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EXM-6

EXM-13

Reference

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Contents

1. Getting Started..... 1

Specifications..... 2

2. Installation..... 3

Insertion in an EXM Carrier..... 3
Running the EXM Configuration Program..... 4
Connecting a Monitor..... 5
Connectors..... 7
Flat-Panel Displays..... 10

3. Operation..... 11

Configuration Using BIOS Setup Screen..... 11
Default Initialization of Video EXMs..... 12

4. Programming Interface..... 13

5. Support and Service..... 17

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1. Getting Started

This manual contains the information you will need to install and use the EXM-6 and EXM-13 VGA video controllers. When discussing information common to both, the term "EXM-6/13" will be used.

EXM-6 implements the full VGA video standard, as well as an extended 800x600 16-color mode. It has a standard DB-15 VGA connector for attachment to an analog VGA or multiscan monitor. It also has an auxiliary video connector similar to the auxiliary video extension in the IBM PS/2 and the feature connector on many VGA cards; this contains auxiliary video signals that can be used for connection to other types of displays, such as certain flat-panel displays. EXM-6 contains 256 KB of video memory.

EXM-13 is a superset of the EXM-6. It supports the additional "super VGA" resolutions of 640×480 256 colors, 800×600 256 colors, and 1024×768 16 colors. It also contains an auxliliary connector, but with more signals available than in the EXM-6. EXM-13 contains 512 KB of video memory and provides faster video performance than EXM-6.

EXM-6/13 uses certain standard memory and I/O addresses and thus cannot be used in systems with other video controllers also using these addresses. Therefore the EXM-6/13 cannot be used in an EPC-2 or EPC-3 system, since these have integrated VGA controllers. Also, more than one EXM-6/13 cannot be used in a single system unless your software ensures that no more than one EXM-6/13 is enabled at any point in time.

Specifications

The following table defines the power and environmental specifications of the EXM-6 and EXM-13.

Characteristic		Value
Temperature	operating	0 to 60°C ambient
	storage	-40 to 125°C
Humidity	operating	0 - 90% noncondensing
	storage	0 - 95% noncondensing
Altitude	operating	10,000 ft (3000 m)
	storage	50,000 ft (15,000 m)
Vibration	operating	0.015 inch (0.38 mm) P-P displacement with 2.5 g peak (max) acceleration over 5-2000 Hz
	storage	0.030 inch (0.76 mm) P-P displacement with 5.0 g peak (max) acceleration over 5-2000 Hz
Shock	operating	30 g, 11 ms duration, half-sine shock pulse
	storage	50 g, 11 ms duration, half-sine shock pulse
Power (EXM-6)	maximum	10 W
	typical	4.5 W
Power (EXM-13)	maximum	8 W
	typical	3.5 W
Current (EXM-6)	maximum	5V @ 2A
	typical	5V @ 0.9A
Current (EXM-13)	maximum	5V @ 1.6A
	typical	5V @ 0.7A
Weight (EXM-6)		4 oz (120 g)
Weight (EXM-13)		3.5 oz (105 g)

2. Installation

Before installing your EXM-6/13, you should 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-6/13, 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-6/13 into an EXM carrier, such as the EXP-MC or the integrated EXM carriers in the EPC-4, 5, ... is straightforward. First ensure that the subplane has been inserted into the backplane. If an EXP-MC is being used, insert it in the desired VMEbus slot and attach it to the chassis. Then remove any blank EXM panel from the carrier (by unscrewing the thumbscrews) and insert the EXM-6/13 into the cardguides. Firmly press the EXM-6/13 front panel to ensure that it has mated with the rear connector, and secure it with the thumbscrews.

- **MAKE SURE THAT POWER TO YOUR SYSTEM IS OFF. THE 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.**

Running the Configuration Program

For the EXM-6/13, the configuration program allows you tro specify in which slot the EXM resides and whether the EXM is enabled. In almost every situation you will find it easier to use the BIOS setup program discussed in the next chapter rather than the configuration program.

For the EXM-6 and EXM-13, the configuration program simply specifies in which slot the EXM-resides, and whether the EXM is to be enabled. This information is recorded in the EPC's nonvolatile memory and is used by the EPC's BIOS at initialization time.

Depending on what types of system configurations you purchased, the EXMCFG configuration program (an MS-DOS program) can be found on your hard disk or floppy diskettes or both. For instance, to execute it from a floppy diskette, put the diskette in your EPC and type

```
a:exmcfg
```

The configuration program must be executed on the EPC in which you've installed the EXM-6/13. An alternative lower-level way to enter your configuration information via the EPC's BIOS setup screen is described in the next chapter.

