

# RB.CA.sgn - the barrel RPC's trigger cable

## Introduction

This document describes the materials used to build the barrel RPC's trigger signal cable. They begin inside the RPC detectors running up to the Link Board VME crate located inside the wheel's towers. For each sector there are 72-90 of these cables, for a total of 944 cables/wheel. The grand total for all CMS is 4720 cables. The estimated medium length is around 15 [m].

The responsible person for technical aspects of these cables is:

Dr. Antonio Ranieri      **INFN** Bari, e-mail: [antonio.ranieri@ba.infn.it](mailto:antonio.ranieri@ba.infn.it)

## Cable

It's the **Novacavi** "4X(5X2XAWG 28) FE2XOH2M-150V", ref. 40R3148. This cable is already **IS23** certified - excluding radiation resistance of outer sheath - by the firm and it will be blue colored as requested for muon cables. See **Appendix 1** for the data-sheets and details.

## Connectors

There is one **3M** socket, series 3417-6600, each side of the cable. This connector is glass filled polyester (PBT) made and UL 94V-0 rated. It's sold at CERN STORE (09.55.03.340.4). There are a total of 9440 pieces for all CMS barrel. See **Appendix 3** for TIS approvals.

# Appendix 1 – Cable

## 1.1 Cable's datasheet

|                              |               |  |             |
|------------------------------|---------------|--|-------------|
| 4X(5X2XAWG 28) FE2XOH2M-150V | Specification |  | 40R3148     |
|                              | Rev.          |  | Page 1 of 1 |

### CONSTRUCTION DETAILS

|                |   |  |
|----------------|---|--|
| Conductor      | : | nomin. sect. 0.08 mm <sup>2</sup> , 7x0,127 mm tinned copper<br>cond. diam. 0.39 mm  |
| Insulation     | : | High density polyethylene, nominal thickness 0,19 mm<br>nominal diameter 0.77 mm   |
| Pairs          | : | WHITE/BLUE WHITE/ORANGE WHITE/GREEN WHITE/BROWN WHITE/GREY<br>nominal diameter 1.54 mm   |
| Lay up         | : | pairs twisted in 4 groups of 5 pairs with central filler<br>LSOH FR, diameter over assembly 4.15 mm                                      |
| Identification | : | numbered polyester tape on each group  |
| Assembly       | : | groups twisted together with suitable LSOH FR fillers<br>diameter over assembly 9.8 mm   |
| Overall Shield | : | aluminium/polyester tape as flame barrier<br>tinned copper braid wire diameter 0.10 mm nominal coverage 85%<br>nominal diameter 10.65 mm |
| Outer sheath   | : | Thermoplastic LSOH flame retardant compound colour according<br>to request<br>nominal thickness 1.30 mm<br>nominal diameter 13.25 mm     |

### ELECTRICAL AND PHYSICAL CHARACTERISTICS

|                             |                             |
|-----------------------------|-----------------------------|
| Electrical resistance sect. | AWG 28 < 222 ohm/km at 20°C |
| Insulation resistance       | > 1000 Mohm x km at 20° C   |
| Impedance :                 | 110 OHM +/-10%              |
| Working voltage             | : 150 V                     |

### OTHER CHARACTERISTICS

|                                  |                      |
|----------------------------------|----------------------|
| Weight :                         | 226 kg/km            |
| Bending radius static            | : 80 mm              |
| Working temperature range static | : from -30 to +70 °C |

### REFERENCE STANDARDS

IEC 60332-1, IEC 60332-3/24CF, CERN IS23 (excluding radiation resistance of outer sheath)

|   |         |             |            |
|---|---------|-------------|------------|
| <b>novacavi</b><br>Cavi elettrici per impieghi speciali | Redatto | Controllato | Data       |
|   | U.T.    | R.T.        | 2004-05-17 |

## 1.2 Cable sheathing compound

P O L Y M E R I C S



## TECHNICAL DATA

### ***megolon* S643**

#### Cable sheathing Compound

#### DESCRIPTION

***megolon* S643** is a thermoplastic, halogen free, fire retardant compound for cable sheathing applications such as data cables and shipboard wiring.

