



# Hardware User Manual

**TCM-BF537 v1.x**

**TCM-BF537BP v1.x**

*...maximum performance at minimum space*

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### **Information**

For further information on technology, delivery terms and conditions and prices please contact Bluetechnix (<http://www.bluetechnix.com>).

### **Warning**

Due to technical requirements components may contain dangerous substances.

The Core Modules and development systems contain ESD (electrostatic discharge) sensitive devices. Electro-static charges readily accumulate on the human body and equipment and can discharge without detection. Permanent damage may occur on devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Unused Core Modules and Development Boards should be stored in the protective shipping



## BLACKFIN Products

### Core Modules:

- TCM-BF518: The new Core Module CM-BF518 is powered by Analog Devices' single core ADSP-BF518 processor; up to 400MHz, 32MB SDRAM, up to 8MB flash. The 2x60 pin expansion connectors are backwards compatible with other Core Modules.
- CM-BF527: The new Blackfin Processor Module is powered by Analog Devices' single core ADSP-BF527 processor; key features are USB OTG 2.0 and Ethernet. The 2x60 pin expansion connectors are backwards compatible with other Core Modules.
- CM-BF533: Blackfin Processor Module powered by Analog Devices' single core ADSP-BF533 processor; up to 600MHz, 32MB SDRAM, 2MB flash, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
- TCM-BF537: Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 500MHz, 32MB SDRAM, 8MB flash, a size of 28x28mm, 2x60 pin expansion connectors, Ball Grid Array or Border Pads for reflow soldering, industrial temperature range -40°C to +85°C.
- CM-BF537E: Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 600MHz, 32MB SDRAM, 4MB flash, integrated TP10/100 Ethernet physical transceiver, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
- CM-BF537U: Blackfin Processor Module powered by Analog Devices' single core ADSP-BF537 processor; up to 600MHz, 32MB SDRAM, 4MB flash, integrated USB 2.0 Device, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
- CM-BF548: The new Blackfin Processor Module is powered by Analog Devices' single core ADSP-BF548 processor; key features are 64MB DDR SD-RAM 2x100 pin expansion connectors.
- CM-BF561: Blackfin Processor Module powered by Analog Devices' dual core ADSP-BF561 processor; up to 2x 600MHz, 64MB SDRAM, 8MB flash, 2x60 pin expansion connectors and a size of 36.5x31.5mm.
- eCM-BF561: Blackfin Processor Module powered by Analog Devices' dual core ADSP-BF561 processor; up to 2x 600MHz, 128MB SDRAM, 8MB flash, 2x100 pin expansion connectors and a size of 44x33mm.

### **Development Boards:**

- EVAL-BF5xx:** Low cost Blackfin processor Evaluation Board with one socket for any Bluetechnix Blackfin Core Module. Additional interfaces are available, e.g. an SD-Card.
- DEV-BF5xxDA-Lite:** Get ready to program and debug Bluetechnix Core Modules with this tiny development platform including an USB-Based Debug Agent. The DEV-BF5xxDA-Lite is a low cost starter development system including a VDSP++ Evaluation Software License.
- DEV-BF548-Lite:** Low-cost development board with one socket for Bluetechnix CM-BF548 Core Module. Additional interfaces are available, e.g. an SD-Card, USB and Ethernet.
- DEV-BF548DA-Lite:** Get ready to program and debug Bluetechnix CM-BF548 Core Module with this tiny development platform including an USB-Based Debug Agent. The DEV-BF548DA-Lite is a low-cost starter development system including a VDSP++ Evaluation Software License.
- EXT-Boards:** The following Extender Boards are available: EXT-BF5xx-AUDIO, EXT-BF5xx-VIDEO, EXT-BF5xx-CAM, EXT-BF5xx-EXP-TR, EXT-BF5xx-USB-ETH2, EXT-BF5xx-AD/DA, EXT-BF548-EXP and EXT-BF518-ETH. Furthermore, we offer the development of customized extender boards for our customers.

### **Software Support:**

- BLACKSheep:** The BLACKSheep VDK is a multithreaded framework for the Blackfin processor family from Analog Devices that includes driver support for a variety of hardware extensions. It is based on the real-time VDK kernel included within the VDSP++ development environment.
- LabVIEW:** LabVIEW embedded support for Bluetechnix Core Modules is done by Schmid-Engineering AG: <http://www.schmid-engineering.ch>
- uClinux:** All the Core Modules are fully supported by uClinux. The required boot loader and uClinux can be downloaded from: <http://blackfin.uClinux.org>.

### **Upcoming Products and Software Releases:**

Keep up-to-date with all the changes to the Bluetechnix product line and software updates at: <http://www.bluetechnix.com>.

## **BLACKFIN Design Service**

Based on more than five years of experience with Blackfin, Bluetechnix offers development assistance as well as custom design services and software development.

## 1 Introduction

The TCM-BF537 is a chip size Core Module designed for industrial temperature range and volume production. It combines power supply, RAM and FLASH into a module as small as a chip package. Different connector options (Ball Grid Array (BGA), Border Pads (BP) and Connectors) provides solutions for all possible requirements.

### 1.1 Overview

The Core Module TCM-BF537 consists of the following components shown in Figure 1-1.

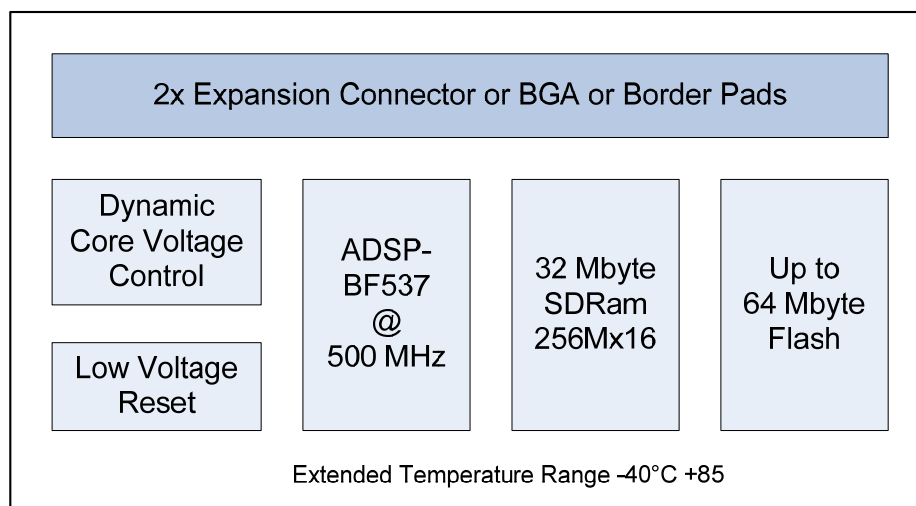


Figure 1-1: Main Components of the TCM-BF537 Core Module

- **Analog Devices Blackfin Processor BF537**
  - ADSP-BF537BBCZ-5A, 500MHz (-40°-85°C)

#### 32 MB SDRAM

- SDRAM Clock up to 133MHz
- See chapter 8 Production Report

#### Up to 64 MB of Byte Addressable Flash

- See chapter 8 Production Report
- Additional flash memory upon request: It can be connected through the expansion board as parallel flash using asynchronous chip select lines or as SPI flash.

#### Low Voltage Reset Circuit

- Resets module if power supply goes below 2.93V.

#### Dynamic Core Voltage Control

- Core voltage adjustable by setting software registers on the Blackfin processor
- Core voltage range: 0.8 – 1.32V



### Peripherals available on all Core Module versions

- SPORT 0
- JTAG
- UART0/UART1
- CAN
- TWI (I2C compatible)
- SPI (Serial Port Interface)
- PPI (Parallel Port Interface)
- Boot Mode Pins
- GPIO's

### Peripherals available on the Connector and BGA version only.

- Data Bus
- Address Bus
- Further GPIO's
- Memory Control Signals

## 1.2 Versions

TCM-BF537: Connector Version 2x60 connector pins

TCM-BF537BGA: 169 BGAs 1.5 mm pitch for volume production

TCM-BF537BP: 76 Border Pads, no Data- and Address bus on border pads

## 1.3 Key Features

- The TCM-BF537, measuring only 28x28mm is the smallest core module available.
- An extended temperature range, suitable for industrial production.
- Allows integration on a two layer baseboard.
- Reduces development costs, fast time to market.
- Very cost effective for small and medium volumes

## 1.4 Target Applications

- Generic high performance signal processor module
- Industrial Automation

## 1.5 Further Information

Further information, and document updates are available on the product homepage:  
<http://www.bluetechnix.com/goto/tcm-bf537>

