External Memory Interface

MicropendousX-LPC182x-GPS-EMI.sch

USB

MicropendousX-LPC182x-GPS-USB.sch

System

MicropendousX-LPC182x-GPS-System.sch

Position_Sensors

MicropendousX-LPC182x-GPS-Position_Sensors.sch

RF

MicropendousX-LPC182x-GPS-RF.sch

LCD

MicropendousX-LPC182x-GPS-LCD.sch

Power Supply

MicropendousX-LPC182x-GPS-Power.sch

Expansion

MicropendousX-LPC182x-GPS-Expansion.sch

Vias

MicropendousX-LPC182x-GPS-Vias.sch

Notes:
  – Design targets Revision 'A' of the LPC182x
  – Pins with more than one function are labeled
    with their pin name and function(s) used
  – VDD controls LPC182x, RF Transceiver, LCD Touchscreen Controller,
    and Motion Sensor so that these can wake up the device
  – VDDIO powers microSD, GPS Module, and LCD Display
    along with all LPC182x IO pins so that these can be
    disabled in low-power modes.
  – Only WAKEUP pin can wake up device from Deep Sleep and Power-Down Modes
  – USB0 can wake up device only from Sleep Mode
  – Power Consumption: Normal 10mA+, Sleep 5.5mA+, Other <1mA

<-- Double-click inside a sheet to go to it

Opendous Inc.
File: MicropendousX-LPC182x-GPS.sch
Sheet: /
Title: MicropendousX-LPC182x-GPS
Size: A4 | Date: 27 jun 2012 | Rev: 1.0
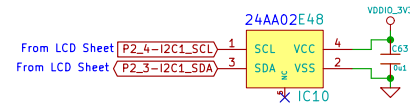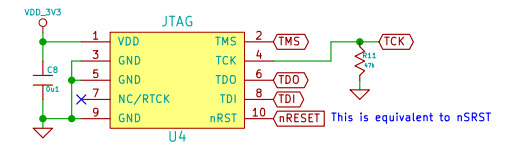KiCad E.D.A. | Id: 1/10

EUI-64 Node Identity

24AA02E48

From LCD Sheet P2_4-I2C1_SCL	1 SCL VCC 4	C63
From LCD Sheet P2_3-I2C1_SDA	3 SDA VSS 2	0u1

IC10

VDDIO_3V3

JTAG

JTAG

VDD_3V3	1 VDD TMS 2	TMS	TCK
	3 GND TCK 4		
C8	5 GND TDO 6	TDO	
0u1	7 NC/RTCK TDI 8	TDI	R11 47k
	9 GND nRST 10	nRESET	This is equivalent to nSRST

U4
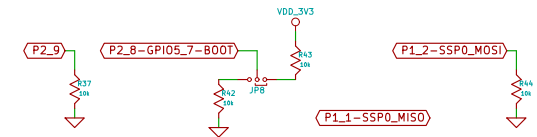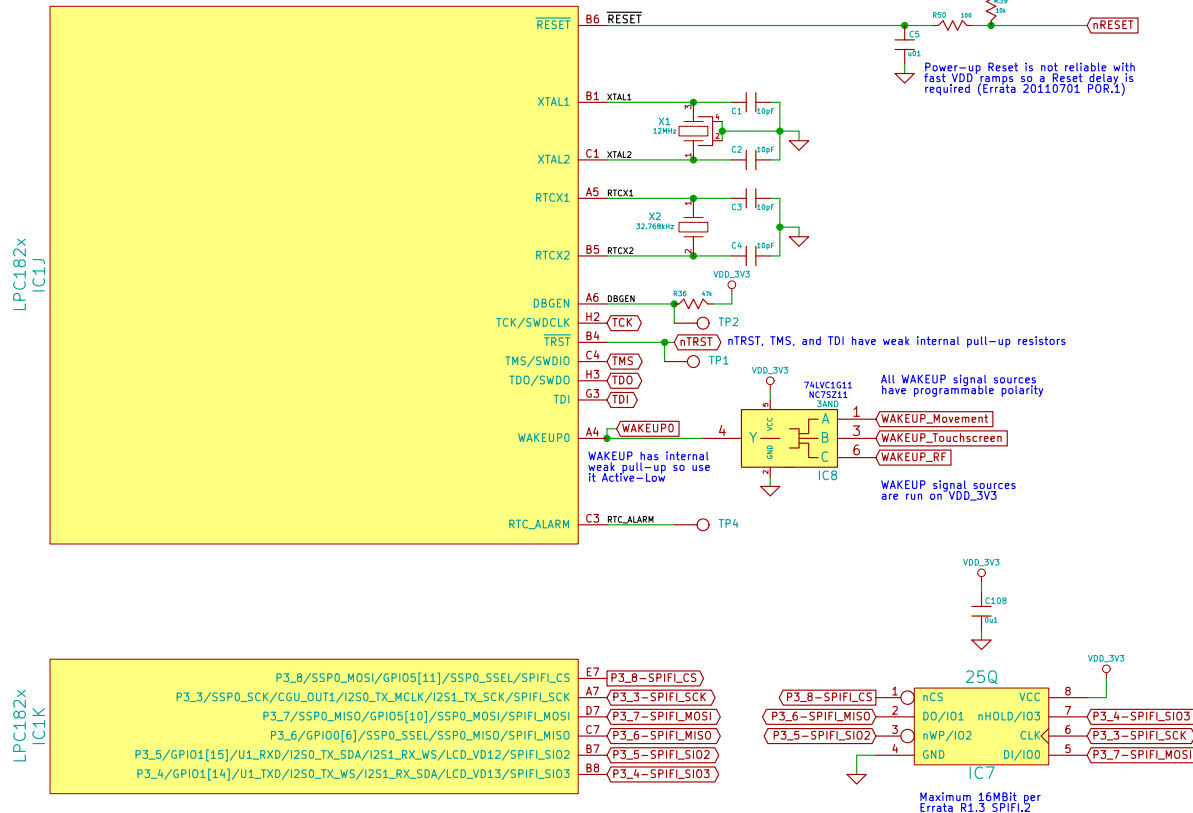
TDO need not be pulled up since
TCK pull-down ensures no random
data is ever sent as TDO is only
valid when clock is valid.

