

20" V80 Monitors

User's Manual

998008 020
February, 1997

 **Intecolor[®]**

Notice

Rockwell Automation Intecolor Corporation assumes no liability for loss or damage resulting from any errors or omissions which this document might contain. Rockwell Automation Intecolor Corporation reserves the right to revise and correct this document without obligation to notify any person of such revision or correction.

Limited Warranty

Rockwell Automation Intecolor Corporation warrants that the product described in this document will be delivered free of defects in materials and workmanship. In the event any such defect is detected within a period of 12 months following the date of initial delivery, Rockwell Automation Intecolor will repair or replace the equipment at no charge.

This warranty is exclusive and in lieu of any warranty of merchantability, fitness for a particular purpose, or any other warranty expressed or implied (except that of title and that against patent infringement), and is extended only to the original purchaser of the equipment. The purchaser voids his title to the benefits of this warranty who does not treat the equipment in accordance with Rockwell Automation Intecolor's recommendations or in accordance with good industry practice.

FCC Warning

The equipment described in this document generates, uses, and emits radio frequency energy. The equipment (except as provided in an open chassis configuration or for OEM console mounting) has been tested and found to comply with FCC Rules, Part 15 subpart J, for Class A computing devices. These rules establish limits for radio frequency emissions considered reasonable for a commercial environment. Accordingly, the user may operate this equipment in a commercial environment without liability in case of interference to other equipment, provided he follows the installation and operation guidelines given in this document. However, the equipment is not certified for operation in a residential environment. The user who operates it in such an environment, and by so doing causes interference with radio communications or broadcast reception, can be required to take remedial action at his own expense.

The use of non-shielded interface or power cords with Rockwell Automation Intecolor monitors is prohibited.

X-ray Emissions

X-ray emissions from an Rockwell Automation Intecolor monitor are below the 0.5 mR/hr maximum recommended by the US Department of Health and Human Resources and specified in "Federal Performance Standards for television Receivers", Section 10 Part 1020, Title 21 of the U.S. Code of Regulation (PL90-620) Vol. 38 No. 198.

Additional Information

Please address all requests for product information, technical assistance, additional manuals, copyright clearance, and all other correspondence to:

Rockwell Automation Intecolor Corporation
 2150 Boggs Road
 Duluth, GA 30136
 USA
 Telephone (770) 623 9145
 FAX (770) 623 9163

Chassis Trak is a trademark of General Devices Corp.
 Macintosh and Mac are trademarks of Apple Computer Corp.
 IBM and OS/2 are trademarks of International Business Machines Corp.

TABLE OF CONTENTS

- Introduction** 1
- About This Manual 1
- 20" Monitor Overview** 2
- Models Covered 2
- Model Numbering Convention 3
- Figures 4
- Unpacking and Installation**..... 8
- Unpacking the Monitor 8
- General Guidelines for Installation 9
- Rack Mounting 11
 - 10U Rackmount Monitor* 12
 - 9U Rackmount Monitor* 14
 - Rack Mounting Procedure* 15
- Panel Mounting 17
 - Panel Mounting Procedure* 18
- Installing Open Chassis Units 20
- Video Signal Connections 22
 - VGA HD-15 Interface* 23
 - RS 343 BNC Interface* 23
 - Termination of the Video Inputs* 24
- Power Connection 25
 - Power Connection Procedure* 25
- Operator Adjustments**..... 26
- Viewing Angle Adjustment 26
- Operator Controls and Indicators 26
- Controls and Indicators 27
 - Power Switch* 27
 - Status LED* 27
 - Brightness Control* 27
 - Contrast Control* 27
 - Manual Degaussing Button* 28
 - Vertical Size* 28
 - Vertical Position* 28
 - Horizontal Size* 28
 - Horizontal Position* 28
- Routine Maintenance** 29
- Cleaning 29
- Line Cord Replacement 29
- Fuse Replacement 29
 - Fuse Replacement Procedure* 30
- Other Maintenance 30
- Users' Guide to Analyze and Correct Problems** 31
- Common Problems and Possible Solutions 31
- Obtaining Service 32
- Obtaining Service in North America 32
- Obtaining Service in Europe 32
- On Site Service 32
- Appendix A: VGA HD-15 Interface**..... 33
- Appendix B: Dealing with Magnetic Interference** 34

Geometric and Color Distortion	34
<i>Metal Shadow Masks</i>	34
<i>Earth's Magnetic Field</i>	34
<i>Industrial Settings</i>	35
<i>Identifying the Source</i>	35
<i>Summary</i>	36
Using the Biot Savart Law to Estimate the Field about a DC Bus	37
<i>Summary</i>	38
Determining the Correct Shield Material	38
<i>General</i>	38
<i>Field Strengths</i>	39
Thresholds for Monitors	39
<i>DC Fields</i>	40
Intecolor Magnetic Shields	40
Appendix C: Long Video Cables	41
General	41
Test Description	41
Results	41
Conclusion	41
Summary	41
Appendix D: Using Differential Input Amplifiers To Eliminate Common Mode Noise In Video Systems	43
General	43
Common Problems	43
<i>The Long Lines Problem</i>	43
<i>The Control Room Problem</i>	45
Differential Input Video Amplifiers as a Solution	45
Summary	47
Supplementary Information	47
<i>Driving the Monitor's Differential Inputs from a VGA Adapter</i>	48
Appendix E: Touch Screen Serial Interface	50
Cable	50
Communications	50
Software	50
Female DB-9 Connector	50
Touch Screen Operation	52
<i>Installing the Touch Screen Driver Software Procedure</i>	52
<i>Touch Screen Calibration</i>	53
<i>Using the Touch Screen with Application Programs</i>	53
Specification Sheets	54
Model E20FBC	55
Model E20FCC	56
Model E20FCD	57
Model E20FEC	58
Model E20FFC	59
Model E20FPC	60
Model E20FRA WA2	61
Model E20FRC	62
Model E20FRD	63
Declaration of Conformity	65

FIGURES AND TABLES

Intecolor 20 Monitors Table	2
Model Numbering Convention	3
20" Desktop Enclosure (EC)	4
20" Open Frame (FC)	4
20" 10U Rackmount Enclosure (RC)	4
20" Benchtop Enclosure (BC)	5
20" 9U Panelmount (PC)	5
20" 9U Rackmount (RD)	6
20" Open Frame - Short Model (CD)	6
20" Special Rackmount (RA-WA2)	6
20" Closed Frame (CC)	7
10U Rackmount Monitor	12
9U Rackmount Installation Diagram	14
Panelmount Diagram	17
Panelmounting Dimensions (9U)	18
20" Chassis Installation (side view)	20
20" Chassis Installation (top view)	21
Back Panel for Model -210	22
Back Panel for Models -200 and -220	22
Rear Panel for Model -210	26
Rear Panel for Models -200 and -220	26
Front Panel Controls	27
Recommended Size Settings Table	28
Circuit Board with Fuses	30
Trouble Shooting Table	31
HD15	33
HD-15 Pin Assignments Table	33
Magnetic Interference Identification Table	35
Biot-Savart Law Diagram	37
Permeability Classification Table	38
Field Strength versus "Jitter" Amplitude Graph	40
Differential Input Amplifier Specifications Table	47
VGA Card Adapter	49
DB-9 Female Connector (solder term end)	50
Infra-Red Touch Screen Interface Table	50
Capacitive Touch Screen Interface Table	51
Resistive Touch Screen Interface	51
SAW Touch Screen Interface	51
Intecolor 20" Monitors Specifications Table	54

00 48 07 04 11 07

Introduction

About This Manual

This manual provides information about the installation, operation and routine maintenance of Intecolor monitors. The specific models covered are listed in the following guide. To order additional copies of this manual contact Intecolor and request part number 998008.

20" Monitor Overview

Models Covered

The following table lists the monitors discussed in this manual. Refer to the following *Figures* section for drawings of the respective models.

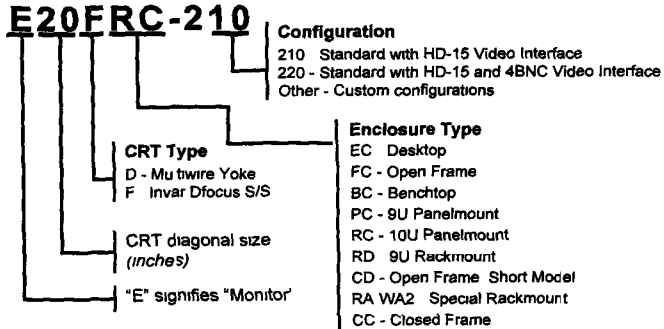
Intecolor 20" Monitors Table

Monitor	Model Number	Package Type
20" Variable Scan (30-82kHz)	E20FBC XXX	Berchtop
20" Variable Scan (30-82kHz)	E20FCC XXX	Closed Chassis
20" Variable Scan (30-82kHz)	E20FCD-XXX	Open Chassis, Short Mode
20" Variable Scan (30-82kHz)	E20FEC XXX	Desktop
20" Variable Scan (30-82kHz)	E20FFC XXX	Open Frame
20" Variable Scan (30-82kHz)	E20FPC XXX	9U Panel mount
20" Variable Scan (30-82kHz)	E20FRA-WA2	Special Rackmount
20" Variable Scan (30-82kHz)	E20FRC XXX	10U Rackmount
20" Variable Scan (30-82kHz)	E20FRD XXX	9U Rackmount

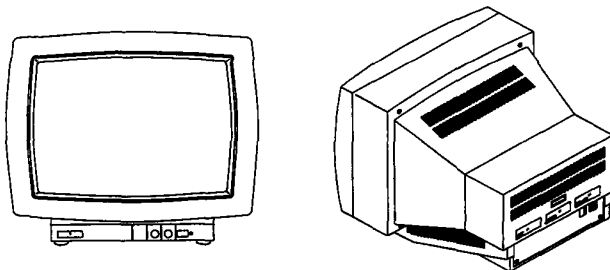
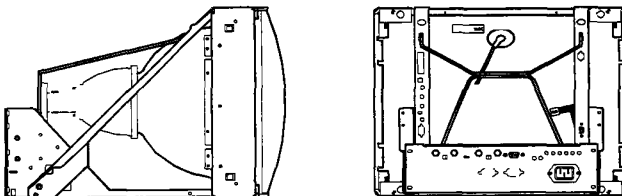
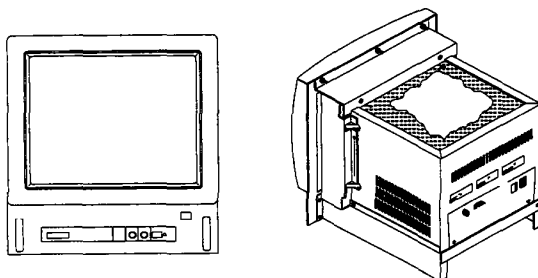
Model Numbering Convention

This section explains how to interpret the model number of the 20 monitor. The following diagram identifies the sections of the model number.

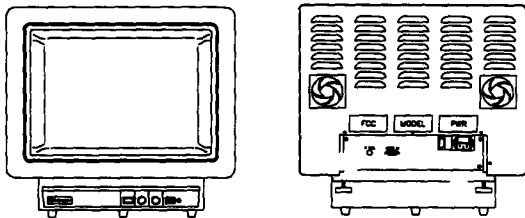
Model Numbering Convention



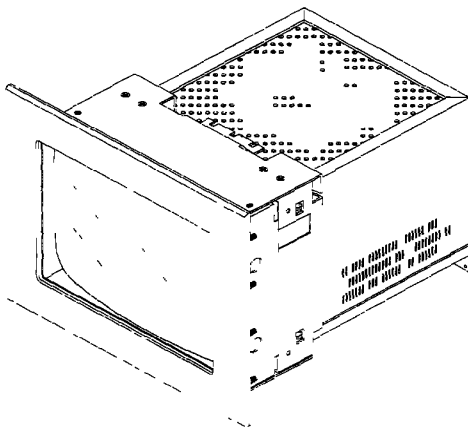
998011

Figures**20" Desktop Enclosure (EC)****20" Open Frame (FC)****20" 10U Rackmount Enclosure (RC)**

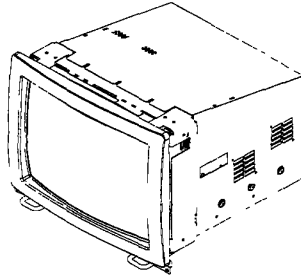
20" Benchtop Enclosure (BC)



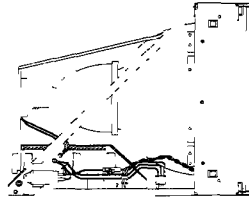
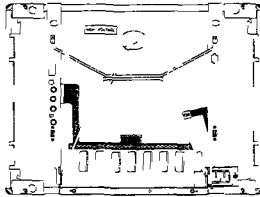
20" 9U Panelmount (PC)



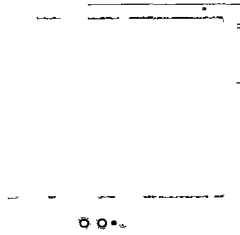
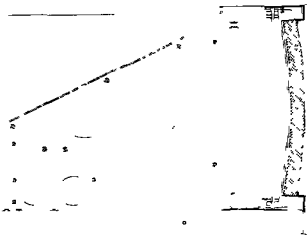
20" 9U Rackmount (RD)



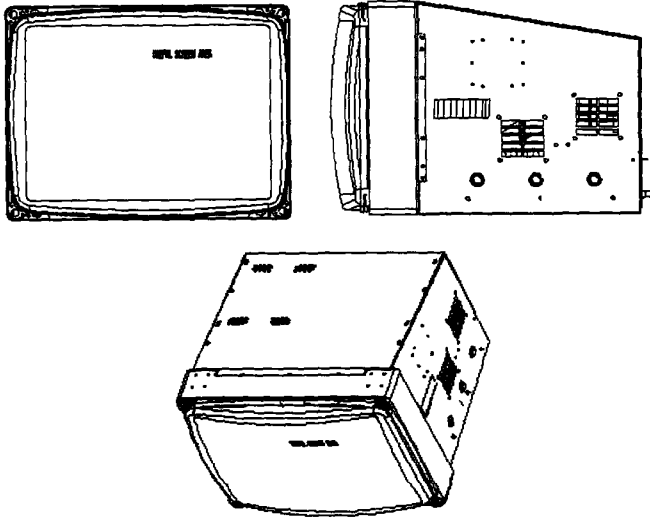
20" Open Frame - Short Model (CD)



20" Special Rackmount (RA-WA2)



20" Closed Frame (CC)



Unpacking and Installation

Unpacking the Monitor

Before unboxing a new monitor, inspect the shipping carton for damage. If damage is visible, immediately contact the shipper and request assistance. Otherwise, proceed with unboxing.

