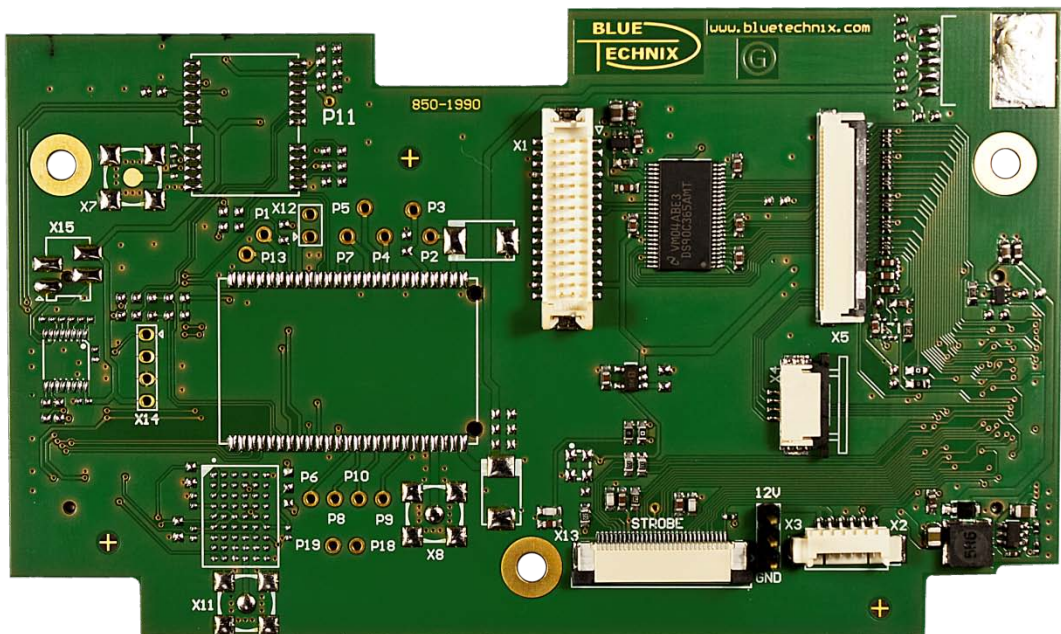
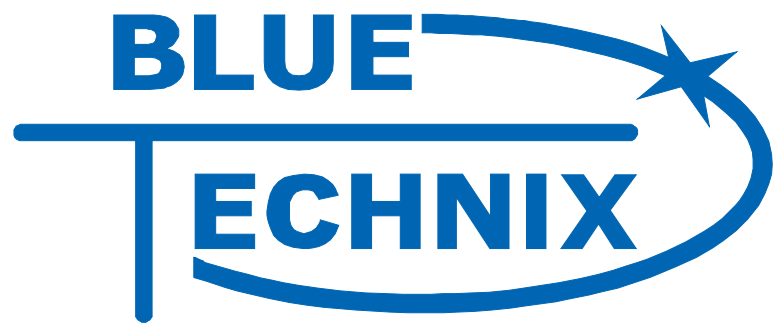




# Hardware User Manual

**EXT-SBC-i.MX51-DISP V1.2**

*...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.

## i.MX Core Modules

### [CM-i.MX27-C-C-Q26S128F32N512](#)

The Core Module CM-i.MX27 is powered by Freescales' SoC i.MX27 (ARM 926 core, up to 400MHz). It addresses 128MB DDR-RAM, has an onboard NOR-flash of 32MByte and a NAND-flash with 512MByte at a size of 55x45mm.

### [CM-i.MX31-C-C-Q26S128F40N128-E](#)

The Core Module CM-i.MX31 is powered by Freescales' SoC i.MX31 (ARM1136JF-S core, up to 532MHz). It addresses 128MB DDR-RAM, has an onboard NOR-flash of 40MByte and a NAND-flash with 128MByte at a size of 55x45mm. Core module is available as connector or BGA.

### [CM-i.MX53-C-I-Q24S1024F4N2048](#)

The Core Module CM-i.MX53 is powered by Freescales' SoC i.MX53 (ARM® Cortex™-A8, up to 1GHz). It addresses 1024MB DDR2-SDRAM, has an onboard NOR-flash of 4MByte and a NAND-flash with 2048MByte at a size of 80x45mm.

