

Manufacturer  
630 Komas Drive | Suite 200  
Salt Lake City | UT 84108 | USA  
P +1 (801) 582-5533 | F +1 (801) 582-1509  
[www.blackrockmicro.com](http://www.blackrockmicro.com)



# CerePlex W

## *Instructions for Use*



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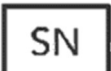


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# Warnings and Precautions

- Do not touch any exposed metal plates or input contacts of the connectors at the bottom of the CerePlex W when in use. This may result in inducing electric charge to the neural tissue. Irreversible damage may occur.
- Note that this product contains an internal battery. Please refer to the Cleaning, Maintenance, and Disposal section for disposal instructions.
- Do not:
  - Recharge the device with an uncertified charger
  - Short circuit, crush, or disassemble the device
  - Expose the device to temperatures greater than 100°C (212°F)
- When plugging in the CerePlex W device to its mating connector, please make sure the orientations of the connectors are matched, then carefully align the pins and plug-in gently. Excessive force during connection and disconnection can damage the connectors and cause harm to the subject.
- Use antistatic or ESD safe gloves when using the CerePlex W or the wireless receiver.
- The CerePlex W device and its receiver system are only approved for use with Blackrock Microsystems data acquisition systems.
- Do not use the CerePlex W device with non-approved electrodes.
- The CerePlex W must be used with a Blackrock CerePort array, or a Blackrock adaptor approved for use with alternative arrays.
- Use the CerePlex W device in a clean and dry environment, do not use the CerePlex W device near liquids.
- Do not drop or put excessive force on the CerePlex W device. High mechanic force can damage the device permanently.
- Do not use the CerePlex W with other RF radiator in the 3-4GHz frequency range, which will cause interference to and from the CerePlex W device.
- For cleaning the device, please use water and gauze to gently wipe the surface, do not use isopropanol (IPA) for cleaning, since it will dissolve the acrylic clear surface coating on the case.

# Symbols

BS EN ISO 15223-1:2016 Medical Devices – Symbols to Be Used with Medical Device Labels, Labeling, and Information to Be Supplied			
Reference	Symbol	Title	Meaning
5.1.1		Manufacturer	Indicates the medical device manufacturer.
5.1.3		Date of Manufacture	Indicates date of manufacture and is accompanied by a date.
5.1.5		Batch Number	Indicates the manufacturer's batch or lot code, for example on a medical device or the corresponding packaging. The code shall be placed adjacent to the symbol.
5.1.6		Catalog Number	Indicates the manufacturer's catalog number so that the device may be identified. For Blackrock Microsystems it is called the Part Number (PN).
5.1.7		Serial Number	Indicates the manufacturer's serial number so that a specific medical device can be identified.
5.4.3		Consult Instructions for Use	Indicates the need for the user to consult the instructions for use, which you are currently reading.
5.4.4		Caution	Indicates the need for the user to consult the instructions for use for important cautionary information such as warning and precautions that cannot, for a variety of reasons, be presented on the medical device itself.

ISO 7000 / IEC 60417:2002 DB – Graphical Symbols for Use on Equipment			
Reference	Symbol	Title	Meaning
5134		Electrostatic Sensitive Devices	Indicates packages containing electrostatic sensitive devices, or to identify a device or a connector that has not been tested for immunity to electrostatic discharge.
5140		Non-Ionizing Electromagnetic Radiation	Indicates equipment in the medical electrical area that include RF transmitters or that intentionally apply RF electromagnetic energy for diagnosis or treatment.
5639		Rechargeable Battery	Indicates rechargeable cells or batteries

# What This Manual Covers

The Blackrock CerePlex W is a fully digital telemetry system used for neural recording. The CerePlex W was designed to be used in conjunction with either the Cerebus recording system or the CerePlex Direct recording system for high fidelity transmission and recording of extracellular spikes and local field potentials from the brain. The Blackrock CerePlex W converts analog signals to digital format at the recording site. Digital transmission dramatically reduces the mechanical noise that would otherwise be introduced through physical disruption of passive wires.