WARNING: Unboxing a 20" monitor requires lifting the unit, which can weigh from about 55lb to over 100lb, depending on configuration and enclosure, from floor level to a height of about 3 ft. To avoid the danger of personal injury, it is recommended that the lifting be done by two persons.

After unpacking, retain the original box and packing material in case the monitor must be shipped to another site or returned to Intecolor for any reason.

The monitor shipping carton contains the following items:

- **Monitor**
- **This User's Manual**
- **6ft AC power cord (when specified)**
- **6ft video cable (when specified)**
- **Package of mounting hardware and labels (panelmounts only)**

Note: An optional tilt and swivel base for a monitor with desktop enclosure may be shipped in a separate box when UPS packaging is used.

General Guidelines for Installation

When installing the monitor it is important to take account of environmental factors at the site which could affect performance. It is also important to consider possible effects of equipment operation on personnel and on other equipment nearby. Following the guidelines given in this section of the manual will ensure that the monitor provides safe and reliable service.

- Determine the power requirement for the monitor to be installed by consulting the specification sheets appendix. Ensure that sufficient power is available from a single phase AC outlet at the site.
- Determine the space requirement for the monitor by consulting the dimensional drawing for the appropriate enclosure type. Ensure that sufficient space is available around air inlets and outlets to provide the circulation necessary for cooling. Never allow air passages in the enclosure to become obstructed.
- Dust and smoke particles can cause problems, since they are attracted by the unit's high voltage components and can collect at ventilating holes in the enclosure and interfere with cooling. Even units which are supplied in sealed enclosures can be indirectly affected, since their enclosures are fitted with closed loop heat exchangers or air conditioners which have their own air vents. Accordingly, where dust and smoke are problems it is especially important to keep air vents and fan filters clean.
- Determine the maximum ambient temperature for the monitor by consulting the specification sheets at the back of this manual. This maximum is a function of the type of enclosure supplied with the monitor. Ensure that the ambient air temperature will not exceed this maximum. A user supplied fan, heat exchanger or air conditioner may be required to meet this condition in industrial installations of the console, rackmount or panelmount units into customer supplied enclosures.
- Magnetic fields in the environment can cause distortion of the monitor's display. Avoid situating the unit near the sources of strong fields, especially large motors, transformers or power busses, whenever possible. Rack cabinets and consoles which are made of steel can become magnetized through the use of arc welders in their construction and by other means. It is a good idea to degauss a steel enclosure before installing a rack mounting, panel mounting or open frame monitor in it. Even the earth's magnetic field can cause minor distortions of the display in some cases.

General Guidelines for Installation (con't)

- The monitor is normally equipped with a high contrast anti-glare screen suitable for operation under normal indoor lighting conditions. Operator adjustable brightness and contrast controls are provided on monitors supplied in free standing enclosures to compensate for variations in ambient lighting. Some monitors are supplied to customer specification without glare treatment and/or without controls. In any case, situating the monitor screen in the glare of direct artificial light or sunlight should be avoided.
- Leave the monitor's enclosure or cover in place at all times during operation. The cover affords protection against high voltages inside the monitor and inhibits radio-frequency emissions.

which might interfere with other equipment

The Federal Communications Commission has prepared a pamphlet which addresses the problem of **radio frequency interference** to radio and television reception, which should be consulted in case of problems with such interference. This publication, "How to Identify and Resolve Radio/TV Interference Problems" (Stock #004 000-00345-4) may be obtained from the US Government Printing Office, Washington, DC 20402

- Determine the minimum and maximum ambient **humidity** for the **monitor** by consulting the specification sheets at the back of this manual. Ensure that the humidity of the ambient air will not exceed these limits. In very dry environments, static charges build up very readily. Proper grounding of the equipment through the AC power cord can help reduce the likelihood of static discharges, which may cause shocks and damage electronic components.

Note: X-ray emissions from Intecolor monitors are lower than the maximum levels allowable under the US code for television receivers

Rack Mounting

The rack mounting versions of the 20" monitor are designed for installation in a rack cabinet that conforms to EIA standards for equipment with 19"(483mm) wide panels. This section applies to both the 10U and 9U rackmount units.

The cabinet must be tall enough to accommodate the monitor's panel height of 9 or 10 rack units, 15.75" (400mm) or 17.5"(445mm) respectively, and deep enough to accommodate the monitor's depth while providing rear clearance for cabling and air flow. A cabinet with depth of 22" (559mm) is sufficient.

The monitor is designed to be supported in the cabinet by telescoping slides. Slide mounting points are provided on the lower sides of the monitor chassis. These mounting points are designed to accommodate General Devices Co. Chassis-Trak® Model C-300-S or equivalent slides. Slides of this kind are available from Intecolor in 18" and 24" lengths, with or without 6" extenders.

Note: The mounting rails that run vertically along the inside edges of the front and rear openings of EIA rack cabinets can be of two types. "Wide" rails have holes spaced 5"(127mm) and 1.25"(31.8mm) on centers, in a repeating pattern. These rails are prevalent in Europe.

"Universal" rails have holes spaced 5"(127mm), 6.25"(31.8mm), and 6.25"(31.8mm) on centers, in a repeating pattern. Thus, the "Universal" rails have a hole pattern that contains the "Wide" pattern but provides an additional hole at the midpoint of the pattern. "Universal" rails are most prevalent in the US.

In addition to the installation procedure, the following subsections also include additional information about the 10U and 9U monitors:

10U Rackmount Monitor

The 10U monitor has two sets of mounting points for slides located along the sides of the chassis

- **Upper mounting points** (identified by "R")
Used for most installations. These points are located 1 75" (44 45mm) above the bottom edge of the chassis and front panel.
- **Lower mounting points** (identified by "W")
Provided for specific customers with special mounting requirements. These points are located 1 22" (30 99mm) above the bottom edge of the chassis.

In addition, the front panel has two pairs of holes

- **Lower pair**
Located 0 85" (21 59mm) above the bottom panel edge. If mounting the unit in cabinets that have "Universal" rail patterns, the lower pair may be used for retainer screws.

Note: Retainer screws prevent the unit from being pulled out on its slides accidentally. They are not intended to support the weight of the unit.

- **Upper pair**
Located 1 48" (37 59mm) above the bottom panel edge. This upper pair is available for custom mounting configurations. Retainer screws can not be used when mounting in a cabinet with "Wide" rail hole spacing. The reason is that the retainer screws used in installations of standard cabinets would interfere with the retainer screws that hold the slides to the front rails.

10U Rackmount Monitor

Rack Mounting Procedure

Step by step instructions for mounting follow. This procedure applies to both the 10U and 9U units

1. Locate the points on the cabinet front and rear mounting rails where the slides are to be mounted
 - a First, locate the points at which the bottom edge of the monitor front panel will intersect with the cabinet front mounting rails. The holes in the monitor front panel (lower corners) should be aligned with holes in the front mounting rails.
 - b Next, locate points on the front rails 1 75 '(44 5mm) for the 10U, or 3 5 '(88 9mm) for the 9U, above the points of intersection. The center line of each slide should cut across these points.
 - c Finally, locate points on the rear rails equal in height to the slide center line points on the front rails.

Note: Clearance between the inside edges of the front mounting rails is nominally 17 75 '(451mm) for standard cabinets.

This clearance can vary somewhat and might or might not be adjustable. Insure that the clearance is at least 17 65 '(449mm) for standard monitors and at least 17 73 '(450mm) for monitors with Option 0E4001 magnetic shields installed.

Note: Option 0E4001 magnetic shields are secured with nylon rivets inserted through their sides. The rivet heads require clearance greater than 7 73 '(450mm). If this additional clearance is not available the rivets must be removed before the monitor is installed in the cabinet.

2. Disassemble each slide by first pressing out the spring loaded stop that holds the intermediate section of the slide to the stationary section. Then pull the intermediate section all the way out of the stationary section.
3. Mount the stationary section of the left slide to the front and rear mounting rails of the cabinet's left side, using the hardware supplied with the slides.
4. Tighten the mounting screws only enough to hold the slides in place. In a similar manner, mount the stationary section of the right slide.

Note: Slides are usually supplied in 18" or 24" lengths. Eighteen inch slides may be fitted to cabinets with depths between 18" and 24", by first installing extenders on the stationary sections of the slides. Likewise, 24" slides may be fitted to cabinets with depths between 24" and 30".

5. Adjust the spacing between the inside edges of the stationary sections of the slides to 16 8 '(427mm) and fully tighten the mounting screws holding the stationary sections to the front and rear mounting rails of the cabinet.
6. Locate holes in the cabinet front mounting rails corresponding to the holes near the lower left and right corners of the monitor front panel. Install clip nuts behind the holes in the rails.
7. Take up the sections of the slides that were previously removed from

the stationary sections. Pull the interior sections out of the intermediate sections far enough to gain access to the mounting holes drilled in the interior sections.

8. Align the left interior section's mounting holes with corresponding holes on the left lower side brace of the monitor chassis. Attach the interior section of the left slide to the left side of the chassis with hardware supplied. Tighten screws securely. Attach the interior section of the right slide to the right side of the chassis.
9. Install the monitor chassis, with slide extensions installed, into the prepared cabinet from the front of the cabinet. Lift the monitor chassis to the height required for alignment of the intermediate sections of the slides (attached to the chassis) with the corresponding stationary sections (attached to the cabinet rails). Push the intermediate sections of the slides into the stationary sections until the retaining locks are engaged.

WARNING: To avoid danger of personal injury or accidental damage to equipment, it is recommended the monitor be lifted by two persons, both wearing back braces.

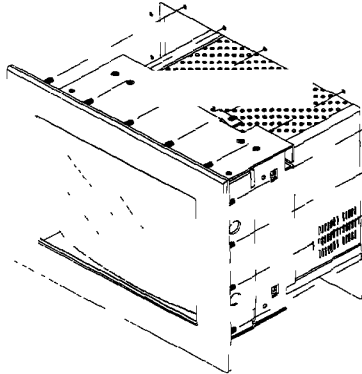
10. If the monitor will be accessible from the rear after installation, cabling may be installed from the rear at a later time. Otherwise, power and video cabling should be installed at this time, while the monitor is supported by the slides in extended position.
11. Slide the chassis into the cabinet. Secure the monitor chassis to the cabinet by installing screws through the holes near the lower corners of the monitor front panel in such a way that they engage the clip nuts installed previously behind corresponding holes in the rails.

Panel Mounting

The Panelmount units have a panel height of 9U (15.75" or 400mm) and are equipped with rear controls (A remote control option is available) They are designed to provide protection against water and dust to NEMA 4 and NEMA 12 standards when properly installed

Note: This monitor can be mounted in EIA racks that have rails with either Universal or Wide hole patterns

Panelmount Diagram



No slides or shelves are required because these panel mounting units are designed to be held in place and supported by the panels in which they are installed

The supporting panels should be at least 14 gauge to ensure proper sealing against water and dust and to provide proper support. The mounting hardware supplied accommodates panels up to 0.25" (6.35mm) thick. Supporting panels must be cut and drilled to Intecolor specifications prior to installation.

Alternatively, these units may be bolted to the front rails of EIA standard 19" rack cabinets. Their mounting stud patterns (or bolt hole patterns) correspond to the hole patterns on the front rails of such cabinets.

The cabinet which is to receive the monitor must provide adequate interior clearances. Refer to the appropriate drawings for the required clearances behind panel heights and widths.

The cabinet should be deep enough to accommodate the monitor's depth while providing rear clearance for cabling and air flow. A cabinet with a depth of 22" (559mm) is sufficient.

998011

Tools you will need to install the unit include

- 3/8" Deep Well Socket
- 1/4" Drive Extension - 12" or longer
- 1/4" Drive Ratchet or 1/4" Drive Torque Ratchet

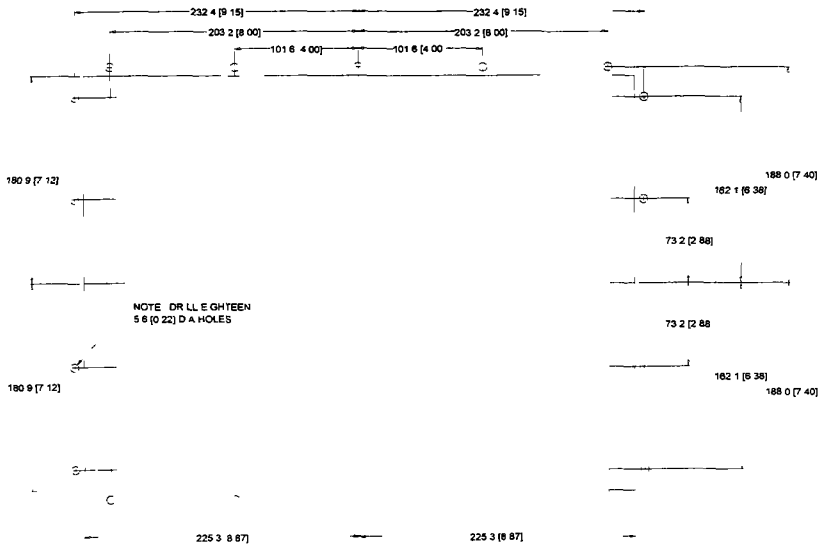
Follow the steps to install the 9U monitor. Refer to the panel cutout drawing below.

