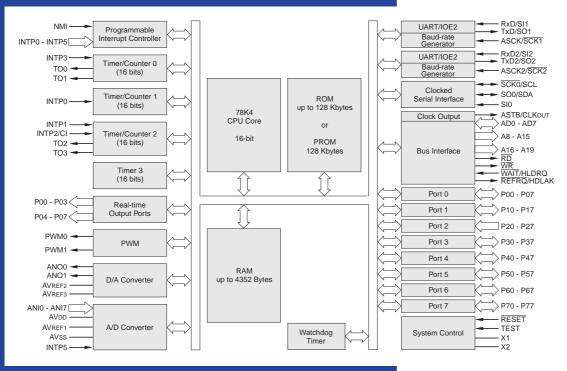# 78K4 family

Product Letter

µPD78403x

16-bit Microcontrollers

Description

The µPD78403x microcontrollers are members of NEC's 16-bit 78K4 family. This family is pin-compatible to the predecessor 78402x and 7823x families. They also offer an easy migration path from NEC's 78K0 8-bit microcontrollers for applications requiring large on-chip memory and high processing performance.

Applications

µPD78403x devices are designed for use in printers, telephones and DC motor control applications.

Features

- ROMless version available
- Up to 128 Kbytes Mask ROM and PROM versions
- Up to 4352 bytes RAM
- 1 Mbyte linear address space
- 125 ns instruction cycle time at 32 MHz
- Bit manipulation over the entire address space
- 3 serial interfaces including 2 UARTs
- 8-channel A/D converter
- 2-channel D/A converter
- 8-channel real-time output port

- 4 x 16-bit timer/counter
- 2-channel PWM output with 12-bit resolution
- 64 I/O pins (46 for ROMless version)
- Interrupt controller (4 programmable priority levels)
- External memory interface with bus hold function
- Clock prescaler (enabled by software)
- Standby control (HALT, IDLE, STOP mode)
- Power supply voltage: 2.7 – 5.5 V
- 80-pin QFP and TQFP packages

Block Diagram

Functional Block Description

CPU

The 78K4 CPU features 8 general register banks with 8 x 16-bit or 16 x 8-bit registers plus 4 x 8-bit registers for 24-bit address expansion. The general-purpose registers are mapped to the internal RAM. Register banks can be switched by software or context switching. Registers can be manipulated in 8-bit units. Pairs of 8-bit general-purpose registers can be manipulated in 16-bit units. For 24-bit address expansion, four of the 16-bit registers can be combined with 8-bit registers. High speed instruction fetch is made possible by a prefetch queue with 5 bytes for internal fetch and 3 bytes for external fetch.

Memory

µPD78403x devices have a 1 Mbyte linear address space and offer an ample choice of on-chip memory combinations, including a ROMless version and a PROM version (see table).

Ports

ROM/PROM-based devices have 8 (8) input pins, 64 (48) input/output pins, 24 (8) of which are capable of directly driving LEDs. 54 (32) input/output pins have internal pull-up resistors that can be enabled via software. 8 port pins can drive Darlington transistors directly. Numbers in brackets apply to ROMless versions.

Real Time Output Ports

An interrupt generated by a timer/counter or an external interrupt causes these ports to output data which has previously been stored in a buffer for a jitter-free pulse output.

A/D Converter

An 8-channel A/D converter with 8-bit resolution is provided on chip using successive approximation. The overall power consumption of the system can be reduced by disabling the A/D resistor chain.

D/A Converter

A 2-channel D/A converter with 8-bit resolution uses the R-2R resistor ladder method. The D/A converter can be used in real-time mode. In this case, analog voltage output is synchronized with the output trigger. This mode allows sine wave generation.

Serial Interface

Three serial interfaces include two full-duplex UARTs with on-chip baud rate generators (conforming to RS232). The maximum UART speed is 2 Mbps. The additional CSI (Clocked serial Interface) supports data transfer of up to 1.44 Mbps and can be used in I^2C mode (at 400kHz) on the µPD78403xY.

Timer

All devices have 4 channels of 16-bit timers controlled by 7 interrupts. All timers are equipped with a capture register and three timers can be used as event counters and feature additional compare registers. Two timers are able to output PWM/PPG or pulses. The on-chip watchdog timer monitors CPU operation.

PWM Output

Two channels of PWM output circuits with 12-bit resolution are provided. At this resolution PWM frequencies up to 62.5KHz can be generated. Both channels can select either a high or low active level. These outputs are ideal for controlling the speed of DC motors.

Clock Generator

The on-chip clock generator oscillates at frequencies between 2 and 32 MHz.

Interrupt Controller

Powerful interrupt handling capability is based on a macro service, context switching and vectored interrupts. An external non-maskable interrupt is provided. The interrupt controller handles the different maskable and non-maskable interrupt requests issued by internal peripheral hardware (17 sources plus 1 for I^2C version) or external devices (6 sources plus 1 for I^2C version).

