

# Colibri VFxx

## Datasheet



## Revision History

| Date          | Doc. Rev. | Colibri VFxx Version | Changes   |
|---------------|-----------|----------------------|---|
| 08-Aug-2013   | Rev. 0.9  | V1.0                 | Initial Release: Preliminary version  |
| 24-Oct-2013   | Rev. 1.0  | V1.0                 | Official release: Minor changes   |
| 07-Jan-2014   | Rev. 1.1  | V1.1                 | Changes regarding new HW version 1.1, remove Security features from VF61 variant  |
| 05-Mar-2014   | Rev. 1.2  | V1.1                 | Update flash size of VF61   |
| 14-Mar-2014   | Rev. 1.3  | V1.1                 | Add information about compatibility of CAN interface with other Colibri modules   |
| 03-Jul-2014   | Rev. 1.4  | V1.1                 | Correction of operating temperature range of IT-Version<br>Corrections in Table 5-27<br>Clarifications in the section 7 "Bootstrap Option"<br>Minor changes   |
| 17-Nov-2014   | Rev. 1.5  | V1.1                 | Correction in section 10.2 "Recommended Operation Conditions"<br>Correction of VF61 block diagram<br>Section 10.7 renamed and updated<br>Clarifications in section 5.12 "PWM"<br>Minor changes  |
| 15-April-2015 | Rev. 1.6  | V1.1                 | Section 1.3.3 Interfaces: updated number of available GPIOs   |
| 25-Sep-2015   | Rev. 1.7  | V1.2                 | Update module version<br>Section 5.22: change SAI clock output from EXT_AUDIO_MCLK to CKO1<br>Section 5.22: correction "FIF" to "FIFO"  |
| 16-Feb-2016   | Rev. 1.8  | V1.2                 | Replace Figure 7, minor changes   |
| 13-Feb-2017   | Rev. 1.9  | V1.2                 | Updated web-links (Section 1.2, 1.4 and 10.5.1)<br>Changed heading to "Colibri Carrier Board Schematics" (Section 1.4.6)<br>Updated remarks in the Table 5-4 (Section 5.2.1)  |
| 06-April-2017 | Rev. 2.0  | V1.2                 | Added voltage level for the I/Os in the table.  |
| 25-May-2018   | Rev. 2.1  | V1.2                 | Added typical current values (Section 10.3)   |
| 18 Apr-2019   | Rev. 2.2  | V1.2                 | Added remark to flash endurance (Section 1.3.2)<br>Added remark to suspend (Section 8)<br>Added GPIO pins for VF50 (Section 3.2, 4.4)<br>Updated web-links (Section 10.5.1)<br>Minor changes  |
| 10-May-2019   | Rev. 2.3  | V1.2                 | Removed faulty statement about USB recovery mode (Section 5.4)<br>Added note about baud rate limitations (Section 5.9)<br>Changed min VCC_BATT to 2.4V (Section 10.2)<br>Minor changes  |
| 29-May-2019   | Rev. 2.4  | V1.2                 | Added remark about back feeding for USB (Section 5.4)   |
| 24-Oct-2022   | Rev. 2.5  | V1.2                 | Section 1.1: added Purpose of the Datasheet<br>Section 5.1.3: clarified reset behaviour<br>Section 10.3: renamed to "Power Consumption"<br>Section 10.3: clarified module power consumption<br>Section 10.4: clarified power-up ramp time requirements<br>Section 10.6: updated Table 10-3<br>Updated email and main office addresses<br>Updated disclaimer<br>Minor cosmetic changes |

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# 1 Introduction

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## 1.1 Purpose of the Datasheet

The datasheet represents the hardware capabilities of the Colibri Vybrid. For information on the actual features supported by software, please refer to the relevant SoM product page on the Toradex website (Colibri VF50 page: <https://developer.toradex.com/hardware/colibri-som-family/modules/colibri-vf50>, Colibri VF61 page: <https://developer.toradex.com/hardware/colibri-som-family/modules/colibri-vf61>).

## 1.2 Hardware

The Colibri VF50 and VF61 are both SODIMM sized computer modules based on the Freescale Vybrid embedded System-on-Chip (SoC). The Vybrid SoC features a Cortex-A5 processor supporting a clock frequency of up to 500MHz. The Colibri VF61 additionally features a second Cortex-M4 processor core which can be clocked at up to 167MHz maximum. This unique heterogeneous dual core system allows for running a second hard real time operating system on the M4 core for time and security critical tasks.

The module targets a wide range of applications, including: Digital Signage, Medical Devices, Navigation, Industrial Automation, HMIs, Avionics, Entertainment System, POS, Data Acquisition, Thin Clients, Robotics, Gaming and many more.

It offers a wide range of interfaces from simple GPIOs, industry standard I2C and SPI buses through to high speed USB 2.0 interfaces. Both Colibri VFxx modules feature a Fast Ethernet PHY with IEEE1588 time stamping on the module. Additionally, a second PHY can be integrated on the customer carrier board by using the RMI interface.

Existing customers will benefit from an extremely easy migration path from the current Colibri PXAxxx or Colibri T20/30 module range to the Colibri VFxx – all Colibri modules are electrically pin compatible. New customers will also appreciate the ability to select the Colibri module most suitable for their application to achieve the optimum price/performance balance without the need to support different carrier board designs.

## 1.3 Software

Initially, the Colibri VFxx modules are provided with an embedded Linux Image. Additionally, a Windows Embedded Compact Image available. More information can be found here: <http://developer.toradex.com/software/windows-embedded-compact/vf50-vf61-wec-software>

For the additional Cortex-M4 processor of the Colibri VF61, Toradex provides the free and open source real-time operating system eCos. Additional information and download links can be found here: <http://developer.toradex.com/knowledge-base/ecos-rtos-on-the-cortex-m4-of-a-colibri-vf61>

Toradex also works with third-party partners should you require another Operating System.

## 1.4 Main Features Colibri VFxx

### 1.4.1 CPU

|  | Colibri VF50    | Colibri VF61                |
|--|-----------------|-----------------------------|
| Freescale Vybrid Controller                        | MVF50NN151CMK40 | MVF61NN151CMK50             |
| CPU Cores  | 1               | 2                           |
| ARM Cortex-A5 with TrustZone                       | ✓               | ✓                           |
| ARM Cortex-M4                                      | -               | ✓                           |
| Instruction Cache                                  | 32KB            | 32KB (A5)<br>16KB (M4)      |
| L1 Cache   | 32KB            | 32KB (A5)<br>16KB (M4)      |
| L2 Cache   | -               | 512KB (A5)                  |
| NEON   | ✓               | ✓                           |
| VFPv4 floating point unit                          | ✓               | ✓                           |
| Maximum CPU frequency                              | 400MHz          | 500MHz (A5)<br>167 MHz (M4) |
| Secure High Assurance Boot                         | -               | -                           |
| AES, DES/3DES, SHA-1, SHA-224, SHA-256             | -               | -                           |
| Tamper Detection                                   | -               | -                           |
| Run-time Integrity Checker and Security Controller | -               | -                           |
| Random Number Generator (NIST SP 800-90)           | -               | -                           |
| Secure JTAG Controller (with electrical fuses)     | -               | -                           |
| Secure real-time clock                             | -               | -                           |
| Universal Unique ID                                | -               | -                           |

### 1.4.2 Memory

|                                     | Colibri VF50           | Colibri VF61           |
|-------------------------------------|------------------------|------------------------|
| DDR3 RAM (16 bit mode, no ECC)*     | 128MB                  | 256MB                  |
| DDR3 RAM (8 bit mode, ECC enabled)* | 64MB                   | 128MB                  |
| On-chip SRAM                        | 1.5MB (512KB with ECC) | 1.0MB (512KB with ECC) |
| NAND Flash (8Bit)                   | 128MB                  | 512MB                  |

\*The DDR3 RAM can be software configured to be used either in 16bit mode without ECC or in 8bit mode with ECC. Flash write endurance is limited. Extensive writing to the memory can wear out the memory cell. Software wear levelling makes sure the cells are getting worn out evenly. More information can be found here <http://developer.toradex.com/knowledge-base/flash-memory> and here [https://en.wikipedia.org/wiki/Flash\\_memory#Write\\_endurance](https://en.wikipedia.org/wiki/Flash_memory#Write_endurance).

### 1.4.3 Interfaces

|  | Colibri VF50 | Colibri VF61 |
|--|--------------|--------------|
| LCD RGB 24bpp (1024x768 maximum resolution)                                | ✓            | ✓            |
| Resistive Touch Screen 4 Wire  | ✓            | ✓            |
| Resistive Touch Screen 5 Wire  | -            | -            |
| Audio I/O  | -            | ✓            |
| ADC 12bit  | 4+12*        | 4+8*         |
| DAC 12bit  | 2*           | -            |
| Camera Interface (10bit)   | ✓            | ✓            |
| I2C  | 1+3*         | 1+3*         |
| SPI  | 1+3*         | 1+3*         |
| UART   | 3+2*         | 3+2*         |
| SD/SDIO/MMC (4bit)   | 1+1*         | 1+1*         |
| GPIO   | Up to 103    | Up to 99     |
| USB 2.0 High Speed OTG (host/device)                                       | ✓            | ✓            |
| USB 2.0 High Speed Host  | ✓            | ✓            |
| 10/100 Mbit/s Ethernet with auto MDI/MDI-X and IEEE1588                    | ✓            | ✓            |
| RMI interface for 2 <sup>nd</sup> Ethernet PHY on Baseboard with L2 Switch | ✓*           | ✓*           |
| PWM  | 4+13*        | 4+13*        |
| S/PDIF In  | ✓*           | ✓*           |
| S/PDIF Out   | ✓*           | ✓*           |
| Enhanced Serial Audio Interface (I2S, AC97 compatible)                     | ✓*           | ✓*           |
| CAN  | 2*           | 2*           |
| Reference Clock Output   | 1+1*         | 1+1*         |
| QuadSPI  | 2*           | 2*           |
| Analogue Video ADC inputs (PAL/NTSC)                                       | -            | 4*           |
| Anti-Tamper Protection Signals   | -            | -            |

\*These interfaces are available on pins that are not compatible within the Colibri family. There are restrictions to using different interfaces simultaneously, please check the available alternative functions of the Vybrid pins.

### 1.4.4 Supported Operating Systems

|                                   | Colibri VF50 | Colibri VF61 |
|-----------------------------------|--------------|--------------|
| Embedded Linux                    | ✓            | ✓            |
| Windows CE6.0                     | ✓            | ✓            |
| Android (contact Toradex)         | ✓            | ✓            |
| eCos RTOS (M4 Processor)          | -            | ✓            |
| Freescale MQX RTOS (M4 Processor) | -            | ✓            |

## 1.5 Reference Documents

### 1.5.1 Freescale Vybrid Controller

You will find more details about the Vybrid chip in the Datasheet and Technical Reference Manual provided by NXP:

<http://www.nxp.com/products/microcontrollers-and-processors/arm-processors/vfxxx-controller:VYBRID>

### 1.5.2 Ethernet Physical Layer Transceiver

Colibri VFxx uses the Microchip KSZ8041NL Ethernet PHY:

<http://www.microchip.com/wwwproducts/en/KSZ8041>

### 1.5.3 Audio Codec and Touch Screen Controller (only on Colibri VF61)

Colibri VF61 uses the Cirrus Logic WM9715L Audio Controller:

<https://www.cirrus.com/products/wm9715/>

### 1.5.4 Toradex Migration Guide

This document provides additional information about pin usage and describes the functional compatibility with the rest of the Colibri family. Please study this document in detail prior to starting your carrier board design.

<http://docs.toradex.com/100188-colibri-migration-and-design-guide.pdf>

<http://developer.toradex.com/carrier-board-design>

### 1.5.5 Toradex Developer Center

There is additional information in the Toradex Developer Center, which is regularly updated with the latest product support information.

Please note that the Developer Center is common for all Toradex products. You should always check to ensure if information is valid or relevant for the Colibri VFxx.

<http://www.developer.toradex.com>

### 1.5.6 Colibri Carrier Board Schematics

We provide the complete schematics and the Altium project file which includes library symbols and IPC-7351 compliant footprints for the Colibri Evaluation Board and other Carrier Boards free of charge. This is a great help when designing your own Carrier Board.

<http://developer.toradex.com/carrier-board-design/reference-designs>



## 2 Architecture Overview

### 2.1 Block Diagram Colibri VF61

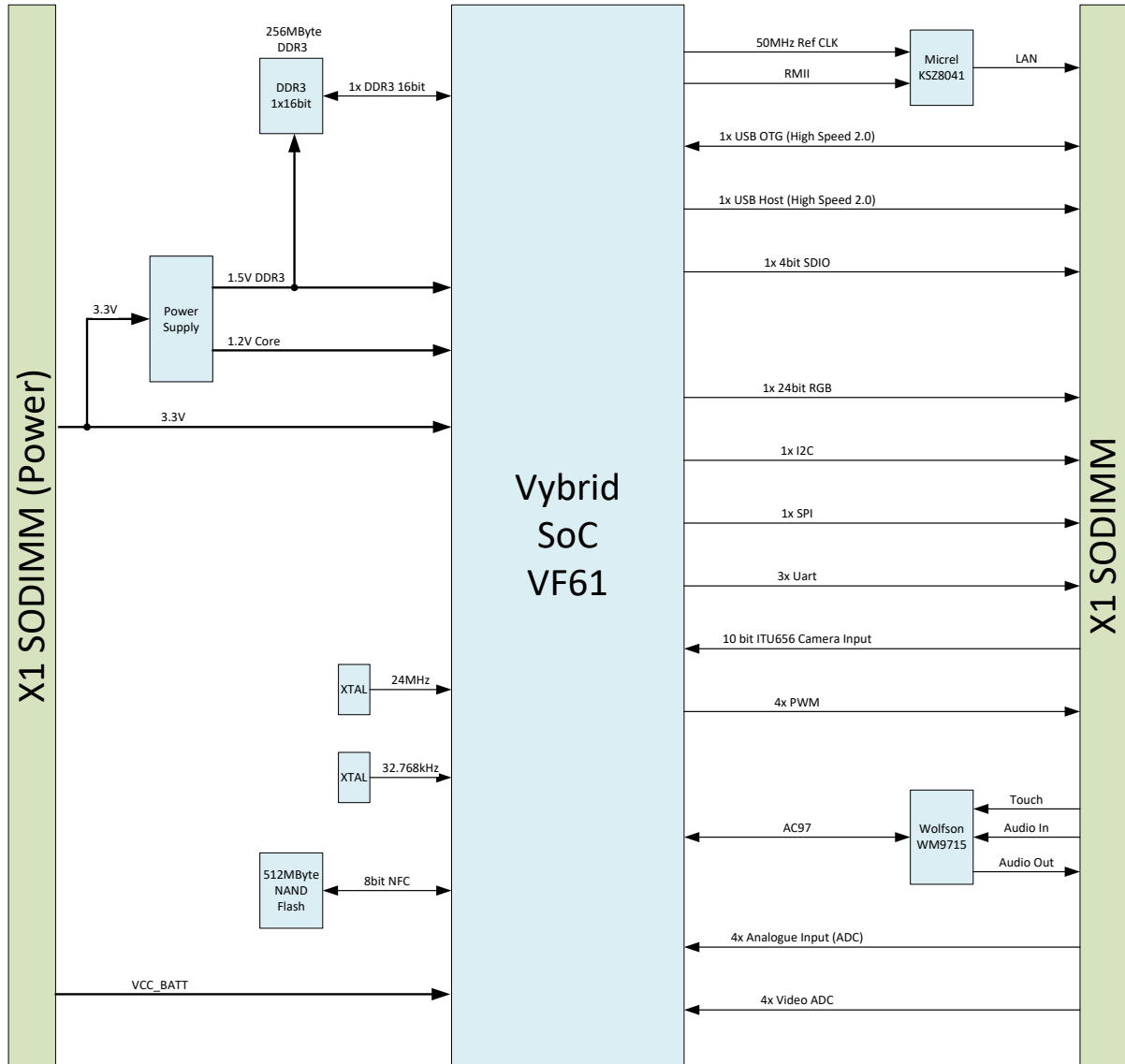


Figure 1 Colibri VF61 Block Diagram

## 2.2 Block Diagram Colibri VF50

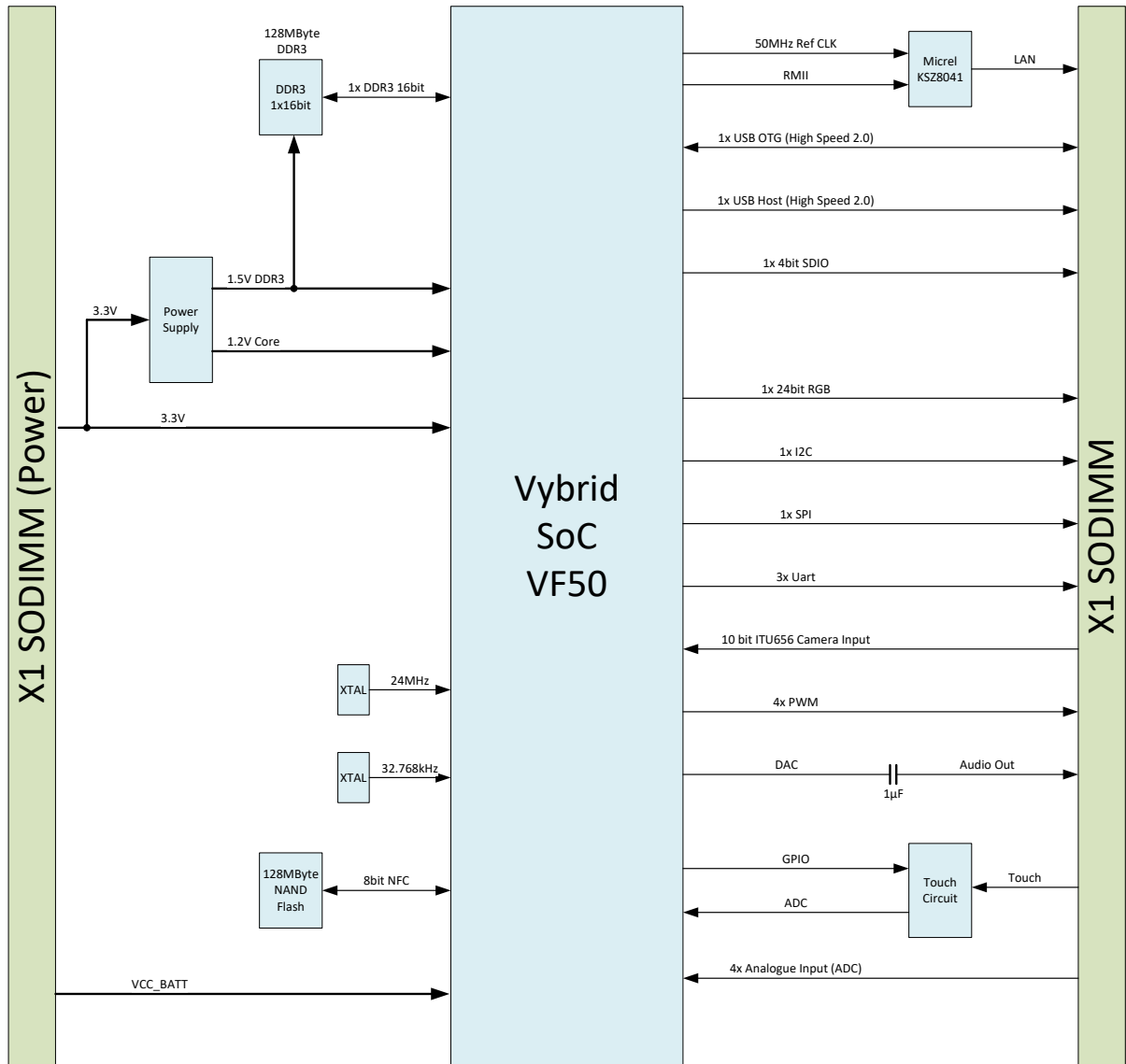


Figure 2 Colibri VF50 Block Diagram

## 3 Colibri VFxx SODIMM Connector

### 3.1 Physical Location

Colibri VFxx modules are equipped with a 200 Pin SODIMM edge connector (X1). Some of the edge connector fingers are missing because they are not connected to any signal on the module. In order to be compatible with the pin numbering of the Colibri family, these pin numbers are maintained. The figure below shows these pin positions and numbers.

