

## Using the 24LC21 Dual Mode Serial EEPROM

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### INTRODUCTION

The Microchip Technology Inc. 24LC21 is a 1K-bit (128 x 8) dual mode serial EEPROM that was developed primarily for use in computer monitors. This part was developed with inputs from several computer monitor manufacturers, in accordance with the VESA<sup>®</sup> (Video Electronics Standards Association) monitor committee. This committee has developed a serial communication protocol called Data Display Channel (DDC<sup>™</sup>) which was created to eliminate the need to change dip switches when configuring a new system or adding a new monitor or video card. The 24LC21 device is used in the monitor to store and transmit the EDID (extended display ID) table which contains all set-up parameters needed by the video card to operate with a particular monitor. With this system, the user can now plug any compatible monitor into any compatible graphics board and the graphics board will automatically know what type of monitor is being used and configure itself accordingly. This automatic configuration is the cornerstone for Microsoft<sup>®</sup>'s 'Plug and Play' capability being built into the new 'Windows 95<sup>™</sup>' release.

### DEVICE OPERATION

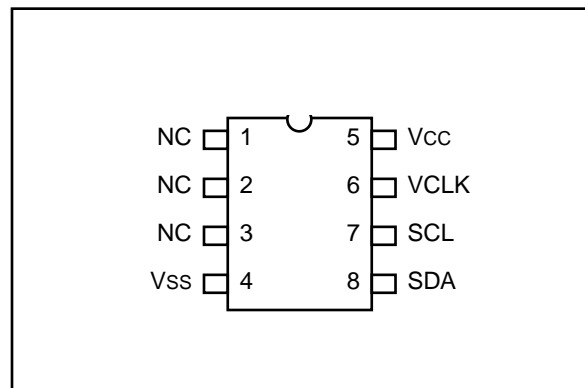
The 24LC21 can operate in two modes of operation. These two modes of operation are the transmit only mode and bi-directional mode. Upon power-up, the device will always be in the transmit-only mode. Transmit only mode is also referred to as DDC1 mode. The transmit only mode only allows the video card to read the contents of the 24LC21 in a sequential manner, one bit at a time. Writing to the device is not possible in transmit only mode.

The device will automatically transition to the bi-directional mode whenever a falling edge is seen on the SCL pin. Bi-directional mode is also referred to as DDC2 mode, and is implemented as the standard I<sup>2</sup>C<sup>™</sup> protocol. This allows a controller to read and write specific addresses in the device like a standard I<sup>2</sup>C Serial EEPROM device. Once the device has transitioned to the bi-directional mode, there is no way to return to transmit only mode other than to reset (power-down) the device.

### TRANSMIT ONLY MODE (DDC1)

The 24LC21 will always power-up in the transmit only mode. In this mode, the 24LC21 will output one bit of data at the SDA pin for every rising edge on the VCLK pin. The data will be transmitted in 8-bit words, with each word followed by a 9th null bit. This null bit will always be high. A timing diagram for transmit only mode is shown in Figure 1. As long as VCLK is present and no falling edges on SCL are received, the 24LC21 will repeatedly cycle through the entire memory array.

