## Features

- **Module Size: 55 x 72 mm (Smaller than Smart Card)**
- **Microcontroller: Atmel ARM9®-based AT91RM9200**
- **SDRAM: 128 Mbits**
- **Flash: Atmel DataFlash® 32 Mbits**
- **Fingerprint Sensor: Atmel FingerChip® AT77C101B-CB02V**
- **Operating Temperature Range: -30° C to +65° C**
- **Operating Voltage: 3.3V ±10%**
- **Power Consumption: 200 mA in Typical Conditions**
- **Operating System: Linux® (Kernel 2.4.19)**
- **Available interfaces on Extension Connector:**
  - **Drivers Provided for SPI, Ethernet, Serial DBGU**
  - **Drivers not Provided for USB Host and Device, TWI, RS-485, IrDA, SmartCard, MMC/SD Card, SSC, RTC, JTAG…**
- **Software Suite with Embedded Pre-loaded Bio-engine**

## Description

This document describes the specifications of Atmel's AT77SM0101BCB02VKE FingerChip biometric module. Based on Atmel's FingerChip fingerprint sensor, ARM9 microcontroller and flash memory, the AT77SM0101BCB02VKE provides the main biometric functions such as user enrollment, authentication and identification in a packaged module, making it easy to integrate into a final system.

The AT77SM0101BCB02VKE is particularly well-suited to Physical Access Control, Point of Sale devices, Time and Attendance or Vending Machines.

The AT77SM0101BCB02VKE provides great flexibility because of its memory capacity and powerful microcontroller loaded with the Linux operating system, and features many possible interfaces, including Ethernet. The AT77SM0101BCB02VKE biometric module requires the purchase of the Evaluation/Development Kit AT77SM0101BCB02VEK to develop the user interface of the final application.

## Applications

- Physical Access Control
- Time and Attendance Systems
- Automated Teller Machines, Points of Sale
- Vending Machines
- Smart Homes
- Locks, Safes
- Reference Design for ARM9 and FingerChip Design Development

**Figure 1.** FingerChip Biometric Module AT77SM0101BCB02VKE



# FingerChip®
# Biometric
# Module

## AT77SM0101BCB02VKE

## Functional Description

The AT77SM0101BCB02VKE is a biometric sub-system based on Atmel's FingerChip fingerprint sensor. It comprises a fingerprint sensor connected to a board that embeds processing capabilities through an ARM9-based AT91RM9200 microprocessor, and memory to store the software and fingerprint templates.

The biometric module must be connected to a motherboard for power supplies and interface connections. Connection to the motherboard is achieved through two standard connectors located on the sides of the module board.

The module is loaded with a Linux operating system, an Atmel driver for the FingerChip sensor, and by default, authentication software (biometric library) for extraction of fingerprint characteristics and comparison with enrolled templates (also called bio-engine). The standalone module can perform the following:

- Enrollment: an operation where the end-user scans his fingerprint by sweeping it across the FingerChip sensor, providing a fingerprint signature reference (template)
- Authentication: accurate matching of the newly acquired fingerprint against the template stored in the board's memory during the enrollment procedure, used to validate user authentication
- Identification: matching of the fingerprint image against the correct template within a database of previously acquired templates

These three functions can then be used in any application requiring authentication to grant rights to a user, or to change criteria of the user's profile. Examples of typical applications might include physical access control or time and attendance monitoring.

The AT77SM0101BCB02VEK Evaluation Kit provides all the tools necessary for easy development of a customized application using the biometric module APIs.

The AT77SM0101BCB02VKE biometric module lets you add convenient and secured user authentication to your products in a surprisingly reduced development time.