LPC182x
IC1J

RESET	B6 RESET

VDD_3V3
R50 100
C5
0u1
R39 10k
nRESET

Power-up Reset is not reliable with
fast VDD ramps so a Reset delay is
required (Errata 20110701 POR.1)

XTAL1	B1 XTAL1
XTAL2	C1 XTAL2

X1 12MHz
C1 10pF
C2 10pF

RTCX1	A5 RTCX1
RTCX2	B5 RTCX2

X2 32.768kHz
C3 10pF
C4 10pF

DBGEN	A6 DBGEN
TCK/SWDCLK	H2 TCK
TRST	B4 nTRST
TMS/SWDIO	C4 TMS
TDO/SWDO	H3 TDO
TDI	G3 TDI

VDD_3V3
R36 47k
TP2
TP1
nTRST, TMS, and TDI have weak internal pull-up resistors

WAKEUP0	A4 WAKEUP0

74LVC1G11
NC7SZ11
3AND

A	1 WAKEUP_Movement
B	3 WAKEUP_Touchscreen
C	6 WAKEUP_RF

Y IC8

All WAKEUP signal sources
have programmable polarity

WAKEUP signal sources
are run on VDD_3V3

WAKEUP has internal
weak pull-up so use
it Active-Low

VDD_3V3
C108 0u1

RTC_ALARM	C3 RTC_ALARM

TP4

Boot Mode Selection

P2_9
P2_8-GPIO5_7-BOOT
VDD_3V3
R43 10k
P1_2-SSP0_MOSI

R37 10k
R42 10k
JP8
P1_1-SSP0_MISO
R44 10k

Boot Mode	P2_9(A0)	P2_8(A8)	P1_1(A6)	P1_2(A7)
SPIFI (SPF)	LOW	LOW	HIGH	LOW
USB0 (USB)	LOW	HIGH	HIGH	LOW
USART0	LOW	LOW	LOW	LOW
EMC 8-Bit	LOW	LOW	LOW	HIGH
EMC 16-Bit	LOW	LOW	HIGH	HIGH
EMC 32-Bit	LOW	HIGH	LOW	LOW
USB1	LOW	HIGH	LOW	HIGH
SPI (SSP)	LOW	HIGH	HIGH	HIGH
USART3	HIGH	LOW	LOW	LOW

Note boot pins have weak internal pull-ups of about 50k Ohm to VDDIO

Taken from LPC18x0 Datasheet - Table 5

LPC182x
IC1K

P3_8/SSP0_MOSI/GPIO5[11]/SSP0_SSEL/SPIFI_CS	E7 P3_8-SPIFI_CS
P3_3/SSP0_SCK/CGU_OUT1/I2S0_TX_MCLK/I2S1_TX_SCK/SPIFI_SCK	A7 P3_3-SPIFI_SCK
P3_7/SSP0_MISO/GPIO5[10]/SSP0_MOSI/SPIFI_MOSI	D7 P3_7-SPIFI_MOSI
P3_6/GPIO0[6]/SSP0_SSEL/SSP0_MISO/SPIFI_MISO	C7 P3_6-SPIFI_MISO
P3_5/GPIO1[15]/U1_RXD/I2S0_TX_SDA/I2S1_RX_WS/LCD_VD12/SPIFI_SIO2	B7 P3_5-SPIFI_SIO2
P3_4/GPIO1[14]/U1_TXD/I2S0_TX_WS/I2S1_RX_SDA/LCD_VD13/SPIFI_SIO3	B8 P3_4-SPIFI_SIO3

