Majenko Technologies

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chipKIT™ Lenny Development Board

DS1184 Revision 2

Arduino Leonardo-compatible PIC32-based development board with USB interface

DRAFT

Contents

1 Overview **2**

2 Board Layout **3**

3 5V Operation **5**

4 Programming **5**
- 4.1 Entering the bootloader . . . 5
- 4.2 Uploading Firmware . . . 5

5 Electrical Characteristics **6**
- 5.1 Absolute Maximum Ratings . . . 6
- 5.2 DC Characteristics . . . 6
- 5.3 AC Characteristics . . . 6

Appendix A Pin Mapping **7**
- A.1 Board Pins . . . 7
- A.2 Chip Pins . . . 8

Appendix B Peripheral Mapping **9**
- B.1 SPI . . . 9
- B.2 I²C . . . 9
- B.3 UART . . . 9
- B.4 PWM . . . 9
- B.5 Interrupts . . . 9

Appendix C FastProg **10**

Appendix D Schematic **11**

Appendix E License **12**
- E.1 License Brief . . . 12
- E.2 License Full Text . . . 13
  - E.2.1 Definitions . . . 13
  - E.2.2 Fair Dealing Rights. . . . 14
  - E.2.3 License Grant. . . . 14
  - E.2.4 Restrictions. . . . 14
  - E.2.5 Representations, Warranties and Disclaimer . . . 15
  - E.2.6 Limitation on Liability. . . . 15
  - E.2.7 Termination . . . 15
  - E.2.8 Miscellaneous . . . 16

Appendix F Document Revisions **17**

1 Overview

The chipKIT™ Lenny development board is a PIC32-based USB interface and prototyping board. It is designed to interface directly with a computer's USB port and provide a number of USB functions including CDC/ACM serial and HID Keyboard and Mouse.

The board presents the PIC32's GPIO and peripheral pins in a footprint compatible with the Arduino Leonardo and offers similar functionality but with extra enhancements.

The powerful PIC32 chip provides plenty of resources for even the most demanding of situations.

High-Performance 32-bit RISC CPU:

- **PIC32MX270F256D**
- **40MHz maximum frequency**
- **256KB Flash**
- **64KB SRAM**
- **SPI**
- **I^{2}C**
- **UART**

USB Programming Port

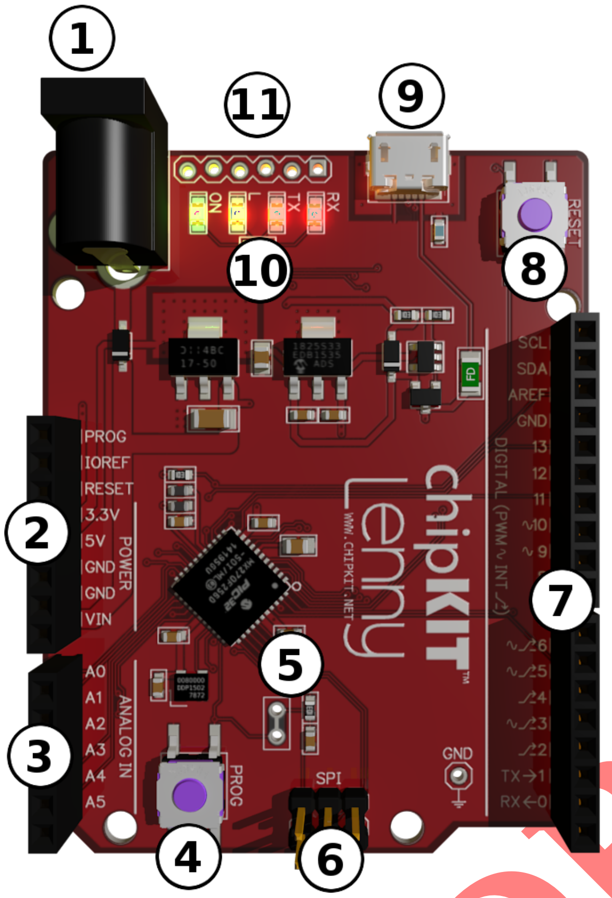
- **CDC/ACM STK500v2 Bootloader**

PROG Button and LEDs

- **PROG "User" button on separate IO with FastProg**
- **Three independant LEDs with USB RX/TX control**

2 Board Layout

Appendix A on page 7 lists all the pin mappings for the board presented as viewed from the IO pins, the chip's pins and the internal port names.



