Steel

Higher-strength IF steels HX

Product information

thyssenkrupp

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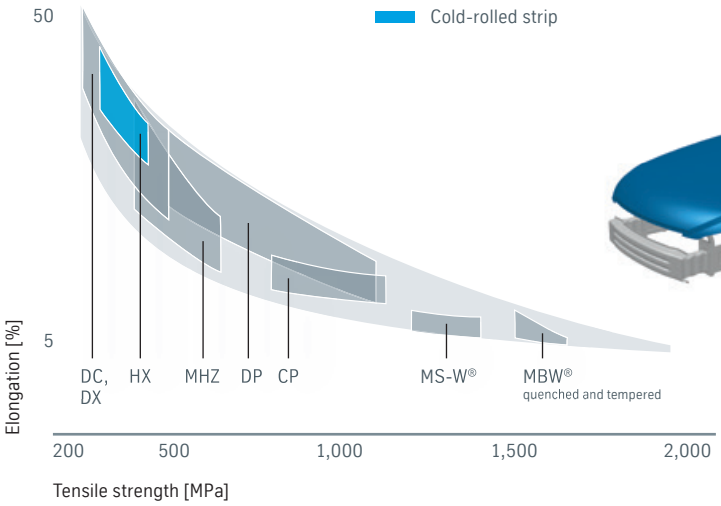
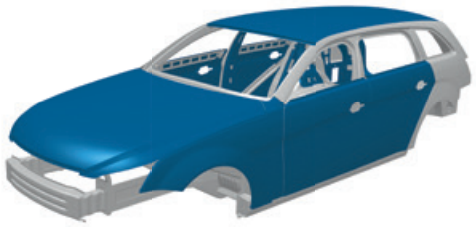
Overview of steel grades



Recommended applications



Content

Areas of application

For deep-drawn parts with very complex geometries, thyssenkrupp offers cold-rolled, higher-strength IF steels. Carbon and nitrogen, the interstitial elements which are usually present in these steels, are completely bound. With their simultaneously high r and n values, they are particularly suitable for a combination of stretch forming and deep drawing. The desired level of strength is achieved with solid solution solution hardening elements, i.e., phosphorus, silicon and manganese.

Higher-strength IF steels are ideal for the production of complex parts with very strict formability and strength requirements, for example for, door inner panels, wheel arches, side panels, spare wheel wells, floor panels and tunnel panels. Higher-strength IF steel by thyssenkrupp is resistant to aging and suitable for all common welding processes due to the complete binding of carbon and nitrogen. Higher-strength IF steel by thyssenkrupp is available on request for long-term corrosion protection and optimum processing in various high-quality surface finishes.

Steel grade designations and surface refinements

	DIN EN 10152, 10268, 10346	Surface refinements					
		UC	EG	GI	GA	ZM	AS
To DIN EN							
Steel grade	Standard designation						
● HX 160	Special mill grade/HX160YD	◉	◉	◉	◉	◉	
● HX 180	HC180Y/HX180YD	◉	◉	◉	◉	◉	
● HX 220	HC220Y/HX220YD	◉	◉	◉	◉	◉	
● HX 260	HC260Y/HX260YD	◉	◉	◉	◉	◉	
● HX 280	Special mill grade			●			

Steel grade designations and surface refinements

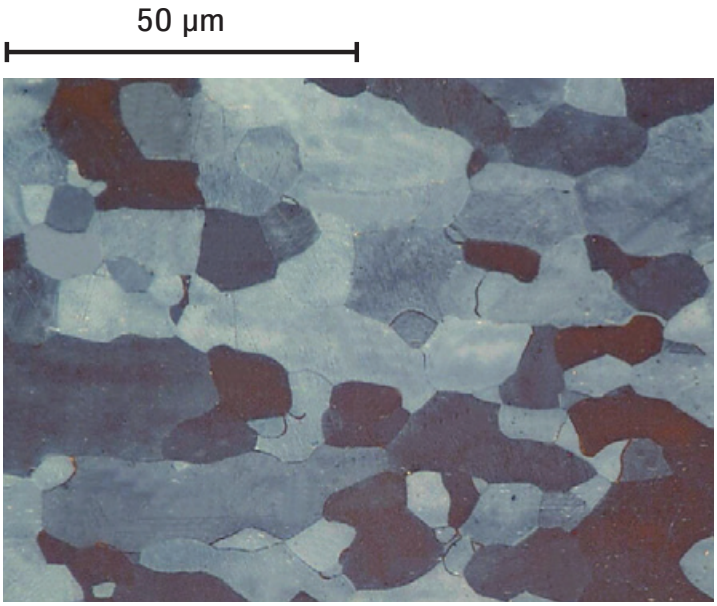
	VDA 239-100	Surface refinements					
		UC	EG	GI	GA	ZM	AS
To VDA							
Steel grade	Standard designation						
● CR160IF	CR160IF	◉	◉	◉	●		
● CR180IF	CR180IF	◉	◉	◉	◉	◉	
● CR210IF	CR210IF	◉	◉	◉	◉	◉	
● CR240IF	CR240IF	◉	◉	◉	◉	◉	

