SanDisk Application Note

UniDirectional to BiDirectional Serial Data Conversion for the MultiMediaCard

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Considerations for Interfacing to SanDisk Flash

Introduction

Althought SanDisk's MultiMediaCard already has a Serial Peripheral Interface (SPI), data throughput and faster transfers can be achieved when the card is in the MultiMediaCard mode. The design described in this application note provides a simple means to translate an existing SPI or serial port to a MultiMediaCard interface.

This design uses a Program Array Logic (PAL) device in the form of an ICT Inc., PEEL 22lV10AZ-25 CMOS Programmable Electrically Erasable Logic Device to convert an existing unidirectional SPI port to a bidirectional MultiMediaCard port.

SPI2MMC PAL

The SPI2MMC PAL is intended to convert a host's two line, unidirectional (transmit and receive) port to a two line, directionally controlled, bidirectional port. The initial design was used to convert a host's SPI port to a MultiMediaCard port, but it could be used to convert any port with single unidirectional input and output ports to a MultiMediaCard single bidirectional DAT[0] / CMD port.

The SPI2MMC PAL is based on an ICT Inc., PEEL 22lV10AZ-25 CMOS Programmable Electrically Erasable Logic Device. The 22LV10AZ has a voltage operation range between +2.7V and +3.6V that exactly matches the effective operating range of the SanDisk MultiMediaCard. This device can be reviewed at ICT Inc.'s web site http://www.ictpld.com/products/22lv10az.htm.

The SPI2MMC PAL requires three outputs and one input from the host. There are two outputs to the MultiMediaCard. These signals are described in Table 1.

Table 1 PAL Signal Definitions

Signal Name	PAL Direction	Function	Corresponding Host SPI Line	PAL Pin Number
Tx	Input	Transmit line from the Host	MOSI	1
Td/Tc	Input	Transmit line Directional Control from the Host	--	2
Rx	Output	Receive line to the Host	MISO	21
Rd/Rc	Input	Receive line Directional Control from the Host	--	3
CMD	Input / Output	Corresponds to MultiMediaCard's CMD line	--	23
DAT	Input / Output	Corresponds to MultiMediaCard's DAT[0] line	--	22

Signals

Tx
The Tx (or transmit) signal is the serial data output from the host. The PAL's Tx pin is a high impedance input.

Td/Tc
The Td/Tc signal is the directional control signal for the Tx line. Td/Tc is a digital output signal from the host. A "1" on the Td/Tc pin 2 applies the Tx pin 1's data to the DAT output pin 22. A "0" on the Td/Tc pin 2 applies the Tx pin 1's data to the CMD output pin 23. The PAL's Td/Tc pin is a high impedance input.

Rx
The Rx (or receive) signal is the serial data input to the host. The PAL's Rx pin is a digital output that "rests" at a logic "1" value when no data is being received. The Rx will always equal "1" when Tx is "0" and Td/Tc = Rd/Rc. This prevents "feedback" of the host's transmitted data to the receive line, so the user does not receive what he sends.

Rd/Rc
The Rd/Rc signal is the directional control signal for the Rx line. Rd/Rc is a digital output signal from the host. A "1" on the Rd/Rc pin 3 applies the DAT line's data input pin 22 to the Rx pin 21. A "0" on the Rd/Rc pin 3 applies the CMD line's data input pin 23 to the Rx pin 21. The PAL's Rd/Rc pin is a high impedance input.

CMD
The CMD (or command) signal is one of two bi-directional serial data ports connected directly to the MultiMediaCard. The PAL's CMD pin acts as both a digital input from the MultiMediaCard's CMD pin 2 and as an output from the host's Tx line. The PAL's CMD line always "rests" at a logical "1" so that either the Tx line or the MultiMediaCard's CMD line can drive pin 23.

DAT
The DAT (or data) signal is one of two bi-directional serial data ports connected directly to the MultiMediaCard. The PAL's DAT pin acts as both a digital input from the MultiMediaCard's DAT[0] pin 7 and as an output from the host's Tx line. The PAL's DAT line always "rests" at a logical "1" so that either the Tx line or the MultiMediaCard's DAT line can drive pin 22.

