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LOMAS DATA PRODUCTS, INC.

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COLOR MAGIC   OWNER'S MANUAL
REV.O

PROPRIETARY NOTICE

LOMAS DATA PRODUCTS, INC.

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1.0 COLOR MAGIC INTRODUCTION

COLOR MAGIC was designed specifically to bring the wide range of software available for the IBM-PC to the S100 bus. With COLOR MAGIC and the appropriate software the majority of software available for the IBM-PC including software that writes directly to video RAM and the hardware control ports of the IBM-PC can now be used with any of LOMAS DATA PRODUCT's high performance CPU boards. Each CPU board has an EPROM specifically designed to emulate the ROM BIOS of the IBM-PC. There are several issues in emulating the IBM-PC, the first is hardware compatibility. The major hardware items of the IBM-PC which must be considered in an emulation are as follows:

       1.   The microprocessor being used.
       2.   The floppy disk controller hardware.
       3.   The display hardware.
       4.   The keyboard hardware.
       5.   The timer hardware.
       6.   The I/O hardware i.e. RS232 and Printer ports.

Each of the above issues will be discussed individually.

1.1 MICROPROCESSOR COMPATIBILITY

Currently three different microprocessors may be used to obtain compatibility with the IBM-PC: the 8086/8088, the 80186 and the 80286. Each of these processors offer different levels of performance and different degrees of compatibility with the 8088 of the IBM-PC. The 8088 and 8086 may be considered together as one type of microprocessor. The 8086/88 offers the greatest compatibility level with the IBM-PC as it is the same as used by the PC. When using an 8086/88, the degree of compatibility with the PC is determined by the remaining hardware in the system. The 80186 and 80286 offer additional potential for incompatibility with the PC. Each of these microprocessor uses interrupts which Intel warned manufactures were reserved and should not be used in order to maintain upward compatibility of products with these microprocessors. For whatever reason, IBM decided to use these reserved interrupts which means that special programming must be used to get around the fact that the hardware interrupts generate the same interrupt vectors as several of the internally generated interrupts of the 80186 and the 80286. In some cases the software interrupt calls used to request functions in the IBM-PC ROM also conflict with interrupts with special functions on the 80186 and 80286. For the most part the overlap of these vectors can be worked around.

1.2 FLOPPY DISK HARDWARE

For most software, major differences in hardware from the IBM-PC do not affect compatibility with PC software. The major criteria for the hardware is that it be capable of reading and writing 48 TPI diskettes with 8 or 9 512 byte sectors per track. Most software designed to run on the PC, access the diskette through

either the I/O system or though the ROM BIOS call. As long as
the ROM BIOS call is faithfully emulated virtually all software
will work. One notable exception is software designed to copy,
copy protected software like COPYIIPC. This type of software
accesses the hardware directly and will not work with out a disk
controller that exactly emulates the PC's disk controller. LOMAS
DATA PRODUCTS emulates the ROM BIOS call with software that uses
our LDP72 floppy disk controller to read and write PC compatible
diskettes. The EPROM that accompanies the THUNDER 186 when
ordered with COLOR MAGIC, emulates the ROM BIOS calls with the
onboard floppy disk controller. For user's who elect to use 8"
floppy drives with either of the two different controllers,
software which is designed to use copy protection will not be
able to be used as copy protected software expects drive A: to be
a 5 1/4" drive.

1.3 DISPLAY COMPATIBILITY

There are two levels of display compatibility, INTERRUPT 10
compatibility, and hardware compatibility. It is possible to
have INTERRUPT 10 compatibility without the hardware being even
close to IBM-PC compatible. It is even possible to provide
INTERRUPT 10 compatibility with a serial terminal and appropriate
software support. INTERRUPT 10 compatibility is sufficient to
run a large portion of IBM-PC software, possibly as much as 75%.
For many of the popular software packages for the PC, a higher
degree of compatibility is required. Software packages that fall
into this catagory are LOTUS 1-2-3, DBASE III, SUPERCALC 3, and
others. These programs all have drivers that write directly to
VIDEO RAM on the VIDEO CARD. In order for these programs to
function properly the output device must be a memory mapped video
board with the video RAM at the same location as in a PC. Some
programs also require further compatibility. These programs take
direct control of the hardware by replacing the drivers in the PC
ROM BIOS with their own drivers. LOMAS DATA PRODUCTS has
addressed display compatibility by having the video RAM in the
same locations as the IBM-PC's, having the I/O ports of the video
board at the same locations as the IBM-PC color graphics board,
and by providing a ROM BIOS INTERRUPT 10 compatible software
driver. With this approach we have been able to run some of the
most difficult programs for compatibles to run, these include
LOTUS 1-2-3, DBASE III, and MICROSOFT'S FLIGHT SIMULATOR.

