FT245BM Designers Guide
Version 2.0

Introduction

Welcome to the FT245BM Designer's Guide. The Designers Guide includes printouts of a number of FT245BM reference schematics and explanations of the key points of each schematic. These are intended to be used in conjunction with the FT245BM data sheet, the current version of which should also be downloaded from the FTDI web site.

The schematic files are downloadable separately as a ZIP archive which contains the schematics both in OrCAD SDT 16-bit DOS format and in OrCAD Capture for Windows 32-bit format.

The OrCAD SDT 16-bit DOS format schematics are readable by OrCAD SDT version 3.2 and above. These consist of files with the following extensions –

- **.sch = OrCAD 16-bit DOS binary schematic file**
- **.lib = OrCAD 16-bit DOS binary component library file**
- **.src = OrCAD DOS library source (text) file**

The OrCAD Capture for Windows schematics are readable by OrCAD Capture version 7.2 and above. These consist of a file with a .dsn extension.

Notes for Protel users

OrCAD 16-bit DOS schematics can be imported into Protel schematic capture for Windows. Before reading in the schematic (.sch) file, create a Protel library first by reading in the OrCAD library source (.src) file and save it in Protel binary library format. Both OrCAD and Protel use the same default extensions for schematic and library files, so if you do not wish to overwrite the original OrCAD files, save the Protel versions to a different folder.

Figure 1.0 FT245BM – 5 volt Bus Powered Example Schematic (245-5VB)