● Cold-rolled strip
● Serial production for interior parts
◉ Serial production for interior and exterior parts
UC Uncoated
EG Electrogalvanized zinc coating
GI Hot-dip zinc coating
GA Galvannealed
ZM ZM EcoProtect®
AS Aluminum-silicon coating

Material characteristics

HX steels by thyssenkrupp are ideally suited for very complex forming operations involving deep drawing and stretch forming because both the r and the n values are high.

Micrograph of HX



The picture shows the typical microstructure of a higher-strength IF steel according to Klemm. The ferritic matrix is free of solute atoms.

Technical features

Chemical composition

Mass fractions in ladle analysis	C [%] max.	Si [%] max.	Mn [%] max.	P [%] max.	S [%] max.	Al [%] total	Ti [%] max.	Nb [%] max.
To DIN EN								
Steel grade								
● HX 160	0.01	0.30	0.60	0.060	0.025	≥ 0.010	0.12	0.09
● HX 180	0.01	0.30	0.70	0.060	0.025	≥ 0.010	0.12	0.09
● HX 220	0.01	0.30	0.90	0.080	0.025	≥ 0.010	0.12	0.09
● HX 260	0.01	0.30	1.60	0.10	0.025	≥ 0.010	0.12	0.09
● HX 280 [1)]	0.01	0.25	1.60	0.10	0.025	≥ 0.010	0.12	0.09

[1)] Special mill grade.

Chemical composition

Mass fractions in ladle analysis	C [%] max.	Si [%] max.	Mn [%] max.	P [%] max.	S [%] max.	Al [%] min.	Ti [%] max.	Nb [%] max.
To VDA								
Steel grade								
● CR160IF	0.01	0.30	0.60	0.060	0.025	0.010	0.12	0.09
● CR180IF	0.01	0.30	0.70	0.060	0.025	0.010	0.12	0.09
● CR210IF	0.01	0.30	0.90	0.080	0.025	0.010	0.12	0.09
● CR240IF	0.01	0.30	1.60	0.100	0.025	0.010	0.12	0.09

Mechanical properties

Test direction transverse to rolling direction	Surface refinement	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation A_{80} [%] min.	Vertical anisotropy r_{90} min.	Strain-hardening exponent n_{90} min.
To DIN EN						
Steel grade						
● HX 160 [1]	UC/EG [2]	160–210	300–350	38	1.9	0.20
● HX 180	UC/EG [2]	180–230	330–400	35	1.7	0.19
● HX 220	UC/EG [2]	220–270	340–420	33	1.6	0.18
● HX 260	UC/EG [2]	260–320	380–440	31	1.4	0.17
● HX 160	GI/GA/ZM [3]	160–220	300–360	37	1.9	0.20
● HX 180	GI/GA/ZM [3]	180–240	330–390	34	1.7	0.18
● HX 220	GI/GA/ZM [3]	220–280	340–420	32	1.5	0.17
● HX 260	GI/GA/ZM [3]	260–320	380–440	30	1.4	0.16
● HX 280 [1]	GI/GA/ZM [3]	280–340	390–450	29	1.4	0.15

Refer to the applicable standards for supplements and deductions for individual coatings and values or for other thicknesses.

[1] Special mill grade.

[2] The mechanical properties are valid for the thickness range from 0.7 to 2.0 mm.

[3] The mechanical properties are valid for the thickness range from 0.7 to 1.5 mm.

● Cold-rolled strip
UC Uncoated
EG Electrogalvanized zinc coating
GI Hot-dip zinc coating
GA Galvannealed
ZM ZM EcoProtect®

Mechanical properties

Test direction in rolling direction	Yield strength $R_{p0.2}$ [MPa]	Tensile strength R_m [MPa]	Elongation A_{50} [%] min.	Elongation A_{80} [%] min.	Vertical anisotropy $r_{0/20}$ min.	Strain-hardening exponent $n_{10-20/Ag}$ min.
To VDA						
Steel grade						
● CR160IF	160–210	280–340	40	38	1.4	0.20
● CR180IF	180–240	330–400	38	35	1.2	0.19
● CR210IF	210–270	340–410	36	33	1.1	0.18
● CR240IF	240–300	360–430	34	31	1.0	0.17

Restrictions as per VDA 239-100 Section 7.2. The average vertical anisotropy $r_{m/20}$ can be agreed for initial approval.

