

Notification about the transfer of the semiconductor business

The semiconductor business of Panasonic Corporation was transferred on September 1, 2020 to Nuvoton Technology Corporation (hereinafter referred to as "Nuvoton"). Accordingly, Panasonic Semiconductor Solutions Co., Ltd. became under the umbrella of the Nuvoton Group, with the new name of Nuvoton Technology Corporation Japan (hereinafter referred to as "NTCJ").

In accordance with this transfer, semiconductor products will be handled as NTCJ-made products after September 1, 2020. However, such products will be continuously sold through Panasonic Corporation.

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Nuvoton Technology Corporation Japan

MN103SK0/K1 Series

32-bit Single-chip Microcontroller

■ Overview

The MN103S is a 32-bit microcontroller combining ease of use intended for programs development in the C language with a simple, high-performance architecture made possible through pursuit of cost performance.

Built around a compact 32-bit CPU with a basic instruction word length of 1 byte, this LSI includes internal memory for instructions and data, a clock generator, bus controller, interrupt controller, watchdog timer, standard peripheral circuitry such as timers and serial interfaces, PWM circuit best suited to controlling 3-phase motors, arithmetic unit for speed-up of inverter control and A/D converters for motor position control. The MN103S Series' high-speed CPU coupled with abundance of peripheral features provides an easy means of developing low-cost, high-performance and multifunctional system on chip for motor and power control applications requiring fast response - a feature previously unavailable with conventional microcontrollers.

■ Product Summary

This datasheet describes the following model.

Model	ROM Size	RAM Size	Classification	Package
MN103SFK0K	256 KB	8 KB	Flash EEPROM version	QFP100-P-1818B
MN103SFK1K				LQFP080-P-1414A TQFP080-P-1212D

■ Features

• CPU core

MN103S core

4 GB of linear address space (for instructions / data)

LOAD/STORE architecture with 5-stage pipeline

46 basic instructions + 23 extension instructions

6 addressing modes

Instruction set of 1 byte in word length

Extension arithmetic unit incorporated (high-speed multiply, multiply and accumulate and saturation operation instructions)

Machine cycle: 16.7 ns (oscillation frequency: 10 MHz, 6 multiplying)

Operation mode: NORMAL mode, SLEEP mode, HALT mode, STOP mode

• Oscillation circuit

External oscillation (crystal/ ceramic), Internal oscillation (10 MHz)

• ROM correction

Maximum 4 parts in a program

• Internal memory

ROM 256 Kbytes

RAM 8 Kbytes

• Interrupts

Internal interrupts: MN103SFK0K: 54 interrupts / MN103SFK1K: 54 interrupts

Watchdog timer overflow interrupts

System error interrupts

Fail safe function interrupts

<Timer Interrupts>

Timer 0 underflow interrupts

Timer 1 underflow interrupts

Timer 2 underflow interrupts

Timer 3 underflow interrupts

Timer 4 underflow interrupts

Timer 5 underflow interrupts

Timer 6 underflow interrupts

Timer 7 underflow interrupts

Timer 8 underflow interrupts

Timer 9 underflow interrupts

Timer 10 underflow interrupts

Timer 11 underflow interrupts

Timer 16 overflow/underflow interrupt

Timer 16 compare/capture A interrupt

Timer 16 compare/capture B interrupt

Timer 17 overflow/underflow interrupt

Timer 17 compare/capture A interrupt

Timer 17 compare/capture B interrupt

Timer 18 overflow/underflow interrupt

Timer 18 compare/capture A interrupt

Timer 18 compare/capture B interrupt

Timer 19 overflow/underflow interrupt

Timer 19 compare/capture A interrupt

Timer 19 compare/capture B interrupt

Timer 20 overflow/underflow interrupt

Timer 20 compare/capture A interrupt

Timer 20 compare/capture B interrupt

■ Features (continued)

• Interrupts (continued)

<Timer Interrupts> (continued)

Timer 21 overflow/underflow interrupt
 Timer 21 compare/capture A interrupt
 Timer 21 compare/capture B interrupt
 Timer 23 overflow/underflow interrupt
 Timer 23 compare/capture A interrupt
 Timer 23 compare/capture B interrupt

