Welcome to E-XFL.COM

What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Discontinued at Digi-Key
Core Processor	C166SV2
Core Size	16-Bit
Speed	40MHz
Connectivity	EBI/EMI, SPI, UART/USART
Peripherals	PWM, WDT
Number of I/O	79
Program Memory Size	128KB (128K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	8K x 8
Voltage - Supply (Vcc/Vdd)	2.35V ~ 2.7V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	100-LQFP
Supplier Device Package	PG-TQFP-100-16
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/saf-xc164n-16f40f-bb

Revision History:	**2005-01**	V1.0
Previous Version:	None	

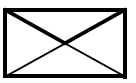
Page	Subjects (major changes since last revision)

Controller Area Network (CAN): License of Robert Bosch GmbH

We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

mcdocu.comments@infineon.com



2 General Device Information

2.1 Introduction

The XC164N derivatives are high-performance members of the Infineon XC166 Family of full featured single-chip CMOS microcontrollers. These devices extend the functionality and performance of the C166 Family in terms of instructions (MAC unit), peripherals, and speed. They combine high CPU performance (up to 40 million instructions per second) with high peripheral functionality and enhanced IO-capabilities. They also provide clock generation via PLL and various on-chip memory modules such as program Flash, program RAM, and data RAM.

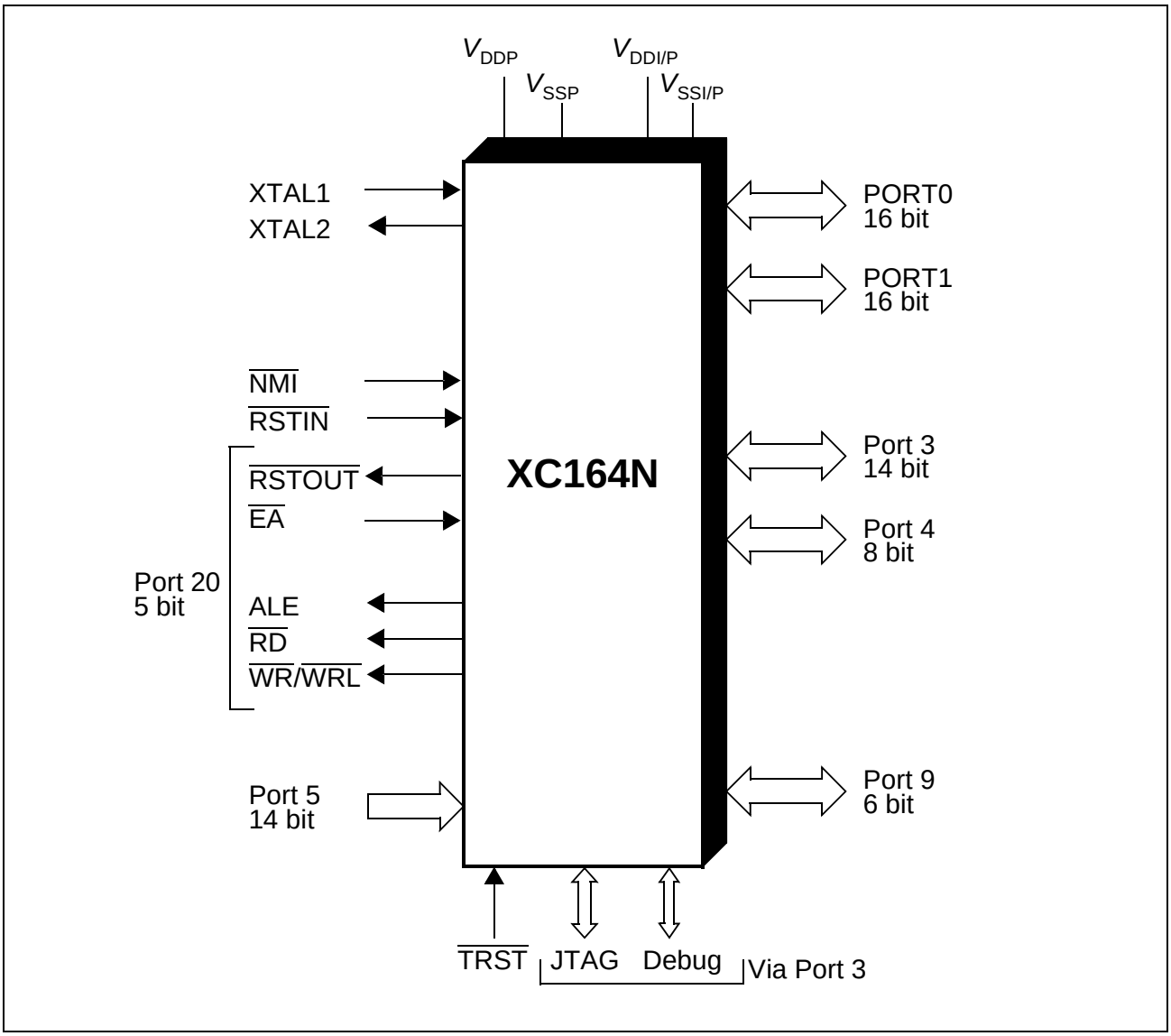


Figure 1 Logic Symbol

2.2 Pin Configuration and Definition

The pins of the XC164N are described in detail in **Table 2**, including all their alternate functions. **Figure 2** summarizes all pins in a condensed way, showing their location on the 4 sides of the package. E*) marks pins to be used as alternate external interrupt inputs.

