PHYTEC

COMBI-Modul 167
phyPS 404

Hardware Manual

Edition April 2002

A product of a PHYTEC Technology Holding company

In this manual are descriptions for copyrighted products that are not explicitly indicated as such. The absence of the trademark (™) and copyright (©) symbols does not imply that a product is not protected. Additionally, registered patents and trademarks are similarly not expressly indicated in this manual.

The information in this document has been carefully checked and is believed to be entirely reliable. However, PHYTEC Meßtechnik GmbH assumes no responsibility for any inaccuracies. PHYTEC Meßtechnik GmbH neither gives any guarantee nor accepts any liability whatsoever for consequential damages resulting from the use of this manual or its associated product. PHYTEC Meßtechnik GmbH reserves the right to alter the information contained herein without prior notification and accepts no responsibility for any damages which might result.

Additionally, PHYTEC Meßtechnik GmbH offers no guarantee nor accepts any liability for damages arising from the improper usage or improper installation of the hardware or software. PHYTEC Meßtechnik GmbH further reserves the right to alter the layout and/or design of the hardware without prior notification and accepts no liability for doing so.

	EUROPE	NORTH AMERICA
Address:	PHYTEC Technologie Holding AG Robert-Koch-Str. 39 D-55129 Mainz GERMANY	PHYTEC America LLC 255 Ericksen Avenue NE Bainbridge Island, WA 98110 USA
Ordering Information:	+49 (800) 0749832 order@phytec.de	1 (800) 278-9913 info@phytec.com
Technical Support:	+49 (6131) 9221-31 support@phytec.de	1 (800) 278-9913 support@phytec.com
Fax:	+49 (6131) 9221-33	1 (206) 780-9135
Web Site:	http://www.phytec.de	http://www.phytec.com

2nd Edition April 2002

Preface 1
1 Introduction to the COMBI-Modul 167 3
1.1 Overview 3
1.2 Block Diagram 5
1.3 Software Development Tools 7
2 Components on the COMBI-Modul 167 9
2.1 Power Supply 9
2.2 Digital Inputs and Outputs 10
2.2.1 24 V-Inputs IN0..IN23 10
2.2.2 Relay Outputs 12
2.2.3 24 V-Outputs 13
2.2.4 PWM Outputs 15
2.3 Analog Inputs and Outputs 16
2.3.1 Analog Inputs 16
2.3.2 Analog Outputs 17
2.4 I²C Bus 18
2.4.1 Real-Time Clock (RTC) 18
2.4.2 I²C EEPROM 19
2.4.3 Temperature Sensor 20
2.5 Interfaces on the COMBI-Modul 167 21
2.5.1 CAN Interface 21
2.5.2 First RS-232 Interface 22
2.5.3 Second RS-232 Interface 22
2.6 Display and Control Units 23
2.6.1 HEX-Encoding Switches S301, S302 23
2.6.2 DIP Switch S300 24
2.6.3 RUN/STOP Switch 25
2.6.4 Status LEDs 25
2.7 Other Components 26
2.7.1 RESET 26
2.7.2 Jumper Configuration 26
2.7.3 Battery 27
2.7.4 Expansion Connector 28
2.8 Port Assignment Summary 29

3 Memory Models 35
3.1 Memory Configuration 35
3.1.1 Chip Select Signals 35
3.1.2 Chip Select Signal for CODE Flash U4/5 38
3.1.3 Chip Select Signal for SRAM U6/7 39
3.1.4 Chip Select Signal for DATA Flash U2/3 40
3.1.5 Chip Select Signal for External UART 41
3.1.6 Chip Select Signal /CS4 42
4 Hints for Installing the COMBI-Modul 167 43
5 Hints for Operating the COMBI-Modul 167 44
6 Technical Specifications 45
Index 49

Index of Figures

Figure 1: Block Diagram COMBI-Modul 167 5
Figure 2: View of the COMBI-Modul 167 (Top Side) 6
Figure 3: Location of the Function Blocks 7
Figure 4: Connecting a Power Supply 9
Figure 5: Circuitry on the 24 V-Inputs 10
Figure 6: Input Circuitry Options 11
Figure 7: Relay Output Circuitry 12
Figure 8: 24 V-Outputs Circuitry 13
Figure 9: PWM Outputs Circuitry 15
Figure 10: Analog Inputs Circuitry 16
Figure 11: Analog Outputs Circuitry 17
Figure 12: HEX-Encoding Switches S301, S302 23
Figure 13: DIP-Switch S300 24
Figure 14: Memory Configuration Example 36

Index of Tables

Table 1: I/O Port Arrangement of the 24 V-Inputs 10
Table 2: Function and I/O Port Arrangement of Relay Outputs 12
Table 3: Function and I/O Port Arrangement of 24 V-Outputs 14
Table 4: Accessing the Error Detection State of the 24 V-Outputs 14
Table 5: LEDs for Output State Control 14
Table 6: Function and I/O Port Arrangement of PWM Outputs 15
Table 7: Function and I/O Port Arrangement of Analog Inputs 16
Table 8: Function and I/O Port Arrangement of Analog Outputs 17
Table 9: RTC Address 19
Table 10: I²C EEPROM Address 19
Table 11: I²C Temperature Sensor Address 20
Table 12: Example Values for CAN Cable Parameters 21
Table 13: First RS-232 Pin Assignment 22
Table 14: Optional Second RS-232 Pin Assignment at JPRS-232 22
Table 15: Function and I/O Port Arrangement of the HEX-Encoding Switches 23
Table 16: Function and Data Line Arrangement of the DIP Switch 24
Table 17: Encoding the RUN/STOP Switch S303 Positions 25
Table 18: Example for Using the Status LED's 25
Table 19: Expansion Connector Pin Assignment 28
Table 20: Connector Pin Assignment COMBI-Modul 167 (Upper Row) 30
Table 21: Connector Pin Assignment COMBI-Modul 167 (Lower Row) 31
Table 22: Port Pin Assignment for I^2C Bus, RTC Interrupt and HEX-Encoding Switch 32
Table 23: Port Pin Assignment for RUN/STOP Switch, Status LEDs, S300 and Second Serial Interface 32
Table 24: Port Pin Assignment for External Connections 33

Table 25: Standard Assignment for /CS Signals 35
Table 26: /CS0 Configuration for CODE Flash 38
Table 27: Address Range with 256 kByte CODE Flash..... 38
Table 28: /CS2 Configuration for SRAM..... 39
Table 29: Address Range with 256 kByte SRAM..... 39
Table 30: /CS1 Configuration for DATA Flash 40
Table 31: /CS3 Configuration for External UART 41
Table 32: Functions of Chip Select Signal /CS4 42
Table 33: /CS4 Configuration..... 42
Table 34: Technical Data 24 V-Inputs 45
Table 35: Technical Data Relay Inputs 46
Table 36: Technical Data 24 V-Outputs..... 46
Table 37: Technical Data Analog Inputs..... 47
Table 38: Technical Data Analog Outputs 47

Preface

This COMBI-Modul 167 Hardware Manual describes the board's design and functions. Precise specifications for the Infineon C167CR microcontroller can be found in the enclosed microcontroller Data Sheet/User's Manual. If software is included please also refer to additional documentation for this software.

In this hardware 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.

The following manuals are available for additional information:

Installation and Getting Started Guide

- describes the initial installation steps for this control unit and provides QuickStart instruction on how to get the device up and running with an existing example program

Infineon C167CR User's Manual / Data Sheet

- describes the features and functions of the C167CR micro-controller in detail

Module Software Drivers

- describes the accompanying software driver functions for accessing the COMBI-Modul 167 function components and demonstrates their use with an example program

Example circuitry shown in this manual is provided as general circuitry examples and do not necessarily reflect the actual circuit design. The exact circuitry is provided in the schematics included with the COMBI-Modul 167.

1 Introduction to the COMBI-Modul 167

1.1 Overview

The COMBI-Modul 167 is a compact control system for universal processing purposes of standard industrial signals. The board is designed for a great variety of uses, such as main control unit in measurement, control and data processing applications. The COMBI-Modul 167 is also an ideal solution in distributed field bus systems in conjunction with other components and systems of the IGAS-(**I**nte**g**rated **A**utomation **S**ystem) product series.

The COMBI-Modul design is primarily based on the proven PHYTEC microcontroller core boards and makes use of the Infineon C167 microcontroller resources. Most of the microcontroller's I/O ports are interrupt capable, thus enabling very short response times.

Peripheral sensors, actuators and control devices can be easily connected to the board using lug connector strips. Use of stable, removable screw thimbles (f.e. COMBICON) enables easy exchange of the connected sensors and actuators. The board is installed in an industry proven PHOENIX casing and can be mounted on a DIN/EN chassis bar.

The COMBI-Modul 167 is populated with 256 kByte (up to 1 MB optional) static RAM (battery buffered) and 256 kByte (up to 2 MB optional) Flash memory. The board offer serial RS-232 interfaces for connection to terminals or programming devices. The COMBI-Modul 167 also features an optically isolated CAN (Controller Area Network) field bus interface and a battery-buffered Real-Time Clock (RTC).

