

MN101E50 Series

8-bit Single-chip Microcontroller

■ Overview

The MN101E series of 8-bit single-chip microcomputers (the memory expansion version of MN101C series) incorporate multiple types of peripheral functions. This chip series is well suited for camera, VCR, MD, TV, CD, LD, printer, telephone, home automation, pager, air conditioner, PPC, fax machine, music instrument and other electrical appliances.

This LSI has embedded flexible microcomputer applications, optimized hardware configurations and a simple yet efficient instruction set. MN101EF50D has an internal 64 KB of ROM and 4 KB of RAM. Peripheral functions include 5 external interrupts, 25 internal interrupts including NMI, 11 timer counters, 4 types of serial interfaces, A/D converter, LCD driver, watchdog timer and buzzer output. The system configuration is suitable for system control microcontrollers such as cameras, timer selectors for VCR, CD players or minicomponents.

With 4 oscillation systems (high-speed internal frequency: 20 MHz, high-speed crystal/ceramic frequency: max. 10 MHz / low-speed crystal/ceramic frequency: 32.768 kHz and PLL: frequency multiplier of the high-speed frequency) contained in the chip, the system clock can be switched to high-speed frequency input (NORMAL mode), PLL input (PLL mode) or low-speed frequency input (SLOW mode). The system clock is generated by dividing the oscillation clock or PLL clock. The optimum operating clock for the system can be selected by switching its frequency ratio by programming.

The machine cycle (minimum instruction execution time) is 100 ns when the external oscillation fosc is 10 MHz (PLL is not used). The machine cycle is 50 ns (maximum) when the internal oscillation frequency is 20 MHz (PLL is not used). A machine cycle in the PLL mode is 50 ns (maximum).

■ Product Summary

This datasheet describes the following model.

| Model | ROM Size | RAM Size | Classification | Package |
|------------|----------|----------|----------------------|----------------|
| MN101EF50D | 64 KB | 4 KB | Flash EEPROM version | LQFP064-P-1414 |

■ Features

- Memory
 - ROM capacity: 64 KB
 - RAM capacity: 4 KB
- Package
 - LQFP064-P-1414 (14 mm × 14 mm / 0.8 mm pitch)
- Machine Cycle
 - High-speed mode
 - 0.05 μs / 20 MHz (2.7 V to 5.5 V)
 - 0.125 μs / 8 MHz (1.8 V to 5.5 V)
 - Low-speed mode
 - 62.5 μs / 32 kHz (1.8 V to 5.5 V)
- Clock Gear Circuit:
 - Variable internal system clock speed (fosc/1, fosc/2, fosc/4, fosc/16, fosc/64 and fosc/128)
- High-speed Clock (fppll-div) Gear Circuit for peripherals:
 - Select among "Stop", fppll/1, fppll/2, fppll/4, fppll/8 and fppll/16.
- Oscillation Circuit
 - High-speed: internal oscillation (frc) or crystal/ceramic (fosc)
 - Low-speed: crystal/ceramic (fx)
 - * High-speed internal oscillation: 20 MHz / 16 MHz (selectable)
 - * 20 MHz can be selected only when internal high-speed oscillator is used without using external high-speed oscillator or low-speed oscillators.
- Clock Multiplication Circuit
 - PLL output clock (fppll)
 - fosc × n (n: 2, 3, 4, 5, 6, 8, 10)
 - frc/2 × n (n: 4, 5)
 - * When clock multiplication circuit is not used, fppll = fosc or fppll = frc
- Memory Bank
 - Data memory space is expandable with the memory bank system. (16 banks with 64 KB each)
 - Consists of banks for the source address and banks for the destination address.
- Operating Mode
 - NORMAL Mode (high-speed mode)
 - PLL Mode
 - SLOW Mode (low-speed mode)
 - HALT Mode
 - STOP Mode
 - Clock Transition Mode
- Operating Voltage
 - 1.8 V to 5.5 V
- Operating Ambient Temperature:
 - 40°C to +85°C

■ Features (continued)

• Interrupt: 30 sets

<Processing error interrupt>

Non-maskable interrupt (NMI)

