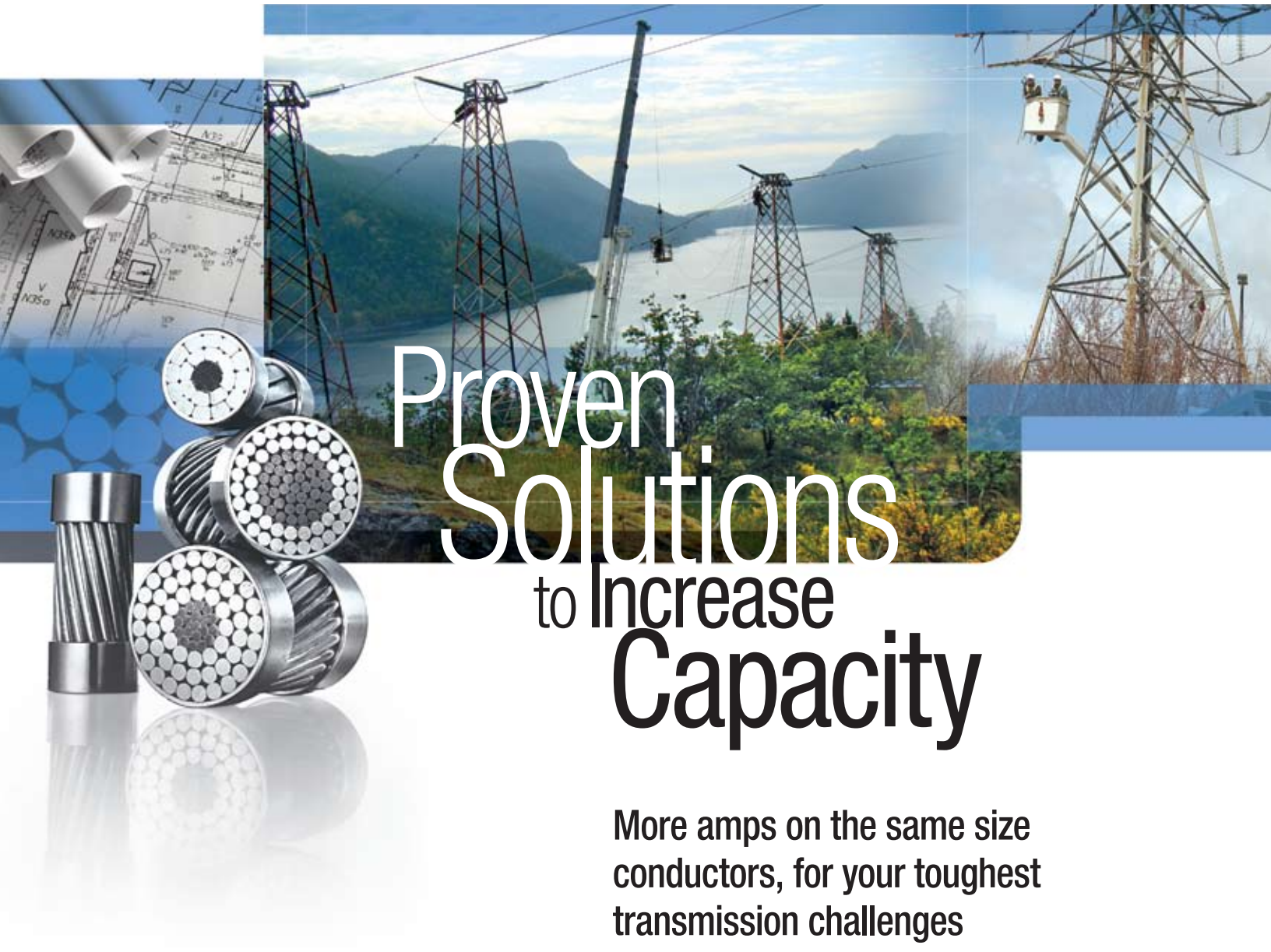
3M™ Aluminum Conductor Composite Reinforced (ACCR)

Technical Summary for Common Constructions and Sizes

Metric Units



Proven Solutions to Increase Capacity

More amps on the same size conductors, for your toughest transmission challenges

3M

3M™ ACCR Round-wire Specifications

The strong, lightweight, high capacity conductor

3M Aluminum Conductor Composite Reinforced (ACCR) is an all-aluminum-based conductor designed as a drop-in replacement for ACSR and ACSS. Its properties enable transmission capacity increases, up to twice as much or more, on existing structures, while matching or improving tensions and clearances.