**Figure 2.** AT77SM0101BCB02VKE Block Diagram
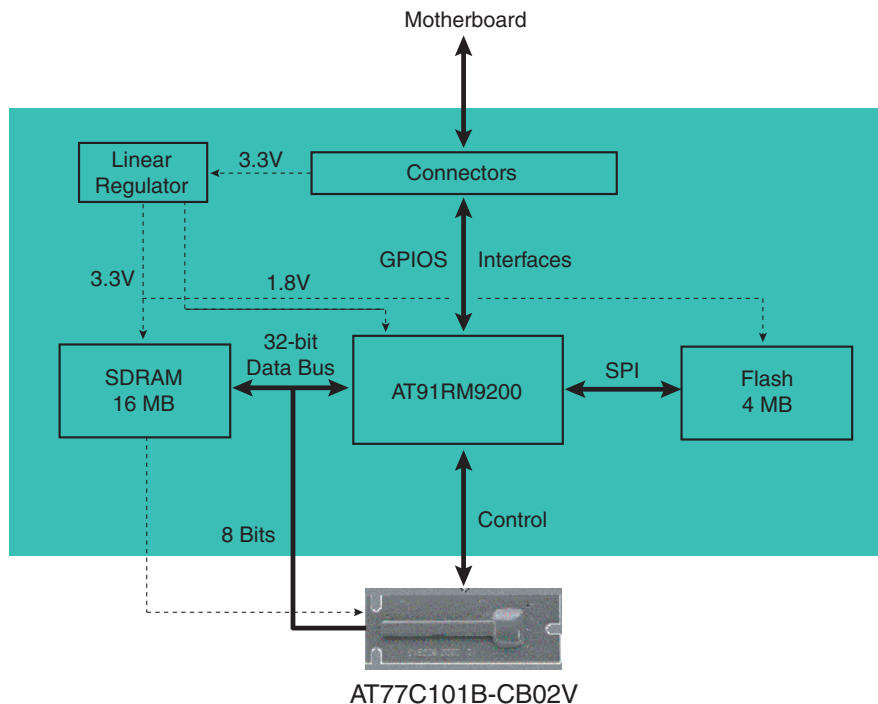


AT77C101B-CB02V

## Technical Description

Atmel's FingerChip biometric module includes the AT77C101B-CB02V FingerChip sensor (8-bit parallel interface) connected through a flex cable to the module itself.

## Module Size and Length of Flex

The board size of the module is 55 mm x 72 mm. It has three screw holes for easy fixing to the motherboard or casing of the final system.

The flexible cable is 5 cm long. It is a single straight cable made of copper.

**Figure 3.** AT77SM0101BCB02VKE Board Dimensions
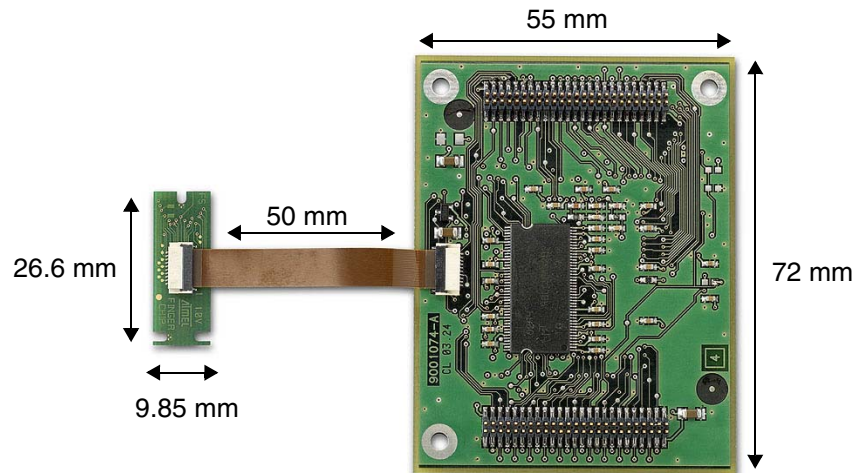


The dimensions of the sensor are 26.6 mm x 9.85 mm x 2.6 mm for the PCB. The die size is 1.7 mm x 17.3 mm.