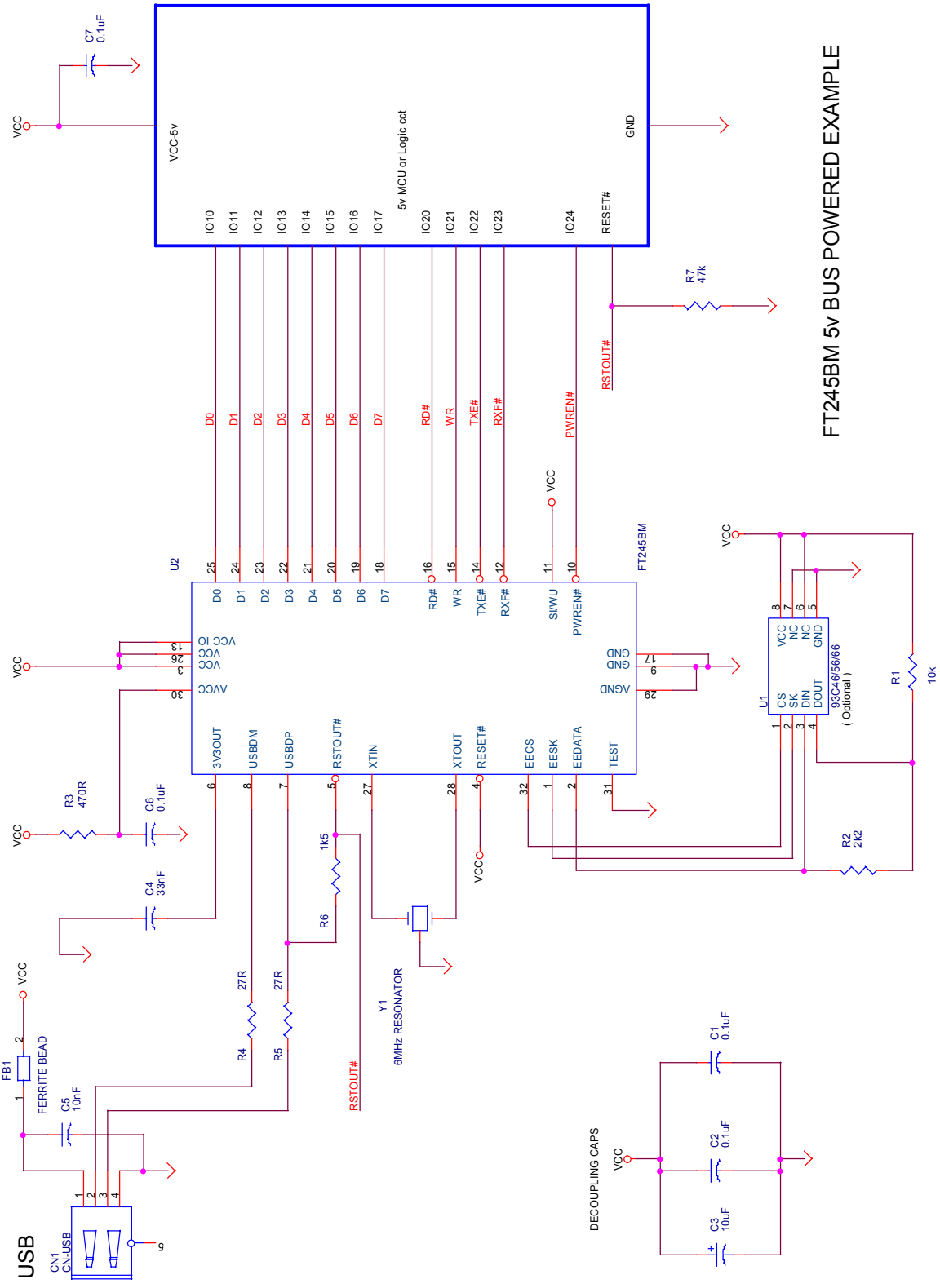

Figure 1.0 is an example of a 5 volt, USB bus powered design using the FT245BM connected to a 5v MCU or other external logic.

- **In this example, we assume that the total current of the design is <= 100mA (low power), and that the MCU / logic can detect USB suspend mode using either the PWREN# pin of the FT245BM and put itself and any circuitry it is controlling into a low power state in order to meet the total USB suspend current requirement of 500uA or less.**
- **RSTOUT# is used to provide a power-on reset to the external logic in this example. If the MCU has it's own power-on reset logic then there is usually no need to use RSTOUT# to reset the device and this connection and the 47k pull-down can be omitted.**
- **The design uses two IO Ports of the MCU to communicate with the FT245BM device. One 8 bit Port is used to transfer the data, the other port is used to control the 4 wire handshake (RD#, WR, TXE#, RXF#) as required by the FT245BM device.**

General Design Notes:

- **PWREN# is high on power-on and only goes low (active) after the device has been configured (successfully enumerated) by USB. During USB suspend PWREN# will go high. For a high power bus powered USB device (100mA .. 500mA) you must use PWREN# for power control as no USB device is allowed to draw more than 100mA from the bus until USB configuration is complete.**
- **RSTOUT# has no pull-down capability – it drives to 3.3v when not in reset, and goes tri-state during power-on reset. If used to reset an external device, a pull-down resistor must be added to make it low during reset.**
- **If the MCU is responsible for power management of the design, then connect the PWREN# pin of the FT245BM to the MCU.**
- **If the design requires to wake the Host PC from USB suspend mode, then connect the SI/WU pin and PWREN# pin to the MCU.**
- **If the "Send Immediate" function is required, then connect the SI/WU pin to the MCU.**
- **If the SI/WU pin is not required, tie it high.**
- **A suitable 3-pin ceramic resonator could be a Murata CSTCR6M00G15 or equivalent. See http://www.murata.com/catalog/p63e.pdf for details If you prefer to use a 2 pin resonator or a crystal refer to Figures 4 and 5 of the FT245BM data sheet for details.**
- **A suitable ferrite bead could be a Steward MI0805K400R-00 or equivalent. This is also available from DigiKey as Part # 240-1035-1. For specifications consult the Steward web site - http://www.steward.com**

Figure 2.0 FT245BM – 5 volt Self Powered Example Schematic (245-5VS)

