

POTSwap™ – LTE910PS Product User Manual



JANUS REMOTE
COMMUNICATIONS

Bulletin	JA16-LTE-UM
Revision	08
Date	19 May 2021

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1 POTSwap General Description

The POTSwap allows landline telephones to replace their POTS (plain old telephone service) connection with a wireless cellular connection. Both dial-in and dial-out voice is supported. Contact Janus Remote Communications with details of your application.

An FXS connection (RJ11 jack) provides complete Central Office emulation including dial tone, ringing and busy signal generation as well as DTMF detection and generation. The POTSwap emulates all the functions of a wired telephone connection and is fully compatible with all common landline telephone standards.

Wireless connectivity is provided by an integrated cellular module which provide support for current mobile network technologies with service available from numerous wireless carriers.

Configuration of the POTSwap can be achieved via a local serial USB connection.

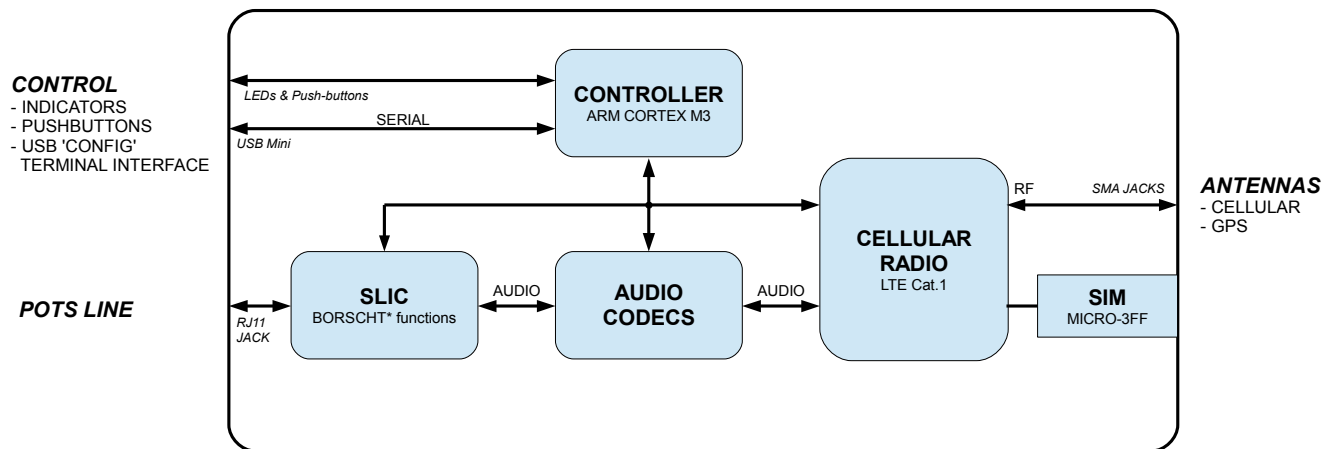


Figure 1 POTSwap Block Diagram

2 Integrated Cellular Modem

Cellular communication for the POTSwap is provided by an integrated cellular modem module. This module offers the ability to support multiple carriers with firmware changes in future products.

The POTSwap provides one platform that supports current cellular technology with the future in mind.

3 Operation

3.1 Set-Up:

Operating the POTSwap with voice (telephone) equipment can be achieved through the following steps:

1. Gather the required equipment:

- LTE POTSwap
- Power Supply - This can be hard-wired from a user supplied power source via the terminal block header (See section 9 - Compatible Terminal Block Connectors) or using the optional wall transformer (See section 11 - Accessories).
- Cellular antennas - Two LTE cellular antennas are recommended. (See section 11 - Accessories).
- GPS antenna - An active GPS antenna must be connected the the GPS antenna connector to provide E911 location support. (See section 11 - Accessories)
- The POTSwap requires an activated SIM card. A 'micro' (3FF size) SIM card is required.

2. Install the SIM card in the rear panel SIM slot. The gold contact side faces down; the camphered corner edge goes in first. The panel slot is sized such that a dime coin can be used to assist in seating and unseating the SIM card.

See section 6 - SIM Card Installation.

3. Connect the cellular antennas to the SMA connectors labeled 'CELL 1' and 'CELL 2'. This can be a local antenna or a remote antenna connected by a coaxial cable.