## 2 Specification

### 2.1 Functional Specification

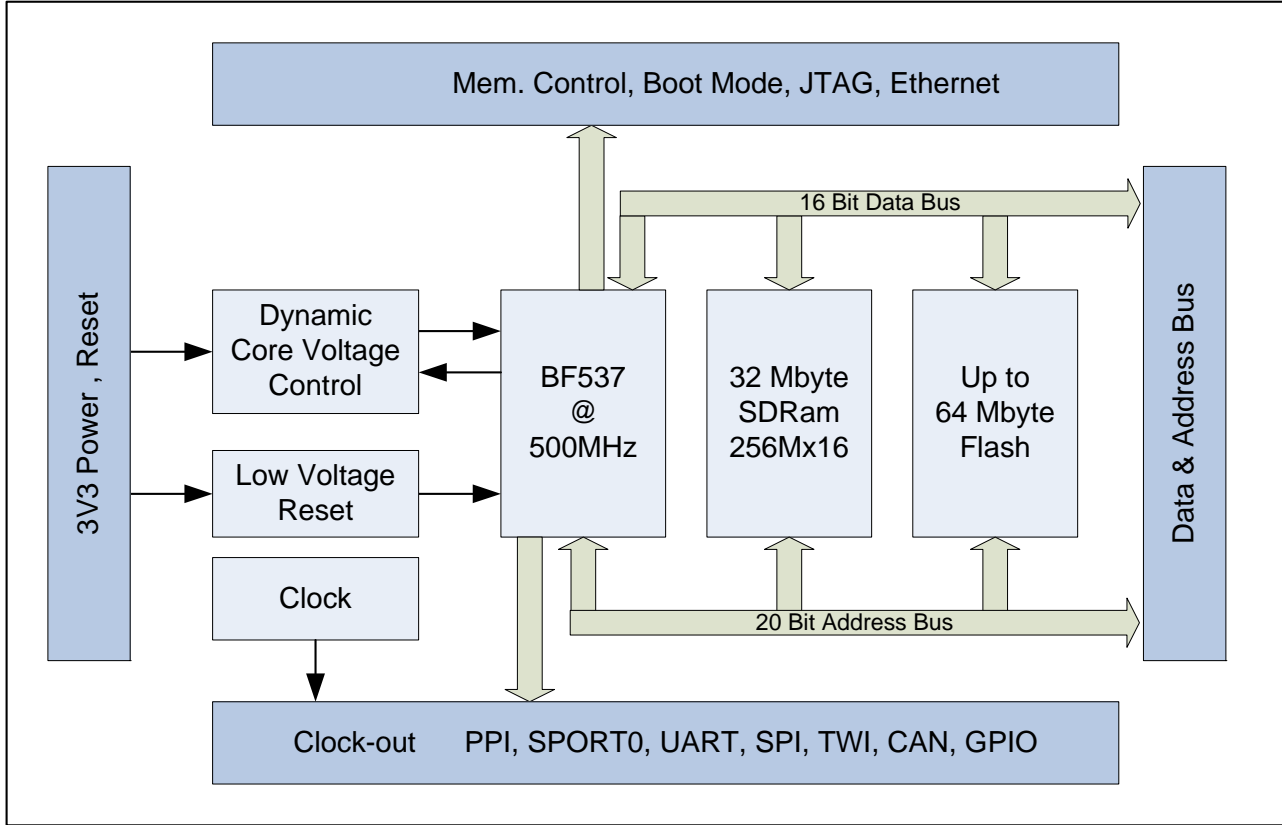


Figure 2-1: Detailed Block Diagram

Figure 2-1 shows a detailed block diagram of the TCM-BF537 module. Beside the SDRAM and a few other control pins, the TCM-BF537 has most pins of the Blackfin processor on its two 60 pin connectors, or its BGA, or its Border Pads.

Dynamic voltage control allows reducing power consumption to a minimum adjusting the core voltage and the clock frequency dynamically in accordance to the required processing power.

A low voltage reset circuit guarantees a power on reset and resets the system when the input voltage drops below 2.93V for at least 140ms.

## 2.2 Boot Mode

By default the boot mode = 000 (BMODE2 = Low, BMODE1 = Low, BMODE0=Low). All BMODE pins have on board pull down resistors.

Switch Settings BM2,BM1,BM0	Description
000	Execute from 16-bit external memory (bypass boot ROM)
001	Boot from 8-bit or 16-bit memory (EPROM/flash)
010	Reserved
011	Boot from serial SPI memory (EEPROM/flash)
100	Boot from SPI Host (slave mode)
101	Boot from serial TWI memory (EEPROM/flash)
110	Boot from TWI host (slave mode)
111	Boot from UART host (slave mode)

Table 2-1: Boot Mode TCM-BF537

Connect BMODE0 to Vcc and leave BMODE1, BMODE2 pins open for Boot Mode 001 equals to 8 or 16 bit PROM/FLASH boot mode. This is the default boot mode for the BLACKSheep software.

## 2.3 Flash Memory Map<sup>\*)</sup>

Blackfin Start Addr.	Blackfin End Addr.	FA24 (PG15) **)	FA23 (PG14) **)	FA22 (PG13) **)	FA21 (PF5)	FA20 (PF4)	Flash Start Addr.	Flash End Addr.
0x20000000	0x201FFFFFF	0	0	0	0	0	0x00000000	0x001FFFFFF
0x20000000	0x201FFFFFF	0	0	0	0	1	0x00200000	0x003FFFFFF
0x20000000	0x201FFFFFF	0	0	0	1	0	0x00400000	0x005FFFFFF
0x20000000	0x201FFFFFF	0	0	0	1	1	0x00600000	0x007FFFFFF
0x20000000	0x201FFFFFF	0	0	1	0	0	0x00800000	0x009FFFFFF
0x20000000	0x201FFFFFF	0	0	1	0	1	0x00A00000	0x00BFFFFFF
0x20000000	0x201FFFFFF	0	0	1	1	0	0x00C00000	0x00DFFFFFF
0x20000000	0x201FFFFFF	0	0	1	1	1	0x00E00000	0x00FFFFFF
0x20000000	0x201FFFFFF	0	1	0	0	0	0x01000000	0x011FFFFFF
0x20000000	0x201FFFFFF	0	1	0	0	1	0x01200000	0x013FFFFFF
0x20000000	0x201FFFFFF	0	1	0	1	0	0x01400000	0x015FFFFFF
0x20000000	0x201FFFFFF	0	1	0	1	1	0x01600000	0x017FFFFFF
0x20000000	0x201FFFFFF	0	1	1	0	0	0x01800000	0x019FFFFFF
0x20000000	0x201FFFFFF	0	1	1	0	1	0x01A00000	0x01BFFFFFF
0x20000000	0x201FFFFFF	0	1	1	1	0	0x01C00000	0x01DFFFFFF
0x20000000	0x201FFFFFF	0	1	1	1	1	0x01E00000	0x01FFFFFF
0x20000000	0x201FFFFFF	1	0	0	0	0	0x02000000	0x021FFFFFF
0x20000000	0x201FFFFFF	1	0	0	0	1	0x02200000	0x023FFFFFF
0x20000000	0x201FFFFFF	1	0	0	1	0	0x02400000	0x025FFFFFF
0x20000000	0x201FFFFFF	1	0	0	1	1	0x02600000	0x027FFFFFF
0x20000000	0x201FFFFFF	1	0	1	0	0	0x02800000	0x029FFFFFF
0x20000000	0x201FFFFFF	1	0	1	0	1	0x02A00000	0x02BFFFFFF
0x20000000	0x201FFFFFF	1	0	1	1	0	0x02C00000	0x02DFFFFFF
0x20000000	0x201FFFFFF	1	0	1	1	1	0x02E00000	0x02FFFFFF
0x20000000	0x201FFFFFF	1	1	0	0	0	0x03000000	0x031FFFFFF
0x20000000	0x201FFFFFF	1	1	0	0	1	0x03200000	0x033FFFFFF
0x20000000	0x201FFFFFF	1	1	0	1	0	0x03400000	0x035FFFFFF

0x20000000	0x201FFFFF	1	1	0	1	1	0x03600000	0x037FFFFF
0x20000000	0x201FFFFF	1	1	1	0	0	0x03800000	0x039FFFFF
0x20000000	0x201FFFFF	1	1	1	0	1	0x03A00000	0x03BFFFFF
0x20000000	0x201FFFFF	1	1	1	1	0	0x03C00000	0x03DFFFFF
0x20000000	0x201FFFFF	1	1	1	1	1	0x03E00000	0x03FFFFFF

Table 2-2: Memory Map

The flash memory is subdivided into addressable banks with 2 MByte size.

The pin-connections for FA22-FA24 can be customized. Please contact Bluetechnix Support for more information.

**\*) Be aware that you have to unlock the flash before starting an erase process!**

**\*\*) Only valid if 64 MByte flash mounted (see chapter 8 Production Report)**

### 2.3.1 Asynchronous Memory Banks

The maximum amount of memory addressable by a single asynchronous memory bank, of the Blackfin processor is 1MB. On this module, each 2MB segment of Flash is addressed over 2 asynchronous memory banks. In order to be able to use more than 2MB without using more than 2 banks, 2 GPIOs (PF4, PF5) are used to select which 2MB section of the FLASH is visible in the memory window of the Blackfin processor. This frees up the remaining banks for the user.

Aside from the first 2 async memory banks, which are used for FLASH addressing, the core module has 2 banks of the Asynchronous Memory interface available, these can be addressed through the following addresses:

Bank	Start Address	End Address	Size	Comment
0	0x20000000	0x200FFFFFFF	1MB	(Addresses FLASH)
1	0x20100000	0x201FFFFFFF	1MB	(Addresses FLASH)
2	0x20200000	0x202FFFFFFF	1MB	Use nAMS 2
3	0x20300000	0x203FFFFFFF	1MB	Use nAMS 3

Table 2-3: Asynchronous memory banks

These memory banks can be used to access various memory mapped devices or peripherals.

**\*There are 19 address lines (A1 to A19) (The A0 signal is produced through addressing logic on ABE0 and ABE1), this allows the entire 1MB to be addressable bitwise.**

See section 5.6, Flash Memory Extension PINS.

## 2.4 SDRAM Memory Map

Start Addr.	End Addr.	Size	Comment
0x00000000	0x01FFFFFFF	32MByte	16 Bit Memory interface

Table 2-4: SDRAM memory map

## 2.5 Electrical Specification

### 2.5.1 Supply Voltage

- 3.3V DC +/-10%

### 2.5.2 Supply Voltage Ripple

- 100mV peak to peak 0-20 MHz

### 2.5.3 Input Clock Frequency

- 25MHz

The Blackfin Processor Input Clock frequency is 25 MHz, this frequency is derived from the on-board crystal/oscillator and drives the Blackfin Processor's Clock generator. This frequency is also provided on the connector as pin 78 (CLKBUF).

