Altera FPGA 全速漂移 开发指南

开发板硬件系统设计概述

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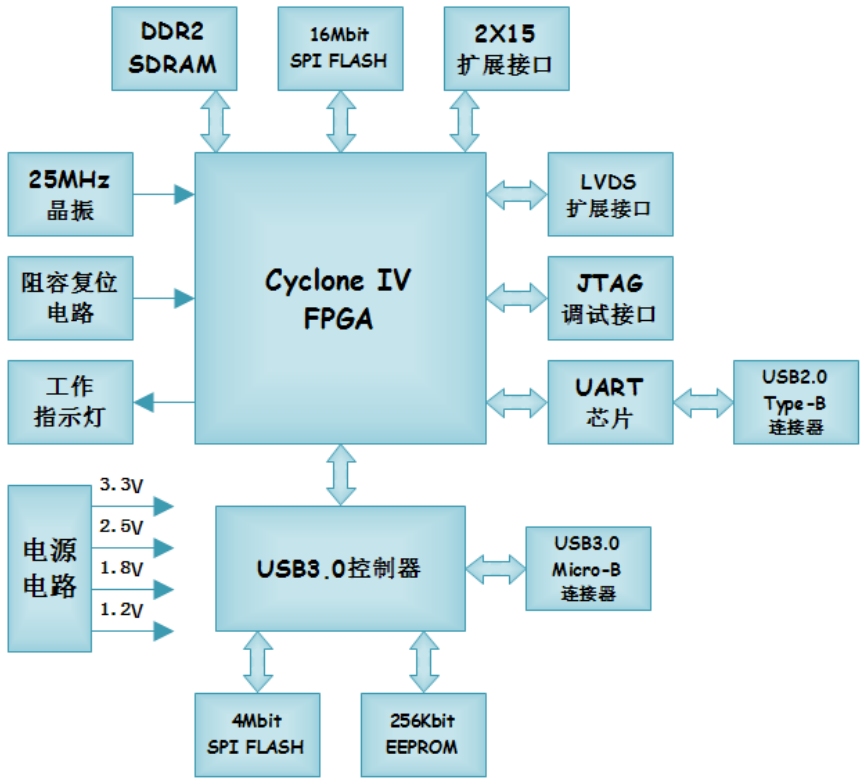
1 硬件电路概述

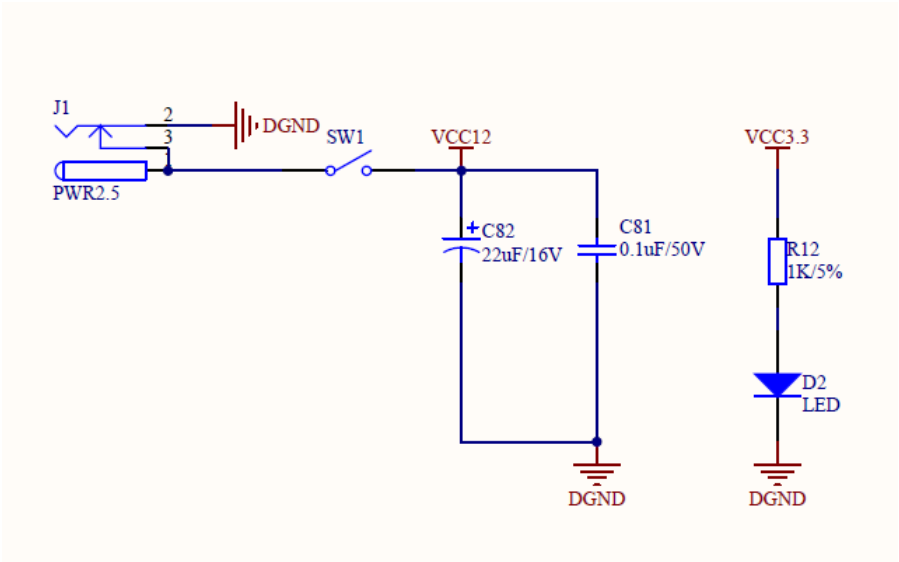
如图所示，我们的 HSC 开发板围绕 FPGA 和 USB3.0 控制器 FX3 有丰富的外设接口。包括 1 颗 DDR2 SDRAM、1 颗用于 FPGA 配置的 SPI FLASH、1 颗用于 FX3 配置的 SPI FLASH 和 1 颗 EEPROM、1 颗 UART 芯片，25MHz 有源晶振、阻容复位电路、1 个工作指示灯，FPGA 调试用的 JTAG 接口、LVDS 扩展接口、用于 UART 收发传输的 USB2.0 Type-B 插座、用于 USB3.0 传输的 Micro-B 插座。



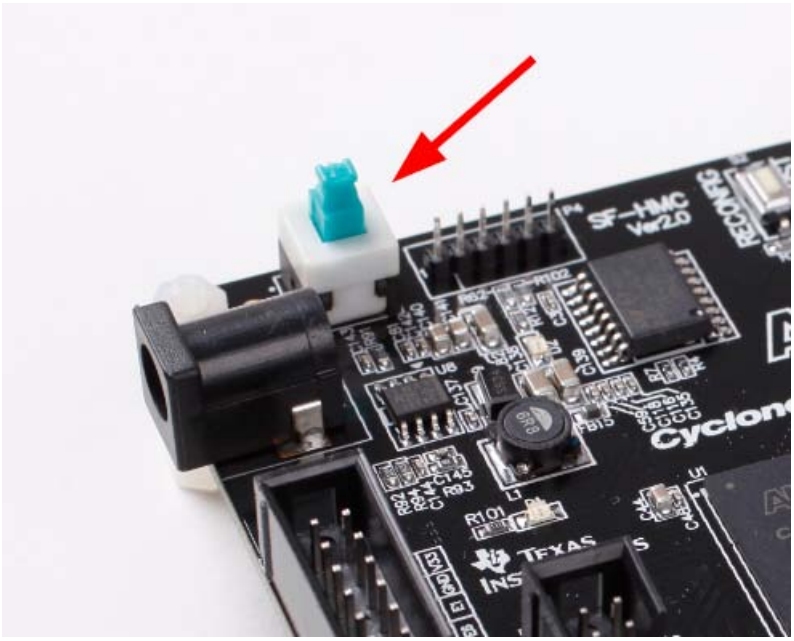
2 芯片电路详解

2.1 电源电路

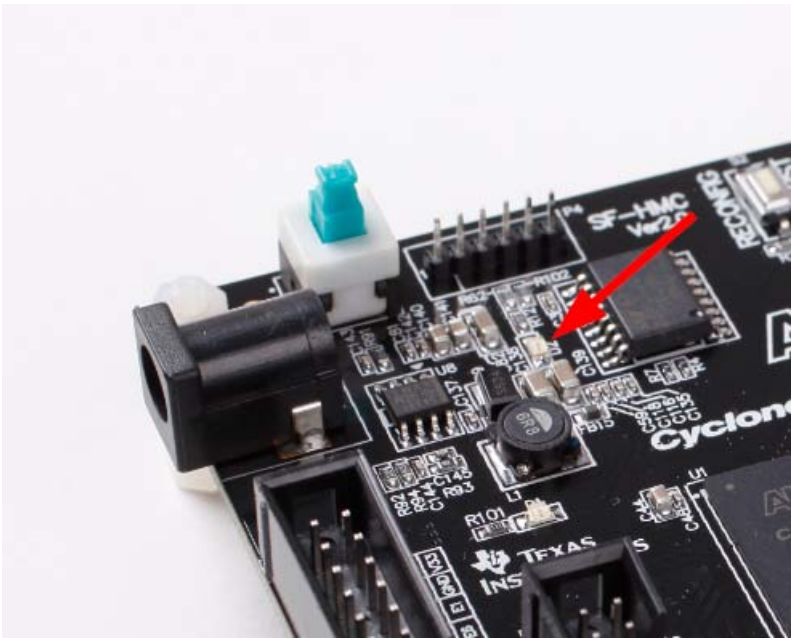
HSC 开发板使用 12V 直流电源供电，连接到 J1 插座，按下 SW1 开关后电源导通，同时电源指示灯 D2 将被点亮。



