MN103SJ7/N0/N1/N2/N4/N5/N6 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, DMA controller, 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 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 LSI 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	Pins	Timer (8bit/ 16bit)	PWM	Serial I/F	A/D	VGA	Package
MN103SFJ7A	32 KB	2 KB	TQFP48	8/1	1	2	2	—	TQFP48-P-0707B
MN103SFN0D	64 KB	4KB	QFP44 TQFP48	8/2	1	2	2	—	QFP044-P-1010F TQFP48-P-0707B
MN103SFN0X		8 KB							
MN103SFN0G	128 KB	6 KB							
MN103SFN0Y		8 KB							
MN103SFN1D	64 KB	4 KB	TQFP64	12/3	2	3	2	—	TQFP064-P-1010C
MN103SFN1X		8 KB							
MN103SFN1G	128 KB	6 KB							
MN103SFN1Y		8 KB							
MN103SFN2D	64 KB	4 KB	TQFP80	12/5	2	3	2	—	TQFP080-P-1212D
MN103SFN2X		8 KB							
MN103SFN2G	128 KB	6 KB							
MN103SFN2Y		8 KB							
MN103SFN4D	64 KB	4 KB	QFP44 TQFP48	8/2	1	2	2	1	QFP044-P-1010F TQFP48-P-0707B
MN103SFN4X		8 KB							
MN103SFN4G	128 KB	6 KB							
MN103SFN4Y		8 KB							
MN103SFN5D	64 KB	4 KB	TQFP64	12/3	2	3	2	2	TQFP064-P-1010C
MN103SFN5X		8 KB							
MN103SFN5G	128 KB	6 KB							
MN103SFN5Y		8 KB							
MN103SFN6D	64 KB	4 KB	TQFP80	12/5	2	3	2	2	TQFP080-P-1212D
MN103SFN6X		8 KB							
MN103SFN6G	128 KB	6 KB							
MN103SFN6Y		8 KB							

■ Features

- CPU core

  MN103S core
  4 GB of address space (for instructions / data)
  LOAD/STORE architecture with 5-stage pipeline
  46 basic instructions + 8 extension instructions
  6 addressing modes
  Instruction set of 1 byte in word length
  Extension arithmetic unit incorporated (high-speed multiply instruction, high-speed division instruction etc.)
  Machine cycle: 16.7 ns (oscillation frequency: 10 MHz, 6 multiplying)
  Operation mode: NORMAL mode, SELLP mode, HALT mode, STOP mode

- Oscillation Circuit

  External oscillation (crystal/ ceramic)
  Clock multiply circuit Oscillation clock can be multiplied by from 3 to 12

- Internal memory

  ROM: 32 K/64 K/128 K bytes RAM: 2 K/4 K/6 K/8 K bytes
  The ROM/RAM size is different in each product.
  Please refer to [■ Product Summary] for details.

- DMA Controller

  Number of channels: 1 channel
  Startup sources: 15 sources (MN103SFN0/N4 series)
  20 sources (MN103SFN1/N5 series)
  22 sources (MN103SFN2/N6 series)
  (External interrupts: Max 12 sources, Serial Interface: Max 9 sources, Software start: 1 source)
  Transfer modes: 3 modes (One word transfer, Burst transfer, Intermittent transfer)
  *: There is not the function in the MN103SFJ7A.

- Interrupts

  Non-maskable interrupts
  Watchdog timer overflow interrupts
  System error interrupts
  Fail safe function interrupts
  Internal interrupts (Level interrupt)
  MN103SFJ7A: 23 interrupts
  MN103SFN0/N4 series: 29 interrupts
  MN103SFN1/N5 series: 42 interrupts
  MN103SFN2/N6 series: 48 interrupts

  <Timer Interrupts>
  Timer 0 underflow interrupt
  Timer 1 underflow interrupt
  Timer 2 underflow interrupt
  Timer 3 underflow interrupt
  Timer 4 underflow interrupt
  Timer 5 underflow interrupt
  Timer 6 underflow interrupt
  Timer 7 underflow interrupt
  Timer 8 underflow interrupt
  Timer 9 underflow interrupt
  Timer 10 underflow interrupt
  Timer 11 underflow interrupt
  Timer 16 overflow/underflow interrupt
  Timer 16 compare/capture A interrupt