4. Connect a GPS antenna to the SMA connector labeled 'GPS'. (See Section 7 - GPS.)

5. Connect power to the unit.

Once powered, the unit should show a connection to the cellular carrier within a minute. This will be indicated by a rapidly flashing GREEN 'STATUS' LED, a GREEN 'CELL' LED, and a steady signal strength indication on the Received Signal Strength LED stack.

3 Operation continued

3.2 Voice Operation

Voice operation requires a standard voice telephone device to be connected to the POTSwap.

3.2.1 Placing calls:

When the connected telephone device is taken off hook, the POTSwap will present an audio dial tone signal. Dialing can proceed with up to 30 digits being accepted. If the Dialing Tone Timeout (30 second default) elapses before the first digit is dialed, the dialing session is ended by an Open Switching Interval (900 millisecond default). If the Dialing Digit Timeout (4 second default) elapses after a dialed digit, dialing is concluded and a call to the dialed number is placed. At any time the number sign ('#') can be dialed and the call is placed immediately, avoiding the Dialing Digit Timeout. Note that if Fixed Format Dialing is enabled, the dialed number must consist of a ten digit phone number that includes the area code, or an eleven number when the first digit is a '1'.

Telephone devices that automatically take the phone off-hook and place a call to a fixed telephone number are compatible with the POTSwap. Dialing digits should not be sent faster than 100 ms per digit, with a minimum DTMF tone duration of 45 ms.

The POTSwap is compatible with DTMF dialing only. Pulse dialing (rotary phones) is not supported.

3.2.2 Receiving calls:

Incoming calls will cause the POTSwap to generate a ringing signal on the phone line. Taking the connected telephone line off-hook will answer the incoming call. Note that cellular carriers typically impose a 30 second limit on unanswered ringing before a call is transferred to a voice mail system.

3.2.3 Call Disconnect:

A call can always be terminated by placing the connected telephone equipment on-hook. If a cellular call is terminated on the carrier side (the result of a connected party ending the call or due to loss of signal) the POTSwap will use an Open Switching Interval to aid in disconnecting automated type telephone equipment. It removes the voltage from the phone line connection for a short time to signal that the call has been terminated. The OSI interval can be adjusted using the user configuration menu.

3.2.4 Unconnected Busy:

In some instances when dialing a number that is busy, the cellular carriers will not make an audio connection to a busy tone. If this occurs, the POTSwap will generate the busy tone locally for a period defined by the user configurable Busy Dwell Timeout parameter. Following the busy tone, the POTSwap will terminate the call by generating an Open Switching Interval (see section 4 - Configuration).



Figure 2 Voice Operation

4. Configuration

Configuration of the POTSwap is available via communications with the CONFIG USB connection. Configuration can be accomplished by connecting a terminal device (e.g. laptop or desktop computer running a terminal emulator) to the CONFIG port using a USB cable with a USB 'mini' type B connector for the POTSwap. The USB connection requires a CP210x USB to UART Bridge VCP Driver. Normally this will be automatically installed by the operating system. Otherwise it can be downloaded from Silicon Laboratories at www.silabs.com.

Serial interface settings for the CONFIG port are 115200 baud and 8N1 (8 data bits, no parity, 1 stop bit).

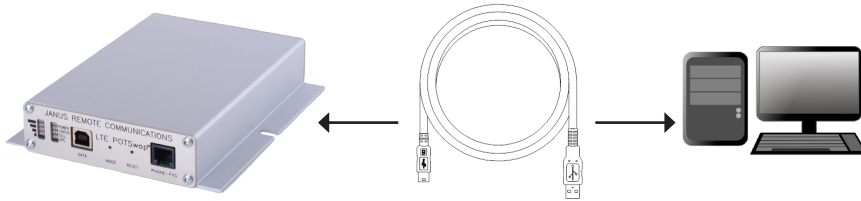


Figure 3 Serial USB Connection

When the POTSwap is first powered on, it will output something similar to the following:

```
WireLine III Board - POTSwap - [FIRMWARE VERSION]

12.288MHz Codec Build
LE910 Power-Up Mode
This device and/or modem are not certified for E911 Voice Calling

WireLine_Open
  900 Open Switching Interval
30000 Dialing Tone Timeout
 4000 Dialing Digit Timeout
 6000 Busy Dwell Timeout
   0 Fixed Format Dialing
   0 Fail Over Mode
   3 Inbound Audio Gain
   3 Outbound Audio Gain
```

The first line will contain the version number of the firmware in a YYMMDD (year, month, day) format. Following this are the current configuration settings. Several of these parameters are user configurable and can be adjusted by entering the CONFIG command during the power-up sequence.

