Features

- **Based on Keil™ Development Chain**
- **Same Interface for the Simulator and the Emulator**
- **Final Phase of Development can be done using a Smart Card Sample**
  - **Flash-based Microcontroller-Production can Start Immediately**
- **Supported on PC (Windows)**
- **Includes:**
  - **Simulation Software with an RS232 to ISO7816 Interface Allows Test with the Final Application**
  - **Emulation Software and Hardware**
  - **Development Chip similar to Production Device**
  - **Built-in Card Reader to program Card Samples**

Description

One of the essential characteristics of integrated circuits for Smart Cards is the high level of system security. They have only one input/output through which the interior of the chip is neither visible nor controllable. This, in addition to the problem of security of access, makes application code difficult to test and design.

Atmel has developed a complete set of simulation and emulation tools to facilitate the development of an AT89SC application. Associated with an External Reader Interface which provides a physical link with an external card reader, these tools allow the user to test the AT89SC functionality in a real application.

The document “AT89SC Smart Card Development Kit” describes the Emulator. “Smart Card Simulation Kit User’s Manual” describes the simulation. Both are provided with the tools.

The Smart Card Development Kit (SDK) is built around a development version of the AT89SC device called the Development Chip. The Development Chip has an additional bus connection used to connect an external RAM which emulates the internal memory (Flash/EEPROM) of the Production Chip.

The SDK has an embedded ISO Interface used to communicate either with the Development Chip or with the Embedded Smart Card Reader. This Embedded Reader allows the programming of an application on the Production Chip.

Smart Card Development Kit (SDK)

AT89SC SDK Summary

Complete User Guide Available Under NDA

Rev. 1069AS–07/98

Application Validation Flow

Following a rigorous methodology is the most secure route for the validation and integration of software into the AT89SC devices.

The flow presented below ensures that all the elements of the AT89SC Development Kit are used in the most efficient manner and guarantees that the application software is fully validated.

Stage 1: Simulation

Simulation runs on a host computer using Atmel AT89SC DLL libraries. The PC is connected to the remote reader through the External Reader Interface (RS232 to ISO).

Stage 2: Development Chip Emulation with External Memory

A ROM monitor on the SDK is activated and connected with the debugger on the PC. The user environment on the PC is the same as for simulation.

The application software is loaded into the external RAM memory (used to emulate the internal Flash/EEPROM memory) which is connected to the Development Chip through the additional bus interface. *The AT89SC development products are capable of emulating the Flash/EEPROM* even while using the external RAM memory.

The ISO Interface of the Development Chip is connected to a remote reader through the External Reader Interface. The application software is then run on the Development Chip.

If the developer is careful to use only the addresses available in the AT89SC device, the ensuing code is very similar to the final code.

Stage 3: Development Chip, Internal and/or External Memory

From this stage, the debugger is no longer used.

The application software is loaded into the emulation RAM memory of the SDK. The ISO Interface of the Development Chip can be connected to a remote reader through the External Reader Interface.

At this point, the user has the possibility of adding a debug code to the external RAM. Code execution can be tracked through an additional DPRAM.

The same procedure can be repeated using the internal nonvolatile memory of the Development Chip in place of the emulation RAM memory.

If an error occurs during debug (e.g. deadlock), the Flash memory can always be recovered and the Development Chip can be re-used.

Stage 4: Development Chip, Internal Memory Only

The application software is loaded into the internal memory of the Development Chip.

The ISO Interface of the Development Chip is connected to a remote reader through the External Reader Interface.

The application does not use emulation memory, and the Development Chip runs exactly the same way as the Production Chip.

The developer can then proceed to characterize the application in terms of performance by modifying the ISO supply voltage and clock frequency.

The Development Chip Flash content can always be recovered by using a special procedure. Therefore, even if the code is bugged (e.g. deadlock), the Development Chip can be re-used.

Stage 5: Production AT89SC

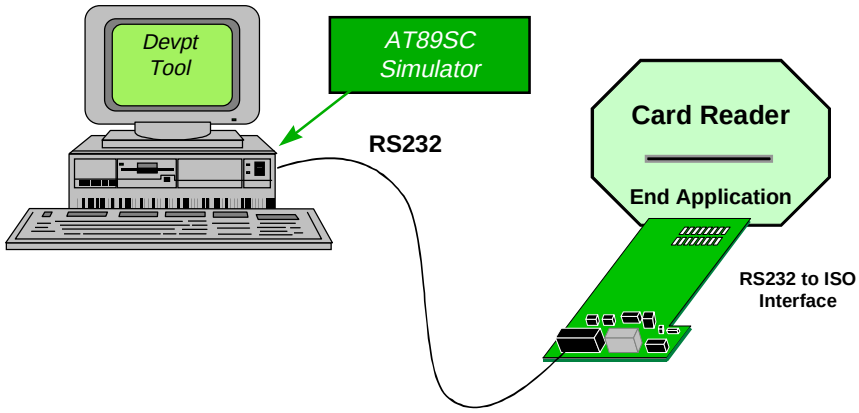
The application is loaded and programmed into the Production Chip through the Embedded Smart Card Reader which can then be inserted in the standard reader for normal use.

