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## Introduction to TSC87C51/C52 OTP Microcontrollers

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### Introduction

The Microcontroller market is moving very fast, surprisingly the OTP market is even faster due to the following reasons:

- Time to market for new systems is the key answer to be on the leading edge and to continue to grow.
- Late orders coming from end customers or need for customized versions to better serve the market.

That's why the OTP market represents already more than 15% of the total volume.

Now TEMIC introduces brand new products –completing its existing offering– to better serve your needs. You can have access to the TSC87C51 and TSC87C52 One–Time–Programmable C51 microcontrollers and speed up your market penetration while preserving a low system cost.

These products have been qualified in order to be compatible with the Industry standard from Intel as TEMIC is one of the three major Intel licensed manufacturer.

TEMIC will continue to expand its global offering with also the compatible Mask ROM products which are still being supported with new improvements. These product always guarantee full compatibility with C51 Intel architecture. Therefore, it is easy qualify TEMIC products in your existing or new applications.

Thank you to get access to the TEMIC C51 OTP family through all the documentation and support like this design guide which is providing all the information on the products the way to implement them in the application and how to program them.

### TEMIC Microcontrollers Overview

In the 8–bit microcontroller market, the 80C51 architecture has become an industry standard in embedded applications. Introduced in the early's 1980's by TEMIC/Matra MHS under Intel License, the 80C51 is still a market leader.

For over 15 years, TEMIC has been a leading provider of 80C51 microcontrollers to major embedded markets. Today, TEMIC is ranked number 3 in worldwide sales of 80C51 devices, representing over 20% market share. This unsurpassed experience is at the service of TEMIC customers in every application.

TEMIC now enlarges its product range by adding one time programmable (OTP) versions of standard products and the highly increased number of product derivatives for applications mainly targeted in the Communication and Computer area.

Also the market is in need for a more powerful solution to meet the requirements of increasingly sophisticated embedded applications. High growth markets, including applications in communication, automotive and personal computing are driving these requirements. Therefore TEMIC has introduced in 1996 the first two products of the Intel–licensed TSC80251 8–bit extended architecture.

## C51 Standard Microcontrollers selection table

| Device   | ROM (byte) | RAM (byte) | Max Speed (MHz) | I/O | Serial Interfaces | 16-bit Timers | WD | Other Features |
|--|------------|------------|-----------------|-----|-------------------|---------------|----|----------------|
| <b>General Purpose Microcontrollers – 5 Volt</b>             |            |            |                 |     |                   |               |    |                |
| TSC80C31   | –          | 128        | 44              | 32  | UART              | 2             |    | SR, ST         |
| TSC80C51   | 4 K        | 128        | 44              | 32  | UART              | 2             |    | SR, ST         |
| TSC87C51   | 4 K OTP    | 128        | 44              | 32  | UART              | 2             |    | SR, ST         |
| 80C32  | –          | 256        | 44              | 32  | UART              | 3             |    | SR, ST         |
| 80C52  | 8 K        | 256        | 36              | 32  | UART              | 3             |    | SR, ST         |
| TSC87C52   | 8 K OTP    | 256        | 36              | 32  | UART              | 3             |    | SR, ST         |
| 80C154   | –          | 256        | 36              | 32  | UART              | 3             | ●  | SR, ST         |
| 83C154   | 16 K       | 256        | 36              | 32  | UART              | 3             | ●  | SR, ST         |
| 83C154D  | 32 K       | 256        | 36              | 32  | UART              | 3             | ●  | SR, ST         |
| <b>General Purpose – Low Voltage: 3 Volt, up to 20 MHz !</b> |            |            |                 |     |                   |               |    |                |
| TSC80C31-L   | –          | 128        | 20              | 32  | UART              | 2             |    | SR, ST         |
| TSC80C51-L   | 4 K        | 128        | 20              | 32  | UART              | 2             |    | SR, ST         |
| TSC87C51-L   | 4 K OTP    | 128        | 16              | 32  | UART              | 2             |    | SR, ST         |
| 80C32-L  | –          | 256        | 16              | 32  | UART              | 3             |    | SR, ST         |
| 80C52...-L   | 8 K        | 256        | 16              | 32  | UART              | 3             |    | SR, ST         |
| TSC87C52-L   | 8 K OTP    | 256        | 16              | 32  | UART              | 3             |    | SR, ST         |
| 80C154-L   | –          | 256        | 16              | 32  | UART              | 3 (WD)        | ●  | SR, ST         |
| 83C154...-L  | 16 K       | 256        | 16              | 32  | UART              | 3 (WD)        | ●  | SR, ST         |
| 83C154D...-L   | 32 K       | 256        | 16              | 32  | UART              | 3 (WD)        | ●  | SR, ST         |
| <b>General Purpose – Very Low Voltage: 1.8 Volt</b>          |            |            |                 |     |                   |               |    |                |
| TSC80CL31  | –          | 128        | 4               | 32  | UART              | 2             |    | SR, ST         |
| TSC80CL51  | 4 K        | 128        | 4               | 32  | UART              | 2             |    | SR, ST         |

