

Errata Sheet

December 23, 1998 / Release 1.2

Device:	SAB 83C166W-5M SAB 83C166W-5M-T3 SAB 83C166W-5M-T4 SAB 80C166W-M SAB 80C166W-M-T3 SAB 80C166W-M-T4
Stepping Code / Marking:	ES-DC, DC
Package:	MQFP-100

This Errata Sheet describes the deviations from the current user documentation. The classification and numbering system is module oriented in a continual ascending sequence over several derivatives, as well already solved deviations are included. So gaps inside this enumeration could occur.

The current documentation is: Data Sheet: SAB 80C166W/83C166W Data Sheet 02.94
User's Manual:
SAB80C166/83C166 User's Manual 06.90/08.97, including
Addendum to SAB80C166/83C166 User's Manual 9.90
Instruction Set Manual 12.97 Version 1.2

Note: Devices marked with EES- or ES are engineering samples which may not be completely tested in all functional and electrical characteristics, therefore they should be used for evaluation only.

The specific test conditions for EES and ES are documented in a separate Status Sheet.

Change summary to Errata Sheet Rel.1.1 for devices with stepping code/marking ES-DC, DC:

- new format, including standard problem identification codes of C166 microcontroller family (in parenthesis)
- PEC Transfers after JMPR (problem 34 (BUS.18))
- Modifications of ADM field while bit ADST = 0 (problem 33 (ADC.11))
- Note about workaround for Tasking compiler added for problem 31 (CPU.16)
- Problem History: truncated to CB-step as last device step included

Functional Problems:

Problem 34 (BUS.18): **PEC Transfers after JMPR instruction**

Problems may occur when a PEC transfer immediately follows a taken JMPR instruction when the following sequence of 4 conditions is met (labels refer to following examples):

1. in an instruction sequence which represents a loop, a jump instruction (Label_B) which is capable of loading the jump cache (JMPR, JMPA, JB/JNB/JBC/JNBS) is taken
2. the target of this jump instruction **directly** is a **JMPR** instruction (Label_C) which is also taken and whose target is at address A (Label_A)
3. a **PEC** transfer occurs immediately after this JMPR instruction (Label_C)
4. in the following program flow, the JMPR instruction (Label_C) is taken a second time, and no other JMPR, JMPA, JB/JNB/JBC/JNBS or instruction which has branched to a different code segment (JMPS/CALLS) or interrupt has been processed in the meantime (i.e. the condition for a jump cache hit for the JMPR instruction (Label_C) is true)

In this case, when the JMPR instruction (Label_C) is taken for the second time (as described in condition 4 above), and the 2 words stored in the jump cache (word address A and A+2) have been processed, the word at address A+2 is erroneously fetched and executed instead of the word at address A+4.

Note: the problem does **not** occur when

- the jump instruction (Label_C) is a JMPA instruction
- the program sequence is executed from internal ROM/Flash

Example1:

```
Label_A: instruction x           ; Begin of Loop
        instruction x+1
        .....
Label_B: JMP Label_C ; JMP may be any of the following jump instructions:
                JMPR cc_zz, JMPA cc_zz, JB/JNB/JBC/JNBS
                ; jump must be taken in loop iteration n
                ; jump must not be taken in loop iteration n+1
        .....
Label_C: JMPR cc_xx, Label_A     ; End of Loop
                ; instruction must be JMPR (single word instruction)
                ; jump must be taken in loop iteration n and n+1
                ; PEC transfer must occur in loop iteration n
```

Example2:

```
Label_A: instruction x           ; Begin of Loop1
        instruction x+1
        .....
Label_C: JMPR cc_xx, Label_A     ; End of Loop1, Begin of Loop2
                ; instruction must be JMPR (single word instruction)
                ; jump not taken in loop iteration n-1, i.e. Loop2 is entered
                ; jump must be taken in loop iteration n and n+1
                ; PEC transfer must occur in loop iteration n
        .....
Label_B: JMP Label_C           ; End of Loop2
                ; JMP may be any of the following jump instructions:
                ; JMPR cc_zz, JMPA cc_zz, JB/JNB/JBC/JNBS
                ; jump taken in loop iteration n-1
```

A code sequence with the basic structure of Example1 was generated e.g. by a compiler for comparison of double words (long variables).