<Serial Interface>

Serial 0 reception end interrupts
 Serial 0 transmission end interrupts
 Serial 1 reception end interrupts
 Serial 1 transmission end interrupts
 Serial 2 reception end interrupts
 Serial 2 transmission end interrupts
 Serial 3 reception end interrupts
 Serial 3 transmission end interrupts

<PWM>

PWM0 overflow interrupts of PWM cycle
 PWM0 underflow interrupts
 PWM1 overflow interrupts of PWM cycle
 PWM1 underflow interrupts

<A/D interrupt>

A /D 0 conversion end interrupt
 A /D 0 conversion end B interrupt
 A /D 1 conversion end interrupt
 A /D 1 conversion end B interrupt
 A /D 2 conversion end interrupt
 A /D 2 conversion end B interrupt

External interrupts: MN103SFK0K: 16 interrupts / MN103SFK1K: 12 interrupts

IRQ0: Edge, both edges, level interrupts, noise filter connectable
 IRQ1: Edge, both edges, level interrupts, noise filter connectable
 IRQ2: Edge, both edges, level interrupts, noise filter connectable
 IRQ3: Edge, both edges, level interrupts, noise filter connectable
 IRQ4: Edge, both edges, level interrupts, noise filter connectable
 IRQ5: Edge, both edges, level interrupts, noise filter connectable
 IRQ6: Edge, both edges, level interrupts, noise filter connectable
 IRQ7: Edge, both edges, level interrupts, noise filter connectable
 IRQ8: Edge, both edges, level interrupts, noise filter connectable
 IRQ9: Edge, both edges, level interrupts, noise filter connectable
 IRQ10: Edge, both edges, level interrupts, noise filter connectable
 IRQ11: Edge, both edges, level interrupts, noise filter connectable
 IRQ12: Edge, both edges, level interrupts, noise filter connectable (only MN103SFK0K)
 IRQ13: Edge, both edges, level interrupts, noise filter connectable (only MN103SFK0K)
 IRQ14: Edge, both edges, level interrupts, noise filter connectable (only MN103SFK0K)
 IRQ15: Edge, both edges, level interrupts, noise filter connectable (only MN103SFK0K)

■ Features (continued)

- Timer counter

8-bit timer for general use 16 sets
 16-bit timer for general use 7 sets

Timer 0 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Baud rate timer
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 1 underflow,
 Timer 2 underflow, TM0IO pin input

Timer 1 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Baud rate timer, Cascade connection (connected to Timer 0)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 0 underflow,
 Timer 2 underflow, TM1IO pin input

Timer 2 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Baud rate timer, Cascade connection (connected to Timer 1)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 0 underflow,
 Timer 1 underflow, TM2IO pin input

Timer 3 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Baud rate timer, Cascade connection (connected to Timer 2)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 0 underflow,
 Timer 1 underflow, Timer 2 underflow, TM3IO pin input

Timer 4 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 5 underflow,
 Timer 6 underflow, TM4IO pin input

Timer 5 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 4)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 4 underflow,
 Timer 6 underflow, TM5IO pin input

Timer 6 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 5)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 4 underflow,
 Timer 5 underflow, TM6IO pin input

Timer 7 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 6)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, Timer 4 underflow,
 Timer 5 underflow, Timer 6 underflow, TM7IO pin input

Timer 8 (8-bit Timer for general use)

Interval timer, Timer pulse output, Event count
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM8IO pin input
 Timer 9 underflow, Timer 10 underflow

Timer 9 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (Connected to Timer 8)
 Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM9IO pin input
 Timer 8 underflow, Timer 10 underflow

■ Features (continued)

• Timer counter (continued)

Timer 10 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (Connected to Timer 9)

Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM10IO pin input
Timer 8 underflow, Timer 9 underflow

Timer 11 (8-bit timer for general use)

Interval timer, Timer pulse output, Event count, Cascade connection (Connected to Timer 10)