SW1 开关如图箭头所指。

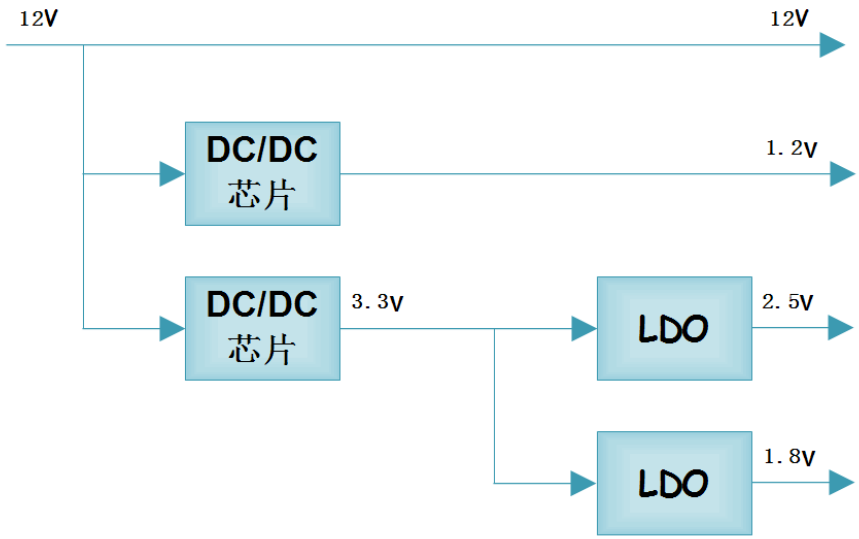


电源指示灯 D2 如图箭头所指。

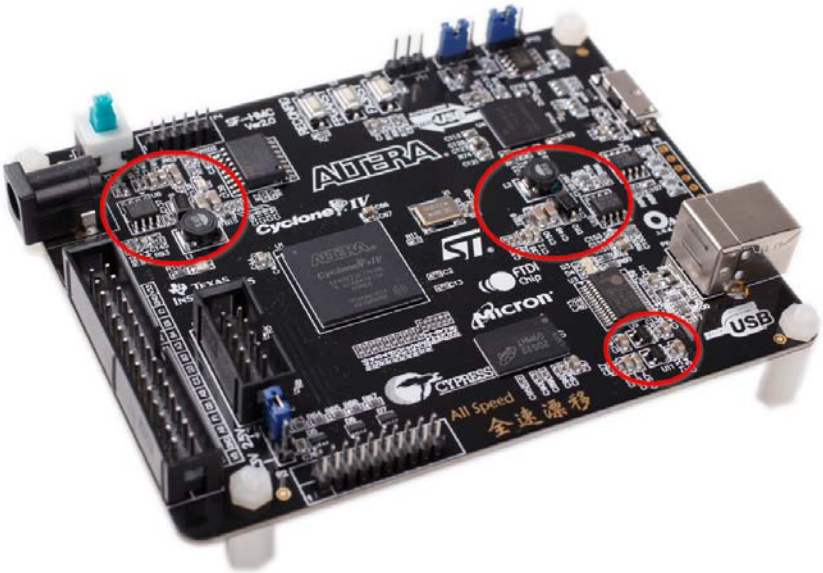


电源电路的供电拓扑如图所示。12V 电源输入后，直接可作为液晶屏的背光电压（引导背光连接插座上）；12V 通过两路 DC/DC 芯片，分别产生

3.3V 和 1.2V；3.3V 电压同时作为两路 LDO 的输入，分别产生 2.5V 和 1.8V 的电压。此外，UART/USB 转换芯片 PL2303 所需要的 5V 电压，直接通过 USB 接口获得；USB3.0 控制器芯片 FX3 所需要的 5V 电压，也是直接通过 USB 接口获得。

