



LunaPlugs® E1.0

Power Connectors

User Manual V1.0

August 2024



Contents

1. Terms and Conditions.....	3
1.1 Disclaimer:	3
1.2 Licensing:	3
2. Series Overview.....	4
2.1 Introduction:	4
2.2 Key Characteristics*:	4
2.3 Connector Families (>20x):	5
2.4 Connector Siblings (10x)	6
2.5 Design Package Purchasing Options:	10
2.6 LunaPlugs® Product Matrix (Full Series):	11
3. Performance Characteristics.....	12
3.1 The Importance of Thermal Management:	12
3.2 Sources of Performance Variation	12
4. 3D Printing.....	14
4.1 Printer Compatibility:	14
4.2 Printer Settings:	14
4.3 Orientation & Scaling:	14
4.4 Material Requirements	15
5. Auxiliary Components & Tooling.....	15
5.1 Additional Components Required:	15
5.2 Tools Required:	15
5.3 Tools Recommended:	16
6. Product Assembly Instructions.....	17
6.1 Soldering:	17
6.2 Connector Assembly:	20

1. Terms and Conditions

Full terms and conditions are available at www.LunaDrives.com.

1.1 Disclaimer:

To use any LunaDrives® products or data, as well as agreeing to the Full Terms and Conditions (as above), you also agree to independently verify sufficient manufacturing quality, materials and assembly performance characteristics have been demonstrated prior to use, for any given use-case.

Whilst providing opportunity for risk reduction and performance gains; LunaDrives™ do not accept liability for any loss, harm or injury arising from the use of our designs.

ELECTRICITY KILLS - ALWAYS CONSULT A SUITABLY QUALIFIED ELECTRICAL ENGINEER BEFORE USE.

1.2 Licensing:

1.2.1 *Personal Use* Licenses:

Receipted purchases (sent via email) from our website permit perpetual personal use of our designs.

By purchasing a personal use license, ***you can:***

- Make as many as you want for your own use.
- Integrate into your own designs, so long as they are not derived from ours.
- Create photographs and videos and share online your experiences with our designs.

But you agree to NEVER, modified or as supplied by Luna Drives:

- Distribute the designs to others, digitally or physically.
- Upload the designs online.
- Sell the designs or physical products derived thereof.
- Use the designs or physical products derived thereof, for any company or commercial purpose, internally, externally, publicly or otherwise.
- Hold Luna Drives responsible for any loss, damage or injury arising from your use.

1.2.2 *Commercial Use* Licenses:

We welcome and support enterprise, big and small. Our commercial licenses are strictly controlled and available on a case-by-case basis. Contact us directly with your proposals/requirements and we will indicate available options.

2.Series Overview

“No-one needs soggy electrics” – N. Woollen, 2023 (Inventor of LunaPlugs®).

2.1 Introduction:

LunaPlugs® Experimental (E1.0) are a range of **3D Printable power connectors**, principally designed for use in **high current DC applications**. Born of necessity, they provide users with improved **performance & safety*** characteristics over and above the standard bodies normally used with EC style contacts. Designed for the purposes of building a new generation of high-performance electrically powered products and technologies.

2.2 Key Characteristics*:

- **3D Printable** (Bodies & Glands tested on low-cost domestic FDM and SLA printers)
- **High Voltage** (see contacts data at www.LunaDrives.com).
- **High Current** (see contacts data at www.LunaDrives.com)
- **Water-Tight** (IP68, immersion tested to 2m depth for 4-hours).
- **Robust** (Material dependent: Impact, crush, chemical, UV, heat, water)
- **Versatile** (10x Cross-compatible lead-end, panel mount, bulkhead mount, male and female siblings available for all 20+ families/channel configurations).
- **Systematic Approach** providing all the connections required for your power circuits, from batteries to drive units.

*Subject to [Terms and Conditions](#).

2.3 Connector Families (>20x):

EC8x1 family will be available at launch. We expect all families to be available by summer 2025.

If you urgently require a family that is not currently available or have any other requests e.g. you'd like to use different contacts/terminal types, please contact us through our [website](#).

Keep informed of our latest design releases and updates by subscribing social media channels and/or our [mailing list](#).

