FIRST Control System Cable Specifications

Revision 1

1. FIRST ROBOTICS CABLE PHILOSOPHY

Summary

This document is designed to help FIRST vendors build high-quality cables for teams**. FIRST teams are not expected to build their own cables.** While some forms of cable fabrication are difficult to avoid in FRC, the elimination of wire strippers, crimp tools, and soldering irons from FTC is achievable with a combined effort from vendors to ensure high-quality cables are always available for teams. Vendors and other parties interested in producing cables for teams should be able to hand this document to a cable manufacturer and quickly move towards production.

While several cables are listed in this document, note that most teams will use only a small subset of the SKUs shown.

Mechanical Reliability

Cables should be optimized for high mechanical cycle ratings and flexibility. Silicone or other flexible insulation materials and high strand counts should be prioritized. Sometimes, the crimp terminal or connector housing will be the limiting factor with respect to wire selection and strand counts. A stranding table is in the “Requirements” section of this document.

Flat-/Ribbon-Style joined-conductor cables tend to have poor flexibility, so they are generally avoided.

To minimize the probability of cuts and breaks, cables will be joined with braided overwrap. Note the free-wire diagrams provided in the first section of the document.

Official housings and crimp terminals must be used to ensure mechanical and thermal stability, and cables must not use smaller conductors than specified in this document.

All PCB-Side connectors employ rigid pins. This keeps the flexural, and arguably higher-risk terminals cable-side rather than PCB-side.

Electrical Reliability

CAN Bus Differential Pairs must be twisted. They must be CAN-FD compliant with 40-80 twists per meter (60 twister per meter nominal). Power pairs should always be joined in some manner to minimize magnetic loop area. Do not mix gold-plated and tin-plated terminals. Mixing terminal material introduces risk of galvanic corrosion and reduced signal integrity.

Receptacle/Plug Combinations

Molex SL, Molex Micro-Fit+, and Molex Mega-Fit housings are only offered in Male/Plug variants for PCBs. They are all offered in Male/Plug *and* Female/Receptacle variants for cables.

Where possible, cables are limited to Receptacle-Receptacle variants. This will be the case for FTC Battery and FTC Device Cables. This will not be the case for FRC Twisted-Pair CAN Bus and Power cables. The reason for this is that many FRC devices ship with embedded "pigtail" cables of both genders that are designed to be daisy-chained together. This alone necessitates receptacle-plug variants alongside standard receptacle-receptacle variants. If vendors decided to ship with pigtail cables that only utilized male/plug connectors, they would lose the ability to plug directly into Systemcore and daisy chain with other pigtail-based devices, so this is unreasonable. In addition, FRC sometimes calls for long runs of cable with lengths beyond stocked options.

Plug-Plug cables are unnecessary and will not be produced.

Color-Coding

- Red wire insulation is strictly reserved for VCC connections.
- Black wire insulation is strictly reserved for Gnd/V- connections.
- CAN LOW connections must use green wire insulation.
- CAN HIGH connections must use yellow wire insulation.
- Molex Micro-Fit+ Housings are offered in multiple colors, each with a unique polarization pattern. **All cables must use black housings.**

To support Systemcore's 5 CAN Buses, CAN Bus coloring schemes may be desired. The recommended approach is that of colored jacketing, colored sleeves, colored velcro tie wraps on either side of each cable, or colored rubberbands on either end of each cable. Colored tie-wraps and rubber bands minimize SKU counts and purchasing requirements for teams.

Transparency

Vendors must list wire gauge, strand counts, insulation materials, and overwrap materials on product pages.

2. MOLEX HOUSINGS AND TERMINALS

Molex offers terminals with tin plating, standard gold plating, and heavy gold plating. SL series terminals are offered in standard retention force and high retention force variants.

FIRST-compatible cables will use official Molex connector housings and standard gold-plated crimp terminals with standard retention force.

Why use standard gold plating?
Systemcore uses gold-plated Molex SL wire-to-board terminals. Gold-plated terminals have higher mate/unmate cycle ratings (200 cycles) compared to tin-plated terminals (20 cycles). Heavy plating does not materially change mate/unmate forces and therefore increases the mate/unmate cycle rating of the terminal, so crimp terminals with heavy gold plating may be used as substitutes for terminals with standard gold plating. Standard gold plating strikes the right balance of cost and durability for FIRST teams.

Can you mix gold-plated and tin-plated terminals?
Mixing gold and tin is not recommended due to the risk of galvanic corrosion in humid environments impacting long term electrical performance and analog signal integrity.

Why use standard retention force terminals?
High force terminals provide extra connector retention in latch-less connectors, but they experience greater wear with each mate/unmate cycle. Given the use of positive locking connector housings, Molex recommends standard force terminals.

Wear Patterns
By standardizing on Molex connectors, we can ensure that flexural crimp elements are exclusively cable-side. This means any reduction in spring force over prolonged use over several years is limited to easily replaceable cables rather than pcb-mounted components.

For additional questions and information on Molex parts, please visit the Molex FIRST Portal at https://www.molex.com/en-us/experience/first-robotics

MOLEX SL 22-24 AWG GOLD-PLATED CRIMP EXPLORATION

Available Gold-Plated Crimp Terminals:

- (Female) 71851 series with high retention force:
  - 0.381µm Plating, High Retention Force, Reel Packaging – 16021124
  - 0.762µm Plating, High Retention Force, Reel Packaging – 16021111
  - 0.381µm Plating, High Retention Force, Bag Packaging – 16021125
  - 0.762µm Plating, High Retention Force, Bag Packaging - 16021115
- (Female) 70058 series with standard retention force:
  - 0.380µm Plating, Standard Retention Force, Reel Packaging – 16020087
  - 0.750µm Plating, Standard Retention Force, Reel Packaging – 16020088
  - 0.380µm Plating, Standard Retention Force, Bag Packaging – 16020103
  - 0.750µm Plating, Standard Retention Force, Bag Packaging – 16020104
- (Male) 70021 series:
  - 0.381µm Plating, Reel Packaging – 16020081
  - 0.762µm Plating, Reel Packaging – 16020116
  - 0.381µm Plating, Bag Packaging – 16020115
  - 0.762µm Plating, Bag Packaging – 16020117

Final Crimp Terminal Selection (Standard Retention, Standard Gold Plating)

- Reel Packaging: 16020087 (Female / Receptacle), 16020081 (Male / Plug)
- Bag Packaging: 16020103 (Female / Receptacle), 16020115 (Male / Plug)

MOLEX SL HOUSING EXPLORATION

Molex SL Receptacle Housings can be separated into six distinct families:

Non-Polarized

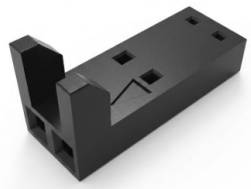
Front Rib

Back Rib

Positive Latch

Positive Latch + TPA

Friction Lock



Images courtesy of Molex

All cables will utilize **Positive Latch** receptacle housings.

Molex plug housings come in panel-mount and non-panel-mount variants. Cables will utilize **non-panel-mount** plug housings.

All cables must allow for 12.7mm of free wire to minimize crimp terminal stress.

MOLEX MICRO-FIT+ 20-24 AWG GOLD-PLATED CRIMP EXPLORATION

Available Gold-Plated Crimp Terminals:

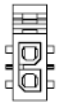
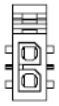
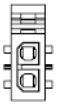
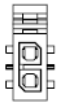
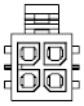
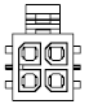
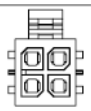
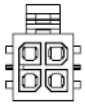
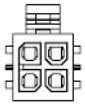
- (Female) 206460 series:
  - 0.380µm Plating – 2064600022
  - 0.750µm Plating – 2064600023
- (Male) 215953 series:
  - 0.380µm Plating – 2159530022
  - 0.750µm Plating – 2159530023

Final Crimp Terminal Selection (Standard Gold Plating)

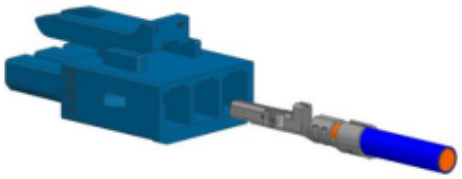
- 2064600022 (Female / Receptacle), 2159530022 (Male / Plug)

MOLEX MICRO-FIT+ HOUSING EXPLORATION

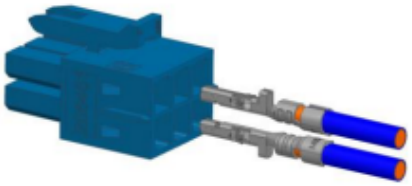
Molex Micro-Fit+ Housings ship in several colors, each of which signals a distinct polarization pattern. All cables must utilize the ‘A’ Polarization pattern with black housing plastic.

CKT	POLARIZATION "A"- BLACK	POLARIZATION "B" - NATURAL	POLARIZATION "C" - RED	POLARIZATION "D" - BLUE	POLARIZATION "E" - YELLOW
2					
4					

For dual-row Micro-Fit+ Housings, such as those used for the FIRST Control System, terminals must be inserted upside-down into the bottom row



Single Row Receptacle –
Terminal position into the housing

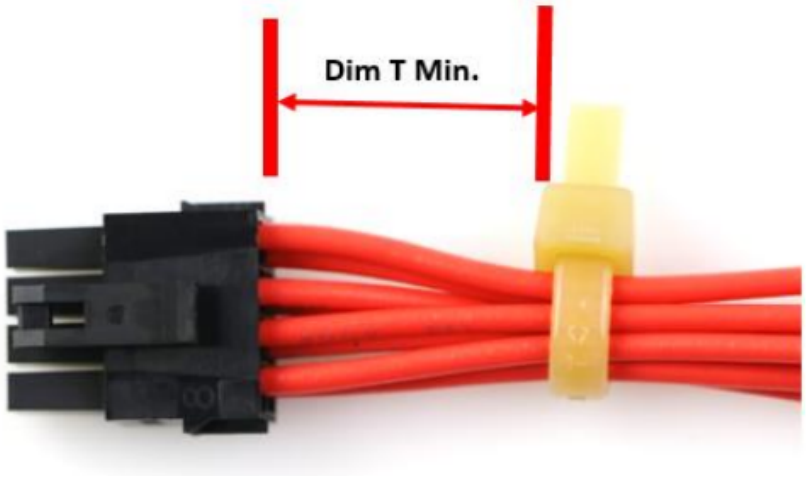


Dual Row Receptacle –
Terminal position into the housing

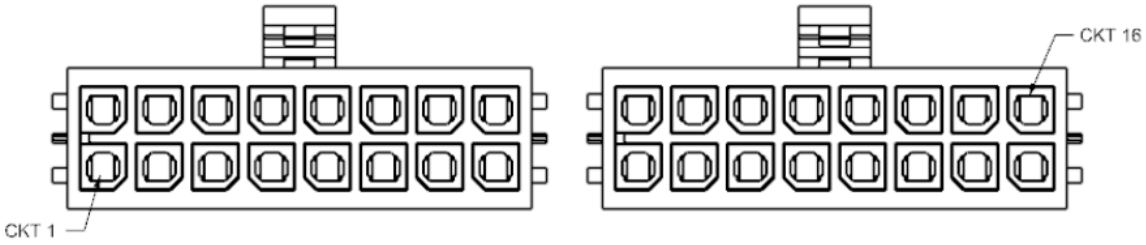
Images courtesy of Molex

All cables must allow for 12.7 mm of free wire to minimize terminal stress:

CKT Size			Dim T Min.
2	4	6	0.50" (12.7mm)
8			0.75" (19.1mm)
10	12		1.00" (25.40mm)
14	16		1.25" (31.75mm)
18	20		1.50" (38.09mm)
22	24		1.75" (44.45mm)



Receptacle Pinout:



Images courtesy of Molex

MOLEX MEGA-FIT 10 AWG GOLD-PLATED CRIMP EXPLORATION

Available Crimp Terminals:

- (Female) 172063 series:
  - 0.380µm Plating – 1720630335
  - 0.760µm Plating – 1720631335
- (Male) 105418 series:
  - 0.380µm Plating – 1054180312
  - 0.760µm Plating – 1054181312

Final Crimp Terminal Selection (Standard Gold Plating)

- 1720630335 (Female / Receptacle), 1054180312 (Male / Plug)

MOLEX MEGA-FIT HOUSING EXPLORATION

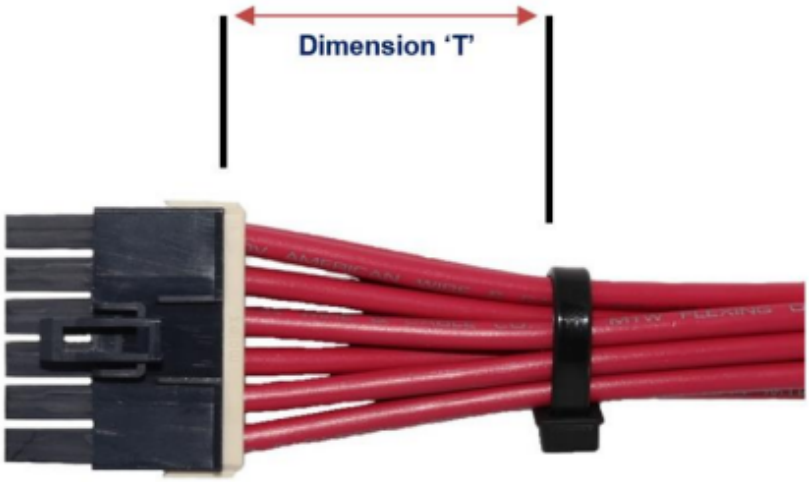
Single-row and dual-row Mega-Fit receptacles utilize different latching architectures.

	Single-Row	Dual-Row
Receptacle		
Plug		

Mega-Fit cables for FIRST exclusively utilize **Single-Row** Receptacles.

Heat shrink / Jacketing should allow for 12.7mm of free wire as shown:

Circuit Sizes	Dimension T Minimum
2	.50" (12.7 mm)
3-6	.75" (19.1 mm
7-8	1.00" (25.4 mm
10-12	1.25" (31.75 mm



Images courtesy of Molex

MOLEX CRIMP TOOLS

Connector	Wire Gauge	Hand Crimp Tool
Molex SL	24-22 AWG	63811-8700
Molex SL	30-24 AWG	200218-7000
Molex Micro-Fit+	20 AWG	213309-4500
Molex Mega-Fit	10 AWG	213309-6000
Molex Mega-Fit	12 AWG	223863-1300

3. FIRST ROBOTICS CABLE SPECIFICATIONS

General Requirements:

- **Plating**: Use gold-plated crimp terminals for high-reliability interconnects as explicitly defined by the exact terminal part number in each spec
- **Length definition**: Finished length is measured inner-face to inner-face along the cable centerline. Tolerance: ±2% or ±5 mm (whichever is greater).
- **Crimp & Strip**: Crimp and strip dimensions must meet the requirements in each cable specification and the vendor application tooling specs for the specific terminal + wire OD.
- **Color & Polarity**: Follow the pin-to-color maps in each cable's spec. Keying orientation (latch, polarization) is mandatory.
- **Labeling**: No labels/markings required
- **Batching & Packaging**: To be determined per-order
- **QA**:
    - Only Use official Molex terminals and housings.
    - Review official Molex documentation
    - Verify insulation support engagement.
    - No nicks, cuts, or insulation damage. No bent or recessed terminals.
    - Continuity and pin-to-pin verification for all cables
    - No inter-pin shorts.
    - Insulation Resistance / Hi-Pot: 500 VDC, 1 s; ≥ 100 MΩ between any two conductors.

Stranding:

X/Y = X Strands of Y AWG

AWG	Poor Stranding	Acceptable Stranding	Good Stranding
10	19/22	105/30	413/36
12	19/25	65/30	168/34
18	16/30	41/34	168/40
20	10/30	26/34	104/40
22	7/30	19/34	65/40
24	7/32	19/36	42/40
28	7/36	19/40	45/44

SmartIO Molex SL Cables:

CABLE TYPE	LENGTHS
SL-R-3_SL-R-3_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm
SL-R-3_SL-P-3_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm

CAN Bus and Low-Current Power Molex SL Cables:

CABLE TYPE	LENGTHS
SL-R-2_SL-R-2_CAN_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm
SL-R-2_SL-P-2_CAN_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm
SL-R-2_SL-R-2_PWR_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm
SL-R-2_SL-P-2_PWR_<length>	300mm, 600mm, 900mm, 1200mm, 1500mm

Quadrature Encoder and I2C Molex SL Cables:

CABLE TYPE	LENGTHS
SL-R-4_SL-R-4_<length>	300mm, 600mm

Device Port and Bridge Port Micro-Fit+ Cables

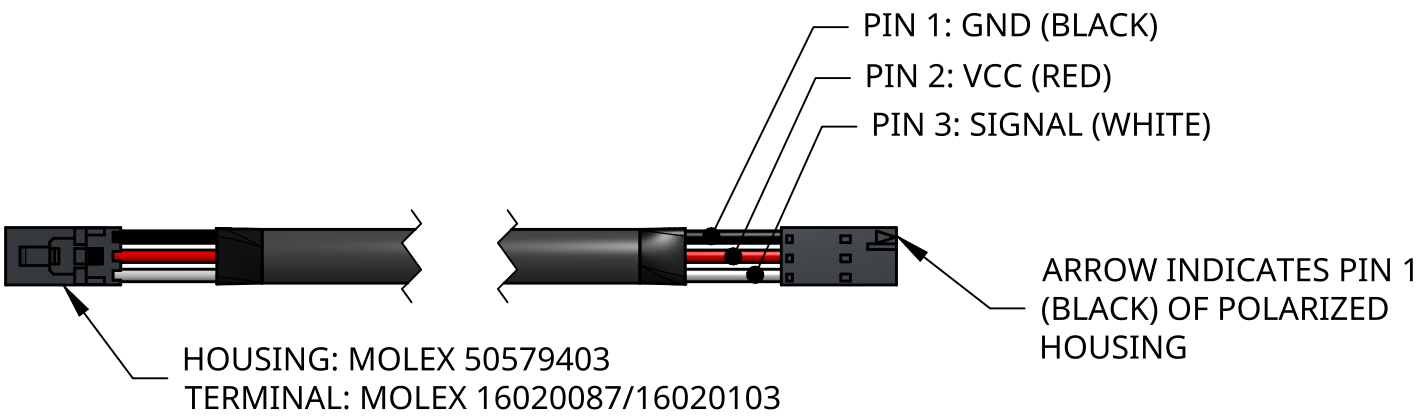
CABLE TYPE	LENGTHS
MFP-R-4_MFP-R-4_DEVICE_<length>	300mm, 600mm, 900mm,1200mm,1500mm
MFP-R-4_BARE_<length>	1200mm
MFP-R-4_XT30-P-2_LEGACY_<length>	600mm

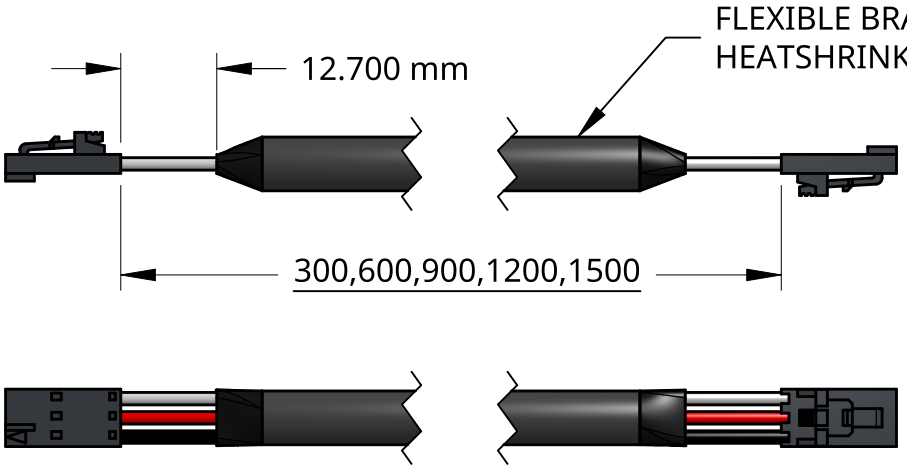
Battery Mega-Fit Cables

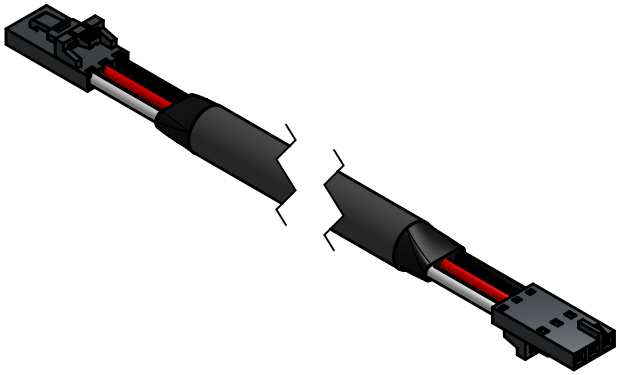
CABLE TYPE	LENGTHS
MEGA-R-2_MEGA-R-2_<length>	600 mm

Adapter Cables

CABLE TYPE	NOTES	LENGTHS
SH-4_SL-R-4_QWIIC_<length>	SparkFun Qwiic Devices	300mm
PH_4_SL-R-4_CHUB_STEMMA_<length>	Legacy Encoders, I2C, STEMMA	300mm, 600mm
PH-4_SL-R-3_CHUBN_<length>	Connects ‘n’ pin (Rev mag & pot, Swyft, Brushland)	300mm, 600mm
PH-4_SL-R-_CHUBNP1_<length>	Connects ‘n + 1’ pin (Rev mag & touch, Swyft, Brushland)	300mm, 600mm
PH-3_SL-R-3_GB_<length>	3-wire GoBilda sensors	300mm, 600mm
PA-4_SL-R-4_ROBITS_<length>	AndyMark sensors	300mm, 600mm