Count clock source: IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM11IO pin input
Timer 8 underflow, Timer 9 underflow, Timer 10 underflow

Timer 16 (16-bit timer for general use)

Interval timer, Event count, Up/down count, Timer output, PWM output, Input capture, one-shot output, External trigger start

Count clock source: IOCLK, IOCLK/8, IOCLK/64, Timer 7 underflow, TM16BIO pin input

Timer 17 (16-bit timer for general use)

Interval timer, Event count, Up/down count, Timer output, PWM output, Input capture, one-shot output, External trigger start

Count clock source: IOCLK, IOCLK/8, IOCLK/64, Timer 11 underflow, TM17BIO pin input

Timer 18 (16-bit timer for general use)

Interval timer, Event count, Up/down count, Timer output, PWM output (output to 6 ports all at once is possible),

Input capture, one-shot output, External trigger start

Count clock source: IOCLK, IOCLK/8, Timer 6 underflow, Timer 7 underflow, TM18BIO pin input

Timer 19 (16-bit timer for general use)

Interval timer, Event count, Up/down count, Timer output, PWM output, Input capture, one-shot output, External trigger start

Count clock source: IOCLK, IOCLK/8, Timer 10 underflow, Timer 11 underflow, TM19BIO pin input

Timer 20 (16-bit timer for general use)

Interval timer, Event count *, Up/down count, Timer output *, PWM output *, Input capture *, one-shot output *,

External trigger start *, Start by PWM0 overflow/underflow interrupt, A/D conversion start trigger generation

Count clock source: MCLK, MCLK/8, IOCLK, IOCLK/8, Timer 6 underflow,
Timer 7 underflow, TM20BIO pin input * *: only MN103SFK0K

Timer 21 (16-bit timer for general use)

Interval timer, Event count *, Up/down count, Timer output *, PWM output *, Input capture *, one-shot output *,

External trigger start *, PWM1 overflow/underflow interrupt, A/D conversion start trigger generation

Count clock source: MCLK, MCLK/8, IOCLK, IOCLK/8, Timer 10 underflow,
Timer 11 underflow, TM21BIO pin input * *: only MN103SFK0K

Timer 23 (16-bit timer for general use)

Interval timer, Event count, Up/down count, Timer output, PWM output (output to 6 ports all at once is possible),

Input capture, one-shot output, External trigger start

Count clock source: IOCLK, IOCLK/8, Timer 10 underflow, Timer 11 underflow, TM23BIO pin input

• Watchdog Timer

Detection time 6.55 ms to 1677.72 ms (oscillation frequency 10 MHz)

Generates non-maskable interrupt at detection

Generates hard-reset at second consecutive overflow

■ Features (continued)

• A/D Converter

Minimum conversion time 1.0 μ s

MN103SFK0K: 20 channels, 3 converters

MN103SFK1K: 16 channels, 3 converters

Use of 3 converters allows simultaneous sampling of 3 phases

A/D conversion start trigger is in synchronization with complementary 3-phase PWM cycle and 16-bit timer

• Complementary 3-phase PWM output

Min. resolution: 16.7 ns

Triangular and saw-tooth waves output

Incorporates a dead time insertion circuit

Can overwrite registers by double buffer during PWM operation

PWM output protection circuit supporting external interrupts and non-maskable interrupt

Output timing varying function

• Serial Interface 4 channels

Serial 0 (Multi-master IIC / Synchronous serial interface)

Synchronous serial interface

Overrun error detection

Transfer clock source: 1/2, 1/4, 1/16 and 1/32 of timer 0 underflow,

1/2, 1/4, 1/16 and 1/32 of timer 1 underflow,

1/2, 1/4, 1/16 and 1/32 of timer 2 underflow,

1/2, 1/4, 1/16 and 1/32 of timer 3 underflow, IOCLK/2, IOCLK/4, SBT0 pin

Can be selected as the first bit to be transferred, Any transfer size from 1 to 8 bits can be selected.

Can be continuously transmitted, received or transmitted and received.

Maximum transfer rate: 5.0 Mbps

Multi-master IIC

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

Supports General call communication mode.

