SmartCart:
Critical Design Review

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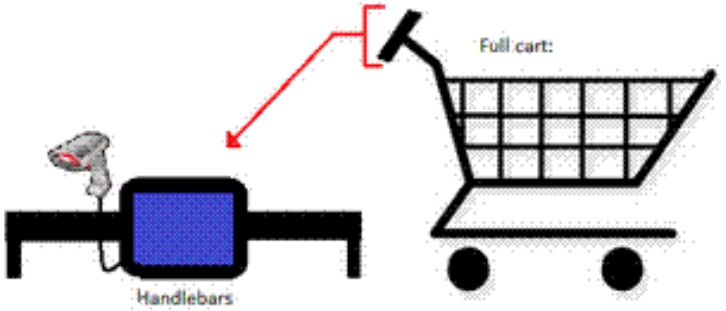
Product Definition

An interactive touchscreen display affixed onto the handlebars of a shopping cart which allows users to:

- Scan items to a checkout list
- Find aisle locations of items
- Search for item availability
- Obtain item coupons

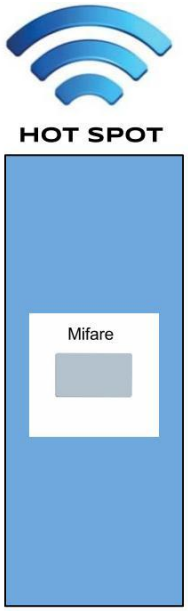


SmartCart is a smart shopping system designed for consumer convenience and can be applied to:

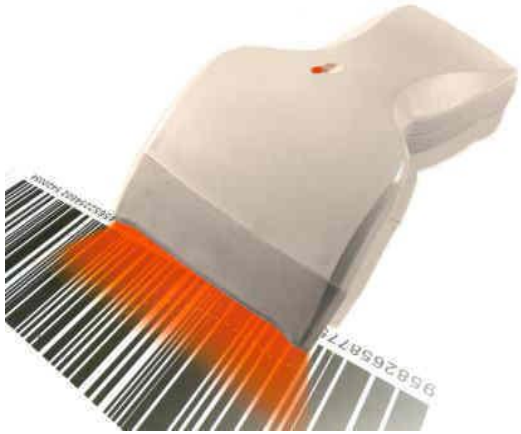
- Supermarkets
- Department Stores
- Anything that uses shopping carts

