



TAKING CONTROL FORWARD

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# CPAC-1054 (CICU): General Guidelines - Installation and Operation

<b>Description</b>	General installation and operational guidelines for the CPAC-1054 (CICU) unit		
<b>Issued by</b>	Lars-Gunnar Sundin	<b>Classification</b>	Open within project
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# 1. Document Information

## 1.1 Purpose

The purpose of this document is solely to give general guidelines for the installation of CPAC-1054 (CICU) in buses supplied by Volvo Bus Corporation (VBC).

It does not replace the more specific instructions needed for the installation of CPAC-1054 (CICU) as part of the assembly instructions needed for different types of buses including all equipment and functions.

This latter type of document is written by the manufacturing entity of each type of bus or bus family.

Note 1: Since the use of the CPAC-1054 (CICU) is bus specific there is no general "User Manual" for CPAC-1054 (CICU).

## 1.2 Revision History

Rev	Date	Name	Description
A	2016-06-14	L-G Sundin	First external version
A2	2016-06-20	L-G Sundin	Minor correction: antenna interface connector (SMC> SMB)
A3	2016-06-20	L-G Sundin	Use of antenna frequency bands clarified
B	2016-07-06	L-G Sundin	Max output power corrected to 15 dBm (conducted)
C	2016-12-06	L-G Sundin	General clean-up. Definition of antenna feeder coaxial cable added.
D	2017-03-29	L-G Sundin	Antenna type corrected to Hubert+Suhner 1354.17.0001 (the 1356.17.0008 given in earlier revisions is very similar but only used for prototypes)

## 1.3 Confidentiality

This document is solely to be used by VBC, or companies specifically appointed by VBC for integrating the CPAC-1054 (CICU) unit and its antenna in VBC supplied buses.

The document is neither intended for the end users of the buses, nor for the general public.

## 1.4 References

Ref	Title	Registration number

## 1.5 Terminology

Term	Explanation
CICU	Designation used by Volvo Bus Corporation for the CPAC-1054 unit
MCS	Machine Control System
TBD	To Be Defined
VBC	Volvo Bus Corporation

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## 2. Overview



*Electrical prototype bus at charging station. WLAN/WiFi antenna of the charging station – similar to that of the bus – can be noted immediately to the left of the pantograph upper mounting in the tower.*

The CPAC-1054 (CICU) is installed in VBC buses for electrical charging control and subsidiary functions of electrical or electrical hybrid busses at charging stations. It is not intended for any other use.

The CPAC-1054 (CICU) communicates via a WLAN/WiFi connection for Hi-Power charging (HPC) and via a cable for Low-Power (“overnight”) charging (LPC). The communication is regulated by the ISO 15118 standard.

This document focuses on general aspects of the WLAN/WiFi communication.

The WLAN/WiFi connection is solely used for M2M communication between the bus and the charging station. WLAN/WiFi is used for the movement control of the tower mounted pantograph and for handling the charging sequence. No human action is required or used for the WLAN/WiFi communication between the charging station and the bus. The connection is not used for voice - or - general purpose data transfer not related to the basic charging and associated functions.

The WLAN/WiFi function of the charging station pantograph tower has a master role in the communication, while the WLAN/WiFi function of the bus has the client/slave role. The WLAN/WiFi communication is done in the vertical plane and can only be performed when the bus and the bus antenna is positioned underneath the antenna of the charging tower.

The WLAN/WiFi communication may have a function related to the positioning of the bus with respect to the pantograph, but this is often handled by other means. To support positioning operations, similar hi-gain antennas<sup>1</sup> are used in both the charging station tower and the bus.