The configuration program first displays a screen showing what devices appear to be installed in each EXMbus slot, and what devices it expects to find in each slot. Follow the instructions and select the slot in which your EXM-6/13 is installed.

The next screen, specific to the EXM-6/13, asks you about the only configuration option available - whether you want the EXM enabled or not. If you have only one EXM-6/13 in the system, you should answer yes (enabled). If you have multiple EXM-6/13 modules in the same system, you must not enable more than one of them (enabling and disabling can be done dynamically by software).

Follow the remainder of the instructions on the screen of the configuration program to save the specified configuration in the EPC's nonvolatile RAM. After this, every time you boot or reset your EPC, the BIOS will initialize the EXM-6/13 in the specified slot to the specified configuration.

Connecting a Monitor

A monitor is connected via the 15-pin D connector on the EXM-6/13 front panel. The EXM-6/13, being a VGA graphics controller, produces analog color signals, meaning that old-style EGA, CGA, and monochrome monitors cannot be used. VGA monitors may be color or gray scale; the EXM-6/13 automatically senses the difference between the two. If using a multiscan monitor, make sure to set the monitor's switch to analog (not TTL).

The monitor type cannot be detected correctly if the monitor is disconnected or powered off when the EPC is powered on or reset. Typical symptoms are lack of color on a color monitor and an error message about lack of a suitable video adapter when invoking Windows. If a color monitor is not detected correctly under MS-DOS, the command

```
mode co80
```

can be used to switch the controller into color mode.

Monitors that can be used are VGA-compatible monitors (i.e., those compatible with the IBM PS/2 and with PC VGA add-in cards) and multiscan (multifrequency or "multisync") monitors. If you cannot mate your monitor to the EXM-6/13 because you have a cable with a 9-pin connector, either (1) you have a TTL monitor that is not compatible with VGA or (2) you have a multisync monitor (which are usually shipped with 9- and 15-pin cables or adapters) and are using the wrong cable.

To ensure a reliable connection, the monitor's cable should be screwed into the EXM-6/13's connector.

Connecting a monitor is not absolutely necessary; its presence or absence does not affect the operation of the system. Also, the monitor can usually be safely connected and/or disconnected during operation.

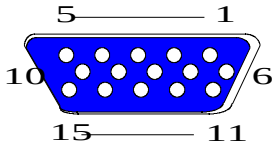
The EXM-6/13 supports some video modes beyond the IBM-standard VGA modes, most importantly the 800 × 600 modes. Use of these modes requires a super-VGA or multiscan monitor, as well as special software drivers. Drivers for Microsoft Windows for 800×600×16 (EXM-6/13) and 1024×768×16 (EXM-13) are provided on a diskette. This diskette is normally distributed with other RadiSys software; if you don't have it, call RadiSys customer support for a copy.

EXM-6/EXM-13 REFERENCE

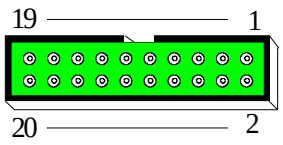
To install the driver, you need to run the Windows setup program, but you need to run it under DOS, not under Windows. Exit from Windows and refer to a section in your Windows manual entitled something like "Running Setup from MS-DOS" or "Installing a Device Driver Not Supplied with Windows." The setup program will ask for your driver diskette.

Connectors

The DB-15 monitor connector is defined as



Pin	Signal	Pin	Signal
1	Red	9	(key)
2	Green	10	Ground
3	Blue	11	(not used)
4	(not used)	12	(not used)
5	Ground	13	Horizontal sync
6	Ground	14	Vertical sync
7	Ground	15	(not used)
8	Ground		

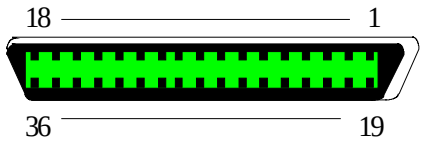


The EXM-6 contains a 20-pin auxiliary connector. Usually this connector is not used. It provides auxiliary video signals for enhanced video control and special types of displays (e.g., flat panels). The connector is a 3M series 3592 (or equivalent) header with 0.100" × 0.100" pin spacing and mates with a 3M series 3421 or equivalent connector.