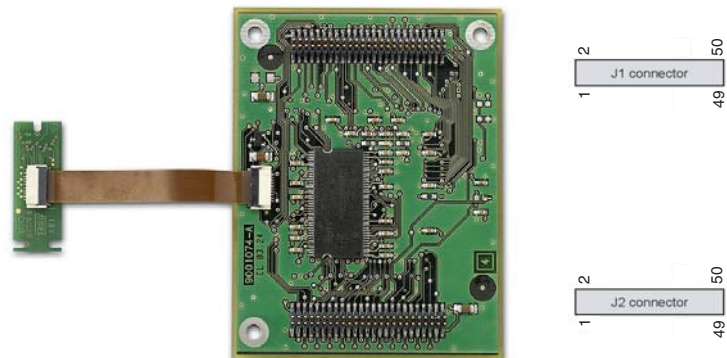## Description of Motherboard Interface

**Figure 4.** Motherboard Interface

**Table 1.** J1 Pin Description

| Pin | Description | Pin | Description |
| --- | --- | --- | --- |
| 1 | GND | 2 | 3V3 |
| 3 | NBS3 | 4 | NBS1 |
| 5 | PC10 | 6 | NRD_NOE_NCFOE |
| 7 | PC11 | 8 | NWR0_NWE_NCFWE |
| 9 | PC12 | 10 | NCS3_NSMCS |
| 11 | PC14* | 12 | PC15* |
| 13 | PC1 | 14 | PC0* |
| 15 | PC2 | 16 | PC3 |
| 17 | PC4 | 18 | PC5 |
| 19 | PC6 | 20 | PA15/EMDC |
| 21 | PA0/MISO | 22 | PA16/EMDIO |
| 23 | PA1/MOSI | 24 | PA17/TXD0 |
| 25 | PA2/SPCK | 26 | PA18/RXD0 |
| 27 | PA4/NPCS1 | 28 | PA19/SCK0 |
| 29 | PA5/NPCS2 | 30 | PA20/CTS0 |
| 31 | PA6/NPCS3 | 32 | PA21/RTS0 |
| 33 | PA7/EREFCK | 34 | PA22 |
| 35 | PA8/ETXEN | 36 | PA23/IRQ3 |
| 37 | PA9/ETX0 | 38 | PA24 |
| 39 | PA10/ETX1 | 40 | PA25/TWD |
| 41 | PA11/ECRSDV | 42 | PA26/TWCK |
| 43 | PA12/ERX0 | 44 | PA29 |
| 45 | PA13/ERX1 | 46 | PA28 |
| 47 | PA14/ERXER | 48 | PA27 |
| 49 | 3V3 | 50 | GND |

Note:    Pins 11, 12 and 14: do not use when the AT77C101B is connected to the module.

**Table 2.** J2 Pin Description

| Pin | Description | Pin | Description |
|-----|-------------|-----|-------------|
| 1 | GND | 2 | 3V3 |
| 3 | PB22 | 4 | PC9 |
| 5 | PB19 | 6 | PC8 |
| 7 | PB18 | 8 | PC7 |
| 9 | PB17 | 10 | DDP |
| 11 | PB16 | 12 | DDM |
| 13 | PB15 | 14 | HDPA |
| 15 | PB14 | 16 | HDMA |
| 17 | PB13 | 18 | PB29/IRQ0 |
| 19 | PB12 | 20 | PB28/FIQ |
| 21 | PB11 | 22 | PB27 |
| 23 | PB10 | 24 | PB26 |
| 25 | PB9 | 26 | PB25 |
| 27 | PB8 | 28 | PB24 |
| 29 | PB7 | 30 | PB23 |
| 31 | PB6 | 32 | NRST |
| 33 | PB5 | 34 | NTRST |
| 35 | PB4 | 36 | TMS |
| 37 | PB3 | 38 | TCK |
| 39 | PB2 | 40 | TDO |
| 41 | PB1 | 42 | TDI |
| 43 | PB0 | 44 | JTAGSEL |
| 45 | PA31 | 46 | PB21 |
| 47 | PA30 | 48 | PB20 |
| 49 | 3V3 | 50 | GND |

The pins are used to connect the following interfaces:

- USB device: pins 10 and 12 of J2 connector
- USB host: pins 14 and 16 of J2 connector
- TWI: pins 40 and 42 of J1 connector
- JTAG: pins 32, 34, 36, 38, 40, 42 and 44 of J2 connector
- SPI: pins 21, 23, 25, 27, 29 and 31 of J1 connector
- Two serial links: RS-232, RS-485, IrDA and/or Smart Card
- Ethernet or MMC/SD card

## Board's Main Components

**ARM9-based AT91RM9200 Microcontroller**

The AT91RM9200 microcontroller features the following:

- 200 MIPS capability
- 16 KB data cache
- 16 KB instruction cache
- 16 KB SRAM
- ROM boot
- Ethernet MAC
- USB 2.0 full-speed host and device
- USART, DMA, TWI, SPI, SSC, MCI

The ARM9 operates at 200 MHz on the module.

**Memory**

The AT77SM0101BCB02VKE biometric module features:

- 128 Mbits (16 Mbytes) of SDRAM on a 32-bit parallel data bus interface operating at 66 MHz
- 32 Mbits (4 Mbytes) of Atmel DataFlash on an SPI bus operating at 10 MHz

**AT77C101B-CB02V Sensor**

The sensor has the following characteristics:

- A sensitive layer over a 0.8 µm CMOS array
- An image zone of $0.4 \times 14$ mm, equalling 0.02 in. $\times$ 0.55 in.
- An image array of $8 \times 280$, equalling 2240 pixels
- A pixel pitch of 50 µm $\times$ 50 µm, equalling 500 dots-per-inch resolution
- A pixel clock of up to 2 MHz with a capacity of up to 1780 frames per second
- A die size of $1.7 \times 17.3$ mm
- An operating voltage range of 3V to 5.5V
- A natural protection from electrostatic discharge (ESD) up to 16 kV of air discharge. Use of metal casing or metalized plastic in the final application is strongly recommended
- A power consumption of 20 mW at 3.3V, 1 MHz, 25°C
- An operating temperature range of -40°C to +85°C
- A strong resistance to abrasion with the capability to withstand over 1 million finger sweeps
- A sweep speed ranging from 2 cm/s to 20 cm/s
- A low power consumption of 6 mA typical in acquisition mode and 10 µA in standby mode
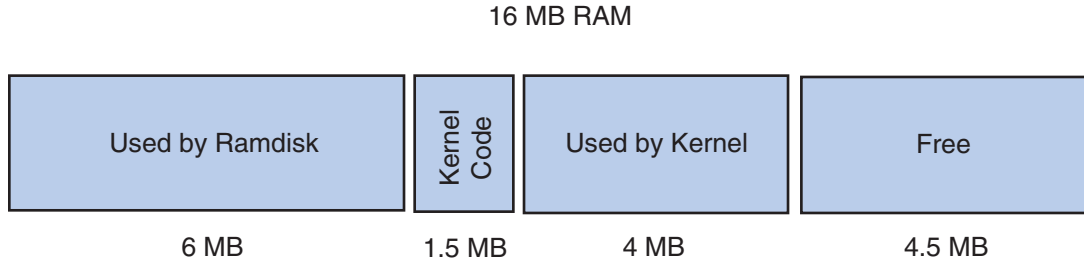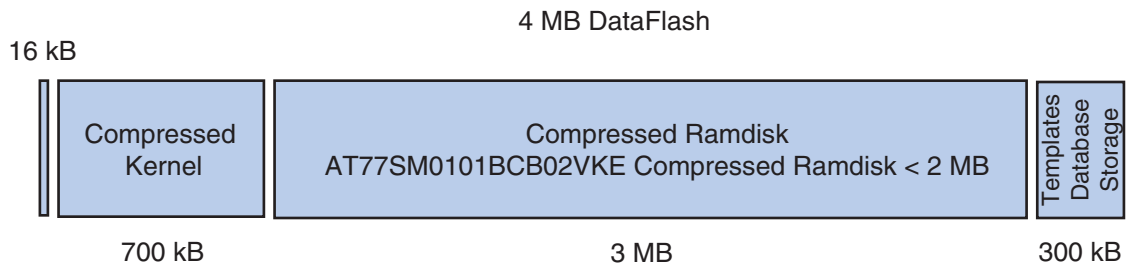
## Storage Capacity

