ELEKTRONIKON® MKIV

AIR CONTACT GSM-GPRS modem
EU Part.Nr. 1900 0711 XX (65-70)
US Part.Nr. 1900 0711 XX (75-80)

Hardware Manual

Version 1.4

The version of the entire document is increased on the occasion of each modification.
Modifications are listed in the chapter “Version History“.

IMPORTANT REMARKS

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Symbols for attention notes

Warning for general dangers.

Warning for dangerous electrical voltage.

ESD endangered devices. Housings and connections are only to be opened from trained persons!

Remarks.

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1 Introduction

1.1 Preface

This manual gives all the main information relevant the Air Contact module for Atlas Copco compressors. It provides also preliminary hardware information for the system programmer. The manual contains interconnections, technical data and mounting requirements.

1.2 Product Description

This manual describes the main part of the AIR CONTACT modem GSM/GPRS module.

The main features of the product are the following:

1. send some diagnostic SMS message to GSM telephone network on digital input events.
2. establish a data modem connection over the GSM network.
3. send a special diagnostic SMS message in case of loss of main power.
4. send a special diagnostic SMS message in case of backup battery replacement service

1.3 FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT NOTE:
FCC Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20cm between the radiator and your body.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2 Glossary

ELEKTRONIKON® MkIV	Compressor control electronic of the fourth generation.
CPU	Control Process Unit.
PCB	Printed Circuit Board
HMI	**H**uman **M**achine **I**nterface
Main Controller	Main control part of each compressor. Contains MMI, I/O's
IC	Integrated circuit.
EMC	Electromagnetic Compatibility
LED	Light Emitting Diode
Flash EPROM	Erasable Programmable Read Only Memory. Flash types allows an electronic erase.
SRAM	Static Random Access Memory

3 Features

Main Parts

- HMI
  - 2 x 7-segment LED display
  - 1 push button
  - 1 Service hours rotary switch with 10 positions
  - status LEDs
  - 1 x CAN address dip switch
- 512 kByte Flash EPROM
- 128 kByte SRAM
- 1 kbytes E2PROM emulated in a 8Kbytes Flash sector
- 1 RS232 serial Line
- 1 CAN BUS serial line (not optocoupled)
- Digital Inputs to be connected to a free contact
- Antenna with magnetic base, 5m coaxial cable, SMA right angle connector
- 1 GSM dual band AT modem with rechargeable LI-ION battery.

Optionally a GSM/GPRS dual band AT modem could be mounted

Power Supply: wide range voltage (100 ÷ 240 VAC)

4 Function Description

4.1 General

The Main Controller is supplied with nominal 115/230 VAC.

The device has **not** a fuse in the power supply line. A fuse **T1AH, 250V (slow-blow) CSA certified and UL recognized** has to be provided **externally** as described in *paragraph 10.1*.

Warning, dangerous electrical voltage can be at the connector. Never touch connections, when the device is running.

Protective earth PE has to be connected.

The Main Controller contain electrostatically sensitive components:
Prior to assembly and service operations, the personnel must be free of electrostatic charge, e.g. by touching the PE fixing screw or other grounded metal surfaces in the control cabinet.

4.2 Digital Input

The controller supplies a ground, which could be returned to a digital input over an external voltage free contact..

- Note, that the digital inputs are **not** isolated.
- When relay contacts are used, they generate typical 20ms bounces. The filtering of these signals has been done in software.

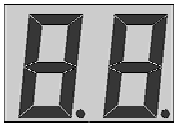
4.3 HMI

The HMI (**H**uman **M**achine **I**nterface) consist of:

- 2 x 7-segment LED display
- 1 push button
- 3 LEDs
- 1 x selector rotary dip switch
- accessible SIM card holder
- Customer specific adhesive lexan front foil

4.3.1 LED-Display

The LED-display provided for the Air Contact is a simple 2 digit 7-segment LED. It is used mainly to show the time left in service hours. One digit is for the thousands of hours and the other one for the hundreds of hours. Some other diagnostic numeric codes could be also showed.



Parameter	Value
dimensions	16 x 26 mm
Digits	2 x 7segment
Color	Red Led Segments

4.3.2 Push button

The module has 1 push button. It is mechanically protected from accidental pushing. It is used to reset the service hours counter.

4.3.3 Leds

Three LEDs are mounted on the PCB, visible to the operator through dedicated holes in the front panel and have the function to indicate machine status. One LED is controlled by microcontroller, one LED is directly controlled by modem AT interface and one LED is used to indicate power on.

4.3.4 Switches

One rotary selector switch with 10 positions is provided in the design to adjust the service time hours. The switch is accessible from outside and can be turned with a screw driver. Service Time hours from 1000 up to 9000 are possible. The switch is used to select the thousands of hours.

4.3.5 Sim Card Holder

A SIM card holder is provided in the design to insert and change the SIM card. The SIM card holder is accessible from outside the front panel under a plastic cap removable by service personnel.