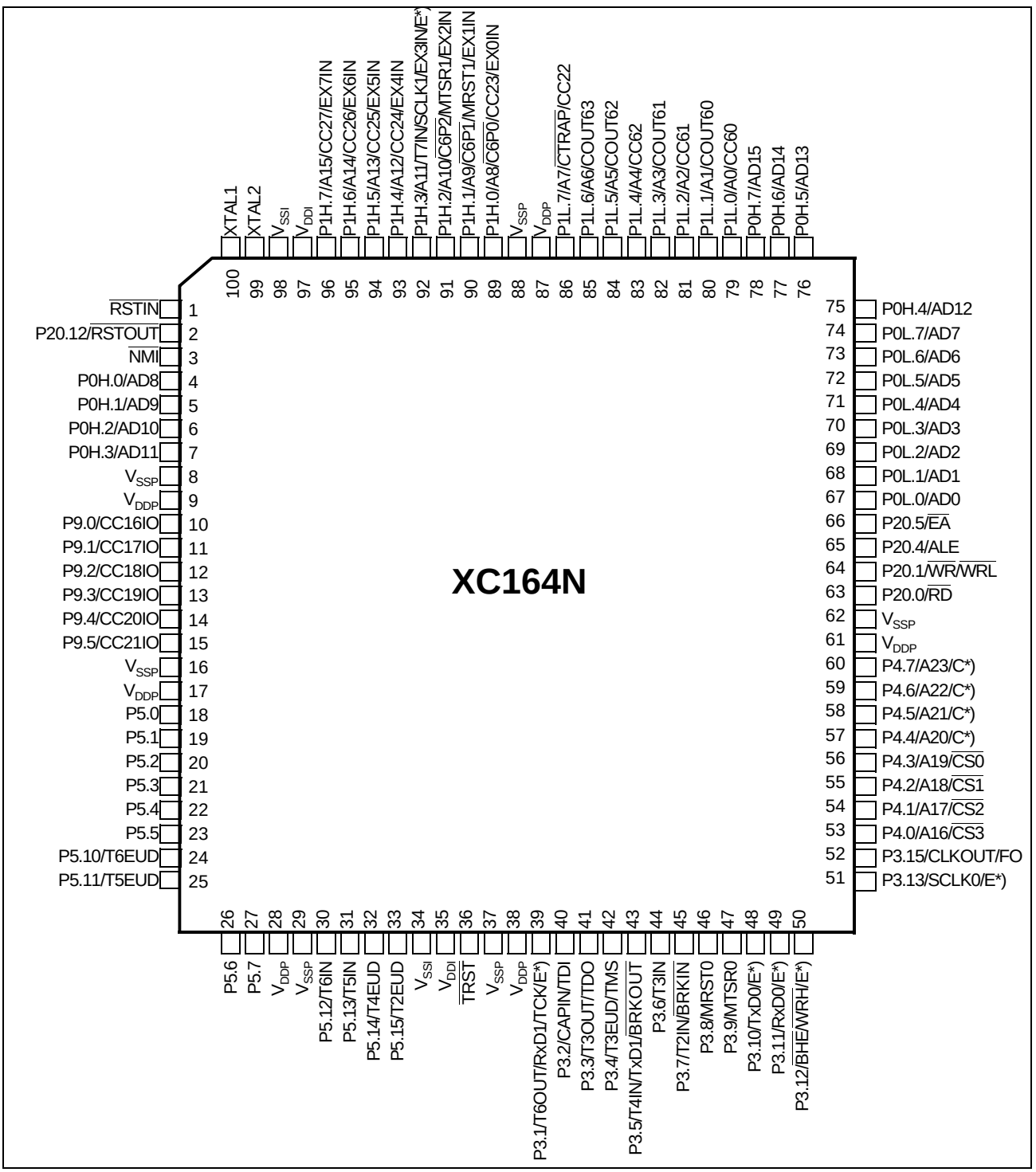


Figure 2 Pin Configuration (top view)

Table 2 Pin Definitions and Functions (cont'd)

Symbol	Pin Num.	Input Outp.	Function	
P20		IO	Port 20 is a 5-bit bidirectional I/O port. Each pin can be programmed for input (output driver in high-impedance state) or output. The input threshold of Port 20 is selectable (standard or special). The following Port 20 pins also serve for alternate functions:	
P20.0	63	O	$\overline{RD}$	External Memory Read Strobe, activated for every external instruction or data read access.
P20.1	64	O	$\overline{WR}$/$\overline{WRL}$	External Memory Write Strobe. In $\overline{WR}$-mode this pin is activated for every external data write access. In $\overline{WRL}$-mode this pin is activated for low byte data write accesses on a 16-bit bus, and for every data write access on an 8-bit bus.
P20.4	65	O	ALE	Address Latch Enable Output. Can be used for latching the address into external memory or an address latch in the multiplexed bus modes.
P20.5	66	I	$\overline{EA}$	External Access Enable pin. **A low level** at this pin during and after Reset forces the XC164N to latch the configuration from PORT0 and pin $\overline{RD}$, and to begin instruction execution out of external memory. **A high level** forces the XC164N to latch the configuration from pins $\overline{RD}$, ALE, and $\overline{WR}$, and to begin instruction execution out of the internal program memory. "ROMless" versions must have this pin tied to '0'.
P20.12	2	O	$\overline{RSTOUT}$	Internal Reset Indication Output. **Is activated** asynchronously with an external hardware reset. It may also be activated (selectable) synchronously with an internal software or watchdog reset. **Is deactivated** upon the execution of the EINIT instruction, optionally at the end of reset, or at any time (before EINIT) via user software.
			Note: Port 20 pins may input configuration values (see $\overline{EA}$).	

Table 2 Pin Definitions and Functions (cont'd)

Symbol	Pin Num.	Input Outp.	Function
V_{DDP}	9, 17, 38, 61, 87	-	Digital Pad Supply Voltage (Pin Output Drivers): +5 V during normal operation and idle mode. Please refer to the **Operating Conditions**
V_{SSI}	34, 98	-	**Digital Ground.** Connect decoupling capacitors to adjacent V_{DD}/V_{SS} pin pairs as close as possible to the pins. All V_{SS} pins must be connected to the ground-line or ground-plane.
V_{SSP}	8, 16, 37, 62, 88	-	

so-called General Purpose Registers (GPRs).
The upper 256 bytes of the DPRAM are directly bitaddressable. When used by a GPR, any location in the DPRAM is bitaddressable.

1024 bytes (2 × 512 bytes) of the address space are reserved for the Special Function Register areas (SFR space and ESFR space). SFRs are wordwide registers which are used for controlling and monitoring functions of the different on-chip units. Unused SFR addresses are reserved for future members of the XC166 Family. Therefore, they should either not be accessed, or written with zeros, to ensure upward compatibility.

In order to meet the needs of designs where more memory is required than is provided on chip, up to 12 Mbytes (approximately, see **Table 3**) of external RAM and/or ROM can be connected to the microcontroller. The External Bus Interface also provides access to external peripherals.

Table 3 XC164N Memory Map[1)]

Address Area	Start Loc.	End Loc.	Area Size[2)]	Notes
Flash register space	$FF'F000_H$	$FF'FFFF_H$	4 Kbytes	Flash only[3)]
Reserved (Acc. trap)	$F8'0000_H$	$FF'EFFF_H$	<0.5 Mbytes	Minus Flash regs
Reserved for PSRAM	$E0'0800_H$	$F7'FFFF_H$	<1.5 Mbytes	Minus PSRAM
Program SRAM	$E0'0000_H$	$E0'07FF_H$	2 Kbytes	Maximum
Reserved for pr. mem.	$C2'0000_H$	$DF'FFFF_H$	< 2 Mbytes	Minus Flash
Program Flash	$C0'0000_H$	$C1'FFFF_H$	128 Kbytes	up to 128 Kbytes
Reserved	$BF'0000_H$	$BF'FFFF_H$	64 Kbytes	
External memory area	$40'0000_H$	$BE'FFFF_H$	< 8 Mbytes	Minus res. seg.
External IO area[4)]	$20'0800_H$	$3F'FFFF_H$	< 2 Mbytes	
Reserved	$20'0000_H$	$20'07FF_H$	2 Kbytes	
External memory area	$01'0000_H$	$1F'FFFF_H$	< 2 Mbytes	Minus segment 0
Data RAMs and SFRs	$00'8000_H$	$00'FFFF_H$	32 Kbytes	Partly used
External memory area	$00'0000_H$	$00'7FFF_H$	32 Kbytes	

1) Accesses to the shaded areas generate external bus accesses.

