PolaRx4
Product Family Hardware Manual

Version 2.0.0

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CE NOTICE

PolaRx4 receivers carry the CE mark and are as such compliant with the 2004/108/EC - EMC Directive and amendments, 2006/95/EC - Low Voltage Directive, both amended by the CE-marking directive 93/68/EC.

With regards to EMC, these devices are declared as class B, suitable for residential or business environment.

ROHS/WEEE NOTICE

PolaRx4 receivers comply with European Union (EU) Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive).

PolaRx4 receivers comply with the European Union (EU) Directive 2002/96/EC on waste electrical and electronic equipment (WEEE). The purpose of this Directive is the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. If purchased in the European Union, please return the receiver at the end of its life to the supplier from which it was purchased.

SAFETY INFORMATION

 Statement 0000/WARNING: IMPORTANT SAFETY INSTRUCTIONS
This warning symbol means danger and indicates that you are in a situation that may result in body injury and physical damage. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and familiarize yourself with standard practices for preventing accidents. Use the statement number provided at the beginning of each warning to locate its translation in the translated safety warnings that accompanied this device.

 Statement 0001/WARNING: The power supply provided by Septentrio (if any) should not be replaced by another. If you are using the receiver with your own power supply, it must have a double isolated construction and must match the specifications of the provided power supply.

 Statement 0003/WARNING: Ultimate disposal of this product should be handled according to all national laws and regulations.

 Statement 0005/WARNING: The equipment and all the accessories included with the product may only be used according to the specifications in the delivered release note, in the manual and in all other documents delivered with the receiver.

 Statement 0007/WARNING: Never place the equipment in direct sunlight.

 Statement 0008/WARNING: The outside of the instrument may be cleaned using a clean, lightly dampened cloth. Do not use any cleaning liquids containing alcohol, methylated spirit, ammonia etc.

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1 PolaRx4_PRO and PolaRx4TR_PRO

1.1 Rear Panel Connectors

The rear panel features the following connectors (PPS IN only available on PolaRx4TR_PRO).

1.1.1 MAIN (TNC)

Connect an active GNSS antenna to this connector. The gain at the connector (antenna gain minus cable losses) must be in the range 15 to 50dB.

By default, the receiver provides a 5V DC supply on the MAIN connector to feed the antenna. Other voltages can be imposed through pin ANT_EXT of the IN connector on the front panel (see section 1.2.6). The maximum supported current is 200mA.

Never inject a DC voltage into the MAIN connector as it may damage the receiver. When using a splitter to distribute the antenna signal to several receivers, make sure that no more than one output of the splitter passes DC. Use DC-blocks otherwise.

1.1.2 PPS OUT (BNC)

xPPS output (5V, output impedance 50Ohms). The rate and polarity of the xPPS output signal are specified by the **`setPPSParameters`** command (see the Command Line Interface Reference Guide). The pulse duration is 1.2ms.

1.1.3 REF IN (BNC)

Use this connector to provide the receiver with an external 10-MHz frequency reference, to be used instead of the internal oscillator. The reference signal must be sinusoidal with a peak-to-peak amplitude (unloaded) ranging from 0.5V to 2V (-8dBm to +4dBm in a 50Ω load).

Connecting or disconnecting the external 10-MHz reference is preferably done with the receiver switched off. If the 10-MHz reference is connected or removed during operation, the receiver will reset.

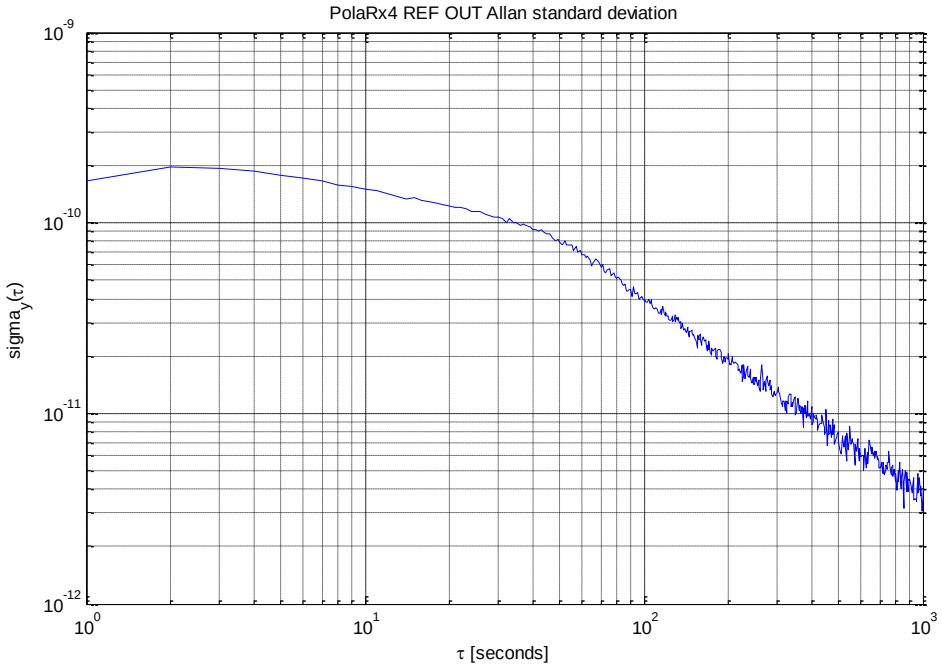
If you are not using an external frequency reference, it is recommended to connect the supplied 50Ω terminator to the REF IN connector.

