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Details	
Product Status	Active
Core Processor	HC11
Core Size	8-Bit
Speed	4MHz
Connectivity	SCI, SPI
Peripherals	POR, WDT
Number of I/O	38
Program Memory Size	20KB (20K x 8)
Program Memory Type	OTP
EEPROM Size	512 x 8
RAM Size	768 x 8
Voltage - Supply (Vcc/Vdd)	4.5V ~ 5.5V
Data Converters	A/D 8x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 125°C (TA)
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Package / Case	52-LCC (J-Lead)
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Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=mc68711e20mfne2

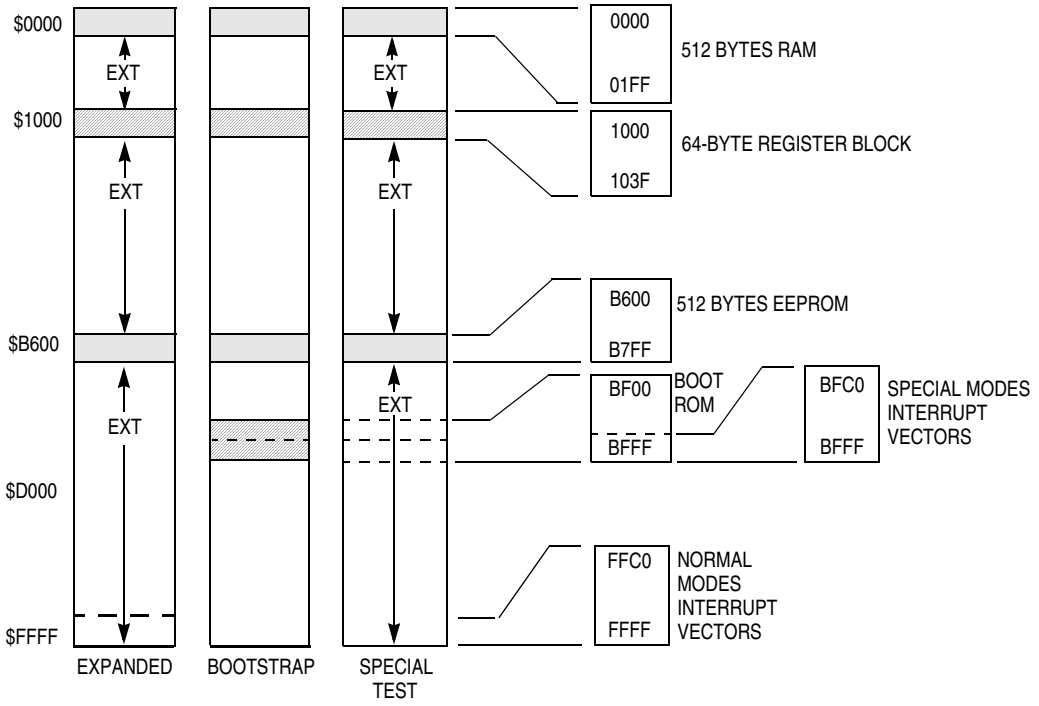


Figure 2-3. Memory Map for MC68HC11E1

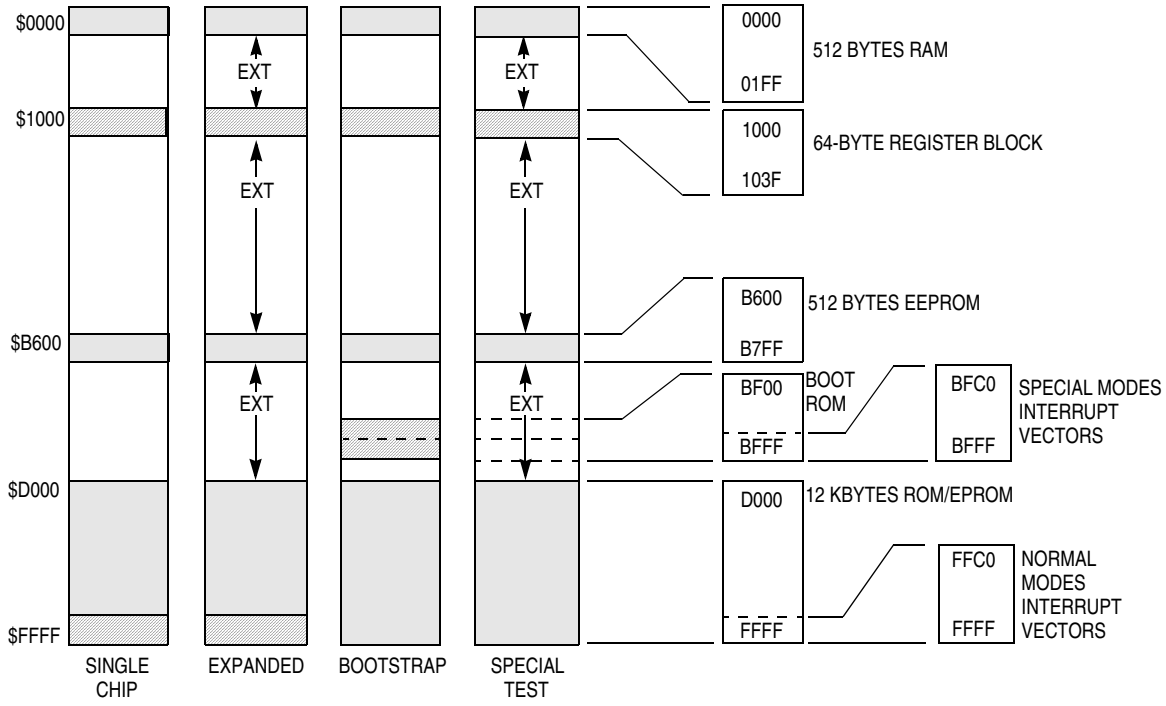


Figure 2-4. Memory Map for MC68HC(7)11E9

Addr.	Register Name		Bit 7	6	5	4	3	2	1	Bit 0
$103E	Reserved		R	R	R	R	R	R	R	R
$103F	System Configuration Register (CONFIG) See page 43.	Read:					NOSEC	NOCOP	ROMON	EEON
		Write:								
		Reset:	0	0	0	0	U	U	1	U
$103F	System Configuration Register (CONFIG)(3) See page 43.	Read:	EE3	EE2	EE1	EE0	NOSEC	NOCOP		EEON
		Write:								
		Reset:	1	1	1	1	U	U	1	1

1. Can be written only once in first 64 cycles out of reset in normal modes or at any time during special modes.
2. MC68HC711E9 only
3. MC68HC811E2 only

= Unimplemented R = Reserved U = Unaffected
I = Indeterminate after reset

Figure 2-7. Register and Control Bit Assignments (Sheet 6 of 6)

2.3.1 RAM and Input/Output Mapping

Hardware priority is built into RAM and I/O mapping. Registers have priority over RAM and RAM has priority over ROM. When a lower priority resource is mapped at the same location as a higher priority resource, a read/write of a location results in a read/write of the higher priority resource only. For example, if both the register block and the RAM are mapped to the same location, only the register block will be accessed. If RAM and ROM are located at the same position, RAM has priority.