1.4 KEYBOARD COMPATIBILITY

Another area which requires varying degrees of compatibility
depending on the program being run is the keyboard interface.
The PC keyboard provides a greater degree of flexibility than a
normal terminal keyboard interface. With the PC interface and
keyboard, each key has a separate code which is sent to the
interface including keys like the shift key on the right side of
the keyboard and the shift key on the left side of the keyboard.
The keyboard also indicates to the interface when a key is
pressed and when the key is released. The PC provides a software
interface to the keyboard to through INTERRUPT 16. INTERRUPT 16

returns a 16 bit value indicating both the ASCII code for the key
and its scan code.   COLOR MAGIC provides   an   IBM compatible
hardware interface to the keyboard.   All port locations and
control bits are in the same location as the PC.   When used in
conjunction with one of our CPU boards and the appropriate
EPROMS, the interface provided is 100% compatible with the PC's.
We have not found any PC program where the keyboard has caused a
compatibility problem.

1.5 TIMER HARDWARE

Timer hardware falls into two catagories, interrupt generation
and speaker interface. The PC uses an Intel 8253 to generate
interrupts for time keeping at a 18.2 interrupt per second rate.
The 8253 is also used to provide a programmable tone to an 8 ohm
speaker for audible feedback to the user. COLOR MAGIC provides
an entirely compatible interface with all control ports and
values necessary, the same as in the PC. This allows the user to
attach a speaker and get the same audible output as he is
accustomed to on the PC.   Programs which use the PC's clock
interrupt for timing will get the same timing information when
using COLOR MAGIC. Our systems, when using COLOR MAGIC, use the
interrupt available from the COLOR MAGIC for keeping a PC
compatible Time Of Day Clock supported by interrupt 12 on the PC.

1.6 OTHER I/O HARDWARE

There are several other PC hardware items   which   require
consideration in PC compatibility, RS232 I/O devices and printer
ports. Most software using these ports do so through the ROM
BIOS calls provided by the PC.   For most applications it is
sufficient to emulate the ROM BIOS calls and not the specific
hardware. One exception is some communications packages that
interface directly to hardware for communications. This software
must be run on PC compatible hardware.

1.7 PC COMPATIBILITY WITH A LDP CARDSET

If you are purchasing COLOR MAGIC for use with a LOMAS DATA
PRODUCTS card set you can expect between 95 and 98%   PC
compatibility with PC-DOS programs. This compatibility   is
provided with a combination of hardware compatibility with COLOR
MAGIC and with software compatibility with EPROMs -that emulate
the functions of the PC ROM BIOS.   Our ROM BIOS supports all
functions of the PC ROM BIOS except the cassette call, -INTERRUPT
15, and the ROM BASIC function call, INTERRUPT 18. Game programs
which load without operating system support such as MICROSOFT
FLIGHT SIMULATOR, may or may not work. Many of these games use
software timing loops which cause the programs to run much faster
on our system and may make them unusable. It is intended to be
compatible with the majority of applications running under
PC-DOS, not independently loaded game programs.   LOMAS DATA
PRODUCTS CANNOT GUARANTEE THE COMPATIBILITY OF ANY PC PROGRAMS
WITH OUR SYSTEM. It has been our experience that the vast
majority of PC programs do work without modification on our

system. The following are some of the programs that have been
tested and found to work properly: LOTUS 1-2-3, DBASE III,
WORDSTAR, VOLKSWRITER, MICROSOFT FLIGHT SIMULATOR.