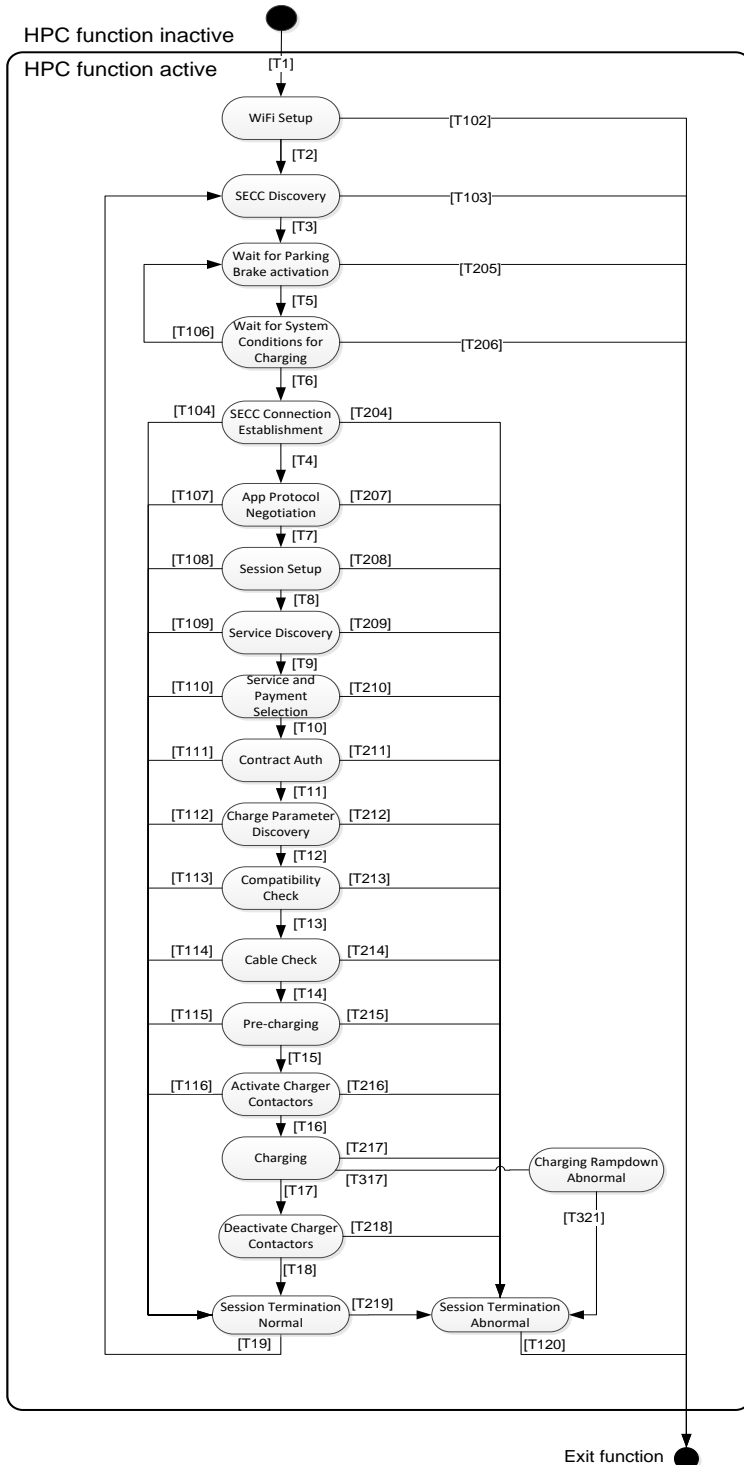
<sup>1</sup> The hi-gain property of the antennas as such, is not used by the system, but the antenna lobe property with confined sharp flanks in (or close to) the antenna near field is.

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### 3. Operation

This section gives a description<sup>2</sup> of the HPC (Hi Power Charging) sequence, focused on the use of the WLAN/WiFi, particularly the start-up sequence. Other portions have been deleted.

#### 3.1 State Machine for HPC and initiation of communication



<sup>2</sup> The info is derived from a various specification document.



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## 3.2 Description of the HPC initial transition sequence involving WLAN/WiFi

This section, as an illustration, contains the more detailed sequence for the upstart of the HPC charging including role of WLAN/WiFi. The HPC Transition T-designations refer to the figure in section 3.1.

### **HPC Transition T1:**

REQ 0567-0056-P06

The HPC function shall be started and begin in the state WLAN/WiFi Setup, IF ALL of the following is true:

- A recognized SSID with WPA2 security enabled is within range
- EmergencySwitchStatus=NotEmergency
- BatterySwitchStatus=Active
- ServiceSwitchStatus=ServiceNotOngoing
- PowerNetDRStatus=Active
- ChargingCableConnected = InActive

*State: WLAN/WiFi Setup*

*Connect to the charging station network through the detected SSID and receive an IP address for the vehicle.*

Entry:

None

Do:

REQ 0567-0057-B01

Establish a connection to the detected SSID, using the corresponding password.

REQ 0567-0317-P09

The WLAN/WiFi Setup shall be retried as long as the SSID is within range.

Exit:

REQ 0567-0060-C04

Set VP212.ChargingDriverMessage = 0x0 (No driver message)

### **HPC Transition T102:**

REQ 0567-0061-B02

Exit function IF ANY of the following conditions are true:

- EmergencySwitchStatus=Emergency
- BatterySwitchStatus=Inactive
- ServiceSwitchStatus=ServiceOngoing
- PowerNetDRStatus=Inactive
- Detected SSID no longer within range

### **HPC Transition T2:**

REQ 0567-0062-B01

Go to state SECC Discovery if the following condition is true:

- Communication setup is successful

... etc.

## 4. Installation

### 4.1 CPAC-1054 (CICU) unit



CPAC-1054 (CICU) – exterior view

### 4.2 Mounting requirements - unit

The CPAC-1054 (CICU) unit shall normally be mounted in a separate compartment inside the bus.

- The unit can be mounted horizontally or vertically.
- No hot surfaces shall be close to or come in contact with the unit and cables.
- No moving parts shall be allowed touch the cables or the unit
- The mounting of the unit shall be such that unintentional touching of the unit box during operation is avoided since the exterior surface may be warm/hot.