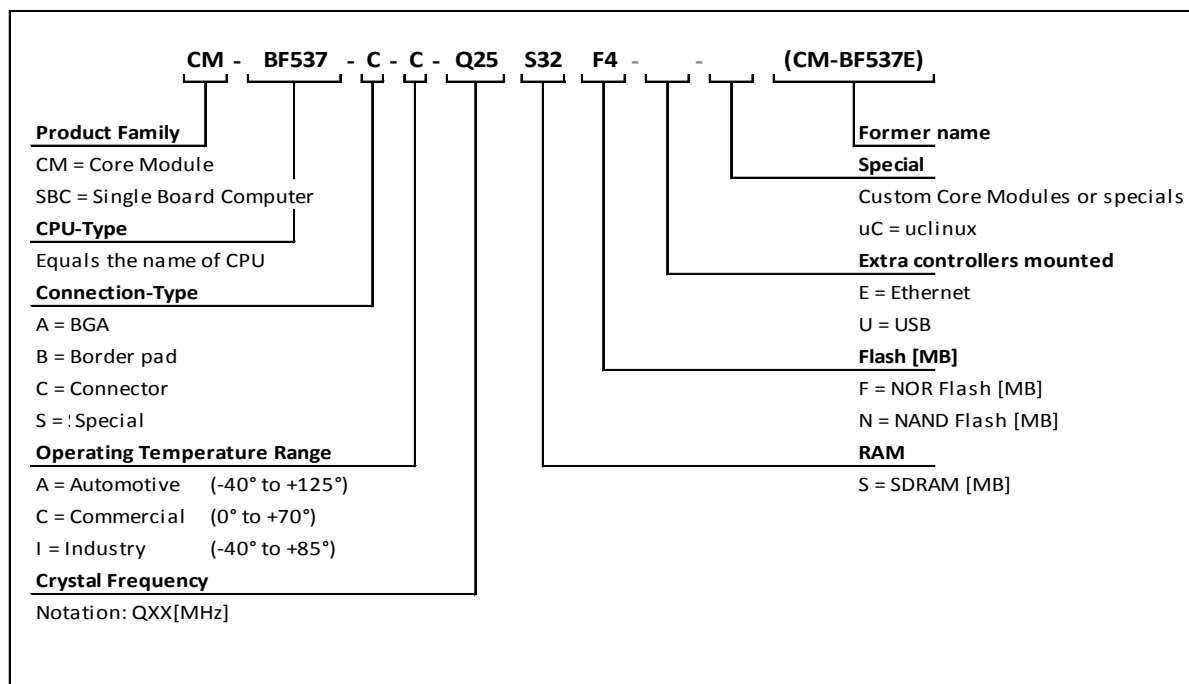
## Core Module naming information

The idea is to put more Core Module specific technical information into the product name. New Core Module names will have following technical information covered in their names.

- Product Family,
- CPU-Type,
- Connection-Type,
- Operating Temperature Range,
- Crystal Frequency [MHz],
- RAM [MB],
- Flash [MB],
- External Controllers
- Optional
  - o Special and/or
  - o Former name

That expands of course the name but allows the customer to get the most important Core Module specific information at the first sight. Have a look at the example below to get an idea of the new Core Module names.

### Example CM-BF537-C-C-Q25S32F4 (CM-BF537E)



## i.MX Development Boards

### [DEV-i.MX27](#)

The DEV-i.MX27 development board is an extendable development platform for the CM-i.MX27 processor modules. With display connector and keypad it can be used as a reference design for a low power mobile handheld device powered by a single Lithium Ion battery. The development board provides all interfaces of the connector version on dedicated expansion connectors. Extender boards can be plugged on top of the development board in order to enable additional interfaces.

### [DEV-iMX31](#)

The DEV-i.MX31 Development Board is an extendable development platform for the CM-i.MX31 processor module. With display connector and keypad it can be used as a reference design for a low power mobile handheld device powered by a single Lithium Ion battery. The development board provides all interfaces of the connector version on dedicated expansion connectors. Extender boards can be plugged on top of the development board in order to enable additional interfaces.

### [SBC-i.MX51-S-C-Q24S512N2048](#)

The Single-Board Computer SBC-i.MX51 is based on Freescale's high-performance i.MX51 mobile platform, incorporating an ARM Cortex-A8 CPU, an Image Processing Unit (IPUv3EX), a Video Processing Unit (VPU) and a Graphical Processing Unit (GPU). The IPUv3EX provides comprehensive support for connectivity to displays and cameras. The VPU supports hardware encoding and decoding of MPEG-4, H.263, H.264 and many more standards. The GPU serves 3D and 2D acceleration in hardware. The board's memory capabilities (NAND Flash, DDR2) and numerous interfaces like Ethernet, HDMI, 4xUSB and USB-OTG turn the SBC-i.MX51 into the ultimate development board for future high-end embedded devices.

### [DEV-i.MX53](#)

The DEV-i.MX53 development board is an extendable development platform for the CM-i.MX53 processor module. The development board provides all interfaces of the connector version (Ethernet, HDMI, 4xUSB and USB-OTG) on dedicated extender connectors. Extender boards can be plugged on top of the development board in order to enable additional interfaces.

### [Extender boards](#)

Extender boards (EXT-SBC-i.MX51-) are expanding the development board SBC-i.MX51 by several interfaces and functionalities. Targeted application areas are: audio/video processing, security and surveillance, Ethernet access, positioning, automation and control, experimental development and measuring.