1.8 COLOR MAGIC COMPATIBILITY WITH OTHER PRODUCTS

COLOR MAGIC has been designed to be 100 % compatible with the
IEEE standard for the S100 bus, IEEE 696. When used in a system
of other manufacturers boards it is the responsibility of the
user to provide the necessary software support to emulate the PC
ROM BIOS. The software to provide PC ROM BIOS compatibility is
highly hardware dependent. It is therefore impractical for LOMAS
DATA PRODUCTS to provide EPROMs or complete software packages for
other manufacturers equipment. LOMAS DATA PRODUCTS cannot
provide the source code to its proprietary set of EPROMs for use
with other manufacturers products. LOMAS DATA PRODUCTS will make
available object modules which support the PC ROM BIOS interrupt
functions 10H and 16H. These functions are the ones that handle
the keyboard and video. We cannot guarantee that these modules
are useable in any particular application. They are not included
in the price of COLOR MAGIC but are available for minimal cost.
To order contact LOMAS DATA PRODUCTS or your dealer.

1.9 LIMITED WARRANTY INFORMATION

LOMAS DATA PRODUCTS will repair or replace, at our option, any
parts found to be defective in either materials or workmanship
for a period of one year from date of invoice.   Defective parts
must be returned to LOMAS DATA PRODUCTS for replacement.

If a defective part causes a LOMAS DATA PRODUCTS product to
operate improperly during the one year warranty period, we will
service it free (original owner only) if delivered and shipped at
owner's expense to and from LOMAS DATA PRODUCTS.   If improper
operation is due to an error or errors on part of the purchaser,
there may be a repair charge. The purchaser will be notified of
any anticipated charges.

We are not responsible for damages caused by use of solder
intended for purposes other than electronic equipment
construction, failure to follow printed instructions, misuse or
abuse, unauthorized modifications, theft, fire, accidents, or use
of our products in applications in other than those· intended by
LOMAS DATA PRODUCTS.

Return to the purchaser of a fully functioning unit meeting all
advertised specifications in effect as of the date of purchase is
considered to be complete fulfillment of all warranty obligations
assumed by LOMAS DATA PRODUCTS.   This warranty covers only
products marketed by LOMAS DATA PRODUCTS and does not cover other
equipment used in conjunction with products from LOMAS DATA
PRODUCTS.

Prices and specifications are subject to change without notice,
owing to the volatile nature and pricing structure of the

electronics industry.

1.10 RETURN POLICY

It is LOMAS DATA PRODUCT's policy that boards may be returned for
refund within 15 days of shipment date. This applies to boards
purchased directly from LOMAS DATA PRODUCTS only. Boards are
shipped sealed in plastic with registration cards. If you return
a board that has been removed from the plastic, there will be a
restocking charge to cover retesting and verification of the
board. If you purchased your board through a dealer, you must
make arrangements with the dealer if you desire to return the
board for any reason. LOMAS DATA PRODUCTS cannot refund money to
the purchaser, for any board purchased from a dealer. The dealer
is the party responsible for determining whether a refund will be
allowed.

2.0 COLOR MAGIC SPECIFICATION

2.1 I/O PORT LOCATIONS

The I/O ports of COLOR MAGIC are assigned to correspond to the port assignments of the IBM-PC for the corresponding functions. The following is a list of device addresses on the COLOR MAGIC:

HEX ADDRESS	REGISTER FUNCTION
40	8253 TIMER 0
41	8253 TIMER 1
42	8253 TIMER 2
43	8253 TIMER CONTROL PORT
60	8255A PORT A
61	8255A PORT B
62	8255A PORT C
63	8255A COMMAND PORT
3D8	MODE CONTROL REGISTER
3D9	COLOR SELECT REGISTER
3DA	STATUS REGISTER
3DB	CLEAR LIGHT PEN LATCH
3DC	PRESET LIGHT PEN LATCH
3D0 THRU 3D8	6845 DISPLAY CONTROLLER REGISTERS

Through jumper selection the above ports can be relocated to any one of 64 different base addresses. When readdressed, IBM-PC compatibility is lost. All port addresses are moved as a group and have an offset of multiples of 400H added to the above address.