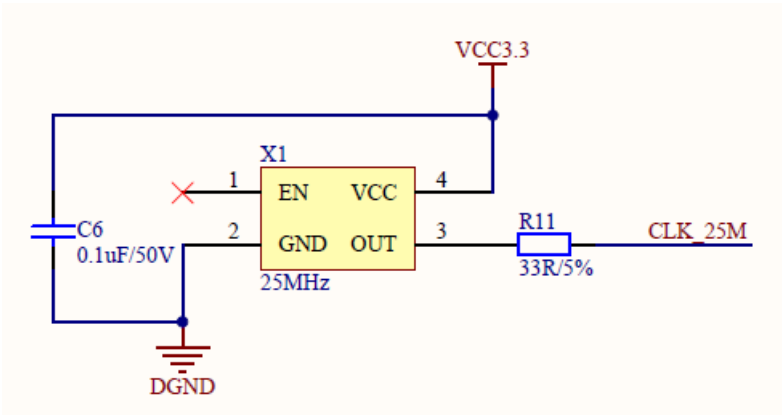


电源电路即如图所示圈出来的部分。



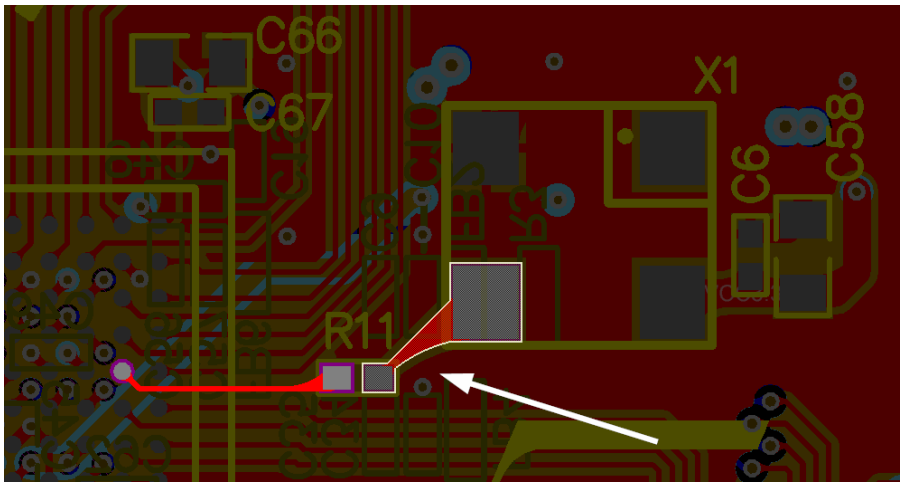
2.2 FPGA 时钟与复位电路

如图所示，25MHz 的有源晶振连接到 FPGA 的时钟专用引脚上。



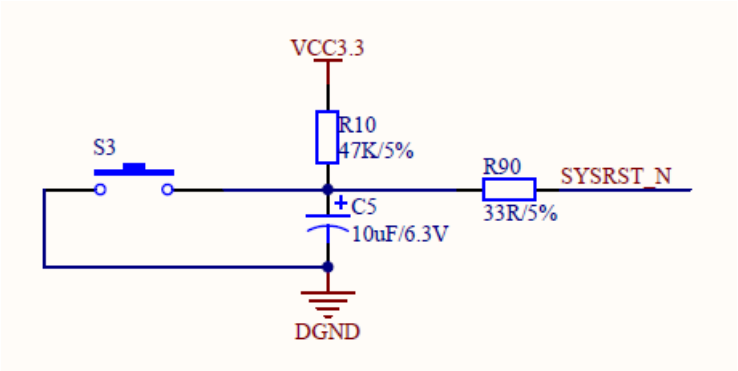
如图所示，晶振紧挨着 FPGA 放置。

如图所示，时钟走线也是尽可能的短。

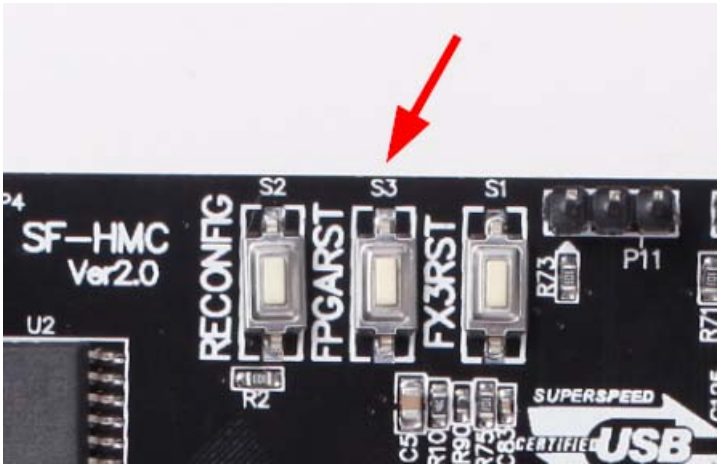


外部输入的时钟虽然只有 25MHz，但在 FPGA 内部，可以通过 PLL 产生更高倍频或更低分频的时钟频率。

FPGA 的复位电路如图所示，上拉 47K 电阻，按键 S3 可以实现手动复位。

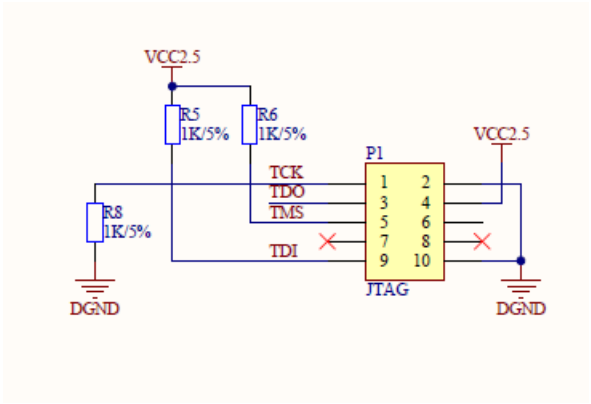


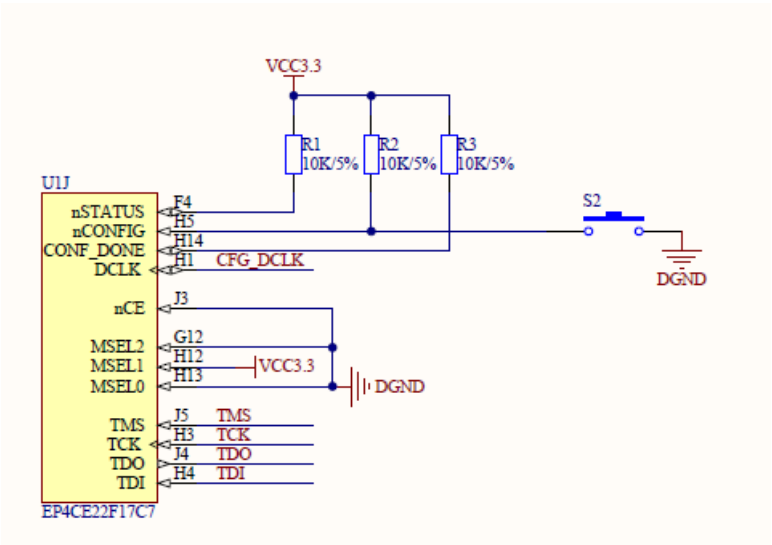
FPGA 复位按键 S3，如图所示。



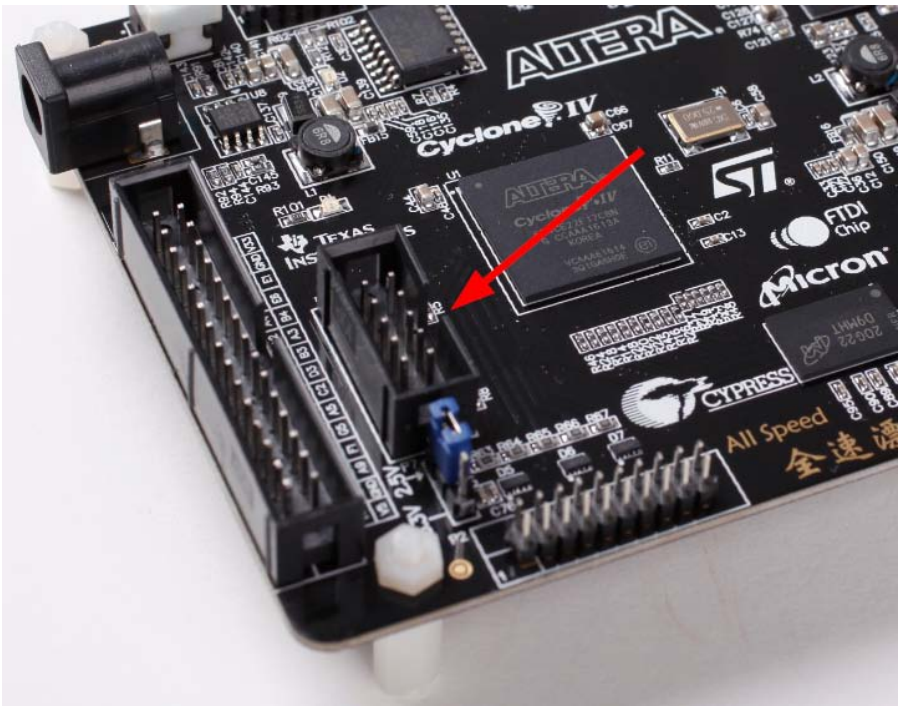
2.3 FPGA 配置电路

FPGA 配置烧录的 JTAG 接口电路如图所示。按键 S2 可实现可重配置功能。

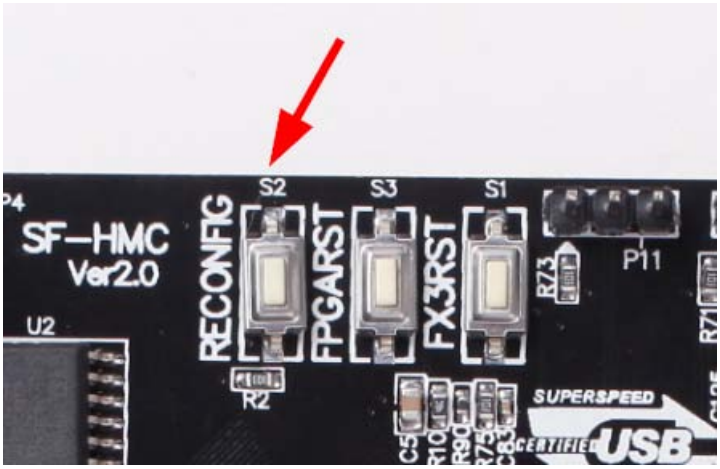




FPGA 配置烧录的 JTAG 接口如图箭头所指。