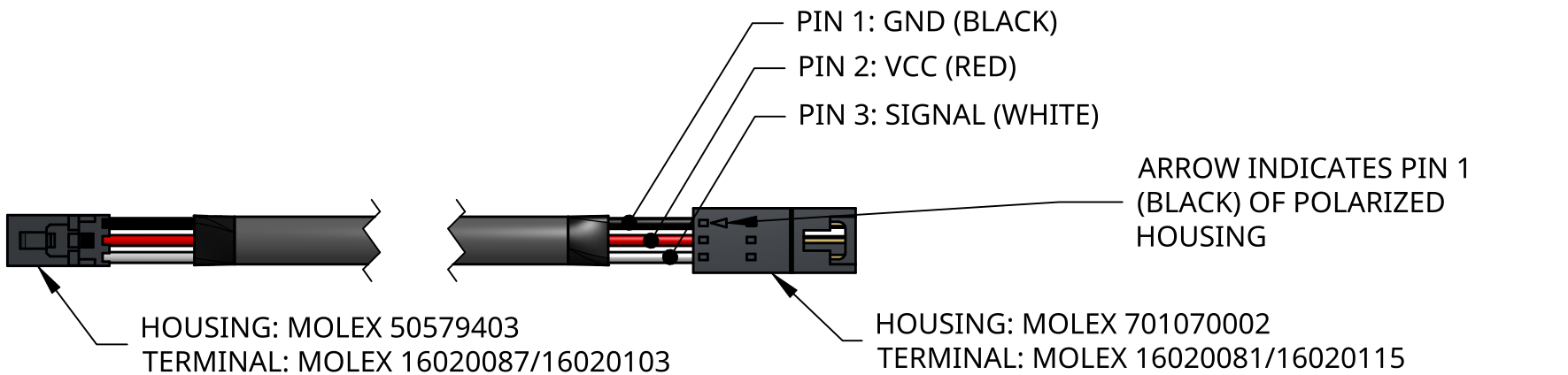


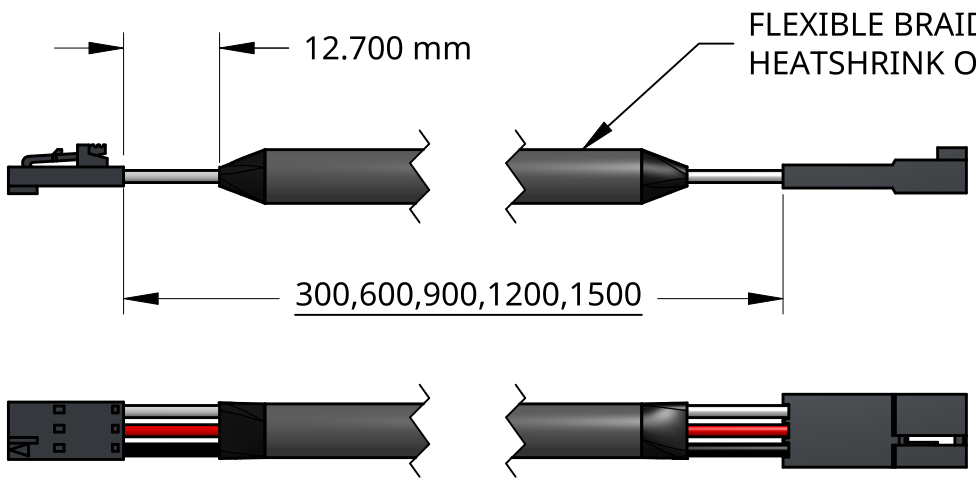
UL3132 SILICONE WIRE, <= 1.63mm INSULATION OD
STRIP LENGTH: 2.54-3.17 mm (MOLEX)
22AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

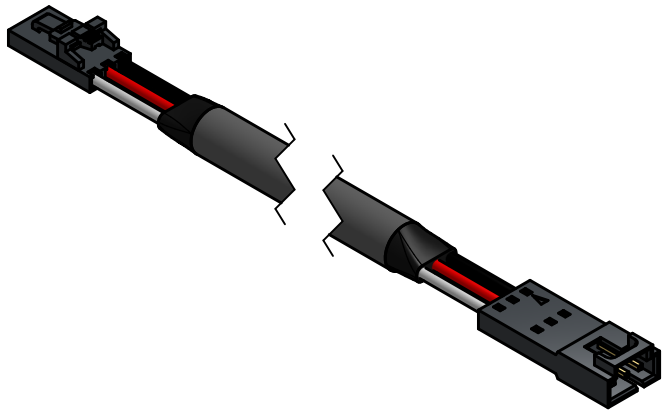
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-3_SL-R-3_IO	1/17







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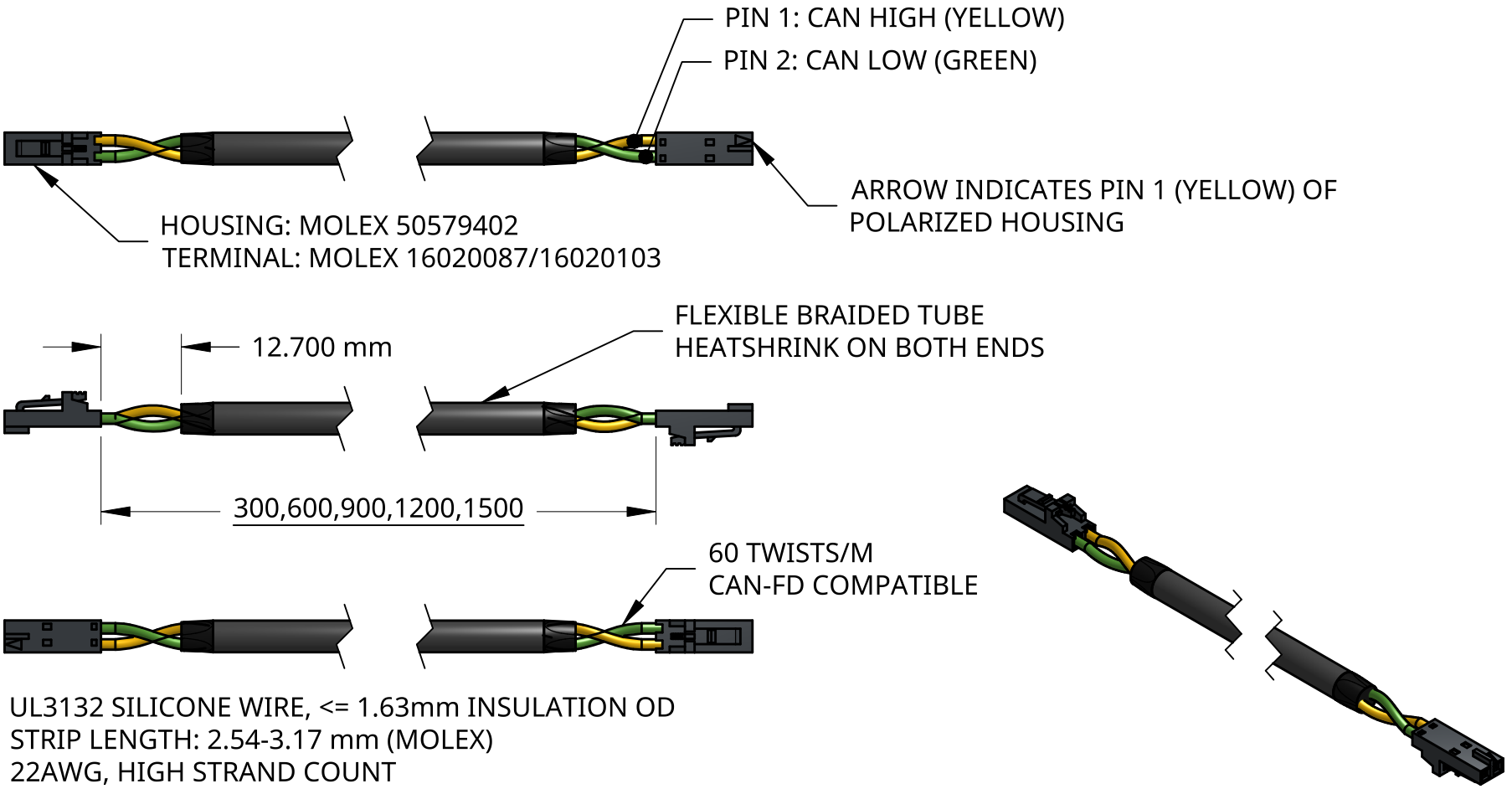
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-3_SL-P-3_IO	2/17



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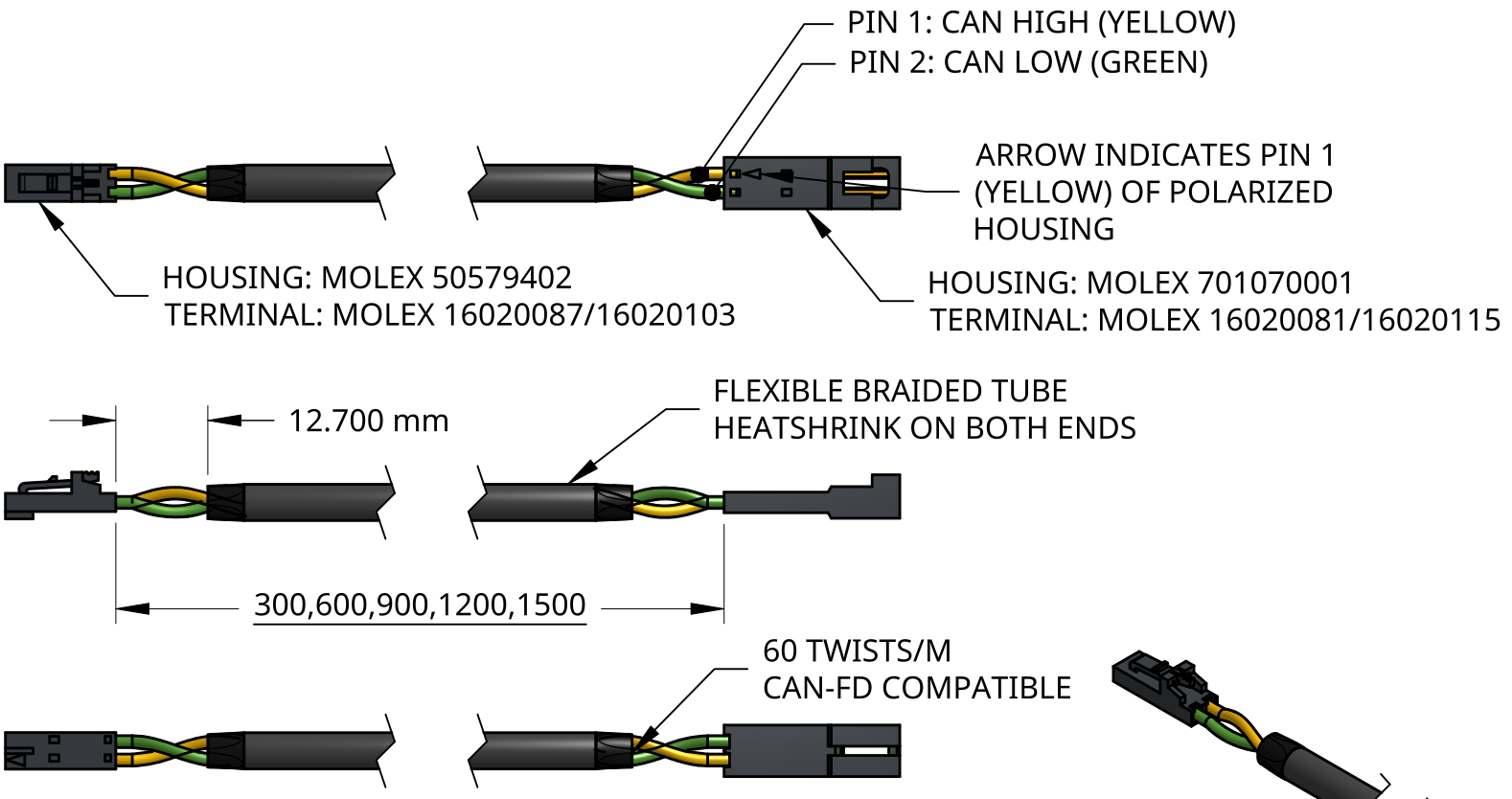
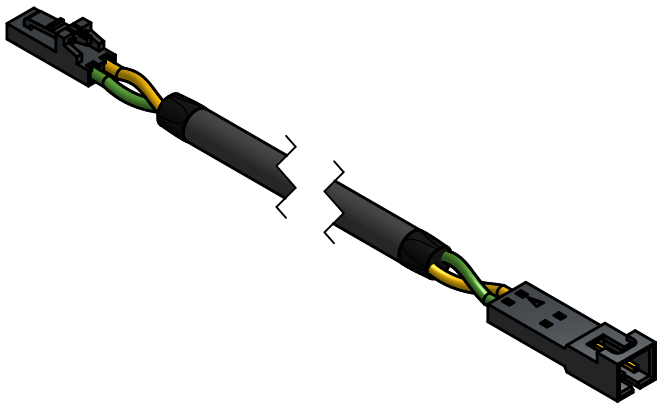
120OHM CHARACTERISTIC IMPEDANCE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-2_SL-R-2_CAN	3/17