1.1.4 REF OUT (BNC)

This connector provides a 10-MHz output signal synchronized with the frequency reference used by the receiver. It is a sinusoidal signal with unloaded peak-to-peak amplitude of 1.1V, and output impedance of 50Ohms.

If a 10-MHz reference is fed to the REF IN connector, REF OUT simply duplicates REF IN, which allows to chain receivers using the same clock reference.

If REF IN is not used, the 10-MHz signal at the REF OUT connector is taken from the internal receiver clock. It is a VTCXO disciplined to GNSS time so that REF OUT provides a stable reference frequency. The Allan standard deviation of the clock at the REF OUT connector when REF IN is not used is shown below.



It takes a few minutes after start up to lock the clock to GNSS time. The REFOUT_LOCKED bit of the `RxState` field in the `ReceiverStatus` SBF block indicates when lock is achieved.

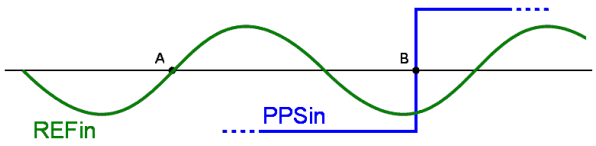
1.1.5 PPS IN (BNC) – PolaRx4TR_PRO Only

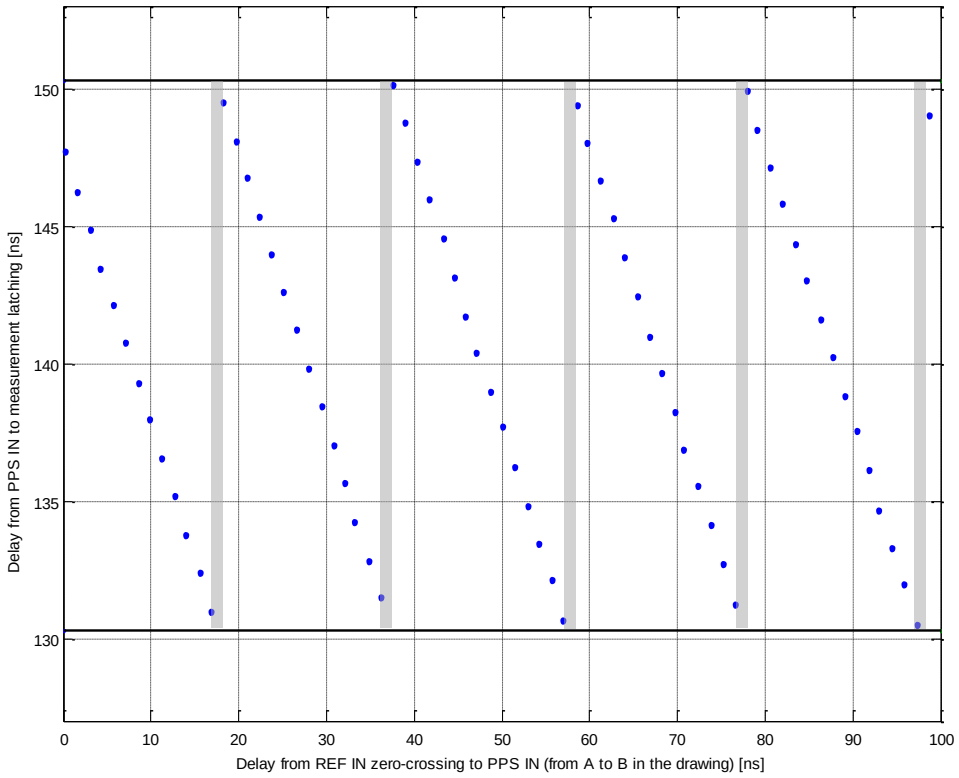
This connector is only available on PolaRx4TR_PRO. It is a time synchronization input (input level 3.3V CMOS with 10kΩ pull down resistor, 5V tolerant, V_{IH}>2.3V, V_{IL}<1V), to be connected to a one pulse-per-second external reference.

