

## CMOS 8-Bit Microcontroller

**TMP87CM53F**

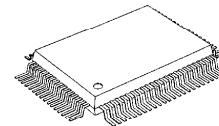
The 87CM53 is the high speed and high performance 8-bit single chip microcomputers. These MCU contain CPU core, ROM, RAM, input/output ports, an A/D converter, DTMF generator, multi-function timer/counters, two serial interfaces, and two clock generators on a chip. The 87CM53 provides high current output capability for LED direct drive.

| Part No.   | ROM          | RAM          | Package            | OTP MCU    |
|------------|--------------|--------------|--------------------|------------|
| TMP87CM53F | 32 K × 8-bit | 1024 × 8-bit | P-QFP80-1420-0.80B | TMP87PM53F |

**Features**

- ◆ 8-bit single chip microcomputer TLCS-870 Series
- ◆ Instruction execution time: 0.5  $\mu$ s (at 8 MHz, gear ratio 1/1), 122  $\mu$ s (at 32.768 kHz)
- ◆ 412 basic instructions
  - Multiplication and Division (8 bits × 8 bits, 16 bits ÷ 8 bits)
  - Bit manipulations (Set/Clear/Complement/Move/Test/Exclusive or)
  - 16-bit data operations
  - 1-byte jump/subroutine-call (Short relative jump / Vector call)
- ◆ 15 interrupt sources (External: 5, Internal: 10)
  - All sources have independent latches each, and nested interrupt control is available.
  - edge-selectable external interrupts with noise reject
  - High-speed task switching by register bank changeover
- ◆ 10 Input/Output ports (72 pins)
  - High current output: 7 pins (typ. 20 mA)
- ◆ Two 16-bit Timer/Counters
  - Timer, Event counter, Programmable pulse generator output, Pulse width measurement, External trigger timer, Window modes
- ◆ Two 8-bit Timer/Counters
  - Timer, Event counter, Capture (Pulse width/duty measurement), PWM output, Programmable divider output modes
- ◆ Time Base Timer (Interrupt frequency: 0.95 Hz to 16384 Hz)
- ◆ Divider output function (frequency: 0.976 kHz to 8.192 kHz)
- ◆ Tone generator
  - Single tone / Dual tone (DTMF) output function
  - Melody (sine wave / square wave) output function
- ◆ Watchdog Timer
- ◆ 8-bit Serial Interface
  - 8 bytes transmit/receive data buffer
  - Internal/external serial clock, and 4/8-bit mode
- ◆ UART
- ◆ 8-bit successive approximate type A/D converter with sample and hold
  - 8 analog inputs
  - Conversion time: 23  $\mu$ s or 92  $\mu$ s (at 8 MHz, gear ratio 1/1)