#### APPLICATIONS

- UK: BS 7878 : 7
- CENELEC HD 624.7 S1
- IEC 60092-359 SHF1

#### TECHNICAL PROPERTIES

| Primary Properties                 | Unit | Nominal Value | Test Method   |
|------------------------------------|------|---------------|---------------|
| Tensile strength                   | MPa  | 13.0          | IEC 60811-1-1 |
| Elongation at break                | %    | 140           | IEC 60811-1-1 |
| Oxygen Index                       | %    | 40            | ISO 4589-2    |
| Density                            | g/cc | 1.53          | ASTM D-792    |
| Mooney viscosity (1+4 mins, 140°C) |      | 38            | ASTM D-1646   |

| Mechanical Properties                     | Unit | Nominal Value | Test Method   |
|---|------|---------------|---------------|
| Tear strength                             | N/mm | 3.5           | BS 6469:99.1  |
| Tensile strength after 7 days at 100°C    | MPa  | 16            | IEC 60811-1-2 |
| Variation                                 | %    | +23           |               |
| Elongation at break after 7 days at 100°C | %    | 115           | IEC 60811-1-2 |
| Variation                                 | %    | -18           |               |

Issue 2

Date : 20/05/03

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S643

[www.scapapolymerics.com](http://www.scapapolymerics.com)

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| Thermomechanical Properties | Unit | Nominal Value | Test Method   |
|-----------------------------|------|---------------|---------------|
| Hot pressure at 80°C        | %    | 33            | IEC 60811-3-1 |
| Cold impact at -25°C        | %    | Pass          | IEC 60811-1-4 |

| Fire and Smoke Test Properties   | Unit    | Nominal Value | Test Method |
|----------------------------------|---------|---------------|-------------|
| Flammability temperature index   | °C      | 280           | ISO 4589-3  |
| Halogen acid gas evolution       | %       | 0             | IEC 60754-1 |
| Corrosivity of gases             |         |               | IEC 60754-2 |
| pH                               |         | 5.2           |             |
| Conductivity                     | μS/cm   | 7.0           |             |
| Smoke density – Flaming mode     | Ds max  | 86            | ASTM E-662  |
| Time to maximum                  | minutes | 13            |             |
| Smoke density – Non-flaming mode | Ds max  | 166           | ASTM E-662  |
| Time to maximum                  | minutes | 15            |             |
| Toxicity index                   |         | 1.27          | NES 713     |

| Oil Resistance Properties |             |          | Tensile Strength (MPa) | Variation (%) | Elongation at Break (%) | Variation (%) | Volume Swell (%) |
|---------------------------|-------------|----------|------------------------|---------------|-------------------------|---------------|------------------|
| Medium                    | Temperature | Duration |                        |               |                         |               |                  |
| IRM 902                   | 23°C        | 7 days   | 14.8                   | +14           | 160                     | +15           | 2                |
| IRM 902                   | 70°C        | 4 hours  | 11.8                   | -10           | 200                     | +43           | 15               |
| Diesel                    | 23°C        | 7 days   | 12.3                   | - 5           | 124                     | -11           | 65               |
| Diesel                    | 70°C        | 4 hours  | 1.5                    | -88           | 95                      | -32           |                  |

| Electrical Properties             | Unit   | Nominal Value          | Test Method  |
|-----------------------------------|--------|------------------------|--------------|
| Insulation resistance at 20°C     |        |                        | BS 6469:99.2 |
| Initial value                     | ohm.cm | 2.5 x 10 <sup>14</sup> |              |
| After 12 hours immersion in water | ohm.cm | 5.3 x 10 <sup>12</sup> |              |

| Other Properties | Unit    | Nominal Value | Test Method |
|------------------|---------|---------------|-------------|
| Hardness         | Shore D | 59            | ASTM D-2240 |

