AN 11.12

Configuring the USB2504 via SMBus

1 Preface

This application note provides information on configuring the USB2504 4-port USB2.0 HUB with an external SMBus master.

2 Audience

This application note assumes that the reader is familiar with hardware design, USB protocols and USB Hubs. The goal of the application note is to provide information on configuring the USB2504 with an external SMBus master.

3 Overview

When the default configuration with strapping options for USB2504 is not sufficient to define a specific implementation, additional configuration information must be provided by an external source. This application note describes the use of an external SMBus master as the source of the additional configuration information.

4 Configuration Choices

The USB2504 supports several OEM selectable features. Configuration choices are self-powered hub, bus-powered hub, or a dynamically switching between self and bus-power. When a down stream port will be permanently attached to a USB device, the USB2504 supports configuration as a compound device.

5 SMBus

The USB2504 may be configured by an external EEPROM or SMBus master when the default configuration with strapping options is not sufficient. For example, when the Vendor ID and/or Product ID must be changed from the default, then an external configuration source is required. This application note describes the use of an external SMBus master.

5.1 Selection of External SMBus Configuration

Three configuration pins on USB2504 are sampled following hardware reset to determine the external configuration source and the SMBus address. This usually happens when power is initially turned on. The pin CFG_SEL2 can be either low or high at the end of reset while pin CFG_SEL1 must be low at the end of reset to select SMBus as the source of configuration information. The pin CFG_SEL0 determines the SMBus slave address. The address is 0101100 (binary) when low at the end of reset, and 0101101 (binary) when high.

5.2 SMBus Configuration Process

The USB2504 is ready to accept SMBus Read Byte or Write Byte commands following hardware reset. The SMBus register space for USB2504 is located from 0 to 10 (hex). There is no particular order the configuration registers are required to be loaded. It isn't until the command register is loaded that the entire register space is changed to active configuration. Registers can be read to verify that correct values have been loaded. The final step of loading is to write to the command register at address 0.

5.2.1 SMBus Configuration Step by Step

1. End of hardware reset - RESET_N goes high
   USB2504 is ready to accept SMBus commands 500us after RESET_N goes high.
2. Load registers from 1 to 10 (hex) by SMBus command write.
3. Optionally read back registers 1 through 10 (hex) to verify correct value. This is not a required step.
4. Write to command register at location 0 the command USB_ATTACH. The byte value is 01 (hex). The USB2504 will not attach even if VBUS_DET is asserted until the USB_ATTACH command has been sent to the command register. Once the USB_ATTACH command has been received the SMBus slave is powered off and will not respond to any further SMBus commands. RESET_N must be pulsed low to reactivate SMBus again.

5.3 SMBus Register Configuration Space

An overview of the SMBus register space is shown in Table 5.1, "SMBus Register Address Layout".

Table 5.1 SMBus Register Address Layout

BYTE LOCATION	REGISTER	DESCRIPTION
0	Status/Command	Status and Command register
1	Vendor ID LSB	Vendor ID is assigned by USB-IF
2	Vendor ID MSB	
3	Product ID LSB	Product ID is assigned by manufacturer
4	Product ID MSB	
5	Device ID LSB	Device ID is assigned by manufacturer
6	Device ID MSB	
7	Config Data Byte 1	Configuration Data byte 1 for hub controller options
8	Config Data Byte 2	Configuration Data byte 2 for hub controller options
9	Non-removable downstream devices	Defines ports with permanently attached devices if any. The hub must be configured as a compound device if one or more devices are permanently attached to the hubs downstream ports
A	Ports Disabled in Self Power mode	Selects if ports 2 through 4 are disabled in self power mode.
B	Ports Disabled in Bus Power Mode	Selects if ports 2 through 4 are disabled in bus power mode
C	Max Power in Self Power mode	Defines maximum current drawn from VBUS in self-powered mode in increments of 2mA..
D	Max Power in Bus Power mode	Defines maximum current drawn from VBUS in bus-powered mode in increments of 2mA.

Table 5.1 SMBus Register Address Layout (continued)

BYTE LOCATION	REGISTER	DESCRIPTION
E	Hub Controller Max Current in Self Power mode	Defines maximum current drawn from VBUS in self-powered mode by USB2504 itself
F	Hub Controller Max Current in Bus Power mode	Defines maximum current drawn from VBUS in bus-powered mode by USB2504 itself
10	Power-On Time	Time until power is stable on down stream ports after port power is enabled in increments of 2ms.