<Timer interrupts>

Timer 0 interrupt

Timer 1 interrupt

Timer 2 interrupt

Timer 3 interrupt

Timer 4 interrupt

Timer 6 interrupt

Time base interrupt

Timer 7 interrupt

Timer 7 compare register 2 match interrupt

Timer 8 interrupt

Timer 8 compare register 2 match interrupt

24H timer interrupt

Alarm match interrupt

<Serial interrupt>

Serial Interface 0 interrupt

Serial Interface 0 UART reception interrupt

Serial Interface 1 interrupt

Serial Interface 1 UART reception interrupt

Serial Interface 2 interrupt

Serial Interface 2 UART reception interrupt

Serial Interface 4 interrupt

Serial Interface 4 stop condition interrupt

<A/D interrupt>

A/D conversion interrupt

<Low voltage detection interrupt>

Low voltage detection interrupt

<External interrupt>

IRQ0: Edge selection, noise filter connectable

IRQ1: Edge selection, noise filter connectable

IRQ2: Edge selection, noise filter connectable, both edges interrupt

IRQ3: Edge selection, noise filter connectable, both edges interrupt

IRQ4: Edge selection, noise filter connectable, both edges interrupt, key scan interrupt

■ Features (continued)

- Timer Counter: 11 sets

General-purpose 8-bit timer: 5 sets

General-purpose 16-bit timer: 2 sets

8-bit free-run timer: 1 set

Time-base timer: 1 set

Baud rate timer: 1 set

24 H timer: 1 set

<Timer 0> (General-purpose 8-bit timer)

Square wave output (Timer pulse output), added pulse (2 bits) type PWM output, event count, simple pulse width measurement

Large current output selectable

Clock source :

fppll-div, fppll-div/4, fppll-div/16, fppll-div/32, fppll-div/64, fppll-div/128, fs/2, fs/4, fs/8, fslow, external clock, Timer A output

Real-time control:

Timer (PWM) output is controlled among the three values: "Fixed to High", "Fixed to Low",

or "Hi-Z" at falling edge of External Interrupt 0 (IRQ0)

Double-buffered compare register (×1)

<Timer 1> (General-purpose 8-bit timer)

Square wave output (Timer pulse output), event count, timer synchronous output, 16-bit cascade connection (connected with Timer 0)

Clock source:

fppll-div, fppll-div/4, fppll-div/16, fppll-div/32, fppll-div/64, fppll-div/128, fs/2, fs/4, fs/8, fslow, external clock, Timer A output

Double-buffered compare register (×1)

<Timer 2> (General-purpose 8-bit timer)

Square wave output (Timer pulse output), added pulse (2 bits) type PWM output, event count, simple pulse width measurement

Large current output selectable, 24-bit cascade connection (connected with Timer 0, 1), timer synchronous output

Clock source:

fppll-div, fppll-div/4, fppll-div/16, fppll-div/32, fppll-div/64, fppll-div/128, fs/2, fs/4, fs/8, fslow, external clock, Timer A output

Real-time control:

Timer (PWM) output is controlled among three status: "Fixed to High", "Fixed to Low",

or "Hi-Z" at falling edge of External Interrupt 0 (IRQ0)

Double-buffered compare register (×1)

<Timer 3> (General-purpose 8-bit timer)

Square wave output (Timer pulse output), event count, 16-bit cascade connection (connected with Timer 2),

32-bit cascade connection (connected with Timer 0, 1, 2)

Double-buffered compare register (×1)

Clock source:

fppll-div, fppll-div/4, fppll-div/16, fppll-div/32, fppll-div/64, fppll-div/128, fs/2, fs/4, fs/8, fslow, external clock, Timer A output

<Timer 4> (General-purpose 8-bit timer)

Square wave output (Timer pulse output), added pulse (2 bits) type PWM output, event count, simple pulse width measurement

Clock source:

fppll-div, fppll-div/4, fppll-div/16, fppll-div/32, fppll-div/64, fppll-div/128, fs/2, fs/4, fs/8, fslow, external clock, Timer A output

<Timer 6> (8-bit free-run timer, time-base timer)

8-bit free-run timer

Clock source:

fppll-div, fppll-div/2², fppll-div/2³, fppll-div/2¹², fppll-div/2¹³, fs, fslow, fslow/2², fslow/2³, fslow/2¹², fslow/2¹³

Time base timer

Interrupt generation cycle:

fppll-div/2⁷, fppll-div/2⁸, fppll-div/2⁹, fppll-div/2¹⁰, fppll-div/2¹³, fppll-div/2¹⁵, fslow/2⁷, fslow/2⁸, fslow/2⁹, fslow/2¹⁰, fslow/2¹³, fslow/2¹⁵

