ALCAN CABLE

ARMOURED CABLE

CANADIAN PRODUCT CATALOGUE

grounded in service
wired to innovate.™

ALCAN

About this catalogue

This catalogue is intended to provide introductory technical data to aid the correct selection of wire and cable for permanent installation in commercial, institutional and industrial premises. Such installations are governed by the requirement of the Canadian Electrical Code Part I, and enforced by the appointed authority having jurisdiction in this area under provincial law (federal law in the case of federal territories), with or without Code amendments as the case may be.

Wires and cables in installations falling under the jurisdiction of the provincial and territorial inspection authorities are almost invariably required to be certified to the requirements of CSA standards under the approval of the CSA Technical Committee on Wiring Products.

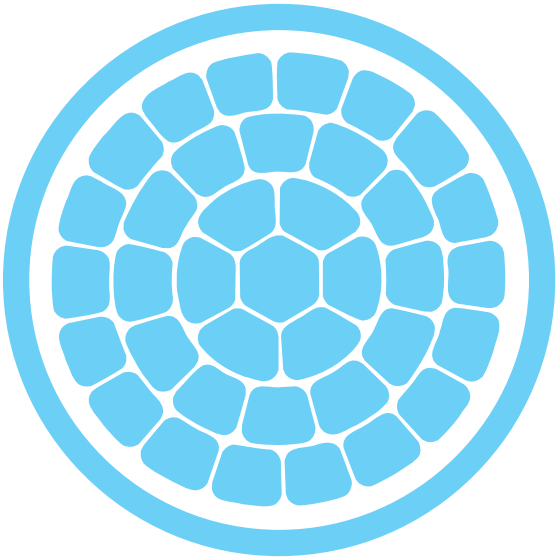
This catalogue provides information on standard products stocked by Alcan's Distributors. Alcan manufactures a wide range of additional products in various sizes which can be supplied by special order. For more information, contact your distributor or visit www.cable.alcan.com for the most current list of product offerings.

Wire and cable products supplied by Alcan comply with the codes, standards and product specifications as indicated in this catalogue.

Weights and measurements are subject to manufacturing tolerances and product design changes. Consequently, Alcan does not accept responsibility for costs incurred by a purchaser as a result of weights and measurements not conforming exactly to those indicated.

Alcan Cable
Division of Alcan Inc.

ABOUT ALCAN



Alcan is a name people know and trust. For over a century, our products have helped supply communities with power from coast to coast across the continent. And in that time we've become synonymous not only with aluminium, but with the latest technology and highest standards of quality and service.

We offer a full range of bare and insulated wires to both the utility and distribution markets, and support them with technical experts specifically trained to help our customers achieve their desired end results.

We believe our customers' satisfaction relies entirely on the quality of our products. That's why we work hard to ensure they're consistently superior to anything else on the market. Our distribution centre, technical centre and manufacturing facilities have all attained ISO 9000 certification, and we're proud to have the only North American manufacturing plant with the triple accreditation of ISO 9000, 14000 and 18000.

We're committed to the success of our products, and to the satisfaction of our customers. That's why Alcan will continue to be a name people know and trust.

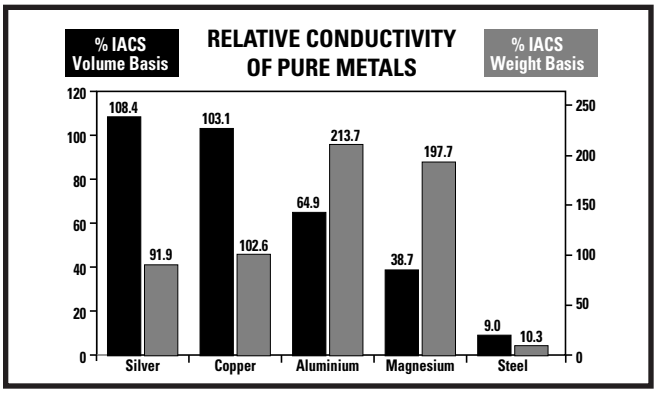
NUAL CONDUCTORS

NUAL is an aluminium alloy formulated by Alcan specifically for use in building wire applications. NUAL is CSA-certified as an ACM ("Aluminium Conductor Material") meeting all of the requirements of the Canadian Electrical Code. It is identified by the Aluminium Association as AA8030.

Conductivity

Comparing equal-sized cables, the conductivity of NUAL conductor is 61% IACS to that of copper, the most commonly used benchmark material. The actual mass of aluminium, by volume, is approximately one-third that of copper. On this basis, a given mass of NUAL alloy will produce twice the length of conductor as an equal amount of copper. In practice, NUAL conductors weigh about half as much as copper conductors of equal ampacity.

The reduction in weight, achieved by using NUAL instead of copper conductors, generally leads to lower installation cost, reduced wear on equipment and cables and less strain on the installer.



Creep Resistance

The special formulation of NUAL, coupled with the heat treatment applied during the processing of the alloy, produces a significant reduction in the metal's tendency to "creep" under heat and pressure. As a result, electrical connections made with NUAL conductors are as stable as connections made with copper conductors.

Coefficient of Thermal Expansion

The coefficient of thermal expansion is used to calculate dimensional variations of any material subjected to a change in temperature. NUAL has a thermal coefficient slightly higher than copper, which means that it will expand or contract slightly more than copper. For this reason, aluminium conductor cannot be terminated with a copper-bodied connector.