**Figure 5.** RAM Memory Mapping

16 MB RAM

| Used by Ramdisk | Kernel Code | Used by Kernel | Free |
|:---:|:---:|:---:|:---:|
| 6 MB | 1.5 MB | 4 MB | 4.5 MB |

**Figure 6.** DataFlash Memory Mapping

4 MB DataFlash

16 kB

| Compressed Kernel | Compressed Ramdisk AT77SM0101BCB02VKE Compressed Ramdisk < 2 MB | Templates Database Storage |
|:---:|:---:|:---:|
| 700 kB | 3 MB | 300 kB |

## Biometric Performances

The device's biometric performances are characterized by the following:

- An image size of $500 \times 400$
- 256 levels of grey
- A finger swiping speed from 2 to 15 cm/s
- An FRR under 3% at an FAR $10^{-4}$ rate using an IKENDI® algorithm
- An authentication time of under 10 ms
- A biometric template size of 384 bytes
- An authentication algorithm size of 420 kbytes
- An identification time of under 1 second for 50 templates

## Software

### Operating System Driver Modules

The biometric module comes preloaded with the Linux operating system (kernel 2.4.19 rmk 7). The kernel includes:

- Ramdisk support
- A serial port driver supporting DBGU and up to four UARTs
- An SPI driver
- Ethernet layers 10/100 Mbits (compatible with MII protocol)
- Watchdog support

Further information can be retrieved at http://www.arm.linux.org.uk.

**7**

Two drivers are provided as modules that can be loaded or unloaded during runtime. These are:

- The FingerChip driver: FingerChip_mod.o, version 2.0 enabling on-the-fly reconstruction of images
- A GPIOs driver: Leds_mod.o, version 2.0, used to drive switches, LEDS etc.

# Environmental Specifications

## Operating Conditions

### Absolute Maximum Ratings*

| | |
|---|---|
| Power Supply Voltage ($V_{CC}$) .................................-0.3V to 4.6V<br><br>Storage Temperature ($T_{stg}$) ............................. -40° C to +85° C | *NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. |

### Recommended Conditions of Use

| Parameter | Symbol | Comments | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Positive supply voltage | $V_{CC}$ | 3.3V ±10% | 3 | 3.3 | 3.6 | V |
| Operating temperature range | $T_{amb}$ | Telecom: "T grade" | -30° C to +65° C | | | °C |

### Sensor Resistance

| | Min Value | Standard Method |
|---|---|---|
| **ESD** | | |
| Air discharge on die surface (Zap gun), sensor included in casing | ±16 kV | NF EN 6100-4-2 |
| **Mechanical Abrasion** | | |
| Number of cycles without lubricant<br>[a multiplication by a factor of 20 should be applied for correlation with a real finger] | 200,000 | MIL E 12397B |
| **Chemical Resistance** | | |
| Cleaning agents, acid, grease, alcohol, diluted acetone | 4 hours | Internal method |

Note: Resistance characteristics are given for the sensor only.

### Electrical Characteristics

| Parameter | Symbol | Comments | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Current on $V_{CC}$ | $I_{CC}$ | 3.3V ±10% | | 200 | 300 | mA |

## Module Integration

**Mechanics**

The size of the board and the flex cable make integrating the standalone module into the final product simple and convenient. In addition, the module can be fixed to the main board or the casing using three screws.

**Fingerprint Sensor**

Atmel recommends fixing the sensor by inserting it into the casing's groove. Care should be given to ensuring that:

- The casing provides sufficient aeration
- The board is implemented vertically with the flex connector outputs oriented downwards
- The sensor is protected from direct exposure to rain when used outdoors

**Connection of the Module Board to the Motherboard**

The standalone module board measures 55 mm by 72 mm. It has three screw holes for easy fixing to the motherboard or casing of the final system. Connection to the motherboard is achieved through two connectors each comprising 2 x 25 pins, which are located on the sides of the module board. The height of the components under the module must not exceed 5 mm.