Workarounds:

1. use a JMPA instruction instead of a JMPR instruction when this instruction can be the direct target of a preceding JMPR, JMPA, JB/JNB/JBC/JNBS instruction, or
2. insert another instruction (e.g. NOP) as branch target when a JMPR instruction would be the direct target of a preceding JMPR, JMPA, JB/JNB/JBC/JNBS instruction, or
3. change the loop structure such that instead of jumping from Label_B to Label_C and then to Label_A, the jump from Label_B directly goes to Label_A.

Notes on compilers:

In the **Hightec** compiler beginning with version Gcc 2.7.2.1 for SAB C16x – V3.1 Rel. 1.1, patchlevel 5, a switch `-m bus18` is implemented as workaround for this problem. In addition, optimization has to be set at least to level 1 with `-u1`.

The **Keil C** compiler versions < V4.0 and run time libraries do not generate or use instruction sequences where a JMPR instruction can be the target of another jump instruction, i.e. the conditions for this problem do not occur.

In V4.0, the problem may occur when optimize (size or speed, 7) is selected. Lower optimization levels than 7 are not affected.

In V4.01, a new directive FIXPEC is implemented which avoids this problem.

In the **TASKING C166** Software Development Tools, the code sequence related to problem BUS.18 can be generated in Assembly. The problem can also be reproduced in C-language by using a particular sequence of GOTOs.

With V6.0r3, TASKING tested all the Libraries, C-startup code and the extensive set of internal test-suite sources and the BUS.18 related code sequence appeared to be NOT GENERATED.

To prevent introduction of this erroneous code sequence, the TASKING Assembler V6.0r3 has been extended with the CHECKBUS18 control which generates a WARNING in the case the described code sequence appears. When called from within EDE, the Assembler control CHECKBUS18 is automatically 'activated'.

Problem 33 (ADC.11): Modifications of ADM field while bit ADST = 0

The A/D converter may unintentionally start one auto scan single conversion sequence when the following sequence of conditions is true:

- (1) the A/D converter has finished a fixed channel single conversion of an analog channel $n > 0$ (i.e. contents of `ADCON.ADCH = n` during this conversion)
- (2) the A/D converter is idle (i.e. `ADBSY = 0`)
- (3) then the conversion mode in the ADC Mode Selection field ADM is changed to Auto Scan Single (`ADM = 10b`) or Continuous (`ADM = 11b`) mode without setting bit `ADST = 1` with the same instruction

Under these conditions, the A/D converter will unintentionally start one auto scan single conversion sequence, beginning with channel $n-1$, down to channel number 0.

In case the channel number ADCH has been changed before or with the same instruction which selected the auto scan mode, this channel number has no effect on the unintended auto scan sequence (i.e. it is not used in this auto scan sequence).

Note:

When a conversion is already in progress, and then the configuration in register ADCON is changed,

- the new conversion mode in ADM is evaluated after the current conversion
- the new channel number in ADCH and new status of bit ADST are evaluated after the current conversion when a conversion in fixed channel conversion mode is in progress, and after the current conversion sequence (i.e. after conversion of channel 0) when a conversion in an auto scan mode is in progress.

In this case, it is a specified operational behaviour that channels n-1 .. 0 are converted when ADM is changed to an auto scan mode while a fixed channel conversion of channel n is in progress (see e.g. 80C166 User's Manual, 06.90, p.8-58)

Workaround:

When an auto scan conversion is to be performed, always start the A/D converter with the same instruction which sets the configuration in register ADCON.