2) The areas marked with "<" are slightly smaller than indicated, see column "Notes".

3) Not defined register locations return a trap code.

4) Several pipeline optimizations are not active within the external IO area. This is necessary to control external peripherals properly.

3.3 Central Processing Unit (CPU)

The main core of the CPU consists of a 5-stage execution pipeline with a 2-stage instruction-fetch pipeline, a 16-bit arithmetic and logic unit (ALU), a 32-bit/40-bit multiply and accumulate unit (MAC), a register-file providing three register banks, and dedicated SFRs. The ALU features a multiply and divide unit, a bit-mask generator, and a barrel shifter.

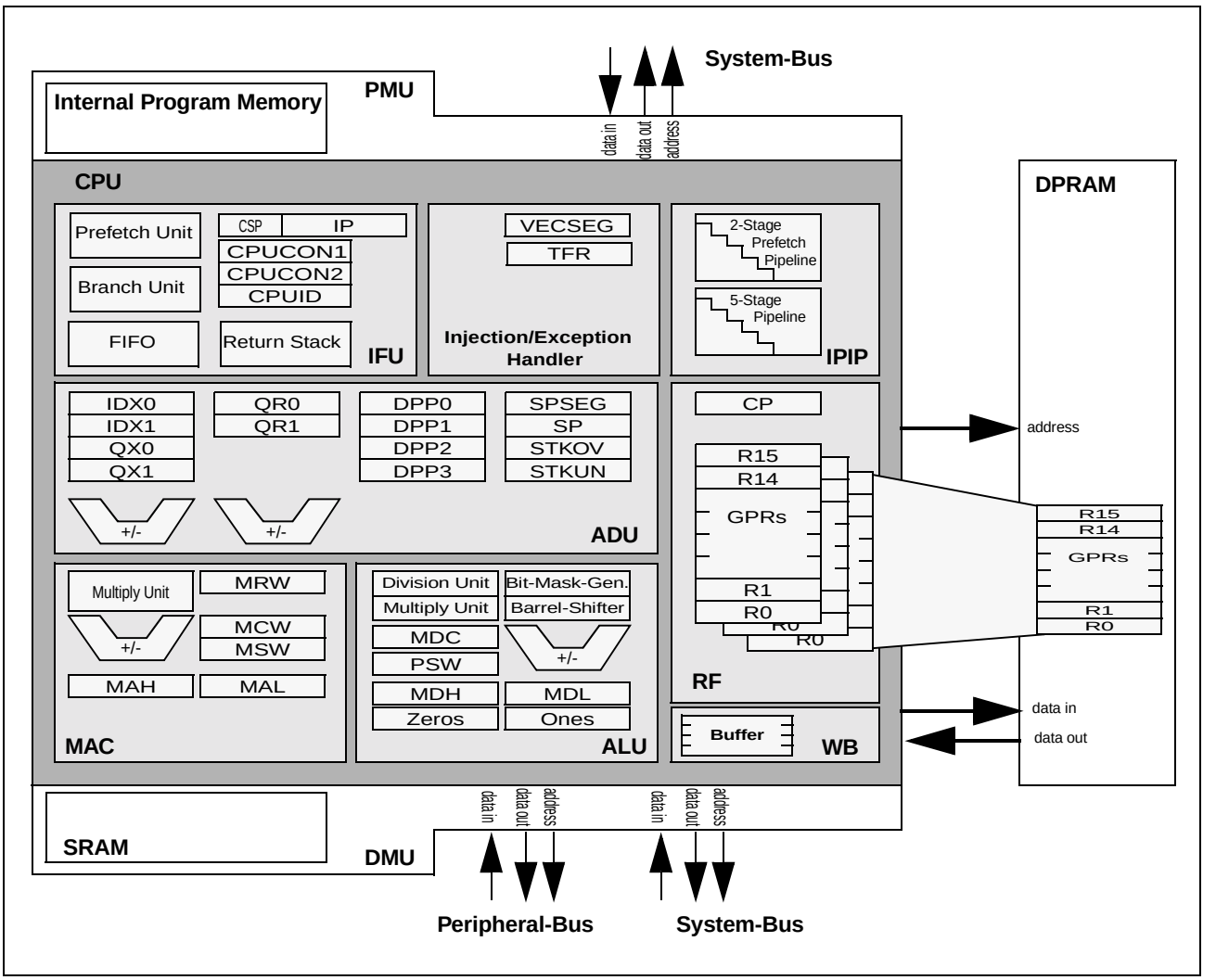


Figure 4 CPU Block Diagram

Based on these hardware provisions, most of the XC164N's instructions can be executed in just one machine cycle which requires 25 ns at 40 MHz CPU clock. For example, shift and rotate instructions are always processed during one machine cycle independent of the number of bits to be shifted. Also multiplication and most MAC instructions execute in one single cycle. All multiple-cycle instructions have been optimized so that they can be executed very fast as well: for example, a 32-/16-bit division is started within 4 cycles, while the remaining 15 cycles are executed in the

Table 4 XC164N Interrupt Nodes (cont'd)