■ Features (continued)

<Timer Interrupts> (continued)
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

<Serial Interface>
Serial 0 reception end interrupts
Serial 0 communication/transmission end interrupts
Serial 1 reception end interrupts
Serial 1 communication/transmission end interrupts
Serial 2 reception end interrupts
Serial 2 communication/transmission end interrupts

<PWM>
PWM0 overflow interrupts
PWM0 underflow interrupts
PWM0 synchronous A/D start A
PWM0 synchronous A/D start B
PWM1 overflow interrupts
PWM1 underflow interrupts
PWM1 synchronous A/D start A
PWM1 synchronous A/D start B

<A/D>
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

<DMA>
DMA transfer end interrupt
DMA request after DMA transfer end interrupt
DMA transfer request overflow interrupt

External interrupts:

MN103SFJ7A	:	4 interrupts
MN103SFN0/N4 series	:	8 interrupts
MN103SFN1/N5 series	:	10 interrupts
MN103SFN2/N6 series	:	12 interrupts

External interrupt pins	:	From IRQ00 to IRQ11
Interrupt detection condition	:	Each edge, both edges, high-level and low-level detection Each interrupt detection condition is able to filtering with the noise filter

■ Features (continued)

- Timer counter

8-bit timer	8	sets (MN103SFJ7A, MN103SFN0/N4 series)
	12	sets (MN103SFN1/N5, MN103SFN2/N6 series)
16-bit timer	1	sets (MN103SFJ7A)
	2	sets (MN103SFN0/N4 series)
	3	sets (MN103SFN1/N5 series)
	5	sets (MN103SFN2/N6 series)

Timer 0 (8-bit timer)
Interval timer, Timer pulse output, Event count, Baud rate timer
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM0IO pin input, Timer 1 underflow, Timer 2 underflow

Timer 1 (8-bit timer)
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, TM1IO pin input, Timer 0 underflow, Timer 2 underflow

Timer 2 (8-bit timer)
Interval timer, Timer pulse output [*1], Event count [*1], Baud rate timer, Cascade connection (connected to Timer 1)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM2IO pin input [*1], Timer 0 underflow, Timer 1 underflow

Timer 3 (8-bit timer)
Interval timer, Timer pulse output [*1], Event count [*1], Baud rate timer, Cascade connection (connected to Timer 2)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM3IO pin input [*1], Timer 0 underflow, Timer 1 underflow, Timer 2 underflow

Timer 4 (8-bit timer)
Interval timer, Timer pulse output, Event count
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM4IO pin input, Timer 5 underflow, Timer 6 underflow

Timer 5 (8-bit timer)
Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 4)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM5IO pin input, Timer 4 underflow, Timer 6 underflow

Timer 6 (8-bit timer)
Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 5)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM6IO pin input, Timer 4 underflow, Timer 5 underflow

Timer 7 (8-bit timer)
Interval timer, Timer pulse output, Event count, Cascade connection (connected to Timer 6)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM7IO pin input, Timer 4 underflow, Timer 5 underflow, Timer 6 underflow

Timer 8 (8-bit Timer) [*2]
Interval timer, Timer pulse output [*3], Event count [*3]
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM8IO pin input [*3], Timer 9 underflow, Timer 10 underflow

■ Features (continued)

- Timer counter (continued)

Timer 9 (8-bit timer) *2
Interval timer, Timer pulse output *3, Event count *3, Cascade connection (Connected to Timer 8)
Count clock source : IOCLK, IOCLK/8, IOCLK/32, IOCLK/128, TM9IO pin input *3,
Timer 8 underflow, Timer 10 underflow

Timer 10 (8-bit timer) *2
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) *2
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)
Interval timer, Event count, Up/down count, Timer output, PWM output, Input capture, one-shot output, External trigger start
Start by PWMn overflow interrupt, PMWn underflow interrupt, A/D conversion start trigger generation
Count clock source : IOCLK, IOCLK/8, Timer 6 underflow, Timer 7 underflow, TM16BIO pin input

Timer 17 (16-bit timer) *2 , *4
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) *5
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, IOCLK/64, Timer 7 underflow, TM18BIO pin input