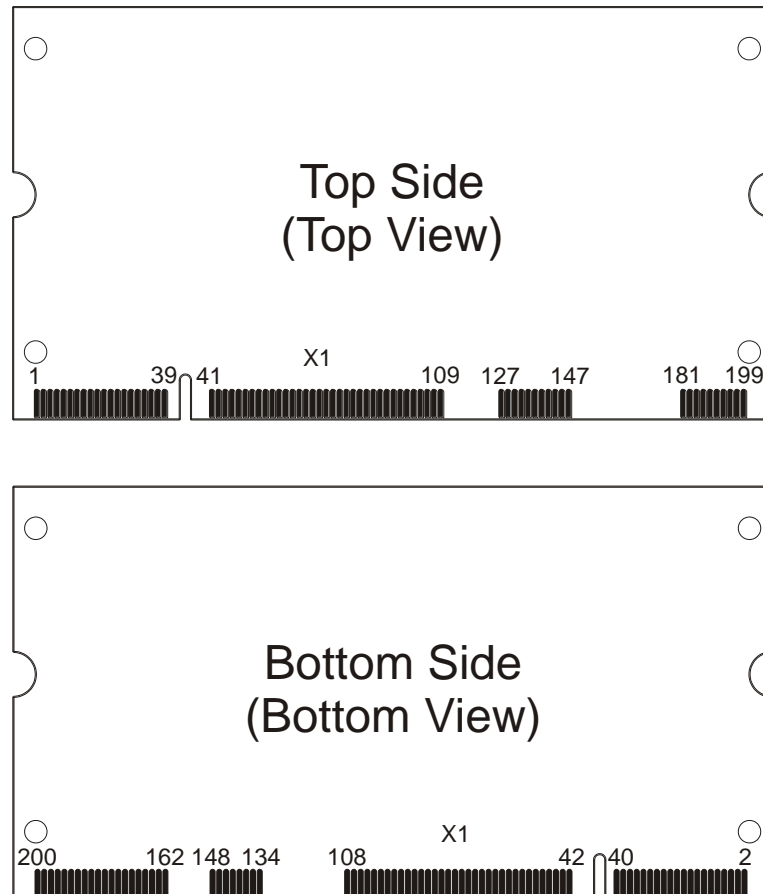


Figure 3 Location and pin numbering of SODIMM edge connector

### 3.2 Pin Assignment

The table below details the SODIMM 200 way connector pin functionality.

It should be noted that some of the pins are multiplexed; there is more than one Vybrid pin connected to one SODIMM or FFC pin. For example, PTB9 and PTC6 are both assigned to SODIMM pin 67. Care should be taken to ensure that multiplexed pins are tri-stated when they are not being used (e.g., if Vybrid pin A and pin B are tied to SODIMM pin 1, then if you are driving Vybrid pin A, then pin B should be tri-stated). Additional information can be found in chapter 4.1: Function Multiplexing.

Some of the SODIMM pins are not connected to anything on the module. The finger pads of these pins are not present on the modules.

- X1 Pin: Pin number on the SODIMM connector (X1).
- Compatible function: The default function which is compatible with all Colibri modules. **IMPORTANT:** There are some limitations. You can find more information about pin compatibility in the “**Colibri Migration Guide**”.
- VFxx CPU Pin: The name of the pin of the Vybrid chip. This is also the name of the GPIO function which is available on this pin
- Non VFxx CPU Pins: Peripheral functions which are not directly provided by the Vybrid chip.
- Note: Additional information. Some pins are noted as “only GPIO”. These pins can provide only the GPIO functionality, not the Colibri compatible function. Some of the Colibri compatible functions might be emulated by programmably manipulating the GPIO.

Table 3-1 X1 Connector

| X1 Pin | Compatible Function                 | VFxx CPU Pin | Non VFxx CPU Pins | Note   |
|--------|-------------------------------------|--------------|-------------------|--|
| 1      | Audio Analogue Microphone Input     |              | MIC_IN            | Colibri VF61 only, not available on Colibri VF50 |
| 3      | Audio Analogue Microphone GND       |              | MIC_GND           | Colibri VF61 only, not available on Colibri VF50 |
| 5      | Audio Analogue Line-In Left         |              | LINEIN_L          | Colibri VF61 only, not available on Colibri VF50 |
| 7      | Audio Analogue Line-In Right        |              | LINEIN_R          | Colibri VF61 only, not available on Colibri VF50 |
| 9      | Audio_Analogue GND                  |              | VSS_AUDIO         | Colibri VF61 only, not available on Colibri VF50 |
| 11     | Audio_Analogue GND                  |              | VSS_AUDIO         | Colibri VF61 only, not available on Colibri VF50 |
| 13     | Audio Analogue Headphone GND        |              | HEADPHONE_GND     | Colibri VF61 only, Colibri VF50: VSS_AUDIO       |
| 15     | Audio Analogue Headphone Left       |              | HEADPHONE_L       | Colibri VF61 only, Colibri VF50: DAC00           |
| 17     | Audio Analogue Headphone Right      |              | HEADPHONE_R       | Colibri VF61 only, Colibri VF50: DAC01           |
| 19     | UART_C RXD                          | PTB5         |                   |  |
| 21     | UART_C TXD                          | PTB4         |                   |  |
| 23     | UART_A DTR                          | PTA20        |                   | only GPIO  |
| 25     | UART_A CTS, Keypad_In<0>            | PTB13        |                   |  |
| 27     | UART_A RTS                          | PTB12        |                   |  |
| 29     | UART_A DSR                          | PTA31        |                   | only GPIO  |
| 31     | UART_A DCD                          | PTA21        |                   | only GPIO  |
| 33     | UART_A RXD                          | PTB11        |                   |  |
| 35     | UART_A TXD                          | PTB10        |                   |  |
| 37     | UART_A RI, Keypad_In<4>             | PTA30        |                   | only GPIO  |
| 39     | GND                                 |              | GND               |  |
| 41     | GND                                 |              | GND               |  |
| 43     | WAKEUP Source<0>, SDCard CardDetect | PTB20        |                   |  |
| 45     | GPIO                                | PTB19        |                   | only GPIO  |
| 47     | SDCard CLK                          | PTA24        |                   |  |
| 49     | SDCard DAT<1>                       | PTA27        |                   |  |
| 51     | SDCard DAT<2>                       | PTA28        |                   |  |

| X1 Pin | Compatible Function                       | VFxx CPU Pin     | Non VFxx CPU Pins   | Note                                       |
|--------|---|------------------|---------------------|--|
| 53     | SDCard DAT<3>                             | PTA29            |                     |  |
| 55     | GPIO                                      | PTB17            |                     | only GPIO                                  |
| 57     | LCD RGB Data<16>                          | PTE11            |                     |  |
| 59     | PWM<A>, Camera Input Data<7>              | PTB0<br>PTC7     |                     | Multiplexed (Two Vybrid Pins)              |
| 61     | LCD RGB Data<17>                          | PTE12            |                     |  |
| 63     | GPIO                                      | PTB16            |                     | only GPIO                                  |
| 65     | Camera Input Data<9>, Keypad_Out<3>       | PTB18            |                     |  |
| 67     | PWM<D>, Camera Input Data<6>              | PTB9<br>PTC6     |                     | Multiplexed (Two Vybrid Pins)              |
| 69     | GPIO                                      | PTD30            |                     | only GPIO                                  |
| 71     | Camera Input Data<0>, LCD Back-Light GPIO | PTC0             |                     |  |
| 73     | GPIO                                      | PTB21            |                     | only GPIO                                  |
| 75     | GPIO                                      | PTD12            |                     | only GPIO                                  |
| 77     | GPIO                                      | PTB22            |                     | only GPIO                                  |
| 79     | Camera Input Data<4>                      | PTC4             |                     |  |
| 81     | Camera Input VSYNC                        | PTB7             |                     |  |
| 83     | GND                                       |                  | GND                 |  |
| 85     | Camera Input Data<8>, Keypad_Out<4>       | PTC8             |                     |  |
| 87     | nReset Out                                | RESETB/RESET_OUT |                     | Not GPIO capable                           |
| 89     | GPIO                                      | JTDI             |                     | GPIO Pin PTA9                              |
| 91     | Recovery Mode                             |                  | Recovery glue logic | Pull to GND for entering the Serial loader |
| 93     | GPIO                                      | PTB28            |                     | only GPIO                                  |
| 95     | GPIO                                      | PTC30            |                     | only GPIO                                  |
| 97     | Camera Input Data<5>                      | PTC5             |                     |  |
| 99     | GPIO                                      | PTD29            |                     | only GPIO                                  |
| 101    | Camera Input Data<2>                      | PTC2             |                     |  |
| 103    | Camera Input Data<3>                      | PTC3             |                     |  |
| 105    | GPIO                                      | PTB26            |                     | only GPIO                                  |
| 107    | GPIO                                      | PTD27            |                     | only GPIO                                  |
| 109    | GND                                       |                  | GND                 |  |
| 111    |   |                  | no connection       |  |
| 113    |   |                  | no connection       |  |
| 115    |   |                  | no connection       |  |
| 117    |   |                  | no connection       |  |
| 119    |   |                  | no connection       |  |
| 121    |   |                  | no connection       |  |
| 123    |   |                  | no connection       |  |
| 125    |   |                  | no connection       |  |
| 127    | GPIO                                      | PTD26            |                     | only GPIO                                  |
| 129    | USB Host Power Enable                     | PTD4             |                     | only GPIO                                  |

| X1 Pin | Compatible Function           | VFxx CPU Pin              | Non VFxx CPU Pins | Note                             |
|--------|-------------------------------|---------------------------|-------------------|----------------------------------|
| 131    | Usb Host Over-Current Detect  | PTE3                      |                   | only GPIO                        |
| 133    | GPIO                          | PTD9                      |                   | only GPIO                        |
| 135    | GPIO                          | PTD10                     |                   | only GPIO                        |
| 137    | USB Client Cable Detect       | PTC29<br>USB0_VBUS_DETECT |                   | Multiplexed<br>(Two Vybrid Pins) |
| 139    | USB Host DP                   | USB1_DP                   |                   |                                  |
| 141    | USB Host DM                   | USB1_DM                   |                   |                                  |
| 143    | USB Client DP                 | USB0_DP                   |                   |                                  |
| 145    | USB Client DM                 | USB0_DM                   |                   |                                  |
| 147    | GND                           |                           | GND               |                                  |
| 149    |                               |                           | no connection     |                                  |
| 151    |                               |                           | no connection     |                                  |
| 153    |                               |                           | no connection     |                                  |
| 155    |                               |                           | no connection     |                                  |
| 157    |                               |                           | no connection     |                                  |
| 159    |                               |                           | no connection     |                                  |
| 161    |                               |                           | no connection     |                                  |
| 163    |                               |                           | no connection     |                                  |
| 165    |                               |                           | no connection     |                                  |
| 167    |                               |                           | no connection     |                                  |
| 169    |                               |                           | no connection     |                                  |
| 171    |                               |                           | no connection     |                                  |
| 173    |                               |                           | no connection     |                                  |
| 175    |                               |                           | no connection     |                                  |
| 177    |                               |                           | no connection     |                                  |
| 179    |                               |                           | no connection     |                                  |
| 181    | GND                           |                           | GND               |                                  |
| 183    | Ethernet Link/Activity Status |                           | LINK_AKT          |                                  |
| 185    | Ethernet Speed Status         |                           | SPEED100          |                                  |
| 187    | Ethernet TXO-                 |                           | TXO-              |                                  |
| 189    | Ethernet TXO+                 |                           | TXO+              |                                  |
| 191    | Ethernet GND                  |                           | AGND_LAN          |                                  |
| 193    | Ethernet RXI-                 |                           | RXI-              |                                  |
| 195    | Ethernet RXI+                 |                           | RXI+              |                                  |
| 197    | GND                           |                           | GND               |                                  |
| 199    | GND                           |                           | GND               |                                  |
| 2      | Analogue Input<3>             | ADC1SE9                   |                   |                                  |
| 4      | Analogue Input<2>             | ADC0SE9                   |                   |                                  |
| 6      | Analogue Input <1>            | ADC1SE8                   |                   |                                  |
| 8      | Analogue Input <0>            | ADC0SE8                   |                   |                                  |
| 10     | Audio_Analogue VDD            |                           | AVDD_AUDIO        |                                  |
| 12     | Audio_Analogue VDD            |                           | AVDD_AUDIO        |                                  |

| X1 Pin | Compatible Function  | VFxx CPU Pin     | Non VFxx CPU Pins | Note  |
|--------|----------------------|------------------|-------------------|---|
| 14     | Resistive Touch PX   | PTA19            | TSPX              | CPU Pin only available on VF50  |
| 16     | Resistive Touch MX   | PTA18            | TSMX              | CPU Pin only available on VF50  |
| 18     | Resistive Touch PY   | PTA16            | TSPY              | CPU Pin only available on VF50  |
| 20     | Resistive Touch MY   | PTB2             | TSMY              | CPU Pin only available on VF50  |
| 22     |                      | PTC31            |                   |   |
| 24     | Battery Fault Detect | PTB3             |                   |   |
| 26     | nReset In            | RESETB/RESET_OUT |                   | Not GPIO capable  |
| 28     | PWM<B>               | PTB8             |                   |   |
| 30     | PWM<C>               | PTB1             |                   |   |
| 32     | UART_B CTS           | PTD3             |                   |   |
| 34     | UART_B RTS           | PTD2             |                   |   |
| 36     | UART_B RXD           | PTD1             |                   |   |
| 38     | UART_B TXD           | PTD0             |                   |   |
| 40     | VCC_BATT             |                  | VCC_BATT          |   |
| 42     | 3V3                  |                  | 3V3               |   |
| 44     | LCD RGB DE           | PTE4             |                   |   |
| 46     | LCD RGB Data<7>      | PTE16            |                   |   |
| 48     | LCD RGB Data<9>      | PTE18            |                   |   |
| 50     | LCD RGB Data<11>     | PTE20            |                   |   |
| 52     | LCD RGB Data<12>     | PTE7             |                   |   |
| 54     | LCD RGB Data<13>     | PTE8             |                   |   |
| 56     | LCD RGB PCLK         | PTE2             |                   |   |
| 58     | LCD RGB Data<3>      | PTE26            |                   |   |
| 60     | LCD RGB Data<2>      | PTE25            |                   |   |
| 62     | LCD RGB Data<8>      | PTE17            |                   |   |
| 64     | LCD RGB Data<15>     | PTE10            |                   |   |
| 66     | LCD RGB Data<14>     | PTE9             |                   |   |
| 68     | LCD RGB HSYNC        | PTE0             |                   | Do not pull up these signals during power up (strapping) see information in section 7 |
| 70     | LCD RGB Data<1>      | PTE24            |                   |   |
| 72     | LCD RGB Data<5>      | PTE28            |                   |   |
| 74     | LCD RGB Data<10>     | PTE19            |                   |   |
| 76     | LCD RGB Data<0>      | PTE23            |                   |   |
| 78     | LCD RGB Data<4>      | PTE27            |                   |   |
| 80     | LCD RGB Data<6>      | PTE15            |                   |   |
| 82     | LCD RGB VSYNC        | PTE1             |                   | Do not pull up these signals during power up (strapping) see information in section 7 |
| 84     | 3V3                  |                  | 3V3               |   |
| 86     | SPI CS               | PTD5             |                   |   |
| 88     | SPI CLK              | PTD8             |                   |   |

| X1 Pin | Compatible Function  | VFxx CPU Pin | Non VFxx CPU Pins | Note  |
|--------|----------------------|--------------|-------------------|---|
| 90     | SPI RXD              | PTD6         |                   |   |
| 92     | SPI TXD              | PTD7         |                   |   |
| 94     | Camera Input HSYNC   | PTB6         |                   |   |
| 96     | Camera Input PCLK    | PTA7         |                   |   |
| 98     | Camera Input Data<1> | PTC1         |                   |   |
| 100    | Keypad_Out<1>        | PTD13        |                   | only GPIO                                     |
| 102    | GPIO                 | PTA12        |                   | only GPIO                                     |
| 104    | GPIO                 | PTD28        |                   | only GPIO                                     |
| 106    | GPIO                 | PTD31        |                   | only GPIO                                     |
| 108    | 3V3                  |              | 3V3               |   |
| 110    |                      |              | no connection     |   |
| 112    |                      |              | no connection     |   |
| 114    |                      |              | no connection     |   |
| 116    |                      |              | no connection     |   |
| 118    |                      |              | no connection     |   |
| 120    |                      |              | no connection     |   |
| 122    |                      |              | no connection     |   |
| 124    |                      |              | no connection     |   |
| 126    |                      |              | no connection     |   |
| 128    |                      |              | no connection     |   |
| 130    |                      |              | no connection     |   |
| 132    |                      |              | no connection     |   |
| 134    | GPIO                 | PTA17        |                   | only GPIO                                     |
| 136    | GPIO                 | PTE21        |                   | LCD RGB Data<18>, compatible with Colibri Txx |
| 138    | GPIO                 | PTE22        |                   | LCD RGB Data<19>, compatible with Colibri Txx |
| 140    | GPIO                 | PTE13        |                   | LCD RGB Data<20>, compatible with Colibri Txx |
| 142    | GPIO                 | PTE14        |                   | LCD RGB Data<21>, compatible with Colibri Txx |
| 144    | GPIO                 | PTE5         |                   | LCD RGB Data<22>, compatible with Colibri Txx |
| 146    | GPIO                 | PTE6         |                   | LCD RGB Data<23>, compatible with Colibri Txx |
| 148    | 3V3                  |              | 3V3               |   |
| 150    |                      |              | no connection     |   |
| 152    |                      |              | no connection     |   |
| 154    |                      |              | no connection     |   |
| 156    |                      |              | no connection     |   |
| 158    |                      |              | no connection     |   |
| 160    |                      |              | no connection     |   |
| 162    |                      | VADCSE0      |                   | Analog Video Input (Colibri VF61 only)        |
| 164    |                      | VADCSE1      |                   | Analog Video Input (Colibri VF61 only)        |



| X1 Pin | Compatible Function | VFxx CPU Pin                       | Non VFxx CPU Pins | Note                                   |
|--------|---------------------|------------------------------------|-------------------|--|
| 166    |                     | VADCSE2                            |                   | Analog Video Input (Colibri VF61 only) |
| 168    |                     | VADCSE3                            |                   | Analog Video Input (Colibri VF61 only) |
| 170    |                     | EXT_TAMPER0                        |                   | Security Feature (not supported)       |
| 172    |                     | EXT_TAMPER1                        |                   | Security Feature (not supported)       |
| 174    |                     | EXT_TAMPER2/EXT_W<br>M0_TAMPER_IN  |                   | Security Feature (not supported)       |
| 176    |                     | EXT_TAMPER3/EXT_W<br>M0_TAMPER_OUT |                   | Security Feature (not supported)       |
| 178    |                     | EXT_TAMPER4/EXT_W<br>M1_TAMPER_IN  |                   | Security Feature (not supported)       |
| 180    |                     | EXT_TAMPER5/EXT_W<br>M1_TAMPER_OUT |                   | Security Feature (not supported)       |
| 182    | 3V3                 |                                    | 3V3               |  |
| 184    | GPIO                | PTD25                              |                   | only GPIO                              |
| 186    | GPIO                | PTD24                              |                   | only GPIO                              |
| 188    | GPIO                | PTD11                              |                   | only GPIO                              |
| 190    | SDCard CMD          | PTA25                              |                   |  |
| 192    | SDCard DAT<0>       | PTA26                              |                   |  |
| 194    | I2C SDA             | PTB15                              |                   |  |
| 196    | I2C SCL             | PTB14                              |                   |  |
| 198    | 3V3                 |                                    | 3V3               |  |
| 200    | 3V3                 |                                    | 3V3               |  |

## 4 I/O Pins

### 4.1 Function Multiplexing

The Freescale Vybrid SoC I/O pins can be configured in any of up to eight alternate functions. Most of the pins can also be used as “normal” GPIOs (General Purpose I/O, sometimes also referred to as Digital I/O). For example, the Vybrid signal pin on the SODIMM finger pin 19 has the primary function SCI1\_RX (Colibri standard function UART\_C\_RXD), but can also provide the following alternative functions: PTB5 (GPIO), FTM0\_CH5 (PWM output), ADC1\_SE4 (ADC input), LCD39 (LCD output), VIU\_DE (Camera input), VIU\_DATA23 (Camera Input) or QSPI1\_A\_DQS (QSPI interface).