Product Description

FIND



SCAN



SEARCH

SmartCart

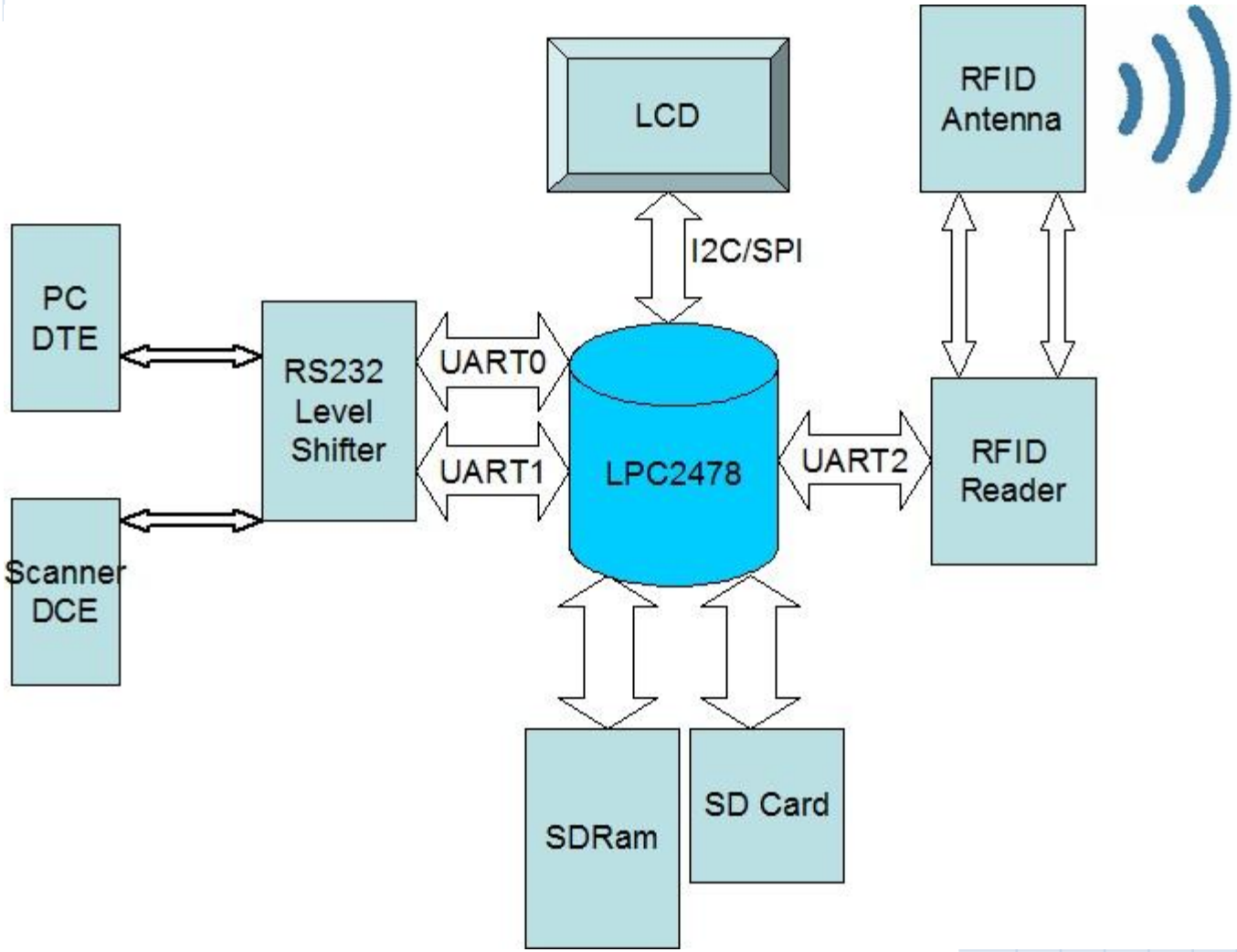
Product Description

COUPONS

ADVERTISEMENTS

SmartCart

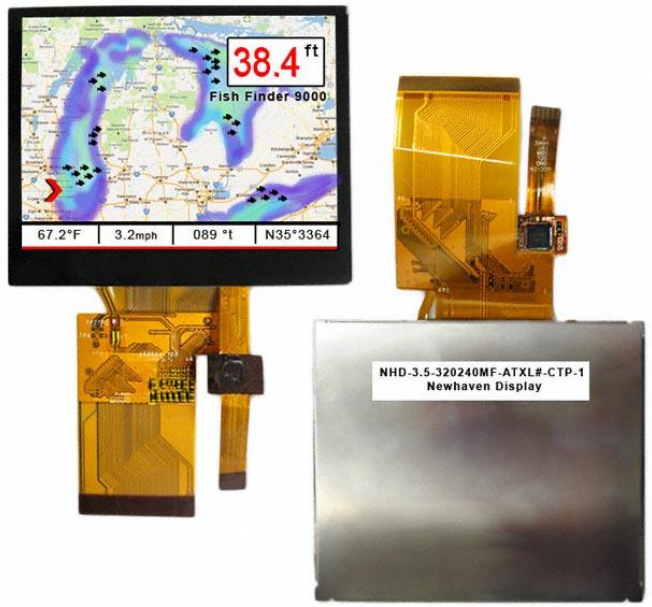
High Level Block Diagram



LCD Touchscreen

Capacitive Touch Panel
- Prefers 3.0V for logic
- I2C (mapped to VICVectAddr9)
- 6-pin Connector

TFT
- Prefers 3.3V for logic
- Backlight needs 19.2V
- SPI
- 54-pin Connector



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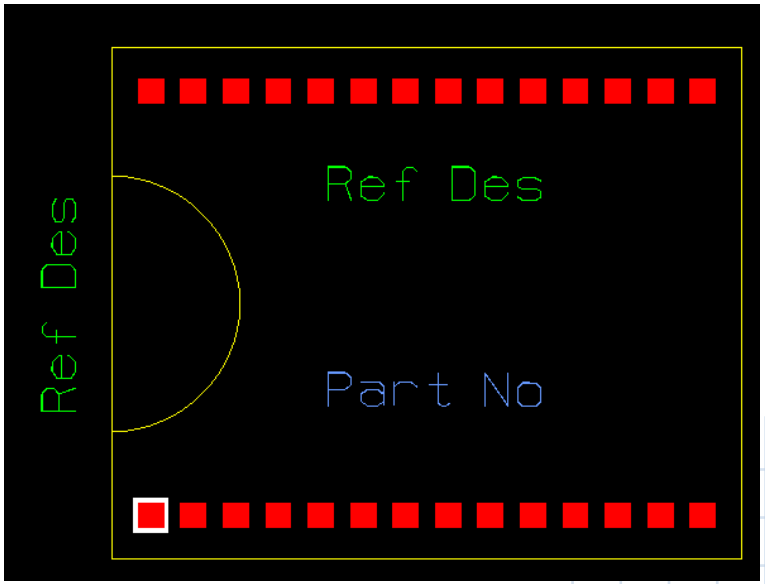
RFID

Purpose: Uses radio frequency communication to identify current aisle location. Interrupt driven (mapped to VICVectAddr29).

13.56 MHz RFID Mifare Read / Write Module:

- UART interface
- 5V power supply
- PCB antenna required



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PCB Antenna/ RFID Tags

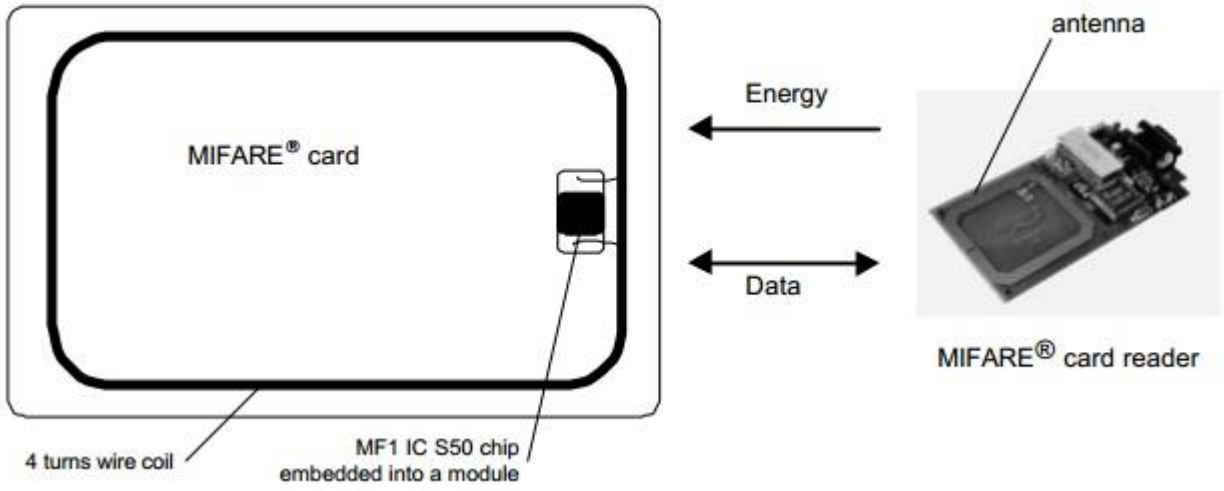
Purpose: Allows communication between smart system and tag

13.56 MHz Mifare PCB Antenna

- 55mmx55mm
- 70-80mm read range

Mifare 1K Card

- NXP S50 Card
- R/W 1K Bytes



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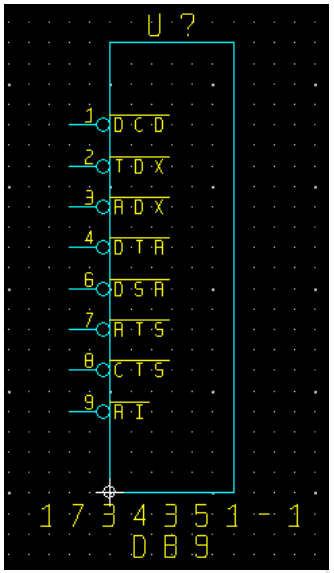
Barcode Scanner

