

SEA 9745

4G/GPS Communication Module for CompactRIO™ (USA)



Part No.: 60000070



S&E-A Science & Engineering
Applications Datentechnik
GmbH

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Getting Started

General



The safety ratings and specifications in this document are specific to the SEA 9745 module and may differ for other components in the system. To determine the safety ratings and specification of the entire system refer to each component in the system.

Before starting to work with the SEA 9745 module please read this document and the software manual carefully. If there are any questions about operating the module or if any term is not understood, please contact the vendor before using the module.



Ensure that you use the latest version of the manuals: Check the Support/Downloads area on the S.E.A. website <http://www.sea-gmbh.com> for updates and get the latest version if available.



Refer to the software manual for details on programming and integration of the SEA 9745 module.



Refer to the appropriate National Instruments™ documentation for details on National Instruments hardware.

We believe that all information in this manual is accurate. The document has been carefully reviewed for technical accuracy. In the event of techni-

cal or typographical errors, we reserve the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult the vendor if errors are suspected.

End User License Agreement (EULA)

Before operating the SEA 9745 and the provided software you have to agree to the terms and conditions (EULA). This agreement is part of the software installation procedure. In addition, the terms and conditions are available through the LabVIEW menu after installation (Tools > SEA > `product name` > Legal Information). If you do NOT agree you can send back the hardware and software package within a period of two weeks after delivery. In this case S.E.A. will refund the product price and shipping costs.

Safety Guidelines

To protect persons against any harm and the module from damage, the operation of the SEA 9745 module is only allowed according to the rules described in this document.

Operator Protection



Hot or Cold Surface The metallic surface of the module might become hot or cold as well. Touching the surface may result in bodily injury.
Do not dismount the module from the chassis during operation. Wait until the module temperature has reached 20 °C.



Do not insert or remove the module from the system or connect/disconnect wires or connectors to/from the module unless power has been switched completely off. Make sure working in an ESD safe environment.



Do not open or disassemble the module or other hardware parts.
Guarantee is void if the seal is broken!



Use only isolated power supplies with a nominal voltage of 12 VDC, made for use with CompactRIO systems.



Keep the module and the antennas at least 1 meter away from human bodies during operation.

Safety Critical Applications



The module is not failure tolerant and therefore not suitable for use in safety critical applications.



Do not use the module for medical applications or any live supporting apparatus.



Do not solely use the module for geoposition determination, when a failure can be a danger for the environment, material or can possibly harm humans.

Hazardous Locations



The module is suitable for use in non hazardous locations only. Keep the module always away from hazardous locations and explosive areas.



Protect the module from thunderstorm and lightning strikes or other electrical hazards.



Use the module only in dry areas. Do not operate the module in bath areas, kitchens etc., where water or vapor can be getting in contact with the module or cables.

Hazardous Voltages

A voltage is hazardous when higher than 25 V_{RMS} or 60 VDC to earth ground according to IEC 60364-4-41 (SELV). If the module specifications allow to connect hazardous voltages to the module, take the following precautions, when connecting hazardous voltages to the module:



Make sure that only qualified personnel wires hazardous voltage adhering to local electrical standards.



Do not mix hazardous voltage circuits and human-accessible circuits on the same module.



The module must not be operated in high voltage areas.

Electromagnetic Compatibility Guidelines

This equipment has been tested and found to comply with the regulatory requirements and limits for electromagnetic compatibility (EMC). These requirements and limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the supplier or an experienced radio/TV technician for help



Changes or modifications could void the user's authority to operate the equipment.

To meet the RF exposure rules and regulations and minimize the radio frequency exposure to humans, you must follow the following directives:

- Installers and operators have to follow the transmitter operating and antenna installation instructions for satisfying RF exposure compliance, please refer to the user manual of the antenna.
- The antennas used for this transmitter have to be installed to provide a separation distance of at least 1 m /3,3 ft from persons and must not be co-located or operated in conjunction with any other antenna or transmitter.
- Use only antenna types, which are designed for the use with the module. If unsure ask the antenna supplier (i.e. S.E.A.).
- The GSM antennas used for this module must not exceed 7,5 dBi (GSM), 3 dBi (PCS) or 5,5 dBi (LTE, Band 4) for mobile and fixed or mobile operating configurations.
- Do not operate the module and antenna near other RF systems.
- Use only antenna cables and connectors made for cellular systems and frequencies. Do not bend the antenna cabling less than the bending radius of 30 mm.
- Do not open or disassemble the module, antenna or other hardware parts.