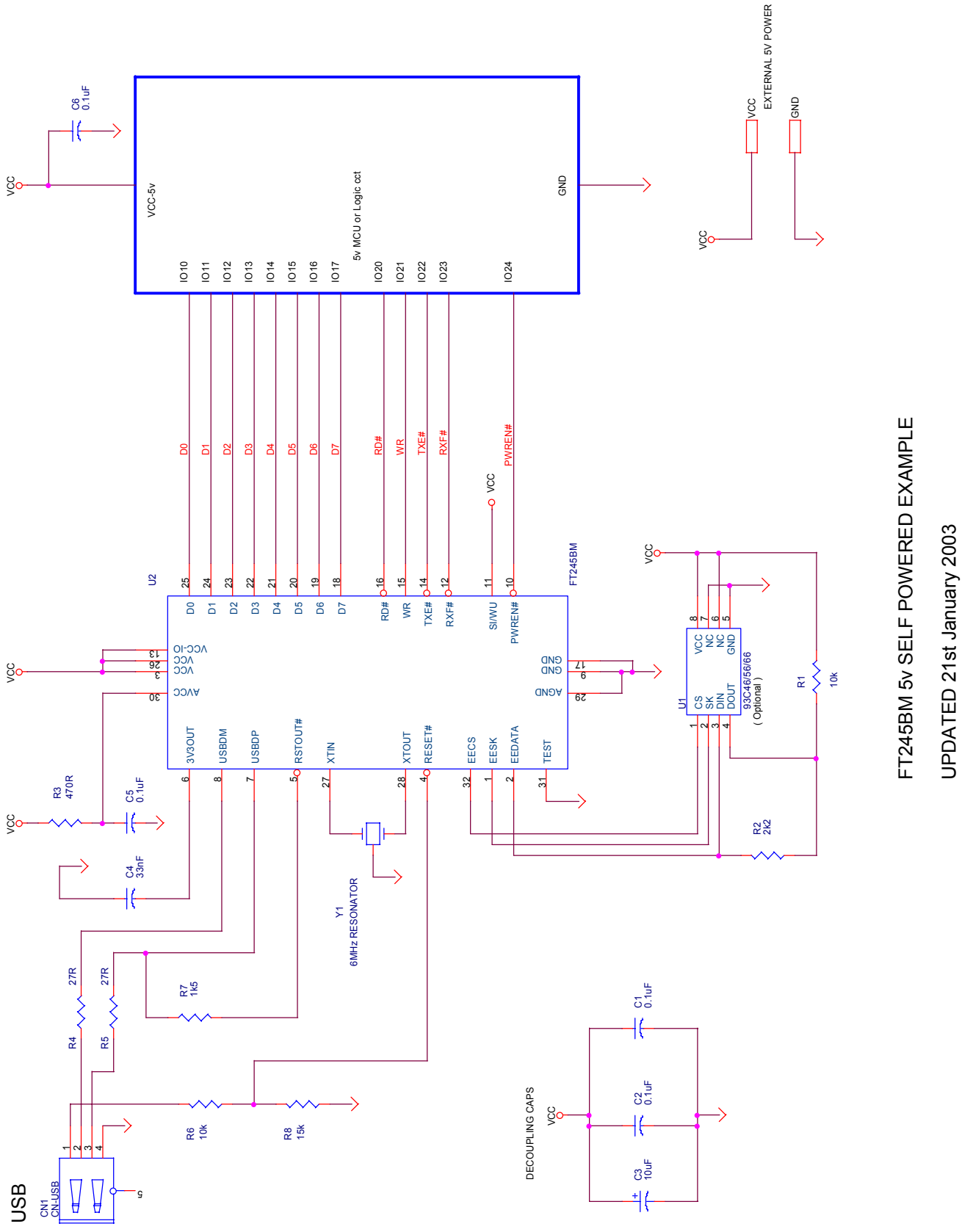

Figure 2.0 is an example of a 5 volt, USB self powered design using the FT245BM connected to a 5v MCU or other external logic. A USB self power design has it's own PSU and does not draw it's power from the USB bus. In such a case, no special care need be taken to meet the USB suspend current (0.5mA) as the device does not get its power from the USB port.

- **In this case it is still useful to connect PWREN# to the CPU as this will let the CPU know that the PC is in suspend mode and thus unable to communicate with the device. If the device requires to "wake up" the PC then the MCU should connect one of it's IO Ports to the SI/WU pin of the FT245BM. The default state of SI/WU should be high - strobing this low for a few milliseconds then taking it high again will cause a USB resume sequence thus requesting the PC to wake up. To use this feature, Remote Wake-Up must be enabled in the 93C46 EEPROM.**
- **Set the Power Control field in the 93C46 EEPROM to tell the USB Host that this is a USB self powered device.**
- **Self powered designs should NOT force current back into the Host PC (or HUB) via the USB Port when the said Host / Hub is powered down and the self powered device is still powered-up from it's own PSU. This rule includes injecting current into the powered down Host / Hub via the 1k5 pull-up on USB D+. Failure to do this can result in unreliable operation in the field. This is an integral part of the USB specification and applies to all USB Self Powered devices (not just FT245BM peripherals). In this design, the presence of power on the host/hub USB port is used to control the RESET# pin of the FT245BM. When the Host / Hub is powered up, RSTOUT# pulls the top end of the 1k5 resistor on USB D+ to 3.3v nominal thus identifying the device as a full speed device to USB. When the Host / HUB powers down, the FT245BM is reset and RSTOUT# will go low thus preventing current being injected into the Host / Hub USB D+ line via the 1k5 resistor.**

