

Instrumentation Cables

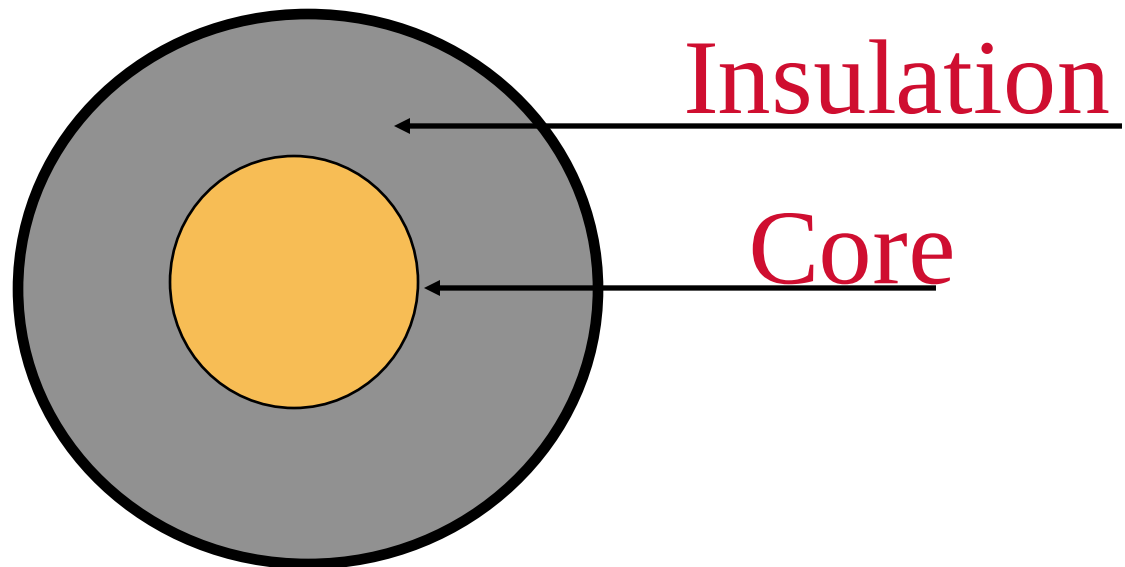


By:

Setal Kalavadia

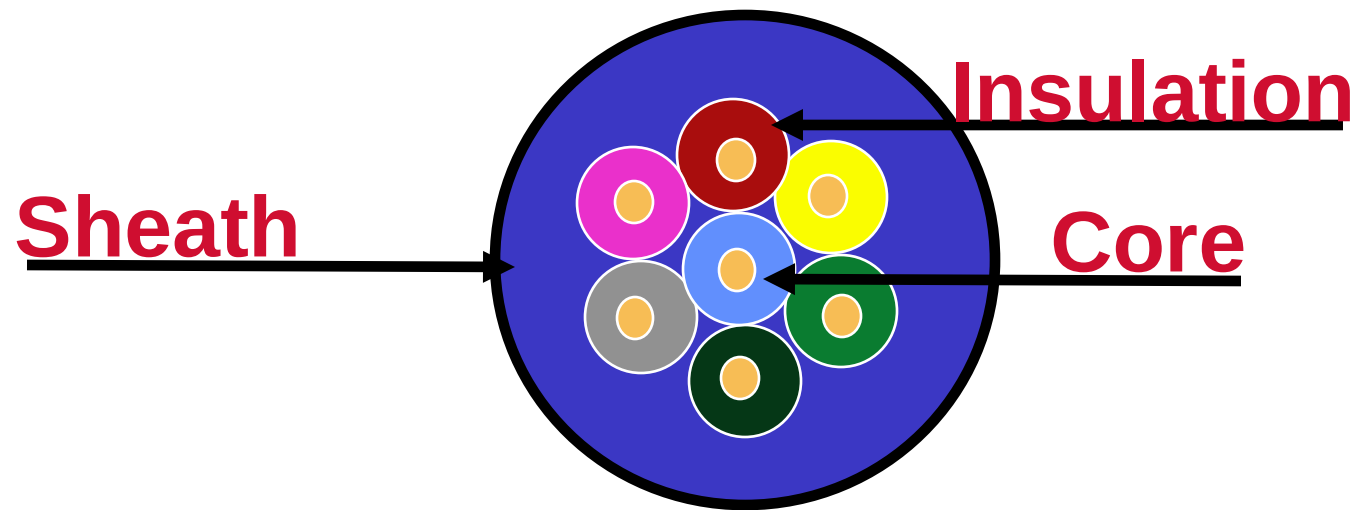
CABLE CONSTRUCTION

Single Core



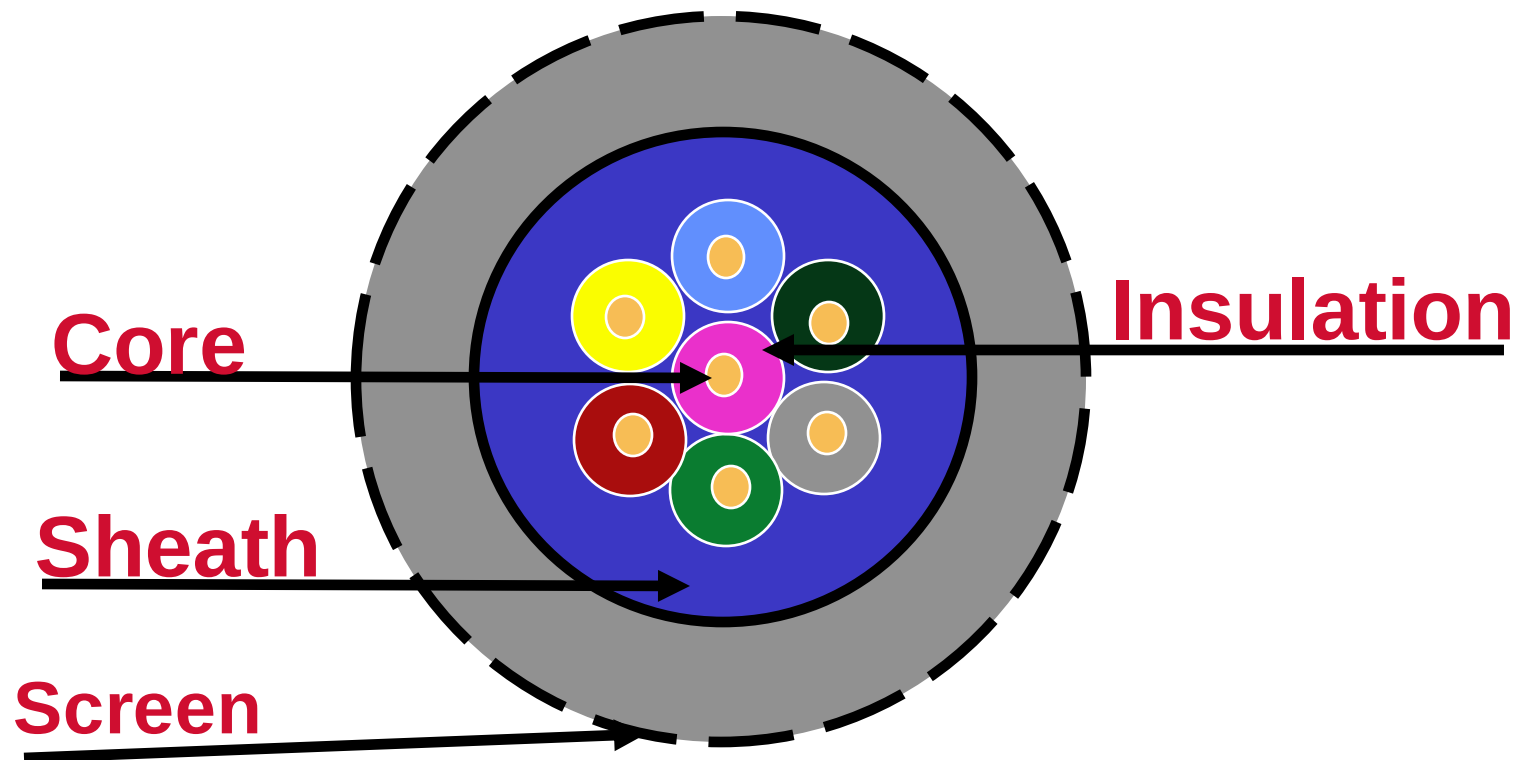
CABLE CONSTRUCTION

Multi- Core

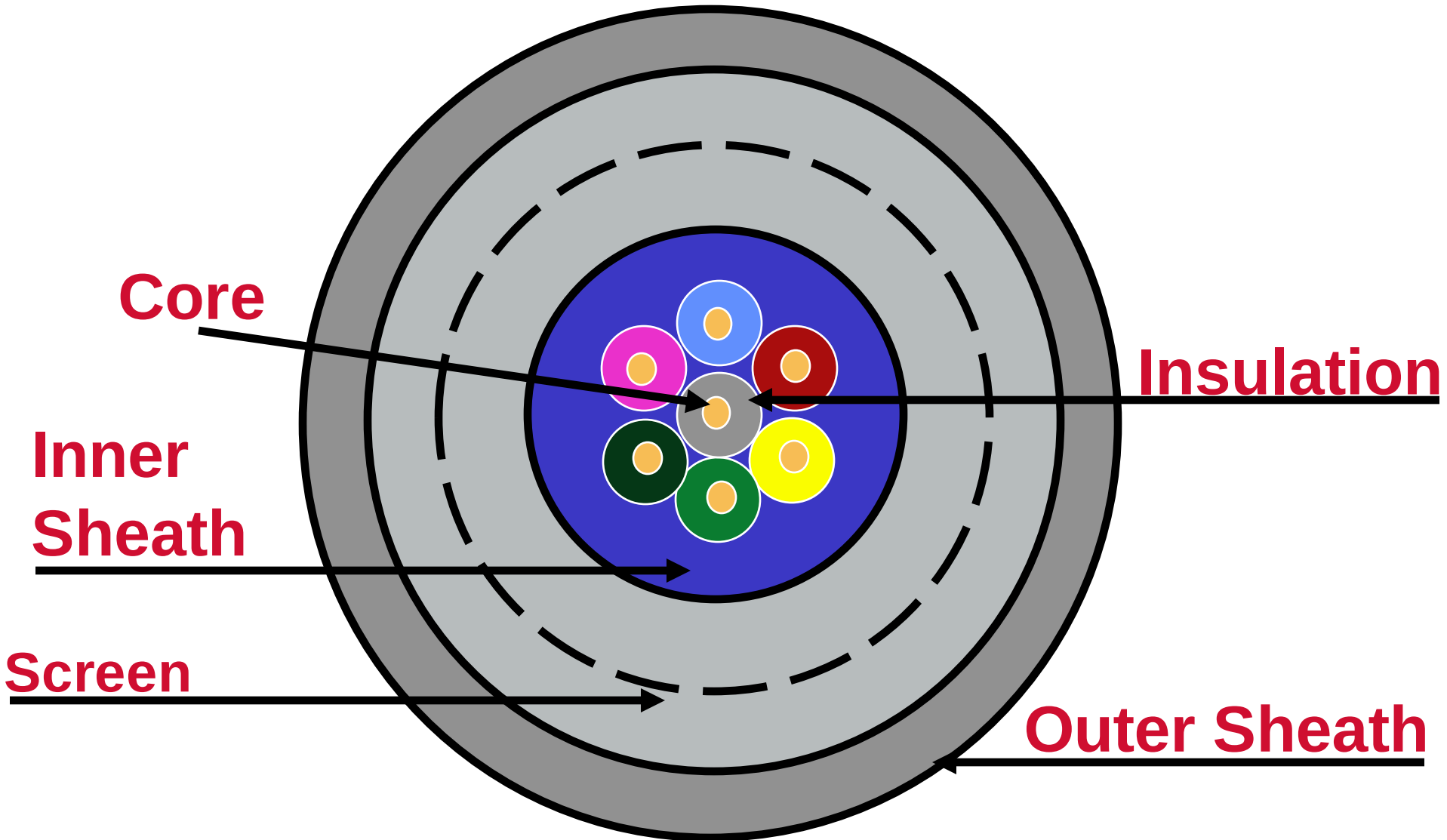


CABLE CONSTRUCTION

Multi- Core with Protection



Screened Multi- Core Cable



Schedule Of Standard Cable Types

Conductor Material:

- **Signal cable:**
Annealed stranded copper
- **Extension cable:**
J type, K type, T type, S type

Schedule Of Standard Cable Types

Pair / Core/ Triad:

- **Pair:**

1, 2, 5, 10, 20

- **Core:**

2, 4, 7, 12, 19, 27, 37

- **Triad:**

1, 2, 5, 10, 20

Schedule Of Standard Cable Types

Conductor Size:

- **0.5 mm²**
- **1.0 mm²**
- **1.5 mm²**
- **2.5 mm²**

Schedule Of Standard Cable Types

Screen:

- **Unscreen**
- **Overall Screen**
- **Individual Screen**
- **Overall & individual screen**

Schedule Of Standard Cable Types

Conductor Insulation:

- **Polyethylene (PE)**
- **Polyvinyl chloride (PVC)**
- **Cross linked polyethylene (XLPE)**

Schedule Of Standard Cable Types

Armour (Galvanized steel round wire):

- Unarmoured
- 0.9 mm dia
- 1.25 mm dia
- 1.4 mm dia
- 1.6 mm dia

Schedule Of Standard Cable Types

Sheath (outer/inner) Material:

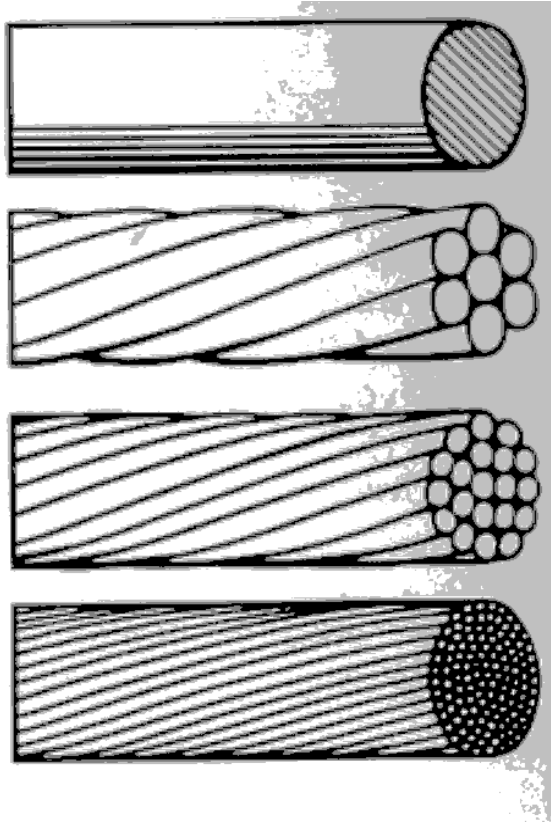
- **PVC**

Outer Sheath Colour:

- **Blue (IS)**
- **Grey (Non IS)**
- **Black (Power)**
- **Yellow (K type)**

Flexibility and Stranding

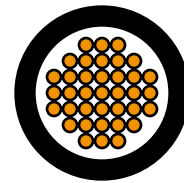
FLEXIBILITY



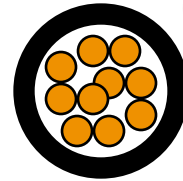
- ❑ **Solid Conductors are not flexible**
- ❑ **7 wire Multi Strand slightly flexible**
- ❑ **Class 5 flexible**
- ❑ **Class 6 Super Flexible**

Conductor Stranding

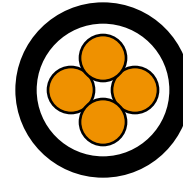
class 6: super wire stranding



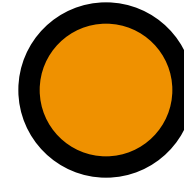
class 5: fine wire stranding



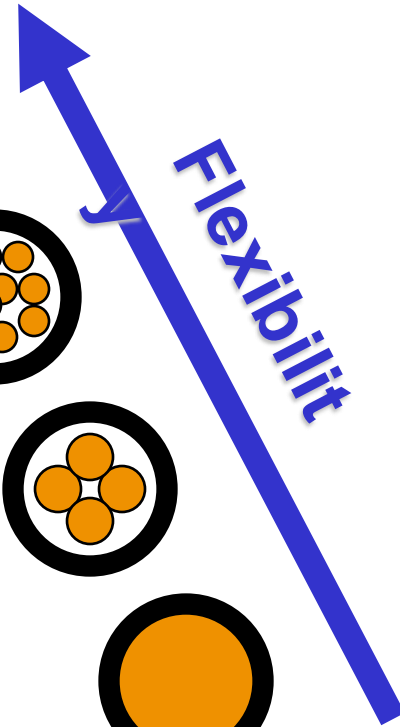
class 2: multi-strands



class 1: single core



Flexibility



ADDITIVES

•Fillers

Chalk, Talc

- cost reduction
- improvement of electrical properties

•Plastizisers

- oily substances or materials added to the plastifiable compound to improve its softness

Stabilizers Heat , Cold, UV stabilizers

- increase of thermal stability
- absorb detrimental UV rays and convert them into harmless thermal energy