4.3.6 Lexan adhesive front foil

A coulored custom specific adhesive front foil in Lexan material is provided on the front panel to show connectors code and labels indication.

4.4 Nonvolatile RAM functionality

Like the Main MkIV Controllers the Air Contact GSM module has an Nonvolatile RAM feature to save data before a power off occurs. The concept behind is the same. If the power supply falls below the specified minimum voltage an interrupt occurs. From now on the CPU saves the specific data in the Flash EPROM.

4.5 CAN-Bus

The C164CI has an integrated On-Chip CAN unit according the CAN specification V2.0 part B. This module handles the completely autonomous transmission and reception of CAN telegrams. That means, once the transmit buffer has written or the receive buffer is empty no CPU time is required. The CAN unit can receive and transmit standard frames with 11-bit identifier as well as extended frames with 29-bit identifier. Which kind of configuration will be used depends on the software protocol. The baudrate is programmable in a wide range, but only standards will be implemented.

Switches:

One 8 dip switch selector is provided in the design to set the CAN-Bus **node number.** The switches are accessible from outside. Node numbers from 1 up to 31 are possible.

8 x Dip Switch CANbus Node Address

Dip Swich Number	Function
1,2,3	Reserved to Modem functionality
4,5,6,7,8	LAN address selector (Binary Code, valid = 1 to 31)

Note:the address dip switch is read only at power on of the supply

Example of address selection:

CANbus Node Address = 1, the Dip switch configuration is:

Dip Sw number	1	2	3	4	5	6	7	8
ON								x
OFF	x	x	x	x	x	x	x	

4.6 RS232

This interface is useful for point to point communication at low speed. The signals are referred to ground. In Air Contact configuration the externally accessible RS232C serial is used to connect directly to Modem serial interface.

- The pin assignment is compatible with a DCE connection
- RS232C is not suitable for high speed and long distance.
- hardware handshake is provided.

An internal electronic switch is used to connect alternalively the Modem serial connection to microcontroller serial port (referenced as PORT1) or to the DB9 connector serial port (referenced as PORT2).

4.7 GSM Modem

A mountable on PCB commercial modem module is used to integrate a GSM telephone connection to the electronic stand alone controller. The antenna is external. Optionally a compatible GSM/GPRS commercial modem module could be soldered on the same PCB place as alternative to the standard GSM modem.

5 Microcontroller

The design of the Air Contact is a typical embedded control application that demands for the usage of a microcontroller. The choosen microcontroller should fulfil following requirements:

- high level system integration
- eliminate the need for additional peripheral devices
- provide system security and fail-safe mechanisms
- provide effective means to control and reduce the power consumption

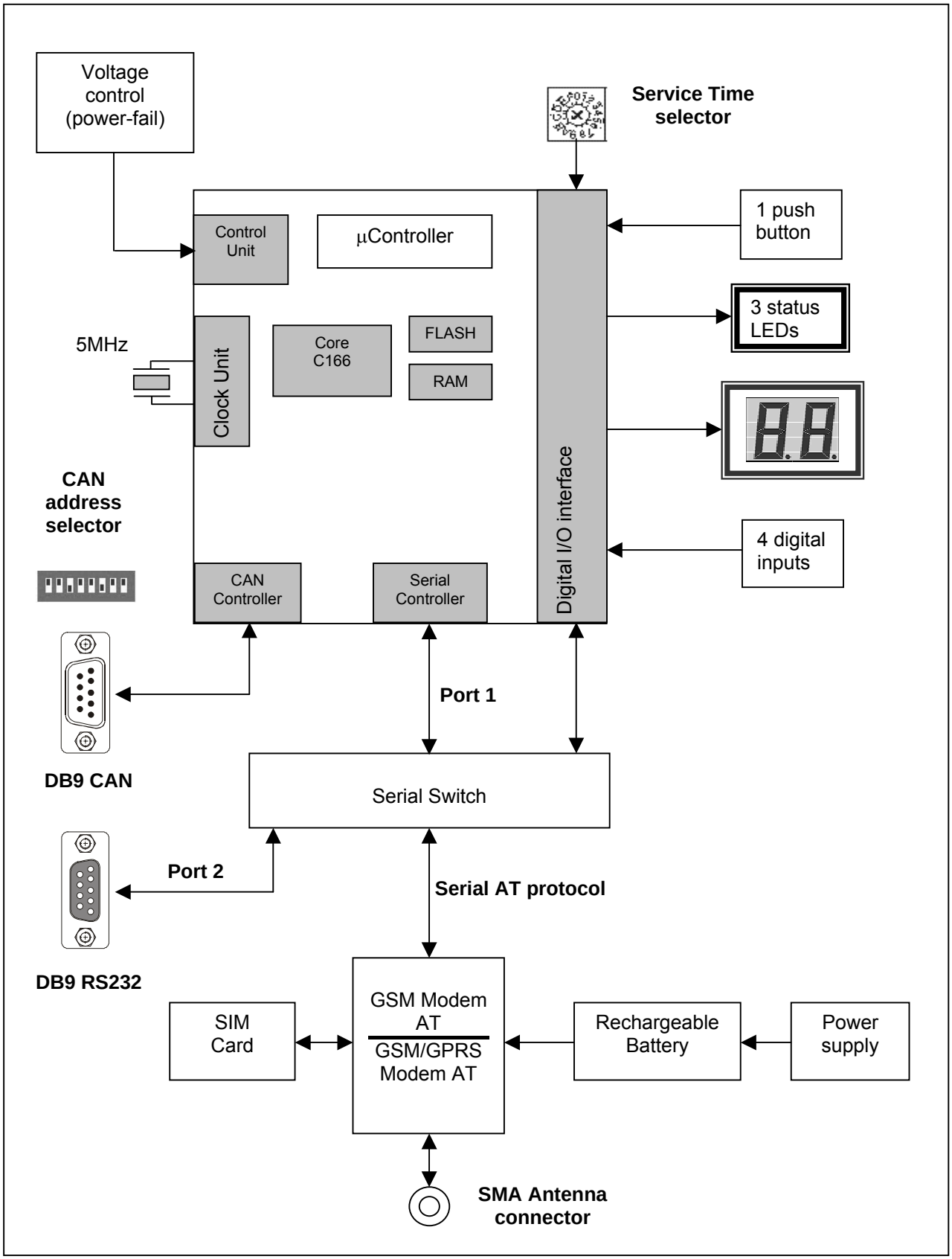
For this reason the Infineon C164CI microcontroller is chosen. This microcontroller is a member of the successful 166-family. The 166-family are 16-bit oriented microcontrollers that offer a wide range of different types beginning from a small low cost up to a high integrated type. This family of microcontrollers was also distributed by ST Thomson but not all types are available from them. The fact that these microcontrollers are used in different industrial and automotive applications as well makes possible that a lot of software and development tools are available on the market.

