

CMOS 8-Bit Microcontroller

TMP87CH36N, TMP87CK36N, TMP87CM36N

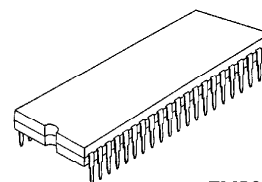
The 87CH36/CK36/CM36 is high speed and high performance 8-bit single chip microcomputer. This MCU contains CPU core, ROM, RAM, input/output ports, six multi-function timer/counter, serial bus interface, on-screen display, PWM, 6-bit A/D conversion inputs and remote control signal preprocessor on a chip.

| Part No. | ROM | RAM | Package | OTP MCU |
|------------|-----------|----------|-------------------|------------|
| TMP87CH36N | 16 Kbytes | 1 Kbytes | SDIP42-P-600-1.78 | TMP87PM36N |
| TMP87CK36N | 24 Kbytes | | | |
| TMP87CM36N | 32 Kbytes | | | |

Features

- ◆ 8-bit single chip microcomputer TLCS-870 Series
- ◆ Instruction execution time : 0.5 μ s (at 8 MHz)
- ◆ 412 basic instructions
 - Multiplication and Division (8 bits \times 8 bits, 16 bits \div 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)
- ◆ 12 interrupt sources (External : 3, Internal : 9)
 - 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
- ◆ 6 Input/Output ports (34 pins)
 - High current output : 4 pins (typ. 20 mA)

SDIP42-P-600-1.78



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TMP87CM36N
TMP87PM36N

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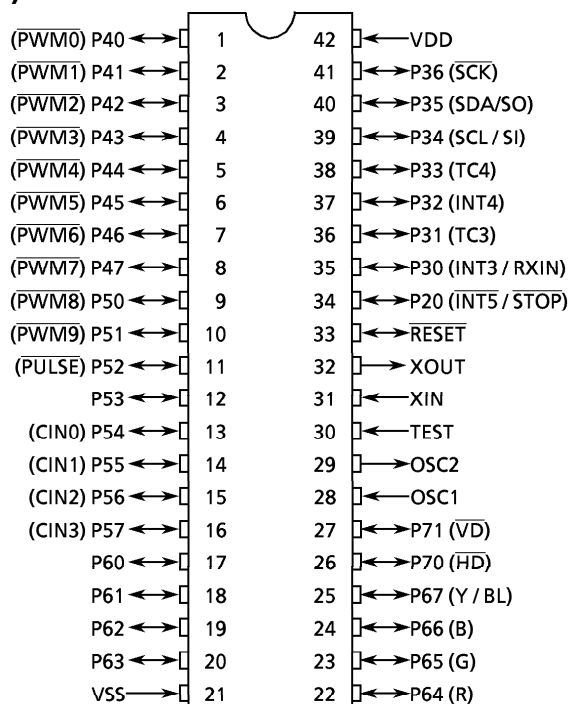