>20 Families (Terminal Configurations)

No. Pins	1	2	3	4	5	6	7	8	9
EC5	✓ EC5x1	EC5x2	✓ EC5x3	EC5x4	EC5x5	EC5x6	EC5x7	EC5x8	EC5x9
EC8	✓ EC8x1	✓ EC8x2	EC8x3	EC8x4	EC8x5	✓  EC8x6	EC8x7	EC8x8	✓  EC8x9
Combi	✓  EC5x4 EC8x3	✓ C2 EC5x6 EC8x3							

NB: GREEN TICKED ITEMS WILL BE RELEASED AS A PRIORITY.

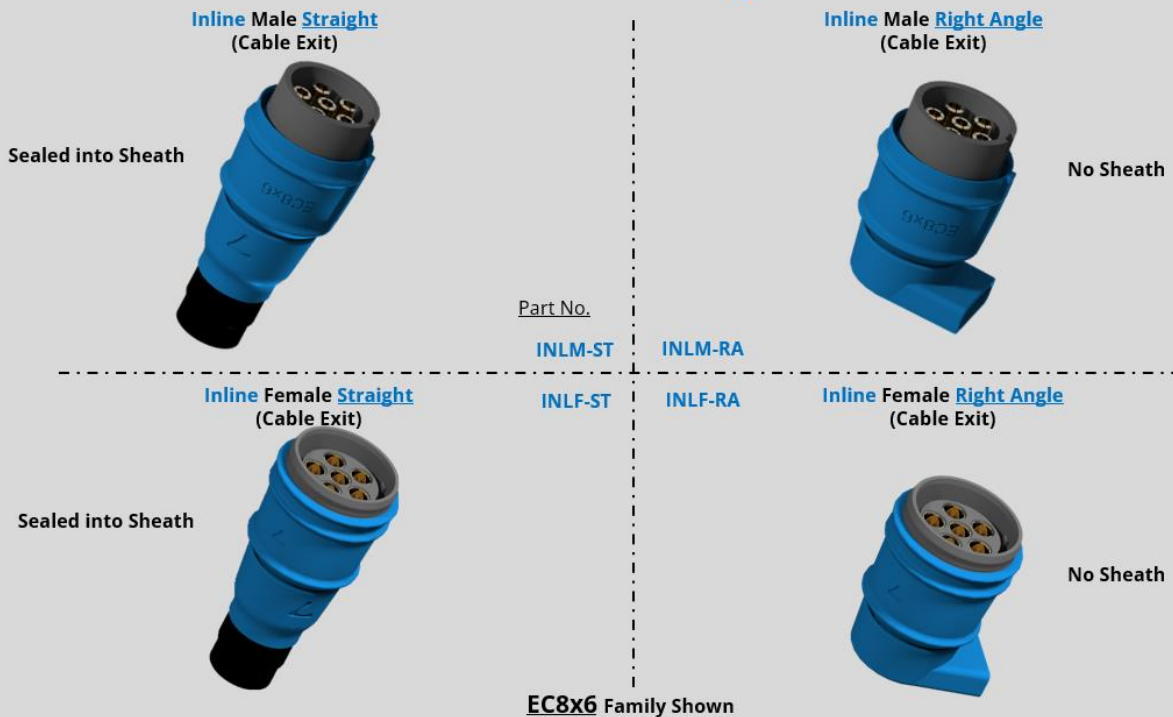
2.4 Connector Siblings (10x)

All siblings from the same family are cross-compatible ie any of the 5x Male connectors, will connect with any of the 5x Females (EC8x6 Full Family being shown below).