VDD_3V3
C108 0u1

25Q

P3_8-SPIFI_CS	1 nCS VCC 8		VDD_3V3
P3_6-SPIFI_MISO	2 DO/IO1 nHOLD/IO3 7	P3_4-SPIFI_SIO3	
P3_5-SPIFI_SIO2	3 nWP/IO2 CLK 6	P3_3-SPIFI_SCK	
	4 GND DI/IO0 5	P3_7-SPIFI_MOSI	

IC7

Maximum 16MBit per
Errata R1.3 SPIFI.2

RTC_ALARM

Notes:
 – Boot pins have weak internal pull–ups of about 50k Ohm to VDDIO
   so VDDIO_3V3 must be enabled at the same time as VDD_3V3 at startup
 – MODE HIGH enables Burst Mode which is more efficient at lower power
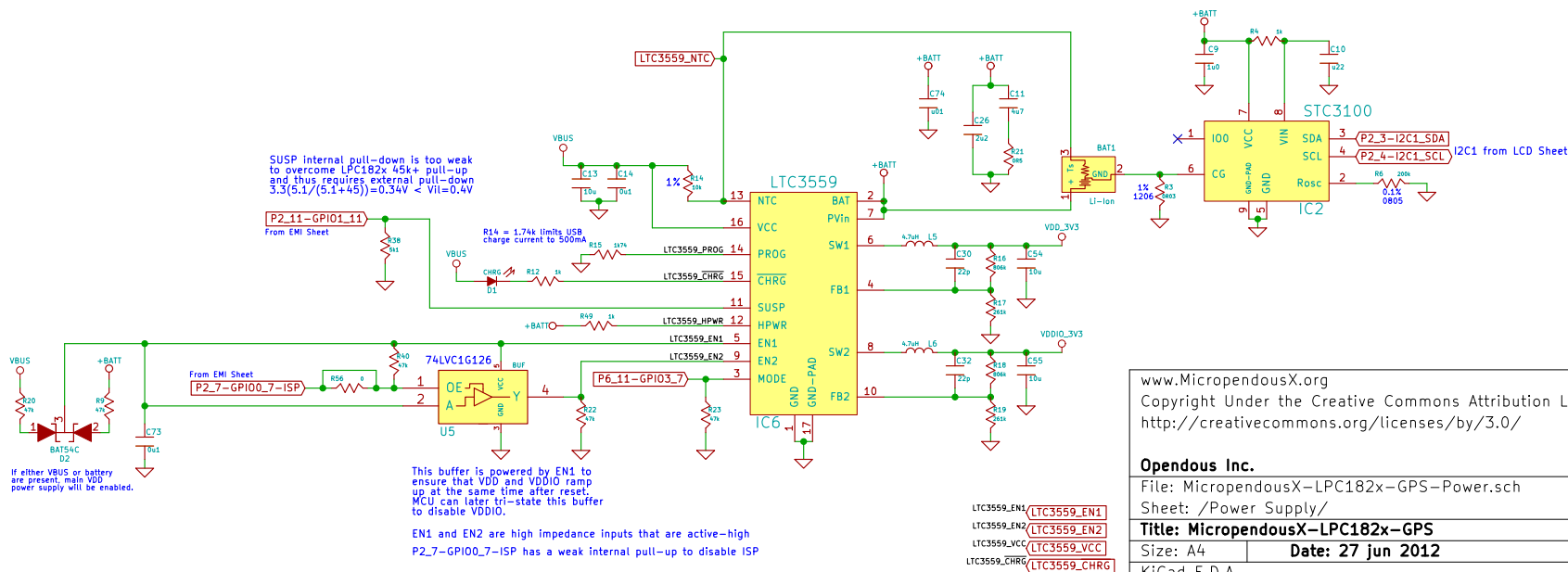 – HPWR and SUSP have 2M Ohm weak pull–downs
 – regulator outputs 3.3V nominal but lowering the
   voltage to 3.0V will reduce power consumption and
   be within all components' supply margins
 – use low ESL reverse geometry X?R caps closest to device
 – BAT54C reverse leakage is maximum 2uA

VBAT must be < 3.6V
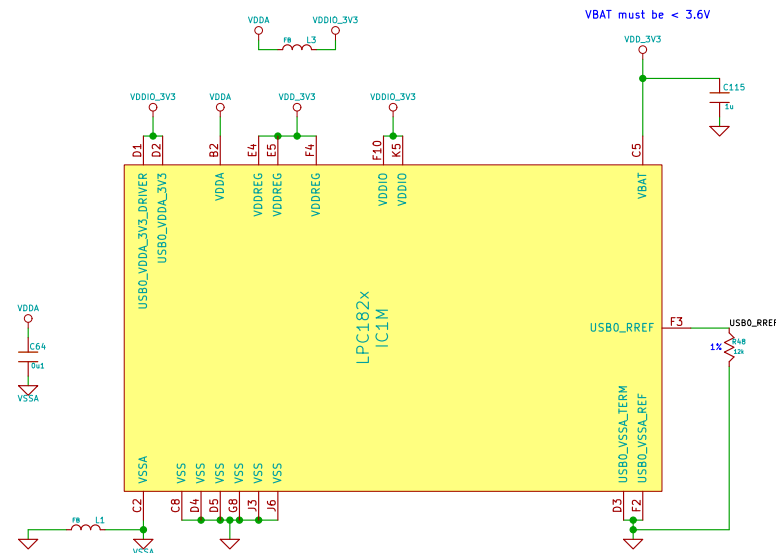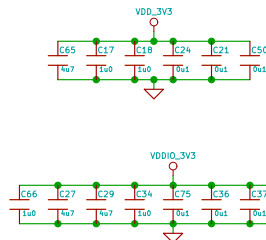
LPC182x
IC1M