The Infineon microcontroller C164CI has following basic feature:

- High performance 16-bit CPU core
- Control oriented instruction set with high efficiency (bit, byte and word data types)
- Internal 2kByte RAM
- External bus interface (8-bit in the ELEKTRONIKON® MkIV application)
- flexible interrupt system with different priority levels
- 10-bit A/D converter
- CAN controller
- Asynchronous Serial Interface
- Synchronous Serial Interface
- Watchdog
- General purpose timer unit
- I/O lines with individual bit addressability
- internal PLL

The Infineon microcontroller C164CI is the core component in the Main Controller design. Around the C164CI external RAM, Flash EPROM, LCD-Display, I/O's and all communication interfaces (CAN-Bus, RS485, I^2C-Bus) are provided. For all Main Controller the identical fundamental core design is used and they differ only in the peripherals.

5.1 Block diagram



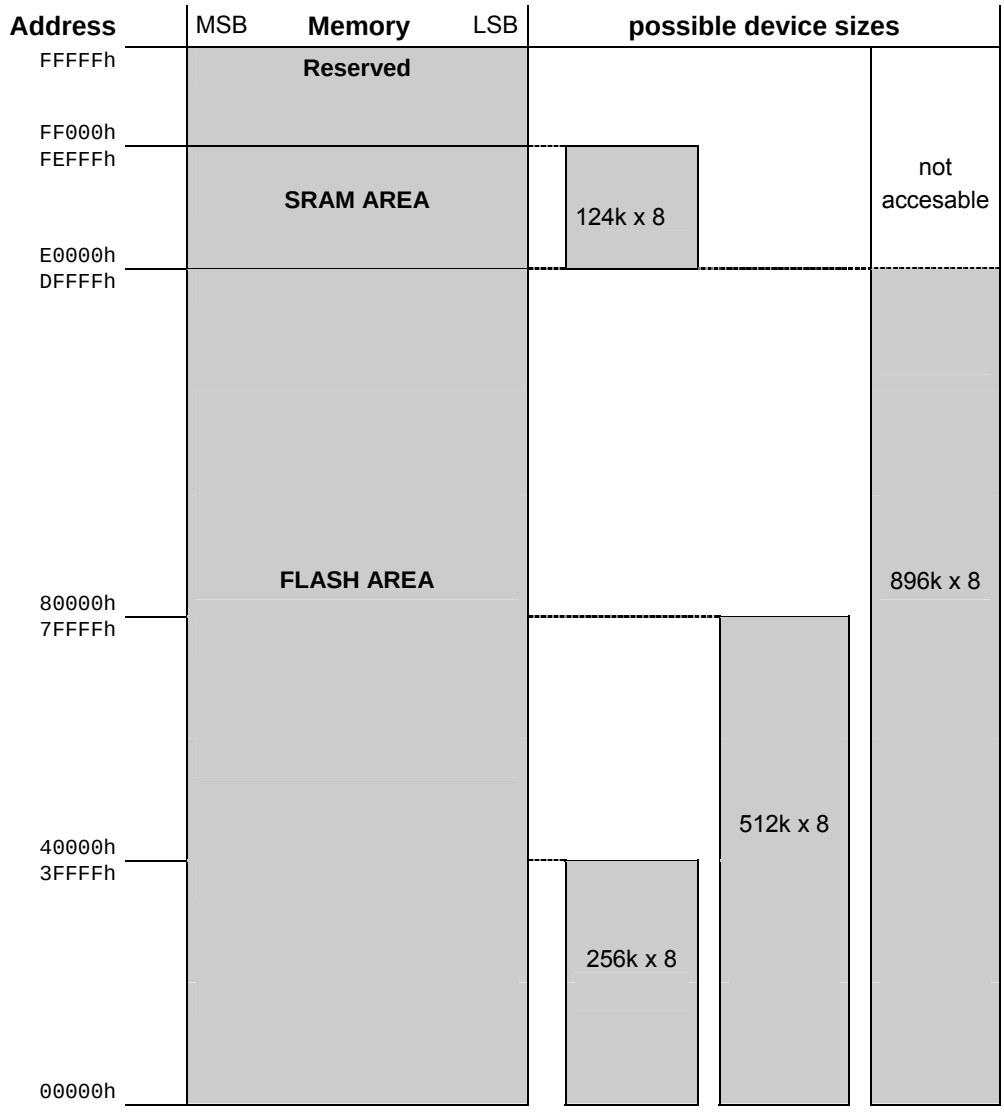
5.2 Memory-Layout

The Siemens microcontroller C164CI is configured so that up to 1MByte external, linear memory is addressable. Code and data are accessed in the same address space. The C164CI has internal

- 2 kByte RAM
- Special Function Register area

The internal and the external memory area are mapped into common address space. For more information refer to the Siemens data book. The table below shows the external memory configuration. The memory is 8-Bit oriented.

External 8-Bit Memory Organisation



Default configuration for the memory is 512kByte Flash and 124kByte SRAM, optionally the 1024kByte flash could be also mounted.

5.2.2 Flash EPROM

For code memory a Flash EPROM is provided. Flash EPROM's have the property that they are in circuit programmable. This allows to program the controller without opening it and making it easy field updates. Following device sizes are provided in the controller design:

- 256 kByte Typ: 29F200
- 512 kByte Typ: 29F400
- 1024 kByte Typ: 29F800

This two types are called bottom boot sector Flash EPROM because they consist 1x16kByte, 2x8kByte, 1x32kByte and the rest are 64kByte sectors.
To provide that three different types of Flash EPROM on the PCB do not cause additional costs and allows to adapt the right size. Which type will be used will be decided during the project and it depends on device costs and size of application software.

Technical data

