Prysmian Australia Pty Ltd
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CABLE DESCRIPTION

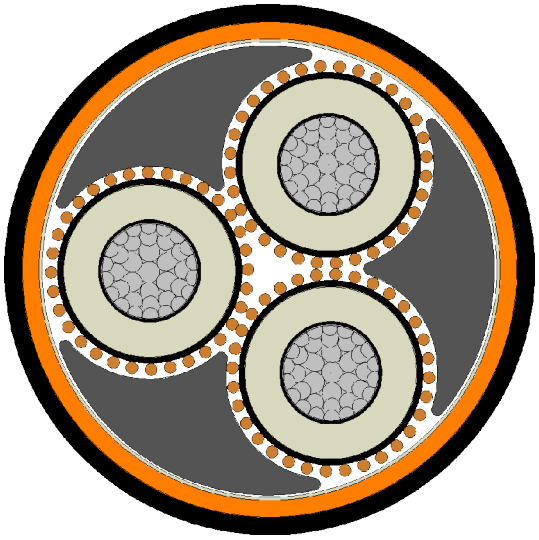
12.7/22kV 3 core 240mm² compacted aluminium conductor, Semi conductive XLPE conductor screen, Trer Retardant XLPE insulated, Semi conductive XLPE insulation Screen, 13.2kA for 1 second plain annealed copper wire screen, Laid up, non-hygroscopic polypropylene filled and taped, 5V-90 PVC Inner sheathed (1.7mm), HDPE outer sheathed (1.9mm),

STANDARD	AS/NZS 1429.1 : 2006 & TES 20-39	Reference Number	20334670

PHYSICAL CHARACTERISTICS

Conductor Diameter			
	Nominal	(mm)	18.1
Insulation Thickness (Nominal)		(mm)	5.5
Diameter over Insulation	Minimum	(mm)	28.7
	Nominal	(mm)	30.3
	Maximum	(mm)	32.3
Screen Stranding per phase (Nominal)		(No/mm)	52/0.85
Sheath Thickness Inner/Outer (Nominal)		(mm)/(mm)	1.7/1.9
Overall Cable Diameter			
	Nominal	(mm)	80.2
Cable Mass	Approx	(kg/km)	6,040
Minimum Bending Radius			
	During Installation	(mm)	2,000
	Installed	(mm)	1,200
Max. Pulling Tension	Stocking [f]	(kN)	9.6
	Conductor [f]	(kN)	25.0

CROSS-SECTIONAL DRAWING (NTS) [g]



ELECTRICAL CHARACTERISTICS [a]

Max. DC Resistance	@ 20˚C	(Ohm/km)	0.125
	@ 90˚C	(Ohm/km)	0.160
Max. AC Resistance @ 50Hz	@ 20˚C	(Ohm/km)	0.126
	@ 90˚C	(Ohm/km)	0.161
Inductive Reactance @ 50Hz		(Ohm/km)	0.0995
Star Inductance		(mH/km)	0.317
Capacitance per Core (Phase to Earth)		(µF/km)	0.309
Charging Current Per Phase		(A/km)	1.23
Maximum Design Stress		(kV/mm)	2.92
3 Phase Voltage Drop @ 50Hz & 90°C		(mV/A.m)	0.328
Zero Sequence Impedance @ 50Hz (R_o + jX_o) [c]	@ 20˚C	(Ohm/km)	0.762 + j 0.0542
	@ 90˚C	(Ohm/km)	0.973 + j 0.0542
Positive Sequence Impedance @ 50Hz (R_1 + jX_1)	@ 20˚C	(Ohm/km)	0.126 + j0.0995
	@ 90˚C	(Ohm/km)	0.161 + j0.0995

CONTINUOUS CURRENT RATING [b]

Unenclosed in Air	(A)	438
Buried Direct	(A)	385
Buried in Ducts	(A)	329

SHORT CIRCUIT RATING

Metallic Screen [d]	(kA/1 Sec.)	13.2
Phase Conductor [e]	(kA/1 Sec.)	22.7

[a] Values given are calculated only.
[b] Based on 40°C ambient air temperature, not exposed to direct sunlight, burial depth of 0.8m, soil temperature of 25°C and soil thermal resistivity of 1.2°C.m/W. For single core cables, these are arranged in a trefoil formation "Touching". Screens solid point bonded (ie: bonded at both ends)
[c] Zero Sequence Impedance based on current return path through metallic screen only.
[d] Screen Short Circuit rating based on 80°C - 250°C temperature rise.
[e] Phase Conductor Short Circuit rating based on 90°C - 250°C temperature rise.
[f] To avoid exceeding maximum sidewall bearing pressure (SWBP) of 1450kg/m, maximum pulling tension (T) and minimum bending radius (R) indicated above may have to be reduced and increased respectively by using the formula SWBP (kg/m) = T (kN) / [0.0098 x R (m)].
[g] Colours are for illustration only and may not necessarily reflect actual colours in final product.