The converse is not true: aluminium-bodied connectors have been used reliably for years on both copper and aluminium conductors. Since the majority of electrical connectors used today are made of aluminium, NUAL is the best choice of conductor material to use. In this case, the expansion and contraction of the conductor and connector are identical, negating any response in the material due to changes in temperature.

Connection Performance

The composition of NUAL conductors provides a major improvement in connection performance, which is at the heart of its ACM designation. In particular, the addition of iron imparts a high level of resistance to creep when the conductor is fully annealed, and guarantees connection stability even during prolonged overloads and overheating. When used with CSA certified 90°C rated mechanical connectors (marked AL9CU or AL90CU) the evidence of connector tests carried out at the Georgia Power test facility indicates a level of performance equal to that of copper, connected in the same manner. In fact, the tests merely substantiate close to 20 years of trouble-free operation in the field since the introduction of NUAL into Alcan Cable products installed under Code rules.

Note that connections to NUAL conductors should not be tightened on a regular basis, as this may deteriorate the connection.

Corrosion Resistance

The inherent corrosion-resistance of aluminium is due to the thin, tough oxide coating that forms instantly when a fresh surface of metallic aluminium is exposed to air. This type of oxide is particularly resistant to most types of corrosion. The ability of aluminium to withstand harsh environments is responsible for its widespread use in trays and conduit for electrical cable as well as many industrial components and vessels. When corrosion has appeared, it is usually related to connections between dissimilar metals in the presence of moisture – protective measures such as a grease, anti-oxidant or protective coating should be used to prevent these occurrences. Environments that do tend to be aggressive to aluminium include alkaline soils and some types of acids. This means that buried aluminium conductors should be protected from corrosion by insulation or an extruded covering. In sulphur-bearing environments, aluminium performs much better than copper. These include some soils as well as railway tunnels and similar locations.

Flexibility

NUAL conductors are significantly more flexible and are much less subject to "springback" than copper. NUAL also "trains" easily, enabling better terminations with less effort. The "workability" of NUAL is due partly to its chemical composition and partly to the properties introduced by Alcan's manufacturing process.

Types AC90, ACWU90, TECK90

Alcan armoured cable is available in NUAL conductors in sizes from 8 AWG up to and including 2000 kcmil. Conductors are ASTM Class B compressed or compact stranded.

NUAL conductors meet the requirements of CSA Standard C22.2 No. 38 ACM alloy conductors.

Alcan interlocked aluminium armoured AC90, ACWU90 and TECK90 cables are approved for a wide variety of applications governed by the Canadian Electrical Code, Part I and the safety requirements of provincial electrical inspection authorities.

Type AC90 has been used for many years as general wiring for lighting, receptacles and other branch circuit and feeder applications in non-combustible buildings such as offices, hotels, shopping centres and factories. Type ACWU90 is used for feeders and service entrances, as well as certain dedicated branch circuits in non-combustible buildings. Types AC90, ACWU90 and TECK90 are acceptable for consumer service conductors, although Type AC90 is restricted to services above ground in dry locations.

The interlocked armour used by Alcan results in a cable that is more flexible and easier to install than conventional sheathed cable. Alcan's interlocked armoured cables can bend to an inside radius, for permanent installation, as small as 6 times the cable diameter.

AC90, ACWU90 and TECK90 armoured cables can be installed in cable trays (enclosed ventilated or non-ventilated, and ladder-type), suspended on Unistrut supports, or clamped directly to walls or ceilings in indoor locations. In addition, Types ACWU90 and TECK90 cable are certified for outdoor and other wet applications, including direct burial in the earth.

Type TECK90 cable is a rugged, durable cable of versatile construction proven through many years of service in mines and major resource industries such as the pulp and paper, petrochemical and metal industries. The excellent inherent properties of TECK90 cable materials and construction ensure its continued reliability, even when exposed to many forms of environmental degradation and attack.

TECK90 and ACWU90 cables are certified for use in all classes and divisions of hazardous locations. Alcan Cable does not recommend the use of single-conductor TECK90 and ACWU90 cable in Class I, Zone 1 locations. Use of single-conductor AC90 and unjacketed TECK90 is not recommended in circuits rated over 425 amps. The National Building Code of Canada permits unjacketed armoured cables for normal feeder and branch circuits in non-combustible buildings, including return air plenums. Further explanation is given in our Applications Catalogue.

TRISTRIPE™ Colour Coding

Alcan TRISTRIPE colour coding is provided in conductor sizes 8 AWG and larger. TRISTRIPE consists of 3 highly durable extruded polymer stripes applied equally spaced around the circumference of black weather resistant insulation. The conductor colour is always visible, whatever the angle of view.

CEC ampacities

Size	Ampacity	
	Table 3	Table 4
8	45	30
6	80	*55
4	105	65
3	120	75
2	140	*95
1	165	105
1/0	190	120
2/0	220	145
3/0	255	165
4/0	300	**185
250	330	215
300	375	240
350	415	260
400	450	290
500	515	330
600	585	370
750	670	405
1000	800	480
1500	1020	580

* For 3 wire 120/240 and 120/208 V residential services or sub-services the allowable ampacity for size number 6AWG shall be 60 A and size 2AWG shall be 100 A. In this case the 5% adjustment per Rule 8-106(1) cannot be applied.

** Subject to the permission and conditions of the electrical inspection authority having jurisdiction, the conductors shall be allowed for 200 A rated residential services.

Table 3 ampacities are for free air installations.
Table 4 ampacities are for 3 conductors in conduit, not including neutral conductor for above ground installations.