Source of Interrupt or PEC Service Request	Control Register	Vector Location[1)]	Trap Number
CAPCOM Register 30	CC2_CC30IC	xx'0114$_H$	45$_H$ / 69$_D$
CAPCOM Register 31	CC2_CC31IC	xx'0118$_H$	46$_H$ / 70$_D$
CAPCOM Timer 0	CC1_T0IC	xx'0080$_H$	20$_H$ / 32$_D$
CAPCOM Timer 1	CC1_T1IC	xx'0084$_H$	21$_H$ / 33$_D$
CAPCOM Timer 7	CC2_T7IC	xx'00F4$_H$	3D$_H$ / 61$_D$
CAPCOM Timer 8	CC2_T8IC	xx'00F8$_H$	3E$_H$ / 62$_D$
GPT1 Timer 2	GPT12E_T2IC	xx'0088$_H$	22$_H$ / 34$_D$
GPT1 Timer 3	GPT12E_T3IC	xx'008C$_H$	23$_H$ / 35$_D$
GPT1 Timer 4	GPT12E_T4IC	xx'0090$_H$	24$_H$ / 36$_D$
GPT2 Timer 5	GPT12E_T5IC	xx'0094$_H$	25$_H$ / 37$_D$
GPT2 Timer 6	GPT12E_T6IC	xx'0098$_H$	26$_H$ / 38$_D$
GPT2 CAPREL Reg.	GPT12E_CRIC	xx'009C$_H$	27$_H$ / 39$_D$
Unassigned node	---	xx'00A0$_H$	28$_H$ / 40$_D$
Unassigned node	---	xx'00A4$_H$	29$_H$ / 41$_D$
ASC0 Transmit	ASC0_TIC	xx'00A8$_H$	2A$_H$ / 42$_D$
ASC0 Transmit Buffer	ASC0_TBIC	xx'011C$_H$	47$_H$ / 71$_D$
ASC0 Receive	ASC0_RIC	xx'00AC$_H$	2B$_H$ / 43$_D$
ASC0 Error	ASC0_EIC	xx'00B0$_H$	2C$_H$ / 44$_D$
ASC0 Autobaud	ASC0_ABIC	xx'017C$_H$	5F$_H$ / 95$_D$
SSC0 Transmit	SSC0_TIC	xx'00B4$_H$	2D$_H$ / 45$_D$
SSC0 Receive	SSC0_RIC	xx'00B8$_H$	2E$_H$ / 46$_D$
SSC0 Error	SSC0_EIC	xx'00BC$_H$	2F$_H$ / 47$_D$
PLL/OWD	PLLIC	xx'010C$_H$	43$_H$ / 67$_D$
ASC1 Transmit[2)]	ASC1_TIC	xx'0120$_H$	48$_H$ / 72$_D$
ASC1 Transmit Buffer	ASC1_TBIC	xx'0178$_H$	5E$_H$ / 94$_D$
ASC1 Receive	ASC1_RIC	xx'0124$_H$	49$_H$ / 73$_D$
ASC1 Error	ASC1_EIC	xx'0128$_H$	4A$_H$ / 74$_D$
ASC1 Autobaud	ASC1_ABIC	xx'0108$_H$	42$_H$ / 66$_D$
End of PEC Subch.	EOPIC	xx'0130$_H$	4C$_H$ / 76$_D$
CAPCOM6 Timer T12	CCU6_T12IC	xx'0134$_H$	4D$_H$ / 77$_D$

Table 4 XC164N Interrupt Nodes (cont'd)

Source of Interrupt or PEC Service Request	Control Register	Vector Location[1)]	Trap Number
CAPCOM6 Timer T13	CCU6_T13IC	xx'0138$_H$	4E$_H$ / 78$_D$
CAPCOM6 Emergency	CCU6_EIC	xx'013C$_H$	4F$_H$ / 79$_D$
CAPCOM6	CCU6_IC	xx'0140$_H$	50$_H$ / 80$_D$
SSC1 Transmit	SSC1_TIC	xx'0144$_H$	51$_H$ / 81$_D$
SSC1 Receive	SSC1_RIC	xx'0148$_H$	52$_H$ / 82$_D$
SSC1 Error	SSC1_EIC	xx'014C$_H$	53$_H$ / 83$_D$
Unassigned node	---	xx'0150$_H$	54$_H$ / 84$_D$
Unassigned node	---	xx'0154$_H$	55$_H$ / 85$_D$
Unassigned node	---	xx'0158$_H$	56$_H$ / 86$_D$
Unassigned node	---	xx'015C$_H$	57$_H$ / 87$_D$
Unassigned node	---	xx'0164$_H$	59$_H$ / 89$_D$
Unassigned node	---	xx'0168$_H$	5A$_H$ / 90$_D$
Unassigned node	---	xx'016C$_H$	5B$_H$ / 91$_D$
Unassigned node	---	xx'0170$_H$	5C$_H$ / 92$_D$
Unassigned node	---	xx'0174$_H$	5D$_H$ / 93$_D$
Unassigned node	---	xx'0100$_H$	40$_H$ / 64$_D$
Unassigned node	---	xx'0104$_H$	41$_H$ / 65$_D$
Unassigned node	---	xx'012C$_H$	4B$_H$ / 75$_D$
Unassigned node	---	xx'00FC$_H$	3F$_H$ / 63$_D$
Unassigned node	---	xx'0160$_H$	58$_H$ / 88$_D$

1) Register VECSEG defines the segment where the vector table is located to.
Bitfield VECSC in register CPUCON1 defines the distance between two adjacent vectors. This table represents the default setting, with a distance of 4 (two words) between two vectors.

2) The interrupt nodes assigned to ASC1 are only available in derivatives including the ASC1. Otherwise, they are unassigned nodes.

When a capture/compare register has been selected for capture mode, the current contents of the allocated timer will be latched (‘captured’) into the capture/compare register in response to an external event at the port pin which is associated with this register. In addition, a specific interrupt request for this capture/compare register is generated. Either a positive, a negative, or both a positive and a negative external signal transition at the pin can be selected as the triggering event.

The contents of all registers which have been selected for one of the five compare modes are continuously compared with the contents of the allocated timers.

When a match occurs between the timer value and the value in a capture/compare register, specific actions will be taken based on the selected compare mode.