About 15 seconds following the application of power, the unit offers a short interval wherein the user can enter the terminal configuration menu. The following text will be output:

```
WireLine III Board - POTSwap
Entering Terminal Mode, 10 seconds to type first command
Type ? for help, Q to exit
FW: HH:MM:SS MTH DY YEAR
READY
```

4. Configuration continued

At this point the user has 10 seconds to enter one of the following commands followed by a line termination ('Enter' key on PC's):

TERMINAL MENU COMMANDS

COMMAND	FUNCTION
?, H	Outputs the current menu options.
Q, QUIT	Exits the menu and causes the POTSwap to proceed with the normal operation.
XMODEM	Download upgrade binary
REBOOT	Restart Application
CONFIG	Configure Settings
IDENTIFY	Display Cellular IMEI (International Mobile station Equipment Identity) and phone number

These commands are NOT case sensitive. Terminal menu commands operate as follows:

?, H: Entering a '?' or 'H' character will output the Terminal menu command menu again. It can be useful if the menu has scrolled off of a screen.

Q ,QUIT: Entering 'Q' or 'QUIT' will exit the DEBUG menu and continue with the normal start-up and operation of the POTSwap.

XMODEM: Used for firmware upgrades.

REBOOT: Entering 'REBOOT' will restart the POTSwap, similar to pressing the RESET button.

CONFIG: Entering 'CONFIG' will cause the configuration menu to be output:

IDENTIFY: Displays the phone # and IMEI number of the cellular radio.

```
Janus Remote Communications - WireLine III Board - POTSwap Configuration
=====
Open Switching Interval [900 ] 0-1200 ms
Dialing Tone Timeout   [30000] 500-60000 ms
Dialing Digit Timeout  [4000 ] 250-15000 ms
Busy Dwell Timeout     [6000 ] 1000-30000 ms
Fixed Format Dialing    [0] 0-1
Fail Over Mode         [0] 0-2

Inbound Audio Gain     [4] 1-16
Outbound Audio Gain    [4] 1-16

Press M=Modify, D=Defaults, X=Exit and Save, Q=Quit and Discard
```

The configuration menu lists the name of the parameter, the current setting (in brackets), and the range or values of settings available. These settings may vary depending on the model of Plug-In Terminus terminal used in the POTSwap. Following the list of parameters are options for changing the configuration settings or leaving this menu: M, D, X, and Q. These single character command options can be entered in upper or lower case, and no enter key is required.

CONFIGURATION COMMANDS

COMMAND	FUNCTION
M - MODIFY	Enter the parameter modification menu.
D - DEFAULTS	Set all parameters to their default (factory) value.
X - EXIT AND SAVE	Save changes and exit the configuration menu.
Q - QUIT AND DISCARD CHANGES	Discard changes and exit the configuration menu.

M - MODIFY Commands:

Entering an 'M' command will cause the current setting for each parameter to be output, and allows changing the parameter setting. Currently, the following parameters can be modified:

4. Configuration continued

CONFIGURATION PARAMETERS

PARAMETER	DEFAULT	RANGE	FUNCTION
Open Switching Interval	900	0-1200 (milliseconds)	Sets the period that the battery voltage is removed from the telephone line following the termination of a call from the carrier side, a dialing timeout, or a locally generated busy tone. (AKA Kewlstart.)
Dialing Tone Timeout	30000 (milliseconds)	500-60000	Sets time limit for first dialing digit to be entered following going off-hook. Exceeding the time limit will cause Open Switching Interval to be generated.
Dialing Digit Timeout	6000 (milliseconds)	250-15000	Sets time limit for time between entering dialing digits. Exceeding the time limit will cause Open Switching Interval to be generated.
Busy Dwell Timeout	6000 (milliseconds)	1000-30000	Sets length of time a busy tone is generated locally on calls where the cellular carrier does not provide an audio connection to a busy tone. The Open Switching Interval will be generated following the busy tone.
Fixed Format Dialing	0	0-1	Enables Fixed Format dialing. When set to '1' (enabled), only 10 digit (or 11 digits when first digit is a '1') dialing and 911 dialing is allowed. When set to '0' (disabled), any number of dialed digits is accepted once the Dialing Digit Timeout is exceeded. Dialing the number sign ('#') short-cuts the Dialing Digit Timeout and immediately accepts the dialed digits.
Fail Over	0	0-2	Dial tone availability: 0 - Any network availability, including emergency (911) ONLY. 1 - Home network registration 2 - Home or Roaming registration
Inbound Audio Gain	4	1-16	Sets inbound audio gain.
Outbound Audio Gain	4	1-16	Sets outbound audio gain.