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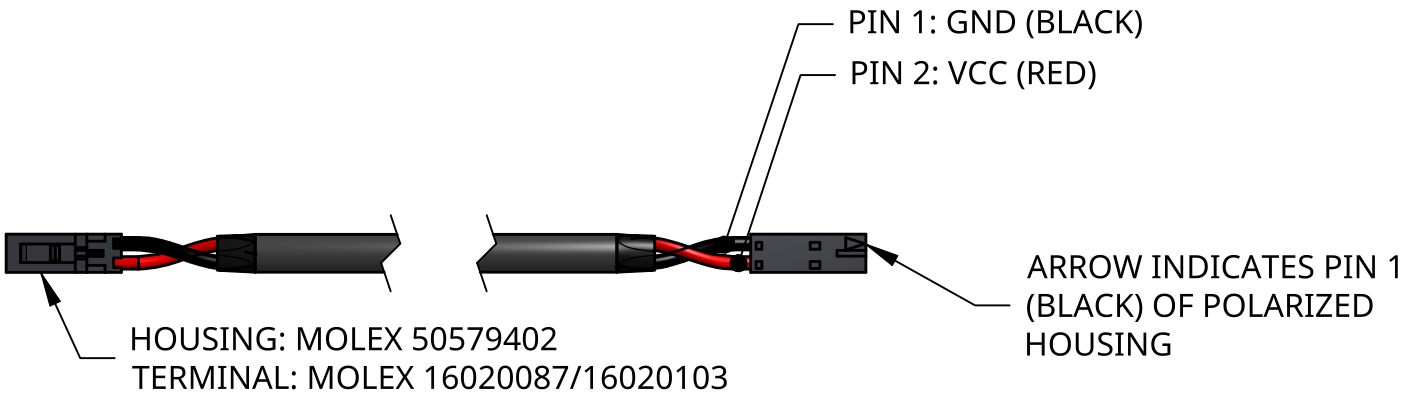
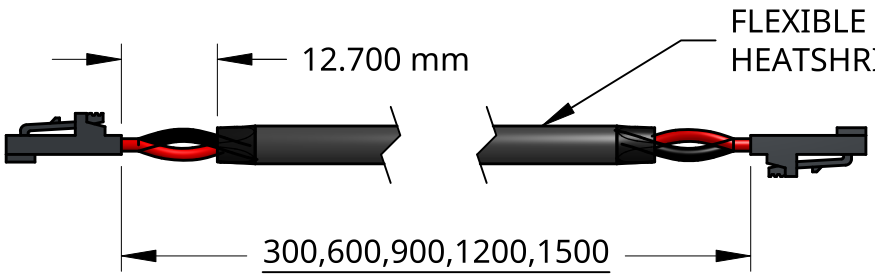
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE
120OHM CHARACTERISTIC IMPEDANCE

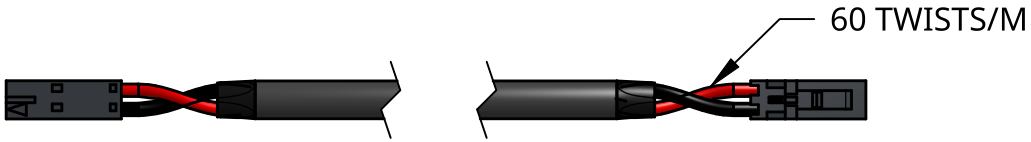
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

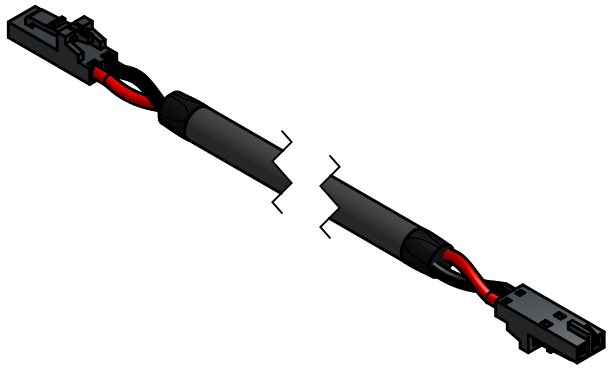
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-2_SL-P-2_CAN	4/17









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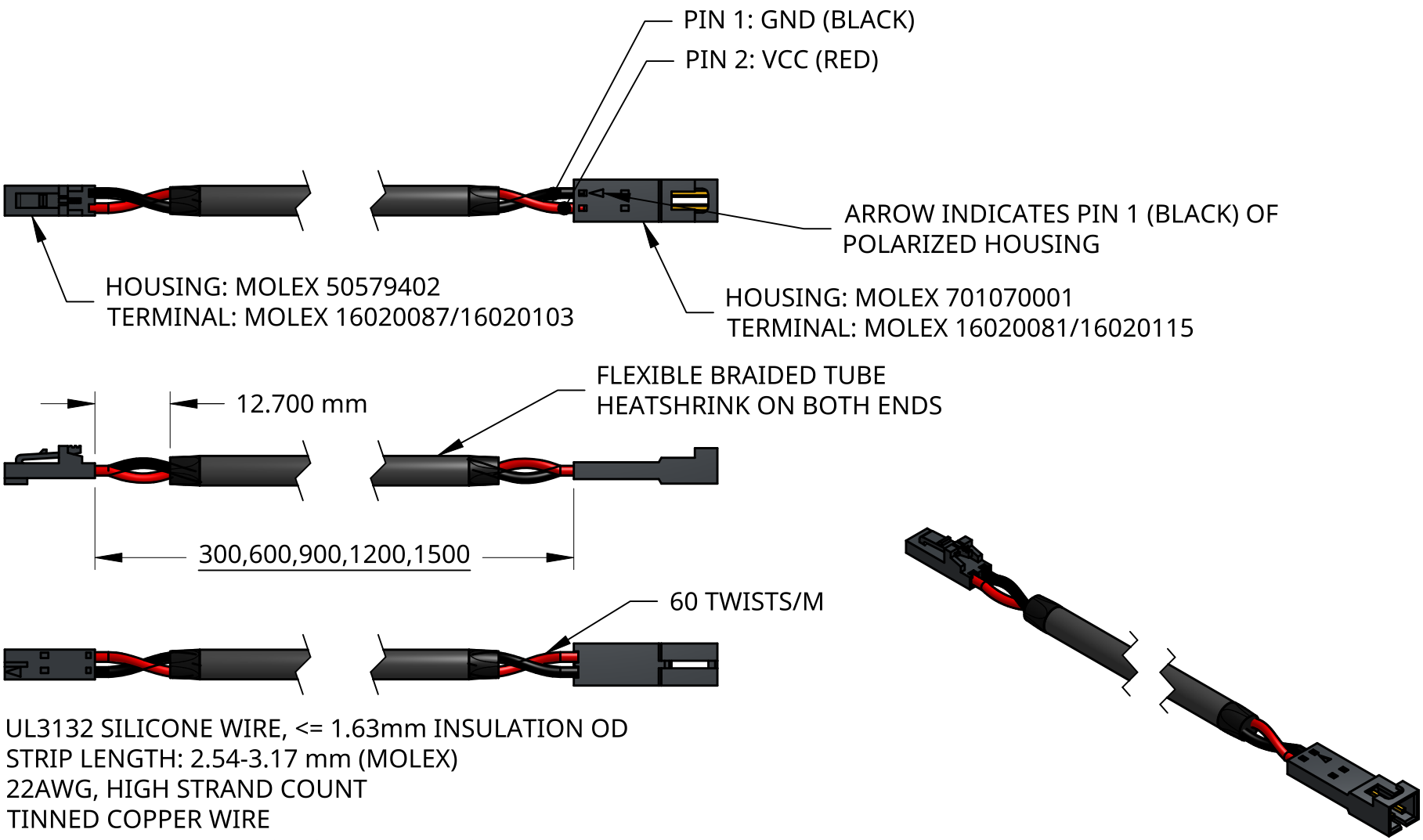
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-2_SL-R-2_POWER	5/17