### PACKAGE TYPE



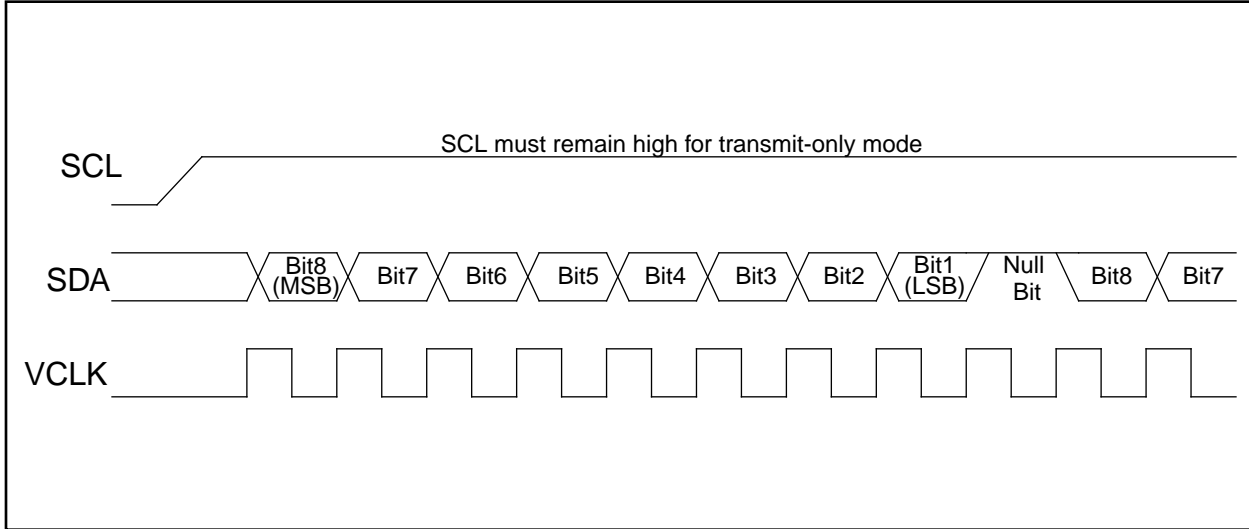
Upon power-up, the device will not output valid data until it has been initialized. This initialization procedure (Figure 1) data will not be available until after the first 9 clocks are sent to the device. The exact memory location that the 24LC21 begins to transmit data is unknown at power-up, and the initialization procedure only initializes the device, not the starting address or bit location. In order to for a controller to determine what address is being read, a 'framing' or 'syncing' procedure must be executed by the video card.

# AN610

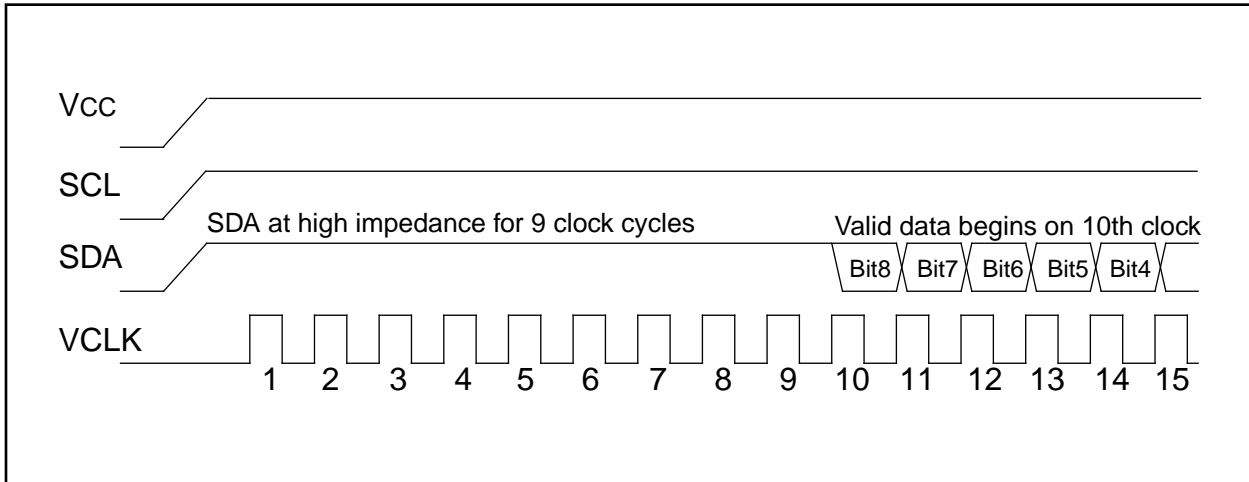
A framing procedure involves looking for the header portion of the EDID table which is a byte of 00H followed by 6 bytes of FFH and another byte of 00H. A framing routine would continue to clock data from the 24LC21 until this unique header has been found. At this point, the current location in the EDID table has been determined and the controller has now synchronized itself with the device. Care must be

taken while using the device in the transmit only mode to prevent noise on the SCL pin, as a falling edge seen on this pin will immediately send the part into the bi-directional mode. In a DDC1-only monitor, SCL is not connected to the VGA connector, but must still be terminated to VCC through a pullup resistor.