Use this input to synchronize the internal receiver time to an external time source. For proper operation, the PPS IN input should be used in combination with the REF IN input. REF IN provides the receiver with a precise external frequency reference, and PPS IN provides a precise time reference. It is important that the PPS input signal and the 10-MHz reference be generated from the same external clock and that the PPS input signal be synchronized with UTC (offset with UTC smaller than 0.5 milliseconds). It is also necessary that REF IN and PPS IN be present from the start-up of the receiver. Plugging in a PPS input signal when the receiver is already operating will lead to erroneous measurements.

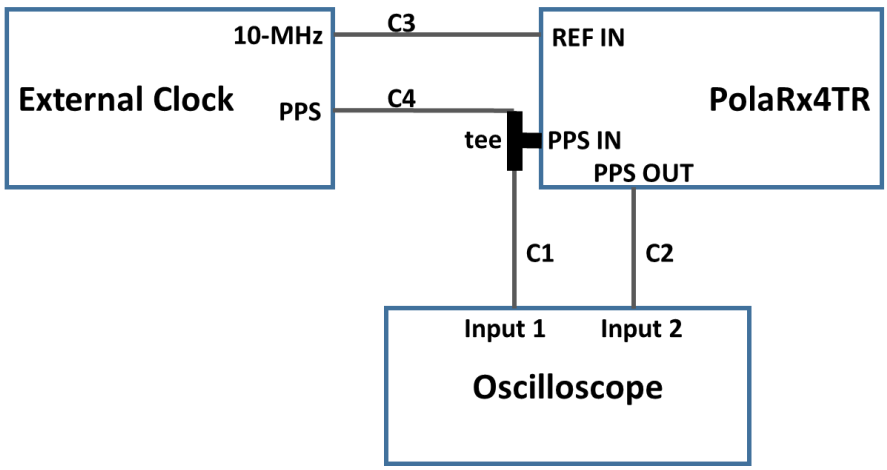
The receiver synchronizes its measurement latching with the first low-to-high transition it detects on the PPS IN connector. There is no user command to enter. Once this initial time synchronization is done, the signal on the PPS IN connector is ignored: the receiver simply integrates its frequency reference to keep track of the time. If the PPS input signal originates from the same clock as the 10-MHz reference signal, the receiver time will stay in sync with the external clock time.

The delay between a low-to-high transition on the PPS input connector and the latching of the measurements in the receiver depends on the setup, and in particular on the phase relationship between the 10-MHz frequency reference and the PPS input signal at the REF IN and PPS IN connectors. It can take a value from 130.3 to 150.3 ns (+/-2 ns), as shown in the figure below.

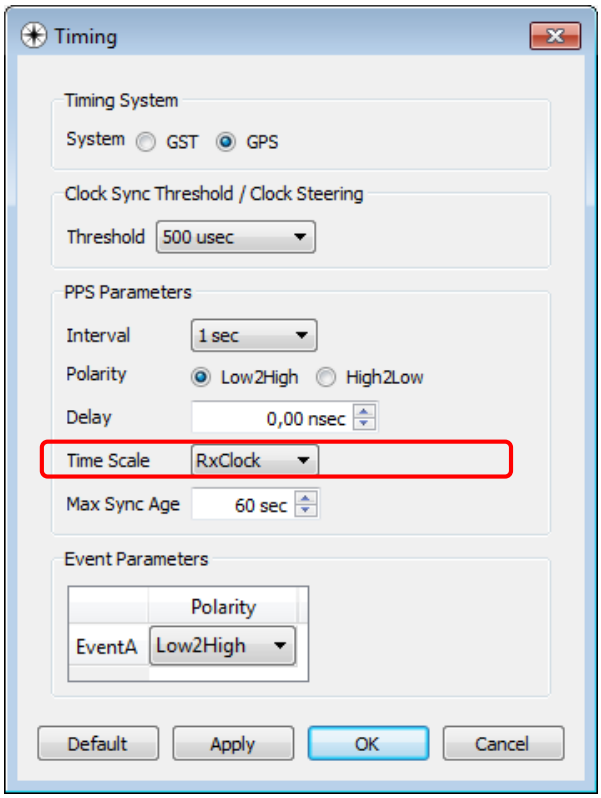




A way to measure the delay between the PPS input pulse and the measurement latching is to use an oscilloscope (or a time interval counter) connected as shown below. For this measurement, it is not needed to connect an antenna to the PolaRx4TR. For easier interpretation of the results, cables C1 and C2 should have the same length.