Panel Mounting Procedure

1. Cut and drill the panel as shown in the following figure. Units are in mm (inches).

Note: Use M5 or #10-32 self locking nuts for mounting.

Panelmounting Dimensions (9U)



Note: If access to the rear of the monitor is not available following installation, the power and video cables should be attached to the rear of the monitor at this time. In addition, any necessary adjustments of the rear panel brightness, contrast, size and position controls should be made at this time.

2. Install the monitor in the prepared cutout.
3. Install lock nuts and washers, supplied with the monitor, behind the holes running along the sides and top/bottom of the cutout in the panel.

WARNING: To avoid danger of personal injury or accidental damage to equipment, it is recommended the monitor be lifted by two persons, both wearing back braces.

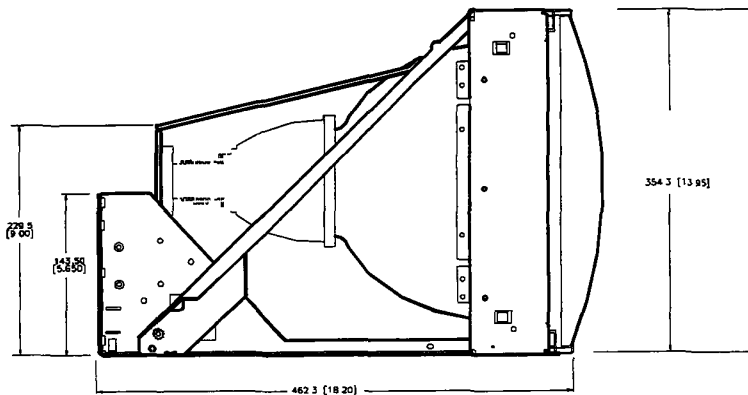
4. Tighten all mounting bolts evenly to a torque of 24 inch-pounds.

998011

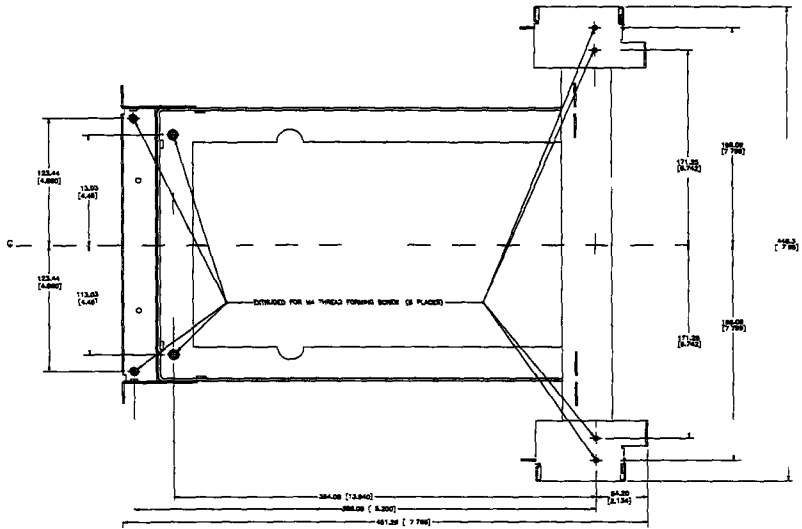
Installing Open Chassis Units

Open chassis monitors are designed for installation in customer supplied consoles. Mounting points are provided on the chassis base. Refer to the figures on this page and the following page for dimensioning and mounting information.

20" Chassis Installation (side view)



20" Chassis Installation (top view)

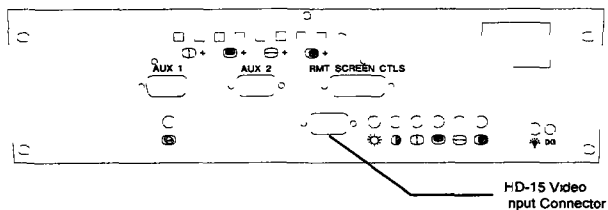


998011

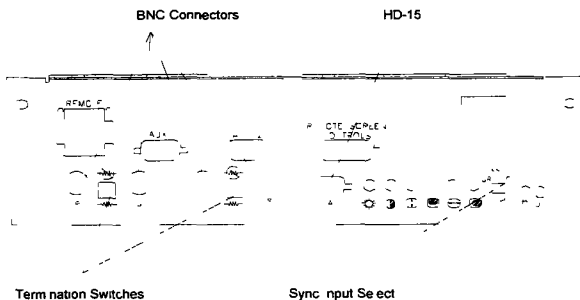
Video Signal Connections

Video cables connecting the monitor to the video signal source should be made up according to standard industry practice. Generally, they should be shielded, properly terminated, and as short as possible.

Back Panel for Model -210



Back Panel for Models -200 and -220



VGA HD-15 Interface

The Intecolor monitors described in this manual are equipped with female HD-15 video input connectors. In all cases, the connectors are wired in conformance with IBM VGA standard interface conventions ¹

The HD-15 input of the monitor may be connected via the standard cable to the output of any IBM compatible VGA adapter.

A six foot video cable terminated at each end with a male HD-15 connector (Option 0E2003) is available from Intecolor for use with this interface ²

The monitor's HD-15 input may be connected via other appropriate cables to video generators which do not conform to VGA standards. The main requirement is that the generator provide analog RGB video signals (0.286V Black level, 1.000V White level, into 75 ohms) and either separate horizontal and vertical sync signals, or a separate composite sync signal, in the appropriate frequency ranges.

Cable requirements for video generators that do not have VGA interfaces may be determined by referring to the video generator manufacturer's instructions and to the pin assignment diagram for the monitor's HD-15 connector given in an appendix to this manual.

Note: When using the HD-15 interface, the slide switch on the chassis or rear panel of the monitor should be in the center ("VGA") position.

RS-343 BNC Interface

The Intecolor monitors described in this manual with model numbers ending in -220 are equipped with 4 BNC connectors which accept red, green and blue video signals (RS-343 analog signaling), and (if necessary) a separate composite sync signal from the user's video source. The BNC interface provides access to built-in differential input amplifiers. Effective utilization of the differential input amplifiers is described in *Appendix C Using Differential Input Amplifiers To Eliminate Common Mode Noise In Video Systems*.

Connections between the monitor and the video source are generally made with 75 ohm coaxial cables fitted at each end with BNC connectors. Four such cables (all of equal length) are needed when separate composite sync is used, three when sync is supplied on the green video line. When connecting the cables for video and sync, ensure that the video generator's red output is connected to the monitor's red input, and so on. The BNC interface can be adapted to other types of video generator interfaces by means of special cables. For example, certain NEC, Matrox, and other video cards which operate within the range of Intecolor variable scan monitors but have DB-9 outputs can be connected by means of such cables. The main requirement is that the video generator present analog (RS343) video signals and some form of composite sync.

Note: When using the BNC interface, the slide switch on the rear panel of the monitor should be set for "G" (composite sync on green), or "CS" (separate

¹ See the *VGA HD-15 Interface* appendix for HD-15 pin-outs.

² Longer cables (up to approximately 130 feet, in some cases) may be used provided they are properly constructed. Separate 75 ohm coaxial cables must be used for transmitting the red, green and blue video signals. (See the *Long Video Cables* appendix.)

composite sync), depending on the method of synchronization to be used. Consult the documentation supplied by the manufacturer of the video generator to determine what method is being used.

Termination of the Video Inputs

A block of four miniature toggle switches is included on the chassis or rear panel of the monitor adjacent the BNC connectors. These switches are used for switching termination resistors in parallel with the monitor's video and sync inputs. Termination of the inputs with a 75 ohm resistive load (switches closed) is required when the monitor is situated at the end of the video transmission line, either because it is the only monitor, or it is at the end of a "daisy chain". This is the case whether the HD-15 VGA interface or the BNC interface is used.

Multiple monitors may be driven by a single video card by connecting the monitors in series or "daisy chain" fashion. Use the BNC interface, with "T" type connectors (available from Intecolor as an option) at the inputs of the intermediate monitors, and leave their termination switches in the open position. Only the last monitor in the chain should have its termination switches closed.

Power Connection

Intecolor monitors automatically adjust to the line voltage and frequency supplied to them (within the limits specified). No switches or jumpers need to be changed to match the monitor to the voltage supply.

A six foot UL Listed power cord suitable for 115VAC operation in the US is available as Option OE2101. The user might wish to use a different power cord, depending on the country in which the monitor is to be operated, the main voltage available, the distance to the main receptacle, etc.

In all cases, the power cord used should conform to one of the following specifications:

- **90-125 VAC Operation (USA):** UL Listed Cord Set (maximum 15 feet, minimum 18 AWG), type SVT or SJT, three conductor cord with a parallel blade, grounding type attachment plug rated for 10A, 125V
- **180-250 VAC Operation (outside USA):** Cord Set, 18 AWG (minimum) and grounding type attachment plug rated for 10A, 250 V. The Cord Set should be marked HAR and have the appropriate safety approvals for the country in which the equipment will be installed.
- **180-250 VAC Operation (USA):** UL Listed Cord Set (maximum 15 feet, minimum 18 AWG), type SVT or SJT, three conductor cord with a tandem blade, grounding type attachment plug rated for 10A, 250V

Power Connection Procedure

To connect the monitor to the AC supply, insert the female (unpronged) end of the AC power cord into its receptacle at the rear of the monitor. Then plug the male end of the power cord into a suitable outlet, outlet strip, or switched accessory outlet.

WARNING. The power outlet must provide **single phase AC**, sufficient power delivery capacity for the monitor(s) connected, and a **true earth ground** for the power cord's ground pin. **DO NOT** use a power cord which has become badly kinked, frayed or has any part of its inner conductor exposed.

Operator Adjustments

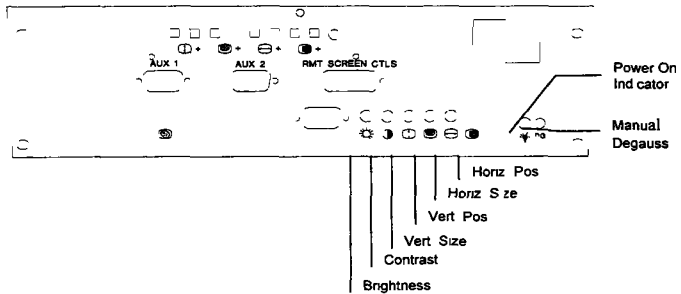
Viewing Angle Adjustment

The 20" desktop and benchtop enclosures have optional tilt-swivel bases which allow adjustment for a comfortable viewing angle and a minimum of glare.

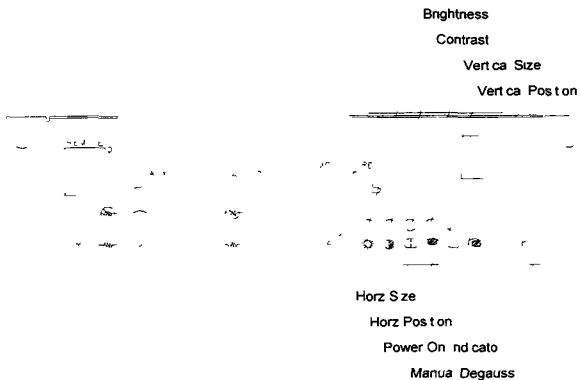
Operator Controls and Indicators

All versions of the monitor are furnished with rear panel controls. Front panel controls or external controls may be installed on some units. When front or external controls are present, the corresponding rear panel controls are disabled. The rear panel controls on 20" monitors are laid out as shown in the following illustrations.

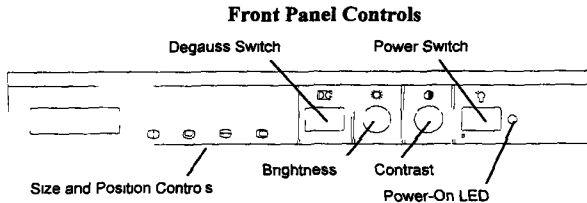
Rear Panel for Model -210



Rear Panel for Models -200 and -220



Monitors with desktop and rackmount enclosures have front panel controls and a front panel LED. The controls are laid out as shown in the following illustration.



Controls and Indicators



Power Switch

Turn on the monitor by pressing the right side of the switch marked "1". (Pressing the left side of the switch marked "0" turns the unit off.)

Status LED

When the monitor is powered up and operating correctly, the status indicator LED (green) will be illuminated. If the light should go out while the power switch is in the "on" position, a misadjustment or malfunction has occurred. Remove power immediately.

WARNING: Do not assume that the monitor is powered off when the status LED is not lit.



Brightness Control

Use the brightness control to adjust the overall intensity of the display. After allowing the CRT to warm up for at least a minute, adjust for the least amount of brightness needed to make the display clearly viewable.



Contrast Control

Use the contrast control to vary the difference between the display's light and dark elements. With a suitable image displayed on the screen, adjust the contrast control to achieve the best balance between image brightness and fine detail rendition. The optimum setting may vary slightly with different types of displays and changes in ambient lighting, as well as individual taste.

998011



or



Manual Degaussing Button

The display screen is degaussed automatically each time the monitor is powered on. This degaussing eliminates color impurities and other distortions of the display by neutralizing the effects of magnetic fields in the surrounding environment.

When the unit is left on for a long period, or is repositioned following power-up, the screen may pick up additional magnetic flux, causing colors to appear "blotchy" or otherwise distorted. If this happens, degauss the screen manually by pressing the degaussing button. For full effectiveness, allow at least fifteen minutes between manual degaussings. Shorter intervals may result in an incomplete removal of flux and residual color impurities.

If the unit is located near electric transformers, motors, loudspeakers or other strong magnetic sources, degaussing alone may not be sufficient to eliminate interference. Try reorienting the unit relative to the magnetic source or moving the monitor further away. If this still does not solve the problem, consider using Intecolor's magnetic shielding option (available for all but desktop enclosures).



Vertical Size

Use this control to make the display taller or shorter. Consult the chart following for recommended display height.



Vertical Position

Use this control to center the display vertically on the screen.



Horizontal Size

Use this control to make the display wider or narrower. Consult the chart below for recommended display width.