2.2 MEMORY ADDRESS AND SIZE

Memory on the COLOR MAGIC may be either 16k bytes or 32k bytes. 16 K bytes are all that are necessary for IBM-PC compatibility. The memory is dual ported, allowing access from both the graphic display controller and the S100 bus. Dual porting is accomplished by allowing the bus and the graphics controller equal time slices based on the character display rate. It is not necessary to disable the display to access memory or to allow access to memory only during video sync pulses. Accesses to video RAM will normally incur at least one wait state. The standard base address for the memory is B8000H which corresponds to the address of video RAM on the IBM-PC color graphics card. Video RAM on COLOR MAGIC may be addressed at any 32K byte boundary. See the appropriate jumper section for memory address selection. When addressed, COLOR MAGIC can be jumpered to assert PHANTOM so that the memory on COLOR MAGIC may overlay other system memory that responds to PHANTOM.

2.3 VIDEO OUTPUT

Both composite and RGB video outputs are provided. RGB output is provided on an IBM-PC compatible DB9P connector and may be plugged into a standard IBM-PC compatible RGB monitor. Composite output is provided on a connector compatible with the composite

output of the IBM-PC video board. The connector will accept a
standard COAX connector. Scan and refresh rates are programmable
within certain ranges. With standard software the display is
refreshed at a 60 HZ rate with 200 lines of video data. The
horizontal sync rate is 62.5 microseconds and the vertical sync
rate is 16.67 milliseconds. Provisions are NOT made for
modulating the signal for connection to a standard television
set.

2.4 BUS INTERFACE

COLOR MAGIC has been designed to be compatible with the IEEE
specification for the S100 bus, IEEE 696. COLOR MAGIC will
perform 8 or 16 bit memory transfers depending on the state of
the XTRQ bus line. Eight bit I/O transfers are assumed, no
provision for 16 bit I/O transfers has been made. See the
appendix of this manual for the S100 bus pin definition. For
more information on the S100 bus the following book is an
excellent reference:

        INTERFACING TO S100/IEEE 696 MICROCOMPUTERS
        by Sol Libes and Mark Garetz
        publisher OSBORNE/McGraw-Hill

3.0 COLOR MAGIC INSTALLATION INFORMATION

This chapter provides information on installation of the COLOR
MAGIC in a S100 bus computer. When shipped all jumpers are set
properly for emulation of an IBM-PC. If you are using COLOR
MAGIC to emulate an IBM-PC in a LOMAS DATA PRODUCTS system there
should be no need to change any jumper options on the COLOR
MAGIC. The following sections will provide complete descriptions
of all option jumpers for those users that are using COLOR MAGIC
for other than IBM-PC applications or are using COLOR MAGIC is
system supporting other than LOMAS DATA PRODUCTS.

3.1 CONNECTING COLOR MAGIC TO KEYBOARDS AND MONITORS

In order to use COLOR MAGIC as the system console two connections
to the board must be made, one for the keyboard and one for the
monitor. Optionally an 8 ohm speaker may also be connected for
audio output. The cable to connect COLOR MAGIC to an RGB monitor
is provided with COLOR MAGIC. The header end is plugged onto
connector J1 with pin 1 being the upper left pin of the
connector. Care should be taken to insure the connector in
plugged into COLOR MAGIC properly. The other end of the cable is
a DB9S connector suitable for plugging an IBM-PC compatible
monitor cable into. Connector J2 at the upper right side of the
board is provided for attaching a composite video cable to.   J2
is compatible with the connector on the rear of the IBM-PC color
graphic board for attachment to a composite video monitor.

Also provided with COLOR MAGIC is a five pin DIN connector,
compatible with the keyboard connector for an IBM-PC compatible
keyboard. It is the responsibility of the user to provide the
connector and cabling to connect the DIN connector to J3 of COLOR
MAGIC. The pin numbers on the DIN connector correspond to the
pin numbers of J3, which is numbered from 1 to 5 from right to
left. IT IS IMPORTANT THAT THE CONNECTIONS ARE PROPER OR DAMAGE
MAY RESULT TO THE KEYBOARD WHICH IS PLUGGED INTO THE CONNECTOR.
DOUBLE CHECK ALL CONNECTIONS BEFORE PLUGGING IN YOUR KEYBOARD.