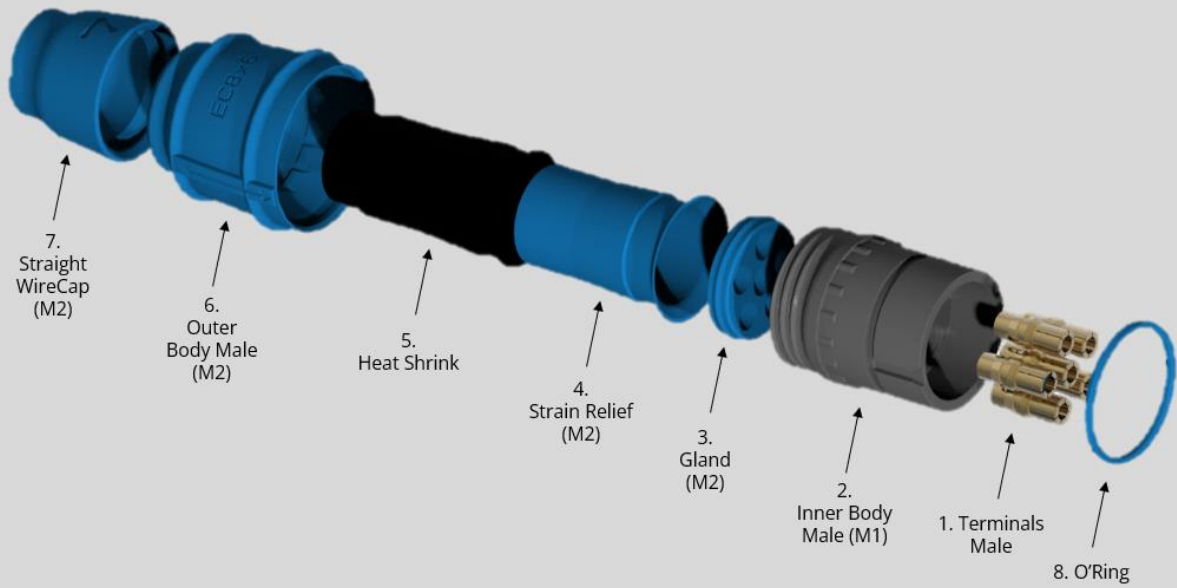
6x Surface Mount Siblings/Family



4x Inline Siblings/Family

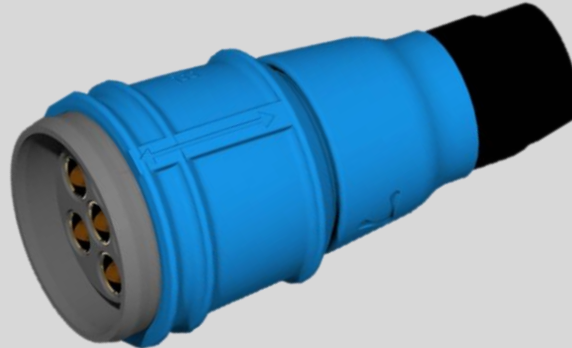


2.4.1 Inline Siblings:

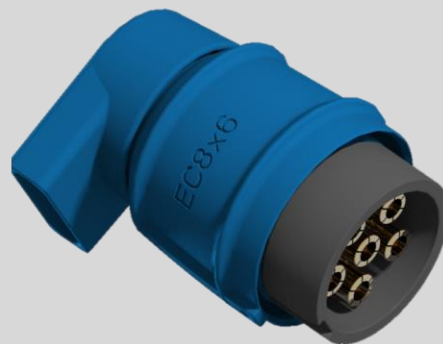


Male EC8x6 inline (male shown).

Inline sibling design packages include both inline and right-angle cable exits.



