

kitCON-167

Hardware-Manual

Edition June 1997

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Preface

This kitCON-167 User's Manual describes the board's design and functions. Precise specifications for the C167 microcontroller family can be found in the enclosed microcontroller Data Sheet/User's Manual. Please also refer to the enclosed documentation for the software development tools for use in programming the kitCON-167.

In this User's Manual and in the attached schematics, low active signals are denoted by a "/" in front of the signal name (i.e.: /RD). A "0" indicates a logic-zero or low-level signal, while a "1" represents a logic-one or high-level signal.

Handle the kitCON-167 with care in respect to ESD requirements. Take precautions to use the module only in an ESD-safe workplace.

The kitCON-167 is one of a series of PHYTEC kitCONs which can be fitted with different controllers and, hence, offers various functions and configurations. PHYTEC supports all common Siemens' 8- and 16-bit controllers in two ways:

- (1) as the basis for Starter Kits in which user-designed hardware can be implemented on a wrap-field around the controller and
- (2) as universal, insert-ready, fully functional micro- and mini-MODULS which can be embedded directly into the user's peripheral hardware design.

PHYTEC's microcontroller modules allow engineers to shorten development horizons, reduce design costs and speed project concepts from design to market. Please contact PHYTEC for additional information:

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1. Introduction to the kitCON-167

The kitCON-167 is a EURO-sized (100 x 160 mm) Evaluation Board for the Siemens C167x microcontroller of the C16x-microcontroller family in a MQFP-144 package. The kitCON-167 is pre-configured and equipped with all necessary connectors required for immediate start-up (*refer to figure 2*).

The kitCON-167 offers the following features:

- Evaluation Board in EURO-card format 160 x 100 mm, including wrap-field (90x60 mm) for easy layout of user circuitry
- Improved interference safety through multi-layer technology
- Requires single unregulated 8 to 12 V/500 mA power source
- 256 KByte Flash on-board (PLCC-package)(optionally expandable to up to 2MB)¹
- on board Flash-programming
- No need for a dedicated programming voltage through use of 5V-Flash-devices
- 64 KByte SRAM on Board (optionally expandable to up to 2MB)¹
- On-Chip Bootstrap-Loader
- All controller ports, as well as data and address lines, are extended from the controller to the pins of the kitCON-Connector in the middle of the board
- RS-232 serial interface, available at DB9-socket P1
- Supplemental debug-interface (RS-232), available at DB9-plug P2
- If equipped with a C167Cx controller an additional CAN-Interface is available at DB9-plug P2
- Two LED's to display the boards status
- Real-Time Clock¹
- Up to three free Chip-Select signals for easy connection of peripheral devices (controller-dependent)
- Provision for operating the board with an ICE/connect-167 for easy emulation of the controller
- Provision for operating the board with a Quad-Connector for easy emulation of the controller

¹ For more information about additional configurations see the PHYTEC product catalog

¹ The real-time clock is only available on Moduls purchased from PHYTEC

1.1 Block Diagram

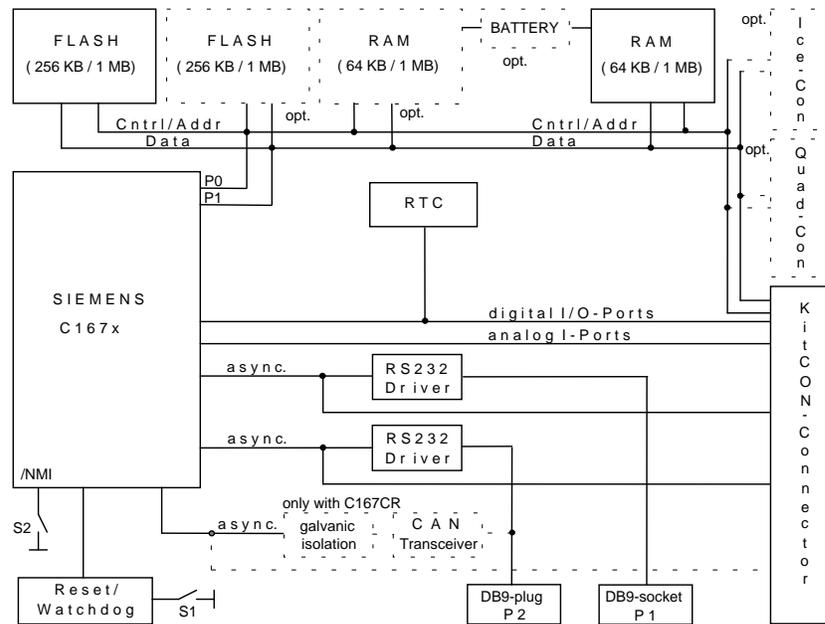


Figure 1: Block Diagram

1.2 Overview of the kitCON-167

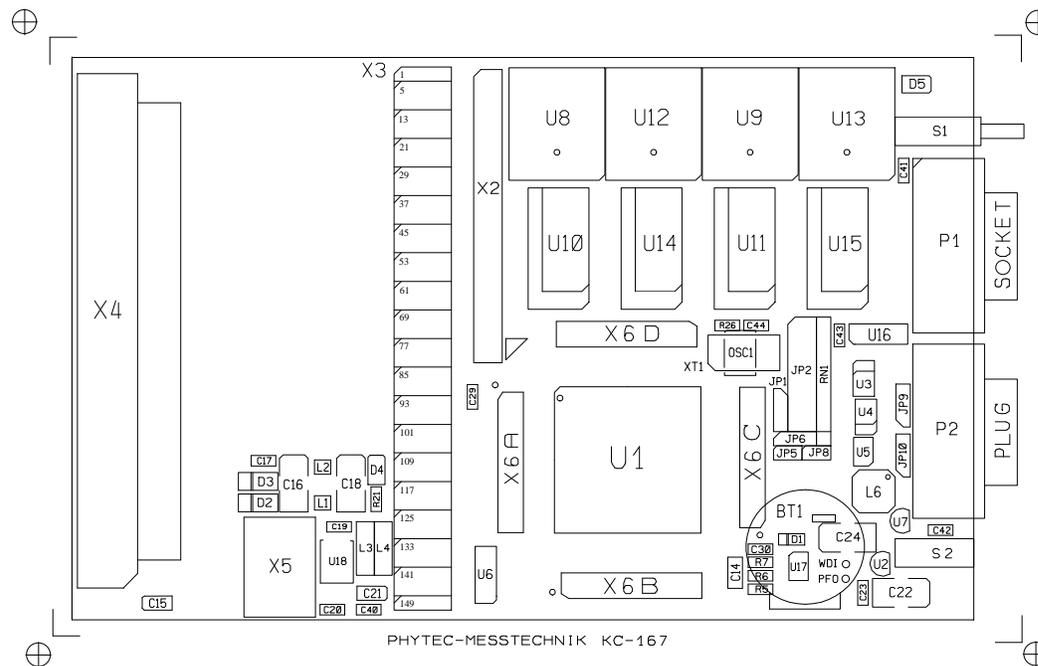


Figure 2a: View of the kitCON-167 (component side)

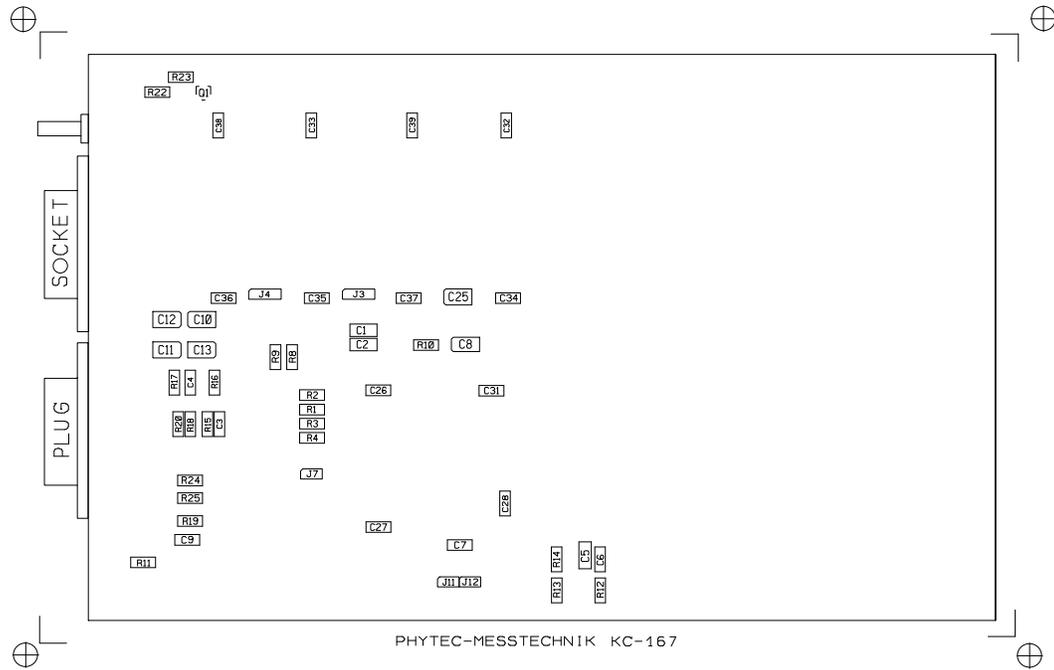


Figure 2b: View of the kitCON-167 (soldering side)

2. Quickstart Instructions

In this chapter you will find a step by step description for putting the kitCON-167 into operation. Please note that the following instructions refer to the current versions of the FlashTools and the monitor-program from Keil Elektronik GmbH as of the pressing of this manual. To ensure putting the kitCON-167 quick and safe into operation, the use of the PC-software is described only for DOS. Using it in conjunction with other operating systems or environments might cause disturbances of the proceeding, especially of the serial communication.

