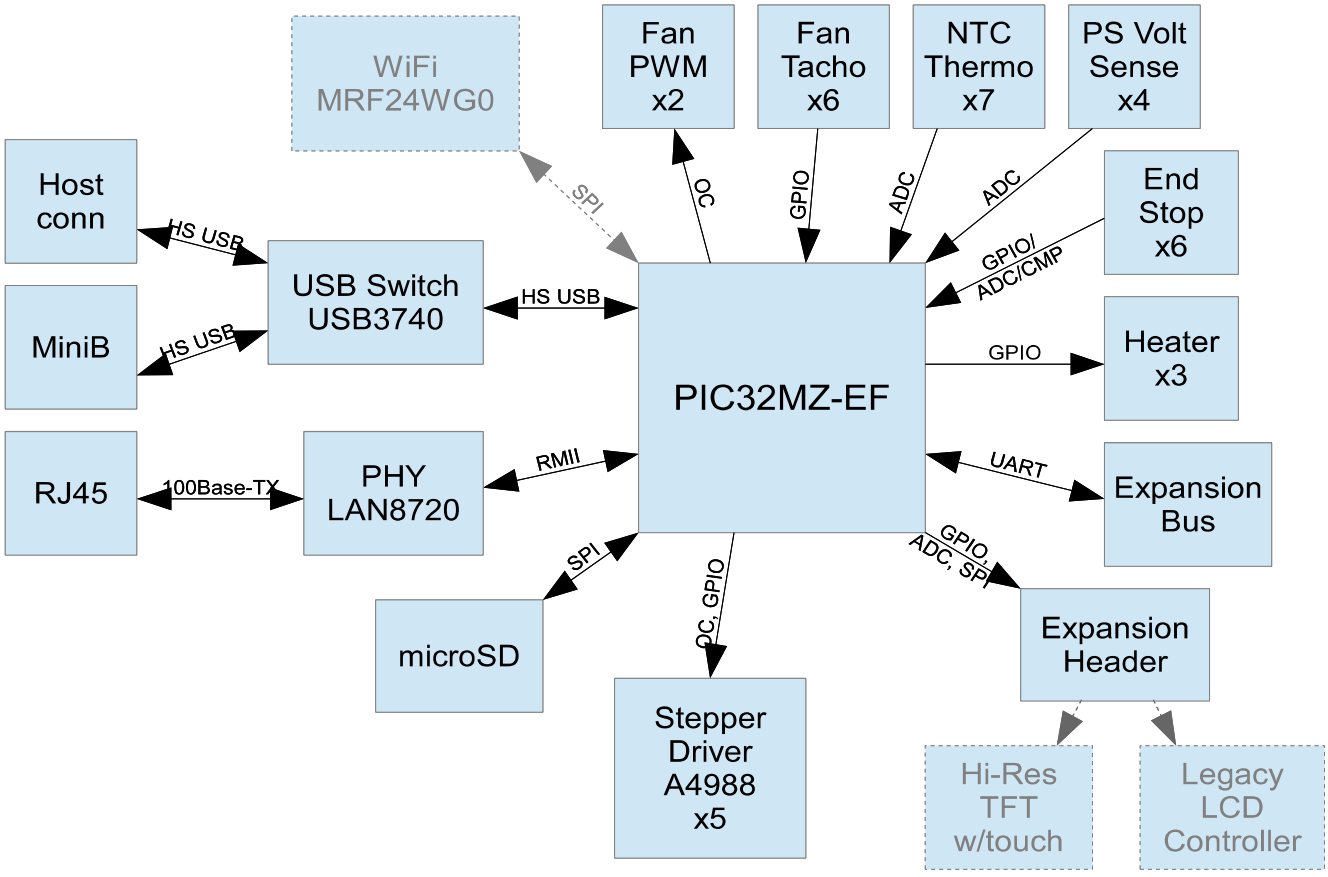
Chipkit 3DP

Overview

The purpose of the Chipkit 3DP is to provide a high performance motion control system based on Microchip components, and targeting low- to medium-power CNC applications such as 3D Printers, Pick & Place, Pen Plotters, Laser Cutters, hobby-grade Milling Machines and Foam Cutters.
Key features include:

- Precise real time motion planning and stepper control using true floating point math;
- High performance MCU with hardware FPU (PIC32MZ2048EF);
- Low cost (<$99);
- Onboard support for standard 3D Printer configuration (5 steppers + 2 hot ends + heated bed + PWM-controlled fans);
- Connectivity including USB Device (PC), Ethernet, USB Host (MSD support), onboard microSD card, optional WiFi;
- Expansion bus for added functionality and distributed peripherals;
- Support for legacy RepRap LCD interface and hi-res TFT w/touch screen.