Simulator

The simulation on the PC validates the application. The PC is connected to the remote reader through the External Reader Interface (RS232 to ISO) as shown below.

The Simulator is activated from the Keil Debugger.

Figure 1. AT89SC Simulator



Virtual Registers

The Keil debugger has virtual registers which allow the configuration of the simulation to be modified.

I/O Line Simulation

The I/O line of the ISO Interface can be simulated either with the serial window of dScope, or with one of the serial communication ports (COMx) of the PC.

Memory Simulation

Two different types of memory (EEPROM) write accesses are simulated:

- Byte access, where only one byte is automatically written when the MOVX instruction is executed
- Page access, where latches (for a complete page or a partial page) are set by the application, then the physical writing is activated by setting the bit EEWR of the register MCON

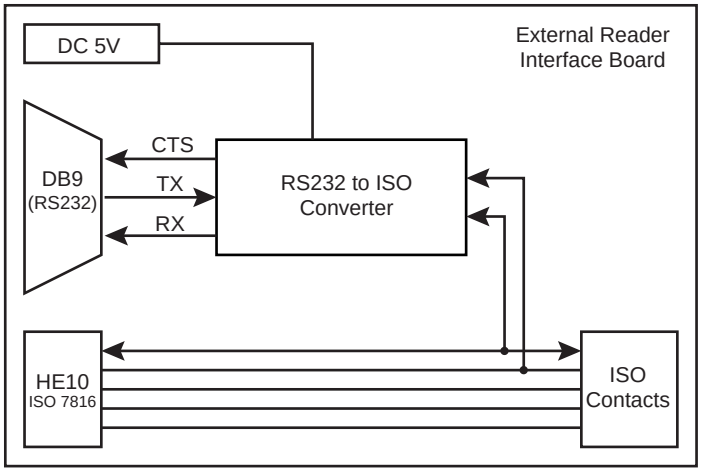
External Reader Interface

The External Reader Interface is a board which allows an external reader to be connected with either a Simulator on the PC by the COM port (RS232 to ISO), or with a Development Chip on the SDK (ISO to ISO). The External Reader Interface is used with both the Simulator and the Emulator.

It is composed of:

1. An ISO footprint contact for reader connection
2. An HE10 with ISO signals for SDK connection
3. A DB9 for RS232 connection with the Simulator on the PC
4. An ISO to RS232 converter
5. A jack connector to supply power

Figure 2. RS232 to ISO Interface Board



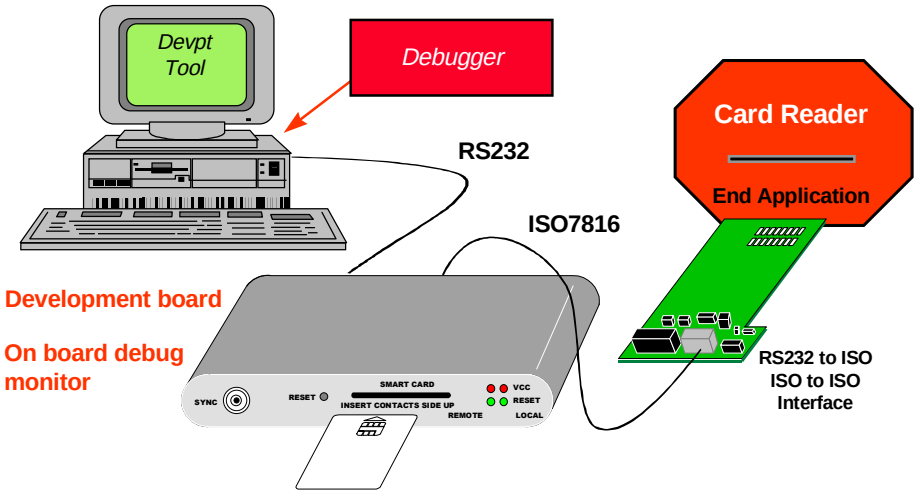
Emulator

The SDK includes a Development Chip, similar in terms of functionality to the Production Chip, but with a direct access to internal buses and the possibility of disabling the security features. During the emulation phase, the code runs on the Development Chip CPU.

The SDK replaces the Flash and EEPROM memory of the Development Chip with a larger RAM. This allows the developer to add debugging routines.

The developer can progressively remove the debugging routines to reach the final code. The program is then transferred from the RAM to the non volatile memory of the Development Chip.