Problem 32 (PWRDN.1): Execution of PWRDN Instruction while pin NMI# = high

When instruction PWRDN is executed while pin NMI# is at a high level, power down mode should not be entered, and the PWRDN instruction should be ignored. However, under the conditions described below, the PWRDN instruction may not be ignored, and no further instructions are fetched from external memory, i.e. the CPU is in a quasi-idle state. This problem will only occur in the following situations:

- a) the instructions following the PWRDN instruction are located in external memory, and a **multiplexed bus** configuration **with memory tristate waitstate** (bit MTTCx = 0) is used, or
- b) the instruction preceding the PWRDN instruction **writes** to external memory, and the instructions following the PWRDN instruction are located in external memory. In this case, the problem will occur for any bus configuration.

Note: the on-chip peripherals are still working correctly, in particular the Watchdog Timer will reset the device upon an overflow. Interrupts and PEC transfers, however, can not be processed. In case NMI# is asserted low while the device is in this quasi-idle state, power down mode is entered.

Workaround:

Ensure that no instruction which writes to external memory precedes the PWRDN instruction, otherwise insert e.g. a NOP instruction in front of PWRDN. When a multiplexed bus with memory tristate waitstate is used, the PWRDN instruction should be executed out of internal RAM.

Problem 31 (CPU.16): Data read access with MOVB [Rn], mem instruction to internal ROM/Flash/OTP

When the *MOVB [Rn], mem* instruction (opcode 0A4h) is executed, where

1. mem specifies a direct 16-bit byte operand address in the internal ROM/Flash memory,

AND

2. [Rn] points to an **even** byte address, while the contents of the word which includes the byte addressed by *mem* is **odd**,

OR

[Rn] points to an **odd** byte address, while the contents of the word which includes the byte addressed by *mem* is **even**

the following problem occurs:

a) when [Rn] points to **external** memory, the data value which is written back is always 00h

b) when [Rn] points to the **internal** RAM or SFR address space,

- the (correct) data value [mem] is written to [Rn]**+1**, i.e. to the **odd** byte address of the selected word in case [Rn] points to an **even** byte address,

- the (correct) data value [mem] is written to [Rn]**-1**, i.e. to the **even** byte address of the selected word in case [Rn] points to an **odd** byte address.

Workaround:

When *mem* is an address in internal ROM/Flash/OTP memory, substitute instruction

MOVB [Rn], mem e.g. by *MOV Rm, #mem*
MOVB [Rn], [Rm]

Notes on compilers:

- the **Keil C166 Compiler V3.10** has been extended by the directive **FIXROM** which avoids accesses to 'const' objects via the instruction *MOVB [Rn], mem*.
- the **Tasking** compiler provides a workaround for this problem from version **V6.0r2** on

Problem 30 (CPU.17): Arithmetic Overflow by DIVLU instruction

For specific combinations of the values of the dividend (MDH,MDL) and divisor (Rn), the Overflow (V) flag in the PSW may not be set for unsigned divide operations, although an overflow occurred.

E.g.:

MDH MDL Rn MDH MDL
F0F0 0F0Fh : F0F0h = FFFF FFFFh, but no Overflow indicated!
(result with 32-bit precision: 1 0000h)

The same malfunction appears for the following combinations:

n0n0 0n0n : n0n0
n00n 0nn0 : n00n
n000 000n : n000
n0nn 0nnn : n0nn where n means any Hex Digit between 8 ... F

i.e. all operand combinations where at least the most significant bit of the dividend (MDH) and the divisor (Rn) is set.

In the cases where an overflow occurred after DIVLU, but the V flag is not set, the result in MDL is equal to FFFFh.

Workaround:

Skip execution of DIVLU in case an overflow would occur, and explicitly set V = 1.

```
E.g.:      CMP Rn, MDH
           JMPR cc_ugt, NoOverflow      ; no overflow if Rn > MDH
           BSET V                       ; set V = 1 if overflow would occur
           JMPR cc_uc, NoDivide        ; and skip DIVLU
NoOverflow: DIVLU Rn
NoDivide:  ...                        ; next instruction, may evaluate correct V flag
```

Note:

- the KEIL C compiler, run time libraries and operating system RTX166 do not generate or use instruction sequences where the V flag in the PSW is tested after a DIVLU instruction.