Note! Bluetechnix is offering tailored board developments as well.

## 1 Introduction

The EXT-SBC-i.MX51-DISP is a pluggable extender board for the SBC-i.MX51. It offers a display and a camera interface (BLT-ISM-Connector) for the SBC-i.MX51. It is a low cost extender board designed for audiovisual systems e.g. HMI, touch-control, interactive systems etc

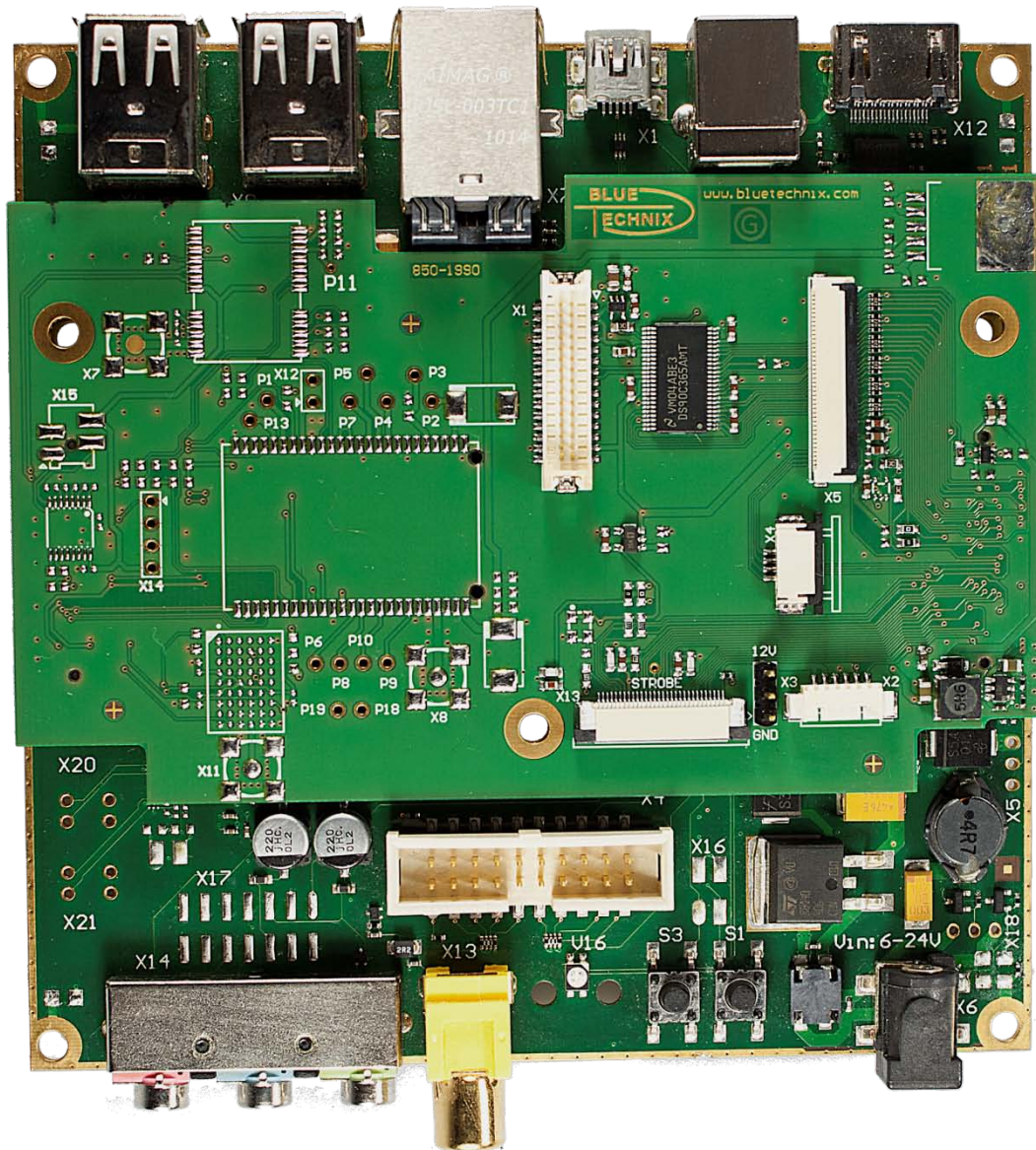


Figure 1-1: Connected EXT-SBC-i.MX51-DISP on SBC-i.MX51

## 1.1 Overview

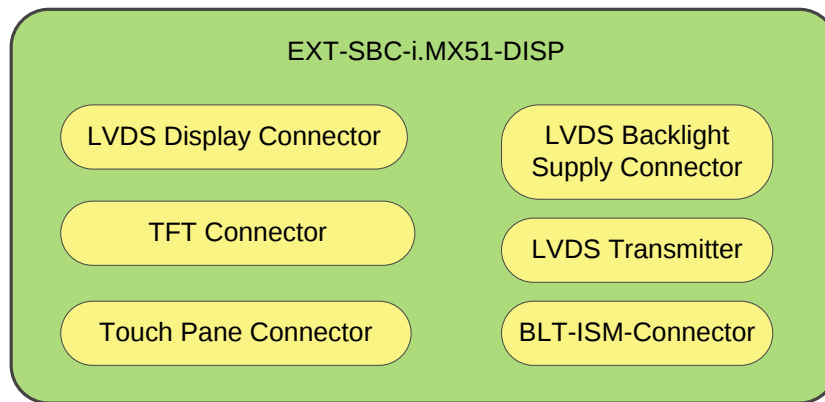


Figure 1-2: Main components of EXT-SBC-i.MX51-DISP

## 1.2 Key Features

- **TFT Connector**
  - o 40 pin ZIF connector
  - o Various EDT displays available (3,5" to 7"; 320x240 to 800x480)
- **LVDS Connector**
  - o 30 pin connector
  - o Supports Toshiba LT084AC3711 LVDS display
- **LVDS Transmitter**
  - o National Semiconductor DS90C365
- **Touch Panel Connector**
  - o 4 pin Connector for connection of a resistive Touch Panel
- **Power Supply**
  - o LVDS Backlight supplied via separate external power supply (not included)
  - o EXT-SBC-i.MX51-DISP is powered via SBC-i.MX51
- **Camera Connector (BLT-ISM-Connector)**
  - o 30 pin ZIF connector
  - o Compatible with all Bluetechnix [Image Sensor Modules](#)

## 1.3 Applications

- Rapid prototyping
- POS terminals
- Automation and control systems
- Graphical User Interfaces

## 2 General Description

### 2.1 Functional Description

#### 2.1.1 Powering

The EXT-SBC-i.MX51-DISP is supplied by the SBC-i.MX51. Please consider the chapter Electrical Specifications. If an LVDS display is used (e.g. LT084AC3711) an external 12V power supply must be connected to the connector X3.