sector erase time [1)]	typ.	1	s
chip erase time [1)]	typ.	8	s
byte programming time [1)]	typ.	7	µs
chip programming time [1)]	typ.	3.6	s
access time read cycle	typ.	250	ns

1) The data above specifies only the time required from the Flash EPROM. For a complete software download the time to transfer the data (baudrate), handshaking and check sum control should be added. The whole downloading time depends on the software concept too.

- Flash EPROM has a limited number of program/erase cycles per sector. It is not suitable for data memory that are updated every PLC cycle. The manufacturers of this devices guarantees the minimum of 1 million program/erase cycles.
- Flash EPROM allows only an erase operation for a whole sector (16kByte or 64kByte) and not for a byte.
- the program sequence for the Flash EPROM depends on manufacturer. The software must support different types.
- To the Flash EPROM **only 16 Bit** access (word) is allowed.

5.2.3 SRAM

The SRAM (Static RAM) is provided as data memory. Of course it could be used also as code memory with the C164CI microcontroller.

128 kByte only 124 kByte useable

Technical data

access time read/write	typ.	250	ns

The data bus to the SRAM is 8 Bit wide.

6 GSM components

6.1 EU GSM modem module

The EU GSM modem is the Wavecom Wismo Quick Q2400A.

It is a self-contained E-GSM 900/1800 dual-band module including following features:

- 2 watts E-GSM 900 radio section running under 3.6 volts
- 1 watt GSM1800 radio section running under 3.6 volts
- Digital section running under 2.8 volts
- 3V only SIM interface
- Real time clock with calendar
- Battery charge management
- Echo cancellation + noise reduction
- Full GSM software stack
- Complete shielding
- Complete interfacing through a 60-pin GPC connector:
  - Power supply
  - Serial link
  - SIM card interface
- RF connection pads (to the antenna)

6.1.1 RF functionalities

The radio frequency part is based on specific dual band chip including:

- Low – IF receiver
- Dual RF synthesizer
- Digital IF to Baseband Converter
- Offset PLL transmitter
- One logarithmic Power Amplifier module
- Dual band Power amplifier module

6.1.2 Baseband functionalities

The digital part is based on a Philips-VLSI chip (ONE C GSM).
The chipset is using a 0.25micron mixed technology CMOS wich allow massive integration as well as low current consumption.