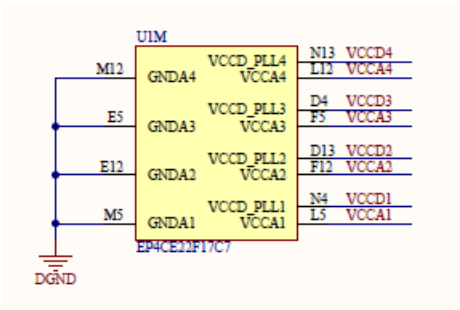
如图所示，按键 S2 可实现 FPGA 的重配置功能。

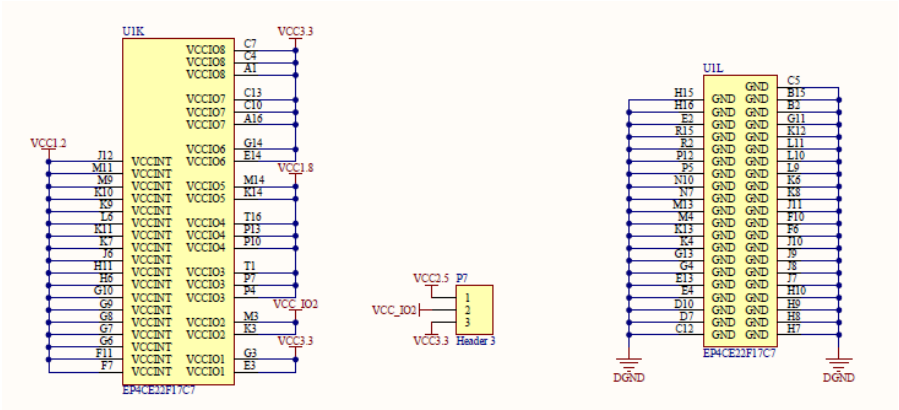


2.4 FPGA 供电电路

FPGA 的供电电路如图所示。VCCIO 为 FPGA 的 IO 接口电压，VCCINT 为

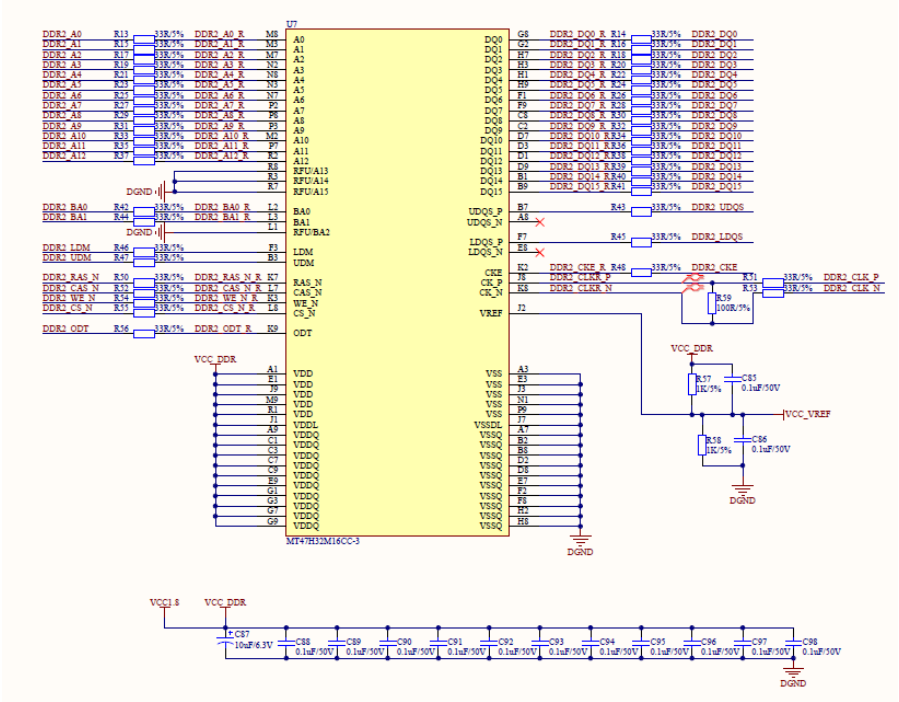
FPGA 的核心电压，VCCD_PLL 和 VCCA 为 FPGA 内部 PLL 的数字电压和模拟电压。注意这里的 P7 是跳线插座，若连接 2.5V，这 LVDS 插座的 IO 接口电平可实现正常的 LVDS 功能，若连接 3.3V，则 LVDS 插座的 IO 接口电平为 3.3V。





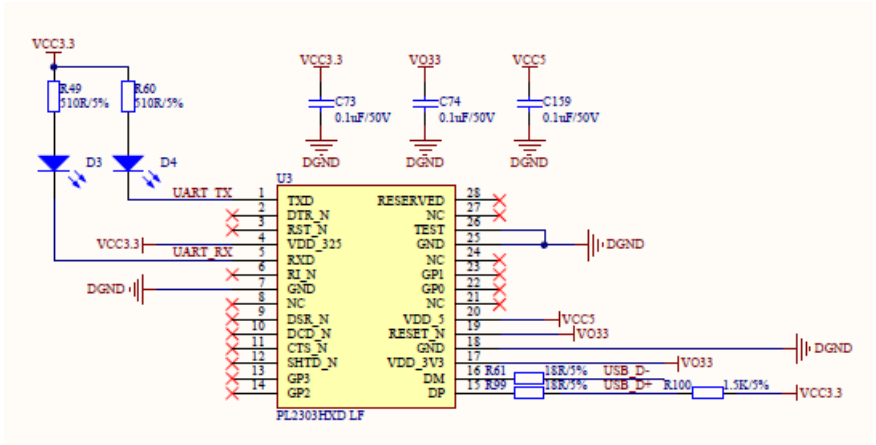
2.5 DDR2 芯片电路

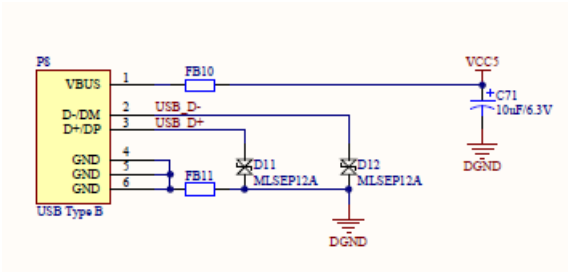
如图所示，这是 DDR2 芯片的原理图。



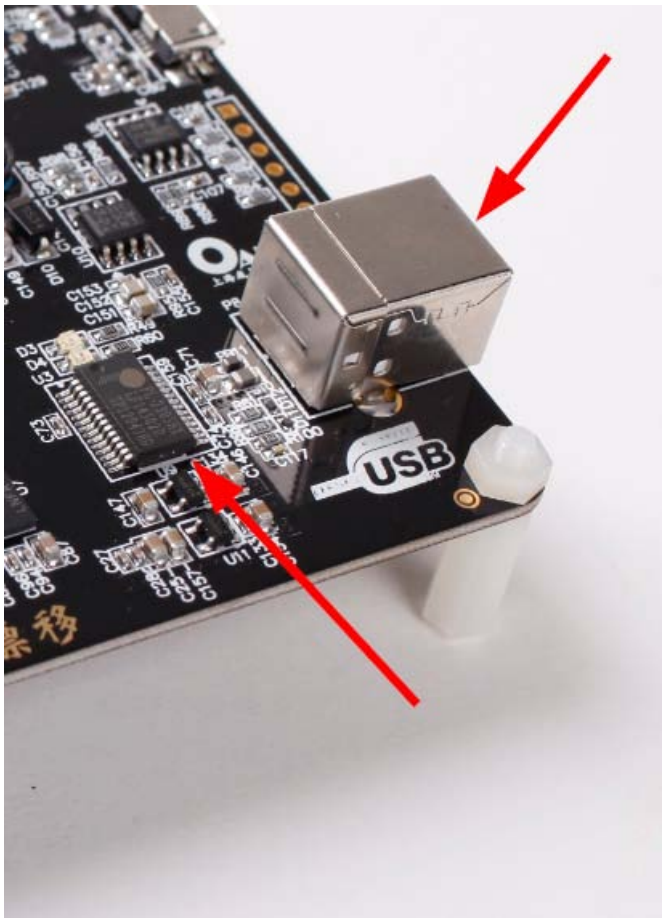
2.6 UART 芯片电路

如图所示，UART 转 USB 桥接芯片 PL2303 实现 PC 端虚拟 COM 口与 FPGA 通信。UART 接口的收发信号有数据变化时，LED 指示灯 D3 和 D4 也会相应进行闪烁。