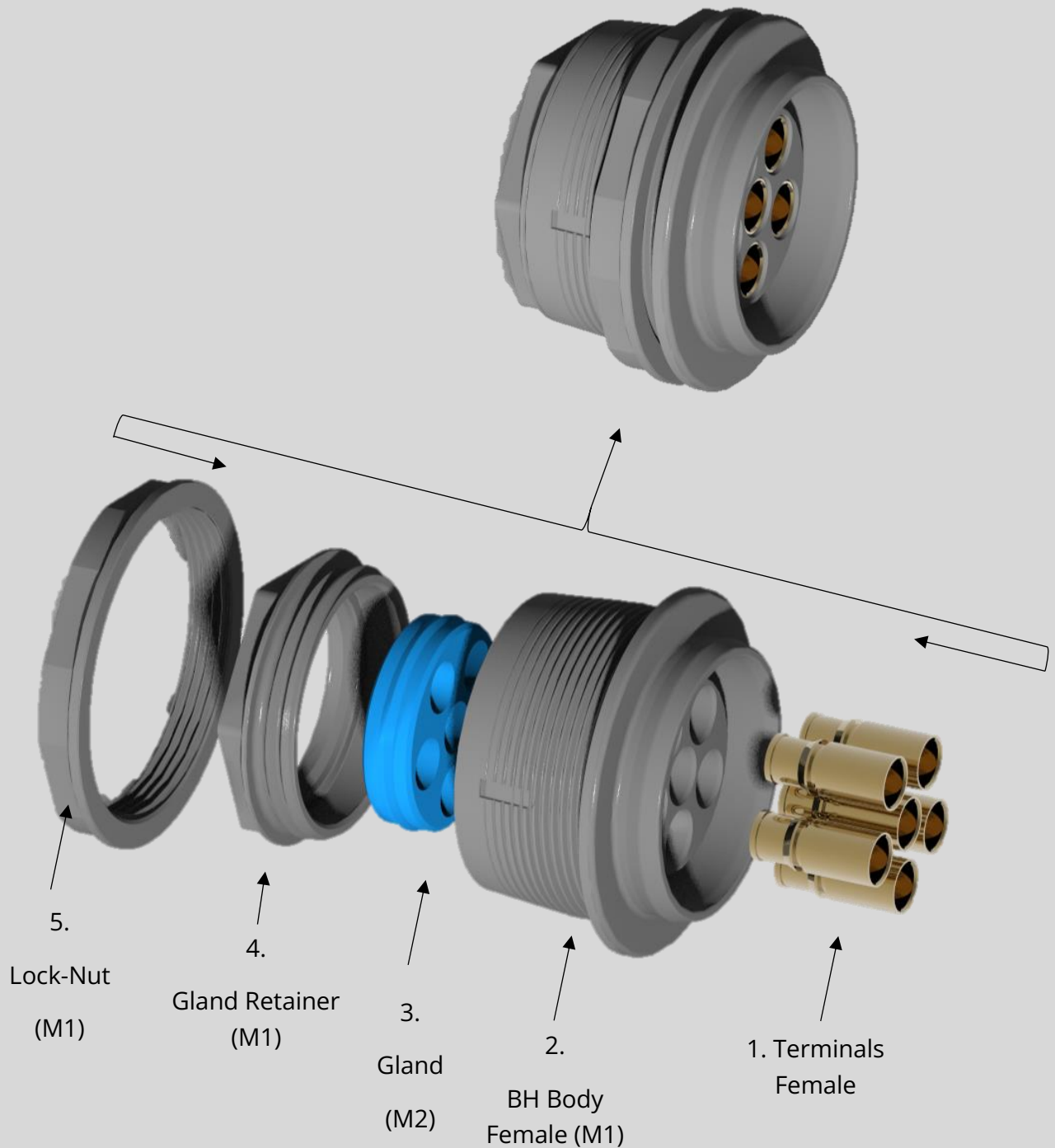
Inline cable exit (female shown)



Right-angle cable exit (male shown)

2.4.2 Bulkhead Female Siblings:

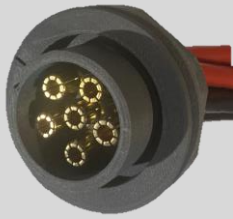
Can be fitted through circular holes, dimensions on drawings provided.