6.1.3 Applications

The module is designed to be integrated into various types of applications such as handsets or vertical applications (telemetry, multimedia,..).
For vertical applications, the internal firmware offers a set of AT commands to control the module.

6.2 US GSM/GPRS modem module

The US GSM/GPRS modem is the Wavecom Wismo Quick Q2426B.

It is a self-contained GSM/GPRS 850/1900 dual-band module including following features:

- 2 watts GSM 850 radio section running under 3.6 volts
- 1 watt GSM1900 radio section running under 3.6 volts
- Digital section running under 2.8 volts
- 3V only SIM interface
- Real time clock with calendar
- Battery charge management
- Echo cancellation + noise reduction
- Full GSM or GSM/GPRS software stack
- Complete shielding
- Complete interfacing through a 60-pin GPC connector:
    - Power supply
    - Serial link
    - SIM card interface
- RF connection pads (to the antenna)

6.2.1 RF functionalities

The radio frequency part is based on specific dual band chip including:

- Low – IF receiver
- Dual RF synthesizer
- Digital IF to Baseband Converter
- Offset PLL transmitter
- One logarithmic Power Amplifier module
- Dual band Power amplifier module

6.2.2 Baseband functionalities

The digital part is based on a Philips-VLSI chip (ONE C GSM/GPRS Kernel).
The chipset is using a 0.25micron mixed technology CMOS wich allow massive integration as well as low current consumption.

6.2.3 Applications

The module is designed to be integrated into various types of applications such as handsets or vertical applications (telemetry, multimedia,..).
For vertical applications, the internal firmware offers a set of AT commands to control the module.

6.3 Antenna

The antenna has a magnetic base and it is prewired with 5 m of coaxial 50Ω cable. It is delivered with SMA male right angle connector. With this solution the extra depth necessary in front of the module to mount the antenna cable is less than 25 mm.

7 Technical Data

CPU-Core

Parameter	Value
CPU	Siemens C164CI-20MHz
Address range	1 MByte
CPU-Bus configuration	8/16 Bit
Internal RAM	2 kByte
Flash EPROM	512 kByte
RAM	128 kByte
Nonvolatile RAM	1 kByte

CAN-Bus

Parameter	Value
Controller	Integrated in CPU
Type /Specification	Full CAN / BASIC CAN / V2.0 Part B
Number of Nodes	max. 32
Physical Layer	ISO11898
Baudrate	programmable
Common Mode Rejection	-2.....+7V
Isolated	no
Connector Type	Sub-D 9 pole male (according to CiA)

RS232

Parameter	Value
Controller	integrated in CPU
Configuration	half duplex
Baudrate	programmable
Driver Output Voltage 0 Level 1 Level Output Level max.	 +5.0V....+15V (3kΩ to 7kΩ load) -5.0V.....-15V (3kΩ to 7kΩ load) ±25V (no load)
Receiver Input Voltage 0 Level 1 Level Input Level max.	 +3.0V....+15V (3kΩ to 7kΩ load) -3.0V.....-15V (3kΩ to 7kΩ load) ±25V (no load)
Isolated	no
Signals Handshake	Hardware
Connector Type	Sub-D 9 pole female

Display

Parameter	Value
Type	7segment 2 digits
Technology	LED
Viewing Area	16.2 x 26.7 mm
Foil Material type	Polyester PETP
LED	3 x Green
Keys	1
Rotary switch selector	1
Dip Switch selector	1

Digital Inputs

Parameter	**Value**
Number	4
Input Activation	Connection to digital input ground through free relay contact
Isolation	No

EU GSM modem

Parameter	**Value**
Type	E-GSM 900/1800 dual band
Power Output	2 watt E-GSM 900 MHz 1 watt GSM 1800 MHz
SIM interface	3 Volt only SIM interface, fully compliant with GSM 11.11 specifications
Software	Fully GSM software Stack
Antenna Specification	50 Ohms, coaxial cable, SMA connector
RF performance	Fully compliant with GSM 05.05 specifications
Temperature range	Operating: -20°C to +55°C Storage: -30°C to +85°C
Supply	From a dedicated LI-ION battery
Battery Charger	Internal
Battery Life Time	Typical from 2 to 3 years (*)

(*) the worst case happens at high operating temperature

US GSM/GPRS modem

Parameter	**Value**
Type	GSM/GPRS 850/1900 dual band
Power Output	2 watt GSM 850 MHz 1 watt GSM 1900 MHz
SIM interface	3 Volt only SIM interface, fully compliant with GSM 11.11 specifications
Software	Fully GSM or GSM/GPRS software Stack
Antenna Specification	50 Ohms, coaxial cable, SMA connector
RF performance	Fully compliant with GSM 05.05 specifications
Temperature range	Operating: -20°C to +55°C Storage: -30°C to +85°C
Supply	From a dedicated LI-ION battery
Battery Charger	Internal
Battery Life Time	Typical from 2 to 3 years (*)