LPC182x
IC1L

P6_9/EMC_DYCS0/T2_MAT2/GPIO3[5]
P6_11/EMC_CKEOUT0/T2_MAT3/GPIO3[7]
P6_11-GPIO3_7

USB0_RREF
USB0_VSSA_TERM
USB0_VSSA_REF

Power Management
Li–Ion Charger, Guage, and Dual Buck Regulators

LTC3559_NTC

LTC3559
IC6

LTC3559_PROG
LTC3559_CHRG
LTC3559_HPWR
LTC3559_EN1
LTC3559_EN2

NTC   BAT
VCC   PVin
PROG   SW1
CHRG   FB1
SUSP
HPWR   SW2
EN1
EN2   FB2
MODE
GND GND-PAD

STC3100
IC2

I00   VCC   SDA
CG   GND-PAD   SCL
      GND   Rosc

P2_3-I2C1_SDA
P2_4-I2C1_SCL
I2C1 from LCD Sheet

R6 200k
0.1%
0805

BAT1
Li-Ion

+BATT

VBUS

R14 = 1.74k limits USB
charge current to 500mA

SUSP internal pull–down is too weak
to overcome LPC182x 45k+ pull–up
and thus requires external pull–down
3.3(5.1/(5.1+45))=0.34V < Vil=0.4V

P2_11-GPIO1_11
From EMI Sheet

From EMI Sheet
P2_7-GPIO0_7-ISP

74LVC1G126
U5

OE   VCC   BUF
A   GND   Y

P6_11-GPIO3_7

This buffer is powered by EN1 to
ensure that VDD and VDDIO ramp
up at the same time after reset.
MCU can later tri-state this buffer
to disable VDDIO.

EN1 and EN2 are high impedance inputs that are active–high
P2_7-GPIO0_7-ISP has a weak internal pull–up to disable ISP

BAT54C
D2

If either VBUS or battery
are present, main VDD
power supply will be enabled.

LTC3559_EN1   LTC3559_EN1
LTC3559_EN2   LTC3559_EN2
LTC3559_VCC   LTC3559_VCC
LTC3559_CHRG LTC3559_CHRG

Notes:

IC1A (LPC182x)