### 4.3 Mounting requirements - cables

- Cables shall be connected to the CPAC-1054 (CICU) unit according to the connector marking.
- The cables shall be strapped to avoid tension (push/pull/torque) on the connectors.
- Cable and connector mounting and clamping shall follow “Volvo Design guidelines”
- The cables harness shall not be visible or easily accessible after mounting
- The cables shall normally be routed away from electrical disturbance sources like radio transmitters, electrical motors, power inverters etc.
- All electrical equipment within 2 m from the cables shall comply with the Volvo EMC directives

#### 4.4 Mounting requirements - WLAN/WiFi antenna connected to the unit



*Antenna (front and back), interconnecting antenna cable and CPAC-1054 unit<sup>3</sup>*

The WLAN/WiFi antenna shall be mounted horizontally at the roof of the bus near the charging rails.

A special mounting bracket made for the bus model shall be used. The antenna mounting geometry shall match the arrangements of the charging system (rails, pantograph, charging tower antenna etc) including positioning requirements.

The antenna shall be mounted in such a way that the antenna cable connecting to the CPAC-1054 (CICU) unit can be routed to the unit in the cabin/compartiment inside the bus according to the rules for such cable routing.

*NOTES: The antenna is only for outside/outdoor mount. Shall normally always be used together with associated 7.5 m coaxial cable included with the antenna.*

<sup>3</sup> Note: The CPAC -1054 unit in these photos has special test cables mounted. These test cables are not part of the operational cable arrangement, only the interconnecting feeder coaxial cable between the unit and the antenna.





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## 5. Modes of Operation

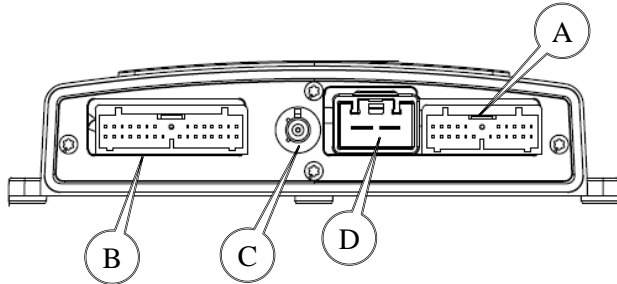
The CPAC-1054 (CICU) unit has two basic operation modes, Sleep and Operational Mode.

- Sleep Mode
  - The power state Sleep is realized by disabling all power to the unit with the exception of circuits for wake-up handling and hardwired I/O.
  - When the CICU detects a power connection, it initiates “wake up” of the unit, by turning on the dc-dc converters, starting the microcontroller.
  - Sleep state is entered when charging is finished or interrupted.
- Operational Mode
  - In Operating Mode, all processes in normal operation. Power source: main 24V battery.

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## 6. Additional technical data

### 6.1 Overview of Connectors



Pos.	Description
A	22-pin JAE connector
B	30-pin JAE connector
C	External Wi-Fi Antenna connector
D	Heater Interface, 2-pin Yazaki connector

- Connector A: type JAE IL-AG5-22P-D3L2, miscellaneous signals to and from CICU unit
- Connector B: type JAE IL-AG5-30P-D3L2, miscellaneous signals to and from CICU unit
- Connector C: type SMB, Fakra Black, Code-A, coaxial connection CICU antenna and CICU unit
- Connector D: type YESC Kaizen 7382-5608-30, interface to heater of high power charger rails.

### 6.2 Radio Interface for M2M communication

WLAN/WiFi module: type U-BLOX ODIN-W260

- Dual band WLAN/WiFi (2.4 and 5 GHz).  
NOTE: Only 5 GHz band is used for CPAC-1054 (CICU)
- WLAN/WiFi standards: IEEE 802.11a/b/g and IEEE 802.11 d/e/h
- WLAN/WiFi output power: 15 dBm (max conducted)
- Globally certified

### 6.3 Power

- External Power: nom 24 V (8 – 32 V)
- External fuse: 10 A (slow blow)
- Power consumption: < 100 mA@24V (max 3 W)

### 6.4 Environment

- IP class: IP32, ISO 20653
- Temperature (operational): -40 - +85 °C
- Temperature (storage): -40 - +85 °C

### 6.5 Physical Specification

- Size: 187 mm x 121 mm x 43 mm
- Weight: 255 g

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## 6.6 WLAN/WiFi Antenna including feeder coaxial cable

- WLAN/WiFi antenna: type Huber & Suhner Sencity SPOT-L (1354.17.0001).
  - Frequency bands: 5150 – 5875 MHz (Band: 4900 - 5150 MHz not used)
  - Polarization: Linear
- Dimensions (excluding feeder coaxial cable): 305 mm x 305 mm x 15 mm
- Weight: 1.2 kg
- Connectors, antenna and feeder coaxial cable:
  - Antenna element: N type,
  - Coaxial cable: Fakra Code A
- Antenna feeder coaxial cable:
  - Length (standard cable): 7,5 m
  - Attenuation (standard cable): 16.7 dB
  - NOTE: If for some reason this standard cable can't be used a replacement shall have a minimum attenuation of 16.7 dB.
- Temperature: -45 - +70 °C
- IP class: IP67