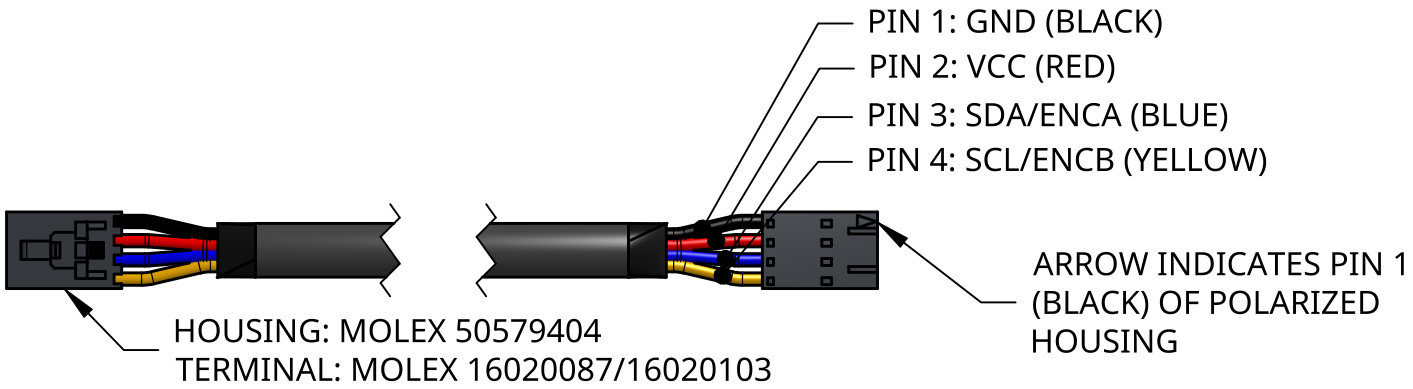


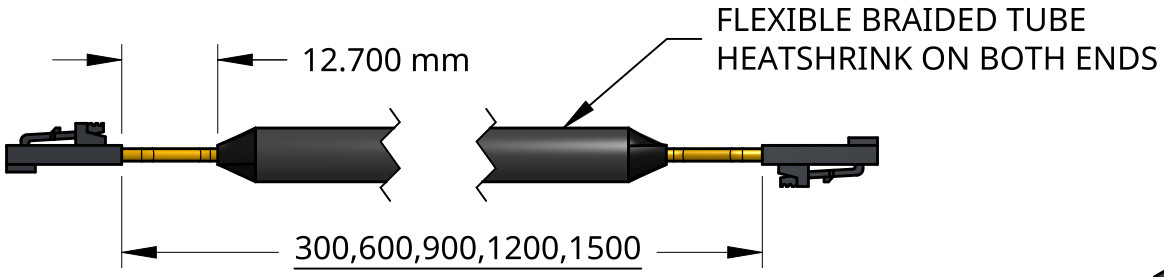
UL3132 SILICONE WIRE, <= 1.63mm INSULATION OD
STRIP LENGTH: 2.54-3.17 mm (MOLEX)
22AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

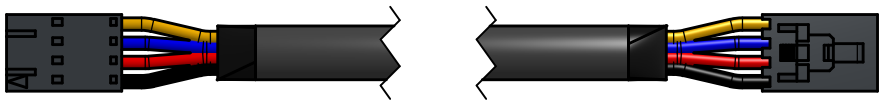
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

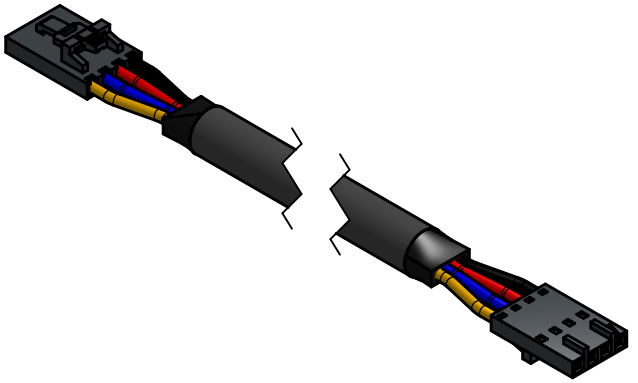
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

SL-R-2_SL-P-2_POWER	6/17







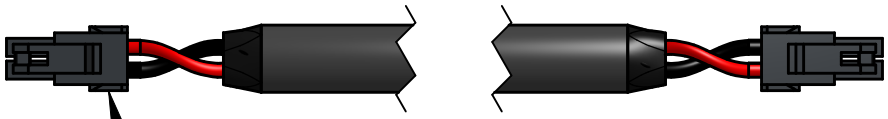


UL3132 SILICONE WIRE, <= 1.63mm INSULATION OD
STRIP LENGTH: 2.54-3.17 mm (MOLEX)
22AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

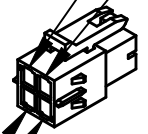
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

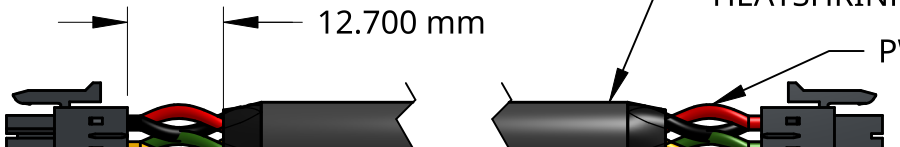
SL-R-4_SL-R-4_I2CENC	7/17



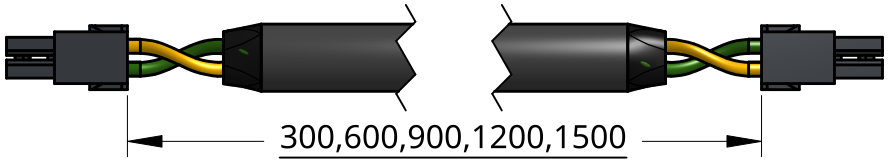
HOUSING: MOLEX 2064610400
TERMINAL: MOLEX 2064600022



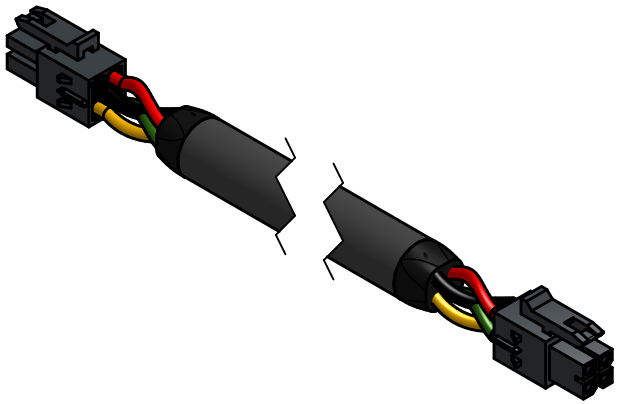
PIN 4: GND (BLACK)
PIN 3: VCC (RED)
PIN 2: CAN H (YELLOW)
PIN 1: CAN L (GREEN)



12.700 mm
FLEXIBLE BRAIDED TUBE
HEATSHRINK ON BOTH ENDS
PWR PAIR: 60 TWIST/M
CAN BUS PAIR: 60 TWIST/M, CAN-FD COMPATIBLE



300,600,900,1200,1500

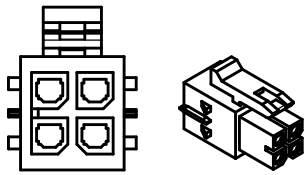


UL3132 SILICONE WIRE, <= 1.85mm INSULATION OD
STRIP LENGTH: 2.54-2.92 mm
20AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE
CAN BUS PAIR: 120OHM CHARACTERISTIC IMPEDANCE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

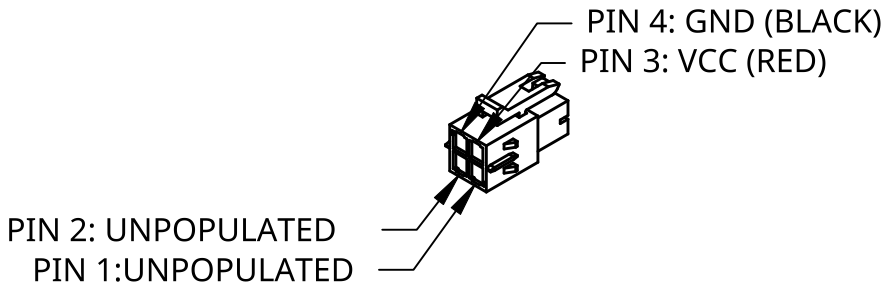
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

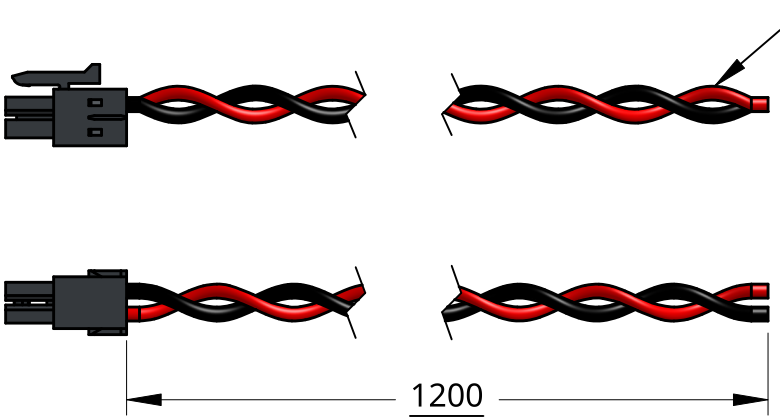
MICRO-FIT+ (**PLUS**)
BLACK 'A' POLARIZATION

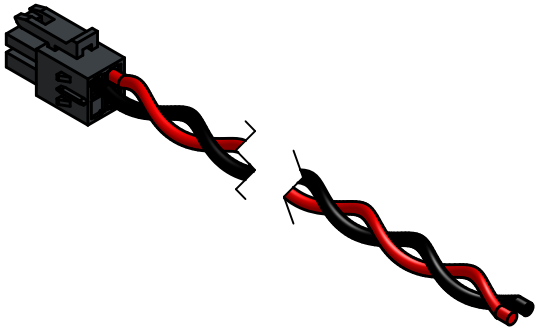


SCALE 2:1

MFP-R-4_MFP-R-4_DEVICE	8/17





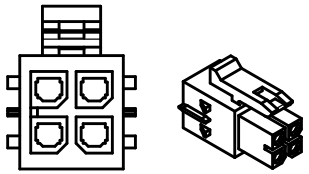


UL3132 SILICONE WIRE
20AWG, HIGH STRAND COUNT, <= 1.85mm INSULATION OD
STRIP LENGTH: 2.54-2.92 mm
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

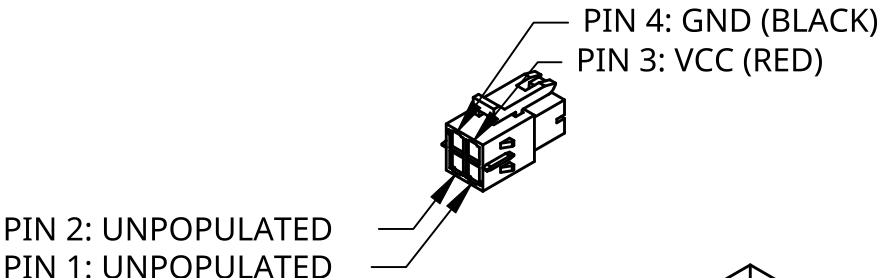
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