Limitations

The current implementation of the SPI2MMC PAL provides no MultiMediaCard clock signal. It assumes that a valid and "data aligned" clock is provided by the host.

Note that the PEEL 22lV10AZ-25 has a propagation delay of 25n seconds. Host system's using MultiMediaCard clock speeds approaching 20MHz may need to check for data misalignment due to this delay.

A limited number of PAL programmers can correctly program the PEEL 22lV10AZ-25 low voltage PAL. One such Programmer is System General's AllWriter Universal Programmer. System General Corporation's web site is http://www.sg.com.tw/HomePage.htm.

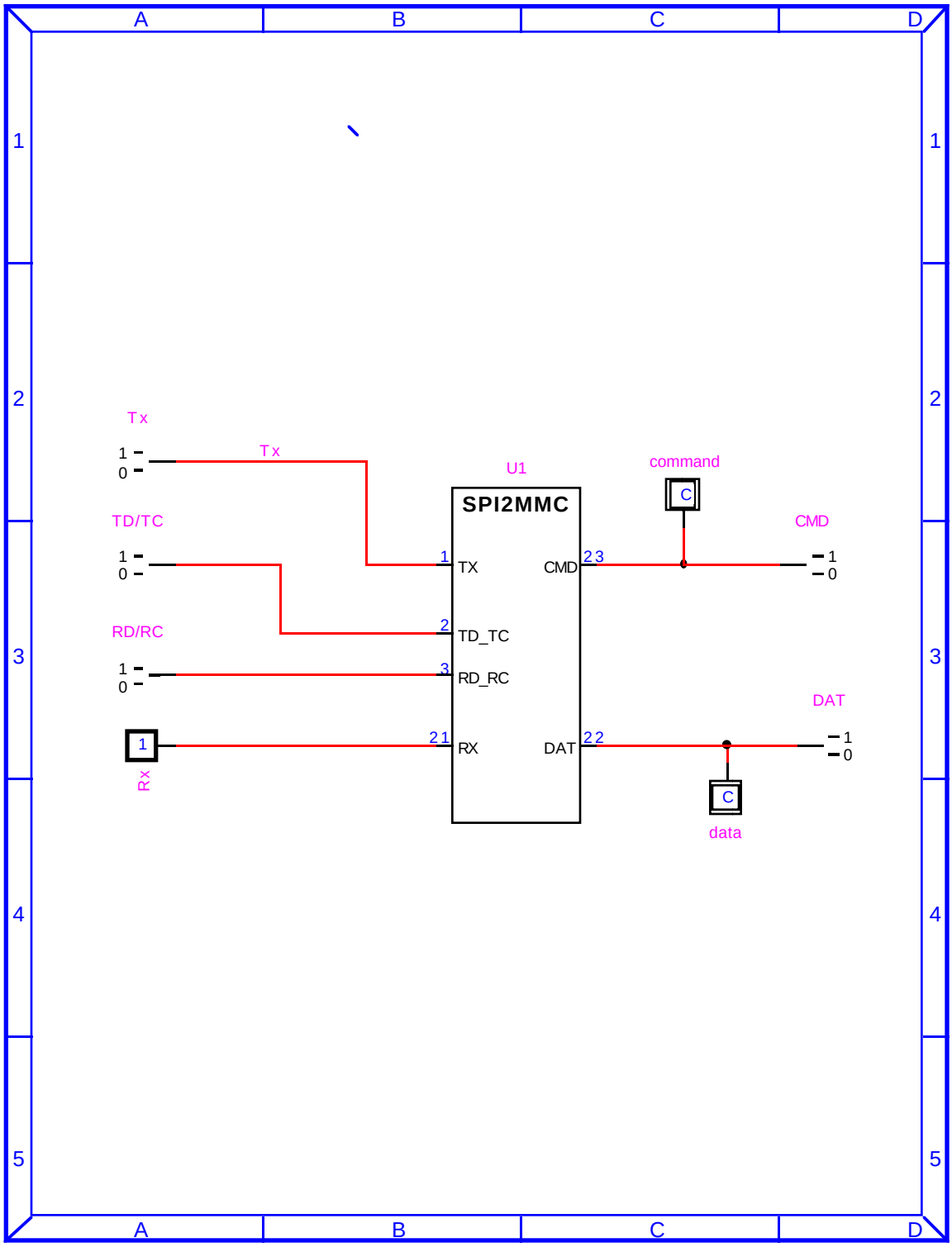

Figure 1 Schematic

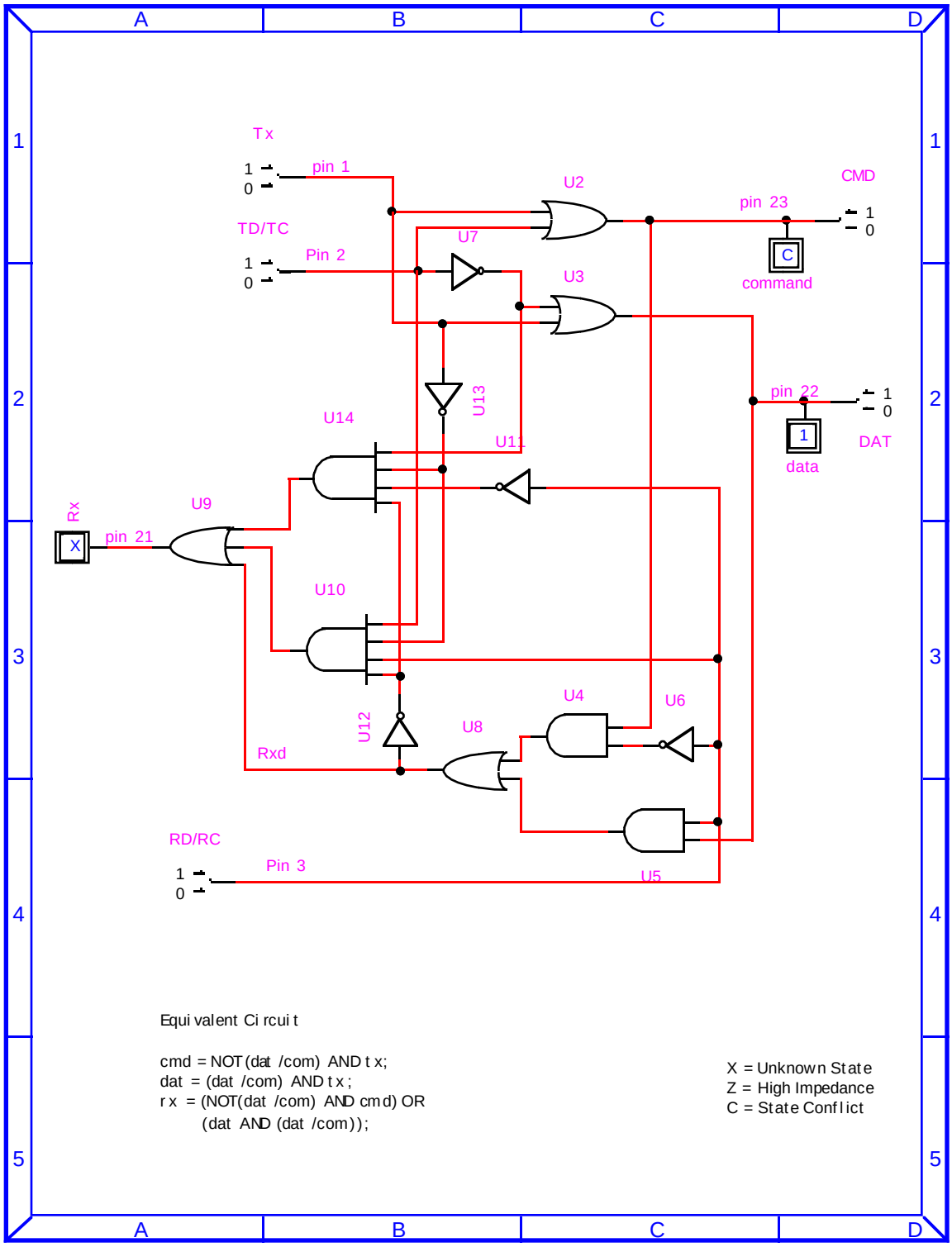

Figure 2 PAL Circuit Equivalent Schematic

PAL ABEL File

```
module _SPI2MMC

title '2 wire Uni-direction to 2 wire Bi-directional serial interface

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Sunnyvale CA   1 December 1998'

SPI2MMC     device      'P22V10';

" Inputs

      TX          pin  1;
      TD_TC       pin  2;
      RD_RC       pin  3;

" Outputs

      CMD         pin 23;
      DAT         pin 22;
      RX          pin 21;
      RXD         pin 20;     " Interim Rx signal (un-filtered)

      X,C,L,H       = .X., .C., 0, 1;

equations

      CMD    = TX # TD_TC;

      DAT    = TX # !TD_TC;

      RXD  = (CMD & !(RD_RC)) # (DAT & (RD_RC));

      RX    = RXD # (!(TD_TC) & !TX & !(RD_RC) & !RXD) # ((TD_TC) & !TX
              & (RD_RC) & !RXD);

"test_vectors
"     ([TX,       TD_TC,      RD_RC]      ->    [CMD,  DAT,  RX])