### 2.2 PCB Placement

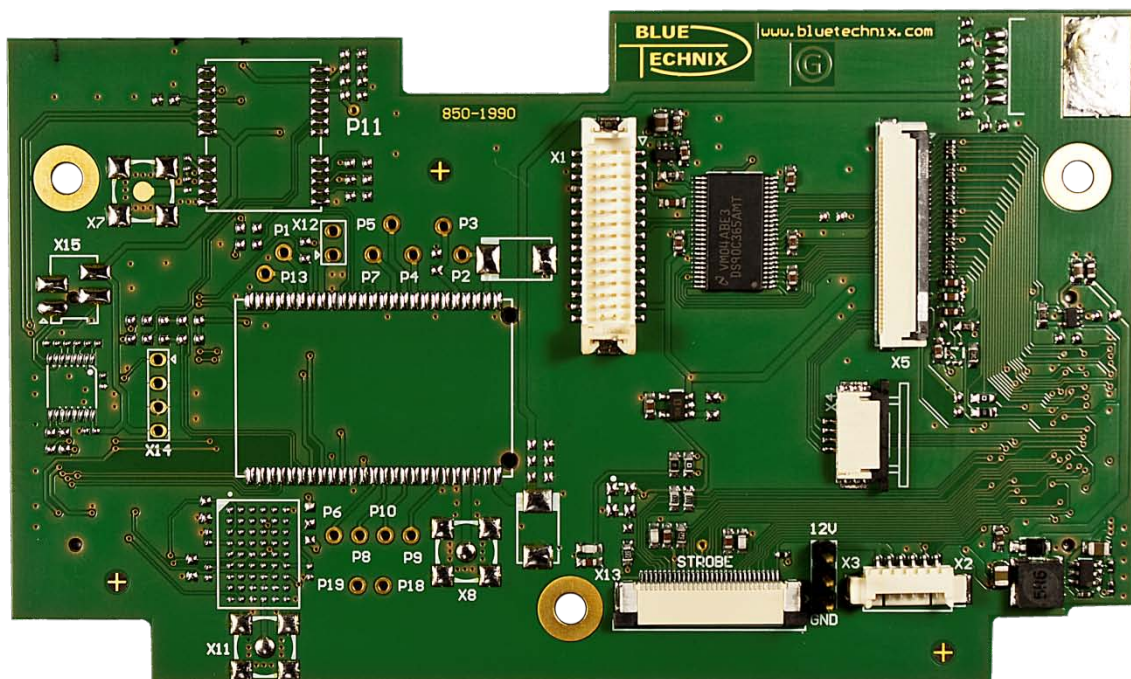


Figure 2-1: Connector positions



## 3 Specifications

### 3.1 Electrical Specifications

#### 3.1.1 Digital I/O Characteristics

| Parameter                 | Power Domain | Symbol   | Min   | Typ.  | Max   | Unit |
|---------------------------|--------------|----------|-------|-------|-------|------|
| High-Level Output Voltage | P_VIOHI      | $V_{oh}$ | 2.625 | 2.775 | 3.075 | V    |
| High-Level Output Voltage | P_SW4        | $V_{oh}$ | 1.65  | 1.8   | 2.1   | V    |
| Low-Level Output Voltage  | all domains  | $V_{ol}$ | -     | -     | 0.15  | V    |
| High Level Output Current | all domains  | $I_{oh}$ | 1.9   | -     | 6.6   | mA   |
| Low-Level Output Current  | all domains  | $I_{ol}$ | 1.9   | -     | 6.6   | mA   |
| High-Level Input Voltage  | P_VIOHI      | $V_{ih}$ | 1.95  | -     | 2.775 | V    |
| Low-Level Input Voltage   | P_VIOHI      | $V_{il}$ | 0     | -     | 0.83  | V    |
| High-Level Input Voltage  | P_SW4        | $V_{ih}$ | 1.26  | -     | 1.8   | V    |
| Low-Level Input Voltage   | P_SW4        | $V_{il}$ | 0     | -     | 0.54  | V    |

Table 3-1: Digital IO characteristics

#### 3.1.2 Analog Inputs

| Parameter                     | Symbol   | Min | Typ. | Max | Unit    |
|-------------------------------|----------|-----|------|-----|---------|
| Resolution                    |          |     | 10   |     | Bit     |
| Conversion Current            | $I_c$    |     | 1    |     | mA      |
| Conversion Core Input Voltage | $V_{in}$ | 0   | -    | 2.4 | V       |
| Conversion Time Per Channel   | $t_c$    |     |      | 10  | $\mu$ s |

Table 3-2: ADC characteristics

#### 3.1.3 Maximum Ratings

Stressing the device above the rating listed in the absolute maximum ratings table may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or any other conditions greater than those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Symbol          | Parameter                         | Min  | Max | Unit |
|-----------------|-----------------------------------|------|-----|------|
| $V_{IO}$        | Input or output voltage           | -0.5 | 3.6 | V    |
| $V_{LED}$       | Backlight supply voltage          | 0    | 20  | V    |
| $I_{OH}/I_{OL}$ | Current per pin                   | 0    | 10  | mA   |
| $T_{AMB}$       | Ambient temperature               | -20  | 70  | °C   |
| $T_{STO}$       | Storage temperature               | -55  | 100 | °C   |
| $T_{SLD}$       | Solder temperature for 10 seconds |      | 260 | °C   |
