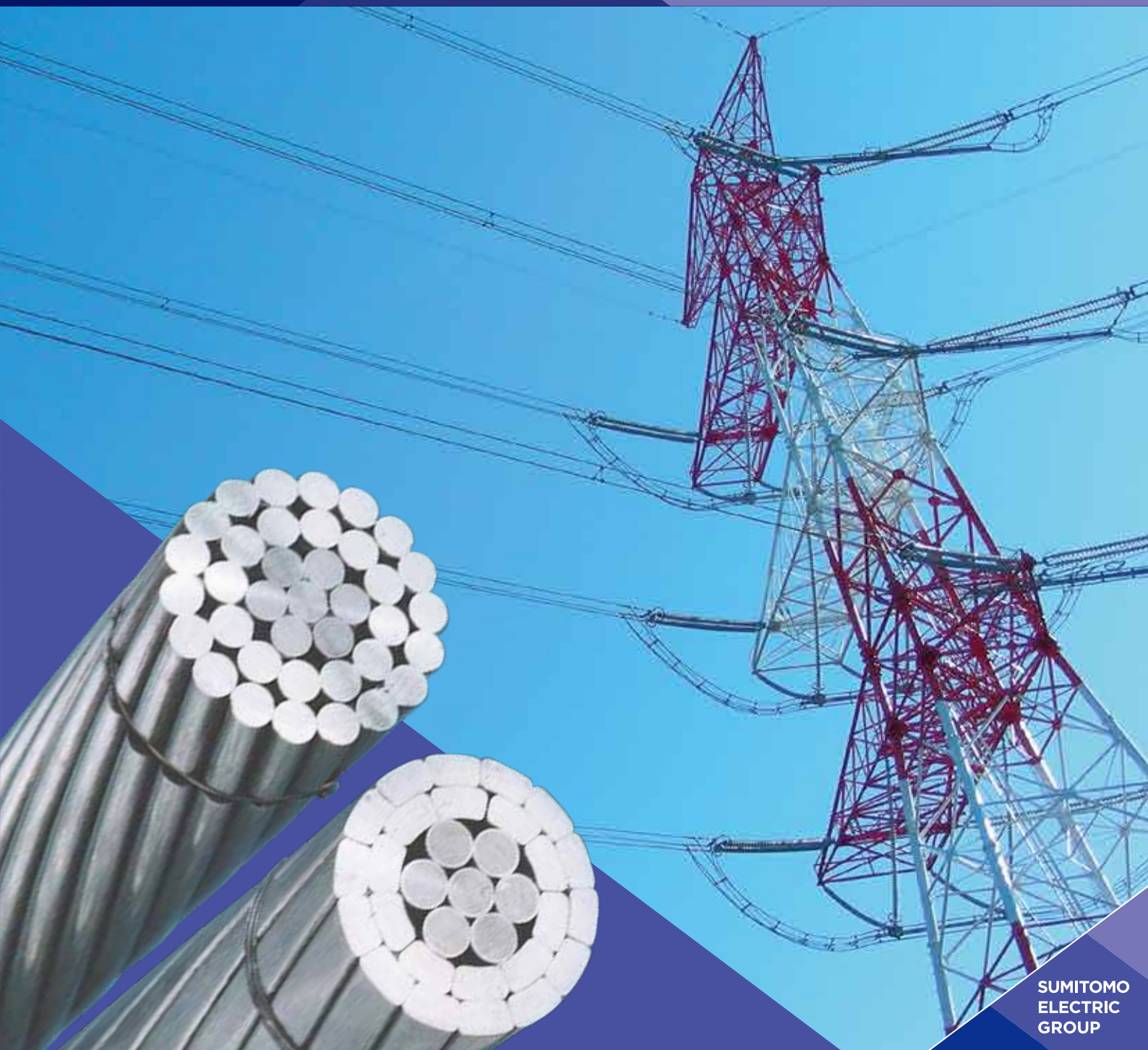
住友電工

Invar Core Conductor

ZTACIR/AS

Super thermal-resistant aluminum alloy conductor Al-clad invar reinforced



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Sumitomo Electric is the pioneer of invar core conductor. We developed invar core conductor in 1981 and have then supplied more than 8,500km of invar core conductors to worldwide customers (as of July 2016).