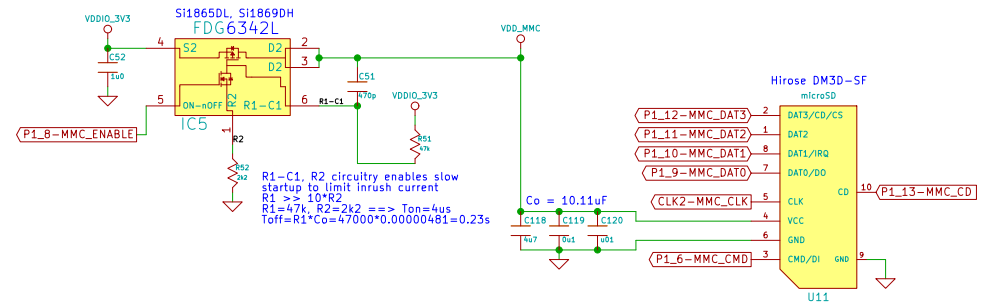| Pin	Signal
B10	P2_9/GPIO1[10]/CTOUT_3/U3_BAUD/EMC_A0
E8	P2_10/GPIO0[14]/CTOUT_2/U2_TXD/EMC_A1
A9	P2_11/GPIO1[11]/CTOUT_5/U2_RXD/EMC_A2
B9	P2_12/GPIO1[12]/CTOUT_4/U2_UCLK/EMC_A3
A10	P2_13/GPIO1[13]/CTIN_4/U2_DIR/EMC_A4
H1	P1_0/GPIO0[4]/CTIN_3/SSP0_SSEL/EMC_A5
K2	P1_1/GPIO0[8]/CTOUT_7/SSP0_MISO/EMC_A6
K1	P1_2/GPIO0[9]/CTOUT_6/SSP0_MOSI/EMC_A7
C6	P2_8/CTOUT_0/U3_DIR/GPIO5[7]/EMC_A8
C10	P2_7/GPIO0[7]/CTOUT_1/U3_UCLK/T3_MAT3/EMC_A9
G9	P2_6/U0_DIR/USB0_IND0/GPIO5[6]/CTIN_7/T3_CAP3/EMC_A10
F5	P2_2/U0_UCLK/USB0_IND1/GPIO5[2]/CTOUT_6/T3_CAP2/EMC_A11
G7	P2_1/U0_RXD/USB0_PWR_FAULT/GPIO5[1]/T3_CAP1/EMC_A12
G10	P2_0/U0_TXD/USB0_PWR_EN/GPIO5[0]/T3_CAP0/ENET_MDC/EMC_A13
G4	P1_7/GPIO1[0]/U1_DSR/CTOUT_13/USB0_PWR_EN/EMC_D0
H5	P1_8/GPIO1[1]/U1_DTR/CTOUT_12/MMC_VOLT0/EMC_D1
J5	P1_9/GPIO1[2]/U1_RTS/CTOUT_11/MMC_DAT0/EMC_D2
H6	P1_10/GPIO1[3]/U1_RI/CTOUT_14/MMC_DAT1/EMC_D3
J7	P1_11/GPIO1[4]/U1_CTS/CTOUT_15/MMC_DAT2/EMC_D4
K7	P1_12/GPIO1[5]/U1_DCD/T0_CAP1/MMC_DAT3/EMC_D5
H8	P1_13/GPIO1[6]/U1_TXD/T0_CAP0/MMC_CD/EMC_D6
J8	P1_14/GPIO1[7]/U1_RXD/T0_MAT2/EMC_D7
K4	P1_6/GPIO1[9]/CTIN_5/MMC_CMD/EMC_WE
J1	P1_3/GPIO0[10]/CTOUT_8/USB0_IND1/SSP1_MISO/MMC_RST/EMC_OE
J4	P1_5/GPIO0[8]/CTOUT_10/USB0_PWR_FAULT/SSP1_SSEL/MMC_POW/EMC_CS0
J2	P1_4/GPIO0[11]/CTOUT_9/USB0_IND0/SSP1_MOSI/MMC_VOLT1/EMC_BLS0
F6	P6_4/GPIO3[3]/CTIN_6/U0_TXD/EMC_CAS
F9	P6_5/GPIO3[4]/CTOUT_6/U0_RXD/EMC_RAS
K3	CLK0/EMC_CLK0/CLKOUT/MMC_CLK/EMC_CLK01/ENET_TX_CLK/ENET_REF_CLK/SSP1_SCK
K6	CLK2/CLKOUT/MMC_CLK/I2S1_RX_SCK/I2S0_TX_MCLK/EMC_CLK23/EMC_CLK3

IC1E (LPC182x)

Pin	Signal
H4	PF_4/SSP1_SCK/GP_CLKIN/TRACECLK/I2S0_RX_SCK/LCD_CLKIN/I2S0_TX_MCLK
A8	P3_0/I2S0_RX_MCLK/I2S0_TX_MCLK/SSP0_SCK/I2S0_RX_SCK/I2S0_TX_SCK
G6	P3_2/CAN0_TD/USB1_IND0/GPIO5[9]/LCD_VD14/I2S0_RX_SDA/I2S0_TX_SDA
F7	P3_1/CAN0_RD/USB1_IND1/GPIO5[8]/LCD_VD15/I2S0_RX_WS/I2S0_TX_WS
H7	xP6_0/I2S0_RX_MCLK/I2S0_RX_SCK
J9	xP6_2/GPIO3[1]/EMC_CKEOUT1/U0_DIR/T2_CAP1/I2S0_RX_SDA
G5	xP6_1/GPIO3[0]/EMC_DYCS1/U0_UCLK/T2_CAP0/I2S0_RX_WS

Net labels / cross-references

- P2_9 — Used in System Sheet
- P2_10-GPIO0_14 — Used in RF Sheet
- P2_11-GPIO1_11 — Used in Power Supply Sheet
- P2_12-GPIO1_12 — Used in RF Sheet
- P2_13-GPIO1_13 — Used in RF Sheet
- P1_0-SSP0_SSEL — Used in RF Sheet
- P1_1-SSP0_MISO — Used in RF and System Sheets
- P1_2-SSP0_MOSI — Used in RF and System Sheets
- P2_8 — Used in System Sheet
- TP3 P2_7 has weak internal pull-up to disable ISP
- P2_6-GPIO5_6 — Used in Position Sensors Sheet
- P2_2-GPIO5_2 — Used in Position Sensors Sheet
- P2_1-U0_RXD — Used in Position Sensors Sheet
- P2_0-U0_TXD — Used in Position Sensors Sheet
- P1_8-MMC_ENABLE
- P1_9-MMC_DAT0
- P1_10-MMC_DAT1
- P1_11-MMC_DAT2
- P1_12-MMC_DAT3
- P1_13-MMC_CD
- P1_6-MMC_CMD
- P1_5-GPIO0_8 — Used in Position Sensors Sheet
- P1_4-GPIO0_11 — Used in Position Sensors Sheet
- P6_4-GPIO3_3 — Used in Power Supply Sheet
- P6_5-GPIO3_4 — Used in Power Supply Sheet
- CLK2-MMC_CLK
- P3_0-SSP0_SCK — Used in RF Sheet
- P3_1-GPIO5_8 — Used in Position Sensors Sheet

