



## **ST72324 QUICK REFERENCE NOTE**

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by Microcontroller Division Applications

### **INTRODUCTION**

The purpose of this document is to give you a basic understanding of the ST72324 and to help you quickly get started with developing your application.

It also highlights important aspects of the ST72324 that you should not overlook when reading the datasheet.

Section 1 gives an overview of the key benefits of the device.

Sections 2 and 3 contain helpful pointers to help you choose the right tool for the development environment and start working with ST72324.

In each section of this application note, you will find many useful technical tips to help you make the most of the ST72324 features in your design.

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## 1 OVERVIEW OF DEVICE FEATURES

ST72324 family extends the ST7 mid-range for appliance, industrial and automotive applications, requiring medium and large memory capacities and up to 32 I/O ports. The device has software LIN compatibility and supports extended temperature range (-40°C to +125°C), which are key features for supporting automotive applications.

**Table 1. Device features**

<b>Program Memory</b>	8 to 32k dual voltage Flash or ROM with Read-out protection capability
<b>RAM</b>	384 to 1K bytes
<b>Package</b>	SDIP42, TQFP44 10x10, SDIP32, TQFP32 7x7
<b>Number of I/O ports</b>	Up to 32 I/O ports <ul style="list-style-type: none"> <li>– 32/24 multi functional bidirectional I/O lines</li> <li>– 22/17 alternate function lines</li> <li>– 12/10 high sink outputs</li> </ul>
<b>Clock Source</b>	<ul style="list-style-type: none"> <li>– External Clock Source</li> <li>– 4 Crystal/Ceramic Oscillator types</li> <li>– Internal High Frequency RC Oscillator</li> </ul>
<b>Power Saving Modes</b>	Halt, Active-Halt, Wait and Slow
<b>Interrupt Management</b>	<ul style="list-style-type: none"> <li>– Nested interrupt controller</li> <li>– 10 interrupt vectors plus TRAP and RESET</li> <li>– 9/6 external interrupt lines (on 4 vectors)</li> </ul>
<b>Operating Voltage</b>	3.8V to 5.5V
<b>Temperature Range</b>	-40°C to +125°C
<b>A/D</b>	10-bit A/D with up to 12 input pins
<b>Timers</b>	<ul style="list-style-type: none"> <li>– Main Clock Controller with: Real time base, Beep and Clock-out capabilities</li> <li>– Configurable watchdog timer</li> <li>– Two 16-bit timers with input capture, output compare and PWM modes</li> </ul>
<b>Communication Peripherals</b>	<ul style="list-style-type: none"> <li>– SPI synchronous serial interface</li> <li>– SCI asynchronous serial interface (LIN compatible)</li> </ul>
<b>Instruction Set</b>	<ul style="list-style-type: none"> <li>– 8-bit Data Manipulation</li> <li>– 63 Basic Instructions</li> <li>– 17 main Addressing Modes</li> <li>– 8 x 8 Unsigned Multiply Instruction</li> </ul>
<b>Special Features</b>	In-Application Programming and In-Circuit Programming

## 2 ST72324 KEY BENEFITS

### 2.1 8-BIT SOLUTION FOR MID-RANGE APPLICATIONS

The device offers the following state-of-the-art benefits:

- Reduced board size, as most components are integrated in the device. There is no need for a separate RESET generator, low voltage detection circuitry (LVD) or auxiliary voltage detection (AVD) for early warning of power failures.
- Availability in a range of pin-compatible devices from 8K to 32K of ROM or Flash program memory. Hence, there is no need to re-design the board if the application code size increases.
- Up to 32 I/O ports and a 10-bit A/D converter with up to 12 input channels reduce the integration effort and board size.
- True open drain I/O pins for applications requiring high current, e.g. for driving relays through I/Os.
- 17 addressing modes are supported, resulting in more compact code.
- Flash with Read-out protection against piracy and also Register Access Security System (RASS) to prevent accidental programming/erasing.

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*Useful Tips:*

#### ***Emulate Data E<sup>2</sup>PROM with program area***

To store non-volatile parameters (such as user preferences and calibration constants), you can emulate Data EEPROM with the HDFlash Memory.

For more information, refer to:

AN1502: Emulated Data EEPROM with ST7 HDFlash memory

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### 2.2 ENHANCED CLOCK MANAGEMENT MODULE

This module allows you to select different main clock sources:

- An external source
- 4 crystal or ceramic resonator oscillator types
- An internal high frequency oscillator

Each oscillator is optimized for a given frequency in terms of consumption. This can be selected through the option byte.

