Milk-V Duo Product Brief

Revision 1.1

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Milk-V Technology

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1.1 Chapter 1. About MILKV-DUO

The MILKV-DUO board features a CV1800B microcontroller can run at 1.0 GHz. It also includes a co-processor RISCV C906 that operates at 700 MHz. The microcontroller comes equipped with a internal 64MB DDR2 ,32KB I-cache, a 64KB D-cache, as well as vector and floating-point units (FPU). The built-in CVITEK TPU (Tensor Processing Unit) makes the board suitable for AI and machine learning applications.

The MILKV-DUO board has a 40-pin 21x51 ‘DIP’ style PCB that is 1mm thick and has 0.1” through-hole pins with edge castellations. This design makes it easy to integrate the board into existing systems or use it as a standalone platform. The board exposes 26 multi-function 3.3V General Purpose I/O (GPIO) pins, of which 23 are digital-only and 2 are ADC capable. This enables users to easily connect external sensors and other peripherals to the board.

The MILKV-DUO board has a highly flexible power supply architecture that offers various options for powering the unit from USB-C or external supplies. It includes a USB-C port for power and data, which can also be used for reprogramming the TF CARD. In addition, it has a 5-pin Ethernet port without a transformer and a 16-pin FPC interface for a camera.

To support developers and makers, the MILKV-DUO board comes with a comprehensive SDK, software examples, and documentation. This makes it easy for users to get started with the board and develop their own applications. The board also supports a range of development tools and environments, making it easy to integrate into existing workflows.

Overall, the MILKV-DUO board offers an ideal solution for developers and makers who require a reliable and high-performance platform for their projects. With its impressive features and flexible design, it is an excellent choice for a wide range of applications, including robotics, industrial control, and embedded systems.

MILKV-DUO has been designed to be a low cost yet flexible development platform for CV1800B, with the following key features:

- CV1800B microcontroller with internal 64MB DDR2.
- USB C port for power and data (and for reprogramming the TF CARD)

- 40 pin 21×51 'DIP' style 1mm thick PCB with 0.1" through-hole pins also with edge castellations
- Exposes 25 multi-function 3.3V General Purpose I/O (GPIO)
- 23 GPIO are digital-only and 2 are ADC capable
- Can be surface mounted as a module
- 5-pin Ethernet port
- A 16-pin FPC interface for camera
- Simple yet highly flexible power supply architecture
- Various options for easily powering the unit from USB-C or external supplies
- High quality, low cost, high availability
- Comprehensive SDK, software examples and documentation

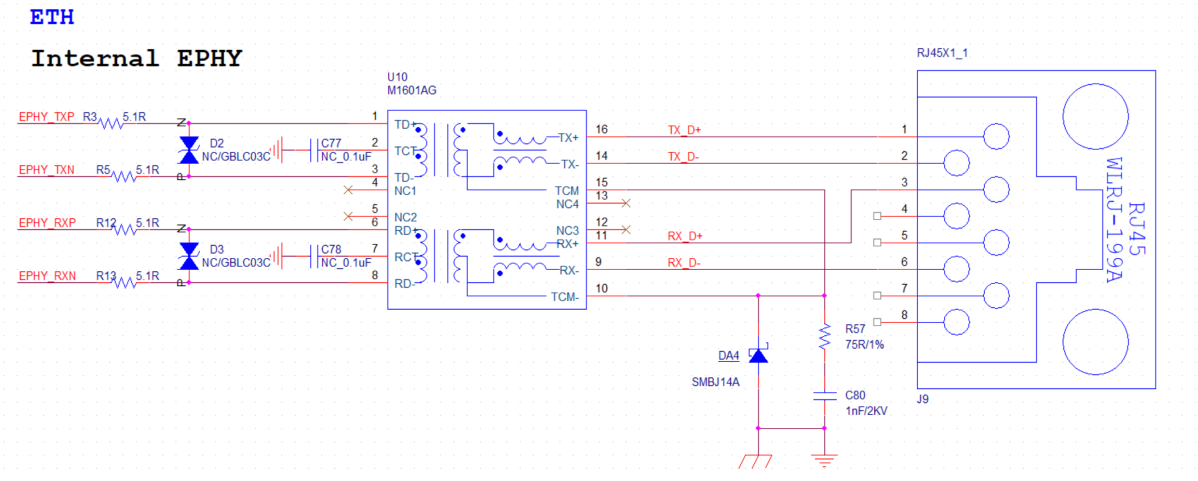
For full details of the CV1800B microcontroller please see the CV180XB Datasheet, however the headline features are:

- 1GHz RISC-V C906 main processor with integrated Vector and FPU units.
- 700MHz RISC-V C906 co-processor with integrated FPU unit.
- Built-in CVITEK TPU for intelligent reference solutions like human detection, area detection, and motion detection.
- Video encoding capabilities include H.264/H.265 for resolutions up to 2880x1620@20fps.
- Supports multiple bit rates and modes like CBR, VBR, and FIXQP, and ROI encoding.
- Supports various high-definition CMOS sensors like SONY, OnSemi, and OmniVision.
- Offers programmable frequency output for sensor reference clock.
- **ISP and image processing features include 90/180/270-degree rotation, mirror/flip functions, 2-layer OSD overlay, 3A algorithm, noise reduction,** bad pixel correction, lens shading and distortion correction, gamma correction, dynamic contrast enhancement, color management, fog removal, digital image stabilization, and PC-based ISP tuning tools.
- CV hardware acceleration engine supports partial OpenCV library in software-hardware hybrid mode.
- Audio codec supports 16-bit audio source/voice input and output, with built-in microphone input, mono output, and AEC, ANR, and AGC functions.
- Ethernet module with 1 Ethernet MAC for network data reception and transmission, with built-in PHY and switch for flexible network configurations.

1.2 Chapter 2. Interfaces

1.2.1 2.1. Ethernet

The CV1800B chip features a built-in 100Mbps PHY, which is connected to a 5-pin solder pad on the MilkV DUO board. To use the Ethernet port, an external transformer and RJ45 socket, or a network socket with a transformer, is required. The reference design for connecting an external transformer and RJ45 socket is shown below:



1.2.2 2.2. USB 2.0

The CV1800B chip supports USB Dual-Role Device (DRD) and can operate in both Host and Device modes.

1.2.3 2.2.1 USB Features

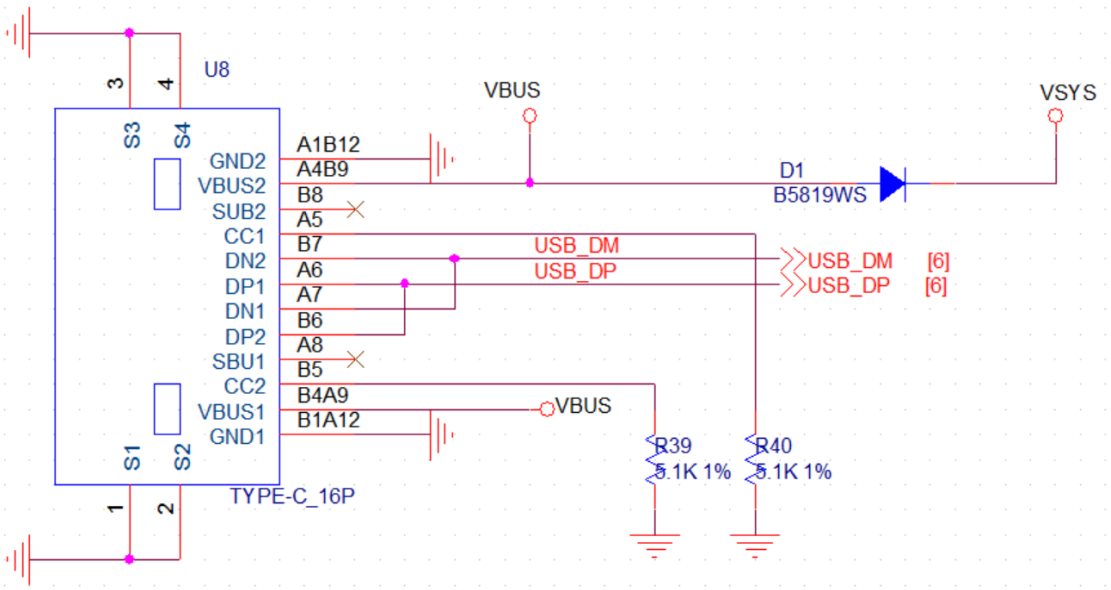
The following are the USB features of CV1800B:

- Compliant with USB 2.0 transmission protocol specifications
- Backward compatible with USB 1.1 transmission protocol specifications
- Supports HS/FS/LS three speed modes
- Supports Host or Device functionality
- Supports four types of USB transfer protocols: Control Transfer, Bulk Transfer, Isochronous Transfer, and Interrupt Transfer
- Can be connected to a USB Hub to expand a single interface to multiple USB interfaces
- Through USB Hub expansion, up to 127 Device devices can be connected
- Supports USB 2.0 sleep/resume power-saving mode
- Supports HID devices such as keyboards and mice
- Device mode is mainly used for downloading and updating internal software, and can also be used for other functions, such as data transfer
- The maximum transfer rate can reach above 40MB/s

1.2.4 2.2.2 USB Device Mode

In Device mode, the MILKV-DUO functions as a USB slave device and can be configured through software. Its storage media, such as an SD card, can be accessed from a computer when connected via USB Type-C. The specific design is shown in the following figure:

The MILKV-DUO chip provides the capability to operate in USB Host mode through software or hardware configuration. Two USB pads on the back of the PCB are reserved for this purpose, and they can be used to connect the MILKV-DUO to a USB Type-A port on a baseboard or a USB hub. To do this, users can design USB pads on the baseboard and connect them with Surface Mount Technology (SMT) or use 2-pin, 2.54mm spaced pogo pins to connect the USB signals to the baseboard

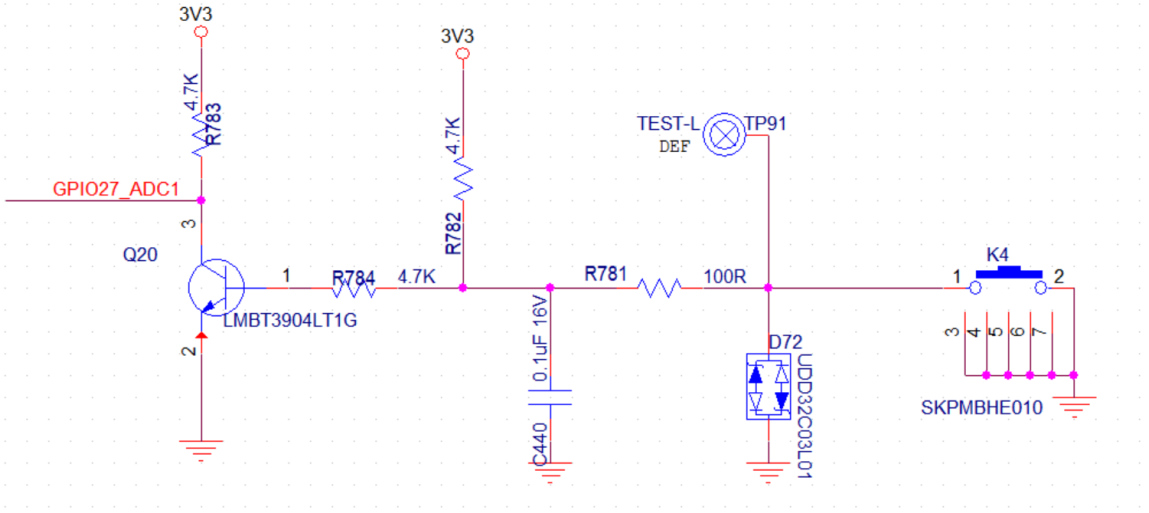


The MILKV-DUO can operate in USB Device mode for firmware burning and downloading when USB_VBUS_DET (PIN45/ADC2) is detected through a resistor-divided 5V_USB_IN and powered high. However, if the USB port is not being used for burning, USB_VBUS_DET (PIN45/ADC2) can be directly connected to ground, and the MILKV-DUO will operate in Host mode, enabling it to connect to external USB devices such as USB HUBs or USB 2.0 devices.

By default, PIN45 on the MILKV-DUO mainboard is used as an input for ADC2, with a maximum 3.3V level divided to 1.65V using a voltage divider consisting of two resistors. If the user wants to use PIN45 as a USB burning detection pin, it is recommended to add a button in the baseboard design. When the button is pressed, the system will power on, and USB_VBUS_DET will detect a high level, causing the USB interface to enter Device mode for firmware downloading. On the other hand, when the button is not pressed, USB_VBUS_DET detects a low level, and the USB interface enters Host mode, allowing external connections to USB HUBs or USB 2.0 devices. The recommended circuit design for this is shown below:

Please note that the USB signal line should be connected in series with no more than 5.1 ohms of resistance to minimize electromagnetic interference (EMI) issues. If the USB Device is external to the board, an Electrostatic Discharge (ESD) protection device should be added to the signal line, and the parasitic capacitance should be less than 5 pF. In addition, if the Device is connected to a large load current device such as a mobile hard disk, a capacitor of 220uF or more should be added near the socket to prevent the system power supply from dropping during insertion or being unable to recognize the insertion due to voltage drop. When designing the bottom board, these considerations should be taken into account.

- Use short and wide PCB traces whenever possible to minimize signal loss and crosstalk.



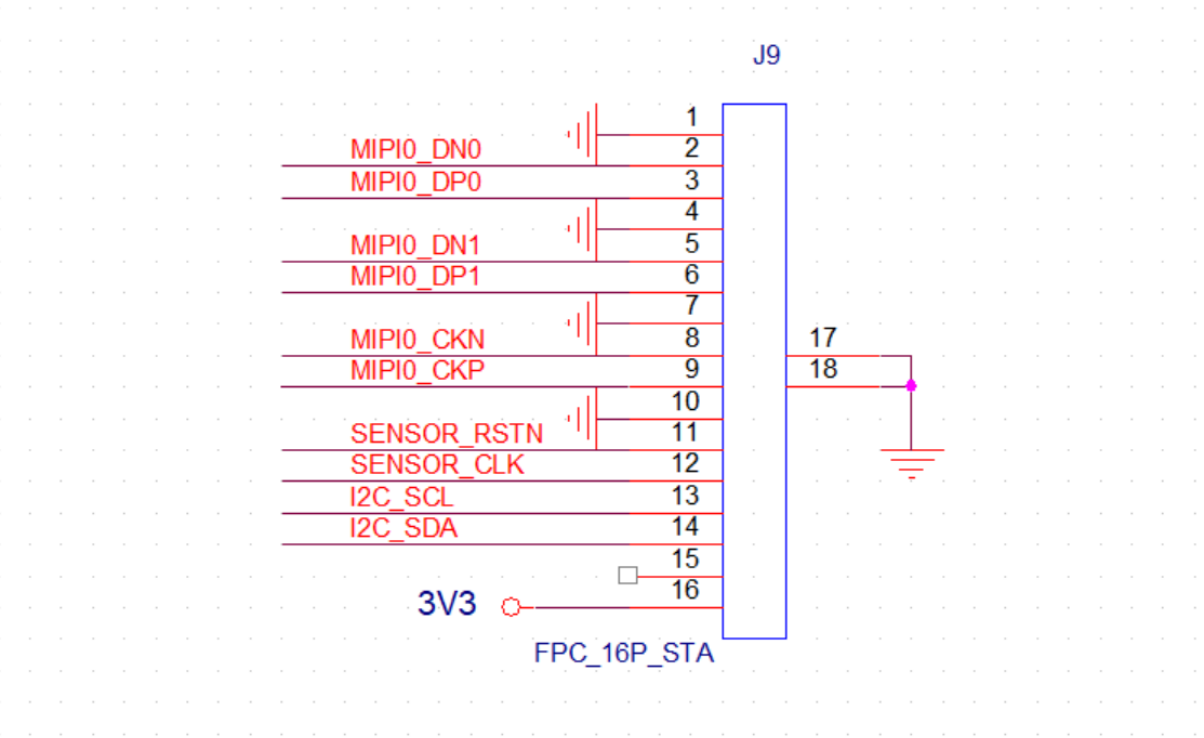
- Avoid large areas of copper on the PCB, especially near the USB signal lines, as they can cause signal reflection and EMI issues.
- Install necessary EMI filters and ESD protection devices on the bottom board to ensure the system's stability and reliability.
- Consider USB device load current when designing the layout of power supply capacitors and ground capacitors to ensure the system's power supply stability.
- **When using an external USB HUB on the bottom board, ensure its quality and compatibility, and pay attention to its rated current and** power supply mode.
- **When using external USB 2.0 devices, ensure that their current and voltage comply with USB 2.0 specifications, and make sure that the device is** compatible and that the driver is installed properly.