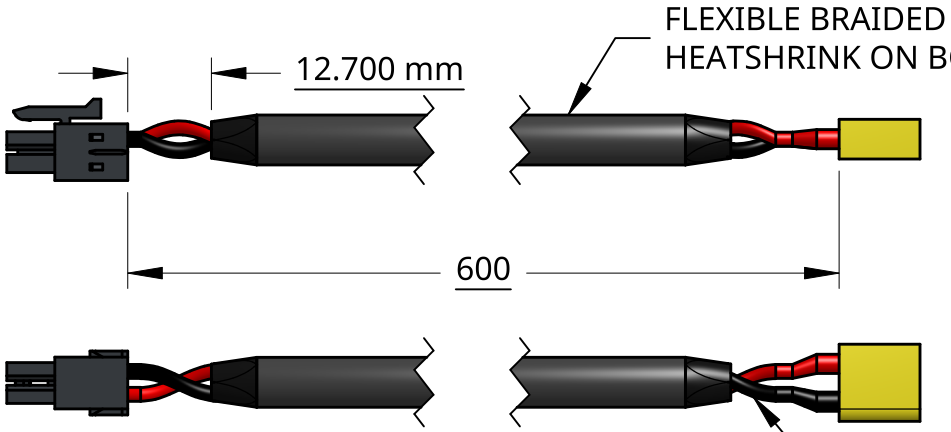
MICRO-FIT + (**PLUS**)
BLACK 'A' POLARIZATION

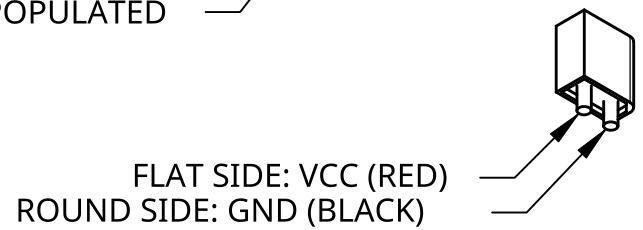


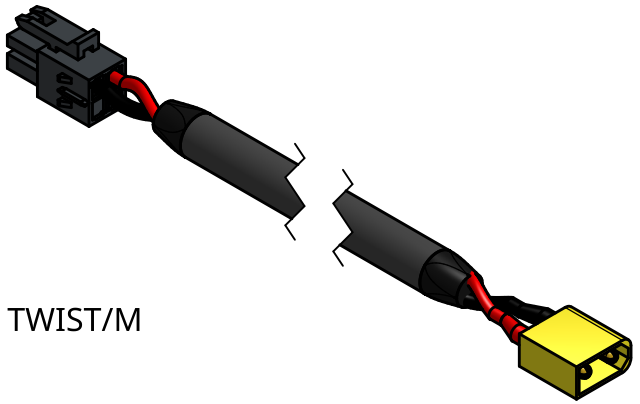
SCALE 2:1

MFP-R-4_BARE_POWER	9/17







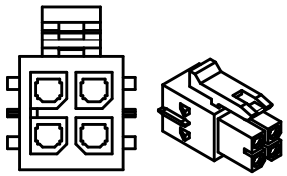


UL3132 SILICONE WIRE, <= 1.85mm INSULATION OD
STRIP LENGTH: 2.54-2.92 mm (MOLEX)
20AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE
CAN PAIR: 120OHM CHARACTERISTIC IMPEDANCE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

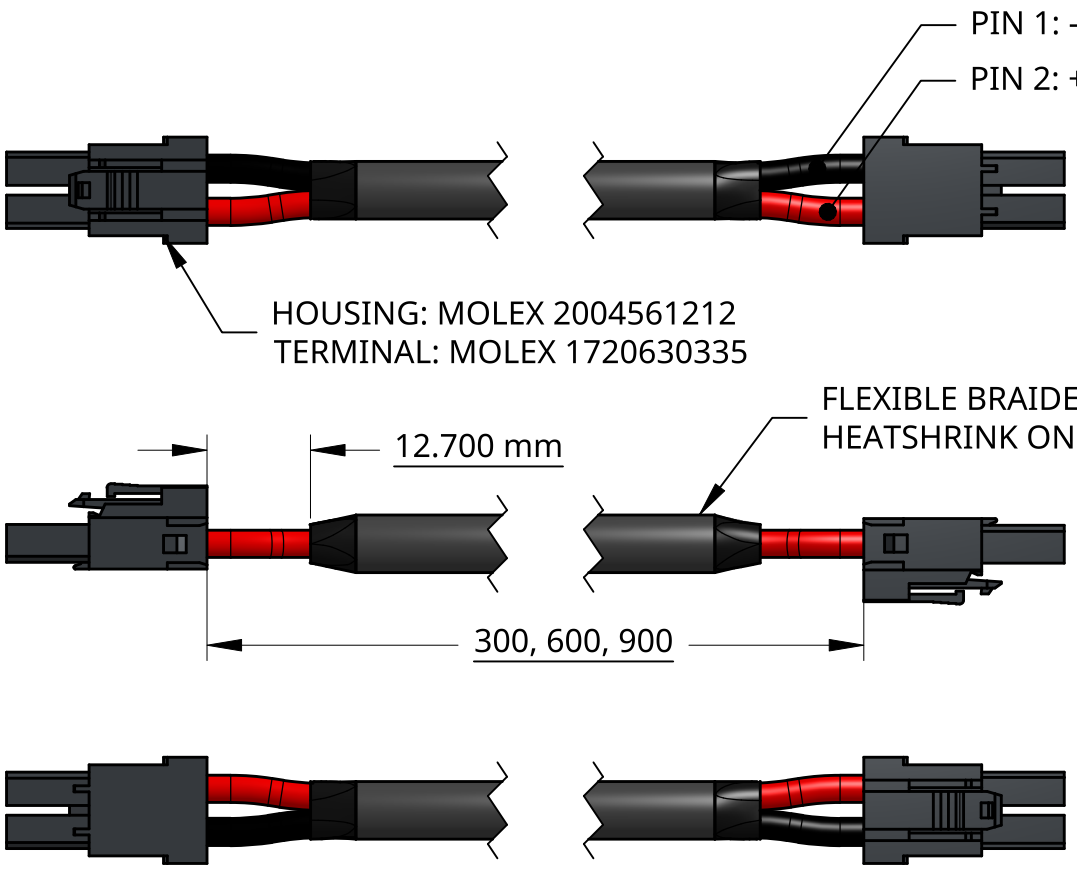
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

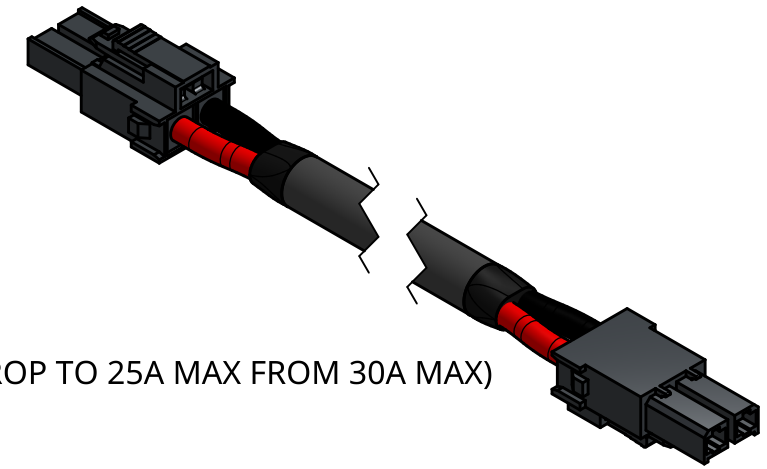
MICRO-FIT+ (**PLUS**)
BLACK 'A' POLARIZATION



SCALE 2:1

MFP-R-4_XT30-P-2_LEGACY	10/17



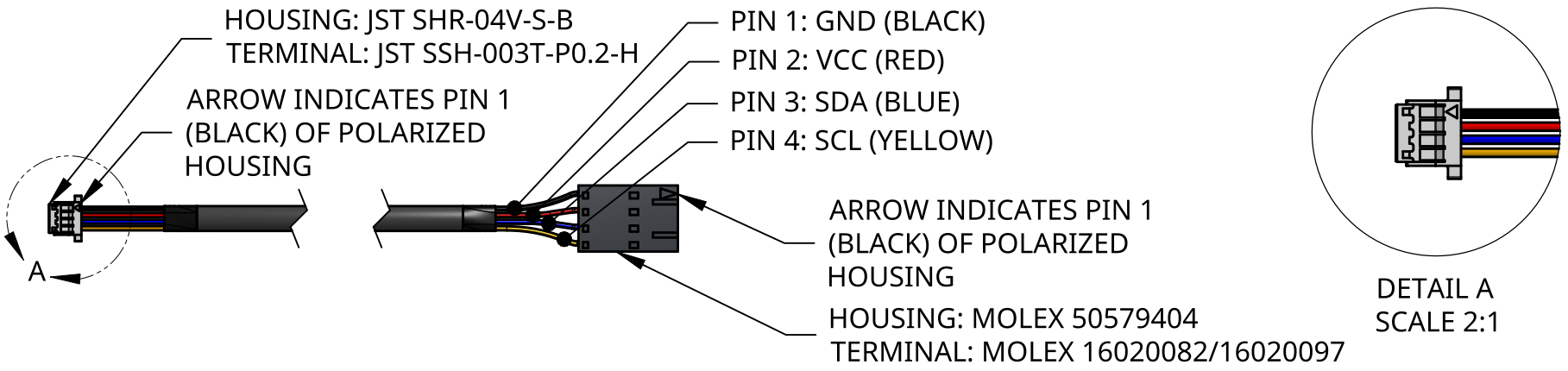


UL11028 mPPE WIRE, 3.4-3.6mm INSULATION OD
(UL3530 SILICONE WIRE IS FEASIBLE, BUT REQUIRES 12AWG CRIMPS (DROP TO 25A MAX FROM 30A MAX)
STRIP LENGTH: 4.8-5.4 mm
10AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
BONDED INSULATION

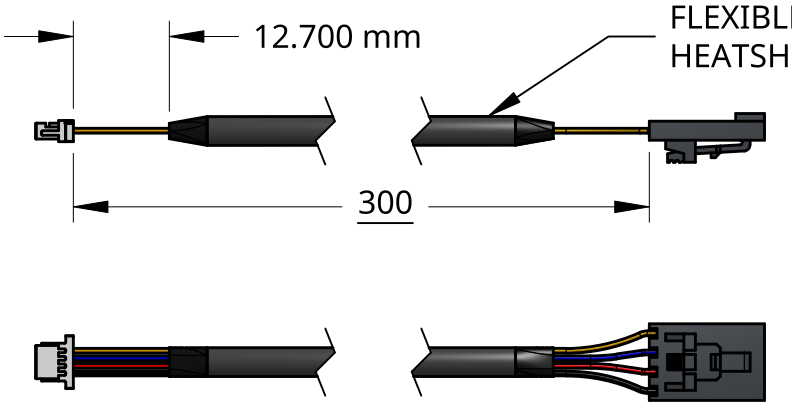
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

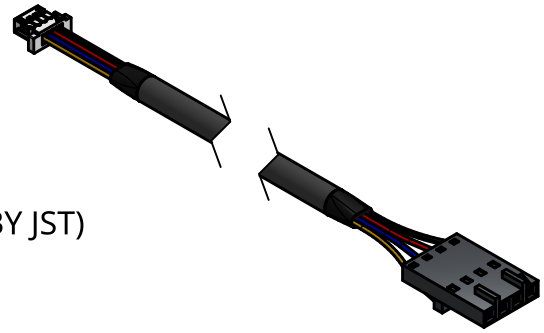
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