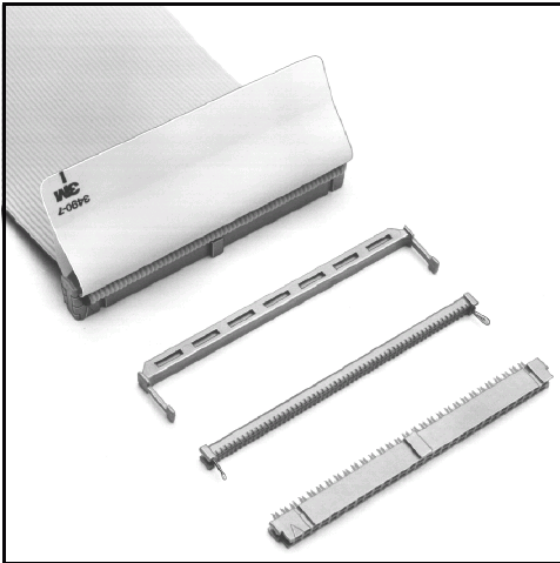
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## Appendix 2 – Connectors (at both side)

### 2.1 Datasheet

# 3M™ Pak 100 Wiremount Socket

.100" × .100" for .050" Pitch Cable (Optional Plastic or Metal Strain Relief) 3000 Series



- Industry standard IDC socket
- Optional plastic or low profile metal strain relief
- Positive locking metal "J" clips provide high cover retention
- Mates with 3M headers, plugs and pin strips for quick connect/disconnect capability
- Open or closed end covers available
- Accepts flat cable or discrete wire
- Military polarization, with or without centerbump

Date Modified: May 30, 2003

TS-0718-06  
Sheet 1 of 2

### Physical

#### Insulation

Material: Glass Filled Polyester (PBT)  
Flammability: UL 94V-0  
Color: Gray

#### Contact

Material: Copper Alloy

#### Plating

Underplating and U-Slot: 100  $\mu$ " [ 2.54  $\mu$ m ] Nickel — QQ-N-290, Class 2  
Wiping Area: 30  $\mu$ " [ 0.76  $\mu$ m ] Gold — MIL-G-45204, Type II, Grade C  
Wire Accommodation: 26 & 28 AWG Solid or Stranded

**Marking:** 3M Logo, Part Identification Number and Orientation Triangle

### Electrical

**Current Rating:** 1 A

**Insulation Resistance:**  $> 1 \times 10^9 \Omega$  at 500 Vdc

**Withstanding Voltage:** 1000 Vrms at Sea Level

### Environmental

**Temperature Rating:** -55°C to +105°C

UL File No.: E68080



Interconnect Solutions  
<http://www.3M.com/interconnects/>

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For technical, sales or ordering information call  
**800-225-5373**

# 3M™ Pak 100 Wiremount Socket

.100" × .100" for .050" Pitch Cable (Optional Plastic or Metal Strain Relief) 3000 Series

| Contact Quantity | Dimensions    |             |             |
|------------------|---------------|-------------|-------------|
|                  | Socket Series | A           | B           |
| 10               | 3473          | 0.68 [17.3] | 0.54 [13.7] |
| 14               | 3385          | 0.88 [22.4] | 0.74 [18.8] |
| 16               | 3452          | 0.98 [24.9] | 0.84 [21.3] |
| 20               | 3421          | 1.18 [30.0] | 1.04 [26.4] |
| 24               | 3626          | 1.38 [35.1] | 1.24 [31.5] |
| 26               | 3399          | 1.48 [37.6] | 1.34 [34.0] |
| 30               | 3419          | 1.68 [42.7] | 1.54 [39.1] |
| 34               | 3414          | 1.88 [47.7] | 1.74 [44.2] |
| 36               | 9436          | 1.98 [50.3] | 1.84 [46.7] |
| 40               | 3417          | 2.18 [55.4] | 2.04 [51.8] |
| 44               | 9444          | 2.38 [60.5] | 2.24 [56.9] |
| 50               | 3425          | 2.68 [68.1] | 2.54 [64.5] |
| 60               | 3334          | 3.18 [80.8] | 3.04 [77.2] |