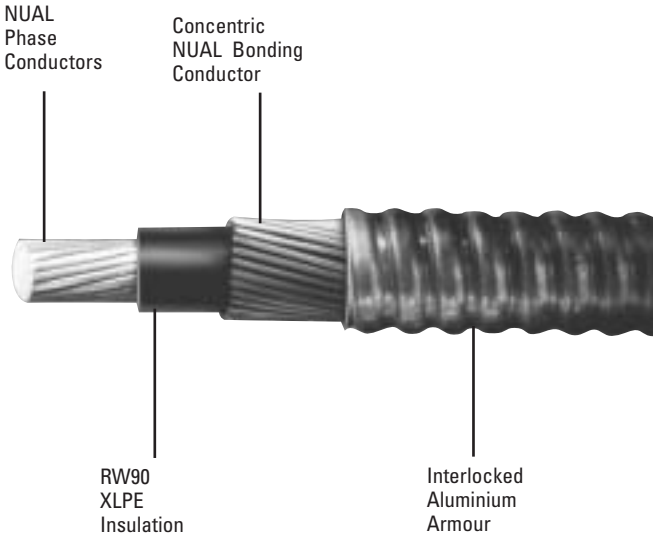
Alcan AC90 Armoured Cables

AC90 is a flexible, interlocked aluminium armoured cable having one to four 90°C rated crosslinked polyethylene insulated conductors and one bare bonding conductor. On single-conductor cables, the bonding conductor is applied concentrically around the phase conductor.

AC90 reduces problems and labour costs associated with conduit wiring. Conductors are factory-assembled with a flexible, interlocked aluminium armour eliminating the need for conduit, conduit fittings and the labour intensive operations of pulling in conductors, threading and forming conduits. The Canadian Electrical Code permits AC90 for open and concealed wiring in dry locations. AC90 is considered similar to pipe and wire by the Canadian building codes.

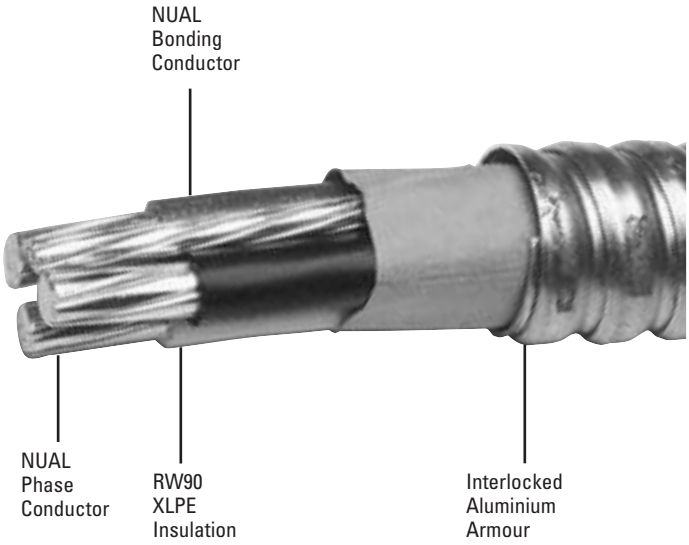
AC90 Single-Conductor Cable

Alcan AC90 single-conductor cable is available in sizes ranging from 1/0 AWG to 750 kcmil in NUAL.



AC90 Multi-Conductor Cable

Alcan AC90 multi-conductor is available in sizes ranging from 6 AWG to 750 kcmil in NUAL.



Standard
CSA C22.2 No. 51

NUAL® CONDUCTORS

TABLE 1

NUAL AC90 – 600V

Conductor Size AWG/kcmil	NUAL COMPACT				
	Approximate Diameters		Bonding Conductor Size	Conductor Metal Mass	Total Mass
	Under Armour (mm)	Over Armour (mm)	AWG/kcmil	(kg/km)	(kg/km)
SINGLE CONDUCTOR					
1/0	14.7	21.0	4	209	375
2/0	15.7	22.0	2	280	457
3/0	16.8	23.2	2	329	578
4/0	18.2	24.5	2	390	664
250	19.9	26.2	1	469	703
300	21.1	27.4	1	540	864
350	23.0	29.3	1/0	640	887
750	31.2	38.0	3/0	1290	1710
THREE CONDUCTOR					
6	15.1	21.4	8	134	324
4	17.9	23.9	6	214	436
2	20.4	26.8	6	318	577
1	23.2	29.1	4	412	695
1/0	24.8	31.1	4	506	826
2/0	27.0	33.3	4	620	971
3/0	29.4	35.9	4	768	1150
4/0	32.4	39.3	4	952	1421
250	36.1	42.5	2	1150	1696
300	38.7	45.4	2	1361	1951
350	41.4	48.0	2	1572	2200
400	43.6	50.3	2	1781	2447
500	47.8	54.8	1	2233	2964
750	57.2	64.0	1/0	3318	4194
FOUR CONDUCTOR					
6	17.2	23.7	8	171	402
4	20.3	26.6	6	272	538
2	23.3	29.6	6	411	720
1	26.8	32.8	4	530	890
1/0	28.6	34.9	4	654	1044
2/0	30.6	36.9	4	807	1231
3/0	33.1	39.8	4	1004	1512
4/0	36.4	43.0	4	1250	1810
250	40.4	47.0	2	1502	2158
300	43.3	50.0	2	1784	2490
350	46.3	52.8	2	2065	2818
400	48.8	55.5	2	2343	3144
500	53.4	60.3	1	2939	3817
750	64.0	70.8	1/0	4374	5430