The standard-version of the kitCON-167 houses the C167CR microcontroller, which includes an on-chip Bootstrap-Loader.

Generally the Bootstrap-Loader allows downloading and starting of any program suitable for the specific controller. Depending on the terminal-program used, different applications and tools will be loaded and executed. For instance when executing the PHYTEC terminal program FLASHT.EXE, routines for programming the Flash (the so called FlashTools¹) will automatically be loaded and started. This is in contrast to the terminal-program MON166.EXE from Keil Elektronik GmbH, which downloads a Monitor program enabling simple Debugging of user code.

The following sections provide a step by step description for starting the kitCON-167 using the FlashTools as well as for starting the kitCON using a Monitor program².

¹ Software-tool for on board Flash-programming, will be automatically loaded if the terminal-program FLASHT.EXE is used

² The Monitor-program is only available on Moduls purchased from Siemens

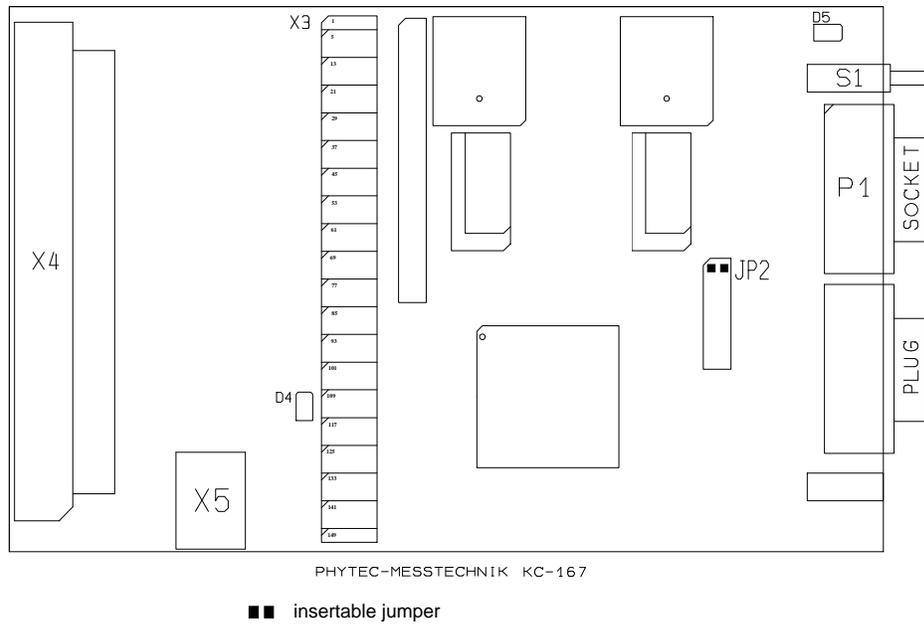


Figure 3: Important jumper and connectors for starting

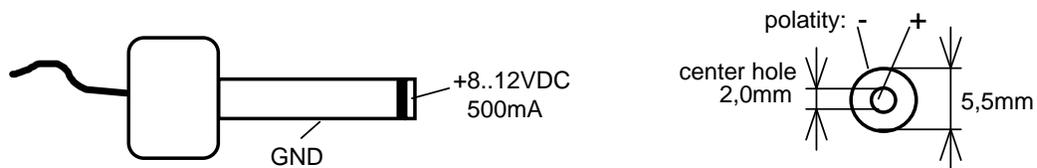


Figure 4: The power-plug

2.1 Starting the kitCON using a Monitor Program

- Use of the Monitor program requires a kitCON-167 and an IBM-PC or a compatible system. Typically, all jumpers for configuring the kitCON-167 have been correctly set upon delivery of the module.
- Connect your Host-PC (COM1 or COM2) to the DB9-socket P1 on the kitCON-167 using a serial cable as shown below.

PC DB9-plug COM1,2		kitCON-167 DB9-socket P1
RxD PIN 2	to	TxD PIN 2
TxD PIN 3	to	RxD PIN 3
GND PIN 5	to	GND PIN 5

No Hardware-Handshake-Line is required to invoke communication between the kitCON-167 and the Host-PC, as the firmware contains a transmission protocol to ensure fault-free data transmission between the PC and the kitCON-167.

- Ensure that the **red** Boot-Jumper JP2 (the bipolar pin-row next to the quartz XT1) is closed at pins 1+2
- Attach a power supply to the power-connector X5. An unregulated 8V to 12V/500mA power source can be used to supply the board. Use only a fixed voltage power supply and no power supply with variable voltage. Double check the correct polarity of the plug as shown in figure 4. If the power supply is attached correctly the red LED D4 will shine.
- Push switch S1 to perform a Reset and to start the Bootstrap-Loader on the kitCON-167.
- Invoke the Terminal program MON166.EXE on your Host-PC by entering the following:

```
mon166 [BR(Baudrate)] [COM port number]
```

Other communication or terminal programs are not suitable for data transmission to and from the Monitor on the kitCON-167, as a special transmission protocol is required. Ensure that only DOS is active at the time of the invocation.

Ensure that the directory from where MON166.EXE is started, contains the two files 'boot' and 'monitor' for the Controller C167.

- The Monitor program will automatically be loaded after invoking MON166.EXE and the green LED D5 shines. The loading procedure can be viewed on the monitor screen of the Host-PC.
- After successfully loading, the Monitor program will be automatically started and its '#' prompt will appear on the screen of the Host-PC.
- Enter '*load Pathname\hello167*' now in order to load the demo program.
- Once downloading has finished and the '#' prompt reappears, enter the command 'g' to execute the demo program. Successful execution results in the message 'Hello World !...' which appears on the screen of the Host-PC.
- To leave the Monitorprogram press 'F1'

Quickstart Instructions for using a Monitor program - summary

- Connect the kitCON-167 with an IBM-PC or a compatible system using a serial cable (P1 to COM1 or COM2)
- Connect **red** jumper JP2 at 1+2
- Attach an unregulated power supply with 8V to 12/500mA to X5 on the kitCON-167. Double check the correct polarity.
- Press switch 'S1' to perform a RESET
- Start MON166.EXE on your Host- PC (*mon166 [2 (for COM2)]*) from the DOS environment
- After the '#' prompt appears, enter '*load Pathname\hello167*'
- Press 'ENTER'
- After the '#' prompt reappears enter 'g'
- Press 'ENTER'

"Hello World !..." appears on the screen of your Host-PC.

- To leave the Monitorprogram press 'F1'

2.2 Starting the kitCON and programming the Flash

- Use of the FlashTools requires a kitCON-167 and an IBM-PC or a compatible system. Typically, all jumpers for configuring the kitCON-167 have been correctly set upon delivery of the module.
- Connect your Host-PC (COM1 or COM2) to the DB9-socket P1 on the kitCON-167 using a serial cable as shown below.

PC DB9-plug COM1,2		kitCON-167 DB9-socket P1
RxD PIN 2	to	TxD PIN 2
TxD PIN 3	to	RxD PIN 3
GND PIN 5	to	GND PIN 5

No Hardware-Handshake-Line is required to invoke communication between the kitCON-167 and the Host-PC, as the firmware contains a transmission protocol to ensure fault-free data transmission between the PC and the kitCON-167.

- Ensure that the **red** Boot-Jumper JP2 (the bipolar pin-row next to the quartz XT1) is closed at pins 1+2
- Attach a power supply to the power-connector X5. An unregulated 8V to 12V/500mA power source can be used to supply the board. Use only a fixed voltage power supply and no power supply with variable voltage. Double check the correct polarity of the plug as shown in figure 4. If the power supply is attached correctly the red LED D4 will shine.
- Push switch S1 to perform a Reset. and to start the Bootstrap-Loader on the kitCON-167.
- Invoke the Terminal program FLASHT.EXE on your Host-PC by entering the following:

```
flasht [BR(Baudrate)] [COM port number]
```

Other communication or terminal programs are not suitable for data transmission to and from the Monitor on the kitCON-167, as a special transmission protocol is required. Ensure that only DOS is active at the time of the invocation.