- Along with the above mentioned options for selection of clock source, the clock management also supports a **Main Clock Out option** which can be used to drive external

devices on your application board and a **Beep Out option** which generates 3 selectable frequencies at a 50% duty cycle.

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**Useful Tips:****Calibrating Peripheral Parameters for Internal RC Oscillator**

Peripherals like the Timer, SCI etc. which depend upon time calculation, can be calibrated by determining the Internal RC accuracy error.

For more information, refer to:

AN1530: Accurate Timebase for low cost ST7 applications with Internal RC oscillator

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## 2.3 INTEGRATED FEATURES FOR MORE RELIABILITY

The system integrity module consists of the Low Voltage Detector (LVD) and Auxiliary Voltage Detector (AVD).

- LVD secures the power up and power down stages by keeping the MCU in reset state. There is no need for an external reset generator.
- AVD generates an interrupt when the voltage crosses the threshold voltage. This interrupt can be used as an early warning of an imminent LVD reset so software can perform a safe shut down.

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**Useful Tips:****Safe Shutdown with AVD Interrupt**

Using the AVD interrupt, the application can store the application context in emulated Data EEPROM before the LVD generates a reset.

For more information, refer to:

AN1502: Emulated Data EEPROM with ST7 HDFlash memory

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## 2.4 NESTED INTERRUPTS

Nested or concurrent interrupt management with:

- Flexible interrupt priority and level management.
- Up to 4 software programmable nesting levels.

This allows easy implementation of a priority based interrupt driven architecture. The device also has 4 vectors for external interrupts which allows for fast and flexible implementation of external interrupt handling.

### 2.5 POWERFUL INDUSTRY STANDARD COMMUNICATION INTERFACES

The ST72324 SCI is supported by LIN communication software. LIN is a low cost communication architecture for local interconnect networks in vehicles. This makes the ST72324 suitable for use in automotive applications.

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*Useful Tips:*

***Using LIN for automotive networks***

The software LIN compatible SCI can be used in automotive application for connecting various intelligent mechatronical systems. For more information how to use LIN refer to:  
AN1278: LIN Solutions

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SPI is a powerful interface for communicating with on-board components with very little CPU overhead.

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*Useful Tips:*

***Software SS management for SPI***

The application can choose to manage the Slave Select signal by software. This will free one I/O line for application usage

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### 2.6 IN-CIRCUIT PROGRAMMING AND IN-APPLICATION PROGRAMMING

In addition to using a socket-type programming tool, the following two modes allow you to program the ST72324 without removing it from the application board.

ICP: In-Circuit-Programming: ICP is the ability to program the Flash memory (All Flash sectors and the option byte row) of a microcontroller using the ICC (In-Circuit Communication) protocol after the device has been plugged into the board, but not while the application is running.

IAP: In-Application-Programming: IAP is the ability to re-program the Flash memory (Option Bytes and All Flash sectors except Sector 0) of a microcontroller while the device is plugged into the application and the application is running. As sector 0 contains the software driver that does the re-programming, it is write protected and therefore is not re-programmable. You have to initially program the software driver in sector 0 using ICP.

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*Useful Tips:*

***Using In-Application Programming***

Applications can use In-Application Programming as a very flexible way of programming the ST72324. For more information on how to use IAP refer to:  
AN1576: In-Application programming drivers for ST7 HDFSFlash or XFlash MCUs

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In the ICP minimum configuration, only 3 wires are needed (ICCCLK, ICCDATA,  $\overline{\text{RESET}}$ ). You may also use it as a basis to develop your own debugging tool.

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*Useful Tips:*

***Developing a programming tool using ICC***

The ICC protocol can be used to develop a custom programming tool.

For more information refer to:

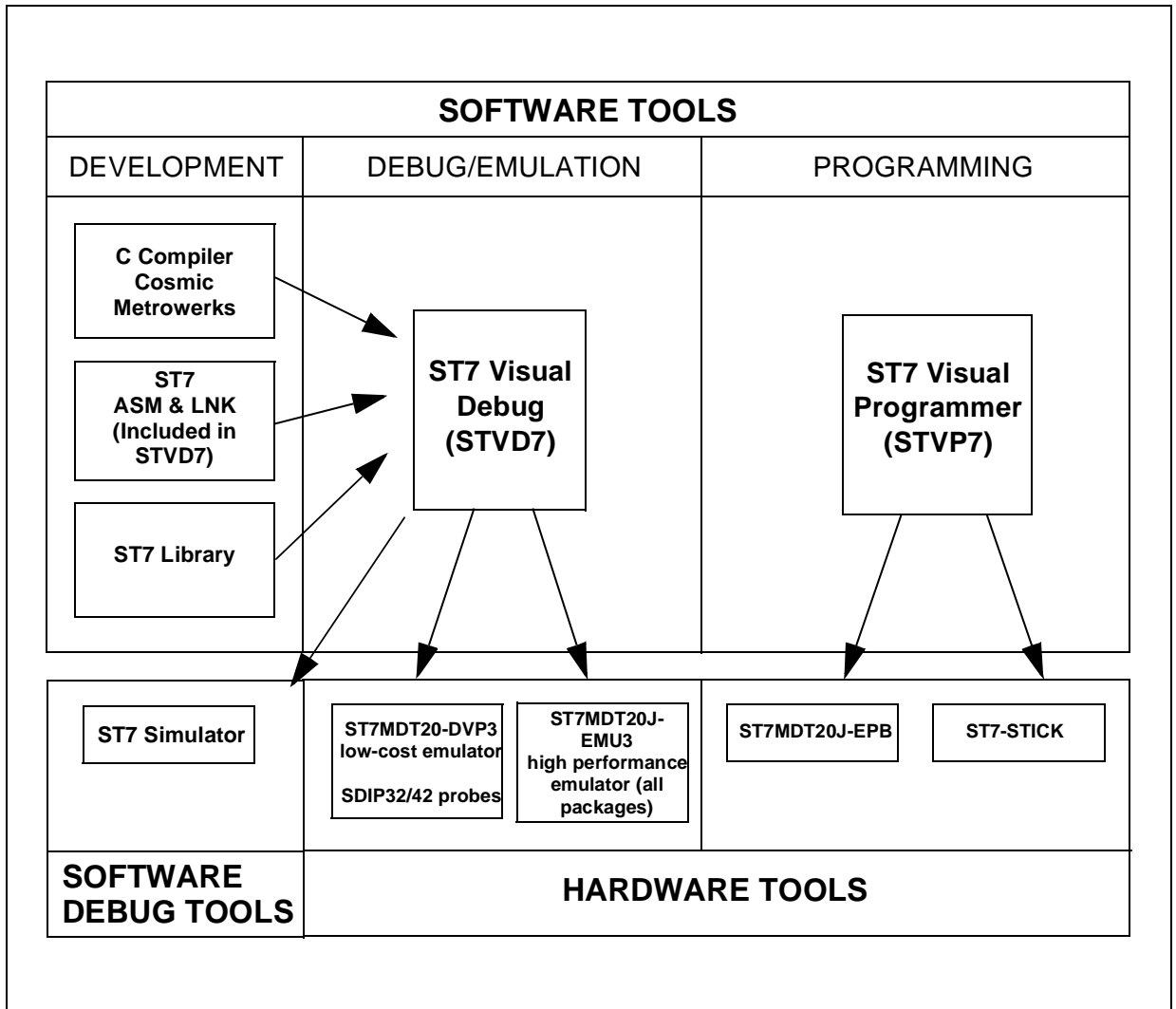
ST7 Flash Programming Reference Manual

ST7 ICC Protocol Reference Manual

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### 3 ST72324 DEVELOPMENT TOOLS

Figure 1. Development Tools overview





## 3.1 CODE DEVELOPMENT TOOLS

### 3.1.1 ST7 Assembler and Linker

The ST7 assembler, based on a meta-assembler technology, has full-featured macros and powerful conditional assembly directives. Relocatable object files generated by the assembler are then combined by the linker into a single executable file.

This is available on the STMicroelectronics Microcontroller Development Tools CD-ROM or can be downloaded from <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools.

### 3.1.2 C Compiler toolchains from Cosmic and Metrowerks

- Free evaluation version limited to 2K
- Low-cost lite C compiler limited to 8K

This compilers can be embedded in the STVD7 IDE interface, or used through dedicated graphical interfaces.

Web:

Cosmic Software Inc.: [www.cosmic-software.com](http://www.cosmic-software.com)

Metrowerks: [www.metrowerks.com](http://www.metrowerks.com)

### 3.1.3 ST7 Software Library: ST7LIB

STMicroelectronics provides a full set of libraries for ST7 microcontrollers, offering a wide range of benefits:

- Supports all ST72324 peripherals: ADC, SCI, SPI, I/O, ITC, WDG, TIMER16, MCC
- Cosmic & Metrowerks compliant
- Hides the hardware layer
- Standardizes the source code
- Reduces development time without in-depth study of peripherals
- Highly compact
- Comprehensive documentation
- Free download from <http://www.st.com/mcu>>ST MCU Support>Downloads

### 3.2 DEBUGGING TOOLS

#### 3.2.1 ST7 Visual Debug IDE: STVD7

STVD7 provides a graphical interface for C or Assembler coding, compiling, downloading and debugging with ST7 Emulators. STVD7 interfaces easily with Cosmic and Metrowerks C compilers. STVD7 drives all the ST development tools.