Timer 19 (16-bit timer) *2
Interval timer, Event count, Up/down count, Timer output, PWM output, Input capture, one-shot output, External trigger start
Start by PWMn overflow interrupt, PWMn underflow interrupt, A/D conversion start trigger generation
Count clock source : IOCLK, IOCLK/8, Timer 10 underflow, Timer 11 underflow, TM19BIO pin input

Timer 20 (16-bit timer) *2 , *4
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 6 underflow, Timer 7 underflow, TM20BIO pin input

Note) *1: The function using the TMnIO pin (n = 2, 3) cannot be used by the MN103SFN0/N4 series.
*2: There is not the function in the MN103SFN0/N4 series.
*3: The function using the TMnIO pin (n = 8, 9) cannot be used by the MN103SFN1/N5 series.
*4: There is not the function in the MN103SFN1/N5 series.
*5: There is not the function in the MN103SJ7A.

■ Features (continued)

- 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

- A /D Converter

  A/D0
    Resolution 10 bits
    Minimum conversion time 0.5 µs
    Analog input 5 channels (AD0IN00 to AD0IN04)
    A/D conversion start trigger is in synchronization with complementary 3-phase PWM cycle and 16-bit timer
  A/D1
    Resolution 10 bits
    Minimum conversion time 0.5 µs
    Analog input
      MN103SFJ7A : 3 channels (AD1IN00 to AD1IN02)
      MN103SFN0/N4 series: 3 channels (AD1IN00 to AD1IN02)
      MN103SFN1/N5 series: 7 channels (AD1IN00 to AD1IN06)
      MN103SFN2/N6 series: 11 channels (AD1IN00 to AD1IN10)
    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
    A/D conversion start trigger, 16-bit timer start trigger

- VGA

  VGA
    MN103SFN4 series 1 sets
    MN103SFN5/N6 series 2 sets
  The gain of eight stages can be set (2.05, 3.03, 4.00, 4.98, 5.96, 7.90, 9.83, and 19.40times)
  Offset voltage cancel cansel function(short-circuit or switching)

■ Features (continued)

- Serial Interface 3 channels

Serial 0 (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, SBT0 pin
  - Can be selected as the first bit to be transferred, Any transfer size from 2 to 8 bits can be selected.
  - Can be continuously transmitted, received or transmitted and received.
  - Maximum transfer rate: 5.0 Mbps
- Full duplex UART
  - Parity check, Overrun and flaming error detection
  - Transfer clock source:
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 0 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 1 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 2 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 3 underflow,
    - IOCLK/16, 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 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 2 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:
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 0 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 1 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 2 underflow,
    - 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 3 underflow,
    - IOCLK/16, 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

■ Features (continued)

Serial 2 (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, SBT2 pin

Can be selected as the first bit to be transferred, Any transfer size from 2 to 8 bits can be selected.

Continuous transmission, reception and transmission / reception

Maximum transfer rate: 5.0 Mbps

Corresponding to the 4 channel system communication and the SPI communication

Full duplex UART

Parity check, Overrun and flaming error detection

Transfer clock source

1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 0 underflow,
1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 1 underflow,
1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 2 underflow,
1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 of timer 3 underflow,
IOCLK/16, 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

- Regulator

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

- Power Supply Detection

Detection level 3.6 V to 4.3 V

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

■ Features (continued)

- Port / pins

(MN103SFJ7A)

I/O ports	28 pins
Motor control output	6 pins
External interrupt	4 pins
A/D input	6 pins
Input ports	
VGA, A/D input	2 pins
Special pins	14 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Mode pin	2 pins
Debug pin	2 pins
Power pin	7 pins

(MN103SFN0/N4 series)

I/O ports	28 pins
Motor control output	6 pins
External interrupt	8 pins
A/D input	6 pins
Input ports	
VGA, A/D input	2 pins
Special pins	14 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Mode pin	2 pins
Debug pin	2 pins
Power pin	7 pins

(MN103SFN1/N5 series)

I/O ports	46 pins
Motor control output	12 pins
External interrupt	10 pins
A/D input	8 pins
Input ports	
VGA, A/D input	4 pins
Special pins	14 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Mode pin	2 pins
Debug pin	2 pins
Power pin	7 pins

(MN103SFN2/N6 series)

I/O ports	60 pins
Motor control output	12 pins
External interrupt	12 pins
A/D input	12 pins
Input ports	
VGA, A/D input	4 pins
Special pins	16 pins
Reset input pin	1 pin
Oscillation pin	2 pins
Mode pin	2 pins
Debug pin	2 pins
Power pin	9 pins