The round-wire construction is composed of a multi-strand, aluminum-matrix core surrounded by aluminum-zirconium outer wires that are round in shape.

Round-wire, the most commonly used transmission conductor construction, frequently offers the largest capacity increase because of its low weight, allowing it to operate at high temperatures with less sag than steel core conductors and other types of construction, such as trapwire or compact conductors.

Physical Properties	Unit	Ostrich 300	Linnet 336	Ibis 397	Hawk 477	Dove 557
Designation		ACCR_297-T16	ACCR_340-T16	ACCR_405-T16	ACCR_470-T16	ACCR_573-T16
Stranding		26/7	26/7	26/7	26/7	26/7
Diameter						
Individual Core Wire	mm	2.1	2.3	2.5	2.7	2.9
Individual Al Wire	mm	2.7	2.9	3.2	3.4	3.8
Total Core	mm	6.3	6.8	7.4	8.0	8.8
Total Conductor	mm	17.2	18.4	20.1	21.6	23.9
Area						
Aluminum	mm^2	150	172	205	238	291
Total Area	mm^2	175	200	239	277	338
Weight						
Core	N/m	0.838	0.957	1.139	1.319	1.604
Aluminum	N/m	4.079	4.668	5.569	6.462	7.879
Total Weight	N/m	4.916	5.625	6.707	7.781	9.483
Strength	N	53,823	61,830	73,396	85,406	102,754
Thermal Elongation						
Core	10^{-6}/°C	6.3	6.3	6.3	6.3	6.3
Aluminum	10^{-6}/°C	23.0	23.0	23.0	23.0	23.0
Complete Cable	10^{-6}/°C	16.7	16.7	16.7	16.7	16.7
Heat Capacity						
Core	W-sec/m-°C	28	32	38	44	53
Aluminum	W-sec/m-°C	398	455	542	629	767

Electrical Properties						
Resistance						
DC @ 20°C	ohms/km	0.1826	0.1596	0.1338	0.1153	0.0945
AC @ 25°C	ohms/km	0.1870	0.1634	0.1369	0.1180	0.0968
AC @ 50°C	ohms/km	0.2055	0.1795	0.1505	0.1297	0.1064
AC @ 75°C	ohms/km	0.2240	0.1957	0.1640	0.1414	0.1159
AC @ 100°C	ohms/km	0.2425	0.2119	0.1776	0.1530	0.1255
AC @ 210°C	ohms/km	0.3239	0.2830	0.2373	0.2045	0.1677
AC @ 240°C*	ohms/km	0.3461	0.3024	0.2535	0.2185	0.1792
Geometric Mean Radius	mm	6.97	7.46	8.15	8.78	9.69
Reactance (0.315 m spacing, 60hz)						
Inductive Xa	ohms/km	0.2848	0.2797	0.2731	0.2675	0.2600
Capacitive X'a	Mohms-km	0.1704	0.1671	0.1629	0.1594	0.1546
Ampacity						
210° C	amps	863	942	1,059	1,168	1,332
240° C*	amps	944	1,011	1,136	1,254	1,431

To learn more about 3M ACCR, or to download the PLS-CADD™ data files, visit us at www.3M.com/ACCR

* Emergency operating temperature, 1,000 hours cumulative over the life of the conductor. Ampacity ratings were calculated using IEEE Std. 738-1993, with inputs of 40°C air temperature, 0.6 m/s wind, and emissivity and absorptivity of 0.5, at sea level.