IC5 / FDG6342L

Si1865DL, Si1869DH
FDG6342L

VDDIO_3V3

C52 1u0

VDD_MMC

C51 47p

VDDIO_3V3
R51 47k

P1_8-MMC_ENABLE

R1-C1
R2

R1-C1, R2 circuitry enables slow
startup to limit inrush current
R1 >> 10*R2
R1=47k, R2=2k2 ==> Ton=4us
Toff=R1*Co=47000*0.00000481=0.23s

U11 — Hirose DM3D-SF (microSD)

Signal	Pin	Net
DAT3/CD/CS	2	P1_12-MMC_DAT3
DAT2	1	P1_11-MMC_DAT2
DAT1/IRQ	8	P1_10-MMC_DAT1
DAT0/DO	7	P1_9-MMC_DAT0
CD	10	P1_13-MMC_CD
CLK	5	CLK2-MMC_CLK
VCC	4	
GND	6	
CMD/DI	3	P1_6-MMC_CMD
GND	9	

Co = 10.11uF
C118 4u7   C119 5u1   C120 u01

Opendous Inc.
File: MicropendousX-LPC182x-GPS-EMI.sch
Sheet: /External Memory Interface/
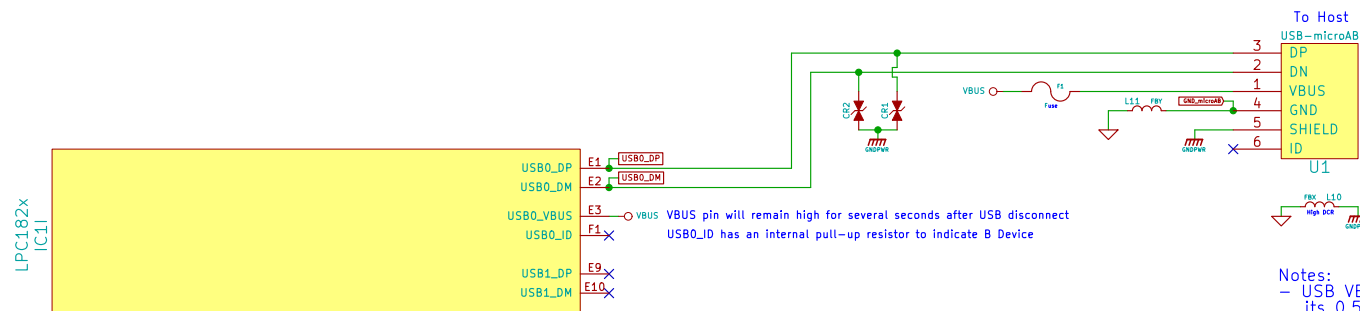Title: MicropendousX-LPC182x-GPS
Size: A4   Date: 8 jun 2012
KiCad E.D.A.   Rev: 1.0   Id: 6/10

USB Device Mode

To Host
USB—microAB

3	DP
2	DN
1	VBUS
4	GND
5	SHIELD
6	ID

U1

VBUS

F1
Fuse

L11 FBY

GND_microAB

GNDPWR

CR2 CR1

GNDPWR

FBX L10
High DCR

GNDPWR

LPC182x
IC1

USB0_DP	E1	USB0_DP
USB0_DM	E2	USB0_DM
USB0_VBUS	E3	VBUS
USB0_ID	F1	
USB1_DP	E9	
USB1_DM	E10	

VBUS pin will remain high for several seconds after USB disconnect
USB0_ID has an internal pull—up resistor to indicate B Device