- with the TASKING C166 compiler, for the following intrinsic functions code is generated which uses the overflow flag for minimizing or maximizing the function result after a division with a DIVLU:

```
_div_u32u16_u16()
_div_s32u16_s16()
_div_s32u16_s32()
```

Consequently, an incorrect overflow flag (when clear instead of set) might affect the result of one of the above intrinsic functions but only in a situation where no correct result could be calculated anyway. These intrinsics first appeared in version 5.1r1 of the toolchain.

Libraries: not affected

Problem 29 (BUS.15): Non-multiplexed Bus without Read/Write Delay

When a non-multiplexed external bus is used in the configuration without Read/Write Delay and with normal (non-extended) ALE, i.e. when

- bit SYSCON.RWDC = 1 (access controlled by SYSCON), or
 - bit BUSCON1.RWDC1 = 1 and BUSCON1.ALECTL1 = 0 (access controlled by BUSCON1,
- then both the RD# and WR# signal may be driven low during a read or instruction fetch cycle which follows a write cycle.

Note that this problem depends on supply voltage and ambient temperature, and that it may only occur in an area around Vccmax (5.5 V) and TAmin (-40 °C)

Note: in a **multiplexed** bus configuration, in general always Read/Write Delay must be used (i.e. bit RWDCx must remain at its default state '0'), otherwise an external bus contention will occur. Therefore, all systems which do not use a non-multiplexed external bus configuration are not affected by this problem.

Workaround:

Use a non-multiplexed bus configuration where

- bit SYSCON.RWDC = 0, and
- bit BUSCON1.RWDC1 = 0 when BUSCON1.RWDC1 = 0

Deviations from Electrical- and Timing Specification:

The following table lists the deviations of the DC/AC characteristics from the specification in the 80/83C166W Data Sheet 02.94:

Problem 11: Input Leakage Current (I_{oz1}) at Port 5

The input leakage current (I_{oz1}) of some devices can deviate from the actual specified limit value of ±200 nA at input voltages (V_{in}) close to 0 V. High ambient temperature and maximum supply voltage lead to a maximum increase of the leakage current.

The following equation describes the behavior of the leakage current for input voltages between 0 V and 200 mV and covers all specified operating conditions. This equation stands for an exponential decrease from ±10 µA leakage current at V_{in} = 0 V to ±200 nA at V_{in} = 200 mV.