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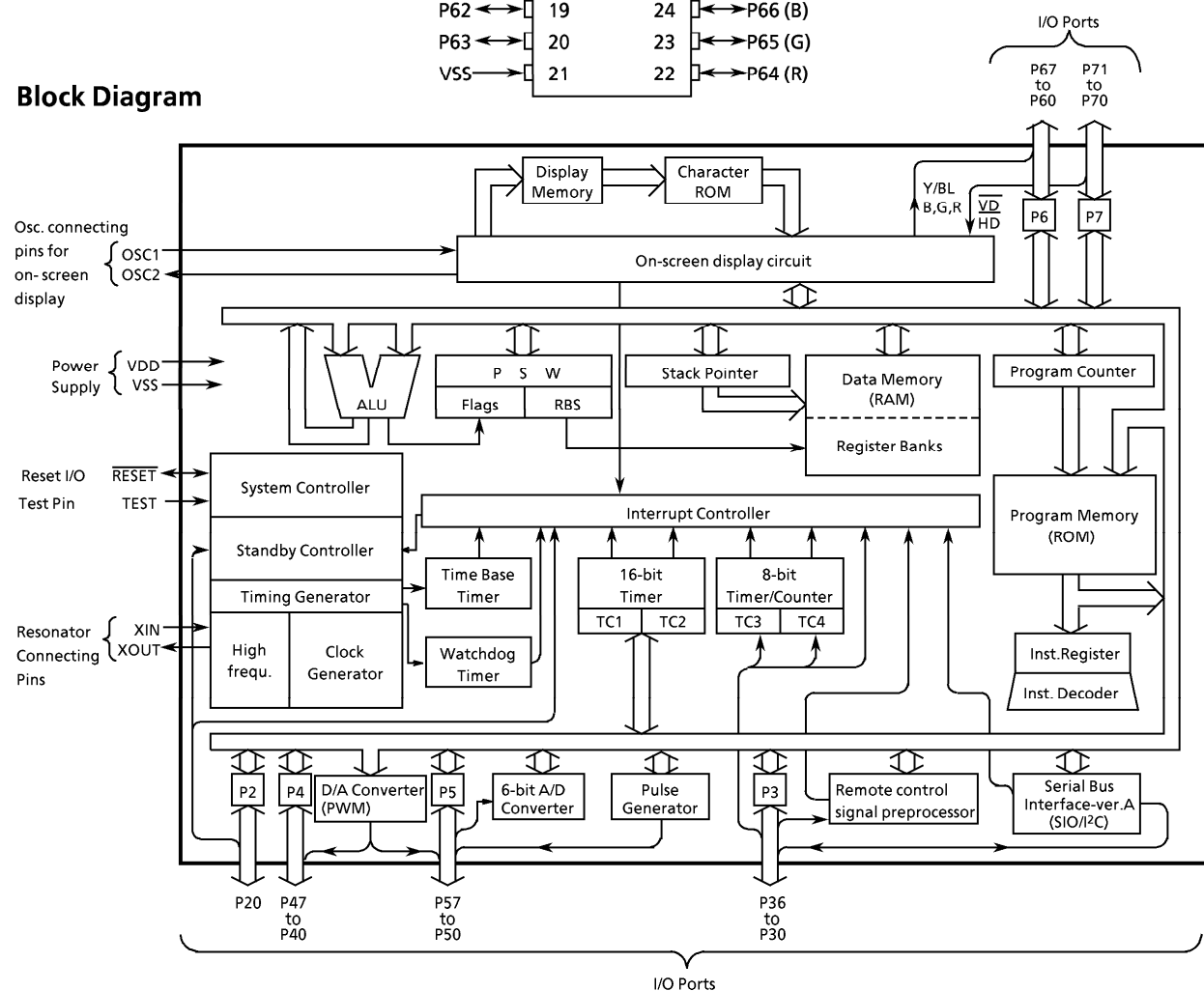
- ◆ Two 16-bit Timers
- ◆ Two 8-bit Timer/Counters
 - Timer, Event counter, Capture (Pulse width/duty measurement) modes
- ◆ Time Base Timer (Interrupt frequency : 1 Hz to 16384 Hz)
- ◆ Watchdog Timer
 - Interrupt source/reset output (programmable)
- ◆ Serial bus Interface
 - I²C-bus, 8-bit SIO modes
- ◆ On-screen display circuit
 - Character patterns : 128 characters
 - Characters displayed : 24 columns × 12 lines
 - Composition : 14 × 18 dots
 - Size of character : 3 kinds (line by line)
 - Color of character : 8 kinds (character by character)
 - Variable display position : Horizontal 128 steps, Vertical 256 steps
 - Fringing, Smoothing function
- ◆ D/A conversion (Pulse Width Modulation) outputs
 - 14-bit resolution (1 channel)
 - 7-bit resolution (9 channels)
- ◆ 6-bit A/D conversion input (4 channels)
- ◆ Pulse output (Clock for PLL IC)
- ◆ Remote control signal preprocessor
- ◆ Two Power saving operating modes
 - STOP mode : Oscillation stops. Battery/Capacitor back-up. Port output hold/high-impedance.
 - IDLE mode : CPU stops, and Peripherals operate. Release by interrupts.
- ◆ Operating voltage : 4.5 to 5.5 V at 8 MHz
- ◆ Emulation Pod : BM87CM37N0A