**Notes:**

- This polarizing groove is non-existent on 3385 and 3473 Series.
- The optional high cable-profile cover for cable thicker than .040 [1.02] (does not have cable exit recess).
- The low profile strain relief can be used with the 4600 Series Plug and .1 x .1 Headers with ejector latches. The latches will only function as an ejector.
- See TS-0721 for mating post pattern.

### Ordering Information

#### Sockets

**XXXX-XXXX**

Socket Series: See Table for 3M Part Number

Cover: 6 = Open End (For Daisy Chaining or Bussing)  
7 = Closed End (For End Cable Termination)  
8 = Open End for Higher Profile Cables (60 Pos Only)  
9 = Closed End for Higher Profile Cables (60 Pos Only)

Polarization: 0 = Military (Dual Slot)  
6 = Centerbump and Military

Strain Relief: 00 = No Strain Relief  
XX = "Contact Quantity" for Plastic Strain Relief (i.e. 50 for a 50 Position Strain Relief)

#### Strain Relief (Order Separately)

**3448-X0XX**

Type: 2 = Low Profile (Metal)  
3 = Plastic

XX = "Contact Quantity" See Table (i.e. 50 for a 50 Position Strain Relief)

#### Keying Plug (Order Separately)

**3435-0**

#### Pull Tabs (Order Separately)

**3490-X**

See TS-0720

TS-0718-06  
Sheet 2 of 2

**3M Interconnect Solutions**  
http://www.3M.com/interconnects/

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## 2.2 The connector is sold at cern store

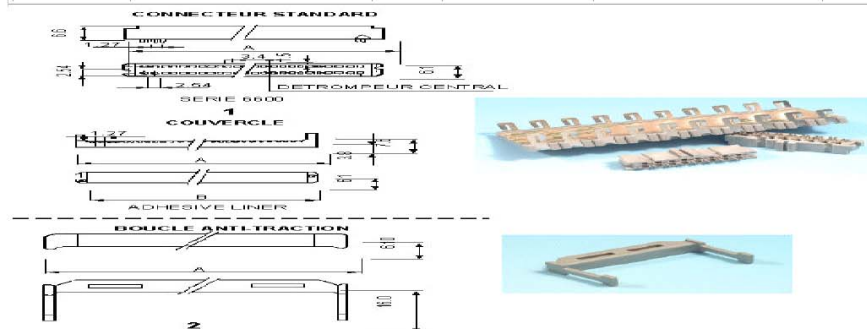


The image shows the CERN Stores Catalogue search interface. At the top, there are icons for a document, flags (UK, France), a printer, and a book. The main search area has two input fields: "SCEM Code:" and "Keyword(s):", with a "Search" button below them. Navigation arrows point to "09.55.02" on the left, "Group: 09.55" in the center, and "09.55.03.B" on the right.

### 09.55.03.A- FLAT CABLE CONNECTOR - SOCKET CONNECTOR - 2,54 x 2,54 mm

Technical information : [product manager](#)