Horizontal Position

Use this control to center the display horizontally.

Recommended Size Settings Table

	Vertical Size	Horizontal Size	Screen Resolutions
3:4 Aspect	10.60" (270mm)	14.17" (360mm)	640 x 480, 800 x 600, 1024 x 768
4:5 Aspect	10.60" (270mm)	13.25" (337mm)	1280 x 1024

Routine Maintenance

Cleaning

Occasionally clean the monitor panel and cabinet with a soft cloth dampened (not soaked) with a mild household detergent (non-abrasive) Ensure that air vents are cleared of dust

The screen may be cleaned with a soft cloth dampened with a mild glass cleaner Keep turning a fresh side of the cloth toward the screen surface to avoid scratching it with accumulated grit To minimize the risk of abrasion, allow the screen to stand dry

Special care should be taken when cleaning a resistive touch screen or polycarbonate shield that is installed over the CRT screen The surface can be easily damaged by abrasive and certain chemical cleaners Never use alcoholic or ammoniac cleaners

Replace air filters over fans or heat exchanger intakes periodically to ensure proper air flow for cooling (Applicable to units in some industrial enclosures)

Line Cord Replacement

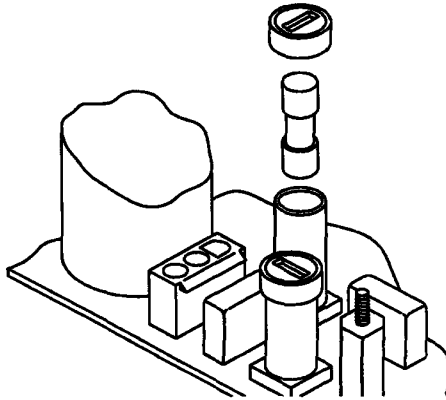
To avoid shock and fire hazards, the Intecolor monitor's power cord should be replaced if the insulation becomes broken or if it develops a loose internal connection

Fuse Replacement

Line fuses (2) are situated inside the monitor chassis on the main circuit board, at the rear corner of the board nearest the AC input connector Refer to the figure on the following page

WARNING: Fuse replacement requires work in areas that can present dangerous voltages Always disconnect the AC power cord and wait one minute before attempting fuse replacement Replace rear cover before restoring power to the monitor

Circuit Board with Fuses



Fuse Replacement Procedure

1. First unplug the power cord and remove the monitor's rear cover (except on open frame units)
2. Insert the tip of a flat-bladed screwdriver into the slot of the fuse holder and twist counter-clockwise to remove the holder from the receptacle
3. Replace the fuse with a new unit having the same rating and reinsert the holder

Note: If the fuse continues to blow, consult a qualified service technician

WARNING: To avoid danger of fire, always replace the fuse with one of the same type and rating

Other Maintenance

All maintenance (other than fuse and power cord replacement described above) should be performed by qualified service personnel only

Users' Guide to Analyze and Correct Problems

Common Problems and Possible Solutions

The problems most frequently encountered by users are also the easiest to correct. By following the procedures outlined in the following table, the user can often correct a problem immediately, without recourse to a specially trained service technician.

Otherwise, he or she will be confident that service is in fact required, and will be in a position to provide valuable information to service personnel.

Trouble Shooting Table

Symptom	Possible Problem	Action
Status LED does not come on when power switch is closed	Power cord not connected	Open power switch. Reconnect power cord at monitor and at AC outlet. Close power switch.
	No power available at AC outlet	Test AC outlet by plugging in a lamp or other known good device.
	Power cord faulty	Replace power cord.
	Monitor faulty	Have monitor serviced.
Status LED is on, but screen is blank	Screen saver activated	Disable screen saver by activating an input to the host system.
	Brightness and contrast controls not properly adjusted	Turn brightness and contrast controls CW.
No raster visible even when brightness and contrast controls are set full CW	Monitor out of adjustment or faulty	Have monitor serviced.
Raster dimly visible with brightness and contrast controls set full CW, but no display present	Video cable problem	Check for proper installation of video cable(s). Refer to installation instructions. Replace suspected faulty cable(s).
	Fault in video source	Test video source by connecting to another monitor that is known to be operational.
	Fault in monitor	Have monitor serviced.
Display is present, but garbled or rolling	Monitor not synched to video source	Refer to installation instructions. Check for proper video cable installation. Replace suspected faulty cable. Check to ensure that video source is operating within the monitor's range.
Display is present and stable, but appears "wrapped" at one side or otherwise not properly centered or sized	Size and position controls misadjusted	Adjust controls for proper size and position of display. Refer to operator instructions.

Symptom	Possible Problem	Action
Display is present and stable, but missing some color(s)	Video cable problem	Check for proper video cable installation If using BNC inputs, test monitor as follows: Disconnect signal cable(s) corresponding to the missing color(s). Disconnect signal cable corresponding to a displayed color and connect it to the input(s) corresponding to the missing color(s). If a missing color reappears, the signal cable corresponding to that color is faulty, otherwise, the monitor is faulty. Replace suspected faulty cable
	Fault in monitor	Have monitor serviced
Display is present and stable, but colors are not pure	Monitor requires degaussing	Manually degauss the monitor Refer to operator instructions
Display is present, but "jitters" or is severely distorted NOTE: Do not confuse the flicker associated with an interlaced video mode with jitter	Interfering external AC or DC magnetic shield	If possible, reposition the monitor beyond the proximity of large transformers, motors, bus bars, etc. Ask Intecolor about various shielding options available to protect the monitor
Display is present, but "bars" appear across it	"Noise" generated by other equipment in the environment is present at the video inputs	Consult the application note which discusses methods of eliminating noise using the monitor's differential inputs

Obtaining Service

Technical Support is available for all Intecolor products, both in and out of warranty.

For the nearest service center, please do one of the following:

- Call (770) 622 6202
- Fax the request for service to (770) 623 9165 with Attention Technical Support

Obtaining Service in North America

Depot repair service for all Rockwell Intecolor products, both in and out of warranty, is available at the Rockwell Intecolor factory in Atlanta, Georgia, USA.

- For repairs call customer service at (770) 623 9145
- For 24-hour technical support, call (770) 393 5904

Obtaining Service in Europe

Rockwell Intecolor Europe, located in Amsterdam, provides technical support and repair services for the EC. The telephone number for this office is (011) 31 29-753 1262.

On Site Service

On site service is available anywhere in the world with 48 hours notice. The fee for this service is travel and expenses plus \$100/hr on-site, with a 16 hour minimum. Call Rockwell Intecolor customer service in Atlanta at (770) 623 9145.

Appendix A: VGA HD-15 Interface

HD15



This figure is the view looking into the pin end of the male connector or solder term end of the female connector
The female HD-15 connector on monitor rear panel has the following pin assignments

HD-15 Pin Assignments Table

Pin	Signal	Description
1	Red Video	Input, Analog
2	Green Video	Input, Analog ³
3	Blue Video	Input, Analog
4	ID2	Output, TTL low
5	Composite Sync	Input, TTL, pulsed
6	Red Return	
7	Green Return	
8	Blue Return	
9	Reserved	
10	Ground	
11	ID0	Output, TTL low
12	ID1	Output, TTL floating
13	Horz Sync	Input, TTL, pulsed ⁴
14	Vert Sync	Input, TTL, pulsed
15	Reserved	

³Monochrome video generators should present video to this pin. Composite sync may be presented to this pin together with green or monochrome video. In this case, the monitor's sync selector switch must be set to Sync on Green³

⁴With a VGA adapter, the polarization of this signal, together with the polarization of the vertical sync signal, vary with the adapter's operating mode as shown in the table below. This mode information is not needed by Intecolor monitors, since they are variable scan monitors.

Signal	Mode 1	Mode 2	Mode 3	Mode 4
H Sync	+	-		+
V Sync	-	+		+

Appendix B: Dealing with Magnetic Interference

Geometric and Color Distortion

The display on a computer monitor's cathode ray tube (CRT) is produced by the modulation of the drive currents of the tube's electron guns as the beams produced by the guns are swept over the screen in a raster scan pattern by a magnetic deflection system. The fact that the electron beams can be controlled by magnetic devices designed for this purpose and situated within the monitor indicates that they can also be subject to the influence of magnetic fields produced outside the monitor.

An external field can act directly on the CRT's electron beams, distorting the geometry of the display. An external DC field directed perpendicular to the longitudinal axis of the CRT (i.e., a transverse field) will tend to cause a displacement of the display, while a DC field directed parallel to the axis will tend to cause a rotation.

Similar effects are produced by AC fields, except that the displacements or rotations have alternating directions, according to the frequencies of alternation of the currents associated with the field sources. These alternations are usually seen as "jitter".

Metal Shadow Masks

Color monitors are subject to an additional type of interference from external fields. The CRTs in these monitors are equipped with perforated metal shadow masks, situated immediately behind their faceplates, used to keep the electron beams properly aligned on their respective phosphor dots. The shadow mask is intended to keep the colors in the display "pure" by absorbing beam energy that is not properly directed, however, the shadow mask can become magnetized, and its residual magnetism can produce misalignment of the beams sufficient to produce considerable color blotching. It is most common for a shadow mask to become magnetized by involving the physical movement of the monitor in such a way that the shadow mask cuts across the lines of the earth's magnetic field.

Earth's Magnetic Field

Effects of the earth's magnetic field on monitor displays are not generally a problem in fixed installations. Most monitors, including all Intecolor products, are equipped with automatic and manual degaussing systems to neutralize the effects of the earth's field on the shadow mask. Compensation for the effects of the field on the deflection system is generally accomplished, in such cases, by mechanical adjustment of the yoke for a given broad geographical area. However, in mobile installations (shipboard installations, for example) the case is different. Here, the monitor is being reoriented continuously with respect to the earth's field, and some kind of shielding is required since continuous degaussing and readjustment of the yoke are not generally practical.

Industrial Settings

There are many sources of magnetism which can affect a monitor. Industrial installations are often complicated by the presence of large buses, motors or transformers which generate very strong fields. The effects of such fields can be severe. Since they are often associated with low frequency alternating currents, they often produce their major symptom by interacting with the vertical deflection system of the monitor. The result is a vertical jitter that can make the display completely unreadable.

One particularly elusive source of magnetic interference in industrial settings is the permanently magnetized steel cabinet. Monitors are often mounted in console cabinets without regard to the possibility that these cabinets might have become permanently magnetized in one way or another, even in the course of their fabrication through the use of arc welding.

Another problem related to console installations arises from the fact that monitors are not only subject to external fields, but also produce fields themselves (through their deflection systems). When mounted in very close proximity to one another in a single console, two or more monitors can interfere with one another.

Identifying the Source

A summary of the most common types of magnetic interference to monitors, together with symptoms and possible remedies, is provided in the following table.

Magnetic Interference Identification Table

Source of Interference	Most Common Symptom	Possible Remedy
Earth's field	Color impurity raster rotation	Degaussing yoke alignment, or (for mobile installations) shadow mask shield
Adjacent monitor	Color impurity vertical jitter, ripple	Cylindrical yoke shield to contain the field produced by the yoke of the adjacent monitor
Magnetized cabinet	Color impurity	Demagnetize cabinet
Large DC bus	Severe color impurity severe geometric distortion	Ferrite shield (a high permeability, low remanence alloy is generally required double shielding may be required in extreme cases)
Large transformer, motor etc nearby	Color impurity severe jitter ripple	Full shield (carbon steel shielding is effective in some situations involving AC fields)

Summary

In general, some kind of shielding is generally required to protect the monitor from the effects of the external field. However, it is good to consider the possibility of moving an affected monitor or moving the affecting source before shielding. In some cases, an interfering magnetic source (for example, a small transformer mounted near a monitor, or a small conductor running alongside a monitor in a cabinet) can be moved or reoriented with little effort, producing a major improvement in monitor performance.

The rationale here depends on the basic law of magnetism (Coulomb's law), which states that the force exerted by a magnetic pole on another magnetic pole is inversely proportional to the square of distance between the poles. If the interfering source is considered to be a magnetic dipole, and the monitor is thought to lie between its two poles on a line connecting them, it is subject to the force acting between the poles. The line is then considered as a flux line, or line of force. When this line is straight, or in other words, when the monitor lies directly between the poles, the force acts on it with maximum intensity, since it acts over the shortest possible distance. (The intensity H on a given line is the force per unit length of the line or F/L .)

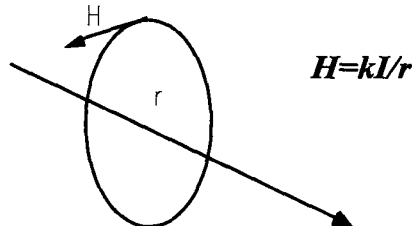
If the monitor is moved in such a way that there is still a flux line passing through it and connecting the poles, but no longer straight, the line becomes longer, and the intensity of the force acting on the monitor is reduced in proportion. Thus the effect is the same as if the two poles of the source were moved apart while the monitor stayed on a straight line between them.

Whether or not shielding is indicated, and whether shielding would be most effective and cost efficient if applied to the source rather than to the monitor, it is always helpful to know the source of the interfering field and its strength and orientation at the point of interest. The following sections of this paper describe fields of various kinds, methods for estimating their strengths, and general considerations regarding shielding against them.

Using the Biot Savart Law to Estimate the Field about a DC Bus

When the source of the field is known to be a large current carrying conductor (bus), and this conductor is laid out in a straight line, the strength H of the field at any point on a circle of radius r about the conductor is related to the current I in the bus by the Biot-Savart law

Biot-Savart Law Diagram



The Biot-Savart law holds for situations in which the radius of interest is much smaller than the straight run of the bus

The constant k is 2 when the current, radius and the field strength H are expressed in cgs units of abamperes, centimeters and Oersteds (Gilberts/cm), as is common practice in industry. If the MKS system of measurement were used, k would be $1/2\pi$. In that case, current would be expressed in amperes, the radius in meters, and the field strength in amperes/meter.