1.2.5 2.3 CSI-2 (MIPI serial camera)

MilkV-Duo provides a 16-pin FPC interface that supports 2-lane data for MIPI camera input. The I2C, sensor Clock (CLK), and reset (RST) signals are at a voltage level of 1.8V.

If a user wants to design their own camera, the design requirements are as follows:

- **Use 100 ohm differential routing with appropriate line width and spacing. Avoid via stitching as much as possible. Refer to the previous layout** for existing routing methods, or refer to public board layouts if none exist. Use GND as the reference plane and try to maintain the integrity of the reference plane.
- **Control the length of the differential pairs P/N within 20 mil, and ensure that the deviation between the line length of the differential pairs** is within ±300mil based on the line length of the clock signal.
- **Control the differential impedance to 100ohm +/10%. When passing through the connector, adjacent differential signal pairs must be isolated using** GND pins.
- **The total length of the signal path should be within 4 inches. Consider joint control of packaging, PCB, external wire materials, etc., when** setting length constraints and bus length.



1.2.5.1 MILKV-Duo Sensor Support List

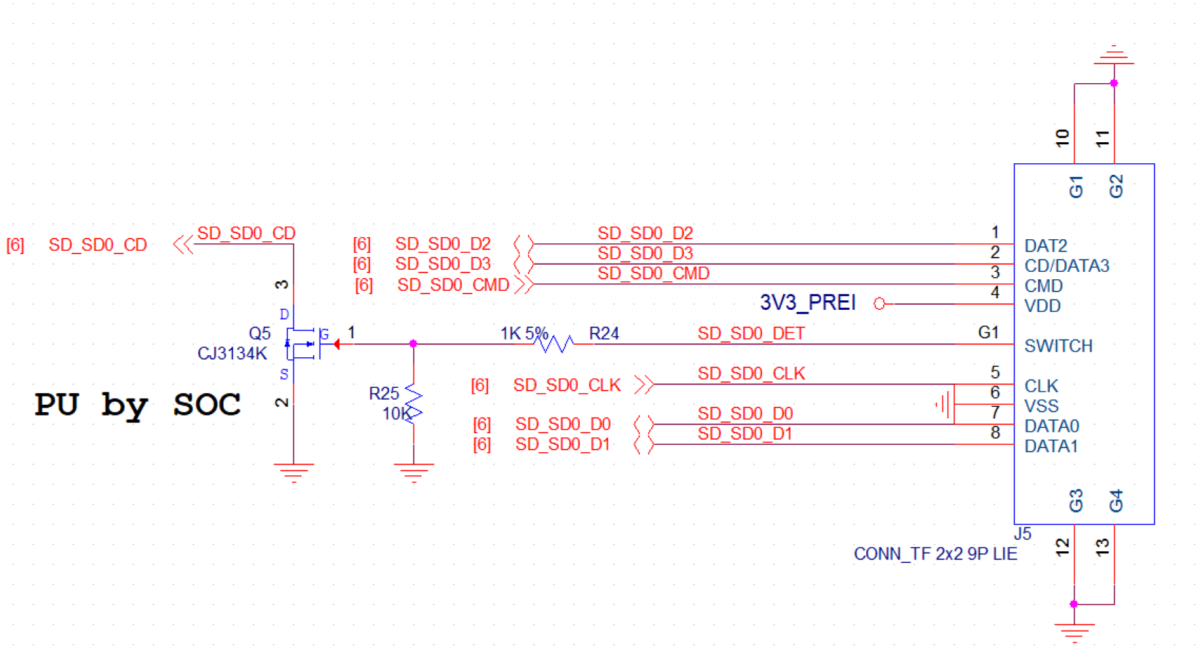
Manufacturer	Part Number	Resolution	Type	Unit cell size	Resolution	Status
Sony	IMX307	2MP	1/2.8	2.8 um	1920x1080	done
Sony	IMX327	2MP	1/2.8	2.8 um	1920x1080	done
Sony	IMX385	2MP	1/2.0	3.75 um	1920x1080	done
SmartSense	SC035HGS	0.3MP	1/6”	3.74 um	640x480	done
SmartSense	SC2335	2MP	1/2.8	2.5 um	1920x1080	done
SmartSense	SC2336	2MP	1/3.0	2.7 um	1920x1080	doing
SmartSense	SC200AI	2MP	1/2.8	2.9 um	1920x1080	done
Galaxycore	GC1054	1MP	1/4.0	3.0 um	1280x720	done
Galaxycore	GC2053	2MP	1/2.9	2.8 um	1920x1080	done
Galaxycore	GC2063	2MP	1/2.9	2.8 um	1920x1080	done
Galaxycore	GC2093	2MP	1/2.9	2.8 um	1920x1080	done
OmniVision	OS02D10	2MP	1/2.7	3.0 um	1920x1080	done
OmniVision	OS02K10	2MP	1/2.8	2.9 um	1920	done

- Manufacturer: the company that produces the camera module
- Part Number: the specific model of the camera module
- Resolution: the number of pixels the camera sensor can capture
- Type: the size of the camera sensor
- Unit cell size: the size of each pixel on the camera sensor
- Status: whether the camera module is completed or in progress

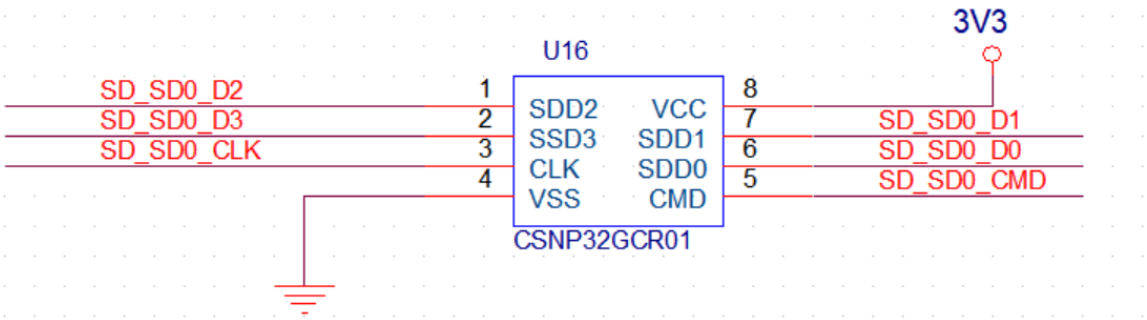
1.2.6 2.4 TF CARD

The CV1800B chip supports two SD3.0 interfaces, where SDIO0 supports devices that comply with the Secure Digital Memory (SD 3.0) protocol and SDIO1 supports devices that comply with the Secure Digital I/O (SDIO 3.0) protocol. The features of the SDIO controller are as follows:

- Support for SD card and SDIO devices.
- Transfer data between SD/SDIO and system memory through an internal DMA controller.
- Support for generation and checking of CRC for commands and data.
- Ability to generate frequencies required for different modes through an internal divider.
- Mechanisms to disable internal and interface clocks to meet power-saving requirements.
- Support for 1-bit and 4-bit data transfer interfaces to communicate with devices.
- Support for data read and write operations with block sizes ranging from 1 to 2048 bytes.
- Support for SDIO protocol, including interrupt handling, suspend, resume, and read wait operations.