### 2.5.4 Real Time Clock Crystal

- 32.768kHz

### 2.5.5 Supply Current

- Maximum current: 300mA at 3.3V
- Typical operating conditions at 25°C environment temperature:
  - Processor running at 500MHz, Core Voltage 1.2V, SDRAM 50% bandwidth utilization at 125MHz; 150mA at 3.3V
  - Processor running at 250MHz, Core Voltage 0.85V SDRAM 50% bandwidth utilization at 83,3MHz; Ethernet Idle: 85mA at 3.3V

## 2.6 Environmental Specification

### 2.6.1 Temperature

- Operating at full 500MHz:: -40 to + 85° C

### 2.6.2 Humidity

Operating: 10% to 90% (non condensing)

## 3 TCM-BF537C (Connector Version)

### 3.1 Mechanical Outline

Figure 3-1 shows the top view of the Core Module. All dimensions are given in millimeters!

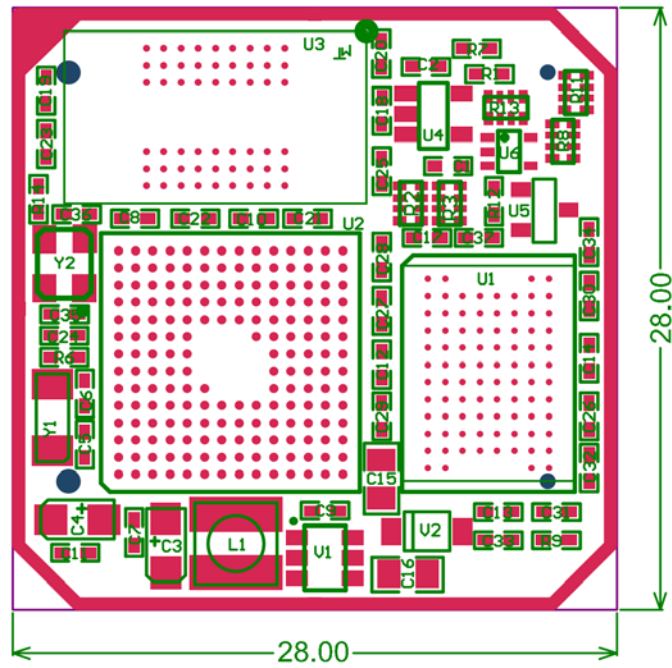


Figure 3-1: Mechanical Outline (top view)

Figure 3-2 shows the bottom view of the Core Module (connector version).

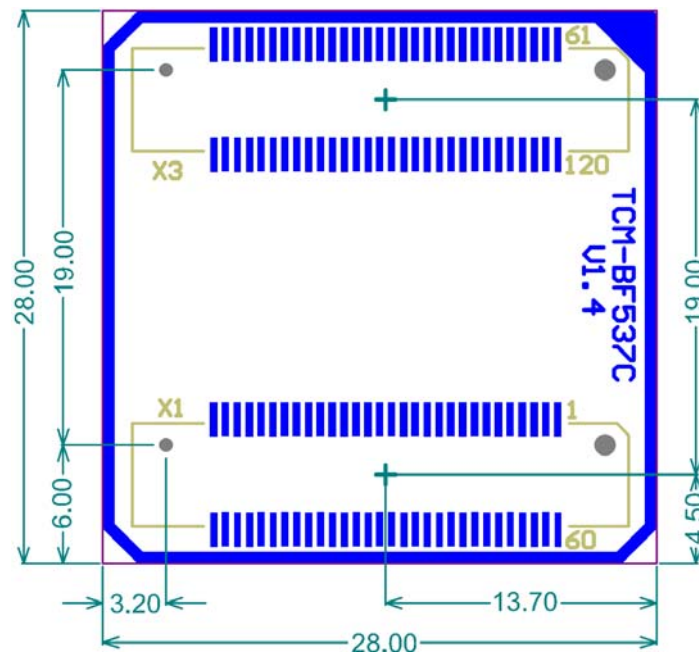


Figure 3-2: Mechanical Outline (bottom view)

Figure 3-3 shows a side view of the Core Module with mounted connectors.

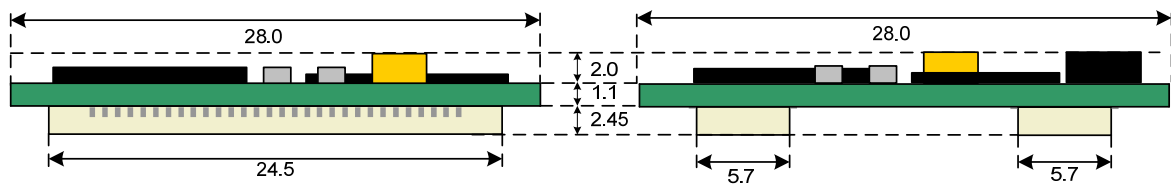


Figure 3-3: Side View with Connectors mounted

The total minimum mounting height including receptacle at the motherboard is 5.8mm.

### 3.2 Footprint

For the Connector version (2x Hirose 0.6mm pitch) the footprint for the base board looks like that as shown in Figure 3-4.

For the baseboard the following connectors have to be used.

Baseboard Part	Manufacturer	Manufacturer Part No.
X1, X2	Hirose	FX8-60S-SV

Table 3-1: Baseboard connector types

The Connectors on the TCM-BF537 are of the following type:

Part	Manufacturer	Manufacturer Part No.
X1, X2	Hirose 3mm height	FX8-60P-SV

Table 3-2: Core Module connector types

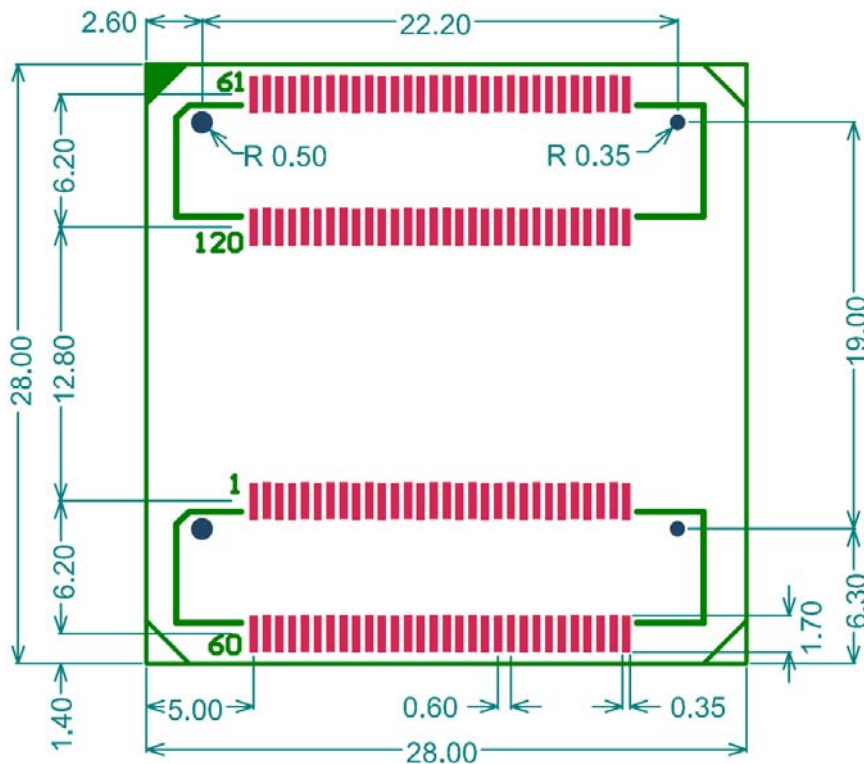


Figure 3-4: Recommended Footprint for Base Board (top view)