## Specifications

<b>Model Name</b>	<b>CerePlex W</b>
<b>Channel Count</b>	96
<b>Input Frequency Range</b>	0.3 Hz—7.5 kHz
<b>Maximum Input Voltage</b>	± 8.192 mV with respect to reference
<b>Resolution</b>	16-bit ADC, 12-bit transmission to receiver (12 most significant bits)
<b>Input Impedance</b>	1300 MΩ @ 10 Hz, 13 MΩ @ 1 kHz
<b>Headstage connection to Receiver</b>	Both wired and wireless connection
<b>Battery</b>	Built-in 3.7 V 400 mAh Li-ion rechargeable battery. Life time: 3.5 hours. Charging time: ~1 hour.
<b>Input Connector</b>	Blackrock CerePort pedestal
<b>Wireless Transmission Range</b>	3 m line of sight, 2 m free roaming (maximum)
<b>Weight</b>	26.4g (without battery)/33.5 g (with battery)
<b>Size</b>	32.5 mm x 32.5 mm x 21 mm
<b>Noise</b>	<3 μV rms
<b>Water Ingress Protection</b>	Ordinary Equipment, not fluid resistant, IP20

# Overview of Hardware

The CerePlex W system consists of two major subsystems: the headstage, and the receiver along with the receiving antennas. Each component is described in more detail below. All the components included with the system are:

- (1) CerePlex W (PN: 9583)
- (1) Wireless Receiver (PN: 9660)
- (8) Antennas
- (8) SMA antenna cables
- (8) SMA to N adaptors
- (1) 12 V AC-DC power supply
- (1) Micro-USB to USB A cable
- (1) 5-wire micro-USB to micro-USB cable
- (1) Magnetic wand

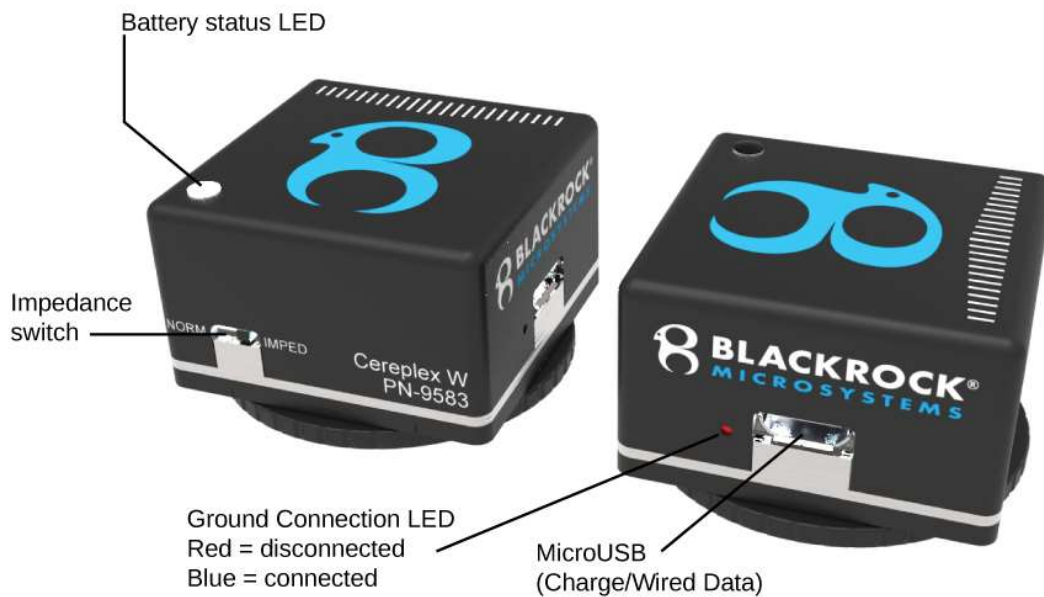


Figure 1-CerePlex W headstage

## CerePlex W Headstage

### Basic Functions

The CerePlex W headstage combines a fully digital neural recording amplifier with a radio-frequency transmitter. The amplifier is built on the same platform as other Blackrock CerePlex recording headstages and offers the same low-noise performance. The digital data stream from the amplifier system is encoded and transmitted to the receiving antennas by an on-board radio and antenna. The battery and connection indicator LEDs, as well as the impedance mode switch and micro USB port are shown in **Figure 1**.