D – DEFAULTS Command:

Entering the 'D' command will change all of the settings back to the factory defaults. These settings will not be saved unless the 'X' Exit and Save command is issued. Older versions of firmware will request that the POTSwap be restarted to effect the changes; current versions will restart automatically.

X – EXIT AND SAVE Command:

Entering the 'X' command will save any changes made using the 'M' Modify or 'D' Defaults commands. This will also exit the menu system and requires that the POTSwap be restarted either by pressing the RESET push button or by un-powering and re-powering the unit.

Q – QUIT AND DISCARD Command:

Entering the 'Q' command will discard any changes made using the 'M' Modify or 'D' Defaults commands. This will also exit the menu system and requires that the POTSwap be restarted either by pressing the RESET push button or by un-powering and re-powering the unit.

5. External Interfaces

5.1 Front Panel



Figure 4 Front Panel

Received Signal Strength Indicator

A stack of 4 green LED's on the left side of the front panel indicate the relative signal strength of the cellular radio signal. It is analogous to the 'bars' display on a cellular telephone handset.

RSSI INDICATOR

LED's ILLIMINATED	SIGNAL STRENGTH	RSSI (dBm)
4	Excellent	-73 or better
3	Good	-83 to -74
2	OK	-93 to -84
1	Marginal	-109 to -94

If no signal is detected, the LED's on the stack alternately illuminate from bottom to top and back in a 'scanning' manner.

LED Operational indicators

LED	LED COLOR	INDICATION
POWER	Green	Power status
STATUS	Green	System status
CELL	Green or Red	Cellular radio status
GPS	Green or Red	GPS fix indication

General status conditions can be inferred as follows:

Normal operation would be indicated as follows:

POWER LED	Solid Green
STATUS LED	Fast Green blink when on-hook
CELL LED	Solid Green
GPS LED	Solid Green

POWER LED

LED STATUS	INDICATION
ON	System is powered
OFF	System has no power
Blinking	System Fault

STATUS LED

LED STATUS	INDICATION
ON	Phone line (RJ11) is OFF-HOOK (also during initialization)
Blinking fast (12.5 Hz)	Phone line (RJ11) is ON-HOOK

5. External Interfaces continued

CELL LED:

LED STATUS	CELLULAR RADIO
Green	Registered home or roaming
Red	Not Registered

* When the CELLULAR LED stays red (not registered) for more than a few minutes after powering the POTSwap, it is usually an indication of a poor antenna connection or a problem with the activation on the cellular network. Check that the SIM card is properly installed and that it has valid activation with a cellular carrier.

GPS LED:

LED STATUS	Indication
Green	GPS has location fix
Red	No GPS location fix

PUSH BUTTONS

Two push buttons are provided on the front panel of the POTSwap. These can be operated with a small diameter object such as a paperclip. There is tactile feedback that indicates when the push button has been operated.

Applying pressure to the push buttons beyond the point at which they actuate can damage the switch.

The RESET push button performs the same function as powering the unit off and then on; the configuration parameters are not affected.

PUSH BUTTON FUNCTIONS

PUSH BUTTON	FUNCTION
MODE	Future Use
RESET	System Restart

PHONE – FXS Connector:

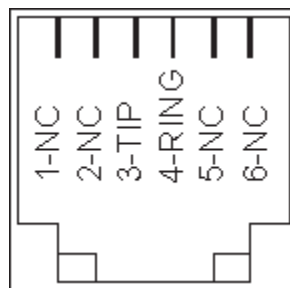


Figure 5 RJ11 Jack

A standard RJ11 jack (6P2C – 6 position 2 conductor) supports the landline telephone interface.

