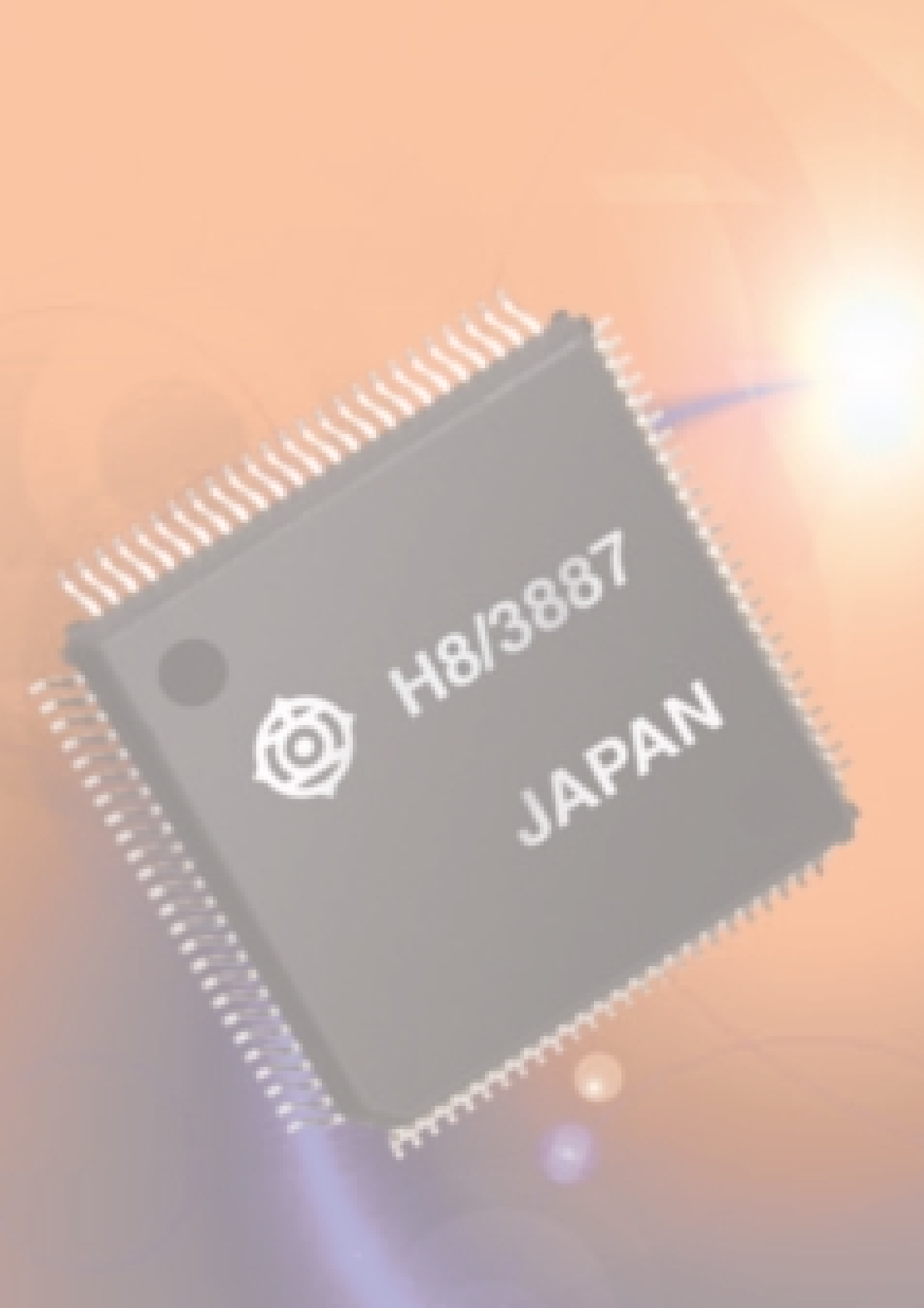
October 1999

H8/300 and H8/300L

8-Bit

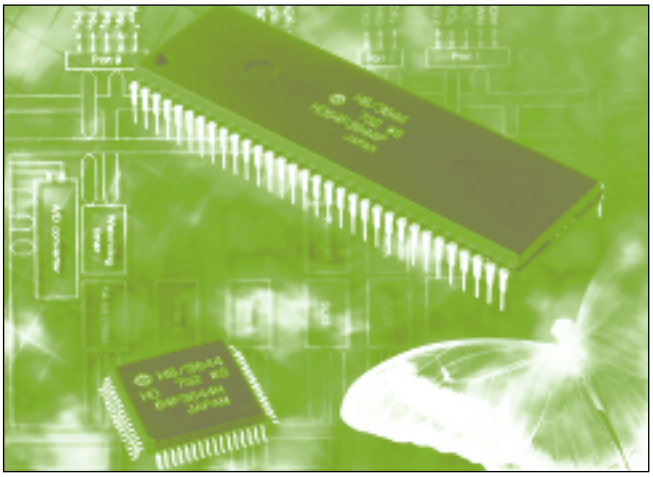
Microcontrollers

HITACHI


H8/3887
JAPAN

H8/300 and H8/300L

16-Bit Microcontrollers



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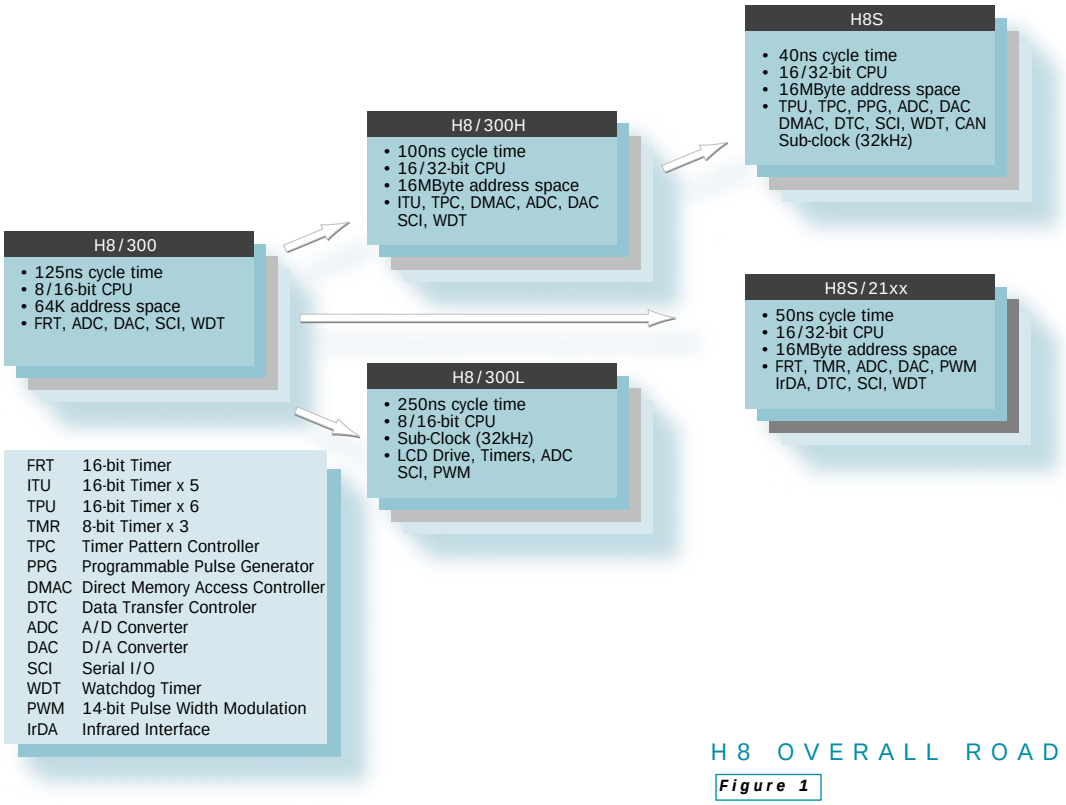
Welcome **To**

Hitachi's H8 microcontroller family has grown to fulfil a wide range of needs in different application areas, from low cost applications such as digital cameras and electricity meters, to high performance motor control and mobile telecoms applications. The H8 family actually comprises of a number of different series of devices, all code compatable, offering different performance levels. *See figure 1*. There are many advantages to choosing a Hitachi Microcontroller, these include

- One common architecture covering a wide variety of applications
- Maintaining your investment in code for the future
- Leveraging Hitachi's expertise in low power and low cost applications
- A wide range of low cost, easy to use development tools
- Wide range of low cost Flash devices

Due to the pressures imposed by EMC and board space constraints, on-chip memory becomes ever more important, and the H8 family has a wide range of memory technologies and sizes, including Flash, OTP and mask ROM devices, with ROM sizes from 8 kbytes to 256 kbytes, and RAM from 256 to 16 kbytes. Hitachi has two 8-bit micro-controller families aimed at different applications areas. First the H8/300, is aimed at applications in the industrial, computer and telecoms arenas where high performance is required. The second H8/300L, is aimed at telecom and consumer applications where low power and low cost are the key design criteria. The H8/300 is a powerful 8-bit CPU core optimised for 'C' with a general purpose register architecture. The H8/300's are amongst the fastest 8-bit micro-controllers in the world with a 125nS cycle time. Even though it is an 8-bit device, the internal Data Bus is 16-bit and so many 16-bit operations can be performed. For example a 16-bit addition can be executed in one instruction cycle. The H8/300 family also offers a high level of peripheral integration along with large blocks of on-chip memory, both ROM and OTP and FLASH memory versions being available. *See figure 2*.



H8 OVERALL ROADMAP

Figure 1

H8/300 Roadmap

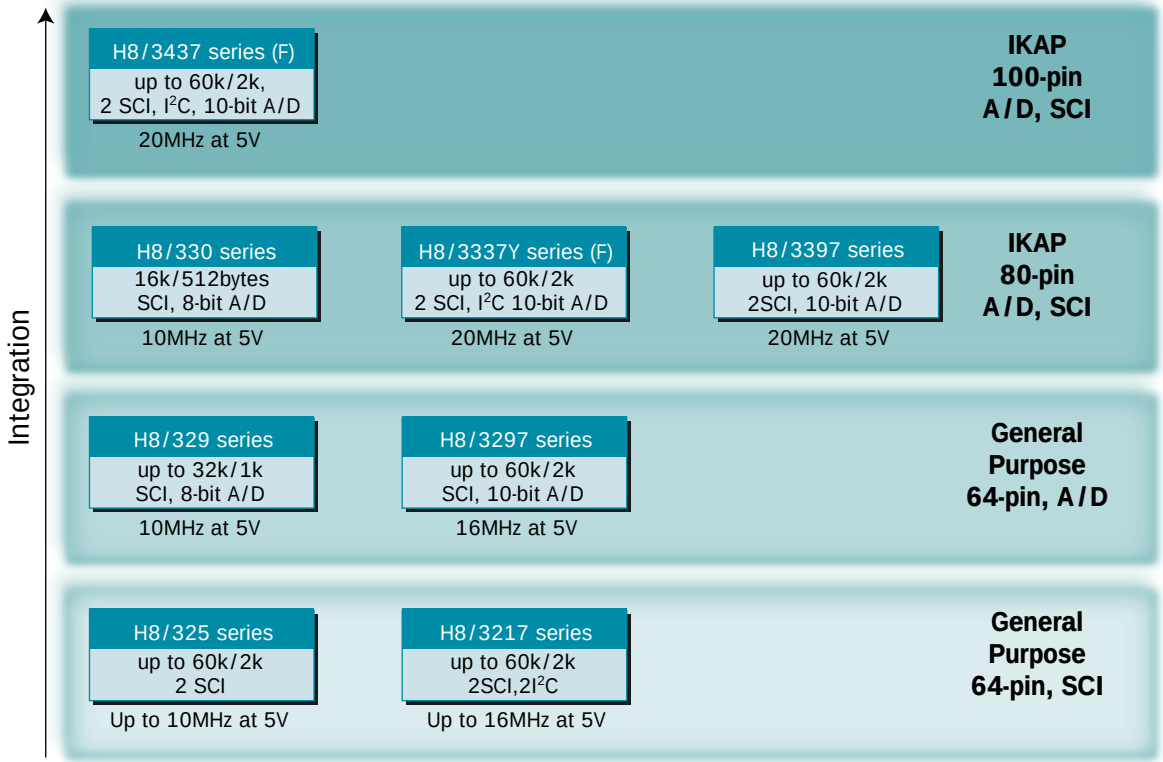


Figure 2 (F) FLASH version available Note: most 5V derivatives are also available in 3V/5MHz or 3V/10MHz

H8/300L Roadmap

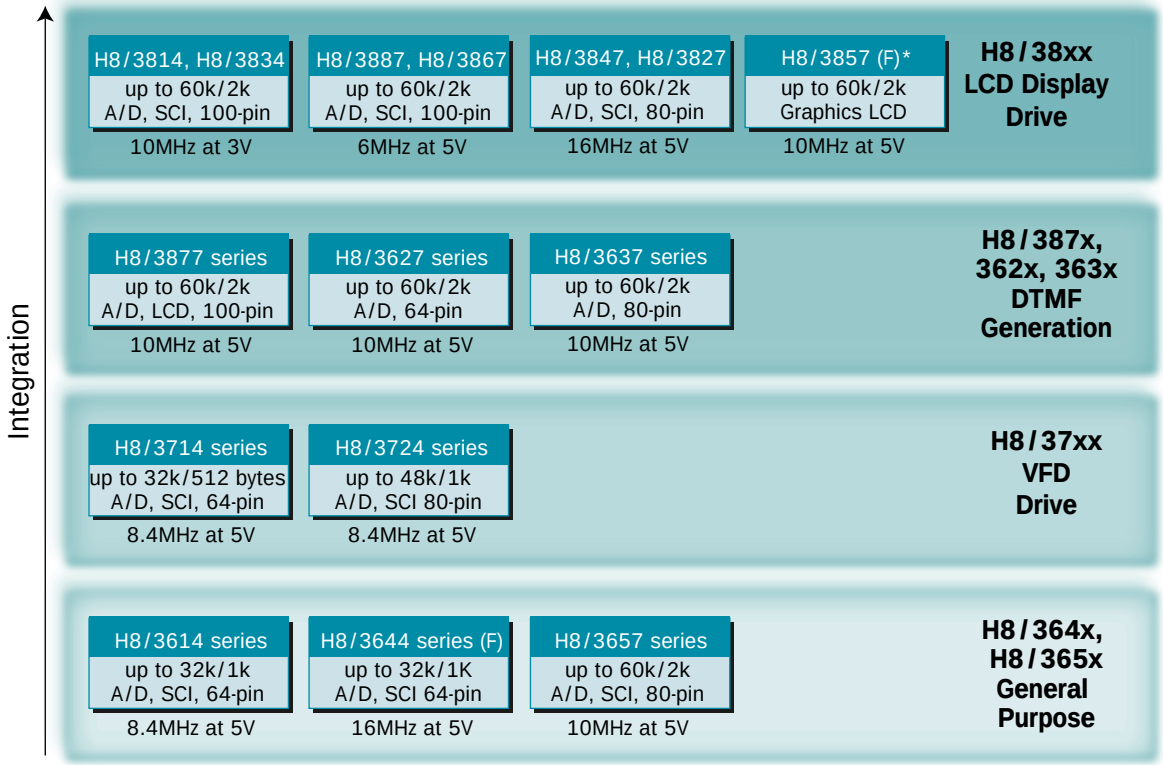


Figure 3 * Under development (F) FLASH version available
Note: 5V H8/300L devices will normally operate down to 2.7v, at lower frequency

With the H8/300L, Hitachi has taken the CPU core from the H8/300 family and integrated it with large on-chip memory blocks and peripherals more typically seen on 4-bit micro-controllers, such as LCD drivers and DTMF generators. These devices have been implemented on a low power, low cost CMOS process, producing highly integrated devices for cost sensitive and battery powered applications, such as meters, cameras and feature phones. The H8/300L family is shown in *figure 3*.
The H8/300H are 16-bit microcontrollers that offer users a performance and memory upgrade from the H8/300 family. The H8/300H CPU is a superset of the H8/300, upward code compatibility allowing users to easily migrate between devices. The H8/300H offers a high speed operation 16-bit CPU core (100 ns minimum instruction cycle time) along with powerful on-board peripherals and a high level of memory integration. The 16-bit CPU core allows the users to access 16 Mbytes of external memory, current on-board memory options are up to 256 kbytes of mask ROM or OTP or 256 kbytes of FLASH memory, and up to 8 kbytes of SRAM. The H8/300H is ideal for many telecoms and motor control applications

The H8S is the latest addition to the H8 range, offering a combination of the highest performance 16-bit CPU (with a 40 ns minimum instruction cycle time) and low power consumption. Two CPU cores are available in the H8S family, the standard core, the H8/2000 and the H8/2600 core, which adds a hardware multiplier and decreases the execution time of certain instructions. The H8/2600 core is particularly useful for applications where DSP functionality is required, such as high end motor control. The H8S instruction set is again a superset of the standard H8/300 instruction set, allowing existing H8 users to easily migrate upwards to higher performance levels.
The H8S has a wide variety of powerful on-board peripherals and currently supports up to 256 kbytes of on-board program memory and 16 kbytes of RAM.
These features make the H8S ideal for many of todays most complex applications and provide an upgrade path for existing Hitachi microcontroller users while maintaining the investment in existing software.
The H8/300H and H8S also offer the ability to generate customer specific microcontrollers using Hitachi's uCBIC (Cell Based IC) technology. This gives the ability to easily produce "pick and mix" microcontrollers with a choice of memory type and size, and a choice of peripherals including timers serial ports etc, and customer specified logic. More details of this can be found in Hitachi's uCBIC customised microcontroller brochure.

H8/300 CPU **Overview**

The H8/300 combines a fast, powerful 8-bit CPU core with a comprehensive range of on-chip peripherals and memory options. The H8/300 has been developed to provide designers with a high performance, integrated solution for a wide range of applications.

The H8/300 CPU is based around a general register architecture. The CPU model is shown in *figure 4*.

Each register can be used for any purpose, holding either data or an address. (The registers can either be addressed as up to 16, 8-bit registers or 8, 16-bit registers). Each CPU register can be used as an accumulator, an index register, an address pointer or as local storage.

Having so many available accumulators makes for a more efficient compiler. The compiler can calculate the address of a variable in a register and in the next instruction use the same register as an address pointer to access the variable. This significantly reduces both the amount of code that is required to perform such an operation as well as decreasing the time to execute the operation. Typical instruction execution times are shown in *table 1*.

Although the H8/300 is based on an 8-bit CPU, its registers and memory can be accessed as 16 bit locations, in fact the internal data bus of the H8/300 is 16-bits wide, giving fast, 2 state word access to memory.

The H8/300 supports three operating modes': single chip mode and expanded mode with either the ROM enable or disabled. These modes are shown in *figure 5*. The modes' of operation are selected by the inputs at the mode pins (MD1 and MD0). In single chip mode, only the on-chip RAM, ROM and register field are used, this mode is very effective in reducing EM emissions as there is no external data bus and control signals. In the expanded modes, access is permitted to external memory and devices. The H8/300L has been developed for low cost, single chip applications, and has no external data bus.

In expanded mode, the H8/300 normally take three states to access external memory, but there is an option to expand the access cycle using an external wait pin, to allow the H8/300 to access slower peripherals. A number of members of the H8/300 family, have a more advanced wait state controller, which allows a three extra modes of operation.

- Programmable Wait Mode, where you can program a number of additional wait states into any external memory access.
- Pin Wait Mode, after the programmed number of wait states, if the WAIT pin is low, then wait states are added until the pin goes high.
- Pin Auto-wait Mode, where the number of wait states programmed into the wait state controller is added if the WAIT pin is low.

All of Hitachi's H8s are supported by Z-TAT (Zero-Turn Around Time) devices. In these microcontrollers, the on-board memory is EPROM rather than mask ROM. These are particularly useful for prototyping and for small to medium volume production runs, and for a quick turn around, for products that need to get to market quickly. Each device in Hitachi's H8 range is supported by at least one, pin compatible Z-TAT device, normally the version with the largest on-chip memory.