Conversion Factors:

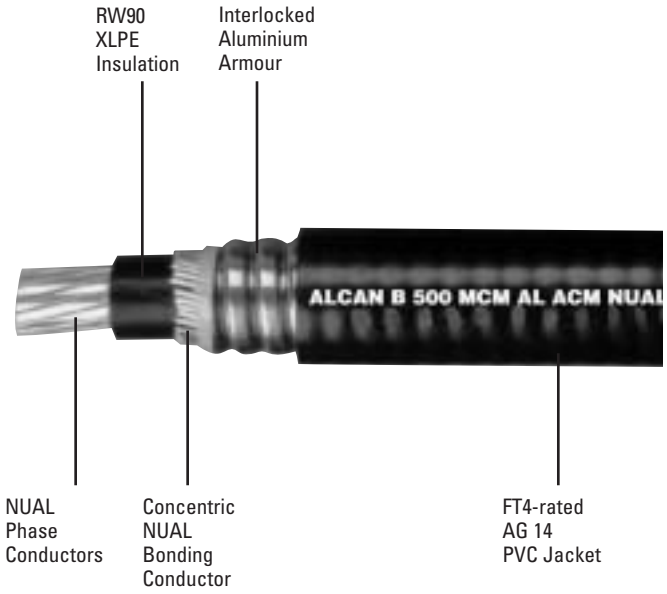
kcmil x 0.5067 = mm^2
mm x 0.0394 = inches
kg/km x 0.6720 = lb/M ft.

Alcan ACWU90 Armoured Cables

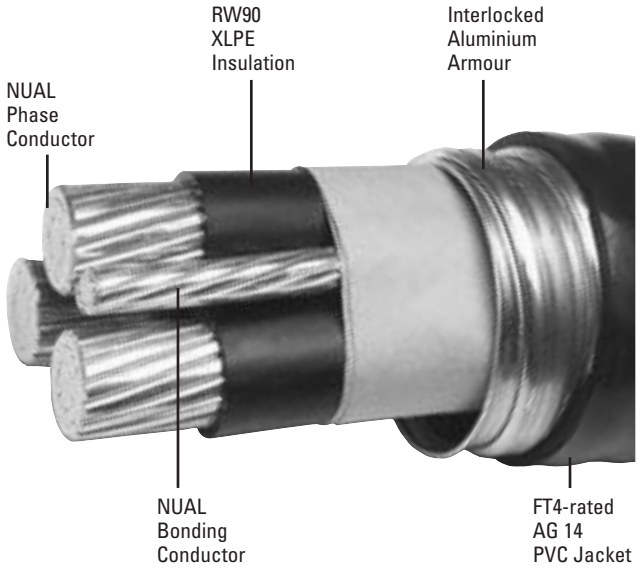
ACWU90 is a flexible, interlocked aluminium armoured, PVC-jacketed cable having one to four 90°C wet-rated crosslinked polyethylene insulated conductors and one bare bonding conductor. For single-conductor cables, the bonding conductor is applied concentrically around the phase conductor. The FT4-rated PVC jacket allows the cable to be used in direct burial applications, corrosive environments and in non-combustible buildings. ACWU90 reduces problems and labour costs associated with conduit wiring. Conductors are factory-assembled with a flexible, interlocked aluminium armour and impervious PVC jacket, eliminating the need for conduit, conduit fittings and the labour-intensive operations of pulling in conductors, threading and forming conduits. Multi-conductor ACWU90 is CSA-certified for open and concealed wiring in both dry and wet locations and for use in Class1 Zone 1 and 2, and Classes 2 and 3, Divisions 1 and 2 hazardous locations. Above ground it may be supported on racks and trays or clamped directly to walls and ceilings; below ground it can be buried directly, with protection as required by provincial inspection authorities. Alcan Cable's ACWU90 has calibrated markings located every 1 metre allowing for easy and accurate length determination.

NUAL ACWU90 single-conductor cable is available in sizes ranging from 1 AWG to 1500 kcmil and from 6 AWG to 750 kcmil in multi-conductor constructions.

ACWU90 Single-Conductor Cable



ACWU90 Multi-Conductor Cable



*Single conductor armoured cables should not be used in hazardous locations. The armour and concentric bonding conductors of single conductor metal sheathed and metal armoured cables may carry a standing voltage with respect to ground, which is directly proportional to the magnitude of the current in the conductor, and the length of the cable, which may create sparks if grounded.

Standard
CSA C22.2 No. 51
FT4-Rated: vertical cable-tray test
CSA C22.2 No. 174 Hazardous Locations

Warning

FLAMMABLE:	**Non-metallic coverings of electric cable will burn and may transmit fire when ignited.**
TOXIC:	**Burning non-metallic coverings may emit acid gases which are highly toxic, and dense smoke.**
CORROSIVE:	**Emission of acid gases may corrode metal in the vicinity, such as sensitive instruments and reinforcing rods in concrete.**