**FIGURE 1: TRANSMIT ONLY MODE**



**FIGURE 2: DEVICE INITIALIZATION FOR TRANSMIT-ONLY MODE**



## BI-DIRECTIONAL MODE (DDC2)

Bi-directional mode is essentially the standard I<sup>2</sup>C protocol and allows the controller to read and write to the device. The 24LC21 supports byte and page writes and byte and sequential reads in the bi-directional mode. This mode will be used primarily before the monitor leaves the factory to load the EDID table into the device, but it also provides a means of updating the table if necessary. It is also used for faster (up to 100 kHz) data transmission, or transmission of only specific requested data in a DDC2 system. (The I<sup>2</sup>C protocol allows the host to request data from a specific portion of the EDID table rather than waiting for the entire table.) When writing to the device, the VCLK pin must be held high while the write command is being loaded or the write will be aborted and no data will be written. Note that this is the opposite of the 24LC01B, where the WP pin must be held low for the device to be written.

## EDID TABLE

The EDID table is the Extended Display ID table, specified by VESA, that will be stored in the 24LC21 and contains information about what type of display it is and the capabilities of the display. The basic EDID table consists of 128 bytes of data. A breakdown of the table is shown below in Table 1. A complete description of the table can be found in the VESA DDC Specification.

**TABLE 1: EDID TABLE DESCRIPTION**

| Bytes | Description                                     |
|-------|---|
| 8     | Header  |
| 10    | Vendor/Product Description                      |
| 2     | EDID Version/Revision                           |
| 15    | Basic Display Parameters/Features               |
| 19    | Established/Standard Timings                    |
| 72    | Detailed Timing Descriptions<br>(18 bytes each) |
| 1     | Extension Flag                                  |
| 1     | Checksum  |

# AN610

## USING THE 24LC21 IN A SYSTEM

In order to use the 24LC21 in a monitor system, it must be programmed with a proper EDID table and then properly connected to the signals coming from the video controller card. The VESA committee has specified that the connections for DDC transmission can be part of the standard 15-pin VGA connector. A table of pinouts for this connector are shown in Table 2. Signals that pertain to the use of the 24LC21 are highlighted.

Programming of the 24LC21 can be accomplished via Microchip Technology's SEEVAL programming and evaluation system or by any final test system at the customer site which can communicate over the I<sup>2</sup>C bus.