P-QFP80-1420-0.80B



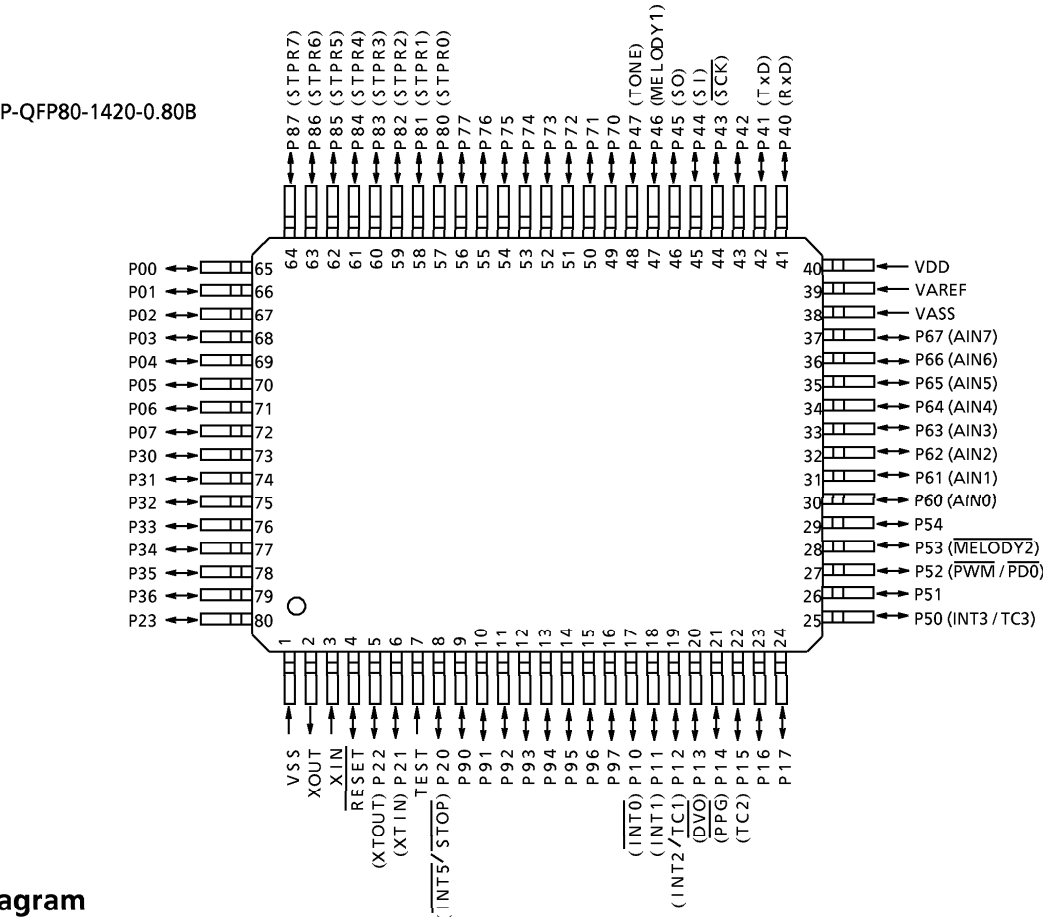
TMP87CM53F  
TMP87PM53F

980910EBP1

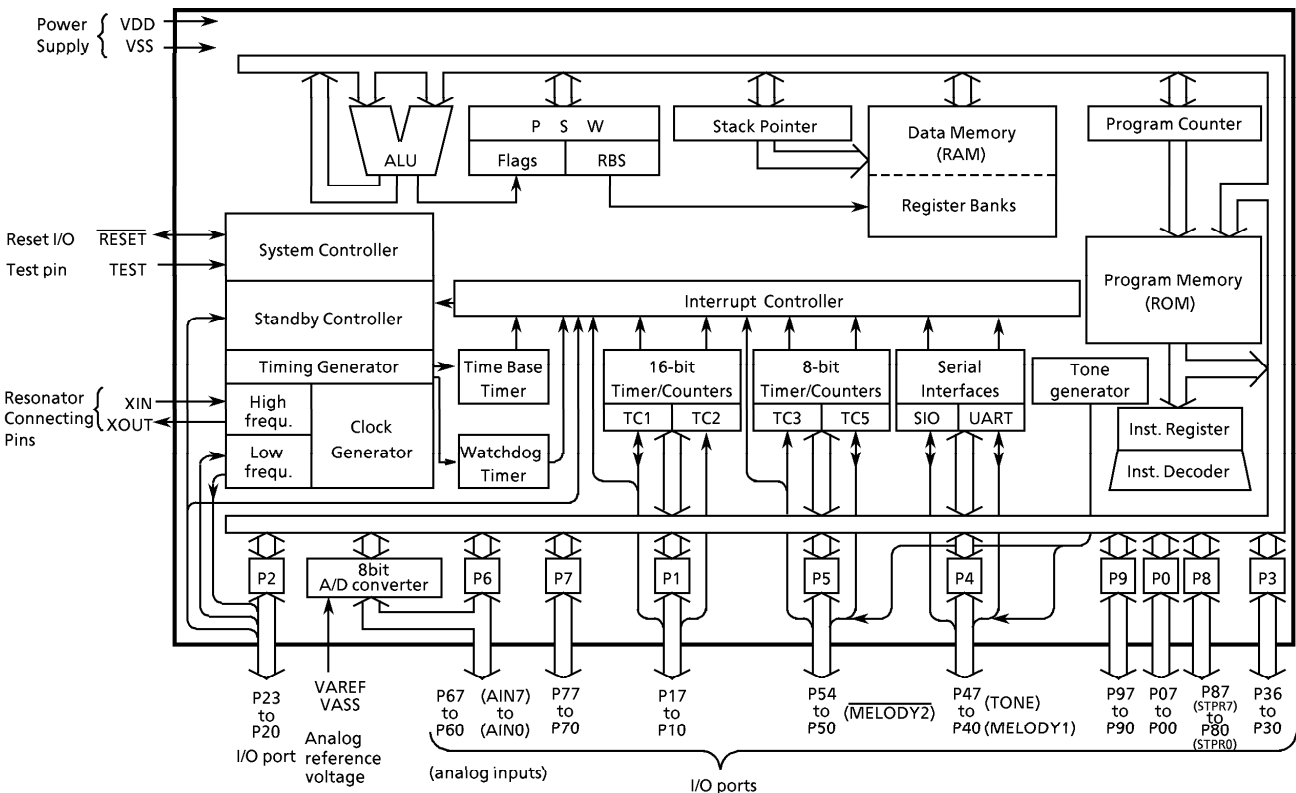
- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.
- TOSHIBA is continually working to improve the quality and the reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.

