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# EXM-12

# Prototyping EXM

# Reference

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**NOTES**

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# 1. Product Description

This manual contains the information needed to install and use the EXM-12 prototyping module.

The EXM-12 is a prototyping module for use with products compatible with the EXM expansion interface. The EXM-12 printed-circuit board is filled with an array of holes spaced 100 mils apart, along with hole spacing for inserting a 40-pin header at the front of the board.

It contains EXM expansion interface logic and two user-programmable PALs (part number TIBPAL20L8-15) for decoding of EXM expansion interface transactions. These PALs are socketed 24-pin PALs. The EXM-12 is shipped with these PALs installed and programmed to a default configuration.

A floppy diskette is provided with the EXM-12 containing ABEL-compatible source files for the PALs as well as an OrCAD-compatible schematic file and its archive library.

# 1 1

**NOTES**

# 2. Installation

2 2

Before installing the EXM-12, unpack and inspect it for shipping damage.

- **DO NOT REMOVE THE MODULE FROM ITS ANTI-STATIC BAG UNLESS YOU ARE IN A STATIC-FREE ENVIRONMENT. THE EXM-12, LIKE MOST OTHER ELECTRONIC DEVICES, IS SUSCEPTIBLE TO ESD DAMAGE. ESD DAMAGE IS NOT ALWAYS IMMEDIATELY OBVIOUS, IN THAT IT CAN CAUSE A PARTIAL BREAKDOWN IN SEMICONDUCTOR DEVICES THAT MIGHT NOT IMMEDIATELY RESULT IN A FAILURE.**

- **ENSURE THAT THE INSTALLATION PROCESS AS DESCRIBED HEREIN IS ALSO PERFORMED IN A STATIC-FREE ENVIRONMENT.**

## Insertion in an EXM Carrier

Insertion of the EXM-12 into an EXM carrier is straightforward. Remove a blank EXM panel from the carrier (by unscrewing the thumbscrews) and insert the EXM-12 into the card guides. Firmly press the EXM-12 front panel to ensure that the module is properly seated in the subplane and secure it with the thumbscrews.

- **MAKE SURE THAT POWER TO YOUR SYSTEM IS OFF. THIS EXM IS NOT DESIGNED TO BE INSERTED OR REMOVED FROM A LIVE SYSTEM.**

- **WHEN INSERTING THE EXM, AVOID TOUCHING THE CIRCUIT BOARD, AND MAKE SURE THE ENVIRONMENT IS STATIC-FREE.**

- **INSERT IT WITH ADEQUATE CONTINUOUS FORCE RATHER THAN TAPPING OR HAMMERING ON IT.**

2 2

# Configuring the BIOS Setup

The EXM configuration data in the EPC to which the EXM-12 is connected needs to be modified to recognize and enable the card and select from the available options. From the command line, invoke the BIOS setup function by pressing the CTRL-ALT-ESC keys simultaneously.

## Enabling the EXM module

Once in the setup program, a menu displays specifying which function keys are available for further configuration. Press the F2 function key to invoke the EXM menu. The screen display resembles Figure 1 below.

```
          ID OB1 OB2
Slot 0    FF  00  00
     1    DB  C1  00
     2    F3  05  00
     3    DE  00  39
     4    ED  01  00
     5    DC  F5  91
```

Figure 1. EXM Setup Screen.

The setup screen displays the EXM configuration data (in hexadecimal) stored in nonvolatile memory which the EPC uses at power-up to recognize and configure each installed EXM. The displayed data shows SLOT, ID, OB1 and OB2 for each installed EXM.

Note that all slots are listed on the screen even if the actual system configuration does not have all the possible EXM slots. All slots **not** occupied by an EXM module should show an ID of FF and OB1/OB2 of 00 00 indicating that no EXM is present. A typical value for the EXM-12 is shown in bold letters in slot 2.

Slot, OB1 and OB2 are defined as follows:

SLOT indicates the slot in which the EXM is installed. See the diagram below to determine which EXM slot the EXM-12 occupies. Note that dashed lines indicate EXM slots that may not be available on all systems.