MEGA-R-2_MEGA-R-2	11/17



DETAIL A
SCALE 2:1





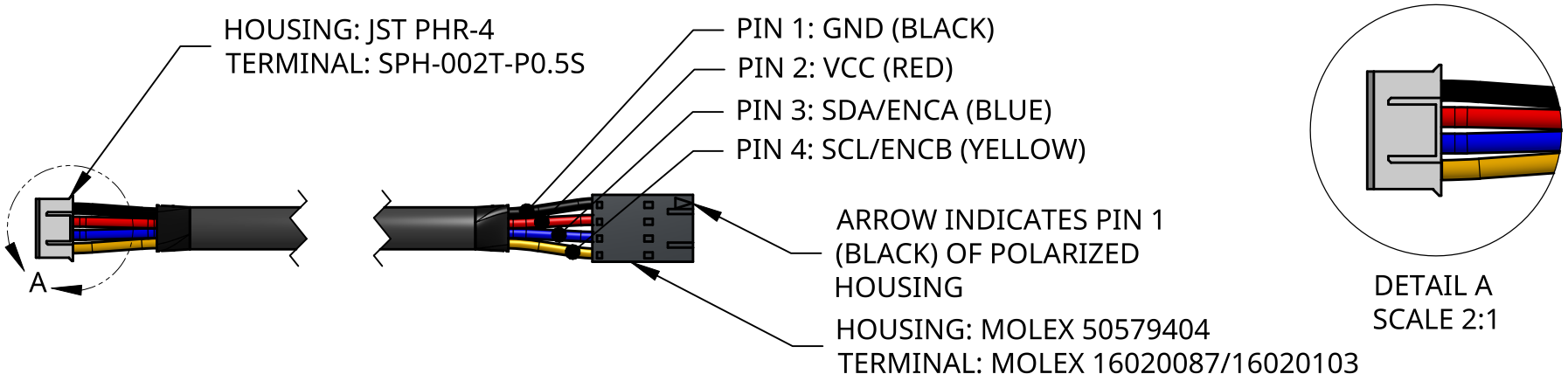
TEFLON, SILICONE, OR MPPE WIRE, <= 0.8mm INSULATION OD (LIMITED BY JST)
STRIP LENGTH: 2.54-3.17mm (MOLEX), 1.5mm (JST)
28AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

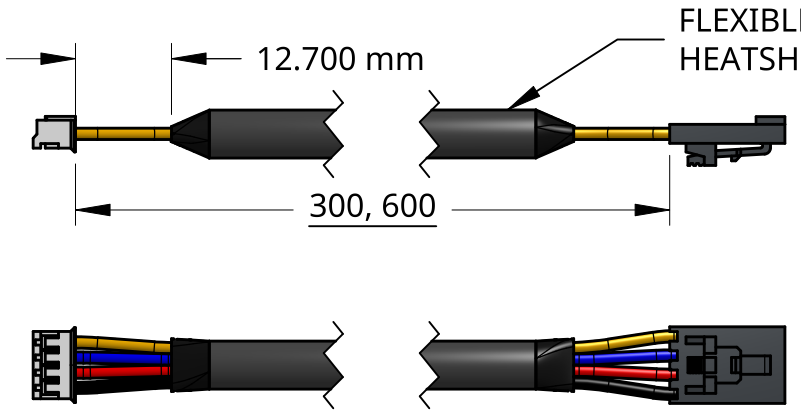
OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

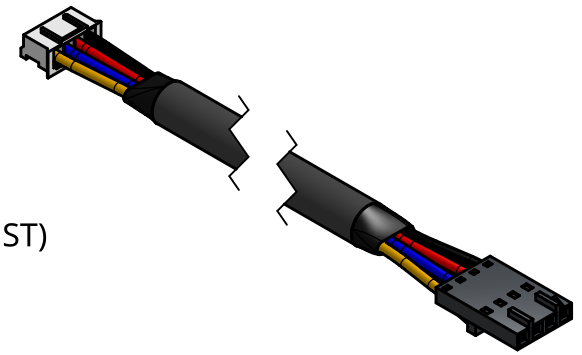
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

NOTE MOLEX TERMINAL PN FOR 28AWG

SH-4_SL-R-4_QWIIC	12/17





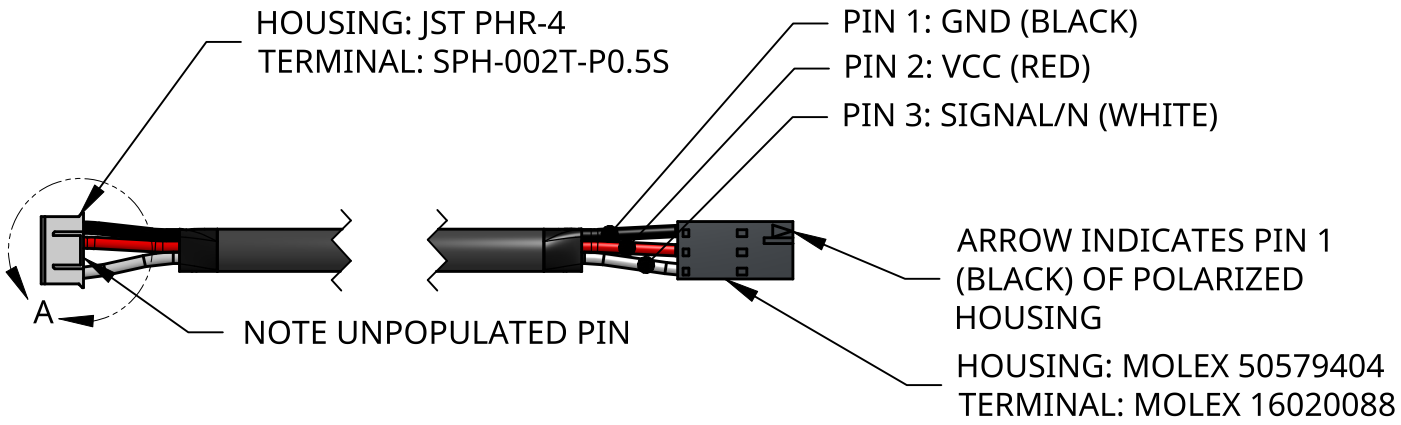


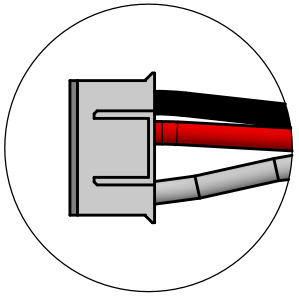
UL3132 SILICONE WIRE, 1.09 mm - 1.5mm INSULATION OD (LIMITED BY JST)
STRIP LENGTH: 2.54-3.17mm (MOLEX), 2.5mm (JST)
24AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

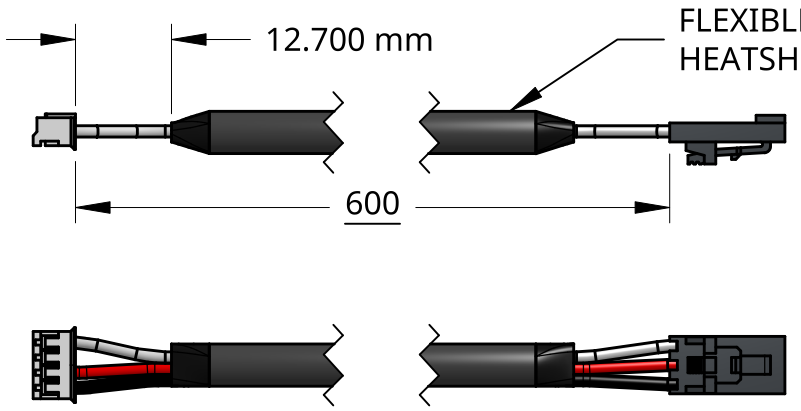
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

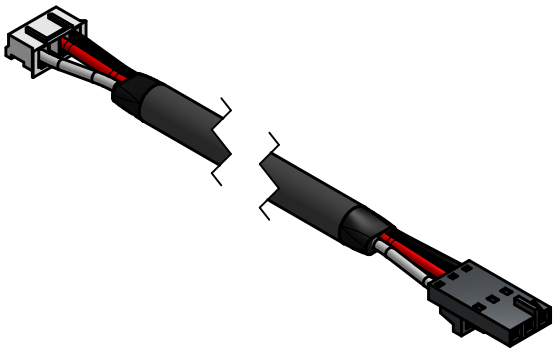
PH-4_SL-R-4_CHUB_STEMMA	13/17





DETAIL A
SCALE 2:1



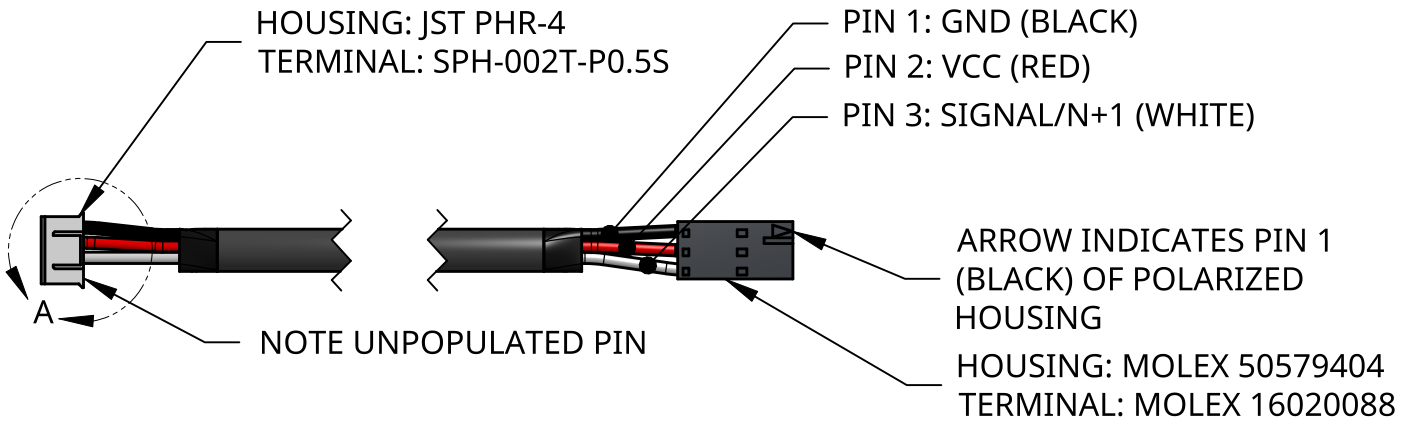


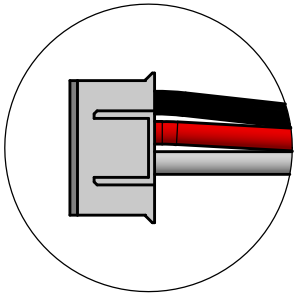
UL3132 SILICONE WIRE, >= 1.09 mm OD, <= 1.5mm OD (LIMITED BY JST)
STRIP LENGTH: 2.54-3.17mm (MOLEX), 2.5mm (JST)
24AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