The fully static RAM can be used to store instructions, variables, and temporary data. The direct addressing mode can access RAM locations using a 1-byte address operand, saving program memory space and execution time, depending on the application.

RAM contents can be preserved during periods of processor inactivity by two methods, both of which reduce power consumption. They are:

1. In the software-based stop mode, the clocks are stopped while V_{DD} powers the MCU. Because power supply current is directly related to operating frequency in CMOS integrated circuits, only a very small amount of leakage exists when the clocks are stopped.
2. In the second method, the MODB/V_{STBY} pin can supply RAM power from a battery backup or from a second power supply. Figure 2-8 shows a typical standby voltage circuit for a standard 5-volt device. Adjustments to the circuit must be made for devices that operate at lower voltages. Using the MODB/V_{STBY} pin may require external hardware, but can be justified when a significant amount of external circuitry is operating from V_{DD}. If V_{STBY} is used to maintain RAM contents, reset must be held low whenever V_{DD} is below normal operating level. Refer to Chapter 5 Resets and Interrupts.

0	0	Bootstrap	1	0
0	1	Special test	1	1

IRV(NE) — Internal Read Visibility (Not E) Bit

IRVNE can be written once in any mode. In expanded modes, IRVNE determines whether IRV is on or off. In special test mode, IRVNE is reset to 1. In all other modes, IRVNE is reset to 0. For the MC68HC811E2, this bit is IRV and only controls the internal read visibility function.

0 = No internal read visibility on external bus

1 = Data from internal reads is driven out the external data bus.

In single-chip modes this bit determines whether the E clock drives out from the chip. For the MC68HC811E2, this bit has no meaning or effect in single-chip and bootstrap modes.

0 = E is driven out from the chip.

1 = E pin is driven low. Refer to the following table.

Mode	IRVNE Out of Reset	E Clock Out of Reset	IRV Out of Reset	IRVNE Affects Only	IRVNE Can Be Written
Single chip	0	On	Off	E	Once
Expanded	0	On	Off	IRV	Once
Bootstrap	0	On	Off	E	Once
Special test	1	On	On	IRV	Once

PSEL[3:0] — Priority Select Bits

Refer to Chapter 5 Resets and Interrupts.

2.3.3 System Initialization

Registers and bits that control initialization and the basic operation of the MCU are protected against writes except under special circumstances. Table 2-2 lists registers that can be written only once after reset or that must be written within the first 64 cycles after reset.

Table 2-2. Write Access Limited Registers

Operating Mode	Register Address	Register Name	Must be Written in First 64 Cycles	Write Anytime
SMOD = 0	$x024	Timer interrupt mask 2 (TMSK2)	Bits [1:0], once only	Bits [7:2]
	$x035	Block protect register (BPROT)	Clear bits, once only	Set bits only
	$x039	System configuration options (OPTION)	Bits [5:4], bits [2:0], once only	Bits [7:6], bit 3
	$x03C	Highest priority I-bit interrupt and miscellaneous (HPRIO)	See HPRIO description	See HPRIO description
	$x03D	RAM and I/O map register (INIT)	Yes, once only	—
SMOD = 1	$x024	Timer interrupt mask 2 (TMSK2)	—	All, set or clear
	$x035	Block protect register (BPROT)	—	All, set or clear
	$x039	System configuration options (OPTION)	—	All, set or clear
	$x03C	Highest priority I-bit interrupt and miscellaneous (HPRIO)	See HPRIO description	See HPRIO description
	$x03D	RAM and I/O map register (INIT)	—	All, set or clear

NOSEC — Security Disable Bit

NOSEC is invalid unless the security mask option is specified before the MCU is manufactured. If the security mask option is omitted NOSEC always reads 1. The enhanced security feature is available in the MC68S711E9 MCU. The enhancement to the standard security feature protects the EPROM as well as RAM and EEPROM.

0 = Security enabled
1 = Security disabled

NOCOP — COP System Disable Bit

Refer to Chapter 5 Resets and Interrupts.

1 = COP disabled
0 = COP enabled

ROMON — ROM/EPROM/OTPROM Enable Bit

When this bit is 0, the ROM or EPROM is disabled and that memory space becomes externally addressed. In single-chip mode, ROMON is forced to 1 to enable ROM/EPROM regardless of the state of the ROMON bit.

0 = ROM disabled from the memory map
1 = ROM present in the memory map

EEON — EEPROM Enable Bit

When this bit is 0, the EEPROM is disabled and that memory space becomes externally addressed.

0 = EEPROM removed from the memory map
1 = EEPROM present in the memory map

2.3.3.2 RAM and I/O Mapping Register

The internal registers used to control the operation of the MCU can be relocated on 4-Kbyte boundaries within the memory space with the use of the RAM and I/O mapping register (INIT). This 8-bit special-purpose register can change the default locations of the RAM and control registers within the MCU memory map. It can be written only once within the first 64 E-clock cycles after a reset in normal modes, and then it becomes a read-only register.

Address: $103D

	Bit 7	6	5	4	3	2	1	Bit 0
Read: Write:	RAM3	RAM2	RAM1	RAM0	REG3	REG2	REG1	REG0
Reset:	0	0	0	0	0	0	0	1

Figure 2-12. RAM and I/O Mapping Register (INIT)

RAM[3:0] — RAM Map Position Bits

These four bits, which specify the upper hexadecimal digit of the RAM address, control position of RAM in the memory map. RAM can be positioned at the beginning of any 4-Kbyte page in the memory map. It is initialized to address $0000 out of reset. Refer to Table 2-4.

REG[3:0] — 64-Byte Register Block Position

These four bits specify the upper hexadecimal digit of the address for the 64-byte block of internal registers. The register block, positioned at the beginning of any 4-Kbyte page in the memory map, is initialized to address $1000 out of reset. Refer to Table 2-5.

When this control bit is clear, the four requested conversions are performed once to fill the four result registers. When this control bit is set, conversions are performed continuously with the result registers updated as data becomes available.

MULT — Multiple Channel/Single Channel Control Bit

When this bit is clear, the A/D converter system is configured to perform four consecutive conversions on the single channel specified by the four channel select bits CD:CA (bits [3:0] of the ADCTL register). When this bit is set, the A/D system is configured to perform a conversion on each of four channels where each result register corresponds to one channel.

NOTE

When the multiple-channel continuous scan mode is used, extra care is needed in the design of circuitry driving the A/D inputs. The charge on the capacitive DAC array before the sample time is related to the voltage on the previously converted channel. A charge share situation exists between the internal DAC capacitance and the external circuit capacitance. Although the amount of charge involved is small, the rate at which it is repeated is every 64 μs for an E clock of 2 MHz. The RC charging rate of the external circuit must be balanced against this charge sharing effect to avoid errors in accuracy. Refer to M68HC11 Reference Manual, Freescale document order number M68HC11RM/AD, for further information.