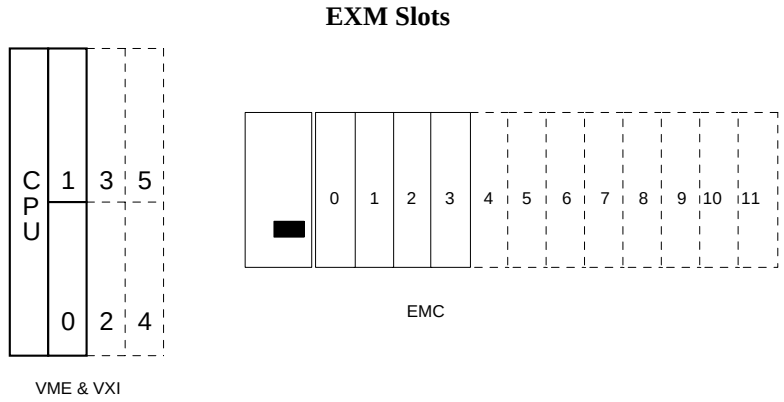



Figure 2. EXM Slot Numbering.

| | |
|---|---|
| ID | is a hard-wired ID value. Each EXM has a unique ID value. |
| OB1/OB2 | are two bytes of option information. |

To add or change an EXM configuration, use the cursor keys (arrows) to move between the fields on the screen. Move the cursor to the appropriate slot entry and type in the correct value.

The **ID** for the EXM-12 should be set to **F3**h.

**OB1** is a hexadecimal value derived by combining the following:

Bits 7 through 4 are unused.
DMA channel 1 is configured using bit 3.
The interrupt is configured using bits 2-1.
The card is enabled or disabled using bit 0.

**OB2** is not used.




| Bit 3<br>DMA Channel 1 | Bits 2-1<br>Interrupt | Bit 0<br>EXM enable |
|---|---|---|
| 0 DMA Disabled<br>1 DMA Enabled | 00 none<br>01 IRQ9<br>10 IRQ5<br>11 IRQ15 | 0 Disabled<br>1 Enabled |

Table 1. OB1 Settings.

For instance, a tyical OB1 value is **05**h (00000101), representing DMA is disabled, interrupt 5 is enabled, and the EXM-12 is enabled. When selecting options, take care that there are no conflicts with other EXM modules. For instance, many of the other EXM modules have programmable interrupts and DMA channels. If more than one device is configured for a given interrupt, unstable conditions could result.

# 3. Prototyping

3 3

## Schematics

Please refer to the schematic diagram of the EXM-12 at the end of this manual. The distribution diskette contains OrCAD-compatible schematic files as well.

## PAL Equations

The EXM-12 contains three PALS, two of which are socketed DIP parts which may be replaced by the user. The EXM-12 is shipped with two installed preprogrammed PALs containing a default configuration. The third PAL, which is not user changeable, implements the EXM-12 configuration option byte register.

One socketed PAL, U1, is intended for I/O port address decode. There are two I/O address ranges: 0-3FF and 8000-83FF. U1 is connected to the following signals shown in Table 2.

| Inputs | Outputs | I/Os |
|---|---|---|
| SA[15,9..0] | SDEN1- | IOSPARE[2..1]- |
| AEN | SDDIR1- | |
| IOR- | CS_10X- | |
| IOW- | CS_102- | |
| CDEN | IOSPARE0- | |
| ACMID- | | |

Table 2. U1 Signals.

Another socketed PAL, U2, is intended for memory address decode. The memory address range is 010000 - FFFFFF in 64K byte blocks. U2 is connected to the following signals.

| Inputs | Outputs | I/Os |
|---|---|---|
| LA[23..17],SA16<br>DACK-<br>MEMW-<br>MEMR-<br>SDDIR1<br>SDEN1-<br>CDEN | MEMCS16-<br>SDDIR-<br>SDEN-<br>MEMSPARE0- | MEMSPARE[4..1]- |

Table 3. U2 Signals.

Please refer to the files included on the distribution diskette for the PAL equations. For example, the file IODEC.ABL contains the following equation:

```
sddir1 = ior;
sden1 = (cden & !aen & (ioadr >= ^h2C0) & (ioadr <= ^h2C7) & (ior # iow))
        # !aen & ior & (ioadr == ^h100) & acmid
        # (!aen & (ioadr == ^h102) & acmid & (ior # iow));
cs_10X = !aen & (ior & (ioadr == ^h100) # (ioadr == ^h102)) & acmid;
iospare0 = cden & !aen & (ioadr >= ^h2C0) & (ioadr <= ^h2C7);
iospare1 = 1;
iospare2 = 1;
```

When modifying the PAL in locations U1 and U2, it is important to preserve certain minterms in the equations for CS_10X, SDDIR1, SDEN1, SDDIR and SDEN. These signals control logic on the EXM-12 to enable the EXM-12 ID and option byte registers. There are specific notes in the source code that describe these issues.