■ Features (continued)

- Package

(MN103SFJ7A)

TQFP048-P-0707B (7 mm square, 0.5 mm pitch)

(MN103SFN0/N4 series)

QFP044-P-1010F (10 mm square, 0.8 mm pitch)

TQFP048-P-0707B (7 mm square, 0.5 mm pitch)

(MN103SFN1/N5 series)

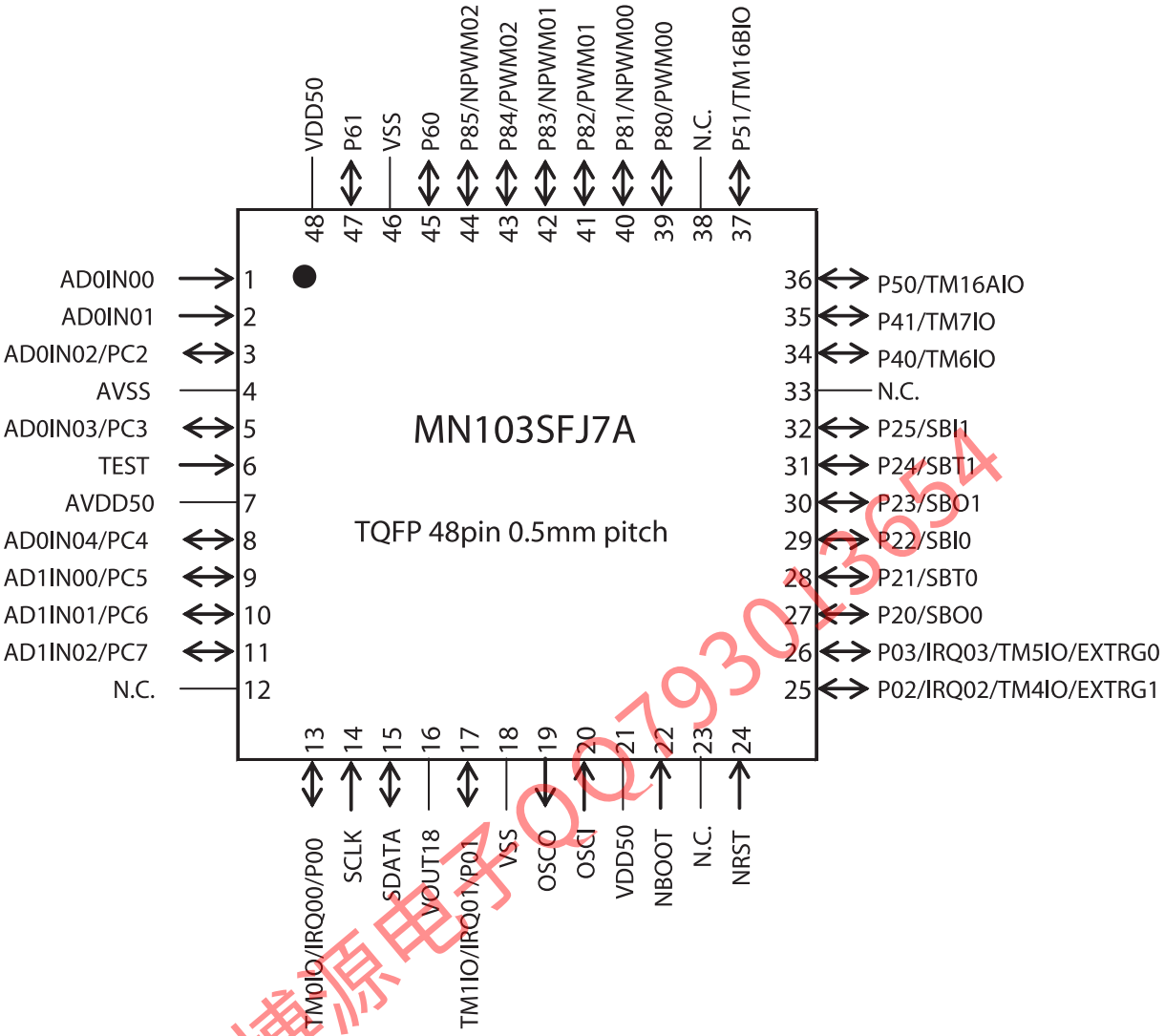
TQFP064-P-1010C (10 mm square, 0.5 mm pitch)