Grosbeak 636	Drake 795	Cardinal 954	Curlew 1033	Finch 1113	Pheasant 1272	Martin 1351	Falcon 1590
ACCR_637-T16	ACCR_824-T16	ACCR_967-T13	ACCR_1036-T13	ACCR_1117-T13	ACCR_1267-T13	ACCR_1334-T13	ACCR_1594-T13
26/7	26/19	54/19	54/19	54/19	54/19	54/19	54/19
1.9	2.1	2.0	2.1	2.2	2.3	2.4	2.6
4.0	4.5	3.4	3.5	3.7	3.9	4.0	4.4
9.4	10.6	10.2	10.6	11.0	11.7	12.0	13.1
25.5	28.6	30.6	31.7	32.9	35.0	35.9	39.3
332	418	490	525	566	642	676	808
385	484	552	591	638	723	761	910
1.790	2.246	2.099	2.246	2.421	2.742	2.886	3.444
9.008	11.330	13.356	14.304	15.427	17.494	18.420	22.018
10.799	13.576	15.455	16.550	17.848	20.236	21.305	25.462
113,874	143,233	147,681	158,357	170,812	191,273	201,504	238,425
6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
16.5	16.5	17.1	17.1	17.1	17.1	17.1	17.1
59	75	70	75	81	92	97	115
877	1,102	1,299	1,391	1,500	1,700	1,790	2,139

0.0828	0.0658	0.0572	0.0534	0.0495	0.0436	0.0414	0.0347
0.0848	0.0674	0.0585	0.0546	0.0507	0.0447	0.0424	0.0355
0.0932	0.0741	0.0643	0.0600	0.0557	0.0491	0.0466	0.0390
0.1016	0.0808	0.0701	0.0655	0.0607	0.0535	0.0508	0.0425
0.1100	0.0874	0.0759	0.0709	0.0657	0.0579	0.0550	0.0460
0.1469	0.1168	0.1014	0.0947	0.0878	0.0774	0.0735	0.0615
0.1570	0.1248	0.1083	0.1012	0.0938	0.0827	0.0786	0.0657
9.42	10.56	11.35	11.75	12.20	12.99	13.33	14.58
0.2622	0.2535	0.2481	0.2455	0.2426	0.2379	0.2360	0.2292
0.1514	0.1460	0.1428	0.1412	0.1394	0.1364	0.1352	0.1309
1,453	1,692	1,857	1,943	2,041	2,222	2,299	2,590
1,562	1,820	1,999	2,092	2,199	2,395	2,479	2,795

For a complete library of lab and field tests, organized by both conductor size and test subject, visit our website: www.3M.com/ACCR

Conformance to National Standards

All materials shall conform to the applicable American National Standards Institute (ANSI) C119.4; American Society for Testing and Materials (ASTM) Standards B193, B557, B941; or International Annealed Copper Standard (IACS).

3M™ ACCR Trapwire Specifications

Higher conductivity in higher amp applications

3M brings its reputation for reliability to trapwire conductors

3M offers a full line of trapwire, or compact, conductors with diameters comparable to standard conductors.

Trapwire designs replace the round outer wires of the conductor with trapezoidal-shaped wires, in order to maximize the amount of current-carrying aluminum within the same total diameter. The result is an increase in conductivity that may reduce resistive losses on the line. Work with your 3M representative to choose the best solution for your application, considering your capacity needs and the characteristics of your specific project.