This jack simulates what would be provided by a land-line based telephone central office, including power, ringing signal and voice transport.

Any standard telephone device can be connected to this connector.



Under no circumstances should the PHONE – FXS connector be connected to another powered telephone line – e.g. a telephone wall jack or PBX line.

5. External Interfaces continued

5.2 Rear Panel

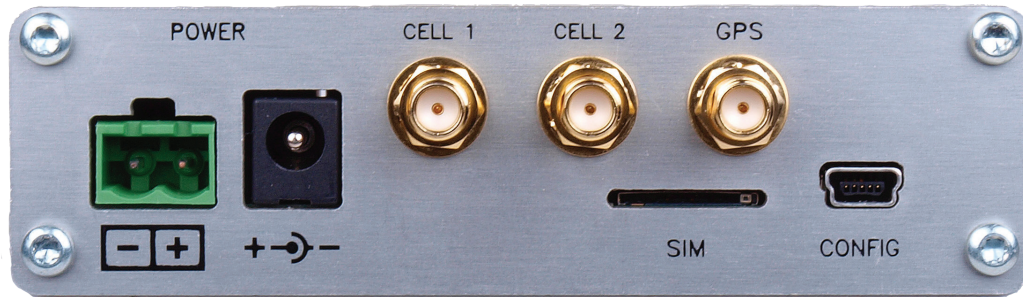


Figure 6 Rear Panel

Power connectors:

Two types of power connector are provided on the POTSwap. These two connectors are connected directly together internally, and are simply provided as a user convenience.



DO NOT APPLY POWER TO BOTH CONNECTORS SIMULTANEOUSLY

The negative terminal of the power supply is connected to the enclosure.

Power supply range can be found in the Specifications section.

Terminal Block Header: This is an industry standard 5.08 mm header that accepts a variety of terminal blocks, including screw terminal, spring clamp and crimp terminal type. See Section 9 – Compatible Terminal Block Connectors.

Circular Jack: The circular DC jack has a 6 mm hole diameter and a 2 mm center pin. It is designed to accept a 5.5 mm diameter plug with a 2.1 mm center hole and a 8.5 mm barrel length. The center pin is the positive terminal.

Antenna Connectors:

CELLULAR: A standard 50 ohm SMA connector is provided for connecting a cellular antenna. The placement of the antenna affects connectivity; a remote antenna location may be necessary in some situations.

GPS: A standard 50 ohm SMA connector is provided for connecting a GPS antenna.



The GPS connector provides a 3.3V bias voltage for active antennas.

CONFIG Connector:

A USB mini type-B connector provides a serial port connection for configuring parameters on the POTSwap and monitoring operation for debugging purposes. The USB connection is supported by a Silicon Laboratories CP210x series UART to USB bridge. Drivers for a variety of operating systems are available from www.silabs.com.

6. SIM Card Installation

The POTSwap requires the installation of an activated SIM card for operation. A 'micro' (3FF) size SIM card is required.

The SIM card holder is mounted to a p.c.board behind the slot, so some care is required to insure that the SIM card is inserted correctly. It should not take much effort to insert the SIM card if properly aligned.



Do NOT force the SIM card into the slot. Do not insert tools, paperclips, etc. into the slot.

Insert the SIM card into the SIM slot with the following orientation:

- gold contact side facing down
- narrow edge with chamfered corner in first.



Do NOT use a SIM card adapter to install nano sized SIMs into the POTSwap. The adapter edge can catch on the SIM socket and cause permanent damage.

7. GPS

7.1 GPS Operation

POTSwap models have a GPS antenna connector installed on the back plate and offer the ability to provide enhanced location information to emergency (911) operators. A suitable GPS antenna must be used and the antenna must be properly located to receive the GPS signals.

 Note: Emergency calls to 911 are not supported on the LTE910PS v3.00 TAUVN model.

The GPS operation is automatic, and is independent of the cellular radio operation. When the unit has acquired a GPS location fix, the GPS LED will be GREEN.

This indication is independent of the cellular signal strength indication. See section 5.1 – Front Panel. A GPS location fix should be available within a few minutes of operation under normal conditions.