The default setting for this pin is the primary function SCI1\_RX. It is strongly recommended to, whenever possible, use a pin for a function which is compatible with all Colibri modules. This guarantees the best compatibility with the standard software and with the other modules in the Colibri family.

Some of the alternative functions are available on more than one pin. For example, the SCI1\_CTS function is available at the SODIMM pins 81, 97 and 105. Care should be taken to ensure that two pins are not configured with the same function. This could lead to system instability and undefined behaviour.

In some cases, the available alternative functions of certain pins on the Vybrid SoC are constrained; to allow maximum flexibility, some of these pins are paired and share the same SODIMM pin. As previously mentioned, ensure that the unused pin in the pair is tri-stated to avoid undesired behaviour and/or hardware damage.

The following X1 connector pins are connected to more than one Vybrid pin:

Table 4-1 Colibri Multiplexed Pins

| X1 Pin # | Vybrid Pin 1 | Vybrid Pin 2     | Remarks  |
|----------|--------------|------------------|--|
| 59       | PTB0         | PTC7             | PWM and Camera input are both Colibri standard functions |
| 67       | PTB9         | PTC6             | PWM and Camera input are both Colibri standard functions |
| 137      | PTC29        | USB0_VBUS_DETECT | USB0_VBUS_DETECT is not GPIO capable                     |

The RESETB/RESET\_OUT pin of the Vybrid SoC is the reset input to the processor as well as a reset output from the SoC. Since the other computer modules in the Colibri family feature separate reset input (SODIMM Pin 26 nRESET\_EXT) and output (SODIMM Pin 87 nRESET\_OUT) pins, the RESETB/RESET\_OUT signal is routed to both SODIMM pins with the circuit shown in Figure 4.

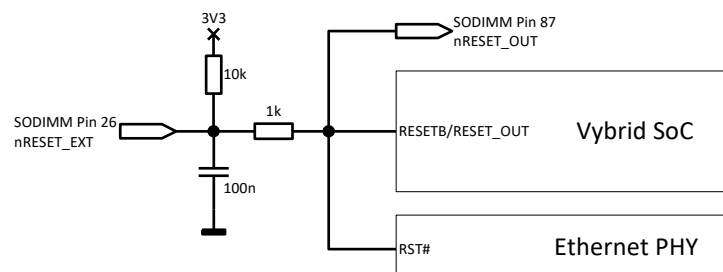


Figure 4 Reset Circuit

## 4.2 Pin Control

The alternative function of each pin can be changed independently. Every pin has a Software MUX Pad Control Register in which the following settings can be set (some settings might be not available on certain pins). The Register is called IOMUXC\_x where x is the name of the Vybrid pin. More information about the available register settings can be found in the Vybrid Reference Manual.

Table 4-2 Software Mux Pad Control Register

| Bit   | Field    | Description  | Remarks  |
|-------|----------|--|--|
| 31-23 | Reserved |  |  |
| 22-20 | MUX_MODE | 000 Select mux mode: ALT0 mux port (GPIO)<br>001 Select mux mode: ALT1 mux port<br>010 Select mux mode: ALT2 mux port<br>011 Select mux mode: ALT3 mux port<br>100 Select mux mode: ALT4 mux port<br>101 Select mux mode: ALT5 mux port<br>110 Select mux mode: ALT6 mux port<br>111 Select mux mode: ALT7 mux port: | Check chapter 4.1 for the available alternative function of the pin                                  |
| 19-14 | Reserved |  |  |
| 13-12 | SPEED    | 00 Low (50 MHz)<br>01 Medium (100 MHz)<br>10 Medium (100 MHz)<br>11 High (200 MHz)   |  |
| 11    | SRE      | 0 Slow Slew Rate<br>1 Fast Slew Rate   | Use slow slew rate if possible for reducing EMC problems   |
| 10    | ODE      | 0 Output is CMOS<br>1 Output is open drain   |  |
| 9     | HYS      | 0 CMOS input<br>1 Schmitt trigger input  |  |
| 8-6   | DSE      | 000 output driver disabled<br>001 150 Ohm (240 Ohm if pad is DDR)<br>010 75 Ohm (120 Ohm if pad is DDR)<br>011 50 Ohm (80 Ohm if pad is DDR)<br>100 37 Ohm (60 Ohm if pad is DDR)<br>101 30 Ohm (48 Ohm if pad is DDR)<br>110 25 Ohm<br>111 20 Ohm (34 Ohm if pad is DDR)  | If possible decrease the drive strength by increasing the resistance in order to reduce EMC problems |
| 5-4   | PUS      | 00 100 kOhm Pull Down<br>01 47 kOhm Pull Up<br>10 100 kOhm Pull Up<br>11 22 kOhm Pull Up   |  |
| 3     | PKE      | 0 Pull/Keeper Disabled<br>1 Pull/Keeper Enabled  | Enable keeper or pull up/down function   |
| 2     | PUE      | 0 Keeper enable<br>1 Pull enable   | Selection between keeper and pull up/down function   |
| 1     | OBE      | 0 Output buffer disabled<br>1 Output buffer enabled  | Set to 0 if pin is used as input (default value)   |
| 0     | IBE      | 0 Input buffer disabled<br>1 Input buffer enabled  |  |

## 4.3 Pin Reset Status

After a reset, all GPIO compatible Vybrid pins that are available at the SODIMM connector are configured to have the output buffer disabled (OBE = 0) and the internal pull up/down resistors disabled (PKE = 0). This means all the pins are initially in high-Z state. As soon as the bootloader is running, it is possible to reconfigure the pins and their states.

## 4.4 List Functions

Below is a list of all the Vybrid pins which are available on the SODIMM connector X1. It shows what alternative functions are available for each pin. The GPIO functionality is located always as the ALTO function. The default functions for compatibility with other Colibri module types are highlighted.

### Function Short Forms

|                |   |
|----------------|---|
| <b>SCI:</b>    | Serial Communications Interface (Universal Asynchronous Receiver/Transmitter) |
| <b>VUI:</b>    | Video Interface Unit (Camera Interface)                                       |
| <b>SPDIF:</b>  | S/PDIF (Sony-Philips Digital Interface I/O)                                   |
| <b>SDIO:</b>   | Secure Card I/O (SD, MMC, CE-ATA, eMMC)                                       |
| <b>SDHC:</b>   | Secure Digital Memory Card High Capacity (SD, MMC, CE-ATA, eMMC)              |
| <b>SPI:</b>    | Serial Peripheral Interface Bus   |
| <b>QSPI:</b>   | Quad Serial Peripheral Interface Bus  |
| <b>FB:</b>     | FlexBus, external bus (only partial usable)                                   |
| <b>DCU:</b>    | Display Control Unit, parallel display interface                              |
| <b>LCD:</b>    | Segmented LCD (only partial usable)   |
| <b>SAI:</b>    | Serial Audio Interface (I2S and AC97)   |
| <b>ESAI:</b>   | Enhanced Serial Audio Interface (I2S and AC97)                                |
| <b>FTM:</b>    | FlexTimer, general purpose timer, can be used as PWM output                   |
| <b>CAN:</b>    | Controller Area Network   |
| <b>I2C:</b>    | Inter Integrated Circuit  |
| <b>RMII:</b>   | Reduced Media Independent Interface (interface between Ethernet MAC and PHY)  |
| <b>NF:</b>     | NAND Flash, Interface for the internal NAND Flash                             |
| <b>ADC:</b>    | Analogue to Digital Converter   |
| <b>DACO:</b>   | Digital to Analogue Converter Output  |
| <b>VADCSE:</b> | Video ADC, composite video input  |
| <b>TAMPER:</b> | Tamper detection signal   |

| X1 Pin | GPIO Pad | GPIO Port | ALT0 (GPIO)          | ALT1                       | ALT2           | ALT3            | ALT4                    | ALT5             | ALT6       | ALT7                      |
|--------|----------|-----------|----------------------|----------------------------|----------------|-----------------|-------------------------|------------------|------------|---------------------------|
| 19     | PAD_27   | PORT0[27] | PTB5                 | FTM0_CH5                   | SCI1_RX        | ADC1_SE4        | LCD39                   | VIU_DE           | VIU_DATA23 | QSPI1_A_DQS               |
| 21     | PAD_26   | PORT0[26] | PTB4                 | FTM0_CH4                   | SCI1_TX        | ADC0_SE4        | LCD38                   | VIU_FID          | VIU_DATA22 | QSPI1_A_DATA0             |
| 23     | PAD_10   | PORT0[10] | PTA20                | TRACED4                    |                |                 | LCD33                   |                  | SCI3_TX    | DCU1_HSYNC/<br>DCU1_TCON1 |
| 25     | PAD_35   | PORT1[3]  | PTB13                | SCI0_CTS                   |                | SPI0_PCS4       | DCU0_TCON7              | FB_AD0           | TRACECTL   |                           |
| 27     | PAD_34   | PORT1[2]  | PTB12                | SCI0_RTS                   |                | SPI0_PCS5       | DCU0_TCON6              | FB_AD1           | NMI        | ENET0_1588_TMR1           |
| 29     | PAD_21   | PORT0[21] | PTA31                | TRACED15                   | SAI3_TX_SYNC   | ENET1_1588_TMR3 | SCI4_CTS                | I2C3_SDA         |            | SCI3_RX                   |
| 31     | PAD_11   | PORT0[11] | PTA21/<br>MII0_RXCLK | TRACED5                    |                |                 |                         | SAI2_RX_BCLK     | SCI3_RX    | DCU1_VSYNC/<br>DCU1_TCON2 |
| 33     | PAD_33   | PORT1[1]  | PTB11                | SCI0_RX                    |                |                 | DCU0_TCON5              | SNVS_ALARM_OUT_B | CKO2       | ENET0_1588_TMR0           |
| 35     | PAD_32   | PORT1[0]  | PTB10                | SCI0_TX                    |                |                 | DCU0_TCON4              | VIU_DE           | CKO1       | ENET_TS_CLKIN             |
| 37     | PAD_20   | PORT0[20] | PTA30                | TRACED14                   | SAI3_RX_SYNC   | ENET1_1588_TMR2 | SCI4_RTS                | I2C3_SCL         |            | SCI3_TX                   |
| 43     | PAD_42   | PORT1[10] | PTB20                | SPI0_SIN                   |                |                 | LCD42                   |                  | VIU_DATA11 | CCM_OBS2                  |
| 45     | PAD_41   | PORT1[9]  | PTB19                | SPI0_PCS0                  |                |                 |                         |                  | VIU_DATA10 | CCM_OBS1                  |
| 47     | PAD_14   | PORT0[14] | PTA24                | TRACED8                    | USB1_VBUS_EN   |                 |                         | SDHC1_CLK        | DCU1_TCON4 |                           |
| 49     | PAD_17   | PORT0[17] | PTA27                | TRACED11                   | SAI3_RX_BCLK   |                 |                         | SDHC1_DAT1       | DCU1_TCON7 |                           |
| 51     | PAD_18   | PORT0[18] | PTA28                | TRACED12                   | SAI3_RX_DATA   | ENET1_1588_TMR0 | SCI4_TX                 | SDHC1_DAT2       | DCU1_TCON8 |                           |
| 53     | PAD_19   | PORT0[19] | PTA29                | TRACED13                   | SAI3_TX_DATA   | ENET1_1588_TMR1 | SCI4_RX                 | SDHC1_DAT3       | DCU1_TCON9 |                           |
| 55     | PAD_39   | PORT1[7]  | PTB17                | CAN1_TX                    | I2C1_SDA       |                 | DCU0_TCON11             |                  |            |                           |
| 57     | PAD_116  | PORT3[20] | PTE11                | DCU0_R6                    |                | RCON4           | LCD11                   |                  |            |                           |
| 59     | PAD_22   | PORT0[22] | PTB0                 | FTM0_CH0                   | ADC0_SE2       | TRACECTL        | LCD34                   | SAI2_RX_BCLK     | VIU_DATA18 | QSPI1_A_CS0               |
|        | PAD_52   | PORT1[20] | PTC7                 | RMII0_TXD0/<br>MII0_TXD[0] |                | SPI1_SOUT       | ESAI_SDO4/<br>ESAI_SDI1 |                  | VIU_DATA7  | DCU0_B0                   |
| 61     | PAD_117  | PORT3[21] | PTE12                | DCU0_R7                    | SPI1_PCS3      | RCON5           | LCD12                   |                  |            | LPT_ALT0                  |
| 63     | PAD_38   | PORT1[6]  | PTB16                | CAN1_RX                    | I2C1_SCL       |                 | DCU0_TCON10             |                  |            |                           |
| 65     | PAD_40   | PORT1[8]  | PTB18                | SPI0_PCS1                  | EXT_AUDIO_MCLK |                 | CKO1                    |                  | VIU_DATA9  | CCM_OBS0                  |
| 67     | PAD_31   | PORT0[31] | PTB9                 | FTM1_CH1                   |                | FTM1_QD_PHB     |                         |                  |            | DCU1_R7                   |
|        | PAD_51   | PORT1[19] | PTC6                 | RMII0_TXD1/<br>MII0_TXD[1] |                | SPI1_SIN        | ESAI_SDO5/ESAI_SDI0     | SDHC0_WP         | VIU_DATA6  | DCU0_G1                   |
| 69     | PAD_64   | PORT2[0]  | PTD30                | FB_AD30                    | NF_IO14        |                 | FTM3_CH1                | SPI2_PCS0        |            |                           |

| X1 Pin | GPIO Pad | GPIO Port | ALT0 (GPIO) | ALT1                       | ALT2        | ALT3                      | ALT4                    | ALT5           | ALT6         | ALT7      |
|--------|----------|-----------|-------------|----------------------------|-------------|---------------------------|-------------------------|----------------|--------------|-----------|
| 71     | PAD_45   | PORT1[13] | PTC0        | RMII0_MDC/<br>MII0_MDC     | FTM1_CH0    | SPI0_PCS3                 | ESAI_SCKT               | SDHC0_CLK      | VIU_DATA0    | RCON18    |
| 73     | PAD_43   | PORT1[11] | PTB21       | SPI0_SOUT                  |             |                           | LCD43                   |                | VIU_DATA12   | DCU1_PCLK |
| 75     | PAD_91   | PORT2[27] | PTD12       | QSPI0_B_DATA0              | SPI3_SOUT   |                           | FB_AD3                  |                |              |           |
| 77     | PAD_44   | PORT1[12] | PTB22       | SPI0_SCK                   |             |                           | VLCD                    | VIU_FID        |              |           |
| 79     | PAD_49   | PORT1[17] | PTC4        | RMII0_RXD0/<br>MII0_RXD[0] | SCI1_RTS    | SPI1_PCS1                 | ESAI_SDO2/<br>ESAI_SDI3 | SDHC0_DAT2     | VIU_DATA4    | DCU0_R1   |
| 81     | PAD_29   | PORT0[29] | PTB7        | FTM0_CH7                   | SCI1_CTS    | QSPI0_B_CS1               | LCD41                   |                | VIU_VSYNC    | SCI2_RX   |
| 85     | PAD_53   | PORT1[21] | PTC8        | RMII0_TXEN/<br>MII0_TXEN   |             | SPI1_SCK                  |                         |                | VIU_DATA8    | DCU0_B1   |
| 87     |          |           |             | RESETB/RESET_OUT           |             |                           |                         |                |              |           |
| 89     | PAD_2    | PORT0[2]  | PTA9        | JTDI                       | RMII_CLKOUT | RMII_CLKIN/<br>MII0_TXCLK | DCU0_R1                 |                | WDOG_b       |           |
| 93     | PAD_98   | PORT3[2]  | PTB28       | SAI0_TX_SYNC               |             | RCON23                    | FB_RW_b                 |                |              | DCU1_B6   |
| 95     | PAD_103  | PORT3[7]  | PTC30       | SAI1_RX_SYNC               | SPI1_PCS2   | RCON28                    | FB_MUXED_BE0_b          | FB_TSIZ0       | ADC0_SE5     | DCU1_B5   |
| 97     | PAD_50   | PORT1[18] | PTC5        | RMII0_RXER/<br>MII0_RXER   | SCI1_CTS    | SPI1_PCS0                 | ESAI_SDO3/<br>ESAI_SDI2 | SDHC0_DAT3     | VIU_DATA5    | DCU0_G0   |
| 99     | PAD_65   | PORT2[1]  | PTD29       | FB_AD29                    | NF_IO13     |                           | FTM3_CH2                | SPI2_SIN       |              |           |
| 101    | PAD_47   | PORT1[15] | PTC2        | RMII0_CRS_DV               | SCI1_TX     |                           | ESAI_SDO0               | SDHC0_DAT0     | VIU_DATA2    | RCON20    |
| 103    | PAD_48   | PORT1[16] | PTC3        | RMII0_RXD1/<br>MII0_RXD[1] | SCI1_RX     |                           | ESAI_SDO1               | SDHC0_DAT1     | VIU_DATA3    | DCU0_R0   |
| 105    | PAD_96   | PORT3[0]  | PTB26       | SAI0_TX_DATA               | SCI1_CTS    | RCON21                    | FB_CS0_b                | NF_CE1_b       |              | DCU1_G6   |
| 107    | PAD_67   | PORT2[3]  | PTD27       | FB_AD27                    | NF_IO11     | I2C2_SDA                  | FTM3_CH4                | SPI2_SCK       |              |           |
| 127    | PAD_68   | PORT2[4]  | PTD26       | FB_AD26                    | NF_IO10     |                           | FTM3_CH5                | SDHC1_WP       |              |           |
| 129    | PAD_83   | PORT2[19] | PTD4        | QSPI0_A_DATA1              |             | SPI1_PCS1                 | FB_AD11                 | SPDIF_SRCLK    |              |           |
| 131    | PAD_108  | PORT3[12] | PTE3        | DCU0_TAG/<br>DCU0_TCON0    |             |                           | LCD3                    |                |              |           |
| 133    | PAD_88   | PORT2[24] | PTD9        | QSPI0_B_DATA3              | SPI3_PCS1   |                           | FB_AD6                  |                | SAI1_TX_SYNC | DCU1_B0   |
| 135    | PAD_89   | PORT2[25] | PTD10       | QSPI0_B_DATA2              | SPI3_PCS0   |                           | FB_AD5                  |                |              | DCU1_B1   |
| 137    | PAD_102  | PORT3[6]  | PTC29       | SAI1_TX_DATA               | SPI0_PCS2   | RCON27                    | FB_BE1_b                | FB_MUXED_TSIZ1 |              | DCU1_B4   |
|        |          |           |             | USB0_VBUS_DETECT           |             |                           |                         |                |              |           |
| 139    |          |           |             | USB1_DP                    |             |                           |                         |                |              |           |