Prerequisites

The SEA 9745 module is shipped with the following accessory:

- Printed 'Hardware Manual - Operation Instructions, Safety Guidelines and Specifications'

In order to operate the module further components are required (not shipped with the module):

- Power cable for external power supply, order no.: 61000011, mandatory for operation
- Ethernet bridge cable, order no.: 61000051, mandatory for operation
- Software driver
Can be downloaded from the support area on <http://www.sea-gmbh.com>.
- CompactRIO system from National Instruments
- Power supply with 7 to 30VDC and 2 A
- GSM antenna
Is required to use the GSM related features. Matching GSM antennas can be purchased separately from S.E.A. Please refer to our web shop.

- **SIM card**
Is required to use the GSM features. The SIM card has to be purchased from a MNO. S.E.A. does not provide SIM cards or any mobile services.
- **GPS antenna**
Is required to use the GPS features. Matching GPS antennas can be purchased separately from S.E.A. Please refer to our web shop.



It is strictly recommended to use the module only in combination with accessories recommended by S.E.A. to avoid incompatibility, malfunction or even damage of the components.

Connecting SEA 9745

The SEA 9745 module provides sockets for one GPS (3) and two GSM antennas [*GMS Antenna 1* (6), *GSM Antenna 2* (5)], one Ethernet port (8), a reset switch (7), a connector for an external GPS receiver (4) and a connector for an external power supply (2). Four LEDs (1) show the current state of the module, refer to Fig. *Front side* on the right.

On the back side of the module there is a SIM card slot and a micro SD card slot, refer to Fig. *Insert SIM* on page 17. The micro SD card slot is designated for special purposes and shall not be used for regular operation.

Finally, on the side with the imprint a set of DIP switches is available. With these switches the behaviour of the module can be controlled, refer to Fig. *DIP Switches* on page 18.



Only one SEA 9745 module can be operated within a single CompactRIO system. It is not possible to operate more than one SEA 9745 module in-

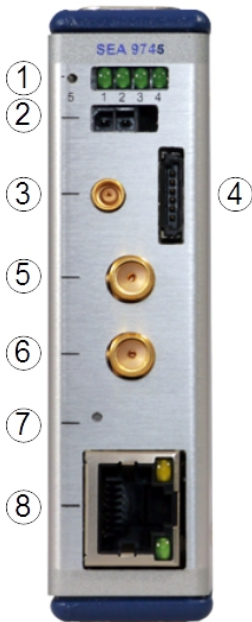


Fig. 1: Front side

side a single CompactRIO system.

GSM/GPS Antenna(s)

The SEA 9745 module features antenna diversity for GSM with providing two antenna sockets: 'GSM Antenna 1' (main) and 'GSM Antenna 2' (diversity). Both GSM antenna sockets are of type SMA (female). The module works fine with only one antenna, however, the connection quality and data throughput may be increased using two antennas. **If only one GSM antenna is used, it shall be connected to the GSM Antenna 1 socket.**

For GPS the SEA 9745 module provides one antenna socket of type MCX. Only active GPS antennas with a supply voltage of 3.3 V and a maximum current of 40 mA are allowed. Antennas with differing specifications will destroy the module.

Select adequate antennas carefully for the intended use case. Mount the antennas mechanically properly at the desired location. Connect only antennas which are proven to work with these modules. Refer to the S.E.A. web shop at <http://www.sea-gmbh.com> for matching antenna types.

If a roof antenna is used, the antenna has to be dismantled when lightning strikes are likely. The module and any antenna or cabling is NOT protected against lightning strikes or any over-voltage. Do NOT operate the module or antenna during thunderstorms, and keep the antenna away from any kind of elevation.