The COMBI-Modul 167 offers the following features:

- populated with Infineon C167CR controller running at 20 MHz CPU clock (100 ns per instruction cycle), bus interface 16-bit, demultiplexed
- 256 kByte (optional 1 MB) SRAM, battery-buffered
- 256 kByte (optional 2 MB) Flash EPROM
- 20 digital inputs, 24 VDC, optically isolated from one another
- 8 of the 20 digital inputs are interrupt capable
- 4 digital inputs with reduced delay time for use as counter, 24 VDC optically isolated
- 8 relay outputs, 250 VAC @ 2 A with overvoltage protection
- 8 transistor outputs, 24 VDC @ 0.5 A, switched by plus level and protected against short circuit
- speedy outputs for PWM applications, 24 VDC @ 0.5 A, switched by minus level
- 4 analog inputs, 10-bit resolution, 0...10 V (0 – 20 mA)
- two analog outputs, 0...10 V., 8 – 10-bit resolution
- battery-buffered Real-Time Clock RTC
- I²C EEPROM for additional data storage and temperature sensor
- optional expansion connector
- optically isolated CAN interface
- RS-232 transceiver for serial interface (optional second RS-232)
- RUN/STOP switch, 4 status LEDs (Power-On, SYSErr, CANErr, RUN), 3 user LEDs
- two HEX-encoding switches, can be used for CAN Node ID configuration
- four-position DIP switch, can be used for CAN baud rate selection
- power supply 24 VDC/1A ±20 %

Hardware revision history:

- DIP switch is now accessible within the controller‘s address/data space and **NO LONGER** via port pins

1.2 Block Diagram

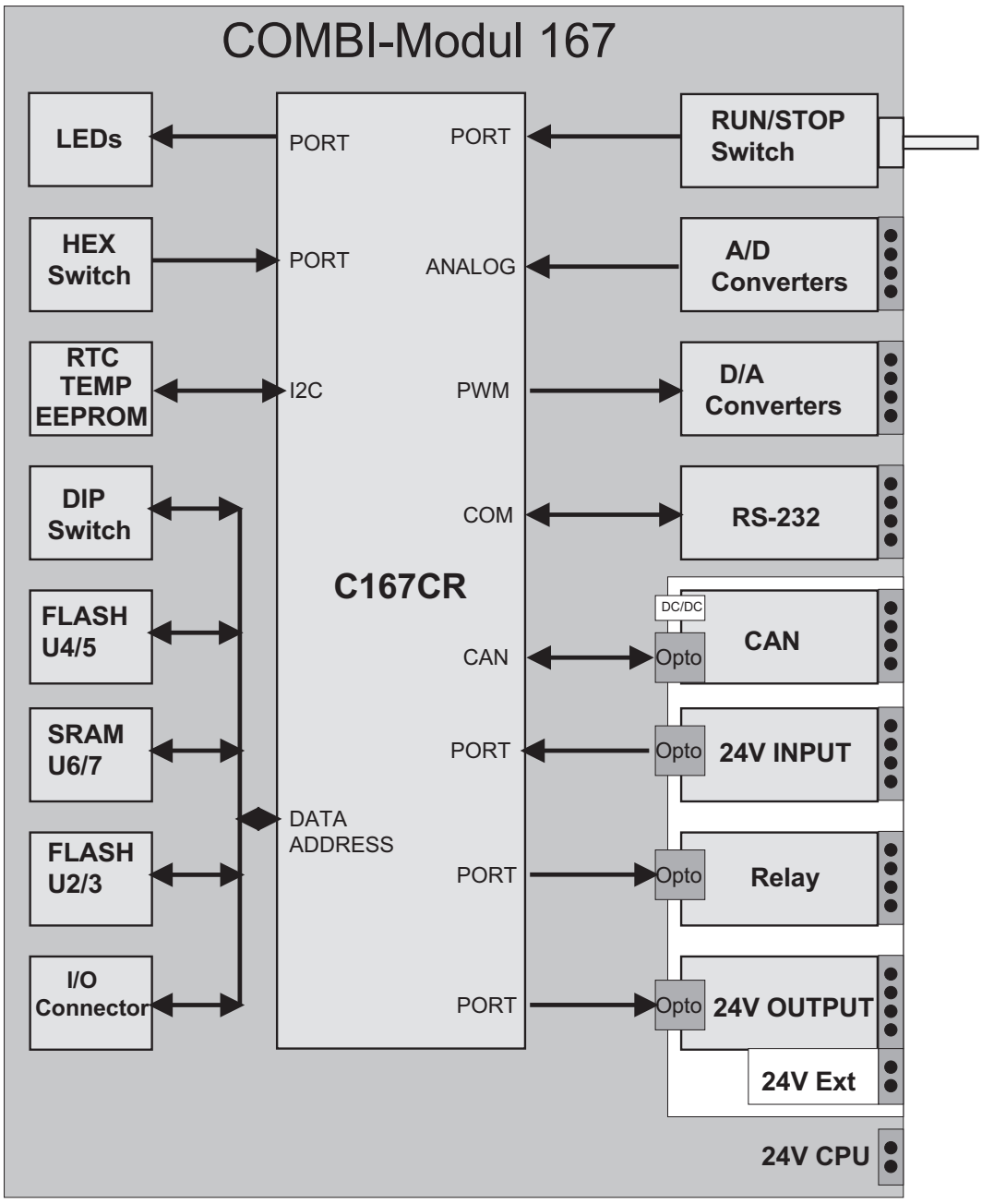


Figure 1: Block Diagram COMBI-Modul 167

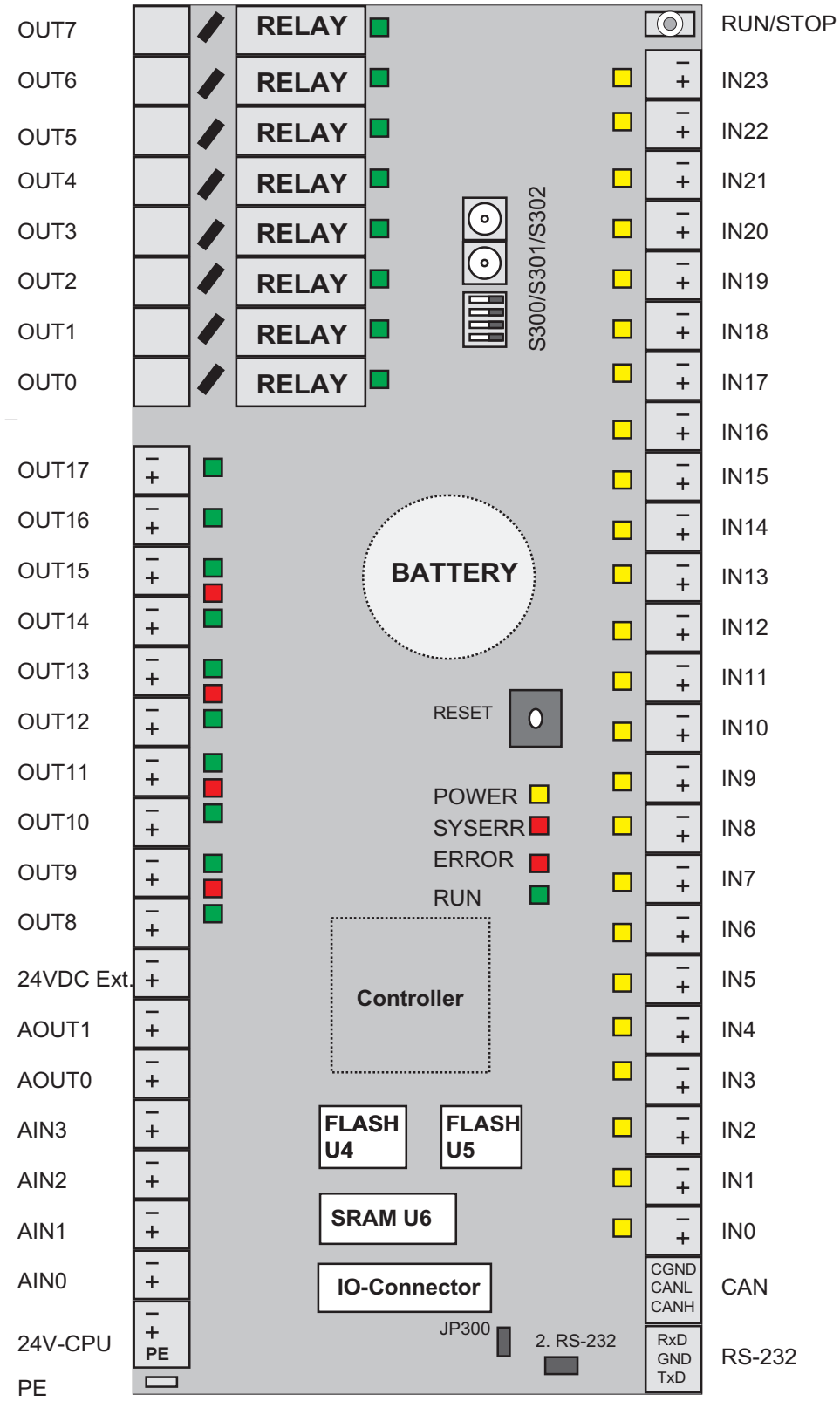


Figure 2: View of the COMBI-Modul 167 (Top Side)

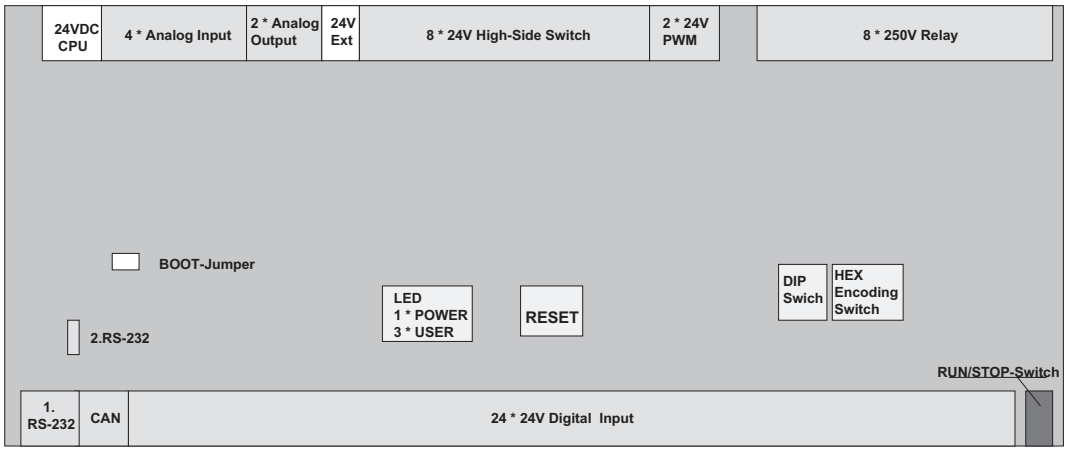


Figure 3: Location of the Function Blocks

1.3 Software Development Tools

Application programs for the COMBI-Modul 167 can be developed using C or Assembler programming languages. The enclosed phyPS driver software allows easy access to the COMBI-Modul's various input/output units.

- PHYTEC FlashTools for Windows
- Keil C166 Software Development Tools:
  - DOS-Monitor-166/167 for IBM-PC
  - Cross-Assembler-166/167 for IBM-PC
  - Cross-C-Compiler-166/167 for IBM-PC
  - PDK for C166/167 with Monitor, Assembler, C-Compiler and Simulator/Debugger for IBM-PC
- phyPS module driver library, provides functions to read/write digital and analog I/Os, for usage of the Flash memory, the UART and RTC with example programs
- CAN driver library: low-level layer 2 drivers with example programs for transmit and receive routines
- Network layer, for example CANopen
- EUROS real-time multitasking operating system

2 Components on the COMBI-Modul 167

2.1 Power Supply

The COMBI-Modul 167 features two galvanic isolated power supply inputs.

The power supply input **24 VDC-CPU** supplies the microcontroller, the core circuitry and the relay on the COMBI-Modul 167. A DC voltage power source in the range of 24 V +/-20 % can be connected to this input. The typical current draw is 80..100 mA.

