Extending TI's Hercules™ MCUs with the integrated flexible HET

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Many embedded systems have an array of timing needs. These needs range from simple input captures to complex pulse trains. Simple hardware timers are acceptable for input captures, output compares, and PWM generation. More complex timing functions are typically generated with external ASICs or FPGAs. These external devices increase cost, power, complexity, and board space.

There are often times as you design your system that it is not clearly known how many serial communication interfaces will finally be needed in the embedded application. Sometimes this can lead to selecting a controller that maybe over-kill for what you need – just to be on the safe side. Having some flexibility to easily extend the serial communication resources on a controller can help with avoiding an over design situation.

The High-End Timer (HET) is a programmable timer co-processor available on TI's high-performance ARM® Cortex®-R based Hercules Microcontrollers (MCU). The HET operates concurrent to the CPU leaving the CPU performance for other tasks. The HET enables sophisticated timing functions for real-time control applications. It can implement classic time functions such as input capture or multiple PWMs, and also higher level timing functions. The programmable nature of the HET allows it to be used to implement several flavors of serial communication protocols such as SPI, I2C, UART as well as more advanced serial communication interfaces such as EnDAT 2.2, SENT and more. Specific end equipment timing needs can also be implemented such as High Speed Capture/Pulse Train Output for Factory Automation PLC.

High End Timer Descriptions and Features

The HET available on both TMS570 and RM high-performance ARM® Cortex®-R based Hercules MCUs is a fifth-generation TI advanced intelligent timer module that provides an enhanced feature set compared to previous generations. The timer consists of a specialized micromachine that executes its own reduced instruction set. The reduced instruction set, based mostly on very simple, but comprehensive instructions, improves the definition and development cycle time of an application and its derivatives. Two 25-bit registers and three 32-bit registers are available to manipulate information such as time, event counts, and angle values. High-resolution hardware channels allow greater accuracy for widely used timing functions such as period and pulse measurements, output compare, and PWMs. The HET breakpoint feature, programmable in each instruction and combined with various stop capabilities, makes the HET software application easy to debug.

Table 1 lists key features of the HET.

Programmable timer for input and output timing functions
Reduced instruction set (29 instructions) for dedicated time and angle functions
Up to maximum of 256 96-bit words of instruction RAM protected by parity
User defined configuration of 25-bit virtual counters for timer, event counters and angle counters
7-bit hardware counters for each pin allow up to 32-bit resolution in conjunction with the 25-bit virtual counters
Up to 32 pins per HET instance usable for input signal measurements or output signal generation
Programmable suppression filter for each input pin with adjustable suppression window
Low CPU overhead and interrupt load
Efficient data transfer to or from the CPU memory with dedicated High-End-Timer Transfer Unit (HTU)
Diagnostic capabilities with different loopback mechanisms and pin status read back functionality

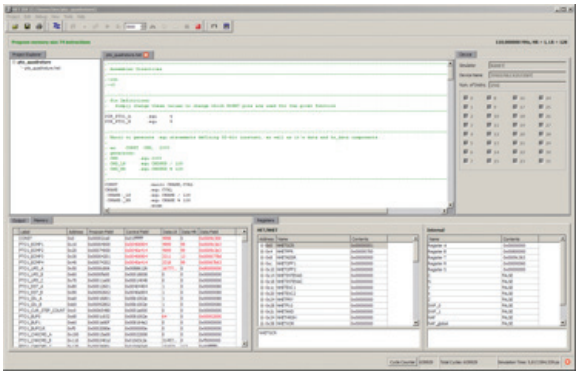
Table 1: *TI programmable HET key features*

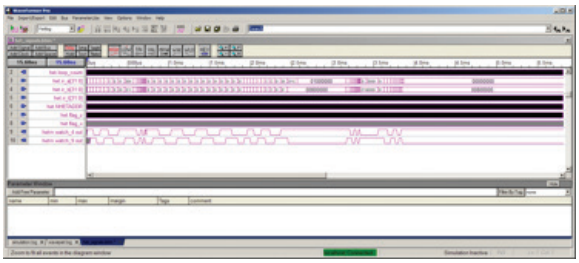
Moving data between the RAM and HET

Many timer applications that run on the HET can require a lot of data to be exchanged between the HET and the host CPU. This data exchange is managed by a dedicated transfer unit called the High-End Timer Transfer Unit (HTU). The HTU has a dedicated access port on the HET memory and can access this memory without contention with any other bus masters (CPU, DMA, etc). The HTU works in synchronization with the HET to manage transfers between the HET RAM and any other memory, usually the CPU RAM

Easy HET software development

The HET IDE makes it easy to develop your own timer programs. You can begin by using the new project wizard to select the Hercules MCU that you wish to target. The Algorithm Library wizard lets you select from a library stocked with commonly used timing functions that you can insert into your own application. If you decide to create your own completely new algorithms, the Insert Instruction wizard is available to speed you along the learning curve of HET assembly syntax. Once you have your HET Program written, the HET IDE allows you to assemble the code and load it into the HET simulator with a click of a button. In the simulator environment, you have full visibility to all internal memory and registers, and you can single step through each instruction to understand exactly how your program works and waveform viewer allows you to quickly trace and visualize the execution of your program.





To test your program, a Memory Trigger editor allows you to simulate CPU reads & writes to the HET memory. A Stimulus editor allows you to quickly simulate external events on any of the HET input pins. If you need even more capability, the HET IDE works with Synapticad Waveformer Pro which allows you to draw, model, or capture stimulus from a logic analyzer and feed the stimulus to your HET program during a simulation. A 90 day Evaluation license for Waveformer Pro is available through Synapticad for all registered HET IDE users.

Kickstart your Creativity

TI experts have created six new HET applications notes. The application notes include an explanation of how to implement any function(s) using the HET and the code examples making it easy to get started.

PWM Generation and Input Capture Using HALCoGen
Monitor PWM outputs using N2HET
Triggering ADC Using Internal Timer Events on Hercules MCUs
Sine Wave Generation Using PWM With Hercules N2HET and HTU
Triangle/Trapezoid Wave Generation Using PWM With Hercules N2HET
Interfacing Quadrature Encoders Using the High-End Timer on Hercules MCUs

Table 2: *HET application notes for ease of implementation*

Get Started Now – For Free

There is no need to wait – you can download the HET IDE for free and start creating your own custom timer programs right now. If you need a bit more help getting started, do HET IDE projects to quickly get you up and running, so that you can become a HET expert in no time at all. Want to get started quickly with hardware as well? The HET IDE can export your custom HET program directly into HALCoGen, the free code generator for Hercules MCUs. All you need to purchase is a Hercules Launchpad and you'll be able to test your HET Program in simulation and on actual hardware.

Download the HET IDE at
www.ti.com/tool/het_ide

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