General Design Notes – See Previous Example

Figure 3.0 FT245BM – 5v Bus Powered Schematic with Power Switching (245-5VSW)

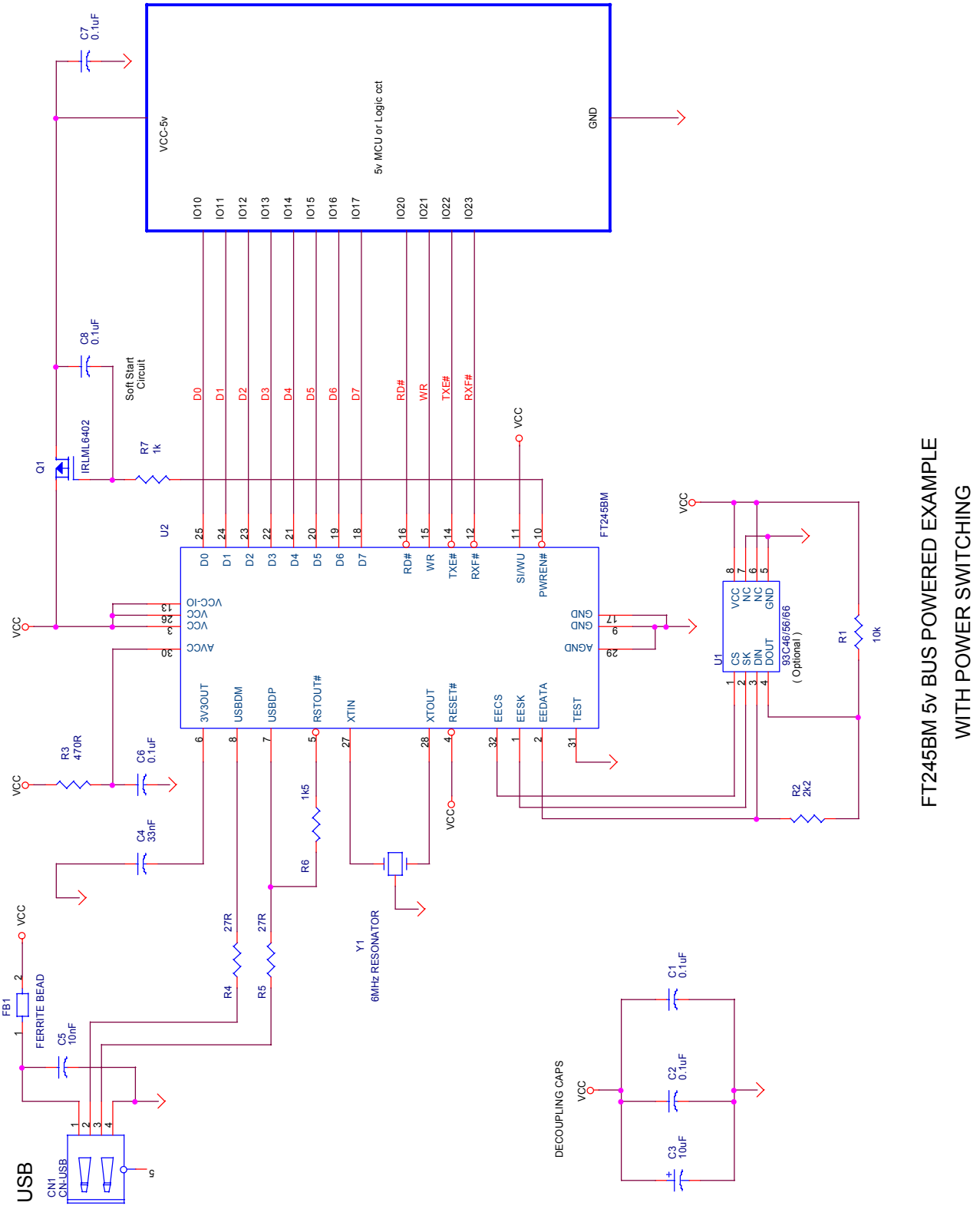

Figure 3.0 is an example of a 5 volt, USB bus powered design using the FT245BM connected to a 5v MCU or other external logic. In this design, the FT245BM controls the power to the auxiliary circuitry using PWEREN# to shut off power to this circuitry when –