(*) the worst case happens at high operating temperature

General

Parameter	**Value**
Supply Voltage	Wide range voltage (100 ÷ 240 VAC)
Power Consumption	10VA
I max	0.15 A
Type of Protection	IP20
Temperature Range Operating Storage	 -10°C…..+55°C **(*)** -30°C…..+70°C
Permissible Humidity	Relative humidity 95% no condensation
Noise emission	EN 55022 class B: 1998 EN 50081-2: 1993
Noise immunity	EN 50082-2: 1995 EN 61000-6-2: 1999
Weight	0.5 kg
Dimensions	~140x105x73mm (LxHxD)
Housing	Plastic Material - UL Flame Category: HB
Mounting	DIN RAIL

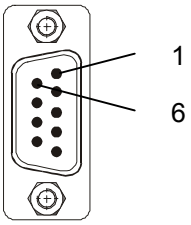
(*) The Operating Temperature Range is limited to +55°C due of modem chip limits

8 Pin Assignment

Pin Assignment CAN-Bus (Lan)

Sub-D 9 pole male

12X1



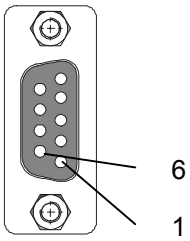
Pin	Function
1	Reserved
2	CAN_LOW
3	CAN_GND
4	Reserved
5	Reserved
6	GND external supply
7	CAN_HIGH
8	Reserved
9	CAN external supply*

* not used for MKIV Component. Supply for CAN-Driver already integrated

Pin Assignment RS232

Sub-D 9 pole female

12X15

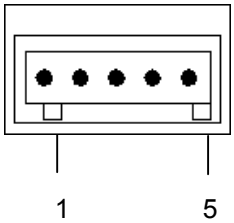


Pin	Function
1	Reserved
2	RxD
3	TxD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	Reserved

Pin Assignment Digital Input

12X9

Male connector, straight, 5-way
pitch 3.5mm.
Model: Wago 734-135

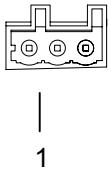


Pin	Function
1	**D**igital **I**nput **01**
2	**D**igital **I**nput **02**
3	**D**igital **I**nput **03**
4	**D**igital **I**nput **04**
5	**Digital Common Ground**

Pin Assignment 100÷240 VAC Supply

12X14

Male connector, straight, 3-way,
pitch 5mm.
Model: Wago 721-133

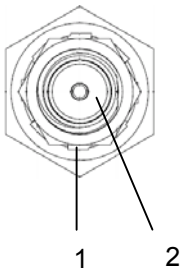


Pin	Function for 230VAC
1	**100 ÷ 240VAC** Supply
2	**100 ÷ 240VAC** Supply (N)
3	**PE**