1: Power Input

The DC Barrel Jack is used to provide power to the board from an external source. It uses a standard 2.1mm jack plug and can accept anywhere between 6.5V and 12V DC with the positive on the central pin.

2: Power Header

The power header presents various power supplies to the user. It also provides a number of internal house-keeping and system management signals. From the top of the image down these are:

- **PROG** – This is a connection to the IO pin, which is driven by the PROG button (see below) for ease of entering programming mode when the board is embedded in a project.
- **IOREF** – The IOREF pin is used by shields to detect the correct voltage to use for IO pins. On the Lenny this is set to 3.3V.
- **3.3V** – The main 3.3V core voltage at which the majority of the board's logic operates.
- **5V** – Many devices require 5V to operate. This pin provides 5V either regulated from the DC input or direct from the USB socket, whichever is connected.
- **GND** – These pins are a ground connection.
- **VIN** – The input voltage. It is connected, via a diode, to the barrel jack. This may either be used to provide power to the board without the bulk of a DC jack plug, or it may be used to provide power to external circuits. The voltage of this pin is dependent on the voltage provided to the barrel jack.

3: Analog Inputs

The Lenny provides 6 dedicated analog inputs. These can read voltages between 0V and 3.3V and provide a 10 bit resolution which yields a value between 0 and 1023.

4: PROG Button

To upload firmware to the board it must first be placed in programming mode. For many chipKIT™ boards this is achieved by holding a PROG button and pressing RESET. However, in the Lenny this has been somewhat simplified by the inclusion of a FastProg circuit. Simply pressing the PROG button resets the board and places it in programming mode. FastProg can be manually disabled (see below) which allows the PROG button to then be used by your own program, but at the expense of a more complex method of entering programming mode.

5: FastProg Jumper

FastProg can be disabled by cutting the track joining the two pins of this unpopulated jumper. A craft (or "X-Acto") knife can be used to cut through the tinned portion of the track. Should FastProg be required again in the future a jumper can be soldered into place to bridge the connections again. Fore more flexible operation a "bus-bar" style removable jumper can be installed to enable and disable FastProg at will.

If FastProg is disabled entering the bootloader becomes more complex:

1. Press and hold the PROG button
2. Briefly press and release the RESET button
3. Release the PROG button

The L led (see below) should start blinking.

6: SPI Header

This header provides an SPI connection (DSPI1) used by standard Arduino shields.

The pins, in the orientation as depicted in the image above, are as follows:

RESET	SCK	MISO
GND	MOSI	5V

7: Digital Pins

17 digital pins are provided for general use. Many of them also have other special functions. Pins 0 and 1 are the primary UART “Serial0”. This is separate from the USB UART connection which is “Serial” since the USB UART connection is directly driven by the internal USB peripheral in the PIC32 (see below).

Pins 2 and 4 are used for the secondary UART “Serial1”. Pins 10 through 13 are also the SPI port DSPI0. These are arranged in the standard Arduino Uno arrangement.

AREF is used to set the analog reference voltage for the ADC, but it is also possible to use it as another analog input or a digital IO pin. SCL and SDA provide access to the primary I2C bus (DTWI0), but again can also be used as digital IO if I2C is not being used. The secondary I2C bus (DTWI1) is presented on the A4/A5 pins as per the Arduino Uno.

Pins 2 through 6 have hardware interrupt capabilities, and pins 3, 5, 6, 9 and 10 can be hardware PWM outputs.

All the digital and analog IO pins and their functions are detailed in Appendix A on page 7.

8: RESET Button

Pressing the RESET button resets the board. Your program is restarted from the beginning and all run-time settings are reset to default.

9: MicroUSB Socket

For communication with a PC and uploading programs a Micro USB cable is required. Simply connect the cable to the Micro USB socket. Power is also provided through this socket if the DC power input is not used.

10: LEDs

The Lenny has four LEDs on-board. Three of them are under control of the PIC32 and one is a static power LED.

- **ON** – Static green Power LED
- **L** – User-controlled yellow LED accessable as PIN_LED1 or IO number 22
- **TX** – This red LED is controlled by the USB Serial software to indicate data transmission. If USB Serial is not being used the LED can be manually controlled as PIN_LED2 or IO number 23.
- **RX** – This red LED is controlled by the USB Serial software to indicate data reception. If USB Serial is not being used the LED can be manually controlled as PIN_LED3 or IO number 24.