| X1 Pin | GPIO Pad | GPIO Port | ALT0 (GPIO) | ALT1                   | ALT2         | ALT3        | ALT4    | ALT5         | ALT6       | ALT7          |
|--------|----------|-----------|-------------|------------------------|--------------|-------------|---------|--------------|------------|---------------|
| 141    |          |           |             | USB1_DM                |              |             |         |              |            |               |
| 143    |          |           |             | USB0_DP                |              |             |         |              |            |               |
| 145    |          |           |             | USB0_DM                |              |             |         |              |            |               |
| 2      |          |           |             | ADC1_SE9               |              |             |         |              |            |               |
| 4      |          |           |             | ADC0_SE9               |              |             |         |              |            |               |
| 6      |          |           |             | ADC1_SE8               |              |             |         |              |            |               |
| 8      |          |           |             | ADC0_SE8               |              |             |         |              |            |               |
| 14     | PAD_9    | PORT0[9]  | PTA19       | TRACED3                | ADC0_SE1     | FTM1_QD_PHB | LCD32   | SAI2_TX_SYNC | VIU_DATA17 | QSPIA_SCK     |
| 16     | PAD_8    | PORT0[8]  | PTA18       | TRACED2                | ADEC0_SE0    | FTM1_QD_PHA | LCD31   | SAI2_TX_DATA | VIU_DATA16 | I2C1_SDA      |
| 18     | PAD_6    | PORT0[6]  | PTA16       | TRACED0                | USB0_VBUS_EN | ADC1_SE0    | LCD29   | SAI2_TX_BCLK | VIU_DATA14 | I2C0_SDA      |
| 20     | PAD_24   | PORT0[24] | PTB2        | FTMO_CH2               | ADC1_SE2     | RCON31      | LCD36   | SAI2_RX_SYNC | VIU_DATA20 | QSPI1_A_DATA2 |
| 22     | PAD_104  | PORT3[8]  | PTC31       | SAI1_TX_SYNC           |              | RCON29      |         |              | ADC1_SE5   | DCU1_B6       |
| 24     | PAD_25   | PORT0[25] | PTB3        | FTMO_CH3               | ADC1_SE3     | EXTRIG      | LCD37   |              | VIU_DATA21 | QSPI1_A_DATA1 |
| 26     |          |           |             | RESETB/<br>RESET_OUT   |              |             |         |              |            |               |
| 28     | PAD_30   | PORT0[30] | PTB8        | FTM1_CH0               |              | FTM1_QD_PHA |         | VIU_DE       |            | DCU1_R6       |
| 30     | PAD_23   | PORT0[23] | PTB1        | FTMO_CH1               | ADC0_SE3     | RCON30      | LCD35   | SAI2_RX_DATA | VIU_DATA19 | QSPI1_A_DATA3 |
| 32     | PAD_82   | PORT2[18] | PTD3        | QSPIO_A_DATA2          | SCI2_CTS     | SPI1_PCS2   | FB_AD12 | SPDIF_PLOCK  |            |               |
| 34     | PAD_81   | PORT2[17] | PTD2        | QSPIO_A_DATA3          | SCI2_RTS     | SPI1_PCS3   | FB_AD13 | SPDIF_OUT1   |            |               |
| 36     | PAD_80   | PORT2[16] | PTD1        | QSPIO_A_CS0            | SCI2_RX      |             | FB_AD14 | SPDIF_IN1    |            |               |
| 38     | PAD_79   | PORT2[15] | PTD0        | QSPIO_A_SCK            | SCI2_TX      |             | FB_AD15 | SPDIF_EXTCLK |            |               |
| 44     | PAD_109  | PORT3[13] | PTE4        | DCU0_DE/<br>DCU0_TCON3 |              |             | LCD4    |              |            |               |
| 46     | PAD_121  | PORT3[25] | PTE16       | DCU0_G3                |              | RCON7       | LCD16   |              |            |               |
| 48     | PAD_123  | PORT3[27] | PTE18       | DCU0_G5                |              | RCON9       | LCD18   |              |            |               |
| 50     | PAD_125  | PORT3[29] | PTE20       | DCU0_G7                |              | RCON11      | LCD20   | I2C0_SDA     |            | EWM_in        |
| 52     | PAD_112  | PORT3[16] | PTE7        | DCU0_R2                |              | RCON0       | LCD7    |              |            |               |
| 54     | PAD_113  | PORT3[17] | PTE8        | DCU0_R3                |              | RCON1       | LCD8    |              |            |               |
| 56     | PAD_107  | PORT3[11] | PTE2        | DCU0_PCLK              |              |             | LCD2    |              |            |               |
| 58     | PAD_131  | PORT4[3]  | PTE26       | DCU0_B5                |              | RCON15      | LCD26   |              |            |               |

| X1 Pin | GPIO Pad | GPIO Port | ALT0 (GPIO) | ALT1                      | ALT2           | ALT3        | ALT4     | ALT5           | ALT6       | ALT7     |
|--------|----------|-----------|-------------|---------------------------|----------------|-------------|----------|----------------|------------|----------|
| 60     | PAD_130  | PORT4[2]  | PTE25       | DCU0_B4                   |                | RCON14      | LCD25    |                |            |          |
| 62     | PAD_122  | PORT3[26] | PTE17       | DCU0_G4                   |                | RCON8       | LCD17    |                |            |          |
| 64     | PAD_115  | PORT3[19] | PTE10       | DCU0_R5                   |                | RCON3       | LCD10    |                |            |          |
| 66     | PAD_114  | PORT3[18] | PTE9        | DCU0_R4                   |                | RCON2       | LCD9     |                |            |          |
| 68     | PAD_105  | PORT3[9]  | PTE0        | DCU0_HSYNC/<br>DCU0_TCON1 | BOOTMOD1       |             | LCD0     |                |            |          |
| 70     | PAD_129  | PORT4[1]  | PTE24       | DCU0_B3                   |                | RCON13      | LCD24    |                |            |          |
| 72     | PAD_133  | PORT4[5]  | PTE28       | DCU0_B7                   |                | RCON17      | LCD28    | I2C1_SDA       |            | EWM_out  |
| 74     | PAD_124  | PORT3[28] | PTE19       | DCU0_G6                   |                | RCON10      | LCD19    | I2C0_SCL       |            |          |
| 76     | PAD_128  | PORT4[0]  | PTE23       | DCU0_B2                   |                | RCON12      | LCD23    |                |            |          |
| 78     | PAD_132  | PORT4[4]  | PTE27       | DCU0_B6                   |                | RCON16      | LCD27    | I2C1_SCL       |            |          |
| 80     | PAD_120  | PORT3[24] | PTE15       | DCU0_G2                   |                | RCON6       | LCD15    |                |            |          |
| 82     | PAD_106  | PORT3[10] | PTE1        | DCU0_VSYNC/<br>DCU0_TCON2 | BOOTMOD0       |             | LCD1     |                |            |          |
| 86     | PAD_84   | PORT2[20] | PTD5        | QSPIO_A_DATA0             |                | SPI1_PCS0   | FB_AD10  |                |            |          |
| 88     | PAD_87   | PORT2[23] | PTD8        | QSPIO_B_CS0               | FB_CLKOUT      | SPI1_SCK    | FB_AD7   |                |            |          |
| 90     | PAD_85   | PORT2[21] | PTD6        | QSPIO_A_DQS               |                | SPI1_SIN    | FB_AD9   |                |            |          |
| 92     | PAD_86   | PORT2[22] | PTD7        | QSPIO_B_SCK               |                | SPI1_SOUT   | FB_AD8   |                |            |          |
| 94     | PAD_28   | PORT0[28] | PTB6        | FTM0_CH6                  | SCI1_RTS       | QSPIO_A_CS1 | LCD40    | FB_CLKOUT      | VIU_HSYNC  | SCI2_TX  |
| 96     | PAD_134  | PORT4[6]  | PTA7        | VIU_PIX_CLK               |                |             |          |                |            |          |
| 98     | PAD_46   | PORT1[14] | PTC1        | RMIIO_MDIO/<br>MII0_MDC   | FTM1_CH1       | SPIO_PCS2   | ESAI_FST | SDHC0_CMD      | VIU_DATA1  | RCON19   |
| 100    | PAD_92   | PORT2[28] | PTD13       | QSPIO_B_DQS               | SPI3_SCK       |             | FB_AD2   |                |            |          |
| 102    | PAD_5    | PORT0[5]  | PTA12       | TRACECK                   | EXT_AUDIO_MCLK |             |          |                | VIU_DATA13 | I2C0_SCL |
| 104    | PAD_66   | PORT2[2]  | PTD28       | FB_AD28                   | NF_IO12        | I2C2_SCL    | FTM3_CH3 | SPI2_SOUT      |            |          |
| 106    | PAD_63   | PORT1[31] | PTD31       | FB_AD31                   | NF_IO15        |             | FTM3_CH0 | SPI2_PCS1      |            |          |
| 134    | PAD_7    | PORT0[7]  | PTA17       | TRACED1                   | USB0_VBUS_OC   | ADC1_SE1    | LCD30    | USB0_SOF_PULSE | VIU_DATA15 | I2C1_SCL |
| 136    | PAD_126  | PORT3[30] | PTE21       | DCU0_B0                   |                |             | LCD21    |                |            |          |
| 138    | PAD_127  | PORT3[31] | PTE22       | DCU0_B1                   |                |             | LCD22    |                |            |          |
| 140    | PAD_118  | PORT3[22] | PTE13       | DCU0_G0                   |                |             | LCD13    |                |            |          |



| X1 Pin | GPIO Pad | GPIO Port | ALT0 (GPIO) | ALT1                               | ALT2         | ALT3 | ALT4       | ALT5       | ALT6       | ALT7        |
|--------|----------|-----------|-------------|------------------------------------|--------------|------|------------|------------|------------|-------------|
| 142    | PAD_119  | PORT3[23] | PTE14       | DCU0_G1                            |              |      | LCD14      |            |            |             |
| 144    | PAD_110  | PORT3[14] | PTE5        | DCU0_R0                            |              |      | LCD5       |            |            |             |
| 146    | PAD_111  | PORT3[15] | PTE6        | DCU0_R1                            |              |      | LCD6       |            |            |             |
| 162    |          |           |             | VADCSE0                            |              |      |            |            |            |             |
| 164    |          |           |             | VADCSE1                            |              |      |            |            |            |             |
| 166    |          |           |             | VADCSE2                            |              |      |            |            |            |             |
| 168    |          |           |             | VADCSE3                            |              |      |            |            |            |             |
| 170    |          |           |             | EXT_TAMPER0                        |              |      |            |            |            |             |
| 172    |          |           |             | EXT_TAMPER1                        |              |      |            |            |            |             |
| 174    |          |           |             | EXT_TAMPER2/<br>EXT_WM0_TAMPER_IN  |              |      |            |            |            |             |
| 176    |          |           |             | EXT_TAMPER3/<br>EXT_WM0_TAMPER_OUT |              |      |            |            |            |             |
| 178    |          |           |             | EXT_TAMPER4/<br>EXT_WM1_TAMPER_IN  |              |      |            |            |            |             |
| 180    |          |           |             | EXT_TAMPER5/<br>EXT_WM1_TAMPER_OUT |              |      |            |            |            |             |
| 184    | PAD_69   | PORT2[5]  | PTD25       | FB_AD25                            | NF_IO9       |      | FTM3_CH6   |            |            |             |
| 186    | PAD_70   | PORT2[6]  | PTD24       | FB_AD24                            | NF_IO8       |      | FTM3_CH7   |            |            |             |
| 188    | PAD_90   | PORT2[26] | PTD11       | QSPIO_B_DATA1                      | SPI3_SIN     |      | FB_AD4     |            |            |             |
| 190    | PAD_15   | PORT0[15] | PTA25       | TRACED9                            | USB1_VBUS_OC |      |            | SDHC1_CMD  | DCU1_TCON5 |             |
| 192    | PAD_16   | PORT0[16] | PTA26       | TRACED10                           | SAI3_TX_BCLK |      |            | SDHC1_DAT0 | DCU1_TCON6 |             |
| 194    | PAD_37   | PORT1[5]  | PTB15       | CAN0_TX                            | I2C0_SDA     |      | DCU0_TCON9 |            |            | VIU_PIX_CLK |
| 196    | PAD_36   | PORT1[4]  | PTB14       | CAN0_RX                            | I2C0_SCL     |      | DCU0_TCON8 |            |            | DCU1_PCLK   |

**\*This pin is not available on VF61**

## 5 Interface Description

### 5.1 Power Signals

#### 5.1.1 Digital Supply

Table 5-1 Digital Supply Pins

| X1 Pin #                            | Signal Name | I/O | Description  | Remarks  |
|-------------------------------------|-------------|-----|--|--|
| 42, 84, 108, 148, 182, 198, 200     | 3V3         | I   | 3.3V main power supply                                 | Use decoupling capacitors on all pins.                         |
| 39, 41, 83, 109, 147, 181, 197, 199 | GND         | I   | Digital Ground   |  |
| 40                                  | VCC_BATT    | I/O | RTC Power supply can be connected to a backup battery. | Connect this pin to 3.3V even if the internal RTC is not used. |

#### 5.1.2 Analogue Supply

Table 5-2 Analogue Supply Pins

| X1 Pin # | Signal Name | I/O | Description          | Remarks  |
|----------|-------------|-----|----------------------|--|
| 10, 12   | AVDD_AUDIO  | I   | 3.3V analogue supply | Always connect this pin <b>to a 3.3V supply</b> . For better Audio accuracy we recommend filtering this supply separately from the digital supply. This pin is connected to the Audio Codec and the analogue supply of the Vybrid. |
| 9, 11    | VSS_AUDIO   | I   | Analogue Ground      | Always connect this pin to GND. For better Audio accuracy we recommend filtering this supply separate from the digital supply. Internally this pin is not connected with Digital GND on the Colibri VFXx module.                   |

#### 5.1.3 Reset

Table 5-3 Reset Pins

| X1 Pin # | Signal Name | I/O | Voltage Level | Description  | Remarks  |
|----------|-------------|-----|---------------|--------------|--|
| 26       | nRESET_EXT  | I   | 3V3           | Reset Input  | This pin is low active and resets the Colibri module.  |
| 87       | nRESET_OUT  | O   | 3V3           | Reset Output | This pin is active low. This pin is driven low at boot up. There is a 10k Ohm pull-up on this pin. |

On the Colibri Vybrid, the nRESET\_EXT (pin 26) performs a warm reset of the module.

The RESETB/RESET\_OUT pin of the Vybrid SoC is bidirectional and connected to both SODIMM signals, nRESET\_EXT and nRESET\_OUT. Figure 4 shows the internal circuit of the reset signal.

## 5.2 GPIOs

Most Vybrid pins have a GPIO (General Purpose Input/Output) function. Please check which pins are GPIO capable in the function list in section 4.4. The GPIO functionality is configured by selecting the alternative function ALTO. For accessing GPIOs, the pins are grouped in ports (PORT0 to PORT4). The mapping between the port name (e.g. PORT0[27]) and pad name (e.g. PTB5) of the GPIO can be found in the same table in section 4.4. Additional to the pad name, the GPIOs also have a pad number (e.g. PAD\_27) which can be found in the same table. Some software implementations might refer to the GPIO pad number.

All GPIO pins can be used as an interrupt source. The interrupt function of each GPIO can be configured to the following modes:

- Interrupt disabled (default after reset)
- Active high level sensitive interrupt
- Active low level sensitive interrupt
- Rising edge sensitive interrupt
- Falling edge sensitive interrupt
- Rising and falling edge sensitive interrupt
- Rising edge sensitive DMA request
- Falling edge sensitive DMA request
- Rising and falling edge sensitive DMA request

A digital filter can be enabled individually for each GPIO. This filter can help prevent glitches from triggering an unwanted interrupt. The filter width is the same within one GPIO port. It can only be changed per port.

### 5.2.1 Wakeup Source

Certain pins can be used to wake up the Colibri from a suspended state (LPStop). There is on-chip analogue glitch filtering, which can be deactivated if required. The enabling of this analogue filter is independent of the digital filter. Each wakeup pin can be individually enabled and selected whether it is triggered on a rising or falling edge.

Table 5-4 Wakeup Pins

| X1 Pin# | Wakeup Source | Remarks                 |
|---------|---------------|-------------------------|
| 19      | WKPU_P5       |                         |
| 21      | WKPU_P4       |                         |
| 24      | WKPU_P3       |                         |
| 27      | WKPU_P9       |                         |
| 30      | WKPU_P1       |                         |
| 33      | WKPU_P8       |                         |
| 43      | WKPU_P13      | Preferred Wakeup Source |
| 45      | WKPU_P12      | Preferred Wakeup Source |
| 50      | WKPU_P16      |                         |
| 59      | WKPU_P0       |                         |
| 63      | WKPU_P11      |                         |
| 81      | WKPU_P7       |                         |
| 94      | WKPU_P6       |                         |
| 95      | WKPU_P15      |                         |
| 196     | WKPU_P10      |                         |

For the Colibri VF61, the WKPU\_P2 (Vybrid pin PTB2) is also connected to the Wolfson WM9715L pin 45. This allows the audio codec to wake up the system by creating a generic interrupt (GENIRQ) if the resistive touch panel interface detects a touch on the display.

For the Colibri VF50, the WKU\_P2 (Vybrid pin PTB2) is connected to the TMSY pin of the resistive touch panel interface.

## 5.3 Ethernet

The Vybrid SoC features two 10/100 Mbit Ethernet media access controls (MACs) with L2 switch and IEEE1588 clock. On the Colibri module, there is one Ethernet transceiver (PHY), which needs only the magnetics to be present on the carrier board. Please check the datasheet of the Microchip/Micrel KSZ8041NL Ethernet PHY to learn more about the features of the chip.

| X1 Pin# | Colibri Signal Name | PHY Signal Name | I/O | Voltage Level | Description                                      |
|---------|---------------------|-----------------|-----|---------------|--|
| 189     | TXO+                | TX+             | O   |               | 100BASE-TX: Transmit + (Auto MDIX: Receive +)    |
| 187     | TXO-                | TX-             | O   |               | 100BASE-TX: Transmit - (Auto MDIX: Receive -)    |
| 195     | RXI+                | RX+             | I   |               | 100BASE-TX: Receive + (Auto MDIX: Transmit +)    |
| 193     | RXI-                | RX-             | I   |               | 100BASE-TX: Receive - (Auto MDIX: Transmit -)    |
| 191     | AGND_LAN            | GND             |     |               | Ethernet ground, on VFxx connected to common GND |
| 183     | LINK_AKT            | LED0            | O   | 3V3           | Link activity indication LED                     |
| 185     | SPEED100            | LED1            | O   | 3V3           | 100Mbit/s indication LED                         |

If the second Ethernet port is required, an additional PHY needs to be implemented on the carrier board. The interface between Colibri VFxx module and PHY is a Reduced Media Independent Interface (RMII). This interface is not part of the Colibri standard interfaces. The signals are mainly located on the camera interface signals.

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name         | I/O | Voltage Level | Description                                |
|---------|---|----------------------------|-----|---------------|--|
| 59      | PWM<A>, Camera Input Data<7>              | RMII0_TXD0/<br>MII0_TXD[0] | O   | 3V3           | Transmit data bit 0 (MAC to PHY)           |
| 67      | PWM<D>, Camera Input Data<6>              | RMII0_TXD1/<br>MII0_TXD[1] | O   | 3V3           | Transmit data bit 1 (MAC to PHY)           |
| 85      | Camera Input Data<8>, Keypad_Out<4>       | RMII0_TXEN/<br>MII0_TXEN   | O   | 3V3           | Transmit data enable (MAC to PHY)          |
| 89      | GPIO                                      | RMII_CLKOUT                | O   | 3V3           | 50 MHz Reference Clock output (MAC to PHY) |
| 79      | Camera Input Data<4>                      | RMII0_RXD0/<br>MII0_RXD[0] | I   | 3V3           | Receive data bit 0 (PHY to MAC)            |
| 103     | Camera Input Data<3>                      | RMII0_RXD1/<br>MII0_RXD[1] | I   | 3V3           | Receive data bit 1 (PHY to MAC)            |
| 101     | Camera Input Data<2>                      | RMII0_CRSDV                | I   | 3V3           | Carrier Sense / Data Valid (PHY to MAC)    |
| 97      | Camera Input Data<5>                      | RMII0_RXER/<br>MII0_RXER   | I   | 3V3           | Receive Error (optional) (PHY to MAC)      |
| 98      | Camera Input Data<1>                      | RMII0_MDIO/<br>MII0_MDC    | I/O | 3V3           | Management data                            |
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | RMII0_MDC/<br>MII0_MDC     | O   | 3V3           | Management clock                           |

## 5.4 USB

Colibri VFxx provides two USB 2.0 High Speed (480 Mbit/s) ports. Both ports can be configured independently as host or client through firmware interfaces. The ports are not true OTG controllers. The Colibri standard requires only one USB port to be configurable as host or client. This port is called USBC in the following table.