The pins on the auxiliary video connector on the EXM-6 are defined as

Pin	Signal	Pin	Signal
1	EVIDEO	11	P6
2	F1	12	P3
3	P7	13	Ground
4	P0	14	P4
5	Ground	15	-BLANK
6	P1	16	P5
7	DCLK	17	HSYNC
8	P2	18	F2
9	EDCLK	19	VSYNC
10	Ground	20	ESYNC

The EXM-13 contains a similar auxiliary connector. Its 36-pin connector is a shielded female AMP 174726-3. It mates with an AMP 174340-3 male connector with 174747 shield case kit, or equivalent.



The pins on the auxiliary video connector on the EXM-13 as well as the wire numbers on a typical flat cable, are defined below.

Pin	Cable wire	Signal	Pin	Cable wire	Signal
1	1	EVIDEO	19	2	Ground
2	3	P7	20	4	P0
3	5	Ground	21	6	P1
4	7	DCLK	22	8	P2
5	9	EDCLK	23	10	Ground
6	11	P6	24	12	P3
7	13	Ground	25	14	P4
8	15	-BLANK	26	16	P5
9	17	HSYNC	27	18	Ground
10	19	VSYNC	28	20	ESYNC
11	21	Ground	29	22	Ground
12	23	reserved	30	24	Ground
13	25	reserved	31	26	Ground
14	27	reserved	32	28	Ground
15	29	Ground	33	30	Ground
16	31	RED	34	32	Ground
17	33	GREEN	35	34	Ground
18	35	BLUE	36	36	Ground

The signals on the auxiliary connectors of the EXM-6 and EXM-13 are described below.

-BLANK — This input/output signal is an alternate blanking signal to the digital-to-analog converter (DAC) in the EXM-6/13. When enabled (see ESYNC), a low input causes the DAC to drive its analog color outputs to 0V. When disabled, this pin outputs the internal blanking signal.

BLUE — This analog output is the same as the blue output on the DB-15 connector (EXM-13 only).

DCLK — This input/output signal is the dot clock to the DAC. When enabled (see EDCLK), it is an input whose rising edge causes the DAC to latch the digital video signals. When disabled, it outputs the internal dot clock.

EDCLK — This input signal controls the source of the dot clock. When high (or unconnected), the clock is internal. When low, the DCLK input is enabled. Also, when EDCLK is low, the internal 36 MHz oscillator is disconnected and DCLK used in its place. While EDCLK is high or unconnected, the VGA miscellaneous output register must be configured so that it is not selected clock source 2.

EVIDEO — This input signal controls the source of the digital video information to the DAC. When high (or unconnected), the digital signals are obtained internally. When low, the digital signals are sourced from P0-P7 on the connector.

ESYNC — This input signal controls the source of the blanking and synchronization signals. When high (or unconnected), they are obtained internally. When low, the inputs -BLANK, HSYNC, and VSYNC are enabled as the source.

F1 — This output signal is the logical and of DCLK and -BLANK. It is provided for certain flat-panel displays, such as the Fujitsu FPF8060 (EXM-6 only).

F2 — This output signal is not currently defined and is always high (EXM-6 only).

GREEN — This analog output is the same as the green output on the DB-15 connector (EXM-13 only).

HSYNC — This input/output signal is the horizontal sync signal on the VGA monitor connector. When enabled (see ESYNC), it is an input and drives the horizontal sync signal on the VGA monitor connector. When disabled, it outputs the horizontal sync signal.

P0-P7 — These input/output signals are the digital video inputs to the EXM-6/13's DAC. When enabled (see EVIDEO), they are inputs that drive the DAC. When disabled, they output the internal digital video signals. P0-P5 represent, respectively, blue, green, red, secondary blue, secondary green, and secondary red.

RED — This analog output is the same as the red output on the DB-15 connector (EXM-13 only).

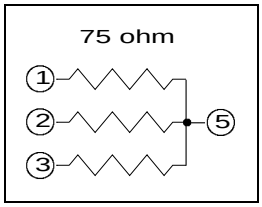
VSYNC — This input/output signal is the vertical sync signal on the VGA monitor connector. When enabled (see ESYNC), it is an input and drives the vertical sync signal on the VGA monitor connector. When disabled, it outputs the vertical sync signal.

Flat-Panel Displays

Flat-panel displays have a number of different conventions for interfacing to a VGA controller. Most require some of the signals on the auxiliary connector. Some connect to the analog color signals; others do not. Some "non-color" flat panels operate best with the video controller in gray-scale mode; others have their own color-to-gray-scale conversion logic and require color mode. The latter may require you to "trick" the EXM into thinking that an analog color monitor is connected.