11: ICSP Header

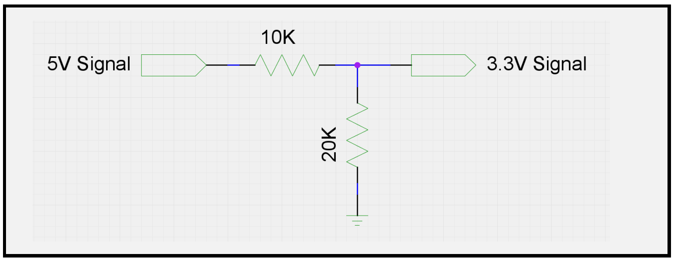
The ICSP header can be used to interface the PIC32 to a hardware PIC programmer, such as a PICkit3 or RealICE. This can be used for such things as upgrading the bootloader, or direct programming of the PIC32 from MPLAB-X.

3 5V Operation

The chipKIT™ Lenny is a 3.3V device. That means that all IO pins operate at 3.3V. Input voltages to the IO pins must not exceed 3.3V or damage to the microcontroller may occur. However, some pins are able to withstand up to 5.5V, and if you need to interface with a 5V device these pins should be used to prevent damage and alleviate the need for a logic level converter.

The pins that are 5V tolerant are: 0-6, 8, SDA and SCL.

Most 5V devices will accept a 3.3V signal without requiring any translation. To translate a 5V signal into a 3.3V one which the Lenny can receive you can, for low speed signals, use a simple voltage divider consisting of a 10K resistor and a 20K resistor:



4 Programming

4.1 Entering the bootloader

The chipKIT™ Lenny includes the simple FastProg circuit for entering the bootloader at a single press of a button. Simply press the PROG button to reset the board and enter into bootloader mode.

The FastProg circuit can be manually disable, if required by simply cutting one link on the board (see Appendix C on page 10). This releases the PROG button to be used for other purposes as well as entering the bootloader. If FastProg is disabled, entering the bootloader then entails holding the PROG button whilst pressing the RESET button.

4.2 Uploading Firmware

Using the bootloader it is possible to upload firmware directly to the board without the need of a hardware programmer. A standard protocol, STK500V2[1], is used through the CDC/ACM port to transfer the firmware into the internal flash of the PIC32 chip.

It is recommended to use an IDE such as UECIDE or the Arduino IDE to upload firmware to the board. It is possible to perform a manual upload from the command line, or integrate the command into your own preferred third party IDE. Please refer to AN1938: Manual Programming of chipKIT™ boards for more detail on manual programming.

[1] STK500 is a proprietary protocol created by Atmel for their hardware programmers. It has since been extended to support bootloaders and has rapidly become the preferred bootloader protocol for many systems.

5 Electrical Characteristics

This section provides an overview of the chipKIT™ Lenny electrical characteristics. Additional information will be provided in future revisions of this document as it becomes available.

Absolute maximum ratings for the chipKIT™ Lenny are listed below. Exposure to these maximum rating conditions for extended periods may affect device reliability. Functional operation of the device at these or any other conditions, above the parameters indicated in the operation listings of this specification, is not implied.

5.1 Absolute Maximum Ratings

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions, above those indicated in the operation listings of this specification, is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Ambient temperature under bias	-40°C to +105°C
Storage temperature	-65°C to +150°C
Voltage on Vin with respect to GND	-0.3V to +12.0V
Voltage on 5V with respect to GND	-0.3V to +5.5V
Voltage on 3.3V with respect to GND	-0.3V to +4.0V
Voltage on any pin that is not 5V tolerant, with respect to GND	-0.3V to +3.6V
Voltage on any 5V tolerant pin with respect to GND	-0.3V to +5.5V
Maximum output current sunk by any I/O pin	15 mA
Maximum output current sourced by any I/O pin	15 mA
Maximum current sunk by all ports	200 mA
Maximum current sourced by all ports	200 mA

5.2 DC Characteristics

Operating voltage (Vin)	+6.5V to +12V
Operating voltage (USB)	+4.5V to +5.5V
Idle[1] current consumption (Vin)	20mA
Idle consumption (USB)	25mA