Pin Assignment Antenna Connector

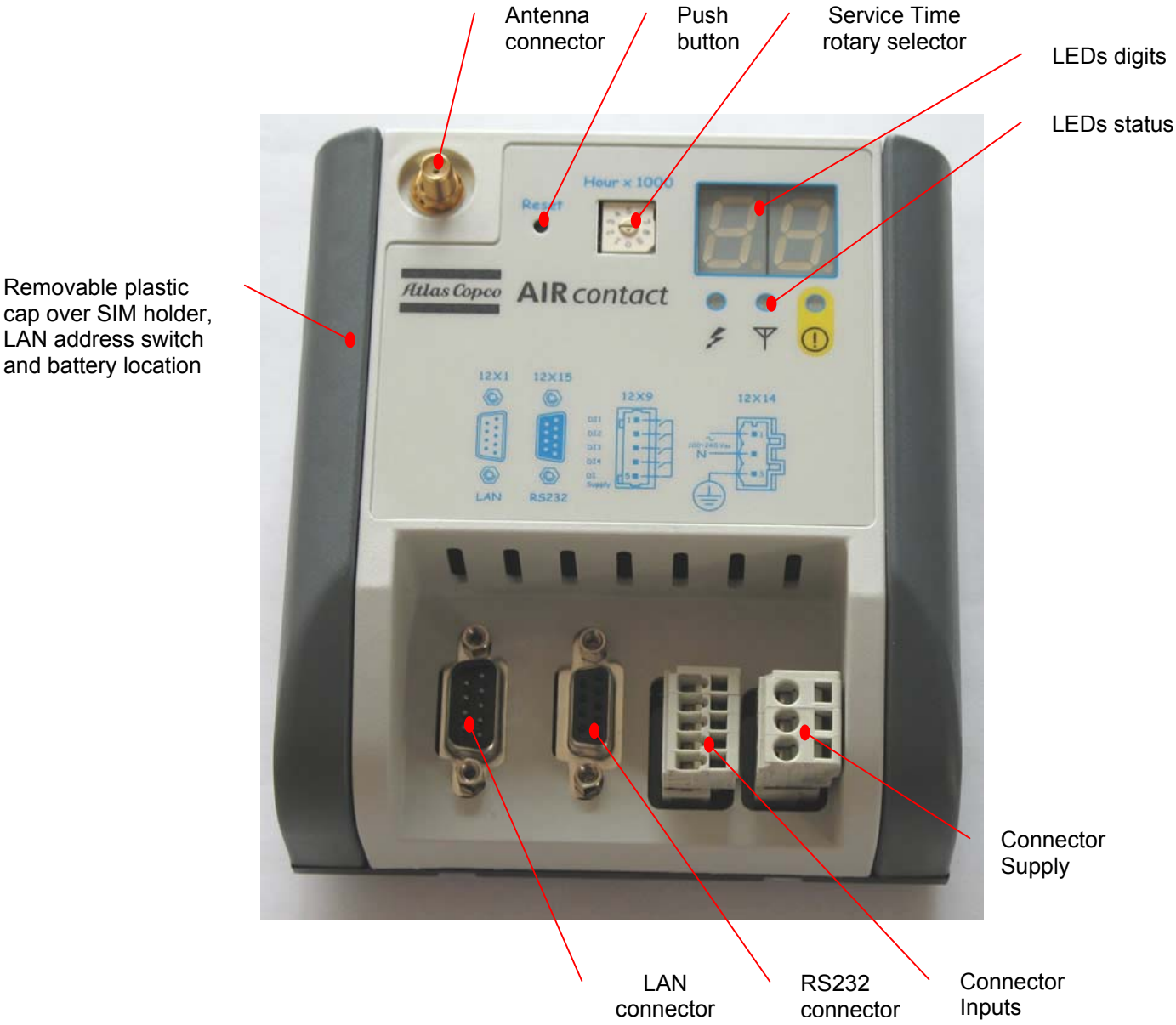
female connector
Model: SMA

Pin	Function
1	**Ground**
2	**GSM RX/TX**

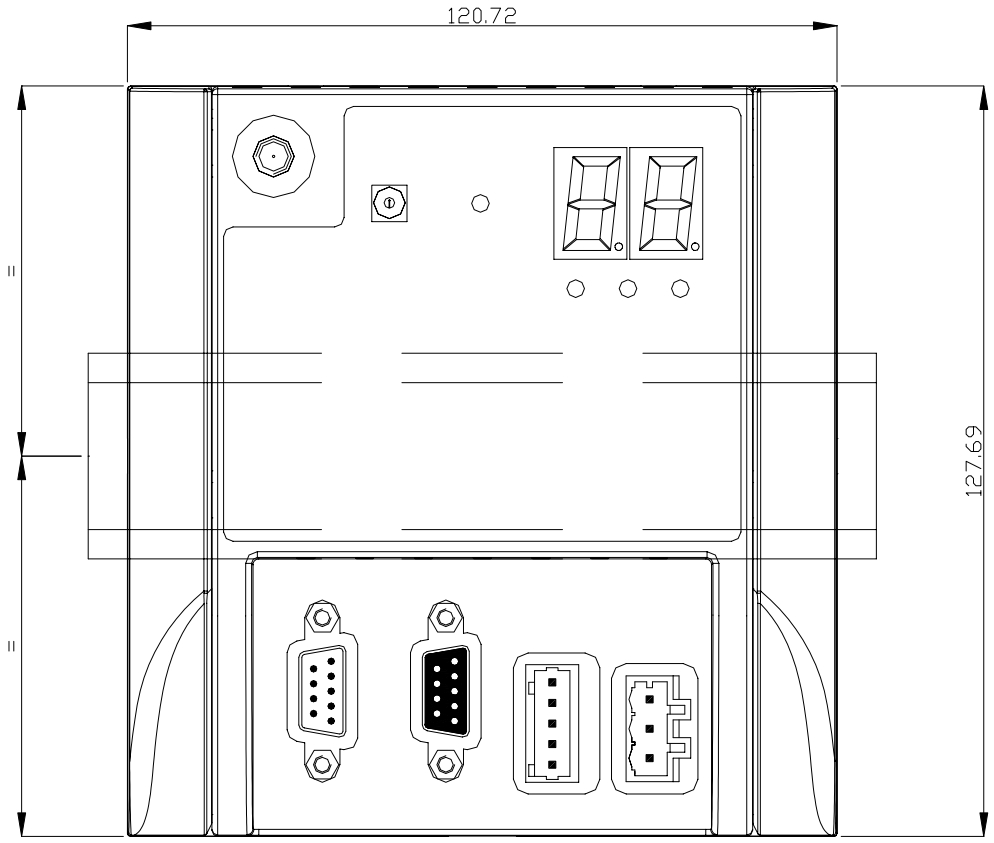


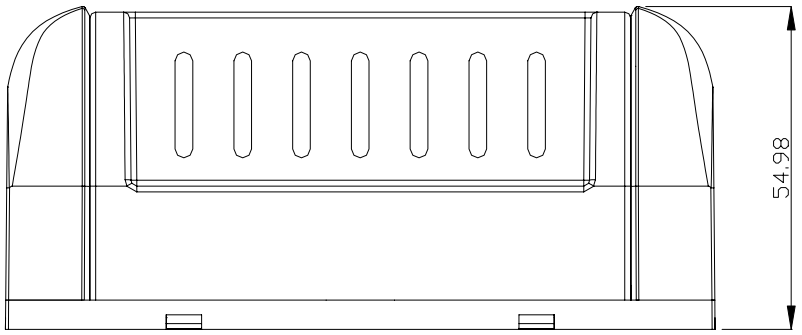
9 Housing

9.1 Front View



9.2 Views





9.3 The GSM module location

The GSM module can be located easily inside the cubicle mounted on a DIN-RAIL. This solution simplifies the housing of the module and the wiring (short wires). This arrangement suits a solution of an antenna cable connected at the housing of the GSM module with a SMA male connector.
The cable will be allowed to come out the cubicle via a PG sleeve.
Please refer to ***Air Contact Installation Manual***.

9.4 The antenna placement

This device has to be placed outside the compressor cubicle. This leads to the need of a cable to connect the antenna to module. The connection distance between antenna and module can also vary from case by case, and to be installed at the customer site. The chosen standard solution is an external antenna with magnetic base, prewired with 5 m cable and connected to the Air Contact via a male SMA right angle type connector.

10 Battery Replacement

The Lithium-ion battery used as backup supply power for the Chip GSM modem needs a replacement after some years of continous work. To execute this service replacement only when there is a really need a software algorithm will be implemented to evaluate the residual power capacity of the battery.

The algorithm use a measure of the battery discharge time. When the battery is not recharging but the Air Contact is working it's residual charge continuosly reduces.
Measuring the speed of discharge and comparing it with a reference value then we can define an Event Level that can activate a warning status. In warning status a service replacement could be activated.