### 3.3 Schematic Symbol of Connector Version

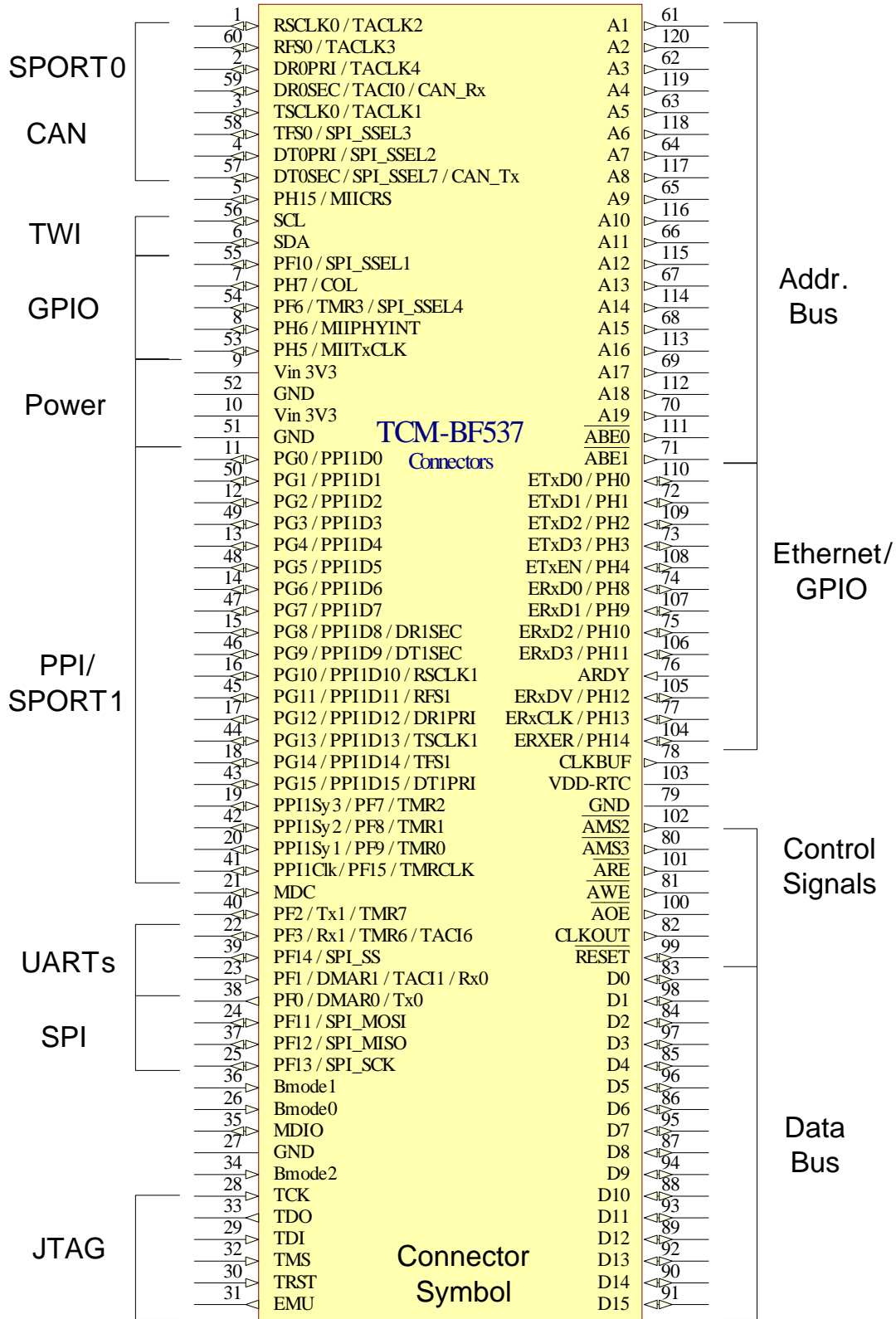


Figure 3-5: Schematics Symbol of Connector Version of the TCM-BF537



### 3.4 Connectors PIN Assignment

Please mind the mounted pull up and pull down resistors on the Core Module. See the third column of Table 3-3 and Table 3-4.

#### 3.4.1 Connector X1 – (1-60)

Pin No.	Signal	Signal Type.
1	RSCLK0 / TACLK2	I/O
2	DR0PRI / TACLK4	O
3	TSCLK0 / TACLK1	I/O
4	DT0PRI / SPI_SSEL2	I
5	PH15 / MIICRS	I/O
6	SDA	I/O
7	PH7 / COL	I/O
8	PH6 / MIIPHYINT	I/O
9	Vin 3.3 V	PWR
10	Vin 3.3V	PWR
11	PG0 / PPI1D0	I/O
12	PG2 / PPI1D2	I/O
13	PG4 / PPI1D4	I/O
14	PG6 / PPI1D6	I/O
15	PG8 / PPI1D8 / DR1SEC	I/O
16	PG10 / PPI1D10 / RSCLK1	I/O
17	PG12 / PPI1D12 / DR1PRI	I/O
18	PG14 / PPI1D14 / TFS1	I/O
19	PPI1SY3/PF7/TMR2	I/O
20	PPI1SY1/PF8/TMR1	I/O
21	MDC	I/O
22	PF3 / Rx1 / TMR6 / TACI6	I/O
23	PF1 / DMAR1 / TACI1 / Rx0	I/O
24	PF11 / SPI_MOSI	I/O
25	PF13 / SPI_SCK	I/O
26	BMODE0	I – 10k pull down
27	GND	PWR
28	TCK	I – 10k pull up
29	TDI	I – 10k pull up
30	$\overline{\text{TRST}}$	I – 4k7 pull down
31	$\overline{\text{EMU}}$	O
32	TMS	I – 10k pull up
33	TDO	O
34	BMODE2	I – 10k pull down
35	MDIO	I/O – 10k pull up
36	BMODE1	I – 10k pull down
37	PF12 / SPI_MISO	I/O
38	PF0 / DMAR0 / Tx0	I/O
39	PF14 / SPI_SS	I/O
40	PF2 / Tx1 / TMR7	I/O
41	PPI1Cik / PF15 / TMRCLK	I/O

42	PPI1Sy2 / PF8 / TMR1	I/O
43	PG15 / PPI1D15 / DT1PRI	I/O
44	PG13 / PPI1D13 / TSCLK1	I/O
45	PG11 / PPI1D11 / RFS1	I/O
46	PG9 / PPI1D9 / DT1SEC	I/O
47	PG7 / PPI1D7	I/O
48	PG5 / PPI1D5	I/O
49	PG3 / PPI1D3	I/O
50	PG1 / PPI1D1	I/O
51	GND	PWR
52	GND	PWR
53	PH5 / MIITxCLK	I/O
54	PF6 / TMR3 / SPI_SSEL4	I/O
55	PF10 / SPI_SSEL1	I
56	SCL	I/O
57	DT0SEC / CANTX / SPI_SSEL7	O
58	TFS0 / SPI_SSEL3	I/O
59	DR0SEC / TACIO / CANRX	I
60	RFS0 / TACLK3	I/O

Table 3-3: Connector X1 pin assignment

Note: The processor pins PF4 and PF5 are used for flash addressing on the Core Module. They are not available on the connectors.

Signal names correspond to those of the Blackfin processor unless otherwise stated.

### 3.4.2 Connector X2 – (61-120)

Pin No.	Signal	Signal Type.
61	A1	O
62	A3	O
63	A5	O
64	A7	O
65	A9	O
66	A11	O
67	A13	O
68	A15	O
69	A17	O
70	A19	O
71	$\overline{ABE1}$ / SDQM1	O
72	PH1/ETxD1	I/O
73	PH3/ETxD3	I/O
74	PH8/ERxD0	I/O
75	PH10/ERxD2	I/O
76	ADRY	I – 10k pull up
77	PH13/ERxCLK	I/O
78	CLKBUF	O
79	GND	PWR

80	$\overline{\text{AMS3}}$	O
81	$\overline{\text{AWE}}$	O
82	CLKOUT (SCLK)	I
83	D0	I/O
84	D2	I/O
85	D4	I/O
86	D6	I/O
87	D8	I/O
88	D10	I/O
89	D12	I/O
90	D14	I/O
91	D15	I/O
92	D13	I/O
93	D11	I/O
94	D9	I/O
95	D7	I/O
96	D5	I/O
97	D3	I/O
98	D1	I/O
99	$\overline{\text{Reset}}$	I - see chapter 0
100	$\overline{\text{AOE}}$	O
101	$\overline{\text{ARE}}$	O
102	$\overline{\text{AMS2}}$	O
103	VDD-RTC	PWR
104	PH14/ERXER	I/O
105	PH12/ERxDV	I/O
106	PH11/ERxD3	PWR
107	PH9/ERxD1	I/O
108	PH4/ETxEN	I/O
109	PH2/ETxD2	I/O
110	PH0/ETxD0	I/O
111	$\overline{\text{ABE0}}/\text{SDQM0}$	O
112	A18	O
113	A16	O
114	A14	O
115	A12	O
116	A10	O
117	A8	O
118	A6	O
119	A4	O
120	A2	O

Table 3-4: Connector X2 pin assignment

Signal names correspond to those of the Blackfin processor unless otherwise stated.

## 4 TCM-BF537B (Border Pad and BGA Versions)

### 4.1 Mechanical Outline

The two figures below shows the top and bottom view of the Core Module. All dimensions are given in millimeters!

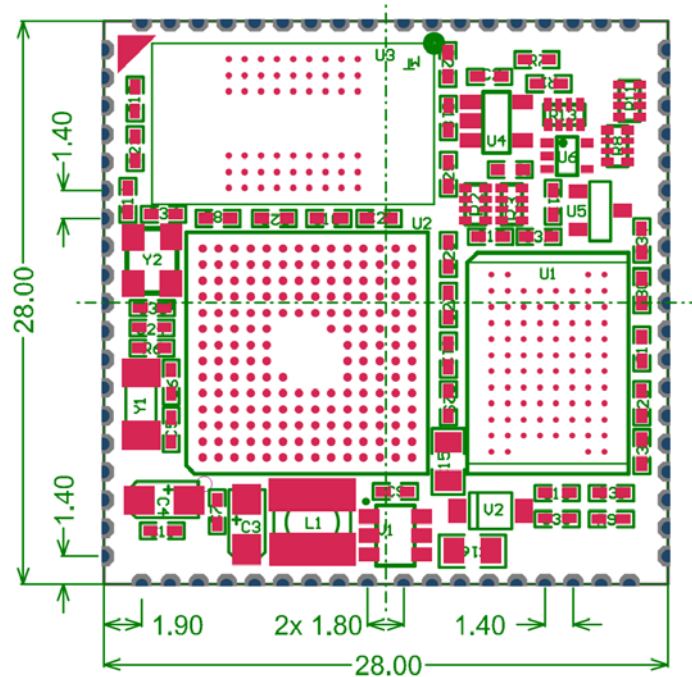


Figure 4-1: Mechanical Outline (top view)

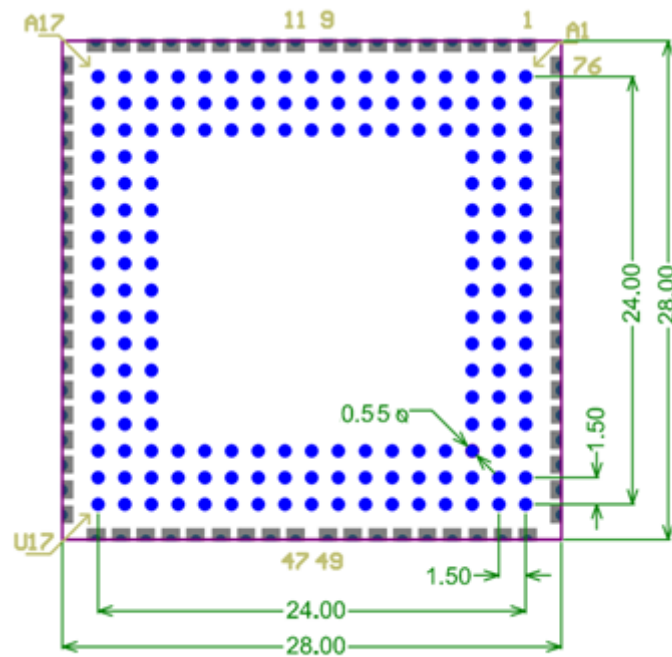


Figure 4-2: Mechanical Outline (**bottom view**)

Figure 4-3 shows a side view of the Core Module with border pads.