5.3.1 SMBus Status and Command Register

The SMBus Status and Command register is the last register to be loaded after all the other registers have been loaded. USB2504 will not attach to the upstream USB port until the USB_ATTACH command is sent and VBUS_DET is asserted.

Table 5.2 Status and Command Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7:3	Reserved	Reserved must be 00000
2	RESET	Reset the SMBus registers to default setting: 0 = Normal Run/Idle State 1 = Force a reset of SMBus registers
1	Write_Prot	Write protect registers 1 through 10: 0 = Do not write protect SMBus registers 1 = Write-protect SMBus registers 1 through 10. This bit is write once and is only cleared by asserting RESET_N
0	USB_ATTACH	Attach to USB and power down SMBus interface: 0 = Default: SMBus slave interface is active 1 = Signals HUB to attach to upstream port when VBUS_DET is active. SMBus interface will power down after the ACK has completed. This bit is write once and is only cleared by asserting RESET_N

5.3.2 SMBus Register VID/PID/DID

Each manufacturer is assigned a Vendor ID (VID) by USB-IF. For example SMSC is assigned 0424 as VID. The least significant byte value 24 is mapped to SMBus location 1 and the most significant byte value 04 is mapped to SMBus location 2. The manufacturer determines Product and Device ID. Most and least significant bytes are mapped in SMBus similar to VID with MSB on even locations and LSB on odd locations.

5.3.3 SMBus Register Config Data Byte 1

This configuration byte selects hub specific implementation dependent functions.

Table 5.3 Config Data Byte 1 Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7	SELF_BUS_PWR	Selects between Self- and Bus-powered operations. 0 = Bus-powered operation. 1 = Self-powered operation.
6	PORT_IND	Port indicator support: Indicates if LED indicators are implemented. 0 = No LED indicators. 1 = LED indicators (green and yellow).
5	HS_DISABLE	High Speed disable: Forces hub to attach as Full-speed only even if the upstream port is high speed capable. 0 = High-/Full-Speed. 1 = Full-Speed only.
4	MTT_ENABLE	Enable Multiple Transaction Translators. 0 = Single Transaction Translator 1 = Multiple Transaction Translators (one TT per port). Recommended
3	EOP_DISABLE	EOP Disable: Disable EOP generation at EOF1 when no downstream directed traffic is in progress. 0 = EOP generation at EOF1 is enabled. 1 = EOP generation at EOF1 is disabled.
2:1	CURRENT_SNS	Over-current sense: Indicates over-current sensing configuration. 00 = Ganged sensing. 01 = Individual port-by-port. 10 = Over-current not supported or reported. 11 = Over-current not supported or reported.
0	PORT_PWR	Port power switching: Indicates whether port power switching is on port-by-port basis or ganged. 0 = Ganged switching. 1 = Individual port-by-port switching.

SELF_BUS_PWR

The USB2504 can operate as either bus- or self-powered. This bit determines which fields to select for descriptor information regarding enabled/disabled ports and reported power consumption.

HS_DISABLE

This bit allows the hub to be configured for full-speed operation. In most implementations the preferred choice is to keep this set to 0 thus enabling high-speed operation. In the event the host is full-speed the USB2504 will as a high-speed device negotiate transfer speed and settle for full-speed as required by USB-IF specification. It is therefore not necessary to set HS_DISABLE even if the hub never will be connected to a high-speed host. SMSC recommends this bit to be set to 0.

MTT_ENABLE

This bit enables Multiple Transaction Translators, one TT per down-stream port for maximum performance on low-speed and full-speed devices. When disabled only one transaction translator is enabled and it is shared with all down-stream ports.

EOP_DISABLE

This bit enables EOP to be generated at EOF1 when no downstream traffic is in progress. SMSC recommends this bit to be set to 1 to disable EOP at EOF1.

CURRENT_SNS

This field indicates if over-current sense is available or not. A self-powered hub must have over-current sensing and protection. The USB2504 has one over-current sense input pin per port OCS[3:0]_N. In ganged over-current sense configuration only one of the OCS_N pins is required to tie to the over current detector. For individual over-current sense each port has a dedicated over-current sense pin typically connected to the FLAG output on the USB port power controller.

Over-current sensing is not required in bus-powered mode. The USB2504 can be configured without over-current sense. For bus-powered hubs the upstream hub or host is responsible for over-current sensing.

