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 consective overflow

■ Features (continued)

- A /D Converter

  Minimum conversion time 1.0 µs

  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)

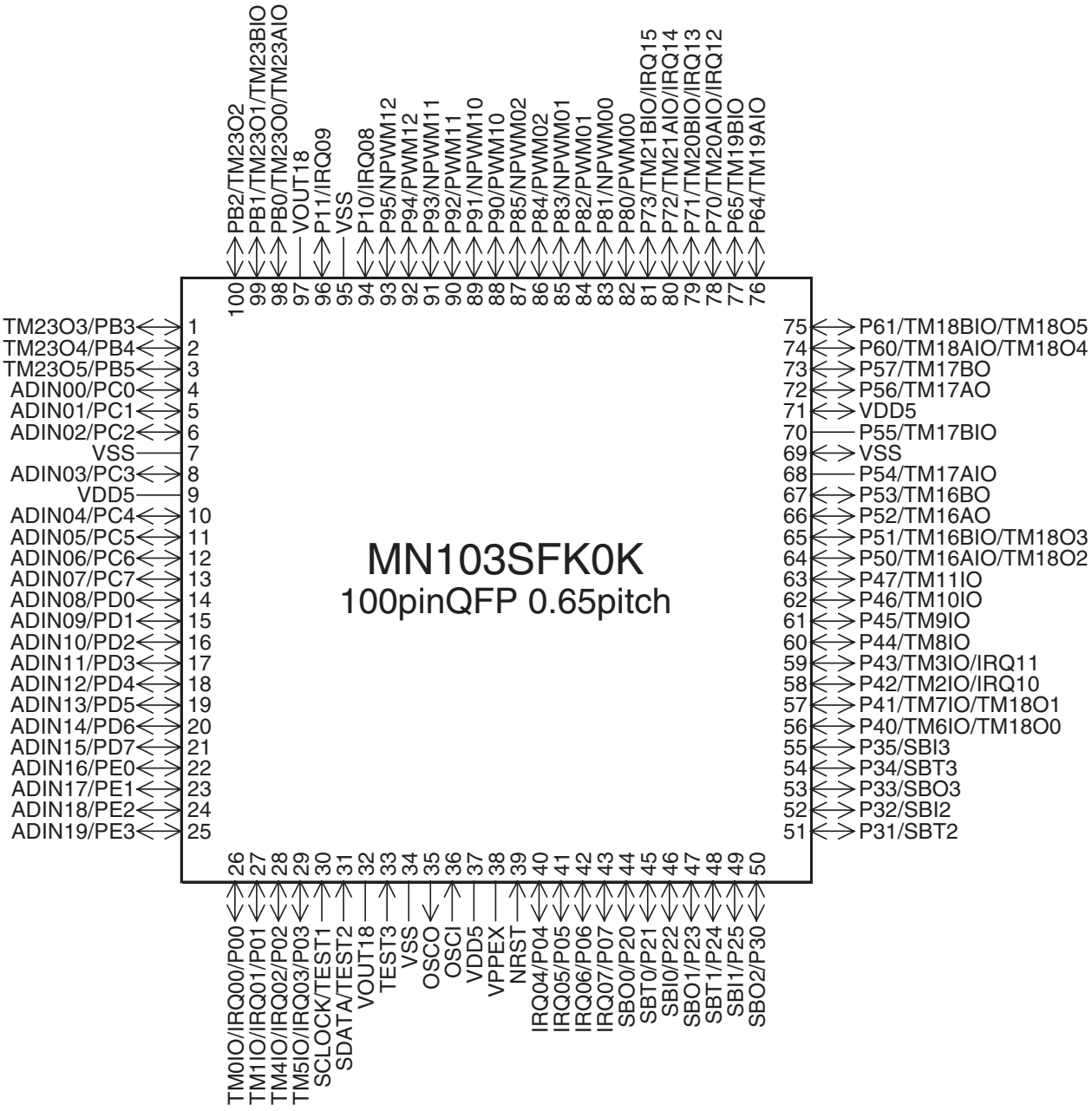
  (MN103SFK1K)