CD:CA — Channel Selects D:A Bits

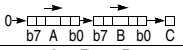
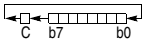
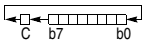
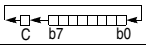
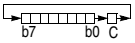
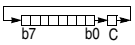
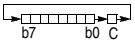
Refer to Table 3-2. When a multiple channel mode is selected (MULT = 1), the two least significant channel select bits (CB and CA) have no meaning and the CD and CC bits specify which group of four channels is to be converted.

Table 3-2. A/D Converter Channel Selection

Channel Select Control Bits CD:CC:CB:CA	Channel Signal	Result in ADRx if MULT = 1
0000	AN0	ADR1
0001	AN1	ADR2
0010	AN2	ADR3
0011	AN3	ADR4
0100	AN4	ADR1
0101	AN5	ADR2
0110	AN6	ADR3
0111	AN7	ADR4
10XX	Reserved	—
1100	V_{RH}(1)	ADR1
1101	V_{RL}(1)	ADR2
1110	(V_{RH})/2(1)	ADR3
1111	Reserved(1)	ADR4

1. Used for factory testing

Table 4-2. Instruction Set (Sheet 5 of 7)

Mnemonic	Operation	Description	Addressing Mode	Instruction			Condition Codes							
				Opcode	Operand	Cycles	S	X	H	I	N	Z	V	C
LSRD	Logical Shift Right Double		INH	04	—	3	—	—	—	—	0	Δ	Δ	Δ
MUL	Multiply 8 by 8	A * B ⇒ D	INH	3D	—	10	—	—	—	—	—	—	—	Δ
NEG (opr)	Two's Complement Memory Byte	0 – M ⇒ M	EXT IND,X IND,Y	70 60 18 60	hh ll ff ff	6 6 7	—	—	—	—	Δ	Δ	Δ	Δ
NEGA	Two's Complement A	0 – A ⇒ A	A INH	40	—	2	—	—	—	—	Δ	Δ	Δ	Δ
NEGB	Two's Complement B	0 – B ⇒ B	B INH	50	—	2	—	—	—	—	Δ	Δ	Δ	Δ
NOP	No operation	No Operation	INH	01	—	2	—	—	—	—	—	—	—	—
ORAA (opr)	OR Accumulator A (Inclusive)	A + M ⇒ A	A IMM A DIR A EXT A IND,X A IND,Y	8A 9A BA AA 18 AA	ii dd hh ll ff ff	2 3 4 4 5	—	—	—	—	Δ	Δ	0	—
ORAB (opr)	OR Accumulator B (Inclusive)	B + M ⇒ B	B IMM B DIR B EXT B IND,X B IND,Y	CA DA FA EA 18 EA	ii dd hh ll ff ff	2 3 4 4 5	—	—	—	—	Δ	Δ	0	—
PSHA	Push A onto Stack	A ⇒ Stk,SP = SP – 1	A INH	36	—	3	—	—	—	—	—	—	—	—
PSHB	Push B onto Stack	B ⇒ Stk,SP = SP – 1	B INH	37	—	3	—	—	—	—	—	—	—	—
PSHX	Push X onto Stack (Lo First)	IX ⇒ Stk,SP = SP – 2	INH	3C	—	4	—	—	—	—	—	—	—	—
PSHY	Push Y onto Stack (Lo First)	IY ⇒ Stk,SP = SP – 2	INH	18 3C	—	5	—	—	—	—	—	—	—	—
PULA	Pull A from Stack	SP = SP + 1, A ⇐ Stk	A INH	32	—	4	—	—	—	—	—	—	—	—
PULB	Pull B from Stack	SP = SP + 1, B ⇐ Stk	B INH	33	—	4	—	—	—	—	—	—	—	—
PULX	Pull X From Stack (Hi First)	SP = SP + 2, IX ⇐ Stk	INH	38	—	5	—	—	—	—	—	—	—	—
PULY	Pull Y from Stack (Hi First)	SP = SP + 2, IY ⇐ Stk	INH	18 38	—	6	—	—	—	—	—	—	—	—
ROL (opr)	Rotate Left		EXT IND,X IND,Y	79 69 18 69	hh ll ff ff	6 6 7	—	—	—	—	Δ	Δ	Δ	Δ
ROLA	Rotate Left A		A INH	49	—	2	—	—	—	—	Δ	Δ	Δ	Δ
ROLB	Rotate Left B		B INH	59	—	2	—	—	—	—	Δ	Δ	Δ	Δ
ROR (opr)	Rotate Right		EXT IND,X IND,Y	76 66 18 66	hh ll ff ff	6 6 7	—	—	—	—	Δ	Δ	Δ	Δ
RORA	Rotate Right A		A INH	46	—	2	—	—	—	—	Δ	Δ	Δ	Δ
RORB	Rotate Right B		B INH	56	—	2	—	—	—	—	Δ	Δ	Δ	Δ
RTI	Return from Interrupt	See Figure 3–2	INH	3B	—	12	Δ	↓	Δ	Δ	Δ	Δ	Δ	Δ
RTS	Return from Subroutine	See Figure 3–2	INH	39	—	5	—	—	—	—	—	—	—	—
SBA	Subtract B from A	A – B ⇒ A	INH	10	—	2	—	—	—	—	Δ	Δ	Δ	Δ

5.2.2 External Reset ($\overline{\text{RESET}}$)

The CPU distinguishes between internal and external reset conditions by sensing whether the reset pin rises to a logic 1 in less than two E-clock cycles after an internal device releases reset. When a reset condition is sensed, the $\overline{\text{RESET}}$ pin is driven low by an internal device for four E-clock cycles, then released. Two E-clock cycles later it is sampled. If the pin is still held low, the CPU assumes that an external reset has occurred. If the pin is high, it indicates that the reset was initiated internally by either the COP system or the clock monitor.

CAUTION

Do not connect an external resistor capacitor (RC) power-up delay circuit to the reset pin of M68HC11 devices because the circuit charge time constant can cause the device to misinterpret the type of reset that occurred.

5.2.3 Computer Operating Properly (COP) Reset

The MCU includes a COP system to help protect against software failures. When the COP is enabled, the software is responsible for keeping a free-running watchdog timer from timing out. When the software is no longer being executed in the intended sequence, a system reset is initiated.

The state of the NOCOP bit in the CONFIG register determines whether the COP system is enabled or disabled. To change the enable status of the COP system, change the contents of the CONFIG register and then perform a system reset. In the special test and bootstrap operating modes, the COP system is initially inhibited by the disable resets (DISR) control bit in the TEST1 register. The DISR bit can subsequently be written to 0 to enable COP resets.

The COP timer rate control bits CR[1:0] in the OPTION register determine the COP timeout period. The system E clock is divided by 2^{15} and then further scaled by a factor shown in Table 5-1. After reset, these bits are 0, which selects the fastest timeout period. In normal operating modes, these bits can be written only once within 64 bus cycles after reset.