Ensure that the directory from where FLASHT.EXE is started, contains the two files 'boot167' and 'flash167'.

- The FlashTools will be automatically loaded after invoking FLASHT.EXE and the green LED D5 shines. The loading procedure can be viewed on the monitor screen of the Host-PC.
- After successfully loading the FlashTools will be started automatically and the FlashTools main menu appears on the monitor screen of the Host-PC.
- All FlashTools menu options are intuitive. Select menu option 7, 'Erase, Load and Software-Reset' to download a demo program. Confirm that the unprotected sectors (i.e. the sectors available for user-applications) of the Flash can be erased by entering "Y".
- Following erasure of the unprotected Flash sectors, the next menu will automatically appear on the monitor screen of the Host-PC. Please press 'F2' to indicate the name of the Hex-Files to be downloaded into the Flash (specify the full pathname). To download the demo program enter 'Pathname\hello167.h86'. Press 'Enter' to start the download.
- HELLO167 will be automatically started following download. Successful execution results in the message 'Hello World !...' which appears on the screen of the Host-PC. The program can also be executed by pressing the RESET button on the kitCON-167 after opening the **red** jumper JP2 at pins 1+2 (i.e.: toggling the kitCON-167 into execution mode).
- To leave FLASHT.EXE press 'F1'

If any difficulties should occur during start-up, please contact the PHYTEC Technical Support hotline at +49 (6131) 9221-31

Quickstart Instructions for Flash programming - summary

- Connect the kitCON-167 with an IBM-PC or a compatible system using a serial cable (P1 to COM1 or COM2).
- Connect **red** jumper JP2 at 1+2
- Attach an unregulated power supply with 8V to 12/500mA to X5 on the kitCON-167. Double check the correct polarity.
- Press switch 'S1' to perform a RESET
- Start FLASHT.EXE on your Host- PC (*flasht [2 (for COM2)]*) from the DOS environment
- Select menu option '7'
- Press 'Y' to confirm 'Erase'
- Press 'F2'
- Enter 'Pathname*hello167.h86*'
- Press 'ENTER'
An automatic software reset will execute the program following download.

"Hello World!..." appears on the screen of your Host-PC.

- To leave the FlashTools press 'F1'

To start the demo program again execute the following steps:

- Disconnect the power source
- Open **red** jumper JP2 at 1+2
- Reconnect the power source

3. Pinout

Please note that all module connections are not to exceed their expressed maximum voltage or current. Maximum input values are indicated in the corresponding controller manuals/data sheets. As damage from improper connections varies according to use and application, it is the user's responsibility to take appropriate safety measures to ensure that the module connections are protected from overloading through connected peripherals.

As shown in figure 5, all relevant controller signals are brought out to the pin-rows (X3) in the middle of the board. The kitCON-167 is also prepared to accommodate an ICE/connect-167 (X2). This special connector enables easy emulation of the processor. The Quad-Connector-System (X6) provides an additional option for connecting an emulator to the board. The following Section provides an overview of the pin assignment of the pin-rows (kitCON-Connector), while the ICE/connect-167 is described in section 3.2. The pinout of the Quad-Connector-System is shown in section 3.3. Sections 3.4 and 3.5 describe the pinout of the DB9-connectors P1 and P2.

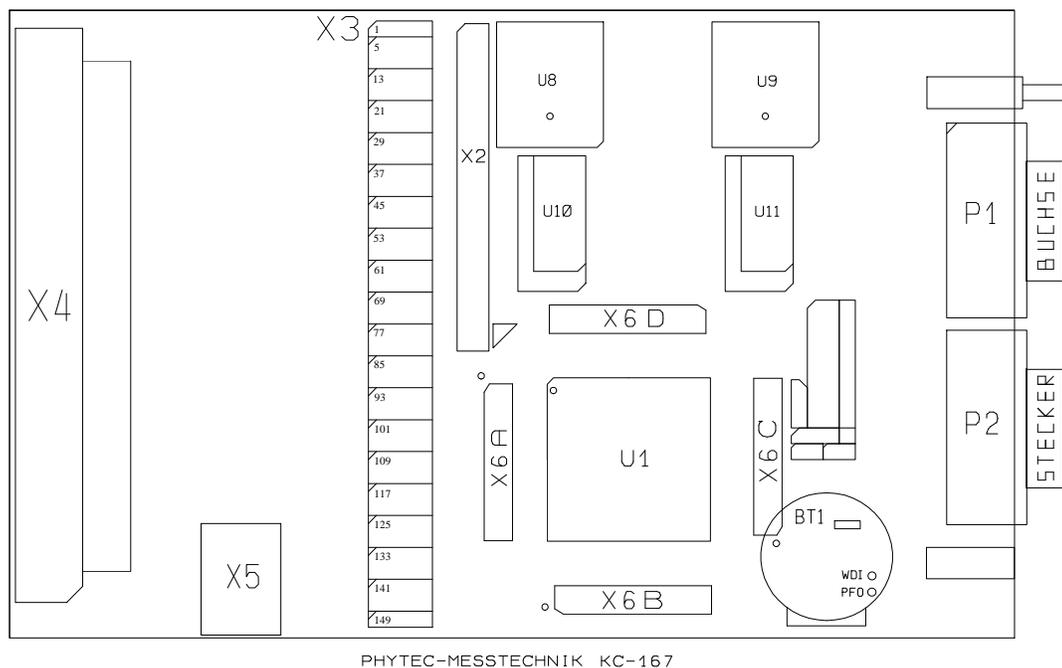


Figure 5: Position of the connectors

3.1 The kitCON-Connector

Supply Voltage	PIN 1	VCC	2	VCC	3	GND	4	GND	
Data-Bus	5	D0	6	D2	7	D4	8	D6	
	9	D1	10	D3	11	D5	12	D7	
	13	D8	14	D10	15	D12	16	D14	
	17	D9	18	D11	19	D13	20	D15	
Address-Bus	21	A0	22	A2	23	A4	24	A6	
	25	A1	26	A3	27	A5	28	A7	
	29	A8	30	A10	31	A12	32	A14	
	33	A9	34	A11	35	A13	36	A15	
	37	A16	38	A18	39	A20	40	A22 / TXDC	
	41	A17	42	A19	43	A21 / RXDC	44	A23	
	45	/RD-U	46	/RD-U	47	/RESO-U	48	/RES-U	
Control-Signals	49	/WRL	50	ALE	51	/EA	52	/NMI-U	
	53	/CS0(P6.0)	54	/CS2(P6.2)	55	/CS4(P6.4)	56	P6.6	
	57	/CS1(P6.1)	58	/CS3(P6.3)	59	/HLD-U	60	P6.7	
	61	VREF	62	VREF	63	P2.8	64		
Special Purose	65	VREF	66	VREF	67	VPP	68		
	69	P5.0	70	P5.2	71	P5.4	72	P5.6	
	73	P5.1	74	P5.3	75	P5.5	76	P5.7	
	77	P5.8	78	P5.10	79	P5.12	80	P5.14	
	81	P5.9	82	P5.11	83	P5.13	84	P5.15	
	85	P2.0	86	P2.2	87	P2.4	88	P2.6	
	89	P2.1	90	P2.3	91	P2.5	92	P2.7	
	Digital-Port P2	93	P2.8	94	P2.10	95	P2.12	96	P2.14
		97	P2.9	98	P2.11	99	P2.13	100	P2.15
101		P3.0	102	P3.2	103	P3.4	104	P3.6	
Digital-Port P3	105	P3.1	106	P3.3	107	P3.5	108	P3.7	
	109	P3.8	110	P3.10, TXD0	111	/WRH	112	/RDY-U	
	113	P3.9	114	P3.11, RXD0	115	P3.13	116	P3.15	
Digital-Port P7	117	P7.0	118	P7.2	119	P7.4	120	P7.6	
	121	P7.1	122	P7.3	123	P7.5	124	P7.7	
Digital-Port P8	125	P8.0	126	P8.2	127	P8.4	128	P8.6	
	129	P8.1	130	P8.3	131	P8.5	132	P8.7	
	133		134		135		136		
	137		138		139		140		
	141		142		143		144		
	145		146		147		148		
Supply Voltage	149	VCC	150	VCC	151	GND	152	GND	

Table 1: Pinout of the kitCON-Connector (X3)

3.2 The ICE/connect-167

The ICE/connect-167 provides an easy possibility for connecting an standard emulator, which uses the controller on board, to the kitCON-167. It can be mounted at position X2 (*refer to figure 5*). It carries all data- and address signals. The control signals coming from the controller are extended via pre-connections at the ICE/connect-167 to the peripheral devices. When using an emulator the control signals are generated by the emulator. Therefore in this case the pre-connections must be opened.

Table 2 shows the pinout of the ICE/connect-167.