WD: Watchdog Timer

SR: Secret ROMencrypted ROM option to secure the ROM against piracy.

ST: Secret Tag a 64-Bit identifier can be customized in order to serialize each microcontroller with a unique number.

## C51 OTP Product features by supplier

In this chapter you will find the benchmark between the TEMIC products and other suppliers on the market of C51 OTP microcontrollers.

This will help you to ensure the compatibility of the TEMIC product in your application after you have exactly listed the features which are being used.

You can note that the standard features are not listed in this table

## 87C51 OTP product features by supplier

| Feature                                      | TEMIC<br>TSC80C51 | TEMIC<br>TSC87C51 | INTEL<br>87C51   | Philips<br>87C51 | LG<br>GMS80C7004 | Atmel<br>AT89C51 | Windbond<br>W87E51 |
|--|-------------------|-------------------|------------------|------------------|------------------|------------------|--------------------|
| Power off Flag                               | No                | Yes               | Yes              | No               | No               | No               | No                 |
| UART : Automatic Address Recognition         | No                | No                | Yes              | No               | No               | No               | No                 |
| UART : Framing error Detection               | No                | Yes               | Yes              | No               | No               | No               | No                 |
| Power-Down output using external interrupt   | No                | No                | Yes              | No               | No               | No               | No                 |
| ALE disabling                                | Yes               | Yes               | Yes              | No               | No               | No               | No                 |
| ONCE mode                                    | No                | Yes               | Yes              | No               | No               | Yes              | No                 |
| EPROM lock bits                              | NA                | Yes <sup>2</sup>  | Yes              | Yes              | Yes              | Yes              | Yes                |
| Four levels priority interrupt               | No                | No                | Yes              | No               | No               | No               | No                 |
| Full static design (Frequency down to 0 Mhz) | Yes               | Yes               | No               | No               | Yes              | Yes              | Yes                |
| <b>Supply voltage</b>                        |                   |                   |                  |                  |                  |                  |                    |
| 5 V  | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| 3 V  | Yes               | Yes <sup>2</sup>  | No               | No               | No               | Yes              | No                 |
| <b>Speed</b>                                 |                   |                   |                  |                  |                  |                  |                    |
| 12/16 MHz                                    | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| 24 MHz                                       | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| 33 MHz                                       | Yes               | Yes               | Yes              | No               | No               | No               | Yes                |
| 40 MHz                                       | Yes               | Yes <sup>2</sup>  | No               | No               | No               | No               | Yes                |
| <b>Range</b>                                 |                   |                   |                  |                  |                  |                  |                    |
| 0°C to 70°C                                  | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| -40°C to 85°C                                | Yes               | Yes               | Yes <sup>3</sup> | Yes              | Yes              | Yes              | No                 |
| <b>Package</b>                               |                   |                   |                  |                  |                  |                  |                    |
| PDIL 40                                      | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| PLCC 44                                      | Yes               | Yes               | Yes              | Yes              | Yes              | Yes              | Yes                |
| PQFP 44                                      | Yes               | Yes               | Yes              | No               | No               | Yes              | No                 |
| TQFP 44                                      | Yes               | Yes               | No               | No               | No               | Yes              | No                 |
| <b>Power consumption (Max., 5V)</b>          | (at 16 MHz)       | (at 16 MHz)       | (at 16 MHz)      | (at 16 MHz)      | (at 12 MHz)      | (at 12 MHz)      | (at 20 MHz)        |
| Active (mA)                                  | 25                | 25                | 38               | 32               | 21               | 25               | 50                 |
| Idle (mA)                                    | 6.5               | 8.5               | 9.5              | 5                | 18               | 6.5              | 7                  |
| PD (µA)                                      | 30                | 50                | 75               | 50               | 50               | 100              | 50                 |