**Figure 7.** Module Board Mechanical Data
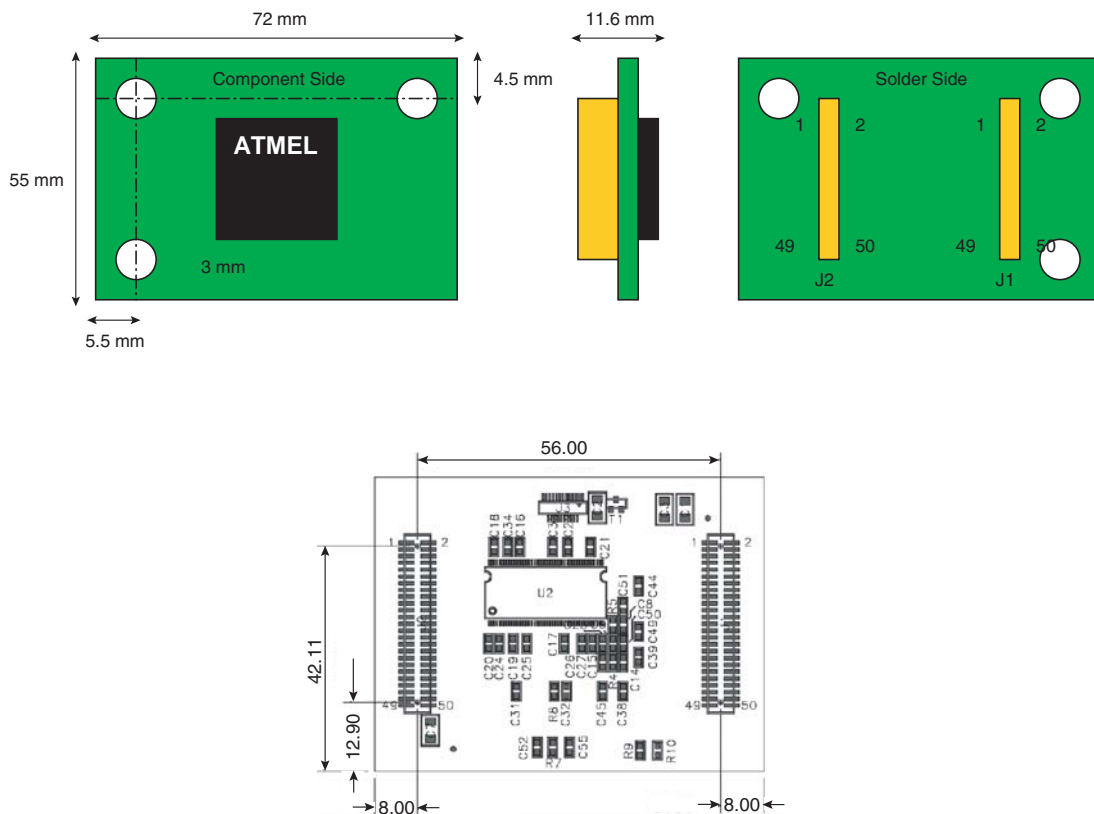
**Electrical Integration**

The motherboard must at least provide power supplies and the required components in order to implement the desired interfaces. Atmel recommends using a linear power supply of 3.3V to power the standalone module.

An example of a possible implementation is given in the Development Kit documentation (this kit can be ordered through your local Atmel distributor). Reading this documentation is strongly recommended to proceed with accurate programming of the board application.

## Evaluation and Development Kit

**Figure 8.** AT77SM0101BCB02VEK



**AT77SM0101BCB02VEK Content**

This kit includes:

*   A demo kit board with an integrated biometric module
*   A power supply with adapters for international power outlets
*   A crossed Ethernet cable
*   A serial cable
*   A "Quick Start" guide
*   A CD-ROM comprising all the necessary tools and documentation

**Authentication Software and SDK**

The Development Kit includes a complete software SDK for easy access to the Finger-Chip's hardware (image capture). This SDK also allows the user to control the bio-engine (authentication software) and manage the database through high-level functions.