# Default PAL Codes

Default PAL codes do not implement the BALE signal. This signal is not necessary for I/O mapped boards, but is necessary for memory-mapped boards.

# Power Consumption

The maximum power consumption of an unpopulated EXM-12 as shipped is 5V @ 0.6A.

# 4. The EXM Expansion Interface



The EXM Expansion Interface is used to provide local expansion of embedded PCs within the context of a larger system architecture. Electrically, the EXM expansion interface is nearly identical to the 16-bit PC/AT Industry Standard Architecture bus (ISA bus). The differences include the following:

1. RESETDRV is negative true in the EXM expansion interface and is positive true in the ISA bus.

2. DMA channel 7, which consists of signals DRQ7 and DACK7, is not present in the EXM expansion interface.

3. The signals SA[17...19] are not present in the EXM expansion interface.

4. The addition of a signal line (EXMID) for EXM module identification.

5. The signal SBHE is negative true in both the EXM expansion interface and the ISA bus. Some versions of the ISA bus documentation from IBM incorrectly define this signal as a positive true signal.

The EXMID line allows the individual expansion modules to be uniquely addressed at power-up, and facilitates software configuration as an alternative to jumpers and switches. This software configuration feature is incorporated into the EXM expansion interface is such a way that unmodified PC add-in card software can be used by EXM expansion modules. The registers that use this feature are described later in this chapter.

# 4 EXM Expansion Interface Signal Definitions and Pin-out

The EXM expansion interface signals use the same names and timing as the IBM PC/AT bus signals. The only exceptions to this are the -RESETDRV signal, which is inverted in the EXM expansion interface, and the -EXMID signal, which is unique to the EXM expansion interface.

The -EXMID signal is routed to each slot and asserted by the CPU board depending on the value of register 96. In addition, the -EXMID signal is routed to each EXM slot to access the ID register (address 100H) and the programmable option select registers (addresses 102H and 103H). The -EXMID and -RESETDRV registers are used to perform module identification and configuration under software.

Refer to the *IBM Technical Reference: Personal Computer AT* document number 6139362 pages 1-31 through 1-37 for the PC/AT bus signal descriptions.

Table 4 provides the pin-out for the EXM expansion connector. The A row is on the component side of the EXM module, where it is populated with PALs, gates, and capacitors. Pin A1 is located on the bottom of the card, when the card is inserted vertically into the expansion interface with the label oriented properly. The B side of the EXM-12 is populated only with smaller resistors and capacitors.

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|---|---|---|---|---|---|---|---|
| A1 | +12V | B1 | GND | A30 | -DACK5 | B30 | -IOR |
| A2 | reserved | B2 | reserved | A31 | -DACK3 | B31 | -SMEMW |
| A3 | +5V | B3 | GND | A32 | -DACK2 | B32 | -SMEMR |
| A4 | +5V | B4 | GND | A33 | reserved | B33 | GND |
| A5 | SD15 | B5 | SD14 | A34 | -DACK1 | B34 | -MEMW |
| A6 | SD13 | B6 | SD12 | A35 | -DACK0 | B35 | -MEMR |
| A7 | SD11 | B7 | SD10 | A36 | -SBHE | B36 | BALE |
| A8 | -12V | B8 | GND | A37 | +5V | B37 | CLK |
| A9 | SD9 | B9 | SD8 | A38 | AEN | B38 | GND |
| A10 | SD7 | B10 | SD6 | A39 | LA23 | B39 | LA22 |
| A11 | SD5 | B11 | SD4 | A40 | LA21 | B40 | LA20 |
| A12 | +12V | B12 | GND | A41 | LA19 | B41 | LA18 |
| A13 | SD3 | B13 | SD2 | A42 | LA17 | B42 | SA16 |
| A14 | SD1 | B14 | SD0 | A43 | TC | B43 | GND |
| A15 | IRQ15 | B15 | IRQ14 | A44 | SA15 | B44 | SA14 |
| A16 | IRQ12 | B16 | GND | A45 | SA13 | B45 | SA12 |
| A17 | IRQ11 | B17 | IRQ9 | A46 | key | B46 | key |
| A18 | IRQ7 | B18 | IRQ6 | A47 | key | B47 | key |
| A19 | IRQ5 | B19 | IRQ4 | A48 | SA11 | B48 | SA10 |
| A20 | +5V | B20 | IRQ3 | A49 | SA9 | B49 | SA8 |
| A21 | -EXMID | B21 | -RESETDRV | A50 | OSC | B50 | GND |
| A22 | -IOCHCK | B22 | GND | A51 | SA7 | B51 | SA6 |
| A23 | DRQ6 | B23 | IOCHRDY | A52 | SA5 | B52 | SA4 |
| A24 | DRQ5 | B24 | -0WS | A53 | SA3 | B53 | SA2 |
| A25 | DRQ3 | B25 | -IOCS16 | A54 | SA1 | B54 | SA0 |
| A26 | DRQ2 | B26 | -MEMCS16 | A55 | +5 | B55 | GND |
| A27 | DRQ1 | B27 | -REFRESH | A56 | +5 | B56 | GND |
| A28 | DRQ0 | B28 | GND | A57 | reserved | B57 | reserved |
| A29 | -DACK6 | B29 | -IOW | A58 | +12 | B58 | GND |