Table 5-1. COP Timer Rate Select

CR[1:0]	Divide E/2^{15} By	XTAL = 4.0 MHz Timeout – 0 ms, + 32.8 ms	XTAL = 8.0 MHz Timeout – 0 ms, + 16.4 ms	XTAL = 12.0 MHz Timeout – 0 ms, + 10.9 ms	XTAL = 16.0 MHz Timeout – 0 ms, + 8.2 ms
0 0	1	32.768 ms	16.384 ms	10.923 ms	8.19 ms
0 1	4	131.072 ms	65.536 ms	43.691 ms	32.8 ms
1 0	16	524.28 ms	262.14 ms	174.76 ms	131 ms
1 1	64	2.098 s	1.049 s	699.05 ms	524 ms
	E =	1.0 MHz	2.0 MHz	3.0 MHz	4.0 MHz

Table 5-4. Interrupt and Reset Vector Assignments

Vector Address	Interrupt Source	CCR Mask Bit	Local Mask
FFC0, C1 – FFD4, D5	Reserved	—	—
FFD6, D7	SCI serial system • SCI receive data register full • SCI receiver overrun • SCI transmit data register empty • SCI transmit complete • SCI idle line detect	I	RIE RIE TIE TCIE ILIE
FFD8, D9	SPI serial transfer complete	I	SPIE
FFDA, DB	Pulse accumulator input edge	I	PAII
FFDC, DD	Pulse accumulator overflow	I	PAOVI
FFDE, DF	Timer overflow	I	TOI
FFE0, E1	Timer input capture 4/output compare 5	I	I4/O5I
FFE2, E3	Timer output compare 4	I	OC4I
FFE4, E5	Timer output compare 3	I	OC3I
FFE6, E7	Timer output compare 2	I	OC2I
FFE8, E9	Timer output compare 1	I	OC1I
FFEA, EB	Timer input capture 3	I	IC3I
FFEC, ED	Timer input capture 2	I	IC2I
FFEE, EF	Timer input capture 1	I	IC1I
FFF0, F1	Real-time interrupt	I	RTII
FFF2, F3	$\overline{\text{IRQ}}$ (external pin)	I	None
FFF4, F5	$\overline{\text{XIRQ}}$ pin	X	None
FFF6, F7	Software interrupt	None	None
FFF8, F9	Illegal opcode trap	None	None
FFFA, FB	COP failure	None	NOCOP
FFFC, FD	Clock monitor fail	None	CME
FFFE, FF	$\overline{\text{RESET}}$	None	None

5.5.1 Interrupt Recognition and Register Stacking

An interrupt can be recognized at any time after it is enabled by its local mask, if any, and by the global mask bit in the CCR. Once an interrupt source is recognized, the CPU responds at the completion of the instruction being executed. Interrupt latency varies according to the number of cycles required to complete the current instruction. When the CPU begins to service an interrupt, the contents of the CPU registers are pushed onto the stack in the order shown in Table 5-5. After the CCR value is stacked, the I bit and the X bit, if $\overline{\text{XIRQ}}$ is pending, are set to inhibit further interrupts. The interrupt vector for the highest priority pending source is fetched and execution continues at the address specified by the vector. At the

5.5.4 Software Interrupt (SWI)

SWI is an instruction, and thus cannot be interrupted until complete. SWI is not inhibited by the global mask bits in the CCR. Because execution of SWI sets the I mask bit, once an SWI interrupt begins, other interrupts are inhibited until SWI is complete, or until user software clears the I bit in the CCR.

5.5.5 Maskable Interrupts

The maskable interrupt structure of the MCU can be extended to include additional external interrupt sources through the $\overline{\text{IRQ}}$ pin. The default configuration of this pin is a low-level sensitive wired-OR network. When an event triggers an interrupt, a software accessible interrupt flag is set. When enabled, this flag causes a constant request for interrupt service. After the flag is cleared, the service request is released.

5.5.6 Reset and Interrupt Processing

Figure 5-5 and Figure 5-6 illustrate the reset and interrupt process. Figure 5-5 illustrates how the CPU begins from a reset and how interrupt detection relates to normal opcode fetches. Figure 5-6 is an expansion of a block in Figure 5-5 and illustrates interrupt priorities. Figure 5-7 shows the resolution of interrupt sources within the SCI subsystem.

5.6 Low-Power Operation

Both stop mode and wait mode suspend CPU operation until a reset or interrupt occurs. Wait mode suspends processing and reduces power consumption to an intermediate level. Stop mode turns off all on-chip clocks and reduces power consumption to an absolute minimum while retaining the contents of the entire RAM array.

5.6.1 Wait Mode

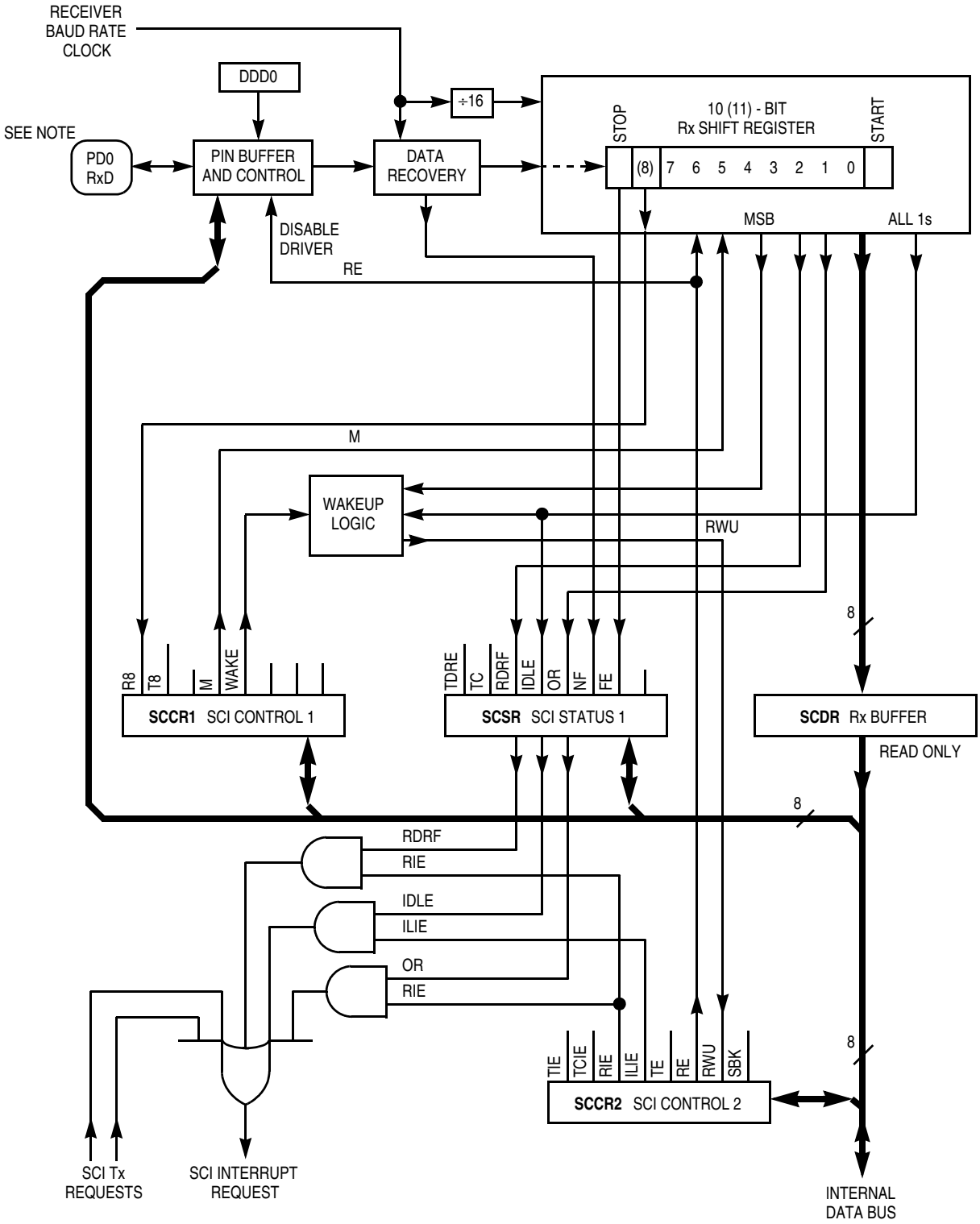
The WAI opcode places the MCU in wait mode, during which the CPU registers are stacked and CPU processing is suspended until a qualified interrupt is detected. The interrupt can be an external $\overline{\text{IRQ}}$, an $\overline{\text{XIRQ}}$, or any of the internally generated interrupts, such as the timer or serial interrupts. The on-chip crystal oscillator remains active throughout the wait standby period.