■ Features (continued)

• Serial Interface (continued)

Serial 1 (Full duplex UART / Synchronous serial interface)

Synchronous serial interface

Overrun error detection

Transfer clock source: 1/2, 1/4, 1/16 and 1/64 of timer 0 underflow,
1/2, 1/4, 1/16 and 1/64 of timer 1 underflow,
1/2, 1/4, 1/16 and 1/64 of timer 2 underflow,
1/2, 1/4, 1/16 and 1/64 of timer 3 underflow, IOCLK/2, IOCLK/4, SBT1 pin

Can be selected as the first bit to be transferred, Any transfer size from 1 to 8 bits can be selected.

Continuous transmission, reception, and transmission/reception

Maximum transfer rate: 5.0 Mbps

Full duplex UART

Parity check, Overrun and flaming error detection

Transfer clock source: 1/32, 1/64, 1/256, and 1/1024 of timer 0 underflow,
1/32, 1/64, 1/256, and 1/1024 of timer 1 underflow,
1/32, 1/64, 1/256, and 1/1024 of timer 2 underflow,
1/32, 1/64, 1/256, and 1/1024 of timer 3 underflow, IOCLK/32, IOCLK/64

Can be selected as the first bit to be transferred, Any transfer size from 7 to 8 bits can be selected.

Continuous transmission, reception, and transmission/reception

Maximum transfer rate: 300 kbps

Serial 2 (Full duplex UART / Synchronous serial interface)

Synchronous serial interface

Parity check, Overrun error detection

Transfer clock source: 1/2 and 1/16 of timer 0 underflow,
1/2 and 1/16 of timer 1 underflow,
1/2 and 1/16 of timer 2 underflow,
1/2 and 1/16 of timer 3 underflow, SBT2 pin

Can be selected as the first bit to be transferred, Any transfer size from 7 to 8 bits can be selected.

Maximum transfer rate: 3.0 Mbps

Full duplex UART

Parity check, Overrun and flaming error detection

Transfer clock source: 1/16 of timer 0 underflow, 1/16 of timer 1 underflow,
1/16 of timer 2 underflow, 1/16 of timer 3 underflow

Can be selected as the first bit to be transferred, Any transfer size from 7 to 8 bits can be selected.

Maximum transfer rate: 375 kbps

Serial 3 (Full duplex UART / Synchronous serial interface)

Synchronous serial interface

Parity check, Overrun error detection

Transfer clock source: 1/2 and 1/16 of timer 0 underflow,
1/2 and 1/16 of timer 1 underflow,
1/2 and 1/16 of timer 2 underflow,
1/2 and 1/16 of timer 3 underflow, SBT3 pin

Can be selected as the first bit to be transferred, Any transfer size from 7 to 8 bits can be selected.

Maximum transfer rate: 3.0 Mbps

Full duplex UART

Parity check, Overrun and flaming error detection

Transfer clock source: 1/16 of timer 0 underflow, 1/16 of timer 1 underflow,
1/16 of timer 2 underflow, 1/16 of timer 3 underflow

Can be selected as the first bit to be transferred, Any transfer size from 7 to 8 bits can be selected.

Maximum transfer rate: 375 kbps

■ Features (continued)

• Regulator

Incorporates regulator, and use of 5 V power supply is possible

• Power Supply Detection

Detection level 3.7 V to 4.4 V

When power supply voltage is under detection level, reset is generated.

• Port / pins

(MN103SFK0K)

I/O ports	84 pins
Motor control output	12 pins
External interrupt	16 pins
A/D input	20 pins
Special pins	16 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Test pin	3 pins
Power pin	10 pins

(MN103SFK1K)

I/O ports	64 pins
Motor control output	12 pins
External interrupt	12 pins
A/D input	16 pins
Special pins	16 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Test pin	3 pins
Power pin	10 pins

• Package

(MN103SFK0K)

QFP100-P-1818B (18 mm square, 0.65 mm pitch)