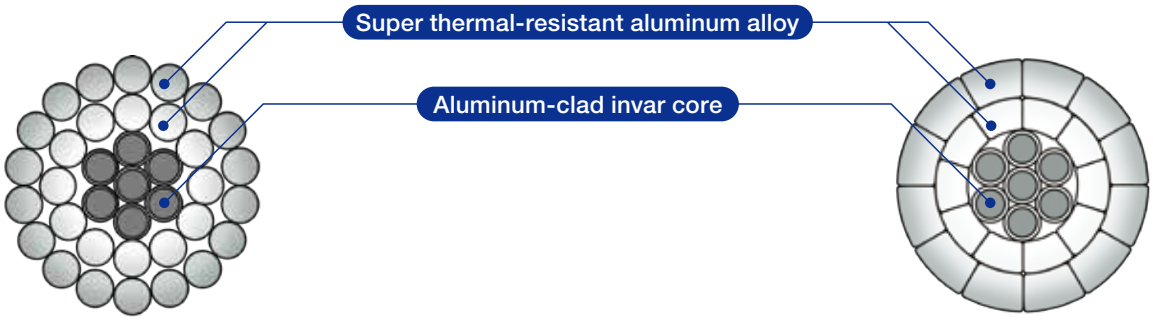
Invar core conductor, ZTACIR/AS, is a kind of High Temperature Low Sag conductors. The combination of Super thermal-resistant aluminum alloy (ZTAl) and Aluminum-clad invar (AS invar) offers excellent sag control and current-carrying capacity characteristics. With this advantage, ZTACIR/AS is useful to up-rate existing transmission lines by simply replacing existing conductor with Invar core conductor.

Advantage

- Double the current-carrying capacity for the same size conductor
- No modification or reinforcement required for existing towers
- Short construction period
- Same installation & maintenance procedure as conventional ACSR

Construction

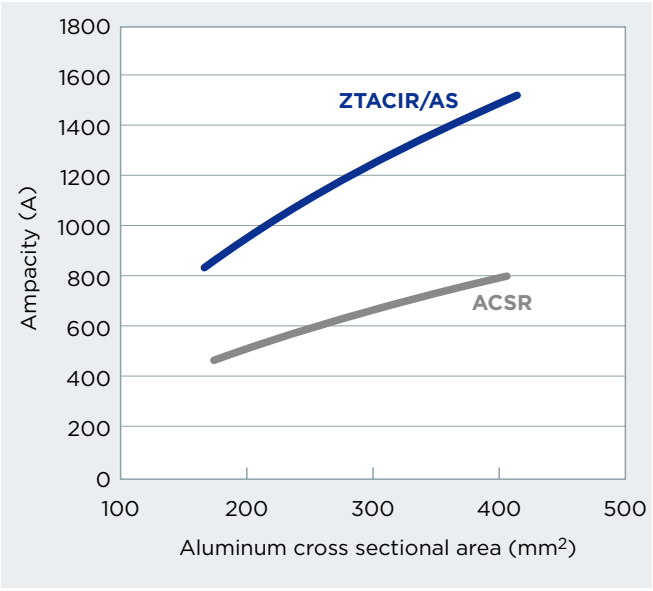
Aluminum-clad invar (AS invar) core is in center and Super thermal-resistant aluminum alloy (ZTAl) wires are stranded concentrically over AS invar core.
Trapezoid aluminum wires are applicable to reduce conductor diameter.