Hardware details

Power

- 12 V nominal primary power rail, direct connection to stepper drivers, hot end switches and PWM switches;
- Dedicated heated bed power rail 12 V nominal / 24 V max;
- 5V 1A switching converter (MCP16321) for USB Host;
- 5V->3.3V 0.5A LDO;
- NTC fuses on both power inputs;
- Voltage monitoring.

Motor Drivers

- 5 x stepper drivers (A4988):
  - 3 x movement;
  - 2 x extruders;
  - Z-axis driver with dual output connector;
- 2 x PWM channels for onboard stepper driver current setting (movement and extruders separate);
- Fixed 16x microstep setting.

Power outputs

- 5 x PWM low side drives:
  - 1 x 12V (24V max) 30A for heated bed:
    - dedicated power rail;
    - LED indication;
    - inductive load protection;
    - low-frequency software drive;
  - 2 x 12V 30A for hot ends:
    - LED indication;
    - low-frequency software drive;
  - 2 x 12V 30A AUX outputs for printing fans, lighting, etc:
    - two parallel connectors each;
    - inductive load protection;
- 4 x fixed voltage outputs:
  - 5.0 V dual connector;
  - 12.0 V dual connector.

Thermal Management

- 7 x thermistor channels:
  - 2 x onboard temperature monitoring;
  - 5 x external;
  - integrated 12-bit ADC with switchable Vref (VDD / 0.25VDD).

Fan Control

- 6 x fan connectors with screw terminal / 3-pin PC connectors with tacho function:
  - 2 x PWM channels shared with AUX outputs, dual connectors each;
  - 2 x fixed 12 V fans.

Communications

- Dual role USB interface connected over USB switch:
  - USB device Mini-B for PC communication;
  - USB host motherboard-style header to panel-mounted Type A connector, for MSD / Android;
- Onboard MicroSD card for local file storage;
- 100MB Ethernet:
  - Web page control panel;
  - TCP Port 22 connection to the G-Code console;
- Expansion header:
  - SPI;
  - 4 x ADC/GPIO;
  - 11 x GPIO;
  - dedicated nRESET input;
  - 3.3 V and 5.0 V power;
- UART-based system expansion bus;
- Landing pattern for MRF24WG0Mx;

User Interface

- Control panel options:
  - QVGA TFT with touch screen and mechanical controls, connected over expansion header;
  - Legacy RepRap Display Controller support through adapter connected to expansion header;
  - Android smartphone/tablet through USB Host connector;
- HTTP/web interface over Ethernet / WiFi.

Misc.

- 6 x endstops with GPIO/ADC/comparator reading to support analog inputs (optical, force sensors);
- Possible expansion modules:
  - multizone heated bed;
  - chamber heater;
  - additional extruders;
  - lighting.

MCU Resources

Timers (9):

- 1 x internal timekeeping;
- 5 x stepper OC;
- 1 x hardware common PWM time base;
- 1 x software PWM;
- 1 x spare;

OC (9):

- 5 x steppers;
- 2 x stepper drivers current setting PWMs;
- 2 x printing fans / AUX.

Communication interfaces:

- Ethernet RMII to LAN8720a PHY;
- USB to Device / Host connectors through USB switch;
- UART1 to debug;
- UART2 to expansion bus;
- SPI1 to onboard microSD card;
- SPI2 to expansion header (TFT Display / SD Card on RepRap Controller);
- SPI3 to MRF24WG0Mx.

ADC (22):

- 7 x thermistors;
- 4 x power rails: heated bed 12..24 V, main 12 V, 5.0 V, 3.3 V;
- USB Host VBUS voltage;
- 6 x end stops / force sensors;
- 4 x to expansion header (touch screen inputs) shared with GPIO.

Comparator (6):

- 6 x end stops / force sensors.

GPIO Pins (40+):

- 13 x to stepper drivers:
  - 5 x DIR;
  - 1 x common EN;
  - 2 x microstep selection (shift register);
- 3 x heaters with software PWM drive;
- 6 x endstops;
- 6 x fan tacho inputs;
- 12 x to expansion header (4 x shared with ADC);
- additional peripheral GPIO.

Software details

Project schedule outline

Stage 1 – Definition / simulation;
Stage 2 – Hardware design and prototyping;
Stage 3 – porting RepRap / Marlin Arduino code;
Stage 4 – Hardware revision and prototyping;
Stage 5 – Redesigning software with GRBL planner and precise stepper drive;
Stage 6 – Adding primary features (USB Host, Ethernet, GUI, bus);
Stage 7 – Designing expansion module prototypes (autoleveling sensors, chamber heater);
Stage 8 – Adding secondary functionality (autoleveling, chamber heater, Android).