(MN103SFN2/N6 series)

TQFP080-P-1212D (12 mm square, 0.5 mm pitch)

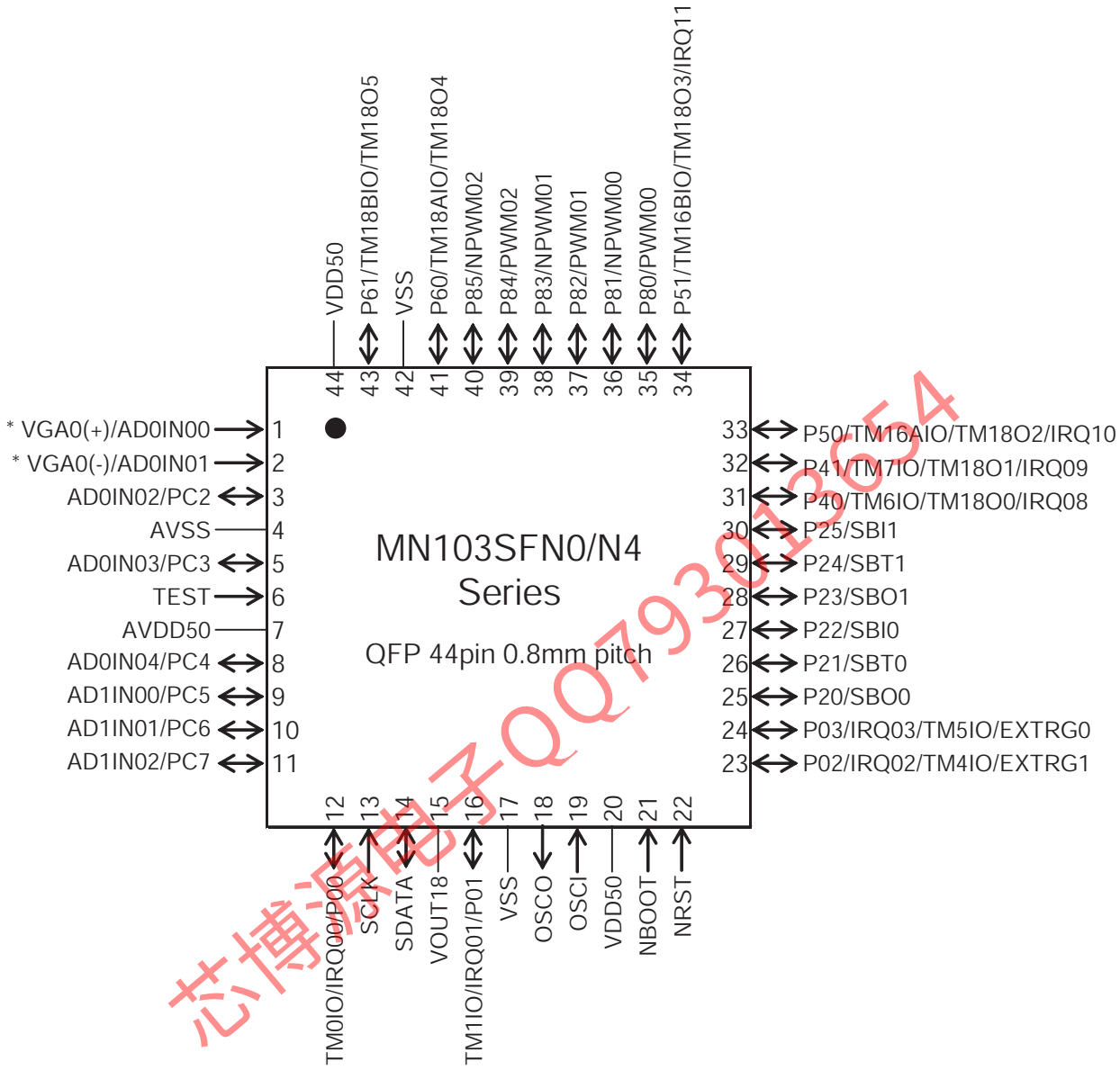
■ Pin Description

- MN103SFJ7A (TQFP048-P-0707B)