GPS External Connector

The GPS External connector is a 6-pin ERNI MiniBridge socket. In order to use this connector the respective DIP switch needs to be enabled first, refer to chapter 'DIP Switches'. The pinout is shown in Fig. *GPS External Pinout* on the right. Through this connector the module provides:

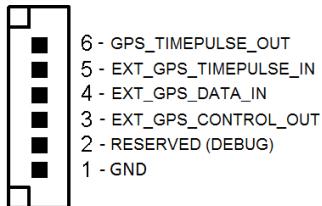


Fig. 2: GPS External Pinout

- an interface for an external GPS receiver
- GPS Timepulse signal output
- a debug interface

An external GPS receiver may be required, when special purpose GPS functionality is required that the integrated GPS receiver cannot provide. The GPS External socket accepts GPS receivers with a RS-232 compatible serial interface (pins 4 and 3) and a 5V-TTL compatible Timepulse signal (pin 5).

S.E.A. separately provides suitable cables for connecting external GPS receiver. Refer to <http://www.sea-gmbh.com> for details.



Depending on the external GPS receiver type or manufacturer the control (configuring) GPS API functions may not be supported, be-

cause these functions use proprietary commands for the integrated GPS receiver.

When reading the GPS data using the *GPS Read Messages* API function no limitations are to be expected, as long as the external GPS receiver outputs the GPS data in NMEA-0183 format.



Do not switch between internal and external GPS receiver while the module is operating. Turn off the module before switching the GPS receiver source.

The second feature is the GPS Timepulse signal output (Pin 6). This output delivers a 5V-TTL compatible GPS time pulse signal from the active GPS receiver (internal or external depending on the DIP switch). Optionally the time pulse signal can be generated/customized in FPGA.

The last feature is the debugging interface for the internal system. This special purpose interface should only be used when instructed by S.E.A. When debugging is enabled (via pin 2) the pins 3 and 4 are used for the serial communication with the internal system and therefore an external GPS cannot be operated simultaneously.

Ethernet Port

The module provides an Ethernet port to connect the module with a Controller. Connect this port with the Ethernet port of a CompactRIO controller using the enclosed Ethernet bridge cable. It is recommended to insert the module in slot 1 due to the length of the enclosed Ethernet bridge cable.

SIM Card Slot

On the back side of the module there is a slot for SIM cards, refer to Fig. *Insert SIM* on the right. It accepts mini SIM cards. Nano and micro SIM cards can be used with an adequate SIM adapter.

Insert the card until the slide-lock mechanism locks. Refer to the scheme on the module cover for proper orientation of the SIM card. It is recommended to use a small screw-driver or tweezers.

To release the SIM card move the slide lock out of the way, see Fig. *Release SIM* on the right. The SIM card is slightly pressed out and can be removed from the module using a small tweezers.

In order to use the available services ensure that the SIM card is enabled for packet data usage by the MNO.



Before inserting the SIM card, switch off the module, otherwise the card will not be recognized.

External Power Supply



Fig. 3: Insert SIM



Fig. 4: Release SIM

For operation of the SEA 9745 module it is mandatory to supply power through the front side power supply connector because the power supply through the backplane is insufficient for the needs of the module.

Connect the module with an adequate power source using the enclosed power cable. The accepted input voltage range is 7 to 30 VDC.



Check the polarity of the wires before powering up the module. Please note that the module's voltage range may possibly differ from the actual CompactRIO controller voltage range. Do NOT rely on the cable colours to assume polarity.



After disconnecting the power supply or activating the sleep mode please wait at least 5 seconds before reconnecting the power supply again or awake from sleep mode. In other cases the module can show unexpected behaviour.

DIP Switches

The DIP switches are placed on the imprinted side of the module. They are considered to customize the module's features according to users needs.

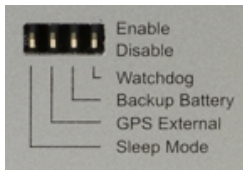


Fig. 5: DIP Switches

The functionality of each DIP switch is explained

in the following table:

Switch	Meaning
Watchdog	<p>This switch allows to enable the module's internal system monitoring. This is useful if the module is operated headless and a recovery strategy is required.</p> <p>Enable: Watchdog is enabled. If an internal system error occurs the module executes a reset.</p> <p>Disable (default): Watchdog is disabled. If an internal system error occurs the module stops with regular operation and will not recover by itself.</p>
Sleep Mode	<p>The sleep mode is like a standby, which allows to reduce the power consumption of the system, when not actively operated. Refer to chapter 'Sleep Mode' for details.</p> <p>Enable: CompactRIO can set the module to sleep mode.</p> <p>Disable (default): CompactRIO cannot set the module to sleep mode.</p>
GPS External	<p>This switch allows to use an external GPS receiver instead of the internal one. Refer to chapter 'GPS External Connector' for details.</p> <p>Enable: an external GPS receiver is used.</p> <p>Disable (default): the internal GPS receiver is used.</p>

Backup Battery	<p>The battery keeps the system clock (RTC) running and stores the GPS almanac while the module is switched off. Refer to chapter 'Backup Battery' for details.</p> <p>Enable: The battery is charged when the module is powered. The GPS almanac and the RTC are maintained while switched off.</p> <p>Disable (default): The battery is not charged when powered. The GPS almanac and the RTC are not maintained while switched off.</p>
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Tab. 1: DIP Switches

LEDs

The LEDs on the front side of the module are numbered from 1 to 4 (from left to right). Next to those LEDs there is a small LED on the left side which has the number 5. The LEDs indicate the module's current state according to the following table:

LED #	Meaning
1	Is steady on when power (through front side connector) is present.
2	Flashes with Timepulse frequency when GPS receives valid data.
3	Is steady on when the module is registered to the mobile network (GSM). May flash during boot phase.

4	Is steady on when a Packet Data connection (GSM) is established.
5	Flashes when the module is booting or performs a factory reset. Is steady on when module is operational.

Tab. 2: LEDs

Backup Battery

The backup battery provides the following features:

- Stores the last GPS almanac.
This feature significantly speeds up the availability of the first valid GPS data after a power-up, because the module does not need to collect the almanac again, which can take several seconds or minutes. This option requires that the location of the GPS antenna didn't changed significantly since the last switch-off.
- Supplies the internal system clock (RTC) with power.
This feature keeps the internal clock (RTC) running maintaining the valid time and date while the module is powered-off.

The battery is designed as a maintenance-free component and is hence not considered to be replaced during a module's lifetime. Therefore it is recommended to take some measures to extend the battery's lifetime:



The battery should not be discharged below a minimum limit to avoid its damage. Therefore do not store the module with enabled battery for long time periods. An acceptable store period is between 2 and 6 weeks depending on the battery condition and the storage conditions (temperature, humidity...). As a general rule: a storage period of 4 weeks is achievable under normal environmental conditions, when the battery is fully charged before.

Reset Switch

In case that the module does not boot up (LED 5 does not light continuously), or some other problem appears that you cannot solve through the module configuration, you can force the module to execute a factory reset procedure.

The reset procedure performs the actions as follows:

1. resets all configuration settings to factory default including the module's IP address (factory default IP: 192.168.1.100)
2. removes all firmware updates downgrading to the production-time firmware version.



Before resetting the module to factory condition save the settings and ensure that you can install the module's firmware update(s).

To perform a factory reset follow the steps:



1. Power down the module
2. Press and hold the Reset switch
3. Power up the module and wait until LED 5 blinks continuously
4. Release the Reset switch and wait until LED 5 is steady on (this can take up to some minutes)

After the reset remember that the module's IP address may have changed. Re-configure your module and install all required firmware update(s).

Sleep Mode

This module supports a low-power sleep mode. In sleep mode typically there is no communication with the module and the power consumption is minimized. The system thermal dissipation may decrease. Refer to the *Specifications* section for more information about power consumption and thermal dissipation. The sleep mode can be enabled by software.

The SEA 9745 module provides an additional hardware (DIP) switch *Sleep Mode* that allows to ignore the sleep mode selection from the software, refer to Fig. *DIP Switches*. This is useful if the entire system should be set to the sleep mode but it still needs to be accessible through the SEA 9745 module. If the hardware sleep mode switch is set to *Enable*, the sleep mode selection by software takes effect on the SEA 9745 module. Otherwise (*Sleep Mode* is set to *Disable*) the SEA 9745 module ignores the sleep mode software selection and continues to operate.

Specifications

The following specifications are typical for the nominal temperature of 20 °C unless otherwise noted.