Many of Hitachi's H8 Microcontrollers are also available as F-ZTAT devices (Flexible - Zero Turn Around Time), in these devices the mask ROM is replaced

H8 REGISTER SET

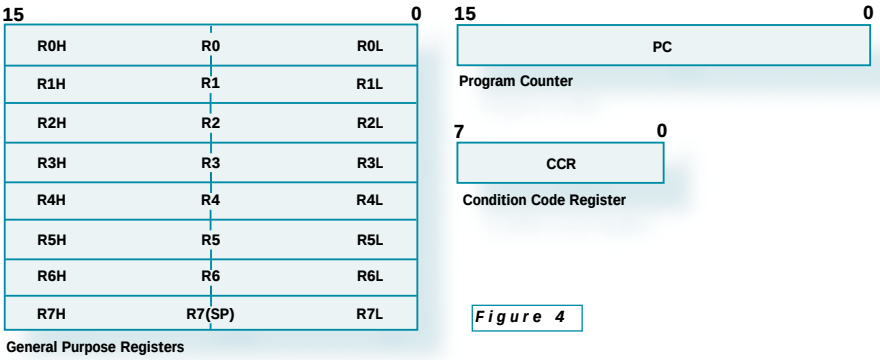


Figure 4

Table 1

H8 INSTRUCTION EXECUTION TIMES

Device	16 + 16 Add	8 x 8 Mult
H8/300 @ 16 MHz	125 nS	875 nS
H8/300L @ 16 MHz	250 nS	1.75 uS

by Flash EPROM. These devices offer the added advantage of in-circuit programmability, which offers easy upgradability for products in the field. Hitachi's H8/300 and H8/300L F-ZTAT devices support a block based memory map, where the flash EPROM, is divided into a number of different sized blocks.

Each of these blocks can be erased or programmed individually, giving the user a great deal of flexibility in choosing the system architecture. The memory map of the H8/3334YF is shown in *figure 6*. The four 128 byte blocks can be used for storing data tables or calibration information, while the other blocks could be used for storing code. This allows the calibration information to be updated without disturbing the program. These flash devices allow many benefits to the user, in development, the ability to reprogram a device in situ increases reliability and also speeds development time. For production, the ability to program and reprogram in-circuit allows the manufacture of products without "personality", where the latest software is downloaded at the end of the line, and 'dead stock' is eliminated, as boards can be reprogrammed at any time. Product support also becomes easier, as upgrades of software becomes possible in the field. To support these different programming requirements, Hitachi F-ZTAT devices can be programmed in three ways:-

H8/300 OPERATING MODES

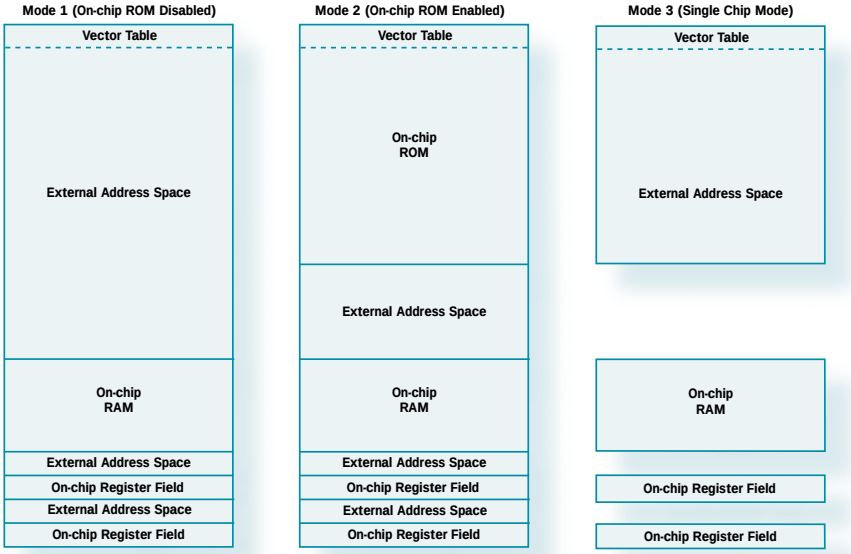


Figure 5

H8 F-ZTAT ADDRESS MAP

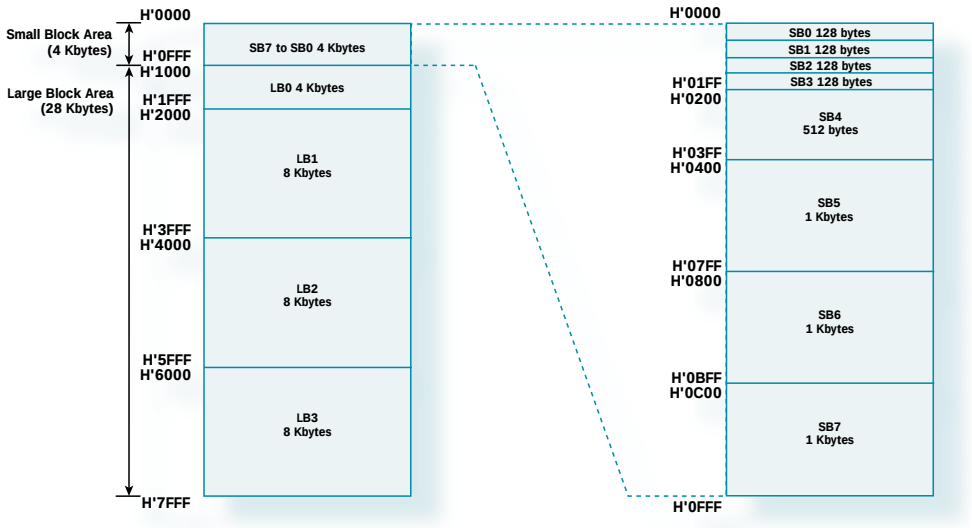


Figure 6

Boot mode

Device is programmed using an on-board boot loader, via a serial port from a PC or other programming device. Ideal for in-circuit programming, software upgrades and bug fixes. Supported by Hitachi's FLASH programming utility.

User mode

Device is programmed using a program provided by the user, ideal for applications where the device is programmed by a host, i.e. PC keyboard controller, computer games, etc. Supported by Hitachi's FLASH programming utility.

PROM mode

Device is programmed using a programming socket and a standard programmer with the appropriate programming algorithm support e.g. Data I/O, Hi-Lo, Stag, MPQ, Elan, Dataman, SMS, Minato.

H8 **Instruction** Set

The H8/300 family has a streamlined instruction set, well suited to the needs of a HLL, and embedded applications in general.

The instruction set comprises of 57 basic instructions *(Table 2)*, which are either 2 or 4 bytes long. All of the most frequently used instructions, such as a 16 bit register to register addition, execute in just 2 states, even complex instructions such as an 8-bit multiply takes only 14 states.

The H8/300 has a rich set of 14 separate bit processing instructions. The H8/300 CPU uses the carry flag as a bit accumulator allowing the programmer to manipulate both bit data and I/O using a full set of Boolean operations. It is also possible to access bit variables indirectly using a value held in a register as a bit pointer.

The H8/300 provides eight addressing modes, which are shown in *table 3*. Direct addressing is supported using either an 8 or 16 bit absolute address. The 16-bit address can access any location in the 64K address space, while the 8-bit addressing mode is used to access the top 256 byte page in memory. This instruction is only two bytes long, and so produces both smaller code and a faster access to memory. This is particularly useful as both the I/O registers and the RAM are located in this page.

The H8/300 also supports a memory indirect addressing mode where a short 8-bit address is used to point to a vector in the first page of ROM. This again produces smaller code. To support array and stack data types, the H8/300 has indirect addressing with either a post-increment or pre-decrement. These modes support both byte and word data.

The powerful instruction set of the H8/300 combined with the wide variety of powerful addressing modes allows the compiler to produce fast and efficient code.

Interrupts

The H8/300 has a powerful interrupt mechanism for supporting a large number of external and internal asynchronous events, for instance the H8/3337Y has 9 external and 26 internal interrupt sources. The external sources can include a Non Maskable Interrupt (NMI) and up to 8 external interrupt pins. The internal sources include all the on-board peripheral blocks. All interrupts can be globally or individually disabled or enabled (except NMI).

The interrupt response time of the H8/300 is very fast, between 17 and 29 states from the interrupt being detected (assuming the interrupt is enabled and an interrupt of a higher priority is not pending).

Table 2

H8 INSTRUCTION SET

Function	Instruction
Data transfer	MOV, PUSH, POP, MOVTPE, MOVFPE, LDM, STM
Arithmetic operations	ADD, SUB, ADDX, SUBX, INC, DEC, ADDS, SUBS, DAA, DAS, MULXU, DIVXU, CMP, NEG
Logic operations	AND, OR, XOR, NOT
Shift operations	SHAL, SHAR, SHLL, SHLR, ROTL, ROTR, ROTXL, ROTXR
Bit manipulation	BSET, BCLR, BNOT, BTST, BAND, BIAND, BOR, BIOR BXOR, BIXOR, BLD, BILD, BST, BIST
Branch	Bcc, JMP, BSR, JSR, RTS
System control	RTE, SLEEP, LDC, STC, ANDC, ORC, XORC, NOP

Table 3

H8 ADDRESSING MODES

Register direct	Rn
Register indirect	@Rn
Register indirect with 16-bit displacement	@(d: 16, Rn)
Register indirect with post-increment/ Register indirect with pre-decrement	@Rn +, @Rn
Absolute address	@aa:8, @ aa:16
Immediate	# xx:8, #xx:16, #xx:3
PC-relative	@(d:8, PC)
Memory indirect	@@aa:8

Power Down **Modes**

The H8/300 family has a individual interrupt vector assigned to each seperate event generated by the on-chip peripherals. This means that instead of having to check the interrupting peripheral's status register to see what the exact cause of the interrupt was, you can immediately start executing the code for that peripheral event. For example, the FRT on the H8/330 has seven separate interrupt vectors, one for each of the 4 input captures, one for each of the two output compares and an interrupt for the timer overflow. This speeds up the execution time of any interrupt service routine, and makes interrupt service routines easier to write and maintain.
The H8/300L has a simplified interrupt controller, where each peripheral typically has it's own interrupt vector, and the exact source must be read from the peripheral status register.

The H8/300 family are designed to minimise power consumption, even when operating at high speeds. At certain times however, performance is not so critical, and low power consumption is required. To meet these demands, the H8/300 family has a range of low power modes, which allow the device to operate in battery powered applications. The H8/300 family has three low power modes, each offering different advantages for various application requirements. These are shown in *table 4*.
The H8/300L family is aimed at cost and power sensitive applications, and have a number of additional low power modes. Many of these are achieved using an additional 32 kHz sub-system oscillator, allowing the microcontroller to be clocked from either source. These are shown in *table 5*.

Together these modes allow the power consumption of the H8/300L devices to be tailored dynamically, by trading performance against power consumed. Oscillator start up time can also be a large factor in the power used in an application. If an application remains in a low power mode for most of the time. then the time taken for the main oscillator to start, to take a measurement, or make a calculation can be significant. Some of the latest generation of H8/300L's have an oscillator start up time 500 times faster than normal, allowing massive power savings in some applications, with rapid responses to external events. A comparison between two of the H8/300L's is shown in *table 6*. These features make the H8/300L family ideal for many power critical applications, such as line powered feature phone's and many types of meter.

H8/300L OPERATING MODES

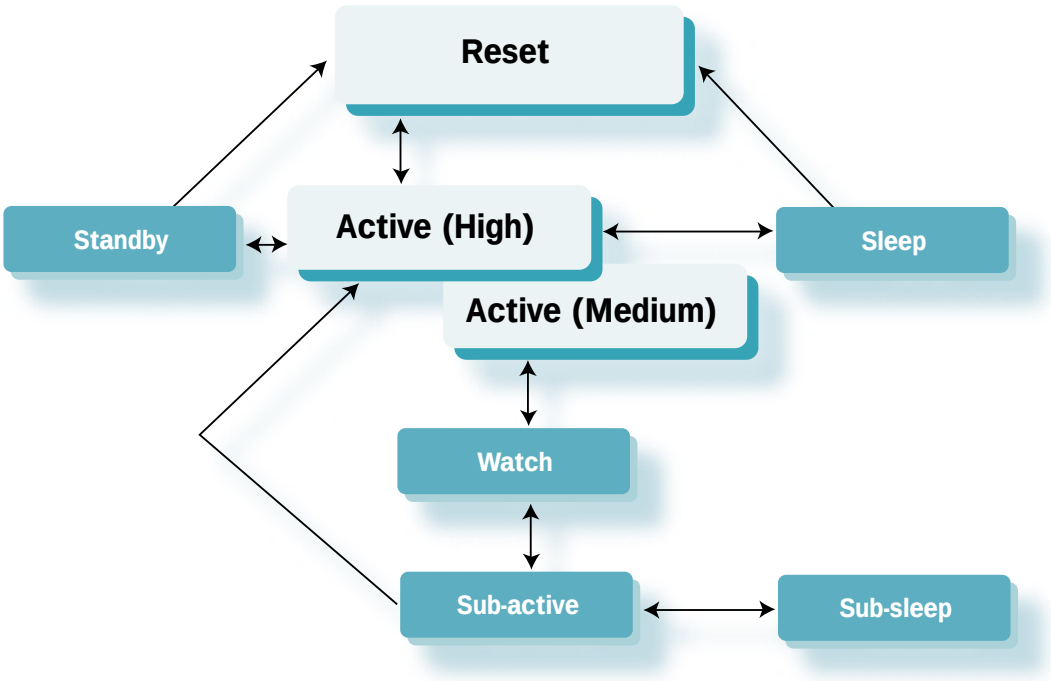


Figure 7

Table 4

H8/300 OPERATING MODES

Mode	Oscillator	CPU	RAM	External Interrupts	Peripherals	Entering Proceedure	Exciting Proceedure	Maximum current H8/3437
Active	Running	Running	Held	Active	Active	RESET		60 mA @ 5v 16 MHz
Sleep	Running	Stopped	Held	Active	Active	Sleep instruction	Int, STBY pin	40 mA @ 5v 16 MHz
Software standby	Stopped	Stopped	Held	Active	Inactive	Sleep instruction	external Int, STBY pin	5.0 µA @ 5v
Hardware standby	Stopped	Stopped	Held	Inactive	Inactive	STBY pin	STBY pin	5.0 µA @ 5v

Table 5

H8/300L OPERATING MODES

Mode	Main Oscillator	Sub Oscillator	CPU	RAM	External Interrupts	Peripherals	Entering Proceedure	Exciting Proceedure	Maximum current (H8/3644)
Active mode	Running	Running	Running	Held	Active	Active	RESET		20 mA @ 5v, 16 MHz
Active medium	Running	Running	Running	Held	Active	Active	Sleep inst.	Sleep inst.	5 mA @ 5v, 16 MHz
Sleep mode	Running	Running	Stopped	Held	Active	Active	Sleep inst.	All interrupts	10 mA @ 5v, 16 MHz
Sleep medium	Running	Running	Stopped	Held	Active	Active	Sleep inst.	All interrupts	4 mA @ 5v, 16 MHz
watch mode	Stopped	Running	Stopped	Held	Limited External Interrupts Active	Timer A only Provides watch function	Sleep inst.	Timer A interrupt or IRQ0	16 µA @ 2.7v, 32 kHz
Sub-active mode	Stopped	Running	Running	Held	Active	Some peripherals active	Sleep inst.	Sleep inst.	20µA @ 2.7v, 32 kHz
Sub-sleep	Stopped	Running	Stopped	Held	Active	Timer A only	Sleep inst.	Timer A interrupt or external	10 µA @ 2.7v, 32 kHz
Standby	Stopped	Running	Stopped	Held	Active	Inactive	Sleep inst.	IRQ	5 µA @ 3v, 32 kHz not used

Table 6

H8/300L POWER CONSUMPTION

	H8/3837	H8/3867
Active Mode 2 MHz/5V	3 mA	0.7 mA
Sub-active mode 32kHz/2.7V	30 µA	15 µA
Watch mode 32kHz/2.7V	3.2 µA	2.8 µA
Oscillator stabilisation time	10 ms	20 µs

H8 **Peripherals**

H8/300 16-BIT FREE RUNNING TIMER

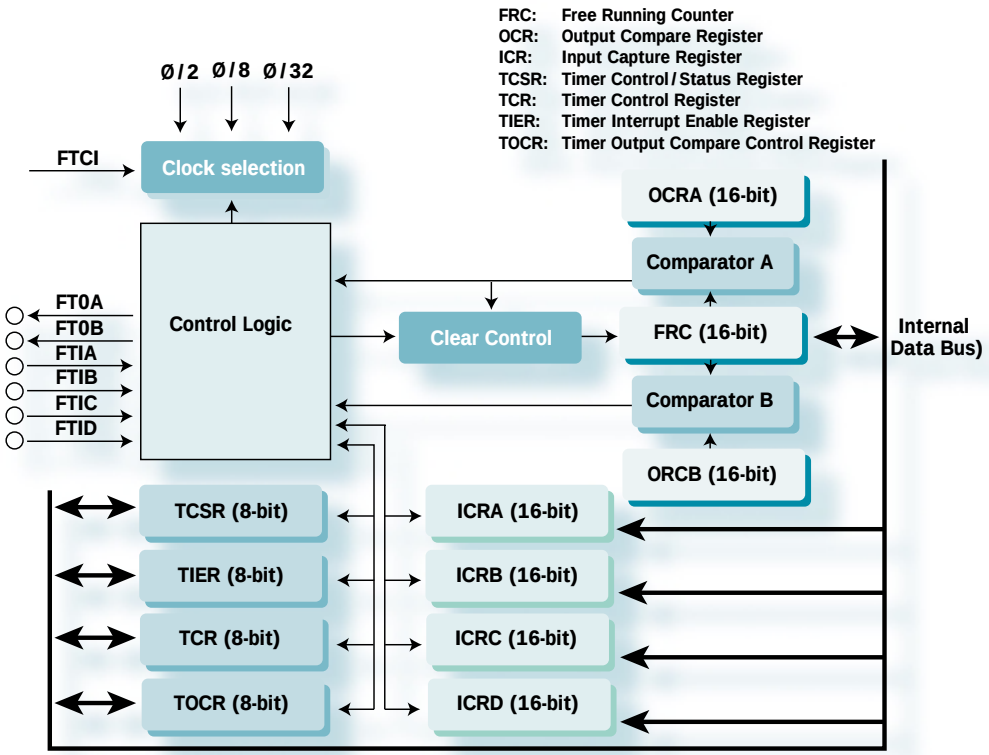


Figure 8

The peripherals on the H8 have been developed to suit many applications, with many types of serial ports and analogue and digital interfaces as well as on-board timer counters. In addition the H8/300L family has a range of additional on-board peripherals aimed at specific applications, these include, LCD and Vacuum Fluorescent display drivers, and telephony functions.

The peripherals on all the H8 devices have been developed with code compatibility in mind, allowing easy transfer of software from one device to another.

Timers

The H8/300 family has a range of 8 and 16-bit general purpose counter/ timers, all of which have a number of input capture registers, ideal for acquiring the exact moment an external signal occurs, with reference to the internal timer, and output compare registers, ideal for generating a variety of output waveforms. These timers can be clocked from a range of internal clock sources, or used as an event counter, clocked via an external pin. Functional diagrams of these timers are shown in *figures 8 & 9*. A number of the H8/300's also have a watchdog timer, which can either reset the chip or provide a Non-maskable interrupt, ideal when system integrity is a concern, if the watchdog feature is not used, the timer can be used as a simple interval timer. Finally a number of devices also have two dedicated 8-bit PWM timers, a diagram of this is shown in *figure 10*.

The full range of timers available on the H8/300 family are shown in *table 7*.