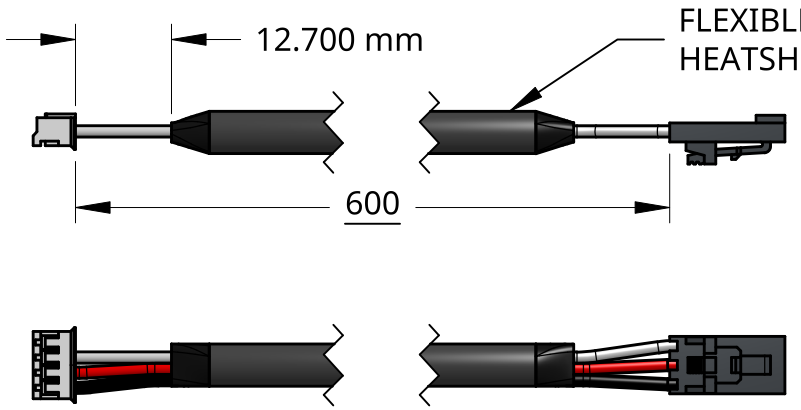
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

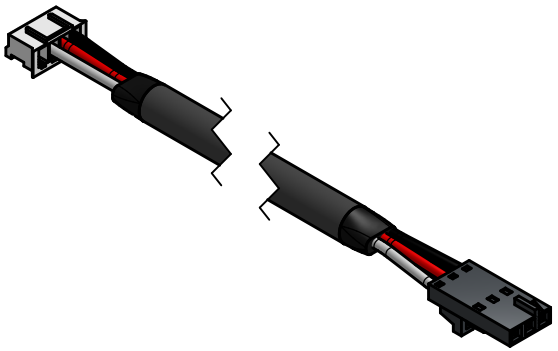
PH-4_SL-R-3_CHUBN	14/17





DETAIL A
SCALE 2:1



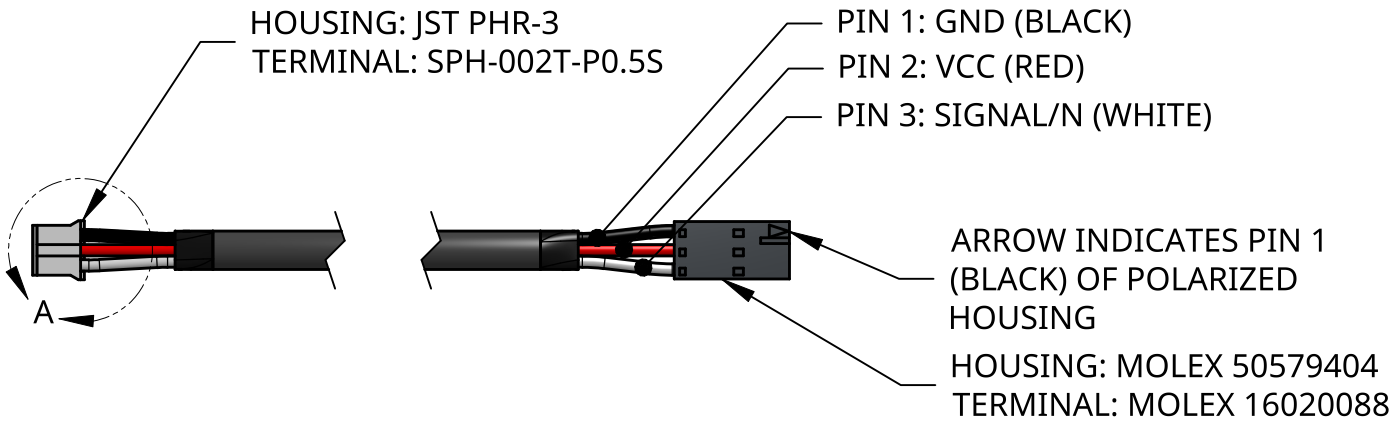


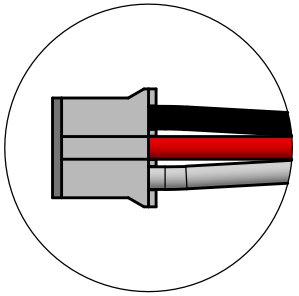
UL3132 SILICONE WIRE, >= 1.09 mm OD, <= 1.5mm OD (LIMITED BY JST)
STRIP LENGTH: 2.54-3.17mm (MOLEX), 2.5mm (JST)
24AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

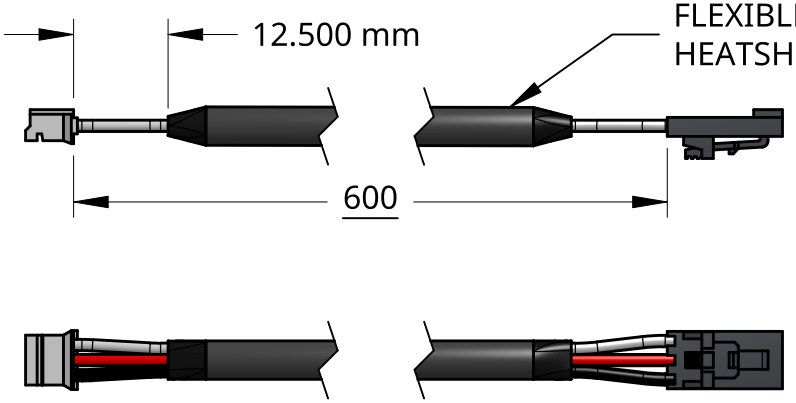
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

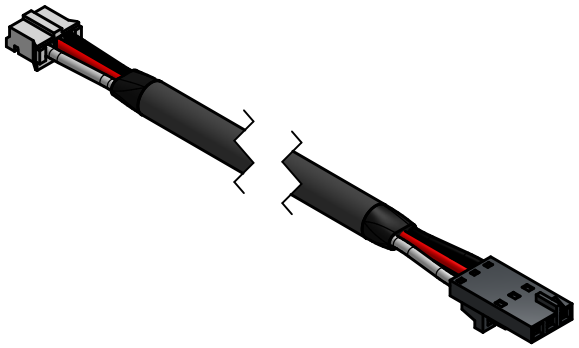
PH-4_SL-R-3_CHUBNP1	15/17





DETAIL A
SCALE 2:1



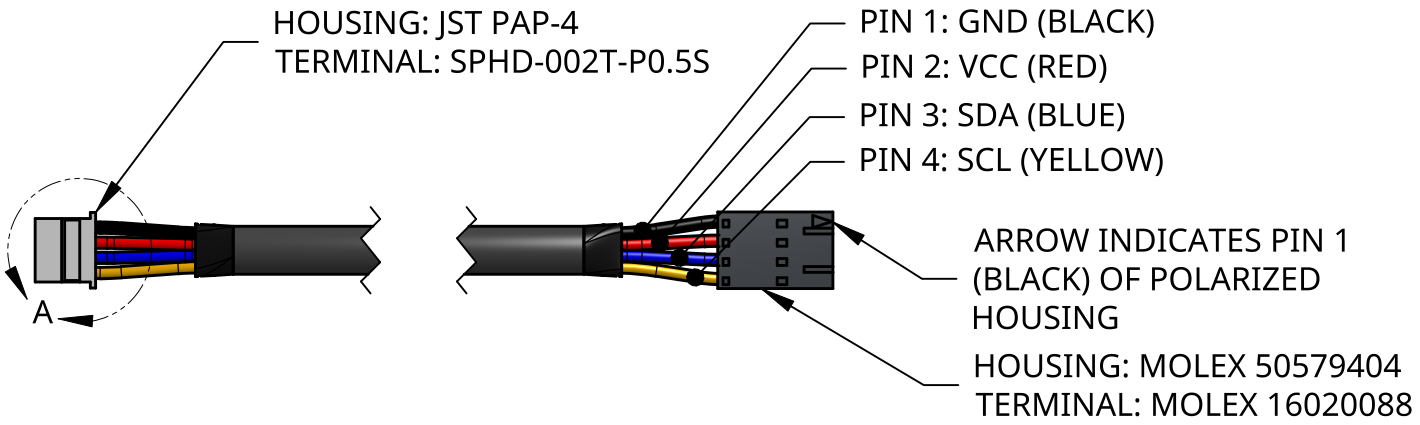


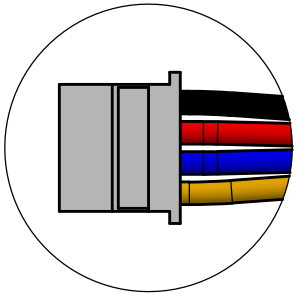
UL3132 SILICONE WIRE, >= 1.09 mm OD, <= 1.5mm OD (LIMITED BY JST)
24AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

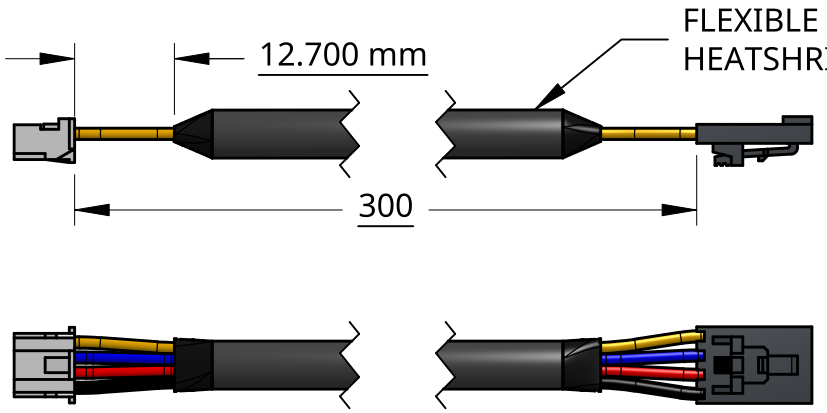
ALL NON-METALLIC MATERIALS UL 94V-0 RATED

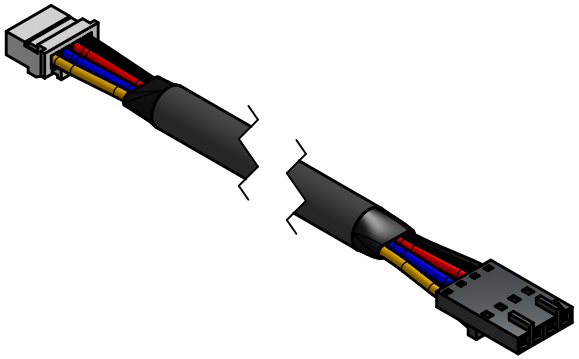
PH-3_SL-R-3_GB	16/17





DETAIL A
SCALE 2:1





UL3132 SILICONE WIRE, >= 1.09 mm OD, <= 1.5mm OD (LIMITED BY JST)
STRIP LENGTH: 2.54-3.17mm (MOLEX), 2.5mm (JST)
24AWG, HIGH STRAND COUNT
TINNED COPPER WIRE
INDIVIDUAL WIRES; NO BONDED/RIBBON CABLE

OFFICIAL MOLEX HOUSINGS AND GOLD CRIMPS ONLY
BRAIDED TUBE, HEATSHRINK ON BOTH ENDS

ALL NON-METALLIC MATERIALS UL 94V-0 RATED

NOTE CLIP POSITION
FOR ANDYMARK STANDARD SENSORS ONLY

PA-4_SL-R-4_ROBITS	17/17