| $\phi_{AMB}$    | Relative ambient humidity         |      | 90  | %    |

Table 3-3: Absolute maximum ratings

#### 3.1.4 ESD Sensitivity



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## 4 Connector Description

### 4.1 Display Data Connector X1 (Toshiba LT084AC3711)

| Pin No. | Signal Name | Type | Power Domain | Description          |
|---------|-------------|------|--------------|----------------------|
| 1       | NC          | NC   |              | Not Connected        |
| 2       | NC          | NC   |              | Not Connected        |
| 3       | P_3V3       | PWR  | P_3V3        | Display Power Supply |
| 4       | GND         | PWR  | GND          | Power Ground         |
| 5       | TxCLK_N     | O    | P_3V3        | LVDS clock           |
| 6       | TxCLK_P     | O    | P_3V3        | LVDS clock           |
| 7       | P_3V3       | PWR  | P_3V3        | Display Power Supply |
| 8       | GND         | PWR  | GND          | Power Ground         |
| 9       | Tx0_N       | O    | P_3V3        | LVDS Channel 0       |
| 10      | Tx0_P       | O    | P_3V3        | LVDS Channel 0       |
| 11      | Tx1_N       | O    | P_3V3        | LVDS Channel 1       |
| 12      | Tx1_P       | O    | P_3V3        | LVDS Channel 1       |
| 13      | Tx2_N       | O    | P_3V3        | LVDS Channel 2       |
| 14      | Tx2_P       | O    | P_3V3        | LVDS Channel 2       |
| 15      | NC          | NC   |              | Not Connected        |
| 16      | NC          | NC   |              | Not Connected        |
| 17      | NC          | NC   |              | Not Connected        |
| 18      | NC          | NC   |              | Not Connected        |
| 19      | NC          | NC   |              | Not Connected        |
| 20      | NC          | NC   |              | Not Connected        |
| 21      | NC          | NC   |              | Not Connected        |
| 22      | NC          | NC   |              | Not Connected        |
| 23      | NC          | NC   |              | Not Connected        |
| 24      | NC          | NC   |              | Not Connected        |
| 25      | NC          | NC   |              | Not Connected        |
| 26      | NC          | NC   |              | Not Connected        |
| 27      | P_3V3       | PWR  | P_3V3        | Display Power Supply |
| 28      | GND         | PWR  | GND          | Power Ground         |
| 29      | NC          | NC   |              | Not Connected        |
| 30      | NC          | NC   |              | Not Connected        |