Purpose:

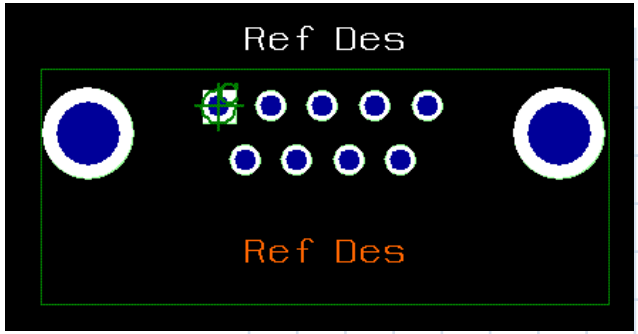
Scan each items barcode and transfer to the RS232 connector, level shifter, and then processor for identification and addition to the "shopping cart" screen of the user interface. Interrupt driven (mapped to VICVectAddr7).

Part:

- ID TECH's "Econoscan ii"
- DB9-DCE Interface
- 5V power supply
- Connector and power supply required



DB9-DCE Connector Symbol and Cell



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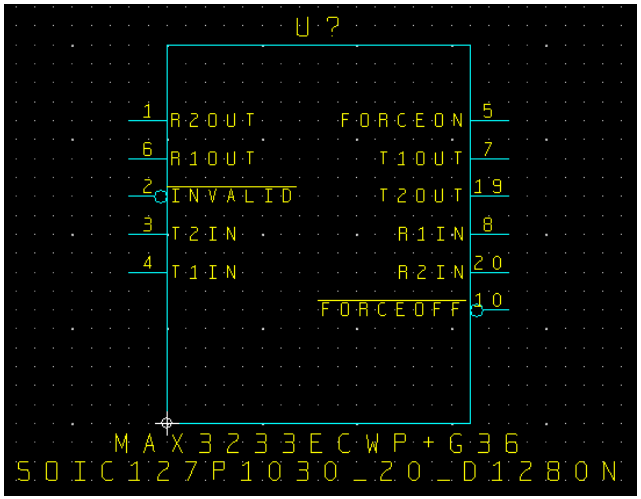
Level Shifter

Purpose:

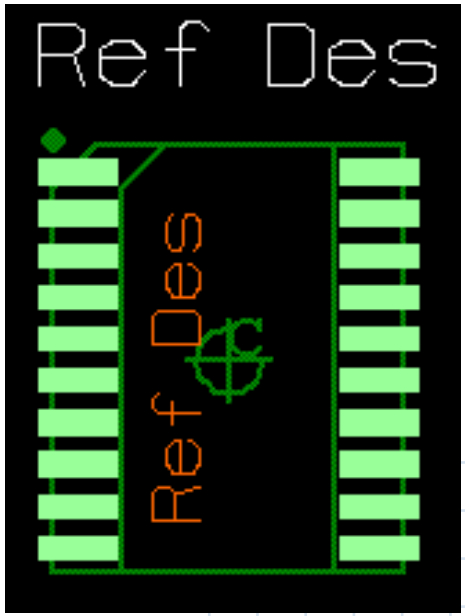
Converts serial data from DB9s to Uart and sends it to either the processor or the RFID module. We will include a multiplexing circuit for this because this part only contains 2 level shifter. We need three level shifters total to upload the bootloader code to the processor, send barcode information to the processor, and transmit commands to the RFID circuit in UART

Part: **Maxim's MAX3233E**

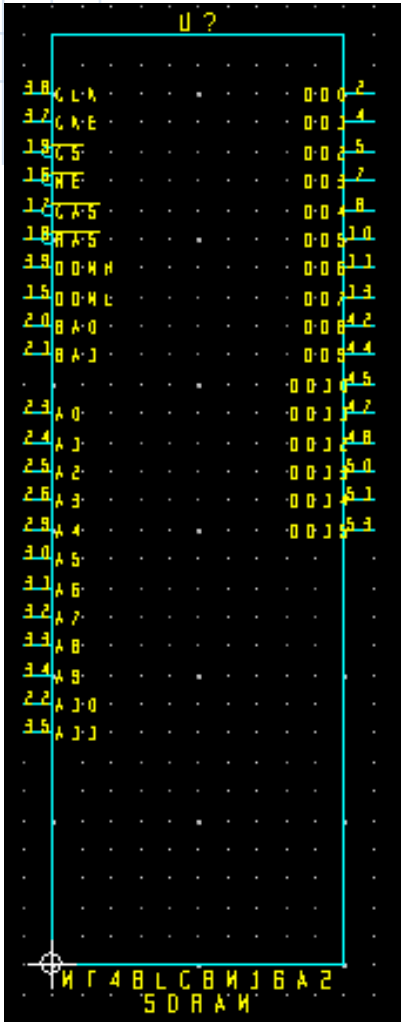
-3.3V Power Supply



The cell (right) was taken from the homework 1 level shifter (SOIC127P1030_20_D1280N) **because the dimensions are not available for the maxim part**



Memory Management: SDRAM



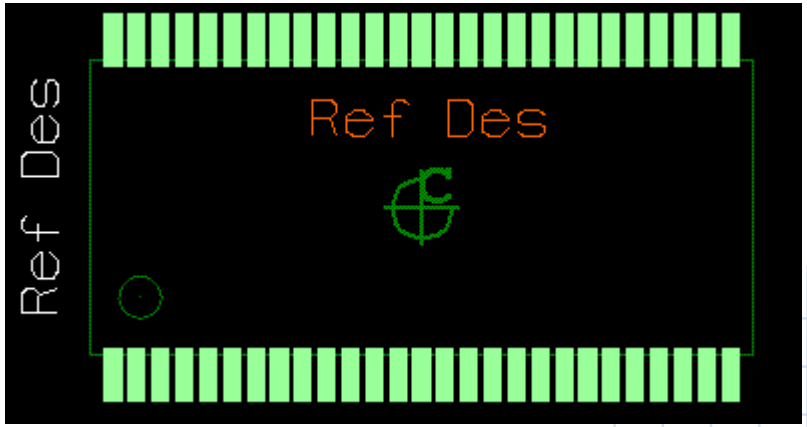
Purpose:

- Store layout map

-Interfaces via external memory controller

Part:

- Micron's MT48LC8M16A2 – 2 Meg x 16 x 4 banks
- 3.3V
- 54 pin TSOP
- Synchronous on positive clock edge
- At least 100 microsec use delay

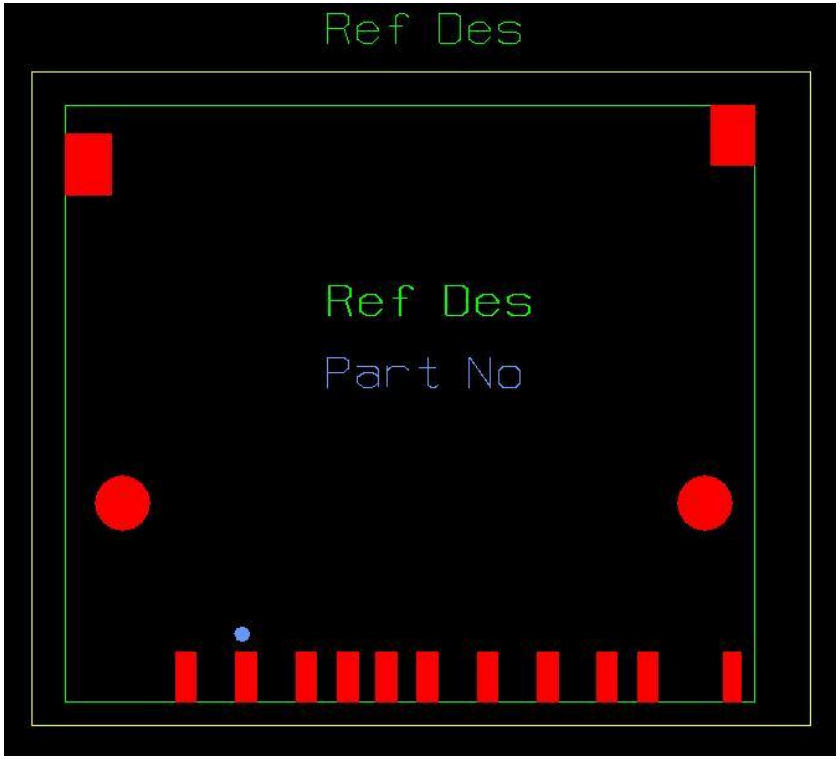


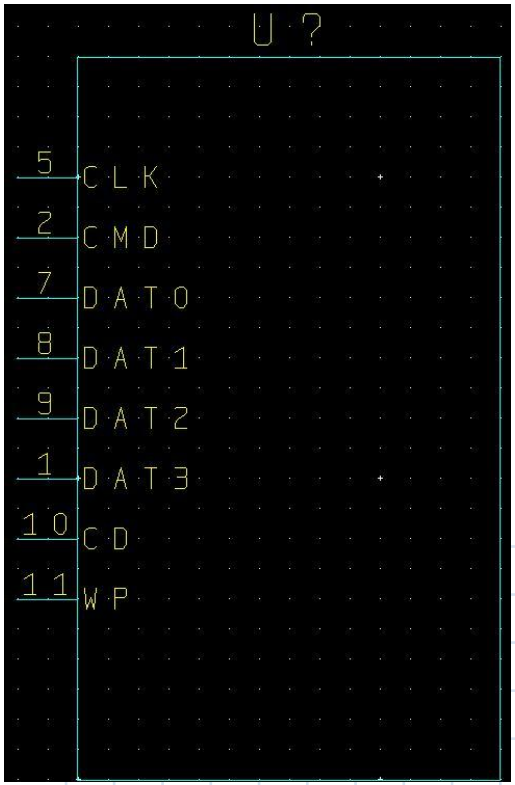
Memory Management: SDCard/Connector

Purpose:

For nonvolatile storage of database and other information. Uses SD/MMC interface on microprocessor. Will use FAT filesystem. Write protect and card detect pins on connector float because if card not inserted and/or locked, card detect and write protect float.