MILKV-DUO connects the SDIO0 interface to the TF card slot, allowing users to store system files in the TF card and boot the system from it. In addition, for the convenience of commercial customization users, SDIO0 is designed to be compatible with an SD NAND (default not mounted)



1.2.7 2.5 GPIO

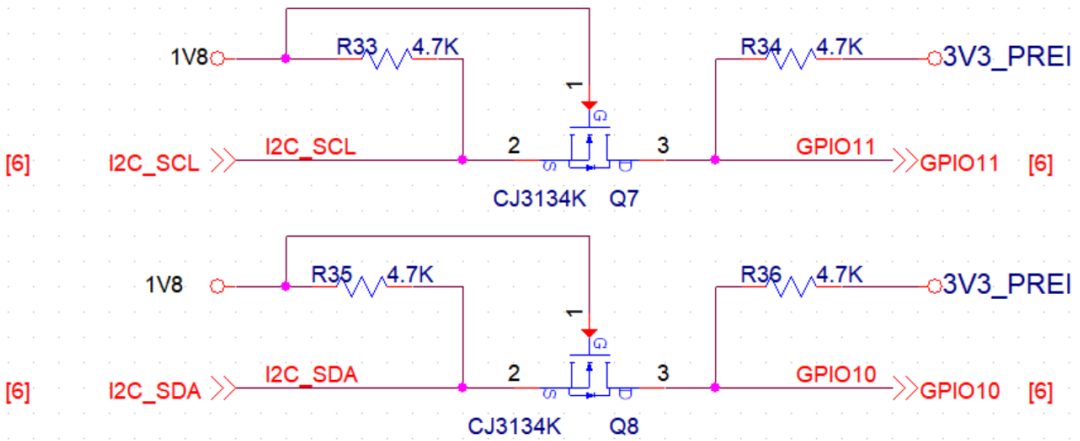
There are 28 pins available for general purpose I/O (GPIO), which correspond to the GPIO pins on the MilkV-Duo 40-pin header. These pins have access to internal peripherals, including SDIO, I2C, PWM, SPI, J-TAG, and UART.

1.2.7.1 2.5.1 I2C

The CV1800B has 5 I2C controllers that can be individually configured as Master/Slave. The I2C controller has the following functional characteristics:

- Supports standard addresses (7-bit) and extended addresses (10-bit).
- Supports transfer rates of standard mode (100 kbit/s) and fast mode (400 kbit/s).
- Supports General Call and Start Byte functions.
- Does not support CBUS devices.
- Supports DMA operations.
- Includes a 64 x 8-bit TX FIFO and a 64 x 8-bit RX FIFO.

When GPIOC9 and GPIOC10 are multiplexed as I2C1, they can be used as a configuration I2C for sensors with a voltage level of 1.8V and external pull-up resistors. Alternatively, they can be used as a general-purpose I2C by using a MOS transistor to convert the voltage level from 1.8V to 3.3V and connecting it to the 40-pin header, which already has pull-up resistors.



MILKV-Duo has not added external pull-up resistors to the pins with IIC functionality in consideration of interface function reuse. When other pins need to be multiplexed as IIC interfaces, external pull-up resistors need to be added and pulled up to 3.3V.

When using the I2C interface, the following considerations should be taken:

- **Selection of pull-up resistors: Pull-up resistors are required on the I2C bus, and resistors with values between 1K and 4.7K are recommended.**
  When more slave devices are connected to the bus or the wiring length is longer, it is recommended to use resistors with smaller values.
- **Avoidance of address conflicts: The addresses of all devices on the I2C bus should not conflict, and the addresses should be directly marked**
  on the design drawings to avoid problems during software design.
- **IO configuration considerations: The IO configuration of the I2C interface needs to be configured according to the Function Pin Mux to ensure**
  normal operation of the interface.

1.2.7.2 2.5.2 UART

UART (Universal Asynchronous Receiver Transmitter) is an asynchronous serial communication interface used to convert data from external peripherals into the internal bus after serial-parallel conversion and output data from the internal bus after parallel-serial conversion to external devices. The UART module is primarily used to interface with the external UART of another chip, enabling communication between two chips.

CV1800B has 5 UART interfaces, with UART0 dedicated as the debugging port. MILKV_DUO provides access to 5 UART interfaces through the 40-pin connector, with UART3 capable of being configured as a full-featured UART.

The UART module has the following features:

- Support for 64 x 8-bit transmit FIFO and 64 x 8-bit receive FIFO.
- Programmable data and stop bit widths with data bits ranging from 5 to 8 bits and stop bits ranging from 1 to 2 bits.
- Supports odd, even parity or no parity.
- Programmable transmission speed.
- Supports receive FIFO interrupt, transmit FIFO interrupt, and error interrupt.
- Supports querying initial interrupt status and interrupt status after masking.
- Supports DMA operation.

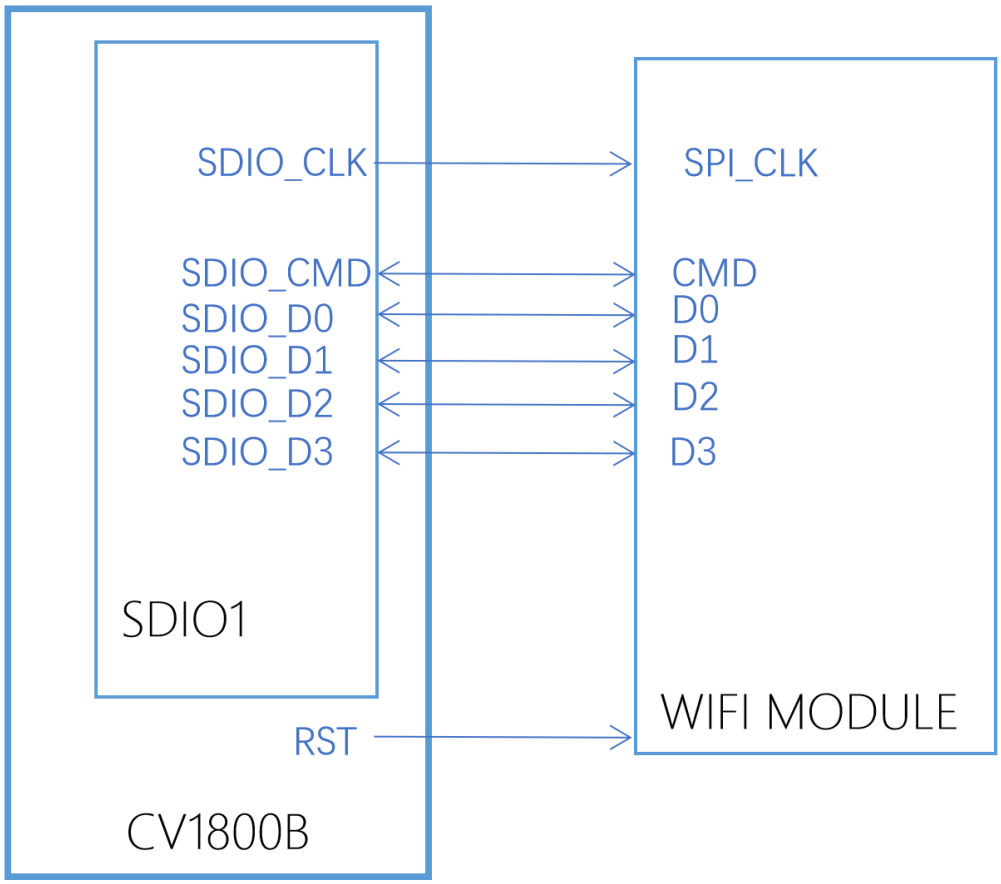
When using the UART interface, it is essential to refer to the Function Pin Mux configuration to ensure proper interface functionality.

