The 64-bit VR4181™ (µPD30181) RISC microprocessor is an NEC VR Series™ device created specifically for Windows® CE-based palm-size PC/smart phone applications. Designed using the popular MIPS® RISC architecture and revolutionary Modular Bus Architecture (MBA), the VR4181 offers excellent power consumption and performance in a highly integrated, low-cost system-on-a-chip (SOC).

The VR4181 microprocessor is the second NEC device to use the ultra-low-power-consuming 66-MHz VR4110™ CPU core based on advanced 0.25-micron technology. The VR4110 CPU has an optimized five-stage pipeline, 4-KB instruction cache, 4-KB data cache, multiply-and-accumulate (MAC) unit, and memory management unit that enable high performance in a compact, low-cost chip.

The VR4181’s integrated peripherals include an LCD controller, CompactFlash™ interface, power management unit, DMA unit, interrupt control unit, timers, real-time clock, one 16550-compatible serial interface, IrDA® 1.0 interface, keyboard interface, touch-panel interface, universal serial bus (USB) functional interface, A/D converter, and D/A converter.

The VR4181 microprocessor complies with the MIPS I, II, and III instruction set architectures (ISAs) and MIPS16 application-specific extension (ASE). The MIPS16 ASE compliance enables the VR4181 to incorporate 16-bit-long instruction format with conventional 32-bit-long instruction support, which results in compact code size, smaller memory foot print, and lower system cost.

The VR4181 is an excellent choice for palm-size PC designers because its high performance, compact size, and low power consumption make it ideal for use in battery-driven, portable handheld systems.
**Vr4110 CPU CORE**
- MIPS III ISA-compliant
- MIPS 16 ASE-compliant for compact code density
  (40% denser code than MIPS32)
- Five-stage pipeline running up to 66 MHz
- Single-cycle MAC instruction for digital signal
  processing operations

**MEMORY MANAGEMENT UNIT**
- 32-bit physical address range of 4 GB with
  40-bit virtual address space
- 32 double-entry TLBs supporting 1~256 KB page sizes
- Up to 64 MB of SDRAM/EDO/fast-page DRAM and
  64 MB of SROM/flash memory/mask ROM
- Up to 66 MHz operation

**CACHE MEMORY UNIT**
- 4-KB direct-mapped instruction cache
- 4-KB direct-mapped data cache
- Write-back cache for reducing store operations

**BUS CONTROL UNIT**
- Ultra-power-saving Modular Bus Architecture (MBA)
- 32-bit and 16-bit addressing modes
- Dynamic bus sizing supports subset of ISA bus

**POWER MANAGEMENT UNIT WITH** **FOUR POWER-SAVING MODES**
- Full speed
- Standby
- Suspend
- Hibernate

**CLOCK GENERATOR UNIT**
- Built-in PPL for frequency multiplication
- External bus frequency of 16 and 33 MHz

**SERIAL INTERFACE UNIT**
- One 16550-compatible channel
- RS-232C compliant
- Up to 115 kbps

**OTHER PERIPHERALS**
- Real-time clock with four built-in timers
- Interrupt control unit with internal and external
  interrupts
- DMA address unit and DMA control unit with
  four different channels
- General-purpose I/O unit
- 64-key keyboard interface
- 12-bit A/D converter for touch-panel interface
  and audio input
- Infrared unit: IrDA 1.0 standard communication
- Audio interface unit and 10-bit D/A converter for
  audio output and microphone input sampling
- USB function interface: file/data synchronization with
  a desktop/laptop systems

**AC/DC Specifications**
- 66 MHz maximum frequency
- 2.5- and 3.3-volt operation
- <250-mW typical power consumption

**PACKAGE**
- Compact size: 16 x 16 x 1.3 mm
- 160-pin LQFP

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**Palm-Sized PC Implementation**

- Vr4181
- 66 MHz
- Flash Memory
- SDRAM
- Serial Connection
- Touch-Panel Interface
- Microphone
- LCD Panel
- LED
- IR
- USB Interface
- Buffer
- Compact Flash
## VR4111, VR4121, AND VR4181 COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>VR4111</th>
<th>VR4121</th>
<th>VR4181</th>
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</thead>
<tbody>
<tr>
<td><strong>CPU Core</strong></td>
<td>VR4110</td>
<td>VR4120</td>
<td>VR4110</td>
</tr>
<tr>
<td><strong>Max. Pipeline Clock</strong></td>
<td>70 MHz</td>
<td>168 MHz</td>
<td>66 MHz</td>
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<tr>
<td><strong>Cache Size</strong></td>
<td>16K instruction cache</td>
<td>16K instruction cache</td>
<td>4K instruction cache</td>
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<tr>
<td></td>
<td>8K data cache</td>
<td>8K data cache</td>
<td>4K data cache</td>
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<tr>
<td><strong>Performance</strong></td>
<td>90 Dhrystone MIPS</td>
<td>215 Dhrystone MIPS</td>
<td>85 Dhrystone MIPS</td>
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<tr>
<td><strong>Instruction Set</strong></td>
<td>MIPS I, II, III</td>
<td>MIPS I, II, III</td>
<td>MIPS I, II, III</td>
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<td></td>
<td>MIPS 16</td>
<td>MIPS 16</td>
<td>MIPS 16</td>
</tr>
<tr>
<td><strong>MAC Instruction</strong></td>
<td>Single-cycle, 16-bit</td>
<td>Single-cycle, 32-bit</td>
<td>Single-cycle, 16-bit</td>
</tr>
<tr>
<td><strong>Operating Voltage</strong></td>
<td>2.5 V (core), 3.3 V (I/O)</td>
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<tr>
<td><strong>Integrated Peripherals</strong></td>
<td>Same</td>
<td>Same</td>
<td>Same plus: CompactFlash™ Interface LCD controller USB functional interface</td>
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<tr>
<td><strong>Memory Interface</strong></td>
<td>64 MB DRAM</td>
<td>64 MB DRAM</td>
<td>64 MB DRAM</td>
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<tr>
<td></td>
<td>64 MB ROM</td>
<td>64 MB ROM</td>
<td>64 MB ROM</td>
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<tr>
<td><strong>Power Consumption</strong></td>
<td>185 mW</td>
<td>300 mW</td>
<td>250 mW</td>
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<tr>
<td><strong>Package</strong></td>
<td>224-pin FPBGA</td>
<td>224-pin FPBGA</td>
<td>160-pin LQFP</td>
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<tr>
<td><strong>Process Technology</strong></td>
<td>0.25-micron</td>
<td>0.25-micron</td>
<td>0.25-micron</td>
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<td></td>
<td>UC2 process</td>
<td>UC2 process</td>
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