When using USB, you have to be careful to not introduce any back feeding into the module.

### 5.4.1 USB Data Signal

Table 5-5 USB Data Pins

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Description  |
|---------|---------------------|--------------------|-----|--|
| 139     | USBH_P              | USB1_DP            | I/O | Positive Differential Signal for USB Host port                     |
| 141     | USBH_N              | USB1_DM            | I/O | Negative Differential Signal for USB Host port                     |
| 143     | USBC_P              | USB0_DP            | I/O | Positive Differential Signal for the shared USB Host / Client port |
| 145     | USBC_N              | USB0_DM            | I/O | Negative Differential Signal for the shared USB Host / Client port |

### 5.4.2 USB Control Signals

Table 5-6 USB OTG Pins

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name             | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------------------|-----|---------------|--|
| 135     | USB_ID              | PTD10                          | I   | 3V3           | Use this pin to detect the ID pin if you use USB OTG   |
| 137     | USBC_DET            | USB0_VBUS_D<br>ETECT/<br>PTC29 | I   | 3V3           | Use this pin to detect if VBUS is present (5V USB supply). Please note that this pin is only 3.3V tolerant<br>This signal is connected to two pins of the Vybrid SoC |

If you use the USB Host function, you need to generate the 5V USB supply voltage on your carrier board. Colibri VFxx provides two optional signals for the USB supply. We recommend using the following pins to guarantee the best possible compatibility, however - you can use other GPIOs or not use the signals at all.

Table 5-7 USB Power Control Pins

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------|-----|---------------|--|
| 129     | USBH_PEN            | PTD4               | O   | 3V3           | This pin enables the external USB voltage supply.                                |
| 131     | USBH_OC             | PTE3               | I   | 3V3           | USB overcurrent, this pin can Signal an over current condition in the USB supply |

## 5.5 Display

Colibri VFxx has a display controller unit (DCU) for TFT displays of up to 1024x768 resolution. The Vybrid SoC features a second DCU, but not all the interface pins are accessible via the SODIMM connector, since the pins are shared with the internal NAND flash interface. Therefore, only one display interface can be used.

### Features for the DCU

- 64 graphics layers
- Each pixel can be blended from up to 6 source layers
- Hardware cursor layer with blinking option
- Display of real-time video from external video source (camera parallel or composite input)
- Fully programmable display timing and resolution
- Gamma correction with 8bit resolution on each colour component
- Temporal dithering

### 5.5.1 Parallel RGB LCD interface

Colibri VFxx provides a parallel LCD interface on the SODIMM connector. It supports up to 24 bit colour per pixel. The first 18bits are backward compatible with the existing Colibri PXAxxx family. The whole 24bit interface is backward compatible with the existing Colibri T20 and T30 modules.

### Features

- Up to XGA (1024x768) resolution
- Up to 24 bit colour
- Supports parallel TTL displays
- Max pixel clock 60MHz

Table 5-LCD signal Pins

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name      | I/O | Voltage Level | 24bit RGB Interface   | 18bit RGB Interface | 16bit RGB Interface |
|---------|---------------------|-------------------------|-----|---------------|---|---------------------|---------------------|
| 76      | LCD RGB Data<0>     | DCU0_B2                 | O   | 3V3           | B2  | B0                  |                     |
| 70      | LCD RGB Data<1>     | DCU0_B3                 | O   | 3V3           | B3  | B1                  | B0                  |
| 60      | LCD RGB Data<2>     | DCU0_B4                 | O   | 3V3           | B4  | B2                  | B1                  |
| 58      | LCD RGB Data<3>     | DCU0_B5                 | O   | 3V3           | B5  | B3                  | B2                  |
| 78      | LCD RGB Data<4>     | DCU0_B6                 | O   | 3V3           | B6  | B4                  | B3                  |
| 72      | LCD RGB Data<5>     | DCU0_B7                 | O   | 3V3           | B7  | B5                  | B4                  |
| 80      | LCD RGB Data<6>     | DCU0_G2                 | O   | 3V3           | G2  | G0                  | G0                  |
| 46      | LCD RGB Data<7>     | DCU0_G3                 | O   | 3V3           | G3  | G1                  | G1                  |
| 62      | LCD RGB Data<8>     | DCU0_G4                 | O   | 3V3           | G4  | G2                  | G2                  |
| 48      | LCD RGB Data<9>     | DCU0_G5                 | O   | 3V3           | G5  | G3                  | G3                  |
| 74      | LCD RGB Data<10>    | DCU0_G6                 | O   | 3V3           | G6  | G4                  | G4                  |
| 50      | LCD RGB Data<11>    | DCU0_G7                 | O   | 3V3           | G7  | G5                  | G5                  |
| 52      | LCD RGB Data<12>    | DCU0_R2                 | O   | 3V3           | R2  | R0                  |                     |
| 54      | LCD RGB Data<13>    | DCU0_R3                 | O   | 3V3           | R3  | R1                  | R0                  |
| 66      | LCD RGB Data<14>    | DCU0_R4                 | O   | 3V3           | R4  | R2                  | R1                  |
| 64      | LCD RGB Data<15>    | DCU0_R5                 | O   | 3V3           | R5  | R3                  | R2                  |
| 57      | LCD RGB Data<16>    | DCU0_R6                 | O   | 3V3           | R6  | R4                  | R3                  |
| 61      | LCD RGB Data<17>    | DCU0_R7                 | O   | 3V3           | R7  | R5                  | R4                  |
| 136     | LCD RGB Data<18>    | DCU0_B0                 | O   | 3V3           | B0  |                     |                     |
| 138     | LCD RGB Data<19>    | DCU0_B1                 | O   | 3V3           | B1  |                     |                     |
| 140     | LCD RGB Data<20>    | DCU0_G0                 | O   | 3V3           | G0  |                     |                     |
| 142     | LCD RGB Data<21>    | DCU0_G1                 | O   | 3V3           | G1  |                     |                     |
| 144     | LCD RGB Data<22>    | DCU0_R0                 | O   | 3V3           | R0  |                     |                     |
| 146     | LCD RGB Data<23>    | DCU0_R1                 | O   | 3V3           | R1  |                     |                     |
| 44      | LCD RGB DE          | DCU0_DE / DCU0_TCON3    | O   | 3V3           | Data Enable (other names: Output Enable)  |                     |                     |
| 68      | LCD RGB HSYNC       | DCU0_HSYNC / DCU0_TCON1 | O   | 3V3           | Horizontal Sync (other names: Line Clock, L_LCKL_A0),<br>Do not pull up these signals during power up |                     |                     |
| 56      | LCD RGB PCLK        | DCU0_PCLK               | O   | 3V3           | Pixel Clock (other names: Dot Clock, L_PCLK_WR)   |                     |                     |
| 82      | LCD RGB VSYNC       | DCU0_VSYNC / DCU0_TCON2 | O   | 3V3           | Vertical Sync (other names: Frame Clock, L_FCLK)<br>Do not pull up these signals during power up      |                     |                     |

Typically, you will also require some signals to control the Backlight and/or the display enable signal. You can use any free GPIO for this function, but we recommend using the same as we did on our standard carrier boards, this minimises the required SW configurations. If you would like to use a PWM signal to control the backlight brightness, use a pin with PWM function for the Backlight Control- see also section 5.12.

The HSYNC and VSYNC signals are also used as boot strapping pins. The pins need to have low logic level during the power up cycle in order to boot from the internal flash memory. Therefore, 10k pull down resistors are placed on the module. It is recommended to add buffers on the carrier board to prevent back feeding problems. The Colibri Evaluation board V3.x and all versions of the Iris Carrier board feature such buffers. Older carrier boards, such as the Colibri Evaluation board V2.x have the signals directly connected to the VGA connector. This can lead to problems if certain monitors with pull up resistors on these signals are plugged in. See also section 7.

### 5.5.2 HDMI

Colibri VFxx does not have an HDMI interface.

### 5.5.3 Analogue VGA

Colibri VFxx does not have an Analogue VGA interface. However, it is possible to add a VGA DAC on the carrier board. The Colibri Evaluation board features a reference design for such a DAC.

### 5.5.4 DDC (Display Data Channel)

Colibri VFxx does not provide a dedicated DDC interface. If required, one of the I<sup>2</sup>C interfaces can be used as DDC. Since the DDC is 5V compatible, a level shifter from 3.3V would be required.

### 5.5.5 LVDS

Colibri VFxx does not have a direct LVDS interface. However, it is very easy to use the parallel LCD port with an LVDS transmitter. The Colibri Evaluation board provides a reference design for an LVDS interface implementation. Contact Toradex if you have any questions how to connect a LVDS transmitter.

## 5.6 External Memory Bus

Colibri VFxx does not feature an external memory bus that is compatible within the Colibri family. There is an external bus (called FlexBus) available as a secondary function of interface pins. Some bus control signals are missing since they are only available on Vybrid pins that are connected to the internal NAND flash. Whenever it is possible, the SPI, QSPI, USB or I<sup>2</sup>C interface should be preferred for connecting a peripheral device including FPGA or DSPs.

Table 5-8 Flex Bus Pins

| X1 Pin# | Colibri Signal Name      | Vybrid Signal Name | I/O | Voltage Level | Description   |
|---------|--------------------------|--------------------|-----|---------------|---|
| 25      | UART_A CTS, Keypad_In<0> | FB_AD0             | I/O | 3V3           | Multiplexed: Address/Data 0<br>Non-Multiplexed: Address 0   |
| 27      | UART_A RTS               | FB_AD1             | I/O | 3V3           | Multiplexed: Address/Data 1<br>Non-Multiplexed: Address 1   |
| 100     | Keypad_Out<1>            | FB_AD2             | I/O | 3V3           | Multiplexed: Address/Data 2<br>Non-Multiplexed: Address 2   |
| 75      | GPIO                     | FB_AD3             | I/O | 3V3           | Multiplexed: Address/Data 3<br>Non-Multiplexed: Address 3   |
| 188     | GPIO                     | FB_AD4             | I/O | 3V3           | Multiplexed: Address/Data 4<br>Non-Multiplexed: Address 4   |
| 135     | GPIO                     | FB_AD5             | I/O | 3V3           | Multiplexed: Address/Data 5<br>Non-Multiplexed: Address 5   |
| 133     | GPIO                     | FB_AD6             | I/O | 3V3           | Multiplexed: Address/Data 6<br>Non-Multiplexed: Address 6   |
| 88      | SPI CLK                  | FB_AD7             | I/O | 3V3           | Multiplexed: Address/Data 7<br>Non-Multiplexed: Address 7   |
|         |                          | FB_CLKOUT          | O   | 3V3           | FlexBus Clock Out   |
| 92      | SPI TXD                  | FB_AD8             | I/O | 3V3           | Multiplexed: Address/Data 8<br>Non-Multiplexed: Address 8   |
| 90      | SPI RXD                  | FB_AD9             | I/O | 3V3           | Multiplexed: Address/Data 9<br>Non-Multiplexed: Address 9   |
| 86      | SPI CS                   | FB_AD10            | I/O | 3V3           | Multiplexed: Address/Data 10<br>Non-Multiplexed: Address 10 |



| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------|-----|---------------|--|
| 129     | USBH_PEN            | FB_AD11            | I/O | 3V3           | Multiplexed: Address/Data 11<br>Non-Multiplexed: Address 11  |
| 32      | UART_B CTS          | FB_AD12            | I/O | 3V3           | Multiplexed: Address/Data 12<br>Non-Multiplexed: Address 12  |
| 34      | UART_B RTS          | FB_AD13            | I/O | 3V3           | Multiplexed: Address/Data 13<br>Non-Multiplexed: Address 13  |
| 36      | UART_B RXD          | FB_AD14            | I/O | 3V3           | Multiplexed: Address/Data 14<br>Non-Multiplexed: Address 14  |
| 38      | UART_B TXD          | FB_AD15            | I/O | 3V3           | Multiplexed: Address/Data 15<br>Non-Multiplexed: Address 15  |
| 186     | GPIO                | FB_AD24            | I/O | 3V3           | Non-Multiplexed: Data 0  |
| 184     | GPIO                | FB_AD25            | I/O | 3V3           | Non-Multiplexed: Data 1  |
| 127     | GPIO                | FB_AD26            | I/O | 3V3           | Non-Multiplexed: Data 2  |
| 107     | GPIO                | FB_AD27            | I/O | 3V3           | Non-Multiplexed: Data 3  |
| 104     | GPIO                | FB_AD28            | I/O | 3V3           | Non-Multiplexed: Data 4  |
| 99      | GPIO                | FB_AD29            | I/O | 3V3           | Non-Multiplexed: Data 5  |
| 69      | GPIO                | FB_AD30            | I/O | 3V3           | Non-Multiplexed: Data 6  |
| 106     | GPIO                | FB_AD31            | I/O | 3V3           | Non-Multiplexed: Data 7  |
| 137     | USBC_DET            | FB_MUXED_TSIZ1     |     | 3V3           | Can be configured either as<br>- FB_TSIZ1: Transfer Size bit 1<br>- FB_BE2_b: Byte Enable for bits 23 to 16                                    |
|         |                     | FB_BE1_b           |     | 3V3           | Byte Enable for bits 15 to 8   |
| 94      | Camera Input HSYNC  | FB_CLKOUT          | O   | 3V3           | FlexBus Clock Out  |
| 105     | GPIO                | FB_CS0_b           | O   | 3V3           | General Purpose Chip Select  |
| 95      | GPIO                | FB_MUXED_BE0_b     |     | 3V3           | Can be configured either as<br>- FB_TA: Transfer Acknowledge<br>- FB_CS3 General Purpose Chip Select<br>- FB_BE0_b Byte Enable for bits 7 to 0 |
|         |                     | FB_TSIZ0           | O   | 3V3           | Transfer Size bit 0  |
| 93      | GPIO                | FB_RW_b            | O   | 3V3           | Read/Write Indication (low for indicating write)   |

## 5.7 IDE

Colibri VFxx does not support an integrated drive electronics interface (IDE).

## 5.8 I2C

Colibri VFxx offers four I<sup>2</sup>C controllers. These implement the I<sup>2</sup>C version 2.0 specification with the exception that high speed mode is not supported. All can be used as master or slave. Port 0 is provided on the pins that are compatible with the Colibri family. The other ports are available as secondary functions of the SODIMM pins.

### Features:

- Supports standard (0-100 kHz) and fast mode of operation (0-400 kHz)
- Independent Master Controller and Slave Controller
- Multi-master operation
- Software selectable acknowledge bit
- Interrupt driven byte-by-byte data transfer
- Arbitration loss interrupt with automatic mode switching from master to slave
- Calling address identification interrupts
- Start and stop signal generation and detection
- Repeated start signal generation
- Acknowledge bit generation and detection
- Bus busy detection
- Basic DMA interface
- SMBus support

There are lots of low speed devices which use I<sup>2</sup>C interfaces such as RTCs or sensors and the interface is also used to configure other devices like cameras or displays. The I<sup>2</sup>C Bus can also be used to communicate with System Management Bus (SMBus) devices.

Table 5-9 I<sup>2</sup>C Signals (Colibri family compatible interface)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description                   |
|---------|---------------------|--------------------|-----|---------------|-------------------------------|
| 194     | I2C SDA             | I2C0_SDA           | I/O | 3V3           | Open Drain Data Signal Port 0 |
| 196     | I2C SCL             | I2C0_SCL           | I/O | 3V3           | Clock Signal Port 0           |

Table 5-10 I<sup>2</sup>C Signals (additional, not compatible with other Colibri family modules)

| X1 Pin# | Colibri Signal Name     | Vybrid Signal Name | I/O | Voltage Level | Description                             |
|---------|-------------------------|--------------------|-----|---------------|---|
| 102     | nPWAIT                  | I2C0_SCL           | I/O | 3V3           | Alternative pin for Clock Signal Port 0 |
| 55      | GPIO                    | I2C1_SDA           | I/O | 3V3           | Open Drain Data Signal Port 1           |
| 72      | LCD RGB Data<5>         |                    |     | 3V3           |   |
| 63      | GPIO                    | I2C1_SCL           | I/O | 3V3           | Clock Signal Port 1                     |
| 78      | LCD RGB Data<4>         |                    |     | 3V3           |   |
| 134     | GPIO                    |                    |     | 3V3           |   |
| 107     | GPIO                    | I2C2_SDA           | I/O | 3V3           | Open Drain Data Signal Port 2           |
| 104     | GPIO                    | I2C2_SCL           | I/O | 3V3           | Clock Signal Port 2                     |
| 29      | UART_A DSR              | I2C3_SDA           | I/O | 3V3           | Open Drain Data Signal Port 3           |
| 37      | UART_A RI, Keypad_In<4> | I2C3_SCL           | I/O | 3V3           | Clock Signal Port 3                     |

## 5.9 UART

Colibri VFxx provides up to five serial UART interfaces (the Vybrid SoC itself features six interfaces, but one of them is not accessible via the SODIMM pins). Three of the five interfaces are backward compatible with the Colibri family with one limitation: The Vybrid SoC does not feature the DTR, DSR, DCD and RI as dedicated signals. However, these signals can be emulated by using GPIOs which are located on these SODIMM pins. The UART0 which is located on the UART\_A pins of the SODIMM is also used as a debug interface.

VF61 supports baud rates between 12000bps and 460800bps.

VF50 supports baud rates between 600bps and 256000bps.