The power supply input **24 VDC-Ext.** supplies the transistor outputs (**OUT8..15**) and the PWM outputs (**OUT16..17**). A DC voltage power source in the range of 24 V +/-20 %, can be connected to this input. The current draw depends on the power consumption of the devices connected to the transistor outputs. The maximum current draw is specified with 4 A.

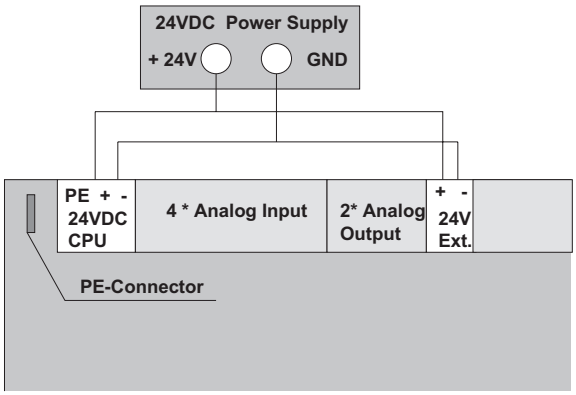


Figure 4: Connecting a Power Supply

Power supply inputs are protected against polarity reversal in each case by a diode in the positive voltage input. Do not connect power supply connections to analog inputs or outputs as this could destroy the analog circuitry.

The flat connector next to the 24 VDC-CPU connection serves as a PE-connector. The flat connector must be connected to protect earth (PE) potential with a short cable that is able to carry high current spikes.

2.2 Digital Inputs and Outputs

2.2.1 24 V-Inputs IN0..IN23

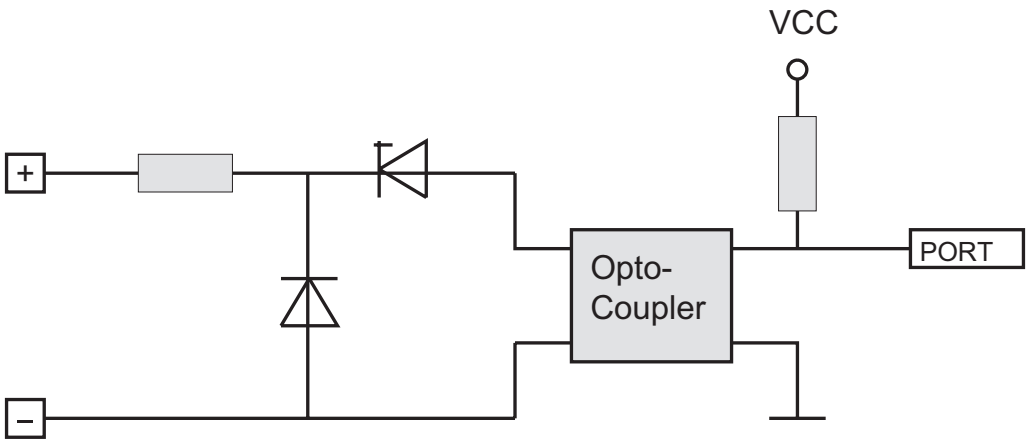


Figure 5: Circuitry on the 24 V-Inputs

The COMBI-Modul 167 provides a maximum of 24 digital inputs that are directly routed to the C167CR microcontroller port pins. The relation of inputs to port pins is shown in *Table 1*.

The inputs labeled as IN8..IN15 can also serve as interrupt inputs. Furthermore, IN20...IN23 can be used as fast timer inputs, with a maximum input frequency of 50 kHz.

Input Label	Port	Special Function
IN8..IN15	P2.8...P2.15	Interrupt input
IN0-IN7 IN16..IN19	P2.0...P2.7 P5.4...P5.7	-
IN20..IN21 IN22..IN23	P3.5,P3.6 P5.12,P5.13	Timer input

Table 1: I/O Port Arrangement of the 24V Inputs

All digital inputs IN0..IN23 are active low with the following switching voltages:

- Input voltage > 13 VDC: ‘0’ (TTL level) on port pin
- Input voltage < 5 VDC: ‘1’ (TTL level) on port pin

The inputs are separated from one another and from the controller core via an opto-coupler. Since the inputs themselves are potential-free, they can be turned on by the 24 VDC or the 24 VDC-GND. The following figure illustrates two connection possibilities for digital inputs:

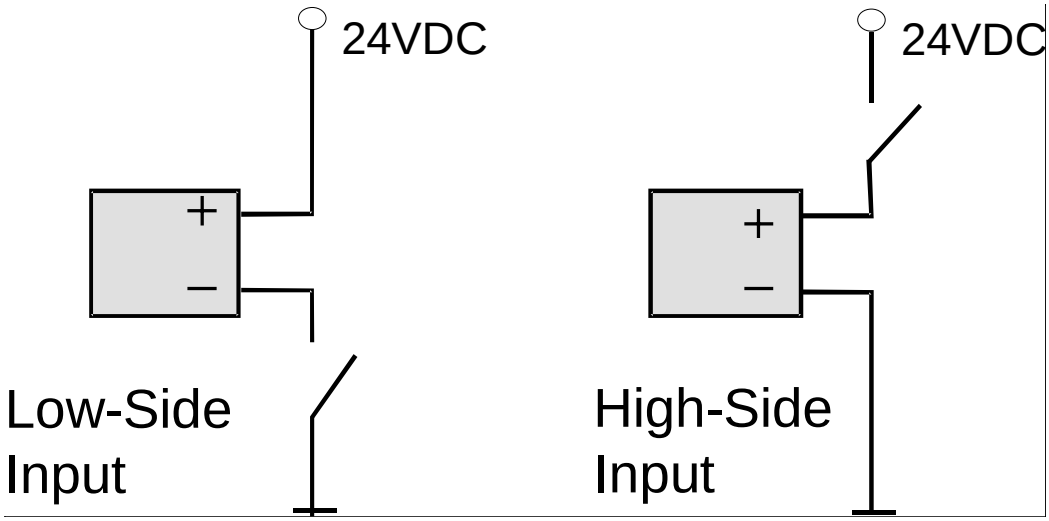


Figure 6: Input Circuitry Options

2.2.2 Relay Outputs

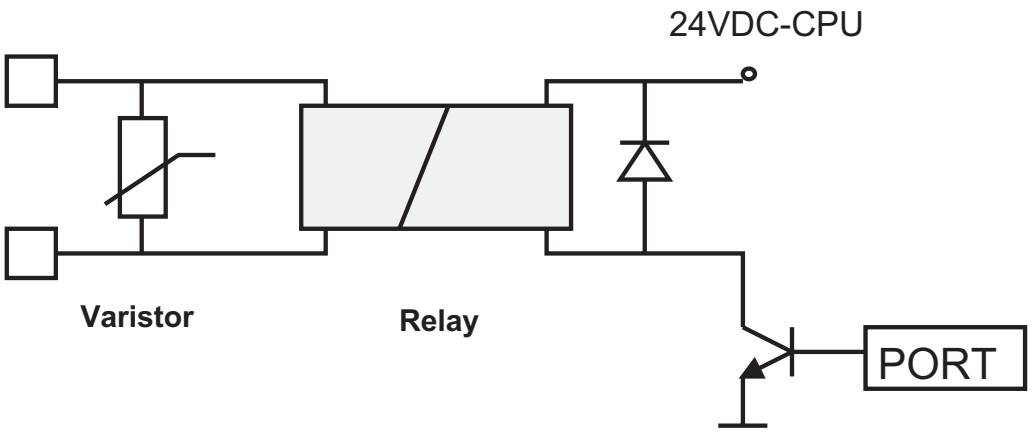


Figure 7: Relay Output Circuitry

The COMBI-Modul 167 provides 8 relay outputs. The relay outputs are active high. Access to these outputs is possible via port pins at P8. The maximum current on the relay outputs is 2 A at 250 VAC (5 A types are available upon request).

High electrical and mechanical noise immunity relays with one closing contact are used. Each relay is protected against overvoltage by a 250 V varistor. Please notice the timing parameters and bounce times listed in *section 6, "Technical Specifications"*.

Output	Port	Level	Function
OUT0..OUT7	P8.0...P8.7	High	Closing contact

Table 2: Function and I/O Port Arrangement of Relay Outputs

Note:
If relays are operated with different voltages, i.e. one relay with 220 V and another one with 24 V, one relay between these two outputs must remain unused!
Additional standards and regulations about power supply specifications specific for each country apply.
Please contact PHYTEC if you have any questions or concerns.

2.2.3 24 V-Outputs

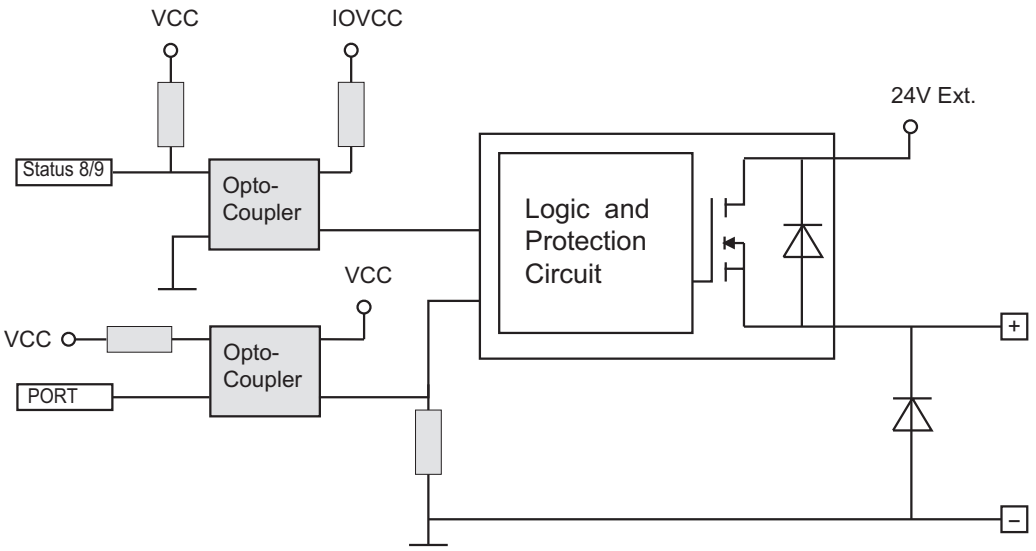


Figure 8: 24 V-Outputs Circuitry

The COMBI-Modul 167 provides 8 outputs for 24 V digital signals. These outputs are active low and protected against short circuit. The switching time is 400µs. The maximum current on the 24 V-Outputs is 0.5 A. The sum of the current load on all outputs **OUT8..OUT17** must not exceed 4 A.