Table 4-1: Display Data Connector description (X1)

### 4.2 LVDS Backlight Supply Connector X2 (Toshiba LT084AC3711)

| Pin No. | Signal Name | Type | Power Domain | Description          |
|---------|-------------|------|--------------|----------------------|
| 1       | 12V         | PWR  | 12V          | Display Power Supply |
| 2       | 12V         | PWR  | 12V          | Display Power Supply |
| 3       | GND         | PWR  | GND          | Power Ground         |
| 4       | GND         | PWR  | GND          | Power Ground         |
| 5       | LVDS-nRESET | O    | P_3V3        | Display ON/OFF       |
| 6       | PWM1        | O    | P_VIOHI      | PWM1 Output          |

Table 4-2: Display Power Connector description (X2)

### 4.3 Display Power Supply Connector X3

| Pin No. | Signal Name | Type | Power Domain | Description                     |
|---------|-------------|------|--------------|---------------------------------|
| 1       | 12V         | PWR  | V_LED        | External Backlight Power Supply |
| 2       | NC          | NC   |              | Not Connected                   |
| 3       | GND         | PWR  | GND          | External Power Ground           |

Figure 4-1: Display Power Supply Connector description (X3)

### 4.4 Touch Panel Connector X4 (Toshiba LT084AC3711)

| Pin No. | Signal Name | Type | Description             |
|---------|-------------|------|-------------------------|
| 1       | ADIN1       | AI   | Touch Panel XR Terminal |
| 2       | ADIN2       | AI   | Touch Panel YU Terminal |
| 3       | ADIN3       | AI   | Touch Panel XL Terminal |
| 4       | ADIN4       | AI   | Touch Panel YD Terminal |

Figure 4-2: Touch Panel Connector description (X4)

### 4.5 Display Connector X5 (ET0500G0DH6)

| Pin No. | Signal Name | Type | Power Domain | Description      |
|---------|-------------|------|--------------|------------------|
| 1       | DISP.nRESET | O    | P_3V3        | Display Reset    |
| 2       | GND         | PWR  | GND          | Power Ground     |
| 3       | DISP2.D4    | O    | P_VIOHI      | Blue Data Bit 5  |
| 4       | DISP2.D3    | O    | P_VIOHI      | Blue Data Bit 4  |
| 5       | DISP2.D2    | O    | P_VIOHI      | Blue Data Bit 3  |
| 6       | DISP2.D1    | O    | P_VIOHI      | Blue Data Bit 2  |
| 7       | DISP2.D0    | O    | P_VIOHI      | Blue Data Bit 1  |
| 8       | DISP2.D4    | O    | P_VIOHI      | Blue Data Bit 0  |
| 9       | GND         | PWR  | GND          | Power Ground     |
| 10      | DISP2.D10   | O    | P_VIOHI      | Green Data Bit 5 |
| 11      | DISP2.D9    | O    | P_VIOHI      | Green Data Bit 4 |
| 12      | DISP2.D8    | O    | P_VIOHI      | Green Data Bit 3 |
| 13      | DISP2.D7    | O    | P_VIOHI      | Green Data Bit 2 |
| 14      | DISP2.D6    | O    | P_VIOHI      | Green Data Bit 1 |
| 15      | DISP2.D5    | O    | P_VIOHI      | Green Data Bit 0 |
| 16      | GND         | PWR  | GND          | Power Ground     |
| 17      | DISP2.D15   | O    | P_VIOHI      | Green Data Bit 5 |
| 18      | DISP2.D14   | O    | P_VIOHI      | Green Data Bit 4 |
| 19      | DISP2.D13   | O    | P_VIOHI      | Green Data Bit 3 |
| 20      | DISP2.D12   | O    | P_VIOHI      | Green Data Bit 2 |
| 21      | DISP2.D11   | O    | P_VIOHI      | Green Data Bit 1 |
| 22      | DISP2.D15   | O    | P_VIOHI      | Green Data Bit 0 |
| 23      | GND         | PWR  | GND          | Power Ground     |
| 24      | TFT.CLK     | O    | P_VIOHI      | Dot Data Clock   |
| 25      | GND         | PWR  | GND          | Power Ground     |
| 26      | TFT.HSYNC   | O    | P_VIOHI      | Horizontal Sync  |
| 27      | TFT.VSYNC   | O    | P_VIOHI      | Vertical Sync    |
| 28      | TFT.DE      | O    | P_3V3        | Data Enable      |
| 29      | TFT.PWRCTRL | O    | P_VIOHI      | Power Control    |
| 30      | P_3V3       | PWR  | P_3V3        | Power Supply     |