Notes:
- USB VBUS Fuse F1 limits inrush current with
  its 0.5 ohm typical resistance
- FBX ferrite bead is high DCR 0805
- FBY ferrite beads are high current 0805
- Choose PTC fuse with 750mA Ihold for temperature compensation
- internal pull—up on USB ID pin indicates B device
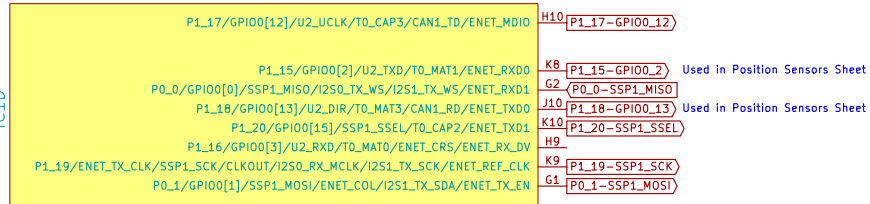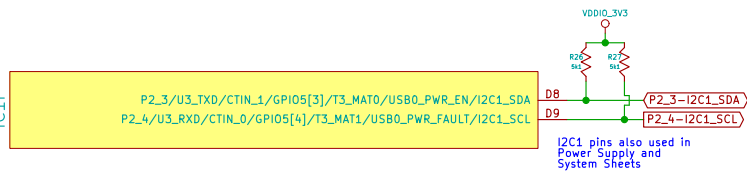
Notes
- Enable the Touchscreen controller to wake up the processor
- Run STMPE610 on always-on VDD to enable Touchscreen wakeup
- Run LCD on VDDIO since it does not need to always be on and has leakage currents
- P1_7-GPIO0_12 is a High Drive Strength Pin that can source 32mA to the LCD Backlight LED
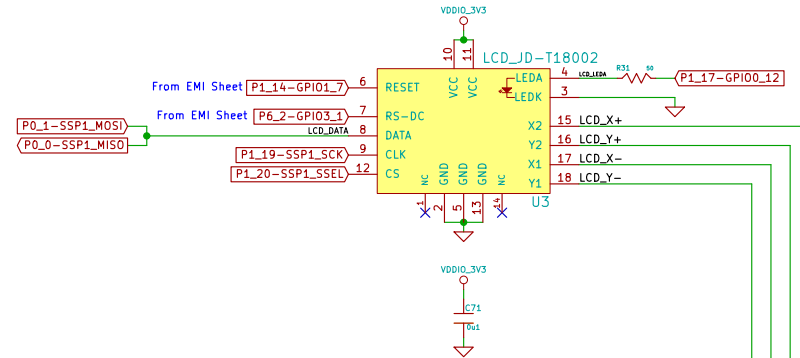
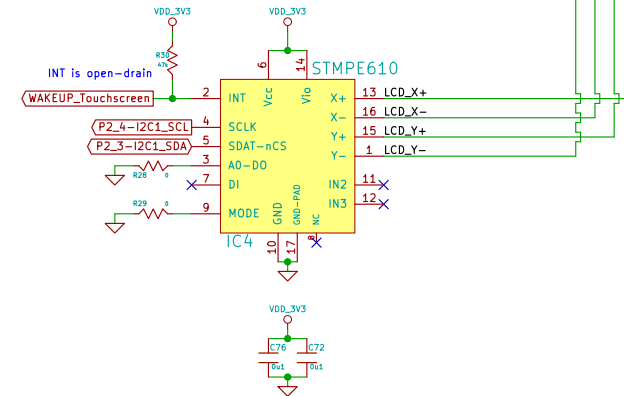## LCD and Resistive Touchscreen

LPC182x IC1D

Pin	Signal	
H10	P1_17/GPIO0[12]/U2_UCLK/T0_CAP3/CAN1_TD/ENET_MDIO	P1_17-GPIO0_12
K8	P1_15/GPIO0[2]/U2_TXD/T0_MAT1/ENET_RXD0	P1_15-GPIO0_2 — Used in Position Sensors Sheet
G2	P0_0/GPIO0[0]/SSP1_MISO/I2S0_TX_WS/I2S1_TX_WS/ENET_RXD1	P0_0-SSP1_MISO — Used in Position Sensors Sheet
J10	P1_18/GPIO0[13]/U2_DIR/T0_MAT3/CAN1_RD/ENET_TXD0	P1_18-GPIO0_13
K10	P1_20/GPIO0[15]/SSP1_SSEL/T0_CAP2/ENET_TXD1	P1_20-SSP1_SSEL
H9	P1_16/GPIO0[3]/U2_RXD/T0_MAT0/ENET_CRS/ENET_RX_DV	
K9	P1_19/ENET_TX_CLK/SSP1_SCK/CLKOUT/I2S0_RX_MCLK/I2S1_TX_SCK/ENET_REF_CLK	P1_19-SSP1_SCK
G1	P0_1/GPIO0[1]/SSP1_MOSI/ENET_COL/I2S1_TX_SDA/ENET_TX_EN	P0_1-SSP1_MOSI

LCD_JD-T18002 U3

From EMI Sheet P1_14-GPIO1_7 → RESET
From EMI Sheet P6_2-GPIO3_1 → RS-DC
P0_1-SSP1_MOSI → DATA
P0_0-SSP1_MISO → CLK
P1_19-SSP1_SCK → CLK
P1_20-SSP1_SSEL → CS

LEDA — R31 — P1_17-GPIO0_12
LEDK

VDDIO_3V3

X2 15 LCD_X+
Y2 16 LCD_Y+
X1 17 LCD_X-
Y1 18 LCD_Y-

C71 0u1 VDDIO_3V3

Resistive Touchscreen Controller

STMPE610 IC4

VDD_3V3   VDD_3V3

R30 47k

INT is open-drain
WAKEUP_Touchscreen → 2 INT Vcc Vio
P2_4-I2C1_SCL → 4 SCLK X+ 13 LCD_X+
P2_3-I2C1_SDA → 5 SDAT-nCS X- 16 LCD_X-
R28 → 3 A0-DO Y+ 15 LCD_Y+
R28 → 7 DI Y- 1 LCD_Y-
R29 → 9 MODE IN2 11
  IN3 12
GND-PAD NC