5.3 AC Characteristics

Nominal core frequency	40MHz
External clock generator frequency	8MHz

[1] Clocking at 40MHz with no program loaded

A Pin Mapping

A.1 Board Pins

Board pin	Port	Static Functions	Assigned Functions
5V		5V Supply Voltage	
Vin		Input power (6.5V - 12V)	
3V3		3.3V Core Supply Voltage	
IOREF		3.3V Logic Voltage	
GND		Common Ground	
RESET		Master reset	
PROG	RB4	SOSCI/RPB4/RB4	
0	RC8	RPC8/PMA5/RC8	U1RX
1	RC9	RPC9/CTED7/PMA6/RC9	U1TX
2	RB7	RPB7/CTED3/PMD5/RB7	INT0/U2TX
3	RC4	RPC4/PMA4/RC4	INT1/PWM
4	RC6	RPC6/PMA1/RC6	INT2/U2RX
5	RB5	RPB5/USBID/RB5	INT3/PWM
6	RC7	RPC7/PMA0/RC7	INT4/PWM
7	RA3	OSC2/CLKO/RPA3/RA3	
8	RC5	RPC5/PMA3/RC5	
9	RC3	AN12/RPC3/RC3	PWM
10	RC1	AN7/RPC1/RC1	SS1/PWM
11	RB13	AN11/RPB13/CTPLS/PMRD/RB13	MOSI1
12	RB1	PGEC1/AN3/C1INC/C2INA/RPB1/CTED12/PMD1/RB1	MISO1
13	RB14	CVREFOUT/AN10/C3INB/RPB14/VBUSON/SCK1/CTED5/RB14	SCK1
14/A0	RA1	PGEC3/VREF-/CVREF-/AN1/RPA1/CTED2/PMD6/RA1	A0
15/A1	RB0	PGED1/AN2/C1IND/C2INB/C3IND/RPB0/PMD0/RB0	A1
16/A2	RC0	AN6/RPC0/RC0	A2
17/A3	RC2	AN8/RPC2/PMA2/RC2	A3
18/A4	RB2	AN4/C1INB/C2IND/RPB2/SDA2/CTED13/PMD2/RB2	A4/SDA2
19/A5	RB3	AN5/C1INA/C2INC/RTCC/RPB3/SCL2/PMWR/RB3	A5/SCL2
20/AREF	RA0	PGED3/VREF+/CVREF+/AN0/C3INC/RPA0/CTED1/PMD7/RA0	AREF
21/PROG	RB4	SOSCI/RPB4/RB4	PROG
22/L	RA10	PGED4/TMS/PMA10/RA10	L LED
23/TX	RA7	PGEC4/TCK/CTED8/PMA7/RA7	TX LED
24/RX	RA8	TDO/RPA8/PMA8/RA8	RX LED
25/MISO	RA4	SOSCO/RPA4/T1CK/CTED9/RA4	MISO2
26/SCK	RB15	AN9/C3INA/RPB15/SCK2/CTED6/PMCS1/RB15	SCK2
27/MOSI	RA9	TDI/RPA9/PMA9/RA9	MOSI2
28/SDA	RB9	RPB9/SDA1/CTED4/PMD3/RB9	SDA1
29/SCL	RB8	RPB8/SCL1/CTED10/PMD4/RB8	SCL1

A.2 Chip Pins

Chip pin	Board Pin	Static Functions	Assigned Functions
1	28/SDA	RPB9/SDA1/CTED4/PMD3/RB9	SDA1
2	4	RPC6/PMA1/RC6	INT2/U2RX
3	6	RPC7/PMA0/RC7	INT4/PWM
4	0	RPC8/PMA5/RC8	U1RX
5	1	RPC9/CTED7/PMA6/RC9	U1TX
6		VSS	
7		VCAP	
8		PGED2/RPB10/D+/CTED11/RB10	USB
9		PGEC2/RPB11/D-/RB11	USB
10		VUSB3V3	
11	11	AN11/RPB13/CTPLS/PMRD/RB13	MOSI1
12	22/L	PGED4/TMS/PMA10/RA10	L LED
13	23/TX	PGEC4/TCK/CTED8/PMA7/RA7	TX LED
14	13	CVREFOUT/AN10/C3INB/RPB14/VBUSON/SCK1/CTED5/RB14	SCK1
15	26/SCK	AN9/C3INA/RPB15/SCK2/CTED6/PMCS1/RB15	SCK2
16		AVSS	
17		AVDD	
18		$\overline{\text{MCLR}}$	
19	20/AREF	PGED3/VREF+/CVREF+/AN0/C3INC/RPA0/CTED1/PMD7/RA0	AREF
20	14/A0	PGEC3/VREF-/CVREF-/AN1/RPA1/CTED2/PMD6/RA1	A0
21	15/A1	PGED1/AN2/C1IND/C2INB/C3IND/RPB0/PMD0/RB0	A1
22	12	PGEC1/AN3/C1INC/C2INA/RPB1/CTED12/PMD1/RB1	MISO1
23	18/A4	AN4/C1INB/C2IND/RPB2/SDA2/CTED13/PMD2/RB2	A4/SDA2
24	19/A5	AN5/C1INA/C2INC/RTCC/RPB3/SCL2/PMWR/RB3	A5/SCL2
25	16/A2	AN6/RPC0/RC0	A2
26	10	AN7/RPC1/RC1	SS1/PWM
27	17/A3	AN8/RPC2/PMA2/RC2	A3
28		VDD	
29		VSS	
30		OSC1/CLKI/RPA2/RA2	CLK
31	7	OSC2/CLKO/RPA3/RA3	
32	24/RX	TDO/RPA8/PMA8/RA8	RX LED
33	21/PROG	SOSCI/RPB4/RB4	PROG
34	25/MISO	SOSCO/RPA4/T1CK/CTED9/RA4	MISO2
35	27/MOSI	TDI/RPA9/PMA9/RA9	MOSI2
36	9	AN12/RPC3/RC3	PWM
37	3	RPC4/PMA4/RC4	INT1/PWM
38	8	RPC5/PMA3/RC5	
39		VSS	
40		VDD	
41	5	RPB5/USBID/RB5	INT3/PWM
42		VBUS	
43	2	RPB7/CTED3/PMD5/RB7	INT0/U2TX
44	29/SCL	RPB8/SCL1/CTED10/PMD4/RB8	SCL1