| Pin No. | Signal Name | Type | Power Domain | Description                  |
|---------|-------------|------|--------------|------------------------------|
| 31      | GND         | PWR  | GND          | Power Ground                 |
| 32      | GND         | PWR  | GND          | Power Ground                 |
| 33      | P_3V3       | PWR  | P_3V3        | Power Supply                 |
| 34      | P_3V3       | PWR  | P_3V3        | Power Supply                 |
| 35      | NC          | NC   |              | Not Connected                |
| 36      | PWM1        | O    | P_VIOHI      | Backlight Brightness Control |
| 37      | ADIN1       | AI   |              | Touch Panel YU Terminal      |
| 38      | ADIN3       | AI   |              | Touch Panel XL Terminal      |
| 39      | ADIN2       | AI   |              | Touch Panel YD Terminal      |
| 40      | ADIN4       | AI   |              | Touch Panel XR Terminal      |

Figure 4-3: Display Connector description (X5)

#### 4.6 Image Sensor Connector X13 (BLT-ISM-Connector)

| Pin No. | SignalName | Type | Power Domain | Description                                              |
|---------|------------|------|--------------|----------------------------------------------------------|
| 1       | VCAMA      | PWR  | P_CAM_2V75   | Camera Analog Voltage Supply                             |
| 2       | GND        | PWR  | GND          | Power Ground                                             |
| 3       | NC         | NC   |              | Not Connected                                            |
| 4       | CAMCLK     | O    | P_SW4        | Camera Master Clock                                      |
| 5       | NRESET     | O    | P_SW4        | Global Reset                                             |
| 6       | SIO.C      | O    | P_SW4        | Configuration Bus Clock Line                             |
| 7       | SIO.D      | I/O  | P_SW4        | Configuration Bus Data Line                              |
| 8       | VCAMC      | PWR  | 1V8          | Camera Core Voltage Supply                               |
| 9       | GND        | PWR  | GND          | Power Ground                                             |
| 10      | CSI1.PCLK  | I    | P_SW4        | Pixel Clock                                              |
| 11      | CSI1.VSYNC | I    | P_SW4        | VSYNC                                                    |
| 12      | CSI1.HSYNC | I    | P_SW4        | HSYNC                                                    |
| 13      | GPIO3.5    | O    | P_SW4        | Camera Trigger                                           |
| 14      | STROBE     | I    |              | Strobe Signal from Camera (available only on solder pad) |
| 15      | NC         | NC   |              | Not Connected                                            |
| 16      | NC         | NC   |              | Not Connected                                            |
| 17      | CSI1.DO    | I    | P_SW4        | Pixel Data                                               |
| 18      | CSI1.D1    | I    | P_SW4        | Pixel Data                                               |
| 19      | VCAMIO     | PWR  | 1V8          | Camera IO Power Supply                                   |
| 20      | GND        | PWR  | GND          | Power Ground                                             |
| 21      | CSI1.D2    | I    | P_SW4        | Pixel Data                                               |
| 22      | CSI1.D3    | I    | P_SW4        | Pixel Data                                               |
| 23      | CSI1.D4    | I    | P_SW4        | Pixel Data                                               |
| 24      | CSI1.D5    | I    | P_SW4        | Pixel Data                                               |
| 25      | GND        | PWR  | GND          | Power Ground                                             |
| 26      | CSI1.D6    | I    | P_SW4        | Pixel Data                                               |
| 27      | CSI1.D7    | I    | P_SW4        | Pixel Data                                               |
| 28      | CSI1.D8    | I    | P_SW4        | Pixel Data                                               |
| 29      | CSI1.D9    | I    | P_SW4        | Pixel Data                                               |
| 30      | CSI1.PWDN  | O    | P_SW4        | Output Enable (Active Low)                               |

Table 4-3: BLT-ISM-Connector interface description (X13)

## **5 Support**

### **5.1 General Support**

General support for products can be found at Bluetechnix' support site <https://support.bluetechnix.at/wiki>

### **5.2 Board Support Packages**

Board support packages, boot loaders and further software downloads can be downloaded at the products wiki page at <https://support.bluetechnix.at/wiki>

### **5.3 i.MX Software Support**

#### **5.3.1 Linux**

Linux BSP and images of derivatives can be found at Bluetechnix' support site <https://support.bluetechnix.at/wiki> at the software section of the related product.

#### **5.3.2 Win CE**

WinCE is only supported on ARM platforms. Please contact Bluetechnix for support information.

### **5.4 i.MX® Design Services**

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

#### **5.4.1 Upcoming Products and Software Releases**

Keep up to date with all product changes, releases and software updates of Bluetechnix at <http://www.bluetechnix.com>.

