P R O D U C T D A T A B U L L E T I N

Hot Dip Galvannealed STEELS

AK Steel

AK Steel's Hot Dip Galvannealed Steels, called ZINCGRIP® GA, are continuously coated on both sides with a zinc-iron alloy. Galvannealed steels are a specialized variation of galvanized steels where induction heating is used to alloy the zinc coating with the steel to create a zinc-iron coating. The hot dip process, pioneered by AK Steel, provides a tight metallurgical bond between the steel and coating. This process results in a material with the strength and formability of steel plus the corrosion protection of the zinc-iron coating. Zinc protects the base metal by providing a barrier to corrosive elements and also by the sacrificial nature of the coating.

ZINCGRIP GA is available with special surface finishes, tailored for specific applications, and in a variety of base metal grades and coating weights. ZINCGRIP GA is widely used in many applications in automotive and general manufacturing.

PRODUCT FEATURES

- **Corrosion Resistance**

  Zinc protects the base metal by providing a barrier to corrosive elements and also by the sacrificial nature of the coating. Ultimate service life depends on coating thickness and the severity of the environment.

- **Excellent Surface Appearance**

  ZINCGRIP GA is available as "Extra Smooth" or "ULTRASMOOTH" for the most demanding surface critical applications.

- **Formability**

  ZINCGRIP GA can be used to produce parts containing simple bends to parts with extreme deep drawing requirements.

- **Paintability**

  ZINCGRIP GA is readily paintable provided proper pre-treatment is performed.

- **Weldability**

  ZINCGRIP GA can be joined using a variety of accepted welding practices. Its spot weldability is improved over free zinc coatings.

COATING CHARACTERISTICS

The hot dip coating process assures a tightly adherent, uniform coating of zinc on both sides of the product. The strip passes through an induction furnace after the coating pot to allow the iron from the base metal to further diffuse into the zinc creating a zinc-iron alloy layer on both surfaces. The coating is nominally 8-13% iron. Precise temperature control provides sufficient ductility in the coating to readily permit normal fabrication practices without incurring significant coating damage or powdering.

ZINCGRIP GA has a dull gray, porous surface with no spangle which provides a good base for painting. For best results, the surface should be carefully cleaned with an alkaline cleaner, however in some cases, cleaning by a solvent may be acceptable. Cleaning should be followed by a pre-treatment prior to painting.

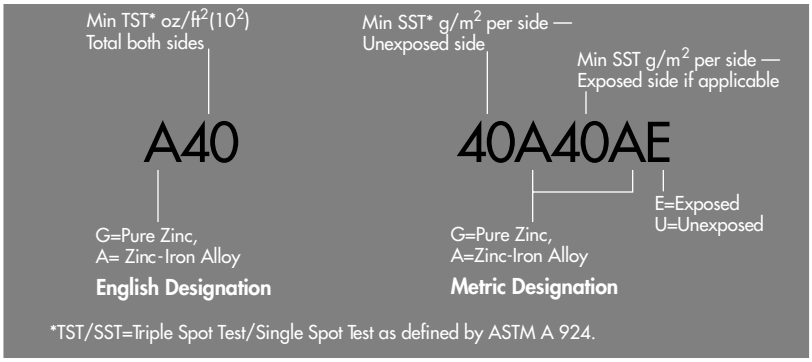
ZINCGRIP GA coatings are specified in several coating weight categories as shown in Table 1. Please note that coatings can be specified using metric or English units. A schematic of the coating cross section is shown in Figure 1. The differences in designation are explained by the diagram in Figure 2.

TABLE 1 – COATING WEIGHT

Coating Designation	Coating Weight Minimum (Inch-Pound) oz/ft^2	Coating Weight Minimum (SI) g/m^2
Triple Spot Designation (Total Both Sides)		
A01	No Min.	No Min.
A20	0.20	61
A30	0.30	92
A40	0.40	122
A50	0.50	153
A60	0.60	183
Single Spot Designation (Single Sides)		
45A/45A	.15/.15	45/45
60A/60A	.20/.20	60/60

FIGURE 1 – COATING CROSS SECTION

FIGURE 2 – COATING DESIGNATION



SURFACE PROTECTION AND LUBRICATION

To prevent rusting in transit and storage, ZINCGRIP GA Steels should be coated with a protective oil. This will be applied as a combination of a mineral oil and rust preventative (two viscosities can be supplied). In some cases, a preapplied press forming lubricant can be supplied which provides uniform lubrication and eliminates housekeeping problems associated with at-press lubrication. A mill-applied phosphate coating is also available for difficult-to-form applications.

FORMABILITY AND MECHANICAL PROPERTIES

The formability of all steel products is a result of the interaction of many variables, the main ones being the mechanical properties of the steel, the forming system (tooling) used to manufacture parts, and the lubrication used during forming. Of these three, AK Steel can only directly affect the mechanical properties of the steel. Tight control over chemical composition, hot rolling parameters, amount of cold reduction, in-line annealing time and temperature, and the amount of additional processing allow the production of high quality ZINCGRIP GA Steels to meet customers' requirements.