1. **The FT245BM is in reset, OR**
2. **The FT245BM has not yet been configured (successfully recognised and enumerated over USB), OR**
3. **USB is in suspend / sleep mode.**

- **A P-Channel Logic Level MOSFET is used as a power switch to control the power to the auxiliary devices – in this example we use a International Rectifier part number IRLML6402. R7 and C8 form a "soft start" circuit which limits the current surge when the MOSFET turns on. Without this, there is a danger that the transient power surge of the MOSFET turning on will reset the FT245BM or the USB Host / Hub controller. The values used allow the attached circuitry to power up with a slew rate of ~ 12.5v per millisecond, in other words the output voltage will transitioning from GND to 5v in around 400uS.**
- **When using this circuit, enable the "Pull-Down on Suspend" option in the EEPROM. This will ensure minimum leakage current during sleep (suspend) mode by gently pulling down the FIFO interface pins of the FT245BM pins to GND during USB suspend.**
- **The auxiliary circuitry attached to the FT245BM device must have it's own power-on-reset circuitry and should NOT use RESETO# to generate a reset for this circuitry. RESETO# does not generate a reset during USB sleep (suspend) when the auxiliary logic is powered-off, thus cannot be used as a reset in this case.**
- **A "USB High-Power Bus Powered Device" (one that consumes more than 100mA and up to 500mA) of current from the USB bus during normal operation must use this power control feature to remain compliant as the USB specification does not allow a USB peripheral to draw more than 100mA of current from the USB Bus until the device has been successfully enumerated. A "USB High-Power Bus Powered Device" cannot be plugged into a USB Bus-Powered Hub as these can only supply 100mA per USB port.**
- **The Power (current) consumption of the device is set in a field in the 93C46 EEPROM attached to the FT245BM. A "USB High-Power Bus Powered Device" must use the 93C46 to inform the system of it's power requirements.**

General Design Notes – See Previous Examples

Figure 4.0 FT245BM – 3.3 volt Bus Powered Example Schematic (245-3VB)