## 6 Ordering Information

### 6.1 Predefined mounting options for EXT-SBC-i.MX51-DISP

| Article Number | Name                                        | Description                                                     |
|----------------|---------------------------------------------|-----------------------------------------------------------------|
| 100-2523-1     | EXT-SBC-i.MX51-DISP                         | Display and camera extender board for SBC-i.MX51                |
| 100-9910-1     | EDT-TFT-5.0"-WVGA-G-ET0500G0DH6             | EDT Display TFT 5.0" WVGA, 300cd/m <sup>2</sup> LED, TTL, touch |
| 100-4110-2     | SBC-i.MX51-S-C-Q24S512N2048<br>(SBC-i.MX51) | Single-Board Computer SBC-I.MX51 based on i.MX51<br>SoC         |

Table 6-1: Ordering information

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**NOTE:** Custom hard and software developments are available on request! Please contact Bluetechnix ([office@bluetechnix.com](mailto:office@bluetechnix.com)) if you are interested in custom hard- and software developments.

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## **7 Dependability**

### **7.1 MTBF**

Please keep in mind that a part stress analysis would be the only way to obtain significant failure rate results, because MTBF numbers just represent a statistical approximation of how long a set of devices should last before failure. Nevertheless, we can calculate an MTBF of the development board using the bill of material. We take all the components into account. The PCB and solder connections are excluded from this estimation. For test conditions we assume an ambient temperature of 30°C of all development board components. We use the MTBF Calculator from ALD (<http://www.aldservice.com/>) and use the reliability prediction MIL-217F2 Part Stress standard. Please get in touch with Bluetechnix ([office@bluetechnix.com](mailto:office@bluetechnix.com)) if you are interested in the MTBF result.

## 8 Product History

### 8.1 Version Information

| Version | Date       | Changes                                      |
|---------|------------|----------------------------------------------|
| 1.2     | 2011-05-30 | Changed layout of Image Sensor Connector X13 |
| 1.1     | 2011-04-20 | First release V1.1 of the Hardware.          |

Table 8-1: Overview product changes

### 8.2 Anomalies

| Version | Date        | Description                |
|---------|-------------|----------------------------|
| 1.1     | 2011-04- 20 | No anomalies reported yet. |

Table 8-2: Overview product anomalies

## 9 Document Revision History

| Version | Date       | Document Revision                  |
|---------|------------|------------------------------------|
| 3       | 2011 08 03 | Changed product photos             |
| 2       | 2011 05 30 | Update for Board Revision 1.2      |
| 1       | 2011 04 20 | First release V1.0 of the Document |

Table 9-1: Revision History

## 10 List of Abbreviations

| Abbreviation          | Description                                 |
|-----------------------|---------------------------------------------|
| <b>ADI</b>            | Analog Devices Inc.                         |
| <b>AI</b>             | Analog Input                                |
| <b>AMS</b>            | Asynchronous Memory Select                  |
| <b>AO</b>             | Analog Output                               |
| <b>CM</b>             | Core Module                                 |
| <b>DC</b>             | Direct Current                              |
| <b>DSP</b>            | Digital Signal Processor                    |
| <b>eCM</b>            | Enhanced Core Module                        |
| <b>EBI</b>            | External Bus Interface                      |
| <b>ESD</b>            | Electrostatic Discharge                     |
| <b>GPIO</b>           | General Purpose Input Output                |
| <b>I</b>              | Input                                       |
| <b>I<sup>2</sup>C</b> | Inter-Integrated Circuit                    |
| <b>I/O</b>            | Input/Output                                |
| <b>ISM</b>            | Image Sensor Module                         |
| <b>LDO</b>            | Low Drop-Out regulator                      |
| <b>MTBF</b>           | Mean Time Between Failure                   |
| <b>NC</b>             | Not Connected                               |
| <b>NFC</b>            | NAND Flash Controller                       |
| <b>O</b>              | Output                                      |
| <b>OS</b>             | Operating System                            |
| <b>PPI</b>            | Parallel Peripheral Interface               |
| <b>PWR</b>            | Power                                       |
| <b>RTOS</b>           | Real-Time Operating System                  |
| <b>SADA</b>           | Stand Alone Debug Agent                     |
| <b>SD</b>             | Secure Digital                              |
| <b>SoC</b>            | System on Chip                              |
| <b>SPI</b>            | Serial Peripheral Interface                 |
| <b>SPM</b>            | Speech Processing Module                    |
| <b>SPORT</b>          | Serial Port                                 |
| <b>TFT</b>            | Thin-Film Transistor                        |
| <b>TISM</b>           | Tiny Image Sensor Module                    |
| <b>TSC</b>            | Touch Screen Controller                     |
| <b>UART</b>           | Universal Asynchronous Receiver Transmitter |
| <b>USB</b>            | Universal Serial Bus                        |
| <b>USBOTG</b>         | USB On The Go                               |
| <b>ZIF</b>            | Zero Insertion Force                        |

Table 10-1: List of abbreviations

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