1.2.7.3 2.5.3 SDIO1

MILKV-Duo's SDIO1 is connected to the 40-pin interface, which can be used to connect SDIO peripherals such as WiFi modules. The SDIO interface mode and speed can be found in the table below:

Speed Mode	Clock Frequency	Voltage
DS (Default Speed)	25 MHz	1.8V/ 3.3V
HS (High Speed)	50 MHz	1.8V/ 3.3V
SDR12	25 MHz	1.8V
SDR25	50 MHz	1.8V
SDR50	100 MHz	1.8V
SDR104	187.5 MHz	1.8V

The other features of SDIO1 are the same as SDIO0, which was introduced in the previous section (2.4). More specific information can be found in the introduction of Chapter 2.4 TF CARD. If the user wants to connect a WiFi module via SDIO1, a diagram provided in the documentation (insert reference here) can be used as a reference for the design.



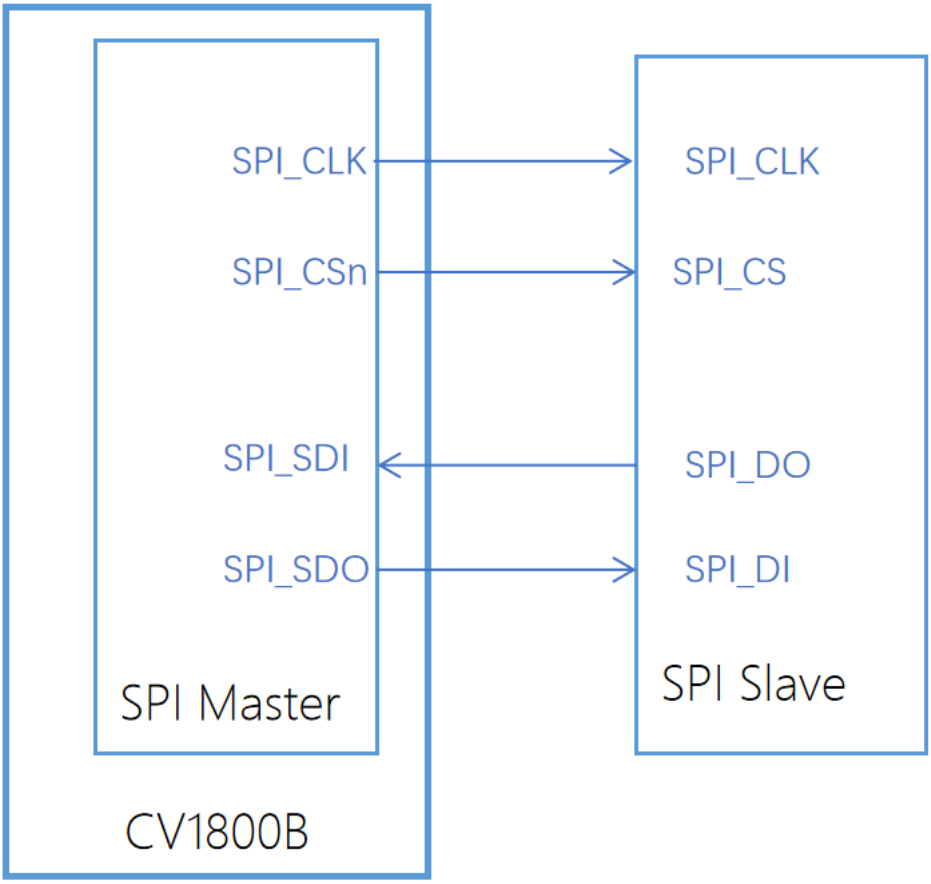
The following table shows the list of wifi modules currently supported by MILKV-Duo:

Interface	Antennas	Model name	IC	Throughput	BT/BLE
SDIO	Single Antenna	AP6212	BCM43438A0	40Mbps	BT4.1
SDIO	Single Antenna	AP6201BM	BCM430132	40Mbps	BT5.0
SDIO	Single Antenna	DXS-S1026_R89S	RTL8189FTV	50Mbps	/
SDIO	Single Antenna	DXS-S1128_R21S	RTL8189FTV	50Mbps	BT4.1
SDIO	Single Antenna	BL-M8821CS1	RTL8821CS	50Mbps	BT4.1
SDIO	Dual Antenna	BL-R8723BT1	RTL8723BU	50Mbps	BT4.0
SDIO	Single Antenna	BL-M6158NS1	SVG6158	50Mbps	/

1.2.7.4 2.5.4 SPI

The MILKV-Duo is equipped with an SPI (Serial Peripheral Interface) controller module, which can function as a Master device to enable synchronous communication with external devices via serial communication. This module provides a means of converting data between serial and parallel formats. The SPI controller module supports three different SPI protocols, which include Motorola SPI (full-duplex), TI SSP (full-duplex), and NS MicroWire (half-duplex). Some of the main features of the SPI controller module include:

- Independent receive and transmit FIFOs.
- Programmable data frame length, with values between 4 and 16 bits.
- Programmable SPI interface clock frequency.
- DMA operation mode support.
- Internal loopback test mode support.
- The working reference clock can be set to either 187.5MHz or 100MHz. The output SPI_SCK signal can support a maximum frequency of 46.875MHz.

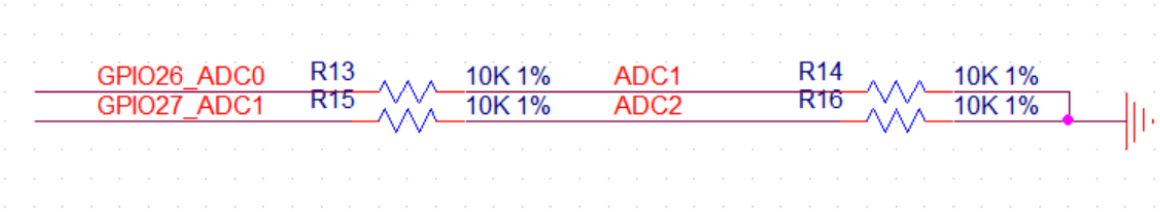


1.2.7.5 2.5.5 ADC

The ADC module that can perform analog-to-digital conversion with the following specifications:

- The controller operates at a frequency of 12.5MHz
- The scan frequency cannot exceed 320K/s
- 12-bit sampling accuracy, with 3 independent channels
- Can trigger the scanning of three channels in sequence at once
- Automatically reports an interrupt when scanning is complete.

The CPU configures the scanning channels, which can simultaneously configure three channels, and starts SARADC to perform channel scanning. After scanning all enabled channels, the channel scan is completed, and the system is notified through an interrupt. The CPU can obtain the conversion result.



Due to the limitation of CV1800B's ADC, which only supports 1.8V voltage level input, MILKV-Duo uses two 10k ohm resistors to voltage divide the analog input from 3.3V to 1.65V before connecting it to the ADC through the 40-pin header. It is important to consider the voltage division effect on the input signal when using this feature.