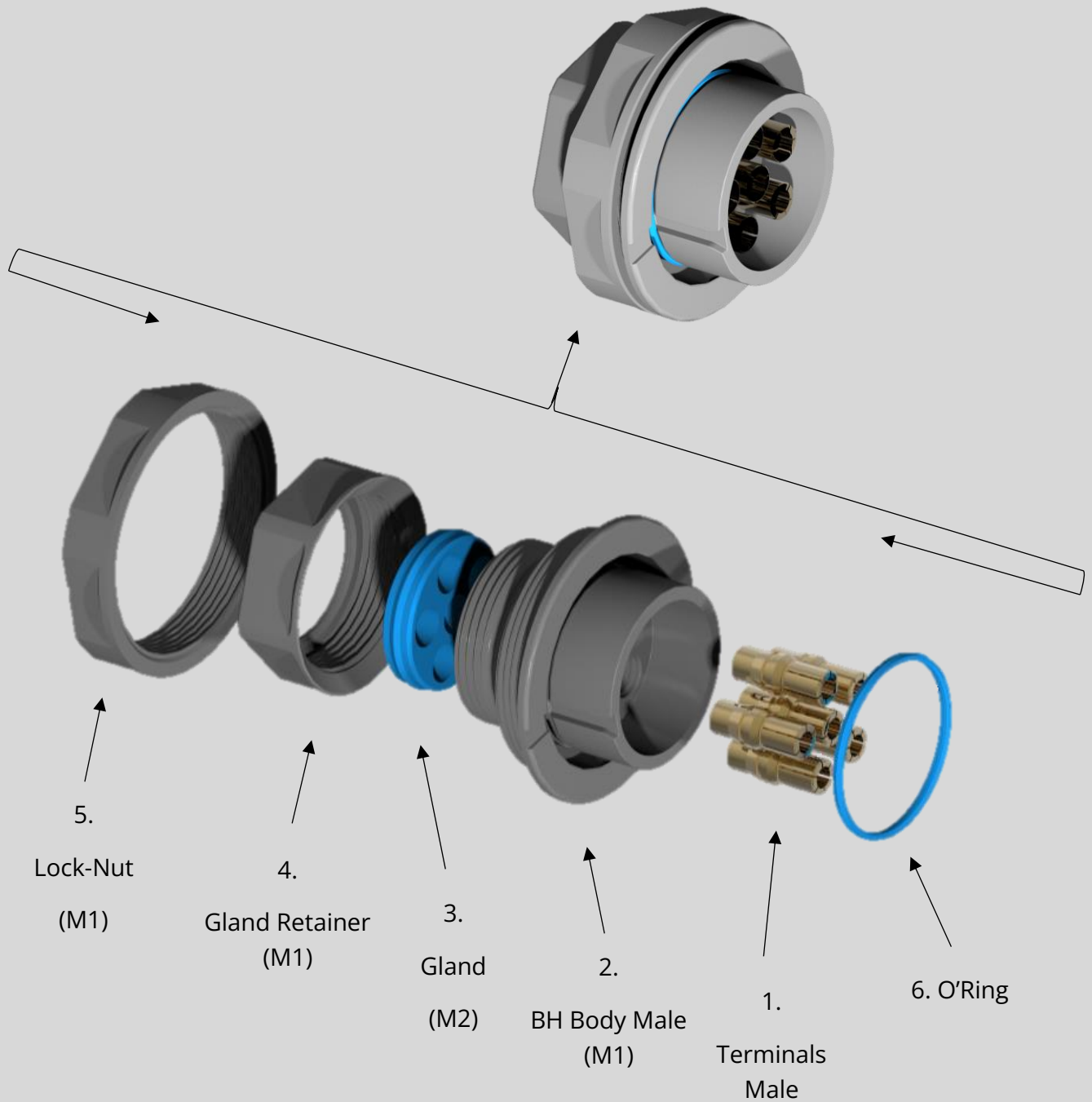
BULKHEAD (BH) Female Connector

Direct product integration capability.

(EC8x6 shown for illustrative purposes)



2.4.3 Bulkhead Male Siblings:



BULKHEAD (BH) Male Connector

Direct product integration capability.
(EC8x6 shown for illustrative purposes)

2.5 Design Package Purchasing Options:

2.5.1 All design packages come with:

- STL files (HD): selected connector(s), associated assembly tools/fixtures & connector dust-caps.
- PDF Assembly and inspection drawing.
- MALE AND FEMALE SIBLINGS ARE SOLD SEPERATELY.

2.5.2 Full Sets (1-5 in figure below):

- Includes all 10x variants, including male and female.

2.5.3 Inline (1-2 in figure below):

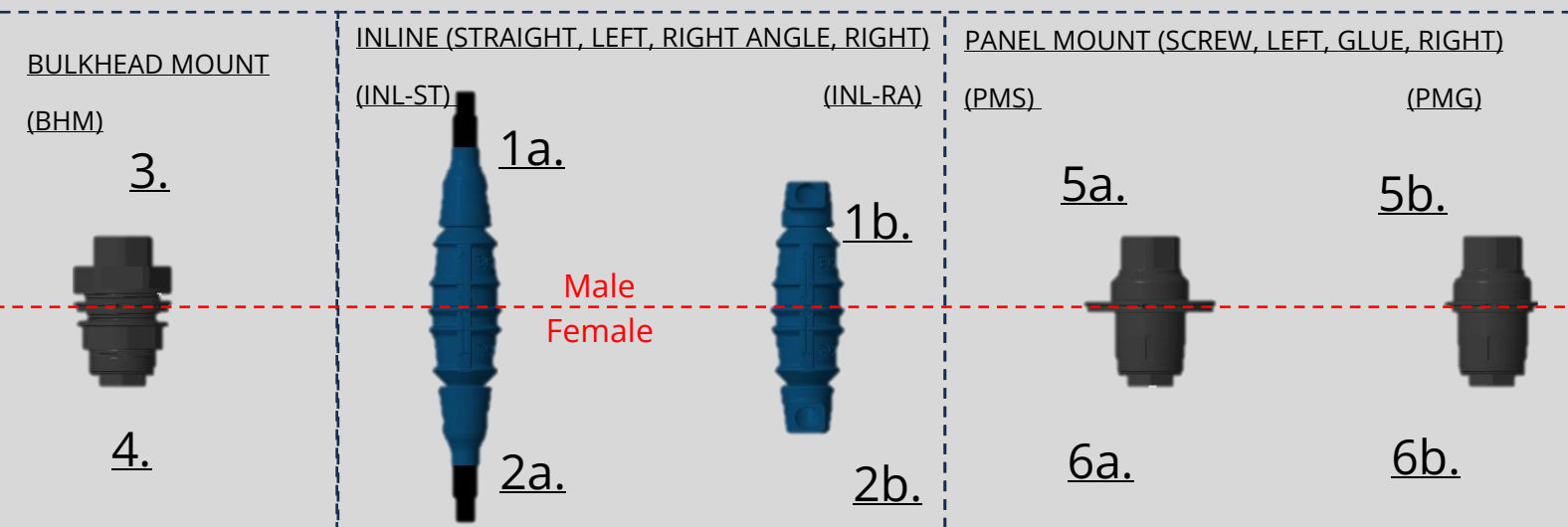
- Includes Straight and Right-Angle Cable exit options, male and female, 4x variants.