## CerePlex W On/Off Switching

Power to the CerePlex W headstage is provided by a rechargeable lithium-ion battery housed within the headstage. Powering the battery on and off is controlled via magnetic reed switch inside the headstage. To turn the power on or off to the headstage, swipe the magnetic wand provided with the system across the area shown in **Figure 2**.



Figure 2—Turning on the power of the CerePlex W headstage using the magnetic wand.

## CerePlex W Battery and Charging

When the battery is low, the battery status LED will turn RED. The battery can be recharged by connecting the CerePlex W headstage to the CerePlex W receiver using the included 5-wire micro-USB cable. The battery status LED will turn YELLOW while the headstage is actively charging and will turn GREEN when charging is complete (**Figure 3**). **Note:** This LED will be unlit while the headstage is in use and is not an indication of a low battery.



Figure 3—The battery status indicator.

The same 5-wire USB cable can be used to operate the CerePlex W headstage in “wired” mode. In wired mode, the headstage transmits data via the cable rather than wirelessly. The headstage battery will continue to charge while transmitting in wired mode.

Use caution when removing the micro-USB cable as excessive force or twisting can damage the connector on the headstage.

The transmission frequency is set at the time of manufacture to 3.5 GHz. The CerePlex W receiver must be tuned to the same frequency as the transmitter. This process is described in Setting Up the CerePlex W section below. It is possible to use two complete CerePlex W systems together for a total of 192 channels *if they are tuned to different frequencies*. If you are interested in using two CerePlex W systems simultaneously, contact a Blackrock Microsystems representative at [support@blackrockmicro.com](mailto:support@blackrockmicro.com).

## CerePlex W Referencing

Unlike the CerePlex Exilis, the CerePlex W does not have reference-toggling capabilities on a bank-by-bank basis. This means the connections between the LGA pads and the electrodes in a CerePort assembly must be carefully planned in order to properly reference your recordings. Banks A and B (channels 1–64) use Ref 1 and Bank C (channels 65–96) use Ref 2.

## CerePlex W Receiver and Antennas

The CerePlex W receiver can use up to 8 antennas to acquire data transmitted from the CerePlex W headstage. The receiver only needs a robust signal from one antenna to reliably receive the transmission. If the signal strength declines from one antenna, the receiver will cycle through the remaining antennas to find a suitable signal. In this way, the 8 antennas can be used to cover a larger operational area than would be possible with a single antenna. If at least one antenna is close enough to the headstage transmitter, the data link will remain intact. If an antenna input channel is receiving data, the blue reception indicator LED for that channel on the front of the receiver will illuminate.

The antennas provided with the CerePlex W system are rugged outdoor antennas designed for harsh conditions (**Figure 4**). They have a wide beam width (receiving angle) of over 45° to better cover an experimental area. The antenna cables are low-loss coax cables specifically designed for high performance in the frequency range used by the CerePlex W system.

After amplifying and decoding the wirelessly transmitted signal, the receiver relays the data to either the digital hub—as part of a Cerebus system—or the CerePlex Direct for further signal processing, display, and storage.

**Figure 5** shows the CerePlex W wireless receiver with important features labeled.



Figure 4—Receiving antenna used with the CerePlex W system.