■ Pin Description (continued)

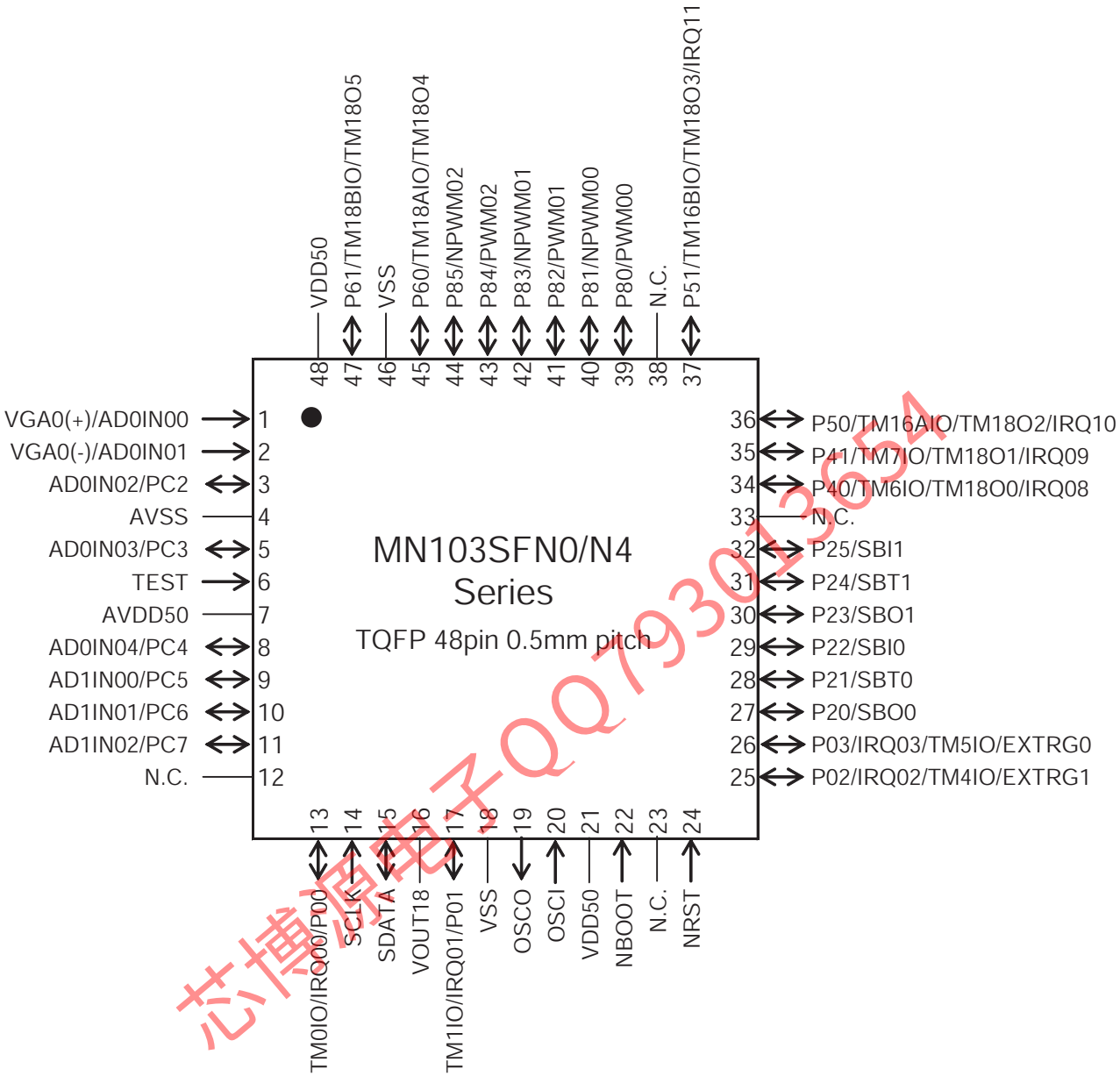
• MN103SFN0/N4 Series (QFP044-P-1010F)



* VGA is not in the MN103SFN0 series.
1,2 pin of MN103SFN0 series are the dedicated input pin for A/D converter.