The reduction of power in the wait condition depends on how many internal clock signals driving on-chip peripheral functions can be shut down. The CPU is always shut down during wait. While in the wait state, the address/data bus repeatedly runs read cycles to the address where the CCR contents were stacked. The MCU leaves the wait state when it senses any interrupt that has not been masked.

The free-running timer system is shut down only if the I bit is set to 1 and the COP system is disabled by NOCOP being set to 1. Several other systems also can be in a reduced power-consumption state depending on the state of software-controlled configuration control bits. Power consumption by the analog-to-digital (A/D) converter is not affected significantly by the wait condition. However, the A/D converter current can be eliminated by writing the ADPU bit to 0. The SPI system is enabled or disabled by the SPE control bit. The SCI transmitter is enabled or disabled by the TE bit, and the SCI receiver is enabled or disabled by the RE bit. Therefore, the power consumption in wait is dependent on the particular application.

masked), the MCU starts up, beginning with the stacking sequence leading to normal service of the $\overline{\text{XIRQ}}$ request. If X is set to 1 ($\overline{\text{XIRQ}}$ masked or inhibited), then processing continues with the instruction that immediately follows the STOP instruction, and no $\overline{\text{XIRQ}}$ interrupt service is requested or pending.

Because the oscillator is stopped in stop mode, a restart delay may be imposed to allow oscillator stabilization upon leaving stop. If the internal oscillator is being used, this delay is required; however, if a stable external oscillator is being used, the DLY control bit can be used to bypass this startup delay. The DLY control bit is set by reset and can be optionally cleared during initialization. If the DLY equal to 0 option is used to avoid startup delay on recovery from stop, then reset should not be used as the means of recovering from stop, as this causes DLY to be set again by reset, imposing the restart delay. This same delay also applies to power-on reset, regardless of the state of the DLY control bit, but does not apply to a reset while the clocks are running.



Note: Refer to Figure B-1. EVBU Schematic Diagram for an example of connecting RxD to a PC.

Figure 7-2. SCI Receiver Block Diagram

7.5.2 Address-Mark Wakeup

The serial characters in this type of wakeup consist of seven (eight if M = 1) information bits and an MSB, which indicates an address character (when set to 1, or mark). The first character of each message is an addressing character (MSB = 1). All receivers in the system evaluate this character to determine if the remainder of the message is directed toward this particular receiver. As soon as a receiver determines that a message is not intended for it, the receiver activates the RWU function by using a software write to set the RWU bit. Because setting RWU inhibits receiver-related flags, there is no further software overhead for the rest of this message.

When the next message begins, its first character has its MSB set, which automatically clears the RWU bit and enables normal character reception. The first character whose MSB is set is also the first character to be received after wakeup because RWU gets cleared before the stop bit for that frame is serially received. This type of wakeup allows messages to include gaps of idle time, unlike the idle-line method, but there is a loss of efficiency because of the extra bit time for each character (address bit) required for all characters.

7.6 SCI Error Detection

Three error conditions – SCDR overrun, received bit noise, and framing – can occur during generation of SCI system interrupts. Three bits (OR, NF, and FE) in the serial communications status register (SCSR) indicate if one of these error conditions exists.

The overrun error (OR) bit is set when the next byte is ready to be transferred from the receive shift register to the SCDR and the SCDR is already full (RDRF bit is set). When an overrun error occurs, the data that caused the overrun is lost and the data that was already in SCDR is not disturbed. The OR is cleared when the SCSR is read (with OR set), followed by a read of the SCDR.

The noise flag (NF) bit is set if there is noise on any of the received bits, including the start and stop bits. The NF bit is not set until the RDRF flag is set. The NF bit is cleared when the SCSR is read (with FE equal to 1) followed by a read of the SCDR.

When no stop bit is detected in the received data character, the framing error (FE) bit is set. FE is set at the same time as the RDRF. If the byte received causes both framing and overrun errors, the processor only recognizes the overrun error. The framing error flag inhibits further transfer of data into the SCDR until it is cleared. The FE bit is cleared when the SCSR is read (with FE equal to 1) followed by a read of the SCDR.

7.7 SCI Registers

Five addressable registers are associated with the SCI:

- Four control and status registers:
  - Serial communications control register 1 (SCCR1)
  - Serial communications control register 2 (SCCR2)
  - Baud rate register (BAUD)
  - Serial communications status register (SCSR)
- One data register:
  - Serial communications data register (SCDR)

The SCI registers are the same for all M68HC11 E-series devices with one exception. The SCI system for MC68HC(7)11E20 contains an extra bit in the BAUD register that provides a greater selection of baud prescaler rates. Refer to 7.7.5 Baud Rate Register, Figure 7-8, and Figure 7-9.

7.7.1 Serial Communications Data Register

SCDR is a parallel register that performs two functions:

- The receive data register when it is read
- The transmit data register when it is written

Reads access the receive data buffer and writes access the transmit data buffer. Receive and transmit are double buffered.