NUAL® CONDUCTORS

TABLE 2

NUAL ACWU90 – 600 V

Conductor Size AWG/kcmil	NUAL COMPACT					
	Approximate Diameters			Bonding Conductor Size	Conductor Metal Mass	Total Mass
	Under Armour (mm)	Over Armour (mm)	Over Jacket (mm)	AWG/kcmil	(kg/km)	(kg/km)
SINGLE CONDUCTOR						
1	13.7	20.1	22.8	4	178	460
1/0	14.7	21.0	23.7	4	209	506
2/0	15.7	22.0	24.7	2	280	594
3/0	16.8	23.2	25.9	2	329	722
4/0	18.2	24.5	27.2	2	390	816
250	19.9	26.2	29.4	1	469	902
300	21.1	27.4	30.7	1	540	1072
350	23.0	29.3	32.6	1/0	640	1108
400	24.0	30.4	33.7	1/0	709	1307
500	26.0	32.4	35.7	2/0	891	1533
600	27.9	34.3	37.5	2/0	1031	1713
750	31.2	38.0	41.3	3/0	1290	1994
1000	35.1	41.9	45.2	3/0	1638	2523
*1500	50.8	51.1	54.4	250	2436	3700
THREE CONDUCTOR						
6	15.1	21.4	23.9	8	134	458
4	17.9	23.9	26.6	6	214	584
2	20.4	26.8	30.1	6	318	761
1	23.2	29.1	32.4	4	412	915
1/0	24.8	31.1	34.4	4	506	1061
2/0	27.0	33.3	36.6	4	620	1220
3/0	29.4	35.9	38.2	4	768	1419
4/0	32.4	39.3	42.6	4	952	1714
250	36.1	42.5	45.8	2	1150	2012
300	38.7	45.4	48.8	2	1361	2289
350	41.4	48.0	51.3	2	1572	2556
400	43.6	50.3	53.6	2	1781	2819
500	47.8	54.8	58.8	1	2233	3481
600	52.0	58.8	63.0	1	2656	4003
750	57.2	64.0	68.2	1/0	3318	4796

Conversion Factors:
kcmil x 0.5067 = mm²
mm x 0.0394 = inches
kg/km x 0.6720 = lb/M ft.
*Conventional stranding

TABLE 3

NUAL ACWU90 – 600 V

Conductor Size AWG/kcmil	NUAL COMPACT					
	Approximate Diameters			Bonding Conductor Size	Conductor Metal Mass	Total Mass
	Under Armour (mm)	Over Armour (mm)	Over Jacket (mm)	AWG/kcmil	(kg/km)	(kg/km)
FOUR CONDUCTOR						
6	17.2	23.7	26.2	8	171	538
4	20.3	26.6	29.9	6	272	741
2	23.3	29.6	32.9	6	411	944
1	26.8	32.8	36.2	4	530	1138
1/0	28.6	34.9	38.2	4	654	1306
2/0	30.6	36.9	40.2	4	807	1507
3/0	33.1	39.8	43.1	4	1004	1809
4/0	36.4	43.0	46.3	4	1250	2130
250	40.4	47.0	50.3	2	1502	2507
300	43.3	50.0	53.3	2	1784	2860
350	46.3	52.8	57.0	2	2065	3318
400	48.8	55.5	59.7	2	2343	3669
500	53.4	60.3	64.5	1	2939	4386
600	58.2	65.0	69.2	1	3502	5068
750	64.0	70.8	75.0	1/0	4374	6094

Conversion Factors:

kcmil x 0.5067 = mm^2
mm x 0.0394 = inches
kg/km x 0.6720 = lb/M ft.

TECK90 Cables

TECK90 is a flexible, interlocked aluminium armoured cable having an inner PVC jacket over the insulated conductors as well as outer PVC jacket over the armour. TECK90 is CSA-approved for open and concealed wiring, direct burial and for use in Class 1, Zone 1 and 2, and classes 2 and 3, Division 1 and 2 hazardous locations.

It is also available as a single-conductor in 600 and 1000 volt constructions in sizes 250 to 750 kcmil in NUAL. On single-conductor cables, the bonding conductor is applied concentrically around the phase conductor.

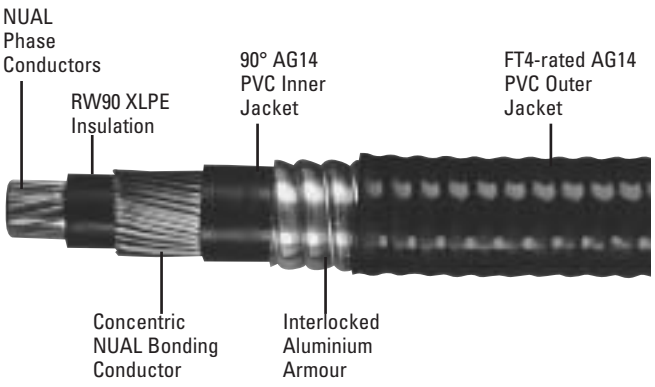
Multi-conductor constructions are available in 600 and 1000 volt ratings in sizes 6 AWG to 750 kcmil (13.3 to 380 mm^2) in NUAL.

All Alcan Cable TECK90 cables are filled to round using non-hygroscopic filler ensuring uniform concentricity which eases pulling.

All Alcan Cable TECK90 jackets have metre markings which greatly ease measuring and cutting lengths. Prior to shipping from the manufacturing facility the accuracy of the markings is verified with gauges calibrated to international standards.