Part: **Kyocera Memory Card Connector 5638 Series**



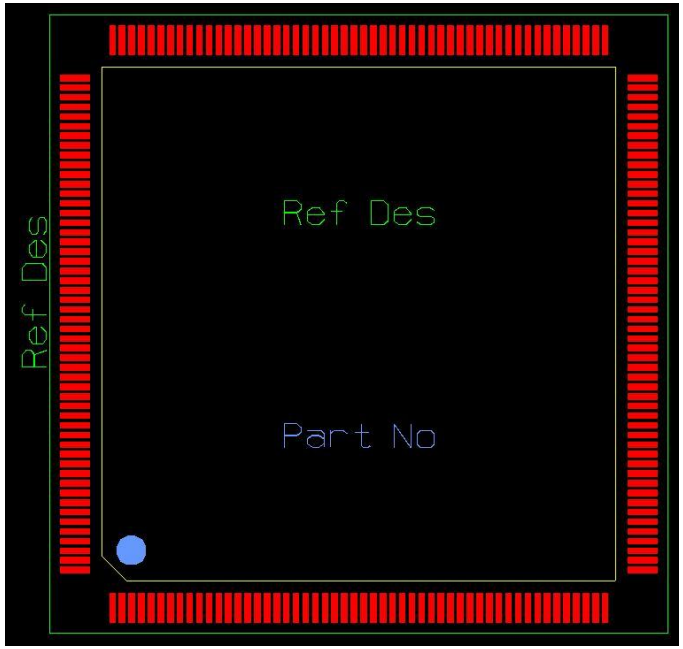


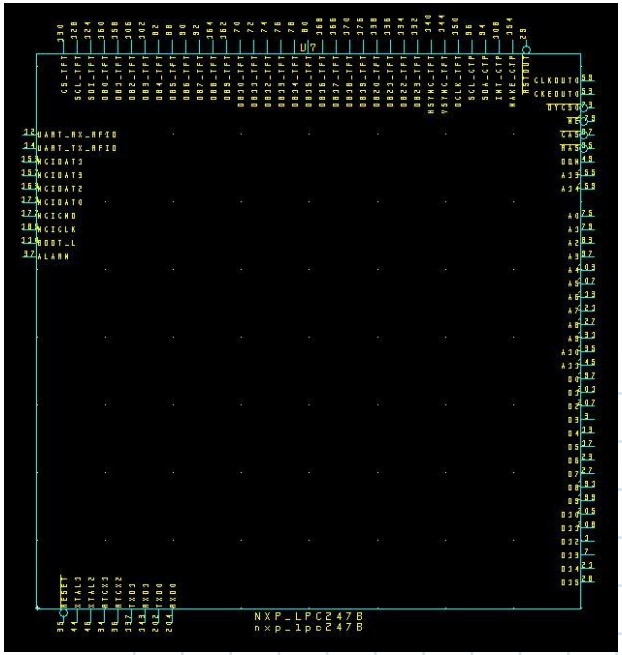
Processor

Testing: There will be DIP switches connected to external reset (identified as bit one in Reset Source ID register 0xE01F C180) and bootloader circuit input pins. There will also be an LED on the reset output pin. Test headers are connected to just about all pins. Unused pins are NC. Two crystals: 32kHz for real time clock (for timer interrupts) [22pF caps] and 20MHz for main oscillator (requiring oscillation mode and driving phase lock loop/PLL ---CLKSRCSEL 0xE01F C10C Register will have have value 01) [18pF caps].

Part: NXP LPC2478

- 208 pins





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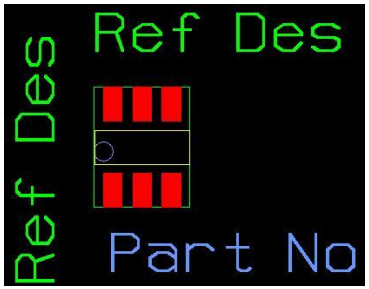
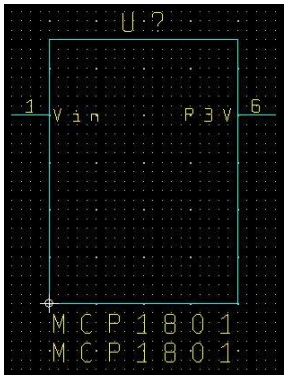
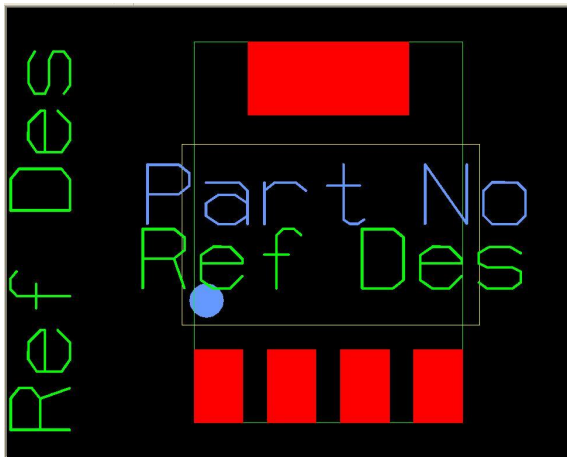
Power Management

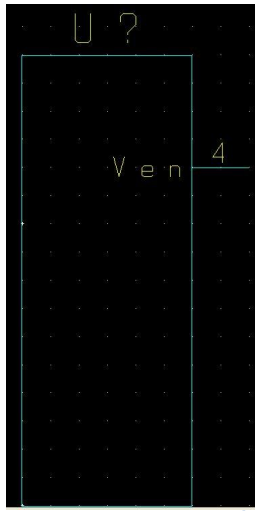
Voltages Needed: 19.2V DC, 5V DC, 3.3V DC, 3V DC
Power Planes: 3.3V DC
Voltages Supplied: 19.2V (to save money on converters) and 5V from external power supplies
Linear Regulators: 3.3V LDO with 5V (500mA max) input and 3.0V LDO with 5V (150mA max) input; Biased with 1uF caps; Enable pins tied high





3V Regulator





3.3V Regulator

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Software Overview

- We will use a C compiler and Eclipse as our development environment to implement a FAT filesystem with map information stored in onboard memory and database information stored in the SD Card. Upon reset the shopping list and current aisle is cleared.

Display States:

- Home State: will allow transition to four other states. The home state should display a map of the store, indicating the last aisle tagged. RFID data should be on the bus if it's in continuous read mode and raises an interrupt. The interrupt handler should update the home screen with the new aisle information and change the aisle indicator. UART interrupts will be disabled until in the appropriate state. More options should be available as transparent buttons on the home screen, Search, and Shopping List. A timer interrupt for two minutes should be enabled in the home state and when it times out, ads should be displayed in the second sleep state.

- Sleep State: This state should also let RFID data be put on the bus to update the current aisle data in memory. Touching the LCD screen in this state should transition back to the home state.