Table 4. EXM Signal Pin-out.

A subset of the EXM expansion interface, along with several other useful signals, are routed to two header locations (JP3 and JP4) just in front of the card edge connector. Refer to Figure 3 on page 13. These header locations can be used to wire the signals to other prototype logic that the user wishes to install. Users can either connect directly to the holes or add a header and wire wrap from these signals to the user logic. Table 4 defines the signal pin-out for these headers.



| JP4 | | | | JP3 | |
|---|---|---|---|---|---|
| Pin | Signal | Pin | Signal | Pin | Signal |
| 1 | SA1 | 29 | SA0 | 1 | SA2 |
| 2 | SA4 | 30 | SA3 | 2 | SA5 |
| 3 | SA7 | 31 | SA6 | 3 | OSC |
| 4 | SA9 | 32 | SA8 | 4 | SA10 |
| 5 | SA12 | 33 | SA11 | 5 | SA13 |
| 6 | SA15 | 34 | SA14 | 6 | TC |
| 7 | LA17 | 35 | SA16 | 7 | LA18 |
| 8 | LA20 | 36 | LA19 | 8 | LA21 |
| 9 | LA23 | 37 | LA22 | 9 | AEN |
| 10 | -SBHE | 38 | SCLK | 10 | BALE |
| 11 | -MEMR | 39 | -DACK0 | 11 | -MEMSPARE3 |
| 12 | -IOSPARE0 | 40 | -MEMW | 12 | -SMEMR |
| 13 | -SMEMW | 41 | DRQ | 13 | -DACK5 |
| 14 | -IOSPARE1 | 42 | -IOR | 14 | -IOW |
| 15 | -IOSPARE2 | 43 | DRQ0 | 15 | -REFRESH |
| 16 | MEMCS16 | 44 | USR0 | 16 | -MEMSPARE2 |
| 17 | DRQ5 | 45 | -IOCS16 | 17 | -0WS |
| 18 | IOCHRDY | 46 | USR1 | 18 | -IOCHCK |
| 19 | -RESETDRV | 47 | -EXMID | 19 | CDEN |
| 20 | IRQ4 | 48 | USR2 | 20 | -MEMSPARE0 |
| 21 | IRQ11 | 49 | INT | 21 | -MEMSPARE1 |
| 22 | -MEMSPARE4 | 50 | USR3 | 22 | -DACK |
| 23 | D0 | 51 | D1 | 23 | D3 |
| 24 | D5 | 52 | D2 | 24 | D4 |
| 25 | D6 | 53 | D7 | 25 | SD9 |
| 26 | -12V | 54 | SD8 | 26 | SD11 |
| 27 | SD13 | 55 | SD10 | 27 | SD12 |
| 28 | SD14 | 56 | SD15 | 28 | +12 |

Table 5. Prototype Interface Connector.

In the preceding table, the following signals are buffered versions of the EXM Expansion Interface signals: TC, AEN, SCLK, BALE, -SBHE, -MEMR, -MEMW, -SMEMR, -RESETDRV. The signals D0-D7 are buffered by a bi-directional buffer. The signals USR0-USR3, MEMSPARE0-MEMSPARE4, IOSPARE0-IOSPARE2, -DACK, INT, DRQ, and CDEN connect to logic or spare PAL pins on the EXM-12.

The remaining signals are directly connected to the EXM expansion interface edge connector.

Note that pin 1 on the PALs and the capacitors and on JP1, JP2, JP3 and JP4 is always denoted by a squared outline around the round hole. Similarly, pin 1 on the socketed PALs is always denoted by a squared outline. Squared holes on the capacitors are +5V, while round holes are ground.