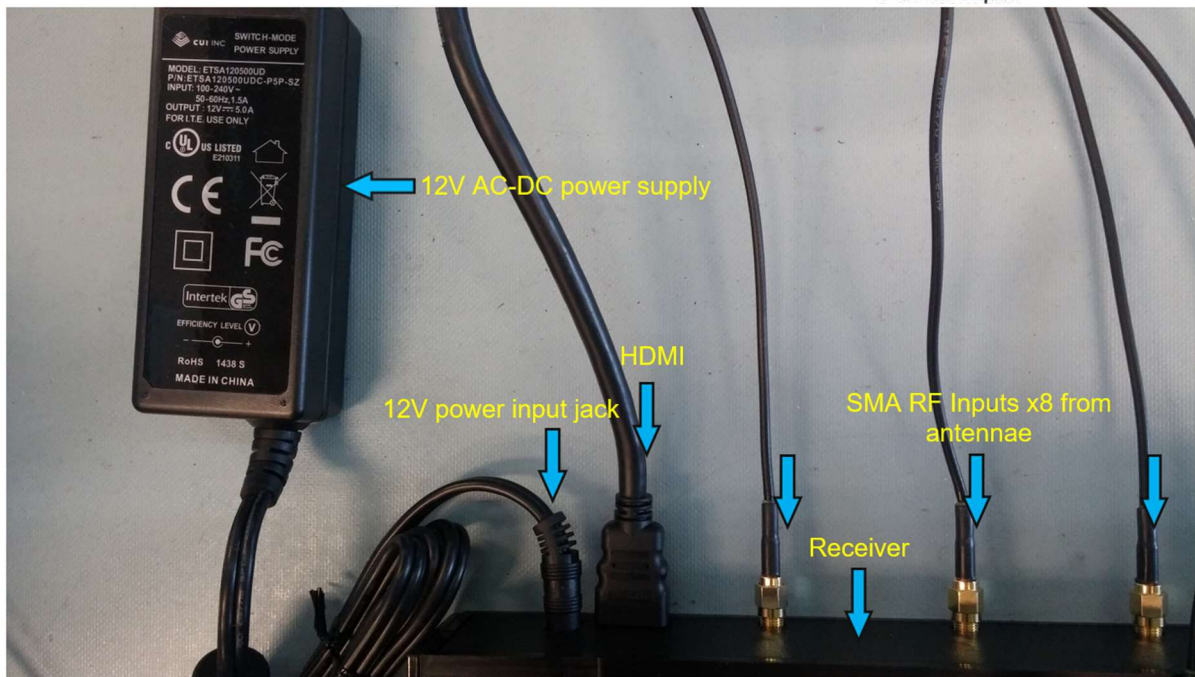
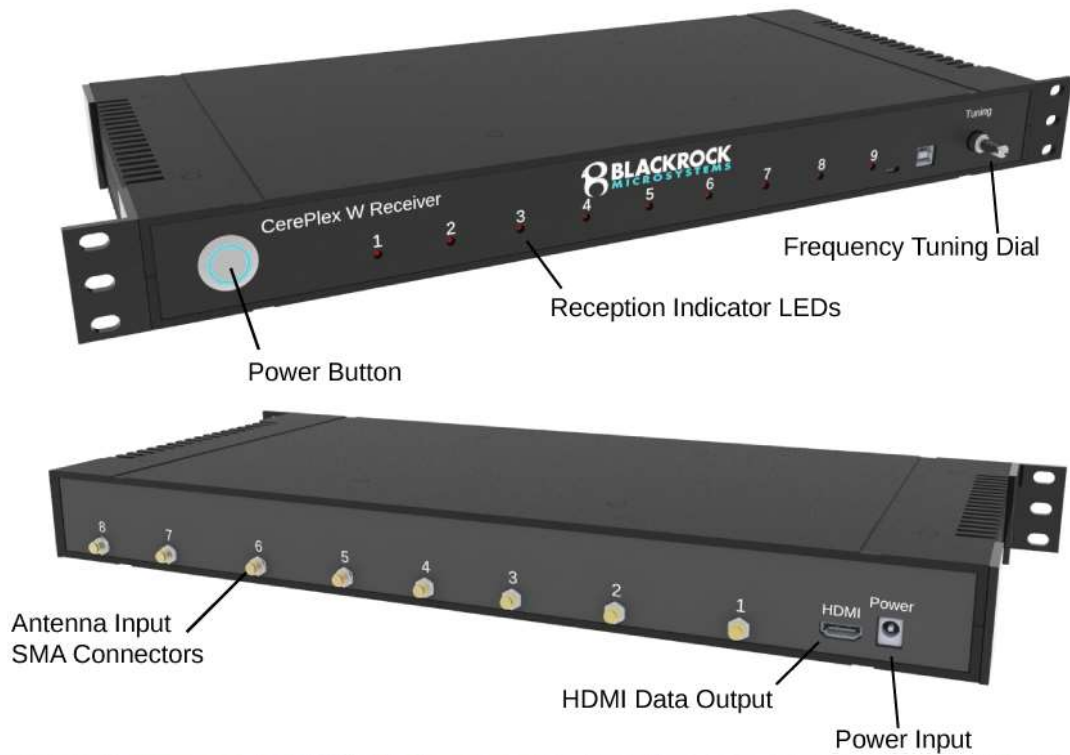