### UART Features

- Full-duplex operation
- RS485 support
- Standard Mark/space non-return-to-zero (NRZ) format
- Programmable 8-bit or 9-bit data format
- Separately enabled transmitter and receiver
- Programmable transmitter output polarity
- Programmable receiver input polarity
- Up to 14-bit break character transmission
- 11-bit break character detection option
- Transmit FIFO (16-entry for UART 0 and 8-entry for the others)
- Receive FIFO (16-entry for UART 0 and 8-entry for rest of UARTs)
- Address match feature in receiver (only UART 0 and 1)
- Support for ISO7816 protocol to interface with SIM cards and smart cards (only UART 0 and 1)
- Support for CEA709.1-B protocol used in building automation and home networking systems
- Hardware flow control (RTS/CTS)
- IrDA 1.4 support on all UARTs

Table 5-11 UART Signals (Colibri family compatible interfaces)

| X1 Pin# | Colibri Signal Name      | Vybrid Signal Name   | I/O | Voltage Level | Description                        |
|---------|--------------------------|----------------------|-----|---------------|------------------------------------|
| 33      | UART_A RXD               | SCI0_RX              | I   | 3V3           | Receive Data UART0                 |
| 35      | UART_A TXD               | SCI0_TX              | O   | 3V3           | Transmit Data UART0                |
| 27      | UART_A RTS               | SCI0_RTS             | O   | 3V3           | Request to send UART0              |
| 25      | UART_A CTS, Keypad_In<0> | SCI0_CTS             | I   | 3V3           | Clear to send UART0                |
| 23      | UART_A DTR               | PTA20                | O   | 3V3           | GPIO only, DTR need to be emulated |
| 29      | UART_A DSR               | PTA31                | I   | 3V3           | GPIO only, DSR need to be emulated |
| 31      | UART_A DCD               | PTA21/<br>MII0_RXCLK | I   | 3V3           | GPIO only, DCD need to be emulated |
| 37      | UART_A RI, Keypad_In<4>  | PTA30                | I   | 3V3           | GPIO only, RI need to be emulated  |
| 36      | UART_B RXD               | SCI2_RX              | I   | 3V3           | Receive Data UART2                 |
| 38      | UART_B TXD               | SCI2_TX              | O   | 3V3           | Transmit Data UART2                |
| 34      | UART_B RTS               | SCI2_RTS             | O   | 3V3           | Request to send UART2              |
| 32      | UART_B CTS               | SCI2_CTS             | I   | 3V3           | Clear to send UART2                |
| 19      | UART_C RXD               | SCI1_RX              | I   | 3V3           | Receive Data UART1                 |
| 21      | UART_C TXD               | SCI1_TX              | O   | 3V3           | Transmit Data UART1                |

Table 5-12 UART Signals (additional, not compatible with other modules)

| X1 Pin# | Colibri Signal Name     | Vybrid Signal Name | I/O | Voltage Level | Description                             |
|---------|-------------------------|--------------------|-----|---------------|---|
| 103     | Camera Input Data<3>    | SCI1_RX            | I   | 3V3           | Alternative pin for Receive Data UART1  |
| 101     | Camera Input Data<2>    | SCI1_TX            | O   | 3V3           | Alternative pin for Receive Data UART1  |
| 94      | Camera Input HSYNC      | SCI1_RTS           | I   | 3V3           | Request to send UART1                   |
| 79      | Camera Input Data<4>    |                    |     | 3V3           |   |
| 81      | Camera Input VSYNC      | SCI1_CTS           | I   | 3V3           | Clear to send UART1                     |
| 97      | Camera Input Data<5>    |                    |     | 3V3           |   |
| 105     | GPIO                    |                    |     | 3V3           |   |
| 81      | Camera Input VSYNC      | SCI2_RX            | I   | 3V3           | Alternative pin for Receive Data UART2  |
| 94      | Camera Input HSYNC      | SCI2_TX            | O   | 3V3           | Alternative pin for Transmit Data UART2 |
| 29      | UART_A DSR              | SCI3_RX            | I   | 3V3           | Receive Data UART3                      |
| 31      | UART_A DCD              |                    |     | 3V3           |   |
| 23      | UART_A DTR              | SCI3_TX            | O   | 3V3           | Transmit Data UART3                     |
| 37      | UART_A RI, Keypad_In<4> |                    |     | 3V3           |   |
| 53      | SDCard DAT<3>           | SCI4_RX            | I   | 3V3           | Receive Data UART4                      |
| 51      | SDCard DAT<2>           | SCI4_TX            | O   | 3V3           | Transmit Data UART4                     |
| 37      | UART_A RI, Keypad_In<4> | SCI4_RTS           | O   | 3V3           | Request to send UART4                   |
| 29      | UART_A DSR              | SCI4_CTS           | I   | 3V3           | Clear to send UART4                     |

## 5.10 SPI

Colibri VFxx has four SPI controllers. Each can operate at up to 25Mbps and provide full duplex, synchronous, serial communication between the Colibri module and external peripheral devices. Each SPI channel consists of four signals; clock, chip select (frame), data in and data out. In the Vybrid datasheets SPI is also called DSPI.

### Features

- Up to 25Mbit/s
- Full-duplex
- Master and Slave mode
- 4-entry deep transmit FIFO
- 4-entry deep receive FIFO
- Up to 6 peripheral chip selects
- Programmable serial frame size of 4-16 bit (expandable by software)
- DMA support

Each SPI channel supports four different modes of the SPI protocol:

Table 5-13 SPI Modes

| SPI Mode | CPOL | CPHA | Description   |
|----------|------|------|---|
| 0        | 0    | 0    | Base value of Clock is low; data is captured on rising edge, data available on first clock edge   |
| 1        | 0    | 1    | Base value of Clock is low; data is captured on falling edge, clock available before data         |
| 2        | 1    | 0    | Base value of Clock is high; data is captured on falling edge, data available on first clock edge |
| 3        | 1    | 1    | Base value of Clock is high; data is captured on rising edge, clock available before data         |

SPI can be used as a fast interface for ADCs, DACs, FPGAs, etc. Some LCD displays require to be configured over SPI prior to being driven via the RGB or LVDS interface.

Table 5-14 SPI Signals (Colibri family compatible interface)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------|-----|---------------|--|
| 86      | SPI CS              | SPI1_PCS0          | I/O | 3V3           | Master Mode: Peripheral Chip Select 0 output<br>Slave Mode: Slave Select input                 |
| 88      | SPI CLK             | SPI1_SCK           | I/O | 3V3           | Master Mode: Serial Clock output<br>Slave Mode: Serial Clock input                             |
| 90      | SPI RXD             | SPI1_SIN           | I   | 3V3           | Master Mode: MISO (Master Input/ Slave Output)<br>Slave Mode: MOSI (Master Output/Slave Input) |
| 92      | SPI TXD             | SPI1_SOUT          | O   | 3V3           | Master Mode: MOSI (Master Output/Slave Input)<br>Slave Mode: MISO (Master Input/ Slave Output) |

Table 5-15 SPI Signals (additional, not compatible with other modules)

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---|--------------------|-----|---------------|--|
| 45      | GPIO                                      | SPI0_PCS0          | I/O | 3V3           | Master Mode: Peripheral Chip Select 0 output<br>Slave Mode: Slave Select input |
| 65      | Camera Input Data<9>, Keypad_Out<3>       | SPI0_PCS1          | O   | 3V3           | Master Mode: Peripheral Chip Select 1 output<br>Slave Mode: not used           |
| 137     | USBC_DET                                  | SPI0_PCS2          | O   | 3V3           | Master Mode: Peripheral Chip Select 2 output<br>Slave Mode: not used           |
| 98      | Camera Input Data<1>                      |                    |     | 3V3           |  |
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | SPI0_PCS3          | O   | 3V3           | Master Mode: Peripheral Chip Select 3 output<br>Slave Mode: not used           |

| X1 Pin# | Colibri Signal Name                 | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|-------------------------------------|--------------------|-----|---------------|--|
| 25      | UART_A CTS, Keypad_In<0>            | SPI0_PCS4          | O   | 3V3           | Master Mode: Peripheral Chip Select 4 output<br>Slave Mode: not used   |
| 27      | UART_A RTS                          | SPI0_PCS5          | O   | 3V3           | Master Mode: Peripheral Chip Select 5 output (can also be configured as Peripheral Chip Select Strobe)<br>Slave Mode: not used |
| 77      | GPIO                                | SPI0_SCK           | I/O | 3V3           | Master Mode: Serial Clock output<br>Slave Mode: Serial Clock input   |
| 43      | WAKEUP Source<0>, SDCard CardDetect | SPI0_SIN           | I   | 3V3           | Master Mode: MISO (Master Input/ Slave Output)<br>Slave Mode: MOSI (Master Output/Slave Input)                                 |
| 73      | GPIO                                | SPI0_SOUT          | O   | 3V3           | Master Mode: MOSI (Master Output/Slave Input)<br>Slave Mode: MISO (Master Input/ Slave Output)                                 |
| 97      | Camera Input Data<5>                | SPI1_PCS0          | I/O | 3V3           | Alternative Pin for<br>Master Mode: Peripheral Chip Select 0 output<br>Slave Mode: Slave Select input                          |
| 79      | Camera Input Data<4>                | SPI1_PCS1          | O   | 3V3           | Master Mode: Peripheral Chip Select 1 output<br>Slave Mode: not used   |
| 129     | USBH_PEN                            |                    |     | 3V3           |  |
| 95      | GPIO                                | SPI1_PCS2          | O   | 3V3           | Master Mode: Peripheral Chip Select 2 output<br>Slave Mode: not used   |
| 32      | UART_B CTS                          |                    |     | 3V3           |  |
| 61      | LCD RGB Data<17>                    | SPI1_PCS3          | O   | 3V3           | Master Mode: Peripheral Chip Select 3 output<br>Slave Mode: not used   |
| 34      | UART_B RTS                          |                    |     | 3V3           |  |
| 85      | Camera Input Data<8>, Keypad_Out<4> | SPI1_SCK           | I/O | 3V3           | Alternative Pin for<br>Master Mode: Serial Clock output<br>Slave Mode: Serial Clock input                                      |
| 67      | PWM<D>, Camera Input Data<6>        | SPI1_SIN           | I   | 3V3           | Alternative Pin for<br>Master Mode: MISO (Master Input/ Slave Output)<br>Slave Mode: MOSI (Master Output/Slave Input)          |
| 59      | PWM<A>, Camera Input Data<7>        | SPI1_SOUT          | O   | 3V3           | Alternative Pin for<br>Master Mode: MOSI (Master Output/Slave Input)<br>Slave Mode: MISO (Master Input/ Slave Output)          |
| 69      | GPIO                                | SPI2_PCS0          | I/O | 3V3           | Master Mode: Peripheral Chip Select 0 output<br>Slave Mode: Slave Select input   |
| 106     | GPIO                                | SPI2_PCS1          | O   | 3V3           | Master Mode: Peripheral Chip Select 1 output<br>Slave Mode: not used   |
| 107     | GPIO                                | SPI2_SCK           | I/O | 3V3           | Master Mode: Serial Clock output<br>Slave Mode: Serial Clock input   |
| 99      | GPIO                                | SPI2_SIN           | I   | 3V3           | Master Mode: MISO (Master Input/ Slave Output)<br>Slave Mode: MOSI (Master Output/Slave Input)                                 |
| 104     | GPIO                                | SPI2_SOUT          | O   | 3V3           | Master Mode: MOSI (Master Output/Slave Input)<br>Slave Mode: MISO (Master Input/ Slave Output)                                 |
| 135     | GPIO                                | SPI3_PCS0          | I/O | 3V3           | Master Mode: Peripheral Chip Select 0 output<br>Slave Mode: Slave Select input   |
| 133     | GPIO                                | SPI3_PCS1          | O   | 3V3           | Master Mode: Peripheral Chip Select 1 output<br>Slave Mode: not used   |
| 100     | Keypad_Out<1>                       | SPI3_SCK           | I/O | 3V3           | Master Mode: Serial Clock output<br>Slave Mode: Serial Clock input   |
| 188     | GPIO                                | SPI3_SIN           | I   | 3V3           | Master Mode: MISO (Master Input/ Slave Output)<br>Slave Mode: MOSI (Master Output/Slave Input)                                 |
| 75      | GPIO                                | SPI3_SOUT          | O   | 3V3           | Master Mode: MOSI (Master Output/Slave Input)<br>Slave Mode: MISO (Master Input/ Slave Output)                                 |

## 5.11 Quad Serial Peripheral Interface (QuadSPI)

The Quad Serial Peripheral Interface is an SPI interface with four bidirectional data lines instead of one transmit and one receive data line. The interface is mainly used for connecting to flash devices. The QuadSPI is not compatible with the Colibri family. The pins are located on the SODIMM connector as secondary functions.

### Features

- Various flash vendor devices supported
- Double Data Rate (DDR) and Single Data Rate (SDR) supported
- Two identical serial flash devices can be connected and accessed in parallel for data read operations with doubled readout bandwidth
- DMA support
- Memory mapped read access to connected flash devices
- Execute in place (XiP) possible
- Peak DDR Read Bandwidth 132MB/s

Table 5-16 QuadSPI Signals (not compatible with other modules)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------|-----|---------------|--|
| 36      | UART_B RXD          | QSPIO_A_CS0        | O   | 3V3           | Chip Select 0  |
| 94      | Camera Input HSYNC  | QSPIO_A_CS1        | O   | 3V3           | Chip Select 1, used to select second instance of QuadSPI device (dual die flash require CS0 and CS1) |
| 38      | UART_B TXD          | QSPIO_A_SCK        | O   | 3V3           | Serial Clock   |
| 86      | SPI CS              | QSPIO_A_DATA 0     | I/O | 3V3           | Serial I/O for command, address and data   |
| 129     | USBH_PEN            | QSPIO_A_DATA 1     | I/O | 3V3           | Serial I/O for command, address and data   |
| 32      | UART_B CTS          | QSPIO_A_DATA 2     | I/O | 3V3           | Serial I/O for command, address and data   |
| 34      | UART_B RTS          | QSPIO_A_DATA 3     | I/O | 3V3           | Serial I/O for command, address and data   |
| 90      | SPI RXD             | QSPIO_A_DQS        | I   | 3V3           | Data Strobe signal, required on some high speed DDR devices  |
| 88      | SPI CLK             | QSPIO_B_CS0        | O   | 3V3           | Chip Select 0  |
| 81      | Camera Input VSYNC  | QSPIO_B_CS1        | O   | 3V3           | Chip Select 1, used to select second instance of QuadSPI device (dual die flash require CS0 and CS1) |
| 92      | SPI TXD             | QSPIO_B_SCK        | O   | 3V3           | Serial Clock   |
| 75      | GPIO                | QSPIO_B_DATA 0     | I/O | 3V3           | Serial I/O for command, address and data   |
| 188     | GPIO                | QSPIO_B_DATA 1     | I/O | 3V3           | Serial I/O for command, address and data   |
| 135     | GPIO                | QSPIO_B_DATA 2     | I/O | 3V3           | Serial I/O for command, address and data   |
| 133     | GPIO                | QSPIO_B_DATA 3     | I/O | 3V3           | Serial I/O for command, address and data   |
| 100     | Keypad_Out<1>       | QSPIO_B_DQS        | I   | 3V3           | Data Strobe signal, required on some high speed DDR devices  |

## 5.12 PWM (Pulse Width Modulation)

The PWM function of Colibri VFxx is provided by the FlexTimer Module (FTM). The Colibri family specifies four PWM pins at the SODIMM connector. Additional to the four standard PWM pins, the module provides an additional 13 PWM capable pins as secondary functions of the SODIMM pins. This leads to a total of 17 PWM output pins.

The FlexTimer Module of the Vybrid SoC consists of four 16bit counters (FTM0 to FTM3). Each of these counters can have up to 8 channels. The channels can have independent duty cycles but are using the same counter. Therefore, the PWM<A> and PWM<C> need to be run with the same frequency but can have different duty cycle. The same restriction also applies between PWM<B> and PWM<D>.

The FTM channels can not only be used as PWM outputs, they can also be configured as input capture or output compare. Additionally, two SODIMM pins can be used as quadrature decoder inputs with filter function.

### Features

- 16bit counter, can be used as free-running counter or with initial and final value
- Counter can be configured to count up or up-down
- FTM source clock can be selected flexible
- Pre-scale divider (1 to 128)
- Capture can occur on rising, falling or on both edges.
- Input filter can be selected for some channels
- In Output Compare mode, the output signal can be set, cleared or toggled on match
- All channels can be configured for centre-aligned PWM mode
- The output pins can be paired for equal, complementary or independent output
- Dead time insertion is available for each complementary pair
- Polarity of each channel is configurable
- Dual edge capture for pulse and period width measurement
- Quadrature decoder input with filters, relative position counter and interrupt on position count

The PWM interface can be used as an easy way to emulate a DAC and generate a variable DC voltage if used with a suitable RC circuit. Other uses include control of LED brightness, display backlights or servo motors. With the additional features of the FTM, 3-phase motors, general purpose or stepper motors can be driven with a minimum amount of external components.

Table 5-17 FlexTimer Module Signals (Colibri family compatible interface)

| X1 Pin# | Colibri Signal Name          | Vybrid Signal Name | I/O | Voltage Level | Description   |
|---------|------------------------------|--------------------|-----|---------------|---|
| 59      | PWM<A>, Camera Input Data<7> | FTM0_CH0           | I/O | 3V3           | FTM channel (PWM Output/ input capture/ output compare) |
| 28      | PWM<B>                       | FTM1_CH0           | I/O | 3V3           | FTM channel (PWM Output/ input capture/ output compare) |
| 30      | PWM<C>                       | FTM0_CH1           | I/O | 3V3           | FTM channel (PWM Output/ input capture/ output compare) |
| 67      | PWM<D>, Camera Input Data<6> | FTM1_CH1           | I/O | 3V3           | FTM channel (PWM Output/ input capture/ output compare) |



Table 5-18 FlexTimer Module Signals (additional, not compatible with other modules)

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---|--------------------|-----|---------------|--|
| 24      | Battery Fault Detect                      | FTM0_CH3           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 21      | UART_C TXD                                | FTM0_CH4           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 19      | UART_C RXD                                | FTM0_CH5           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 94      | Camera Input HSYNC                        | FTM0_CH6           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 81      | Camera Input VSYNC                        | FTM0_CH7           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | FTM1_CH0           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 98      | Camera Input Data<1>                      | FTM1_CH1           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 106     | GPIO                                      | FTM3_CH0           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 69      | GPIO                                      | FTM3_CH1           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 99      | GPIO                                      | FTM3_CH2           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 104     | GPIO                                      | FTM3_CH3           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 107     | GPIO                                      | FTM3_CH4           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 127     | GPIO                                      | FTM3_CH5           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 184     | GPIO                                      | FTM3_CH6           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 186     | GPIO                                      | FTM3_CH7           | I/O | 3V3           | FTM channel (PWM Output/ input capture / output compare) |
| 28      | PWM<B>                                    | FTM1_QD_PHA        | I   | 3V3           | The Quadrature Decoder Phase A input                     |
| 67      | PWM<D>, Camera Input Data<6>              | FTM1_QD_PHB        | I   | 3V3           | The Quadrature Decoder Phase B input                     |

### 5.13 OWR (One Wire)

Colibri VFxx does not feature a One Wire interface.

### 5.14 SD/MMC

Colibri VFxx provides two SDIO interfaces. One interface is located on the standard SODIMM pins while the second interface is available on Colibri family incompatible SODIMM pins. The interfaces are capable of interfacing with SD Memory Cards, SDIO, MMC, CE-ATA cards and eMMC devices. The SDIO interface on the Vybrid SoC uses the DAT3 pin for detecting whether a card is plugged in or not. Due to compatibility issues with the Colibri family, it is not possible to use this feature. Instead, a GPIO should be used to detect the presence of the card by connecting it to the card detect switch of the holder.

**Features**

- Supports SD Memory Card Specification 2.0
- Supports SDIO Card Specification Version 2.0
- Supports addressing high capacity SD 2.0 or SD-HC cards up to 32 GByte
- Supports SPI mode
- Up to 200Mbps per second data rate using 4 parallel data lines (SD 4-bit mode) at 50 MHz
- Up to 208Mbps per second data rate using 4 parallel data lines (MMC 4-bit mode) at 52 MHz
- The IO voltage is 3.3V on the SODIMM pins.

Table 5-19 SDIO Signals (Colibri family compatible interface)

| X1 Pin# | Colibri Signal Name                 | Vybrid Signal Name | I/O | Voltage Level | Description                 |
|---------|-------------------------------------|--------------------|-----|---------------|-----------------------------|
| 47      | SDCard CLK                          | SDHC1_CLK          | O   | 3V3           | Serial Clock                |
| 190     | SDCard CMD                          | SDHC1_CMD          | I/O | 3V3           | Command                     |
| 192     | SDCard DAT<0>                       | SDHC1_DAT0         | I/O | 3V3           | Serial Data 0               |
| 49      | SDCard DAT<1>                       | SDHC1_DAT1         | I/O | 3V3           | Serial Data 1               |
| 51      | SDCard DAT<2>                       | SDHC1_DAT2         | I/O | 3V3           | Serial Data 2               |
| 53      | SDCard DAT<3>                       | SDHC1_DAT3         | I/O | 3V3           | Serial Data 3               |
| 43      | WAKEUP Source<0>, SDCard CardDetect | PTB20              | I   | 3V3           | Card Detect (standard GPIO) |

Table 5-20 SDIO Signals (additional, not compatible with other modules)

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name | I/O | Voltage Level | Description                                       |
|---------|---|--------------------|-----|---------------|---|
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | SDHC0_CLK          | O   | 3V3           | Serial Clock                                      |
| 98      | Camera Input Data<1>                      | SDHC0_CMD          | I/O | 3V3           | Command   |
| 101     | Camera Input Data<2>                      | SDHC0_DAT0         | I/O | 3V3           | Serial Data 0                                     |
| 103     | Camera Input Data<3>                      | SDHC0_DAT1         | I/O | 3V3           | Serial Data 1                                     |
| 79      | Camera Input Data<4>                      | SDHC0_DAT2         | I/O | 3V3           | Serial Data 2                                     |
| 97      | Camera Input Data<5>                      | SDHC0_DAT3         | I/O | 3V3           | Serial Data 3                                     |
| 67      | PWM<D>, Camera Input Data<6>              | SDHC0_WP           | I   | 3V3           | Write Protection (optional)                       |
| 127     | GPIO                                      | SDHC1_WP           | I   | 3V3           | Write Protection (optional, not Colibri standard) |

## 5.15 Analogue Audio (Colibri VF61 only)

Colibri VF61 features an Analogue Audio interface which is provided by the Wolfson WM9715L audio codec. The codec is connected over the AC97 interface to the Vybrid SoC. Please consult the Wolfson WM9715L datasheet for more information.