- ◆ Key on Wake-Up
- ◆ Dual clock operation
- ◆ Internal clock select mode (fc, fc/2, fc/4, fc/8) Initial fc/8 operation
- ◆ Five Power saving operating modes
  - STOP mode: Oscillation stops. Battery/Capacitor back-up.  
Port output hold/high-impedance.
  - SLOW mode: Low power consumption operation using low-frequency clock (32.768kHz).
  - IDLE1 mode: CPU stops, and Peripherals operate using high-frequency clock. Release by interrupts.
  - IDLE2 mode: CPU stops, and Peripherals operate using high and low frequency clock. Release by interrupts.
  - SLEEP mode: CPU stops, and Peripherals operate using low-frequency clock. Release by interrupts.
- ◆ Wide operating voltage: 2.2 to 5.5 V at [3.58 MHz] [3.84 MHz] [4.0 MHz] [4.19 MHz] / 32.768 kHz,  
4.5 to 5.5 V at 8 MHz / 32.768 kHz
- ◆ Emulation Pod: BM87CM53F0A

Pin Assignments (Top View)



Block Diagram



## Pin Function

| Pin Name                   | Input / Output | Function                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                           |
|----------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P07 to P00                 | I/O            | Two 8-bit programmable input/output ports (tri-state).<br>Each bit of these ports can be individually configured as an input or an output under software control.<br>During reset, all bits are configured as input.<br>When used as a divider output or a PPG output, the latch must be set to "1".                                   |                                                                                                                                                                           |
| P17, P16                   | I/O            |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P15 (TC2)                  | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        | Timer/Counter 2 input                                                                                                                                                     |
| P14 (PPG)                  | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | Programmable pulse generator output                                                                                                                                       |
| P13 (DVO)                  |                |                                                                                                                                                                                                                                                                                                                                        | Divider output                                                                                                                                                            |
| P12 (INT2 / TC1)           | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        | External interrupt input 2 or Timer/Counter 1 input                                                                                                                       |
| P11 (INT1)                 |                |                                                                                                                                                                                                                                                                                                                                        | External interrupt input 1                                                                                                                                                |
| P10 (INT0)                 |                |                                                                                                                                                                                                                                                                                                                                        | External interrupt input 0                                                                                                                                                |
| P23                        | I/O            | 4-bit input/output port with latch.<br>When used as an input port, the latch must be set to "1".                                                                                                                                                                                                                                       | Resonator connecting pins (32.768kHz).<br>For inputting external clock, XTIN is used and XTOUT is opened.<br>External interrupt input 5 or STOP mode release signal input |
| P22 (XTOUT)                | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P21 (XTIN)                 | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P20 (INT5/STOP)            |                |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P36 to P30                 | I/O            | 7-bit input/output port (high current output) with latch.<br>When used as an input port, the latch must be set to "1".                                                                                                                                                                                                                 |                                                                                                                                                                           |
| P47 (Tone)                 | I/O (Output)   | 8-bit programmable input/output port (tri-state). Each bit of the port can be individually configured as an input or an output or a port option under software control. During reset, all bits are configured as input.<br>When used as an input port or a SIO input/output, the latch must be set to "1".                             | Tone output                                                                                                                                                               |
| P46 (Melody1)              | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | Melody1 output (sine wave)                                                                                                                                                |
| P45 (SO)                   | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | SIO serial data output                                                                                                                                                    |
| P44 (SI)                   | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        | SIO serial data input                                                                                                                                                     |
| P43 (SCK)                  | I/O (I/O)      |                                                                                                                                                                                                                                                                                                                                        | SIO serial clock input/output                                                                                                                                             |
| P42                        | I/O            |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P41 (TxD)                  | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | SIO serial data output (asynchronous only)                                                                                                                                |
| P40 (RxD)                  | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        | SIO serial data input (asynchronous only)                                                                                                                                 |
| P54                        | I/O            | 5-bit programmable input/output port (tri-state). Each bit of the port can be individually configured as an input or an output or a port option under software control. During reset, all bits are configured as input.<br>When used as an input port, an external interrupt input, or a PWM/PDO output, the latch must be set to "1". |                                                                                                                                                                           |
| P53 (Melody2)              | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | Melody2 output (square wave)                                                                                                                                              |
| P52 (PWM/PDO)              | I/O (Output)   |                                                                                                                                                                                                                                                                                                                                        | 8-bit PWM output or 8-bit programmable divider output                                                                                                                     |
| P51                        | I/O            |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P50 (INT3/TC3)             | I/O (Input)    |                                                                                                                                                                                                                                                                                                                                        | External interrupt input 3 or Timer/Counter 3 input                                                                                                                       |
| P67 (AIN7) to P60 (AIN0)   | I/O (Input)    | 8-bit programmable input/output port (tri-state). Each bit of the port can be individually configured as an input or an output under software control.                                                                                                                                                                                 | A/D converter analog inputs                                                                                                                                               |
| P77 to P70                 | I/O            | 8-bit programmable input/output port (tri-state). Each bit of the port can be individually configured as an input or an output or a port option under software control. During reset, all bits are configured as input.                                                                                                                |                                                                                                                                                                           |
| P97 to P90                 | I/O            |                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                           |
| P87 (STPR7) to P80 (STPR0) | I/O (Input)    | 8-bit programmable input/output port (tri-state). Each bit of the port can be individually configured as an input or an output or a pull-up resistor under software control. During reset, all bits are configured as an input.                                                                                                        |                                                                                                                                                                           |
| XIN, XOUT                  | Input, Output  | Resonator connecting pins for high-frequency clock.<br>For inputting external clock, XIN is used and XOUT is opened.                                                                                                                                                                                                                   |                                                                                                                                                                           |
| RESET                      | I/O            | Reset signal input or watchdog timer output/address-trap-reset output/system-clock-reset output.                                                                                                                                                                                                                                       |                                                                                                                                                                           |
| TEST                       | Input          | Test pin for out-going test. Be tied to low.                                                                                                                                                                                                                                                                                           |                                                                                                                                                                           |
| VDD, VSS                   | Power Supply   | + 5 V, 0 V (GND)                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                           |
| VAREF, VASS                |                | Analog reference voltage inputs (High, Low)                                                                                                                                                                                                                                                                                            |                                                                                                                                                                           |