Figure 5–CerePlex W Wireless Receiver and connections.

# Setting Up the CerePlex W

This section describes how to connect the components of the CerePlex W system to conduct a recording session. The Blackrock digital neural signal simulator (DNSS) is used for a signal source in this section, but the same procedure would be used when recording from an animal.

**Note:** The DNSS is not included in the system and needs to be purchased separately.

## Setting up the Antennas

1. Connect the SMA-N adapters to the antennas as shown in **Figure 6**.
2. Connect the SMA cables to the antennas and receiver.



Figure 6—Connecting the SMA adapter to the antenna.

3. Consider the 45-degree beam angle when assessing coverage of your entire experimental area. The beams should overlap to provide the best recordings (**Figure 7**).
4. Consider that each antenna is phase-dependent. Use the orientation indicator arrows to place antennas with different orientations as shown in **Figure 8**.

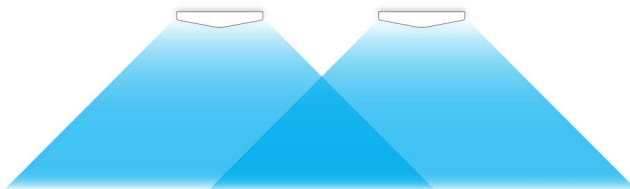


Figure 7—Antenna beams and overlap.



Figure 8—Optimal phase orientation of antenna pairs.

5. The system will prioritize antennas in descending order from 8 to 1, so place antenna 8 to cover the most likely positions/orientation of the CerePlex W.
6. Conductive materials disrupt the wireless signal and should not be placed between antennas and the experimental area. Use plexiglass enclosures instead

- of metal cages, if possible. If a metal cage must be used, place the antennas within the cage.
7. The CerePlex W has a range of approximately 1 m. Every area of the cage should be within 1 m of at least two antennas.
  8. In setups where the CerePlex W IS NOT expected to move throughout the entire enclosure, placing two antennas near each other, pointed in the same direction, and oriented 90° from each other allows for reliable data recording (see **Automatic Wireless Data Validation**, Page 15). See **Figure 9** for a model antenna placement scheme for this condition.
  9. In setups where the CerePlex W IS expected to move throughout the entire enclosure, it is beneficial to ensure the entire enclosure gets maximum antenna coverage. See **Figure 10** for a model antenna placement scheme for this condition.
  10. Every experimental setup is unique. Adjust your antenna orientation, location, and distance while observing the blue antenna indicator lights on the receiver to achieve the best placement for your setup.
  11. For guidance on antenna placement, contact Blackrock Support at [support@blackrockmicro.com](mailto:support@blackrockmicro.com).