2.5.4 Bulkhead (3-4 in figure below):

- Male and Female, 2x variants.

2.5.5 Panel Mount (5-6 in figure below):

- Includes Glue type and Screw type variants, male and female, 4x total variants.



2.6 LunaPlugs® Product Matrix (Full Series):

LUNAPLUGS					
Term. Type(s)	'N' No Contacts	Continuous current (Amps) per contact	*Assy Force (kg)	Compatible Cable Sizes (awg)	Family Base Code
EC5	1	40	1.2	10/12	EC5x1
	2	40	2.4	10/12	EC5x2
	3	40	3.6	10/12	EC5x3
	4	40	4.8	10/12	EC5x4
	5	40	6	10/12	EC5x5
	6	40	7.2	10/12	EC5x6
	7	40	8.4	10/12	EC5x7
	8	40	9.6	10/12	EC5x8
	9	40	10.8	10/12	EC5x9
EC8	1	80	1.4	6/8	EC8x1
	2	80	2.8	6/8	EC8x2
	3	80	4.2	6/8	EC8x3
	4	80	5.6	6/8	EC8x4
	5	80	7	6/8	EC8x5
	6	80	8.4	6/8	EC8x6
	7	80	9.8	6/8	EC8x7
	8	80	11.2	6/8	EC8x8
	9	80	12.6	6/8	EC8x9
EC8+5	6+4	Mixed	13.2	10/12 & 6/8	C1
EC8+5	3+3	Mixed	7.8	10/12 & 6/8	C2
EC8+5	2+8	Mixed	12.4	10/12 & 6/8	C3
*Assembly push force required by users (or mechanisms) to make connection – disassembly/pull/break force is always less. Inline connectors have additional assembly/disassembly force due to flexible body retention system. Oring also provide additional force requirements and depend on the Oring size used and whether or not they're greased.					

Extra Notes:

Whilst attempting to be conservative in our figures, actual performance is dependent on factors in the users control, such as soldering – we provide outline guidance in the [Performance Characteristics](#) section of this manual. Further information on thermal response of the contacts can be found on the LunaPlugs® product pages.

3. Performance Characteristics

3.1 The Importance of Thermal Management:

Thermal management is required to maintain performance and longevity of most, if not all, high powered electrical systems. This can take many forms including, and not limited to, adequate: material selections, airflow, cooling plates/heat sinks, electronic burst and continuous current timing controls.

LunaDrives® Laboratory Test Data suggests that properly assembled EC Terminals generate most heat from their contact interfaces. When encapsulated within connector bodies, this heat conducts and dissipates along the cables. This heat is present in normal use and is accompanied by lower-level heat generated by the cables due their internal resistance. It is crucial to consider thermal management on a system-by-system basis.

Thermally overloading connectors lead to the following known failure modes:

- Melted connector pairs.
- Fused connector pairs.
- Solder melt, disconnection & capacity reduction.
- Reduced male terminal spring leg contact force, increasing interface/contact resistance.

3.2 Sources of Performance Variation

3.2.1 Soldered Joints:

The importance of implementing a proper soldering process, capable of creating repeatably reliable high quality joints must not be underestimated. Soldering voids and/or “dry-joints” are the principal sources of *excessive* heat generation from a newly built connector.

3.2.2 Quality of Materials:

There are large variations in the quality of terminals and cables available, despite their comparable marketing claims. During development of LunaPlugs® we tested many sources of cables and terminals, finding substantial variation in the heat ejection of test specimens sourced from differing suppliers. We put together the [LunaDrives® Approved Materials and Suppliers List](#) to help everyone improve the performance and longevity of their systems whilst avoiding needless system failures.