C76 0u1   C72 0u1   VDD_3V3

LPC182x IC1F

Pin	Signal	
D8	P2_3/U3_TXD/CTIN_1/GPIO5[3]/T3_MAT0/USB0_PWR_EN/I2C1_SDA	P2_3-I2C1_SDA
D9	P2_4/U3_RXD/CTIN_0/GPIO5[4]/T3_MAT1/USB0_PWR_FAULT/I2C1_SCL	P2_4-I2C1_SCL

VDDIO_3V3
R24 5k1   R27 5k1

I2C1 pins also used in
Power Supply and
System Sheets

LCD_LEDA LCD_LEDA
LCD_DATA LCD_DATA
LCD_X+ LCD_X+
LCD_X- LCD_X-
LCD_Y+ LCD_Y+
LCD_Y- LCD_Y-

Notes:
- Target 315MHz RF Band (Short Data Packets, No Streaming, Limited Power) for Sensor Nodes
- Use to transfer Identification and Control signals between nodes
- Refer to Linx Application Note AN-00125 for FCC15.231 A-D Overview
- CC1125 DS 1.12: 315/40=7.9, 40*8=320, (320-315)=5>1MHz TX, similar for XOSC/2 for RX
- Use always-on VDD for power to enable Wake-On-Radio function
- MISO and MOSI are used in System sheet to define boot order
- MISO (P1_1) has a 50k pull-up
- MOSI (P1_2) has a 10k pull-down
- All capacitors should be X7R or C0G/NPO
- For CC1120, use a 32MHz X3
- E48 EEPROM in System sheet is used to give
  every node its own unique EUI-64 address

WARNING: Current RF filter inductor
and capacitor values are for 420MHz

CC112X

IC9

No OSC, using Crystal X3

From EMI Sheet   P2_13-GPIO1_13

From EMI Sheet   P1_0-SSP0_SSEL   11   nCS
From EMI Sheet   P3_0-SSP0_SCK   8   SCLK
From EMI Sheet, also used in System Sheet   P1_2-SSP0_MOSI   7   SI
From EMI Sheet, also used in System Sheet   P1_1-SSP0_MISO   9   SO-GPIO1

To System Sheet   WAKEUP_RF   10   GPIO0
From EMI Sheet (U2_UCLK)   P2_12-GPIO1_12   4   GPIO2
From EMI Sheet (U2_TXD)   P2_10-GPIO0_14   3   GPIO3

315MHz
A1
ANTenna

Opendous Inc.

File: MicropendousX-LPC182x-GPS-RF.sch
Sheet: /RF/
Title: MicropendousX-LPC182x-GPS
Size: A4   Date: 27 jun 2012   Rev: 1.0
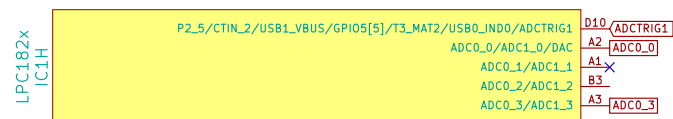KiCad E.D.A.   Id: 5/10

Notes:
- separate the LSM303 from all other electronics
- do not place a GND plane underneath the LSM303
- keep inductors and ferrites very far from the LSM303
- avoid ferrous materials like nickel near the LSM303
- X?R ceramic capacitor materials are ferrous, use C0G/NP0 or tantalum
- set LSM303 INT1 interrupt to Active-Low wakeup the LPC182x
- LSM303 is powered by always-on VDD_3V3 to
  enable the LSM303 to wake up the LPC182x when in motion
- PA6C is powered by VDDIO_3V3 so that it can be turned
  off when the device is not in motion
- PA6C VBACKUP is 2V to 4.3V so direct Li-Ion power is OK
- The 1PPS signal is connected to an interruptable GPIO
  pin so that it can be used as a global timebase for RF

Motion and Orientation Sensor

GPS

Opendous Inc.

File: MicropendousX-LPC182x-GPS-Position_Sensors.sch

Sheet: /Position_Sensors/

Title: MicropendousX-LPC182x-GPS

Size: A4 | Date: 27 jun 2012 | Rev: 1.0

KiCad E.D.A. | | Id: 3/10

Notes:
- there isn't enough room on the PCB for a full expansion header
- these 3 analog pins and some GPIO are exposed as unmasked vias

LPC182x
IC1H

P2_5/CTIN_2/USB1_VBUS/GPIO5[5]/T3_MAT2/USB0_IND0/ADCTRIG1   D10   ADCTRIG1
ADC0_0/ADC1_0/DAC   A2   ADC0_0
ADC0_1/ADC1_1   A1
ADC0_2/ADC1_2   B3
ADC0_3/ADC1_3   A3   ADC0_3

Title: MicropendousX-LPC182x-GPS

Size: A4	Date: 27 jun 2012	Rev: 1.0
KiCad E.D.A.		Id: 10/10