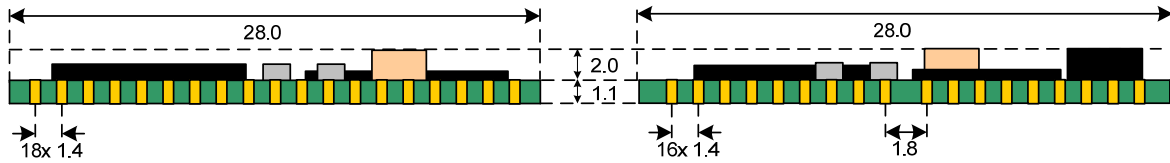


Figure 4-3: Side View of the Border Pads

The total minimum mounting height of the Border Pad version is only 3.1 mm!

### 4.2 Footprint of Border Pad Baseboard

Figure 4-4 shows the pin assignment of the Border Pad Version. The pin Numbering is clockwise ascending. The Pins No. 10 and 48 are not present.

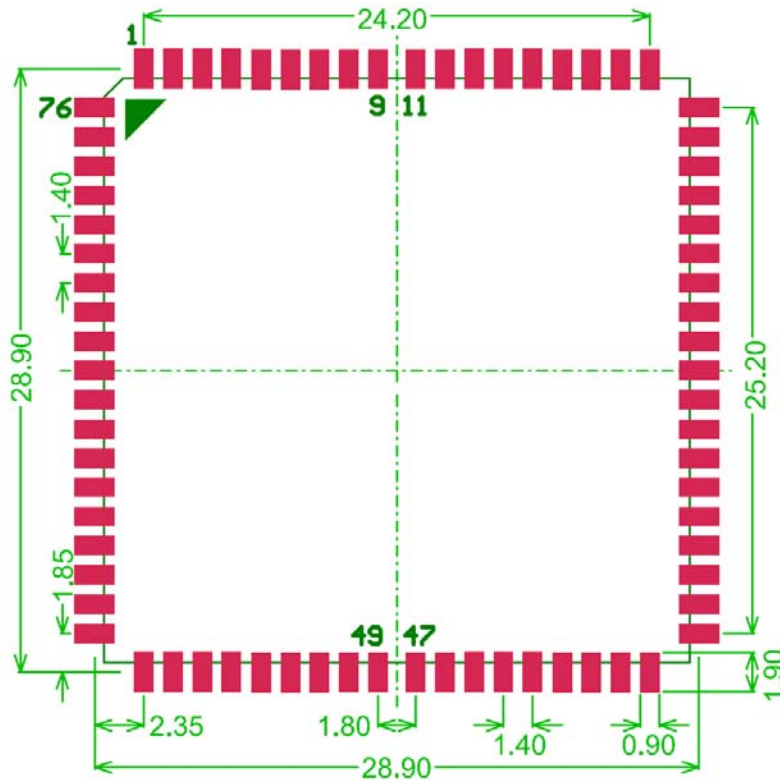


Figure 4-4: Border Pad Footprint for the Base Board (**top view**)

**Note:** Conducting paths and vias within the footprint must be **solder resistant**. Do not place any component within the footprint either.

### 4.3 Schematic Symbol of Border Pad Version

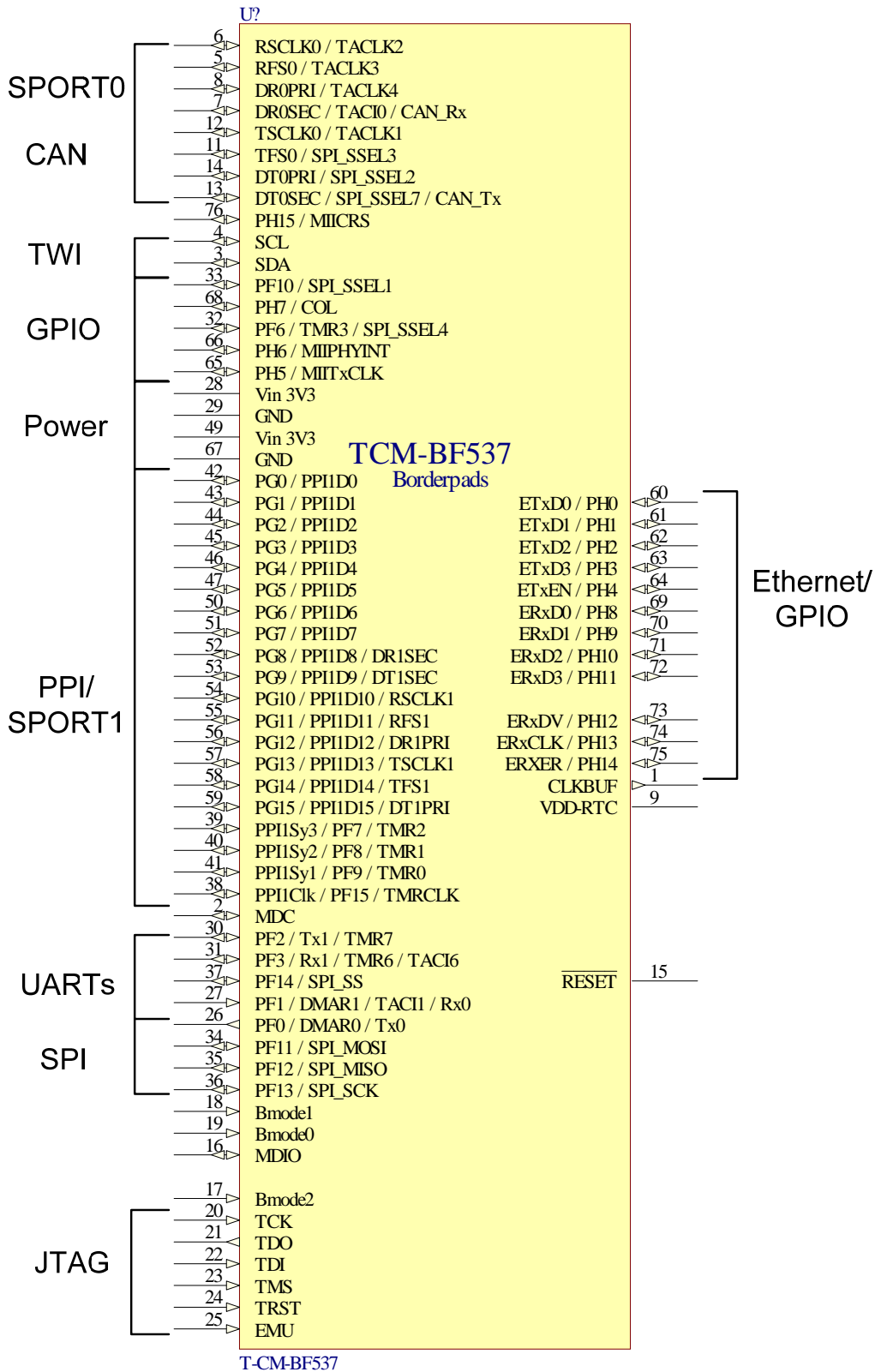


Figure 4-5: Schematics of the Border Pad Version of the TCM-BF537BP

#### 4.4 Border Pad Pin Assignment

Pin No.	Signal	Type
1	CLKBUF	O
2	MDC	O
3	SDA	I/O
4	SCL	I/O
5	RFS0 / TACLK3	I/O
6	RSCLK0 / TACLK2	I/O
7	DROSEC / TACIO / CAN_Rx	I
8	DROPRI / TACLK4	I
9	VDD-RTC	PWR
10	not available	
11	TFS0 / SPI_SSEL3	I/O
12	TSCLK0 / TACLK1	I/O
13	DT0SEC / SPI_SSEL7 / CAN_Tx	O
14	DTOPRI / SPI_SSEL2	O
15	RESET	I – see chapter 0
16	MDIO	I/O – 10k pull up
17	BMODE2	I – 10k pull down
18	BMODE1	I – 10k pull down
19	BMODE0	I – 10k pull down
20	TCK	I – 10k pull up
21	TDO	O
22	TDI	I – 10k pull up
23	TMS	I – 10k pull up
24	TRST	I – 4k7 pull down
25	EMU	O
26	PF0 / DMAR0 / Tx0	I/O
27	PF1 / DMAR1 / TACI1 / Rx0	I/O
28	Vin 3.3V	PWR
29	GND	PWR
30	PF2 / Tx1 / TMR7	I/O
31	PF3 / Rx1 / TMR6 / TACI6	I/O
32	PF6 / TMR3 / SPI_SSEL4	I/O
33	PF10 / SPI_SSEL1	I/O
34	PF11 / SPI_MOSI	I/O
35	PF12 / SPI_MISO	I/O
36	PF13 / SPI_SCK	I/O
37	PF14 / SPI_SS	I/O
38	PPI1Clk / PF15 / TMRCLK	I/O
39	PPI1Sy3 / PF7 / TMR2	I/O
40	PPI1Sy2 / PF8 / TMR1	I/O
41	PPI1Sy1 / PF9 / TMRO	I/O
42	PG0 / PPI1D0	I/O
43	PG1 / PPI1D1	I/O
44	PG2 / PPI1D2	I/O
45	PG3 / PPI1D3	I/O