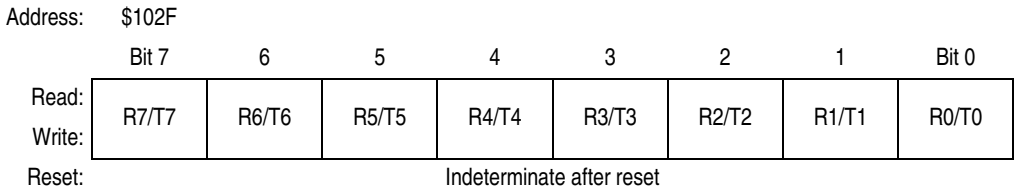


Figure 7-3. Serial Communications Data Register (SCDR)

7.7.2 Serial Communications Control Register 1

The SCCR1 register provides the control bits that determine word length and select the method used for the wakeup feature.

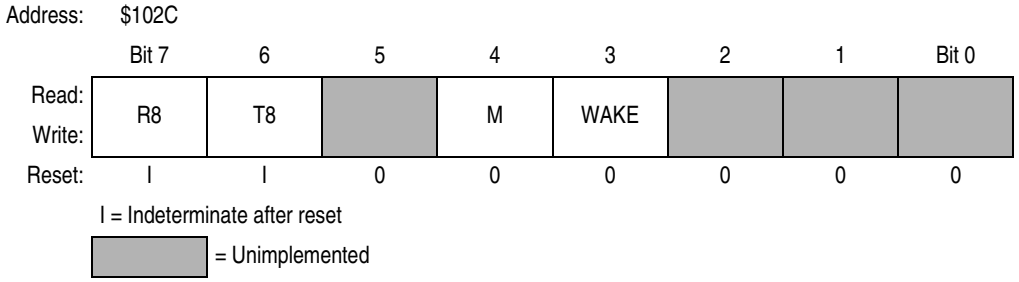


Figure 7-4. Serial Communications Control Register 1 (SCCR1)

R8 — Receive Data Bit 8

If M bit is set, R8 stores the ninth bit in the receive data character.

T8 — Transmit Data Bit 8

If M bit is set, T8 stores the ninth bit in the transmit data character.

Bit 5 — Unimplemented

Always reads 0

M — Mode Bit (select character format)

0 = Start bit, 8 data bits, 1 stop bit
1 = Start bit, 9 data bits, 1 stop bit

WAKE — Wakeup by Address Mark/Idle Bit

0 = Wakeup by IDLE line recognition
1 = Wakeup by address mark (most significant data bit set)

Bits [2:0] — Unimplemented

Always read 0

Chapter 8
Serial Peripheral Interface (SPI)

8.1 Introduction

The serial peripheral interface (SPI), an independent serial communications subsystem, allows the MCU to communicate synchronously with peripheral devices, such as:

- Frequency synthesizers
- Liquid crystal display (LCD) drivers
- Analog-to-digital (A/D) converter subsystems
- Other microprocessors

The SPI is also capable of inter-processor communication in a multiple master system. The SPI system can be configured as either a master or a slave device. When configured as a master, data transfer rates can be as high as one-half the E-clock rate (1.5 Mbits per second for a 3-MHz bus frequency). When configured as a slave, data transfers can be as fast as the E-clock rate (3 Mbits per second for a 3-MHz bus frequency).

8.2 Functional Description

The central element in the SPI system is the block containing the shift register and the read data buffer. The system is single buffered in the transmit direction and double buffered in the receive direction. This means that new data for transmission cannot be written to the shifter until the previous transfer is complete; however, received data is transferred into a parallel read data buffer so the shifter is free to accept a second serial character. As long as the first character is read out of the read data buffer before the next serial character is ready to be transferred, no overrun condition occurs. A single MCU register address is used for reading data from the read data buffer and for writing data to the shifter.

The SPI status block represents the SPI status functions (transfer complete, write collision, and mode fault) performed by the serial peripheral status register (SPSR). The SPI control block represents those functions that control the SPI system through the serial peripheral control register (SPCR).

Refer to Figure 8-1, which shows the SPI block diagram.

8.3 SPI Transfer Formats

During an SPI transfer, data is simultaneously transmitted and received. A serial clock line synchronizes shifting and sampling of the information on the two serial data lines. A slave select line allows individual selection of a slave SPI device; slave devices that are not selected do not interfere with SPI bus activities. On a master SPI device, the select line can optionally be used to indicate a multiple master bus contention. Refer to Figure 8-2.

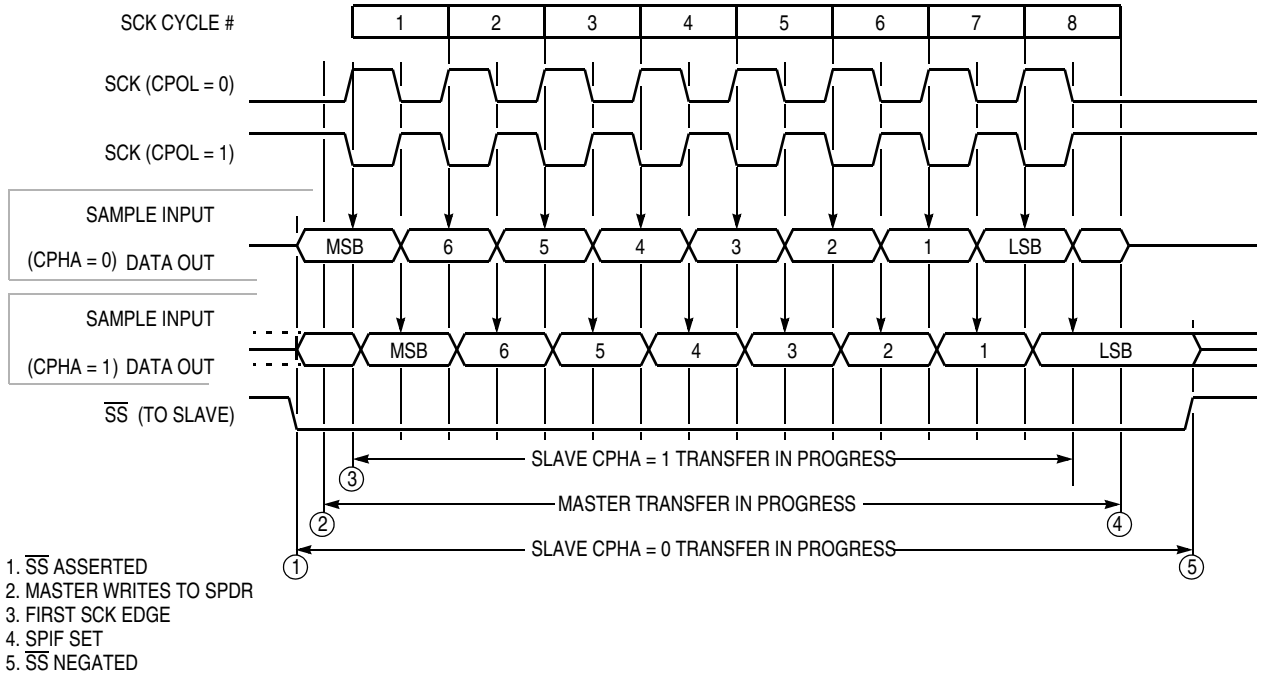


Figure 8-2. SPI Transfer Format

8.5 SPI Signals

This subsection contains descriptions of the four SPI signals:

- Master in/slave out (MISO)
- Master out/slave in (MOSI)
- Serial clock (SCK)
- Slave select ($\overline{SS}$)

Any SPI output line must have its corresponding data direction bit in DDRD register set. If the DDR bit is clear, that line is disconnected from the SPI logic and becomes a general-purpose input. All SPI input lines are forced to act as inputs regardless of the state of the corresponding DDR bits in DDRD register.