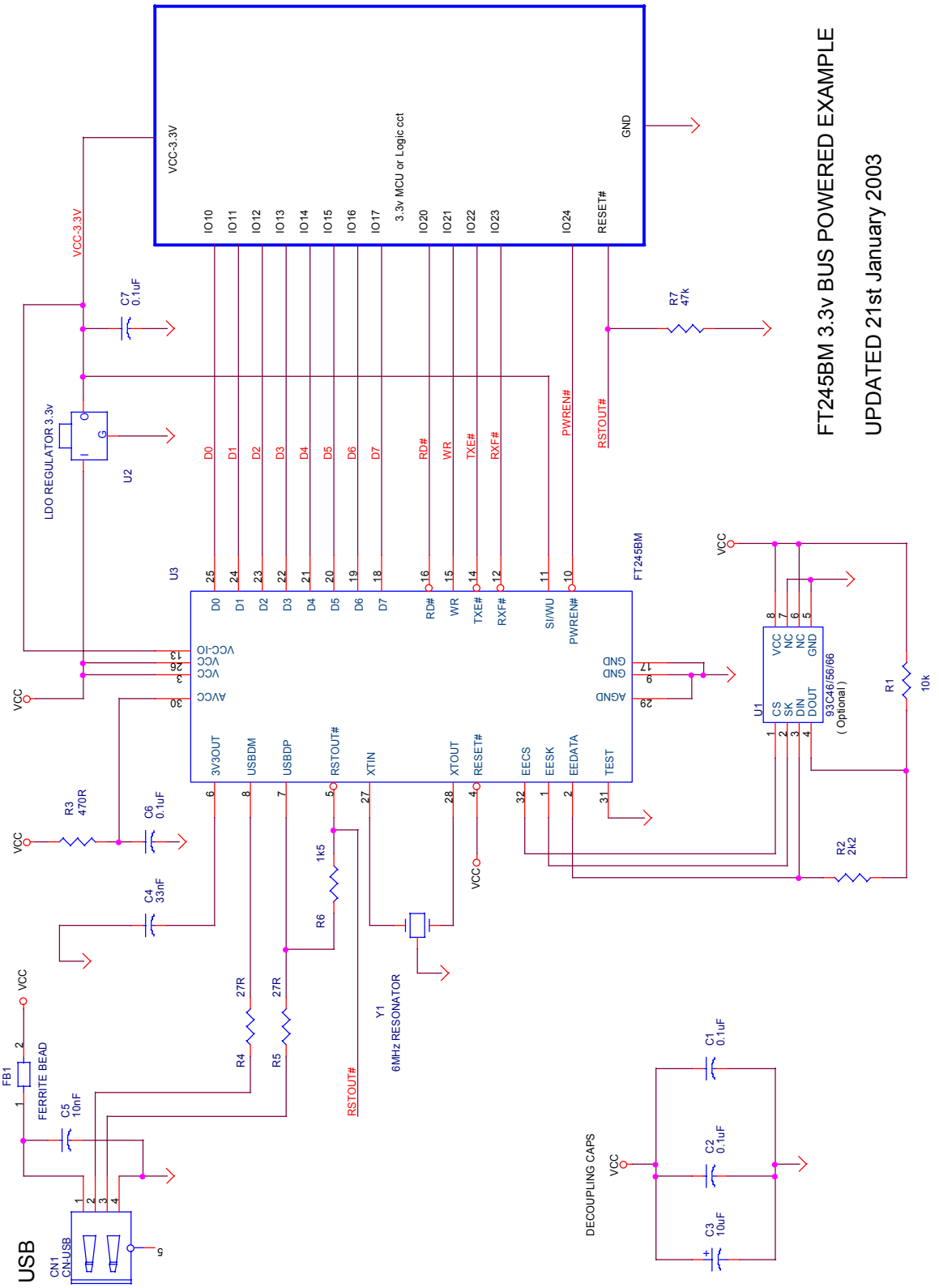

Figure 4.0 is an example of a 3.3 volt, USB bus powered design using the FT245BM connected to a 3.3v MCU or other external logic.

- **The main difference between this circuit and the 5 volt circuit of Figure 1.0 is that a 3.3 volt LDO regulator i.c. is used to provide a 3.3v supply to the auxiliary circuiry.**
- **VCC-IO is driven from the 3.3v LDO regulator i.c. in order to drive the FIFO interface from the FT245BM to the MCU / external logic at 3.3v level instead of 5v level.**
- **As the USB supply rail can drop to 4.4 volts or less under load, an LDO (Low Dropout) voltage regulator must be used in this instance.**
- **The 3.3v LDO voltage regulator must also have a low quiescent (no load) current in order to ensure that the USB suspend current requirement (<= 500uA) is met during USB suspend.**
- **In this example, we assume that the total current of the design is <= 100mA (low power), and that the MCU / logic can detect USB suspend mode using the PWREN# pin of the FT245BM and put itself and any circuitry it is controlling into a low power state in order to meet the total USB suspend current requirement of 500uA or less.**
- **RSTOUT# is used to provide a power-on reset to the external logic in this example. If the MCU has it's own power-on reset logic then there is usually no need to use RSTOUT# to reset the device and this connection and the 47k pull-down can be omitted. Note : If RSTOUT# is used to reset an external device AND to pull-up the USB D+ line, it's Vout high can be as low as 2.2v so it must be used to drive a TTL level reset input on the external device.**

General Design Notes – See Previous Examples

Figure 5.0 FT245BM – 3.3 volt Self Powered Example Schematic (245-3VS)