H8/300 8-BIT TIMER

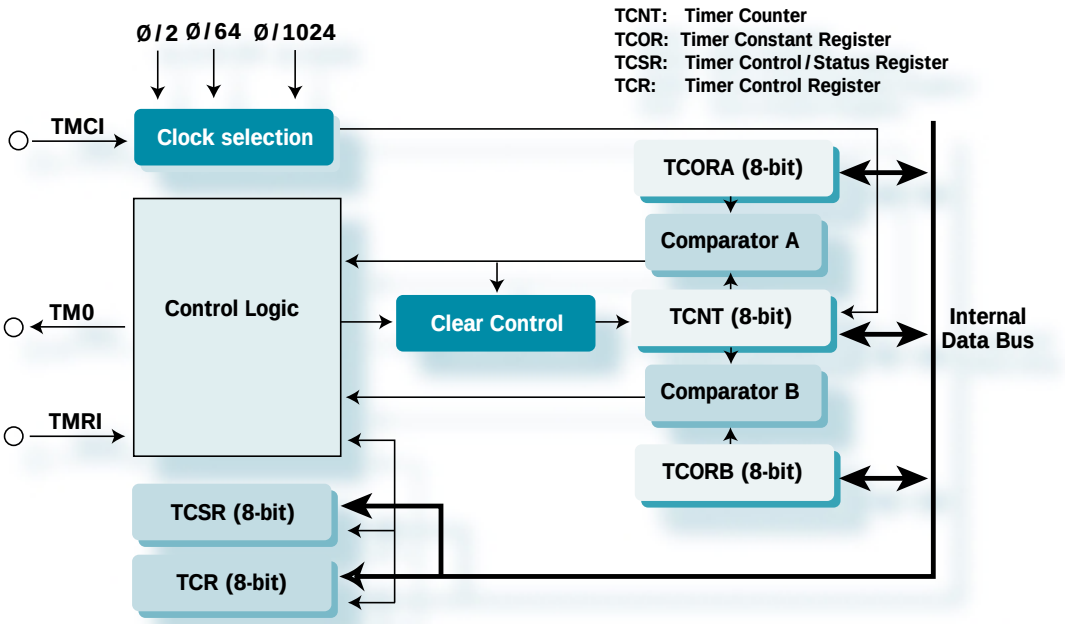


Figure 9

H8/300 PWM TIMER

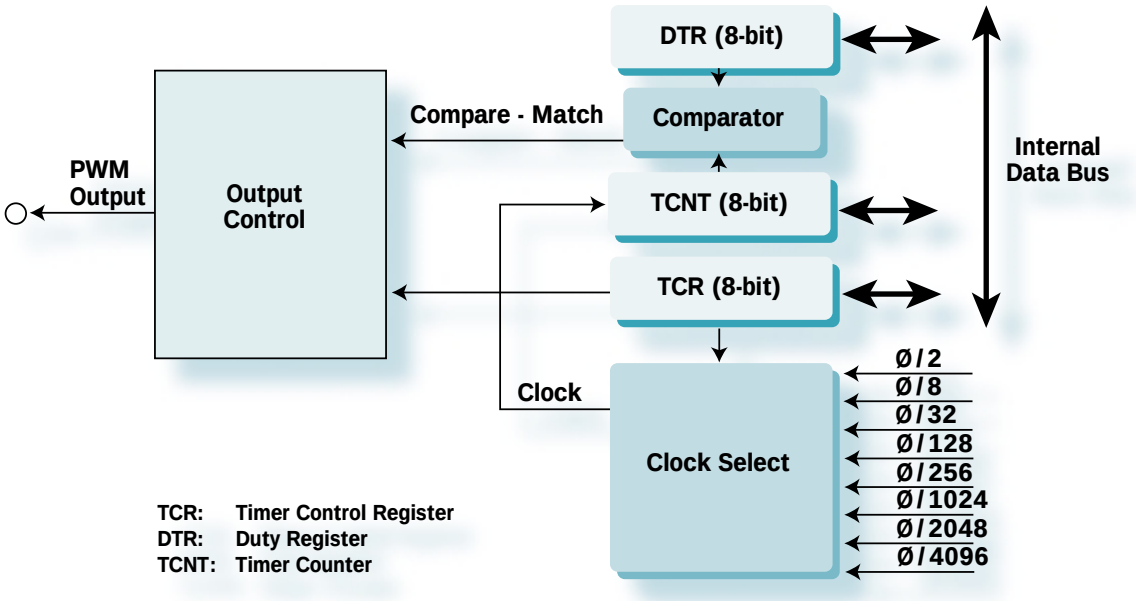


Figure 10

The H8/3217 series have some extra features, making them particularly attractive in consumer and video applications. Two of the 8-bit timers on a number of these devices can be concatenated, allowing the automatic detection of various video control signals, but these features can also be used in a variety of other applications. Each device also has an additional dedicated PWM timer, with 16 outputs.

Table 7

H8/300 Timers

Timer	Description	Clock source	Input Capture	Output Compare	Devices
16-bit FRT	16-bit Free Running Timer with optional clear on compare match	External or choice of 3 internal	1	2 (2 outputs)	H8/325 series
16-bit FRT	16-bit Free Running Timer with optional clear on compare match	External or choice of 3 internal	4	2 (2 outputs)	All devices (except H8/325 series)
8-bit Timer	8-bit Timer with optional clear on compare match	External or choice of 3 internal		2 (one dedicated output allowing generation of waveforms with arbitary duty cycle)	H8/325 series H8/329 series H8/330
8-bit Timer	8-bit Timer with optional clear on compare match	External or choice of 6 internal		2 (one dedicated output allowing generation of waveforms with arbitary duty cycle)	All devices except H8/325, H8/329 H8/330
PWM Timer	2 Channel PWM Timer	Choice of 8 clock sources		2 outputs	H8/330, H8/338 series, H8/3337Y series H8/3397 series H8/3437 series
PWM Timer	16 channel 4 + 4-bit pWM timer	Choice of 2 clock sources		16 outputs	H8/3217 series (except H8/3202)
Watchdog timer	Either watchdog timer (reset or NMI) or interval timer operation	Choice of 8 internal clock sources			H8/3217 series H8/3297 series, H8/3337Y series H8/3397 series H8/3437 series

The H8/300L has a variety of 8 and 16-bit timers dedicated to a variety of functions. Many of these timers can select from a variety of internal and external clock sources, including both the main oscillator, and the 32 kHz sub-oscillator. Timer A is especially useful as it can easily be used to provide a real time clock feature. If it is used with the 32 kHz sub-clock, it can produce an interrupt once per second. This is in fact the basis of watch mode, where only Timer A operates, allowing a very low operating current, but still keeping time. With the 1 second interrupt, a software real time clock becomes very simple to create. Timer A is shown in *figure 11*. The full list of timers, and the devices these appear on are shown in *table 8*.

H8/300L TIMER A

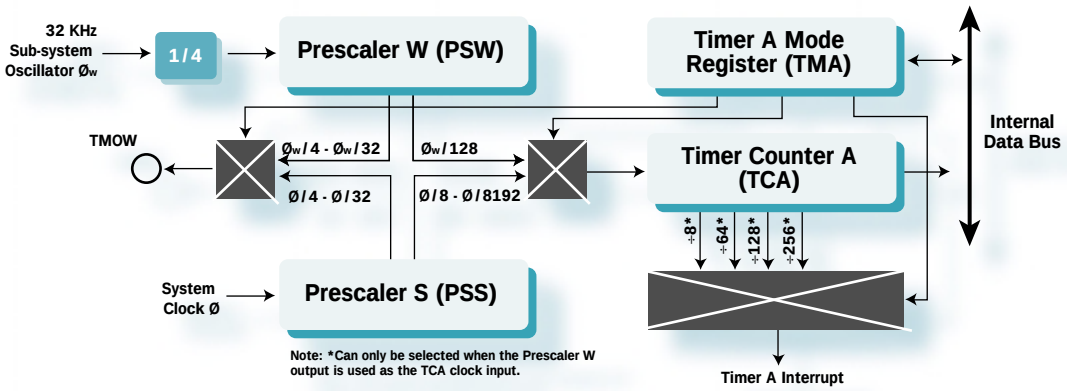


Figure 11

Table 8

H8/300L Timers

Timer Type	Description	Clock source	Timer Input	Timer Output	Devices
Timer A	8-bit timer with clock time base functions	8 Internal		1	H8/3xxx
Timer B	8-bit up counter with auto-reload	External or 7 Internal	1		H8/36xx H8/37xx H8/383x
Timer C	8-bit up/down counter with auto-reload	External or 7 internal	2 (event, up /down control)		H8/361x, H8/37xx H8/383x, H8/388x H8/386x, H8/385x H8/384x, H8/382x
Timer D	8-bit even counter	External	1		H8/361x H8/37xx
Timer E	8-bit up counter with auto-reload and square wave output	8 Internal		1	H8/361x H8/37xx
Timer F	16-bit timer with output compare, configurable as 2 independent 8-bit timers	External or 4 internal	1	2 (output capture)	H8/38xx
Timer G	8-bit timer with input capture on rising and/or falling edge	4 Internal	1 (input capture)		H8/38xx
Timer V	8-bit up timer with compare match output	External or 6 internal	3 (Clock input, reset input and trigger	1	H8/364x
Timer X	16-bit timer with 2 output compare's and 4 input captures	External or 3 internal	4	2	H8/364x
Timer Y	16-bit timer with interval / auto-reload functions	External or 7 internal		1	H8/363x
Watchdog	Watchdog Timer can reset chip on overflow	2 Internal			H8/388x, H8/386x, H8/384x, H8/382x
Asynchronous Event Counter	16-bit or 2 x 8-bit counters that can count asynchronously without a clock input, hence allowing low power modes to be used	None	2		H8/388x, H8/386x H8/384x, H8/382x

Serial Communication Interface

Each H8 microcontroller has at least one channel of serial communications. In the H8/300 family, each channel of SCI is an extremely capable, high performance USART, capable of both asynchronous and synchronous communications, each with it's own dedicated baud rate generator, allowing a wide range of data rates to be chosen from one clock source. Each channel is double buffered, to make sure no data is lost at higher data rates. In asynchronous mode, each channel supports a wide range of data formats, with programmable data length and multiple parity and stop bit options. Various members of the family also have support for inter-processor communications.

In the H8/300L family, there are a range of different types of serial interface, each with different characteristics, these range from simple, clocked synchronous interfaces, ideal for talking to peripheral IC's such as EEPROM's and A/D's, to full blown USART's. An example of the H8/300L serial port is shown in *figure 12*.

The full range of serial interfaces available on the H8/300 and H8/300L devices are listed in *table 9*.

H8 SERIAL COMMUNICATIONS INTERFACE

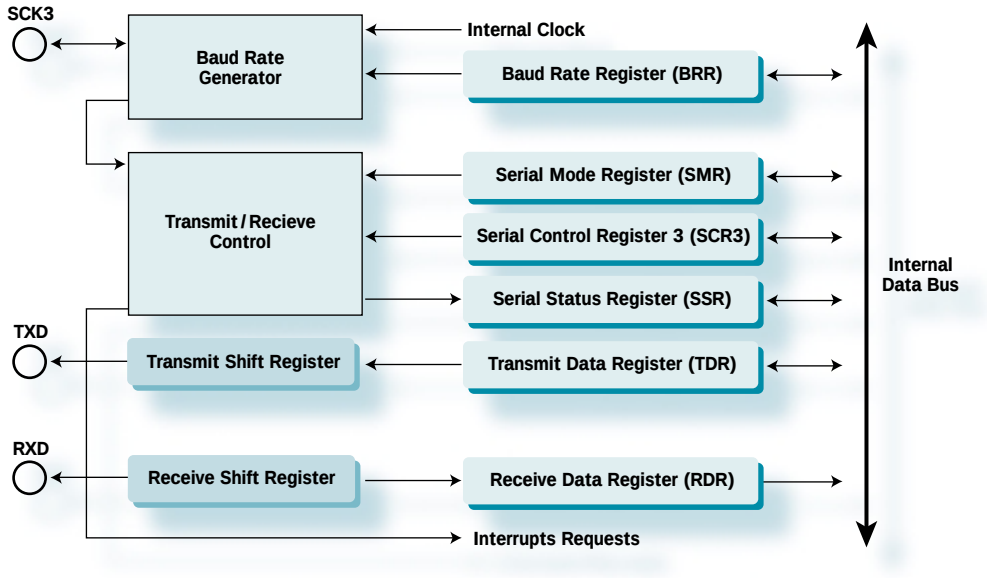


Figure 12

Table 9

H8 Serial Port Configuration

Serial Port	Description	Maximum Synchronous Data Rate	Maximum Asynchronous Data Rate	Devices
SCI 1	8 or 16-bit clock synchronous serial transfer	2 M @ 5v, 16 MHz		H8/36xx, H8/37xx H8/38xx
SCI 2	8-bit clock synchronous serial transfer with 32 byte character buffer	2 M @ 5v, 16 MHz		H8/361x, H8/37xx H8/383x
SCI 3	Full synchronous/asynchronous (UART) supporting multi-processor communications	2 M @ 5v, 16 MHz 1.25 M @ 5v, 10 MHz	250k @ 5v, 16 MHz 156 k @ 5v, 10 MHz	H8/364x, H8/38xx
SCI	Full synchronous/asynchronous (UART) supporting multi-processor communications (except H8/325 series)	4 M @ 5v, 16 MHz 2.5 M @ 5v, 10 MHz	500k @ 5v, 16 MHz 312.5 k @ 5v, 10 MHz	All H8/300's

A number of H8's also have the option of one or more I²C interfaces. The I²C bus interface conforms to and provides a subset of the Philips I²C (inter-IC bus) interface functions. The I²C bus interface uses only one data line (SDA) and one clock line (SCL) to transfer data from a microcontroller to one or more peripheral devices. The I²C bus can be used to talk to a number of off-chip peripheral devices such as EEPROM's, real time clocks and A/D converters, this can save both board and connector space. *Figure 13* shows a block diagram of the I²C interface module.

The I²C bus interface can operate in either master or slave mode. The interface allows the selection of one of 8 internal clocks (in master mode), generated from the internal clock generator. The I²C bus module generates start and stop conditions automatically and auto-loads the acknowledge bit when transmitting. The interface generates direct bus drive for both the SCL and SDA pins. The I²C interface on the H8 supports the high speed, 400 k baud transfer rate.

Analogue Interfaces

Many members of the H8 family have either an 8 or 10-bit A/D converter, with up to 12 channels. Each device includes a analogue multiplexer and a sample and hold circuit, so once a conversion has been initiated, any change in the external input will not affect the result. The A/D converter has both a single shot, and scan mode of operation, which allows continuous conversion on 1 to 4 channels of the A/D, using all four of the result registers. Each A/D also has the ability to begin a conversion when it receives an external signal, using a trigger pin (ADTRG).

On the devices with the 8 bit A/D, a conversion can be as fast as 12.2uS (system clock 10 MHz), on devices with

H8/300 I²C INTERFACE

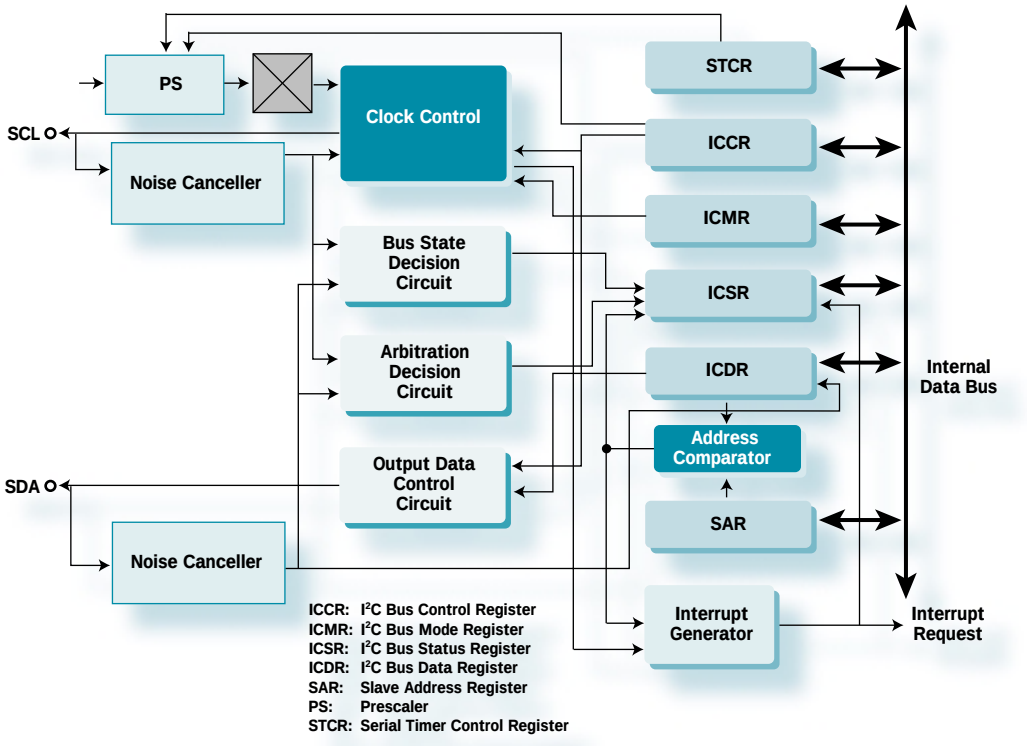


Figure 13

a 10-bit A/D converter, the conversion time can be as fast as 8.4µs per channel, (System clock 16 MHz). The 10-bit A/D converter uses four 16-bit result registers, holding the result in the lowest 10 bits, while the 8-bit A/D uses four 8-bit result registers. A diagram of the A/D off the H8/300 series is shown in *figure 14*.

A number of devices have a two channel, D/A Converter, each with a resolution of 8 bits. The D/A module shares the analogue supply pins with the A/D converter module. Each channel can be independently enabled and disabled and gives an output value of AVcc x (value in D/A register)/256. The D/A has a maximum conversion time of 10µs.

Interface Peripherals

As well as serial communications, the H8/300 family supports a range of different parallel interface peripherals allowing each H8 to easily communicate with other devices. These facilities allow the H8/300 to be used as an intelligent peripheral, such as a notebook keyboard and system controller, by a host processor.

The H8/330 uses a dual port RAM to communicate, this comprises of a set of 15 registers which can be accessed by the CPU or by another device via a SRAM-like interface.

The H8/32x series devices allow connection via a parallel handshaking interface, this interface uses a busy pin, and input and output strobe pins to control the interface.

A number of other H8/300 devices, such as the H8/3337Y series have a dual channel, parallel host interface. This provides an interface which is particularly useful in PC based applications, as the host interface provides 4 data registers, two status registers, a control register, fast A20 gate logic and a host interrupt request circuit.

Devices with this interface, are typically used as systems controllers in laptop computers and Industrial PC's, having all of the facilities needed to monitor and control battery life, keyboard etc.