OPERATIONAL DESCRIPTION

1. CPU CORE FUNCTIONS

The CPU core consists of a CPU, a system clock controller, an interrupt controller, and a watchdog timer. This section provides a description of the CPU core, the program memory (ROM), the data memory (RAM), and the reset circuit.

1.1 Memory Address Map

The TLC8-870 Series is capable of addressing 64K bytes of memory. Figure 1-1 shows the memory address maps of the 87CM53. In the TLC8-870 Series, the memory is organized 4 address spaces (ROM, RAM, SFR, and DBR). It uses a memory mapped I/O system, and all I/O registers are mapped in the SFR/DBR address spaces. There are 16 banks of general-purpose registers. The register banks are also assigned to the first 128 bytes of the RAM address space.

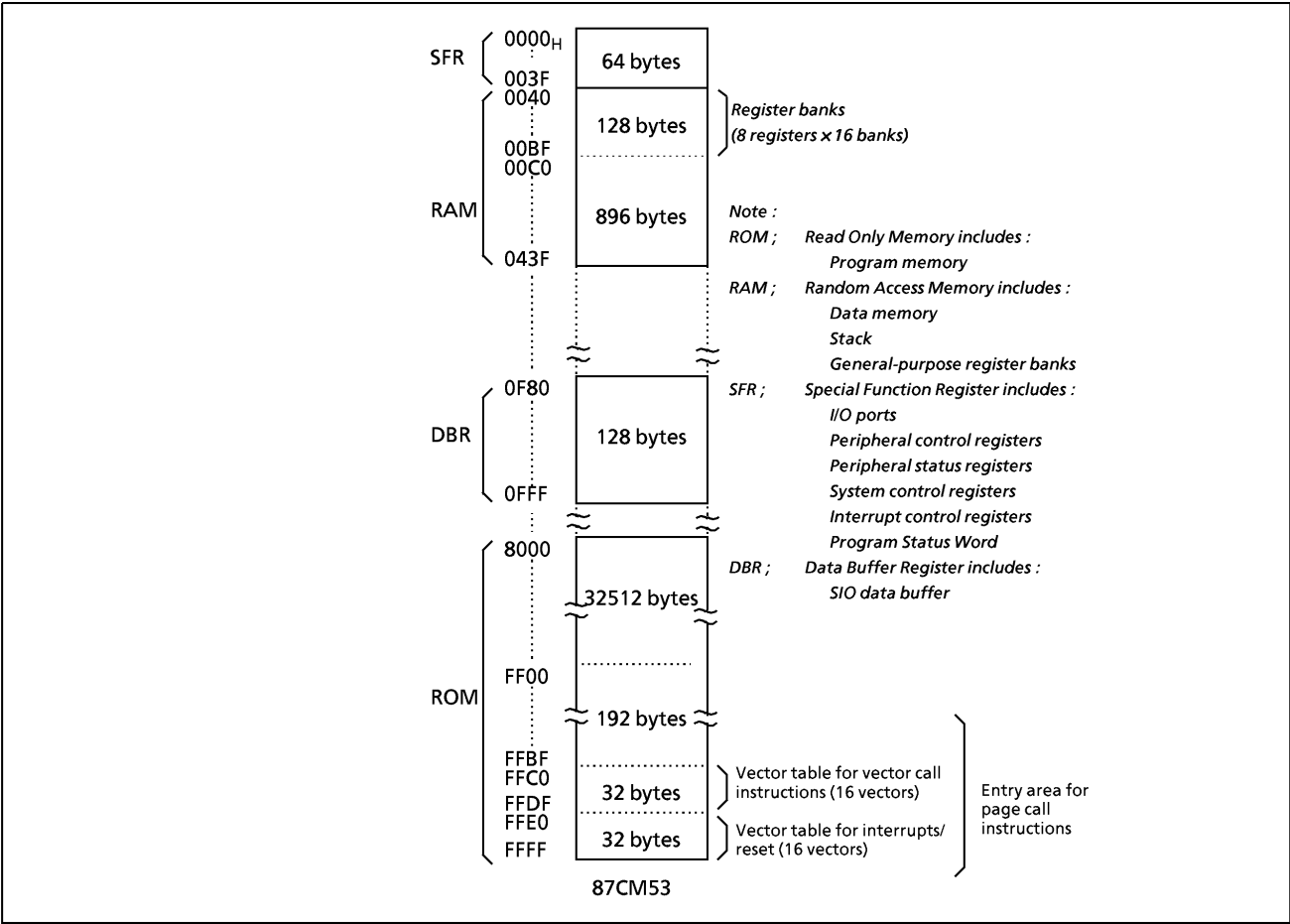


Figure 1-1. Memory Address Maps

## Electrical Characteristics

## Absolute Maximum Ratings

(V<sub>SS</sub> = 0 V)

| Parameter                       | Symbol            | Pins                                     | Ratings                        | Unit |
|---------------------------------|-------------------|------------------------------------------|--------------------------------|------|
| Supply Voltage                  | V <sub>DD</sub>   |                                          | – 0.3 to 6.5                   | V    |
| Input Voltage                   | V <sub>IN</sub>   |                                          | – 0.3 to V <sub>DD</sub> + 0.3 | V    |
| Output Voltage                  | V <sub>OUT</sub>  |                                          | – 0.3 to V <sub>DD</sub> + 0.3 | V    |
| Output Current (Per 1pin)       | I <sub>OUT1</sub> | Ports P0, P1, P2, P4, P5, P6, P7, P8, P9 | 3.2                            | mA   |
|                                 | I <sub>OUT2</sub> | Port P3                                  | 30                             |      |
| Output Current (Total)          | $\Sigma I_{OUT1}$ | Ports P0, P1, P2, P4, P5, P6, P7, P8, P9 | 160                            | mA   |
|                                 | $\Sigma I_{OUT2}$ | Port P3                                  | 120                            |      |
| Power Dissipation [Topr = 70°C] | PD                |                                          | 350                            | mW   |
| Soldering Temperature (time)    | Tsld              |                                          | 260 (10s)                      | °C   |
| Storage Temperature             | Tstg              |                                          | – 55 to 125                    | °C   |
| Operating Temperature           | Topr              |                                          | – 30 to 60                     | °C   |