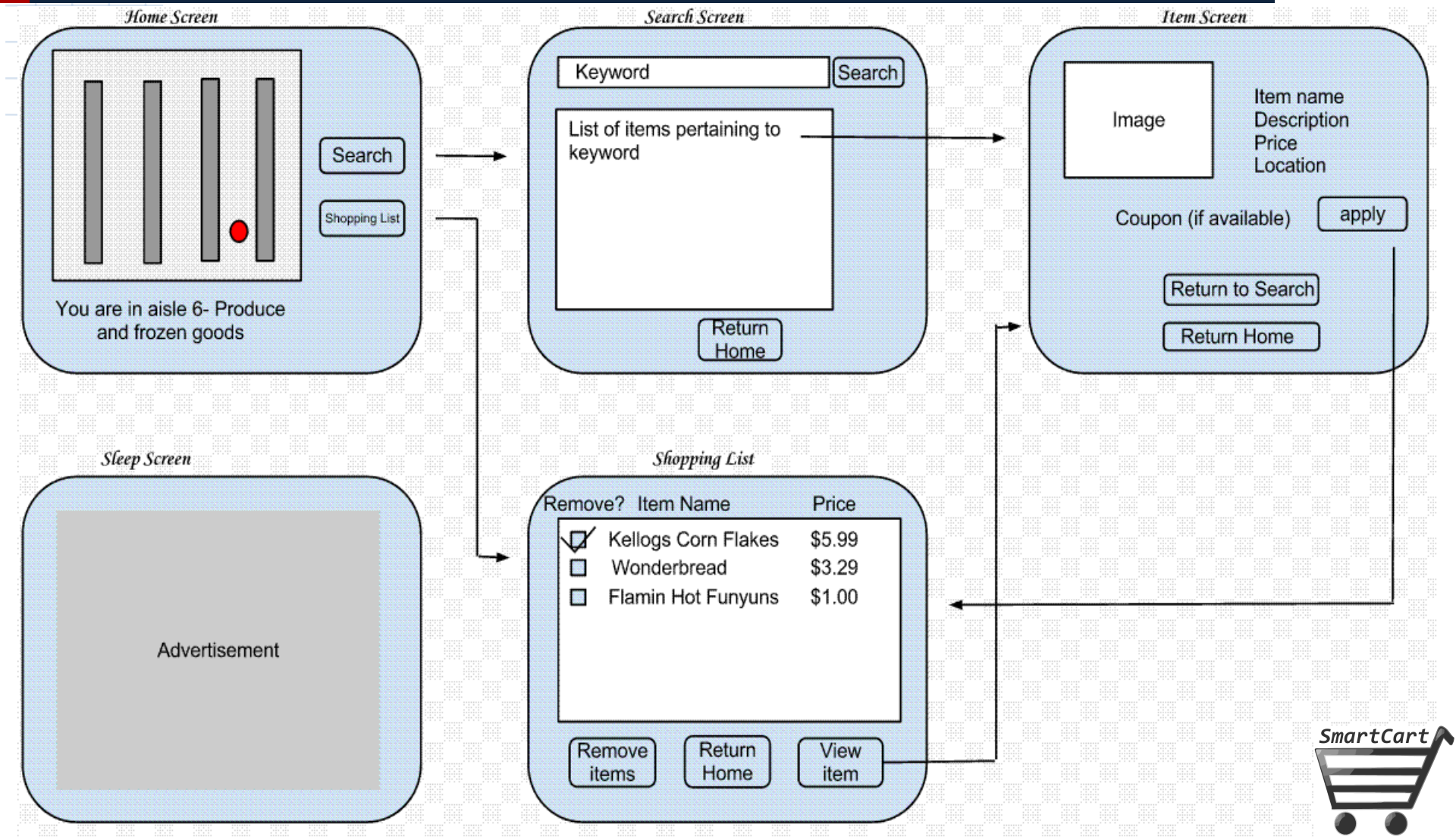
- Search State: Touching Search should transition to a search state where a keyboard graphic would be displayed and allow for character input. Any data from the RFID reader prompted by a new tag will be written to memory so the aisle information can be updated in the background. Character input from the keyboard will run a query on the item database and display a list of items that matched the search keyword. A Search button will also be displayed and a back button.

Software Overview

- Item State:
Selecting an item from the search list will display an product description with an image, price, information about whether the item is in the cart, and applicable coupons that can be applied to the shopping list individually. A back button will take the user back to the search interface with the list displayed or a home button would transition to the home state. This state can also be accessed from the Shopping List State screen

- Shopping List State:
UART will be enabled and a list of all the items in the shopping cart will be displayed. A column of checkboxes, item names, and prices will be displayed. The checkboxes will allow mass removal of items. Touching an item, except for the checkbox, will highlight it and a View button will allow the user to go to the aforementioned product description screen and allow for the same functionality. UART1 will be interrupt driven since it's connected to the barcode scanner. Scanning an item in the list screen will raise an interrupt and the handler will add the product to the list

Software Overview



Software Overview

Command Code Table for SM130:

Code	Command	Description
0x80	Reset	Resets the Module
0x81	Firmware	Reads the Firmware Revision of the Module
0x82	Seek for Tag	Continuously checks for presence of a tag
0x83	Select Tag	Selects a Tag
0x84	NA	Not Implemented
0x85	Authenticate	Authenticates the selected Block
0x86	Read Block	Reads from the specified Block
0x87	Read Value	Reads from a Value Block
0x88	NA	Not Implemented
0x89	Write Block	Writes the data to the specified block
0x8A	Write Value	Formats and Writes a Value block
0x8B	Write 4 Byte Block	Writes 4 byte data to Mifare Ultralight block
0x8C	Write Key	Writes the Key to the EEPROM of the MFRC530
0x8D	Increment	Increments a value block
0x8E	Decrement	Decrements a value block
0x8F	NA	Not Implemented
0x90	Antenna Power	Switches ON or OFF the RF field
0x91	Read port	Reads from the Input port
0x92	Write Port	Writes to the Output port
0x93	Halt	Halts the PICC
0x94	Set Baud Rate	Sets the new baud rate
0x95	NA	Not Implemented
0x96	Sleep	This command puts SM130 in sleep mode