1 No clock out generation    2 Under study, no yet available.    3 except 33 Mhz    NA: Not Available

## 87C52 OTP product features by supplier

| Feature                                      | TEMIC<br>80C52 | TEMIC<br>TSC87C52 | INTEL<br>87C52   | Philips<br>87C52 | Siemens<br>C501-1E<br>LG<br>GMS80C701 | Atmel<br>AT89C52 | Windbond<br>W87E52 |
|--|----------------|-------------------|------------------|------------------|---------------------------------------|------------------|--------------------|
| Power off Flag                               | No             | Yes               | Yes              | No               | No                                    | No               | No                 |
| Enhanced Timer 2                             | No             | Yes               | Yes              | No               | Yes <sup>1</sup>                      | Yes              | No                 |
| UART : Automatic Address Recognition         | No             | No                | Yes              | No               | No                                    | No               | No                 |
| UART : Framing error Detection               | No             | Yes               | Yes              | No               | No                                    | No               | No                 |
| Power-Down output using external interrupt   | No             | No                | Yes              | No               | No                                    | No               | No                 |
| ALE disabling                                | Yes            | Yes               | Yes              | No               | No                                    | No               | No                 |
| ONCE mode                                    | No             | Yes               | Yes              | No               | No                                    | Yes              | No                 |
| EPROM lock bits                              | NA             | Yes <sup>2</sup>  | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| Full static design (Frequency down to 0 Mhz) | Yes            | Yes               | No               | No               | Yes                                   | Yes              | Yes                |
| <b>Supply voltage</b>                        |                |                   |                  |                  |                                       |                  |                    |
| 5 V  | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| 3 V  | Yes            | Yes <sup>2</sup>  | No               | No               | No                                    | Yes              | No                 |
| <b>Speed</b>                                 |                |                   |                  |                  |                                       |                  |                    |
| 12/16 MHz                                    | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| 24 MHz                                       | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| 33 MHz                                       | Yes            | Yes               | Yes              | No               | No                                    | No               | Yes                |
| 40 MHz                                       | Yes            | Yes <sup>2</sup>  | No               | No               | No                                    | No               | Yes                |
| <b>Range</b>                                 |                |                   |                  |                  |                                       |                  |                    |
| 0°C to 70°C                                  | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| -40°C to 85°C                                | Yes            | Yes               | Yes <sup>3</sup> | Yes              | Yes                                   | Yes              | No                 |
| <b>Package</b>                               |                |                   |                  |                  |                                       |                  |                    |
| PDIL 40                                      | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| PLCC 44                                      | Yes            | Yes               | Yes              | Yes              | Yes                                   | Yes              | Yes                |
| PQFP 44                                      | Yes            | Yes               | Yes              | No               | No                                    | Yes              | No                 |
| TQFP 44                                      | Yes            | Yes               | No               | No               | No                                    | Yes              | No                 |
| <b>Power consumption (Max., 5V)</b>          |                |                   |                  |                  |                                       |                  |                    |
|  | (at 16 MHz)    | (at 16 MHz)       | (at 16 MHz)      | (at 16 MHz)      | (at 12 MHz)                           | (at 12 MHz)      | (at 20 MHz)        |
| Active (mA)                                  | 25             | 25                | 38               | 32               | 21                                    | 25               | 50                 |
| Idle (mA)                                    | 8.5            | 8.5               | 9.5              | 5                | 18                                    | 6.5              | 7                  |
| PD (µA)                                      | 50             | 50                | 75               | 50               | 50                                    | 100              | 50                 |