B Peripheral Mapping

B.1 SPI

The Lenny board has 2 SPI ports each capable of up to 20Mbps operation. Both are abstracted by the standard chipKIT™ API's DSPI.h library.

Function	Pin
DSPI0 / SPI1	
MISO (SDI1)	12
MOSI (SDO1)	11
SCK1	13
SS1	10
DSPI1 / SPI2	
MISO (SDI2)	25
MOSI (SDO2)	27
SCK2	26
SS2	9

B.2 I^{2}C

The Lenny board has two I^{2}C ports available. Only one is abstracted by the standard chipKIT™ API's Wire.h library but both are available to the DTWI.h library.

Function	Pin
Wire / DTWI0 / I2C1	
SDA1 (Data)	28/SDA
SCL1 (Clock)	29/SCL
DTWI1 / I2C2	
SDA2 (Data)	A4
SCL2 (Clock)	A5

B.3 UART

The Lenny board has two UART peripherals in addition to the USB UART (CDC/ACM) connection. UART 2 is mapped to Serial0 and UART 1 is mapped to Serial1.

Function	Pin
Serial0 / UART2	
RX	0
TX	1
Serial1 / UART1	
RX	4
TX	2

B.4 PWM

The Lenny board has five hardware PWM pins. They are mapped as follows:

Function	Pin
OC1	6
OC2	5
OC3	3
OC4	9
OC5	10

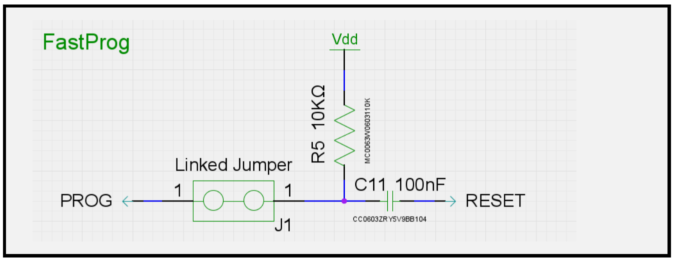
B.5 Interrupts

The Lenny board has five hardware interrupt pins. They are mapped as follows:

Function	Pin
INT0	2
INT1	3
INT2	4
INT3	5
INT4	6

C FastProg

The FastProg system allows rapid entry into a bootloader, which is a task that would otherwise require a complex multi-button operation. When the PROG button is pressed (active LOW) a 100nF capacitor filters the LOW signal to create a brief LOW pulse. This pulse is then applied to the RESET pin to reset the microcontroller whilst the PROG button is still being pressed, allowing the bootloader to instantly start operating. The circuit included in the Lenny is as follows:



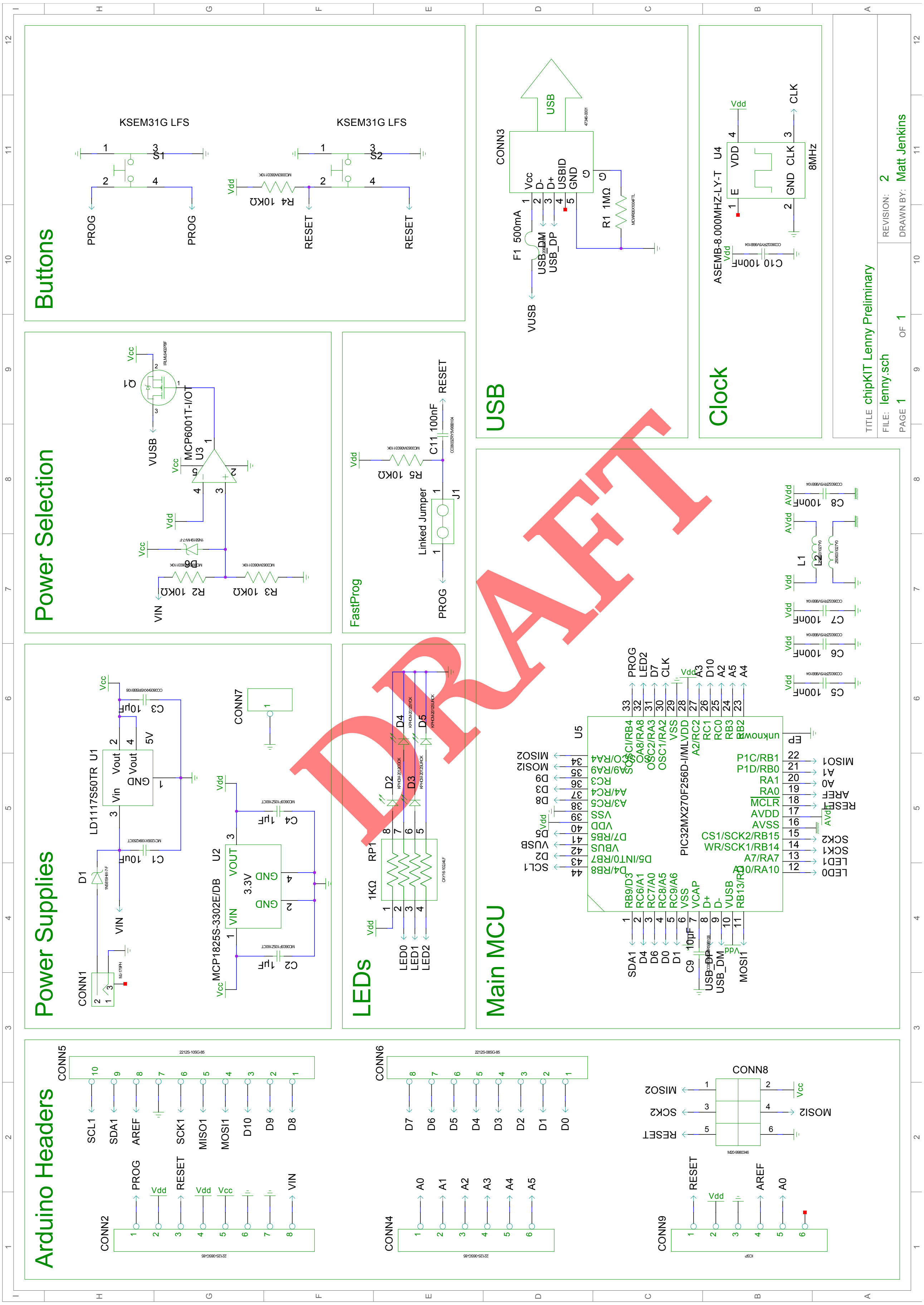
By cutting the link joining the two pins of J1 (Linked Jumper) it is possible to disable the FastProg functionality entirely. The PROG button then becomes available as IO pin 21 for use in your own programs. Normally resistor R5 provides pullup functionality for the PROG button, but with the linked jumper disconnected there is no pullup. As a result, to use PROG in your own program you should enable the internal pullup in the IO pin with:

```
pinMode(21, INPUT_PULLUP);
```

Example 1: Enabling internal pullup for PROG button

Should FastProg functonality be required again in the future, the linked jumper J1 can either be soldered back together, or a 0.1" jumper can be soldered in place to allow FastProg to be enabled and disabled at will.

D Schematic


Buttons
Power Selection
FastProg
USB
Clock
Power Supplies
LEDs
Main MCU
Arduino Headers
DRAFT
TITLE chipKIT Lenny Preliminary
FILE: lenny.sch
PAGE 1 OF 1
REVISION: 2
DRAWN BY: Matt Jenkins

E License

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F Document Revisions

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2. SB . . . 25/08/2916 . . . . Grammatical cleanup