Refer to Figure 3.

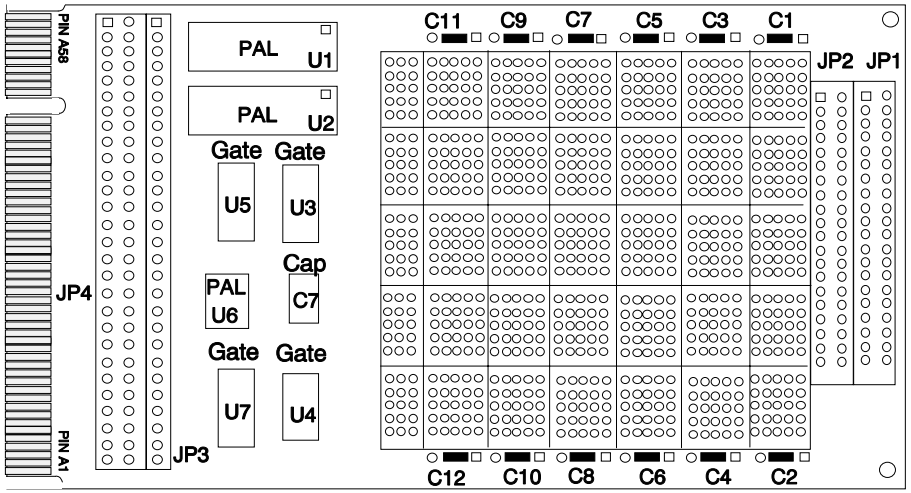



Figure 3. EXM-12 Layout.

# Using the EXM Expansion Interface

1. For all I/O reads and writes, be sure to gate the decode with AEN deasserted. This ensures that DMA activity will not trigger an I/O access to I/O ports defined on the prototype card. Sample equations are provided in Chapter 3.

2. When generating MEMCS16, only use addresses LA17-LA23. The timing of SA0-SA16 is too late to guarantee sufficient setup time to the EXM expansion interface controller chip on the CPU board.

3. Take care when configuring the ports on the EXM-12 that the I/O addresses and memory addresses for the port do not conflict with addresses used by the CPU or other EXMs in the system. Please refer to the respective hardware reference manuals to determine potential conflicts. If there are conflicts, it is possible that permanent damage could occur to the components of the EPC or other EXM products. For instance, the EXM-12 may conflict with the EXM-10A if one enables the EXM-10A buffer memory in the D-page. This is because the default configuration for the EXM-12 also has the D-page enabled.

4. Gate all functions on the prototype card with the CDEN signal. In other words, disable all I/O regions, memory regions, interrupt generation, and DMA usage if CDEN is not asserted.

4 4

5. When decoding both I/O and memory addresses on the EXM-12, take care that the control strobes (e.g., IOR, MEMR) are gated with any data enables to the EXM expansion interface. Otherwise, it is possible that memory accesses can cause I/O decodes and vice versa, causing conflicts with other modules.

# Programming Interface

The EXM-12 defines the following registers in the I/O space.

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | I/O port |
|---|---|---|---|---|---|---|---|---|---|
| Device ID Register | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 100 |
| Config Option Byte 1 Reg | User-specified | | | | Drq | Interrupt | | Cden | 102 |

Figure 4. EXM-12 Registers in I/O Space.

Registers 100 and 102 are standard EXM registers for device identification and configuration. The EXM-12 responds to accesses to these ports only if EXM expansion interface line -EXMID is asserted. An 8-bit read from I/O address 100h returns the value F3, the device ID of the EXM-12. A read/write configuration register appears at I/O address 102h. The bit encodings are defined in Chapter 2.

**User Specified** bits can be used for any purpose that the user wants. These bits are read/write bits and the outputs from the register can be used to control other logic on the prototype card. These bits are available as signals USR0-USR3 as defined in Table 5 on page 12.

**Drq** specifies that DMA channel 1 is disabled or enabled. To use the DMA logic, the user must attach a signal to the DRQ input.

**Interrupt** selects the interrupt to be generated, or specifies that no interrupt is to be generated as defined in Chapter 2. To use the interrupt logic, the user must attach the interrupt source to the INT input.

**CDEN** specifies whether the EXM is disabled or enabled. If disabled, the EXM will not respond to any I/O or memory addresses and will not assert an interrupt output; it will only respond to reads from I/O port 100h and reads and writes from I/O port 102h, and then only if -EXMID is asserted.