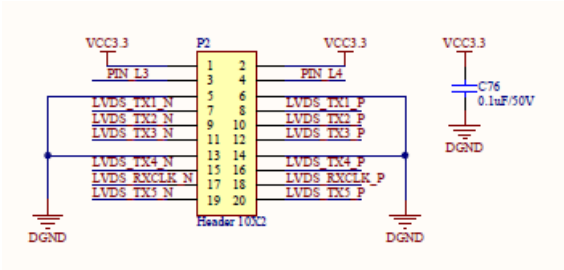


PL2303 芯片与 USB Type-B 接口如图所示。

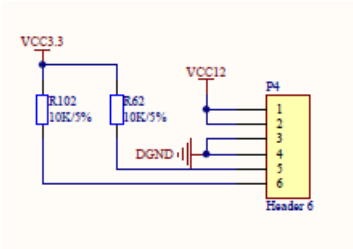


2.7 LVDS 接口与液晶屏背光接口电路

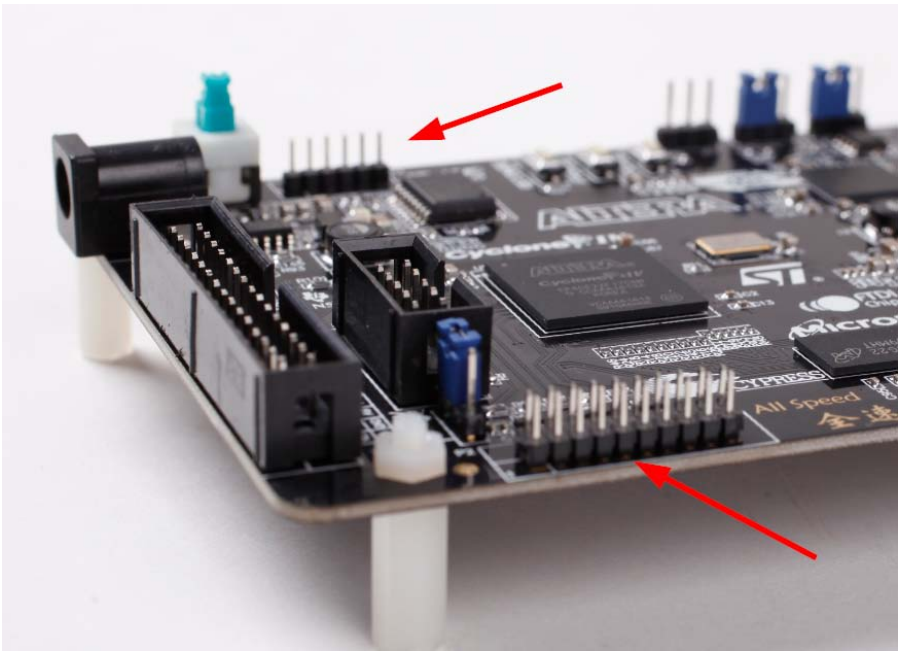
如图所示，FPGA 引出的 LVDS 接口连接到 P2 插座，其定义如图所示。这个插座可以使用我们的 LVDS 专用线缆（需要购买 G065VN01 液晶屏）直接连接到 G065VN01 液晶屏。