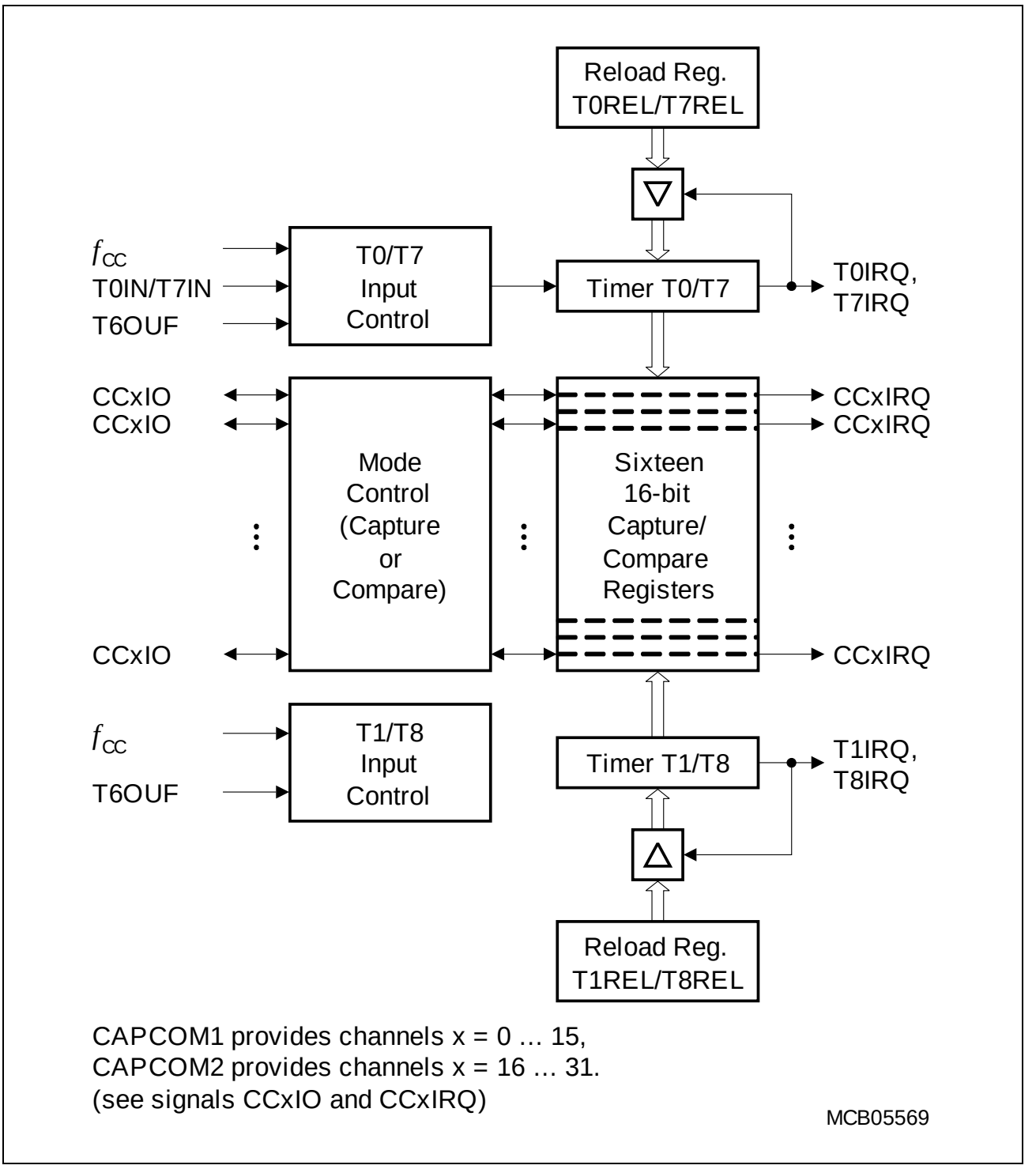
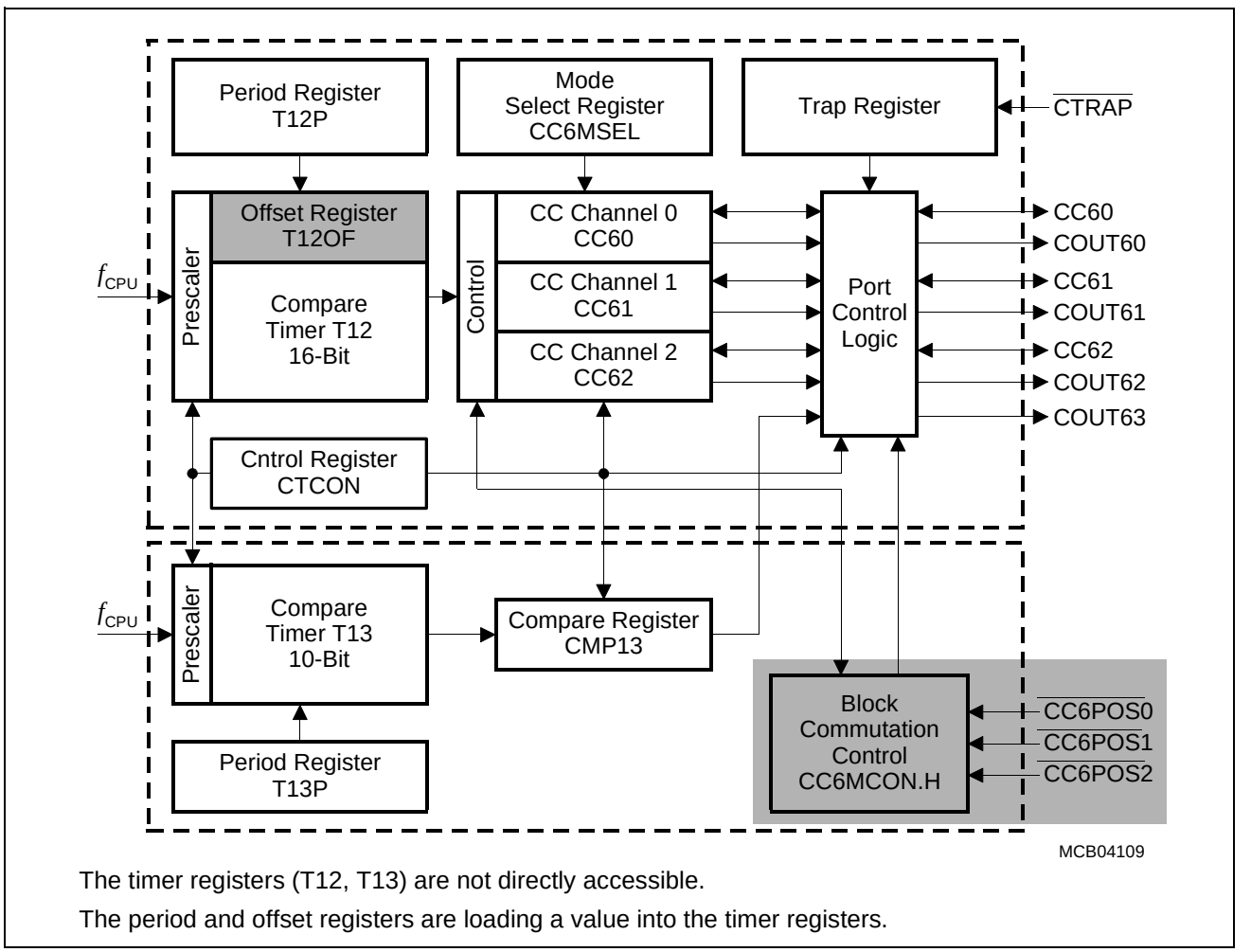


Figure 5 CAPCOM1/2 Unit Block Diagram

3.7 The Capture/Compare Unit CAPCOM6

The CAPCOM6 unit supports generation and control of timing sequences on up to three 16-bit capture/compare channels plus one independent 10-bit compare channel.
In compare mode the CAPCOM6 unit provides two output signals per channel which have inverted polarity and non-overlapping pulse transitions (deadtime control). The compare channel can generate a single PWM output signal and is further used to modulate the capture/compare output signals.
In capture mode the contents of compare timer T12 is stored in the capture registers upon a signal transition at pins CCx.