Ordering Information

Devices

Order Number	ROM (Kbytes)	PROM (Kbytes)	RAM (bytes)
µPD784031	None	—	2048
µPD784035	48	—	2048
µPD784036	64	—	2048
µPD784037	96	—	3584
µPD784038	128	—	4352
µPD78P4038	—	128	4352

Device orders must specify the package code GC (QFP 14 x 14 mm), GK (TQFP 12 x 12 mm) or KK-T. (LCC, for OTP only). All devices are also available with I²C bus. The part number of I²C devices is obtained by adding a 'Y' before the package code.

Documentation

Doc Number	Devices	Type
U11933EE3V0CD00	NEC Microcontrollers	CD-ROM
U11316EJ3V0UM00	µPD784031, µPD784035/6/7	User's Manual Hardware
U10741EJ1V0PM00	µPD784035Y/6Y/7Y	PPI
U10905EJ6V0UM00	78K4 Series (instructions)	User's Manual Software
U16847EJ2V0DS00	µPD784035/6/7	Data Sheet
U11507EJ1V0DS00	µPD784031	Data Sheet
U11504EJ1V0DS00	µPD784031Y	Data Sheet
U10742EJ1V0PM00	µPD78P4038Y	Data Sheet
U10848EJ1V0DS00	µPD78P4038	Data Sheet
U13285EJ1V0AN00	µPD78403x	Application note (HW basics)

Tools

Order Number	Description	Type
CCMSD-I3HD-784xx	C Compiler/Assembler	Software
DSWIN-I3HD-784xx	Simulator	Software
DIWIN-I3HD-784xx	GUI Debugger	Software
IE-78400-R, IE-78400-R-EM, IE-70000-PC-IF-C	In-circuit Emulator	Hardware
IE-784038-R-EM1	Emulation Board	Hardware
EP-78230GC-R	Emulation Probe	Hardware
EP-78054GK-R	Emulation Probe	Hardware
EV9200GC-80	LCC Socket	Hardware
TGK-080SDW	LCC Socket	Hardware
PA-78P4026GC	Programming Adapter	Hardware
PA-78P4026GK	Programming Adapter	Hardware
PA-78P4026KK-T	Programming Adapter	Hardware
FLASHMASTER	Flash Programmer	Hardware

For further information on NEC's 78K4 family or other NEC products visit our European website at **www.nec.de**

μPD78403x

16-bit Microcontrollers

NEC Offices

NEC Electronics (Europe) GmbH, Oberrather Str. 4, D-40472 Düsseldorf,
Tel. (02 11) 65 03 01, Fax (02 11) 65 03-3 27

NEC Electronics (Germany) GmbH, Kanzlerstr. 2, D-40472 Düsseldorf,
Tel. (02 11) 65 03 02, Fax (02 11) 65 03-4 90
- Königstr. 12, D-30175 Hannover, Tel. (05 11) 3 34 02-0, Fax (05 11) 3 34 02-34
- Arabellastr. 17, D-81925 München, Tel. (0 89) 92 10 03-0, Fax (0 89) 91 31 82
- Industriestr. 3, D-70565 Stuttgart, Tel. (07 11) 9 90 10-0, Fax (07 11) 9 90 10-19

NEC Electronics (BNL) - Boschdijk 187a, NL-5612 HB Eindhoven,
Tel. (0 40) 2 44 58 45, Fax (0 40) 2 44 45 80

NEC Electronics (Scandinavia) - Täby Centrum, Entrance S (7th floor),
S-18322 Täby, Tel. (08) 6 38 08 20, Fax (08) 6 38 03 88

NEC Electronics (France) S.A., 9, rue Paul Dautier, B.P. 187,
F-78142 Velizy-Villacoublay Cédex, Tel. (01) 30 67 58 00, Fax (01) 30 67 58 99

NEC Electronics (France) S.A., Representacion en Espana,
Juan Esplandiu 15, E-28007 Madrid, Tel. (01) 5 04 27 87, Fax (01) 5 04 28 60

NEC Electronics Italiana S.R.L., Via Fabio Filzi, 25A, I-20124 Milano,
Tel. (02) 66 75 41, Fax (02) 66 75 42 99
- Rome Office, Via Monte Cervialto, 131, I-00139 Roma,
  Tel. (06) 8 86 22 91/2, Fax (06) 8 86 22 39

NEC Electronics (UK) Ltd., Cygnus House, Sunrise Parkway, Milton Keynes,
GB-MK14 6NP, Tel. (0 19 08) 69 11 33, Fax (0 19 08) 67 02 90
- Scotland Office, Block 3, Carfin Industrial Estate, Motherwell GB-ML1 4UL,
  Tel. (0 16 98) 73 22 21, Fax (0 16 98) 83 38 68

With compliments