如图所示，引出 12V 电源到插座 P4，使用我们提供的背光线缆（需要购买 G065VN01 液晶屏）直接连接到 G065VN01 液晶屏。

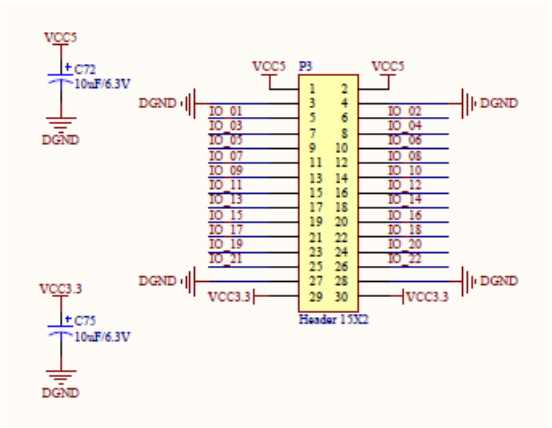


P2（图下侧箭头所指）和 P4（图上侧箭头所指）插座的位置分布如图所示。

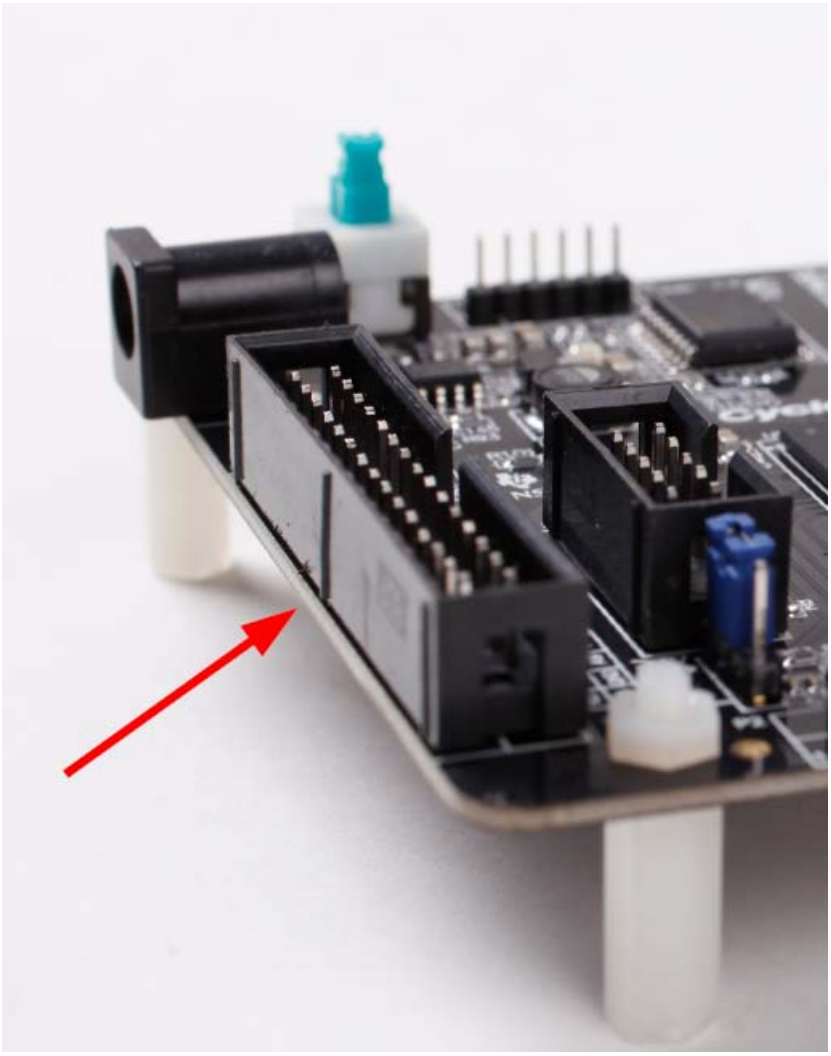


2.8 IO 扩展电路

P3 插座引出 3.3V 电平标准的 IO，其定义如图所示。

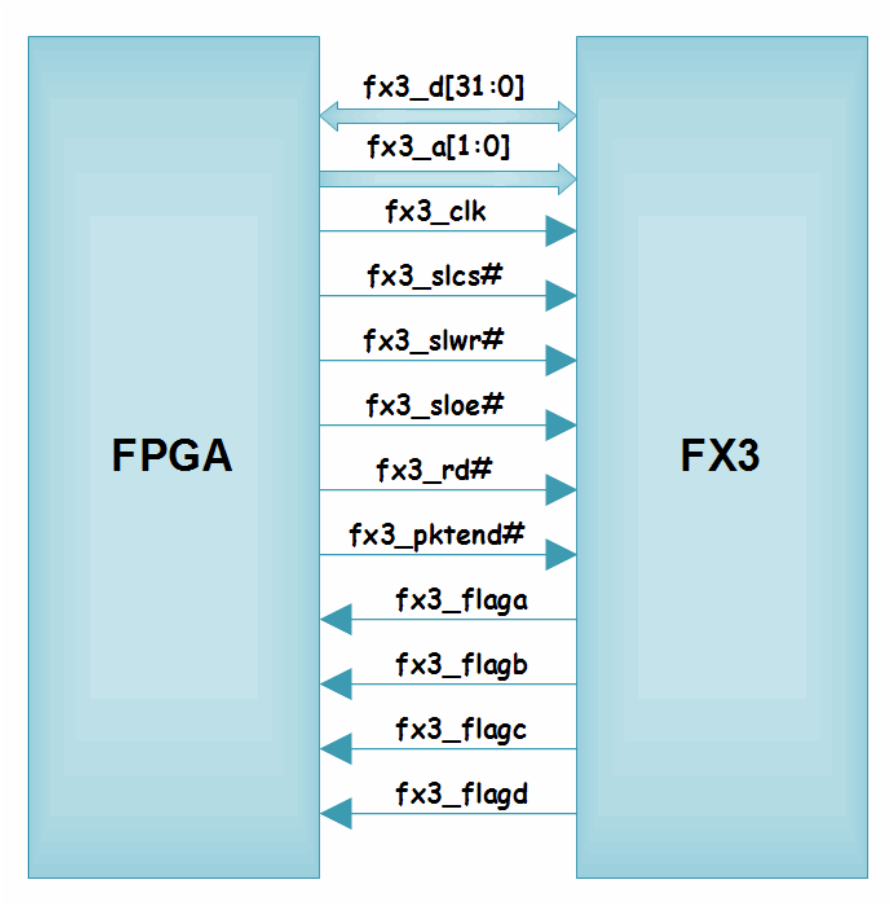


P3 插座的实物如图箭头所示。

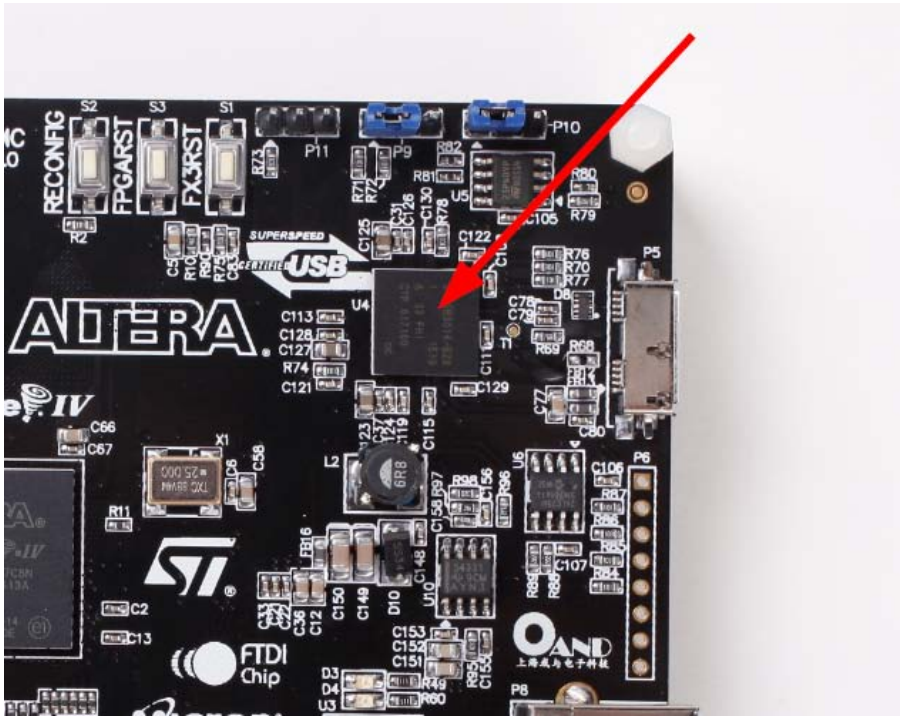


2.9 USB3.0 控制器 FX3 电路

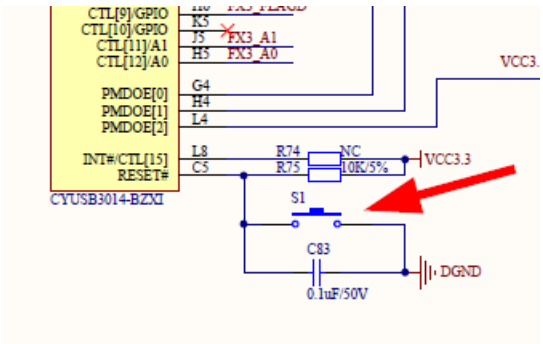
如图所示，USB3.0 控制器 FX3 与 FPGA 之间通过 SlaveFIFO 接口互联，实现大吞吐量数据传输。