3.2.3 Connector Assembly Cycles Increase Connection Interface Resistance:

Whilst some components perform better than others, *all* terminals suffer degradation over time as they are repeatedly assembled and disassembled. Abrasion is the principal source of degradation, which can be greatly exacerbated by making or breaking the connections under load or at high voltages. “Anti-spark”



LunaPlugs® E1.0

systems can be designed into most applications, using resistors to stage voltage increase during connection to avoid spark conditions.

4.3D Printing

4.1 Printer Compatibility:

LunaPlugs™ are designed to be compatible with all FDM ($\leq 0.4\text{mm}$ nozzle) and SLA printers.

4.2 Printer Settings:

When printing on LunaPlugs® on FDM printers, ensure the following settings are in place:

- Z-Seam alignment is turned on and oriented to the back of the build plate.

NB: Rushed speed setting result in poor-quality prints. We found Creality printers prior to their K1 range gave best results at $\sim 30\text{mm/s}$.

4.3 Orientation & Scaling:

4.3.1 Orientation:

Our STL files are provided with coordinate systems, specifying Z-Direction and X-Y seam alignments for best fit. Please ensure that when you place the components in your slicer, that these standardised orientations are maintained e.g. Cura requires resetting positions after placing multiple parts on the build plate.

4.3.2 Printer Tuning:

M1 – start with male and female bodies. Test fit your terminals and ensure they are a close interference. X-Y scaling should be avoided at all costs on these components as it changes the contact between centres distances. Instead, tweak temperatures and flow compensation settings in your slicer software, or for SLA, add inner and outer wall offsets as shown in our Formlabs FR Resin section of the [LunaPlugs® Approved Materials](#) section on our website.

M2 - Start with the glands, tuning until your z-seam is smaller in height than the sealing ring feature on the outer annulus of the gland (principally a retraction speed issue – the softer the filament, the faster the retraction needs to be). Also test fit your 6awg cables, there should be a light interference to super light clearance. If there is too much interference then you will struggle assembling larger connectors. You may want to use grease to aid this step. Once you've got the glands to come out right, then move onto the moldings & scaling.

4.3.3 Scaling:

M1 components ([see section 4.4](#)).

Using the inspection and assembly drawings provided with your selected design package, test/calibration prints should be:

- Measured and deemed within drawing tolerances (we use digital callipers, accurate to 2 decimal places).
- Test assembled, starting with unsoldered terminals to check they fit adequately without wasting soldered terminals.

M2 Moldings Scaling Notes:

M2 Moldings were designed for use with 95A TPU, from FDM printers. When using softer materials, to maintain retention between inline bodies, the moldings & wirecaps require X-Y scaling. We found that on 90A TPU, that 97% scaling in X and Y worked brilliantly to ensure connector retention still worked. Do not apply scaling to glands as they should simply compress and seal during assembly. The softer the material, the better the seal.

4.4 Material Requirements

Our 3D Printable part numbers feature material prefixes. This helps in avoiding material mix-ups.

- M1 – Rigid Flame Retardant HDT Plastics
- M2 – Flexible Plastics
- M3 – Fixturing and Tools – low-cost stiff plastics

Please see the [LunaPlugs® Approved Materials](#) section on our website to discover our latest material recommendations.

5. Auxiliary Components & Tooling

Please see [LunaPlugs® Approved Materials](#) section on our website to discover our tried and tested component recommendations for LunaPlugs®.

5.1 Additional Components Required:

- 5.1.1 Terminals
- 5.1.2 Cable
- 5.1.3 Heat-Shrink
- 5.1.4 Silicone-Glass Sheath
- 5.1.5 ORings
- 5.1.6 Silicone Grease

5.2 Tools Required:

- 5.2.1 3D Printer
- 5.2.2 Soldering Iron (~100W for EC5, ~300W for EC8)
- 5.2.3 Punches (Contact Insertion Tools)
- 5.2.4 Hammer/Mallet

5.2.5 Cable Cutters

5.2.6 Stanley Knife

5.2.7 Heatgun

5.3 Tools Recommended:

5.3.1 Measuring Callipers

5.3.2 Vice

5.3.3 Files (cleaning up soldered joints)

6. Product Assembly Instructions

6.1 Soldering:

Soldering affects performance and assembly. Whilst there are many soldering guides online, the below offers some insight on what will and will not work.