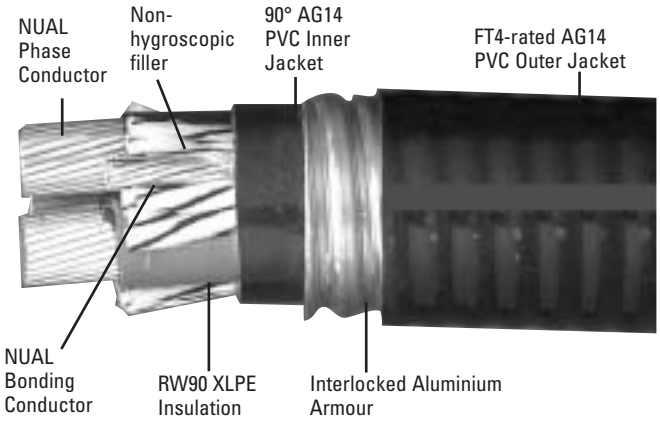
Alcan Cable has chosen not to identify single-conductor TECK90 constructions with H.L. indicating their suitability for use in hazardous locations even though these products meet these requirements.

TECK90 Single-Conductor Cable



*Single conductor armoured cables should not be used in hazardous locations. The armour and concentric bonding conductors of single conductor metal sheathed and metal armoured cables may carry a standing voltage with respect to ground, which is directly proportional to the magnitude of the current in the conductor, and the length of the cable, which may create sparks if grounded.

TECK90 Multi-Conductor Cable



Standard
CSA C22.2 No. 131 (TECK)
CSA C22.2 No. 174 (Hazardous Locations)
FT4-Rated: vertical cable-tray test

Warning

FLAMMABLE:	**Non-metallic coverings of electric cable will burn and may transmit fire when ignited.**
TOXIC:	**Burning non-metallic coverings may emit acid gases which are highly toxic, and dense smoke.**
CORROSIVE:	**Emission of acid gases may corrode metal in the vicinity, such as sensitive instruments and reinforcing rods in concrete.**

NUAL® CONDUCTORS

TABLE 4

NUAL TECK90 – 600 and 1000 V

Conductor Size AWG/kcmil	NUAL Bonding Conductor Size	600 VOLT					1000 VOLT				
		Approximate Diameters			Approximate Mass		Approximate Diameters			Approximate Mass	
		Under Armour (mm)	Over Armour (mm)	Over Jacket (mm)	Conductor Metal (kg/km)	Total (kg/km)	Under Armour (mm)	Over Armour (mm)	Over Jacket (mm)	Conductor Metal (kg/km)	Total (kg/km)
SINGLE CONDUCTOR											
250	1	23.0	29.5	32.0	469	1134	24.2	30.7	33.7	469	1296
300	1	24.3	30.8	33.3	540	1233	25.8	32.3	34.8	540	1312
350	1/0	27.3	33.4	35.9	640	1408	28.3	34.8	37.3	640	1479
500	2/0	29.3	35.8	38.3	891	1749	30.5	37.0	39.5	891	1805
750	3/0	35.4	42.9	46.3	1290	2474	35.7	43.3	46.7	1290	2490
1000	3/0	39.3	46.8	50.2	1638	2955	39.7	47.2	50.6	1638	3068
THREE CONDUCTOR											
6	8	18.0	24.5	27.0	134	672	19.6	26.1	28.6	134	732
4	6	20.7	27.4	28.9	214	836	23.4	29.8	32.3	214	965
2	6	24.6	30.8	33.3	318	1078	26.2	32.7	35.2	318	1162
1	4	27.4	33.9	36.4	412	1288	30.5	37.0	39.5	412	1422
1/0	4	29.3	35.9	38.4	506	1453	32.3	38.8	42.3	506	1682
2/0	4	31.8	39.1	42.5	620	1767	34.5	41.7	45.1	620	1921
3/0	4	34.3	41.7	45.1	768	1981	37.2	44.4	48.1	768	2169
4/0	4	37.1	44.5	47.9	952	2282	39.9	47.4	50.8	952	2539
250	2	41.3	48.2	51.6	1150	2764	45.2	52.7	56.1	1150	3145
300	2	45.7	53.2	56.7	1361	3473	48.4	55.9	60.1	1361	3628
350	2	48.2	55.1	58.4	1572	3510	50.6	58.1	62.3	1572	3929
400	2	50.3	57.7	61.9	1781	4061	53.1	60.6	64.8	1781	4252
500	1	54.5	62.0	66.2	2233	4720	57.6	65.2	69.4	2233	4957
750	1/0	66.0	73.2	77.4	3318	6390	67.2	74.4	78.6	3318	6498
FOUR CONDUCTOR											
6	8	20.6	26.9	29.4	171	787	22.0	28.5	31.0	171	985
4	6	24.8	31.0	33.5	272	1042	26.3	32.8	35.3	272	1130
2	6	27.7	33.9	36.4	411	1284	29.1	35.6	38.1	411	1366
1	4	31.3	37.8	40.3	530	1560	34.0	40.5	43.9	530	1785
1/0	4	33.1	40.7	44.1	654	1863	35.9	43.1	46.5	654	2041
2/0	4	35.3	42.7	46.1	807	2064	38.2	45.4	48.8	807	2289
3/0	4	37.4	44.9	48.6	1004	2363	41.1	48.3	51.7	1004	2676
4/0	4	42.4	50.2	53.6	1250	3014	45.9	53.4	56.8	1250	3235
250	2	47.1	54.1	58.3	1502	3600	49.9	57.4	61.6	1502	3851
350	2	53.0	60.1	64.3	2065	4435	55.9	63.4	67.6	2065	4696
400	2	55.6	63.0	67.2	2343	4878	58.7	66.2	70.4	2343	5202
500	1	60.3	67.8	72.0	2939	5722	63.7	71.2	75.4	2939	6026
750	1/0	74.3	81.8	86.6	4374	8221	75.8	83.3	88.1	4374	8336

Conversion Factors:

kcmil x 0.5067 = mm^2
mm x 0.0394 = inches
kg/km x 0.6720 = lb/M ft.