Please note, pins 41+42, 43+44, 45+46, 47+48, 49+50 and 53+54 are pre-connected on the component side. When using an ICE/connect-167 these pre-connections have to be opened.

Pin	Description	Description	Pin
1	GND	D0	2
3	D1	D2	4
5	D3	D4	6
7	D5	D6	8
9	D7	GND	10
11	D9	D8	12
13	D11	D10	14
15	D13	D12	16
17	D15	D14	18
19	GND	A0	20
21	A1	A2	22
23	A3	A4	24
25	A5	A6	26
27	A7	GND	28
29	A9	A8	30
31	A11	A10	32
33	A13	A12	34
35	A15	A14	36
37	GND	ALE	38
39	GND	XT1	40
41	RES_P	RES_U	42
43	/HLD_P	/HLD_U	44
45	/RDY_P	/RDY_U	46
47	RESO_P	RESO_U	48
49	/NMI-P	/NMI-U	50
51	GND	GND	52
53	/RD_P	/RD_U	54
55	/WRL	/WRH	56
57	P6.6	VCC	58
59	A16	A17	60
61	GND	GND	62
63	A18	A19	64
65	A20	A21	66
67	A22	A23	68
69	GND	GND	70
71	P6.0 (CS 0)	P6.1 (CS 1)	72
73	P6.2 (CS 2)	P6.3 (CS 3)	74
75	P6.4 (CS 4)	NC	76
77	NC	NC	78
79	GND	GND	80

Table 2: Pinout of the ICE/connect-167 (X2)

3.3 The Quad-Connector

The kitCON-167 is also prepared to house a Quad-Connector at X1. In contrast to the ICE-connect this connector system can be used to adapt bondout based emulators or measuring system.

Table 3 shows the pinout of the Quad-Connector.

Quad Connector X6 A

Pin	Description	Description	Pin
1	NC	NC	2
3	P6.0	P6.1	4
5	P6.2	P6.3	6
7	P6.4	/HLD-P	8
9	P6.6	P6.7	10
11	P8.0	P8.1	12
13	P8.2	P8.3	14
15	P8.4	P8.5	16
17	P8.6	P8.7	18
19	VCC	GND	20
21	P7.0	P7.1	22
23	P7.2	P7.3	24
25	P7.4	P7.5	26
27	P7.6	P7.7	28
29	P5.0	P5.1	30
31	P5.2	P5.3	32
33	P5.4	P5.5	34
35	P5.6	P5.7	36
37	P5.8	P5.9	38
39	NC	NC	40

Quad Connector X6 B

Pin	Description	Description	Pin
41	NC	NC	42
43	VREF	VGND	44
45	P5.10	P5.11	46
47	P5.12	P5.13	48
49	P5.14	P5.15	50
51	GND	VCC	52
53	P2.0	P2.1	54
55	P2.2	P2.3	56
57	P2.4	P2.5	58
59	P2.6	P2.7	60
61	GND	VCC	62
63	P2.8	P2.9	64
65	P2.10	P2.11	66
67	P2.12	P2.13	68
69	P2.14	P2.15	70
71	P3.0	P3.1	72
73	P3.2	P3.3	74
75	P3.4	P3.5	76
77	GND	VCC	78
79	NC	NC	80

Quad Connector X6 C

Pin	Description	Description	Pin
81	NC	NC	82
83	P3.6	P3.7	84
85	P3.8	P3.9	86
87	P3.10	P3.11	88
89	/WRH	P3.13	90
91	P3.15	VCC	92
93	GND	VPP	94
95	A16	A17	96
97	A18	A19	98
99	A20	A21	100
101	A22	A23	102
103	VCC	GND	104
105	/RD-P	/WRL	106
107	/RDY-P	ALE	108
109	/EA	D0	110
111	D1	D2	112
113	D3	D4	114
115	D5	D6	116
117	D7	D8	118
119	NC	NC	120

Quad Connector X6 D

Pin	Description	Description	Pin
121	NC	NC	122
123	VCC	GND	124
125	D9	D10	126
127	D11	D12	128
129	D13	D14	130
131	D15	A0	132
133	A1	A2	134
135	A3	A4	136
137	A5	A6	138
139	A7	VCC	140
141	GND	A8	142
143	A9	A10	144
145	A11	A12	146
147	A13	A14	148
149	A15	VCC	150
151	XTO	XTI	152
153	GND	/RES-P	154
155	/RESO-P	/NMI-P	156
157	GND	VCC	158
159	NC	NC	160

Table 3: Pinout of the Quad-Connector X6

3.4 The DB9-socket P1

The DB9-socket P1 serves as RS232-interface. The pinout is shown below.

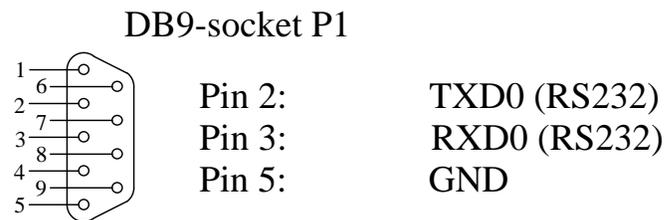


Figure 6: Pinout of the DB9-socket P1 (view on the face)

3.5 The DB9-plug P2

The DB9-plug P2 carries either the CAN-signals or signals of an additional debug interface. This debug interface is used from several monitor programs. For data transmission according to RS232 special software drivers are required which are part of the monitor programs. The pinout of the DB9-plug P2 is shown for both modes in the following.

DB9-plug P2

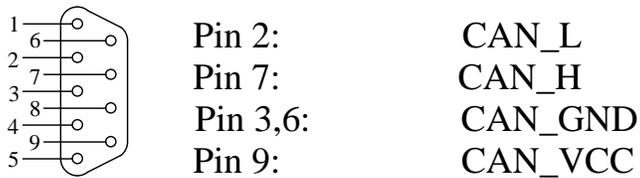


Figure 7a: Pinout of the DB9-plug P2 (CAN-Interface)(view on the face)

RS232-Debug Mode

DB9-plug P2

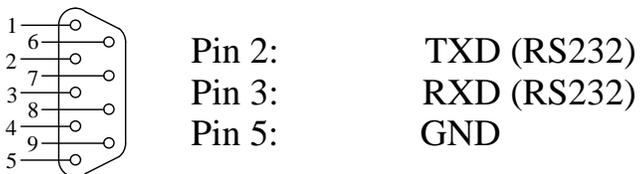


Figure 7b: Pinout of the DB9-plug P2 (RS232 Debug-Interface)(view on the face)

Please note, DB9-plug P2 can only be used as RS232 interface with special software drivers. Usually these are part of several monitor programs

4. Jumper

To configure the module, the kitCON-167 has 12 insertable and solderable jumpers. In order to ensure immediate use of the module the jumpers have been configured prior to delivery. Figure 8a illustrates the numbering of the solderable jumper-pads, while figures 8b and 8c indicate the location of the jumper on the board.

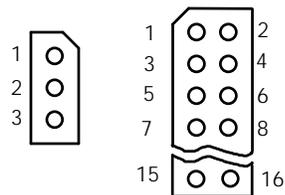
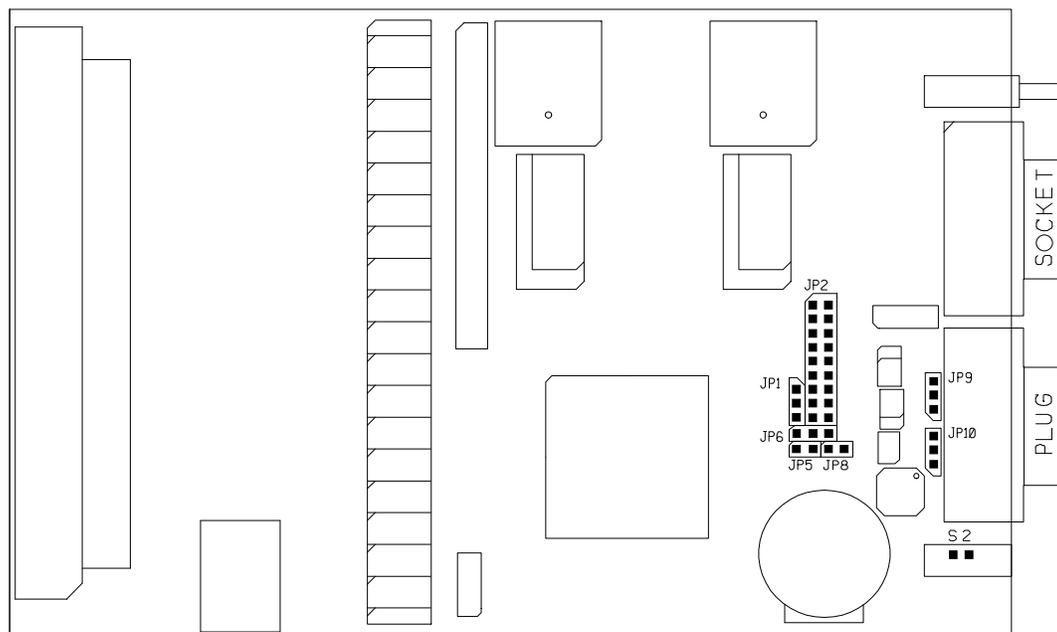