Comparison of Properties : Thermo plastics & TPE

MATERIAL	POLY VINYL CHLORIDE	POLYETHYLENE	POLYURETHANE	POLYAMIDE
ABBREVIATIONS	PVC / HRPVC	LDPE / HDPE	PUR	PA
WORKING TEMP DEG CENT.	- 30 to + 70 / - 20 to + 90	- 50 to + 70 / - 50 to + 100	- 40 to + 90 / 100	- 40 to + 115
DIELECTRIC CONSTANT	4.0 / 3.5	2.3	4 to 6	3.5 to 7.0
VOLUME RESISTIVITY	10^{12} to 10^{15}	10^{17}	10^{12}	10^{14}
TENSILE STRENGTH (N/mm ²)	10 to 25	20 to 30 / 30	30 to 45	50 to 180
ELONGATION %	150 to 300	500 / 800	300 to 600	200 to 300
WATER ABSORPTION % @ 20 °C	0.4	0.1	1.5	1.0 to 2.0
WEATHER RESISTANCE	MODRATE	GOOD / MODRATE	VERY GOOD	GOOD
FUEL RESISTANCE	MODRATE	POOR	GOOD	MODRATE
OIL RESISTANCE	GOOD	MODRATE	GOOD	GOOD
FLAMEABILITY	SELF EXTINGUSHING	FLAMEABLE	SELF EXTINGUSHING	FLAMEABLE

Comparison of Properties: Thermo plastics & Elastomers

MATERIAL	POLY TETRA FLURO ETHYLENE	FLURO ETHYLENE PROPYLENE	CHLOROPRENE RUBBER	SILICON RUBBER
ABREVATIONS	PTFE	FEP	CR	SI
WORKING TEMP DEG CENT.	- 190 to + 260 /	- 100 to + 200	- 40 to + 100	- 60 to + 180
DIELECTRIC CONSTANT	2.1	2.1	6.0 to 8.0	2.8 to 3.2
VOLUME RESISTIVITY	10^{18}	10^{18}	10^{13}	10^{15}
TENSILE STRENGTH (N/mm ²)	14 to 40	20 to 25	25	5 to 10
ELONGATION %	240 to 400	250 / 350	450	200 to 350
WATER ABSORPTION % @ 20 °C	0.01	0.01	1.0	1.0
WEATHER RESISTANCE	VERY GOOD	VERY GOOD	VERY GOOD	VERY GOOD
FUEL RESISTANCE	VERY GOOD	VERY GOOD	POOR	POOR
OIL RESISTANCE	VERY GOOD	VERY GOOD	GOOD	MODRATE
FLAMEABILITY	NON FLAMEABLE	NON FLAMEABLE	SELF EXTINGUISHING	LESS FLAMEABLE

Cross Talk

Signals of one circuit are picked by another.

- **Increases with length**
- **Increases with proximity**
- **Increases with frequency**
- **Wet/Damp atmosphere can increase cross talk.**

ATTENUATION

- Loss of signal as it travels.
- Expressed in dB/km (deciBel)
- Difference between transmitted and received signal strength.

dB Loss = $-10 \times \log_{10}(\text{Power Output/Input})$

**10 dB/km = 10% of the signal power
remains after 1 km**

**Attenuation increases with frequency and
as diameter decreases.**

Protection classes

Protection against Contact and foreign bodies

Protection against

- 0 no protection
- 1 large foreign bodies
- 2 medium sized foreign bodies
- 3 small foreign bodies
- 4 granulated foreign bodies
- 5 accumulation of dust
- 6 ingress of dust

Water protection

Protection against:

- 0 no protection
- 1 dripping water falling vertically
- 2 dripping water falling at an angle
- 3 sprayed water
- 4 splashed water
- 5 water jet
- 6 flooding
- 7 immersion
- 8 submersion

Insulation Resistance

Individual conductor:

When a steady voltage of 500 V d.c is applied for 1 min. The insulation resistance of each conductor measured against the remaining bunched conductors/screens/armour shall not be less than 5 G ohm for 1 Km at 20 deg. C

Individual Screens:

For cable with individually screened pairs, When a steady voltage of 500 V d.c is applied for 1 min. The insulation resistance measured between screens shall be not less than 1 M ohm for 1 Km at 20 deg. C.

Insulation Resistance

Conductor resistance:

The resistance of each conductor in the completed cable at 20 deg C shall not exceed the values given below

Area (mm²)	Resistance (ohm / km)
0.50	36.8
1.00	18.4

Capacitance

Mutual capacitance:

The mutual capacitance of the pairs or adjacent cores shall not exceed the below mentioned value at a frequency of 1 khz.

	<u>0.5 mm²</u>	<u>1.0 mm²</u>	<u>1.5 mm²</u>
	pF/m	pF/m	pF/m
w/o screen	75	75	85
Collective screen	75	75	85
Individual screen	115	115	115

L/R Ratio

Mutual capacitance:

The L/R ratio for adjacent cores shall not exceed the following maximum values:

Conductor	Max L/R ratio
0.5 mm ²	25 uH/ohm
1.0 mm ²	25 uH/ohm
1.5 mm ²	40 uH/ohm