PORT_PWR

This field indicates if port power is controlled individually port-by-port or ganged. For bus-powered applications port power control is required. Port power control is not required for self-powered implementations. If no port power control is used the PORT_PWR field should be set to 0 (i.e. ganged mode) and the Power on time field should be set to 0.

5.3.4 SMBus Register Config Data Byte 2

This configuration byte selects hub specific implementation dependent functions.

Table 5.4 Config Data Byte 2 Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7	DYNAMIC	Dynamic auto-switching Enable. 0 = Dynamic auto-switching disabled. 1 = Dynamic auto-switching enabled.
6	Reserved	Reserved must be 0.
5:4	OC_TIMER	Over-current Timer: Over-current Timer delay. 00 = 0.1ms. 01 = 2ms. 10 = 4ms. 11 = 6ms.
3	COMPOUND	Compound Device: Designates if Hub is part of a compound device. 0 = Hub is not part of compound device. 1 = Hub is part of a compound device.
2:0	Reserved	Reserved must be 000.

DYNAMIC

USB2504 supports a dynamic auto-switching mode, switching between bus- or self-powered.

In implementations that incorporate circuitry to switch between power from an external supply when available or from VBUS when the external supply is disconnected, it is possible to configure USB2504 to dynamically switch configuration. This feature is enabled when the field DYNAMIC is set to 1. When DYNAMIC auto-switching is enabled the SELF_BUS_PWR bit in Config Data Byte 1 is ignored. Instead the state of pin SELF_PWR determines the power mode.

The USB2504 senses changes to the state of pin SELF_PWR when dynamic auto-switching is enabled. When SELF_PWR changes from high to low the USB2504 detaches from the upstream port and when re-enumerated by the host it will report that it is bus-powered and will use the bus-powered configuration from the SMBus registers for descriptor information. On the other hand when SELF_PWR changes from low to high the USB2504 detaches from the upstream port and when re-enumerated by the host it will report as self-powered and will use the self-powered configuration from the SMBus registers for descriptor information.

For example it is possible to implement a HUB that supports four downstream ports in self-powered mode while in bus-powered mode there are only two downstream ports available. Note, however that exposed USB port connectors are required to be active at all times by USB-IF.

OC_TIMER

Additional delay from an over-current event generated from over-current sense circuit is selected in this field. If the over-current sense circuit trips for short surges when a device is first plugged in this delay can be increased from 0.1ms to at most 6ms. During the OC_TIMER delay if the over-current event disappears nothing will be posted to the hub controller and port power is not removed. The most common value for this field is 01 equivalent to 2ms delay.

COMPOUND

This field must be set depending on the setting of the non-removable field. If one or more non-removable devices are attached to downstream ports this field must be set to 1 otherwise it should be set to 0.

5.3.5 SMBus Register Non-Removable Devices

Indicates which port or ports have non-removable devices. A non-removable device is permanently attached to the hub and cannot be disconnected. Another device cannot replace the non-removable device on that port.

Table 5.5 Non-Removable Device Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7:5	Reserved	Reserved must be 000.
4	Port 4 non-removable	0 = Port 4 has no permanently attached device. 1 = Port 4 has a non-removable device attached.
3	Port 3 non-removable	0 = Port 3 has no permanently attached device. 1 = Port 3 has a non-removable device attached.
2	Port 2 non-removable	0 = Port 2 has no permanently attached device. 1 = Port 2 has a non-removable device attached.
1	Port 1 non-removable	0 = Port 1 has no permanently attached device. 1 = Port 1 has a non-removable device attached.
0	Reserved	Reserved must be 0.

5.3.6 SMBus Register Port Disable when Self-Powered

This configuration byte is in effect if the hub is operating as self-powered.

Downstream ports can be permanently disabled on the hub. The first disabled port must be the highest numbered port and each additional disabled port must the next lower port number. For example if only 3 ports are required. Port 4 must be disabled. If two ports are disabled port 4 and port 3 must be disabled.

Table 5.6 Port Disable for self-powered operation Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7:5	Reserved	Reserved must be 000.
4	Port 4 disabled	0 = Port 4 is available. 1 = Port 4 is disabled.
3	Port 3 disabled	0 = Port 3 is available. 1 = Port 3 is disabled.
2	Port 2 disabled	0 = Port 2 is available. 1 = Port 2 is disabled.
1	Port 1 disabled	0 = Port 1 is available. 1 = Port 1 is disabled – NOT a valid choice (implies a HUB with no downstream ports).
0	Reserved	Reserved must be 0.