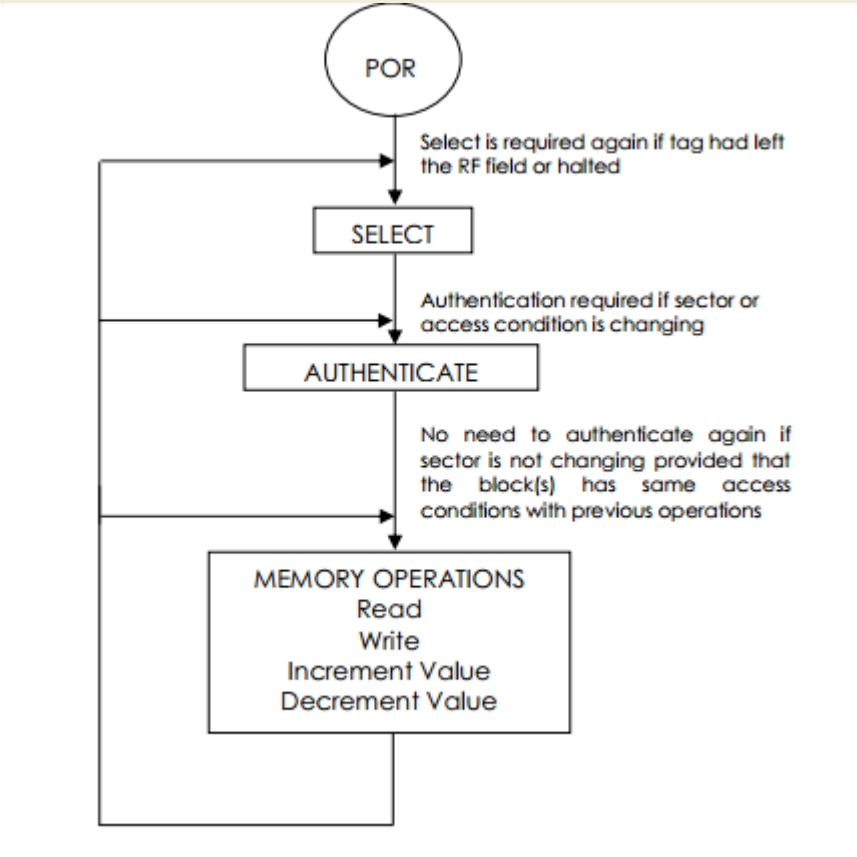
Frame:

Header	Reserved	Length	Command	Data	CSUM
1 Byte	1 Byte	1 Byte	1 Byte	N Bytes	1 Byte

1. Header: 0xFF
2. Reserved: 0x00
3. Length: Command and the Data bytes
4. Command Code
5. Data: W/R to 1K Byte tag
6. CSUM: Check validity of the packet and to trap any data corruption.

Software Overview

Flow Diagram to perform operations on tag



Software Overview

Exception Generation

Address	Exception
0x0000 0000	Reset
0x0000 0004	Undefined Instruction
0x0000 0008	Software Interrupt
0x0000 0018	IRQ

Peripheral Register Addresses

0xE000 4000	Timer 0
0xE000 8000	Timer 1
0xE000 C000	UART0
0xE001 0000	UART1
0xE007 8000	UART2
0xE001 C000	I2C0
0xE002 0000	SPI
0xE002 4000	RTC
0xE008 C000	SD/MMC Card Interface
0xE01F C000	System Control Block

Will use default round robin scheduling or priority of CPU, GPDMA, AHB, LCD

Clocking Registers

PLL Control register (for PLL Control)
- PLLCON - 0xE01F C080

PLL Configuration register (for configuring all multipliers and dividers
- PLLCFG - 0xE01F C084
- FCCO = (2 × M × FIN) / N
  - N and M configurable in register

CPU Clock Configuration register
- CCLKCFG - 0xE01F C104

Peripheral Clock Selection registers 0 and 1
- PCLKSEL0 - 0xE01F C1A8
  - 3:2 PCLK_TIMER0
  - 5:4 PCLK_TIMER1
  - 7:6 PCLK_UART0
  - 9:8 PCLK_UART1
  - 15:14 PCLK_I2C0
  - 17:16 PCLK_SPI
  - 19:18 PCLK_RTC
- PCLKSEL1 - 0xE01F C1AC
  - 17:16 PCLK_UART2
  - 19:18 PCLK_UART3
  - 29:28 PCLK_SYSCON

Debugging Approach

Various approaches involving RS232, LEDs, and Berg test headers

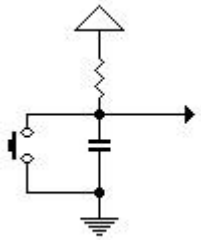
-All pins interfacing to MCU connected to test headers

-RS232 connection to a terminal

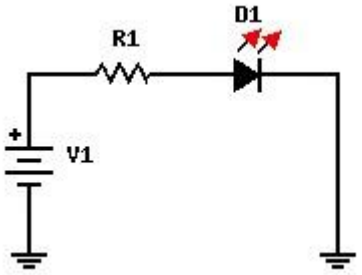
-LED outputs on resets, invalid pins, and output OK and ERR pins