The authentication software is directly preloaded onto the module. The SDK also includes a communication protocol to control the module from a PC.

# Stack Schematics

**Figure 9.** Stack Schematics
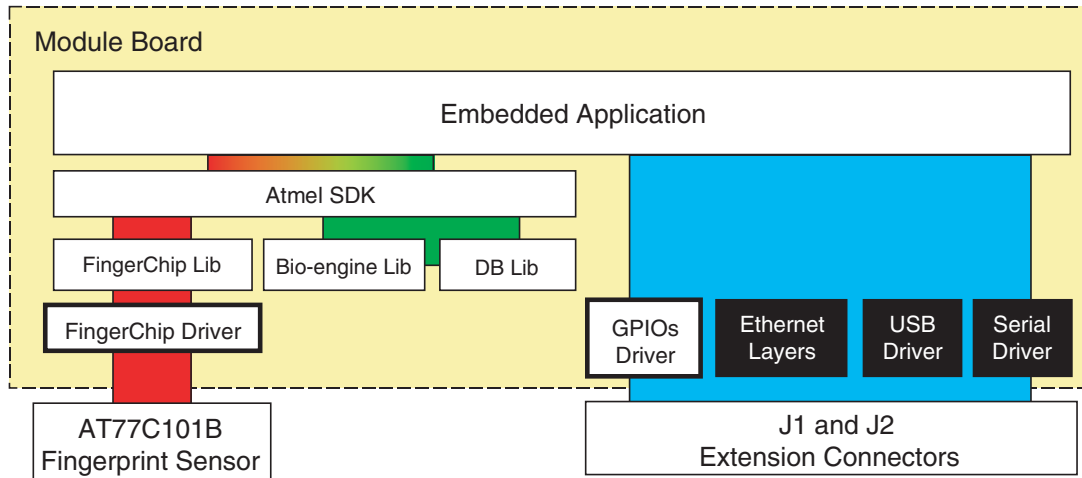


| | |
|---|---|
| 🟥 | The fingerprint acquisition channel runs through Atmel's SDK |
| 🟩 | Enrollment, verification and identification through the bio-engine but controlled by Atmel's SDK |
| 🟩 | Database manipulation is achieved through Atmel's SDK or directly through the bio-engine |
| 🟦 | Generic communication with the outside world is controlled via GPIOs, the Ethernet or USB port or serial link for which drivers are available and directly accessible from the application layer |
| ⬛ | Static drivers |
| ⬜ | Dynamic drivers |