H8/300 A/D CONVERTOR

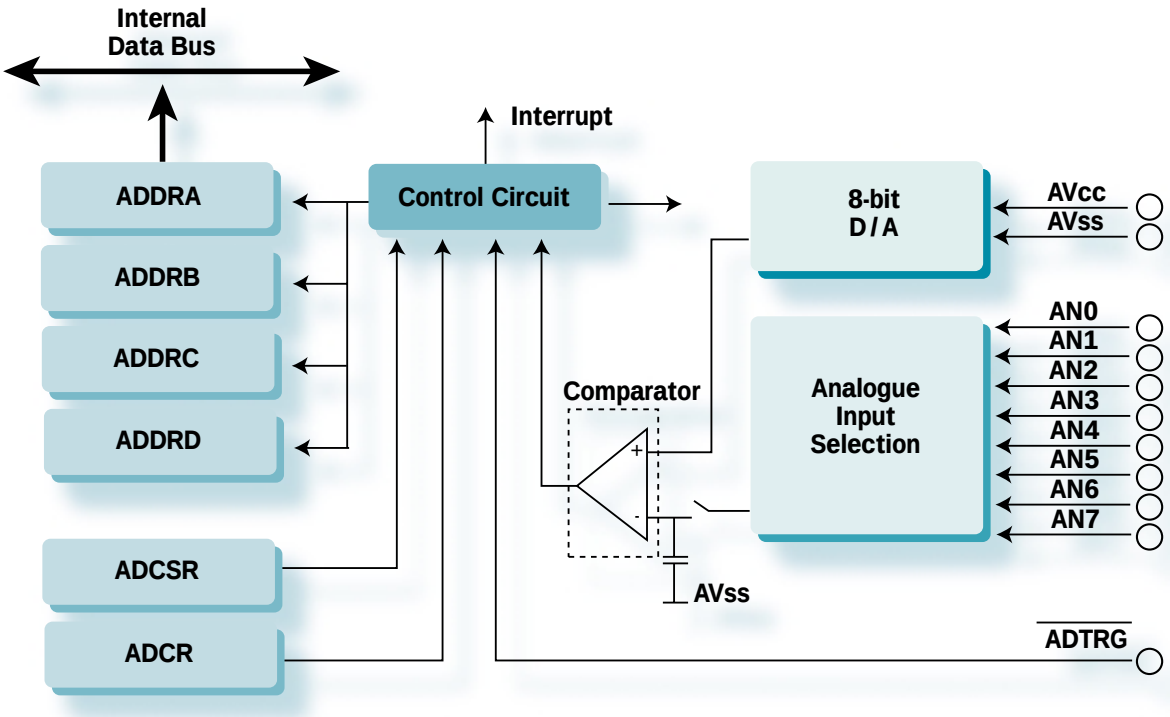


Figure 14

Display Drive

A common requirement in many applications is to display information. For this reason, a number of the devices in the H8/300L family have been designed to offer either Liquid Crystal Display (LCD) or Vacuum Fluorescent Display (VFD) drive capability. In both cases devices are available with on-board controllers to simplify the software and external hardware required to drive these displays.

The H8/37xx series supports VFD drive and provide up to a maximum of 28 segments and 16 digit pins, all of which can also be used as standard I/O. The on-board VFD controller also has built in dimmer and keyscan interval functionality.

The H8/38xx series offers various LCD drive capabilities ranging from 32 x 4 to 52 x 4 of segment drive with support for up to 512 segments using external expansion drivers. The new H8/385x series also adds graphical capabilities with displays of up to 1280 pixels driven directly from the microcontroller.

The newest member s of the H8/38xx family also include a wide range of innovative features to reduce the component count and the total power consumption of the system. These include on-board LCD voltage boosters, built in digital contrast control and built in LCD power supply bleeder resistors.

DTMF Generator

Designed specifically for telecoms applications, the H8/387x, H8/362x and H8/363x series include a dual tone Multi-F generator. In addition, the H8/3877 also includes a multi-tone generator all on chipon-chip. These have been developed to produce the various tones required in many different telephony applications, such as feature phones, pagers and telemetry systems.

H8/3834 LCD DRIVER

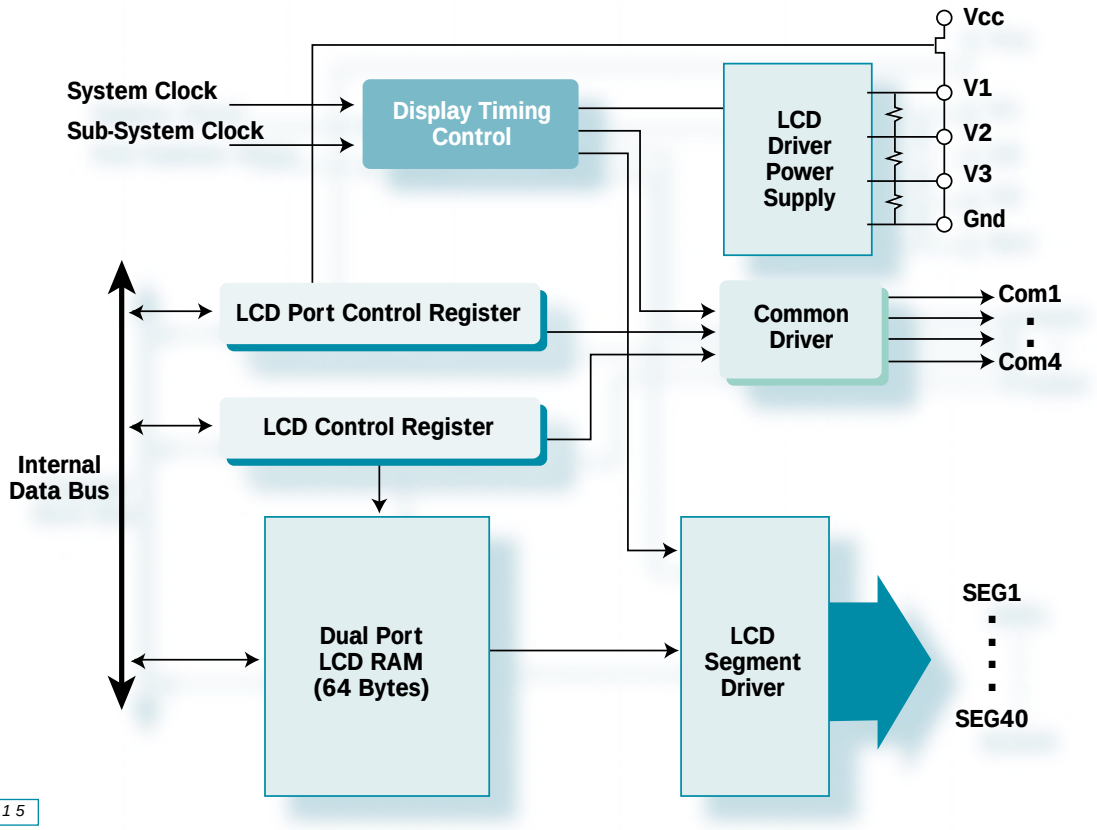


Figure 15

H8/300 **Packaging** Options

The correct choice of package for a micro-controller can be very important in many designs. The package type has obvious implications where space is important, and also can influence the manufactured price of the final product. The correct choice of package can also make it easier to pass the ever stricter EMC regulations that are coming into effect across Europe.

The H8 offers unbeatable integration in a wider range of packages, witness the H8/3837 with 2K of RAM and 60K of PROM, all contained in a tiny Quad Flat pack, measuring 16.0 mm by 16.0 mm across its gull wings.

Hitachi support the H8/300's in windowed ceramic DIL and LCC and in SDIP, PLCC and QFP, the H8/300L comes in SDIP, QFP and TQFP. The full range of packages with device availability in each is shown in *tables 10 & 11*.

Table 10

H8/300L Packaging

	DC-64S	DP-64S	PLCC-68	PLCC-64	LCC-84	QFP-64A	QFP-80A	QFP-100B	TQFP-80C	TQFP-100B
H8/325 family	●1	●	●			●				
H8/3217 family	●2	●				●			●	
H8/329 family	●3	●	●							
H8/330				●	●		●			
H8/338 family				●	●4		●			
H8/3332 Family				●	●5		●			
H8/3297 Family	●6	●				●			●	
H8/3337Y Family				●	●7		●		●	
H8/3437 family								●		●

1 H8/325 & H8/3257 only
2 H8/3217 only
3 H8/327 and H8/329 only
4 H8/337 and H8/338 only
5 H8/3334 only
6 H8/3297 only
7 H8/3337Y only

Table 11

H8/300 Packaging Options

	DC-64S	FP-64A	FP-80A	FP-80B	TFP-80C	TFP-80E	QFP-80A	FP-1000A	FP-100B	TFP-1000B	FP-144H
H8/361x Family	●	●									
H8/362x Family		●									
H8/363x Family				●	●						
H8/364x Family	●	●				●					
H8/365x family											
H8/371x Family	●	●									
H8/372x Family			●	●							
H8/381x Family							●	●	●		
H8/382x Family			●	●	●						
H8/383x Family							●	●	●		
H8/384x Family			●	●	●						
H8/385x Family										●	
H8/386x Family							●	●	●		
H8/387x Family								●			
H8/388x Family							●	●	●		

H8/300 and H8/300L micro-controllers are available in a wide range of package, speed and temperature range o
explanation of this, along with Hitachi's temperature range options are shown below.

H8/300 Selector Guide

Device	H8/325	H8/3217	H8/329	H8/3297	H8/330
ROM (kbytes)	8 - 60 K	16 - 60 K	8 - 32 K	16 - 60 K	16 K
RAM (bytes)	256 - 2 K	512 - 2 K	256 - 1 K	512 - 2 K	512
ROMless Version	y	n	y	n	y
Z-TAT Version	y	y	y	y	y
EPROM Version	y	y	y	y	y
F-ZTAT Version	n	n	n	n	n
16-Bit Timer	1	1	1	1	1
8-bit timer	2	3	2	2	2
PWM Timer	n	16	n	n	2
Watchdog/Interval Timer	n	y	n	y	n
Async/Sync Serial Port	2	2	1	1	1
A/D Converter	n	n	8 ch x 8-bit	8 ch x 10-bit	8 ch x 8-bit
D/A Converter	n	n	n	n	n
Interrupts (Internal, External)	17,4	26,12	18,4	19,4	19,9
Other Features	Parallel Handshake Interface	Host Interface I^2C Bus x 2			Dual Port RAM Host Interface
I/O Lines	53	53	43	43	58
Input Only Lines	0	0	8	8	8
Voltage Range	4.5 - 5.5v	2.7 - 5.5 v	4.5 - 5.5v	4.5 - 5.5v 2.7 - 3.6v	3.0 - 5.5 v
Package	DP-64S, FP-64 TFP-80, CP-68 DC-64S	DP-64S, FP-64A TFP-80C, DC-64S	DP-64S, FP-64 TFP-80, CP-68	DP-64S, FP-64A TFP-80, CP-68 DC-64S	FP-80A, CP-84 CG-84
Databook	ADE-602-029B(0)	ADE-602-068(0)	ADE-602-046A	ADE-602-080A(0)	ADE-602-026A(0)

H8/300 Memory Type and Size

Device/Memory (ROM/RAM)	8 k / 512	16 k / 512	24 k / 1 k	32 k / 1 k	48 k / 2 k
H8/325	H8/322 - M,Z	H8/323 - M,R, Z	H8/324 - M	H8/325 - M, R, Z, E	H8/3256 - M, Z
H8/3217	H8/3217 - M, Z, E		H8/3202 - M		H8/3214 - M, Z H8/3212 - M
H8/329	H8/326 - M	H8/327 - M, R, Z, E	H8/328 - M	H8/329 - M, R, Z, E	
H8/3297		H8/3292 - M		H8/3294 - M, Z	H8/3296 - M
H8/330		H8/330 - M, R, Z, E			
H8/338			H8/336 - M	H8/337 - M, R, Z, E	H8/338 - M, R, Z, E
H8/3337Y				H8/3334Y - M, Z, F	H8/3336Y - M H
H8/3397				H8/3394 - M	H8/3396 - M
H8/3437				H8/3434Y - M, Z, F	H8/3436Y - M H

options. Part numbers in each family are derived by following a few simple rules. An

H8/300L Sele

H8/338	H8/3337Y	H8/3397	H8/3437
24 - 48 K	32 - 60 K	32 - 60 K	32 - 60 K
1 - 2 K	1 - 2 K	1 - 2 K	1 - 2 K
y	n	n	n
y	y	n	y
y	y	n	n
n	y	n	y
1	1	1	1
2	2	2	2
2	2	2	2
n	y	y	y
1	2	2	2
8 ch x 8-bit	8 ch x 10-bit	8 ch x 10-bit	8 ch x 10-bit
2 ch x 8-bit	2 ch x 8-bit	n	2 ch x 8-bit
22,9	26,9	26,9	6,9
	Host Interface I^2C Bus		Host Interface Keyboard Controller I^2C Bus
58	60	60	74
8	6	6	8
4.5 - 5.5 v 2.7 - 3.6v	4.5 - 5.5 v 2.7 - 3.6v	4.5 - 5.5 v 2.7 - 3.6v	4.5 - 5.5 v 2.7 - 3.6v
FP-80A, CP-84 CG-84	FP-80A, TFP-80C CP-84, CG-84	FP-80A, TFP-80C CP-84	FP-100B TFP-100B
ADE-602-039A(0)	ADE-602-078C(0)	ADE-602-078C(0)	ADE-602-077D(0)

Device	H8/3614
ROM (kbytes)	16 - 32 K
RAM (bytes)	512 - 1 K
ROMless Version	n
Z-TAT Version	y
EPROM Version	n
F-ZTAT Version	n
Timer A (8-bit)	y
Timer B (8-bit)	y
Timer C (8-bit)	y
Timer D (8-bit)	y
Timer E (8-bit)	y
Timer F (16-bit)	n
Timer G (8-bit)	n
Timer V (8-bit)	n
Timer X (16-bit)	n
Timer Y (16-bit)	n
PWM Timer	1 (not 3612)
Watchdog / Interval Timer	n
Async / Sync Serial Port	2
A/D Convertor	8 ch x 8-bit
Interrupts (Internal,External)	21,12
LCD Drive	n
Other features	32 kHz osc
I/O Lines	44
Input Only Lines	10
Voltage Range	2.7 - 5.5 v
Package	DP-64S, FP-64A
Databook	ADE-602-069(0)

** Contact Hitachi or your Hitachi*

H8/300L Mem

Device/Memory (ROM/RAM)	8 k / 512
H8/3614	
H8/3644	3640 - M
H8/3627	
H8/3637	
H8/3657	
H8/3714	
H8/3726	
H8/3814S	
H8/3837S	
H8/3877	
H8/3877N	
H8/3827	
H8/3847	
H8/3857	
H8/3867	
H8/3887	

60 k / 2 k
H8/3257 - M, Z, E
H8/3216 - M, R
H8/3297 - M, Z, E
8/3337Y - M, Z, E, F
H8/3397 - M
8/3437Y - M, Z, E, F

M - Mask ROM
R - ROMless
Z - OTP (Z-TAT)
E - EPROM
F - Flash Memory

M - Mask ROM, Z - OTP (Z

H8/3627*	H8/3637*	H8/3644	H8/3657	H8/3714	H8/3726	H8/3814S	H8/3837S
16 - 60 k	16 - 60 k	8 - 32 K	16 - 60 k	16 - 32 K	24 - 48 K	16 - 32 K	16 - 60 K
1 - 2 k	1 - 2 k	512 - 1 K	1 - 2 k	384 - 1 K	384 - 1 K	512	1 - 2 K
n	n	n	n	n	n	n	n
y	y	y	y	y	y	n	y
n	n	n	n	n	n	n	n
n	n	y	n	n	n	n	n
y	y	y	y	y	y	y	y
n	n	y	y	y	y	n	y
n	n	n	n	y	y	y	y
n	n	n	n	y	y	n	n
n	n	n	n	y	y	n	n
y	y	n	n	n	n	y	y
y	y	n	n	n	n	n	y
n	n	y	y	n	n	n	n
n	n	y	y	n	n	n	n
n	y	n	y	n	n	n	n
y	y	y	y	y	y	n	n
y	y	y	y	n	n	n	n
2	2	2	2	2	2	2	3
2 ch x 8-bit	4 ch x 8-bit	8 ch x 8-bit	8 ch x 8-bit	8 ch x 8-bit	8 ch x 8-bit	12 ch x 8-bit	12 ch x 8-b
16,13	17,13	21,12	21,12	10,4	10,6	16,13	20,13
n	n	n	n	n	n	40 x 4	40 x 4
DTMF Gen 32 kHz osc	DTMF Gen 32 kHz osc	32 kHz osc	32 kHz osc	VFD Drive 32 kHz osc	VFD Drive 32 kHz osc	32 kHz osc	32 kHz os
50	61	45	59	40	40	71	71
3	5	8	8	10	10	13	13
2.7 - 5.5 v	2.7 - 5.5 v	2.5 - 5.5 v	2.2 - 5.5 v	2.7 - 5.5 v	2.7 - 5.5 v	2.7 - 5.5 v	2.7 - 5.5
FP-64A, FP-64E	FP-80B, TFP-80C TFP-80F	DP-64S, FP-64A TFP-80C, TFP-80F	FP-80A, FP-80B	DP-64S, FP-64A	FP-80A,	FP-100A, FP-100B TFP-100B	FP-100A, FP-1 TFP-100B
		ADE-602-087D	ADE-602-134	ADE-602-056(0)	ADE-602-044B(0)	ADE-602-054(0)	ADE-602-054

distributor for availability.

ory Type and Size

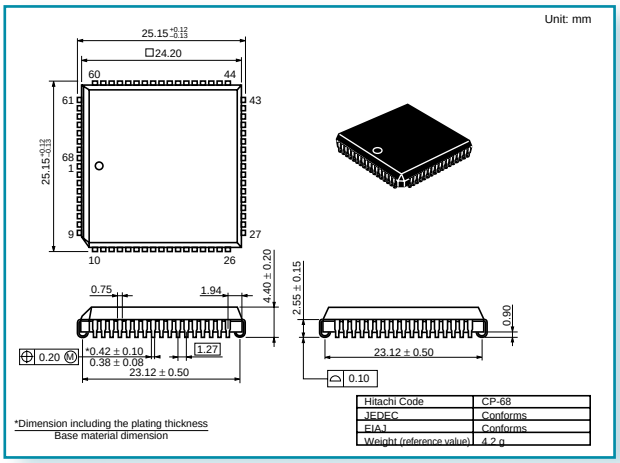
12 k / 512	16 k / 384	16 k / 512	16 k / 1 k	24 k / 384	24 k / 512	24 k / 1k	32 k / 51
		3612 - M				3613 - M	
3641 - M		3642 - M	3642A - F			3643 - M, F	
			3622 - M			3633 - M	
			3652 - M			3653 - M	
	3712 -M			3713 - M			3714 - M,
				3723 - M			3724 - M,
		3812S - M			3813S - M		3814S - M
			3832S - M			3833S - M	
			3822 - M			3823 - M	
			3842 - M			3843 - M	
			3862 - M			3863 - M	
			3882 - M			3883 - M	

Z-TAT), F - Flash Memory

S	H8/3877	H8/3877N	H8/3827	H8/3847	H8/3857*	H8/3867	H8/3887
K	40 - 60 K	40 - 60 K	16 - 60 k	16 - 60 k	40 - 60 k	16 - 60 k	16 - 60 k
	2048	2048	1 - 2 k	1 - 2 k	2048	1 - 2 k	1 - 2 k
	n	n	n	n	n	n	n
	y	y	y	y	n	y	y
	n	n	n	n	n	n	n
	n	n	n	n	y	n	n
	y	y	y	y	y	y	y
	n	n	n	n	y	n	n
	n	n	y	y	y	y	y
	n	n	n	n	n	n	n
	n	n	n	n	n	n	n
	y	y	y	y	y	y	y
	y	y	y	y	n	y	y
	n	n	n	n	n	n	n
	n	n	n	n	n	n	n
	n	n	n	n	n	n	n
	n	n	y	y	y	y	y
	n	n	y	y	y	y	y
	2	2	2	3	2	2	3
bit	8 ch x 8-bit	8 ch x 8-bit	8ch x 10-bit	8ch x 10-bit	8 ch x 8-bit	8ch x 10-bit	8ch x 10-bit
	17,14	17,14	23,13	23,13	16, 13	23,13	23,13
	52 x 4	n	32 x 4	40 x 4	32 x 40	32 x 4	40 x 4
c	DTMG Gen Multi-Tone gen 32KHz osc	DTMG Gen Multi-Tone gen 32KHz osc	asynchronous counter 32KHz osc	asynchronous counter 32KHz osc	Graphics LCD Drive, On-chip LCD Booster 32KHz osc	asynchronous counter LCD step-up 32KHz osc	asynchronous counter LCD step-up 32KHz osc
	72	72	55	71	37	55	71
	8	8	9	13	9	9	13
v	2.7 - 5.5 v	2.7 - 5.5 v	1.8 - 5.5	1.8 - 5.5	3 - 5.5 v	1.8 - 5.5	1.8 - 5.5
100B	FP-100B	FP-100B	FP-80A, FP-80B TFP-80C	FP-100A, FP-100B TFP-100B	FP-144H, TFP-144	FP-80A, FP-80B TFP-80C	FP-100B TFP-100B
D(0)	ADE-602-060	ADE-602-0132	ADE-602-142B	ADE-602-151A	ADE-602-142B	ADE-602-142B	ADE-602-151A