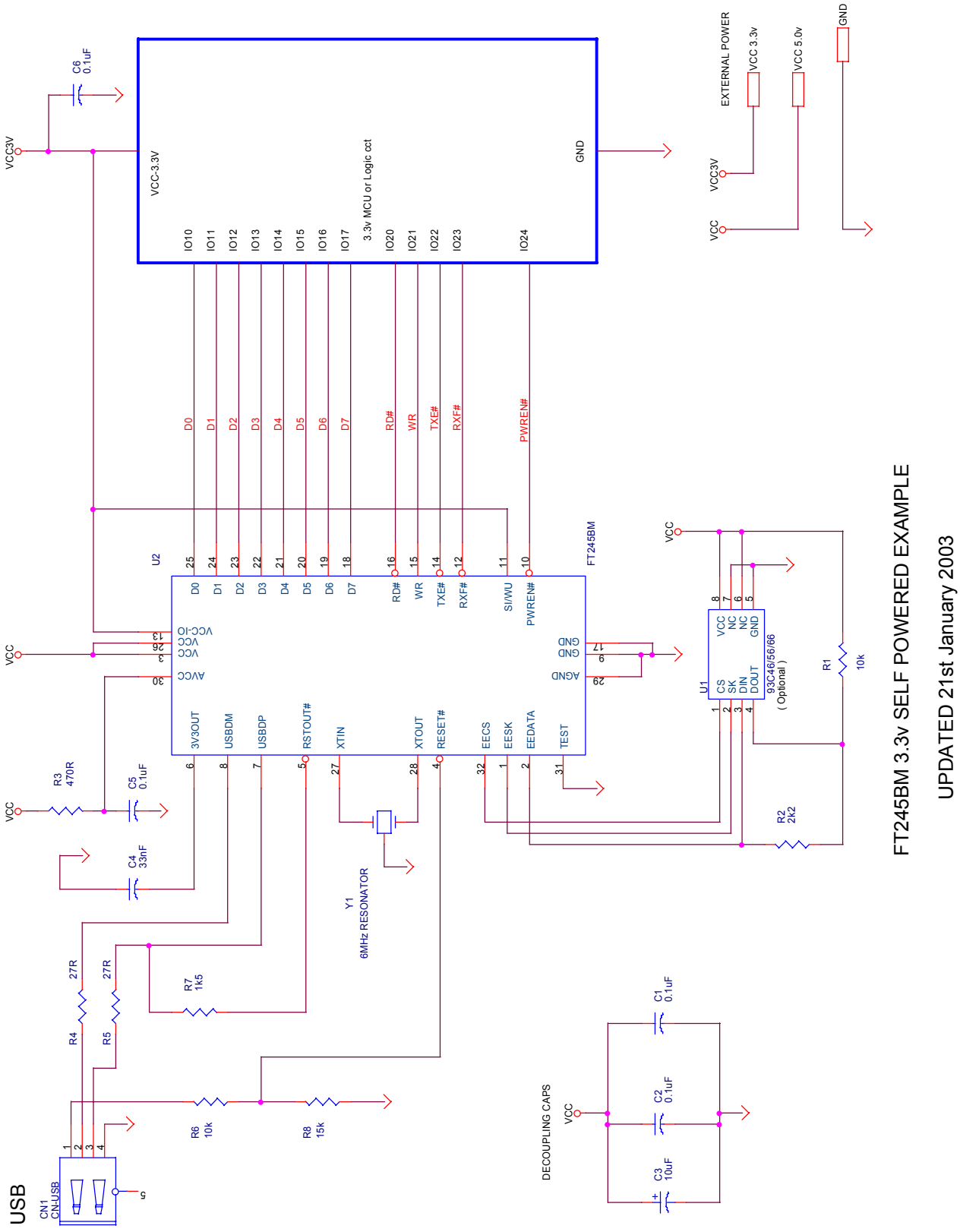

Figure 5.0 is an example of a 3.3 volt, USB self powered design using the FT245BM connected to a 3.3v MCU or other external logic. A USB self power design has it's own PSU and does not draw it's power from the USB bus. In such a case, no special care need be taken to meet the USB suspend current (0.5mA) as the device does not get its power from the USB port. The differences between this circuit and that of Figure 2.0 are minimal. See the notes in Figure 2 for the main details.

- **In this case the internal PSU need to supply 3.3 volts to the auxiliary circuitry and 5 volts to the FT245BM i.c.**
- **The VCCIO power line to the FT245BM is driven from the 3.3v supply in order to drive the auxiliary logic at the correct voltage level.**

Figure 6.0 FT245BM – 3.3v Bus Powered Schematic with Power Switching (245-3VSW)