6.1.1 Soldering for Performance:

- Eliminate or at least minimise voids (air pockets).
- Ensure cleanliness of components prior to soldering.
- Ensure full melt temperature is achieved (avoid dry-joints at all costs!).
- If unsure about the quality of a joint, leave excess cable on and test before assembly.

6.1.2 Soldering for Assembly:

- Excess solder may need filing back to permit assembly to bodies.

What a good joint should look like:



EC5 Pass



Good fill radius, does not breach leadins or mount diameters, insulation-terminal clearance within 0.5-1.5mm, no legs crushed.



EC8 Pass



Good fill radius, does not breach leadins or mount diameters, insulation-terminal clearance within 0.5-1.5mm, no legs crushed.

What a good joint should NOT look like:



Fail
Coaxiality



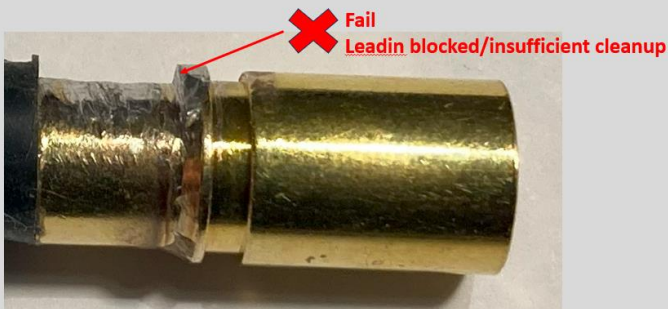
Fail
Solder blocking Leadins

Fail

- Solder on Leadins
- Solder breaches mount diameters



Fail
Crushed Legs



Fail
Leadin blocked/insufficient cleanup



Fail
Solder in groove

6.2 Connector Assembly:

In the following assembly sequence, items in ""s, e.g. "BODY", indicates the STL filename convention for the component, seal or fixture required for a given step.

- 6.2.1 Carefully check the connector drawing BOM Table that you have printed the correct items in sufficient quantities.
- 6.2.2 Populate the main connector body "BODY":
- 6.2.3 Tool Fixture Required: "TOOL_COMP".
- 6.2.4 Terminals must enter from their rear, first inserting the soldered pig-tails from the body front-face, pulling them through until the terminals are ready to punch home.
- 6.2.5 Once the body is loosely populated, mount within the compression tool fixture ("TOOL_COMP"), using the correct diameter punch, gently tap the terminals home. NB: DO NOT punch the terminals all the way through the body, you can tell when they're home because: Male) the terminal cone-base is level with the socket entry face & Female) the full terminal is ~0.5mm subflush to the socket entry face.
- 6.2.6 Silicone grease the cabling insulation, approximately 1cm from the cable ends.
- 6.2.7 Slide the "GLAND" onto the cables and push upto 1cm away from the main body.
- 6.2.8 Silicone grease the OD of the gland prior to pushing upto main connector body.
- 6.2.9 Using the largest punch that fits, gently tap the gland into the body (careful not to bend male legs!). On smaller connectors, or glands printed in material <75shA, the gland-retainer "GLANDRET" maybe used to push the gland into position.
- 6.2.10 Fit and tighten the gland retainer – do not over tighten, it will crack and offer limited retention.

For Inline Connectors:

- a. Use their M2 "MOLDING" & strain reliefs "TRUNK" to retain their glands "GLAND". Make sure to fit heat-shrink and sheathing (if required) to the strain relief ("TRUNK") after having pushed it up the cables to the gland face. **NB: "TRUNK" and sheath/heatshrink is not to be used for Right Angle cable exit versions.**
- b. Right Angle Exit Only: You can now fit the "WIRECAP_RA" to the populated plug, it should easily snap-fit.
- c. Straight Exit Only: Once strain relief "TRUNK" and any heat-shrink/sheathing has been fitted, you can now tighten the "MOLDING" over the populated connector. Use the "TFIXTURE" item as a spanner on the connector face and "SPANNER" item on the flexible body. TIP: It can help to mount "TFIXTURE" into a vice during this operation. Only tighten

LunaPlugs® E1.0

until the “MOLDING” touches the “TFIXTURE” and the alignment arrows meet. “WIRECAP” can now be snap-fitted.

- 6.2.11 MALES ONLY: Using silicone grease, now fit the “ORING” (Can be printed or purchased, see drawings or [LunaDrives® Approved Materials](#) for purchase size requirement).
- 6.2.12 “DCAP” dust caps can now be fitted to protect the connector(s) from contamination both prior to and during use on final product(s).

READY!