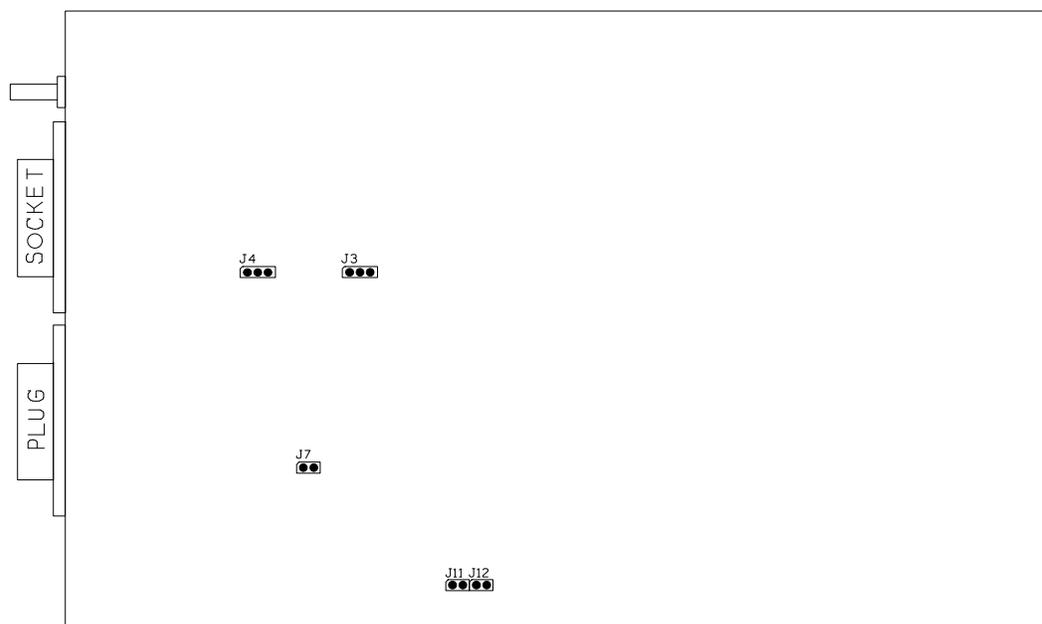
Figure 8a: Numbering of the jumper



PHYTEC-MESSTECHNIK KC-167

■ ■ ■ Insertable Jumper

Figure 8b: Position of the jumper (component side)



●● Solderable Jumper

Figure 8c: Position of the jumper (soldering side)

The jumpers (JP = insertable jumper, J = solderable jumper) have the following functions:

	Default Setting		Alternate Setting	
JP1	(1+2)	external ROM/ Flash active	(2+3)	internal ROM/Flash active
JP2 (1+2)	(closed)	Boostrap Mode	(open)	normal Program Execution Mode
JP2 (3+4, 5+6)	(open) (open)	five /CS-Signals available at port P6		Number of /CS-Signals at port P6 (0, 2 or 3) (refer to 4.1.3)
JP2 (7+8, 9+10)	(open) (open)	two Segment Ad Address Lines (A17, A16) at port P4 available		Number of Segment Address Lines at port P4 (0, 4 or 8) (refer to 4.1.4)
JP2 (11+12, 13+14, 15+16)	(open) (open) (open)	System Clock Speed = XT1 * 4		Prescaler to generat the System Clock Speed from XT1 (*1, *2, *3 or *5) (refer to 4.1.5)
J3	(2+3)	RAM-memory at U10/11 less or equal 256KByte	(1+2)	RAM-memory at U10/11 more than 256KByte
J4	(2+3)	RAM-memory at U14/15 less or equal 256KByte	(1+2)	RAM-memory at U14/15 more than 256KByte
JP5, JP6	(2+3) (closed)	CAN-VCC derived from supply voltage	(1+2) (open)	CAN-VCC derived from CAN-network via DB9-plug P2
J7	(closed)	C167 Controller Pin 84 connected to VCC (normal mode)	(open)	Pin 84 connected to Pin 67 of the kitCON-Con- nector (for programming of On-Chip Flash)
JP8	(open)	P3.2 freely available	(closed)	P3.2 as RS232 Debug- Interface
JP9, JP10	(1+2) (1+2)	DB9-plug P2 for CAN	(2+3) (2+3)	DB9-plug P2 for Debug-Interface
J11	(closed)	VAGND derived from digital ground GND	(open)	VAGND from external ground via kitCON- Connector X3
J12	(closed)	VAREF derived from supply voltage VCC	(open)	VAREF from external voltage source via kitCON-Connector X3

Table 4: Jumper Setting

4.1 Program Storage JP1

At the time of delivery, Jumper JP1 is pre-connected between pads 1+2. This default configuration means that the program stored in the external program memory is executed after Reset. In order to allow the execution of a specific controller's internal program memory, the pre-connections must be opened and the pads 2+3 of jumper JP1 must be connected.

Code-Access	JP1
external Program Storage	1+2*
internal Program Storage	2+3

* = Default-Setting

4.2 Configuration during System Reset JP2

Although most of the programmable features of the C167 are either selected during the initialization phase or repeatedly during program execution, there are some features that must be selected earlier, because they are used for the first access of the program execution. These selections are made during reset via the pins of Port P0, which are read at the end of the internal reset sequence. During reset internal pullup devices are active at Port P0 meaning that high input levels are the default configuration on Port P0. To change the configuration external pulldown devices have to be connected to the respective port pin. This can be done with the help of jumper JP2 meaning that jumper JP2 allows the configuration of the board during system reset (*for more information about the configuration during system reset refer also to the C167 User's manual, chapter "System Reset"*). Some configurations which are usually done only once can be changed by installing optional resistors.

Some of the configurations are fix and can't be changed with jumper JP2. The following figure shows Port P0, the function of the pins during reset and how they can be changed (either with jumper JP2 or with optional resistors). The shaded pins are fix and can't be changed with jumper JP2.

Function of Port P0 during System Reset (High-Byte)							
Bit H7	H6	H5	H4	H3	H2	H1	Bit H0
CLKCFG <i>JP2 15+16, 13+14, 11+12</i>			SALSEL <i>JP2 9+10, 7+8</i>		CSSEL <i>JP2 5+6, 3+4</i>		WRC <i>0</i>

Function of Port P0 during System Reset (Low-Byte)							
Bit L7	L6	L5	L4	L3	L2	L1	Bit L0
BUSTYP <i>1 0</i>	R	BSL <i>JP2 1+2</i>	R	R	ADP <i>R3</i>	EMU <i>R4</i>	

Reserved pins must remain high in order to ensure proper operation

The configuration of these pins must not be changed

The following sections contain a more detailed description of the configuration done with Jumper JP2.

4.2.1 Bootjumper JP2 (Pins 1+2)

The C167 houses an On-Chip Bootstrap-Loader which can be activated with **red** jumper JP2. The Bootstrap-Loader is started if pin 4 of port P0 is low during reset which can be accomplished by closing **red** jumper JP2 at pins 1+2.

Bootjumper	JP2 (1+2)
Bootstrap Mode	closed*
normal Program Execution	open

* = Default-Setting

4.2.2 Chip-Select Signale JP2 (Pin 3+4 and 5+6)

The C167 Controller provides up to five Chip-Select Signals at Port P6. The number of Chip-Select Signals active can be defined during system reset through configuring P0.9 and P0.10. This configuration can be done with jumper JP2 (pins 3+4 and 5+6). These pins are open in the default configuration meaning that all Chip-Select Signals are active. Please note that /CS0 is used to control the Flash devices on U8 and U9 whereas /CS1 is used to control the RAM on U10 and U11. Hence 3 Chip-Select Signals are available for other purposes. Only one Chip-Select Signal is freely available if additional Flashdevices on U12/U13 and RAM on U14/U15 is installed.

Chip-Select Signals	JP2 Pin 3+4	JP2 Pin 5+6
five (/CS0-/CS4)	open*	open*
three (/CS0-/CS2)	closed	closed
two (CS0-/CS1)	open	closed
none	closed	open

* = Default-Einstellung

4.2.3 Segment Address Lines JP2 (Pin 7+8 and 9+10)

The C161 controller family allows user configuration of the number of address-lines available for segment addressing at port P4. By means of configuring port P0.11 and P0.12 during system reset the number of active address lines is specified.

