/O connector
An I/O connector that is mounted on a handle.

I/O ground
The etch on a module with a low impedance path to the handle ground, and a high impedance path to the logic ground.

MMJ
Modified modular jack. This jack looks like a telephone jack.

Module
A printed circuit board. A module is not necessarily attached to a handle.

Module I/O connector
An I/O connector that is mounted on a module.

NEMA
National Electrical Manufacturers Association.

Noise
Unwanted electrical signals that can be generated from a power supply, logic circuitry, or a communications line.

Noise containment
Keeping noise within the BA200 enclosure.

Q22-bus
A bus that passes 16-bit data with 42 bidirectional lines and 2 unidirectional lines.

Quad-height module
A module with four sets of fingers that utilize four sockets in a backplane row of four connectors.

Recessed
A handle that is recessed from the BA200 Series enclosure exterior.

Rework
The process of drilling or doing touch-up on a bulkhead.

Right angle connector
A connector that attaches at a right angle to the BA200 module from a handle. This is the recommended connector for new BA200 module designs.

Side 1
The populated side of a module.

Side 2
The side of a module opposite side 1.

Single
A bulkhead that spans one BA200 Series enclosure slot.

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