Feature

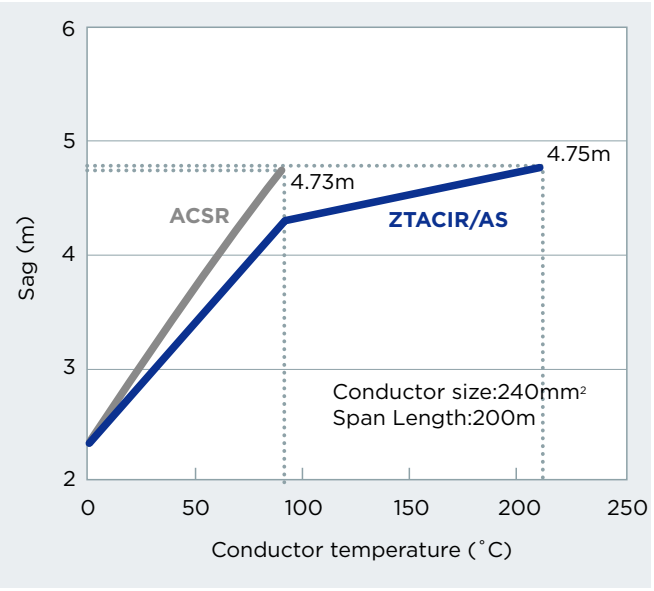
Current capacity

ZTACIR/AS can carry 2.0 times higher current than equivalent size ACSR.



Sag

ZTACIR/AS maintains almost the same sag (= Ground clearance) as equivalent size ACSR in high temperature condition.



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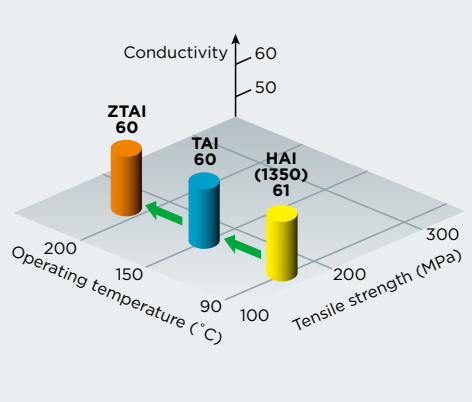
Super thermal-resistant aluminum alloy conductor Al-clad invar reinforced

Super thermal-resistant aluminum alloy [ZTAl]

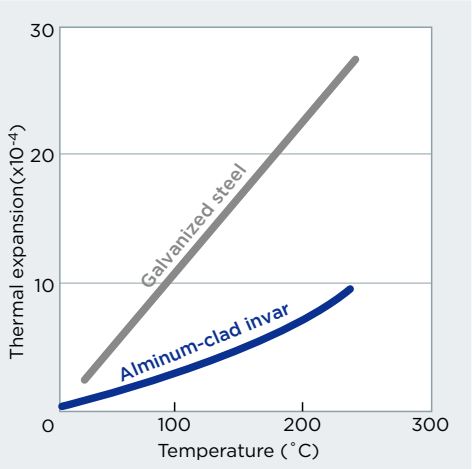


Super thermal-resistant aluminum alloy (ZTAl) improves its thermal-resistant characteristic by adding zirconium. ZTAl can keep its tensile strength in high temperature condition. ZTAl can withstand up to 210˚C and carry 2.0 times current of Hard drawn aluminum (1350). ZTAl maintains nearly the same mechanical and electrical characteristics as Hard drawn aluminum (1350).

Material	Tensile strength (MPa)	Elongation (%)	Conductivity (%)	Continuous operating temp. (˚C)	Current capacity (times)
HAl (1350)	Min. 162	Min. 1.7	Min. 61	Max. 90	1.0
ZTAl	Min. 162	Min. 1.7	Min. 60	Max. 210	2.0

(ϕ3.2mm)

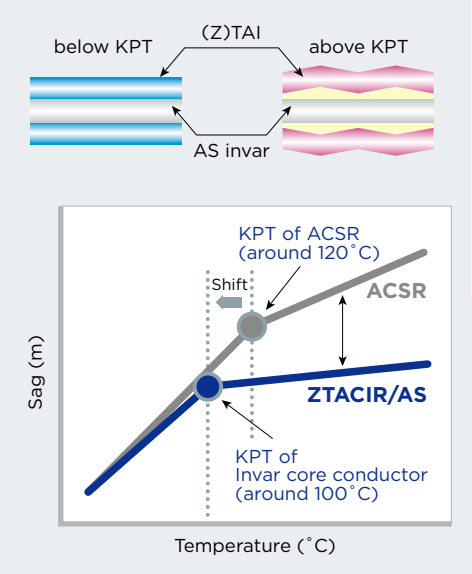
Aluminum-clad invar [AS invar]