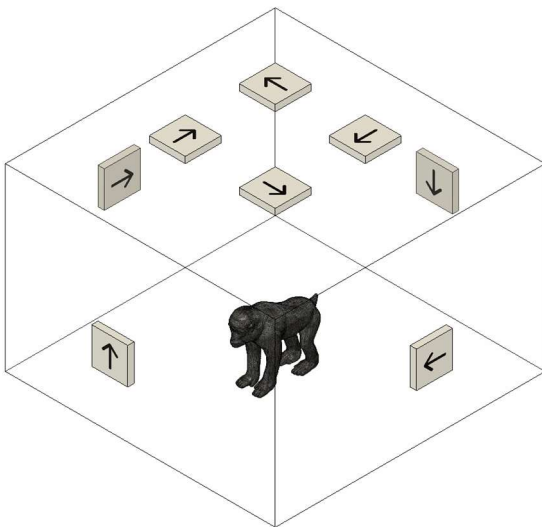


Figure 9–Wireless antenna placement scheme for animal with restricted movement.

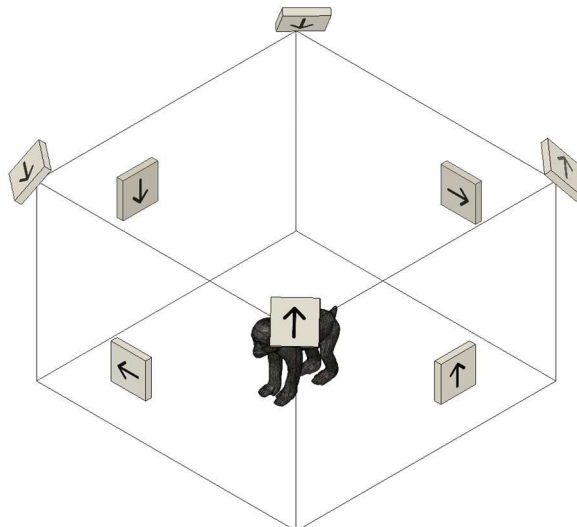


Figure 10–Wireless antenna placement for animal with unrestricted movement.

## Assembling the Wireless System

1. Connect the 12 V power supply to the receiver.
2. Connect the HDMI-A cable to the receiver as well as the digital hub or CerePlex Direct.
3. Launch the Central Software Suite on the host PC.
4. Power on the components of the Blackrock data acquisition system—the digital hub and NSP when using the Cerebus system, or the CerePlex Direct if using the CerePlex Direct system. Refer to the associated data acquisition system product manuals as needed.
5. Connect the CerePlex W headstage to the pedestal connector on the Blackrock DNSS as shown in **Figure 11**.

Caution: Do not overtighten the wheel connector as this can cause damage to the device



Figure 11—The CerePlex W headstage connected to the pedestal connector of the DNSS.

## Testing and Calibrating the Wireless System

1. Place the CerePlex W headstage and DNSS in the experimental area.
2. Turn on the CerePlex W headstage using the magnetic wand as shown in **Figure 2** above.
3. Turn on the CerePlex W receiver by pressing the round power switch shown in **Figure 5** above.
4. The indicator LED on the digital hub or CerePlex Direct change from RED to either BLUE or GREEN, depending on the model, to indicate successful communication between the CerePlex W receiver and the data acquisition system.
5. If the receiver is properly tuned, the reception indicator LEDs on the CerePlex W receiver should illuminate. Adjust the frequency tuning dial to maximize the number of antenna input channels with illuminated reception indicator LEDs.
6. If tuning the receiver frequency does not cause the reception indicator LEDs to illuminate, it could be due to range issues. Make sure the antennas are pointed in the right direction and oriented correctly (see **Figure 7** and **Figure 8**) and that the CerePlex W is within 1 meter of the antenna(s) you are trying to tune.

# Wireless Data Transfer

## *Maximum Sampling Frequency*

The CerePlex W's true sampling rate is approximately 24.5 kS/s. For this reason, recordings using the CerePlex W system cannot record voltages at 30 kS/s even when the sampling rate is chosen to be 30 kS/s through Central's Hardware Configuration tool. However, recordings from the CerePlex W collected through Central will still have data sampled at 30 kS/s. This is accomplished through an up-sampled buffering process.