Pin Assignments (Top View)

SDIP42-P-600-1.78



Block Diagram



Pin Function

| Pin Name | Input/Output | Function | |
|--------------------------|-------------------|--|--|
| P20 (INT5/STOP) | I/O (Input) | 1-bit input / output port with latch. When used as an input port, the latch must be set to "1". | External interrupt input 5 or STOP mode release signal input |
| P36 (SCK) | I/O (I/O) | 7-bit input/output port with latch. When used as an input port, a serial bus interface input/output, a timer/counter input, a remote control signal preprocessor input, or an external interrupt input, the latch must be set to "1". | SIO serial clock input/output |
| P35 (SDA/SO) | I/O (I/O/Output) | | I ² Cbus serial data input/output or SIO serial data output |
| P34 (SCL/SI) | I/O (I/O/Input) | | I ² Cbus serial clock input/output or SIO serial data input |
| P33 (TC4) | I/O (Input) | | Timer/Counter 4 input |
| P32 (INT4) | | | External interrupt input 4 |
| P31 (TC3) | | | Timer/Counter 3 input |
| P30 (INT3/RXIN) | I/O (Input/Input) | | External interrupt input 3 or remote control signal preprocessor input |
| P47 (PWM7) to P41 (PWM1) | I/O (Output) | 8-bit programmable input/output port (tri-state). Each bit of this port can be individually configured as an input or an output under software control. During reset, all bits are configured as inputs. When used as a PWM output, the latch must be set to "1". | 7-bit D/A conversion (PWM) outputs |
| P40 (PWM0) | | | 14-bit D/A conversion (PWM) output |
| P57 (CIN3) to P54 (CIN0) | I/O (Input) | 8-bit input/output port with latch. When used as an input port, a comparator input, a PWM output, or a pulse output, the latch must be set to "1". | 6-bit A/D conversion (Comparator) inputs |
| P53 | I/O | | Pulse output (Clock for PLL IC) |
| P52 (PULSE) | I/O (Output) | | |
| P51 (PWM9) | | | |
| P50 (PWM8) | | | |
| P67 (Y/BL) | I/O (Output) | 8-bit programmable input/output port (P67 to P64 : tri-state, P63 to P60 : High current output). Each bit of this port can be individually configured as an input or an output under software control. During reset, all bits are configured as inputs. When used as the R, G, B, Y / BL outputs of on-screen display circuit, each bit of the P6 port data selection register (bits 7 to 4 in address 0F91 _H) must be set to "1". | Focus signal output or Background blanking control signal output |
| P66 (B) | | | RGB output |
| P65 (G) | | | |
| P64 (R) | | | |
| P63 | I/O | | High current output. |
| P62 | | | |
| P61 | | | |
| P60 | | | |
| P71 (VD) | I/O (Input) | 2-bit input/output port with latch. When used as an input ports, or a vertical synchronous signal input and horizontal synchronous signal input, the latch must be set to "1". | Vertical synchronous signal input |
| P70 (HD) | | | Horizontal synchronous signal input |
| OSC1, OSC2 | Input, Output | Resonator connecting pins for on-screen display circuitry. | |
| XIN, XOUT | | Resonator connecting pins. 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) | |

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 TLCS-870 Series is capable of addressing 64 Kbytes of memory. Figure 1-1 shows the memory address maps of the 87CH36/K36/M36. In the TLCS-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.