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Customer Acceptance:
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Position: _____
Company: _____
Date: _____

Prepared By:
Name: Vasta Alfio
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Current ratings

The current ratings indicated in this manual have been based on the calculation procedures as recommended in IEC 60287 and the following assumptions. Rating factors should be applied to cover any variation.

- Max. continuous conductor temp. = 90 °C
- Ambient air temperature = 40 °C
- Ambient ground temperature = 25 °C
- Depth of laying = 0.8 m
- Thermal resistivity of soil = 1.2 °C.m/W
- Balanced load, comprising either a single three core cable or three single core cables, in trefoil formation touching throughout, with the screens bonded at both ends of the route.
- Installation conditions:
  1. Direct Buried:
     Cables are installed direct in the ground, with suitable compacted backfill
  2. Buried Singleway Ducts:
     Cables are installed with one cable per duct
  3. In Free Air:
     Cables installed shielded from direct sunlight and with a minimum clearance from any vertical wall of 0.3xCable Dia. and 0.5xCable Dia. for single and three core cables respectively to ensure free air circulation.

In order to select the appropriate cable for a given application, consideration must be given to the nature of the installation. It is not possible to provide a definitive guide to specifying the correct cable type for every situation, this choice must be made by the specifier and/or installer based upon a knowledge of the installation, applicable regulations and the characteristics of available cable designs. General guidance on the use of cable types included has been given above, but for further information and guidance it is recommended to make reference to the appropriate cable standard (e.g. AS/NZS 1429.1 or AS/NZS 4026).

Temperature limits

In respect of thermal effects the temperature limit given for each cable type is the maximum temperature due to any combination of the heating effect of current in the conductors and ambient conditions. All insulation and sheathing materials become stiffer as their temperature is lowered and due regard has been taken of this factor in the guidance on minimum installation temperature.

The materials used for these cables are compatible with temperatures of 90 °C for continuous operation and 250 °C for short circuit conditions of up to 5 seconds.

The fault ratings for the conductors and the metallic screens are provided for a time period of 1 second. When other times (t) between 0.2 and 5 seconds are required, the appropriate rating may be obtained by multiplying the 1 second rating by the factor: $1/\sqrt{t}$.

The ratings for the screens are based upon the traditional adiabatic method, which provides a substantial safety margin when account is taken of the heat loss occurring in practice. The non-adiabatic method to IEC standards can be used according to AS/NZS 1429.1 when agreed between the purchaser and supplier. This can provide substantial systems savings.

Short circuit capacity that is related to the energy expended during a short circuit. It is equated to the mass x specified heat capacity x temperature change in the conductor. Two types of conditions have to be considered – symmetrical and earth short circuit currents. Various cable designs have different nominated maximum temperatures after short circuit, depending usually on the type of insulation and sheathing, and these temperatures should not be exceeded.

Economics important criteria related to cable economics are the initial system cost and annual cost of losses. Economics are generally considered on a present value calculation based on initial cost and discounted cost of losses. Data provided in the tables assists specifiers to estimate purchase and running costs.

MEDIUM VOLTAGE CABLES

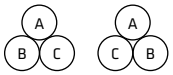
Cable installation

It is recommended that all cables described in this manual be installed in accordance with the Electricity supply authority Specifications or Regulations, the Wiring Rules and any other appropriate national regulations or legislation.

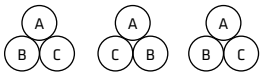
In installing cables, care should be taken to ensure that the ambient and cable temperature has been above 0°C for the previous 24 hours to avoid the risk of cracking of the oversheath.

For groups of parallel single core circuits, the cables should be installed in trefoil touching formation as hereunder:

i) Two conductors per phase.



ii) Three conductors per phase.



Recommended minimum bending radii

It is good practice when planning ducts or trenches to prescribe a bending radius of 3 metres for 11kV, 22kV and 33kV cables and 2 metres for cables below 11kV.