## Packaging
## Mechanical Data

**Figure 10.** Product Reference AT77C101B-CB02V

All dimensions in mm
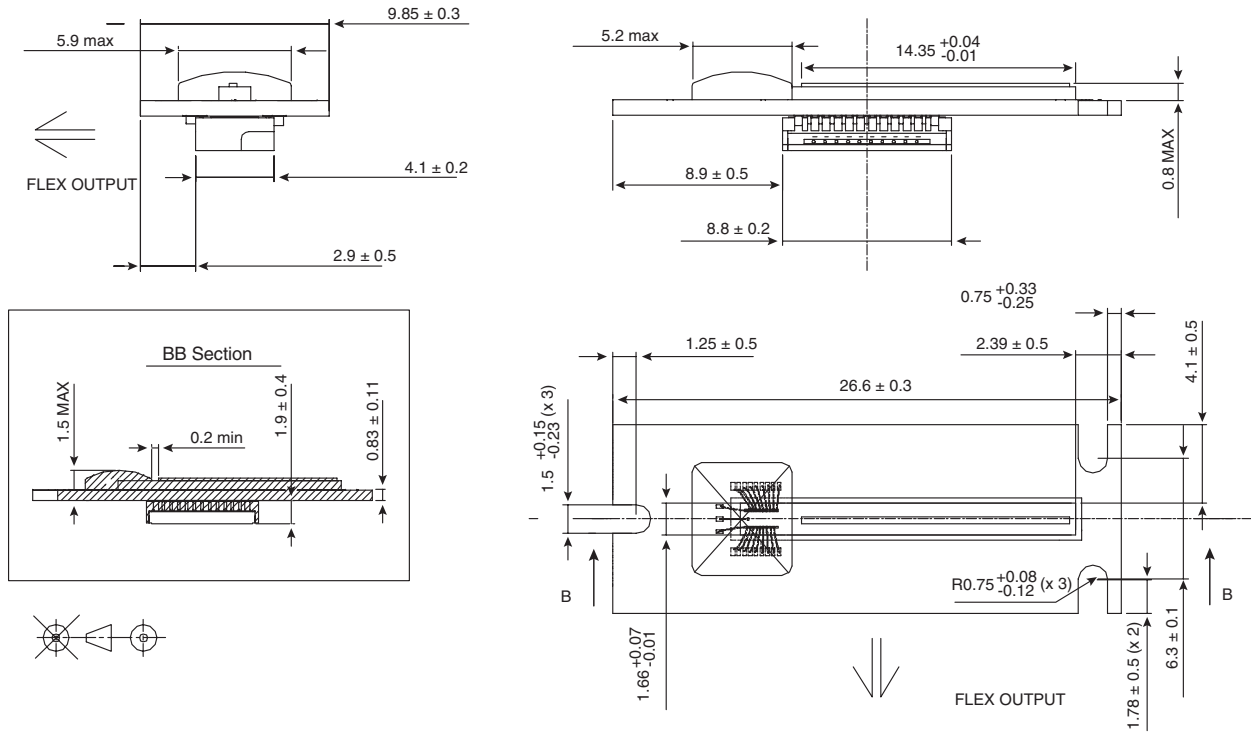
## Ordering Information

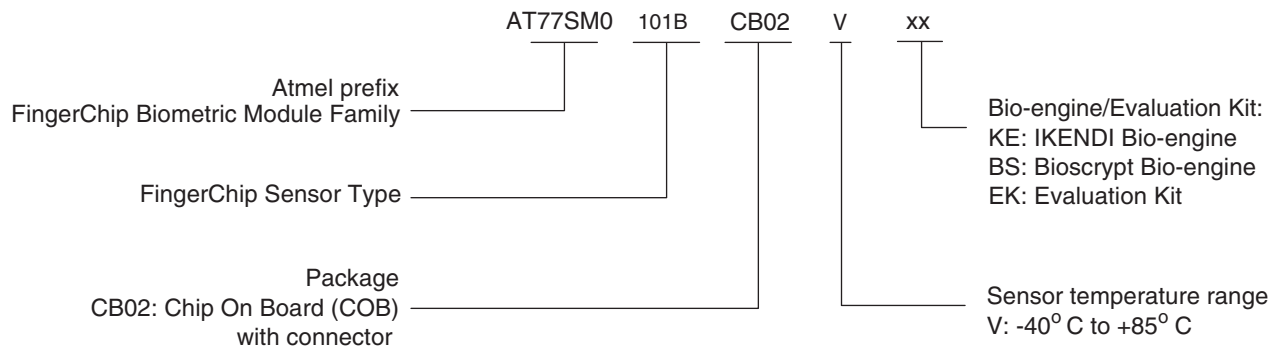The standalone module is available in Europe through Atmel distributors.

Two references are available for the module:

- AT77SM0101BCB02VKE (includes IKENDI bio-engine license)
- AT77SM0101BCB02VBS (includes Bioscrypt Inc. bio-engine license)

The Development Kit (reference AT77SM0101BCB02VEK) is also available in Europe through Atmel's distributors.

## Naming Convention

**Figure 11.** Naming Convention

AT77SM0    101B    CB02    V    xx

Atmel prefix
FingerChip Biometric Module Family

Bio-engine/Evaluation Kit:
KE: IKENDI Bio-engine
BS: Bioscrypt Bio-engine
EK: Evaluation Kit

FingerChip Sensor Type

Package
CB02: Chip On Board (COB)
with connector

Sensor temperature range
V: -40° C to +85° C

![ATMEL logo]

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