INSTALLATION OF ARMOURED CABLES

General considerations of cable installation are addressed in the Application Catalogue. Issues pertaining to the installation of armoured cables are included here, as follows.

Single- vs Multi-Conductor Constructions

General

It is generally accepted that armoured cable installations are more economical than pipe and wire installations, as wire pulling and conduit installation are not required. Armoured cables are readily available in single and multi-conductor constructions. Various aspects should be considered when selecting either type.

While single conductor cables might initially seem more economical, a summary analysis will reveal technical constraints such as voltage drop and installed costs that can substantially reduce any real cost advantages.

Some of these technical concerns are outlined below. For further assistance please contact Alcan Cable.

Cost of Material

Cost analyses show multi-conductors to be more cost effective than single-conductors for many installations. Although single-conductors have higher ampacities, they require proportionally more insulation, armour and jacketing material than a comparable multi-conductor installation.

Cost of Labour

With single-conductors each phase must be installed separately, whereas all phases are installed at once when using multi-conductor cables.

Voltage Drop

In multi-conductor cables, phase conductors (and neutral conductor, where present) are twisted together, for the minimum possible spacing. This geometry leads to the lowest inductive reactance and voltage drop. In single-conductor circuits, phase conductors are laid out in parallel. The extra thickness of the jacket and armour (where present), and the separation required to obtain more favourable free air ratings, lead to greater inductive reactance and voltage drop.

Magnetic Fields and Harmonics

Magnetic fields in harmonic frequencies of ascending order can cause unpredictable effects with sensitive electronic equipment such as computers, and instrumentation. Expensive techniques such as shielding and filtering of power supplies often represent the only corrective solution.

The mutual cancellation effect on magnetic fields of the fundamental (usually 60 hz) frequency is not necessarily extended to fields created by harmonic currents. The magnetic fields having frequencies of the third harmonic, or multiples of the third harmonic, reinforce rather than cancel, and this typically leads to higher magnetic field magnitude in the region surrounding single conductor cables. This effect is greatly diminished in four-conductor constructions where the fields generated by the neutral conductors cancel the fields of the phase conductors.

Harmonics are multiples of the original frequency (60 Hz) and can result from chopping of the waveforms of solid-state devices. Examples of such types of equipment include fluorescent lighting ballasts, dimmers, motor controls, and various other types of industrial control equipment. Odd harmonics (3rd, 5th, 7th, etc.) may cause damaging over-voltages spikes.

Care should also be taken when selecting clamps and connectors. These should be made of non-ferrous materials to avoid overheating from magnetic hysteresis and eddy current losses produced by circulating magnetic fields. Given that third harmonics will amplify these effects, it is especially important to properly balance currents between parallel conductors of the same phase. Balancing third harmonic currents is almost impossible with single conductors. Special consideration should thus be given to multi-conductors, and especially to 4-conductor cable assemblies that can inherently balance harmonic currents.

Installation of Single-Conductor AC90, ACWU90 and TECK90 Cables

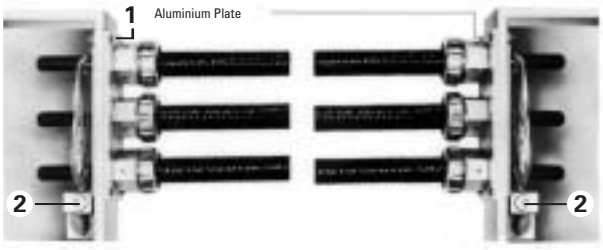
In circuits rated 425 amps and larger it is necessary to isolate the armour from the grounded metal of the enclosure and the armour of the other circuit conductors. Similarly, the armour must be adequately and continuously insulated from grounded metal, such as tray or struts. The most satisfactory way to accomplish this is by means of an outer jacket over the armour. At the remote end of the cable, closest to the point of utilization, armour and bonding conductor will carry a significant potential difference to ground whenever current flows in the central conductor. A spark could be generated if the armour is

grounded through accidental contact with grounded metal. The opening of a sheath circuit that has been accidentally grounded in this manner can produce a spark with considerable energy loss – an unexpected hazard for maintenance crews or non-electrical tradespeople working in the area. Single-conductor circuits in hazardous location are not recommended due to the risk of sparking initiated by standing voltages on the armour.

Circuits rated up to 425 amps inclusive

On any AC system, currents flowing in the centre conductor will induce small currents in the concentrically applied bonding wires and in the interlocked armour.

For circuit ampacities up to and including 425 amps these induced currents do not affect the cable ampacity and may be neglected. We recommend terminating the cables as follows: the bonding wires of all cables entering the equipment enclosure should be bunched and connected to the bonding screw of the terminal (2), the armour of each cable should be attached to the entry plate by means of an approved connector, and the entry plate should be aluminium or some other non-magnetic conducting material (1).

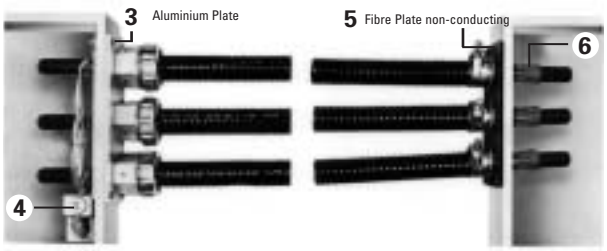


Circuits rated over 425 amps

For single-conductor cables rated over 425 amps, the induced current in the concentric bonding conductor is potentially large and precautions must be taken to eliminate it. It is recommended that the cable at one end, preferably the supply end, enter the panel by means of an aluminium plate (3) and that the bonding wires from each cable be connected together in a common lug and bonded to the metallic enclosure or grounding bus of the equipment (4). At the other end, the cables should enter the panel through a non-conducting plate (5) and the bonding wires cut off as in (6). It may be necessary to run an external bonding conductor to bond the equipment at each end to comply with code rules.