Conductor Physical Properties		Hawk 477TW	Calumet	Oswego	Wabash
Diameter Equivalent Round-wire	**Unit**		**Hawk**	**Dove**	**Grosbeak**
Designation		ACCR-TW_477-T16	ACCR-TW_565-T16	ACCR-TW_665-T16	ACCR-TW_763-T16
Stranding		18/7	20/7	20/19	20/19
Diameter					
Individual Core	mm	2.7	2.9	1.9	2.0
Individual Aluminum	mm	NA	NA	NA	NA
Core	mm	8.0	8.6	9.4	10.2
Total Conductor Diameter	mm	20.0	21.8	23.6	25.2
Area					
Aluminum	mm^2	242	286	337	387
Total Area	mm^2	281	332	390	449
Weight					
Core	N/m	1.319	1.550	1.790	2.099
Aluminum	N/m	6.533	7.738	9.107	10.449
Total Weight	N/m	7.851	9.287	10.898	12.548
Strength	N	85,148	100,306	115,017	133,295
Thermal Elongation					
Core	10^{-6}/°C	6.3	6.3	6.3	6.3
Aluminum	10^{-6}/°C	23.0	23.0	23.0	23.0
Complete Cable	10^{-6}/°C	16.8	16.8	16.5	16.4
Heat Capacity					
Core	W-sec/m-°C	44	51	59	70
Aluminum	W-sec/m-°C	636	754	887	1,017
Conductor Electrical Properties					
Resistance					
DC @ 20°C	ohms/km	0.1134	0.0958	0.0814	0.0709
AC @ 25°C	ohms/km	0.1161	0.0980	0.0834	0.0726
AC @ 50°C	ohms/km	0.1276	0.1077	0.0916	0.0797
AC @ 75°C	ohms/km	0.1391	0.1174	0.0999	0.0869
AC @ 100°C	ohms/km	0.1505	0.1271	0.1081	0.0941
AC @ 210°C	ohms/km	0.2011	0.1699	0.1445	0.1257
AC @ 240°C*	ohms/km	0.2149	0.1815	0.1544	0.1343
Geometric Mean Radius	mm	8.16	8.83	9.58	10.25
Reactance (1 ft spacing, 60hz)					
Inductive Xa	ohms/km	0.2730	0.2671	0.2608	0.2558
Capacitive X'a	Mohms-km	0.1630	0.1590	0.1551	0.1520
Ampacity					
210°C	amps	1,148	1,284	1,427	1,564
240°C	amps	1,232	1,378	1,533	1,681

To learn more about 3M ACCR, or to download the PLS-CADD™ data files, visit us at www.3M.com/ACCR

Because the trapezoidal shape of the outer wires incorporates more aluminum, the weight and sag may increase slightly compared to diameter-equivalent round wire designs. Your 3M representative can help you choose the optimal combination of conductor properties for your application.

* Emergency operating temperature, 1,000 hours cumulative over the life of the conductor. Ampacity ratings were calculated using IEEE Std. 738-1993, with inputs of 40°C air temperature, 0.6 m/s wind, and emissivity and absorptivity of 0.5, at sea level.

Suwanee	Curlew 1033 TW	Hudson	Rio Grande	Pecos	Cumberland
Drake		Cardinal	Pheasant	Martin	Falcon
ACCR-TW_958-T16	ACCR-TW_1033-T13	ACCR-TW_1158-T13	ACCR-TW_1533-T13	ACCR-TW_1622-T13	ACCR-TW_1927-T13
22/19	22/19	25/19	39/19	39/19	39/19
2.3	2.1	2.3	2.6	2.7	2.9
NA	NA	NA	NA	NA	NA
11.3	10.6	11.3	12.9	13.3	14.4
28.1	28.8	30.5	35.1	36.0	39.2
486	523	587	777	822	976
562	590	663	876	927	1100
2.568	2.246	2.568	3.352	3.545	4.168
13.126	14.147	15.859	21.118	22.344	26.545
15.693	16.393	18.426	24.470	25.889	30.714
164,947	158,706	179,658	233,600	247,420	291,555
6.3	6.3	6.3	6.3	6.3	6.3
23.0	23.0	23.0	23.0	23.0	23.0
16.5	17.3	17.3	17.1	17.1	17.1
85	74	85	112	119	140
1,277	1,377	1,543	2,053	2,172	2,580

0.0565	0.0531	0.0473	0.0360	0.0340	0.0286
0.0579	0.0544	0.0484	0.0368	0.0348	0.0293
0.0636	0.0597	0.0532	0.0405	0.0382	0.0322
0.0693	0.0651	0.0580	0.0441	0.0417	0.0351
0.0750	0.0705	0.0628	0.0477	0.0451	0.0380
0.1003	0.0942	0.0839	0.0638	0.0603	0.0508
0.1071	0.1006	0.0897	0.0681	0.0644	0.0542
11.37	11.43	12.08	13.92	14.29	15.55
0.2479	0.2476	0.2434	0.2327	0.2307	0.2243
0.1468	0.1458	0.1429	0.1363	0.1351	0.1310
1,813	1,885	2,035	2,444	2,537	2,847
1,951	2,029	2,191	2,634	2,736	3,072

Conformance to National Standards

All materials shall conform to the applicable American Society for Testing and Materials (ASTM) Standards B193, B557, B941; or International Annealed Copper Standard (IACS).