1.2.7.6 2.5.6 PWM

The chip provides 1 group of 4-channel independent PWM signal output. The PWM clock source can be configured to be either 100MHz or 148.5MHz, with the default being 100MHz. The four PWM channels can operate independently and have the following characteristics:

- Internally equipped with a 30-bit counter, with configurable output period and high/low level pulse count
- **Supports output frequencies of up to 50MHz (100MHz/2) or 74.25MHz (148.5MHz/2), with a minimum frequency of approximately**
  0.093Hz (100MHz/(2^30-1)) or 0.138Hz (148.5MHz/(2^32-1))
- Supports continuous output (PWMMODE = 0) and fixed pulse count output (PWMMODE = 1) modes
- Supports 4-channel PWM synchronous output mode (SHIFTMODE = 1), where the 4 PWM outputs can be adjusted by configuring the register.

1.2.8 2.6 SPI Flash

The CV1800B chip features an SPI NOR controller that enables external access to SPI NOR Flash data. Key features include:

- Support for one external chip select.
- Support for dual/quad read and write operations.
- Compatibility with various specifications of devices.
- Support for 3-byte address devices and 4-byte address devices.
- Support for devices up to a maximum capacity of 256MB.
- Support for BOOT function.

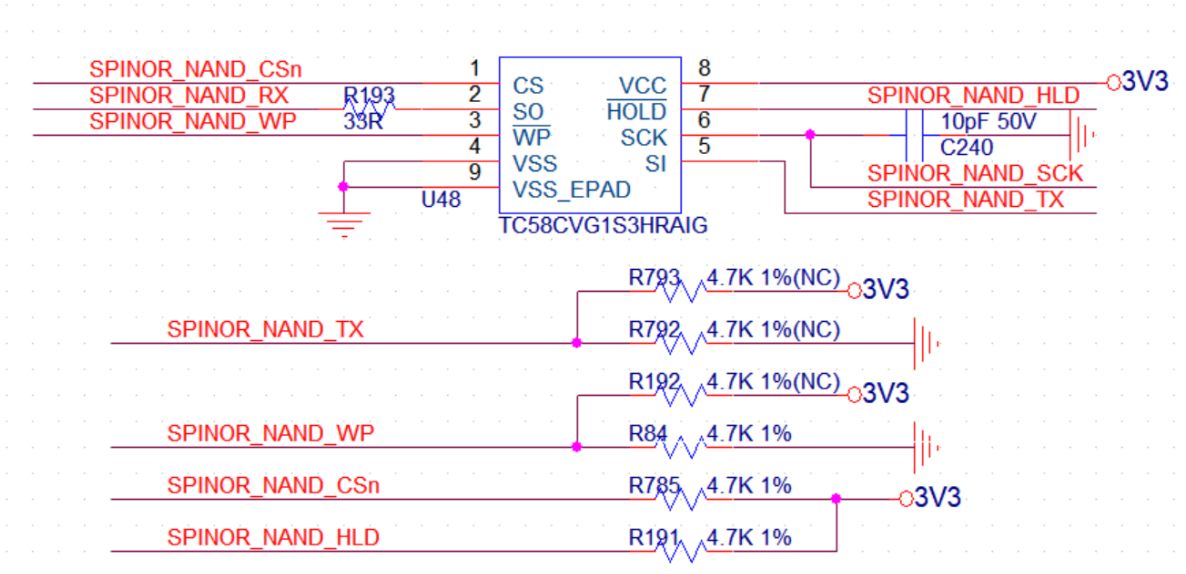
The chip also supports external SPI NAND Flash data access, with the following features:

- Supports 1 chip select for external device.
- Supports SPI NAND Flash x1/x2/x4 read and write operations.
- Supports multiple specifications of SPI NAND Flash devices.

Upon reset, the chip is booted by the built-in ROM (BOOTROM). The type of memory device currently in use is determined by detecting whether there is a weak pull-up or weak pull-down on two pins (SPINOR_MOSI, SPINOR_WP_X). For secure boot chips, signature verification is performed during booting and chip upgrading to ensure the authenticity of software execution or upgrade. The following table shows the correspondence between the boot mode and the corresponding signal latching value:

- Booting from SPI NOR Flash (with SPINOR_WP_X pulled down and SPINOR_MOSI pulled up)
- Booting from SPI NAND Flash (with SPINOR_WP_X pulled down and SPINOR_MOSI pulled down)

If the user intends to design a baseboard for booting from SPI Flash, please refer to the design guidelines provided below.



1.2.9 2.7 RUN

The RUN pin of the MILKV-DUO is connected to the PWR_VBAT_DET pin of the CV1800B through an inverse bipolar transistor. This pin continuously monitors the voltage level, and if it falls below a certain threshold, the chip will automatically reboot. To reboot the MILKV-DUO manually, the RUN pin can be pulled up.

1.2.10 2.8 LEDs

The MILKV-DUO board includes two LEDs, a red power indicator LED and a blue user-defined LED. The red LED is connected to the 3.3V power supply and illuminates when power is applied to the board. The blue LED is connected to GPIOC24 pin of the CV1800B microcontroller and can be controlled by the user's software. The user can turn the blue LED on by setting the GPIOC24 pin to high and turn it off by setting the pin to low. This LED can be used to indicate the state of the system, for example, to signal when certain events occur or to provide feedback during debugging..