The 24 V-Outputs provide an error detection functionality for short circuits (higher than 1.5....2 A) at outputs **OUT8/9**, **OUT10/11**, **OUT12/13** and **OUT14/15**. A red error LED will illuminate in case of a short circuit. The state of the LED is accessible by read instructions and can be reset with the controller's Chip Select signal /CS4. Signals are routed through an opto-coupler for galvanic isolation. Any short circuit is indicated by a low level signal. The state output of the transistor is not static, but the transistor tries to turn on again after a certain period of time. This will automatically switch the status level back to high.

For this reason, each short circuit that occurs is stored in the circuitry until the user program resets the status. Resetting the four status signals is done with an /RD access to the Chip Select signal's /CS4 base address 03H. Following a reset or power-on, the status level must be reset in order to initialize the error detection circuitry and provide known signal levels. It is possible that circuitry may be set to error state, even if a short circuit did not occur.

The user should also note, that any short circuit is detected with a delay time of 1 ms to 5 ms after the output is set.

Output	Port	Switch Function	Comments
OUT8..OUT11	P3.0...P3.3	24 V high-side switch	short circuit protected
OUT12..OUT15	P7.4...P7.7	24 V high-side switch	short circuit protected

Table 3: Function and I/O Port Arrangement of 24 V-Outputs

/CS4 Base Address plus	Data Bit	Error State at...	Signal Active Level
2	D0..D3	OUT8/9...OUT14/15	Low
3	Reset state with /RD access		

Table 4: Accessing the Error Detection State of the 24 V-Outputs

Controlled Output Pair	LED (red)
OUT8/9	D832
OUT10/11	D833
OUT12/13	D834
OUT14/15	D835

Table 5: LEDs for Output State Control

Note:
The BTS712 integrated circuit has been discontinued after finalization of the COMBI Modul-167's design. The BTS712 will be used as replacement part on all devices assembled after year 2001. This also results in a change of the state indication function. The state output will indicate *"Open Load"* state if the output load current is lower than 100 mA at room temperature.

2.2.4 PWM Outputs

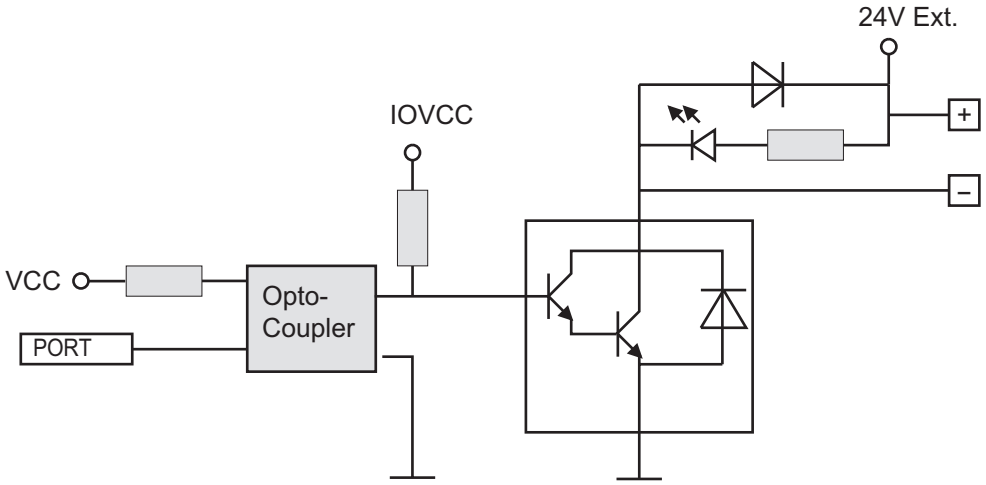


Figure 9: PWM Outputs Circuitry

The COMBI-Modul 167 provides two PWM outputs **OUT16** and OUT17. These outputs are active low and controlled via the controller ports P7.0 = **OUT16** and P7.1 = **OUT17**. These outputs switch the Ground potential when activated, therefore the load must be connected to the 24 V supply.

The maximum current load on the PWM outputs is 0.5 A for each channel. The sum of the current load on all outputs **OUT8..OUT17** must not exceed 4 A.

Output	Port	Switch Function	Maximum Frequency
OUT16 OUT17	P7.0 P7.1	24 V low-side switch	50 kHz

Table 6: Function and I/O Port Arrangement of PWM Outputs

2.3 Analog Inputs and Outputs

2.3.1 Analog Inputs

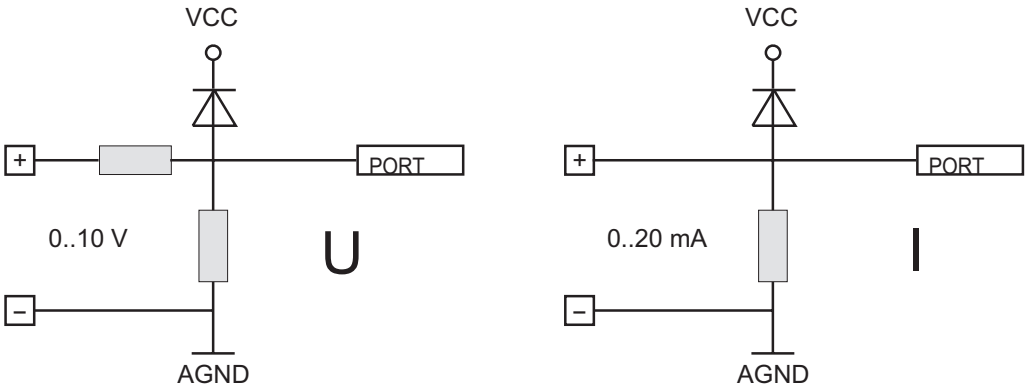


Figure 10: Analog Inputs Circuitry

The standard configuration of the COMBI-Modul 167 provides 4 analog inputs offering an input voltage range of 0...10 V and a resolution of 10-bit. The board can be populated with circuitry for current inputs in the range of 0..20 mA as an alternative to voltage inputs. The board utilizes the C167CR on-chip A/D converter unit. The microcontroller ports P5.0 to P5.3 are used to connect the on-board circuitry to the A/D converter.

Analog Input	Port	Voltage/Current	Resolution
AIN0..AIN3	P5.0...P5.3	0..10 V/0..20 mA	10-bit

Table 7: Function and I/O Port Arrangement of Analog Inputs

Note:
The user must ensure that the voltage level applied to the analog input connectors does not exceed the critical limit of nominal input voltage or current plus 10%. Higher input values can cause damage or destruction of the board!

The analog input circuitry provides an EMC protection circuitry. This circuitry is capable of blocking short term voltage peaks (bursts) of 500 V up to a maximum of 2 kV.

2.3.2 Analog Outputs

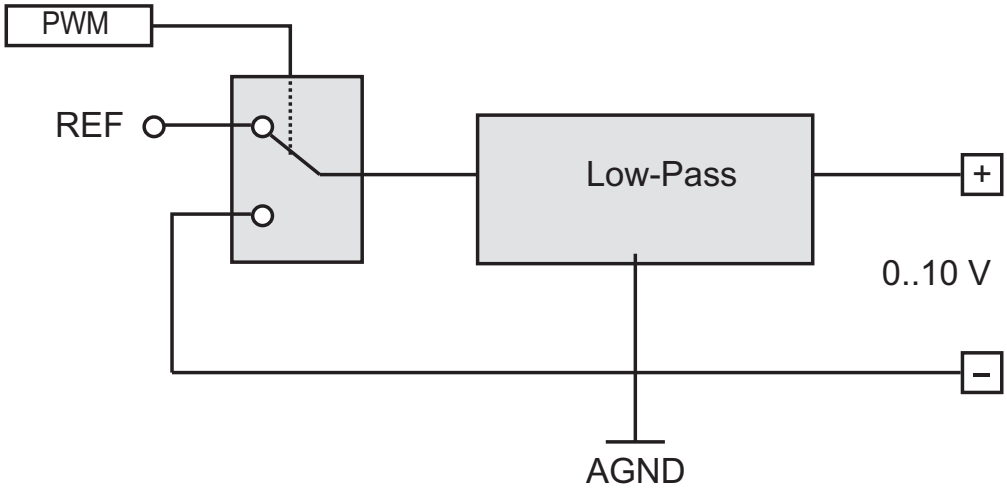


Figure 11: Analog Outputs Circuitry

Two analog output signals can be generated on the COMBI-Modul 167. The C167CR microcontroller provides a Compare/Capture unit that allows generation of pulse width modulated (PWM) signals at ports P7.2 and P7.3. The on-board circuitry, with an active low-pass and operational amplifier, supports analog output signals in the range of 0...10 V with a resolution of 8-bit and an accuracy of ±1 %. A higher D/A resolution is possible, however this reduces the accuracy of the output voltage, since the accuracy depends on the chosen base frequency and therefore the resolution of the PWM signal.

Analog Output	Port	Voltage	Resolution
AOUT0 AOUT1	P7.2 P7.3	0..10 V	8-bit

Table 8: Function and I/O Port Arrangement of Analog Outputs

2.4 I²C Bus

The I^2C bus is realized via port pins P3.8 = SendData (SDA) and P3.9 = SendClock (SCL). The I^2C bus protocol is implemented in firmware.

2.4.1 Real-Time Clock (RTC)

For real-time or time-driven applications, the COMBI-Modul 167 is equipped with an RTC-8583 Real-Time Clock. This RTC device provides the following features:

- Serial input/output bus (I^2C)
- Power consumption
  Bus inactive, CLKOUT = 0 kHz : max. 50 µA
- Clock function with four year calendar
- Century bit for year 2000-compliance
- Universal timer with alarm and overflow indication
- 24-hour format
- Automatic word address incrementing
- Programmable alarm, timer and interrupt functions

If the COMBI-Modul 167 is equipped with a battery, the Real-Time Clock runs independently of the board's power supply (*refer to section 2.7.3, "Battery"*).

Programming the Real-Time Clock is done via the I^2C bus (address 1010001B), which is connected to port P3.9 (SCL) and port P3.8 (SDA). The Real-Time Clock also provides an interrupt output that extends to port P3.7. An interrupt occurs in the event of a clock alarm, timer alarm, timer overflow and event counter alarm. An interrupt must be cleared by software. The Real-Time Clock can be utilized in various applications. *For more information on the features of the RTC-8583, refer to the corresponding Data Sheet.*

Note:
After connection of the supply voltage, or after a hardware reset, the Real-Time Clock generates **no** interrupt. The RTC must first be initialized (*see RTC Data Sheet for more information*)

I²C software drivers and demo programs are included on the tool disk or CD-ROM.