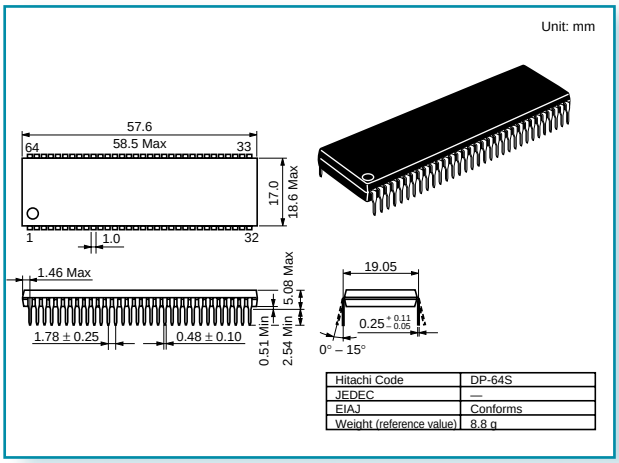
2	32 k / 1 k	32 k / 2 k	40 k / 640	40 k / 2 k	48 k / 1 k	48 k / 2 k	60 k / 2 k
	3614 - M,Z						
	3644 - M, Z, F						
	3634 - M			3635 - M		3636 - M	3637 - M, Z
				3635 - M		3636 - M	3637 - M, Z
	3654 - M			3655 - M		3656 - M	3657 - M, Z
Z							
,Z			3725 - M		3726 - M,Z		
M							
	3834S - M, Z			3835S - M		3836S - M	3837S - M, Z
				3875 - M		3876 - M	3877 - M, Z
				3875N - M		3876N - M	3877N - M, Z
		3824 - M		3825 - M		3826 - M	3827 - M, Z
		3844 - M		3845 - M		3846 - M	3847 - M, Z
				3855 - M		3856 - M	3857 - M, F
		3864 - M		3865 - M		3866 - M	3867 - M, Z
		3884 - M		3885 - M		3886 - M	3887 - M, Z

P a c k a g e s



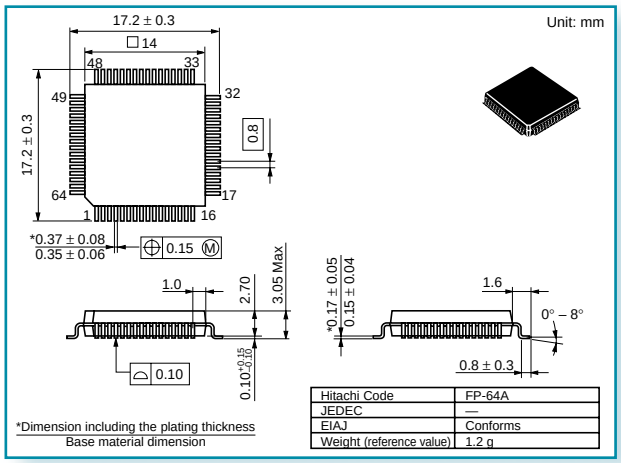
Hitachi Code	CP-68
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	4.2 g

C P - 6 8



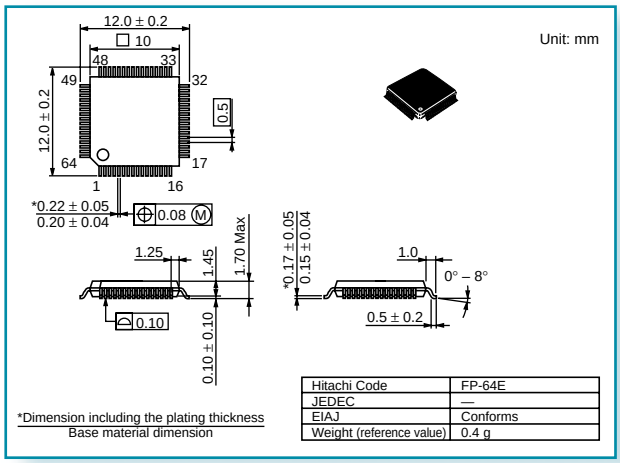
Hitachi Code	DP-64S
JEDEC	—
EIAJ	Conforms
Weight (reference value)	8.8 g

D P - 6 4 S



Hitachi Code	FP-64A
JEDEC	—
EIAJ	Conforms
Weight (reference value)	1.2 g

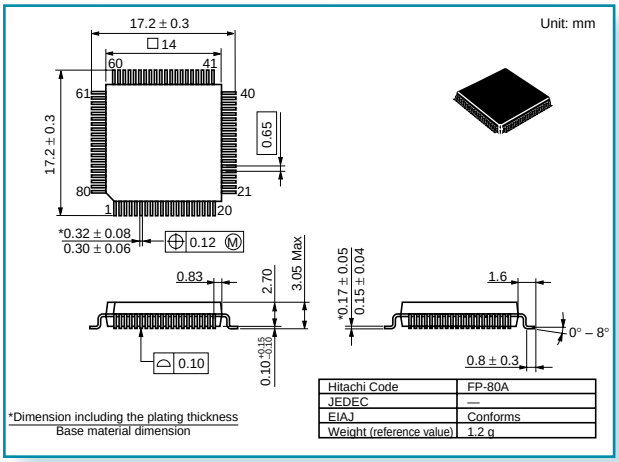
F P - 6 4 A



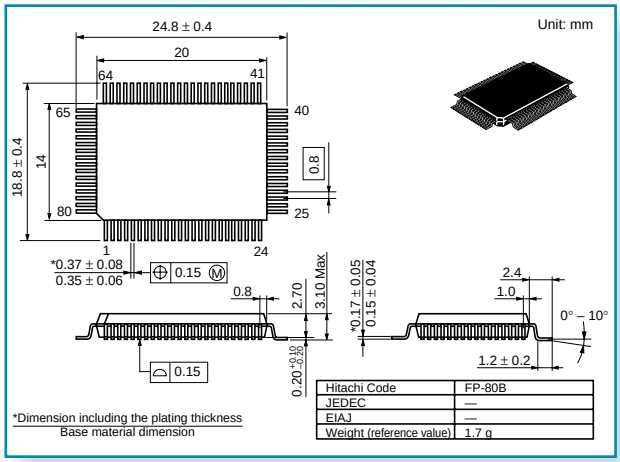
Hitachi Code	FP-64E
JEDEC	—
EIAJ	Conforms
Weight (reference value)	0.4 g

F P - 6 4 E

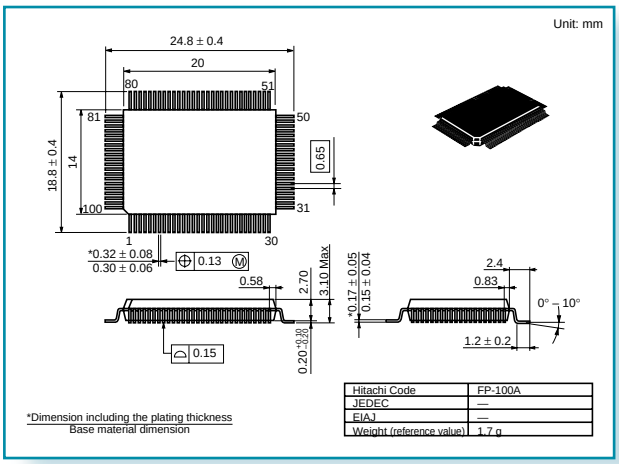
Packages



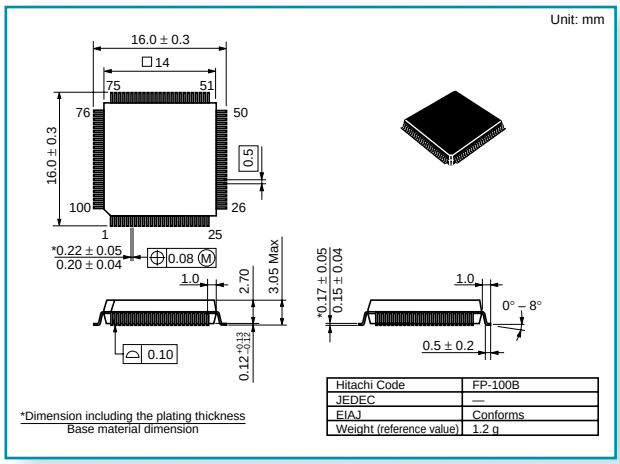
FP-80A



FP-80B

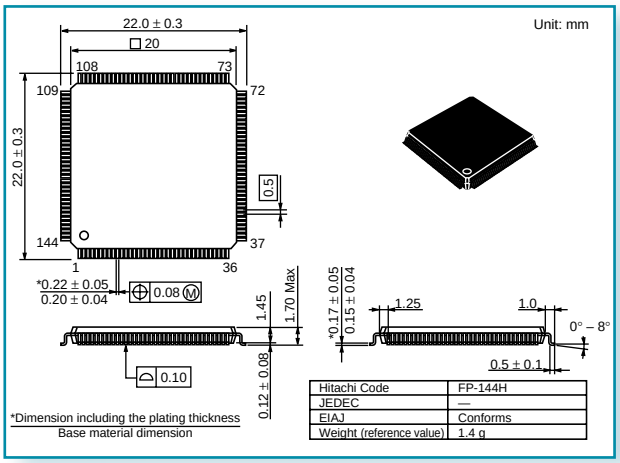


FP-100A

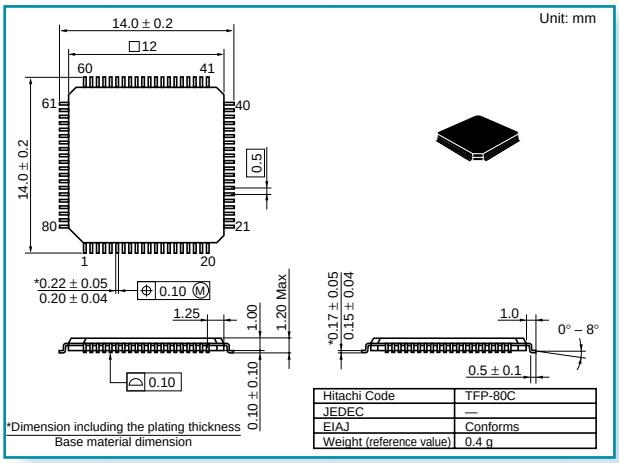


FP-100B

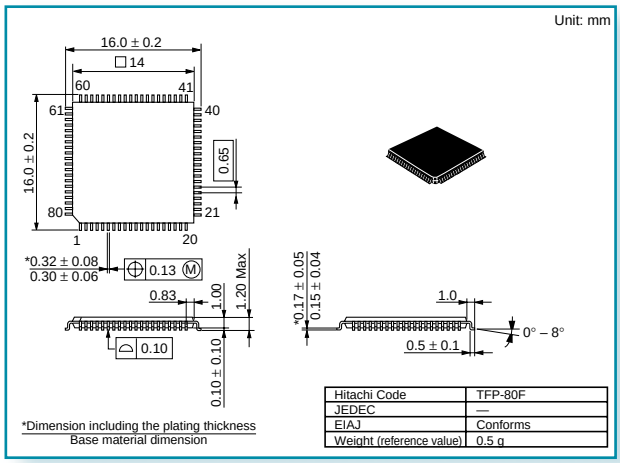
P a c k a g e s



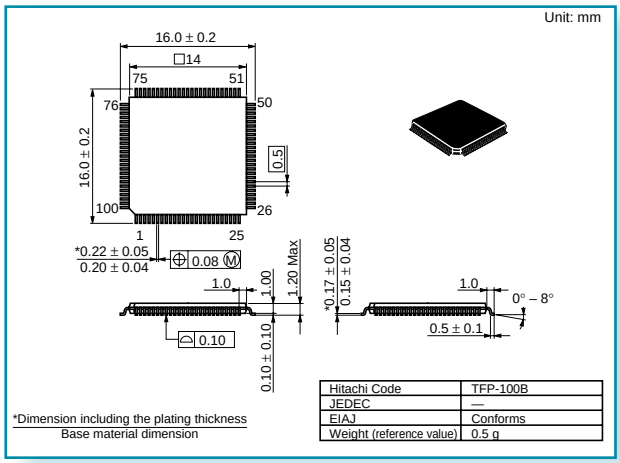
F P - 1 4 4 H



T F P - 8 0 C

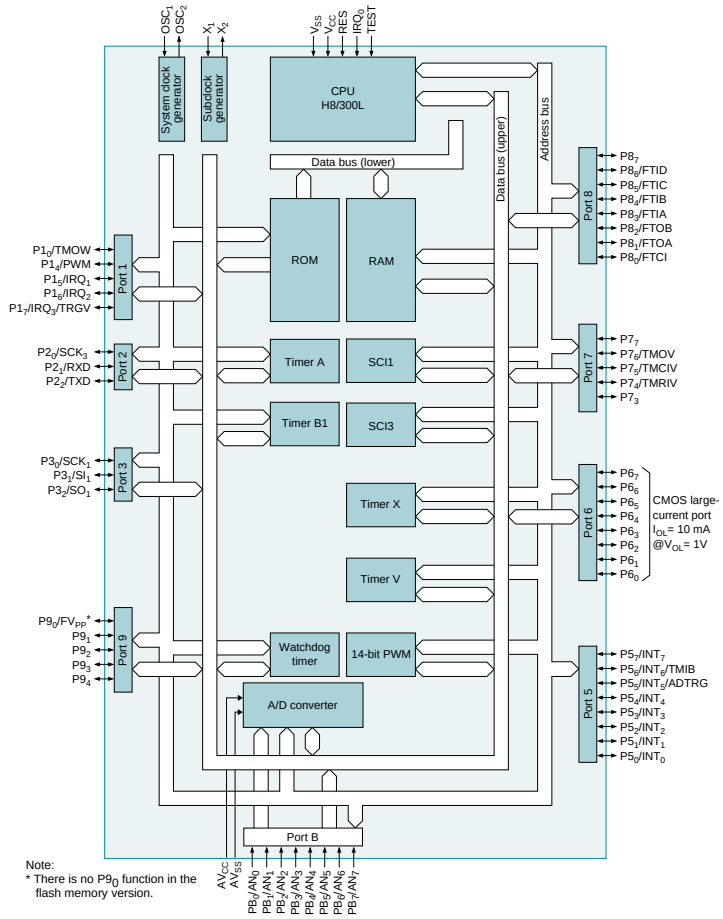


T F P 8 0 F



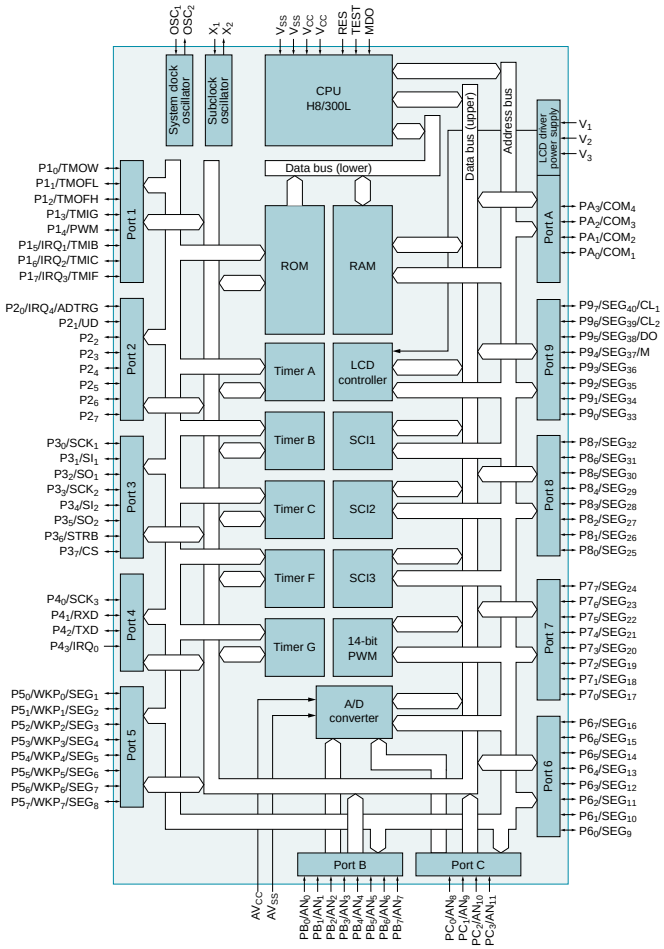
T F P - 1 0 0 B

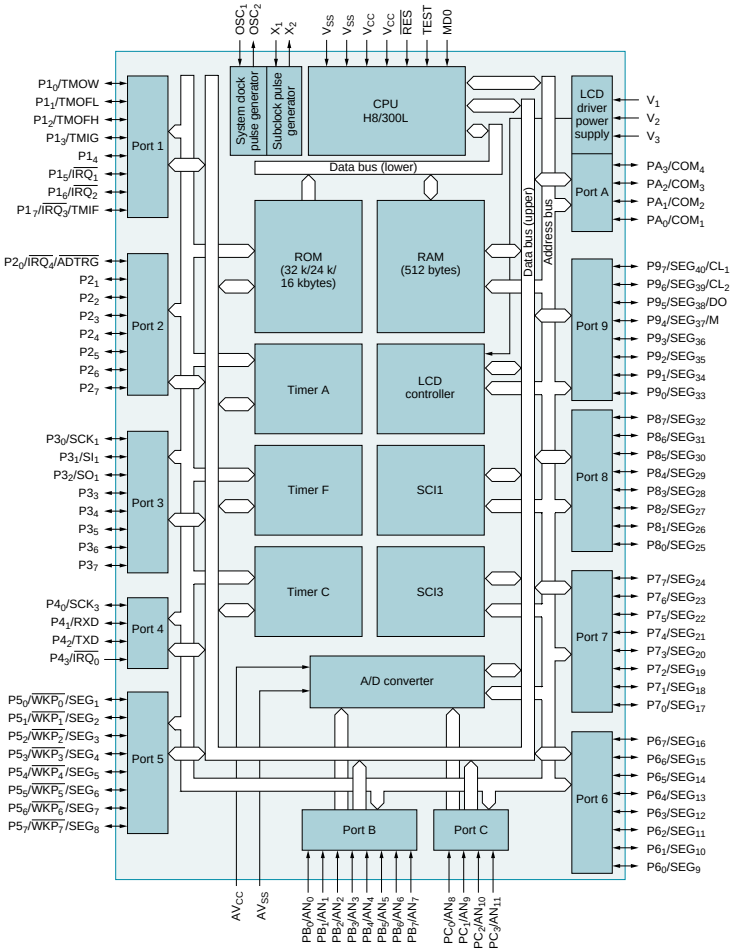
H 8 / 3 6 4 4

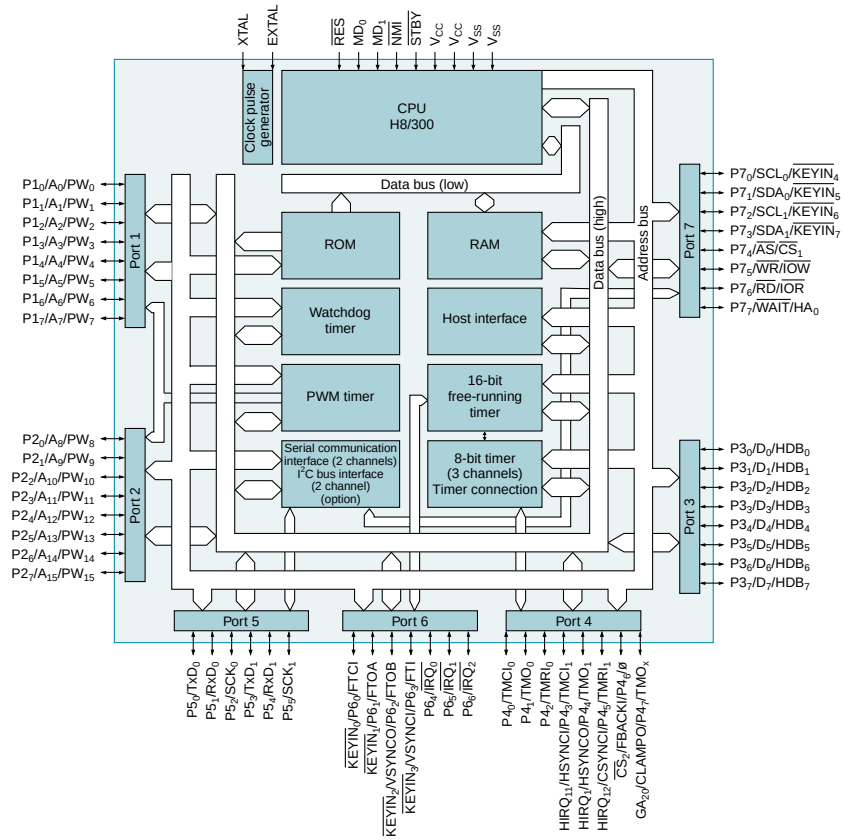


Note:
* There is no $P9_0$ function in the flash memory version.