This is available on the STMicroelectronics Microcontroller Development Tools CD-ROM or can be downloaded from <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools.

#### 3.2.2 ST7 Simulator

A free solution, the ST7 simulator offers the ability to develop an application by simulating the ST7 device. It takes advantage of the powerful and easy to use STVD7 IDE. It simulates the ST7 core and main peripherals.

This is available on the STMicroelectronics Microcontroller Development Tools CD-ROM or can be downloaded from <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools.

#### 3.2.3 Emulators

You can choose between ST7MDT20-DVP3 low-cost real time emulator and ST7MDT20J-EMU3 high performance real time emulator.

##### 3.2.3.1 ST7 Development Kit: ST7MDT20-DVP3

The ST7-DVP3 development kit provides high quality real-time debugging. Its features include:

- Up to 64KB breakpoints and advanced breakpoints on data
- Tracing of up to 512 records
- One input trigger and one output trigger
- Selectable clock frequency 2,4,8 or 16 MHz
- Parallel or USB host interface
- Target voltage 3.3 or 5V

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#### *Useful Tips:*

#### ***Using ST7MDT20-DVP3 with TQFP packages***

Only SDIP32 and SDIP42 passive probes are provided as part of standard package. To use TQFP packages you need to order option ST7MDT20-T32/DVP for TQFP32 package or ST7MDT20-T44/DVP for TQFP44 package separately.

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Web: <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools

### 3.2.3.2 ST7 Emulator: ST7MDT20J-EMU3

The EMU3 is the most recent generation, supporting the new ST7 Flash products. Its features include:

- Up to 64K breakpoints with 4 level sequencer on both address and data and all control signals
- 256K real-time trace recording with timestamp
- 9 external input triggers and 2 output triggers
- Read/Write on the fly
- Performance analysis
- Programmable clock frequency from 32kHz to 16MHz
- Low voltage emulation from 1.8V to 5.5V
- Parallel, USB and Ethernet host interfaces

Web: <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools

## 3.3 PROGRAMMING TOOLS

### 3.3.1 ST7 Visual Programmer: STVP7

STVP7 provides a graphical interface for programming Flash memory and option bytes. This is the software part of the ST programming tool package. The hardware parts are described below.

This is available on the STMicroelectronics Microcontroller Development Tools CD-ROM or can be downloaded from <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools.

### 3.3.2 ST7 Programming Board: ST7MDT20J-EPB /EU/US/UK

- Supports both Motorola S19 and Intel Hex formats with STVP7 Visual Programming Software, for programming Flash and EEPROM.
- Supports In-Circuit programming (ICP Connector).
- Can program all microcontrollers regardless of socket type (Socket Programming).

Web: <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools

### 3.3.3 ST7-STICK

STICK connects a PC to ST7 Flash MCUs soldered on application board with an ICP connector.

- Low cost and easy-to-use kit for ICP
- ST7 Visual Programmer graphical user interface

Web: <http://www.st.com/mcu>>ST MCU Support>Downloads>H/W and S/W Tools

### 3.3.4 ST7 Flash Programmer

The FLASHER ST7 is an in-circuit programming tool that can be used either in a laboratory or in a manufacturing environment.

- Controlled by PC via RS232 port
- Programming / Verifying / Readback supported
- Batch mode processing controlled either from a PC (RS232 connection) or through three TTL I/O lines for automated test systems
- Once setup can be used standalone (without being connected to controller PC)

Web: <http://www.st.com/mcu>>ST MCU Support>Downloads

Or <http://www.segger.com>

## **4 E-SUPPORT**

Many other resources are available for developers from ST Microcontroller Support Site (<http://www.st.com/mcu>>ST MCU Support>Downloads). All the required downloads and references to third party tools are available from this site.

The [www.st.com/mcu](http://www.st.com/mcu) Discussion Forum can be used by developers to exchange ideas. This is best place to find different application ideas and solutions to problems.

The website has a knowledge base of FAQs for microcontrollers. You can search it to find solutions to many problems and answers to queries.

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