I²C Device	I²C Address
RTC	1010001B

Table 9: RTC Address

2.4.2 I²C EEPROM

The COMBI-Modul 167 can be equipped with an I²C EEPROM. Data, which has to be maintained even if a power supply is not connected to the COMBI-Modul 167, can be stored in the I²C EEPROM. The standard I²C EEPROM memory size is 8 kBytes, however it is also possible to populate different size EEPROM devices on the board. The I²C EEPROM is self-protect (via Jumper JP200) from overwriting (optional).

Programming the I²C EEPROM is done via the I^2C bus (address 1010011B), which is connected to port P3.9 (SCL) and port P3.8 (SDA). *For more information on the features of the I²C EEPROM, refer to the corresponding Data Sheet.*

I²C Device	I²C Address
EEPROM	1010011B

Table 10: I²C EEPROM Address

2.4.3 Temperature Sensor

The COMBI-Modul 167 can be equipped with an optional temperature sensor at U205. The I^2C bus also controls this component at address 1001111B. The sensor is located next to the battery holder. *For more information on the features of the I²C temperature sensor, refer to the corresponding Data Sheet.*

The temperature sensor has the following features:

- measurement of temperature in the range of –25...+100°C (+/-3°C)
- adjustable threshold for exceeding temperature limit with interrupt signal

I²C Device	**I²C Address**
Temperature Sensor	1001111B

Table 11: I²C Temperature Sensor Address

2.5 Interfaces on the COMBI-Modul 167

2.5.1 CAN Interface

The C167CR microcontroller is equipped with an integrated FULL-CAN interface. The signals CAN_HIGH, CAN_LOW and CAN_GND are galvanically decoupled and assessable on the COMBICON connectors. An external power supply is not required. *Information about the CAN interface can be found in the C167CR User's Manual/Data Sheet.*

The CAN bus cable can be either a twisted pair or a ribbon cable. The cable has to be terminated with a resistor of 120 Ohm between CAN_H and CAN_L at both ends of the bus cable. The cable shielding should be connected to PE at both ends of the cable. The wave resistance of the cable should be 120 Ohm. The connection between the cable length and the usable CAN bitrate is shown in the table below. These values are approximate values, exact cable parameters must be calculated using the appropriate formulas. It is recommended to optically isolate the CAN nodes for cable extensions of more than 200 meters.

Cable Length [m]	Maximum Bitrate [kBit/s]
0 ... 25	1000
0 ...100	500
0 250	250
0 ... 500	125
0 ...2500	20

Table 12: Example Values for CAN Cable Parameters

The Philips P82C251 is used as a CAN transceiver. This device supports up to 100 nodes on one CAN bus with a maximum bitrate of 1 MBit/s.

2.5.2 First RS-232 Interface

The internal serial interface of the C167CR controller is used for the first RS-232 interface on the COMBI-Modul 167.

This interface is primarily used for communication with PHYTEC FlashTools for program download or for debugging with the corresponding monitor program. The RS-232 level signals RxD, TxD and GND are available at the COMBICON connectors. A shielded serial cable should be used for connecting the board to a host-PC. The shield needs to be connected to PE on one side of the cable in order to ensure proper functioning.

Pin #	RS-232 Signals
1	TxD
2	GND
3	RxD

Table 13: First RS-232 Pin Assignment

2.5.3 Second RS-232 Interface

The COMBI-Modul 167 can also be equipped with an optional second serial RS-232 interface. The second serial interface is realized with the SCC2691 UART chip. Port pin 6.3 of the C167CR controller is used to generate the Chip Select signal for access to the UART. A 3-pin header connector at JPRS-232 (located inside the housing) is provided for the physical connection. Alternatively, it is possible to route the second serial interface signals to the COMBICON connector that is intended for use as the CAN interface. In the latter case, the CAN interface circuitry must not be mounted on the board.

Pin # at JPRS-232	RS-232 Signals
1	TxD
2	RxD
3	GND

Table 14: Optional Second RS-232 Pin Assignment at JPRS-232

The address range for the UART /CS signal (/CS3 of the C167CR) can be configured with software (*refer to the C167CR User's Manual/Data Sheet*). Technical data for the UART chip and the RS-232 transceiver, located at U203, can be found in the corresponding Data Sheets for these components.

2.6 Display and Control Units

2.6.1 HEX-Encoding Switches S301, S302

The COMBI-Modul 167 is equipped with two HEX encoding switches on S301 (MSB) and S302 (LSB). Both switches are located inside the housing and offer no EMC protection circuitry. The two HEX encoding switches are intended for configuration purposes prior to operation rather than implementing the switches as a control unit during runtime.

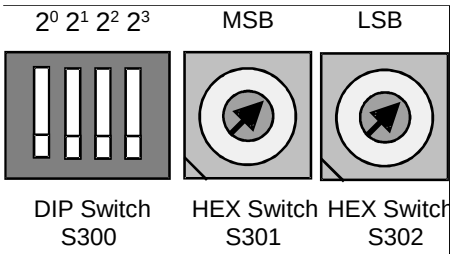


Figure 12: HEX-Encoding Switches S301, S302

Switch	Value	Port Pin
S301	2^0	P5.11
S301	2^1	P5.10
S301	2^2	P5.9
S301	2^3	P5.8
S302	2^0	P3.13
S302	2^1	P3.15
S302	2^2	P5.15
S302	2^3	P5.14

Table 15: Function and I/O Port Arrangement of the HEX-Encoding Switches

The HEX-encoding switch signals are active high. Bounce times during switching must be considered when implementing software functions that access the HEX-encoding switch. These switches can be used for setting up the node address when integrating the COMBI-Modul 167 into a CAN network.

2.6.2 DIP Switch S300

The COMBI-Modul 167 is equipped with a 4-position DIP switch at S300. The DIP switch is located inside the housing and offers no EMC protection circuitry. The DIP switch is intended for configuration purposes prior to operation rather than implementing the switches as a control unit during runtime.

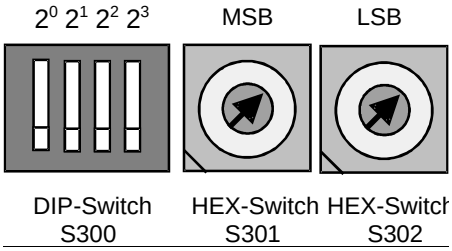


Figure 13: DIP-Switch S300

The 4-position DIP switch can be accessed at the Chip Select signal /CS4 base address. The switch signals are active high and available at data lines D0...D3 with read access.

Switch	Value	Data Line
S300	2^0	D0
S300	2^1	D1
S300	2^2	D2
S300	2^3	D3

Table 16: Function and Data Line Arrangement of the DIP Switch

The bounce times during switching must be considered when implementing software functions that access the DIP switch. These switches can be used for configuration of the CAN bitrate when integrating the COMBI-Modul 167 into a CAN network.

2.6.3 RUN/STOP Switch

The RUN/STOP switch, located at S303, provides 3 switch positions. The following table gives an example on how to use the switch states RUN, STOP and MRES.

Switch Position	Level at P6.6	Level at P3.4
RUN	0	1
STOP	1	1
MRES	1	0

Table 17: Encoding the RUN/STOP Switch S303 Positions

The RUN/STOP switch on the COMBI-Modul 167 is the only control unit which is available for use during system runtime. It offers EMC protection circuitry, which can tolerate voltage bursts up to 2 kV. This requires that the unit is connected to PE via the applicable connector.

The bounce times during switching must be considered when implementing software functions that access the RUN/STOP switch. These switches can be used for configuring operational states of the device when integrating the COMBI-Modul 167 into a CAN network.

2.6.4 Status LEDs

Three of the four status LEDs are connected to port pins on the C167CR. This allows direct access with the bit-clear and bit-set instructions. These LEDs are freely available and can be used as required by the application. The table below illustrates possible applications for the LEDs:

LED	Port Pin	LED on	Meaning
D5 (green)	P4.4	P4.4 = 0	Program is in 'RUN' state
D6 (red)	P4.7	P4.7 = 0	Network error
D7 (red)	P6.5	P6.5 = 0	System error
D8 (yellow)	VCC	-	Power supply is on

Table 18: Example for Using the Status LED's

2.7 Other Components

2.7.1 RESET

The COMBI-Modul 167 is equipped with a TLC7705 Reset controller. The reset signal is released if the voltage level of the nominal 5 V supply drops below the 4.65 V reset threshold.

The Reset push button S1 (located next to the battery holder) can be used to release a manual Reset of the COMBI-Modul 167. The Reset button is located inside the housing and offers no EMC protection circuitry. The Reset button is intended for use during the software design phase, as well as for starting PHYTEC FlashTools on the board.

Note:
When touching the reset push button, electro-static discharges can cause serious damage or even destruction to the COMBI-Modul. The device should be unpacked, handled or operated only in environments in which sufficient precautionary measures have been taken.

2.7.2 Jumper Configuration

The Boot jumper JB300 is used to configure the start condition for the on-chip Bootstrap loader. If the insertable jumper JB300 is closed, then the COMBI-Modul 167 will go into Boostrap mode following a hardware reset. This allows PHYTEC FlashTools to start, in order to download user code into the on-board Flash. If the Boot jumper remains open, then the application code stored in the Flash U4/U5 will be executed after Reset.

Additional solder jumpers are also available on the COMBI-Modul 167. These jumpers are pre-configured according to the memory configuration of the board at time of delivery and must not be changed. Changes of the memory configuration can be made with software.

2.7.3 Battery

The battery that buffers the memory is not essential to the functioning of the COMBI-Modul 167. However, this battery buffer embodies an economical and practical means of storing non-volatile data in SRAM. It is also necessary for data storage in the Real-Time Clock in the event of a power failure. A battery is installed in the battery socket on the board at time of delivery.

Power consumption depends on the installed memory devices and their capacity. The typical current draw for memory chips used on the COMBI-Modul 167 is 1 µA (max. 100 µA) for each RAM device. The RTC typically draws 5 µA (max. 50 µA). The standard version of the board has a typical data retention time of one year when the power supply (24 V CPU) is disconnected.

Exchanging the battery yearly is highly recommend. The COMBI-Modul 167requires a CR2032 battery. The RAM will be buffered for a period of 20 seconds while exchanging the battery. Please ensure that the plus pole of the battery (with the battery markings) is on the top side.

If the SRAM does not require battery buffering, then Jumper J10 can be changed to position 2+3. In this case, only the RTC is supplied by the battery if the power supply is turned off.

Note:
Be advised that despite the battery buffer, changes in the data content within the RAM can occur. The battery buffer does not completely remove the danger of data destruction. Environmental conditions such as high humidity or strong electrical fields generated by motors installed next to the board can increase the risk of data destruction.

Please note that the storage temperature for the module is only 0°C to +70°C when using a battery buffer for the RAM and RTC devices.