8.5.1 Master In/Slave Out

MISO is one of two unidirectional serial data signals. It is an input to a master device and an output from a slave device. The MISO line of a slave device is placed in the high-impedance state if the slave device is not selected.

8.5.2 Master Out/Slave In

The MOSI line is the second of the two unidirectional serial data signals. It is an output from a master device and an input to a slave device. The master device places data on the MOSI line a half-cycle before the clock edge that the slave device uses to latch the data.

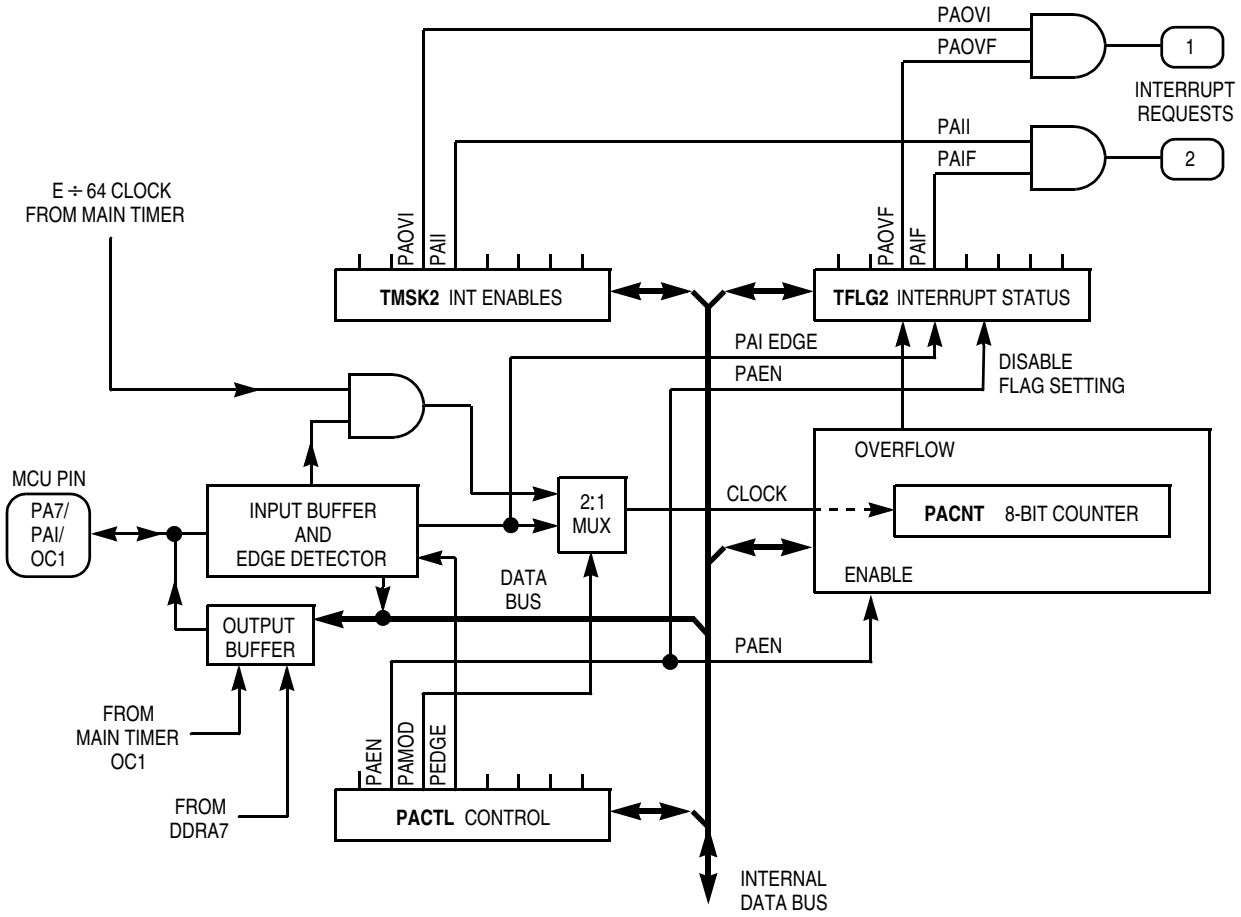


Figure 9-24. Pulse Accumulator

Chapter 11
Ordering Information and Mechanical Specifications

11.1 Introduction

This section provides ordering information for the E-series devices grouped by:

- Standard devices
- Custom ROM devices
- Extended voltage devices

In addition, mechanical specifications for the following packaging options:

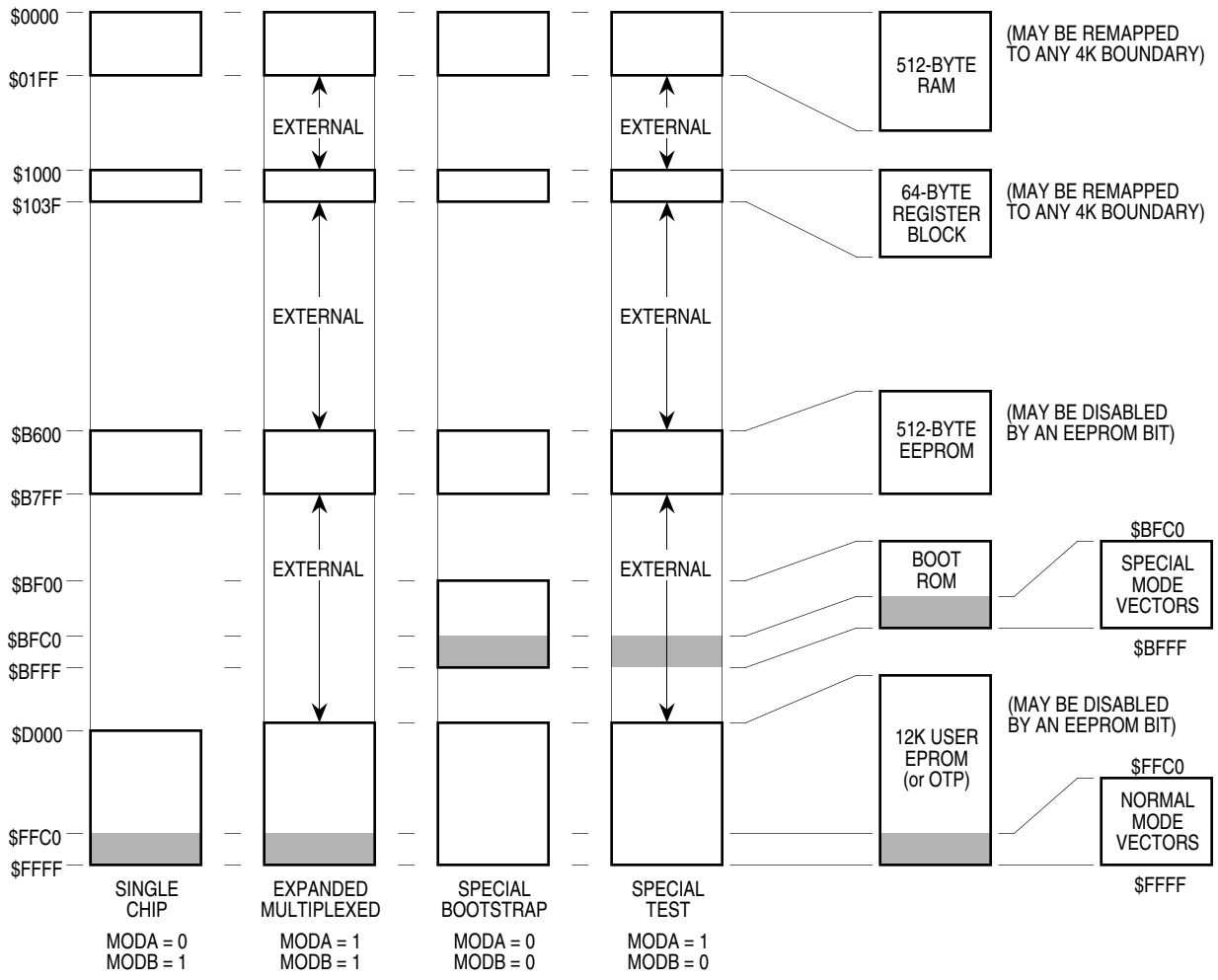
- 52-pin plastic-leaded chip carrier (PLCC)
- 52-pin windowed ceramic-leaded chip carrier (CLCC)
- 64-pin quad flat pack (QFP)
- 52-pin thin quad flat pack (TQFP)
- 56-pin shrink dual in-line package with .070-inch lead spacing (SDIP)
- 48-pin plastic DIP (.100-inch lead spacing), MC68HC811E2 only