Commercial Steel CS Type B should be used for moderate forming or bending applications. CS Type B products are produced from aluminum-killed continuously cast slabs and have a carbon content of .02 to 0.15%. To prevent the occurrence of fluting or stretcher strains during forming CS products must be ordered as "tempered."

For more severe forming applications, Deep Drawing Steel (DDS), should be ordered. DDS has a controlled carbon content (<0.06%) and is produced in such a manner that parts formed from DDS steel should not exhibit stretcher strain.

Extra Deep Drawing Steel (EDDS) or Extra Deep Drawing Steel Plus (EDDS+) should be ordered for the most demanding forming applications. These steels (also known as Interstitial Free or I-F® steels) are produced from vacuum degassed (<0.010%C), stabilized grades. EDDS+ has the lowest carbon content available and has been specially formulated to be AK Steel's most ductile product.

Typical mechanical properties are shown in Table 2, Page 4. The n-value, i.e. strain hardening exponent, has been shown to correlate with stretch forming behavior, while the r-value, r_m, is a measure of deep-drawing capability.

TABLE 2 – TYPICAL MECHANICAL PROPERTIES – STANDARD GRADES

Quality Designation	Description	Avg. YS ksi	Avg. YS MPa	Avg. UTS ksi	Avg. UTS MPa	Min. Elong. %	"n"	"r_m"
Commercial Steel Type B (CS Type B)	May be moderately formed. A specimen cut in any direction can be bent flat on itself without cracking	42	290	48	331	32	–	–
Deep Drawing Steel (DDS)	DDS may be used in drawing applications	26	179	46	317	40	.23	1.5
Extra Deep Drawing Steel (EDDS)	Interstitial Free (I-F) steels are made by adding titanium and/or columbium to the molten steel after degassing and offer excellent drawability	24	165	45	310	42	.23	1.6
Extra Deep Drawing Steel Plus (EDDS+)		22	152	44	303	44	.24	1.7

.0275 - .035 inches sheet thickness

Typical properties produced by AK Steel for these grades.

Commercial Steel, Deep Drawing Steel, and Extra Deep Drawing Steel are designations of the various steels described in the ASTM specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process A 653/A 653M. Each of these steel designations is associated with unique requirements for chemical composition and with non-mandatory, typical mechanical properties. All properties are tested per ASTM A 370.

TABLE 3 – TYPICAL MECHANICAL PROPERTIES – HIGHER STRENGTH GRADES

Quality Designation	Description	YS ksi	YS MPa	UTS ksi	UTS MPa	Elong. %	"n"	"r_m"
Bake Hardenable (BH 180)	Bake Hardenable steels offer good formability and an increase in strength after paint bake.	29	200	48	331	42	.21	1.6
Bake Hardenable (BH 210)	Bake Hardenable steels offer good formability and an increase in strength after paint bake.	34	234	52	359	35	.20	1.6
Dent Resistant 180 (DR 180)	Compared to DS Type B, DR steels have a higher initial YS which contributes to increased strength after forming.	29	200	54	372	35	.22	1.8

SPECIFICATIONS

ZINCGRIP GA Steels are produced in conformance to the following specifications:

ASTM A 653 Base metal chemistry, grades and coatings
ASTM A 924 General requirements and tolerances

For any specification not listed here, please consult your AK Steel Sales or Technical Representative.

ENGINEERING PROPERTIES

TABLE 4

Young's Modulus of Elasticity	200 x 10^6 MPa at 20°C
Density	7.87 g/cm^3 at 20°C
Coefficient of Thermal Expansion	Low-Carbon/HSLA: 12.4 µm/m/°C in 20°C to 100°C range I-F Steel: 12.9 µm/m/°C in 20°C to 100°C range
Thermal Conductivity	Low-Carbon/HSLA: 89 W/m°C at 20°C I-F Steel: 93 W/m°C at 20°C
Specific Heat	481 J/kg/°C in 50°C to 100°C range
Electrical Resistivity	0.142 µΩm at 20°C

OUTSIDE PROCESSING

Tailored blanks, tension leveling, re-squaring, slitting, cutting-to-length, and coil coating are just some of the services AK Steel can provide through arrangements with outside processors.

MORE INFORMATION/TECHNICAL ASSISTANCE

AK Steel's Technical Representatives can provide you with more detailed information concerning this product. They also are available to assist you in solving any welding, forming, painting, or other material selection issue.

MILL LIMITS

ZINCGRIP GA Steels are generally available in thicknesses from 0.018" (0.46 mm) to 0.080" (2.03 mm), and widths up to 80" (2032 mm) depending on thickness. See Table 3. For sizes outside these limits, please inquire.

The standard inner diameter of our coils is 24 in. (609 mm).

AK Steel

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