Let us take an example. If a bus is carrying 300A DC, and a monitor is to be mounted 10 feet away from the bus, the strength of the field produced by the bus as seen by the monitor would be given by

$$H = 2 \frac{300 \cdot 10^3 \text{ abamperes}}{10 \cdot 12 \cdot 2.54 \text{ cm}} = 0.197 \text{ Oe}$$

Alternately, the field could be characterized in terms of its flux density. The flux density B of the field at the point of interest is given by

$$B = \mu_0 \mu_r H$$

where μ_0 is the magnetic constant (the permeability of free space), and μ_r is the relative permeability of the magnetic medium. The magnetic constant is equal to 1 maxwell/gilbert cm in the cgs system (or $4\pi/10^7$ weber/ampere-meter in the MKS system). In this case the medium is air, which like most non-magnetic materials, has a relative permeability approximately equal to 1. Therefore, we have

$$B = 1 \cdot 1 \cdot 0.197 = 0.197 \text{ gauss}$$

One of the conveniences of the cgs system is the fact that the magnetic constant assumes the value of unity under it. This allows one to work with relative permeabilities. Another convenience is the fact that the flux density B in air is numerically equal to the field strength H . The unit of flux density is different than that of field strength, of course. In this case, where H is 0.197 Oersteds (Gilberts/centimeter) B is 0.197 gauss, that is, 0.197 lines of force (Maxwells) per square centimeter.

Once the strength (or density) of the field has been calculated by this method, it only remains to determine if this level of magnetism at the point where the monitor is to be installed is sufficient to produce any distortion of the monitor's image

Summary

Although an application of the Biot-Savart law can provide a rough idea of the field produced around a straight conductor, it is of no use for estimating the strengths of other types of fields, and even most buses do not reflect well the assumptions involved in its application. Overall, some kind of actual measurement of the field is the best basis for choosing a shield. Identification of an elusive source and approximation of a source's strength are relatively easy when a magnetic sensor is available. Directional magnetic sensors which attach to digital VOMs and oscilloscopes are readily available at low cost and greatly aid in the diagnosing of magnetic interference problems.

Determining the Correct Shield Material

General

Knowledge of an interfering field's strength (and its orientation) at the point of installation is important for determining the proper type of material for the shield and its physical configuration. Shields are generally made of ferromagnetic materials, which are characterized by their high magnetic permeabilities (much greater than 1) and by the fact that their permeabilities vary with field strength. Permeability is a physical property which determines how a magnetic force distributes itself in the material's volume. Where the permeability is high, the force remains more concentrated, where the permeability is low, the force is dispersed in a larger volume. High permeability materials (including iron, nickel, cobalt and alloys made from these elements) can function as good shields precisely because fields tend to concentrate themselves in them rather than dispersing themselves in the spaces they enclose. The flux lines, imaginary lines which represent the contours of the field, become packed together in the shield material, running through it rather than through the shielded volume, whose material has a lower permeability. Materials can be arranged into four broad classes with respect to their magnetic properties, as shown in the table below.

Permeability Classification Table

Class of Material	Relative Permeability	Examples of materials in this class
ferromagnetic	$\mu_r \gg 1$ and varies with H	iron nickel cobalt
paramagnetic	$\mu_r > 1$	aluminum beryllium
non-magnetic	$\mu_r \approx 1$	air plastics
diamagnetic	$\mu_r < 1$	bismuth antimony silver

Field Strengths

Ferromagnetic materials differ widely, and some are better suited for specific applications than others. In particular, as already mentioned, the permeability of a ferromagnetic material varies with field strength. Indeed specific materials exhibit specific characteristic permeability changes with field strength.

Certain types of nickel steel alloys ("mumetals") exhibit very high permeabilities (permeabilities relative to that of free space in the order of 500,000), for relatively weak fields (in the order of $1.0E-4$ to $1.0E0$ Oersteds). The very high permeabilities of these materials are realized by means of a process called annealing, in which they are heated to very high temperatures in a dry hydrogen environment and then allowed to cool very gradually in order to remove all residual magnetism. They are excellent choices for shielding against low level and moderate strength fields because they provide excellent attenuation without becoming permanently magnetized themselves. (They exhibit the additional magnetic property of low remanence.) However, because their effectiveness depends in part on the annealing process, these materials cannot be worked without special equipment.

As field strengths increase above about $1.0E+1$ Oersteds, mumetals (in ordinary physical configurations) tend to become magnetically saturated. That is, a limit is reached at which the application of additional magnetic force does not result in an additional concentration of magnetic flux in the material.

The range of application for mumetals as shields can be extended to some extent by changing the physical configuration of the shield material. Double shielding is even used from time to time. However, it sometimes makes more sense to switch to a different ferromagnetic material when field strengths become very high. Carbon steel (cold rolled sheet steel in convenient thicknesses) has permeability characteristics which allow it to provide effective shielding for fields with strengths in the $1.0E-1$ to $1.0E2$ Oersted range.

Carbon steel does not have the low remanence characteristics of mumetal, and could become permanently magnetized to some extent by the force against which it is designed to protect. Carbon steel is best for use when the source of the field is a low frequency alternating current rather than a continuous direct current.

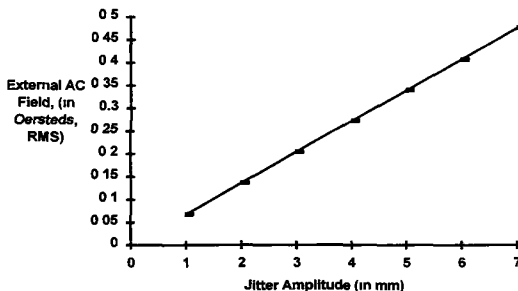
Thresholds for Monitors

For (unshielded) Intecolor 20 monitors, there is a fairly well defined threshold beyond which the strength of an external 50Hz or 60Hz AC field becomes sufficient to produce visible effects on the display. This threshold is about 7 millioersteds (equivalent to a flux density in air of 7 milligauss) for transverse fields.

When affected by an AC field of this strength or greater, the display usually exhibits a vertical or horizontal jitter with a frequency equal to the frequency of alternation of the current producing the field. The peak to peak amplitude of this "jitter" is proportional to the strength of the field and provides a rough indication of field strength.

On a color monitor, jitter of this type is usually accompanied by some color bleeding, and color bleeding often appears even before the jitter.

Field Strength versus "Jitter" Amplitude Graph



DC Fields

For external uniform DC fields, the situation is similar. A displacement of the display is proportional to the strength of an external field (acting transversely), and a field as small as a few millioersteds can produce a visible effect. For example, if a uniform external DC field with a flux density of about 30 milligauss were brought to bear on the top of an unshielded monitor, the electron beams would be displaced to the left about 0.15mm. Since the distance between the screen's phosphor dot trios, and hence between the holes in the shadow mask, is typically about 0.31mm (for a 20" monitor), the beams would be deflected in such a way that they would land on the shadow mask and not go through the holes. This would be sufficient to reduce light output.

To the extent that a DC field is continuously present and the monitor remains in a fixed relationship to it, its effects can go unnoticed. Only when the field is very strong (greater than 1 gauss), or when the monitor is moved in relation to the field, does a visible effect tend to appear. The effects of the earth's field (which, in North America, has a horizontal component of about 0.2 oersteds and a vertical component of about 0.5 oersteds), generally appear only following a movement. For example, if a monitor were oriented initially to the East, so that the horizontal component of the earth's field impinged on the left side, and were then rotated in the horizontal plane by 180 degrees, so that its screen faced West and the earth's field impinged on its right side, the change in the magnetic field of about 0.4 gauss would move the display upwards something over 2 millimeters. (This is valid for a 20" monitor only.)

Intecolor Magnetic Shields

Intecolor Corporation provides various types of magnetic shields designed to protect its monitors in shipboard applications and against some forms of interference typically encountered in industry.

Appendix C: Long Video Cables

General

Users of Intecolor monitors often ask about the maximum permissible length of the cables supplying a monitor's video signals. Intecolor's engineering department has conducted tests which provide a basis for answering this question.

Test Description

Tests were conducted on an Intecolor model E01978 monitor connected to a Quantum video generator by way of various lengths of Belden 9259 RG-59 style 75 Ohm coaxial cable. The generator was set to drive the monitor at 1280x1024 resolution using a 130MHz pixel clock. Observations of the monitor's display were made, and measurements of video rise and fall times were taken using cable lengths of 6, 75 and 250 feet.

Results

The 6 foot cable test provided a baseline for evaluation of longer runs. Here, the display appeared crisp and stable and video signal rise and fall times as measured at the monitor's BNC input terminals were about 5 nanoseconds.

There was no appreciable degradation of performance with 75 feet of cable. The measured rise and fall times were about 10% longer than those for the 6 foot cable, but there was no observable change in display quality.

With the 250 foot coax in place, rise and fall times were nearly twice the values measured with the 6 foot cable (about 10 nanoseconds). The observed display quality was somewhat diminished. However, the smallest font available on the Quantum generator was still legible, vertical lines were well defined, and it was still possible to see the 1 on/1-off vertical grid in the SMPTE pattern.

Conclusion

Provided one uses a high quality, low loss coaxial cable with characteristics similar to the Belden 9259 (rating 3dB loss per 100 feet at 100MHz), 100 foot runs should present no problem for pixel clock rates up to 130MHz.

Depending on the application, runs up to 250 feet may provide acceptable results, even at 130MHz. Lower frequency applications should be more tolerant of long cable runs, since the maximum permissible length is inversely proportional to the pixel clock frequency. A monitor used in a VGA application should do fine with 250 feet of quality cable.

However, two things should be kept in mind. First, it is essential that all signal lines (RGB and separate Sync, if used) have identical cables of the same length. Secondly, long cables not only attenuate and distort video signals, but also provide a path for the introduction of noise.

Summary

The testing described here measured only the attenuation factor and did not take noise factors into account. Noise pickup is highly dependent on the environment of a given installation. It requires separate treatment. Refer to the application note on differential input video amplifiers for a complete treatise on this subject.

998011

Appendix D: Using Differential Input Amplifiers To Eliminate Common Mode Noise In Video Systems

General

Most Rockwell Intecolor monitors have differential video and sync inputs (BNC) as standard equipment. This application note is intended to help the user understand and take maximum advantage of this product feature.

Unlike older generation monitors which operate with digital video (CGA and EGA class monitors, for example), monitors which accept analog video signals (VGA monitors and many higher resolution models) are capable of displaying colors with theoretically infinitesimal gradations of hue, saturation and intensity.

This capability can be a big advantage in many application areas, including that of industrial control. It permits displays to be designed according to ergonomic principles without sacrificing information content, and to represent real objects more faithfully. However, a price is paid for this advantage which can appear exceedingly high in industrial situations. Analog video signals are extremely sensitive to noise, and industrial environments are often very noisy indeed. The problem is all the more serious, the longer the transmission line from the graphics controller to the monitor, and industrial installations often require that monitors be situated at considerable distances from the generator. Therefore, in these situations, analog video can be plagued by interference problems that can be very hard to diagnose and resolve.

Common Problems

The heart of the problem is a phenomenon known as "common mode noise." In the case of coax-connected video systems, common mode noise really means differences in voltage potential between the chassis grounds of different pieces of equipment. Since these pieces of equipment are connected together by the video coax, these differences in ground potentials can force current to flow through the coax shield. This current results in some noise voltage being added to the signal voltage. It might appear that the problem could be avoided by simply floating the equipment chassis, but good practice with regard to safety rules out this work-around, and the problem remains.

Let's look at a couple of examples of systems which might be plagued by this problem, and then examine the solution.

The Long Lines Problem

First, let's consider a system including a computer and graphics generator, mounted in a control room console, and a number of monitors, distributed throughout the plant and connected in daisy chain fashion by a single set of cables to the graphics generator. The monitor at the end of the chain is about 300 feet from the control room and has about 600 feet of cable connected to it.

The computer system and each monitor contain switching power supplies. The console equipment is powered from an isolated, computers-only power main, but the monitors are powered from various other mains. One of the monitors is near an electric overhead crane which is driven by a 50 horsepower motor controlled by triacs. Another

is near several 250 Amp welders. Naturally, all of this equipment is "grounded"

What happens here is very complex, but also very predictable. High frequency noise pulses, generated in the primary circuits of the computer and monitor power supplies, are coupled to the secondary circuits by the capacitance of the switching transformers, and by the capacitance in the mechanical links between the switching transistors and their heatsinks. These noise pulses take paths (however circuitous) through the secondary circuit grounds back to the AC power grounds.

Meanwhile, the crane is operating, and the traces that control its motor are generating many tens of amperes of high frequency noise. This noise is capacitively coupled to the motor frame and returned to ground through the earth-ground connection on the motor. Then there are the welders. Marconi should have had one of these! He could have transmitted across the Atlantic years earlier. These, too, generate large amounts of high frequency noise, much of which is also returned to ground through the power ground wiring.

This scenario is really quite typical, and is in no way exaggerated. Nevertheless, all this noise would cause no problem at all if the "earth ground" between each piece of equipment were completely free of resistance and inductance. A perfectly conducting, inductance-free ground would assure that no potential differences could appear between the equipment frames connected to it. Accordingly, no currents, not even the noise currents described above, could nor flow between the equipment frames, and the noise would be effectively shunted away. Unfortunately, the "earth ground" actually includes a good bit of wire, and this wire has resistance and inductance. Thus, especially at the high noise frequencies where the inductance appears large, the ground connection becomes almost worthless in controlling the path of the noise signals. One of the paths which becomes available in this situation is that through the shields of the video coax cables, which are generally connected to the frames of the video generator and the monitors.

If we could connect an oscilloscope or AC voltmeter across the whole length of the shielding, in such a way that the - terminal was attached to the graphics generator and the + terminal to the last monitor in the daisy chain, we would see a voltage of perhaps 30V peak. Depending upon the distribution of the resistances and inductances in the system, some portion of this voltage, say about 3V peak, appears as an input signal to the monitor and is effectively added to the normal video signal.

To put the problem into perspective, assume that the monitors are being driven in normal fashion with 0.7 Vp signals from the graphics controller, and that this controller provides 8 bits of memory to define the color of each pixel (picture element) on the display.