1.3 Chapter 3. Electrical and mechanical

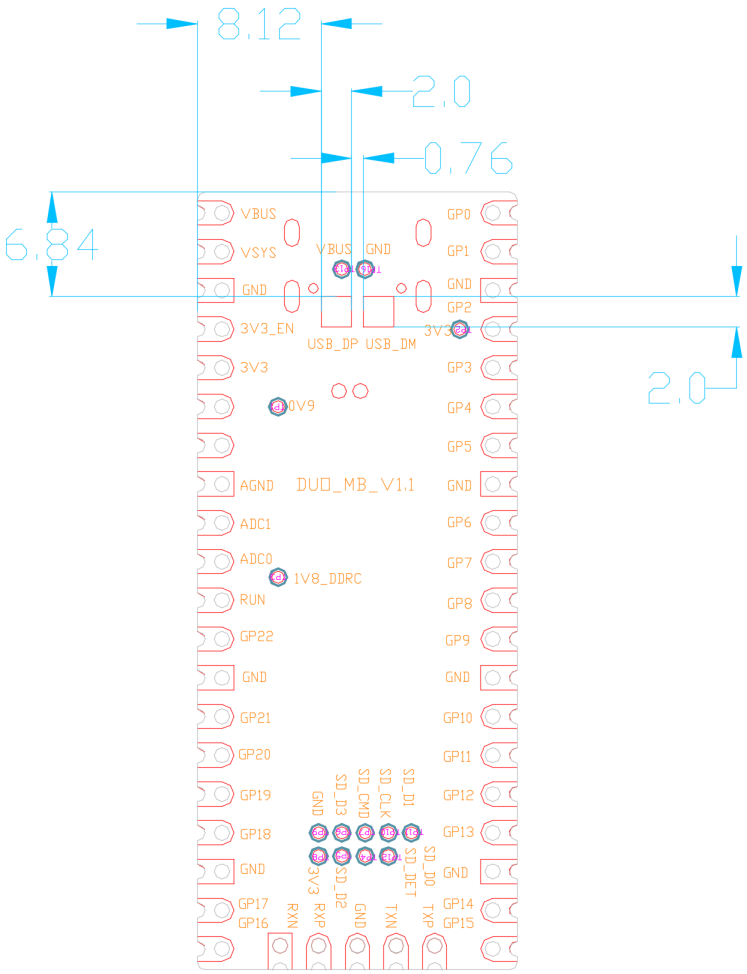
1.3.1 3.1 Mechanical

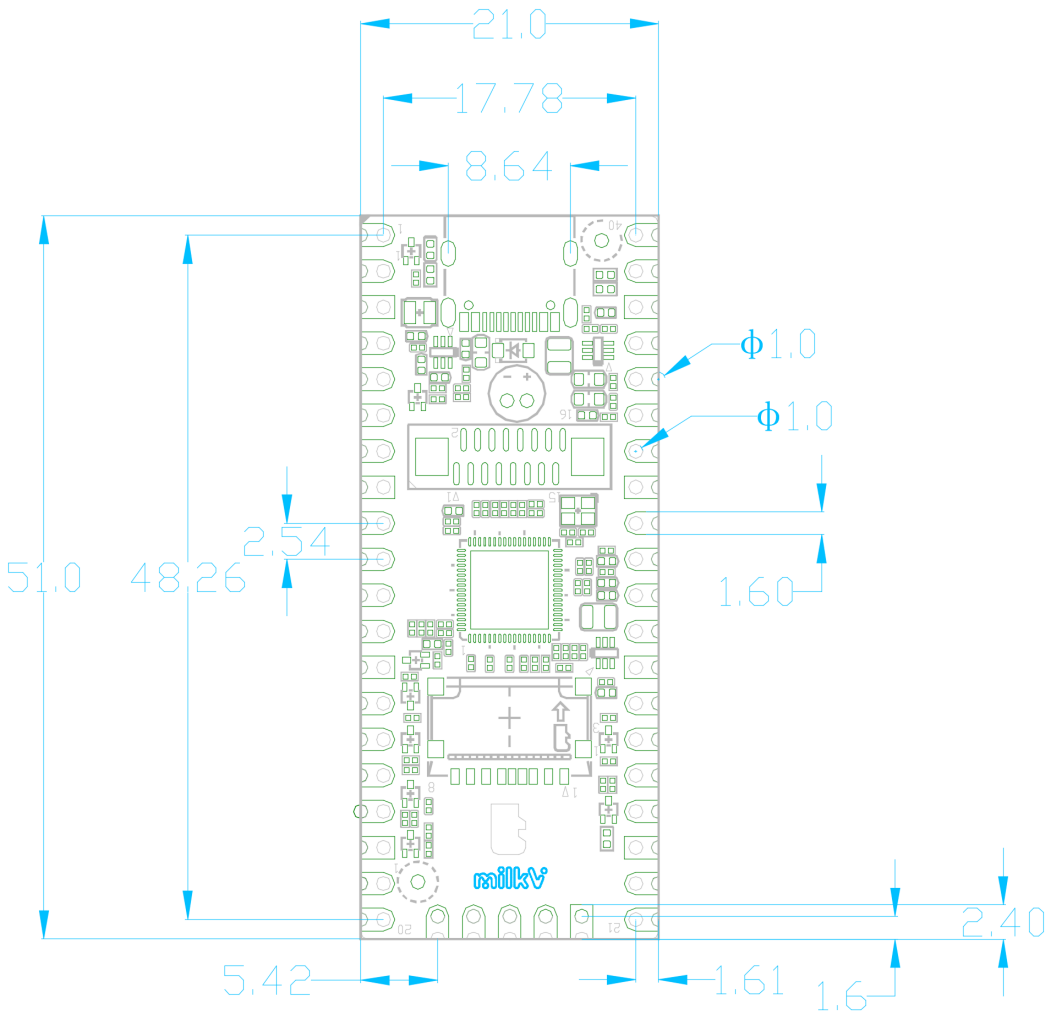
The MILKV_Duo is a single sided 51×21mm 1mm thick PCB with a Type-C port overhanging the top edge and dual castellated/through-hole pins around the remaining edges. Duo is designed to be usable as a surface mount module as well as being in Dual Inline Package (DIP) type format, with the 40 main user pins on a 2.54mm (0.1") pitch grid with 1mm holes and hence compatible with veroboard and breadboard. see Figure below,

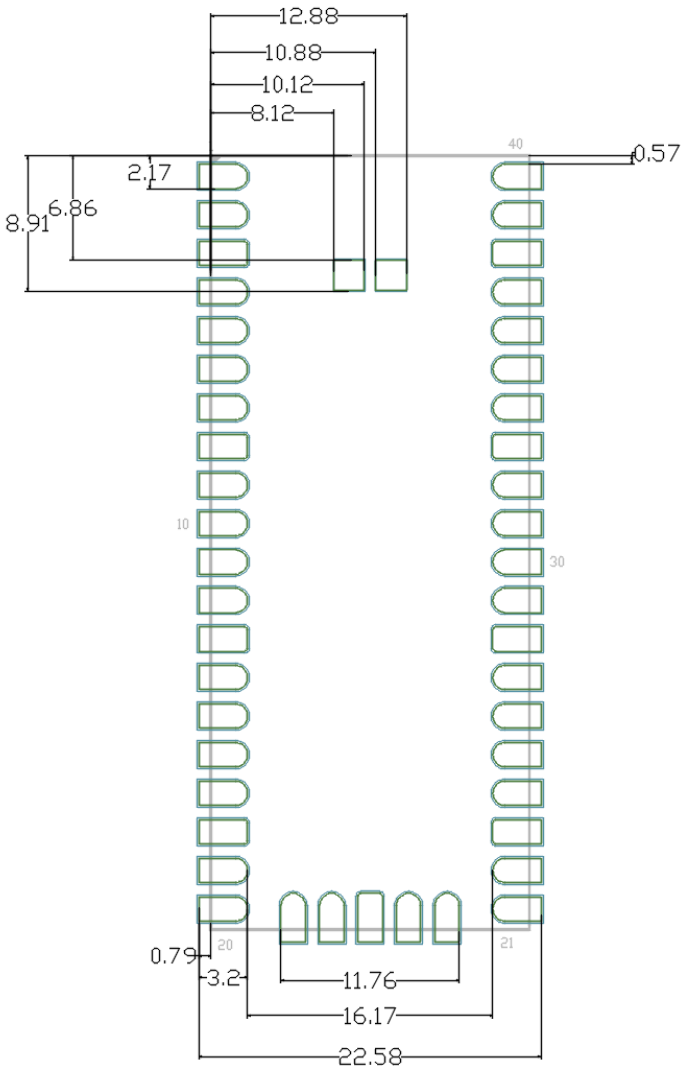
1.3.2 3.2 Surface-mount footprint

The following footprint is recommended for systems which will be reflow-soldering MILKV-Duo units as modules.

The footprint shows the test point locations and pad sizes as well as the 4 USB-C connector shell ground pads . The USB-C connector on MILKV-Duo is a through-hole part, which provides it with mechanical strength. The USB-C socket pins do not protrude all the way through the board, however solder does pool at these pads during manufacture and can stop the module sitting completely flat. Hence we provide pads on the SMT module footprint to allow this solder to reflow in a controlled manner when Pico goes through reflow again. For test points that are not used, it is acceptable to void any copper under these (with suitable clearance) on the carrier board.