The replacement is simple and could be executed without returning the module to the manufacturer. Following is a sequence of operations to replace the battery into the Air Contact box.

1. Unscrew the two screws on the rear of the module (figure 1)
2. Pull the left cap, pay many attention (figure 2)
3. Disconnect the battery connector (figure 3)
4. Replace and connect again the battery (figure 4)
5. Close the left cap (figure 2)
6. To fix the left cap screwing the two screws on the rear of the module (figure 1)

Figure 1

Figure 2

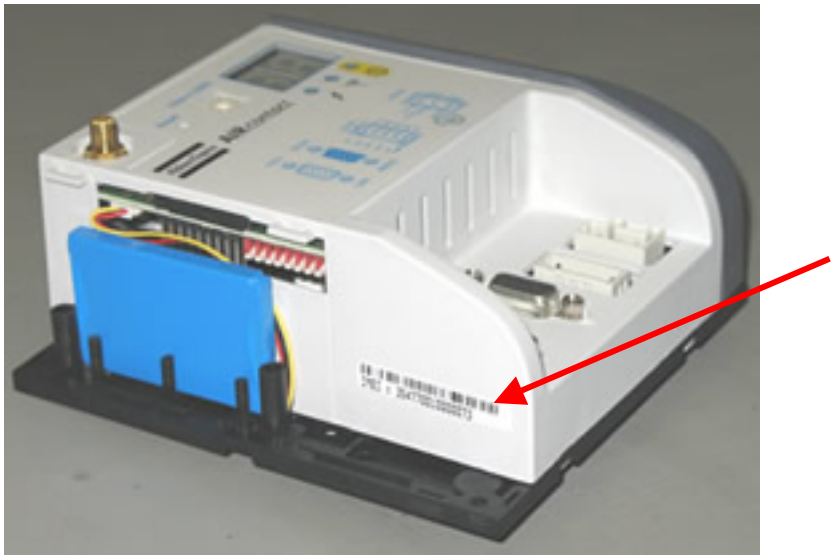
Figure 3

Figure 4

11 IMEI code

The IMEI code it is placed on a label visible removing the left cap.
It is also possible found it (together the part and serial number), on the document placed in the pack.

Please pay attention to don't loose the Aircontact code document.



12 General Operation

The RTS run time Codesys interface is installed in the Air Contact Firmware. With this software library a PLC application program could be downloaded through the CAN interface and simply executed at power on. A specific Codesys GSM library is developed to simplify management of the modem Chip.

The Air Contact could work in two different modes:

1. SMS monitor
2. GSM modem

In SMS monitor mode the digital inputs and some function events has the capability to send a dedicated SMS programmable text message to a specific dial GSM number.

In GSM modem mode the serial AT protocol connection is directly accessible from the DB9-RS232 connector to an external device (PC, Airmonitor, other).

For a detailed documentation on the software features of the Air Contact, please see the dedicated manual ***AirContact_User's Manual***.

13 Versions history

Version.:	**1.0**	**Changes**	**from**	**03.04.2006**	**Author: Maurizio Marmiroli**
Version.:	**1.1**	**Changes**	**from**	**03.04.2006**	**Author: Maurizio Marmiroli**
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