■ Features (continued)

<Timer 7> (General-purpose 16-bit timer)

Clock source:

fpll-div, fs, external clock, Timer A output, Serial Interface 0 transfer clock output,
Timer 6 compare match cycle divided by 1, 2, 4, 16

Hardware configuration:

Double-buffered compare register (×2)
Double-buffered input capture register (×2)
Timer interrupt (×2 vector)

Timer function

Square wave output (Timer pulse output), high-precision PWM output (cycle/duty continuous changeable),
large current selectable, timer synchronous output, event count, input capture function (both edges operable)

Real-time control

Timer (PWM) output is controlled among the three values: "Fixed to High", "Fixed to Low" or "Hi-Z" at falling edge of
External Interrupt 0 (IRQ0)

<Timer 8> (General-purpose 16-bit timer)

Clock source:

fpll-div, fs, external clock, Timer A output, Timer 6 compare match cycle divided by 1, 2, 4, 16

Hardware configuration

Double-buffered compare register (×2)
Input capture register (×1)
Timer interrupt (×2 vector)

Timer function

Square wave output (Timer pulse output), high-precision PWM output (cycle/duty continuous changeable),
large current selectable, event count, pulse width measurement, input capture function (both edges operable)
32-bit cascade connection (connected with Timer 7), 32-bit PWM output, input capture is available in 32-bit cascade

<Timer A> (baud rate timer)

Clock output for peripheral functions

Clock source:

fpll-div divided by 1, 2, 4, 8, 16, 32, fs divided by 2, 4

<24H timer>

Clock source (Usable frequency):

fpll (4 MHz, 4.19 MHz, 5 MHz, 8 MHz, 8.38 MHz, 10 MHz, 16 MHz, 16.77 MHz, 20 MHz), fx (32.768 kHz),
frc (20 MHz, 16 MHz)

Hardware configuration

0.5 second counter, minute counter, hour counter
Alarm compare register (in 0.5 second, in minutes, in hours) (×1)
Timer interrupt (×2 vector)

Timer Function

Interval function (interrupts every 0.5 second, 1 second, 1 minute, 1 hour, 24 hours)
Alarm function

- Watchdog timer

Software processing error detection cycle is selectable from $fs/2^{16}$, $fs/2^{18}$, $fs/2^{20}$.

System reset is generated by the hardware when software processing error is detected twice.

- Synchronous output function (Timer synchronous output, interrupt synchronous output)

Latch data is output from Port 8 at the event timing of synchronous output signal of Timer 1, Timer 2, Timer 7,
or external interrupt 2 (IRQ2)

■ Features (continued)

- Buzzer Output

Output frequency can be selected from $f_{pll-div/2^9}$, $f_{pll-div/2^{10}}$, $f_{pll-div/2^{11}}$, $f_{pll-div/2^{12}}$, $f_{pll-div/2^{13}}$, $f_{pll-div/2^{14}}$, $f_{slow/2^3}$, $f_{slow/2^4}$

- A/D converter

10 bits × 12 channels

- Serial Interface: 4 systems

<Serial Interface 0> (Full duplex UART/ Clock synchronous serial interface)

Clock synchronous serial interface

Transfer clock source:

$f_{pll-div/2}$, $f_{pll-div/4}$, $f_{pll-div/16}$, $f_{pll-div/64}$, $f_s/2$, $f_s/4$, Timer 0 to 4, Timer A output divided by 1, 2, 4, 8, 16, External clock

MSB/LSB can be selected as the first bit to be transferred, arbitrary size of 1 to 8 bits is selectable.

Continuous transmission, continuous reception, continuous transmission/reception are available.

Full duplex UART

Baud rate timer: selected from Timer 0 to 4, or Timer A

Parity check, overrun error/framing error are detected

Transfer bits of 7 to 8 are selectable

<Serial Interface 1> (Full duplex UART/ Clock synchronous serial interface)

Clock synchronous serial interface

Transfer clock source:

$f_{pll-div/2}$, $f_{pll-div/4}$, $f_{pll-div/16}$, $f_{pll-div/64}$, $f_s/2$, $f_s/4$, Timer 0 to 4, Timer A output divided by 1, 2, 4, 8, 16, external clock

MSB/LSB can be selected as the first bit to be transferred, arbitrary size of 1 to 8 bits are selectable.