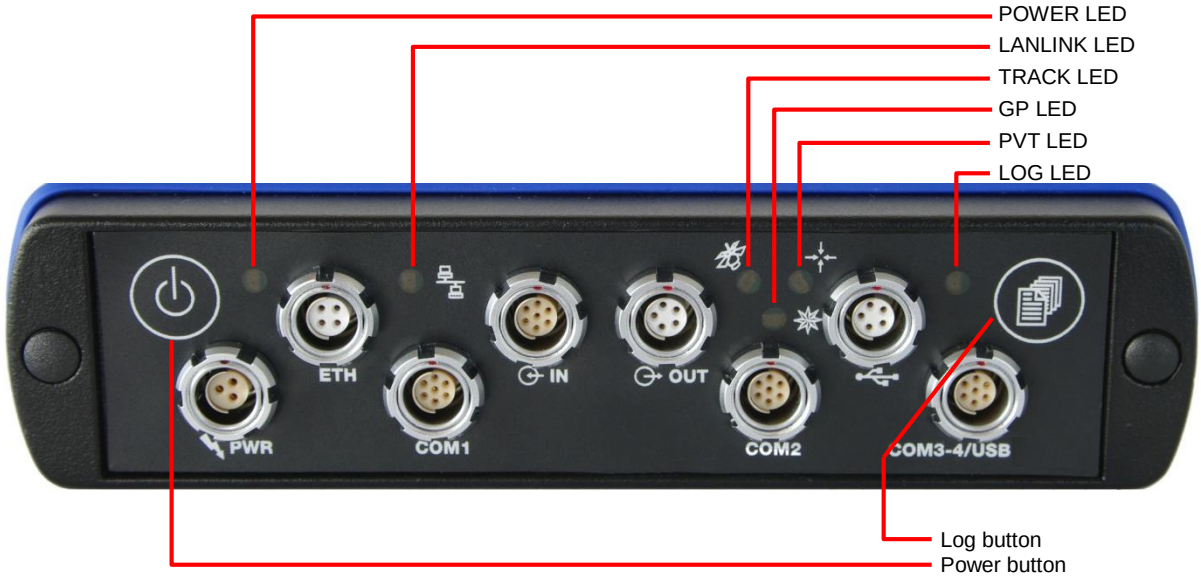
Before measuring the delay, the PolaRx4TR has to be configured to synchronize its PPS OUT signal with the measurement latching epoch. This is done by setting the *TimeScale* argument of the **`setPPSParameters`** command to "`RxClock`". You can do this using RxControl (go to the *Navigation* > *Receiver Operation* > *Timing* menu):



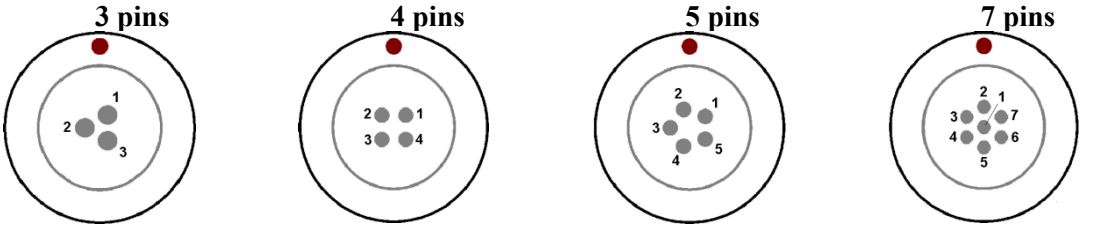
When the PPS OUT signal is configured, the PPS-IN-to-measurement-latching delay is the delay between the leading edges of the pulses on the input 1 and input 2 ports of the oscilloscope. The oscilloscope trigger level should be set to 1V.

To avoid possible 20-ns jumps when power-cycling the receiver, the transition zones (gray bars in the figure on the previous page) should be avoided. So, if the measured PPS-IN-to-measurement-latching delay is within 2ns of the upper (150.3ns) or lower (130.3ns) limits, it is recommended to replace either the C3 or the C4 cable by a cable of another length. A change of 1 meter in the length of the C3 or C4 cable changes the PPS-IN-to-measurement-latching delay by about 5 ns.