**NOTES**



# 5. Support and Service

## In North America

### Technical Support

RadiSys maintains a technical support phone line at (503) 646-1800 that is staffed weekdays (except holidays) between 8 AM and 5 PM Pacific time. If you have a problem outside these hours, you can leave a message on voice-mail using the same phone number. You can also request help via electronic mail or by FAX addressed to RadiSys Technical Support. The RadiSys FAX number is (503) 646-1850. The RadiSys E-mail address on Internet is support@radisys.com. If you are sending E-mail or a FAX, please include information on both the hardware and software being used and a detailed description of the problem, specifically how the problem can be reproduced. We will respond by E-mail, phone or FAX by the next business day.

Technical Support Services are designed for customers who have purchased their products from RadiSys or a sales representative. If your RadiSys product is part of a piece of OEM equipment, or was integrated by someone else as part of a system, support will be better provided by the OEM or system vendor that did the integration and understands the final product and environment.



### Bulletin Board

RadiSys operates an electronic bulletin board (BBS) 24 hours per day to provide access to the latest drivers, software updates and other information. The bulletin

board is not monitored regularly, so if you need a fast response please use the telephone or FAX numbers listed above.

The BBS operates at up to 14400 baud. Connect using standard settings of eight data bits, no parity, and one stop bit (8, N, 1). The telephone number is (503) 646-8290.

## Repair Services

Factory Repair Service is provided for all RadiSys products. Standard service for all RadiSys products covers factory repair with customers paying shipping to the factory and RadiSys paying for return shipment. Overnight return shipment is available at customer expense. Normal turn-around time for repair and re-certification is five working days.

Quick Exchange services (immediate shipment of a loaner unit while the failed product is being repaired) or other extra-cost services can be arranged, but need to be negotiated in advance to allow RadiSys to pool the correct product configurations. RadiSys does not maintain a general "loaner" pool: units are available only for customers that have negotiated this service in advance.

RadiSys does not provide a fixed-price "swap-out" repair service, as customers have indicated that issues of serial number tracking and version control make it more convenient to receive their original products back after repair.




## Warranty Repairs

Products under warranty (see warranty information in the front of this manual) will have manufacturing defects repaired at no charge. Products sent in for warranty repair that have no faults will be subject to a recertification charge. Extended Warranties are available and can be purchased at a standard price for any product still under warranty. RadiSys will gladly quote prices for Extended Warranties on products whose warranties have lapsed; contact the factory if this applies.

Customer induced damage (resulting from misuse, abuse, or exceeding the product specifications) is not covered by the standard product warranty.

## Non-Warranty Services

There are several classes of non-warranty service. These include repair of customer induced problems, repairs of failures for products outside the warranty period,

recertification (functional testing) of a product either in or out of warranty, and procurement of spare parts.



All non-warranty repairs are subject to service charges. RadiSys has determined that pricing repairs based on time and materials is more cost-effective for the customer than a flat-rate repair charge. When product is received, it will be analyzed and, if appropriate, a cost estimate will be communicated to the customer for authorization. After the customer authorizes the repair and billing arrangements have been made, the product will be repaired and returned to the customer.

A recertification service is provided for products either in or out of warranty. This service will verify correct operation of a product by inspection and testing of the product with standard manufacturing tests. There is a product-dependent charge for recertification.

There are only a few components that are generally considered field-repairable, but, because RadiSys understands that some customers want or need the option of repairing their own equipment, all components are available in a spares program. There is a minimum billing charge associated with this program.



## Arranging Service

To schedule service for a product, please call RadiSys Technical Support directly at (503) 646-1800. Have the product model and serial numbers available, along with a description of the problem. A Technical Support representative will issue a Returned Materials Authorization (RMA) number, a code number by which we track the product while it is being processed. Once you have received the RMA number, follow the instructions of the Technical Support representative and return the product to us, freight prepaid, with the RMA number clearly marked on the exterior of the package. If possible re-use the original shipping containers and packaging. In any case, be sure you follow good ESD-control practices when handling the product, and ensure that anti-static bags and packing materials with adequate padding and shock-absorbing properties are used.

Ship the product, freight prepaid, to the following address:

Product Service Center
RadiSys Corporation
15025 SW Koll Parkway
Beaverton, Oregon 97006-6902



When shipping the product, include the following information: return address, contact names and phone numbers in purchasing and engineering, and a description of the suspected problem. Any ancillary information that might be helpful with the debugging process will be appreciated.

## Other Countries

Contact the sales organization from which you purchased your RadiSys product for service and support.



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