Segment Adress Lines	JP2 Pin 7+8	JP2 Pin 9+10
only A16 and A17 are active	open*	open*
four A16 - A19 are active	closed	closed
all A16 - A23 are active	closed	open
none are active	open	closed

* = Default-Einstellung

4.2.4 Clock MODE JP2 (Pin 11+12,13+14 and 15+16)

The CPU-clock can be derived either directly from the oscillator clock or from the on-chip PLL which allows definition of a prescaler. To determine the clock source and the prescaler port P0.13 -P0.15 have to be configured with jumper JP2 (pins 11+12, 13+14 and 15+16) during system reset. The standard version of the kitCON-167 is equipped with a 5MHz quartz meaning that the frequency of the CPU clock is 20MHz with the default jumper setting.

Clock - Mode	JP2 Pin 11+12	JP2 Pin 13+14	JP2 Pin 15+16
XT1 x 4(2,5-6,25 MHz)	open*	open*	open*
XT1 x 3 (3,3-8,3 MHz)	closed	open	open
XT1 x 2(5-12,5 MHz)	open	closed	open
XT1 x5(2-5MHz)	closed	closed	open
OSC1 x 1(1-25MHz) direct drive	closed / open	closed / open	closed

* = Default-Einstellung

4.3 Memory Size J3

Jumper J3 and J4 configures the memory size, which is dependent upon the specific memory devices mounted on U10/U11 and U14/U15 on the board. The standard memory of the kitCON-167 offers 64 KB RAM¹ mounted on U10 and U11. No devices are equipped on U14 and U15.

Memory Size of U10/U11	J3
1 MB RAM	1+2
256 or 64 kByte	2+3*

Memory Size of U14/U15	J3
1 MB RAM	1+2
256 or 64 kByte	2+3

* = Default-Setting

4.4 Supply voltage of the CAN-Interface JP5, JP6

The CAN-driver on the kitCON-167C can be insulated electrically using the optocouplers on U3 and U4. In order to achieve a complete insulation of the CAN-bus the CAN-circuitry should be supplied through the CAN-interface - DB9-plug P2 (12V on pin 9, GND on pin 3 and 6). For that jumper JP6 has to be open and jumper JP5 must be connected between pads 1+2. If jumper JP6 is closed and JP5 is connected between 2+3 the CAN-circuitry is supplied from the kitCON-167C's supply voltage.

Supply voltage of the CAN-circuitry	JP6	JP5
derived from CAN-network via DB9-plug P2	open	1+2
derived from the supply voltage of the kitCON-167C	closed*	2+3*

* = Default-Setting

¹ More information about additional configurations can be found in the PHYTEC product catalog

4.5 On Chip Flash J7

Some derivatives of the C167-Controller provide on-chip Flash memory. To program this memory a programming voltage of 12V is necessary. This has to be connected to pin 84 on the controller when the Flash is programmed. During normal operation this pin must be connected to VCC which can be done by closing jumper JP7. Leaving jumper J7 open connects pin 84 to pin 67 on the kitCON-Connector X3 where the 12V programming voltage can be fed.

Pin 84 (VPP) of the Controller	J7
connected to VCC	closed*
connected to pin 67 of the kitCON-Connector X3	open

* = Default-Setting

4.6 Debug-Interface JP8

The DB9-plug P2 is used from several monitor programs as an additional interface. Use of the Debug-Interface requires port P3.2 to be connected to the RS232-driver, which can be done with jumper JP8. For data transmission according to RS232 special software drivers are required which are part of the monitor programs.

Debug-Interface	JP8
P3.2 freely available	open*
Debug-Interface enabled (P3.2 at RS-232)	closed

* = Default-Setting

Please note, DB9-plug P2 can only be used as RS232 interface with special software drivers. Usually these are part of several monitor programs

4.7 Serial Interface P2 JP9, JP10

If the kitCON-167 houses a C167Cx Controller the DB9-plug P2 carries either the CAN-Signals or the signals of the Debug-Interface. Jumper JP9 and JP10 determine which signals are available at DB9-plug P2.

Signals at DB9-plug P2	JP9	JP10
CAN	1+2*	1+2*
Debug-Interface	2+3	2+3

* = Default-Setting

4.8 Reference voltage of the A/D Converter J11, J12

The A/D converter requires a reference voltage (V_{AREF} , V_{AGND}) applied at pins 37 and 38 of the controller. This reference voltage can be derived either from an external source connected to the kitCON-Connector pins 61/65 and 62/66 or from the supply voltage of the kitCON-167. The source of the reference voltage can be chosen with the jumper J11 and J12.

Reference voltage of the A/D converter	J11 (VAGND)	J12 (VAREF)
external reference voltage connected to kitCON-Connector pins 61/65 and 62/66	open	open
derived from the supply voltage of the kitCON-167	closed*	closed*

* = Default-Setting

5. Memory Models

The C167 Controller provides up to five Chip-Select Signals at port P6 for easy selection of external peripherals or memory banks. Depending of the number of memory devices installed on the kitCON-167 up to four Chip-Select Signals are used internally. /CS0 (P6.0) selects the Flash memory installed on U8/U9 (Flash bank 1). /CS3 (P6.3) selects Flash bank 2 on U12/U13 which can be equipped with either 256Kx8 or 4096Kx8 memory devices optionally. The external memory consists of the two RAM banks on U10/U11 and U14/U15. Both can house memory devices of type 32Kx8, 256Kx8 or 4096Kx8 within a SO28-32 package. /CS1 (P6.1) selects RAM bank 1 on U10/U11 whereas /CS2 (P6.2) selects RAM bank 2 on U14/U15.

In order to use the Chip-Select Signals they have to be enabled during reset (*refer to section 4.2.2*). The assignment of the Chip-Select Signals to specific address areas is done with the corresponding ADDRESELx and BUSCONx register. Note that ADDRESELx has to be configured prior activating of the Chip-Select Signal with BUSCONx. Take care that the memory areas do not conflict.

Prior definition of the ADDRESELx and the BUSCONx register only /CS0 is active in the entire address space and remains active for all areas not assigned to an other Chip-Select Signal.

By configuring the memory cycle wait state ($T_c = 50\text{ns}$) and the R/W-Delay it is possible to use memory devices with access times up to 100ns at a bus cycle time of 150ns. To run the controller without wait state memory devices with 55ns access time have to be installed. The bus cycle time then is 100ns. The R/W-Delay should be always active (*refer to the C167-User' manual for mor information*).

In the following are important timing characteristics. All information refers to a C167CR Controller with a 16-bit bus, non-multiplexed, at 20MHz CPU-clock time (F_{osz}):

$T_c = 50\text{ns} * \text{Waitstates-Control (MCTC in BUSCON)}$

$T_f = 50\text{ns} * \text{Tri-State-Control (MTTC in BUSCON)}$.

Addresses stabil until data valid:	max. 70ns + T_c	SR ¹⁾
/RD low until data valid:	max. 55ns + T_c	SR ¹⁾
/RD low until data valid (RW-Delay):	max. 30ns + T_c	SR ¹⁾
/RD high until databus high-Z:	max. 15ns + T_f	SR ¹⁾
/RD high until data high-Z (RW-Delay):	max. 35ns + T_f	SR ¹⁾
/CSx until data valid:	max. 55ns + T_c	SR ¹⁾
/RD and /WR low:	min. 65ns + T_c	CC ²⁾
/RD and /WR low (RW-Delay):	min. 40ns + T_c	CC ²⁾
Data valid until /WR high:	min. 25ns + T_c	CC ²⁾
/WR high until data valid:	min. 15ns + T_f	CC ²⁾

1) SR = System Time (Time has to be kept from external circuitry),

2) CC = Controller Characteristic (The Controller ensures this time for external peripheral circuitry)

Below you will find two examples for configuring the memory area. These examples match the needs of most standard applications.

Example a)

ADDRESEL1: 0404h = Memory area 04:0000h - 04:FFFFh (64KByte RAM Bank 1 on U10/11)

ADDRESEL2: 0806h = Memory area 08:0000h - 0B:FFFFh (256KByte RAM Bank 2 on U14/15)

ADDRESEL3: 0C06h = Memory area 0C:0000h - 0F:FFFFh (256KByte FLASH Bank 2 on U12/13)

ADDRESEL4: 1000h = Memory area 10:0000h - 10:0FFFh (4KByte free I/O area)

BUSCON0: 04AFh : Bus active for /CS0 (FLASH Bank 1 U8/9)

BUSCON1: 04AFh : Bus active for /CS1 (RAM Bank 1 U10/11)

BUSCON2: 04AFh : Bus active for /CS2 (RAM Bank 2 U14/15)

BUSCON3: 04AFh : Bus active for /CS3 (FLASH Bank 2 U12/13)

BUSCON4: 068Ch : Bus active for /CS4 (FREE I/O)

BUSCON0 - 3: for all 55ns memory devices (0 Waitstate, RW-Delay, no Tri-state, short ALE, 16-Bit Demultiplexed)

BUSCON4: for free I/O area (3 Waitstate, RW-Delay, Tri-state Wait 300ns, long ALE, 16-Bit Demultiplexed)

Example b)