2.7.4 Expansion Connector

The COMBI-Modul 167 provides an 8-bit expansion connector. If the DATA-Flash is not mounted on the board, then the Chip Select signal /CS1 can address a memory area of 128 kByte on the expansion connector. The Chip Select signals /CSKON, /CSIO0 and /CSIO1 are of limited use and are intended for test purposes only.

The following table provides an overview of the expansion connector pinout:

Pin	X300	X301
1	VCC	A0
2	VCC	A1
3	VPD (Battery)	A2
4	D0	A3
5	D1	A4
6	D2	A5
7	D3	A6
8	D4	A7
9	D5	A8
10	D6	A9
11	D7	A10
12	/RD	A11
13	/WRL	A12
14	/RES	A13
15	/CSIO0	A14
16	/CSIO1	A15
17	GND	A16
18	GND	ALE
19	GND	/CSKON
20	GND	/CS1

Table 19: Expansion Connector Pin Assignment

2.8 Port Assignment Summary

The COMBICON connectors on the COMBI-Modul 167 display the individual connector designator and the required polarity of the corresponding input or output. The following tables show the pin assignment for the upper connector row (*see Table 20*) and the lower connector row (*see Table 21*). The assignment between input/output signal and the applicable internal signal level can be found in the *"Description"* column. The following conventions are used for the signal states:

Inputs: Inputs are active LOW

Input voltage > 13 VDC: ‘0’ (TTL level) on port pin
Input voltage < 5 VDC: ‘1’ (TTL level) on port pin

Outputs: Relay Outputs OUT0-7 are active HIGH

The relays are closed with a signal level of logical ‘1’ (TTL) on the corresponding port pin.
The relay contact is opened if a ‘0’ is written to the applicable output pin.

Outputs: 24 V-Outputs OUT8-17 are active LOW

The output transistors have low resistance at a signal level ‘0’ (TTL) on the output of the port pin.
The output transistors has high resistance if a ‘1’ is written to the applicable output pin.

Upper Connector Row Label	Signal / Port Pin	Description
24 VDC-CPU	VCC	Supply voltage for the CPU 24 VDC/ 1 A ± 20 %
AIN0-AIN3	P5.0-P5.3	analog inputs 0 ... 10 V (0 - 20 mA)
AOUT0-AOUT1	P7.2-P7.3	analog outputs 0 - 10 V (PWM outputs with low pass)
Ext.-24 VDC	IOVCC	Supply voltage for the galvanicaly decoupled transistor output circuitry
OUT8- OUT11	P3.0 - P3.3	transistor outputs 24 VDC /0.5 A; switching with plus level, galvanicaly decoupled, active LOW, state after Reset: inactive
OUT12- OUT15	P7.4 - P7.7	transistor outputs 24 VDC /0.5 A; switching with plus level, galvanicaly decoupled, active LOW, state after Reset: inactive
OUT16- OUT17	P7.0 - P7.1	transistor outputs 24 VDC /0.5 A; switching with minus level, galvanicaly decoupled, active LOW, state after Reset: inactive
OUT0- OUT7	P8.0 - P8.7	relay outputs 250 VAC /3 A, active HIGH, state after Reset: relay contact opened

Table 20: Connector Pin Assignment COMBI-Modul 167 (Upper Row)

Lower Connector Row Label	Signal / Port Pin	Description
RS-232 TxD	RSTxD	RS-232 signal level TxD output of the C167CR internal asynchronous interface
RS-232 GND	Ground	Ground potential of the COMBI-Modul 167 for RS-232 connection at 3-pin clamp (Serial0)
RS-232 RxD	RSRxD	RS-232 signal level RxD input of the C167CR internal asynchronous interface
CAN HI	CAN_H	CAN_HIGH signal from the CAN interface, optically isolated
CAN LO	CAN_L	CAN_LOW signal from the CAN interface, optically isolated
CAN GND	GROUND	Ground potential of the CAN interface, optically isolated
IN0 - IN15	P2.0 - P2.15	24 VDC inputs, optically isolated, signals are inverted (24 VDC input level results in a Low level on the corresponding port pin), interrupt capable
IN16 - IN19	P5.4 - P5.7	24 VDC inputs, optically isolated, signals are inverted (24 VDC input level results in a Low level on the corresponding port pin)
IN20, IN21	P3.5, P3.6	24 VDC inputs, optically isolated, signals are inverted (24 VDC input level results in a Low level on the corresponding port pin)
IN22, IN23	P5.12, P5.13	24 VDC inputs, optically isolated, signals are inverted (24 VDC input level results in a Low level on the corresponding port pin)

Table 21: Connector Pin Assignment COMBI-Modul 167 (Lower Row)

The following tables (*see Table 22, Table 23 and Table 24*) give an overview of the pin assignments for additional peripheral components, such as RTC, HEX-encoding switch, RUN/STOP switch, Status LEDs and external UART.

Signal	Port Pin	Description
SCL	P3.9	Clock line I^2C bus
SDA	P3.8	Data line I^2C bus
IRTC	P3.7	Temperature sensor and RTC interrupt line
CPUID.0	P5.11	HEX-encoding switch S301 bit 0, active HIGH
CPUID.1	P5.10	HEX-encoding switch S301 bit 1, active HIGH
CPUID.2	P5.9	HEX-encoding switch S301 bit 2, active HIGH
CPUID.3	P5.8	HEX-encoding switch S301 bit 3, active HIGH
CPUID.4	P3.15	HEX-encoding switch S301 bit 4, active HIGH
CPUID.5	P3.13	HEX-encoding switch S301 bit 5, active HIGH
CPUID.6	P5.15	HEX-encoding switch S301 bit 6, active HIGH
CPUID.7	P5.14	HEX-encoding switch S301 bit 7, active HIGH

Table 22: Port Pin Assignment for I^2C Bus, RTC Interrupt and HEX-Encoding Switch

Signal	Port Pin	Description
RUN/ STOP switch S303	RUN_SW P6.6	RUN/STOP switch for the COMBI-Modul 167 at RUN-SW1, input, active LOW
	MRES, P3.4	RUN/STOP switch in position MRES, input, active LOW
RUN-LED	D5, P4.4	RUN-LED (green), status indication, software programmable, output, active LOW
CANErr	D6, P4.7	CAN-Error-LED (red), status indication, software programmable, output, active LOW
SYSErr	D7, P6.5	SYSTEM error (red), status indication, software programmable, output, active LOW
PON	D8	Power-on status indication (yellow)
NUM	U8, P6.7	Silicon serial number chip on port pin P6.7, use of this chip depends on user software
UART	P6.3	/CS UART (U204, 2nd serial RS-232 interface)
X10.1	TxD1	Transmit line second serial RS-232 interface
X10.2	RxD1	Receive line second serial RS-232 interface
X10.3	GND	Ground

Table 23: Port Pin Assignment for RUN/STOP Switch, Status LEDs, S300 and Second Serial Interface

The following table gives an overview of the assignment between external connectors and the port pins of the C167CR microcontroller.

Port Pin	Connector	Port Pin	Connector	Port Pin	Connector
P2.0	IN0	P8.0	OUT0	P5.11	NO0
P2.1	IN1	P8.1	OUT1	P5.10	NO1
P2.2	IN2	P8.2	OUT2	P5.9	NO2
P2.3	IN3	P8.3	OUT3	P5.8	NO3
P2.4	IN4	P8.4	OUT4	P3.15	NO4
P2.5	IN5	P8.5	OUT5	P3.13	NO5
P2.6	IN6	P8.6	OUT6	P5.15	NO6
P2.7	IN7	P8.7	OUT7	P5.14	NO7
P2.8	IN8	P3.0	OUT8	P3.7	/IRTC
P2.9	IN9	P3.1	OUT9	P3.8	SDA
P2.10	IN10	P3.2	OUT10	P3.9	SCL
P2.11	IN11	P3.3	OUT11	P3.10	TxD
P2.12	IN12	P7.4	OUT12	P3.11	RxD
P2.13	IN13	P7.5	OUT13	P4.5	RxCAN
P2.14	IN14	P7.6	OUT14	P4.6	TxCAN
P2.15	IN15	P7.7	OUT15	P4.7	CANErr-LED
P5.4	IN16	P7.0	OUT16	P4.4	SYSErr-LED
P5.5	IN17	P7.1	OUT17	P6.5	RUN-LED
P5.6	IN18	P7.2	AOUT0	P6.6	RUN/STOP
P5.7	IN19	P7.3	AOUT1	P3.4	MRES
P3.5	IN20	P5.0	AIN0	P6.7	Number Chip
P3.6	IN21	P5.1	AIN1	P6.3	/CSUART
P5.12	IN22	P5.2	AIN2	P6.4	/CSKON
P5.13	IN23	P5.3	AIN3		

Table 24: Port Pin Assignment for External Connections

3 Memory Models

3.1 Memory Configuration

3.1.1 Chip Select Signals

The C167CR microcontroller provides a freely programmable Chip Select unit. All 5 available Chip Select signal are used on the COMBI-Modul 167 as shown in the table below:

/CS Signal	Controlled Device
/CS0	CODE Flash U4/5
/CS1	DATA Flash U2/3 or expansion connector
/CS2	RAM U6/7
/CS3	UART U204
/CS4	DIP switch / ID / output state etc.