**Note:** The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

## Recommended Operating Conditions

(V<sub>SS</sub> = 0 V, Topr = – 30 to 60°C)

| Parameter          | Symbol           | Pins                    | Conditions                     |                 | Min                     | Max                     | Unit |
|--------------------|------------------|-------------------------|--------------------------------|-----------------|-------------------------|-------------------------|------|
| Supply Voltage     | V <sub>DD</sub>  |                         | f <sub>c</sub> = 8 MHz         | NORMAL1, 2 mode | 4.5                     | 5.5                     | V    |
|                    |                  |                         |                                | IDLE1, 2 mode   |                         |                         |      |
|                    |                  |                         | f <sub>c</sub> ≤ 4.2 MHz       | NORMAL1, 2 mode | 2.2<br>Note 2           |                         |      |
|                    |                  |                         |                                | IDLE1, 2 mode   |                         |                         |      |
|                    |                  |                         | f <sub>s</sub> =<br>32.768 kHz | SLOW mode       |                         |                         |      |
|                    |                  |                         |                                | SLEEP mode      |                         |                         |      |
|                    | STOP mode        | 2.0                     |                                |                 |                         |                         |      |
| Input High Voltage | V <sub>IH1</sub> | Except hysteresis input | V <sub>DD</sub> ≥ 4.5 V        |                 | V <sub>DD</sub> × 0.70  | V <sub>DD</sub>         | V    |
|                    | V <sub>IH2</sub> | Hysteresis input        |                                |                 | V <sub>DD</sub> × 0.75  |                         |      |
|                    | V <sub>IH3</sub> |                         |                                |                 | V <sub>DD</sub> < 4.5 V |                         |      |
| Input Low Voltage  | V <sub>IL1</sub> | Except hysteresis input | V <sub>DD</sub> ≥ 4.5 V        |                 | 0                       | V <sub>DD</sub> × 0.30  | V    |
|                    | V <sub>IL2</sub> | Hysteresis input        |                                |                 |                         | V <sub>DD</sub> × 0.25  |      |
|                    | V <sub>IL3</sub> |                         |                                |                 |                         | V <sub>DD</sub> < 4.5 V |      |
| Clock Frequency    | f <sub>c</sub>   | XIN, XOUT               | V <sub>DD</sub> = 4.5 to 5.5 V |                 | 3.58                    | 8.0                     | MHz  |
|                    |                  |                         | V <sub>DD</sub> = 2.7 to 5.5 V |                 |                         | 4.19                    |      |
|                    | f <sub>s</sub>   | XTIN, XTOUT             |                                |                 | 30.0                    | 34.0                    | kHz  |

**Note 1:** The recommended operating conditions for a device are operating conditions under which it can be guaranteed that the device will operate as specified. If the device is used under operating conditions other than the recommended operating conditions (supply voltage, operating temperature range, specified AC/DC values etc.), malfunction may occur. Thus, when designing products which include this device, ensure that the recommended operating conditions for the device are always adhered to.

**Note 2:** Clock frequency fc: The supply voltage range of the conditions shows the value in NORMAL1, 2 modes and IDLE1, 2 modes.

**Note 3:** When the A/D converter is used, V<sub>DD</sub> must be set to ≥ 2.7 V.

## D.C. Characteristics

(V<sub>SS</sub> = 0 V, T<sub>opr</sub> = – 30 to 60°C)