The EXM-6/13 detects the type of monitor in use at the time of system reset by sensing the three analog color signals on the DB-15 VGA connector. If it senses a 75 ohm load on all three color signals, it initializes to color mode. All other conditions initialize the controller to gray-scale mode.

If you are using a flat-panel display that requires color mode (e.g., it does its own conversion) and either doesn't connect to the analog signals or doesn't provide the 75-ohm load on the analog signals, you may need to build a terminating connector that plugs into the DB-15 connector. The terminating connector contains three 75-ohm resistors. The resistors connect the red, green, and blue color signals (pins 1-3) to one of the ground pins (e.g., pin 5).



3. Operation

Configuration Using BIOS Setup Screen

As an alternative to running the EXM configuration program, you can also establish the EXM's configuration using the BIOS setup screen. To invoke the setup program, press CTRL+ALT+ESC at the operating-system prompt, or reboot your EPC, wait for the selftests to complete, and press CTRL+ALT+ESC. Once in the setup program, press the designated function key to invoke the EXM menu. On the screen you should see something like

```
EXM Setup Screen

          ID OB1 OB2
Slot 0    EF  01  00
     1    FF  00  00
     2    FF  00  00
     3    FF  00  00
     4    FF  00  00
     5    FF  00  00
```

This displays the data (in hexadecimal) stored in nonvolatile memory describing the EXM configuration. ID is the EXM's ID (the ID for EXM-6 is EF; the ID for the EXM-13 is ED; the ID for "no device expected" is FF). OB1 and OB2 are two bytes of option information. EXM-6/13 uses only one bit of OB1.

To add or change an EXM-6 configuration, the ID byte for the slot in which the EXM-6 resides should be set to EF, and OB1 should be set according to the following bit definitions:

Bits 7-1 unused	Bit 0 EXM enable
	0 disabled 1 enabled

To add or change an EXM-13 configuration, the above applies except that the ID byte is ED.

Default Initialization of Video EXMs

For a variety of reasons, the BIOS in EPCs automatically enables a video EXM if it finds that none are enabled. The primary reason is the chicken-and-egg problem of configuring the EXM the first time; one needs to be able to see the video output of the setup program in order to configure the video EXM.

If the BIOS finds no enabled video EXM, it searches for the first video EXM by slot and enables it. You should then use the setup program to configure the EXM properly to avoid receiving an EXM CONFIGURATION ERROR message every time the system is booted.

4. Programming Interface

This chapter contains information needed to write custom software drivers for the EXM-6/13. Anyone using the EXM with software compatible with standard PC VGA, EGA, or CGA video adapters can skip reading this chapter.

The EXM-6 and EXM-13 are mapped into both the memory space and I/O space. In the memory space the mapping is

Range		Content
000A0000	000BFFFF	Video RAM
000C0000	000C7FFF	Video BIOS ROM

The EXM-6 and EXM-13 define the following registers in the I/O space.

Port	Functional group	Usage	
100	EXM Configuration	Device ID	
102		Option byte 1	
3B4	Video controller	CRT index register (mono)	
3B5		CRT ctlr data reg (mono)	
		0	Horizontal total register
		1	Horiz display enable end
		2	Start horiz blanking
		3	End horizontal blanking
		4	Start horiz retrace pulse
		5	End horizontal retrace
		6	Vertical total register
		7	Overflow
		8	Preset row scan
		9	Max scan line/others
		A	Cursor start
		B	Cursor end
		C	Start address high
		D	Start address low
		E	Cursor location high
		F	Cursor location low

Port	Functional group	Usage	
		10	Vertical retrace start
		11	Vertical retrace end
		12	Vert display enable end
		13	Offset
		14	Underline location
		15	Start vertical blank
		16	End vertical blank
		17	CRTC mode control
		18	Line compare
3B8		Mode control reg (mono) (W)	
3B9		Preset light pen (mono) (W)	
3BA		Input status reg 0 (mono) (R)	
		Feature control (mono) (W)	
3BB		Clear light pen (mono) (W)	
3BF		Hercules register	
3C0		Attribute index register	
		Attribute data register (W)	
3C1		Attribute data register (R)	
		0X	Palette registers
		10	Attribute mode control
		11	Overscan control
		12	Color plane enable
		13	Horizontal PEL panning
		14	Color select
3C2		Misc output register (W)	
		Input status register 0 (R)	
3C3		Video subsystem enable reg	
3C4		Sequencer index register	
3C5		Sequencer data register	
		0	Reset register
		1	Clocking mode register
		2	Map mask register
		3	Character map select reg
		4	Memory mode register
3CA		Feature control register (R)	
3CC		Misc output register (R)	
3CE		Graphics controller index reg	
3CF		Graphics data register	
		0	Set/reset
		1	Enable set/reset
		2	Color compare
		3	Data rotate
		4	Read map select
		5	Graphics mode
		6	Miscellaneous
		7	Color don't care