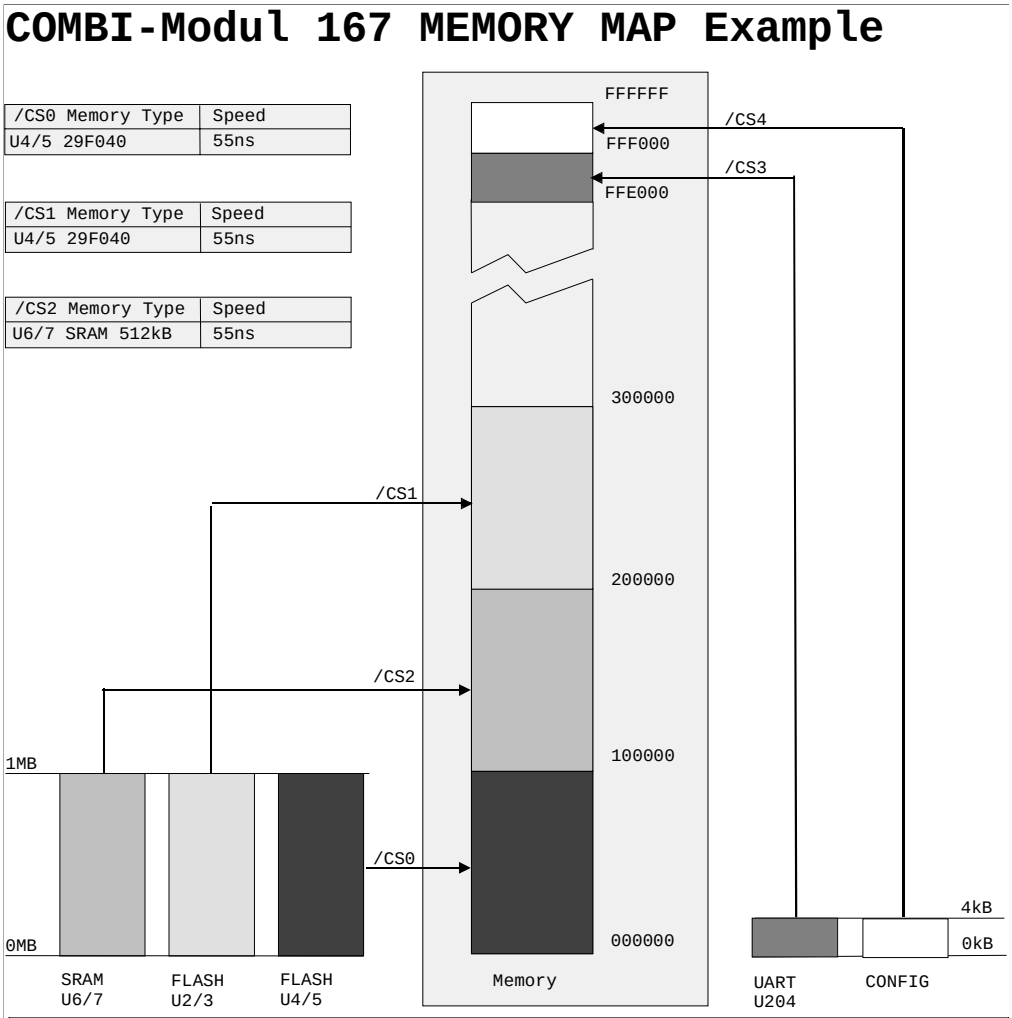
Table 25: Standard Assignment for /CS Signals

The Boot configuration of the COMBI-Modul 167 activates all 5 Chip Select signals on the C167CR controller.

The configuration of memory areas to the corresponding Chip Select signal is done with software. This allows realization of a very flexible memory model which can be changed during runtime.

Following a hardware reset, without activated boot condition (JP300 = open), the entire address space of the controller is assigned to and can only be accessed with /CS0. The microcontroller reads data at address 000000h. With /CS0 line activated, the instructions are fetched from the CODE Flash U4/U5. The external bus interface of the controller must be initialized by software in order to access the other Chip Select signals /CS1../CS4.

The following figure depicts an example configuration for initializing the bus interface.



/CS0 FLASH U4/5 16-bit

ADDRSEL0	RGSAD												RGSZ				HEX
Value	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0008h
BUSCON0	CSW	CSR	-	RDY	-	BUS	ALE	-	BTYP		MTT	RWD	MCTC				HEX
Value	0	0	0	0	0	1	0	0	1	0	1	0	1	1	1	1	04AFh

/CS1 FLASH U2/3 16-bit

ADDRSEL1	RGSAD												RGSZ				HEX
Value	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2008h
BUSCON1	CSW	CSR	-	RDY	-	BUS	ALE	-	BTYP		MTT	RWD	MCTC				HEX
Value	0	0	0	0	0	1	0	0	1	0	1	0	1	1	1	1	04AFh

/CS2 SRAM U6/7 16-bit

ADDRSEL2	RGSAD												RGSZ				HEX
Value	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1008h
BUSCON2	CSW	CSR	-	RDY	-	BUS	ALE	-	BTYP		MTT	RWD	MCTC				HEX
Value	0	0	0	0	0	1	0	0	1	0	1	0	1	1	1	0	04AEh

/CS3 UART U204 8-bit

ADDRSEL3	RGSAD												RGSZ				HEX
Value	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	FFE0h
BUSCON3	CSW	CSR	-	RDY	-	BUS	ALE	-	BTYP		MTT	RWD	MCTC				HEX
Value	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	040Dh

/CS4 CONFIG 8-Bit

ADDRSEL4	RGSAD												RGSZ				HEX
Value	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	FFF0h
BUSCON4	CSW	CSR	-	RDY	-	BUS	ALE	-	BTYP		MTT	RWD	MCTC				HEX
Value	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	040Dh

Figure 14: Memory Configuration Example

In the BUSCONx register not only the bus type is configured, but also the timing parameters for the bus access.

By configuring the memory cycle wait state (Tc = 50 ns) and the read/write delay it is possible to use memory devices with access times up to 100 ns at a bus cycle time of 150 ns. To run the controller without wait state, memory devices with 55 ns access time must be installed. In this case, the bus cycle time is 100 ns. The read/write delay should always be active (*refer to the C167CR User's Manual for more information*).

The following paragraph contains important information on timing characteristics. All information refers to a C167CR controller with a 16-bit bus, demultiplexed, at 20 MHz CPU clock time (F_{osz} = 5 MHz).

Tc = 50 ns * wait state control (MCTC in BUSCON)
Tf = 50 ns * tristate control (MTTC in BUSCON).

addresses stable until data valid:	max. 70 ns + Tc	SR[1]
/RD low until data valid:	max. 55 ns + Tc	SR[1]
/RD low until data valid (rd/wr delay):	max. 30 ns + Tc	SR[1]
/RD high until databus high-Z:	max. 15 ns + Tf	SR[1]
/RD high until data high-Z (rd/wr delay):	max. 35 ns + Tf	SR[1]
/CSx until data valid:	max. 55 ns + Tc	SR[1]
/RD and /WR low:	min. 65 ns + Tc	CC[2]
/RD and /WR low (rd/wr delay):	min. 40 ns + Tc	CC[2]
data valid until /WR high:	min. 25 ns + Tc	CC[2]
/WR high until data invalid:	min. 15 ns + Tf	CC[2]

The following sections contain example configurations of the controller for initializing the individual Chip Select signals.

1: SR = System Time (external circuitry must meet this timing criteria)
2: CC = Controller Characteristic (the controller ensures this time for external peripheral circuitry)

3.1.2 Chip Select Signal for CODE Flash U4/5

The application program for the COMBI-Modul 167 is stored in the CODE Flash U4/5. This memory device is controlled with Chip Select signal /CS0 which is configured for 16-bit demultiplexed bus mode by the hardware boot configuration. Flash devices with either 128 kByte or 512 kByte capacity can be installed on each Flash location U4 and U5. Hence, a total of 256 kByte or 1 MB Flash memory is available to the user. The Flash memory access time is 55 ns in the standard version of the COMBI-Modul 167.

The Flash memory area can be configured to the address range 000000h to 0FFFFFh for example. The following table contains values for the correct bus configuration:

Register	Hex	Function	Binary Value	Description
ADDRSEL0	0008h	RGSZ	1000	Address range 1 MB
		RGSAD	0000.0000.0000	Start address 000000h
BUSCON0	04AFh	MCTC	1101	Wait states = 2
		RWDC	0	RD/WR delay = ON
		MTTC	1	Tristates = 0
		BTYP	10	16-bit demultiplexed
		ALECTL	0	ALE = normal
		BUSACT	1	External bus = ON
		RDYEN	0	READY = OFF
		CSREN	0	/CS active before /RD
		CSWEN	0	/CS active before /WR

Table 26: /CS0 Configuration for CODE Flash

The example in the table above specifies the maximum on-board memory configuration. If only 256 kByte of CODE Flash is installed on the board, the address range must be adjusted as shown below:

Register	Hex	Function	Binary	Description
ADDRSEL0	0008h	RGSZ	0110	Address range 256 kByte

Table 27: Address Range with 256 kByte CODE Flash

3.1.3 Chip Select Signal for SRAM U6/7

The SRAM at U6/7 is implemented as data memory on the COMBI-Modul 167. This memory device is controlled with Chip Select signal /CS2 which must be configured for 16-bit demultiplexed bus mode by the user software. SRAM devices with either 128 kByte or 512 kByte capacity can be installed on each RAM location, U6 and U7. Hence, a total amount of 256 kByte or 1 MB SRAM memory is available to the user. The standard version of the COMBI-Modul 167 offers SRAM memory access time is 55 ns.

The SRAM memory area can be configured to the address range 100000h to 1FFFFFh for example. The following table contains values for the correct bus configuration:

Register	Hex	Function	Binary Value	Description
ADDRSEL2	1008h	RGSZ	1000	Address range 1 MB
		RGSAD	0001.0000.0000	Start address 100000h
BUSCON2	04AFh	MCTC	1111	Wait states = 0
		RWDC	0	RW delay = ON
		MTTC	1	Tristates = 0
		BTYP	00	16-bit demultiplex
		ALECTL	0	ALE = normal
		BUSACT	1	External bus = ON
		RDYEN	0	READY = OFF
		CSREN	0	/CS active before /RD
		CSWEN	0	/CS active before /WR

Table 28: /CS2 Configuration for SRAM

The example in the table above specifies the maximum on-board memory configuration. In case only 256 kByte of SRAM are installed on the board, the address range must be adjusted as shown below:

Register	Hex	Function	Binary	Description
ADDRSEL2	1008h	RGSZ	1000	Address range 256 kByte

Table 29: Address Range with 256 kByte SRAM

3.1.4 Chip Select Signal for DATA Flash U2/3

The DATA Flash at U2/U3 is intended to serve as non-volatile data memory on the COMBI-Modul 167. This memory device can be mounted on customer request. The Flash is controlled with Chip Select signal /CS1 which must be configured for 16-bit demultiplexed bus mode by the user software.

Flash devices with either 128 kByte or 512 kByte capacity can be installed on each location, U2 and U3. Hence, a total of 256 kByte or 1 MB DATA Flash memory is available to the user. The memory access time is configured to 55 ns if the COMBI-Modul 167 is populated with the DATA Flash.
The Flash memory area can be configured to the address range 200000h to 2FFFFFh for example. The following table contains values for the correct bus configuration:

Register	Hex	Function	Binary	Description
ADDRSEL1	2008h	RGSZ	1000	Address range 1 MB
		RGSAD	0010.0000.0000	Start address 100000h
BUSCON1	04AFh	MCTC	1111	Wait states = 0
		RWDC	0	RD/WR delay = ON
		MTTC	1	Tristates = 0
		BTYP	10	16-bit demultiplexed
		ALECTL	0	ALE = normal
		BUSACT	1	External bus = ON
		RDYEN	0	READY = OFF
		CSREN	0	/CS active before /RD
		CSWEN	0	/CS active before /WR

Table 30: /CS1 Configuration for DATA Flash

The example in the table above specifies the maximum on-board memory configuration. In case only 256 kByte of DATA Flash are installed on the board, the address range must be adjusted according to the size.