46	PG4 / PPI1D4	I/O
47	PG5 / PPI1D5	I/O
48	not present	-
49	Vin 3.3V	PWR
50	PG6 / PPI1D6	I/O
51	PG7 / PPI1D7	I/O
52	PG8 / PPI1D8 / DR1SEC	I/O
53	PG9 / PPI1D9 / DT1SEC	I/O
54	PG10 / PPI1D10 / RSCLK1	I/O
55	PG11 / PPI1D11 / RFS1	I/O
56	PG12 / PPI1D12 / DR1PRI	I/O
57	PG13 / PPI1D13 / TSCLK1	I/O
58	PG14 / PPI1D14 / TFS1	I/O
59	PG15 / PPI1D15 / DT1PRI	I/O
60	PH0 / ETxD0	I/O
61	PH1 / ETxD1	I/O
62	PH2 / ETxD2	I/O
63	PH3 / ETxD3	I/O
64	PH4 / ETxEN	I/O
65	PH5 / MIITxCLK	I/O
66	PH6 / MIIPHYINT	I/O
67	GND	PWR
68	PH7 / COL	I/O
69	PH8 / ERxD0	I/O
70	PH9 / ERxD1	I/O
71	PH10 / ERxD2	I/O
72	PH11 / ERxD3	I/O
73	PH12 / ERxDV	I/O
74	PH13 / ERxCLK	I/O
75	PH14 / ERXER	I/O
76	PH15 / MIICRS	I/O

Table 4-1: Border pin assignment

Signal names correspond to those of the Blackfin processor unless otherwise stated.

Not: Please mind the mounted pull up and pull down resistors on the Core Module. See the third column of Table 4-1.



### 4.5 BGA PAD Numbering

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17
C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17
D1	D2	D3												D15	D16	D17
E1	E2	E3												E15	E16	E17
F1	F2	F3												F15	F16	F17
G1	G2	G3												G15	G16	G17
H1	H2	H3												H15	H16	H17
J1	J2	J3												J15	J16	J17
K1	K2	K3												K15	K16	K17
L1	L2	L3												L15	L16	L17
M1	M2	M3												M15	M16	M17
N1	N2	N3												N15	N16	N17
P1	P2	P3												P15	P16	P17
R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17

Figure 4-6: BGA Pad Numbering (top view)

### 4.6 Footprint of BGA Baseboard

Figure 4-7 shows the top view of the BGA footprint for your base board.

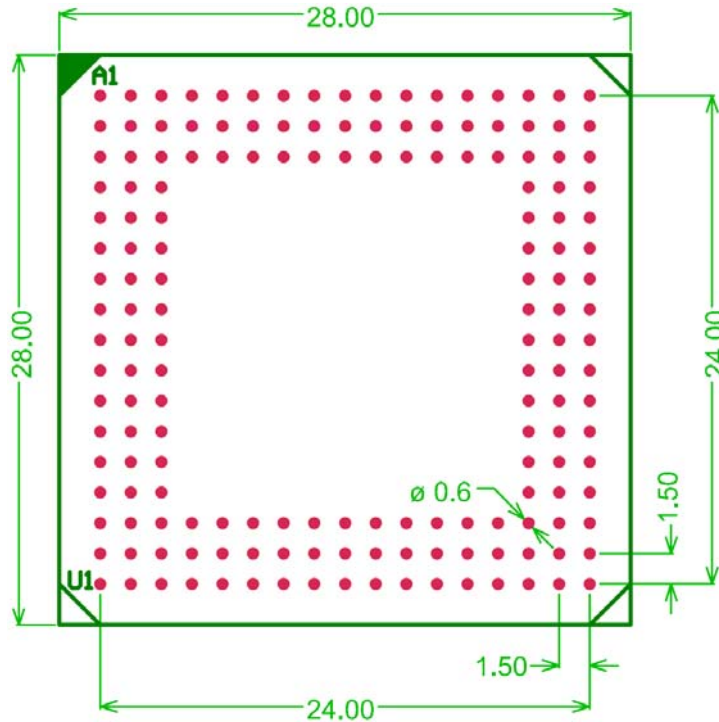


Figure 4-7: Recommended BGA Footprint for the Base Board (top view)

### 4.7 Schematic Symbol of BGA Version

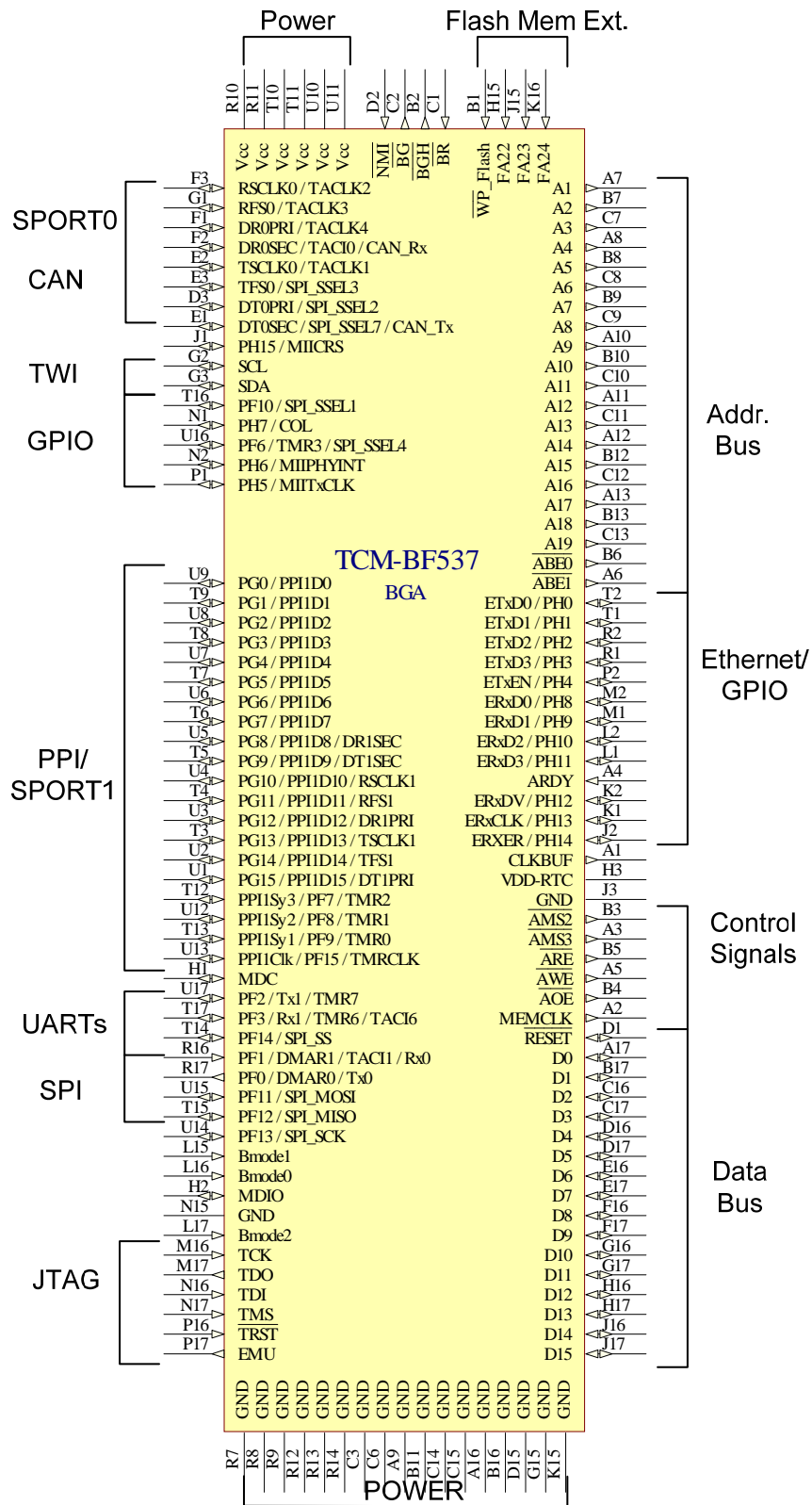


Figure 4-8: Schematics Symbol of the BGA Version of the TCM-BF537BGA

## 4.8 BGA Pin Assignment

Pin No.	Signal	Signal Type.
A1	CLKBUF	O
A2	MEMCLK	O
A3	$\overline{\text{AMS3}}$	O
A4	ARDY	I – 10k pull up
A5	$\overline{\text{AWE}}$	O
A6	$\overline{\text{ABE1}}$	O
A7	A1	O
A8	A4	O
A9	GND	PWR
A10	A9	O
A11	A12	O
A12	A14	O
A13	A17	O
A14	n.c.	-
A15	n.c.	-
A16	GND	PWR
A17	D0	I/O
B1	$\overline{\text{WP\_Flash}}$	I – 10k pull up
B2	$\overline{\text{BGH}}$	O
B3	$\overline{\text{AMS2}}$	O
B4	$\overline{\text{AOE}}$	O
B5	$\overline{\text{ARE}}$	O
B6	$\overline{\text{ABE0}}$	O
B7	A2	O
B8	A5	O
B9	A7	O
B10	A10	O
B11	GND	PWR
B12	A15	O
B13	A18	O
B14	n.c.	-
B15	n.c.	-
B16	GND	PWR
B17	D1	I/O
C1	$\overline{\text{BR}}$	I – 10k pull up
C2	$\overline{\text{BG}}$	O
C3	GND	PWR
C4	n.c.	-
C5	n.c.	-
C6	GND	PWR
C7	A3	O
C8	A6	O
C9	A8	O
C10	A11	O
C11	A13	O