1.2 Front Panel Connectors



The front panel features 8 ODU connectors, which are described in the following sections. These connectors are all of type ODU MINI SNAP Series F. The pinout of the female connectors and the ODU part number of the corresponding male connectors is shown below.



S40F1C-P03MJG0-50CP S40F1C-T04MFD0-50CP S40F1C-P05MFD0-50CP S40F1C-T07MCD0-50CP

1.2.1 COM1

This 7-pin connector provides access to the first serial port (COM1).

Pin #	Description
1	Not connected
2	Signal ground (GND)
3	Not connected
4	Not connected
5	Receive Data (RXD – input to the receiver)
6	Transmit Data (TXD – output from the receiver)
7	Not connected

The receiver behaves as Data Terminal Equipment (DTE).

1.2.2 COM2

This 7-pin connector provides access to the second serial port (COM2).

Pin #	Description
1	+5V DC output
2	Signal ground (GND)
3	Clear To Send (CTS – input)
4	Request To Send (RTS – output)
5	Receive Data (RXD – input)
6	Transmit Data (TXD – output)
7	Not connected

The receiver behaves as Data Terminal Equipment (DTE).

Pin#1 provides a 5V DC voltage, e.g. to allow feeding a Bluetooth™ device.

1.2.3 COM3-4/USB

This 7-pin connector can be configured in two modes:

- COM3 and COM4 mode
- USB mode

The electrical level at pin#7 defines the operating mode.

1.2.3.1 COM3-4 mode

This mode is selected by leaving pin#7 unconnected.

Pin #	Description
1	Not connected
2	GND
3	COM4 RX
4	COM4 TX
5	COM3 RX
6	COM3 TX
7	Leave unconnected

1.2.3.2 USB mode

This mode is selected by applying 5V DC to pin#7.

Pin #	Description
1	Not connected
2	GND
3	USB D-
4	Reserved
5	USB D+
6	Reserved
7	USB Vbus

1.2.4 Ethernet

Pin #	Description
1	TxD+
2	TxD-
3	RxD+
4	RxD-

1.2.5 OUT

Pin #	Description
1	Reserved
2	GND
3	GP1 output, 3.3V. Use the command **`setGPIOFunctionality`** to set the level of this pin.
4	GP2 output, 3.3V. Use the command **`setGPIOFunctionality`** to set the level of this pin.
5	nRST_OUT. Open-collector output, driven low when the receiver is resetting.

1.2.6 IN

Pin #	Description
1	Reserved, leave unconnected.
2	GND
3	Reserved, leave unconnected.
4	nRST_IN. Driving this pin low resets the receiver. Internally pulled-up. Debouncing and deglitching is foreseen.
5	EVENTA, 3.3V CMOS, 5V tolerant, 100kΩ pull down resistor. This is the first digital input for external event timing. Polarity is controlled by the **`setEventParameters`** command.
6	EVENTB, 3.3V CMOS, 5V tolerant, 100kΩ pull down resistor. This is the second digital input for external event timing. Polarity is controlled by the **`setEventParameters`** command.
7	ANT_EXT, external antenna power. Can be used to apply an external supply voltage to the antenna. The voltage applied to ANT_EXT (V_{ANT}) determines the voltage source on the MAIN connector, as follows: • if V_{ANT}<2.0V or ANT_EXT left open, the antenna is powered by the internal 5V supply; • if 3.0V<V_{ANT}<4.0V, there is no power provided to the MAIN connector; • if 5.0V<V_{ANT}<12.0V, the antenna power supply is taken from ANT_EXT. **Warning:** Exceeding 12.0V for V_{ANT}, or drawing more than 200mA from the antenna connector can permanently damage the receiver.

1.2.7 

Pin #	Description
1	Reserved
2	Reserved
3	Reserved

4	Reserved
5	Reserved

1.2.8 PWR

Pin #	Description
1	Power: 9 to 30V DC
2	ON/OFF. When this pin is tied to pin#1, the receiver is always on, regardless of the state of the on/off button.
3	GND

If you are using a different power adaptor than the one provided by Septentrio, make sure that it can sustain a current of 1.5A.

1.3 Log Button

The log button toggles internal logging on and off. See the "*HowTo…*" section of the Firmware User Manual for details.

1.4 Power Button

The power button retains its state through a power outage. If the receiver is on when the power is cut off, it will automatically restart when the power comes back. If it is off, it will remain off after the power comes back.