● Cold-rolled strip
$R_{p0.2}$ Proof strength at 0.2% plastic elongation
R_m Tensile strength
A_{50} Percentage elongation after fracture using a specimen with gauge length L_0 = 50 mm
A_{80} Percentage elongation after fracture using a specimen with gauge length L_0 = 80 mm for sheet thicknesses < 3.0 mm
$n_{10-20/Ag}$ Strain-hardening exponent determined between 10% and 20% plastic strain, e.g., uniform elongation limit if A_g < 20%
$r_{90/20}$ Vertical anisotropy in transverse direction at 20% plastic strain
$r_{m/20}$ Average vertical anisotropy at 20% plastic strain $r_{m/20} = (r_{0/20} + r_{90/20} + 2 \times r_{45/20}) / 4$

Surfaces

Surface refinements

Designation	Specification	Nominal coating on each side of single spot sample: Mass [g/m²]	Nominal coating on each side of single spot sample: Thickness [µm]	Coating on each side of single spot sample: Mass [g/m²]	Coating on each side of single spot sample: Thickness [µm]
Electrogalvanized zinc coating					
EG25/25	DIN EN	18	2.5	≥ 12	≥ 1.7
EG18	VDA 239-100	–	–	18–38	2.5–5.4
EG50/50	DIN EN	36	5.0	≥ 29	≥ 4.1
EG29	VDA 239-100	–	–	29–49	4.1–6.9
EG75/75	DIN EN	54	7.5	≥ 47	≥ 6.6
EG53	VDA 239-100	–	–	53–73	7.5–10
EG100/100	DIN EN	72	10	≥ 65	≥ 9.1
EG70	VDA 239-100	–	–	70–90	9.9–13

On request, material can be supplied with zinc coating on one side or on both sides with different coating weights.

Surface refinements, hot-dip galvanized

	Specification	Minimum coating mass on both sides [g/m²]		Coating on each side of single spot sample		Informative
		Triple spot sample	Single spot sample	Mass [g/m²]	Thickness [µm]	Typical thickness [µm]
Hot-dip zinc coating						
Designation						
GI100	DIN EN	100	85	–	5–12	7
GI40	VDA 239-100	–	–	40–60	5.6–8.5	–
GI140	DIN EN	140	120	–	7–15	10
GI60	VDA 239-100	–	–	60–90	8.5–13	–
GI200	DIN EN	200	170	–	10–20	14
GI85	VDA 239-100	–	–	85–115	12–16	–
Galvannealed						
GA100	DIN EN	100	85	–	5–12	7
GA40	VDA 239-100	–	–	40–60	5.6–8.5	–
GA120	DIN EN	120	100	–	6–13	8
GA50	VDA 239-100	–	–	50–80	7–10	–
ZM EcoProtect®						
ZM070	SEW022	70	60	–	–	–
ZM30	VDA239-100	–	–	30–55	4.5–7.7	–
ZM100	SEW022	100	85	–	–	–
ZM40	VDA239-100	–	–	40–65	6.2–9.2	–
ZM120	SEW022	120	100	–	–	–
ZM50	VDA239-100	–	–	50–80	7.7–12	–

A coating weight of 100 g/m² is recommended. For interior parts that are particularly exposed to corrosion, ZM EcoProtect® zinc-magnesium coating, can be supplied.

Surface finishes and surface qualities

Products	Finish type	Surface quality
Cold-rolled flat products	Uncoated	A Normal surface
		U Unexposed (interior parts)
		B Best surface
		E Exposed (exterior parts)
Electrolytically zinc coated flat products	Electrogalvanized zinc coating	A Normal surface
		U Unexposed (interior parts)
		B Best surface
		E Exposed (exterior parts)
Hot-dip coated flat products	Hot-dip zinc coating	B Improved surface
		U Unexposed (interior parts)
		C Best surface
		E Exposed (exterior parts)
	Galvannealed	B Improved surface
		U Unexposed (interior parts)
		C Best surface
		E Exposed (exterior parts)
	ZM EcoProtect®	B Improved surface
		U Unexposed (interior parts)
		C Best surface
		E Exposed (exterior parts)

A / B / C as per DIN EN
U / E as per VDA 239-100

Surface treatments

Type of surface treatment		UC	EG	GI	GA	ZM	AS
O	Oiled	●	●	●	●	●	●
P	Phosphated		●		●		
µPhos	Micro-phosphated		●				
JAZ®	JFE Advanced Zinc				●		
PO	Phosphated and oiled		●		●		
µPhosO	Micro-phosphated and oiled		●				

● Serial production

UC	Uncoated	GA	Galvannealed
EG	Electrogalvanized zinc coating	ZM	ZM EcoProtect®
GI	Hot-dip zinc coating	AS	Aluminum-silicon coating

Anti-corrosion primer, also called thin-film coating, is a weldable organic zinc dust system applied on one or both sides of electrolytically galvanized steel by the coil coating method. It is used on interior and exterior parts requiring increased corrosion protection.