Alternatively, it is possible to use the /CS1 signal for control of the expansion connector. In this case, the bus mode must be set to 8-bit demultiplexed. The timing parameters depend on the components used at this expansion connector.

3.1.5 Chip Select Signal for External UART

An external UART can populate the COMBI-Modul 167. This UART is controlled with Chip Select signal /CS3, which must be configured for 8-bit demultiplexed bus mode by the user software. Two wait states and one tristate must be configured for the timing parameters.

The UART memory area can be configured to the address range FFE000h to FFEFFFh for example. The following table contains values for the correct bus configuration:

Register	Hex	Function	Binary	Description
ADDRSEL3	FFE0h	RGSZ	0000	Address range 4 kByte
		RGSAD	1111.1111.1110	Start address FFE000h
BUSCON3	040Dh	MCTC	1101	Wait states = 1
		RWDC	0	RD/WR delay = ON
		MTTC	0	Tristates = 1
		BTYP	00	8-bit demultiplexed
		ALECTL	0	ALE = normal
		BUSACT	1	External bus = ON
		RDYEN	0	READY = OFF
		CSREN	0	/CS active before /RD
		CSWEN	0	/CS active before /WR

Table 31: /CS3 Configuration for External UART

3.1.6 Chip Select Signal /CS4

Chip Select signal /CS4 is used to control the error detection circuitry for the 24 V-Outputs, the board‘s configuration ID and the DIP switch. The following table lists the function components that are accessible with /CS4. Only read access is possible within the /CS4 address range.

Memory Range + Base Address		Function
0h	DIP switch	DIP= D0 .... D3
1h	Module configuration ID	D0 - D7
2h	Error 24 V-Outputs RTC interrupt UART interrupt Temperature sensor interrupt	D0 - D3 D5 D4 D6
3h	Reset error signal	with read access at this address
4h	/CS0	expansion connector
5h	/CS1	expansion connector
6h	NC	not connected, reserved for future use
7h	NC	not connected, reserved for future use

Table 32: Functions of Chip Select Signal /CS4

The bus mode must be set to 8-bit demultiplexed for /CS4. Two wait states and one tristate must be configured for the timing parameters. The /CS4 memory area can be configured to the address range FFF000h to FFFFFFh for example. The following table contains values for the correct bus configuration:

Register	Hex	Function	Binary	Description
ADDRSEL4	FFE0h	RGSZ	0000	Address range 4 kByte
		RGSAD	1111.1111.1111	Start address FFF000h
BUSCON4	040Dh	MCTC	1101	Wait states = 2
		RWDC	0	RD/WR delay = ON
		MTTC	0	Tristates = 1
		BTYP	00	8-bit demultiplexed
		ALECTL	0	ALE = normal
		BUSACT	1	External bus = ON
		RDYEN	0	READY = OFF
		CSREN	0	/CS active before /RD
		CSWEN	0	/CS active before /WR

Table 33: /CS4 Configuration

4 Hints for Installing the COMBI-Modul 167

Please note the following installation hints to ensure proper operation of the COMBI-Modul 167:

- The COMBI-Modul 167 design provides an EMC protection circuitry that is connected to protect earth (PE). Ensure that the cable that connects PE to the module is not longer than 100 mm.
- Take special care when installing cables for I/O connections. These cables should not be installed next to other cables that carry high power or signals with high noises. We recommend using shielded cables when installing the product in high noise environments in order to ensure proper EMC behavior.
- Ensure proper electrical separation of the low voltage for the 24 V power supply to the board.
- The COMBI-Modul 167 must be disconnected from a power source while installing/deinstalling the unit.
- The COMBI-Modul 167 should be installed by trained personal (such as technicians) only.
- Shielded twisted pair cables are recommended for connecting the analog inputs and outputs if the module is installed in high noise environments.
- It is recommended to install cables for signal lines and control lines separate from cables that carry power and signals for motors.
- It is strongly recommended to avoid parallel installation of cables with different electrical potentials.

5 Hints for Operating the COMBI-Modul 167

- The COMBI-Modul 167 is not designed for use in life supporting systems.
- We do not guarantee proper operation of the COMBI-Modul 167 when used in high noise environments that exceed common EMC guidelines.
- All values for operation voltage and I/O signals on the COMBI-Modul 167 may not exceed the specified maximum value in order to avoid malfunction and destruction of the device.
- The COMBI-Modul 167 should not be used in a high humidity environment.
- The IP20 protection is guaranteed only if the clear plastic enclosure is installed and the COMBICON connectors are inserted.

6 Technical Specifications

- Supply voltage: 24 VDC +/-20 %
- Power consumption: max. 1 A (typ. 110 mA) (at T=20°C)
- Storage temperature: -20 to +90 °C
- Operating temperature: 0 to +55 °C
- Humidity: 0 % to 95 % r.F. not condensed
- Dimensions.: 292 mm x 127 mm x 99 mm ± 2 mm
- Device height with chassis bar: 107 mm
- Weight: approximately 550 g

24 VDC Inputs:		
IN0 - IN19	input voltage	24 VDC ±20 % >13 VDC = active (‘0’) < 5 VDC = inactive (‘1’)
	input current	typ. 7 mA (24 V) max. 10 mA (30 V)
	maximum delay time	t_{on} ≤ 100 µs at 24 V t_{off} ≤ 25 µs at 24 V
	potential separation	yes
IN20 - IN23	input voltage	24 VDC ±20 % >15 VDC = active (‘0’) < 5 VDC = inactive (‘1’)
	input current	typ. 12 mA (24 V) max. 19 mA (30 V)
	maximum delay time	t_{on} ≤ 10 µs at 24 V t_{off} ≤ 20 µs at 24 V
	potential separation	yes

Table 34: Technical Data 24 V-Inputs

Relay		
OUT0-7 Relay	maximum switching voltage	125 VAC/250 VAC
	maximum switching current	3 A/2 A
	maximum switching power	500 VA
	minimum switching power	200 mW
	response time	typical 8 ms
	fall time	typical 12 ms
	bounce time	typical 1.5 ms
	potential separation	relay contact winding 4 kVeff relay contact to relay contact 1 kVeff
	expected life time	$2*10^5$ switching cycles

Table 35: Technical Data Relay Inputs

24 V-Outputs		
OUT8-15 (transistor)	switched voltage pole	consumer plus pole
	switching voltage	24 VDC ±20 %
	output current	0.5 A / output; total current of all outputs: max. 4 A
	max. switching voltage	30 VDC
	max. delay time	$t_{on} \leq 150$ µs $t_{off} \leq 400$ µs
	error detection	yes
	short circuit resistant	yes
	overtemperature resistant	yes
	protection against overvoltage	diode
OUT16-17 (PWM)	switched voltage pole	consumer minus pole
	switching voltage	24 VDC ±20 %
	output current	0.5 A / output; total current of all outputs: max. 1 A
	max. switching voltage	30 VDC
	max. delay time	$t_{on} \leq 15$ µs at 24 V/ 0.5 A $t_{off} \leq 7{,}5$ s at 24 V/ 0.5 A
	protection against overvoltage	diode
supply voltage for 24 V-Outputs	input voltage	24 VDC/ ± 20 %,total current of all outputs max. 4 A, OUT8..OUT17

Table 36: Technical Data 24 V-Outputs

Analog Inputs		
AIN0-AIN4	input voltage range	0 ... 10 V ±0.5 %
	input resistance	20 kΩ ±0.2 %
	maximum input voltage	11.5 V
	resolution	10-bit
	connection to signal source	two wire connection, single ended
	potential separation	no
	overvoltage protection	yes

Table 37: Technical Data Analog Inputs

Analog Outputs		
AOUT0-AOUT1	input voltage range	0 ... 10 V/ ±1 %
	minimum load resistance	3.3 kΩ/ ±5 %
	resolution	8-10-bit (PWM-Signal)
	connection to signal source	two wire connection, single ended
	potential separation	no

Table 38: Technical Data Analog Outputs

These specifications describe the standard configuration of the COMBI-Modul 167 as of the printing of this manual.

Index

/

/CS0 38
/CS1 40
/CS2 39
/CS3 41

2

24 V-Outputs 13
24 VDC-CPU 9
24 VDC-Ext. 9
24V Inputs IN0..IN23 10

A

Analog Inputs 16
Analog Outputs 17
Assembler 7

B

Battery 27
Block Diagram 5

C

C 7
CAN Bus Cable 21
CAN Driver Library 7
CAN Interface 21
Changing the Battery 27
Chip Select Signal /CS4 42
CODE Flash 38
COMBICON 3
COMBI-Modul 3
Compact Control System 3
Configuration for CODE Flash 38
Configuration for DATA Flash 40
Configuration for External UART 41
Configuration for SRAM 39
Connector Designator 29

D

DIP Switch 24
Display and Control Units 23

E

Expansion Connector 28

F

Features 4
First RS-232 Interface 22
FULL-CAN Interface 21

H

HEX-Encoding Switch 23, 32

I

I/O Port Arrangement of the 24V Inputs 10
I^2C Bus 18
I²C Bus 18
I²C EEPROM 19
I²C EEPROM Address 19
IGAS 3
Index 49
Installation Hints 43
Introduction 3

J

Jumper Configuration 26

L

Location of the Function Blocks . 7

M

Memory Access Time 38, 39, 40
Memory Configuration 26, 35

N

Network Layer 7

O

Operating Hints 44
Overview 3

P

phyPS Driver 7
Port Assignment Summary 29
Power Supply 9
PWM Outputs 15

R

Real-Time Clock 18
Relay Outputs 12
RESET 26
RTC 32
RTC Address 19
RUN/STOP Switch 25, 32

S

S300 24
S301 23
S302 23
S303 25
SCL 18, 19
SDA 18, 19
Second RS-232 Interface 22
Software Development Tools 7
SRAM 39
Status LEDs 25, 32

T

Technical Specifications 45
Temperature Sensor 20
Temperature Sensor Address 20
Timing Characteristics 37

U

U2 40
U3 40
U4 38
U5 38
U6 39
U7 39
UART 32

Document: **COMBI-Modul 167**
Document number: **L-540e_2, April 2002**

How would you improve this manual?

Did you find any mistakes in this manual? page

Submitted by:
Customer number: _____

Name: _____

Company: _____

Address: _____

_____

Return to:

PHYTEC Technologie Holding AG
Postfach 100403
D-55135 Mainz, Germany
Fax : +49 (6131) 9221-33

Published by

PHYTEC

Ordering No. L-540e_2
Printed in Germany