Compare timers T12 (16-bit) and T13 (10-bit) are free running timers which are clocked by the prescaled system clock.



The timer registers (T12, T13) are not directly accessible.

The period and offset registers are loading a value into the timer registers.

Figure 6 CAPCOM6 Block Diagram

For motor control applications both subunits may generate versatile multichannel PWM signals which are basically either controlled by compare timer T12 or by a typical hall sensor pattern at the interrupt inputs (block commutation).

3.8 General Purpose Timer (GPT12E) Unit

The GPT12E unit represents a very flexible multifunctional timer/counter structure which may be used for many different time related tasks such as event timing and counting, pulse width and duty cycle measurements, pulse generation, or pulse multiplication.

The GPT12E unit incorporates five 16-bit timers which are organized in two separate modules, GPT1 and GPT2. Each timer in each module may operate independently in a number of different modes, or may be concatenated with another timer of the same module.

Each of the three timers T2, T3, T4 of **module GPT1** can be configured individually for one of four basic modes of operation, which are Timer, Gated Timer, Counter, and Incremental Interface Mode. In Timer Mode, the input clock for a timer is derived from the system clock, divided by a programmable prescaler, while Counter Mode allows a timer to be clocked in reference to external events.
Pulse width or duty cycle measurement is supported in Gated Timer Mode, where the operation of a timer is controlled by the ‘gate’ level on an external input pin. For these purposes, each timer has one associated port pin (TxIN) which serves as gate or clock input. The maximum resolution of the timers in module GPT1 is 4 system clock cycles.

The count direction (up/down) for each timer is programmable by software or may additionally be altered dynamically by an external signal on a port pin (TxEUD) to facilitate e.g. position tracking.

In Incremental Interface Mode the GPT1 timers (T2, T3, T4) can be directly connected to the incremental position sensor signals A and B via their respective inputs TxIN and TxEUD. Direction and count signals are internally derived from these two input signals, so the contents of the respective timer Tx corresponds to the sensor position. The third position sensor signal TOP0 can be connected to an interrupt input.

Timer T3 has an output toggle latch (T3OTL) which changes its state on each timer over-flow/underflow. The state of this latch may be output on pin T3OUT e.g. for time out monitoring of external hardware components. It may also be used internally to clock timers T2 and T4 for measuring long time periods with high resolution.

In addition to their basic operating modes, timers T2 and T4 may be configured as reload or capture registers for timer T3. When used as capture or reload registers, timers T2 and T4 are stopped. The contents of timer T3 is captured into T2 or T4 in response to a signal at their associated input pins (TxIN). Timer T3 is reloaded with the contents of T2 or T4 triggered either by an external signal or by a selectable state transition of its toggle latch T3OTL. When both T2 and T4 are configured to alternately reload T3 on opposite state transitions of T3OTL with the low and high times of a PWM signal, this signal can be constantly generated without software intervention.

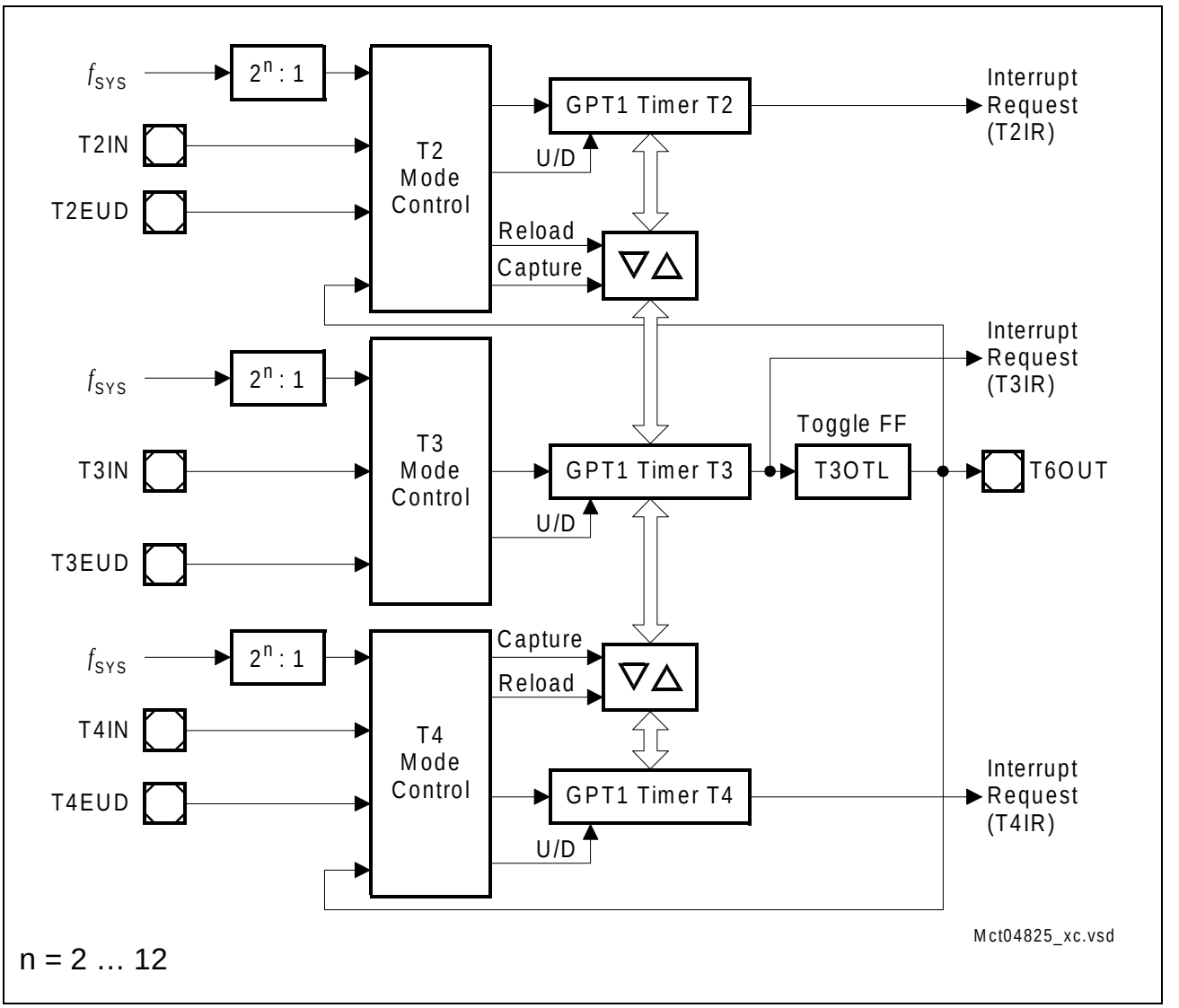


Figure 7 Block Diagram of GPT1

With its maximum resolution of 2 system clock cycles, the **GPT2 module** provides precise event control and time measurement. It includes two timers (T5, T6) and a capture/reload register (CAPREL). Both timers can be clocked with an input clock which is derived from the CPU clock via a programmable prescaler or with external signals. The count direction (up/down) for each timer is programmable by software or may additionally be altered dynamically by an external signal on a port pin (TxEUD). Concatenation of the timers is supported via the output toggle latch (T6OTL) of timer T6, which changes its state on each timer overflow/underflow.