**TABLE 2: VGA CONNECTOR DESCRIPTION**

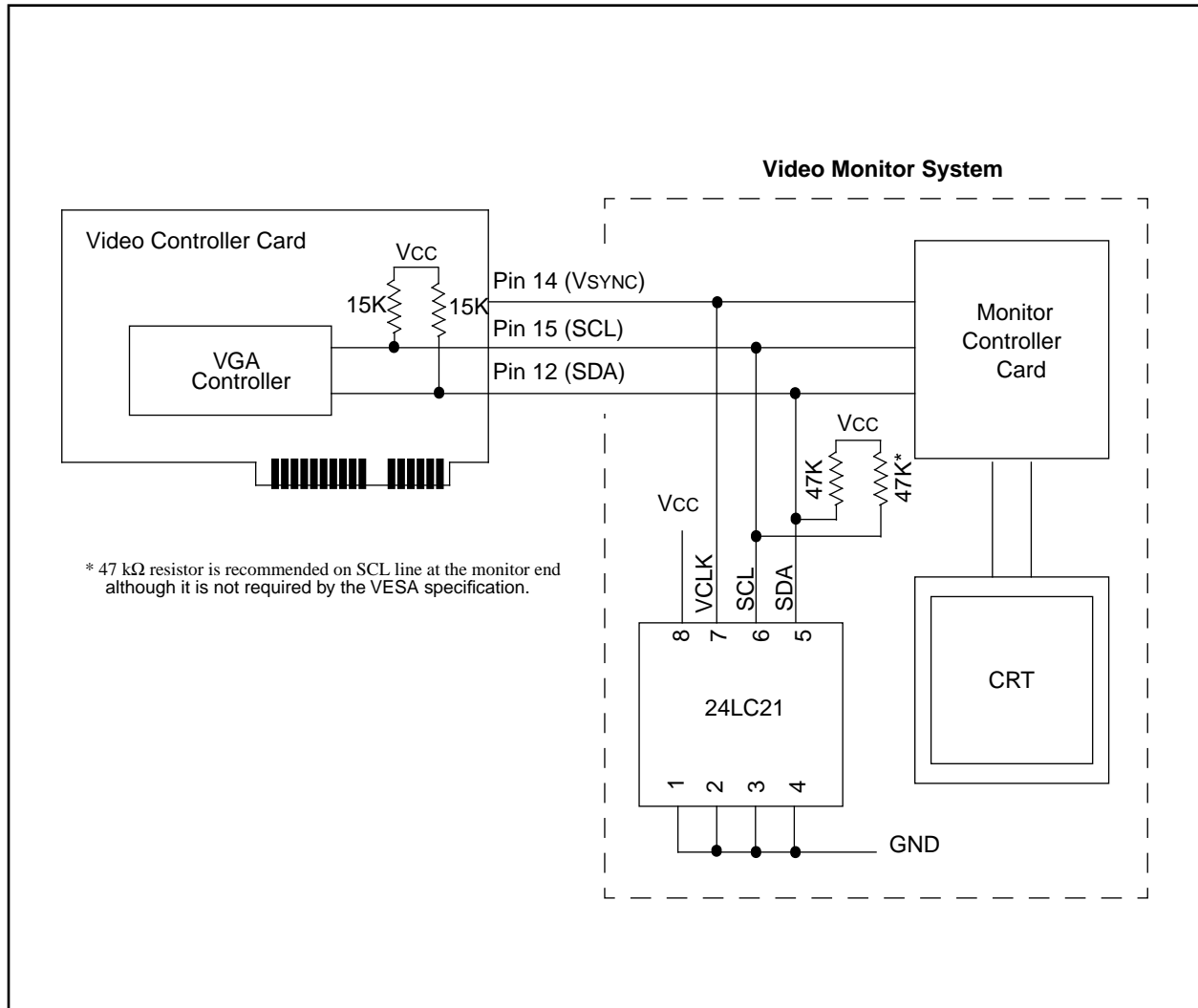
| Pin | Standard VGA       | DDC1 Host                      | DDC2 Host                        | DDC1.2 Display                   |
|-----|--------------------|--------------------------------|----------------------------------|----------------------------------|
| 1   | Red Video          | Red Video                      | Red Video                        | Red Video                        |
| 2   | Green Video        | Green Video                    | Green Video                      | Green Video                      |
| 3   | Blue Video         | Blue Video                     | Blue Video                       | Blue Video                       |
| 4   | Monitor ID Bit2    | Monitor ID Bit2                | Monitor ID Bit2                  | Return                           |
| 5   | Test (Ground)      | Return                         | Return                           | Return                           |
| 6   | Red Video Return   | Red Video Return               | Red Video Return                 | Red Video Return                 |
| 7   | Green Video Return | Green Video Return             | Green Video Return               | Green Video Return               |
| 8   | Blue Video Return  | Blue Video Return              | Blue Video Return                | Blue Video Return                |
| 9   | No Connection      | +5V Supply (optional)          | +5V Supply (optional)            | +5V Supply (optional)            |
| 10  | Sync Return        | Sync Return                    | Sync Return                      | Sync Return                      |
| 11  | Monitor ID Bit0    | Monitor ID Bit0                | Monitor ID Bit0                  | Optional                         |
| 12  | Monitor ID Bit1    | <b>Data from Display (SDA)</b> | <b>Bi-directional Data (SDA)</b> | <b>Bi-directional Data (SDA)</b> |
| 13  | Horizontal Sync    | Horizontal Sync                | Horizontal Sync                  | Horizontal Sync                  |
| 14  | Vertical Sync      | <b>Vertical Sync (VCLK)</b>    | Vertical Sync                    | <b>Vertical Sync (VCLK)</b>      |
| 15  | Monitor ID Bit3    | Monitor ID Bit3                | <b>Data Clock (SCL)</b>          | <b>Data Clock (SCL)</b>          |

## SYSTEM CONFIGURATION

A typical system configuration is shown below. The DDC specification states that a 47 k $\Omega$  pull-up resistor is required on the SDA line at the monitor end. It also

states that a 15K pullup resistor is needed on both the SCL and SDA lines at the video controller end.