5.3.7 SMBus Register Port Disable when Bus-Powered

This configuration byte is in effect if the hub is operating in bus-powered mode.

Downstream ports can be permanently disabled on the hub. The first disabled port must be the highest numbered port and each additional disabled port must be the next lower port number. For example if only 3 ports are required. Port 4 must be disabled. If two ports are disabled port 4 and port 3 must be disabled.

Table 5.7 Port Disable for Bus-Powered Operation Fields

BIT NUMBER	BIT NAME	DESCRIPTION
7:5	Reserved	Reserved must be 000.
4	Port 4 disabled	0 = Port 4 is available. 1 = Port 4 is disabled.
3	Port 3 disabled	0 = Port 3 is available. 1 = Port 3 is disabled.
2	Port 2 disabled	0 = Port 2 is available. 1 = Port 2 is disabled.
1	Port 1 disabled	0 = Port 1 is available. 1 = Port 1 is disabled – NOT a valid choice (implies a HUB with no downstream ports).
0	Reserved	Reserved must be 0.

5.3.8 SMBus Register Max Power Consumption when Self- or Bus-Powered

The current consumed on VBUS by the hub or hub combo is indicated for self- and bus-powered mode. The field value is in increments of 2mA. The maximum allowed current consumption for self-powered devices is 100mA or 32 (hex). A bus-powered device is allowed to consume up to 500mA. A hub must allocate 100mA for each downstream port when it is bus powered.

The most common values for self-powered configuration is 0 or 1 indicating no current draw or up to 2mA leakage on VBUS. For a bus-powered hub with 2 removable ports the maximum value is 300mA or 96 (hex). For a hub with a single removable port the maximum value is 400mA or C8 (hex). Note

that for bus-powered hubs the reported power consumption can include non-removable devices if the non-removable devices report as having zero power and self-powered.

5.3.9 SMBus Register Hub Controller Max Current when Self- or Bus-Powered

The current consumed on VBUS by the hub proper in this case USB2504 is reported in both self- and bus-powered modes. The value is in increments of 2mA. For compound devices this value excludes power consumed by any non-removable devices. For self-powered mode the most common value is 0 or 1 indicating no or up to 2mA leakage current on VBUS. For bus-powered mode the USB2504 can consume up to 170mA when both downstream ports are active in high-speed. The hub controller portion is therefore 170mA/2mA = 85 or 55 (hex).

5.3.10 SMBus Register Power-On Time

This field indicates the amount of time down stream port power is stable after a set port power command. The value is in increments of 2ms. The most common value is 100ms 32 (hex). This value is compatible with most if not all dedicated USB port-power switch circuits on the market. If a custom circuit is used this value could be smaller or larger depending on voltage ramp time, loading and decoupling capacitance on the port.

There are two special cases one for self-powered and one for bus-powered.

SELF-POWERED NO PORT POWER SWITCH

When a hub is in self-powered mode it must allot 500mA for each available downstream port. A self-powered hub must have over-current sense circuitry, but port power switching is not required. If the implementation uses a poly-fuse for over-current sensing, directly connected to the power supply the value in the field Power-On Time must be 0.

BUS-POWERED

Bus-powered mode requires a port power switch. The reason for this requirement is that every USB device must limit current consumption to 100mA before it is enumerated. In the case of hubs the only way to guarantee this in the bus-powered case is to turn off the port power to downstream ports.

6 Examples of Configurations

Four examples of configurations are shown in table 8. The examples illustrate self powered implementations with port power controller or without power switch but using poly-fuse for over-current sense, dynamic auto-switching and compound device. Appendix shows schematics for each example. The designs illustrate different uses of the USB2504. They are not complete designs for production use.

6.1 Example 1: USB2504 as a Full Featured Hub

- Self-powered
- Four downstream Ports
- Port power switching – Individual
- Port over-current sense – Individual
- LED indicators

6.2 Example 2: USB2504 as a Low Cost Hub

- Self-powered
- Four downstream Ports
- Port power switching – none
- Port over-current sense – ganged with poly-fuse

- No LED indicators reported
- Green LEDs for each port active status
- Single Amber LED for over-current notification

6.3 Example 3: USB2504 as a Dynamic Auto-Switching Hub

- Self-powered/Bus-powered – dynamically switching
- Four downstream ports when self-powered
  Two downstream ports when bus-powered
- Port power switching – Individual
- Port over-current sense – Individual
- No LED indicators

6.4 Example 4: USB2504 as a Compound Device with Two Non-Removable Devices

- Self-powered
- Four downstream Ports – (Two removable port 3 and port 4)
- Two non-removable devices (port 1 and port 2)
- Port power switching – Individual
- Port over-current sense – Individual
- LED indicators
- Ports 3 and 4 are disabled if bus-powered (Byte 0B).