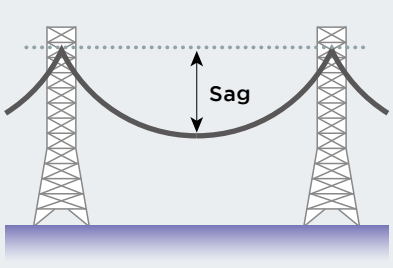
Invar is Fe-36%Ni alloy. “Invar” is an abbreviation of invariable.
That means invar alloy length is invariable against temperature change.
Thermal expansion coefficient of AS Invar is 3.7 x 10^{-6}/˚C(below 230˚C), which is one third of steel's and one sixth of aluminum's.
AS invar adopts aluminum cladding for coating. AS invar withstands high temperature condition and offers better anti-corrosion characteristic.

Material	Coefficient of thermal expansion (/˚C)	Modulus of elasticity (GPa)	Tensile strength [T] (MPa)	Density [D] (g/cm^3)	[T/D]
Steel	11.5x10^{-6} (100)	205.9	1270 (100)	7.8 (100)	163 (100)
AS invar	3.7x10^{-6} (32) [below 230˚C)]	152.0	1080 (85)	7.1 (91)	152 (93)

Principal behind small sag



Due to big difference of thermal expansion between AS invar (3.7x10^{-6}/˚C) and aluminum (23x10^{-6}/˚C), the tension in aluminum layer decreases according to temperature rise.
At knee point temperature (KPT), whole tension transfers to AS invar core and aluminum layer become tension free.
Above KPT, the thermal expansion of AS invar core controls the sag of invar core conductor.
As the thermal expansion of AS invar core is very small, the sag increasing slope goes down considerably.



Thermal expansion coefficient(/˚C)

ACSR		19-20x10^{-6}
Invar core conductor	(below KPT)	17-18x10^{-6}
	(above KPT)	3.7x10^{-6}
Aluminum		23x10^{-6}

Accessories

Compression fittings for Invar core conductor are designed larger than those for conventional ACSR to maintain the same current density and achieve better heat radiation.
Other accessories are basically the same as conventional ACSR.

Installation & Maintenance

Installation and maintenance procedures of Invar core conductor are exactly the same as those of conventional ACSR.

Design

Invar core conductor can be designed to have the same mechanical and electrical characteristics as existing ACSR. Design examples of ZTACIR/AS are shown in below table. Custom-made is available for replacing existing ACSR of each customer.

Size		mm^2	160	240	330	410
Equivalent conductor			Linnet	Lion	Grosbeak	Drake
Stranding	ZTAI	No./mm	30/2.6	30/3.2	26/4.0	26/4.5
	AS invar		7/2.6	7/3.2	7/3.1	7/3.5
Rated Tensile Strength		kN	60.3	89.9	98.1	124.6
Diameter	Conductor	mm	18.2	22.4	25.3	28.5
	AS invar		7.8	9.6	9.3	10.5
Cross sectional area	Aluminum	mm^2	159.3	241.3	326.8	413.4
	AS invar		37.16	56.29	52.84	67.35
	Total		196.5	297.6	379.6	480.8
Weight		kg/km	706.7	1071	1282	1626
D.C.Resistance at 20˚C		Ω/km	0.175	0.116	0.0871	0.0688
Current carrying capacity[*1] (at 210˚C)		A	841	1102	1322	1545
Modulus of elasticity	Conductor	GPa	78.9	78.9	74.4	74.4
	AS invar		152	152	152	152
Coefficient of linear expansion	Conductor	10^{-6}/˚C	16	16	17.5	16
	AS invar		3.7	3.7	3.7	3.7

*1 Ampacity calculation conditions
Ambient temperature:40 degree C, Wind:0.5m/s, Wind direction:45 degree,
Solar radiation:0.1W/cm^2, Absorptivity & Emissivity of conductor surface:0.5

Supply record

Invar core conductor was developed more than 30 years ago and has been supplied more than 8,500km (as of July 2016).

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