C12	A16	O
C13	A19	O
C14	GND	PWR
C15	GND	PWR
C16	D2	I/O
C17	343I/O	I/O
D1	$\overline{\text{Reset}}$	I – see chapter 0
D2	$\overline{\text{NMI}}$	I – 10k pull up
D3	DTOPRI / SPI_SSEL2	O
D15	GND	PWR
D16	D4	I/O
D17	D5	I/O
E1	DTOSEC / CANTX / SPI_SSEL7	O
E2	TSCLK0 / TACLK1	I/O
E3	TFS0 / SPI_SSEL3	I/O
E15	n.c.	-
E16	D6	I/O
E17	D7	I/O
F1	DROPRI / TACLK4	I
F2	DROSEC / TACIO / CANRX	I
F3	RSCLK0 / TACLK2	I/O
F15	n.c.	-
F16	D8	I/O
F17	D9	I/O
G1	RFS0 / TACLK3	I/O
G2	SCL	I/O
G3	SDA	I/O
G15	GND	PWR
G16	D10	I/O
G17	D11	I/O
H1	MDC	I/O
H2	MDIO	I/O – 10k pull up
H3	VDD-RTC	PWR
H15	FA22	I – 10k pull down
H16	D12	I/O
H17	D13	I/O
J1	PH15 / MIICRS	I/O
J2	PH14 / ERXER	I/O
J3	GND	PWR
J15	FA23	I – 10k pull down
J16	D14	I/O
J17	D15	I/O
K1	PH13 / ERxCLK	I/O
K2	PH12 / ERxDV	I/O
K3	n.c.	-
K15	GND	PWR
K16	FA24	I – 10k pull down

K17	n.c.	-
L1	PH11 / ERxD3	PWR
L2	PH10 / ERxD2	I/O
L3	n.c.	-
L15	BMODE1	I – 10k pull down
L16	BMODE0	I – 10k pull down
L17	BMODE2	I – 10k pull down
M1	PH9 / ERxD1	I/O
M2	PH8 / ERxD0	I/O
M3	n.c.	-
M15	n.c.	-
M16	TCK	I – 10k pull up
M17	TDO	O
N1	PH7 / COL	I/O
N2	PH6 / MIIPHYINT	I/O
N3	n.c.	-
N15	GND	PWR
N16	TDI	I – 10k pull up
N17	TMS	I – 10k pull up
P1	PH5 / MIITxCLK	I/O
P2	PH4 / ETxEN	I/O
P3	n.c.	-
P15	n.c.	-
P16	$\overline{\text{TRST}}$	I – 4k7 pull down
P17	EMU	O
R1	PH3 / ETxD3	I/O
R2	PH2 / ETxD2	I/O
R3	n.c.	-
R4	n.c.	-
R5	n.c.	-
R6	n.c.	-
R7	GND	PWR
R8	GND	PWR
R9	GND	PWR
R10	Vcc	PWR
R11	Vcc	PWR
R12	GND	PWR
R13	GND	PWR
R14	GND	PWR
R15	n.c.	-
R16	PF1 / DMAR1 / TAC11 / Rx0	I/O
R17	PF0 / DMAR0 / Tx0	I/O
T1	PH1 / ETxD1	I/O
T2	PH0 / ETxD0	I/O
T3	PG13 / PPI1D13 / TSCLK1	I/O
T4	PG11 / PPI1D11 / RFS1	I/O
T5	PG9 / PPI1D9 / DT1SEC	I/O

T6	PG7 / PPI1D7	I/O
T7	PG5 / PPI1D5	I/O
T8	PG3 / PPI1D3	I/O
T9	PG1 / PPI1D1	I/O
T10	Vcc	PWR
T11	Vcc	PWR
T12	PF7 / PPI1SY3 / TMR2	I/O
T13	PF9 / PPI1SY1 / TMR0	I/O
T14	PF14 / SPI_SS	I/O
T15	PF12 / SPI_MISO	I/O
T16	PF10 / SPI_SSEL1	I/O
T17	PF3 / Rx1 / TMR6 / TACI6	I/O
U1	PG15 / PPI1D15 / DT1PRI	I/O
U2	PG14 / PPI1D14 / TFS1	I/O
U3	PG12 / PPI1D12 / DR1PRI	I/O
U4	PG10 / PPI1D10 / RSCLK1	I/O
U5	PG8 / PPI1D8 / DR1SEC	I/O
U6	PG6 / PPI1D6	I/O
U7	PG4 / PPI1D4	I/O
U8	PG2 / PPI1D2	I/O
U9	PG0 / PPI1D0	I/O
U10	Vcc	I/O
U11	Vcc	I/O
U12	PF8 / PPI1_SY2 / TMR1	I/O
U13	PF15 / PPI1CLK / TMRCLK	I/O
U14	PF13 / SPI_SCLK	I/O
U15	PF11 / SPI_MOSI	I/O
U16	PF6 / TMR3 / SPI_SSEL4	I/O
U17	PF2 / Tx1 / TMR7	I/O

Table 4-2: BGA Version Pin Assignment

Signal names correspond to those of the Blackfin processor unless otherwise stated.

Note: Please mind the mounted pull up and pull down resistors on the Core Module. See the third column of Table 4-2.

## 4.9 Reset circuit

The reset of the flash and the processor are connected to a power monitoring IC. The output can be used as power on reset for external devices, see Figure 4-9.

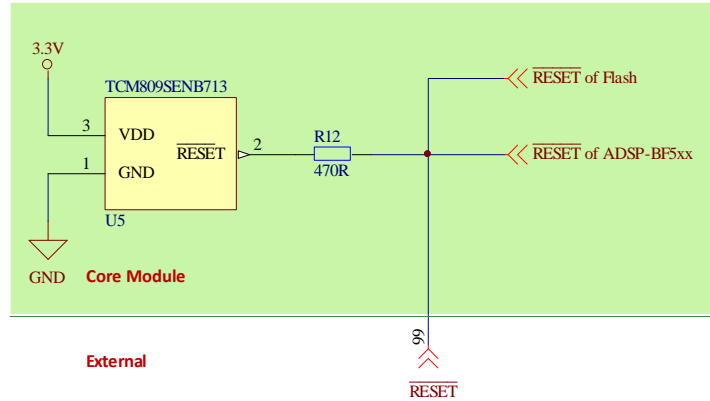


Figure 4-9: Schematic of reset circuit on the Core Module

## 4.10 Flash Memory Extension PINS

### 4.10.1 PINS FA20 to FA24

Flash pin	Blackfin pin
FA20	PF4
FA21	PF5
FA22	PG13
FA23	PG14
FA24	PG15

Table 4-3: Pins FA20 to FA24

All pins are pulled down by default.

The signals FA20 and FA21 are used to address the (first) 8MB of Flash memory. These signals are connected directly with the Blackfin pins PF4 (FA20) and PF5 (FA21) (see chapter 2.3) so you cannot use FA20 or FA21 for your own purposes! The signals FA22-FA24 can be used to address up to 64MByte of Flash memory (if installed on the Core Module). The signals FA22-FA23 are connected through a 0R resistor array with the Blackfin signals PG13 (FA22), PG14 (FA23) and PG15 (FA24). If you need the signals PG13-PG15 for your own purposes (for example to use the SPORT1 interface) AND you want to address up to 64MByte Flash memory, so you can remove the 0R resistor array and use other GPIOs for FA22-FA24 (in this case you must connect these GPIOs externally to FA22-F24). Please contact Bluetechnix Support for further informations.

### 4.10.2 WP\_FLASH

Is pulled high by default so flash is unprotected. To write protect the flash connect this pin to GND.

## 5 Application Example Schematics

In the following two examples connection of a Physical Ethernet chip and a USB 2.0 chip to the Core Module are provided.

### 5.1 Schematic Example for Connecting a Physical Ethernet Chip

Since the ADSP-BF537 Blackfin Chip from Analog Devices already has Ethernet functionality only a physical Ethernet chip needs to be connected to the TCM-BF537 Core Module in order to make use of this feature.