Table 5-21 Audio Interface Pins (VF61)

| X1 Pin# | Colibri Signal Name | WM9715 Pin# | WM9715 Pin Name | I/O | Description   |
|---------|---------------------|-------------|-----------------|-----|---|
| 1       | MIC_IN              | 21          | MIC1            | I   | Microphone Input  |
| 3       | MIC_GND             | (28)        | (MICBIAS)       | O   | Microphone pseudo-ground, is switched by using the MICBIAS output of the WM9715 |
| 5       | LINEIN_L            | 23          | LINE_IN_L       | I   | Left Line Input   |

| X1 Pin# | Colibri Signal Name | WM9715 Pin# | WM9715 Pin Name | I/O | Description   |
|---------|---------------------|-------------|-----------------|-----|---|
| 7       | LINEIN_R            | 24          | LINE_IN_R       | I   | Right Line Input                                    |
| 13      | HEADPHONE_GND       | 37          | OUT3            | O   | Headphone pseudo-ground (do not connect to ground!) |
| 15      | HEADPHONE_L         | 39          | HPOUT_L         | O   | Headphone Left Output                               |
| 17      | HEADPHONE_R         | 41          | HPOUT_R         | O   | Headphone Right Output                              |

## 5.16 DAC output (Colibri VF50 only)

Colibri VF50 features a digital-to-analogue converter (DAC) output on the pins of the headphone output instead of an analogue audio interface. The DAC can be used for low quality audio output due to the buffer and DMA function. The DAC output has a 1 $\mu$ F series capacitor between the Vybrid pin and the SODIMM connector. This allows for using the output as a DC-free audio output.

### Features

- 2 Channels
- 12bit resolution
- 3.3V reference voltage
- 16-word data buffer
- DMA support
- Output load current maximum 1 mA

Table 5-22 DAC Signals (VF50)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Description                                    |
|---------|---------------------|--------------------|-----|--|
| 15      | HEADPHONE_L         | DACO0              | O   | Digital-to-analogue converter output 0         |
| 17      | HEADPHONE_R         | DACO1              | O   | Digital-to-analogue converter output 1         |
| 13      | HEADPHONE_GND       | (VSS_AUDIO)        | O   | Connected to the analogue ground of the module |
| 1       | MIC_IN              | -                  | -   | Not connected                                  |
| 3       | MIC_GND             | -                  | -   | Not connected                                  |
| 5       | LINEIN_L            | -                  | -   | Not connected                                  |
| 7       | LINEIN_R            | -                  | -   | Not connected                                  |

## 5.17 Touch Panel Interface

The implementation of the resistive touch interface depends on the type of Colibri module. The VF61 module features the Wolfson WM9715L which provides the four wire touch interface. The touch interface of the VF50 module is provided by using the ADC and GPIO interfaces of the Vybrid SoC.

### 5.17.1 Colibri VF61 Touch Panel Interface

The Wolfson WM9715L audio codec provides the touch interface for the Colibri VF61 module. Please consult the Wolfson WM9715 documentation for more information.

Table 5-23 Touch Panel Interface Pins (VF61)

| X1 Pin# | Colibri Signal Name | WM9715 Pin# | WM9715 Pin Name | I/O | Voltage Level | Description |
|---------|---------------------|-------------|-----------------|-----|---------------|-------------|
| 14      | TSPX                | 14          | X+/BR           | I/O | AVDD          | X+ (4-wire) |
| 16      | TSMX                | 16          | X-/TL           | I/O | AVDD          | X- (4-wire) |
| 18      | TSPY                | 15          | Y+/TR           | I/O | AVDD          | Y+ (4-wire) |
| 20      | TSMY                | 17          | Y-/BL           | I/O | AVDD          | Y- (4-wire) |

### 5.17.2 Colibri VF50 Touch Panel Interface

Since the Colibri VF50 does not feature an audio codec, the touch interface is provided by using the internal ADC input of the Vybrid SoC. Some resistive touch panels require more current than the GPIO of the Vybrid allows to be drawn. Therefore, additional transistors are used for providing the higher current. The following figure shows the external circuit of the resistive touch interface on the module.

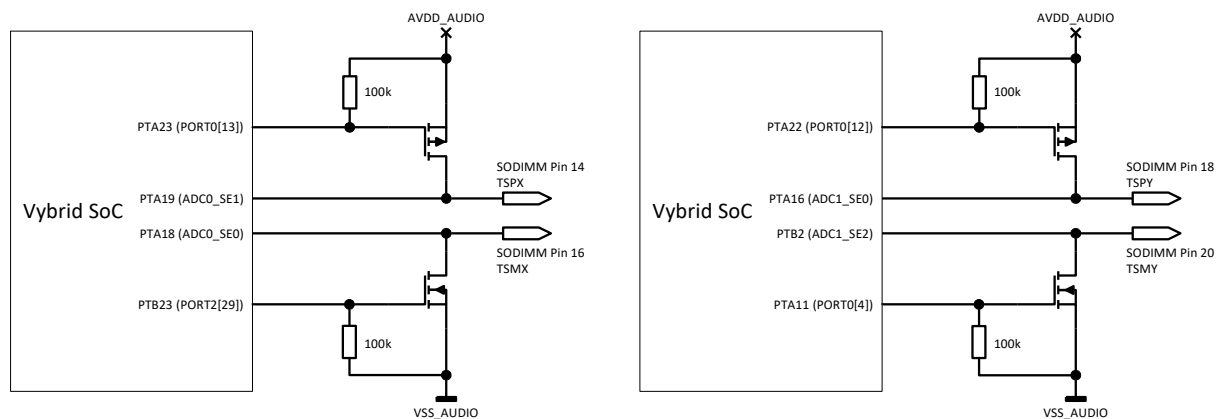


Figure 5 Colibri VF50 Touch Panel Interface Circuit

The touch panel interface of the Colibri VF50 is compatible with the four wire touch interface of the Colibri VF61 and the rest of the Colibri family.

Table 5-24 Touch Panel Interface Pins (VF50)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description                               |
|---------|---------------------|--------------------|-----|---------------|---|
| 14      | TSPX                | ADC0_SE1           | I   | AVDD          | ADC input for X+ (Pin PTA19 of Vybrid)    |
|         |                     | PTA23              | O   | AVDD          | FET gate driver (GPIO register PORT0[13]) |
| 16      | TSMX                | ADC0_SE0           | I   | AVDD          | ADC input for X- (Pin PTA18 of Vybrid)    |
|         |                     | PTA12              | O   | AVDD          | FET gate driver (GPIO register PORT0[5])  |
| 18      | TSPY                | ADC1_SE0           | I   | AVDD          | ADC input for Y+ (Pin PTA16 of Vybrid)    |
|         |                     | PTA22              | O   | AVDD          | FET gate driver (GPIO register PORT0[12]) |
| 20      | TSMY                | ADC1_SE2           | I   | AVDD          | ADC input for Y- (Pin PTA11 of Vybrid)    |
|         |                     | PTA11              | O   | AVDD          | FET gate driver (GPIO register PORT0[4])  |

## 5.18 Analogue Inputs

The analogue-to-digital converter (ADC) input is provided by the Vybrid SoC. There are four analogue inputs available which are located at the standard SODIMM pins which are compatible within the Colibri family. These pins are dedicated as ADC inputs only. They cannot be configured for other functions like GPIO. Additionally, some of the GPIO capable pins on the SODIMM connector feature as alternative function ADC capability. The ADC function of these pins is not compatible with other Colibri modules. It should also be noted that these signals are routed as digital signals on the module. Therefore, the noise level on these pins might be higher than on the dedicated ADC input signals.

The Vybrid SoC has two independent analogue-to-digital converters internally. Each of these converters is multiplexed to up to 10 external signal pads. Additionally, the converters can be multiplexed to measuring the internal temperature sensor, the DAC outputs or the reference voltage.

### Features

- 2 independent ADC
- Linear successive approximation algorithm
- 12bit resolution with 10/11 bit accuracy
- 12bit, 10bit or 8bit output modes
- Up to 1MS/s sampling rate
- Configurable sample time and conversion speed
- Interrupt on conversion complete
- Asynchronous clock source for lower noise operation
- 3.3V reference voltage
- Input voltage level 0 to 3.3V
- Temperature sensor
- Hardware average function
- Self-calibration mode
- DMA

Table 5-25 Dedicated Analogue Input Signals (Colibri family compatible interface)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description         |
|---------|---------------------|--------------------|-----|---------------|---------------------|
| 8       | Analogue Input <0>  | ADC0_SE8           | I   | AVDD          | Dedicated ADC input |
| 6       | Analogue Input <1>  | ADC1_SE8           | I   | AVDD          | Dedicated ADC input |
| 4       | Analogue Input <2>  | ADC0_SE9           | I   | AVDD          | Dedicated ADC input |
| 2       | Analogue Input <3>  | ADC1_SE9           | I   | AVDD          | Dedicated ADC input |

Table 5-26 Analogue Input Signals (additional, not compatible with other modules)

| X1 Pin# | Colibri Signal Name          | Vybrid Signal Name | I/O | Voltage Level | Description                                |
|---------|------------------------------|--------------------|-----|---------------|--|
| 16      | TSMX                         | ADC0_SE0           | I   | AVDD          | ADC input (only available on Colibri VF50) |
| 14      | TSPX                         | ADC0_SE1           | I   | AVDD          | ADC input (only available on Colibri VF50) |
| 59      | PWM<A>, Camera Input Data<7> | ADC0_SE2           | I   | AVDD          | ADC input                                  |
| 30      | PWM<C>                       | ADC0_SE3           | I   | AVDD          | ADC input                                  |
| 21      | UART_C TXD                   | ADC0_SE4           | I   | AVDD          | ADC input                                  |
| 95      | GPIO                         | ADC0_SE5           | I   | AVDD          | ADC input                                  |
| 18      | TSPY                         | ADC1_SE0           | I   | AVDD          | ADC input (only available on Colibri VF50) |

| X1 Pin# | Colibri Signal Name  | Vybrid Signal Name | I/O | Voltage Level | Description                                |
|---------|----------------------|--------------------|-----|---------------|--|
| 134     | GPIO                 | ADC1_SE1           | I   | AVDD          | ADC input                                  |
| 20      | TSMY                 | ADC1_SE2           | I   | AVDD          | ADC input (only available on Colibri VF50) |
| 24      | Battery Fault Detect | ADC1_SE3           | I   | AVDD          | ADC input                                  |
| 19      | UART_C RXD           | ADC1_SE4           | I   | AVDD          | ADC input                                  |
| 22      | VDD_FAULT/SENSE      | ADC1_SE5           | I   | AVDD          | ADC input                                  |

## 5.19 Parallel Camera Interface

The Video-In (VIU3) subsystem can receive data from TV decoder chips, camera sensors and other video devices. The parallel camera interface pins are located on Colibri family compatible SODIMM connector pins. However, the supported input formats and signal mapping is possibly different from other Colibri modules. Please compare the datasheets of the modules to verify compatibility.

Some cameras require a master clock signal. The Colibri family normally provides a clock output at pin 75 of the SODIMM connector. Unfortunately, on the Colibri VFix, this pin is not able to output a master clock signal. If the camera requires a clock signal, either use an external oscillator or use one of the other SODIMM pins of the Colibri VFix which do have clock output functionality. More information about the available clock output pins can be found in section 0.

### Features

- RGB888 (3 cycles), ITU656 10bit and ITU656 8bit compatible
- QVGA to XVGA resolutions
- Up to 1/8 video down-scaling on horizontal and vertical direction
- Up to 2/1 horizontal video up-scaling
- Horizontal mirroring
- Brightness and contrast adjust
- RGB to YUV conversion
- YUV to RGB conversion
- Simple de-interlace function
- Internal DMA
- Max pixel clock input 64MHz

Table 5-27 -Parallel Camera Interface Pins

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name | I/O | Voltage Level | RGB888 3 cycle | ITU656 10bit | ITU656 8bit |
|---------|---|--------------------|-----|---------------|----------------|--------------|-------------|
| 65      | Camera Input Data<9>, Keypad_Out<3>       | VIU_DATA9          | I   | 3V3           | —              | Y9/C9        | Y7/C7       |
| 85      | Camera Input Data<8>, Keypad_Out<4>       | VIU_DATA8          | I   | 3V3           | —              | Y8/C8        | Y6/C6       |
| 59      | PWM<A>, Camera Input Data<7>              | VIU_DATA7          | I   | 3V3           | R7/G7/B7       | Y7/C7        | Y5/C5       |
| 67      | PWM<D>, Camera Input Data<6>              | VIU_DATA6          | I   | 3V3           | R6/G6/B6       | Y6/C6        | Y4/C4       |
| 97      | Camera Input Data<5>                      | VIU_DATA5          | I   | 3V3           | R5/G5/B5       | Y5/C5        | Y3/C3       |
| 79      | Camera Input Data<4>                      | VIU_DATA4          | I   | 3V3           | R4/G4/B4       | Y4/C4        | Y2/C2       |
| 103     | Camera Input Data<3>                      | VIU_DATA3          | I   | 3V3           | R3/G3/B3       | Y3/C3        | Y1/C1       |
| 101     | Camera Input Data<2>                      | VIU_DATA2          | I   | 3V3           | R2/G2/B2       | Y2/C2        | Y0/C0       |
| 98      | Camera Input Data<1>                      | VIU_DATA1          | I   | 3V3           | R1/G1/B1       | Y1/C1        | —           |
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | VIU_DATA0          | I   | 3V3           | R0/G0/B0       | Y0/C0        | —           |

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | RGB888 3 cycle | ITU656 10bit | ITU656 8bit |
|---------|---------------------|--------------------|-----|---------------|----------------|--------------|-------------|
| 96      | Camera Input PCLK   | VIU_PIX_CLK        | I   | 3V3           | CLK            | CLK          | CLK         |
| 94      | Camera Input HSYNC  | VIU_HSYNC          | I   | 3V3           | HSYNC          | —            | —           |
| 81      | Camera Input VSYNC  | VIU_VSYNC          | I   | 3V3           | VSYNC          | —            | —           |

Two additional camera interface signals can be found on alternative functions on some SODIMM pins. The pins can only be used in the RGB888 mode and are not compatible with other Colibri modules.

Table 5-28 –Additional Parallel Camera Interface Pins

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description  |
|---------|---------------------|--------------------|-----|---------------|--|
| 35      | UART_A TXD          |                    |     | 3V3           |  |
| 19      | UART_C RXD          | VIU_DE             | I   | 3V3           | Data Enable (optional)   |
| 28      | PWM<B>              |                    |     | 3V3           |  |
| 21      | UART_C TXD          | VIU_FID            | I   | 3V3           | Field Identification (optional, identification of the upper or lower field for interlaced input formats) |
| 77      | GPIO                |                    |     | 3V3           |  |

## 5.20 Analogue Video ADC inputs (Colibri VF61 only)

Colibri VF61 features four analogue video inputs. The inputs accept PAL or NTSC composite video signals. The analogue to digital converter provides YUV888-formatted data to the video interface unit (VIU). The following figure shows the multiplexing schema for the video input system.

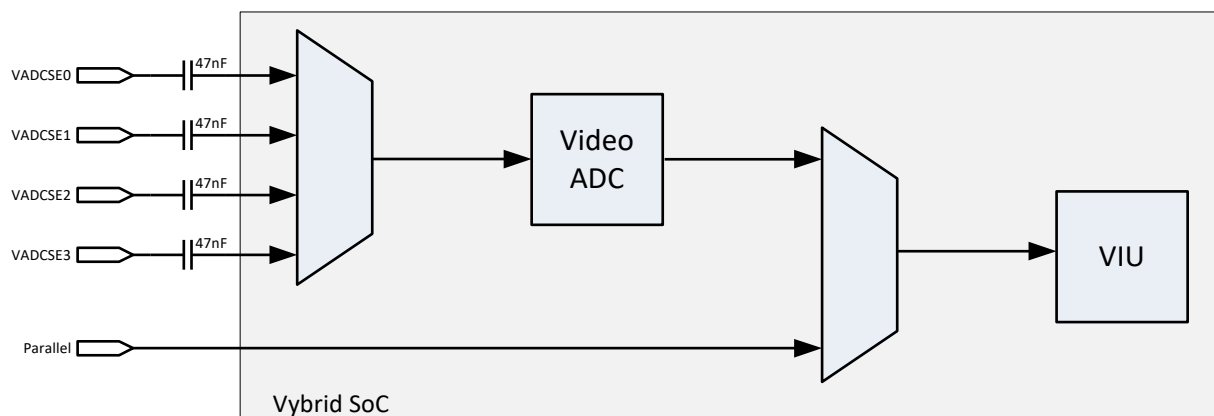


Figure 6 Colibri VF61 Video Input Multiplexing Schema

These analogue video inputs are not available on other Colibri modules. Therefore, the interface is not compatible with the Colibri family. The input signals are placed on unused SODIMM pins of the VF61. These pins are used for the external memory bus on some modules while other modules provide GPIO functionality on these pins. Since the analogue video signals are only inputs and series capacitors of 47nF are placed between the SODIMM connector and Vybrid pins, there are no electrical issues known when the module is placed on a carrier board which uses these pins for the external memory bus.

### Features

- 10bit resolution
- CVBS format
- Programmable anti-aliasing filter, gain and clamp
- PAL and NTSC decoder
- Automatic standards detection
- 2D adaptive comb filter
- Time base correction for VCR signals
- Luma pass band is flat to >6MHz

Table 5-29 Analogue Video Input Signals (Colibri VF61 only)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Description             |
|---------|---------------------|--------------------|-----|-------------------------|
| 162     |                     | VADCSE0            | I   | Composite video input 0 |
| 164     |                     | VADCSE1            | I   | Composite video input 1 |
| 166     |                     | VADCSE2            | I   | Composite video input 2 |
| 168     |                     | VADCSE3            | I   | Composite video input 3 |

## 5.21 S/PDIF (Sony-Philips Digital Interface I/O)

The Vybrid SoC features an S/PDIF input as well as an output interface. The interface can be used to transmit and receive digital audio. The interface is compatible with the AES/EBU IEC 60958 standard and Tech 3250-E with some exceptions. For more information about the limitation, please consult the reference manual for the Vybrid SoC.

The S/PDIF signals are not located on SODIMM connector pins as secondary functions. The location is not compatible with other Colibri modules.

Table 5-30 S/PDIF Signals (not compatible with other modules)

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description        |
|---------|---------------------|--------------------|-----|---------------|--------------------|
| 36      | UART_B RXD          | SPDIF_IN1          | I   | 3V3           | Serial Data Input  |
| 34      | UART_B RTS          | SPDIF_OUT1         | O   | 3V3           | Serial Data Output |

## 5.22 Audio Codec Interfaces

### 5.22.1 Synchronous Audio Interface (SAI)

The Synchronous Audio Interface (SAI) allows connecting I<sup>2</sup>S or AC97 audio codecs. The Wolfson W9715L audio codec of the Colibri VF61 is connected over the SAI2 to the Vybrid SoC. At the SODIMM connector, the SAI3 is available as a secondary function. The pins locations are not compatible with the rest of the Colibri family.