| Parameter                          | Symbol           | Pins                                    | Conditions                                                                                                          | Min                 | Typ. | Max  | Unit |
|------------------------------------|------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------|------|------|------|
| Hysteresis Voltage                 | V <sub>HS</sub>  | Hysteresis input                        |                                                                                                                     | –                   | 0.9  | –    | V    |
| Input Current                      | I <sub>IN1</sub> | TEST                                    | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.5 V / 0 V                                                            | –                   | –    | ± 2  | μA   |
|                                    | I <sub>IN2</sub> | Sink open drain port and tri-state port |                                                                                                                     |                     |      |      |      |
|                                    | I <sub>IN3</sub> | RESET, STOP                             |                                                                                                                     |                     |      |      |      |
| Input Resistance                   | R <sub>IN2</sub> | RESET                                   |                                                                                                                     | 100                 | 220  | 450  | kΩ   |
|                                    | R <sub>IN</sub>  | P8 pull-up resistor                     |                                                                                                                     | 30                  | 70   | 150  |      |
| Output Leakage Current             | I <sub>LO</sub>  | Sink open drain port and tri-state port | V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V                                                                   | –                   | –    | 2    | μA   |
| Output High Voltage                | V <sub>OH2</sub> | Tri-state port                          | V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = – 0.7 mA                                                                 | 4.1                 | –    | –    | V    |
| Output Low Voltage                 | V <sub>OL</sub>  | Except XOUT and P3                      | V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA                                                                   | –                   | –    | 0.4  | V    |
| Output Low Current                 | I <sub>OL3</sub> | Port P3                                 | V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V                                                                    | –                   | 20   | –    | mA   |
| Supply Current in NORMAL 1, 2 mode | I <sub>DD</sub>  |                                         | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.3 V / 0.2 V<br>f <sub>c</sub> = 8 MHz<br>f <sub>s</sub> = 32.768 kHz | TONE no output<br>– | 9    | 12   | mA   |
| Supply Current in IDLE 1, 2 mode   |                  |                                         |                                                                                                                     | TONE output<br>–    | 10.5 | 13.5 |      |
| Supply Current in NORMAL 1, 2 mode |                  |                                         |                                                                                                                     | TONE no output<br>– | 4.5  | 6.5  |      |
| Supply Current in IDLE 1, 2 mode   |                  |                                         |                                                                                                                     | TONE output<br>–    | 6.0  | 8.0  |      |
| Supply Current in SLOW mode        | I <sub>DD</sub>  |                                         | V <sub>DD</sub> = 3.0 V<br>V <sub>IN</sub> = 2.8 V / 0.2 V<br>f <sub>s</sub> = 32.768 kHz                           | TONE no output<br>– | 1.5  | 2.5  | mA   |
| Supply Current in SLEEP mode       |                  |                                         |                                                                                                                     | TONE output<br>–    | 2.0  | 3.0  |      |
| Supply Current in STOP mode        |                  |                                         |                                                                                                                     | TONE no output<br>– | 0.8  | 1.8  |      |
|                                    |                  |                                         |                                                                                                                     | TONE output<br>–    | 1.3  | 2.3  |      |
| Supply Current in SLOW mode        | I <sub>DD</sub>  |                                         | V <sub>DD</sub> = 3.0 V<br>V <sub>IN</sub> = 2.8 V / 0.2 V<br>f <sub>s</sub> = 32.768 kHz                           | –                   | 30   | 60   | μA   |
| Supply Current in SLEEP mode       |                  |                                         |                                                                                                                     | –                   | 15   | 30   | μA   |
| Supply Current in STOP mode        |                  |                                         | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.3 V / 0.2 V                                                          |                     | 0.5  | 10   | μA   |

Note 1: Typical values show those at T<sub>opr</sub> = 25°C, V<sub>DD</sub> = 5 V.

Note 2: Input current: The current through pull-up or pull-down resistor is not included.

## A/D Conversion Characteristics

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 to 5.5 V, T<sub>opr</sub> = -30 to 60°C)

| Parameter                | Symbol            | Conditions                                                                                | Min              | Typ. | Max               | Unit |
|--------------------------|-------------------|-------------------------------------------------------------------------------------------|------------------|------|-------------------|------|
| Analog Reference Voltage | V <sub>AREF</sub> | V <sub>AREF</sub> - V <sub>ASS</sub> ≥ 2.5 V                                              | 2.7              | —    | V <sub>DD</sub>   | V    |
|                          | V <sub>ASS</sub>  |                                                                                           | V <sub>SS</sub>  | —    | 1.5               |      |
| Analog Input Voltage     | V <sub>AIN</sub>  | V <sub>DD</sub> = V <sub>AREF</sub> = 5.0 V<br>V <sub>SS</sub> = V <sub>ASS</sub> = 0.0 V | V <sub>ASS</sub> | —    | V <sub>AREF</sub> | V    |
| Analog Supply Current    | I <sub>REF</sub>  |                                                                                           | —                | 0.5  | 1.0               | V    |
| Nonlinearity Error       |                   | V <sub>DD</sub> = 2.7 to 5.5 V                                                            | —                | —    | ± 1               | mA   |
| Zero Point Error         |                   | V <sub>SS</sub> = 0.0 V                                                                   | —                | —    | ± 1               |      |
| Full Scale Error         |                   | V <sub>AREF</sub> = 2.700 V, 5.000 V                                                      | —                | —    | ± 1               | LSB  |
| Total Error              |                   | V <sub>ASS</sub> = 0.000 V                                                                | —                | —    | ± 2               |      |

Note: Total Error = total number of each type error excluding quantization error.