In this case, the 8-bit controller provides 256 discrete voltage levels to the video monitor, with the smallest increment of voltage being 0.7 / 256

2.73 millivolts. Thus, the noise peaks are an order of magnitude greater in amplitude than the signal pulses. Since much of the noise signal is high frequency "ringing", it will cause vertical noise bars or herringbone patterns on the screen.

²A portion of the noise voltage may be 60 Hz hum and will cause rolling "hum bars" to scroll through the picture.

The Control Room Problem

In this second example, we have a control room with a computer and graphics generator system mounted in EIA racks along with a 20" RGB monitor and several other pieces of control and monitoring equipment. At first glance this situation would seem to present no common mode noise problem. After all, all the equipment is firmly grounded to the same rack system. However, on closer inspection it will appear that the same mechanisms that caused noise in the first example are at work here. While the potential for noise to be generated on a level that would disrupt the video system is certainly not as great, it is nevertheless significant.

We still have switching power supplies driving high frequency noise into the chassis ground of each piece of equipment. The return path for this noise is through the rack, which is common to all the equipment, and then through the path of least resistance (and inductance) back to AC power ground. The noise generated in the computer may find its best path to ground through the video coax shield to the monitor chassis, and then to AC ground through the monitor's power ground. A common mode signal can be impressed on the video which can result in herringbone patterns, and possibly even hum bars. In cases where more than one rack is involved, noise currents generated in one rack may find a lower resistance path to ground through the video cable running to another rack, etc.

Noise problems which appear in such installations may be highly intermittent in nature. Firmly tightening a mounting screw on one piece of equipment or simply wiggling a coax connector may cause the noise to disappear temporarily. But it might re-appear some time later for no apparent reason.

Furthermore, the noise may be evident only when the various pieces of equipment are bolted into the rack. When tested on a bench or otherwise isolated from each other, the system may be completely noise free. Such problems have resulted in countless hours of lost time (and lost sleep) for systems designers.

The noise always finds its easiest path to ground, and as connections oxidize or wiggle loose, the paths change, and the visible consequences of the noise change on the screen. Having short video paths and grounded, rack mounted equipment does not guarantee noise free video.

Differential Input Video Amplifiers as a Solution

A video signal is transmitted typically over a coaxial (or other two conductor) line and is applied to a monitor between an active input terminal and circuit ground (in most cases also chassis ground).

A current is enabled to flow between the chassis of the video generator and that of the monitor through the coax shield (or ground return lead). As a consequence, when current does flow, noise is added to the signal at the monitor's input.

There is a way to eliminate the ground return path through the coax cable shield. The solution is to incorporate a differential amplifier into the monitor.

A differential amplifier has both inputs isolated from ground, so that the coaxial cable shield is not directly grounded to the chassis of the monitor. In fact, the shield is connected to ground only through a fairly high value resistance to allow discharge of static build up and to control high voltage, high impedance common mode signals which might otherwise exceed the capabilities of the differential amplifier.

In the Rockwell Intecolor differential input amplifier, a small value capacitor is also used to bypass radio frequency currents to ground. The

value of this capacitor is small enough to keep current flow through the coax shield small at the noise frequencies of interest

The differential amplifier's name reflects the fact that such an amplifier responds only to the 'difference' in voltage between the two input terminals, and exhibits no response to any signal which is common to the two inputs. The ability to ignore signals common to the two inputs is called 'common mode rejection'.

No differential amplifier has perfect common mode rejection. However, an amplifier's rejection capability can be measured and expressed in Decibels. The common mode rejection ratio (CMRR) is measured by applying a signal to both inputs of the differential amplifier together, with ground as the signal common terminal.

The resulting output signal is then measured and recorded as V_1 . The same signal is then applied to the amplifier in the differential mode, and the output again measured (V_2). The common mode rejection ratio is then calculated by the normal decibel voltage relationship: $CMRR (dB) = 20 \log(V_2/V_1)$.

A simple rule of thumb is that 20 dB represents a factor of 10 increase of the CMRR. An amplifier with a common mode rejection ratio of 10 would have a CMRR spec of 20 dB, a ratio of 100 would result in a 40 dB figure, and a ratio of 1000 would result in a 60 dB figure.

The Rockwell Intecolor differential amplifier has a CMRR of 50 dB. This means that a monitor equipped with this amplifier is about 300 times less sensitive to common mode inputs ("noise") than to differential mode inputs ("signal").

This already high tolerance of "noise" is effectively higher yet by virtue of the fact that isolation of both amplifier inputs from ground reduces the amount of noise generated in the first place. In most applications where such noise is a problem, the use of the differential input amplifiers will completely eliminate all traces of noise.

There are a couple of other specifications related to the differential input amplifier which are of some importance. The input impedance is the load as seen by the applied differential mode signal. In the case of the Rockwell Intecolor product it is switchable between 75 Ohms and about 1 K Ohm.

The "Common Mode Range" is the amount of allowable voltage that can be applied to the amplifier inputs with respect to chassis ground before the amplifier can no longer cope with this common mode signal. The common mode range of the Rockwell Intecolor system is about +/- 7 Volts. This means that the noise applied to the shield of the coaxial input can be 14 Volts peak to peak with respect to chassis ground before the amplifier loses its ability to reject the noise.

It should be kept in mind that an excessive common mode signal can destroy the input stage of the amplifier. The input stage of the Rockwell Intecolor Differential BNC amplifier is tested to withstand 35 V RMS at 60 Hz for 5 seconds.

Summary

In industrial control applications, where long coaxial lines are run between a graphics system and a monitor, where rack mounting is used, or wherever large power loads are switched and shifts in ground potential are likely to occur between the graphics generator and the monitor, the system designer can avoid screen noise problems and potential computer reliability problems by specifying differential inputs on the RGB monitors. Rockwell Intecolor has the solution to these problems in the form of the Differential BNC Input Amplifier.

Supplementary Information

The following table lists the specifications for the Rockwell Intecolor differential input amplifiers.

Differential Input Amplifier Specifications Table

Specification	Description
Input Impedance	75 Ohm or Bridging (approx 2 K Ohm)
Gain	Unity Gain (Video Channels) Unity, 1/2, 1/10 (Sync Channel)
CMRR @ 60 Hz	>70 dB
CMRR @ 50 KHz	>60 dB
CMRR @ 1 MHz	>38 dB
CMRR @ 5 MHz	>22 dB
Common Mode Range	14.5 Volts p-p
Freq Response	+/- 3 dB, 2 Hz to 50 MHz
Max Non-Destructive Common-Mode Input	35 Volts RMS at 60 Hz for 5 seconds
BNC Shell to Ground	47K Ohms, 0.001 uF

Driving the Monitor's Differential Inputs from a VGA Adapter

To take advantage of the differential input amplifiers in the monitor, it is necessary to apply sync to the monitor in composite form. Unfortunately, composite sync is not available at the output connector of a standard VGA adapter. A VGA adapter provides separate horizontal and vertical sync signals, mainly because the separate signals allow certain video mode data - needed by standard VGA monitors - to be encoded in their polarizations.

It is possible to route the outputs of the VGA controller to a simple converter, where a composite sync signal can be generated from the separate signals supplied by the VGA controller. Coaxial lines (75 ohm) can then be run from the converter's outputs to the monitor's video and composite sync inputs.

A circuit for this converter is shown on the following page. Note that a 5VDC power supply must be provided for the converter. The video mode information encoded in the polarization of the separate sync pulses is lost in the conversion process. This information is not needed by a variable scan monitor.

Outputs from the converter may be applied to the monitor's BNC interface. To utilize the BNC interface it is necessary only to make the cable connections, set the monitor's sync selector switch to the 'External' position, and set the monitor's input termination switches to their proper positions ('On' unless the monitor is inside a daisy chain).

Note: Refer to the pin descriptions in the HD-15 interface appendix for details.

The video signals are applied to the HD-15 in the same way for differential operation as for standard VGA operation. However, the composite sync (coax center conductor) must be applied to pin 5 and sync ground (coax shield) to pin 10 for differential operation.

In addition, jumper W1 B must be installed on the interface PCB in the monitor to establish a connection between the composite sync pins at the HD 15 and the sync differential amplifier. In this case, the monitor's sync selector switch should be set to any position except Sync on Green.

Appendix E: Touch Screen Serial Interface

Cable

For Intecolor monitors equipped with touch screens, a serial communications cable is required. A suitable cable can be obtained from Rockwell Automation Intecolor (Option 0E2901 or 0E2902) or made up by the user.

The cable provides a communications channel between the touch screen controller, which is mounted inside the monitor, and an RS-232-C serial port on the host computer. The touch controller is provided with power from the monitor's power supply. Accordingly, no external touch power connections are necessary.

Communications

All touch controllers (except for the MicroTouch capacitive controller) are configured to provide serial communications at 9600 baud, 8 data bits, 1 stop bit, no parity. The MicroTouch controller is set up to detect the baud rate used by the host. For additional information on controller configurations, please refer to the manufacturer's documentation, provided with the touch system.

Software

Software supplied with the touch screen must be loaded on the host computer to handle communications with the touch controller over the channel. Consult the touch screen manufacturer's documentation, supplied with the touch screen, for additional information.

Female DB-9 Connector

When a touch screen is installed, a female DB-9 connector is mounted in an auxiliary interface cutout, either on the monitor's rear panel, or on the left diagonal chassis brace.

DB-9 Female Connector (solder term end)



This connector provides the serial interface for the touch controller. Interconnecting wiring from this connector to the host serial port connection is shown in the accompanying chart.

Infra-Red Touch Screen Interface Table

Mon DB-9	Signal	Connect to Host	DB-9	DB-25
1	Hgh (output)	DCD (input)	1	8
2	TX Data (output)	RX Data (input)	2	3
3	RX Data (input)	TX Data (output)	3	2
4	DSR (input)	DTR (output)	4	20
5	SG	SG	5	7
6	DTR (output)	DSR (input)	6	6
7	CTS (input)	RTS (output)	7	4
8	RTS (output)	CTS (input)	8	5
9	Not Connected			

Capacitive Touch Screen Interface Table

Mon DB-9	Signal	Connect to Host	DB-9	DB-25
1	FG		1	8
2	TX Data (output)	RX Data (nput)	2	3
3	Not Connected		3	2
4	DSR (input)	DTR (output)	4	20
5	SG	SG	5	7
6	DTR (output)	DSR (input)	6	6
7	CTS (input)	RTS (output)	7	4
8	RTS (output)	CTS (input)	8	5
9	x level	RI		

Resistive Touch Screen Interface

Mon DB-9	Signal	Connect to Host	DB-9	DB-25
1	Not Connected		1	8
2	TX Data (output)	RX Data (nput)	2	3
3	Not Connected		3	2
4	Jumpered to pin 6	DTR (output)	4	20
5	SG	SG	5	7
6	Jumpered to pin 4	DSR (input)	6	6
7	Jumpered to pin 8	RTS (output)	7	4
8	Jumpered to pin 8	CTS (nput)	8	5
9	Not Connected			

SAW Touch Screen Interface

Mon DB-9	Signal	Connect to Host	DB-9	DB-25
1	Not Connected	(DCD)	1	8
2	TX Data (output)	RX Data (input)	2	3
3	RX Data (input)	TX Data (output)	3	2
4	DSR (input)	DTR (output)	4	20
5	SG	SG	5	7
6	DTR (cutput)	DSR (nput)	6	6
7	CTS (input)	RTS (output)	7	4
8	RTS (cutput)	CTS (input)	8	5
9	Not Connected			

998011

Touch Screen Operation

Installing the Touch Screen Driver Software Procedure

Prior to using the touch screen, it is necessary to install software on the host computer that will handle communications with the touch screen controller, and to perform a calibration procedure. Details for installation are covered in the manufacturer's documentation provided with the touch system.

Everything you need to install the touch screen driver software is included in the touch screen software packet provided with the system. It contains a utility program that makes installation very easy. Before attempting to install the touch screen software, insure that the version of the operating system running on the target machine is compatible with that required by your particular touch system. There are a few things the user must know about the touch screen hardware configuration of the touch system in order to install the driver properly.

- The type and model of touch controller being used
- The COM port in use for the touch screen. Insure that the RS 232 cable is properly installed between the monitor port and the host's COM1 or COM2 port. Note the COM port being used.
- The baud rate at which the controller is operating in order to set the baud rate at the COM port to match. The controller baud rate is factory set at 9600 (except that a MicroTouch controller is set for baud rate autodetect).

The installation procedure involves transferring driver files from the diskette supplied with the touch system to the host computer's hard disk, and adding instructions to system startup files that will load the drivers following system boot-up.

The installation utility automates the transfer process and creates a special directory on the hard disk to hold the touch software. The user may specify a directory path name, otherwise, a default path name is used. In addition, the utility modifies the system startup files appropriately.

Touch Screen Calibration

Following installation of the driver software, follow the instructions in the manufacturer's documentation provided with the touch system

WARNING: The calibration of the touch screen will be invalidated by any subsequent adjustment of the display size or position. Insure that the display is properly adjusted before beginning calibration.

When the touch system is to be used with multiple applications, and these applications use different video display modes, the calibration procedure should be repeated for each mode that is to be used.

Using the Touch Screen with Application Programs

Following installation of the touch software and calibration, the touch screen is ready to use.

Since, in general the touch screen emulates a mouse, compatibility issues can arise in relation to the way the touch screen emulates mouse buttons, especially multiple buttons. For a complete discussion of these issues, and means of resolving problems, see the relevant sections of the manufacturer's documentation.