"     [ 0,        0,          0]          ->    [ 0,    1,    1 ];

"     [ 0,        0,          1]          ->    [ 0,    1,    1 ];

"     [ 0,        1,          0]          ->    [ 1,    0,    1 ];

"     [ 0,        1,          1]          ->    [ 1,    0,    1 ];

"     [ 1,        0,          0]          ->    [ 1,    1,    1 ];

"     [ 1,        0,          1]          ->    [ 1,    1,    1 ];
```

```
"     [ 1,        1,          0]          ->    [ 1,    1,    1 ];

"     [ 1,        1,          1]          ->    [ 1,    1,    1 ];

end
```

all writer

Universal Programmer

An Affordable Solution for Engineering Applications

Imagine a reliable programmer with an affordable price to meet your project and budget requirements. With the innovative Match Card technology, AllWriter has made the idea a reality! Each plugged-in Match Card incorporates the electronic enhancement required to generate the best waveform quality for a device family. Therefore, the programming reliability is ensured.

Unlike other low-cost solutions in the market, AllWriter is equipped with the embedded CPU and the local power supply required to generate Semi-houses certified environments. The Windows software comes with all the functions and features available only on the high-end models. The advanced hardware of AllWriter assures that the system programs the devices today and the cutting-edge green devices in the future! Like other System General programming systems, the software updates are free!

Specifications

Hardware System
- Embedded CPU
- Local 110/220 Universal switching mode power supply