Figure 3. AT89SC Emulator



The SDK consists of the following elements:

- An AT89C52 which manages the serial link with the PC
- An AT89SC Development Chip similar to the Production Chip
- A DPRAM for the debugger channel and data traces
- An RS232 Interface
- An External Reader Interface board
- Line drivers and level shifts for ISO to CMOS conversion
- Embedded reader for programming a Production Chip

Furthermore, the SDK provides a **"SYNC"** output which can be driven by the application software on the Development Chip. It is connected with port 3.3 of the Development Chip. It can be used to synchronize or trigger an external scope or analyzer. Its management is under user control.

Memory Mapping of the Development Chip

The Development Chip has three different memory mapping possibilities:

1. INTERNAL: internal memory (Flash and EEPROM) is used
2. EXTERNAL: external memory emulation (RAM) is used
3. RECOVER: both internal and external memories are used

With INTERNAL mapping, the Smart Card uses its own code and data memories (Flash and EEPROM). However, a memory extension integrated in the SDK can be used to implement debugging routines or write trace data.

With EXTERNAL mapping, internal memory is no longer visible by the AT89SC, and is replaced by the RAM memory emulation implemented on the daughter board of the SDK.

The RECOVER mapping is reserved for recovering the contents of the internal memory, even if it has been downloaded with a bugged code.

Debug Mode

Debug Mode allows the application to be validated on a Development Chip in a real environment.

The same environment is used for the Emulator as for the Simulator. Both are selected from the dScope Debugger of the Keil Development Chain. The SDK is connected to the PC by an RS232 cable.

The External Interface Reader provides the physical link with the remote reader.

Memory Use

In Debug Mode, the external RAM memory is used to emulate the internal Flash/EEPROM memory. This avoids premature aging of the Flash/EEPROM.

Write accesses are handled by the Development Chip by generating an interrupt just as it would for the real memory. The external RAM memory handles both byte mode and page mode.

Breakpoint Management

Breakpoints are implemented by code substitution.

ISO Interface

During startup, the SDK originates the ISO signals to the Development Chip. This initializes the chip and enables the application to be loaded without power from the remote reader.

Once the application is initialized and ready to be run, the user must verify that the reader selector is set to “remote”. From this point, the ISO signals originate from the reader of the end application.

Synchronization for Analyser

The SDK provides an output to synchronize external equipment (logic analyzer or scope).

This output is set/cleared by the application software by setting/clearing bit 3 of port P3 of the Development Chip.

Program Mode

The following operations can be performed in Program Mode:

- Test the SDK
- Execute final steps of validation using the internal memory (Flash/EEPROM) of the Development Chip
- Download the final application into the Production Chip, which can then be inserted in the standard reader for normal use
- Update software tools on the SDK

SDK Commands

The SDK is connected to a terminal Emulator on the PC by an RS232 link. The different features are activated by entering commands on the keyboard. These commands are grouped in menus according to their purpose.

Table 1. Summary of Major Development Kit Commands

Command	Description
Dump	Displays on the terminal the contents of the current page (XDATA), showing both hexadecimal and ASCII values
Fill	Fills a part of the current page (XDATA) with a defined value
Load	Uploads data to current page (XDATA). The data can be a: - Test bench or Tool to be activated with GO command - Application in daughter board memory emulation - Application to load onto AT89SC via the ISO Interface
Go	Activates a Test bench or Tool previously uploaded
Page	Modifies the mother board memory mapping
Memory Space	Selects the lower or the upper 64K bytes of the SRAM of the mother board as XDATA space
Emulation Memory	Selects the mapping of the Development Chip on the daughter board
Reader	Selects the reader connected with the Development Chip
Smart Card Control	Activates the menu for the smart card features
Features in EEPROM	Activates the menu for the EEPROM utilities
Tests Hardware	Activate the menu for the tests of the SDK
...	...

Software Tools

The software tools provided with the SDK are saved in the EEPROM.

The software tools are used for the following operations:

- The downloading of an application on a chip (development or volume)
- The recovering of the Development Chip in case of deadlock
- The emulation which consists of a ROM monitor coupled with the Keil debugger (dScope) on the PC

Requirements

- **Hardware**: PC 486 (or above) with 10Mb Hard Disk Space and one free RS232 port.
- **Software**: Windows 95 or Windows 3.1, Keil™ Development Chain pk51 Rev. 1.13 and Keil™ Debugger dScope™ 251/51 for Windows Rev. 1.3 (or above) must be installed.
  Terminal Emulator (e.g. hyperterminal) must be available.

Deliverables

AT89SC Smart Card Development Kit (Ref: 040-4200)

- AT89SC Simulation Kit (see description below)
- SDK box
- Cable ISO for extension board

AT89SC Simulation Kit (Ref: 040-4210)

- Extension board: RS232 to ISO Interface
- Cable RS232 for extension board
- Jack connector for power supply
- 3½" Floppy disk (see description below)

Floppy Disk Contents

- User's Manual (Simulation and Emulation)
- Boot Software (Flash and RAM)
- DLL Simulation Keil
- SDK Software Tools
- INTEL to SRECORD Converter
- Code Examples