Physical Characteristics

3M™ Aluminum Conductor Composite Reinforced (ACCR) is a transmission conductor designed to significantly increase capacity on existing structures, even in challenging situations and environments.

Core Strands

The core strands are composed of wires formed from aluminum oxide fibers embedded in high-purity aluminum. This type of material is called a fiber reinforced metal matrix. It contains NO polymers or plastic. The properties that give the conductor its advantages are conferred by the core. The key advantages of the ACCR core, compared to conventional steel cores used in ACSR and ACSS, are its:

- Higher strength to weight ratio and
- Lower thermal expansion

These two properties result in lower sag at higher operating temperatures, enabling higher ampacities at equivalent tensions and clearances.

Core Property Comparison: ACCR vs. ACSR/ACSS

Conductor Core Material	ACCR Aluminum Matrix	ACSR/ACSS Steel
Strength (MPa)	1,378	1,275
Density (g/cm^3)	3.29	7.8
Strength/Density	419	163
Coefficient of Thermal Expansion ($10^{-6}/°C$)	6.3	12.1

Some of the secondary properties of the core are also favorable. These include low creep, higher electrical conductivity (from the aluminum constituent), durability and longevity equivalent to ACSR, and corrosion resistance without coatings or barriers, (similar to all-aluminum conductors).

Aluminum Strands

The aluminum strands are composed of an aluminum-zirconium alloy. They are available in both round and trapezoidal shapes. The minimum conductivity of any individual aluminum strand is not less than 60 percent of the International Annealed Copper Standard (IACS).

The aluminum-zirconium strands are a hard drawn aluminum with mechanical properties very similar to 1350-H19 aluminum (23-25 ksi, 158-172 MPa) ultimate tensile strength. This is NOT a soft annealed aluminum. The addition of a small amount of zirconium to the aluminum confers the property of heat resistance. That is, the aluminum-zirconium may be heated to high temperatures without softening (annealing). Thus when the aluminum-zirconium cools to ambient temperatures, it retains its strength.

Conductor Stranding

3M ACCR uses constructions that are very similar to ACSR. It uses most of the same dimensions for wire sizes and conductor sizes. Aluminum-zirconium layers are helically stranded using the same lay lengths and lay directions as ACSR. The core wires are also helically stranded. Both the core and outer strands contribute to the strength and conductivity of the conductor.

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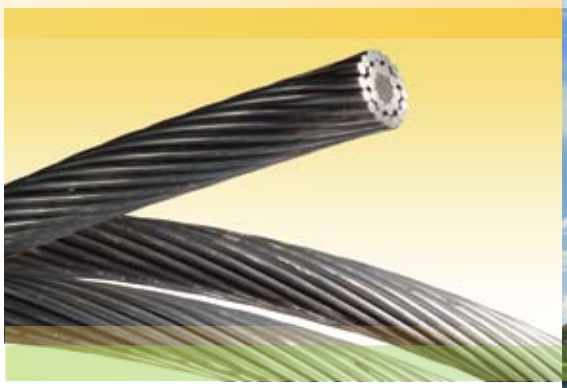

More amps on existing structures

Technical Support

Finding the right solution can require knowledgeable support. Our experienced technical team, with their proven record of successful solutions, can help you with:

- Balancing capacity, efficiency, mechanical load, clearance, economic and environmental objectives to find the best solution;
- Evaluating line characteristics to define the right mix of conductor and accessories;
- Providing you with data and information on the phone, through e-mail or on-site;
- Assisting you to compare options in PLS-CADD™, SAG10™ and other design software;
- Supporting your installation crew with training and consultation throughout the process.

All to provide you the most value from your upgrade and ensure a successful project.

Contact our technical team by calling your local 3M office or e-mailing accr@mmm.com, or visit www.3M.com/accr for more information.

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