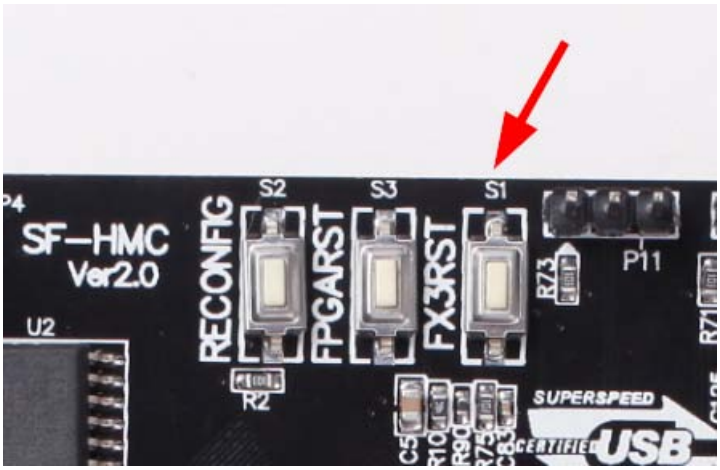


FX3 芯片如图箭头所指。

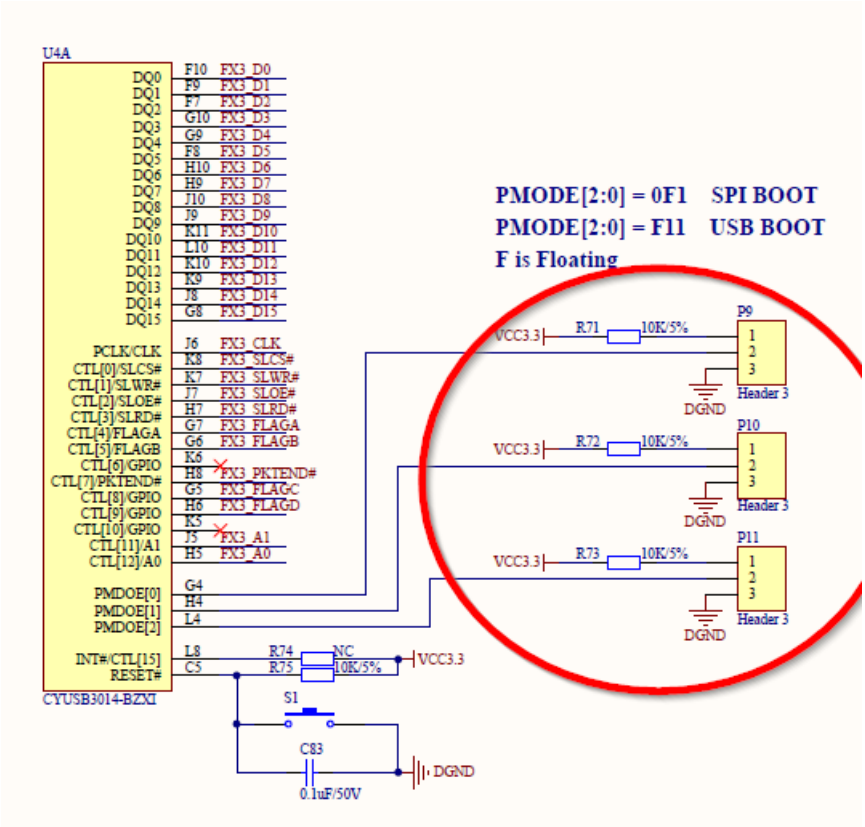


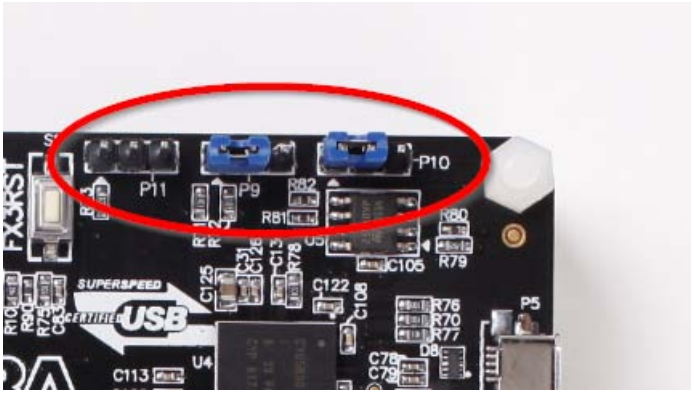
如图所示，FX3 的复位引脚连接到按键 S1，该按键可用于 FX3 的硬件复位。