7.2 GPS Antenna

For best results, it is recommended that an active GPS antenna be used with the POTSwap. The GPS antenna connector provides a 3.3V bias voltage to power an active antenna, and should easily be able to supply the 5 to 25mA of current that a typical active GPS antenna requires. Any standard off-the-shelf active GPS antenna that will operate at the 3.3V bias voltage should suffice. See section 11 – Accessories.

7.3 GPS Antenna location

The ideal GPS antenna position would be an outdoors location with a clear view of the sky to the horizon in all directions, with no obstructing structures or foliage. A higher antenna placement usually gives a better view of the sky over surrounding obstructions. In the northern hemisphere, a southern sky view is preferable over a northern sky view. If the antenna must be indoors, placement as near as possible to a window is preferable. Receiving a GPS location fix deep inside buildings or in dense urban environments (“street canyons”) is normally not possible.

7.4 GPS Troubleshooting

With a terminal attached to the CONFIG port, debug messages are available that can be used to monitor the GPS operation. See section 4 – Configuration, for information on attaching a terminal to the CONFIG port.

There are several types of debug messages output during normal operation. The message with the GPS information includes “\$GPSACP:” near the beginning of the output line, and is output about once per minute. The \$GPSACP message conveys 11 terms, separated by commas:

UTC	UTC time (hhmmss.sss)
latitude	format is ddmn.mmmmm N/S
longitude	format is ddmn.mmmmm E/W
hdop	x.x - Horizontal Dilution of Precision
altitude	x.x Altitude - mean-sea-level (geoid) in meters
fix	0 or 1 - Invalid Fix; 2 - 2D fix; 3 - 3D fix
cog	ddd.mm - Course over Ground (degrees, True)
spkm	x.x Speed over ground (Km/hr)
spkn	x.x- Speed over ground (knots)
date	ddmmyy Date of Fix.
nsat_gps	nn - Total number of GPS satellites in use, 00..12
nsat_glonass	nn - Total number of GLONASS satellites in use, 00..12

The nsat_gps term can be used to provide some useful information about the quality of the GPS antenna system being used. Generally, the better the antenna system, the greater the number of satellites will appear in the ‘nsat_gps’ term. Though it varies over time, the typical maximum number of satellites available is 10. A minimum of 4 is required to get a location fix, and numbers of 8 or more indicate an excellent antenna system.

With no location fix, the \$GPSACP message will appear as follows:

```
[$GPSACP: ,,,,,,1,,,,,]
```

This would be expected after the unit has powered up but before a location fix is aquired. It would also be indicative of a poor antenna system if it was still being reported after several minutes of operation.

A typical fix might appear similar to the following:

```
[$GPSACP: 183117.000,4147.6251N,08815.5097W,1.25,191.0,3,191.69,0.12,0.06,290716,07,04]
```

In this example the ‘nsat_gps’ term indicates that 7 satellites are being used.

8. Specifications

Interfaces

Parameters	Description
Modem/Telephone	RJ11 connector (FXS)
Serial CONFIG	USB Mini -- user terminal interface for configuration and firmware upload.
Cellular Antenna	50 ohm SMA
GPS Antenna	50 ohm SMA w/ 3.3V GPS bias
Power Input	7-15 Vdc; 12W with two input alternatives: <ul style="list-style-type: none">-- 6mm DC power jack with 2mm center pin positive-- 5.08mm (0.200") terminal block header (accepts screw clamp and crimp connector type terminal blocks) At 12 Vdc, nominal on-hook current is <100 mA; off-hook call-in-process current is 100-200 mA. Sub-millisecond events exceeding 500 mA can occur when cellular radio is transmitting. A 12 Vdc 1A supply minimum is recommended.

Features

Parameters	Description
SLIC	Performs all BORSCHT functions: <ul style="list-style-type: none">Battery supply to subscriber lineOvervoltage protectionRinging current supplySupervision of subscriber terminalCoder and decoderHybrid, 2 wire to 4 wire conversionTesting DTMF encoding and decoding REN=1 at 100 ft. (30m)
Voice	VoLTE (4G) and Voice over cellular (3G fallback)
Cellular Connection	4G (LTE) bands 2, 4, 5, 12, 13, 14**, 66 and 71. Plus 3G (fallback) bands 2, 4 and 5.
SIM Card	Micro (3FF size) SIM Card
Push Buttons	MODE, RESET
LEDs	Power, Status, Cellular Link, GPS and Signal Strength
Dimensions (L x W x D)	6.0 in (152mm) x 5.2 in (132mm) x 1.2 in (30mm)
Weight	13 oz (365 g)
Mounting	Integrated mounting brackets

** Band 14 may not be available on some models shipped prior to July 2021. The POTSwap is not certified for operation on FirstNet.