| Buy | SCEM Code                      | Unit | Unit Price | Nb. CONTACTS | A mm | B mm | TYPE 3M   | FIG. |
|-----|--------------------------------|------|------------|--------------|------|------|-----------|------|
|     | <a href="#">09.55.03.310.0</a> | PC   | 0.99       | 10           | 17,3 | 14,0 | 3473-6600 | 1    |
|     | <a href="#">09.55.03.314.6</a> | PC   | 0.99       | 14           | 22,4 | 19,1 | 3385-6600 | 1    |
|     | <a href="#">09.55.03.316.4</a> | PC   | 1.15       | 16           | 24,9 | 21,6 | 3452-6600 | 1    |
|     | <a href="#">09.55.03.320.8</a> | PC   | 1.10       | 20           | 30,0 | 26,7 | 3421-6600 | 1    |
|     | <a href="#">09.55.03.326.2</a> | PC   | 1.25       | 26           | 37,6 | 34,3 | 3399-6600 | 1    |
|     | <a href="#">09.55.03.334.2</a> | PC   | 1.35       | 34           | 47,8 | 44,5 | 3414-6600 | 1    |
|     | <a href="#">09.55.03.340.4</a> | PC   | 1.85       | 40           | 55,4 | 52,1 | 3417-6600 | 1    |
|     | <a href="#">09.55.03.350.2</a> | PC   | 1.65       | 50           | 68,1 | 64,8 | 3425-6600 | 1    |
|     | <a href="#">09.55.03.360.0</a> | PC   | 2.00       | 60           | 80,8 | 77,2 | 3364-6600 | 1    |
|     | <a href="#">09.55.03.364.6</a> | PC   | 3.10       | 64           | 85,8 | 82,5 | 7964-6500 | 1    |
|     | <a href="#">09.55.03.410.7</a> | PC   | 0.32       | 10           | 17,3 | -    | 3448-3010 | 2    |
|     | <a href="#">09.55.03.414.3</a> | PC   | 0.27       | 14           | 22,4 | -    | 3448-3014 | 2    |
|     | <a href="#">09.55.03.416.1</a> | PC   | 0.29       | 16           | 24,9 | -    | 3448-3016 | 2    |
|     | <a href="#">09.55.03.420.5</a> | PC   | 0.29       | 20           | 30,0 | -    | 3448-3020 | 2    |
|     | <a href="#">09.55.03.426.9</a> | PC   | 0.29       | 26           | 37,6 | -    | 3448-3026 | 2    |
|     | <a href="#">09.55.03.434.9</a> | PC   | 0.27       | 34           | 47,8 | -    | 3448-3034 | 2    |
|     | <a href="#">09.55.03.440.1</a> | PC   | 0.29       | 40           | 55,4 | -    | 3448-3040 | 2    |
|     | <a href="#">09.55.03.450.9</a> | PC   | 0.29       | 50           | 68,1 | -    | 3448-3050 | 2    |
|     | <a href="#">09.55.03.460.7</a> | PC   | 0.29       | 60           | 80,8 | -    | 3448-3060 | 2    |
|     | <a href="#">09.55.03.464.3</a> | PC   | 0.43       | 64           | 85,8 | -    | 3448-7964 | 2    |



## Appendix 3 – TIS approval of connectors

### 3.1 Connectors' IS41 compliance

Subject: RE: Safety evaluation for connectors "3M -series 3417-6600"  
Date: Tue, 18 May 2004 09:22:34 +0200  
From: Jonathan Gulley <Jonathan.Gulley@cern.ch>  
To: Fabio Montecassiano <Fabio.Montecassiano@cern.ch>  
CC: Antonio Ranieri <Antonio.Ranieri@ba.infn.it>,  
Emilie Freret <Emilie.Freret@cern.ch>

Dear Fabio  
Your connector is compliant  
Best Regards  
Jonathan

-----Original Message-----

From: Fabio Montecassiano  
Sent: Monday, May 17, 2004 8:23 PM  
To: Jonathan Gulley  
Cc: Antonio Ranieri  
Subject: Safety evaluation for connectors "3M -series 3417-6600"

Dear Jonathan,

please evaluate the IS41 compliance for the connectors  
3M socket series 3417-6600  
which will be used to build 4720 RPC trigger cables (RB.CA.sgn) to be  
installed on the barrel of the CMS experiment. The connector is a female  
cable socket with central polarising slot. It is UL 94V-0 rated and it's  
present at Cern store, SCEM 09.55.03.340.4.

There will be 2 of these connectors for each cable, one at detector side  
and the other at tower side. The grand total is 9440 pieces.

Best regards  
Fabio Montecassiano