Table 6.1 Examples of Different Configurations

BYTE LOCATION	FIELD	EXAMPLE 1	EXAMPLE 2	EXAMPLE 3	EXAMPLE 4
2:1	Vendor ID	0424	0424	0424	0424
4:3	Product ID	2504	2504	2504	2504
6:5	Device ID	10A1	11A1	12A1	20A1
7	Config Data Byte 1	DB	98	9B	9B
8	Config Data Byte 2	10	10	90	18
9	Non-removable downstream devices	00	00	00	03
A	Ports Disabled in Self Power mode	00	00	00	00
B	Ports Disabled in Bus Power Mode	00	00	0C	03
C	Max Power in Self Power mode	00	00	00	00
D	Max Power in Bus Power mode	55	55	55	FA
E	Hub Controller Max Current in Self Power mode	00	00	00	00
F	Hub Controller Max Current in Bus Power mode	55	55	55	55
10	Power-On Time	32	00	32	32

7 Appendix

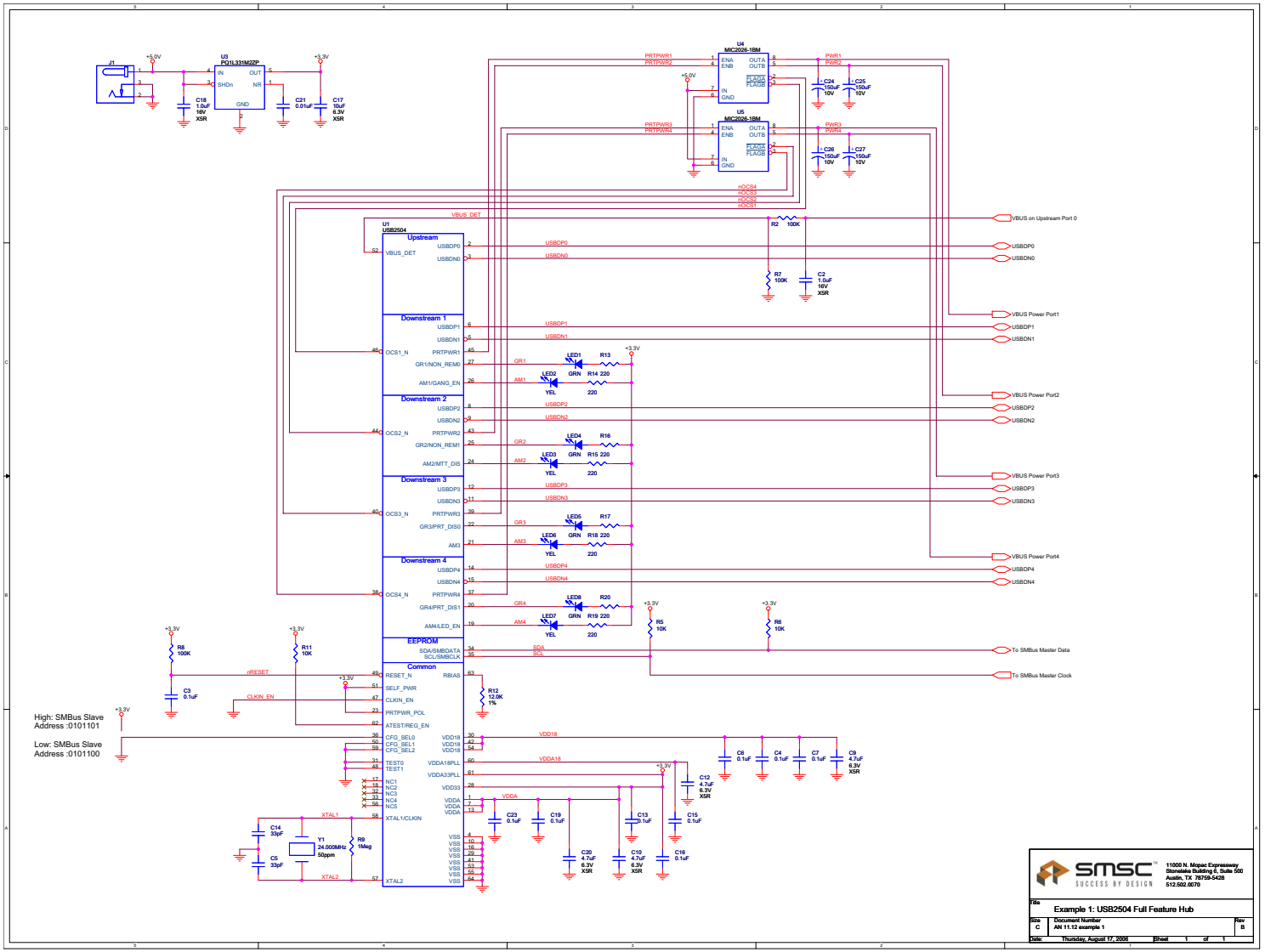

Figure 7.1 USB2504 Full Feature Hub

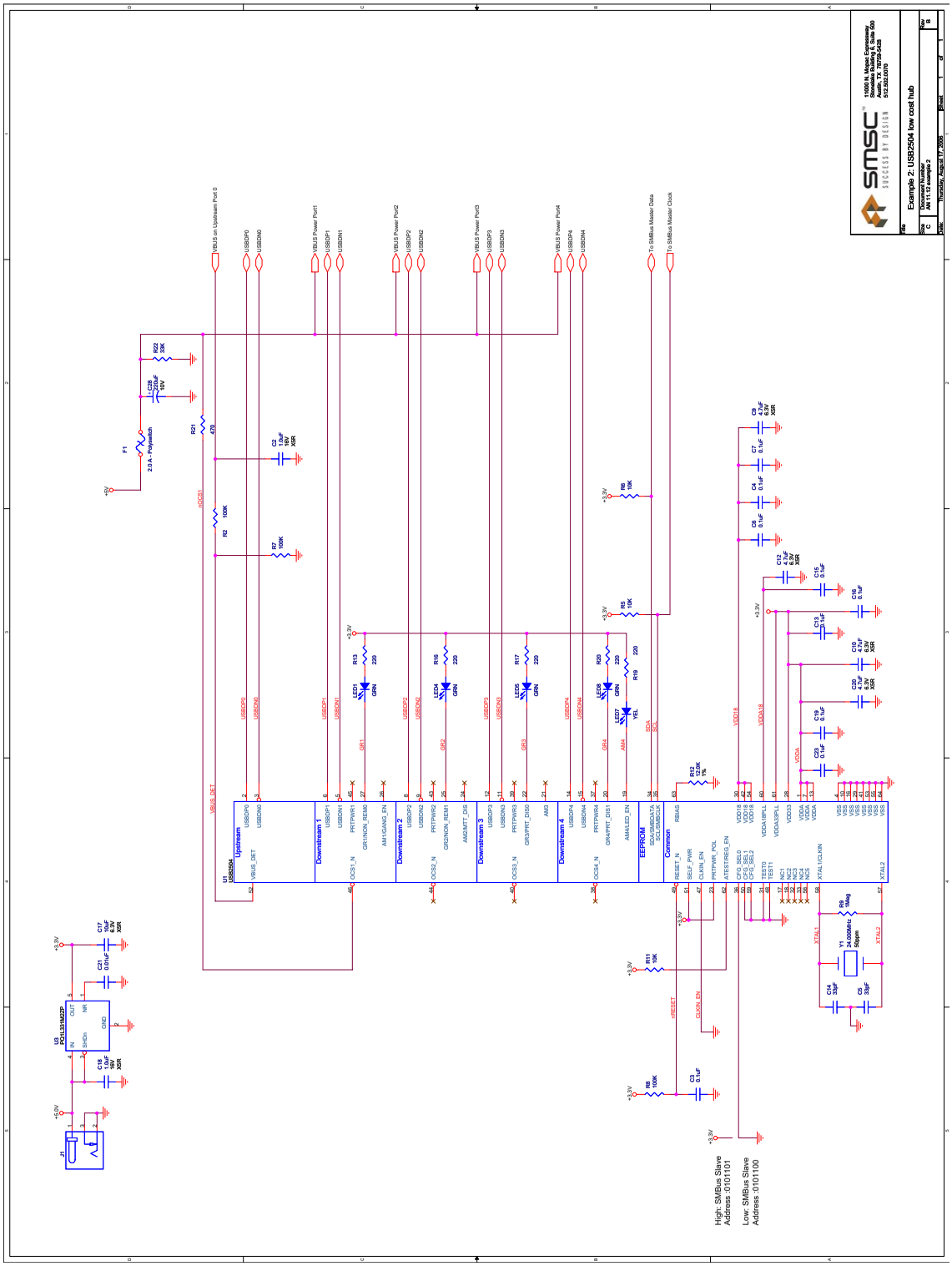