The following tables set out the recommended minimum bending radii for single or multicore polymeric insulated cables greater than 1.1/1.1kV:

Cable description	During installation	Setting at final position or location
Nylon Jacketed	30D*	20D*
HDPE Sheathed	25D	15D
PVC Sheathed and LSOH Sheathed	18D	12D

Where: D = Overall diameter of cable in mm.
D* = Diameter over Nylon jacket component in mm.

The radius is related to the inner surface of the cable and not the axis.

The recommendation for installation allows for the cable to be pulled under tension. Where cables are placed in position adjacent to joints and terminations and the bending is carefully controlled, the controlled bending radius as given in the data tables may be used. Sidewall Bearing Pressures need to be considered also.

Duct sizes

Recommended duct sizes are given in the following table:

Nominal internal duct diameter (mm)	Cable diameter (mm)	
100	Up to 65	
125	Over 65, up to 90	
150	Over 90, up to 115	

Maximum recommended pulling tensions

Using a pulling eye on the conductor:
Copper – 0.07 kN/mm^2 of conductor
Aluminium, Stranded – 0.05 kN/mm^2 of conductor

Using a pulling eye on the Steel wire armour:
$P = 0.005\ D^2$

Using a Stocking grip: $P = 0.12D$
Where: P = Tension in kN
D = Cable diameter in mm

Notes:

1. When considering the use of a stocking grip the tension should not exceed the values given for a pulling eye on the conductor(s).
2. Refer also to Maximum Sidewall Bearing Pressure.

Using bond pulling:
By this method the cable is tied at intervals to a steel hawser which is coiled onto a take-up winch in the normal manner. The hawser would be twice the length of the cable being pulled. In this way the pulling load on the cable is kept to a low value and risk of damage to the cable is minimised.

Maximum sidewall bearing pressure

Another factor which can limit the maximum tension that a cable can withstand is the sidewall bearing pressure exerted on a cable in duct bends and elbows. The sidewall bearing pressure formula is expressed as:

$SWBP = [W^2 + (T/(0.0098 \times R))^2]$ (equation 1)

as most of the time, $[T/(0.0098 \times R)]^2 >> W^2$
equation 1 can therefore be simplified as follows:

$SWBP \approx T/(0.0098 \times R)$ (equation 2)
From eqn. 2 => $T = 0.0098 \times R \times SWBP$ (equation 3)
From eqn. 2 => $R = T / (0.0098 \times SWBP)$ (equation 4)

Where: SWBP = sidewall bearing pressure (kg/m)
W = weight of cable per unit length (kg/m)
T = cable pulling tension (kN)
R = radius of the bend or elbow (m)

The recommended maximum SWBP for sheathed cables shall be 1450kg/m.

Examples:

To find out the maximum pulling tension of a 12.7/22kV 240mm² copper single core PVC sheathed cable based on its minimum recommended bending radius:

1. First calculate the minimum recommended bending radius without considering SWBP:
= 18 x Cable diameter
= 18 x 40.5mm
= 729mm

Then calculate the maximum pulling tensions:

a) Maximum pulling tension for straight pull:
$T = 0.07\ kN/mm^2 \times 240\ mm^2$
= 16.8 kN

b) Maximum pulling tension when taking maximum SWBP into consideration.

From Equation 3: T = 0.0098 x 0.729 x 1450
= 10.4 kN

We have to select the lesser of the two pulling tensions, i.e. 10.4kN. In this example, the maximum SWBP dictates the maximum pulling tension.

2. To find out the minimum bending radius for the same cable if we do need a pulling tension of 16.8kN:

From Equation 4: R = 16.8 / (0.0098 x 1450)
= 1.2m

Joints and terminations

Whilst jointing and terminating of Medium Voltage Polymeric Cables is routine, care is needed to maintain clean working conditions and in ensuring that the insulation semiconducting screen is completely removed and properly connected at the stress control areas. Reference should be made to literature for suitable systems available from Prysmian.

Tests after installation

High Voltage d.c. testing of primary insulation is not recommended and can be detrimental to the cable and accessories. AS/NZS 1429.1 describes an a.c. voltage test at power frequency that should be applied for 24 hours at the normal operating voltage of the system. A sheath integrity test (e.g. with a 1000 Volt minimum rated insulation resistance tester) may be applied between the outer-most metallic layer and the earth to identify post-installation damage, provided the metallic layer is isolated from earth at the joints, terminations, etc.

Short circuit forces

When single core cables are installed touching, special attention should be given to cleating and strapping arrangements to contain the repulsive forces under short circuit conditions. Longitudinal thrust and tensions in cable conductors may be considerable and may cause buckling of conductors and other damage in a joint or termination. When cables are installed, provision should be made to accommodate the resulting longitudinal forces on terminations and joints. Sharp bends and fixings at a bend should be avoided.