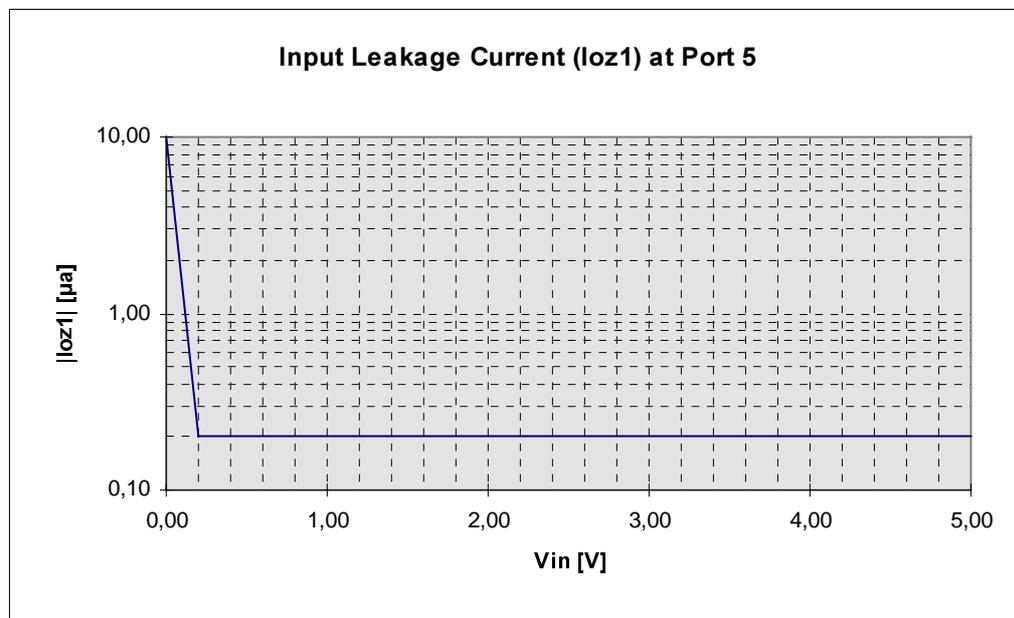
V_{cc} = 5 V ±10 %

T_{amin} ≤ T_a ≤ T_{amax} T_{amin}, T_{amax} see Data Sheet

Input Voltage (V _{in})	0 ≤ V _{in} ≤ 200 mV	200 mV ≤ V _{in} ≤ V _{cc} ¹⁾
Input Leakage Current (I _{oz1})	$I_{oz1} = \pm a \cdot e^{(b \cdot V_{in})}$ a = 10 µA; b = -0,0196 mV ⁻¹	I _{oz1} = ±200 nA

¹⁾ **Note:** For input voltages above 200 mV the input leakage specification remains unchanged.

The figure below shows the input leakage current as function of the input voltage.



History List (since device step CB)

Functional Problems

Functional Problem	Short Description	Fixed in step
34 / BUS.18	PEC Transfers after JMPR Instruction	
33 / ADC.11	Modifications of ADM field while bit ADST = 0 (problem only in Dx-steps, problem not included in earlier steps of 80/83C166/W)	
32 / PWRDN.1	Execution of PWRDN Instruction while pin NMI# = high	
31 / CPU.16	Data read access with MOV B [Rn], mem instruction to internal ROM (problem only in ROM version 83C166/W and Flash/bondout versions)	
30 / CPU.17	Arithmetic Overflow by DIVLU instruction	
29 / BUS.15	Non-multiplexed bus without read-write delay	
28 / CPU.11	Stack Underflow during Restart of Interrupted Multiply	DC
27 / CPU.10	Bit protection for register TFR	DA
26 / CPU.9	PEC Transfers during instruction execution from Internal RAM	DC
25 / INT.7	Bit Instructions on Interrupt Control Registers	DA
24 / CPU.7	Warm Hardware Reset (pulse length < 1032 TCL)	DB
23 / ASC.2	Serial Channel Overrun Error	DA
22 / ADC.4	A/D Converter Overrun Error	DA
21 / CPU.5	Result Forwarding by BFLDL/BFLDH	DA
20 / ADC.3	Restart of A/D Converter	DA
19 / CPU.4	Jump with Cache Hit after branch from internal ROM/Flash	DA
18	Watchdog Timer reset in Idle Mode	CB ¹⁾
17	Interrupted multiplication with interrupt after RETI	CB

The stepping code which is listed in column 'Fixed in step' refers to all qualification steps (early engineering samples (EES), engineering samples (ES)), unless specifically stated otherwise.

Notes: ¹⁾ fixed in all devices with stepping code/marking CB except for CB-ES

AC/DC Deviations

AC/DC Deviation	Short Description	Fixed in step
11 / DC.IOZ1.2	Input Leakage Current (I _{oz1}) at Port 5	

Appendix

In this appendix, some architectural items are described which are not yet documented in a very detailed manner in the current release of the SAB 80C166 User's Manual and/or Data Sheet. In the next revisions, these items will be integrated.

1.) Synchronous READY#: When the 'Synchronous Ready' mode has been selected for external memory accesses, for example by the following instruction sequence,

```
BCLR DP3.14      ;      Pin direction = INPUT
BCLR SYSCON.3    ;      Select 'Synchronous Ready' Mode
BSET RDYEN       ;      Enable READY function
```

this mode will only work properly if the system clock output pin CLKOUT is enabled in addition (P3.15 = 1, DP3.15 = 1, SYSCON.CLKEN = 1). The reason for this is that the system clock is normally required externally as synchronous reference signal.

2.) MDL Register: From the CA-step on, the MDL register may also be read via a short 'reg' addressing mode immediately after a divide instruction. This means that the note concerning the pipeline side effect in the Appendix of previous Errata Sheets must no longer be taken into account.