- 32 meg bit RAM standard
- High speed RS-232C serial interface up to 230,000bps
- IEEE 1284 high speed parallel interface
- Unique Match Card for hardware configurations

Software System
- Windows software

Device Support
- EPROM, EEPROM, Flash EPROM
- PALs, GALs PEEL, PALCE, CPLD, EPLD, EEPLD
- AMD/Vantis MACH, Altera MAX5000/7000, Altera Jam devices
- Xilinx 9500X EPLD, Lattice spLSI, Philips CPLD
- Over 200 Microcontrollers, including Motorola MC68HC705/711 families, Intel Microcontrollers, Philips Microcontrollers, Dallas Microcontrollers, Microchip PIC, Atmel 87/89 series Microcontrollers, WSI PSD devices...etc

Package Support
- Optional adapters to support devices in DIP, PLCC, SOIC, PSOP, TSOP, VSOP and QFP packages.
- Optional converters manufactured by the third party vendors to convert the programming signals from DIP to any other packages.

Device Operation
- Read, Program, Verify, Margin Verify, Illegal Bit Check, Blank Check, Erase, Secure.
- Task Manager for saving operation environments.
- File upload and download.
- EPROM Auto ID, device insertion check.
- Three checksum modes: Byte sum, Word sum and CRC sum.
- Memory edit.
- Set / Split programming for memory devices.
- Serial code programming for memory devices.

File Formats
- Binary
- Standard HEX
- ASCII-SPACE-HEX
- ASCII-OCTAL
- Motorola S (S1, S2, S3)
- Intel MCS 86 HEX
- Tektronix HEX
- Extended Tektronix HEX
- TI HEX
- Xilinx HEX
- Altera POF
- Altera Jam
- Standard JEDEC

SYSTEM GENERAL

ISO 9001

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Figure 3 PAL Programmer