Biased with 65Ohm (3.3V supply) or 150Ohm(5V supply) with 20mA driving

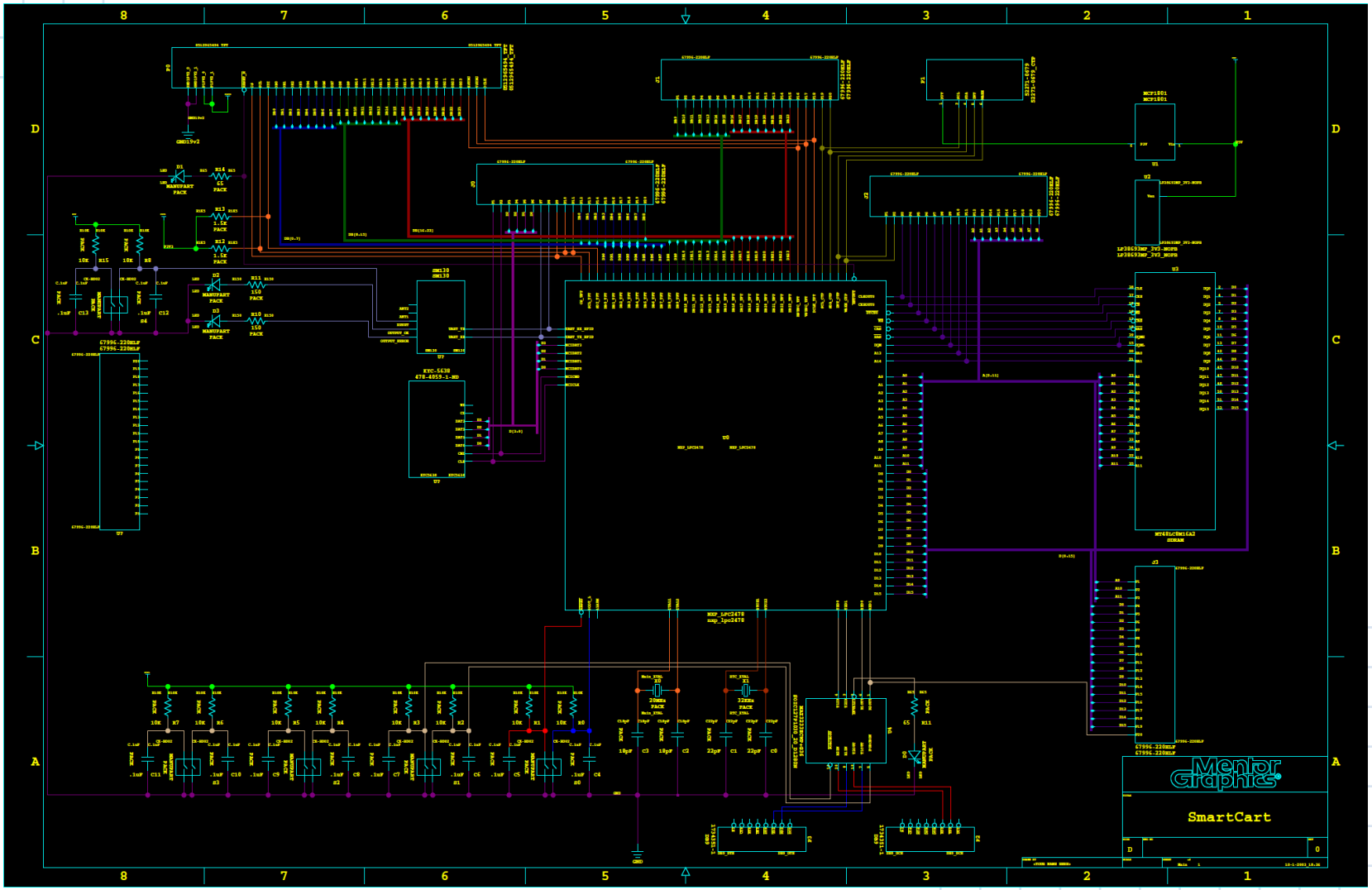
-DIP switches on some pins (e.g. reset)



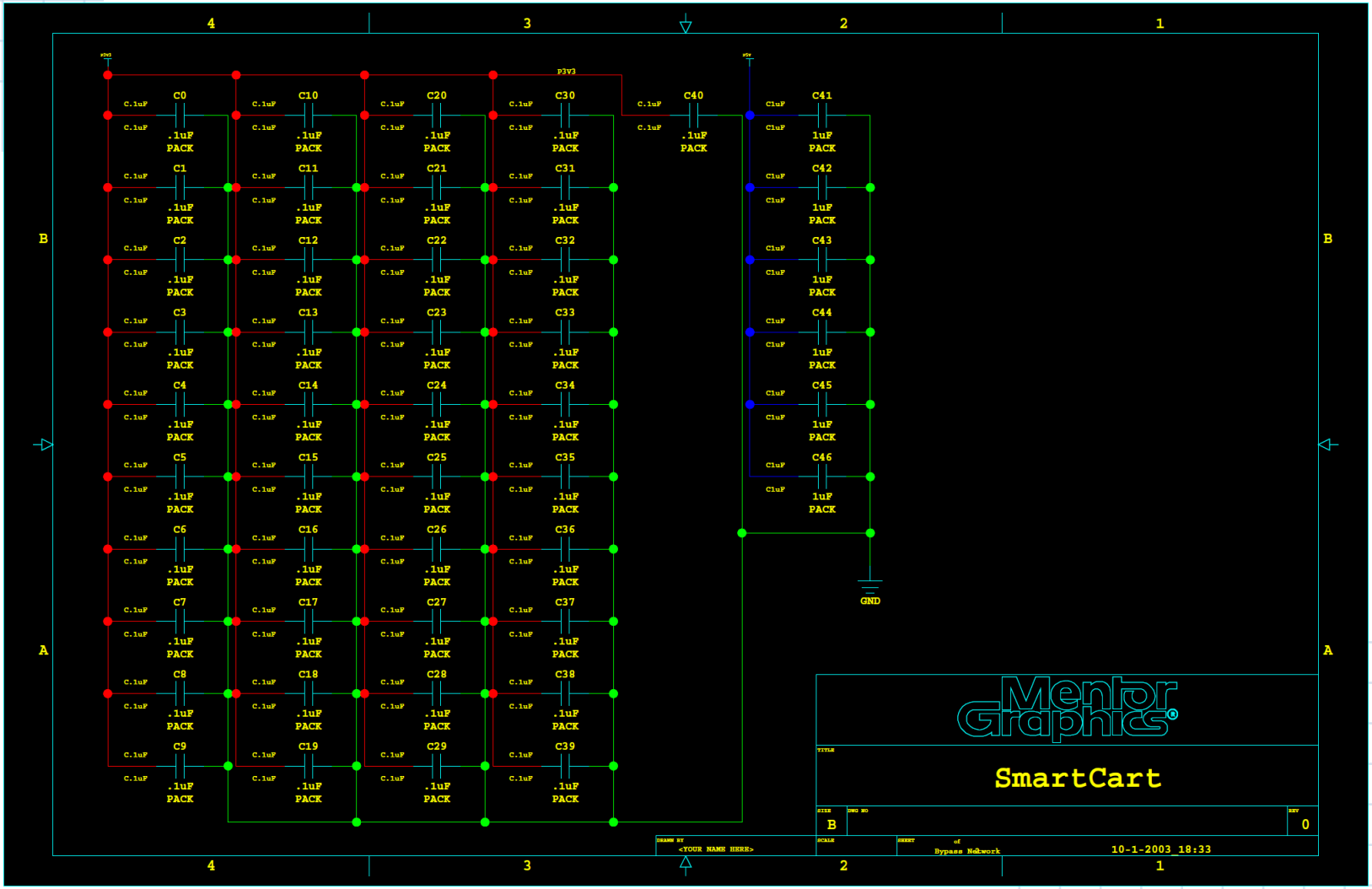
Switch
Debouncing
R = 10kOhm
C = 0.1uF



Schematic (Main)



Schematic (Bypass Caps)



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QUESTIONS?