■ Pin Description (continued)

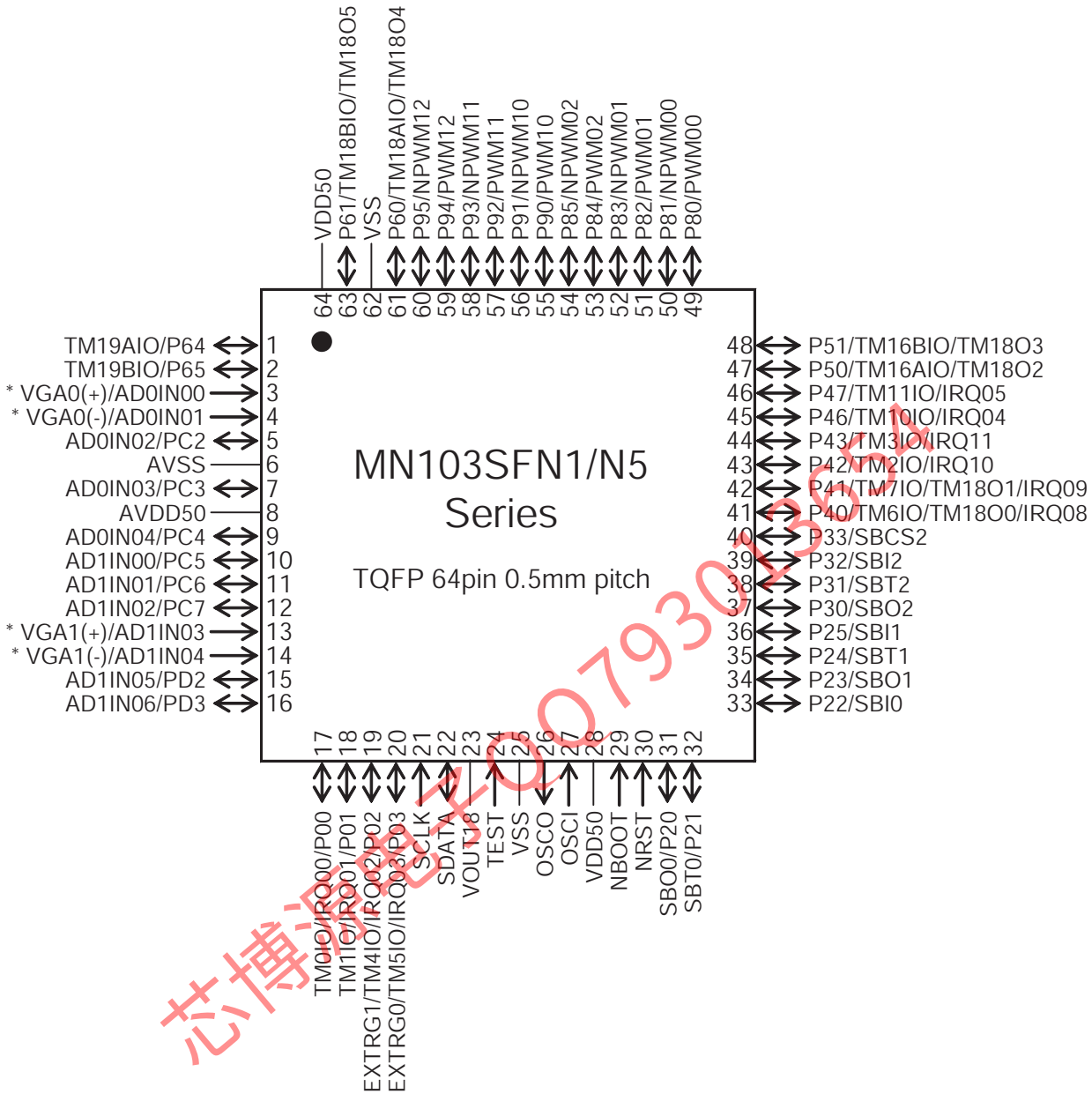
• MN103SFN0/N4 Series (TQFP048-P-0707B)



* VGA is not in the MN103SFN0 series.
1,2 pin of MN103SFN0 series are the dedicated input pin for A/D converter.