Continuous transmission, continuous reception, continuous transmission/reception are available.

Full duplex UART

Baud rate timer: selected from Timer 0 to 4, or Timer A

Parity check, overrun error/framing error are detected

Transfer bits of 7 to 8 are selectable

<Serial Interface 2> (Full duplex UART / Clock synchronous serial interface)

Clock synchronous serial interface

Transfer clock source:

$f_{pll-div/2}$, $f_{pll-div/4}$, $f_{pll-div/16}$, $f_{pll-div/64}$, $f_s/2$, $f_s/4$, Timer 0 to 4, Timer A output divided by 1, 2, 4, 8, 16, External clock

MSB/LSB can be selected as the first bit to be transferred, arbitrary size of 1 to 8 bits are selectable.

Continuous transmission, continuous reception, continuous transmission/reception are available.

Full duplex UART

Baud rate timer: selected from Timer 0 to 4, or Timer A

Parity check, overrun error/framing error are detected

Transfer bits of 7 to 8 are selectable

<Serial Interface 4> (Multi master IIC/ Clock synchronous serial interface)

Clock synchronous serial interface

Transfer clock source:

$f_{pll-div/2}$, $f_{pll-div/4}$, $f_{pll-div/8}$, $f_{pll-div/32}$, $f_s/2$, $f_s/4$, Timer 0 to 4, Timer A output divided by 1, 2, 4, 8, 16, External clock

MSB/LSB can be selected as the first bit to be transferred, arbitrary size of 1 to 8 bits are selectable.

Continuous transmission, continuous reception, continuous transmission/reception are available.

Multi master IIC

7-bit or 10-bit slave address can be set.

General call communication mode is supported

- Auto reset circuit

■ Features (continued)

- Power supply voltage detection circuit

- LED driver: 7 sets

- LCD driver

Segment output: Max. 28 pins (SEG0 to SEG27)

Segment output pins can be switched to I/O ports in 1 bit.

* At reset, SEG0 to SEG27 are input ports.

Common output: 8 pins

COM0 to COM7 can be switched to I/O ports in 1 bit.

* COM4 to COM7 are dual ports with SEG0 to SEG3.

Display mode selection

Static

1/2 duty, 1/2 bias

1/3 duty, 1/3 bias

1/4 duty, 1/3 bias

1/8 duty, 1/3 bias

LCD driver clock

When the source clock is the main clock (fpll)

1/2¹⁸, 1/2¹⁷, 1/2¹⁶, 1/2¹⁵, 1/2¹⁴, 1/2¹³, 1/2¹², 1/2¹¹

When the source clock is the sub clock (fslow)

1/2⁹, 1/2⁸, 1/2⁷, 1/2⁶

Timer 0 to Timer 4

LCD power supply

LCD power supply is separated from V_{DD5} (can be used when V_{LC1} ≤ V_{DD5})

External power supply voltage can be selected. (Supply voltage is supplied from V_{LC1}, V_{LC2}, and V_{LC3} pins)