Prevention of moisture ingress

Care should be exercised during installation to avoid any damage to cable coverings. This is important in wet or other aggressive environments. The protective cap should not be removed from the ends of the cable until immediately prior to termination or jointing. When the caps have been removed the unprotected ends of the cable should not be exposed to moisture.

The possibility of damage to moisture seals during handling and installation or during storage of the cable should be considered and where such damage may have occurred, the seals should be inspected and remade if necessary.

MEDIUM VOLTAGE CABLES

Ratings information

Rating factors – 1.9/3.3kV to 19/33kV, single and three core cables, armoured or unarmoured

1. Cables buried direct in the ground:

Variation in ground temperature							
Ground temperature °C	10	15	20	25	30	35	40
Rating factor	1.11	1.07	1.03	1.00	0.97	0.93	0.89

Variation in thermal resistivity of soil		Values of 'g' °C m/W							
Nominal area of conductor mm²		0.8	0.9	1.0	1.2	1.5	2.0	2.5	3.0
Rating factor									
Single core cables	Up to 150	1.16	1.11	1.07	1.00	0.91	0.81	0.73	0.67
	From 185 - 400	1.17	1.12	1.07	1.00	0.90	0.80	0.72	0.66
	Above 400	1.18	1.13	1.08	1.00	0.90	0.79	0.71	0.65
Three core cables	Up to 16	1.09	1.06	1.04	1.00	0.95	0.87	0.79	0.74
	From 25 - 150	1.14	1.10	1.07	1.00	0.93	0.84	0.76	0.70
	From 185 - 400	1.16	1.11	1.07	1.00	0.92	0.82	0.74	0.68

Variation in depth of laying		
*Depth of laying m	Up to 300 mm²	Above 300 mm²
0.8	1	1
1	0.98	0.97
1.25	0.96	0.95
1.5	0.95	0.94
1.75	0.94	0.92
2	0.92	0.90
2.5	0.91	0.89
3.0 or more	0.90	0.88

*Measured to centre of cable or trefoil group of cables.

Variation in depth of laying		
*Depth of laying m	Up to 300 mm²	Above 300 mm²
0.8	1	1
1	0.98	0.97
1.25	0.96	0.95
1.5	0.95	0.94
1.75	0.94	0.92
2	0.92	0.90
2.5	0.91	0.89
3.0 or more	0.90	0.88

*Measured to centre of cable or trefoil group of cables.

6. MV CABLE SUPPLEMENTARY TECHNICAL DATA INFORMATION

MEDIUM VOLTAGE CABLES

Group rating factors for circuits of three single core cables, in trefoil touching, horizontal formation			Circuit spacing – metres			
Voltage range of cables	No. of circuits	Touching	0.15*	0.30	0.45	0.60
From 1.9/3.3kV to 12.7/22kV	2	0.78	0.81	0.85	0.88	0.90
	3	0.66	0.71	0.76	0.80	0.83
	4	0.60	0.65	0.72	0.76	0.80
19/33kV	2	0.79	0.81	0.85	0.88	0.90
	3	0.67	0.71	0.76	0.80	0.83
	4	0.62	0.65	0.72	0.76	0.80

*These spacings may not be possible for some of the larger diameter cables.

Group rating factors for three core cables, in horizontal formation			Circuit spacing – metres			
Voltage range of cables	No. of circuits in group	Touching	0.15*	0.30	0.45	0.60
From 1.9/3.3kV to 12.7/22kV	2	0.80	0.85	0.89	0.90	0.92
	3	0.69	0.75	0.80	0.84	0.86
	4	0.63	0.70	0.77	0.80	0.84
19/33kV	2	0.80	0.83	0.87	0.89	0.91
	3	0.70	0.73	0.78	0.82	0.85
	4	0.64	0.68	0.74	0.78	0.82

*These spacings may not be possible for some of the larger diameter cables.