■ Pin Description (continued)

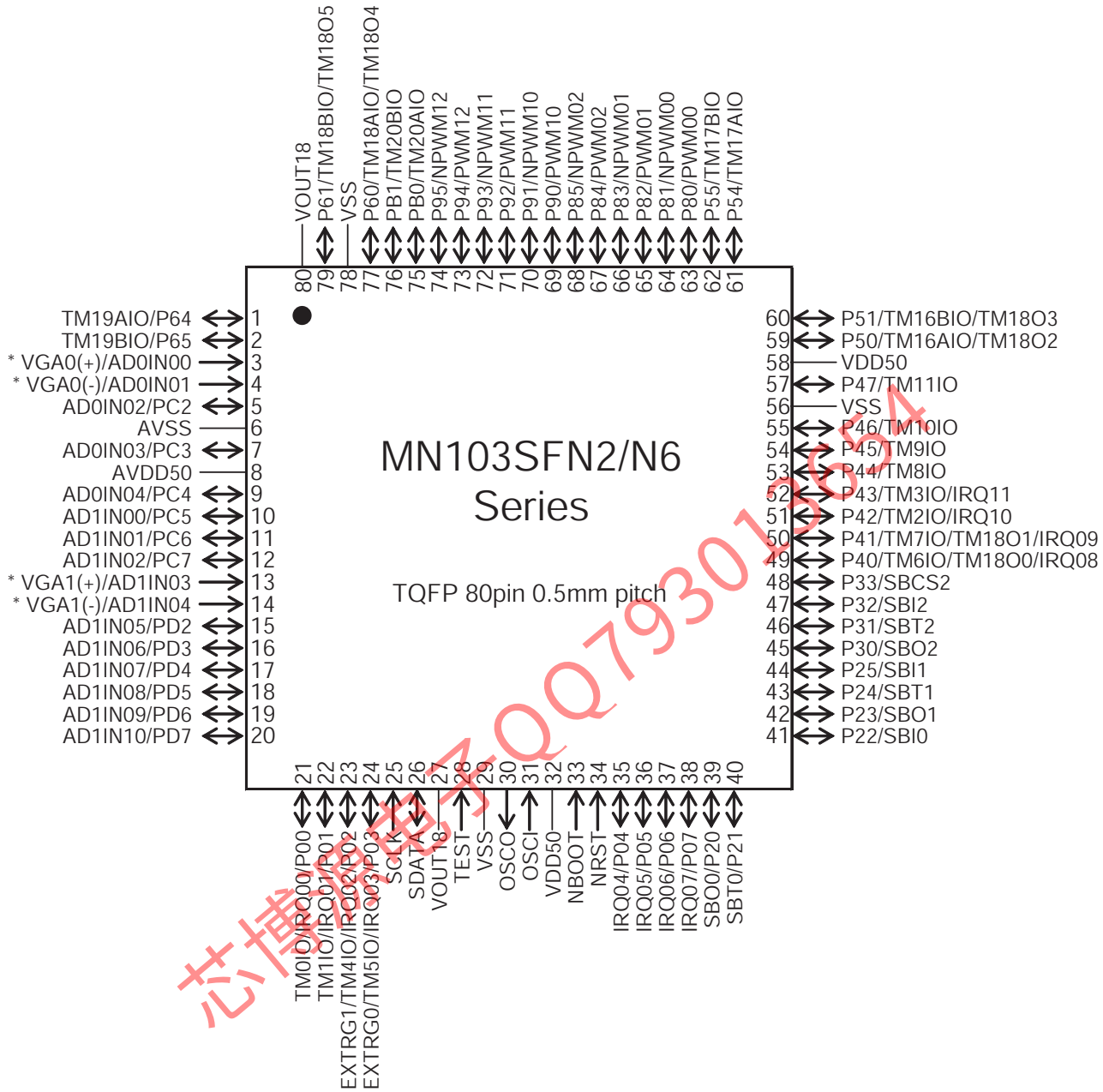
• MN103SFN1/N5 Series (TQFP064-P-1010C)



* VGA is not in the MN103SFN1 series.
3,4,13,14 pin of MN103SFN1 series are the dedicated input pin for A/D converter.

■ Pin Description (continued)

• MN103SFN2/N6 Series (TQFP080-P-1212D)



* VGA is not in the MN103SFN2 series.
3,4,13,14 pin of MN103SFN2 series are the dedicated input pin for A/D converter.

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