**FIGURE 3: USE OF 24LC21 IN VIDEO SYSTEM**



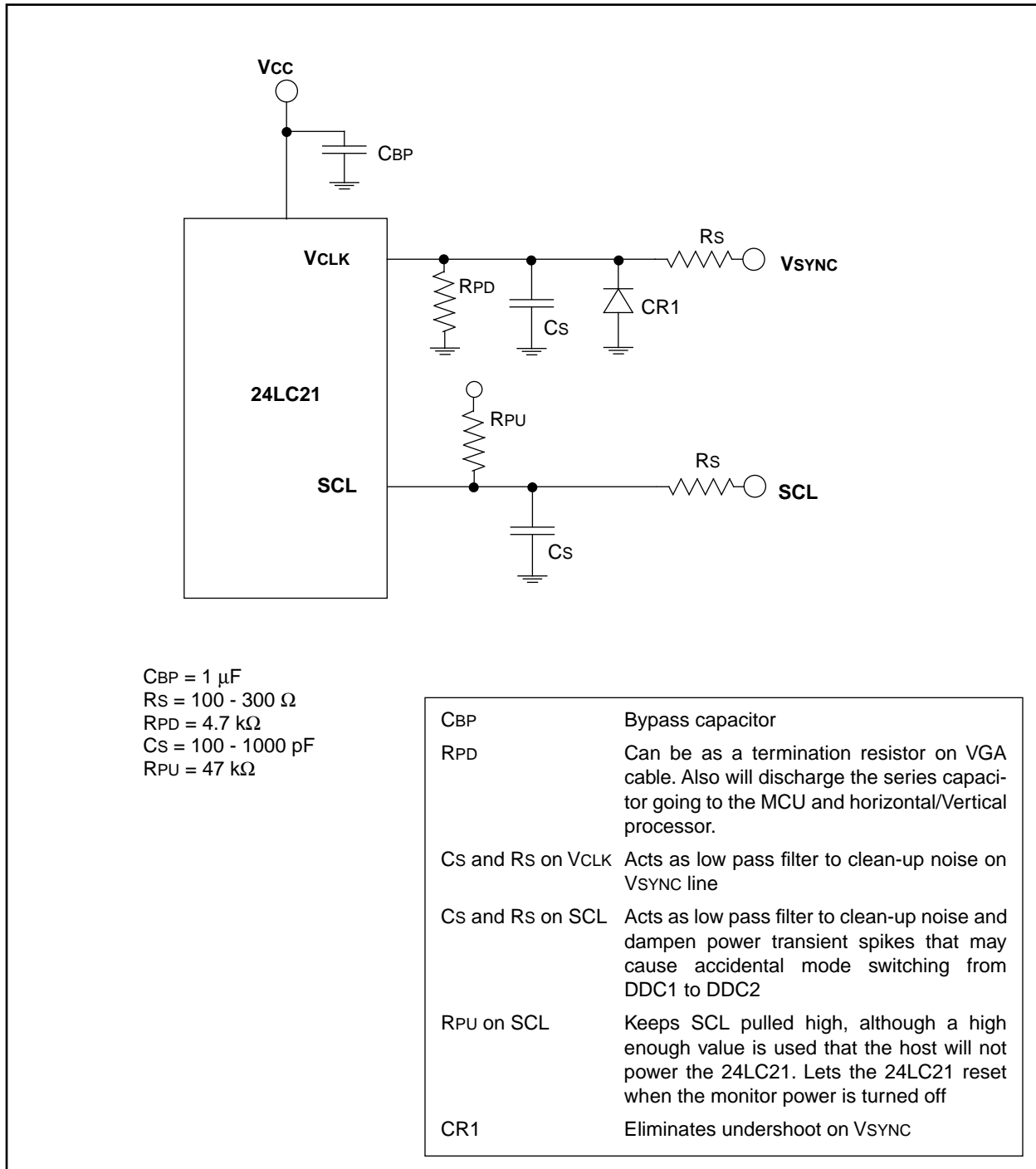
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## POTENTIAL PROBLEMS CAUSED BY NOISE IN A VIDEO SYSTEM

Because the typical application for the 24LC21 is in a computer monitor where electronic noise is prevalent, some precautions may need to be made in order for this device (or any other CMOS device) to work prop-

erly. The diagram below (Figure 4) shows a filter circuit that can be used to reduce the amount of noise seen by the device on the SCL and VCLK pins.

**FIGURE 4: RECOMMENDED FILTER CIRCUIT FOR MONITOR APPLICATIONS**



NOTES:

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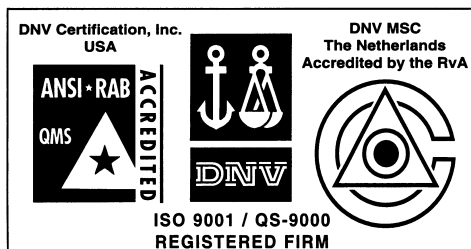
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