8.12
2.0
0.76
6.84
2.0
VBUS
VSYS
GND
3V3_EN
3V3
0V9
AGND
ADC1
ADC0
1V8_DDRC
RUN
GP22
GND
GP21
GP20
GP19
GP18
GND
GP17
GP16
GP0
GP1
GND
GP2
3V3
GP3
GP4
GP5
GND
GP6
GP7
GP8
GP9
GND
GP10
GP11
GP12
GP13
GND
GP14
GP15
VBUS GND
USB_DP USB_DM
DUO_MB_V1.1
GND SD_D3 SD_CMD SD_CLK SD_D1
3V3 SD_D2 SD_DET SD_D0
RXN RXP GND TXN TXP


21.0
17.78
8.64
ϕ1.0
ϕ1.0
2.54
51.0
48.26
1.60
2.40
5.42
1.61
1.6


12.88
10.88
10.12
8.12
40
0.57
2.17
6.86
8.91
10
30
0.79
20
21
3.2
11.76
16.17
22.58

1.3.3 3.3. Thermal

Temperature	Operating Ambient Temperature	Recommended Junction Temperature	Maximum Junction Temperature
Maximum	70°C	85°C ~ 105°C	+125°C
Minimum	-30°C	-30°C	-40°C

- **The maximum working environment temperature depends on the power consumption and heat dissipation conditions of the scenario, without violating**
  the junction temperature.
- **The recommended range of junction temperature is mainly considered for the risk of thermal run-away caused by high temperature and poor heat**
  dissipation conditions, which may lead to the destruction of the chip. Additionally, long-term operation at high temperature may accelerate chip aging and reduce its service life.
- **The DRAM used only guarantees a junction temperature range of -40°C to 115°C. The contents of DRAM cannot be guaranteed to be intact beyond**
  this range.
- When the chip operates at a destructive junction temperature, it may cause irreversible physical damage to the chip.

1.3.4 3.4. Electrical

1.3.4.1 3.4.1 1.8V IO Domine

The electrical characteristics of the 1.8V IO are as follows:

Parameter	Min	Typ	Max	Unit
VIL	-0.3	/	0.58	V
VIH	1.27	/	2	V
VOL	/	/	0.45	V
VOH	1.4	/	/	V
IOL	4.9		46.2	mA
IOH	3.6		42.5	mA

The 1.8V IO involves signals for Ethernet, MIPI signals and control signals for cameras, as well as USB signals. Note: The output current level can be configured through registers, with a total of eight levels available.

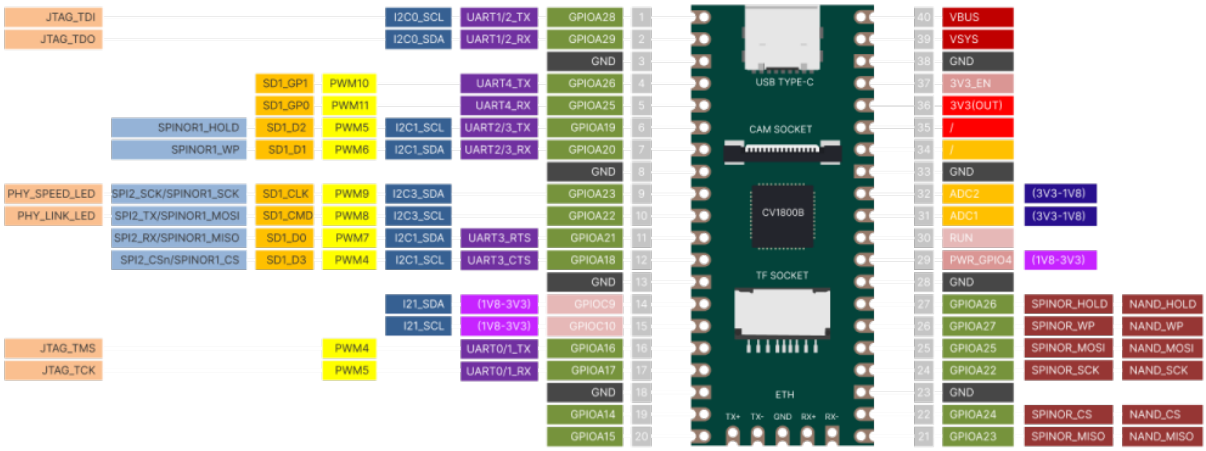
1.3.4.2 3.4.2 3.3V IO Domine

The electrical characteristics of the 3.3V IO are as follows:

Parameter	Min	Typ	Max	Unit
VIL	-0.3	/	0.25VDDIO	V
VIH	0.625VDDIO	/	3.3	V
VOL	/	/	0.125VDDIO	V
VOH	0.75VDDIO	/	/	V
IOL	3.1		36.3	mA
IOH	5.0		46.9	mA

The 3.3V IOs involved include UART, I2C, SPI, FLASH, PWM, and SDIO signals on the 40-pin header. Note: The output current level can be configured through registers, with a total of eight levels available.

1.4 Chapter 4. Pinout



Pin	Function
1	GPIOA28, UART1/2_TX, I2C0_SCL and JTAG_TDI functions. Power domain 3.3V
2	GPIOA29, with JTAG_TDO, I2C0_SDA and UART1/2_RX functions. Power domain 3.3V.
3	GND
4	GPIO26 can be configured as SD1_GP1, PWM10 or UART4_TX functions. It belongs to power dom
5	GPIO25, which can also be reused as UART4_RX, PWM11 and SD1_GP0 functions. Power domain
6	SD1_GP0 function, power domain is 3.3V, which can also be used as PWM11, UART4_RX and GPI
7	GPIO20, which also has SPINOR1_WP, SD1_D1, PWM6, I2C1_SDA and UART2/3_RX functions. Po
8	GND
9	GPIO23, which also has PHY_SPEED_LED, SPI2_SCK/SPINOR1_SCK, SD1_CLK, PWM9 and I2C3
10	GPIO22, which also has PHY_LINK_LED, SPI2_TX/SPINOR1_MOSI, SD1_CMD, PWM8 and I2C3_S
11	GPIO21, which also has SPI2_RX/SPINOR1_MISO, SD1_D0, PWM7, I2C1_SDA and UART3_RTS fu
12	GPIO18, which also has SPI2_CSn/SPINOR1_CS, SD1_D3, PWM4, I2C1_SCL and UART3_CTS fun
13	GND

Table 1 – continued from previous page

Pin	Function
14	GPIOC9 with I21_SDA function. Converted from 1.8V to 3.3V. Cannot be used with SENSOR IIC a
15	GPIOC10 with I21_SCL function. Converted from 1.8V to 3.3V. Cannot be used with SENSOR IIC
16	GPIOA16, which also has JTAG_TMS, PWM4 and UART0/1_TX functions. Power domain 3.3V.
17	GPIOA16, with JTAG_TMS, PWM4, and UART0/1_TX functions. 3.3V power domain.
18	GND
19	GPIOA14. 3.3V power domain.
20	GPIOA15. 3.3V power domain.
21	GPIOA15. 3.3V power domain.
22	GPIOA23 and SPINOR/NAND_MISO. 3.3V power domain.
23	GPIOA24 and SPINOR/NAND_CS. 3.3V power domain.
24	GPIOA22, with SPINOR/NAND_SCK function. 3.3V power domain.
25	GPIOA25, with SPINOR/NAND_MOSI function. 3.3V power domain.
26	GPIOA26, with SPINOR/NAND_HOLD function. 3.3V power domain.
27	GPIOA27, with SPINOR/NAND_WP function. 3.3V power domain.
28	GND
29	PWR_GPIO4, converted from 1.8V to 3.3V.
30	RUN, providing high level to stop the board from working.
31	ADC1, with a voltage range of 03.6V, powered by 1.8V with voltage division.
32	ADC2, with a voltage range of 03.6V, powered by 1.8V with voltage division.
33	GND
34	/
35	/
36	3V3(OUT) 3.3V Output, maximum current of 2A
37	3V3_EN High level can turn off 3.3V on board
38	GND
39	VSYS System voltage, if powered from this pin, voltage range is 5~12V
40	VBUS Type C port output voltage 5V
41	TX+ Ethernet Transmit Positive
42	TX- Ethernet Transmit Negative
43	GND
44	RX+ Ethernet Receive Positive
45	RX- Ethernet Receive Negative
46	USB_DM USB 2.0 Negative
47	USB_DP USB 2.0 Positive