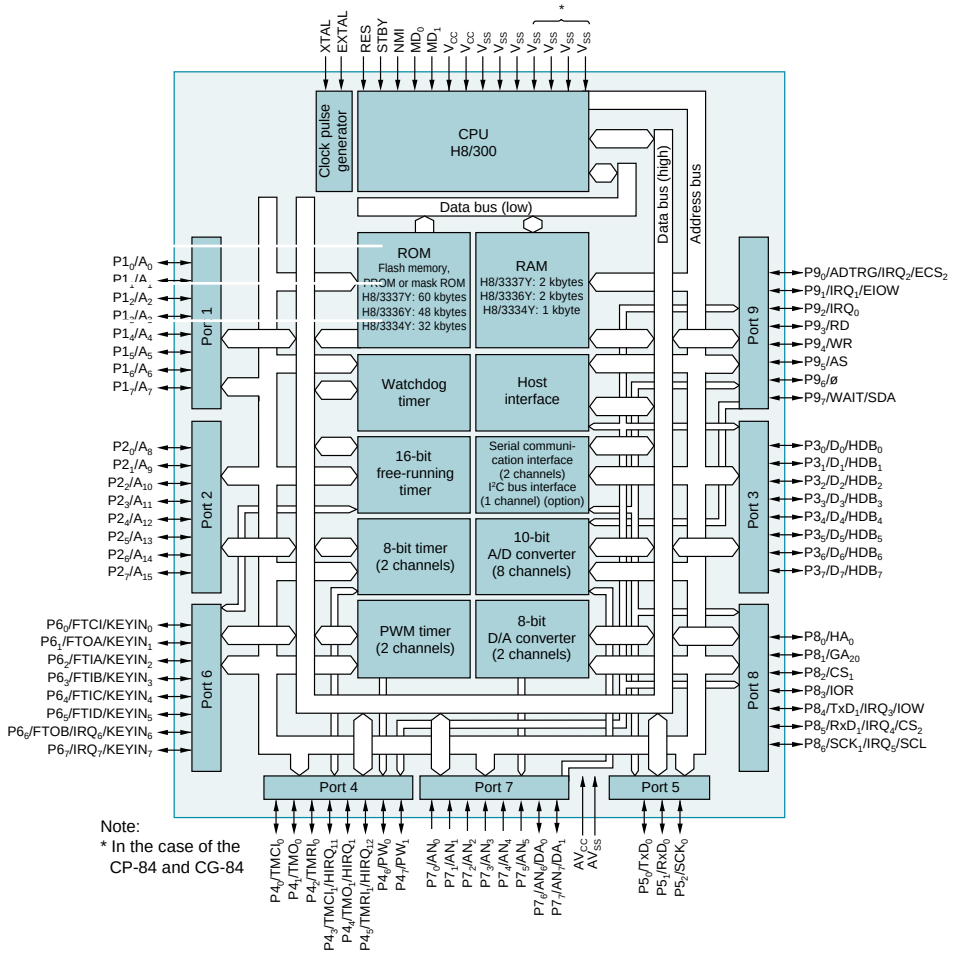
H 8 / 3 8 3 7




OSC1
OSC2
X1
X2
VSS
VSS
VCC
VCC
RES
TEST
MD0
System clock pulse generator
Subclock pulse generator
CPU H8/300L
LCD driver power supply
V1
V2
V3
Data bus (lower)
Data bus (upper)
Address bus
ROM (32 k/24 k/ 16 kbytes)
RAM (512 bytes)
Timer A
LCD controller
Timer F
SCI1
Timer C
SCI3
A/D converter
Port 1
Port 2
Port 3
Port 4
Port 5
Port 6
Port 7
Port 8
Port 9
Port A
Port B
Port C
P10/TMOW
P11/TMOFL
P12/TMOFH
P13/TMIG
P14
P15/IRQ1
P16/IRQ2
P17/IRQ3/TMIF
P20/IRQ4/ADTRG
P21
P22
P23
P24
P25
P26
P27
P30/SCK1
P31/SI1
P32/SO1
P33
P34
P35
P36
P37
P40/SCK3
P41/RXD
P42/TXD
P43/IRQ0
P50/WKP0/SEG1
P51/WKP1/SEG2
P52/WKP2/SEG3
P53/WKP3/SEG4
P54/WKP4/SEG5
P55/WKP5/SEG6
P56/WKP6/SEG7
P57/WKP7/SEG8
PA3/COM4
PA2/COM3
PA1/COM2
PA0/COM1
P97/SEG40/CL1
P96/SEG39/CL2
P95/SEG38/DO
P94/SEG37/M
P93/SEG36
P92/SEG35
P91/SEG34
P90/SEG33
P87/SEG32
P86/SEG31
P85/SEG30
P84/SEG29
P83/SEG28
P82/SEG27
P81/SEG26
P80/SEG25
P77/SEG24
P76/SEG23
P75/SEG22
P74/SEG21
P73/SEG20
P72/SEG19
P71/SEG18
P70/SEG17
P67/SEG16
P66/SEG15
P65/SEG14
P64/SEG13
P63/SEG12
P62/SEG11
P61/SEG10
P60/SEG9
AVCC
AVSS
PB0/AN0
PB1/AN1
PB2/AN2
PB3/AN3
PB4/AN4
PB5/AN5
PB6/AN6
PB7/AN7
PC0/AN8
PC1/AN9
PC2/AN10
PC3/AN11

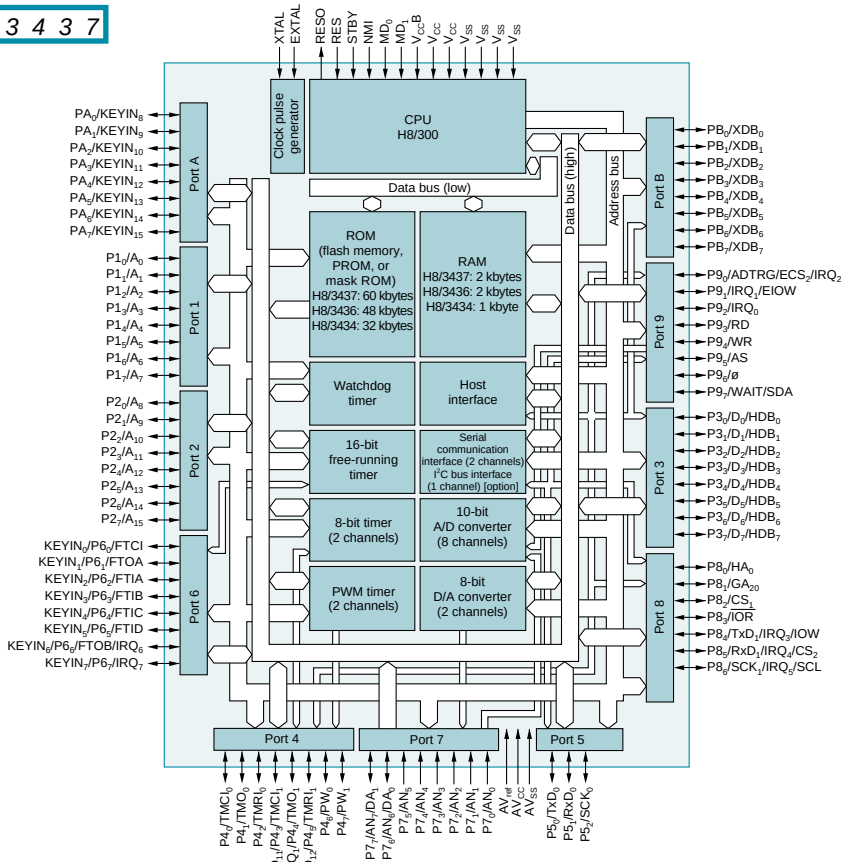

XTAL
EXTAL
RES
MD0
MD1
NMI
STBY
VCC
VCC
VSS
VSS
Clock pulse generator
CPU H8/300
Data bus (low)
Data bus (high)
Address bus
ROM
RAM
Watchdog timer
Host interface
PWM timer
16-bit free-running timer
Serial communication interface (2 channels) I2C bus interface (2 channel) (option)
8-bit timer (3 channels) Timer connection
Port 1
Port 2
Port 3
Port 4
Port 5
Port 6
Port 7
P10/A0/PW0
P11/A1/PW1
P12/A2/PW2
P13/A3/PW3
P14/A4/PW4
P15/A5/PW5
P16/A6/PW6
P17/A7/PW7
P20/A8/PW8
P21/A9/PW9
P22/A10/PW10
P23/A11/PW11
P24/A12/PW12
P25/A13/PW13
P26/A14/PW14
P27/A15/PW15
P70/SCL0/KEYIN4
P71/SDA0/KEYIN5
P72/SCL1/KEYIN6
P73/SDA1/KEYIN7
P74/AS/CS1
P75/WR/IOW
P76/RD/IOR
P77/WAIT/HA0
P30/D0/HDB0
P31/D1/HDB1
P32/D2/HDB2
P33/D3/HDB3
P34/D4/HDB4
P35/D5/HDB5
P36/D6/HDB6
P37/D7/HDB7
P55/TxD0
P51/RxD0
P52/SCK0
P53/TxD1
P54/RxD1
P55/SCK1
KEYIN0/P60/FTCI
KEYIN1/P61/FTOA
KEYIN2/VSYNCO/P62/FTOB
KEYIN3/VSYNCI/P63/FTI
P64/IRQ0
P65/IRQ1
P66/IRQ2
P40/TMCI0
P41/TMO0
P42/TMRI0
HIRQ11/HSYNCI/P43/TMCI1
HIRQ1/HSYNCO/P44/TMO1
HIRQ12/CSYNCI/P45/TMRI1
CS2/FBACKI/P46/Ø
GA20/CLAMPO/P47/TMOX

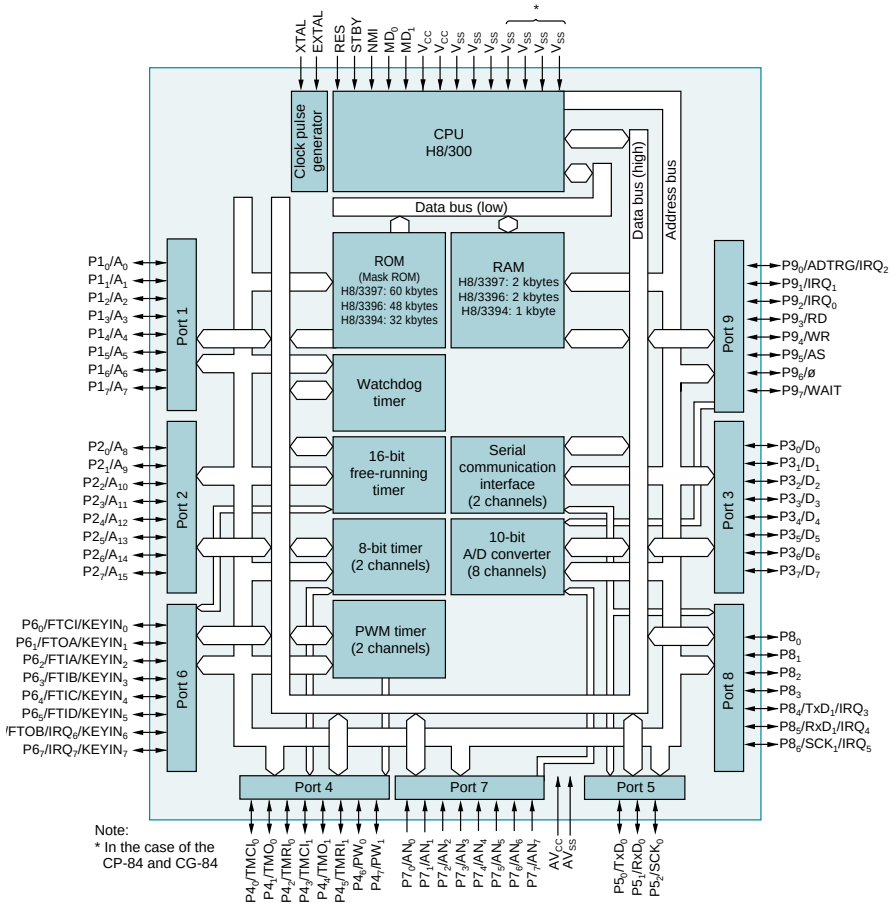
H 8 / 3 3 3 4 Y

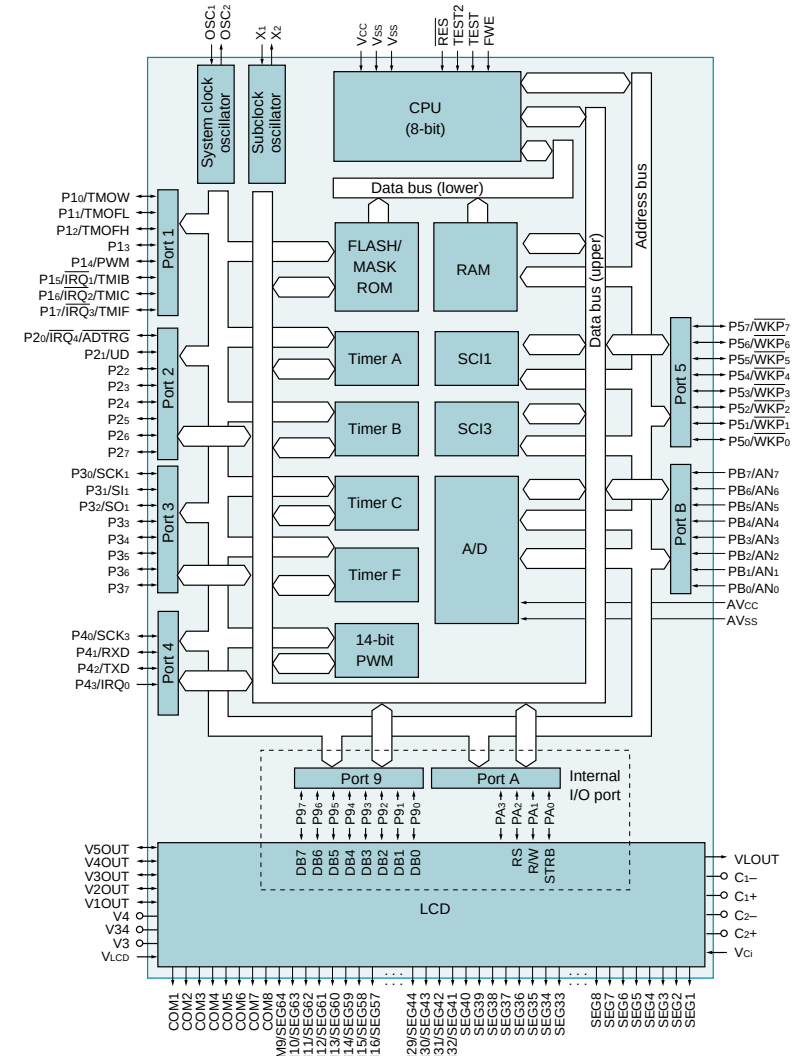


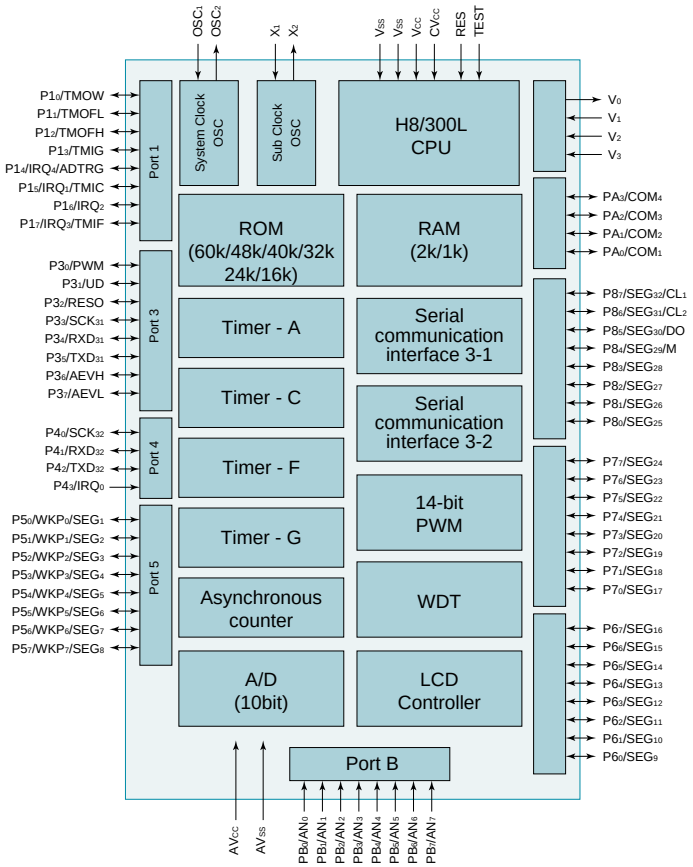
Note:
* In the case of the CP-84 and CG-84

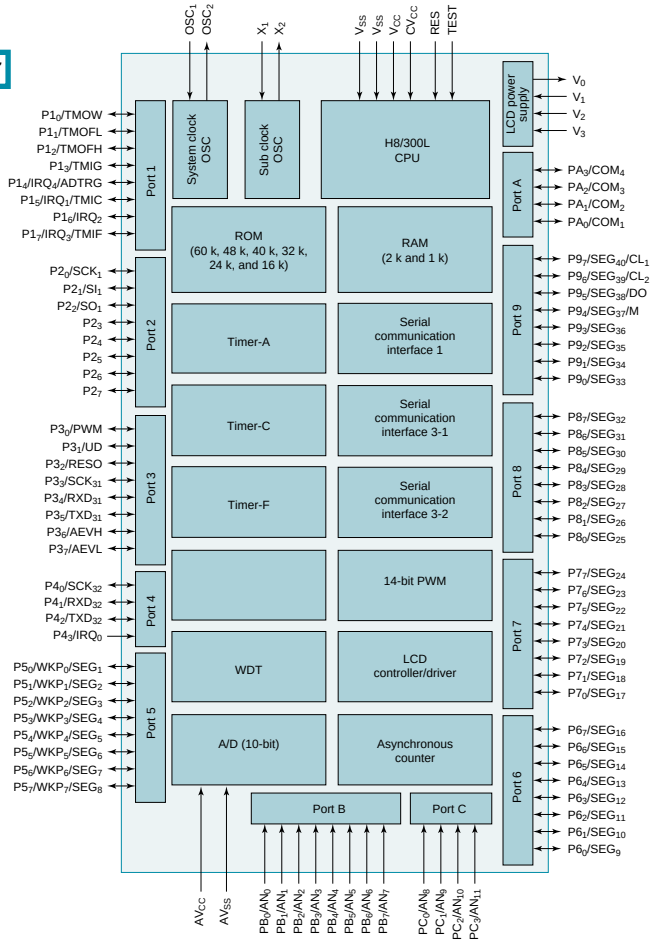
H 8 / 3 4 3 7




XTAL
EXTAL
RES
STBY
NMI
MD0
MD1
VCC
VSS
Clock pulse generator
CPU
H8/300
Data bus (low)
Data bus (high)
Address bus
ROM
(Mask ROM)
H8/3397: 60 kbytes
H8/3396: 48 kbytes
H8/3394: 32 kbytes
RAM
H8/3397: 2 kbytes
H8/3396: 2 kbytes
H8/3394: 1 kbyte
Watchdog timer
16-bit free-running timer
Serial communication interface (2 channels)
8-bit timer (2 channels)
10-bit A/D converter (8 channels)
PWM timer (2 channels)
Port 1
Port 2
Port 3
Port 4
Port 5
Port 6
Port 7
Port 8
Port 9
Note:
* In the case of the CP-84 and CG-84