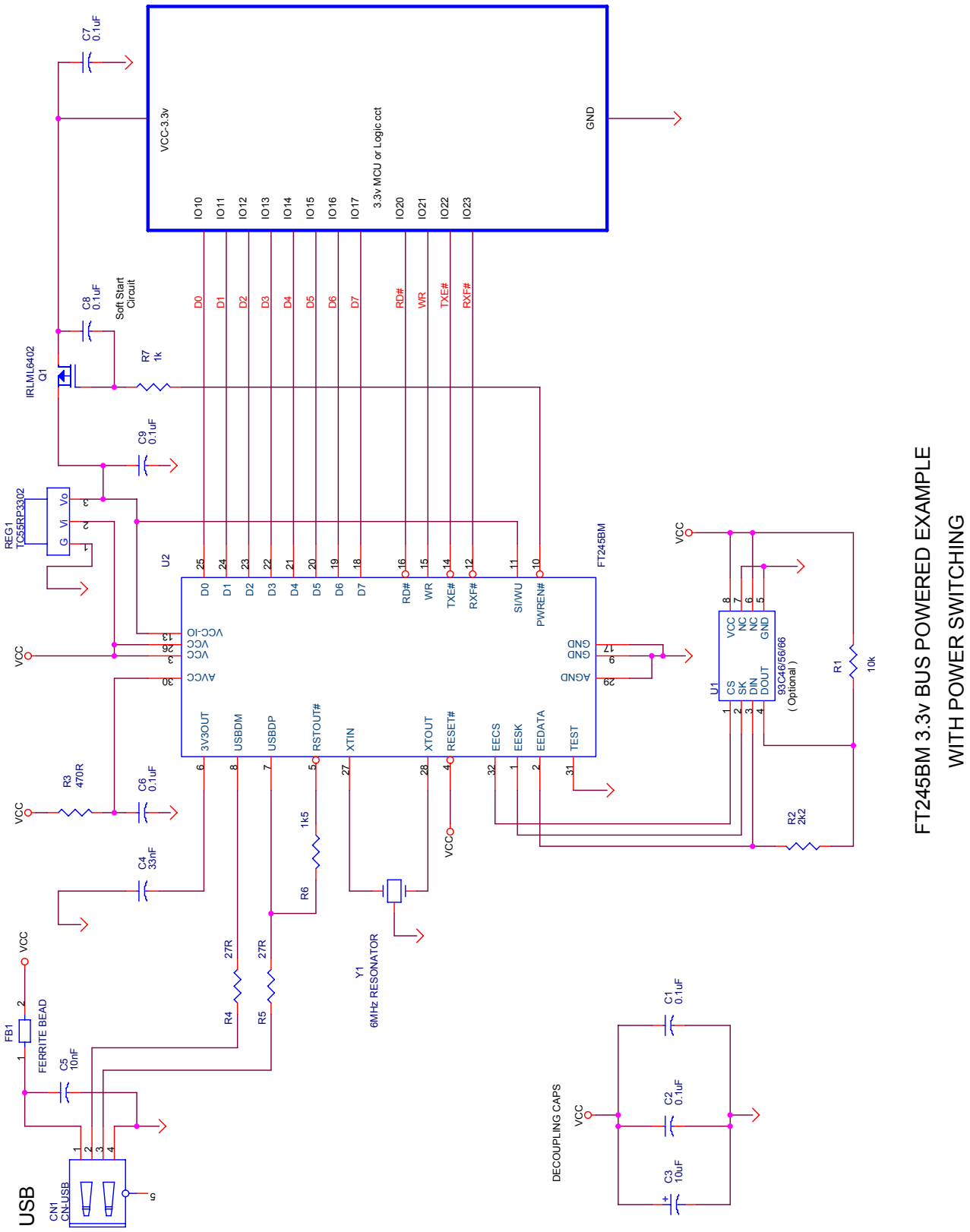

Figure 6.0 is an example of a 3.3 volt, USB bus powered design with power switching using the FT245BM connected to a 3.3v MCU or other external logic. The circuit is essentially a combination of the schematics of Figure 3 and Figure 4.

- **A 3.3 volt LDO regulator i.c. is used to provide a 3.3v VCCIO rail and switched 3.3v supply to the auxiliary circuiry via a IRLML6402 P-Channel MOSFET .**
- **In this example, we use a Telcom / MicroChip TC55RP3302 as the 3.3v LDO regulator. This has a maximum rated output current of 250mA. If a higher current is required, use an LD1117 / LM1117 series LDO regulator instead as these are rated to 800mA. The two are not pin compatible.**
- **R7 and C10 form a soft start circuit which helps prevent excesssive power switching transients when the MOSFET turns on. We would advise you to include these components as without them the current surge when the IRLML6402 MOSFET initially turns on can be capable of resetting the FT245BM or tripping the power sense circuitry in a USB hub.**

General Design Notes – See Previous Examples

Document Revision History

DG245B Version 1.0 – Initial document created 09 August 2002

DG245B Version 2.0 - Created 19th May 2003

- Corrected Pull Up Control Circuit for Self Powered Designs
- Corrected connection of PWRCTL in 3.3v Self Powered Designs
- Updated Schematic Drawings
- Added 3.3v Switched Bus Powered reference schematic

Disclaimer

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