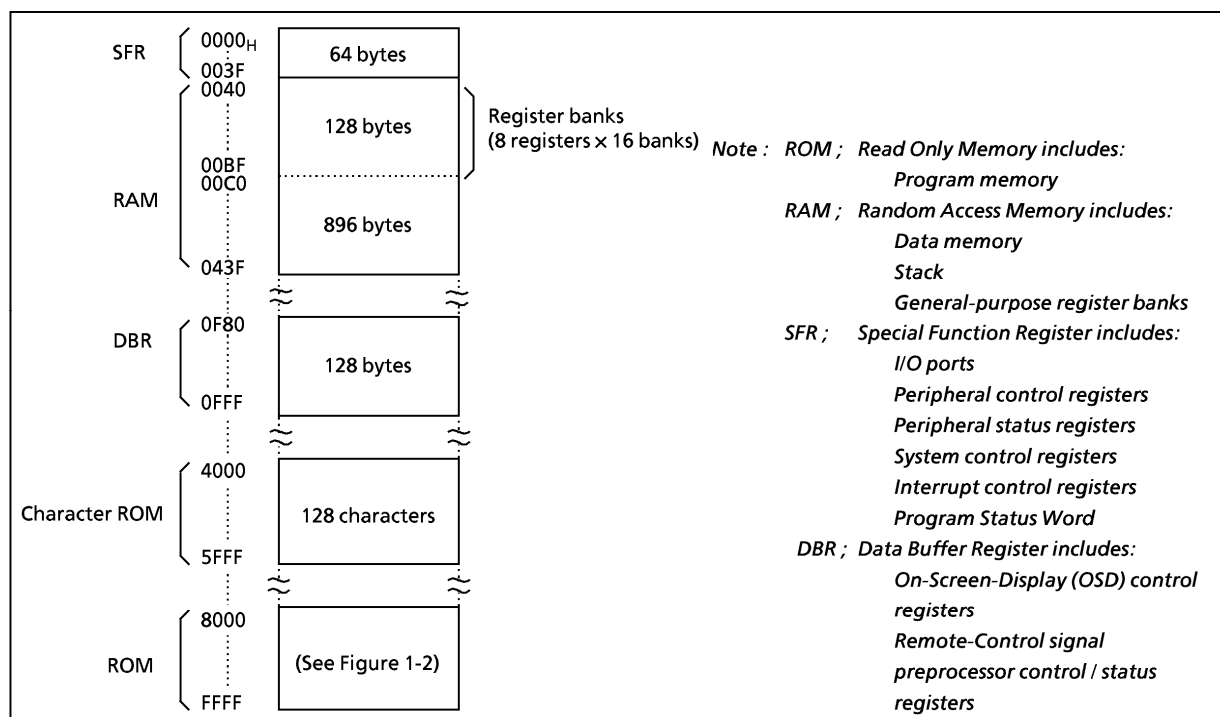


Figure 1-1. Memory Address Map

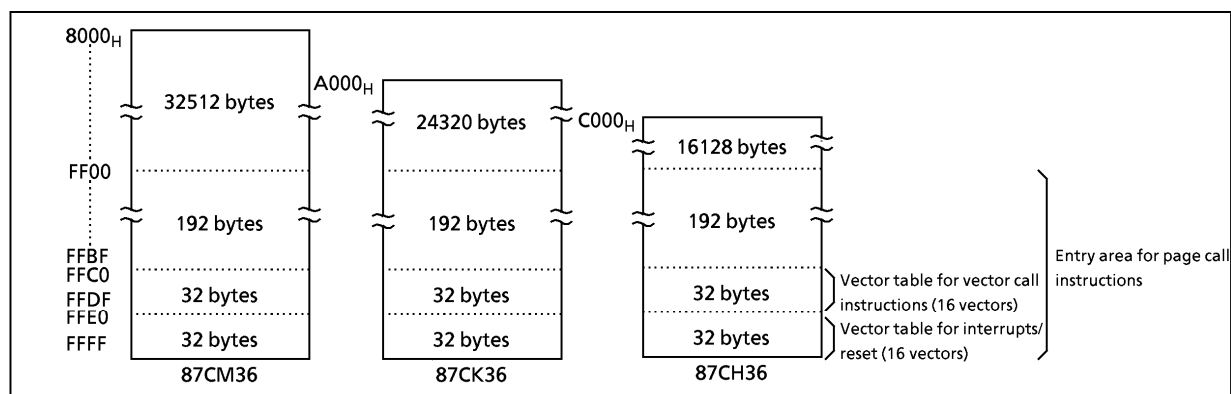


Figure 1-2. ROM Address Maps

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0 V)