11.2 Standard Device Ordering Information

Description	CONFIG	Temperature	Frequency	MC Order Number
52-pin plastic leaded chip carrier (PLCC)				
BUFFALO ROM	$0F	–40°C to +85°C	2 MHz	MC68HC11E9BCFN2
			3 MHz	MC68HC11E9BCFN3
No ROM	$0D	–40°C to +85°C	2 MHz	MC68HC11E1CFN2
			3 MHz	MC68HC11E1CFN3
		–40°C to +105°C	2 MHz	MC68HC11E1VFN2
		–40°C to +125°C	2 MHz	MC68HC11E1MFN2
No ROM, no EEPROM	$0C	–40°C to +85°C	2 MHz	MC68HC11E0CFN2
			3 MHz	MC68HC11E0CFN3
		–40°C to +105°C	2 MHz	MC68HC11E0VFN2
		–40°C to +125°C	2 MHz	MC68HC11E0MFN2

Figure 2 shows how the bootloader program differentiates between the default baud rate (7812 baud at a 2-MHz E-clock rate) and the alternate baud rate (1200 baud at a 2-MHz E-clock rate). The host computer sends an initial $FF character, which is used by the bootloader to determine the baud rate that will be used for the downloading operation. The top half of Figure 2 shows normal reception of $FF. Receive data samples at [1] detect the falling edge of the start bit and then verify the start bit by taking a sample at the center of the start bit time. Samples are then taken at the middle of each bit time [2] to reconstruct the value of the received character (all 1s in this case). A sample is then taken at the middle of the stop bit time as a framing check (a 1 is expected) [3]. Unless another character immediately follows this $FF character, the receive data line will idle in the high state as shown at [4].

The bottom half of Figure 2 shows how the receiver will incorrectly receive the $FF character that is sent from the host at 1200 baud. Because the receiver is set to 7812 baud, the receive data samples are taken at the same times as in the upper half of Figure 2. The start bit at 1200 baud [5] is 6.5 times as long as the start bit at 7812 baud [6].



NOTE: Software can change some aspects of the memory map after reset.

Figure 1. MC68HC711E9 Composite Memory Map

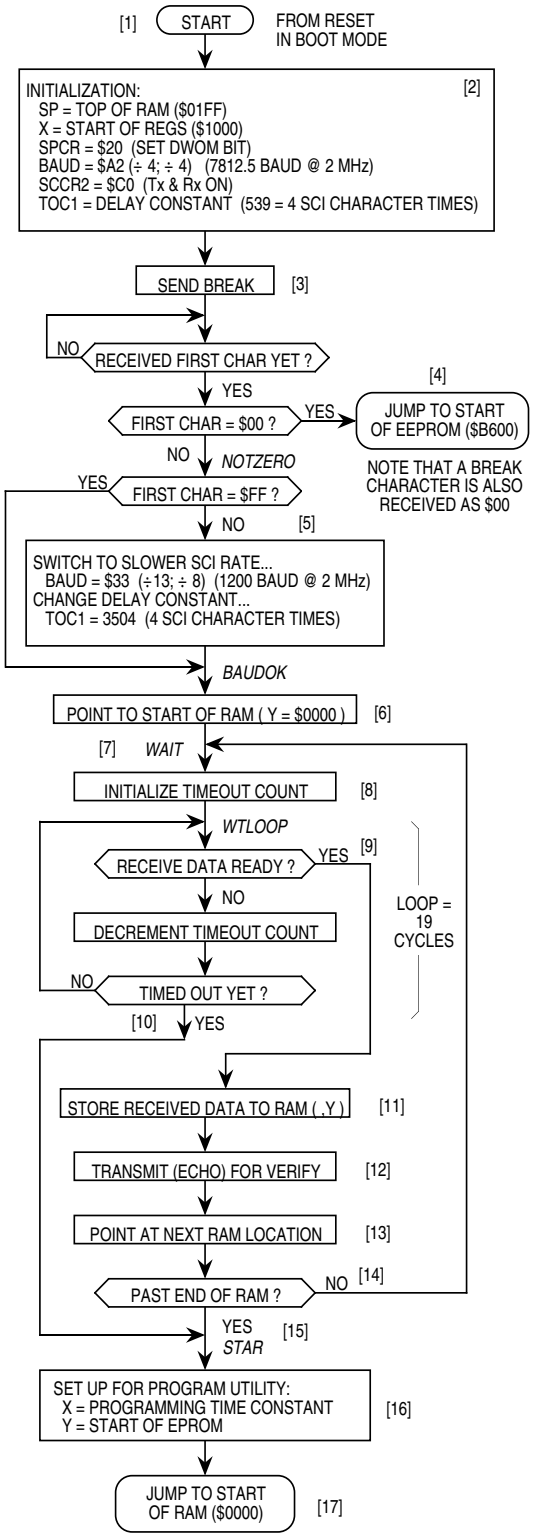


Figure 3. MC68HC711E9 Bootloader Flowchart