Port	Functional group	Usage	
		8	Bit mask
		9	Address offset A (PR0A)

		A	Address offset B (PR0B)
		B	Memory size (PR1)
		C	Video select (PR2)
		D	CRT control (PR3)
		E	Video control (PR4)
		F	Lock/status (PR5)
3D4		CRT index register (color)	
3D5		CRT controller data (color)	
		0	Horizontal total
		1	Horiz display enable end
		2	Start horizontal blanking
		3	End horizontal blanking
		4	Start horiz retrace pulse
		5	End horizontal retrace
		6	Vertical total register
		7	Overflow
		8	Preset row scan
		9	Max scan line/others
		A	Cursor start
		B	Cursor end
		C	Start address high
		D	Start address low
		E	Cursor location high
		F	Cursor location low
		10	Vertical retrace start
		11	Vertical retrace end
		12	Vert display enable end
		13	Offset
		14	Underline location
		15	Start vertical blank
		16	End vertical blank
		17	CRTC mode control
		18	Line compare
3D8		Mode control reg (color) (W)	
3D9		Color select register (W)	
3DA		Input status reg 0 (color) (R)	
		Feature control (color) (W)	
3DB		Clear light pen (color) (W)	
3DC		Preset light pen (color) (W)	
3DE		AT&T / M24 (W)	

All but the first two registers are standard VGA registers. For further explanation consult the manual of the Western Digital Paradise VGA1A video controller chip (EXM-6), Western Digital WD90C11 video controller chip (EXM-13), the text *EGA/VGA A Programmer's Reference Guide* by B. D. Kliewer (McGraw-Hill), or the text *Programmer's Guide to PC and PS/2 Video Systems* by R. Wilton (Microsoft Press). The other two registers are

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	I/O port

Device ID Reg (EXM-6)	1	1	1	0	1	1	1	1	100
Device ID Reg (EXM-13)	1	1	1	0	1	1	0	1	100
Config Option Byte 1 Reg								Cden	102

These are standard EXM registers for device identification and configuration. The EXM-6/13 responds to accesses to these ports only if EXMbus line -EXMID is asserted. An 8-bit read from I/O address 100h returns the value EF or ED, the device IDs of the EXM-6 and EXM-13. A read/write configuration register appears at I/O address 102h.

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 EXMbus line -EXMID is asserted. (Note that certain EPCs will automatically enable the first video controller found, independent of how CDEN is set.)

5. Support and Service

If you have questions or problems, call 800-950-0044 or 503-646-1800 between the hours of 8 AM and 5 PM Pacific time. Technical support is provided for users who purchased their system from RadiSys or a RadiSys sales representative; if you purchased your system elsewhere, you should contact that party for support.

Repair

Repair service under the standard warranty is provided to the original purchaser. Products returned for warranty repair that are found to be fully functional will be subject to a recertification fee. Typical turnaround time for repair and recertification is five working days (exclusive of shipping time).

Out-of-warranty service is subject to a service charge. After the damaged product is analyzed, the customer will be given a cost estimate and asked for authorization to proceed. All repairs are warranted for 90 days.

Shipping

Products requiring service may be returned to RadiSys, shipping prepaid, after issuance of a return materials authorization (RMA). Return authorization may be obtained by calling customer service (800-950-0044) with the product model, serial number, and problem description. Proper packaging, preferably the original shipping containers, should be used. Be sure to use anti-static and padded packaging, and to include a written description of the problem. The customer assumes all liability for loss or damage in transit in both directions. Unless otherwise agreed in advance, products will be returned to the customer with shipping and any repair charges due on delivery. Ship the product needing service, freight prepaid, to:

Product Service Center
RadiSys Corporation
15025 S.W. Koll Parkway
Beaverton, OR 97006 USA

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