High Power Processing in the world of PC/104:

The Embedded PC Based on a High Performance RISC Processor - Renesas SH4

When it comes to processors, the PC/104 Standard seems to be devoted entirely to the x86 family from AMD or Intel. As proof that this does not always have to be the case, Emtrion has developed a successor to its proven 486 Embedded PC that is based on the Renesas SH4. This new version leaves the experts baffled due to its even lower power consumption and a factor 10 increase in processing power. The module generated a great deal of attention during its first presentation at the embedded systems show 2001 in Nuremberg.

Although most x86 based PC/104 CPU modules are sufficient for a variety of applications, the demand for high performance processing in embedded applications is growing significantly. The processing capabilities of x86 processors in these applications are quite often inadequate. Process visualization systems for the automation industry, web applications, simulation programs and consumer electronics products all have a tendency to use system features focusing on multimedia aspects, which in turn contributes to the demand for processing power. Sometimes however, the main system requirement is only that of speed and the ability to boot up within seconds after switching on. Having to wait 15 to 20 seconds for the system to boot in these applications would be unacceptable. In general, high performance processors are readily available, but at a high price. And, since in the embedded area, processor activity is often associated with the consumption of a limited energy resource, power consumption is nearly always a major issue.

Unbelievable but True - So Many MIPS at Such Low Power

The beginning of 2000 saw developers searching for a high performance processor for their next PC/104 generation. Focusing on the above-mentioned requirements, they made an overwhelming choice for the SH4 processor belonging to the Renesas SuperH family. The particular device chosen was the 167 MHz clocked HD6417750-167, which delivers over 250 MIPS at a power consumption of only 1.5 W. Comparative measurements made with a regular Pentium III 500 reveal that around 300 MIPS can be achieved – of course with the necessary cooling. However, the low power consumption of the SH4 eliminates the need for heat dissipation measures such as a fan or heat sink. The excellent capabilities of this Renesas processor are currently demonstrated in various products such as Sega's Dreamcast Game Console. Even in the game area, high performance processing is a must - e.g. in 3D animations.

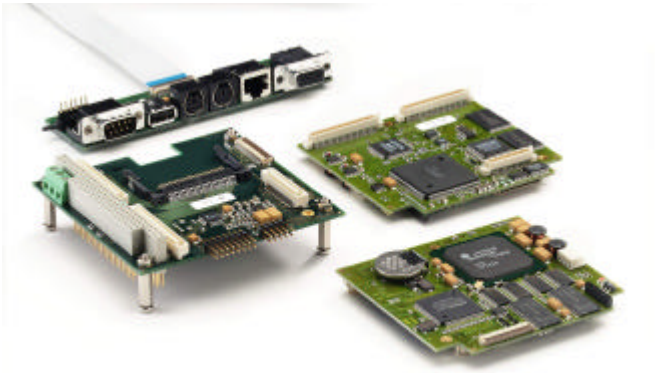
The Aero 8000 from Compaq is also equipped with an SH4. This product was described as the fastest Windows CE computer around in a comparative test in a Windows CE journal.

The Renesas SuperH family of processors is well established in the world of embedded development. As an example, the official Windows CE reference platform is based on the SH3 processor – a less performance version of the SH4. Beginning with the SH1, the processor family has been constantly improved and developed, resulting in the SH2, SH3 and the current flagship - the SH4. The performance of these RISC processors has now reached a stage where they can be utilized in applications that are far beyond the capabilities of the x86 standard. Contrary to the PC world, the issue of binary compatibility in embedded systems is of little significance. Developers are often quite happy to do without using an "open" PC system in exchange for an embedded system that has been optimized for quality, reliability and safety with respect to the desired application.

However, what is of importance is the user interface. This should be intuitive and straightforward to use, thus guaranteeing efficient operation of the product. This objective can easily be achieved when running the Windows CE 4.0 operating system on a Renesas SH4 based platform.

Emtrion's Two Board Design Offers Maximum Flexibility

Emtrion's HiCO-SH4 is a high performance low power embedded PC comprising of a core and a carrier module. The core module contains the SH4 processor, together with a HD64465 companion chip and all the essential system components. This includes 16 MB Flash , 16 MB or 64 MB RAM, USB controller, interfaces for PS/2 keyboard, mouse and serial channels as well as audio logic. The VGA graphics hardware includes 1.2 MB of video memory and it supports both LCD and CRT displays. Other onboard interfaces include Ethernet and an ISA bus interface. The core module's fine-pitch connectors allow it to be mounted to any suitable carrier board. The carrier board supplied by Emtrion has a PC/104 interface (16-Bit), a Compact Flash socket as well as a color LCD interface. The two-board design allows application specific modifications to take place without the need to redesign the processor module. Emtrion also provides a connector module that is attached via a flat foil cable. This module incorporates numerous connectors to the outside world that facilitate both quick prototyping in the lab as well as convenient external connectivity in production models.



The advantages of using PC/104 technology are only fully realized when individual PC/104 modules are combined to form a new extensive system. To serve this purpose, engineers at Emtrion have developed several PC/104 modules providing digital I/Os, field-bus interfaces, additional processor intelligence, flash memory, etc. This modular building block principle allows a rapid cost-effective customization of embedded systems to suit the respective application.

Rapid Software Development with Standard Packages

The HiCO-SH4 offers numerous options for its software development. Applications can be created using Visual C++ or Visual Basic. An assortment of development environments incorporating compliers and cross-debuggers are available, such as GNU or Greenhills. Furthermore, the choice of real-time embedded operating systems is vast and includes QNX, OS9, Linux, VxWorks and Windows CE just to mention the most well known. It was the availability of a Windows operating system that caused engineers at Emtrion to strongly favor the

SH4 processor. Emtrion's famous Starterkits for Windows CE with the HiCO486 already forms the basis of many customer applications. The experience Emtrion has attained from the use of this product clearly shows that the modern system designer is primarily interested in efficient rapid application development and would gladly abandon tedious drawn out methods of programming. Windows CE has proved that it is ideal for integrating complex IT technologies into the embedded world.

When developing applications for the Windows CE operating system, a developer is usually already familiar with the IDE (Integrated Developer Environment) used, since it is compatible with that used for the Windows-9x/NT operating systems. No specialized knowledge on the organization of the embedded system is required, and amount of detailed knowledge required on the processor's registers and protected mode addressing is now less than ever.

The real-time operating system Windows CE offers 256 thread priorities as well as nested interrupts, which allow an effective control of complex processes. Standard versions of the OS support COM/DCOM, web server functions, TCP/IP stack and a great deal more. Emtrion offers complete starter kits for the HiCO-SH4, including an LCD display with touch screen, development environment, sample programs with source code, etc.

The markets for products using such a high performance PC/104 module are almost unlimited and cover all areas of industry, ranging from automation technology (e.g. in the implementation of process visualization systems, complex multi-axis or NC controllers and data gateways), vehicle navigation systems, image processing, multimedia devices to play MP3 files and video clips to sophisticated slot machines for casinos and arcades.

Figure 1: PC/104 technology running at over 250 MIPS: A Renesas SH4 high performance processor with minimum power consumption allows modern embedded applications to achieve impressive performance.

Figure 2: Sega Dreamcast: The consumer world moves on – a marriage of Renesas SH4 and Windows CE bring high processing power into the living room.

Figure 3: Already known to the embedded development world for years, the SuperH family from Renesas has been constantly improved and developed. The SH4, now the current flagship, will eventually be replaced by the SH5.

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