Specification Sheets

This appendix contains specification sheets for all of the Intecolor 20" industrial display products

Intecolor 20" Monitors Specifications Table

Monitor	Model Number	Package Type
20" Variable Scan (30-82kHz)	E20FBC	Benchtop
20" Variable Scan (30-82kHz)	E20FCC	Closed Chassis
20" Variable Scan (30-82kHz)	E20FCD	Open Chassis Short Model
20" Variable Scan (30-82kHz)	E20FEC	Desktop
20" Variable Scan (30-82kHz)	E20FFC	Open Frame
20" Variable Scan (30-82kHz)	E20FPC	9U Panel Mount
20" Variable Scan (30-82kHz)	E20FRA-WA2	Special Rackmount
20" Variable Scan (30-82kHz)	E20FRC	10U Rackmount
20" Variable Scan (30-82kHz)	E20FRD	9U Rackmount

Model E20FBC**30kHz to 82kHz Variable Scan Benchtop 20in. Monitor**

Display		Environmental	
CRT Type	20in diagonal, 0.28mm pitch, SP phosphor 51 5% glass, AGRAS coating, Low thermal expans on shadow mask, DAF electron guns, Tensic-band implosion protected Manual and automatic	Temperature	Operating 0C to 50C Non-Operating 30C to 65C
Degaussing		Relative Humidity	10% to 90% non-condensing
Image Size (4 3 Aspect)		Altitude	Operating 0 to 10,000 ft (3000m) Non-Operating 0 to 40,000 ft (12000m)
Horizontal	14 0in (356mm)	Electrostatic Discharge	Operating 8 0KVDC (IEC 801-2, level 3) Non-Operating 2C 0KVDC
Vertical	10 5in (267mm)	Vibration	Operating 0 01in p-p, 5-54Hz sine, 1 5g peak, 54-500Hz sine Non-Operating 0 02in p-p, 5-50Hz sine, 2 5g peak 50 500Hz sine
Image Size (5 4 Aspect)		Shock	Operating 2C (1/2 sine, 11msec) Non-Operating 30g (1/2 sine, 11msec)
Horizontal	13 1in (333mm)	X-ray Emissions	Designed for compliance with DHHS CFR 21 1020
Vertical	10 5in (267mm)		
Non Linearity (CHP Method)		Electrical	
Horizontal	5% max	Line Voltage	9C 264VAC
Vertical	4% max	Line Frequency	45-70Hz
Pincushion		Ground Leakage	1 0 uA max at 1 5KVDC
Horizontal	3mm max	Power Consumption	130W max
Vertical	4mm max		
Keystone		Cables	
Horizontal	1% max	Standard	None
Vertical	1% max	Optional	US Power Cord (0E2101), 6ft VGA Cable (0E2003)
Regulation	2mm max peak deviation	Physical	
Misconvergence	0 3mm max inside centered circle 280mm dia., 0 4mm max outside	Dimensions	19 2in W x 18 3in H x 22 4in D (487mm x 464mm x 569mm)
Luminance	30 fL, small white square	Net Weight	70lb (32kg)
Luminance Uniformity	Corners at least 70% of center	Warranty	
CIE coordinates for white	x 0 281, y 0 311 (9300K)	Standard	12 months
		Optional	Extensions available
Video		MTBF	>55,000 hours at 25C, Ground Bengin
Supported Standards	IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 60Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz	Certifications	UL 1950 Listed C-UL 1950 L std FCC Class A CE96 (EMC Directive 89/336/EEC LV Directive 71/23/EEC)
Deflection Frequencies			
Horizontal	Variable 30kHz to 82kHz		
Vertical	Variable 40Hz to 80Hz		
Retrace Times			
Horizontal	2 8usec min		
Vertical	0 475msec min		
Amplifier Bandwidth	150MHz		
Black Level Stability	Within 1%		
Input Signals	Video RGB analog (white level = 0 714V above ref black, into 75 Ohms differential) Std Sync H and V separate (TTL levels) Sync with BNC Opt. Composites on green video (0 286V below ref black) or Composite separate (into 75 Ohms differential) HD15 (RGB, HS, VS) HD15 (RGB HS, VS) and 4 BNC (RGB CS)		
Std Input Connection			
Opt Input Connection			
Operator Controls			
Front Panel	Power Degauss Brightness Contrast, H Size H Position V Size V Position		

998011

Model E20FCC**30kHz to 82kHz Variable Scan Enclosed Chassis 20in. Monitor**

Display		Environmental	
CRT Type	20 in diagonal, 0.28mm pitch, SP phosphor, 51.5% glass, AGRAS coating, Low thermal expansion shadow mask, DAF electron guns, Tension-band implosion protected	Temperature	Operating 0C to 50C Non-Operating 30C to 65C
Degaussing	Manual and automatic	Relative Humidity	10% to 90% non-condensing
Image Size (4:3 Aspect)		Altitude	Operating 0 to 10,000 ft (3000m) Non-Operating 0 to 40,000 ft (12000m)
Horizontal	14.0 in (356mm)	Electrostatic Discharge	Operating 8 kVDC (IEC 801 2, level 3) Non-Operating 20 kVDC
Vertical	10.5 in (267mm)	Vibration	Operating 0.01 in p-p, 5-54Hz sine, 1.5g peak, 54-500Hz sine Non-Operating 0.02 in p-p, 5-50Hz sine, 2.5g peak, 50-500Hz sine
Image Size (5:4 Aspect)		Shock	Operating 20g (1/2 sine, 11msec) Non-Operating 30g (1/2 sine, 11msec)
Horizontal	13.1 in (333mm)	λ-ray Emissions	Designed for compliance with DHHS CFR 21.1020
Vertical	10.5 in (267mm)		
Non Linearity (CHP Method)		Electrical	
Horizontal	5% max	Line Voltage	90-264VAC
Vertical	4% max	Line Frequency	45-70Hz
Pincushion		Ground Leakage	1.0 uA max at 1.5KVDC
Horizontal	3mm max	Power Consumption	130W max
Vertical	4mm max		
Keystone		Cables	
Horizontal	1% max	Standard	None
Vertical	1% max	Optional	US Power Cord (0E2101), 6ft VGA Cable (0E2003)
Regulation	2mm max peak deviation		
Misconvergence	0.3mm max inside centered circle 280mm dia., 0.4mm max outside 30 fl., small white square	Physical	
Luminance	30 fL, small white square	Dimensions	17.7 in W x 13.9 in H x 19.2 in D (448mm x 354mm x 487mm)
Luminance Uniformity	Corners at least 70% of center	Net Weight	65lb (30kg)
CIE coordinates for white	x 0.281, y 0.311 (9300K)	Warranty	
Video		Standard	12 months
Supported Standards	IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SGI/IBM RISC 1280x1024 at 60Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz)	Optional	Extensions available
Deflection Frequencies		MTBF	>55,000 hours at 25C, Ground Ben gn
Horizontal	Variable 30kHz to 82kHz	Certifications	UL 950 Recognized Component C UL 1950 Recognized Component FCC Class A CE96 (EMC Directive 89/336/EEC LV Directive 73/23/EEC)
Vertical	Variable 40Hz to 80Hz		
Retrace Times			
Horizontal	2.8usec min		
Vertical	0.47msec min		
Amplifier Bandwidth	150MHz		
Back Level Stability	Within 1%		
Input Signals	Video RGB analog (white level 0.714V above ref black, into 75 Ohms, differential) Std Sync H and V separate (TTL levels) Sync with BNC Opt Composite on green video (0.286V below ref black) or Composite separate (into 75 Ohms differential)		
Std Input Connect on	HD15 (RGB, HS, VS)		
Opt Input Connect on	HD15 (RGB, HS, VS) and 4 BNC (RGB, CS)		
Operator Controls			
Rear Panel	Degauss Brightness Contrast, H Size H Position V Size V Position BNC Opt on only Sync Input Select, RGBS Term nat on Sw tches		

Model E20FCD**30kHz to 82kHz Variable Scan Short Open Frame 20in. Monitor**

Display		Environmental	
CRT Type	20in diagonal, 0.28mm pitch, SP phosphor, 51.5% glass, AGRAS coating, Low thermal expansion shado w mask, DAF electron guns, Tension-band implosion protected Manual and automatic	Temperature	
Degaussing		Operating	0C to 55C
Image Size (4:3 Aspect)		Non-Operating	-30C to 65C
Horizontal	14 0in (356mm)	Relative Humidity	10% to 90% non-condensing
Vertical	10 5in (267mm)	Altitude	
Image Size (5:4 Aspect)		Operating	0 to 10,000 ft (3000m)
Horizontal	13 1in (333mm)	Non-Operating	0 to 40,000 ft (12000m)
Vertical	10 5in (267mm)	Electrostatic Discharge	
Non Linearity (LHP Method)		Operating	8 0KVDC (IEC 801 2, level 3)
Horizontal	5% max	Non-Operating	20 0KVDC
Vertical	4% max	Vibration	
Pincushion		Operating	0 01in p-p, 5-54Hz sine, 1 5g peak, 54 500Hz sine
Horizontal	3mm max	Non-Operating	0 02in p-p, 5 50Hz sine, 2 5g peak 50-500Hz sine
Vertical	4mm max	Shock	
Keystone		Operating	20g (1/2 sine, 11msec)
Horizontal	1% max	Non-Operating	30g (1/2 sine, 11msec)
Vertical	1% max	X ray Emissions	Designed for compliance with DHHS CFR 21 1020
Regulation	2mm max peak deviation	Electrical	
Misconvergence	0 3mm max inside centered circle 280mm dia , 0 4mm max outside	Line Voltage	90-264VAC
Luminance	30 fL, small white square	Line Frequency	45 70Hz
Luminance Uniformity	Corners at least 70% of center	Ground Leakage	1 0 uA max at 1 5KVDC
CIE coordinates for wh te	x 0 281, y 0 311 (9300K)	Power Consumption	130W max
Video		Cables	
Supported Standards	IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 60Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz	Standard	None
Deflect on Frequencies		Optional	US Power Cord (0E2101), 6ft VGA Cable (0E2003)
Horizontal	Variable 30kHz to 82kHz	Physical	
Vertical	Variable 40Hz to 80Hz	D imensions	17 7m W x 13 9m H x 16 5in D (450mm x 353mm x 419mm)
Retrace Times		Net We ght	55lb (25kg)
Horizontal	2 8usec min	Warranty	
Vertical	0 475msec min	Standard	12 months
Amp fier Bandwidth	150MHz	Optional	Extensions available
Black Level Stability	Within 1%	MTBF	>55 000 hours at 25C, Ground Ben gn
Input Signals	Video RGB analog (white level = 0 714V above ref black, into 75 Ohms differential), Std Sync H and V separate (TTL levels), Sync with BNC Opt Composite on green video (0 286V below ref black) or Composite separate (nto 75 Ohms differential) HD15 (RGB, HS, VS) HD15 (RGB, HS, VS) and 4 BNC (RGB CS)	Certifications	UL 1950 Recognized Component, C-UL 1950 Recognized Component Certifiable FCC Class A when suitably enclosed CE96 (LV D rective 73/23/EEC)
Std Input Connection			
Opt Input Connection			
Operator Controls			
Rear Pane	Degauss Brightness Contrast, H Size + Position, V Size, V Position BNC Option on y Sync Input Select, RGBS Terminal on Sw to 1cs		

Model E20FFC**30kHz to 82kHz Variable Scan Open Frame 20in. Monitor**

Display		Environmental	
CRT Type	20in diagonal, 0.28mm pitch, SP phosphor, 51.5% glass, AGRAS coating, Low thermal expansion shadow mask, DAF electron guns, Tension-band implosion protected Manual and automatic	Temperature	
		Operating	0C to 55C
		Non-Operating	-30C to 65C
		Relative Humidity	10% to 90% non-condensing
		Altitude	
		Operating	0 to 10,000 ft (3000m)
		Non-Operating	0 to 40,000 ft (12000m)
Degaussing		Electrostatic Discharge	
Image Size (4:3 Aspect)		Operating	8 kVDC (IEC 801-2, level 3)
Horizontal	14.0in (356mm)	Non-Operating	20 kVDC
Vertical	10.5in (267mm)	Vibration	
Image Size (5:4 Aspect)		Operating	0.01in p-p, 5-54Hz sine, 1.5g peak, 54-500Hz sine
Horizontal	13.1in (333mm)	Non-Operating	0.02in p-p, 5-50Hz sine, 2.5g peak, 50-500Hz sine
Vertical	10.5in (267mm)	Shock	
Non Linearity (CHP Method)		Operating	20g (1/2 sine, 11msec)
Horizontal	5% max	Non-Operating	30g (1/2 sine, 11msec)
Vertical	4% max	X-ray Emissions	Designed for compliance with DHHS CFR 21.1020
Pincushion			
Horizontal	3mm max		
Vertical	4mm max		
Keystone			
Horizontal	1% max		
Vertical	1% max		
Regulation	2mm max peak deviation		
Misconvergence	0.3mm max inside centered circle 280mm dia., 0.4mm max outside 30 fL, small white square	Electrical	
Luminance	Corners at least 70% of center x 0.281, y 0.311 (9300K)	Line Voltage	90-264VAC
Luminance Uniformity		Line Frequency	43-70Hz
CIE coordinates for white		Ground Leakage	1.0 uA max at 1.5kVDC
		Power Consumption	130W max
Video		Cables	
Supported Standards	IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 72Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz	Standard	None
		Optional	US Power Cord (0E2101), 6ft VGA Cable (0E2003)
Deflection Frequencies		Physical	
Horizontal	Variable 30kHz to 82kHz	Dimensions	17.7in W x 14.0in H x 18.2in D (450mm x 354mm x 462mm)
Vertical	Variable 40Hz to 80Hz	Net Weight	55lb (25kg)
Ketrace Times		Warranty	
Horizontal	2.8usec min	Standard	12 months
Vertical	0.475msec min	Optional	Extensions available
Amplifier Bandwidth	150MHz	MTBF	>55,000 hours at 25C Ground Ben gn
Black Level Stability	Within 1%		
Input Signals	Video RGB analog (white level = 0.714V above ref black, into 75 Ohms differential) Std Sync H and V separate (TTL levels), Sync with BNC Opt Composite on green video (0.286V below ref black) or Composite separate (into 75 Ohms differential)	Certifications	UL 1950 Recognized Component, C-UL 1950 Recognized Component Certified by FCC Class A when suitably enclosed CE96 (LVD directive 73/23/EEC)
Std Input Connect on	HD15 (RGB HS VS)		
Opt Input Connect on	HD15 (RGB HS, VS) and 4 BNC (RGB CS)		
Operator Controls			
Rear Pane	Degauss, Brightness, Contrast, H Size, H Position V Size, V Position BNC Option only Sync Input Select, RGBS Termination Switches		