ADDRESEL1: 0006h = Memory area 00:0000h - 03:FFFFh (256KByte RAM Bank1 on U10/11)

ADDRESEL2: 0806h = Memory area 08:0000h - 0B:FFFFh (256KByte RAM Bank2 on U14/15)

ADDRESEL3: 0C06h = Memory area 0C:0000h - 0F:FFFFh (256KByte FLASH Bank2 on U12/13)

ADDRESEL4: 1006h = Memory area 10:0000h - 13:FFFFh (256KByte free I/O)

BUSCON0: 04AFh : Bus active for /CS0 (FLASH Bank1 U8/9)

BUSCON1: 04AFh : Bus active for /CS1 (RAM Bank1 U10/11)

BUSCON2: 04AFh : Bus active for /CS2 (RAM Bank 2U14/15)

BUSCON3: 04AFh : Bus active for /CS3 (FLASH Bank2 U12/13)

BUSCON4: 068Ch : Bus active for /CS4 (FREE I/O)

BUSCON0-3: for all 55ns memory devices active (0 Waitstate, RW-Delay, no Tri-state, short ALE, 16-Bit Demultiplexed)

BUSCON4: for free I/O area (3 Waitstate, RW-Delay, Tri-state, long ALE, 16-Bit Demultiplexed)

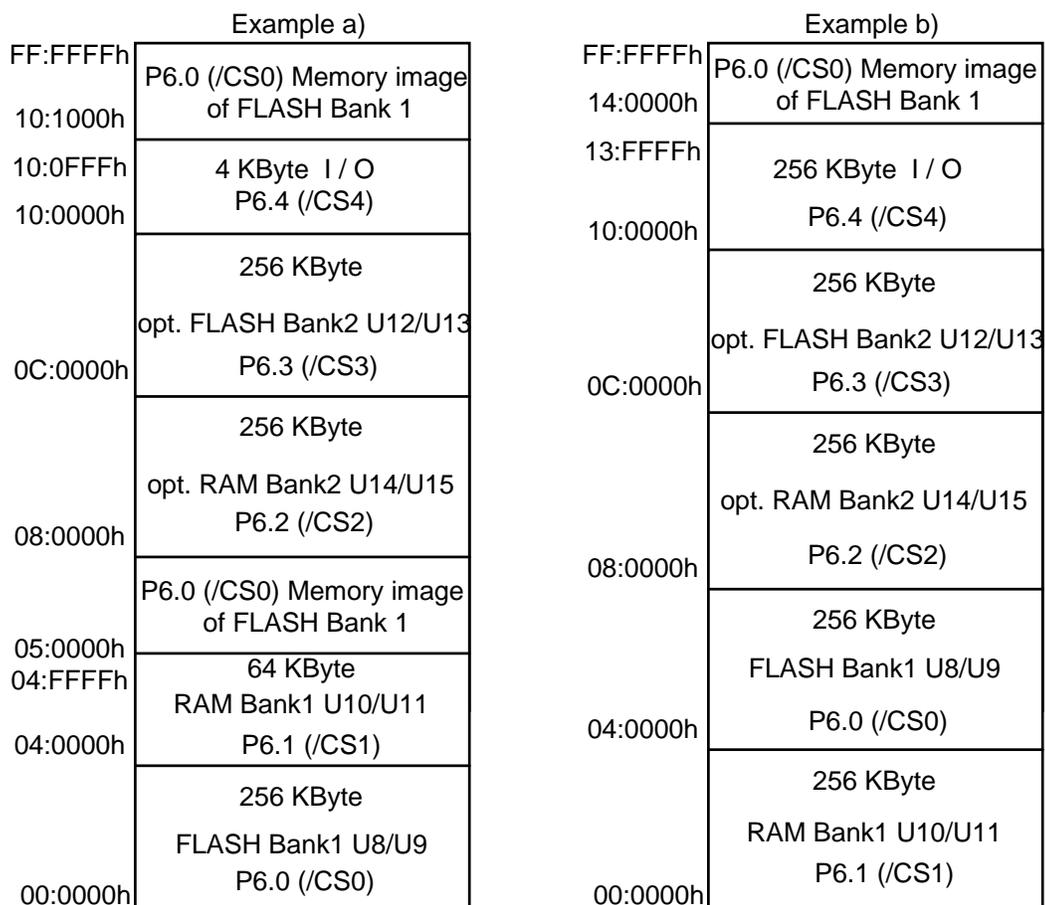


Figure 9: Memory Model Examples

6. Flash-Memory

Flash is a highly functional means of storing non-volatile data. With the kitCON-167 equipped with Flash-devices this modern technique is at your disposal. The kitCON-167 can house Flash-devices of type 29F010 (128KByte memory) or of type 29F040 (512KByte memory) as Flash memory. Either two or four Flash devices can be mounted on U8, U9, U12 and U13. This gives a minimum memory of 256KByte (two 29F010) and a maximum of 2MByte (four 29F040). These Flash-devices are programmable with 5-V. Consequently, no special programming voltage is required.

On Board programming is done with an utility program developed by PHYTEC, so called "FlashTools" (*refer to chapter 13. "Flash-Tools"*). Prior using of the FlashTools they have to be loaded with the Bootstrap-Loader.

Use of a Flash device as the only code memory results in no or only a limited usability of the Flash memory as non-volatile memory for data. This is due to the internal structure of the Flash device, as during the Flash-internal programming process the reading of data from Flash is not possible. Hence, for Flash programming, program execution must be transferred out of Flash (such as into von-Neumann RAM). This usually equals the interruption of a "normal" program execution.

As of the printing of this manual, Flash devices generally have a life expectancy of at least 100,000 Erase-/Program-cycles.

7. The CAN-Interface

The kitCON-167 can be equipped with a C167C controller. One of the special features of this controller is the On-Chip Full-CAN-Controller which enables the kitCON-167 to be run within a CAN-network. Running the C167 controller with 20mhz CPU clock, a bit rate of up to 1MBaud can be achieved.

When utilising the CAN-interface the portpins P4.5 (RXDC) and P4.6 (TXDC) shouldn't be connected to any other circuitry. The CAN-bus can be connected directly to DB9-plug P2. The pinout of the DB9-plug P2 is shown in figure 10. The CAN-signals from the controller are also present on pin 40 and pin 43 of the kitCON-connector.

The DB9-plug P2 can also be used for the additional debug-interface. Hence make sure that jumper JP9 and JP10 are both closed at pins 1+2 in order to have the CAN-signals available at DB9-plug P2.

The programming of the CAN-controller is done by means of control-registers, which are mapped into segment 0 of the normal memory area at the addresses 00:EF00h through 00:EFFFh.

The exact meaning of the registers and how to program the controller can be read in the corresponding controller manual of the C167C.

DB9-plug P2

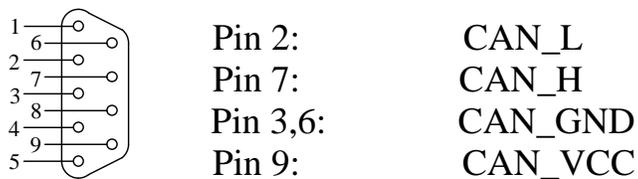


Figure 10: Pinout of the DB9-plug P2 (CAN-interface)(view on the face)

8. The LEDs

8.1 The Status LEDs D4 and D5

The kitCON-167 is fitted with two LEDs D4 and D5 to indicate to the status of the board.

The red LED D4 simply indicates a correct connection to the power source.

The green LED D5 gives the status of the initialisation of the controller done by software. At the end of the basic initialisation in any program a 'EINIT' command should be executed. Following execution of this command the SYSCON-register is protected and can not be changed accidentally. The green LED is switched on after this command is executed to indicate the end of the basic initialisation (see the 'Instruction Set Manual' for further information about 'EINIT').

These LEDs are controlled by hardware automatically.

9. The Battery Buffer

To prevent loss of data in case of sudden power failure the kitCON-167 can be equipped with a battery. This battery buffers the memory devices on U10, U11, U14 and U15, as well as the real-time clock. However, this battery-buffer is not otherwise essential to the functioning of the kitCON-167.

Position BT1 on the component side of the module is provided for mounting a battery type CR2032. As of the pressing of this manual, a lithium battery is recommended as it offers relatively high capacity at low self-discharge. In the event of a power failure at VCC, the RAM memory blocks and the real-time clock will be buffered by a connected battery via VBAT.

The current consumption depends on the components used and memory size. For the standard devices used on the board the draw is typically 1 μA (max. 100 μA) per RAM-device. The power consumption of the real-time clock is 50 μA .

Regarding data and code integrity, please be advised that despite the battery buffer, changes in the data content within the RAM can occur given disturbances. The battery-buffer does not completely remove the danger of data destruction.

Please note that utilizing the battery buffer for the RAMs and the real-time clock the storage temperature is only 0°C to +70°C.