### Features

- Maximum frame size 32 words
- Word size between 8bit and 32bit
- Asynchronous 32x32bit FIFO for each transmit and receive channel
- DMA support



Table 5-31 SAI Signals

| X1 Pin# | Colibri Signal Name                 | Vybrid Signal Name | I/O | Voltage Level | Description         |
|---------|-------------------------------------|--------------------|-----|---------------|---------------------|
| 192     | SDCard DAT<0>                       | SAI3_TX_BCLK       | O   | 3V3           | Transmit Bit Clock  |
| 53      | SDCard DAT<3>                       | SAI3_TX_DATA       | O   | 3V3           | Transmit Data       |
| 29      | UART_A DSR                          | SAI3_TX_SYNC       | O   | 3V3           | Transmit Frame Sync |
| 49      | SDCard DAT<1>                       | SAI3_RX_BCLK       | I   | 3V3           | Receive Bit Clock   |
| 51      | SDCard DAT<2>                       | SAI3_RX_DATA       | I   | 3V3           | Receive Data        |
| 37      | UART_A RI, Keypad_In<4>             | SAI3_RX_SYNC       | I   | 3V3           | Receive Frame Sync  |
| 65      | Camera Input Data<9>, Keypad_Out<3> | CKO1               | O   | 3V3           | Audio Master Clock  |

Table 5-32 Typical usage of SAI

| X1 Pin# | Vybrid Signal Name | I2S Codec | I/O | Voltage Level | AC97 Codec     |
|---------|--------------------|-----------|-----|---------------|----------------|
| 192     | SAI3_TX_BCLK       | I2S_SCLK  | O   | 3V3           | AC97_BIT_CLK   |
| 53      | SAI3_TX_DATA       | I2S_DOUT  | O   | 3V3           | AC97_SDATA_OUT |
| 29      | SAI3_TX_SYNC       | I2S_LRCLK | O   | 3V3           | AC97_SYNC      |
| 49      | SAI3_RX_BCLK       | -         | I   | 3V3           | -              |
| 51      | SAI3_RX_DATA       | I2S_DIN   | I   | 3V3           | AC97_SDATA_IN  |
| 37      | SAI3_RX_SYNC       | -         | I   | 3V3           | -              |
| 65      | CKO1               | SYS_MCLK  | O   | 3V3           | AC97_MCLK      |

### 5.22.2 Enhanced Serial Audio Interface (ESAI)

The Enhanced Serial Audio Interface (ESAI) provides a full-duplex serial port for serial communication with a variety of serial devices such as audio codecs, S/PDIF transceivers or DSPs. The Vybrid SoC features up to 12 pins for connecting the ESAI to an external device. 8 of these pins are available externally as secondary functions of the SODIMM pins. Most peripherals do not require the missing RX bit clock, RX frame sync or the high frequency RX and TX clock signals. Please check the datasheet of the peripheral to see which signals are required. The ESAI interface is not compatible with other Colibri modules.

#### Features

- Up to six transmitters and four receivers
- Programmable word length (8, 12, 16, 20, 24bits)
- AC97 and I<sup>2</sup>S support
- 128 word transmit FIFO shared by six transmitter
- 128 word receive FIFO shared by four receivers

Table 5-33 ESAI Signals

| X1 Pin# | Colibri Signal Name                       | Vybrid Signal Name      | I/O | Voltage Level | Description   |
|---------|---|-------------------------|-----|---------------|---|
| 98      | Camera Input Data<1>                      | ESAI_FST                | O   | 3V3           | Frame sync for transmitter and receivers in synchronous mode and for the transmitter in asynchronous mode |
| 71      | Camera Input Data<0>, LCD Back-Light GPIO | ESAI_SCKT               | I/O | 3V3           | Transmit serial bit clock, direction can be programmed  |
| 101     | Camera Input Data<2>                      | ESAI_SDO0               | O   | 3V3           | Serial transmit data 0  |
| 103     | Camera Input Data<3>                      | ESAI_SDO1               | O   | 3V3           | Serial transmit data 1  |
| 79      | Camera Input Data<4>                      | ESAI_SDO2/<br>ESAI_SDI3 | I/O | 3V3           | Serial transmit data 2 or serial receive data 3   |
| 97      | Camera Input Data<5>                      | ESAI_SDO3/<br>ESAI_SDI2 | I/O | 3V3           | Serial transmit data 3 or serial receive data 2   |
| 59      | PWM<A>, Camera Input Data<7>              | ESAI_SDO4/<br>ESAI_SDI1 | I/O | 3V3           | Serial transmit data 4 or serial receive data 1   |
| 67      | PWM<D>, Camera Input Data<6>              | ESAI_SDO5/<br>ESAI_SDI0 | I/O | 3V3           | Serial transmit data 5 or serial receive data 0   |

## 5.23 Clock Output

Colibri VFxx provides two general purpose external clock signals (CKO) which are accessible through three SODIMM pins. The location of these pins is not compatible with the Colibri family.

Additional to the general purpose clock outputs, the module features dedicated clock outputs for example for the RMII or audio interface. Please check the relevant sections in this document for more information about the dedicated clock output signals.

The general purpose clock outputs can be sourced from a large variety of internal clock sources and PLLs. In addition, it is possible to set an individual divider value from 1 to 16. Therefore, the CKO pins can also be used for observing the internal clocks.

Table 5-34 Clock Output Signals

| X1 Pin# | Colibri Signal Name                 | Vybrid Signal Name | I/O | Voltage Level | Description                    |
|---------|-------------------------------------|--------------------|-----|---------------|--------------------------------|
| 65      | Camera Input Data<9>, Keypad_Out<3> | CKO1               | O   | 3V3           | General Purpose Clock Output 1 |
| 35      | UART_A TXD                          |                    |     | 3V3           |                                |
| 33      | UART_A RXD                          | CKO2               | O   | 3V3           | General Purpose Clock Output 2 |

## 5.24 Keypad

You can use any free GPIOs to realize a Matrix keypad interface.

## 5.25 CAN

Colibri VFxx features two Controller Area Network (CAN) interfaces. The interface is located as secondary functions on the SODIMM pins. The interface is therefore not compatible with all the modules in the Colibri family. If only one CAN interface is required, the interface on Pin 63/55 is preferable since it is compatible with the Colibri iMX6 modules. In order to be compliant with the CAN standard, a transceiver on the carrier board is required.

### Features

- Full implementation of the CAN protocol version 2.0B
- Bit rate up to 1Mb/s
- Flexible mailboxes of 0 to 8 bytes data length
- 6 frames receive FIFO
- Listen-only mode
- Programmable transmission priority scheme
- 16bit free running time stamp timer
- Short latency
- Receive FIFO ID filtering

Table 5-35 CAN Signals

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description                                    |
|---------|---------------------|--------------------|-----|---------------|--|
| 63      | GPIO                | CAN1_RX            | I   | 3V3           | CAN receive pin, compatible with Colibri iMX6  |
| 55      | GPIO                | CAN1_TX            | O   | 3V3           | CAN transmit pin, compatible with Colibri iMX6 |
| 196     | I2C SCL             | CAN0_RX            | I   | 3V3           | CAN receive pin                                |
| 194     | I2C SDA             | CAN0_TX            | O   | 3V3           | CAN transmit pin                               |

## 5.26 JTAG

There is a JTAG interface available on PCB test points. On the Evaluation Board 3.1 the signals are accessible through the pogo pins. The reference voltage is 3.3V, hence jumper JP 29 must be in position 2-3.

A JTAG interface is not required to work with the Colibri VFxx. You should always be able to reprogram the module via Recovery Mode (serial downloader).

## 6 Recovery Mode

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The UART\_A (SCI0) can be used to download new software. This is normally only required if the Bootloader does not boot anymore. In the Freescale documentation of the Vybrid the recovery mode is also called serial downloader.

To enter the recovery mode, either connect the recovery mode pads on the front of the module together (see picture below) or pull SODIMM pin 91 to GND with a 10KOhm resistor while power up the module. If the Colibri Evaluation Board V3.x is used, the SW9 button can be pressed during switching on the power supply for the module.

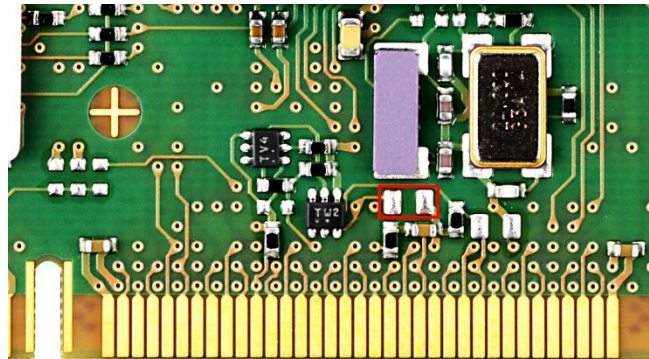


Figure 7 Location of recovery mode pads

The serial loader requires hardware flow control signals RTS/CTS. Enable the hardware flow control in your RS232 host adapter or short the two signals on the carrier board. You can find additional information in our Developer Centre:

<http://developer.toradex.com/knowledge-base/vfxx-recovery-mode>

## 7 Bootstrap Options

The Vybrid SoC has several different boot modes (BOOT\_MODE[1:0]). The VFxx knows the following boot modes:

Table 7-1 Boot Mode Pins

| BOOT_MODE1 | BOOT_MODE0 | Boot Type   |
|------------|------------|---|
| 0          | 0          | Boot from fuse settings (default)                     |
| 0          | 1          | Serial Downloader (Recovery Mode)                     |
| 1          | 0          | Boot with RCON strapping pin settings (not available) |

The module boots by default with the fused RCON settings (BOOT\_MODE[1:0] = 00). The fuse settings are configured to boot the module from the internal NAND flash.

As described in the previous section, the Colibri module can be set into the recovery mode. If pin 91 of the SODIMM connector is pulled down during the power up sequence an internal circuit sets the boot mode to the serial downloader (BOOT\_MODE[1:0] = 01).

The boot mode “Boot with RCON strapping pin settings” is not available for the Colibri VFxx modules, since the modules are fused. The Freescale documentation of the SoC can be a little confusing, but this boot mode is only available if the SoC is not fused.

Table 7-2 BOOT\_MODE Strapping Signals

| X1 Pin# | Colibri Signal Name | Vybrid Signal Name | I/O | Voltage Level | Description                      |
|---------|---------------------|--------------------|-----|---------------|----------------------------------|
| 82      | LCD RGB VSYNC       | BOOTMOD0           | I   | 3V3           | Internally pulled down with 10kΩ |
| 68      | LCD RGB HSYNC       | BOOTMOD1           | I   | 3V3           | Internally pulled down with 10kΩ |

Use the VSYNC and HSYNC signals with caution. Make sure that the signals are not pulled up externally during the power up cycle of the module. Therefore, we recommend adding buffers to the sync signals on the carrier board. The Colibri Evaluation board V3.x and all versions of the Iris Carrier board feature such buffers. The older carrier boards, such as the Colibri Evaluation board V2.x connect the sync signals directly to the VGA and LCD display connectors. This can lead to problems if a monitor or display pulls up these signals.

## 8 Suspend

The Vybrid SoC on the Colibri VFxx has several different suspend modes which help to reduce the power consumption of the module. The following suspend modes are supported:

Table 8-1 Suspend Modes

| Name    | Description   |
|---------|---|
| Run     | Device operates at the highest specified frequency, all peripherals are operational.  |
| Wait    | The device waits for an interrupt. The A5, the M4 or both cores are halted. The normal recovery is from an interrupt.                                       |
| LPRun   | Low Power Run mode is a dynamic power-saving mode. The running clocks are scaled down to lower frequencies.   |
| ULPRun  | Ultra-Low Power Run mode is an extension of the LPRun mode. The clock frequencies are scaled down to 32kHz or 128kHz  |
| Stop    | Lowest power mode in which all power rails are retained. Clocks to the peripherals are gated by the clock control module (CCM). SRAM contents are retained. |
| LPStop3 | Selected power rails are switched off (e.g. 1.2V Core is switched off). First 64K SRAM is retained  |
| LPStop2 | Selected power rails are switched off (e.g. 1.2V Core is switched off). First 16K SRAM is retained  |
| LPStop1 | Selected power rails are switched off (e.g. 1.2V Core is switched off). SRAM content is lost  |
| VBAT    | Only the RTC battery voltage (VCC_BATT) is available. The module main power (3V3) is not available. Only RTC is running                                     |

Since the normal GPIO pins lose their state in LPStop3 mode and lower, only the pins which are wake up capable can generate an interrupt which will wake up the system. More information about these wakeup sources can be found in section 5.2.1 of this document.

The DDR3 RAM on the module is powered in all states (except VBAT state) and retains its contents if it goes into the self-refresh operation. More information about the suspend mode can be found in the reference manual of the Freescale Vybrid SoC.

\*Vybrid modules prior to version 1.2A do not support suspend.

## 9 Known Issues

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The USB serial downloader is not working. If the Bootloader needs to be recovered, use the UART\_A serial loader or the JTAG interface.

## 10 Technical Specifications

### 10.1 Absolute Maximum Rating

Table 10-1 Absolute Maximum Ratings

| Symbol        | Description                   | Min  | Max       | Unit |
|---------------|-------------------------------|------|-----------|------|
| Vmax_3V3      | Main Module Supply            | -0.3 | 3.6       | V    |
| Vmax_AVDD     | Analogue Supply               | -0.3 | 3.6       | V    |
| Vmax_VCC_BATT | RTC Supply                    | -0.3 | 3.6       | V    |
| Vmax_IO       | Most pins with GPIO functions | -0.5 | 3V3+0.3V  | V    |
| Vmax_AIN      | Analog Input                  | -0.3 | AVDD+0.3V | V    |
| Vmax_USB      | USB Voltage                   | -0.5 | 5.25      | V    |

### 10.2 Recommended Operating Conditions

Table 10-2 Recommended Operating Conditions

| Symbol   | Description    | Min   | Typ | Max   | Unit |
|----------|----------------|-------|-----|-------|------|
| 3V3      | Digital Supply | 3.135 | 3.3 | 3.465 | V    |
| AVDD     | Analog Supply  | 3.0   | 3.3 | 3.6   | V    |
| VCC_BATT | RTC Supply     | 2.4   | 3.3 | 3.6   | V    |

### 10.3 Power Consumption

For designing and scaling the power supplies, it is advised to follow the recommendations provided in the specification of the Colibri product family. Following those recommendations ensures that the carrier board being designed will be compatible with all existing and future Colibri modules. For details, please refer to the Colibri Family Specification or the Colibri Carrier Board Design Guide.

Please note that scaling the carrier board power supplies for a particular module only may cause compatibility issues with other existing and future modules within the Colibri family. For designing carrier boards specifically for the Colibri Vybrid, please consult our Developer Website for module-specific power consumption information at <https://developer.toradex.com/linux-bsp/how-to/hardware-related/colibri-vfix-power-consumption>.

### 10.4 Power-Up Ramp Time Requirements

The timing requirements for the power-up and power-down are in the Colibri Carrier Board Design Guide <https://docs.toradex.com/102491-colibri-arm-carrier-board-design-guide.pdf>



## 10.5 Mechanical Characteristics

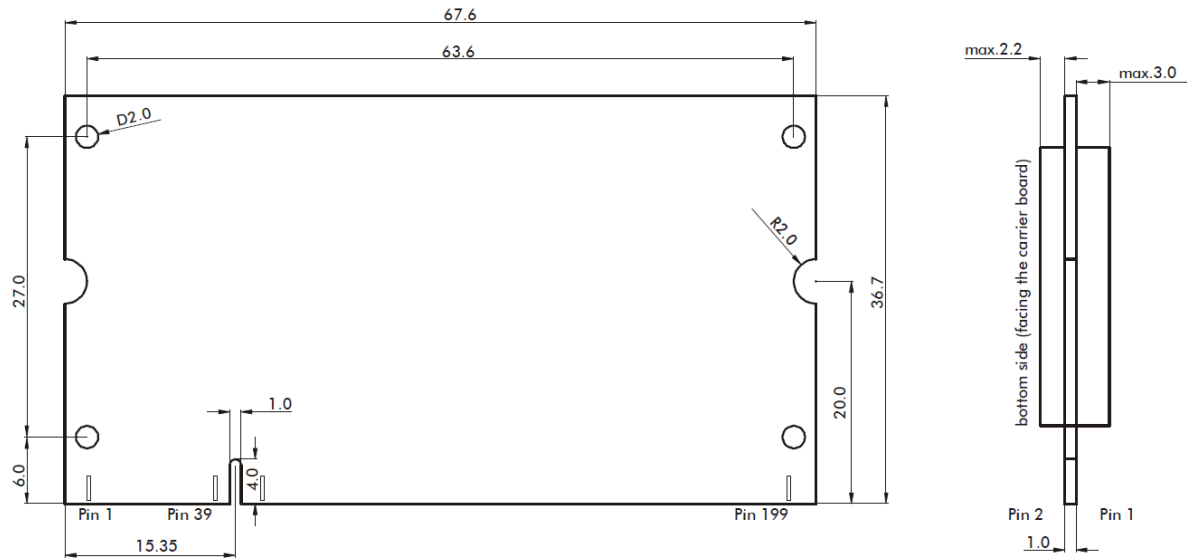


Figure 8 Mechanical dimensions of the Colibri modules  
Tolerance for all measures: +/- 0.1mm

### 10.5.1 Sockets for the Colibri Modules

The Colibri modules fit into a regular 2.5V (DDR1) SODIMM200 memory socket. A selection of SODIMM200 socket manufacturers is detailed below:

|                         |   |
|-------------------------|---|
| AUK Connectors:         | <a href="http://www.aukconnector.com/">http://www.aukconnector.com/</a>   |
| CONCRAFT:               | <a href="http://www.concraft.com.tw/connector_products.html">http://www.concraft.com.tw/connector_products.html</a> |
| Morethanall Co Ltd.:    | <a href="http://www.morethanall.com/">http://www.morethanall.com/</a>   |
| Tyco Electronics (AMP): | <a href="http://www.te.com/usa-en/home.html">http://www.te.com/usa-en/home.html</a>                                 |
| NEXUS COMPONENTS GmbH   | <a href="https://www.nexus-de.com/en">https://www.nexus-de.com/en</a>   |

## 10.6 Thermal Specification

Table 10-3 Thermal Specification

| Module                          | Description  | Min | Typ | Max | Unit |
|---------------------------------|--|-----|-----|-----|------|
| Colibri VFxx                    | Operating temperature range  | 0   |     | 70  | °C   |
| Colibri VFxx IT                 | Operating temperature range  | -40 |     | 85  | °C   |
| Colibri VFxx<br>Colibri VFxx IT | Storage Temperature  | -55 |     | 100 | °C   |
| Colibri VFxx<br>Colibri VFxx IT | Thermal Resistance Junction-to-Ambient, Vybrid Chip only.<br>(Theta-JA) <sup>1</sup>   |     | 28  |     | °C/W |
| Colibri VFxx<br>Colibri VFxx IT | Thermal Resistance Junction-to-Case, Vybrid Chip only.<br>(Theta-JC) <sup>1</sup>      |     | 10  |     | °C/W |
| Colibri VFxx<br>Colibri VFxx IT | Thermal Resistance Junction-to-Top of Package, Vybrid Chip only, (Psi-JT) <sup>1</sup> |     | 2   |     | °C/W |

<sup>1</sup> A High K JEDEC four layer Board as defined by JEDEC Standard JESD51-6, board mounted horizontal, natural convection.

## 10.7 Product Compliance

Up-to-date information about product compliance such as RoHS, CE, UL-94, Conflict Mineral, REACH etc. can be found on our website at:

<http://www.toradex.com/support/product-compliance>