2. Cables in singleway ducts, buried direct in the ground:

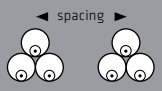
Variation in ground temperature							
Ground temperature °C	10	15	20	25	30	35	40
Rating factor	1.11	1.07	1.03	1.00	0.97	0.93	0.89

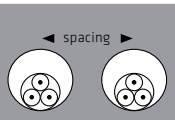
Variation in thermal resistivity of soil		Values of 'g' °C m/W							
Nominal area of conductor mm²		0.8	0.9	1.0	1.2	1.5	2.0	2.5	3.0
Rating factor									
Single core cables	Up to 150	1.10	1.07	1.05	1.00	0.94	0.87	0.81	0.75
	From 185 - 400	1.11	1.08	1.06	1.00	0.94	0.86	0.79	0.73
	Above 400	1.13	1.09	1.06	1.00	0.93	0.84	0.77	0.70
Three core cables	Up to 16	1.05	1.04	1.03	1.00	0.97	0.92	0.87	0.83
	From 25 - 150	1.07	1.05	1.03	1.00	0.96	0.90	0.85	0.78
	From 185 - 400	1.09	1.06	1.04	1.00	0.95	0.87	0.82	0.76

MEDIUM VOLTAGE CABLES

Variation in depth of laying	Rating factors	
*Depth of Laying m	Single core	Multicore
0.8	1	1
1	0.98	0.99
1.25	0.95	0.97
1.5	0.93	0.96
1.75	0.92	0.95
2	0.90	0.94
2.5	0.89	0.93
3.0 or more	0.88	0.92

*Measured to centre of cable or trefoil group of cables.

Group rating factors for single core cables in single way ducts, laid in trefoil touching, horizontal formation			Circuit spacing – metres 	
Voltage range of cables	No. of circuits	Touching	0.45	0.60
From 1.9/3.3kV to 12.7/22kV	2	0.85	0.88	0.90
	3	0.75	0.80	0.83
	4	0.70	0.76	0.80
19/33kV	2	0.85	0.88	0.90
	3	0.76	0.80	0.83
	4	0.71	0.76	0.80

Group rating factors for three core cables in singleway ducts, in horizontal formation			Circuit spacing – metres 		
Voltage range of cables	No. of ducts in group	Touching	0.30	0.45	0.60
From 1.9/3.3kV to 12.7/22kV	2	0.88	0.91	0.93	0.94
	3	0.80	0.84	0.87	0.89
	4	0.75	0.81	0.84	0.87
19/33kV	2	0.87	0.89	0.92	0.93
	3	0.78	0.82	0.85	0.87
	4	0.73	0.78	0.82	0.85

3. Cables installed in free air:

Variation in ambient air temperature								
Ambient air temperature °C	15	20	25	30	35	40	45	50
Rating factor	1.26	1.20	1.15	1.10	1.05	1.00	0.94	0.88

Grouping of cables in air:

Derating is not necessary if the following minimum clearance between adjacent circuits can be maintained

1 The horizontal clearance is not less than twice the diameter of an individual cable.
2 The vertical clearance is not less than four times the diameter of an individual cable.
3 Where the number of circuits is more than three, they are installed in a horizontal plane.

General information

AS 1018	Partial discharge measurements
AS/NZS 1026	Electric cables – Impregnated paper insulated for working voltages up to and including 19/33 (36)kV
AS/NZS 1125	Conductors in insulated electric cables and flexible cords
AS/NZS 1429.1	Electric cables – Polymeric insulated Part 1: electric cables for working voltages 1.9/3.3 (3.6)kV up to and including 19/33 (36)kV
AS/NZS 1660	Test methods for electric cables, cords and conductors
AS 1931	High-voltage testing techniques
AS/NZS 2857	Timber drums for insulated electric cables and bare conductors
AS/NZS 2893	Electric cables – lead and lead alloy sheaths – composition
AS/NZS 3008	Electrical installations – selection of cables
AS/NZS 3808	Insulating and sheathing materials for electric cables
AS/NZS 3863	Galvanized mild steel wire for armouring cables
AS 3983	Metal drums for insulated electric cables and bare conductors
AS/NZS 4026	Electric cables – for underground residential distribution systems
IEC 754-2	Test on gases evolved during combustion of electric cables, Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity
IEC 60287	Electric cables – calculation of the current rating
IEC 60332-1	Tests on electric and optical fibre cables under fire conditions, Part 1: Test for vertical flame propagation for a single insulated wire or cable
IEC 60332-3	Tests on electric cables under fire conditions, Part 3: Test for vertical flame spread of vertically-mounted bunched wires or cables
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 1kV (Um = 1.2kV) up to 30kV (Um = 36kV) - Part 2: Cables for rated voltages from 6kV (Um = 7.2kV) up to 30kV (Um = 36kV)
IEC 60949	Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects
IEC 60986	Short-circuit temperature limits of electric cables with a rated voltages from 6kV (Um = 7.2kV) up to 30kV (Um = 36kV)
IEC 61034	Measurement of smoke density of cables burning under defined conditions