1.5 LEDs

LED Name	LED Behaviour
POWERLED	LED lights when the receiver is switched on.
LANLINKLED	LED blinks when sending or receiving data over Ethernet.
LOGLED	LED lights when data is being written to the internal SD memory card.
PVTLED	LED lights when a PVT solution is available.
GPLED	General-purpose LED. The function of this LED is configured with the **`setLEDMode`** command. By default, this LED has the DIFFCORLED function (see below).
DIFFCORLED	Differential correction indicator. In rover PVT mode, this LED reports the number of satellites for which differential corrections have been provided in the last received differential correction message (RTCM or CMR). **LED behaviour** / **Number of satellites with corrections** LED is off — No differential correction message received blinks fast and continuously (10 times per second) — 0 blinks once, then pauses — 1, 2 blinks twice, then pauses — 3, 4 blinks 3 times, then pauses — 5, 6 blinks 4 times, then pauses — 7, 8 blinks 5 times, then pauses — 9 or more The LED is solid 'ON' when the receiver is outputting differential corrections as a static base station.

TRACKLED

LED behaviour	Number of satellites in tracking
blinks fast and continuously (10 times per second)	0
blinks once, then pauses	1, 2
blinks twice, then pauses	3, 4
blinks 3 times, then pauses	5, 6
blinks 4 times, then pauses	7, 8
blinks 5 times, then pauses	9 or more

1.6 Cables

Cable Name: CBLe_COM_1,8 Part #: 200416

COM1/COM2 to PC (DSUB9-female). To be connected to either the COM1 or COM2 connector. Note that RTS/CTS lines are only available when connected to COM2.

Cable Name: CBLe_COM_DUO_7 Part #: 201204

Dual COM3 and COM4 to PC (DSUB9-female). To be connected to the COM3-4/USB connector. Note that RTS/CTS is not supported on these ports.

Cable Name: CBLe_GPO_OE_5 Part #: 201203

Open-ended cable to be used with the OUT connector (see pinout in section 1.2.5).

Pin#	Function	Wire Color
1	Reserved	Blue
2	GND	Blue/Black
3	GP1 output	Orange
4	GP2 output	Green
5	nRST_OUT	Brown

Cable Name: CBLe_GPI_OE Part #: 200419

Open-ended cable to be used with the IN connector (see pinout in section 1.2.6).

Pin#	Function	Wire Color
1	Reserved	Orange
2	GND	Green
3	Reserved	Yellow
4	nRST_IN	Black
5	EVENTA	Red
6	EVENTB	Purple
7	ANT_EXT	Brown

Do not leave the red and purple wires floating. Tie them to ground if not used. This is to avoid crosstalk effects that could lead to spurious level transitions on the EventA and EventB inputs.

Cable Name: CBLe_USB	Part #: 201202

USB cable to be connected to the COM3-4/USB connector.

Cable Name: CBLe_ETH_MS	Part #: 200418

Ethernet to hub/switch (straight) (RJ45). To be connected to the ETH connector.

Cable Name: CBLe_ETH_MX	Part #: 200417

Ethernet to PC (crossed) (RJ45). To be connected to the ETH connector.

Cable Name: CBLe_PWR_OE	Part #: 200422

Open-ended cable for the PWR connector (see pinout in section 1.2.8).

Pin#	Function	Wire Color
1	Power	Blue and green (these two wires are both connected to Pin#1)
2	ON/OFF	Red
3	GND	Black and Purple (these two wires are both connected to Pin#3)

1.7 Internal Logging on SD Memory Card

The receiver incorporates a SD memory card for internal logging. Refer to the "*How-to…*" section of the Firmware User Manual to learn how to use this feature.

To prevent data corruption, logging is protected against accidental power outages. There is no need to unmount the SD memory card before switching off the receiver.

1.8 Stand-By Mode

The receiver can be put in stand-by mode by entering the command "**`exePowerMode, StandBy`**" (see Command Line Interface Reference Guide).

Waking up from stand-by mode is done by sending characters to the COM1 serial port.