3.3 SPEAKER CONNECTION

For user's which desire to have an audible output from COLOR
MAGIC, a connector is provided for connecting an eight Ohm
speaker directly to COLOR MAGIC or alternately connecting the
audio input of a monitor equipped with a speaker.   JP 14 is
provided for the connection to the speaker.   When used with a
monitor equipped with an audio amplifier such as the AMDEK 600,
as 100 Ohm resistor should be inserted with pin 2 of JP 14(the
left pin). When used with a monitor with audio output capability
it is possible to vary the volume.

3.4 LIGHT PEN CONNECTION

An IBM-PC compatible light pen connector is provided on COLOR
MAGIC for systems that require use of a light pen. The light pen
connector is on the upper left of the board, J4.

3.5 CONNECTOR PINOUT'S

RGB CONNECTOR (J1)
```
PIN                SIGNAL
1                  GND
2                  INTENSITY OUTPUT
3                  NC
4
NC
5                  RED OUTPUT
6                  HORIZONTAL SYNC
7                  GREEN OUTPUT
8                  VERTICAL SYNC
9                  BLUE OUTPUT
10                 GND
```

KEYBOARD CONNECTOR (J3)
```
PIN                SIGNAL
1                  KEYBOARD CLOCK
2                  KEYBOARD DATA
3                  KEYBOARD RESET
4                  GND
5                  5 VOLTS (300 MA max)
```

LIGHT PEN CONNECTOR (J4)
```
PIN                SIGNAL
1                  LIGHTPEN INPUT
2                  NC
3                  LIGHTPEN SWITCH
4                  GND
5                  5 VOLTS
6                  12 VOLTS
```

SPEAKER CONNECTION
```
PIN                SIGNAL
1                  AUDIO OUTPUT
2                  5 VOLTS
```

Pin 1 of connectors J3, J4, and JP14 are on the right.

3.6 MEMORY ADDRESS JUMPER OPTION

The onboard memory may be addressed at any 32 Kbyte boundary. Normally is is addressed at B8000H as in the IBM-PC. For some applications it may be desirable to move the location of the memory to another area. JP 6 allows selection of the base address of the onboard memory. When the appropriate address jumper is installed the corresponding address line must be a 0 to match. When the jumper is removed the corresponding address line must be a 1 to match. The following is a list of the pins corresponding to the address lines:

```
PIN'S              ADDRESS BIT
1-16               A22
2-15               A21
```

3-14	A20
4-13	A19
5-12	A18
6-11	A17
7-10	A16
8-9	A15

JP 9 corresponds to A23. When connected from 1 to 2, A23 must be a 0 to enable the RAM. When connected from 2 to 3, A23 must be a 1 to enable the RAM.

3.7 I/O ADDRESS SELECTION

JP 12 is provided for selection of the I/O port addresses on the COLOR MAGIC. Normally it is desirable for the ports on COLOR MAGIC to correspond to their counterparts on the IBM-PC color graphic board, but COLOR MAGIC may be addressed at locations other than those of the PC. This may be desirable in systems where more than one COLOR MAGIC is required. With all the shunts installed on JP 12, COLOR MAGIC is addressed as in an IBM-PC. I/O address decoding is done by decoding address lines A10 thru A15 to provide a total of 64 different I/O base addresses. The following is a list of address lines and their corresponding jumper:

ADDRESS	JUMPER PINS
A10	11-12
A11	9-10
A12	7-8
A13	6-5
A14	4-3
A15	1-2

With a jumper inserted the corresponding address line must be a 0 to match. When a different base address is selected, the ports on COLOR MAGIC retain their relationship to each other.

3.8 PHANTOM ENABLE

JP 15 is provided to allow the memory on COLOR MAGIC to overlay memory on another memory board. When JP15 is inserted, PHANTOM is asserted whenever memory on COLOR MAGIC is selected. If there is other memory in the system which will respond to the same address range as COLOR MAGIC, that board should be set so that PHANTOM will disable it.