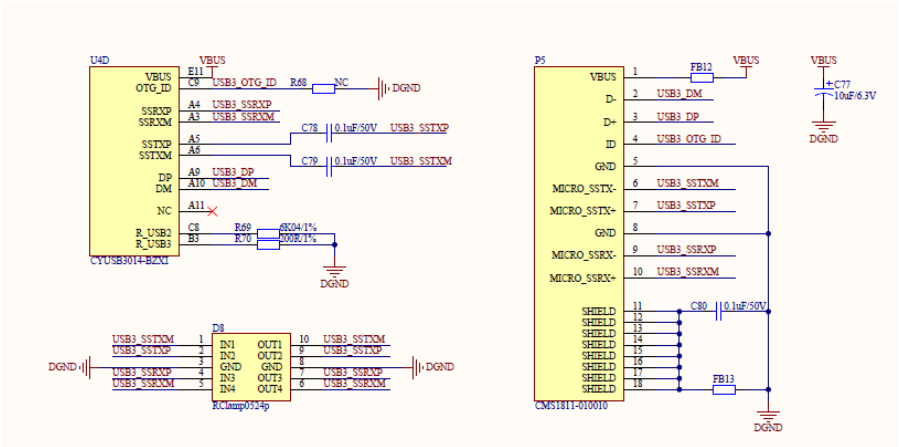


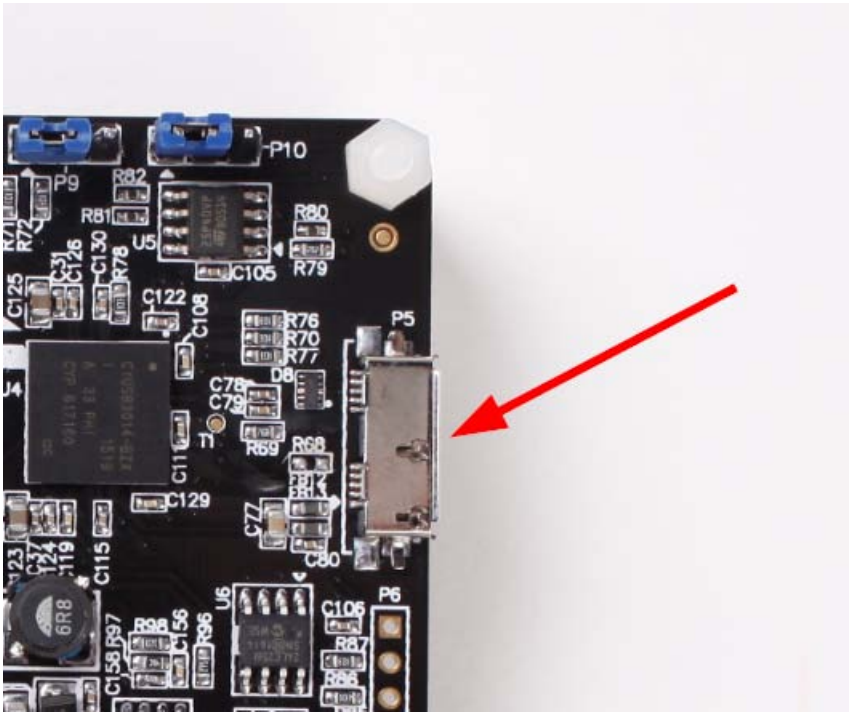
如图所示，跳线槽 P9、P10 和 P11 可用于设定 FX3 的启动模式。





FX3 通过 USB3.0 Micro-B 插座连出，原理图以及实物示意如图所示。





3 FPGA 引脚定义

```
#============================================================
#时钟和复位接口
set_location_assignment PIN_E15 -to ext_clk
set_location_assignment PIN_E16 -to ext_rst_n

#============================================================
#LED 指示灯接口
set_location_assignment PIN_A5 -to led

#============================================================
#DDR2 接口
```

```
set_location_assignment PIN_T15 -to mem_clk_n[0]
set_location_assignment PIN_N16 -to mem_dq[15]
set_location_assignment PIN_J14 -to mem_dq[14]
set_location_assignment PIN_P15 -to mem_dq[13]
set_location_assignment PIN_L13 -to mem_dq[12]
set_location_assignment PIN_L16 -to mem_dq[11]
set_location_assignment PIN_R16 -to mem_dq[10]
set_location_assignment PIN_K16 -to mem_dq[9]
set_location_assignment PIN_N15 -to mem_dq[8]
set_location_assignment PIN_N6 -to mem_dq[7]
set_location_assignment PIN_L8 -to mem_dq[6]
set_location_assignment PIN_R5 -to mem_dq[5]
set_location_assignment PIN_R7 -to mem_dq[4]
set_location_assignment PIN_M6 -to mem_dq[3]
set_location_assignment PIN_N5 -to mem_dq[2]
set_location_assignment PIN_L7 -to mem_dq[1]
set_location_assignment PIN_R6 -to mem_dq[0]
set_location_assignment PIN_K15 -to mem_dqs[1]
set_location_assignment PIN_M7 -to mem_dqs[0]
set_location_assignment PIN_N14 -to mem_dm[1]
set_location_assignment PIN_P3 -to mem_dm[0]
set_location_assignment PIN_T4 -to mem_addr[12]
set_location_assignment PIN_R4 -to mem_addr[11]
set_location_assignment PIN_T7 -to mem_addr[10]
set_location_assignment PIN_J16 -to mem_addr[9]
set_location_assignment PIN_R12 -to mem_addr[8]
set_location_assignment PIN_T5 -to mem_addr[7]
set_location_assignment PIN_P8 -to mem_addr[6]
set_location_assignment PIN_P16 -to mem_addr[5]
set_location_assignment PIN_T12 -to mem_addr[4]
set_location_assignment PIN_T6 -to mem_addr[3]
set_location_assignment PIN_N11 -to mem_addr[2]
```

```
set_location_assignment PIN_R14 -to mem_addr[1]
set_location_assignment PIN_R11 -to mem_addr[0]
set_location_assignment PIN_R13 -to mem_ba[1]
set_location_assignment PIN_P9 -to mem_ba[0]
set_location_assignment PIN_N12 -to mem_cas_n
set_location_assignment PIN_T10 -to mem_cke[0]
set_location_assignment PIN_T14 -to mem_clk[0]
set_location_assignment PIN_R10 -to mem_cs_n[0]
set_location_assignment PIN_T11 -to mem_odt[0]
set_location_assignment PIN_P14 -to mem_ras_n
set_location_assignment PIN_T13 -to mem_we_n

set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_addr
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_ba
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_cke
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_clk
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_clk_n
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_cs_n
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_dm
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_dq
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_dqs
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_odt
```

```
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_ras_n
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_cas_n
set_instance_assignment -name IO_STANDARD "SSTL-18 CLASS I" -to
mem_we_n

#############################################################
#UART 接口
set_location_assignment PIN_G2 -to uart_rx
set_location_assignment PIN_G1 -to uart_tx

#############################################################
#FX3 接口
set_location_assignment PIN_A14 -to fx3_db[31]
set_location_assignment PIN_A7 -to fx3_db[30]
set_location_assignment PIN_A15 -to fx3_db[29]
set_location_assignment PIN_B12 -to fx3_db[28]
set_location_assignment PIN_B13 -to fx3_db[27]
set_location_assignment PIN_A11 -to fx3_db[26]
set_location_assignment PIN_B11 -to fx3_db[25]
set_location_assignment PIN_A13 -to fx3_db[24]
set_location_assignment PIN_A6 -to fx3_db[23]
set_location_assignment PIN_B10 -to fx3_db[22]
set_location_assignment PIN_D6 -to fx3_db[21]
set_location_assignment PIN_B6 -to fx3_db[20]
set_location_assignment PIN_A10 -to fx3_db[19]
set_location_assignment PIN_E7 -to fx3_db[18]
set_location_assignment PIN_C6 -to fx3_db[17]
set_location_assignment PIN_B7 -to fx3_db[16]
set_location_assignment PIN_F13 -to fx3_db[15]
set_location_assignment PIN_D9 -to fx3_db[14]
```

```
set_location_assignment PIN_C9 -to fx3_db[13]
set_location_assignment PIN_C11 -to fx3_db[12]
set_location_assignment PIN_F9 -to fx3_db[11]
set_location_assignment PIN_D11 -to fx3_db[10]
set_location_assignment PIN_D12 -to fx3_db[9]
set_location_assignment PIN_C14 -to fx3_db[8]
set_location_assignment PIN_E11 -to fx3_db[7]
set_location_assignment PIN_D14 -to fx3_db[6]
set_location_assignment PIN_F15 -to fx3_db[5]
set_location_assignment PIN_E10 -to fx3_db[4]
set_location_assignment PIN_F14 -to fx3_db[3]
set_location_assignment PIN_F16 -to fx3_db[2]
set_location_assignment PIN_G15 -to fx3_db[1]
set_location_assignment PIN_G16 -to fx3_db[0]
set_location_assignment PIN_B14 -to fx3_pclk
set_location_assignment PIN_F8 -to fx3_slcs_n
set_location_assignment PIN_D8 -to fx3_slwr_n
set_location_assignment PIN_E8 -to fx3_sloe_n
set_location_assignment PIN_C8 -to fx3_slrd_n
set_location_assignment PIN_D15 -to fx3_flaga
set_location_assignment PIN_C15 -to fx3_flagb
set_location_assignment PIN_A12 -to fx3_flagc
set_location_assignment PIN_D16 -to fx3_flagd
set_location_assignment PIN_E9 -to fx3_pktend_n
set_location_assignment PIN_B16 -to fx3_a[1]
set_location_assignment PIN_C16 -to fx3_a[0]

#############################################################
#200 万像素摄像头接口
set_location_assignment PIN_B3 -to vdb[7]
set_location_assignment PIN_D5 -to vdb[6]
set_location_assignment PIN_A3 -to vdb[5]
```

```
set_location_assignment PIN_A2 -to vdb[4]
set_location_assignment PIN_B4 -to vdb[3]
set_location_assignment PIN_A4 -to vdb[2]
set_location_assignment PIN_E6 -to vdb[1]
set_location_assignment PIN_B5 -to vdb[0]
set_location_assignment PIN_B1 -to vhref
set_location_assignment PIN_E1 -to vpclk
set_location_assignment PIN_F1 -to vscl
set_location_assignment PIN_F2 -to vsda
set_location_assignment PIN_C2 -to vvsync
set_location_assignment PIN_C3 -to vxclk

#============================================================
#LCD 的 LVDS 接口
set_instance_assignment -name IO_STANDARD LVDS -to lvdsclk
set_instance_assignment -name IO_STANDARD LVDS -to lvdsdb[2]
set_instance_assignment -name IO_STANDARD LVDS -to lvdsdb[1]
set_instance_assignment -name IO_STANDARD LVDS -to lvdsdb[0]
set_location_assignment PIN_N2 -to lvdsclk
set_location_assignment PIN_N1 -to "lvdsclk(n)"
set_location_assignment PIN_L2 -to lvdsdb[2]
set_location_assignment PIN_L1 -to "lvdsdb[2](n)"
set_location_assignment PIN_K2 -to lvdsdb[1]
set_location_assignment PIN_K1 -to "lvdsdb[1](n)"
set_location_assignment PIN_J2 -to lvdsdb[0]
set_location_assignment PIN_J1 -to "lvdsdb[0](n)"

set_instance_assignment -name IO_STANDARD LVDS -to lvds_txclk
set_instance_assignment -name IO_STANDARD LVDS -to lvds_rxclk
set_instance_assignment -name IO_STANDARD LVDS -to lvds_rxdb
set_instance_assignment -name IO_STANDARD LVDS -to lvds_txdb
set_location_assignment PIN_N2 -to lvds_txclk
```

```
set_location_assignment PIN_N1 -to "lvds_txclk(n)"
set_location_assignment PIN_M2 -to lvds_rxclk
set_location_assignment PIN_M1 -to "lvds_rxclk(n)"
set_location_assignment PIN_K2 -to lvds_rxdb
set_location_assignment PIN_K1 -to "lvds_rxdb(n)"
set_location_assignment PIN_J2 -to lvds_txdb
set_location_assignment PIN_J1 -to "lvds_txdb(n)"
```