3.) Uninterruptible Instruction Sequences: To be absolutely sure that an instruction (sequence) can not be interrupted, at least 2 instructions (e.g. NOPs) must be programmed after the instruction disabling the interrupts, as shown in the following example (see also the application note AP160902 'How to make instruction sequences uninterruptible' on <http://www.siemens.de/semiconductor/products/ics/34/pdf/ap160902.pdf>).

```
BCLR IEN
NOP                ;      or other appropriate instructions
NOP
...                ;      Start of the uninterruptible range
```

4.) JBC/JNBS Instructions: From the CA-step on, the operation of the semaphore instructions JBC/JNBS has been changed such that these instructions only write back to the bit to be tested when the branch condition is true. This modification has no effect on bits in the internal RAM or on SFR bits which are not modified by hardware. However, the use of these instructions on SFR bits which may be changed both by hardware and software is now directly possible without any special considerations (see also the application note on JBC/JNBS in the SAB 80C166 Family ApNotes collection). The modified operation of the JBC/JNBS instructions is as follows:

JBC:	JNBS:
IF (bit) = 1 THEN	IF (bit) = 0 THEN
(bit) := 0	(bit) := 1
(IP) := target	(IP) := target
ELSE	ELSE
next instruction	next instruction
END IF	END IF

5.) P3.12 (BHE#) in Single Chip Mode: From the DA-step on, when the Single Chip mode is selected during reset (pin BUSACT# = 1, EBC0 = EBC1 = 0), this pin is also floating (and no longer driving a low level) after reset like all other port pins. This means that the note concerning this pin in the Appendix of previous Errata Sheets must no longer be taken into account.

6.) Power Down Mode: When driving the XTAL1 input with an external clock source, XTAL1 must be held at V_{CC} to $V_{CC}-0.1V$ in order to meet the I_{PD} specification of 50 μA .

Functional Improvements/Compatibility Issues

In the following sections, the functional improvements have been implemented in the 80C166/83C166/W beginning with the DA-step are described, and compatibility issues related with these improvements are discussed. These improvements are already included in the CC-step of the bondout version 80C166E and the flash version 88C166/W. In general, all of these improvements are hardware and software upward compatible.

1. Serial Channels ASCx: Start Bit detection (async mode)

Reception of data in the asynchronous mode of ASCx is initiated whenever a high to low transition (start bit) is detected at the respective RxD pin. When RxD stays at a low level during and after the bit time of the stop bit (BREAK situation), a receive interrupt and a framing error is generated, and no further data frames are received until the next high to low transition at pin RxD signals the start of a new data frame. This means that only one incorrect data frame is received at the beginning of such a BREAK situation.

In the previous steps, reception was already initiated when a low level was detected at RxD. In case RxD stayed low during and after the stop bit time slot, a receive interrupt and a framing error was generated, but reception of further data frames proceeded, including generation of receive interrupts and framing errors, until RxD went to a high level (end of BREAK situation). This means that several incorrect data frames could be received during such a BREAK situation.

In systems where the RxD line correctly returns to a high level while no data are transmitted (i.e. no BREAK situations occur), there will be no differences between the current step and previous steps of the 80C166.

In systems where RxD may go to a low level during and after the stop bit time slot, the functionality improvement of the start bit detection in the current step may lead to simpler software implementations of detecting the end of such a BREAK situation.

2. Serial Channels ASCx: Receive data hold time (sync mode)

In the synchronous mode of ASCx, the timing for the receive data on the respective RxD line in relation to the shift clock which is output on the corresponding TxD line is as follows:

Input data setup time to shift clock rising edge: 4 TCL (100 ns @ 20 MHz)
Input data hold time after shift clock rising edge: 0.0 us

In previous steps, this timing was as follows:

Input data setup time to shift clock rising edge: not relevant
Input data hold time after shift clock rising edge: 1/4 of shift clock cycle time

This functionality improvement is upward compatible, since a transmitter which is connected to the RxD line will normally change its data with the falling edge of the shift clock, such that the timing requirements of all steps of the 80C166 are met.

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