## Tone Output Characteristics

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.2 to 5.5 V, T<sub>opr</sub> = -30 to 60°C)

| Parameter                          | Symbol            | Conditions                                                                        | Min | Typ. | Max  | Unit  |
|------------------------------------|-------------------|-----------------------------------------------------------------------------------|-----|------|------|-------|
| Tone Output Voltage (ROW)          | V <sub>TONE</sub> | R <sub>L</sub> ≥ 10 kΩ, V <sub>DD</sub> = 2.2 V                                   | 126 | 150  | 178  | mVrms |
| Pre-Emphasis High Band (COL / ROW) | PEHB              | PEHB = 20 log (COL / ROW)                                                         | 1   | 2    | 3    | dB    |
| Output Distortion                  | DIS               |                                                                                   | —   | —    | 5    | %     |
| Frequency Stability                | Δf                | f <sub>c</sub> = 3.84 MHz, 4.00 MHz, 8.00 MHz<br>(Except error of osc. frequency) | —   | —    | 0.7  | %     |
|                                    |                   | f <sub>c</sub> = 3.58 MHz<br>(Except error of osc. frequency)                     | —   | —    | 0.66 |       |
|                                    |                   | f <sub>c</sub> = 4.19 MHz<br>(Except error of osc. frequency)                     | —   | —    | 0.93 |       |

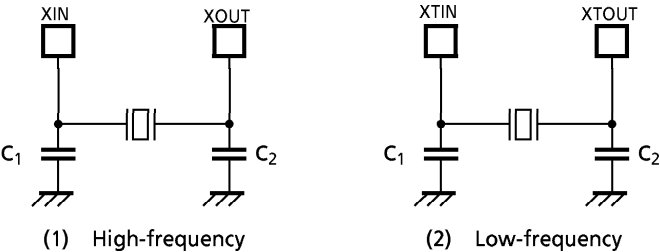
A.C. Characteristics

(V<sub>SS</sub> = 0 V, Topr = – 40 to 85°C)

| Parameter                    | Symbol           | Conditions                                                   | Min       | Typ. | Max      | Unit |
|------------------------------|------------------|--------------------------------------------------------------|-----------|------|----------|------|
| Machine Cycle Time           | tcy              | In NORMAL1, 2 mode (gear ratio)                              | 0.5 (1/1) | —    | 8.9(1/8) | μs   |
|                              |                  | In IDLE1, 2 mode (gear ratio)                                |           |      |          |      |
|                              |                  | In SLOW mode                                                 | 117.6     |      | 133.3    |      |
|                              |                  | In SLEEP mode                                                |           |      |          |      |
| High Level Clock Pulse Width | t <sub>WCH</sub> | For external clock operation (XIN input)<br>fc = 8 MHz       | 50        | —    | —        | ns   |
| Low Level Clock Pulse Width  | t <sub>WCL</sub> |                                                              |           |      |          |      |
| High Level Clock Pulse Width | t <sub>WSH</sub> | For external clock operation (XTIN input)<br>fs = 32.768 kHz | 14.7      | —    | —        | μs   |
| Low Level Clock Pulse Width  | t <sub>WSL</sub> |                                                              |           |      |          |      |

Recommended Oscillating Condition

| Parameter      | Oscillator         | Frequency  | Recommended Oscillator | Recommended Condition |                |
|----------------|--------------------|------------|------------------------|-----------------------|----------------|
|                |                    |            |                        | C <sub>1</sub>        | C <sub>2</sub> |
| High-frequency | Ceramic Resonator  | 8 MHz      | KYOCERA    KBR8.0M     | 30 pF                 | 30 pF          |
|                |                    | 4 MHz      | KYOCERA    KBR4.0MS    |                       |                |
|                |                    |            | MURATA    CSA4.00MG    |                       |                |
|                | Crystal Oscillator | 8 MHz      | TOYOCOM    210B 8.0000 | 20 pF                 | 20 pF          |
|                |                    | 4 MHz      | TOYOCOM    204B 4.0000 |                       |                |
| Low-frequency  | Crystal Oscillator | 32.768 kHz | NDK    MX-38T          | 15 pF                 | 15 pF          |



*Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations*

*Note: To obtain an accurate oscillating frequency the condenser capacity must be adjusted on the set.*