998011

Model E20FPC**30kHz to 82kHz Variable Scan 9U Panelmount 20in. Monitor**

Display		Environmental	
CRT Type	20in diagonal, 0.28mm pitch, SP phosphor, 51.5% glass, AGRAS coating Low thermal expansion shadow mask, DAF electron guns Tension band implosion protected Manual and automatic	Panel Rating	NEMA 4/12/13 (UL 508, C UL 508 certified), Built to IP65 standards
Degaussing		Temperature	Operating 0C to 50C Non-Operating 30C to 65C
Image Size (4:3 Aspect)		Relative Humidity	10% to 90% non-condensing
Horizontal	14.0in (356mm)	Altitude	Operating 0 to 10,000 ft (3000m) Non-Operating 0 to 40,000 ft (12000m)
Vertical	10.5in (267mm)	Electrostatic Discharge	Operating 8.0KVDC (IEC 801 2 level 3) Non-Operating 20.0KVDC
Image Size (5:4 Aspect)		Vibration	Operating 0.01in p-p 5.54Hz sine, 1.5g peak, 54-500Hz sine Non-Operating 0.02in p-p, 5-50Hz sine, 2.5g peak 50-500Hz sine
Horizontal	13.1in (333mm)	Shock	Operating 20g (1/2 sine, 11msec) Non-Operating 30g (1/2 sine, 11msec)
Vertical	10.5in (267mm)	X ray Emissions	Designed for compliance with DHHS CFR 21.1020
Non Linearity (CHP Method)		Electrical	
Horizontal	5% max	Line Voltage	90-264VAC
Vertical	4% max	Line Frequency	45-70Hz
Pincushion		Ground Leakage	1.0 uA max at 1.5kVDC
Horizontal	3mm max	Power Consumption	130W max
Vertical	4mm max	Cables	
Keystone		Standard	None
Horizontal	1% max	Optional	US Power Cord (0E210), 6ft VGA Cab e (0E2003)
Vertical	1% max	Physical	
Regulation	2mm max peak deviation	Dimensions	19.0in W x 15.7in H x 19.5in D (483mm x 399mm x 495mm)
Misconvergence	0.3mm max inside centered circle 280mm dia 0.4mm max outside	Net Weight	65lb (30kg)
Luminance	30 fL small white square	Warranty	
Luminance Uniformity	Corners at least 70% of center	Standard	12 months
CIE coordinates for white	x 0.281 y 0.311 (9300K)	Optional	Extensions available
Video		MTBF	>55,000 hours at 25C Ground Benign
Supported Standards	IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 60Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz)	Certifications	UL 1950 Recognized Component, C UL 1950 Recognized zed Component I CC Class A C E96 (EMC Directive 89/336/EEC 1 V D rective 73/23/EEC)
Deflection Frequencies			
Horizontal	Variable 30kHz to 82kHz		
Vertical	Variable 40Hz to 80Hz		
Retrace Times			
Horizontal	2.8usec min		
Vertical	0.475msec min		
Amplifier Bandwidth	150MHz		
Black Level Stability	With 1%		
Input Signals	Video RGB analog (white level 0.714V above reference black, into 75 Ohms, differential) Std Sync H and V separate (TTL levels) Sync with BNC Option Composite on green video (0.286V below reference black) or Composite separate (into 75 Ohms differential) HD15 (RGB HS VS) HD15 (RGB HS VS) and 4 BNC (RGB CS)		
Std Input Connect on			
Opt Input Connect on			
Operator Controls			
Rear Panel	Degauss, Brightness Contrast H Size H Position V Size V Position BNC Option only Sync Input Select, RGBS Termination Switches		

Model E20FRA-WA2**30kHz to 82kHz Variable Scan 9U Rackmount 20in. Monitor**

Display	Environmental
CRT Type	Temperature
20in diagonal, 0.28mm pitch, SP phosphor, 51.5% glass, AGRAS coating, Low thermal expands on shadow mask, DAF electron guns, Tension-band implosion protected	Operating 0C to 50C Non-Operating -30C to 65C
Degaussing	Relative Humidity
Manual and automatic	10% to 90% non-condensing
Image Size (4:3 Aspect)	Altitude
Horizontal 14.0in (356mm)	Operating 0 to 10,000 ft (3000m) Non-Operating 0 to 40,000 ft (12000m)
Vertical 10.5in (267mm)	Electrostatic Discharge
Image Size (5:4 Aspect)	Operating 8.0KVDC (IEC 801-2, level 3) Non-Operating 20.0KVDC
Horizontal 13.1in (333mm)	Vibration
Vertical 10.5in (267mm)	Operating 0.01in p-p, 5-54Hz sine, 1.5g peak, 54-500Hz sine Non-Operating 0.02in p-p, 5-50Hz sine, 2.5g peak, 50-500Hz sine
Non Linearity (CHP Method)	Shock
Horizontal 5% max	Operating 20g (1/2 sine, 11msec) Non-Operating 30g (1/2 sine, 11msec)
Vertical 4% max	X ray Emissions
Pincushion	Designed for compliance with DHHS CFR 21.1020
Horizontal 3mm max	
Vertical 4mm max	
Keystone	Electrical
Horizontal 1% max	Line Voltage 90-264VAC
Vertical 1% max	Line Frequency 45-70Hz
Regulation 2mm max peak deviation	Ground Leakage 1.0 uA max at 1.5KVDC
Misconvergence 0.3mm max inside centered circle	Power Consumption 130W max
280mm dia., 0.4mm max outside	
Luminance 30 fL, small white square	
Luminance Uniformity Corners at least 70% of center	
CIE coordinates for white x 0.281, y 0.311 (9300K)	
Video	Cables
Supported Standards	Standard None
IBM VGA (640x480 at 60Hz, VESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x364 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 60Hz, HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz)	Optional US Power Cord (0E2101), 6ft VGA Cable (0E2003)
Deflection Frequencies	Physical
Horizontal Variable 30kHz to 82kHz	Dimensions 19.0in W x 15.7in H x 19.7in D (483mm x 399mm x 500mm)
Vertical Variable 40Hz to 80Hz	Net Weight 65 lb (30kg)
Retrace Times	Warranty
Horizontal 2.8usec min	Standard 12 months
Vertical 0.475msec m n	Optional Extensions available
Amplifier Bandwidth 150MHz	
Black Level Stability Withn 1%	MTBF
Input Signals Video RGB analog (white level 0.714V above reference black into 75 Ohms differential), Std Sync H and V separate (TTL levels) Sync with BNC Opt Composite on green video (0.286V below reference black) or Composite separate (into 75 Ohms differential)	>55,000 hours at 25C Ground Benign
Std Input Connection 4 BNC (RGB and CS) and HD15 (RGB, HS, VS)	Certifications
	UL 1950 Recognized Component, C-UL 1950 Recognized Component
Operator Controls	
Front Panel	
Power Degauss, Brightness, Contrast	

Model E20FRD**30kHz to 82kHz Variable Scan 9U Rackmount 20in. Monitor**

<p>Display</p> <p>CRT Type 20in diagonal, 0.28mm pitch, SP phosphor, 51 5% glass, AGRAS coating, Low thermal expansion shadow mask, DAF electron guns, Tension-band implosion protected Manual and automatic</p> <p>Degaussing</p> <p>Image Size (4 3 Aspect) Horizontal 14 0in (356mm) Vertical 10 5in (267mm)</p> <p>Image Size (5 4 Aspect) Horizontal 13 1in (333mm) Vertical 10 5in (267mm)</p> <p>Non Linearity (CHP Method) Horizontal 5% max Vertical 4% max</p> <p>Pincushion Horizontal 3mm max Vertical 4mm max</p> <p>Keystone Horizontal 1% max Vertical 1% max</p> <p>Regulation 2mm max peak deviation</p> <p>Misconvergence 0 3mm max inside centered circ e 280mm dia., 0 4mm max outside</p> <p>Luminance 30 fL small wh te square</p> <p>Luminance Uniformity Corners at least 70% of center x 0 281, y 0 311 (9300K)</p>	<p>Environmental</p> <p>Temperature Operating 0C to 50C Non-Operating -30C to 65C</p> <p>Relative Humidity 10% to 90% non-condensing</p> <p>Altitude Operating 0 to 10,000 ft (3000m) Non-Operating 0 to 40,000 ft (12000m)</p> <p>Electrostatic Discharge Operating 8 0KVDC (IEC 801-2, level 3) Non-Operating 20 0KVDC</p> <p>Vibration Operating 0 01in p-p, 5-54Hz sine, 1 5g peak, 54 500Hz sine 0 02in p-p, 5 50Hz sine 2 5g peak 50-500Hz sine Non-Operating</p> <p>Shock Operating 20g (1/2 sine, 11msec) Non-Operating 30g (1/2 sine 11msec)</p> <p>X-ray Emissions Designed for compliance with DHHS CFR 21 1020</p>
<p>Video</p> <p>Supported Standards IBM VGA (640x480 at 60Hz, YESA 640x480 at 60/72Hz, 800x600 at 56/60/72Hz, 1024x768 at 60/70Hz, DEC 1024x864 at 60Hz, 1280x1024 at 66/72Hz, SUN 1152x900 at 67/76Hz, SG/IBM RISC 1280x1024 at 60Hz HP 700 1280x1024 at 72Hz, IBM RISC 1280x1024 at 77Hz)</p> <p>Deflection Frequencies Horizontal Variable 30kHz to 82kHz Vertical Variable 40Hz to 80Hz</p> <p>Retrace Times Horizontal 2 8usec min Vertical 0 475msec min 150MHz</p> <p>Amplifier Bandwidth Black Level Stability Input Signals Within 1% Video RGB analog (white level = 0 714V above ref black, into 75 Ohms, differential) Std Sync H and V separate (TTL level s), Sync with BNC Opt Composite on green video (0 286V below ref black) or Composite separate (into 75 Ohms differential)</p> <p>Std Input Connection Opt Input Connection HD15 (RGB, HS VS) HD15 (RGB HS VS) and 4 BNC (RGB CS)</p>	<p>Electrical</p> <p>Line Voltage 90-264VAC Line Frequency 45-70Hz Ground Leakage 1 0 uA max at 1 5KVDC Power Consumption 1 0W max</p> <p>Cables Standard None Optional US Power Cord (0E2101), 6ft VGA Cab e (0E2003)</p> <p>Physical</p> <p>Dimensions 19 0in W x 15 7in H x 17 8in D (483mm x 399mm x 452mm)</p> <p>Net Weight 65lb (30kg)</p> <p>Warranty Standard 12 months Optional Extensions available</p> <p>MTBF > 5 000 hours at 25C Ground Benign</p> <p>Certifications UL 1950 Recognized Component, C UL 1950 Recognized Component FCC Class A CE96 (EMC Directive 89/336/EEC LV Directive 73/23/EEC)</p>
<p>Operator Controls</p> <p>Front Pane Power Degauss Brightness Contrast, H Size H Position V Size V Position</p>	

Declaration of Conformity

The following Declarations of Conformity apply to the products included in this manual

00 47 08 04 11 07

DECLARATION OF CONFORMITY

Application of Council Directive: 89/336/EEC

Standard to which Conformity is Declared: EN 55022-1, EN 50082-2

Application of Council Directive: 73/23/EEC

Standard to which Conformity is Declared: EN 60950. 1992

Manufacturer's Name Intecolor Corporation

Manufacturer's Address: 2150 Boggs Road
Duluth, GA 30136

Importer's Name

Importer's Address

Type of Equipment Color Computer Monitor

Model No E20FCC-XXX, E20FCD-XXX, E20FPD XXX, E20FRD XXX,
E20FRE-XXX

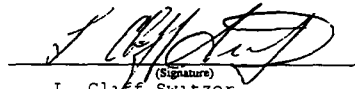
Serial No.

Year of Manufacture

I, the undersigned, hereby declare that the equipment specified
above conforms to the above Directive and Standard

Place Duluth, Georgia

Date January 3, 1997


(Signature)
L. Cliff Switzer
(Full Name)

Vice President, Engineering

meco or P/N 998006-010

DECLARATION OF CONFORMITY

Application of Council Directive: 89/336/EEC

Standard to which Conformity is Declared: EN 50082-2, EN 50081-2

Application of Council Directive: 73/23/EEC

Standard to which Conformity is Declared: EN 60950: 1992

Manufacturer's Name Intecolor Corporation

Manufacturer's Address: 2150 Boggs Road

Duluth, GA 30136

Importer's Name

Importer's Address

Type of Equipment Color Computer Monitor

Model No E20FEC-XXX, E20FPC-XXX, E20FRC-XXX, E20FBC XXX,
E20FSC XXX

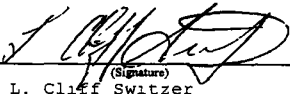
Serial No

Year of Manufacture

I, the undersigned, hereby declare that the equipment specified
above conforms to the above Directive and Standard

Place Duluth, Georgia

Date January 3, 1997


(Signature)

L. Cliff Switzer
(Full Name)

Vice-President, Engineering

Inteco or P/N 998006-0 0

00 47 11 04 11 07

998011

DECLARATION OF CONFORMITY

Application of Council Directive:

Standard to which Conformity is Declared:

Application of Council Directive: 73/23/EEC

Standard to which Conformity is Declared: EN 60950- 1992

Manufacturer's Name Intecolor Corporation

Manufacturer's Address: 2150 Boggs Road

Duluth, GA 30136

Importer's Name:

Importer's Address

Type of Equipment Color Computer Monitor

Model No E20FFC-XXX, E20FCD-XXX

Serial No

Year of Manufacture:

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive and Standard.

Place Duluth, Georgia

Date January 3, 1997



L. Cliff Switzer
(Full Name)

Vice-President, Engineering

Inteco or P/N 998006-010

998011