Internal dividing resistors

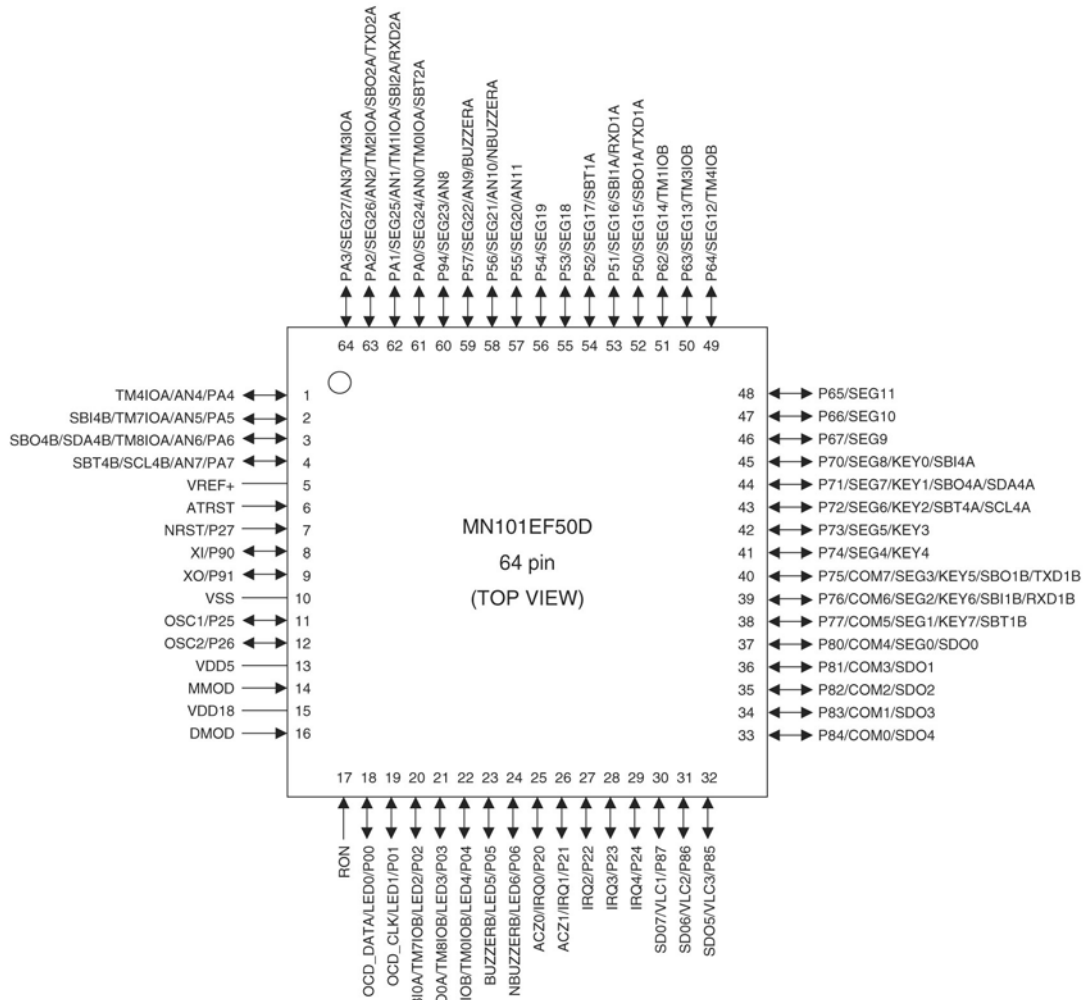
External power supply voltage is divided the voltage input to V_{LC1} by internal resistors.

- Ports

| | |
|---------------------------------|---------|
| I/O ports: | 55 pins |
| LCD segment: | 28 pins |
| LCD common: | 8 pins |
| Serial interface communication: | 18 pins |
| Timer I/O: | 14 pins |
| Buzzer output: | 4 pins |
| A/D input: | 12 pins |
| External interrupt: | 5 pins |
| LCD power supply pin: | 3 pins |
| LED (large current output): | 7 pins |
| High-speed oscillation: | 2 pins |
| Low-speed oscillation: | 2 pins |
| Special function: | 9 pins |
| Operating mode control: | 4 pins |
| Reset: | 1 pin |
| Analog reference voltage: | 1 pin |
| Power supply pins: | 3 pins |

■ Pin Description

- LQFP064-P-1414



Request for your special attention and precautions in using the technical information and semiconductors described in this book

- (1) If any of the products or technical information described in this book is to be exported or provided to non-residents, the laws and regulations of the exporting country, especially, those with regard to security export control, must be observed.
- (2) The technical information described in this book is intended only to show the main characteristics and application circuit examples of the products. No license is granted in and to any intellectual property right or other right owned by Panasonic Corporation or any other company. Therefore, no responsibility is assumed by our company as to the infringement upon any such right owned by any other company which may arise as a result of the use of technical information described in this book.
- (3) The products described in this book are intended to be used for general applications (such as office equipment, communications equipment, measuring instruments and household appliances), or for specific applications as expressly stated in this book.
Consult our sales staff in advance for information on the following applications:
 - Special applications (such as for airplanes, aerospace, automotive equipment, traffic signaling equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.It is to be understood that our company shall not be held responsible for any damage incurred as a result of or in connection with your using the products described in this book for any special application, unless our company agrees to your using the products in this book for any special application.
- (4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.
- (5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.
- (6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.
- (7) This book may be not reprinted or reproduced whether wholly or partially, without the prior written permission of our company.