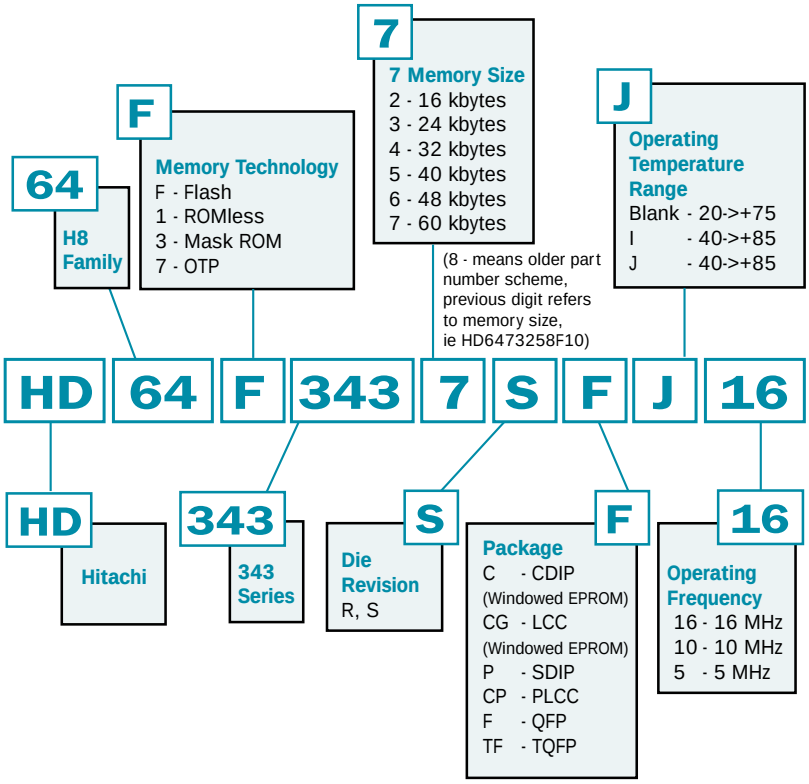

OSC1
OSC2
X1
X2
VCC
VSS
RES
TEST2
TEST
FWE
System clock oscillator
Subclock oscillator
CPU
(8-bit)
Data bus (lower)
Data bus (upper)
Address bus
FLASH/ MASK ROM
RAM
Timer A
Timer B
Timer C
Timer F
SCI1
SCI3
A/D
14-bit PWM
Port 1
Port 2
Port 3
Port 4
Port 5
Port B
Port 9
Port A
Internal I/O port
LCD


OSC1 OSC2 X1 X2 Vss Vss Vcc CVcc RES TEST
P10/TMOW
P11/TMOFL
P12/TMOFH
P13/TMIG
P14/IRQ4/ADTRG
P15/IRQ1/TMIC
P16/IRQ2
P17/IRQ3/TMIF
Port 1
System Clock OSC
Sub Clock OSC
H8/300L CPU
V0
V1
V2
V3
ROM (60k/48k/40k/32k 24k/16k)
RAM (2k/1k)
PA3/COM4
PA2/COM3
PA1/COM2
PA0/COM1
P30/PWM
P31/UD
P32/RESO
P33/SCK31
P34/RXD31
P35/TXD31
P36/AEVH
P37/AEVL
Port 3
Timer - A
Serial communication interface 3-1
P87/SEG32/CL1
P86/SEG31/CL2
P85/SEG30/DO
P84/SEG29/M
P83/SEG28
P82/SEG27
P81/SEG26
P80/SEG25
Timer - C
Serial communication interface 3-2
P40/SCK32
P41/RXD32
P42/TXD32
P43/IRQ0
Port 4
Timer - F
P70/SEG24
P71/SEG23
P72/SEG22
P73/SEG21
P74/SEG20
P75/SEG19
P76/SEG18
P77/SEG17
14-bit PWM
P50/WKP0/SEG1
P51/WKP1/SEG2
P52/WKP2/SEG3
P53/WKP3/SEG4
P54/WKP4/SEG5
P55/WKP5/SEG6
P56/WKP6/SEG7
P57/WKP7/SEG8
Port 5
Timer - G
Asynchronous counter
WDT
P67/SEG16
P66/SEG15
P65/SEG14
P64/SEG13
P63/SEG12
P62/SEG11
P61/SEG10
P60/SEG9
A/D (10bit)
LCD Controller
Port B
AVcc AVss
PB0/AN0 PB1/AN1 PB2/AN2 PB3/AN3 PB4/AN4 PB5/AN5 PB6/AN6 PB7/AN7


OSC1 OSC2 X1 X2 Vss Vss VCC CVCC RES TEST
P10/TMOW
P11/TMOFL
P12/TMOFH
P13/TMIG
P14/IRQ4/ADTRG
P15/IRQ1/TMIC
P16/IRQ2
P17/IRQ3/TMIF
Port 1
System clock OSC
Sub clock OSC
H8/300L CPU
LCD power supply
V0
V1
V2
V3
ROM (60 k, 48 k, 40 k, 32 k, 24 k, and 16 k)
RAM (2 k and 1 k)
Port A
PA3/COM4
PA2/COM3
PA1/COM2
PA0/COM1
P20/SCK1
P21/SI1
P22/SO1
P23
P24
P25
P26
P27
Port 2
Timer-A
Serial communication interface 1
Port 9
P97/SEG40/CL1
P96/SEG39/CL2
P95/SEG38/DO
P94/SEG37/M
P93/SEG36
P92/SEG35
P91/SEG34
P90/SEG33
Timer-C
Serial communication interface 3-1
P30/PWM
P31/UD
P32/RESO
P33/SCK31
P34/RXD31
P35/TXD31
P36/AEVH
P37/AEVL
Port 3
Timer-F
Serial communication interface 3-2
Port 8
P87/SEG32
P86/SEG31
P85/SEG30
P84/SEG29
P83/SEG28
P82/SEG27
P81/SEG26
P80/SEG25
P40/SCK32
P41/RXD32
P42/TXD32
P43/IRQ0
Port 4
14-bit PWM
Port 7
P77/SEG24
P76/SEG23
P75/SEG22
P74/SEG21
P73/SEG20
P72/SEG19
P71/SEG18
P70/SEG17
P50/WKP0/SEG1
P51/WKP1/SEG2
P52/WKP2/SEG3
P53/WKP3/SEG4
P54/WKP4/SEG5
P55/WKP5/SEG6
P56/WKP6/SEG7
P57/WKP7/SEG8
Port 5
WDT
LCD controller/driver
A/D (10-bit)
Asynchronous counter
Port 6
P67/SEG16
P66/SEG15
P65/SEG14
P64/SEG13
P63/SEG12
P62/SEG11
P61/SEG10
P60/SEG9
Port B
Port C
AVCC AVSS
PB0/AN0 PB1/AN1 PB2/AN2 PB3/AN3 PB4/AN4 PB5/AN5 PB6/AN6 PB7/AN7
PC0/AN8 PC1/AN9 PC2/AN10 PC3/AN11

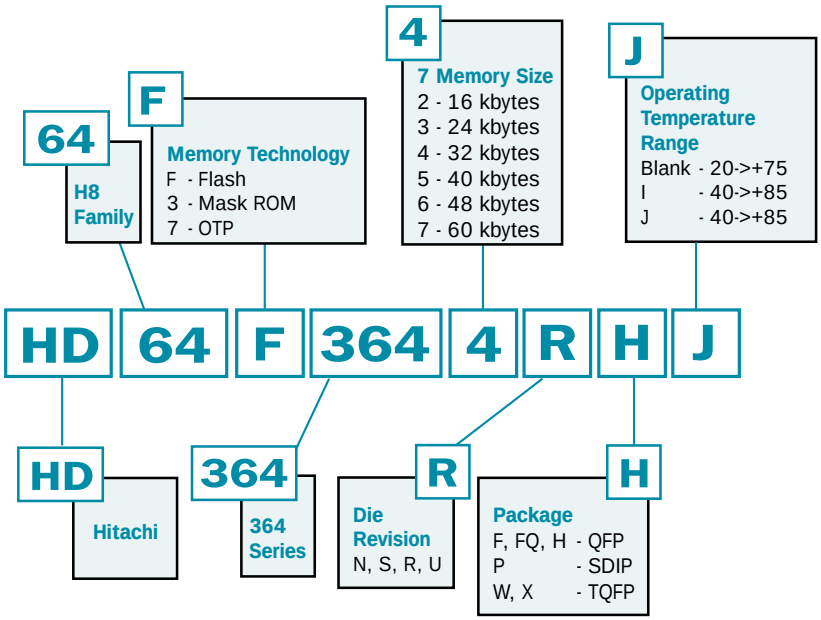
H8/300 Ordering **Information**

Example of an H8/300 Part No. breakdown



H8/300L Ordering **Information**

Example of an H8/300L Part No. breakdown



H8 Support **Tools**

As development times become shorter, the tools used to develop micro-controller based products become ever more crucial to the successful conclusion of a development project.
With this in mind Hitachi Micro Systems Europe Ltd (HMSE) have developed a range of low cost, integrated development tools to enable the rapid prototyping of any embedded product. These tools include an optimising ANSI c-compiler, evaluation board and low cost in-circuit emulators with symbolic and 'C'-level debug capability.

Figure 16

ANSI 'C'-Compiler

The H8 'C' compiler has been developed in Europe to take advantage of the full power of the H8 architecture while still complying totally to the full ANSI C specification. The compiler is memory based, avoiding temporary files or overlays and offers selective optimisation levels for both speed and code size.
The H8 compiler supports IEEE compatible floating point arithmetic and a standard library of function particularly applicable to embedded systems, the source code for these functions is included to allow modification of functions where required. Powerful language extensions and #pragma's allow the use of H8 specific features, including the efficient use of I/O and short addressing modes and the ability to produce interrupt routines requiring no assembly language. Peripheral registers (and thus I/O ports) can be accessed using simple cast statements. For bit addressable I/O locations, the Special function Register (SFR) keyword can be used or a special bit variable can be declared.
The H8 'C' compiler has been optimised to perform typical micro-controller tasks efficiently, these tasks include manipulating I/O and peripheral control registers. To cope with machine specific instructions, such as sleep operations, the H8 'C' compile provides a full set of in-line functions (macros which substitute the function call with in-line code).
The H8 assembler is a powerful, single pass macro assembler. The assembler supports directives for structured control flow, or structured assembly, and a pre-processor for the C language. This is available separately for those who don't want to develope in 'C'.
The H8 linker, XLINK, allows the users to link multiple relocatable object files, allowing very close control of memory allocation. The linker also performs extensive module interface type checking at link time. The linker produces fully PROMable code and has a comprehensive range of output options including many common forms of debug format for supporting simulators, evaluation boards and emulators.
The H8 'C' compiler also comes with a librarian, XLIB, which allows the users to maintain the supplied system libraries as well as creating custom user libraries.

Hitachi's H8 'C' Compilers are now shipped with HWB (Hitachi Workbench). HWB has been designed to provide users with an integrated development environment. HWB is a MS Windows™ application which is able to control the various code generation tools. A typical HWB edit session is shown in *figure 16*.

Projects may be created which allow the user to define all of the source and library files to be used. HWB will calculate the dependencies between these files and a built in make facility will use this information to control all of the compilation tools. Configuring the assembler, compiler and linker is also easy as all the command line options are selected using a series of selection dialogues.

The built in editor supports context sensitive colourisation of source files and supports automatic cursor location to the source line causing a compilation error. The combination of Hitachi's 'C' compiler technology with HWB provides a quick and powerful way to generate 'C' code for any microcontroller application.

PCE Low Cost In-Circuit Emulator

The PCE Range of PC based emulators have been designed to offer engineers a high performance in-circuit emulator for an affordable price. The PCE is supported by CIDE (the 'C' Integrated Development Environment), a windows based, source level debugger. Each PCE emulates the H8 family at full speed in real-time. The PCE comes with a high speed parallel interface (8-bit X/T interface card requiring one PC half-card slot) from the PC to allow fast downloading of code and debug information.
Each PCE supports the full 64k address space of the H8 with high speed SRAM and has the following features, shown in the *table 12*. Each PCE is now supplied with a copy of the CIDE debugger.

Table 12

PCE Specification

	PCE8300	PCE8300L
Operating Voltage	5v	2.7 - 5.5v
Clock	1 - 16 MHz or target clock	1 - 10 MHz or target clock
Complex breakpoints	yes	yes
Break on data compare	yes	yes
Breakpoint pass counter	yes (16-bit)	yes (16-bit)
Multi-level breakpoints	yes	yes
PC Breakpoints	Unlimited	Unlimited
Trace	2048 cycles	2048 cycles
Trace details	Address, Data, R/W CPU Status target probes	Address, Data, R/W CPU Status target probes
Trace aquisition control	yes	yes
Trigger output	yes	yes
Target probes	4	4

Software ordering information

Package	IBM PC
HWB, H8/300 ANSI C-Compiler, Cross Assembler and Utilities	S32HWBIAR3X
CIDE C-level debugger for PCE	S83CIDEPC-L

Software may be purchased in 1, 5 or 10 user licences. This is denoted in the part number by a -1, -5 or -10 repectively. ie Single user licence for the H8/300 compiler for the IBM PC is S16HWBIAR3X-1

CIDE

The 'C' Integrated development Environment (CIDE), has been developed to provide an easy to use, graphical interface for the PCE's in the windows environment.
CIDE provides the user with a point and click user interface with a number of windows, for code, registers, memory, trace, breakpoints and watchpoints.
CIDE provides full 'C' level source debug running on the PCE, allowing the display of 'C' level, assembly level instructions or mixed 'C' and assembly code in the code window.
Complex breakpoints can be set on 'C' level statements or symbolically. For each form of display, 'C', assembly level or mixed, breakpoint and stepping utilities are fully level sensitive. Watchpoints can be set up on any variable or structure defined in your 'C' program as well as at a symbolic or absolute address level.
Structure's and union's may be exploded inside the watch window to expose the data held within. Local variables may also be watched when in scope.
The combination of CIDE with the PCE's provide the user with the shortest learning curve to the best, most cost effective tools available. A snapshot of CIDE during a typical debug session is shown in *figure 17*.

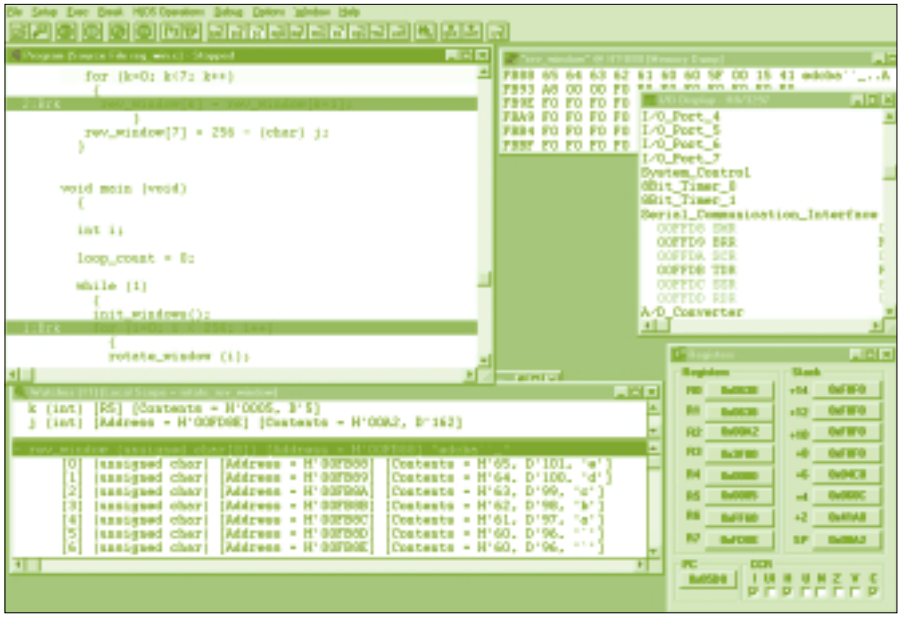


Figure 17

E6000 Emulators

The E6000 emulator is the latest in-circuit emulator from Hitachi. It represents the next step in performance from the PCE. The E6000 offer's full real-time in-circuit emulation and contains high performance break and trace features.
The debugging power of the E6000 comes from the Complex Event Systems (CES). This provides sophisticated break and trace control, with the ability to generate events based on address and data values and the microcontroller control signals. These events may then be used to activate break, trace or timing functions. Events may also be delayed by a specified number of cycles or may be combined to define a complex series of conditions and actions. The E6000 specification is detailed in *table 13*.

Table 13

E6000 Specification

	E6000
Operating Voltage	Automatic tracking of target supply
Clock	1 - 16 MHz or target clock
Complex breakpoints	yes
Break on data compare	yes
Breakpoint pass counter	yes (16-bit)
Multi-level breakpoints	yes
PC Breakpoints	256
Trace	32K cycles
Trace details	Address, Data, R/W CPU Status target probes
Trace aquisition control	yes
Trigger output	yes
Target probes	4

HDI

HDI (Hitachi Debugging Interface) supports all of the E6000 emulators as well as Hitachi's Evaluation Board products. HDI is a fully featured high level debugger, allowing the user complete control of the debug features available. A typical debug session is shown in *figure 18*.
HDI is a generic product, based around the HDI graphical user interface. It can support any of the E6000 emulators or the Hitachi Evaluation Boards by the addition of a target specific DLL. This means that a common development environment can be maintained for a project with one easy to use debug interface, and changing to a different target becomes very simple.