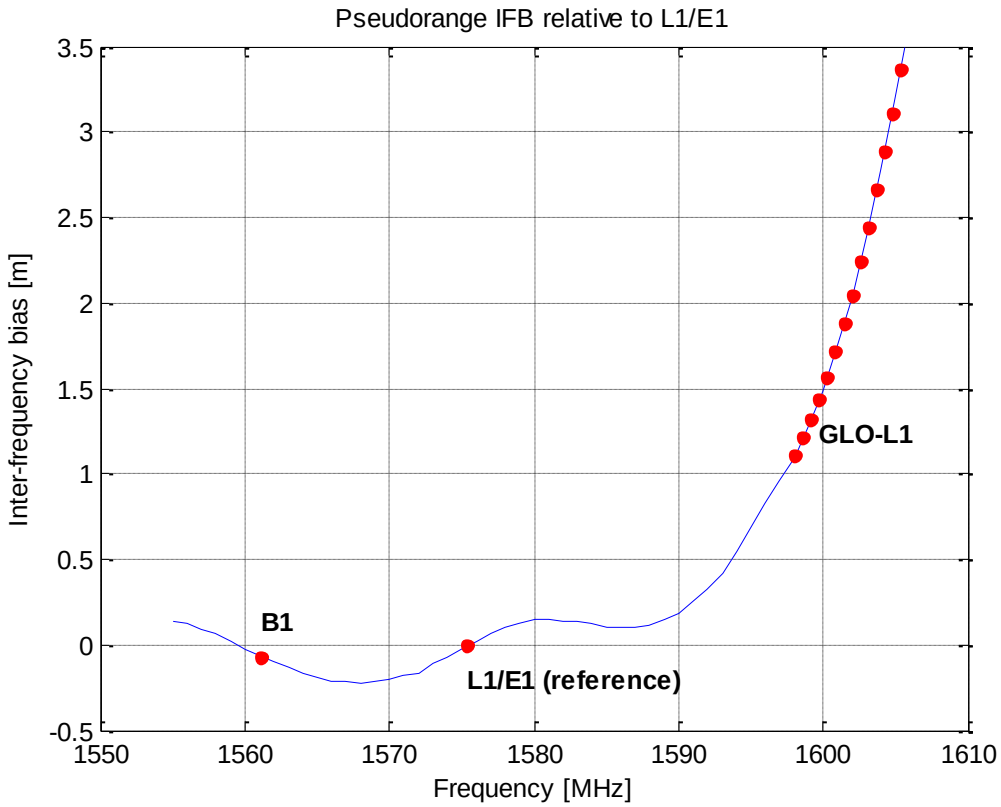
For remotely-operated receivers, make sure that COM1 is remotely accessible before putting the receiver in stand-by mode.

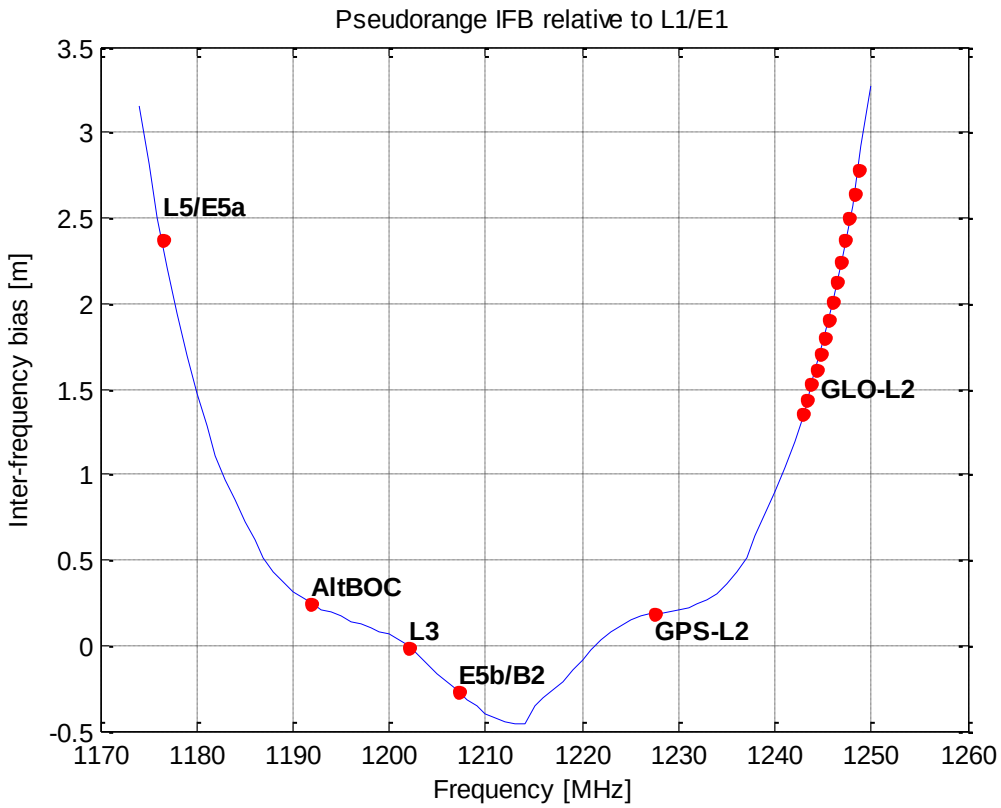
1.9 Applicable Software Package

PolaRx4_PRO and PolaRx4TR_PRO are compatible with Septentrio's SSRC4 Software Packages.