| Parameter | Symbol | Pins | Ratings | Unit |
|---------------------------------|--------------------|--------------------------------------|--------------------------------|------|
| Supply Voltage | V _{DD} | | – 0.3 to 6.5 | V |
| Input Voltage | V _{IN} | | – 0.3 to V _{DD} + 0.3 | V |
| Output Voltage | V _{OUT1} | | – 0.3 to V _{DD} + 0.3 | V |
| Output Current (Per 1 pin) | I _{OUT1} | Ports P2, P3, P4, P5, P64 to P67, P7 | 3.2 | mA |
| | I _{OUT2} | Ports P60 to P63 | 30 | |
| Output Current (Total) | ΣI _{OUT1} | Ports P2, P3, P4, P5, P64 to P67, P7 | 120 | mA |
| | ΣI _{OUT2} | Ports P60 to P63 | 120 | |
| Power Dissipation [Topr = 70°C] | PD | | 600 | mW |
| Soldering Temperature (time) | T _{sld} | | 260 (10 s) | °C |
| Storage Temperature | T _{stg} | | – 55 to 125 | °C |
| Operating Temperature | Topr | | – 30 to 70 | °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_{SS} = 0 V, Topr = – 30 to 70°C)

| Parameter | Symbol | Pins | Conditions | Min | Max | Unit |
|--------------------|------------------|-------------------------|---|------------------------|---|------|
| Supply Voltage | V _{DD} | | f _c = 8 MHz | | | |
| | | | NORMAL mode | 4.5 | 5.5 | V |
| | | | IDLE mode | 2.0 | | |
| Input High Voltage | V _{IH1} | Except hysteresis input | V _{DD} ≥ 4.5 V | V _{DD} × 0.70 | V _{DD} | V |
| | V _{IH2} | Hysteresis input | | V _{DD} × 0.75 | | |
| Input Low Voltage | V _{IL1} | Except hysteresis input | V _{DD} ≥ 4.5 V | 0 | V _{DD} × 0.30 | V |
| | V _{IL2} | Hysteresis input | | | V _{DD} × 0.25 | |
| Clock Frequency | f _c | XIN, XOUT | V _{DD} = 4.5 to 5.5 V | 4.0 | 8.0 | MHz |
| | f _{OSC} | OSC1, OSC2 | Normal frequency mode (FORS = 0, V _{DD} = 4.5 to 5.5 V) | 4.0 | f _{OSC} ≤ f _c × 1.2 ≤ 8.0 | |
| | | | Double frequency mode (FORS = 1, V _{DD} = 4.5 to 5.5 V) | 2.0 | f _{OSC} ≤ f _c × 0.6 ≤ 4.0 | |
| | | | | | | |

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 f_c ; The condition of supply voltage range is the value in NORMAL and IDLE modes.

D.C. Characteristics

(V_{SS} = 0 V, T_{opr} = – 30 to 70°C)