<sup>1</sup> No clock out generation    <sup>2</sup> Under study, no yet available.    <sup>3</sup> except 33 MHz    NA: Not Available

## Glossary

### Power off Flag

This flag is used by the software to make the difference between a power on reset and a reset exiting from power down. In the power down mode, the crystal is stopped and the microcontroller power consumption is closed to zero. This flag is useful for low power application using the power down mode.

### Enhanced Timer 2

Two new features are added to the timer 2 :

- Configuration as an up/down counter
- Clock out generation

### UART : Automatic Address Recognition

Two new features are added to the UART. These features lower the software task during multi mode operation :

- Automatic Address Recognition ; in this mode the address recognition is done by hardware rather than by software.
- Framing error Detection; a new bit warn the software that one stop bit is missing.

### Power-Down output using external interrupt

With this feature an external interrupt can cause a recover from power down mode ; otherwise, only a reset can restart the microcontroller. this feature provides more flexibility for low power systems.

### ALE disabling

The "Address Latch Enable" is activated at a constant rate of 1/6 the oscillator frequency, except during an external data memory access at which one ALE pulse is skipped. When no external RAM and ROM access is required, the ALE is not necessary and can generated noise and EMI. With the ALE disable, this signal is only generated under software when it is required.

### ONCE mode

The ON-Circuit Emulation (ONCE) mode facilitates testing and debugging of the system using the microcontroller without having to remove the device from the circuit. In this mode, the device is placed on an inactive state and an emulator or test CPU can be used to drive the circuit.

### EPROM lock bits

The program lock bits protect the program memory from software piracy.

### Four levels interrupt priority

The initial 8051 architecture has two levels interrupt priority. A second Interrupt Priority register has been added, increasing the number of priority levels to four. This feature provides more flexibility to real time systems.

### Full Static Design

This allows to reduce the system power consumption by bringing the clock frequency down to any value, even 0 Mhz (DC), without loss of data.

## Cross Reference List

Here under is a short version of the Cross Reference list of the main products available.

Updated version with more references is available on our web site at

<http://www.temic.de/semi>

Part-numbers given for Commercial temperature Range (0° to 70° C)

|              | TEMIC         | Intel      | Philips      | Atmel        | Siemens       | Freq (MHz) | Package |
|--------------|---------------|------------|--------------|--------------|---------------|------------|---------|
| <b>87C51</b> | TSC87C51-12CA | P87C52BH   | SC87C51CCN40 | AT89C51-12PC | Not available | 12         | DIP40   |
|              | TSC87C51-12CB | S87C52BH   | SC87C51CCA44 | AT89C51-12JC | Not available | 12         | PLCC44  |
|              | TSC87C51-16CA | P87C52BH-1 | SC87C51CGN40 | AT89C51-16PC | Not available | 16         | DIP40   |
|              | TSC87C51-16CB | S87C52BH-1 | SC87C51CGA44 | AT89C51-16JC | Not available | 16         | PLCC44  |
| <b>87C52</b> | TSC87C52-12CA | P87C52BH   | SC87C52CCN40 | AT89C52-12PC | SAB-C501G-1EP | 12         | DIP40   |
|              | TSC87C52-12CB | S87C52BH   | SC87C52CCA44 | AT89C52-12JC | SAB-C501G-1EN | 12         | PLCC44  |
|              | TSC87C52-16CA | P87C52BH-1 | SC87C52CGN40 | AT89C52-16PC | Not available | 16         | DIP40   |
|              | TSC87C52-16CB | S87C52BH-1 | SC87C52CGA44 | AT89C52-16JC | Not available | 16         | PLCC44  |