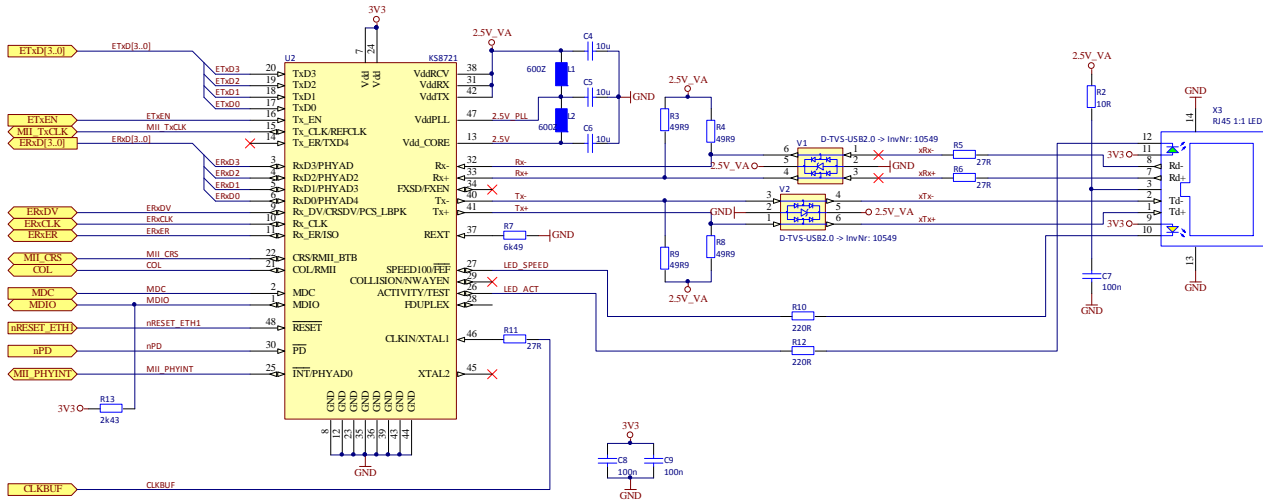


Figure 5-1: Configuration with Physical Chip

Designator	Value	Part Number	Description	Quantity
C4, C5, C6	10u	C0805C106K9PAC	Capacitor non-polarized	3
C7, C8, C9	100n	2238 246 19876	Capacitor non-polarized	3
L1, L2	600Z	74279265	Ferrite	2
R2	10R	MC 0.063W 0603 1% 10R	Resistor	1
R3, R4, R8, R9	49R9	MC 0.063W 0603 1% 49R9	Resistor	4
R5, R6, R11	27R	MC 0.063W 0603 1% 27R	Resistor	3
R7	6k49	MC 0.063W 0603 1% 6K49	Resistor	1
R10, R12	220R	MC 0.063W 0603 1% 220R	Resistor	2
R13	2k43	MULTICOMP	Resistor	1
U2		KSZ8721BLI-LQFP48L	10/100BASE Physical Layer Transceiver	1
V1, V2		USBLC6-2P6	TSV-Diode for USB 2.0	2
X3		RJLBC-060TC1	RJ45-Connector with LEDs	1

Table 5-1: Bill of Material of Sample Schematic



## 5.2 Schematic Example for Connecting a USB 2.0 Chip

The following example shows how to connect a USB 2.0 chip to the TCM-BF537 core Module.

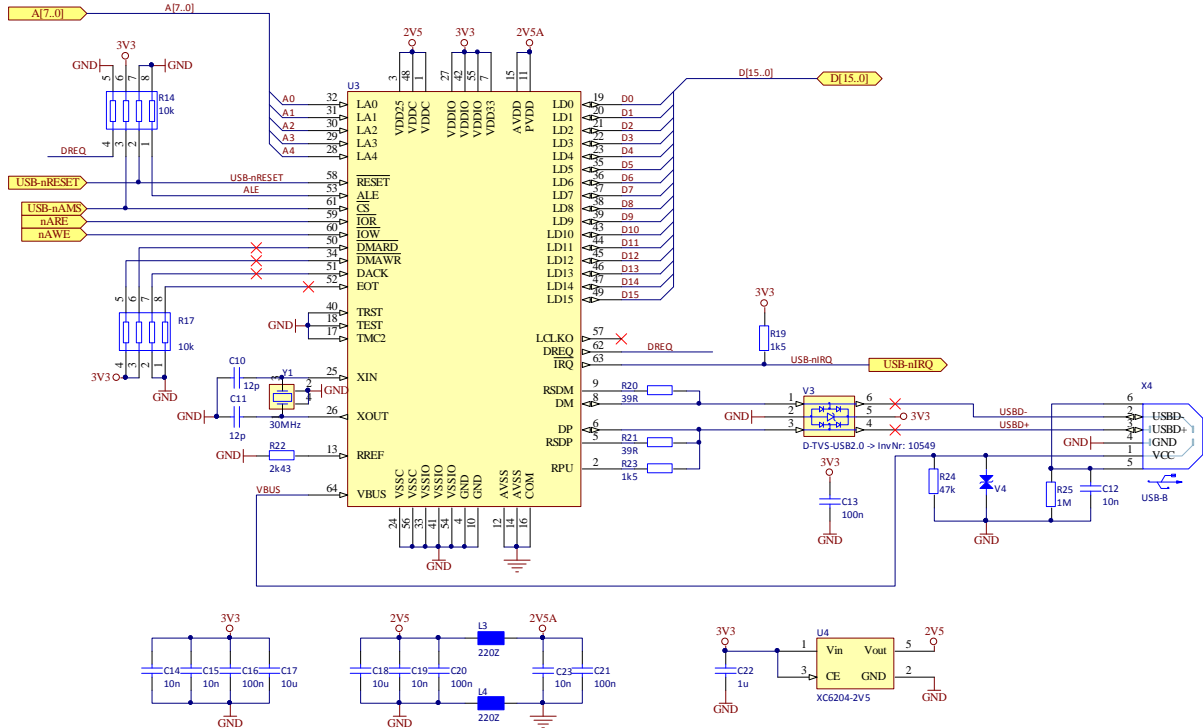


Figure 5-2: Configuration with USB 2.0 Chip

Designator	Value	Part Number	Description	Quantity
C1u, C2u	12p	2238 867 15129	Capacitor non-polarized	2
C3u, C4u, C5u, C9u, C11u	10n	2238 916 15636	Capacitor non-polarized	5
C6u, C10u, C12u	100n	2238 246 19876	Capacitor non-polarized	3
C7u, C8u	10u	C0805C106K9PAC	Capacitor non-polarized	2
L1u, L2u	220R	74279263	Ferrite	2
R1u, R3u, R11u, R12u	10k	MC 0.063W 0603 1% 10K	Resistor	4
R2u	10k	2350 025 11003	4-Resistor Array	1
R4u	1k	MC 0.063W 0603 1% 1k	Resistor	1
R5u, R6u	39R	MC 0.0654W 0603 1% 39R	Resistor	2
R7u	2k43	MULTICOMP	Resistor	1
R8u	1k5	MC 0.063W 0603 1% 1K5	Resistor	1
R9u	47k	MC 0.063W 0603 1% 47k	Resistor	1
R10u	1M	MC 0.063W 0603 1% 1M	Resistor	1
U1u		NET2272REV1A-LF	USB 2.0 Peripheral Controller TQPF	1
V1u		CDS3C05GTA		1
X1u		2411 01	USB-Device Normal	1
Y1u		Q 30.0-JXS32-12-10/20	Crystal Oscillator	1

Table 5-2: Bill of Material of Sample Schematic

## 6 Software Support

### 6.1 BLACKSheep

The Core Module is delivered with a pre-flashed basic version of the BLACKSheep VDK multithreaded framework. It contains a boot-loader for flashing the Core Module via the serial port.

Please consult the software development documents.

### 6.2 uClinux

The Core Module is fully supported by the open source platform at <http://blackfin.uclinux.org>. Since the Core Modules are pre-flashed with BLACKSheep you have to flash uBoot first. To flash uBoot you can use the BLACKSheep boot-loader.

To use the Ethernet functionality of the TCM-BF537 Core Modules you need the EXT-BF5xx-ETH-USB Blackfin Extension Board.

## 7 Anomalies

For the latest information regarding anomalies for this product, please consult the product home page:

<http://www.bluetechnix.com/goto/tcm-bf537>

Date	Revisions	Description
24.10.2007	V1.1 V1.2 V1.3	RTC-Problem: The Clock accuracy of the RTC is much less than specified by the crystal (20ppm). Due to layout issues the measured inaccuracy is about 7-9 sec. / Hour. The RTC Bug affects both the BGA and Border Pad Versions. For accurate time measurements please use the main crystal or an external RTC.

Table 8-7-1: Anomalies

## **8 Production Report**

For the latest information regarding the productions for this product, please consult the product home page:

[https://support.bluetechnix.at/wiki/Revision\\_Report\\_TCM-BF537x](https://support.bluetechnix.at/wiki/Revision_Report_TCM-BF537x)

## 9 Product Changes

For the latest product change information please consult the product web-page at:

<http://www.bluetechnix.com/goto/tcm-bf537>

Version	Changes
V1.1.X	Border Pad and BGA Versions added with 64MB flash addressing option, 28mmx28mm outline
V1.2.X	Component placement changed (connector version)
V1.3.X	Mount option for 64MB flash addressing (connector version)
V1.4.X	Correction of RTC inaccuracy

## 10 Document Revision History

Version	Date	Document Revision
20	2010-11-30	Changed product picture
19	2010-08-31	Complete document revision
18	2010-02-03	Redesign Manual
17	2009-05-25	Table 4.2 L14 -> J16 Symbol BGA updated
16	2009-03-19	Table 8.2 new version added
15	2009-01-19	Chapter 5-1 new schematic, new part list
14	2008-12-02	Chapter 4.9 added Pull up/down information added Correction of the BGA-Pin assignment table
13	2008-10-21	Pin 48 not available instead of 49
12	2008-09-05	Footprints and mechanical drawings updated
11	2008-08-11	English checked for spelling, grammar and clarity
10	2008-08-06	Fixed memory map
9	2008 03 27	Production Report Added
8	2007 24 10	RTC Problem in the Anomaly List added
7	2007 06 04	Unlock flash hint, Document Revision History Table
6	2007 04 17	BP and BGA symbols corrected; Rx1 and Tx1 were mixed up
5	2007 04 04	Corrections of the description of the BP and BGA versions.
4	2007 01 08	Corrected Typo in page 7 Table 2-2: PF5 one time instead of two times PF4
3	2006 10 02	Release V1.1 of TCM Boards Main updates: Separate Connector, Border and BGA pad version Border Pads: 76 Border pads without Data and Address bus pins Connector Version: As in version V1.0 BGA Version: Additional Processor pins, added Flash addressing flexibility Removed limited address range, all 8MB addressable
2	2006 04 26	Updated anomaly list: only 4MB addressable.
2	2006 04 26	Updated document: Connector symbol, fixed Bug naming of pin 22 and pin 40 (connector version) Rx and Tx was flipped.
1	2006 03 07	First release V1.0 of the Document

Table 10-1: Revision History

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