Figure 7.2 USB2504 Low Cost Hub

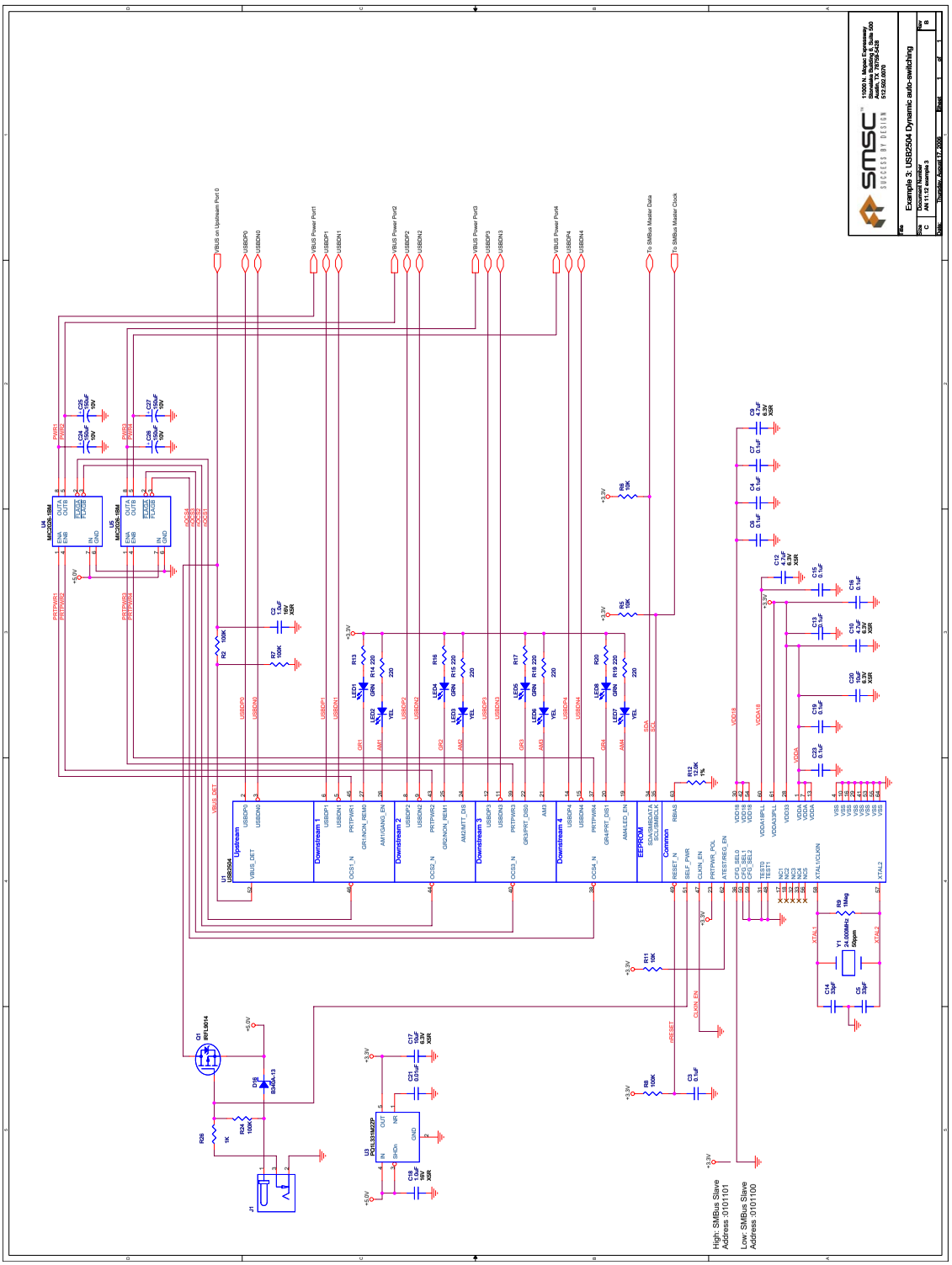

Figure 7.3 USB2504 Dynamic Auto-Switching

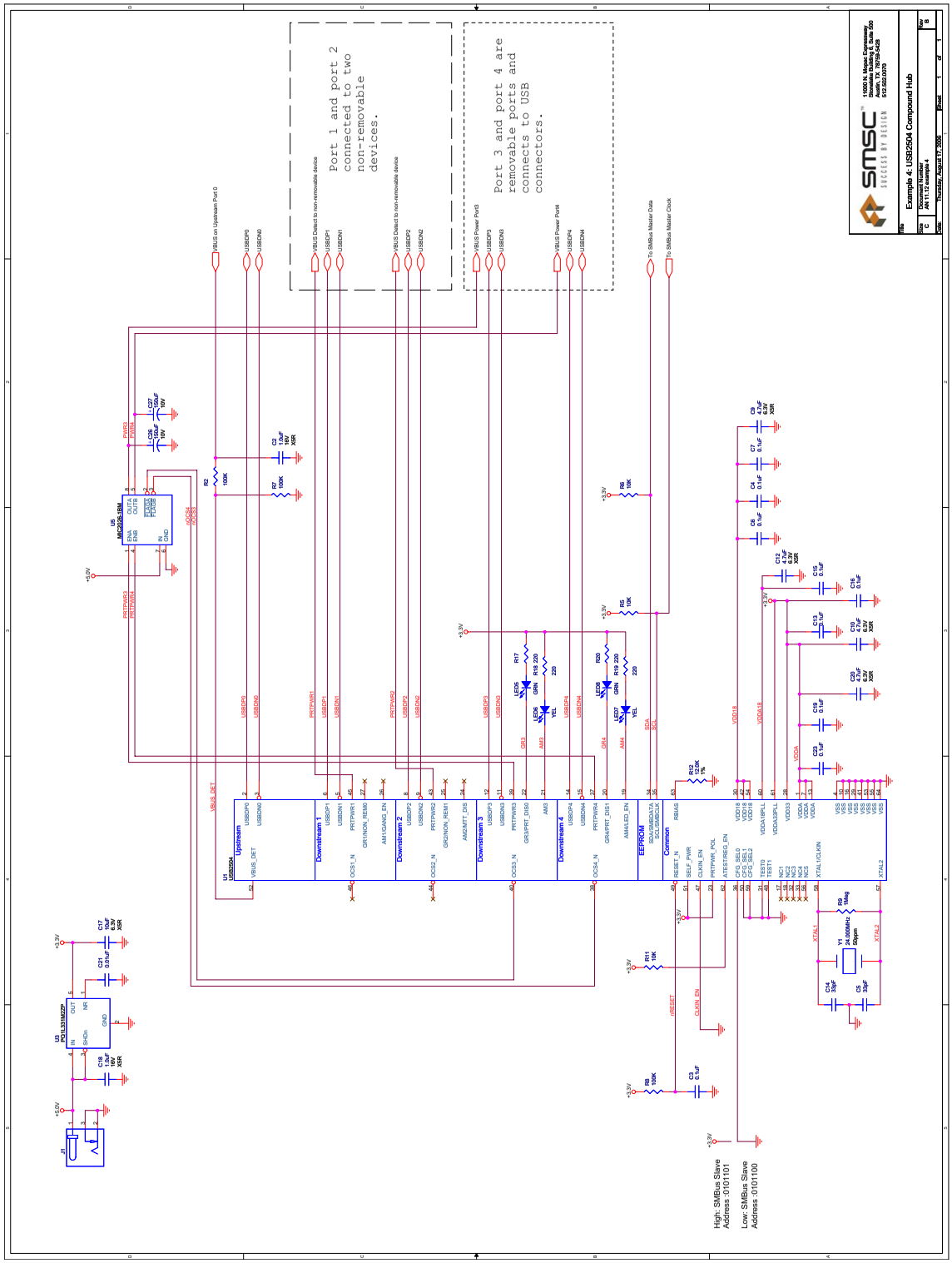

Figure 7.4 USB2504 Compound Hub

80 Arkay Drive
Hauppauge, NY 11788
(631) 435-6000
FAX (631) 273-3123