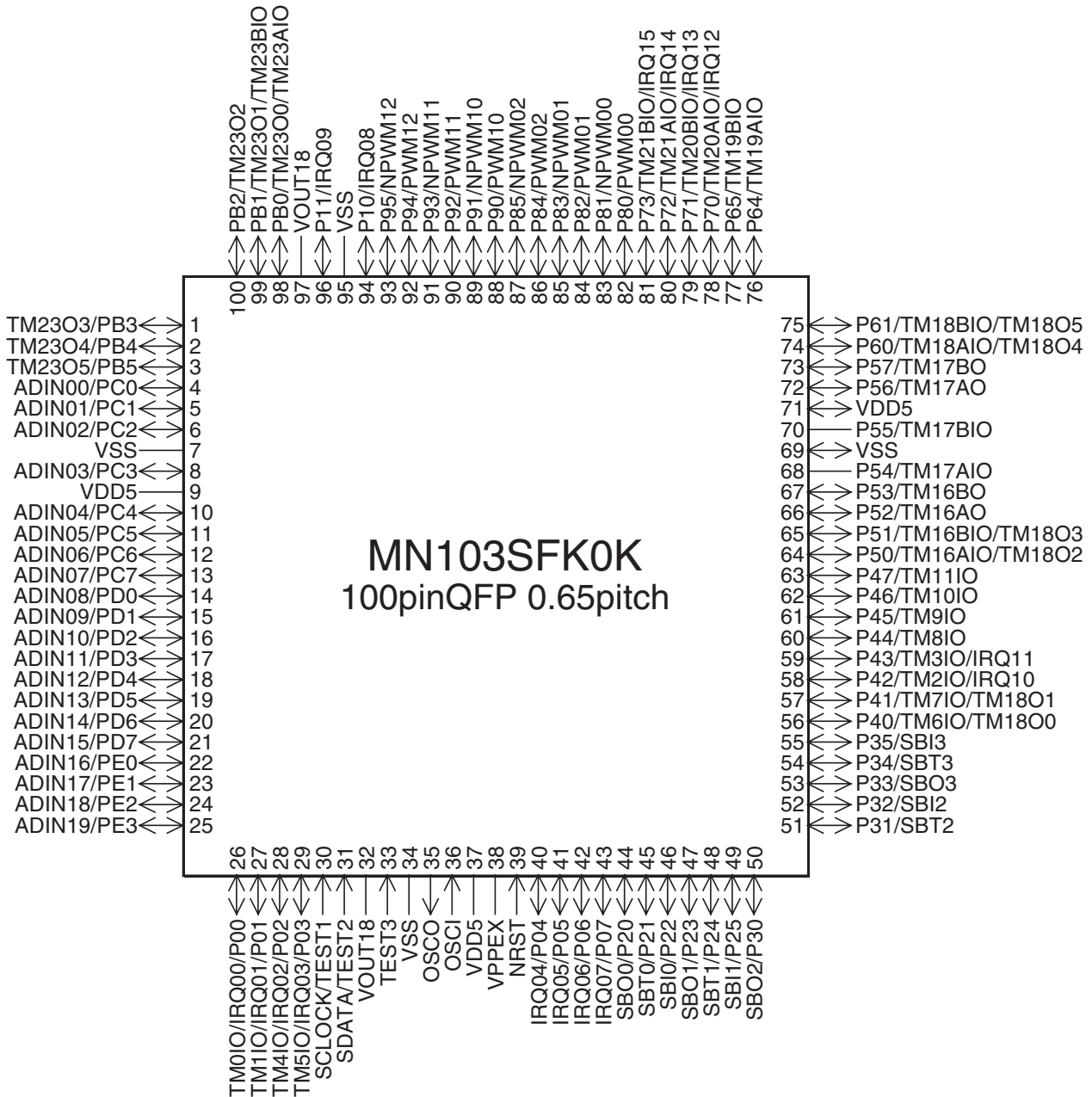
(MN103SFK1K)

LQFP080-P-1414A (14 mm square, 0.65 mm pitch)

TQFP080-P-1212D (12 mm square, 0.50 mm pitch)