The state of this latch may be used to clock timer T5, and/or it may be output on pin T6OUT. The overflows/underflows of timer T6 can additionally be used to clock the CAPCOM1/2 timers, and to cause a reload from the CAPREL register.

The CAPREL register may capture the contents of timer T5 based on an external signal transition on the corresponding port pin (CAPIN), and timer T5 may optionally be cleared

The RTC module can be used for different purposes:

- System clock to determine the current time and date,
  optionally during idle mode, sleep mode, and power down mode
- Cyclic time based interrupt, to provide a system time tick independent of CPU frequency and other resources, e.g. to wake up regularly from idle mode.
- 48-bit timer for long term measurements (maximum timespan is >100 years).
- Alarm interrupt for wake-up on a defined time

DC Characteristics (cont'd)
(Operating Conditions apply)[1)]

Parameter	Symbol		Limit Values		Unit	Test Condition
			min.	max.		
Configuration pull-down current[10)]	I_{CPDL}	8)	–	10	µA	$V_{IN} = V_{ILmax}$
	I_{CPDH}	9)	120	–	µA	$V_{IN} = V_{IHmin}$
Level inactive hold current[11)]	I_{LHI}	8)	–	-10	µA	$V_{OUT} = 0.5 \times V_{DDP}$
Level active hold current[11)]	I_{LHA}	9)	-100	–	µA	V_{OUT} = 0.45 V
XTAL1 input current	I_{IL}	CC	–	±20	µA	0 V < V_{IN} < V_{DDI}
Pin capacitance[12)] (digital inputs/outputs)	C_{IO}	CC	–	10	pF	

1) Keeping signal levels within the limits specified in this table, ensures operation without overload conditions. For signal levels outside these specifications, also refer to the specification of the overload current I_{OV}.

2) This parameter is tested for P2, P3, P4, P9.

3) The maximum deliverable output current of a port driver depends on the selected output driver mode, see **Table 12**, **Current Limits for Port Output Drivers**. The limit for pin groups must be respected.

4) As a rule, with decreasing output current the output levels approach the respective supply level ($V_{OL} \rightarrow V_{SS}$, $V_{OH} \rightarrow V_{DDP}$). However, only the levels for nominal output currents are guaranteed.

5) This specification is not valid for outputs which are switched to open drain mode. In this case the respective output will float and the voltage results from the external circuitry.

6) An additional error current (I_{INJ}) will flow if an overload current flows through an adjacent pin. Please refer to the definition of the overload coupling factor K_{OV}.

7) This specification is valid during Reset for configuration on $\overline{RD}$, $\overline{WR}$, $\overline{EA}$, PORT0.

8) The maximum current may be drawn while the respective signal line remains inactive.

9) The minimum current must be drawn to drive the respective signal line active.

10) This specification is valid during Reset for configuration on ALE.

11) This specification is valid during Reset for pins P4.3-0, which can act as $\overline{CS}$ outputs.

12) Not subject to production test - verified by design/characterization.

5) This parameter is determined mainly by the transistor leakage currents. This current heavily depends on the junction temperature (see **Figure 12**). The junction temperature T_J is the same as the ambient temperature T_A if no current flows through the port output drivers. Otherwise, the resulting temperature difference must be taken into account.

6) All inputs (including pins configured as inputs) at 0 V to 0.1 V or at V_{DDP} - 0.1 V to V_{DDP}, all outputs (including pins configured as outputs) disconnected. This parameter is tested at 25 °C and is valid for $T_J \geq 25$ °C.

7) This parameter is determined mainly by the current consumed by the oscillator switched to low gain mode (see **Figure 11**). This current, however, is influenced by the external oscillator circuitry (crystal, capacitors). The given values refer to a typical circuitry and may change in case of a not optimized external oscillator circuitry.

5 Timing Parameters

5.1 Definition of Internal Timing

The internal operation of the XC164N is controlled by the internal master clock f_{MC}.

The master clock signal f_{MC} can be generated from the oscillator clock signal f_{OSC} via different mechanisms. The duration of master clock periods (TCMs) and their variation (and also the derived external timing) depend on the used mechanism to generate f_{MC}. This influence must be regarded when calculating the timings for the XC164N.