Environmental

Parameters	Description
Operating Temperature	-40° C to +60° C (-40° F to 140° F) (Note: Operating temperature may be further limited by specific Plug-In Terminus terminal)
Relative Humidity	5% to 95% (non-condensing)

9. Compatible Terminal Block Connectors

The POTSwap has a 0.200" terminal block header, also referred to as a 5.08 mm Eurostyle connector. It supports a variety of plug-in terminal block types, including screw terminal, spring contact and crimp terminals.

Manufacturers for these terminal blocks include:

- Camden Electronics
- FCI Electronics
- Molex
- OST (On Shore Technology)
- Phoenix Contact
- TE Connectivity (Tyco/Buchanan)
- Weidmüller
- Würth Elektronik

Below is a small sample of compatible connectors:

TYPE	MANUFACTURER	PART NO.	DESCRIPTION
Screw Terminal	TE Connectivity ¹	796634-2	vertical screw, horizontal plug
	TE Connectivity	1986484-2	horizontal screw, vertical plug
	Molex	395300002	vertical screw, horizontal plug
	Molex	395332002	horizontal screw, vertical plug
	Weidmuller	1943580000	vertical screw, horizontal plug
Spring Clamp	Weidmuller	1013680000	orange
	Weidmuller	1013430000	black
Crimp Housing & Contacts	TE Connectivity	1986160-2	crimp housing, green
	TE Connectivity	965901-1	crimp terminal, 20-17 AWG
	TE Connectivity	965899-1	crimp terminal, 13-17 AWG
	Weidmuller	1610490000	crimp housing, orange
	Weidmuller	1711960000	crimp housing, black
	Weidmuller	1604250000	crimp contact, 24-22 AWG
	Weidmuller	1567060000	crimp contact, 20-17 AWG
	Weidmuller	1567070000	crimp contact, 16-14 AWG

Note:

1 - This component is available from Janus Remote Communications. See 'TERMINAL BLOCK' in Section 10.

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10. Ordering Information

LTE POTSwap MODEL	DESCRIPTION
LTE910PS v1.00	AT&T
LTE910PS v3.00	Verizon

11. LTE POTSwap™ Carrier Certifications and Regulatory Approvals

The POTSwap includes several cellular carrier and regulatory approvals and certifications, as stated in our Product Briefs, User Manuals, and other documentation. *Ultimately, the customer is responsible for ascertaining and abiding by the Federal, State and local laws, regulations and other requirements regarding the application in which they will deploy the POTSwap.*

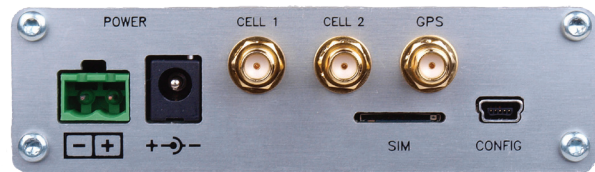
12. Accessories

The following accessories are available from Janus Remote Communications:

ACCESSORY	DESCRIPTION	JANUS STORE PART #
Power Supply	Wall transformer with circular DC connector, 12V 2A	MC-0004
Cellular Antenna	LTE Antenna w/Swivel	ANT-0086
GPS Antenna	Active Antenna, Magnetic Mount, Waterproof, 10 ft. SMA	ANT-0030
Terminal Block	Screw terminal block for the 5.08 mm power connector	MC-0392-G



Front



Back

Revision History

Revision	Revision Date	Note
00	07/24/19	LTE POTSwap User Manual Release
01	02/18/20	Updated Bands
02	03/12/20	Updated Specs
03	05/19/20	Updated Ordering Information
04	09/17/20	Updated Ordering Information, 7.4 GPS Troubleshooting and 8. Power Input
05	09/22/20	Remove information on Data Services
06	11/25/20	Carrier, Certifications and Regulatory Approvals Customer Notice
07	02/03/21	Serial interface settings for the CONFIG port updates - 4.0 Configurations
08	05/19/21	Updated AT&T and Verizon Ordering Information

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