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

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

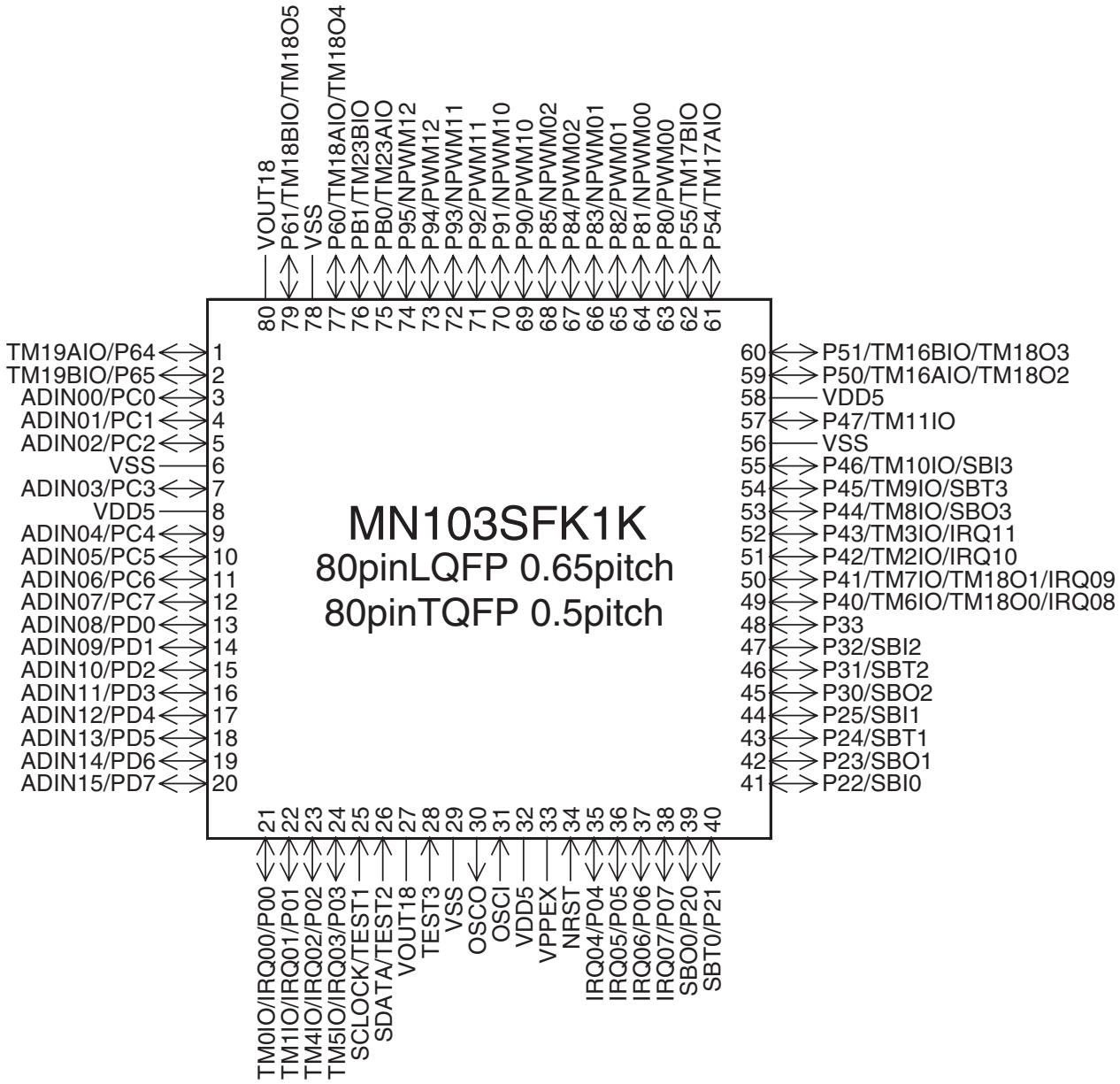
■ Pin Description (continued)

• MN103SFK0K (QFP100-P-1818B)



■ Pin Description (continued)

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



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