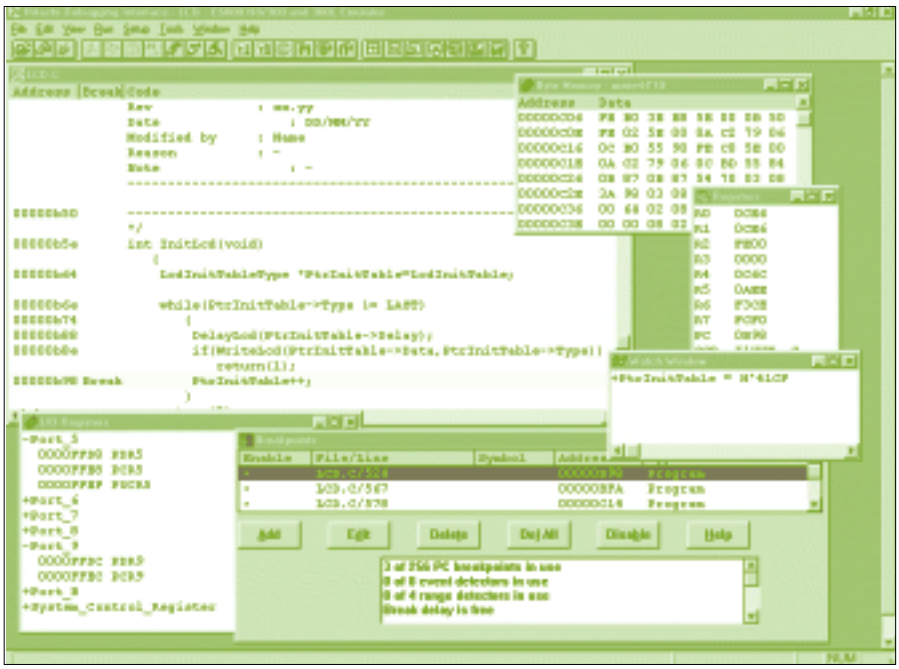


Figure 18

Table 14

H8/300 Development Hardware ordering information

Device	PCE Emulator	System Kit 5	E6000	System Kit 6	Package	PCE Header	E6000 Header	Programming Adaptor Z-TAT (OTP)	Programming Adaptor ZTAT (Flash)
H8/325 Family	PCE3257	S5-3257	E6-3257[1]	S6-3257[1]	DP-64S	PHB325D64S	HS3257ECS61H[1]	HS328ESS01H HS3257ESS01H	
					CP-68	PHB325P68	N/A	HS328ESC01H HS3257ESC01H	
					FP-64A	EFA832XQ64DP64[2]	HS3257ECH61H[1]	HS328ESH01H HS3257ESH01H	
H8/329 Family	PCE339	S5-329			DP-64S CP-68 FP-64A	PHB3297D64S PHB3297P68 EFA832XQ64DP64[2]		HS328ESS02H HS328ESC02H HS328ESH02H	
H8/330	PCE330	S5-330			FP-80A CP-84	EFA833XQ80PL84 PHB3337P84		HS338ESH01H HS338ESC01H	
H8/338 Family	PCE338	S5-338			FP-80A CP-84	EFA833XQ80PL84 PHB3337P84		HS338ESH02H HS338ESC02H	
H8/3217 Family	N/A	N/A	E6-3318R[1]	S6-3318R[1]	DP-64S FP-64A TFP-80C		EHB3217D64S EHB3217Q64A HS3217ECN61H[1]	HS3217ESSS1H HS3217ESHS1H HS3217ESNS1H	
H8/3297 Family	PCE3297	S5-3297	E6-3437[1]	S6-3437[1]	DP-64S CP-68 FP-64A TFP-80C	PHB3297D64S PHB3297P68 PHB3297Q64A N/A	HS3297ECS61H[1] N/A HS3297ECH61H[1] HS3297ECN61H[1]	HS3297ESSS1H HS3297ESCS1H HS3297ESHS1H HS3297ESNS1H	
H8/3337 Family	PCE3337	S5-3337	E6-3437[1]	S6-3437[1]	FP-80A CP-84 TFP-80C	EFA833XQ80PL84[3] PHB3337P84 N/A	HS3337ECH61H[1] N/A HS3337ECN61H[1]	HS3337ESHS1H HS3337ESCS1H HS3337ESNS1H	HS3334ESHF1H HS3334ESCF1H HS3334ESHF1H
H8/3437 Family	N/A	N/A	E6-3437[1]	S6-3437[1]	FP-100B TFP-100B		HS3437ECH61H[1] HS3437ECN61H[1]	HS3437ESHS1H HS3437ESNS1H	HS3434ESHF1H HS3434ESNF1H

1. Contact Hitachi or your Hitachi Distributor for availability
2. Requires EFA832XQ64DP64 + PHB325D64S
3. Requires EFA833XQ80PL84 + PHB3337P84

For further details and availability contact your Hitachi representative.

System Kits

System kit's are available for all of Hitachi's emulators. The system kit includes all of the software and hardware components (apart from the emulator header) required for development. The S5 system kit contains the PCE emulators, Hitachi's H8 C-compiler, assembler, linker and librarian along with a copy of the CIDE C-level debugger. The S6 system kit contains the E6000 emulator and HDI debugger, along with Hitachi's H8 C-compiler, assembler, linker and librarian. These kits are available at a cost, lower than that of the total cost of all the individual components.
The part numbers and ordering information for all of Hitachi's emulators and system kits is listed in *tables 14 & 15*, along with the part numbers of the various programming sockets required to program the H8 OTP's and Flash microcontrollers.

Table 15

H8/300L Development Hardware ordering information

Device	PCE Emulator	System Kit	E6000 Emulator	E6000 System Kit	Package	PCE Emulator Header	E6000 Emulator Header	Programming Adaptor
H8/3614 Family	PCE3614	S5-3614			DP-64S FP-64A	PHB300LD64S PHB300LQ64A		HS3614ESS01H HS3614ESH01H
H8/3644 Family	PCE3644	S5-3644	E6-3927T[3]	S6-3927T[3]	DP-64S FP-64A	PHB300LD64S PHB300LQ64A	EHB3644D64S EHB3644Q64A	Contact MQP[1] Data I/O or Minato
H8/3714 Family	TBA[2]	TBA[2]			DP-64S FP-64A	PHB300LD64S PHB300LQ64A		HS3714ESS01H HS3714ESH01H
H8/3724 Family	PCE3724	S5-3724			FP-80A FP-80B	PHB300LD80A PHB300LQ80B		HS3724ESH01H HS3724ESF01H HS3726ESH01H HS3726ESF01H
H8/3814 Family	PCE3834	S5-3834			QFP-100A QFP-100B	PHB300LD100A PHB300LQ100B		N/A
H8/3834 Family	PCE3834	S5-3834			QFP-100A QFP-100B TFP-100B	PHB300LD100A PHB300LQ100B		HS3834ESF01H HS3834ESH01H HS3834ESN01H HS3836ESH01H HS3836ESN01H
H8/3877 Family	PCE3877	S5-3877			QFP-100B	PHB300LQ100B		HS3877ESH01H
H8/3827 Family			E6-3880	S6-3880	FP-80A FP-80B TFP-80C		EHB3864Q80A HS3864ECF61H HS3864ECN62H	Contact Data I/O or Minato
H8/3847 Family			E6-3880	S6-3880	QFP-100A QFP-100B TFP-100B		HS3887ECF61H EHB3887Q100B EHB3887Q100B	Contact Data I/O or Minato
H8/3857			TBA[2]	TBA[2]	FP-144H		TBA[2]	TBA[2]
H8/3867 Family			E6-3880	S6-3880	FP-80A FP-80B TFP-80C		EHB3864Q80A HS3864ECF61H HS3864ECN62H	Contact Data I/O or Minato
H8/3867 Family			E6-3880	S6-3880	QFP-100A QFP-100B TFP-100B		HS3887ECF61H EHB3887Q100B EHB3887Q100B	Contact Data I/O or Minato

1. Contact MPQ Electronics for H8/3644 programming adaptors
2. Contact Hitachi or your Hitachi Distributor for availability
3. E63927T only supports 10 MHz operation, Please contact Hitachi for 16 MHz support if required.

Evaluation Boards

Hitachi has developed a range of low cost evaluation boards to support a number of H8 microcontrollers. Each of these evaluation boards comes complete with all the hardware and software required to evaluate an application using the H8 microcontroller. A full list of the evaluation boards for the H8/300 and H8/300L is given in *table 16*.
Each board has two RS-232 serial interfaces, one, used for communication with a host PC, the second available to the users application. Each board requires a single 5v supply, and contains on-board SRAM for the user application along with circuitry to control the reset and NMI lines. The address and data bus along with the other I/O pins are available to the user on the PCB.
Each evaluation board comes with a serial cable and full documentation along with evaluation copies of the Hitachi and GNU C-compilers and source level debuggers (on CD ROM). Full device data on CD ROM is also included.

In addition, evaluation boards developed to support the H8 devices with on-chip flash memory have additional circuitry to support the programming of the on-board flash memory. This circuitry is contained on a separate "breakoff" PCB, which can be removed from the main evaluation board PCB (while still leaving it able to function as an evaluation board) and used to supply the power and control signals to program devices in the users application. Flash evaluation boards are also shipped with a copy of the Hitachi Flash Programming software.

Table 16

H8 Evaluation Boards

Evaluation Board	Supported devices
EVB3644F	H8/3644 series
EVB3217	H8/3217 series
EVB3334	H8/3334Y series
EVB3437F	H8/3297 series
	H8/3334Y series
	H8/3437 series

Flash Development Tools (FDT)

This is a Windows™ application which allows the in-circuit programming of a Hitachi H8 microcontroller with on-board flash memory. FDT can be used to program devices in both Boot and User mode, and so allows the user maximum flexibility in application design.

FDT supports the following features.

- Blank Check
- Read Flash Memory
- Program Flash Memory (from S-record)
- Program with verify
- Erase (block by block)
- User specified command

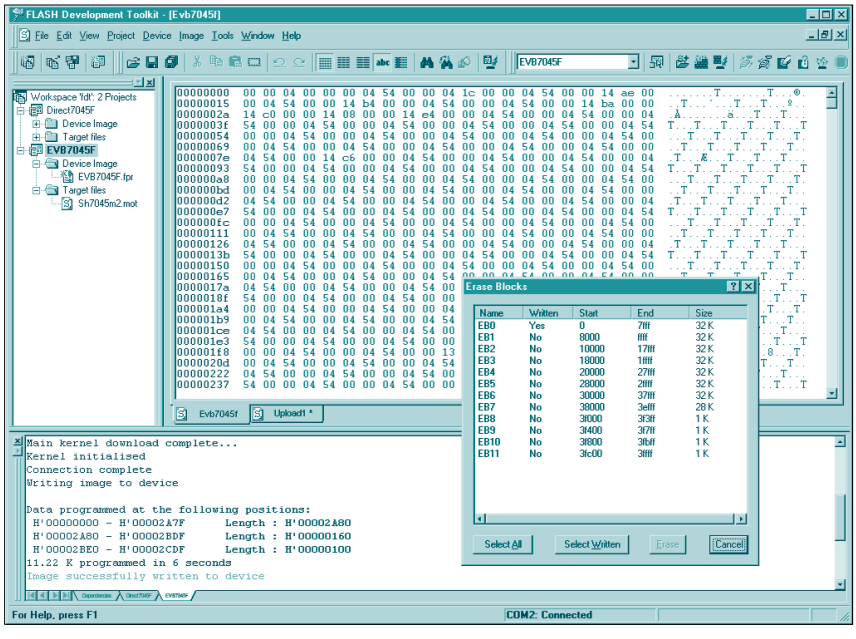


Figure 19

H8 Third **Support** Tools

Hitachi works with many third party companies to support our Microcontrollers, the following list is of some of the companies who currently support H8/300 and H8/300L products.

Third Party Emulators

Contact:
UK: 01256 811998
email: sales@ash-uk.demon.co.uk

Germany: 08233/32681
email: ashling.ger@t_online.de

France: (1) 46 66 27 50
email: ash-fr@world_net.sct.fr

Rest of Europe: 353 61 334466
email: ashling@iol.ie

Contact:
Lauterbach Datentechnik Gmbh,
Fichtenstr. 27,
D-85649 Hofolding, Germany.
Tel: +49 (08104)-8943-0
Fax: +49 (08104)-8943-30
E-mail: info@lauterbach.com
www: http://www.lauterbach.com

Lauterbach Inc.
5, Mt. Royal Av.
Marlborough, MA 01752
USA
Tel: +1 (508) 303-6812
Fax +1 (508) 303-6813
E-mail: info_us@lauterbach.com

Contact:
Pentica Systems Ltd.,
Oaklands Park, Wokingham,
Berks RG41 2FD.
Tel: (0118) 9 792101
World Wide Web Home Page,
http://www.pentica.co.uk/
Email address,
100315.1366@compuserve.com

Third Party Compilers

Contact:
Sweden:
IAR Systems AB,
P.O. Box 23051,
S-750 23 UPPSALA
Tel: +46 18 16 78 00
Fax: +46 18 16 78 38
E-mail: info@iar.se

Germany:
IAR Systems Gmbh,
Brucknerstraße 27,
D-81677 München
Tel: +49 89 470 6022
Fax: +49 89 470 9565
E-mail: info@iar.de

UK:
IAR Systems Ltd.,
9 Spice Court,
Ivory Square.,
Plantation Wharf,
York Road,
London SW11 3UE
Tel: +44 171 924 3334
Fax: +44 171 924 5341
E-mail: info@iarsys.co.uk

US:
IAR Systems Inc.,
One Maritime Plaza,
San Francisco, CA 94111
Tel: +1 415 765 5500
Fax: +1 415 765 5503
E-mail: info@iar.com

Home Page: http://www.iar.se

EPPROM Programmer Manufacturers

Data I/O
Phone: +49 89 858 580
Fax: +49 89 858 5810
WWW: http://www.dataio.com

(UK - Direct Insight Ltd.)
Phone: +44 1 280 700262
Fax: +44 1 280 700577
WWW: http://www.edasource.com/

Dataman Programmers Ltd.
Phone: +44 1 300 320719
Fax: +44 1 300 32 10 1 2
WWW: http://www.dataman.com

Lloyd Research
Phone: +44 1 489 574040
Fax: +44 1 489 885853
WWW: http://www.lloydres.co.uk

MQP
Phone: +44 1 666 825666
Fax: +44 1 666 825141
WWW: http://www.mqp.com

Stag Programmers Ltd.
Phone: +44 1 707 332148
Fax: +44 1 707 371503
WWW: http://www.stag.co.uk

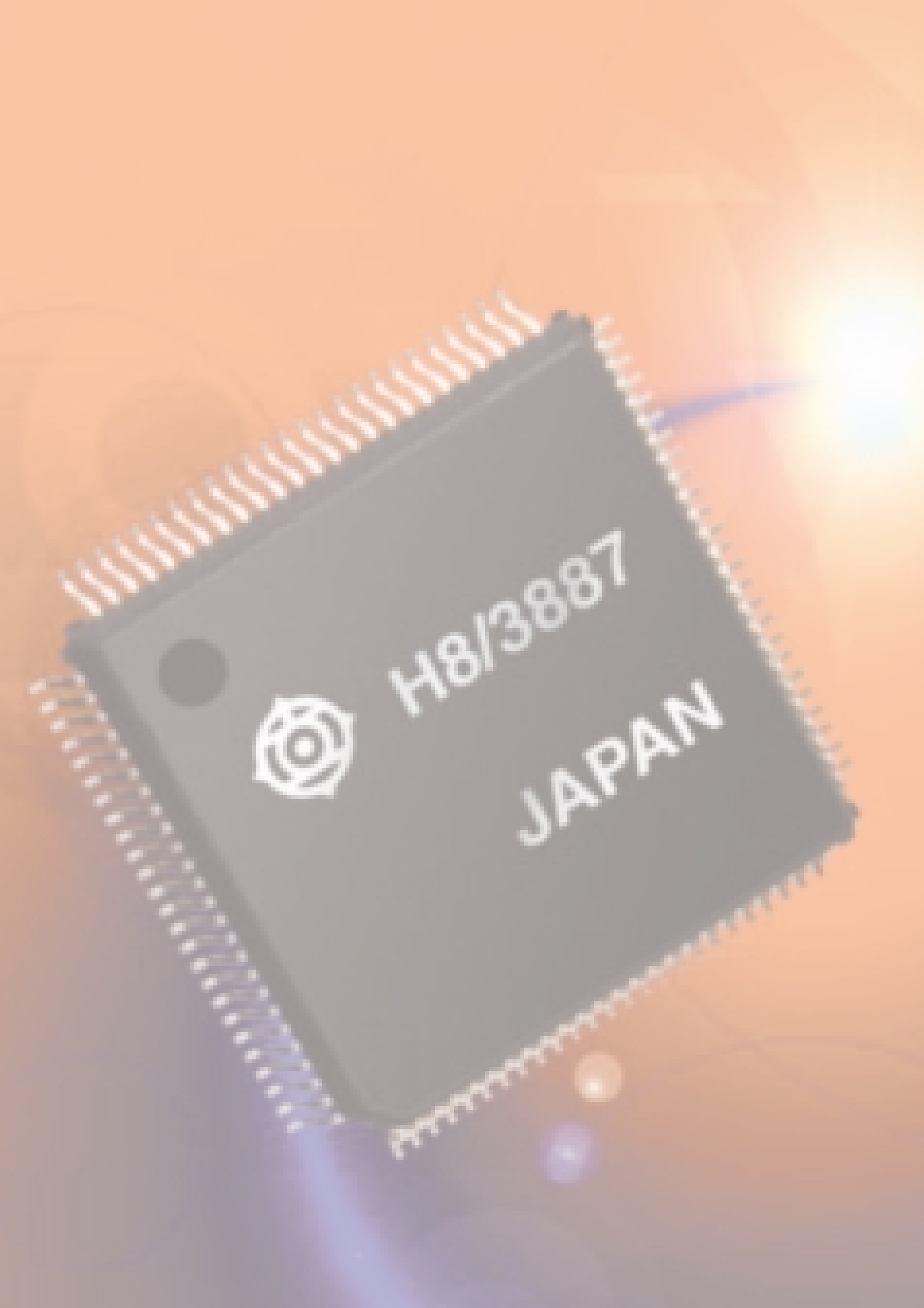
SMS Holdings
Phone: +49 7 522 97280
Fax: +49 7 522 972850
WWW: http://www.sms-sprint.com

Minato
Smart Communications
Phone: +44 181 953 9292
Fax: +44 181 953 9299
WWW: http://www.minato.co.jp
www.smartcom.co.uk

Both One Time Programmable (OTP) and on-chip FLASH devices can be programmed using 'standard' EPROM programmers. The device is placed into a special mode of operation which allows it to emulate the pin interface of a standard EPROM or FLASH device.

In order to place the chip into Programmer mode either a special socket adapter is required (Hitachi parts are listed in this brochure), or a special programming interface for the EPROM programmer being used.

Various manufacturers support Hitachi devices, either using Hitachi standard socket adapters, or via their own custom solution. The list shown details some of the EPROM programmer manufacturers in Europe providing support for Hitachi microcontrollers. Please contact them for specific details.


H8/3887
JAPAN

HITACHI http://www.hitachi-eu.com/hel/ecg/

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02100 Espoo.
Tel: (+358) 9 455 2488
Fax: (+358) 9 455 2152

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P.O.Box 153, Østre Strandvei 4B,
N-3482 Tofte
Tel: (+47) 32 79 51 11
Fax: (+47) 32 79 52 30

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Haukadalsgaten 10, Box 1062,
S-16421 Kista, Stockholm
Tel: (+46) 85 62 712 00
Fax: (+46) 87 51 50 73

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Odeon House, Eyre Square
Galway, Eire
Tel: (+353) 91 56 20 20
Fax: (+353) 91 56 20 14

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Hitachi Europe (France) S.A.
18, rue Grange Dame Rose, B.P 134
F-78148 Veliz Cedex, France
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(INT) (+49) 89 99 1800
Fax: (Local) (0 89) 9 29 30 00
(INT) (+49) 89 929 3000

North Germany/Benelux
Am Seestern 18; D40547 Dusseldorf
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Tel: (+49) 02 11 52 83-0
Fax: (+49) 02 11 52 83-7 79

Central Germany
Friedrich-List-Str. 42;
D-70771 Leinfelden-Echterdingen
Tel: (+49) 7 11 9 90 85-5
Fax : (+49) 7 11 9 90 85-99

South Germany/Austria
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Fax: (+49) 089 9 91 80-266

Italy
Via Tommaso Gulli, 39 1-20147, Milano
Tel: (+39) 2 48 78 61
Fax: (+39) 2 48 78 63 91

Via F.D'Ovidio, 1-00135 Roma
Tel: (+39) 6 82 00 18 24
Fax: (+39) 6 82 00 18 25

South Africa
7th Floor, Nedbank Gardens, 33 Bath Avenue,
Rosebank 2196 (Jb)
Tel: (+27) 11 44 290 80
Fax: (+27) 11 442 9745

Spain
c/Bunganvilla , 5; E-28036 Madrid
Tel: (+34) 91 7 67 27 82, - 92
Fax: (+34) 91 3 83 85 11

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(INT) (+49) 89 9 29 11 85

Kurfurstendamm 115b
D-10711 Berlin
Tel: (+49) 30 89 36 81-0
Fax: (+49) 30 8 91 10 31

Hungary
East-West Business Center; Rakoczi UT 1-3
H-1088 Budapest
Tel: (+36-1) 2 66 66 58.
Fax: (+36-1) 2 66 - 49 27

Spain
Gran Via Carlos III, 101 1°;
E-08028 Barcelona
Tel: (+34) 34 90 - 78 01
Fax: (+34) 33 39 - 78 39

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