## *Automatic Wireless Data Validation*

All firmware versions of the CerePlex W and the wireless receiver have automatic wireless data validation protocols, but these protocols differ depending on what firmware is running on the CerePlex W and the CerePlex receiver. Contact [support@blackrockmicro.com](mailto:support@blackrockmicro.com) to check your firmware versions.

### Loss of Lock (LOL)

The wireless data sent from the CerePlex W is Manchester Encoded, which contains rich clock frequency components in its spectrum for better facilitating data recovery on the receiver side. Once the data is received by the receiver, the receiver will try to recover the clock signal from the Manchester Encoded data received by each antenna input. The ability to recover clock from the received wireless data stream is a key requirement and indication of good signal reception and ensures wireless communication quality and bit error rate. If the receiver can recover clock signal from one antenna input, that antenna input channel's Reception Indicator LED will illuminate blue. Otherwise, that antenna input channel's Reception Indicator LED will not illuminate, indicating a poor signal reception for that antenna, and the incoming data will be discarded. Antenna data that passed the LOL check can then move to the next Frame Check process.

### Frame Check (FC)

Data frames sent from the CerePlex W begin with a 24-bit sync signal and end with a 48-bit suffix. Once a sync signal is identified, the remaining bits are read for the frame. An inability to read the sync and suffix messages de asserts the "FrameCheck" flag and this specific frame of data is not buffered. In this case, the previous valid frame of data is re-used. Frames passing the FC check then go on to be further validated.

## Identical Stream Logic (ISL)

When two or more antenna input channels pass the LOL check, the individual channel's data from a CerePlex W frame are further validated. Each CerePlex W channel is devoted 12 bits of information within a frame. The ISL compares information from two CerePlex W channels, therefore making comparisons in 24-bit segments. If two or more antenna input channels show identical information between these 24-bit segments on different antenna input channels, the higher-priority antenna input channel's information for that 24-bit segment of the frame goes into the wireless receiver's output buffer. ISL occurs for all CerePlex W and receiver firmware versions.

## Checksum

Unlike the ISL protocol, the checksum protocol requires only one antenna input channel to operate. The last 12 bits of the CerePlex W's frame are the sum of all previous 12-bit segments within that frame. Integer overflow is handled by wrapping; if the checksum bits are not equal to the sum of the previous 12-bit segments within the frame, that frame's data is discarded and does not qualify to enter the receiver's output buffer. The checksum data validation step is only utilized when the CerePlex W firmware AND the receiver have v2.0 firmware or later.

# Cleaning, Maintenance, and Disposal

The rechargeable battery used to power the CerePlex W headstage is rated for approximately 500 recharge cycles. Eventually, the battery will lose its ability to maintain its original capacity. At such time, contact a Blackrock representative if you would like to coordinate a replacement.

The CerePlex W headstage should be kept dry and free of debris. A gentle cleaning using small amounts of water with gauze can clean the outside of the headstage if necessary.

There is a conductive filament film membrane that permits contact between pads on the pedestal connector and pads on the CerePlex W headstage (**Figure** ). Eventually, this filament film will compact or become soiled and fail to permit reliable connection between the pedestal and headstage. If this appears to be the case, contact a Blackrock representative if you would like to purchase a replacement by emailing [support@blackrockmicro.com](mailto:support@blackrockmicro.com).

All devices, both used and unused, should not be disposed with household waste. Return to a recycling point for electric and electronic devices.

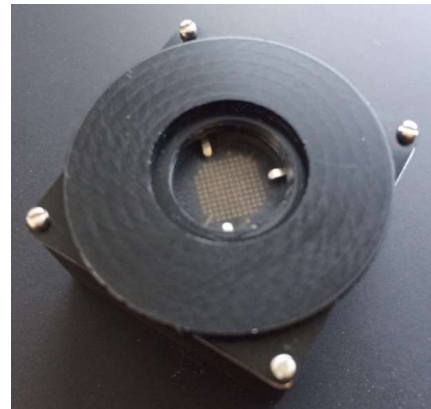


Figure 12–View of the CerePlex W headstage input connector.