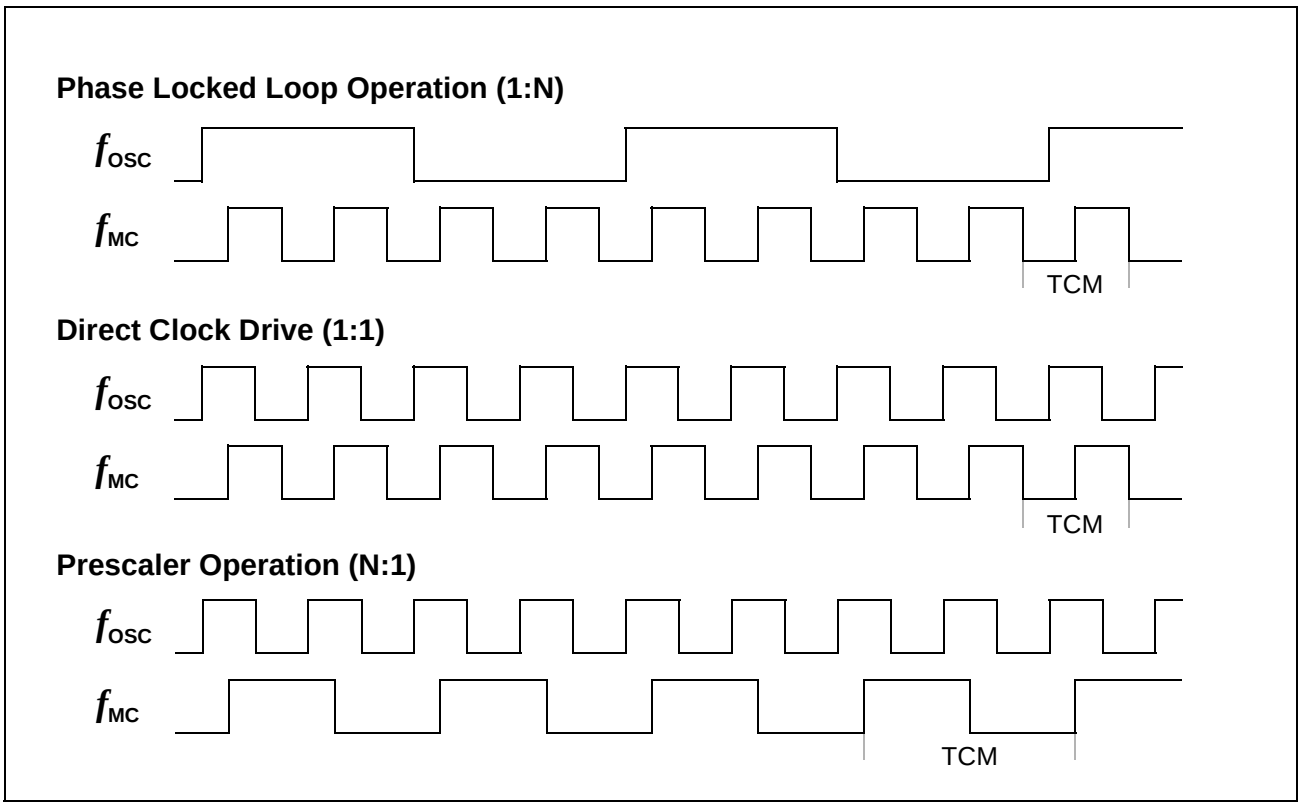


Figure 13 Generation Mechanisms for the Master Clock

*Note: The example for PLL operation shown in **Figure 13** refers to a PLL factor of 1:4, the example for prescaler operation refers to a divider factor of 2:1.*

The used mechanism to generate the master clock is selected by register PLLCON.

CPU and EBC are clocked with the CPU clock signal f_{CPU}. The CPU clock can have the same frequency as the master clock ($f_{CPU} = f_{MC}$) or can be the master clock divided by two: $f_{CPU} = f_{MC} / 2$. This factor is selected by bit CPSYS in register SYSCON1.

The specification of the external timing (AC Characteristics) depends on the period of the CPU clock, called “TCP”.

The other peripherals are supplied with the system clock signal f_{SYS} which has the same frequency as the CPU clock signal f_{CPU}.

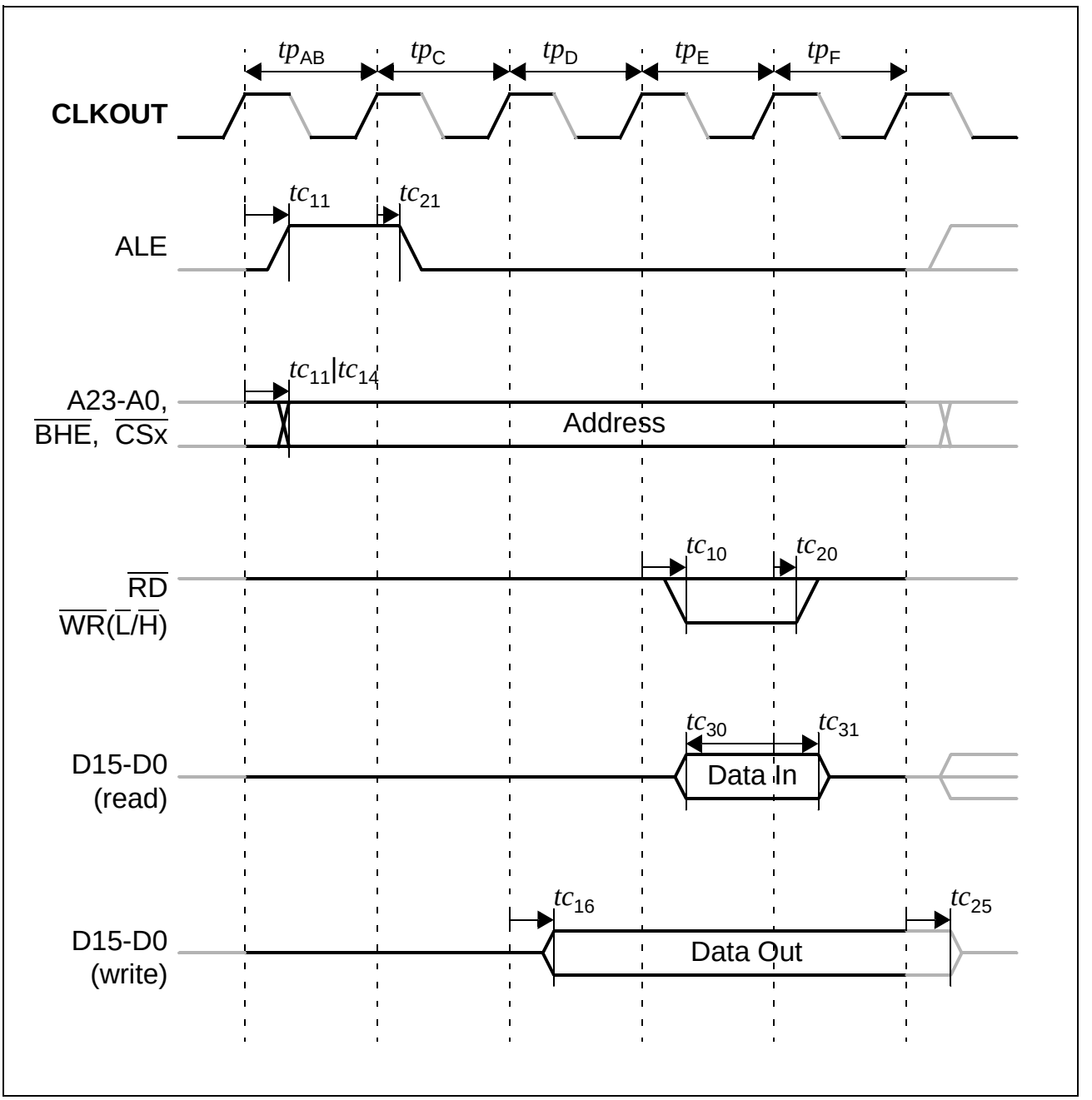


Figure 20 Demultiplexed Bus Cycle

w w w . i n f i n e o n . c o m

Published by Infineon Technologies AG