GSM Characteristics		
<u>Frequency Bands</u> GSM GPRS EDGE UMTS HSDPA HSUPA LTE	MHz	850 / 900 / 1800 / 1900 850 / 1900 / 2100 700 / AWS (B4) / 2100
<u>Max. Data Rates</u> ¹ GPRS EDGE HSDPA HSUPA LTE	kbit/s kbit/s Mbit/s Mbit/s Mbit/s	(UL: Upload, DL: Download) multislots class 10 85.6 (DL) / 42.8 (UL) multislots class 12 236.8 (DL) / 236.8 (UL) category 24 42.2 (DL) category 6 5.76 (UL) category 3, MIMO 100 (DL) / 50 (UL)
Approved MNOs		AT&T

¹ Data rates are max. possible values. Typically the effective data rates are much lower.

GPS Characteristics		
Number of Channels		50
Frequency Band		GPS L1
<u>Time-To-First-Fix</u> Cold Start, w/o Battery	s	26
Cold Start w. Battery		3
Max. Update Rate	Hz	4
<u>Position Accuracy</u> Horizontal	m	2.5 ¹
Vertical		10 to 40
Velocity Accuracy	m/s	0.1
Max. Altitude	m	2000
Max. Speed	km/h	500
Timepulse Accuracy	ns	50
<u>Timepulse Logic</u> Low	V	0 to 0.3
High		0.7 to 5

1 CEP, 50%, 24 hour static, -130dBm, SEP: <3.5m

Power Requirements²		
Operating Voltage Typical	VDC	7 to 30 12
<u>Operating Current</u> Typical Peak Sleep Mode	mA	202 325 2
Physical Characteristics		
Weight	g	ca. 200
Dimensions	mm	80 x 23 x 88
Environmental Conditions		
Operating Temperature	°C	-25 to +60
Storage Temperature	°C	-40 to +85
Ingress Protection ³		IP 30
Operating humidity	% ⁴	10 to 90

2 The exact power consumption is dependant on the active communication standard as well as the antenna and reception quality.

3 with connected power cable

4 RH, noncondensing

Shock and Vibration		
<u>Operating Vibration</u> Random (IEC 60068-2-64) Sinusoidal (IEC 60068-2-6)	Hz	5 g _{rms} , 10 to 575 5 g, 10 to 575
<u>Operating Shock</u> (IEC 60068-2-27)		15 g, 11 ms half sine, 30 g, 11 ms half sine, 50 g, 3 ms half sine, (10 shocks at 6 orientations)

Tab. 3: Specifications

Electromagnetic Compatibility

For EMC compliance, it is only allowed to operate the SEA 9745 with original and shielded antenna cabling only. For further information about antennas and cabling please refer to our website: <http://www.sea-gmbh.com>



This product meets the essential requirements of the following US directives:

- FCC 47 CFR Part 15B: Class B

This product contains FCC ID: N7NMC7700

PTCRB

This product is tested to comply with PTCRB standards. PTCRB is a global organization created by mobile network operators to provide an independent evaluation process where GSM/UMTS/LTE type certification can take place.

For more information see <http://www.ptcrb.com>.



Canada

This product meets the requirements of the **INDUSTRY OF CANADA RULES.**

This product contains transmitter module IC: 2417C-MC7700 where 2417C-MC7700 is the module's certification number.



This product is conform with the following European Union directives:

- Directive 1999/5/EC (Radio Equipment & Telecommunications Terminal Equipments, R&TTE)

In order to satisfy the essential requisite of the Directive 99/5/EC, this product is compliant with the following standards:

- Radio: EN 301 511 and EN 301 908
- EMC: EN 301 489-1/-7

- Health: EN 62311
- Safety: EN 60950-1

Note: The R&TTE compliance is partly covered by the integrated radio module.

Maintenance

Only use a clean and dry towel to wipe the SEA 9745. The SEA 9745 is not water resistant and should not be operated in humid environments.

The SEA 9745 does not contain components, which have to be maintained.



Opening the SEA 9745 will destroy the heat conductors and will void warranty.

Contact and Support

Address:

S.E.A. Datentechnik GmbH
Muelheimer Strasse 7
53840 Troisdorf
Germany

Support channels:

1. website: <http://www.sea-gmbh.com>
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