10. The Real-Time Clock RTC-8583¹

For real-time applications the kitCON-167 the board houses a real-time clock of type RTC_8583. This real-time clock device provides the following features:

- Serial input/output bus (I²C)
- operating current (f = 0Hz) max. 50µA (important for battery buffer)
- Clock function with four year calendar
- Universal timer with alarm and overflow indication
- 24- and 12-hour format
- automatic word address incrementing
- Programmable alarm, timer and interrupt function

If the kitCON-167 is equipped with a battery the real-time clock runs independently of the board.

Programming the real-time clock is done via the I²C-bus which is connected to port P2.1 (SCL) and port P2.2 (SDA). The real-time clock also provides an interrupt output which is connected to port P2.0. An interrupt occurs in case of a clock alarm, timer alarm timer overflow and event counter alarm. It has to be cleared by software. With the interrupt function the real-time clock can be utilized in various applications. The software going with the kitCON-167 includes a library with functions to program the real-time clock via the I²C-bus as well as example programs (*for more information about the registers of the real-time clock refer to the data-sheet*)

¹ The real-time clock is only available on Moduls purchased from PHYTEC

11. Technical Specifications

The physical dimensions of the kitCON-167 are represented in figure 11. The board's profile is ca. 17 mm. thick, including the DB9 socket. The components on the soldering side have a maximum height of 3.5 mm and approximately 12 mm on the component side. The board itself is approximately 1.5 mm thick.

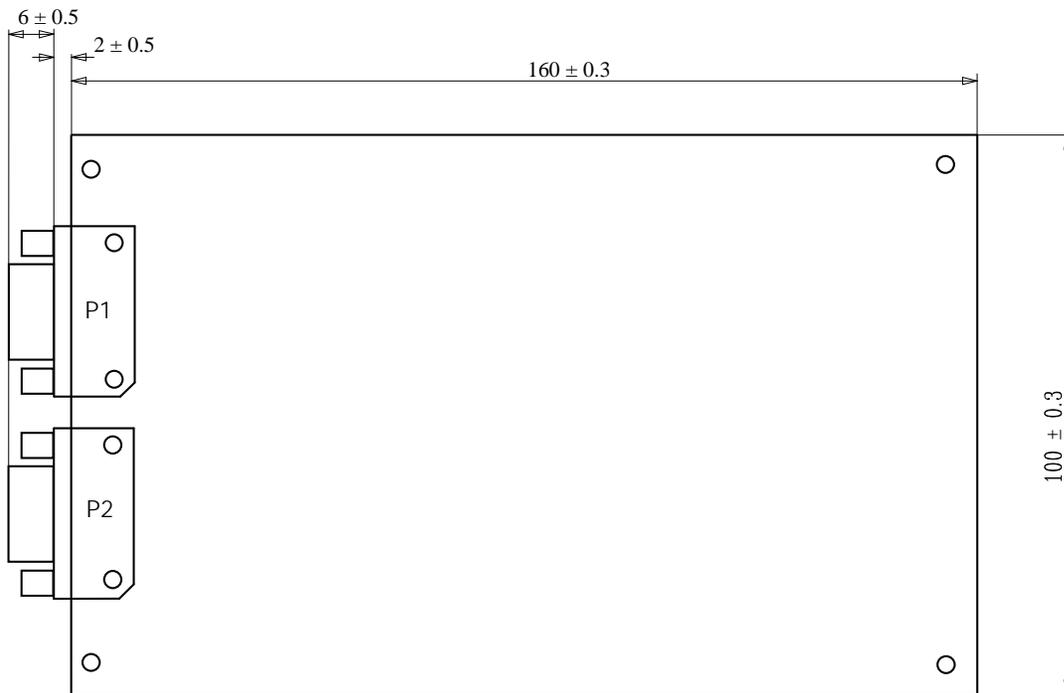


Figure 11: Physical Dimensions

Additional specifications:

- Dimensions: 160 x 100 mm., ± 0.03 mm.
- Weight: approximately 125g., if fitted with 2MB RAM device and 2MB Flash
- Storage temperature: -40°C to $+90^{\circ}\text{C}$, using the battery buffer 0°C to $+70^{\circ}\text{C}$
- Standard operating temperature: 0°C to $+70^{\circ}\text{C}$, extended -40°C to $+85^{\circ}\text{C}$
- Maximum ambient humidity: 90% r.F. not condensed
- Operating voltage: $5\text{V} \pm 10\%$
- Supply voltage: 8V to $12\text{V}/500\text{mA}$, VBAT $3\text{V} \pm 20\%$
- Maximum power consumption: 300 mA. at 20 MHz oscillator frequency.

These specifications describe the standard configuration of the kitCON-167 as of the pressing of this Manual.

Typically the current consumption is less than 150mA with 64kByte SRAM memory and 256kByte Flash memory at 20°C .

Please note that utilizing the battery buffer for the RAMs and the real-time clock the storage temperature is only 0°C to $+70^{\circ}\text{C}$.

12. Hints for Handling the kitCON-167

Removal or exchange of components on the kitCON-167 (controller, memory, quartz etc.) is not advisable given the compact nature of the kitCON-167. Should this nonetheless be necessary, please ensure that the board, as well as surrounding components and sockets, remain undamaged during removal. Overheating the board can cause the solder pads to loosen, rendering the module inoperable. Carefully heat neighbouring connections in pairs. After a few alternations, components can be removed with the solder-iron tip. Alternatively, a hot air gun can be used to heat and loosen the bonds.

When changing the controller it has to be taken care that the controller to be used is pin-compatible to the C167 Controller and that special hardware features are compatible with the layout of the board.

13. FlashTools

Flash is a highly functional means of storing non-volatile data. With the kitCON-167 equipped with at least two Flash-devices this modern technique is at your disposal. One of the main advantages of using Flash devices is the on-board programming capability. On Board programming can be easily done with a special utility program, the 'FlashTools', described in this chapter.

The FlashTools do not resist permanently on the board. They have to be loaded with the Bootstrap-Loader prior programming of the Flash.

The following section describes the use of the Bootstrap-Loader as well as of the FlashTools. These description are valid only for the use of the enclosed FlashTools and is not intended as guidelines for use with any other Flash utility program.

13.1 Starting FlashTools

To load the FlashTools the Bootstrap-Loader has to be started first after Reset. Once activated, the Bootstrap Loader awaits the start of a terminal program on the Host-PC to which the kitCON-167 is connected. Depending on the terminal-program started, a specific program will be downloaded into the external RAM and executed. To use the FlashTools the terminal program FLASHT.EXE has to be invoked.

Programming the Flash devices with the help of the FlashTools can be done as described below.

Connect the **red** Boot-Jumper JP2 Pin 1+2

Connect the kitCON-167 to a Host- PC (using either the COM1 or COM2 serial communication port) with a serial cable as shown below:

Host-PC (COM1 or 2)		kitCON-167 DB9 socket P1
RxD Pin 2	to	TxD Pin 2
TxD Pin 3	to	RxD Pin 3
GND Pin 5	to	GND Pin 5

Attach a power supply to the power-connector X5. An unregulated 8V to 12V/500mA power source can be used to supply the board. Use only a fixed voltage power supply and no power supply with variable voltage. Double check the correct polarity of the plug as shown in figure 4. If the power supply is attached correctly the red LED D4 will shine.

Push switch S1 to perform a Reset. and to start the Bootstrap-Loader on the kitCON-167.

Invoke the included terminal program using the following syntax:

```
flasht [BR(Baudrate)] [COM parameter]
```

Ensure that the directory from where flasht is started, contains the two files 'boot167' and 'flash167'.

The Bootstrap-Loader determines the baudrate automatically. Hence, only after starting the Bootstrap-loader on the kitCON-167, the terminal program can be started with a baudrate of your choice. Thereafter, the Bootstrap-loader will automatically configure the serial port for this baudrate.

Please note that some controllers are only able to generate specific baudrates. Hence, it is possible that a baudrate specified by the invocation of the terminal program can not be generated by the controller and transmission fails. In this case the terminal program should be invoked again specifying a lower baudrate.

Once FLASHT.EXE has been successfully invoked, loading of the FlashTools starts and the green LED D5 shines. The downloading can be viewed on the Host-PC monitor screen. FlashTools start immediately following loading and the main menu appears on the screen. You can leave the FlashTools at any time except during a download by pressing 'F1'.

13.2 Downloading into Flash

The main menu gives access to the different functions of the FlashTools. The tools enable the partial or total erasure of the Flash device, as well as programming of the device. They also allow device status information to be read from the Flash. All menu options are intuitive. Only Intel hexfiles can be used for programming purposes.

After user code has been downloaded into the Flash, it can be executed following a software reset. Alternatively, **red** jumper JP2 can be opened at pins 1+2 in order to switch the kitCON-167 into execution mode following a hardware reset.

FLASHT.EXE can always be exited, except during downloading of user code, with the special-function key 'F1'.

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