| Parameter | Symbol | Pins | Conditions | Min | Typ. | Max | Unit |
|-------------------------------|------------------|--|--|-----|------|-----|------|
| Hysteresis Voltage | V _{HS} | Hysteresis inputs | | – | 0.9 | – | V |
| Input Current | I _{IN1} | TEST | V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V | – | – | ± 2 | μA |
| | I _{IN2} | Open drain ports | V _{DD} = 5.5 V, V _{IN} = 5.5 V | – | – | 2 | |
| | I _{IN3} | Tri-state ports | V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V | – | – | ± 2 | |
| | I _{IN4} | RESET, STOP | V _{DD} = 5.5 V, V _{IN} = 5.5 V / 0 V | – | – | ± 2 | |
| Input Resistance | R _{IN2} | RESET | | 100 | 220 | 450 | kΩ |
| Output Leakage Current | I _{LO1} | Sink open drain ports | V _{DD} = 5.5 V, V _{OUT} = 5.5 V | – | – | 2 | μA |
| | I _{LO2} | Tri-state ports | V _{DD} = 5.5 V, V _{OUT} = 5.5 V / 0 V | – | – | ± 2 | |
| Output High Voltage | V _{OH2} | Tri- state port | V _{DD} = 4.5 V, I _{OH} = – 0.7 mA | 4.1 | – | – | V |
| Output Low Voltage | V _{OL} | Except XOUT, OSC2 and ports P60 to P63 | V _{DD} = 4.5 V, I _{OL} = 1.6 mA | – | – | 0.4 | V |
| Output Low Current | I _{OL3} | Ports P60 to P63 | V _{DD} = 4.5 V, V _{OL} = 1.0 V | – | 20 | – | mA |
| Supply Current in NORMAL mode | I _{DD} | | V _{DD} = 5.5 V f _c = 8 MHz | – | 10 | 16 | mA |
| Supply Current in IDLE mode | | | V _{IN} = 5.3 V / 0.2 V | – | 6 | 8 | mA |
| Supply Current in STOP mode | | | V _{DD} = 5.5 V V _{IN} = 5.3 V / 0.2 V | – | 0.5 | 10 | μA |

Note 1 : Typical values show those at T_{opr} = 25°C, V_{DD} = 5 V.

Note 2 : Input Current I_{IN1}, I_{IN4}; The current through pull-up or pull-down resistor is not included.

Note 3 : Typical current consumption during A/D conversion is 1.2 mA.

A/D Conversion Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = – 30 to 70°C)

| Parameter | Symbol | Pins | Conditions | Min | Typ. | Max | Unit |
|----------------------------|------------------|--------------|-------------------------|-----------------|------|-----------------|------|
| Analog Input Voltage Range | V _{AIN} | CIN3 to CIN0 | | V _{SS} | – | V _{DD} | V |
| Conversion Error | | | V _{DD} = 5.0 V | – | – | ± 1.5 | LSB |

A.C. Characteristics

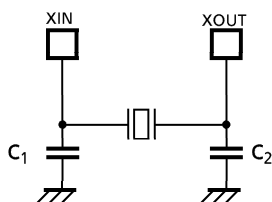
(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = -30 to 70°C)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|------------------------------|------------------|--|------|------|-----|------|
| Machine Cycle Time | t _{cy} | In NORMAL mode | 0.5 | - | 1.0 | μs |
| | | In IDLE mode | | | | |
| High-Level Clock Pulse Width | t _{WCH} | For external clock operation (XIN input), f _c = 8MHz | 62.5 | - | - | ns |
| Low-Level Clock Pulse Width | t _{WCL} | | | | | |

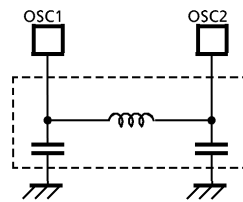
Recommended Oscillating Condition

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = -30 to 70°C)

| Parameter | Oscillator | Frequency | Recommended Oscillator | Recommended Conditions | |
|----------------------------|--------------------|-----------|--------------------------------------|------------------------|----------------|
| | | | | C ₁ | C ₂ |
| High-frequency Oscillation | 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 | | |
| OSD | LC Resonator | 8 MHz | TOKO A285TNIS-11695 | - | - |
| | | 7 MHz | TOKO TBEKSES-30375F8Y | | |



(1) High-frequency



(2) LC Resonator for OSD

Note : On our OSD circuit, the horizontal display start position is determined by counting the clock from LC oscillator. So, the unstable start of oscillation after the rising edge of Horizontal Sync. Signal will be cause the OSD distortion.

Generally, smaller C and larger L make clearer wave form at the beginning of oscillation.
We recommend that the value of LC oscillator should be equal and bigger than 33μH.

Note : To keep reliable operation, shield the device electrically with the metal plate on its package mold surface against the high electric field, for example, by CRT (Cathode Ray Tube).