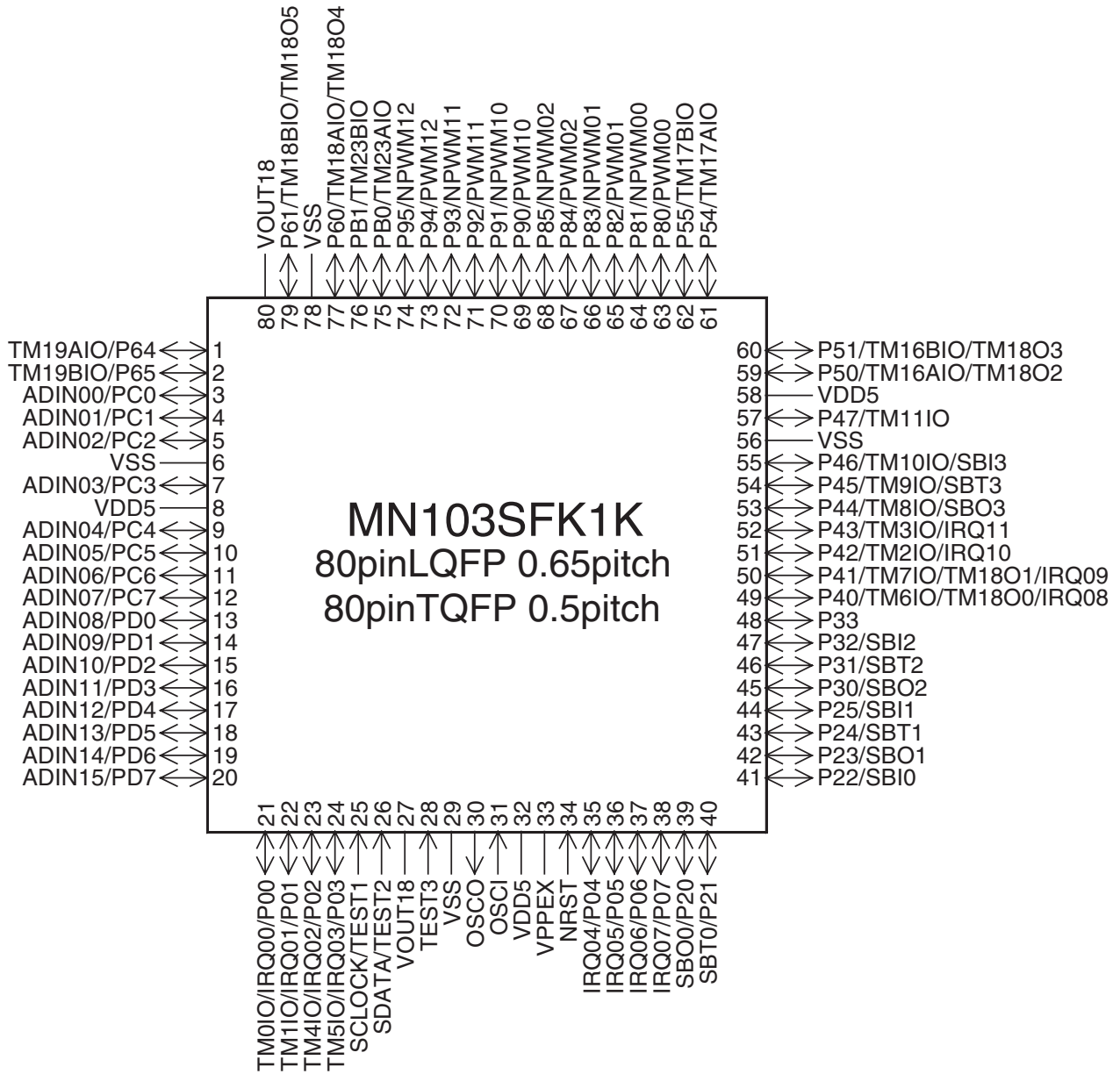
■ Pin Description (continued)

- MN103SFK0K (QFP100-P-1818B)



■ Pin Description (continued)

- MN103SFK1K (LQFP080-P-1414A, TQFP080-P-1212D)



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