Note 1:
Single-conductor type AC90 cables, in circuits rated over 425 amps and sized according to Table 3, C.E. Code Part I, ampacities are not recommended due to the excessive risk of overheating caused by circulating armour and bonding conductor currents. The PVC jacket is the only practical, effective means of armour isolation from grounded metal parts.

Note 2:
To avoid the heating effect caused by eddy currents, ensure that individual single conductor cables are not surrounded by magnetic material. Avoid the use of steel or iron cable connectors or steel clips on steel supports.



Single- and Multi-Conductors Armoured Cables

The Canadian Electrical Code requires that conductors in vertical raceways be supported independently of the terminal connections and at intervals detailed in Table 21 of the Code (see table below), to prevent the conductors from being pulled out of their connectors by gravity. In practice the conductors must be secured within the enclosure in order to relieve all stress on the connections. Furthermore, the insulation on conductors must not be subject to damage by bends in contact with bushings or other fittings.

In the case of armoured cables, adequate support is mainly achieved by clamping the cable at intervals to ladder type or other type of cable tray, although clamping to the wall of a vertical shaft or service space is frequently practised. Compliance with Code Rule 12-618 requires that a maximum spacing of 1.5m. be maintained between clamps. This applies both horizontally and vertically. When the wiring is concealed, for example in service shafts or spaces where the armoured cables are fished, the spacing between the supports for the conductors in pipe and wire or cables shall not exceed the distances specified in Table 21-C.E. Code Part 1, to prevent the weight of the cable from damaging conductor insulation and to prevent the conductors from being pulled out of equipment terminals. Some authorities having jurisdiction require that vertical installations exceeding 30m in length have a bend or series of bends not less than a total of 90 degrees, in addition to the normal cable supports.

There are several methods available to support and secure conductors in raceways and to support and secure armoured cables. For armoured cables installed vertically, one such method is to deflect the cables horizontally between successive clamps by a distance not less than twice the diameter of the cable, alternating the direction of the offset at successive clamps throughout the run.

When installing cable in vertical runs, pulling the cable from the top of the run rather than the bottom will greatly reduce the pulling tension, and reduce mechanical forces on the armour and jacket accordingly. Braking devices should be used on reels and pay-offs to avoid accelerating speed when pulling from the top. Pulling eyes or grips should transfer the pulling tension to the cable core as much as possible, rather than to the jacket or armour. This will prevent armour movement over the core, or opening of the armour interlocks. The armour and jacket should be stripped back from the core when braided grips (such as Kellems grips) are used, to allow an even distribution of force on the cable components.

To reduce the stress at the higher clamps, and reduce the likelihood of cable slippage through them, circuits should be designed if possible with horizontal sections at the top, rather than at the bottom of the run. Care should be taken not to transfer forces generated at bends to enclosures of electrical equipment or to box clamps.

A variety of clamp designs are available for different securement needs. In vertical applications the clamp design should permit the clamping force to be transferred through the jacket and armour to the underlying core. Clamps having hexagonal head or socket head securing bolts, permitting them to be tightened securely with a wrench, are recommended over those having slotted head bolts or screws. Clamp designs with rubber or other flexible inserts which cushion tightening forces are not recommended, as they diminish the transfer of tightening force to the inner cable core. In the absence of clamp manufacturers' instructions, adequate clamping force can usually be achieved with a deflection of 3-6mm. on the cable surface at the inner face of the clamp. Clamps which distort in shape, or which leave a gap between cable surface and the clamp, when fully tightened at the tightening bolts, should be avoided. Cable ties should not be used in vertical installations when the cable or wire bundle exceeds 15mm.

When single conductor cables are supplied from a low impedance transformer, the short circuit currents may be excessive in the case of a low impedance fault, causing the conductors to fly apart due to extreme magnetic forces. It is recommended that single conductor cables at the supply end be separated with blocks made from rigid materials, such as wood, to restrain the cable movement when significant short circuit forces may be encountered. Note: the impedance of cables beyond the first several meters of a cable installation from the supply end of a transformer will automatically limit the fault current so that short circuit forces are greatly reduced with increasing distance from the transformer. Short circuit forces are reduced in proportion to the square of the cable length from the supply end.

(TABLE 21- C.E. CODE PART I)
Supporting of Conductors in Vertical Runs of Raceways

Conductor Sizes AWG and kcmil	Maximum Distance – Metres
14 to 8	30
6 to 1/0	60
2/0 to 4/0	55
250 to 350	40
Over 350 to 500	35
Over 500 to 750	30
Over 750	25

After the circuit has been loaded in service, it is recommended that a visual inspection of the installation be included in order to observe the vertical movement, if any, of the cables. Evidence of movement may be scratch marks on the jacket or armour below the cable clamps, swelling of the armour or "concertina" effects at the lower end, visible opening of the armour at the upper end, distortion or movement of equipment enclosures, and/or disengaged or broken box clamps. Regular inspections over the life of the cable will diminish the risk of ultimate failure of cables which are inadequately supported.

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