# Troubleshooting

Some common error states and their respective resolutions are listed below. For further information please contact Blackrock Support at [support@blackrockmicro.com](mailto:support@blackrockmicro.com).

Problem	Symptom	Failure	Potential fix
CerePlex W does not turn on using the magnetic wand.	There is no signal on Central Spike Panel and no Blue LEDs on receiver.	This may be caused by a depleted battery.	Please recharge the CerePlex W device use the Micro-USB cable through the computer USB port or through the receiver.
Signal frequently cuts out or is very noisy.	The blue LEDs on the receiver are blinking frequently.	This is likely due poor wireless link quality.	Retune your receiver following the instructions in the Testing and Calibrating the Wireless System section above.  The antennas need to be properly mounted to provide maximum coverage to achieve best signal quality. See <b>Setting Up the CerePlex W</b> (Page 12).
High baseline noise, i.e. low signal-to-noise ratio (SNR)	Central Single Neural Channel shows no spikes and jagged waveforms.  Blue connection LED on CerePlex W is off or blinking.	Poor electrical connections and grounding.	Test alternative reference selections.  Ground sources of electrical noise near the experimental area to earth ground. DO NOT ground the animal to earth ground.  Verify that the CerePlex W is plugged in correctly.

# Return Merchandise Authorization

In the unlikely event that your CerePlex W needs to be returned to Blackrock for repair or maintenance, do not send any equipment back without a Return Merchandise Authorization Number. An RMA number will be issued to you by a Blackrock representative. If you need to obtain an RMA number, you may contact a product support representative at +1 (801) 582-5533 or by emailing [support@blackrockmicro.com](mailto:support@blackrockmicro.com).

Once an RMA number has been issued, it is important to safely pack the returned item for shipping back to Blackrock. It is preferred that you save the original boxes and packing materials that your system arrived in for return shipment. Please address the package as follows:

**Blackrock Microsystems, LLC**  
 ATTN: RMA#  
 630 S. Komas Dr., Suite 200  
 Salt Lake City, UT 84108 USA  
 Tel: +1 (801) 582-5533

# Warranty

Blackrock Microsystems (“Blackrock”) warrants its products are free from defects in materials and manufacturing for a period of one year from the date of shipment. At its option, Blackrock will repair or replace any product that does not comply with this warranty. This warranty is voided by: (1) any modification or attempted modification to the product done by anyone other than an authorized Blackrock employee; (2) any abuse, negligent handling or misapplication of the product; or (3) any sale or other transfer of the product by the original purchaser.

Except for the warranty set forth in the preceding paragraph, Blackrock provides no warranties of any kind, either express or implied, by fact or law, and hereby disclaims all other warranties, including without limitation the implied warranties of merchantability, fitness for a particular purpose, and non-infringement of third-party patent or other intellectual property rights.

Blackrock shall not be liable for special, indirect, incidental, punitive, exemplary or consequential damages (including without limitation, damages resulting from loss of use, loss of profits, interruption or loss of business or other economic loss) arising out of non-compliance with any warranty. Blackrock’s entire liability shall be limited to providing the remedy set forth in the previous paragraph.

# Support

Blackrock prides itself in its customer support. For additional information on this product or any of our products, you can contact our Support team through the contact information below:

## **Manuals, Software Downloads, and Application Notes**

[www.blackrockmicro.com/technical-support](http://www.blackrockmicro.com/technical-support)

## *Complaints*

When filing a complaint, please provide the product description, product number, software version, lot number, complainant's name and address, and the nature of the complaint.

### **Issues or Questions**

[www.blackrockmicro.com/technical-support](http://www.blackrockmicro.com/technical-support)

[support@blackrockmicro.com](mailto:support@blackrockmicro.com)

U.S. +1 (801) 582-5533

The CerePlex W is not intended for use on human subjects.