1.10 Pseudorange Inter-Frequency Biases

The figures below show the nominal receiver pseudorange inter-frequency biases (IFB) as a function of the carrier frequency. The bias at the L1/E1 carrier frequency (1575.42MHz) is taken as a reference and is therefore arbitrarily set to 0. The red dots mark the frequency of common GNSS carriers. The figures only account for the receiver IFBs, and do not include any biases in the antenna or splitter.





A positive value of the IFB at frequency *F* means that the pseudorange at that frequency will be larger than the pseudorange at L1/E1, even in the absence of any ionospheric divergence or satellite bias. For example, the second graph shows that the receiver introduces about 2.4m bias in the GPS L5 pseudoranges compared to the GPS L1 pseudoranges.

The graphs are provided for illustrative purpose only. They give an indication of the order of magnitude of the biases to be expected for PolaRx4 receivers, and of the shape of the bias-versus-frequency curve. The exact bias values are slightly different for each receiver unit and depend on many parameters next to the frequency (signal modulation, temperature, aging, impedance matching with antenna,…). However, some general properties will be true in all cases:

- The largest IFBs are found at the L5 and the GLONASS frequencies, with typical values of a few meters.
- For GLONASS, the IFBs increase with the GLONASS frequency number. A difference of 1.5 to 3 meters between the lowest and the highest frequency number is typical.

1.11 Hardware Specifications

Power consumption:	6 W (operating) 0.9 W (stand-by, see section 1.8)
Size:	234 x 140 x 37 mm (length including the connectors)
Temperature Range:	-40 to +60 °C (operational) -55 to +85 °C (storage)
Ingress Protection:	IP65
Shock:	MIL-STD-810F, 516.5
Vibration:	MIL-STD-810F, 514.5

2 Power Failover

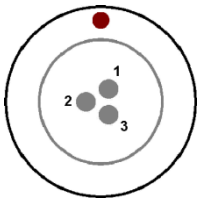
The optional power failover is a power source switch which automatically switches over to a 12-V battery backup supply during outages of the main power supply.

The typical setup is depicted below.

In normal operation, the receiver is powered from the power supply connected to MAINS – ADAPTER. When the voltage at that connector drops below 10.8V, the receiver is powered from the battery instead. A charger is permanently connected to the CHARGER input to charge the battery when the battery is not used to power the receiver.

2.1 Connectors

The four connectors are all of type ODU MINI SNAP Series F, 3 pins. The ODU part number of the corresponding male connectors is S40F1C-P03MJG0-50CP. The pinout of the female connector is shown below:



2.1.1 MAINS – ADAPTER

Pin #	Description
1	To be connected to the main power supply: 12 V DC.
2	Internally connected to pin#2 of the RECEIVER connector.
3	GND

The voltage provided to the MAINS – ADAPTER connector must not exceed 12V.

2.1.2 BATTERY

Pin #	Description
1	To be connected to the "+" terminal of the battery.
2	Power source indicator: DC level is 0V when power at the RECEIVER connector is drawn from battery, and 12V when drawn from mains.
3	To be connected to the "-" terminal of the battery.

2.1.3 CHARGER

Pin #	Description
1	To be connected to the "+" terminal of the battery charger.
2	NC
3	To be connected to the "-" terminal of the battery charger.

To avoid damaging the battery, only use a charger made for your particular battery type.

2.1.4 RECEIVER

Pin #	Description
1	12V DC power output
2	Internally connected to pin#2 of the MAINS - ADAPTER connector.
3	GND

2.2 Cables

Cable Name: CBLe_PWR_OE	Part #: 200422

Open-ended cable:

Pin#	Wire Color
1	Blue and green (these two wires are both connected to Pin#1)
2	Red
3	Black and Purple (these two wires are both connected to Pin#3)

Cable Name: CBLe_PWR_FOPX	Part #: 213468

Failover to PolaRx4 cable. Used to connect the RECEIVER connector of the power failover device to the PWR connector of the PolaRx4 receiver.

2.3 Hardware Specifications

Size: 118 x 84.6 x 34.6 mm (length including the connectors)

Temperature Range: -40 to +60 °C (operational)
-55 to +85 °C (storage)

Ingress Protection: IP65
Shock: MIL-STD-810F, 516.5
Vibration: MIL-STD-810F, 514.5