The available dimensions, depending on the available dimensions of the substrate material, are sheet thicknesses from 0.4 to 2.4 mm and strip widths up to 1,870 mm in all surface types for interior and exterior parts.

Notes on applications and processing

Forming

Higher-strength IF steels are suitable for complex deep-drawn parts which are subject to deep-drawing and stretch-forming loads. The choice of the right type for a given strength should also be made with a special focus on the actual anticipated forming stresses. This allows optimum leveraging of specific benefits so that the steels can also be used for difficult drawn parts. During stretch forming with firmly clamped bulk, the greatest drawing depths are achieved with grades that have a high n value. Failure due to local constriction occurs later here, because a larger area of material is involved in the deformation zone.

In contrast to this, steels with a high r value behave more favorably in deep drawing in terms of the limiting drawing ratio. A high r value indicates that, in a tensile test, the material flows out of the sample width rather than the sheet thickness. High r values under deep drawing load thus improve both the resilience to local constriction in the frame and the flow of material under the blank holder. In a combination of stretching and deep-drawing load steels with equally high r and n values offer advantages; this is very much the case with higher-strength IF steels.

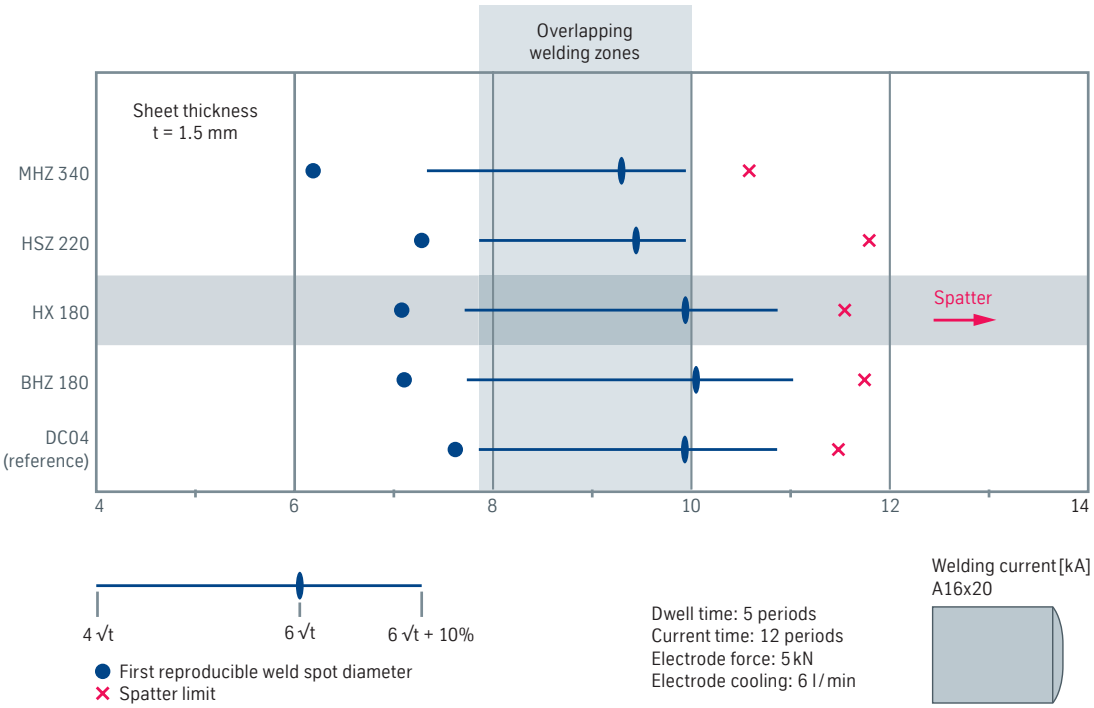
Processing instructions for joining

When it comes to joining higher-strength IF steels, the processor can choose from a large number of joining processes. They are suitable for welding in both same-grade and hybrid joints with other common steel grades. The precondition is welding parameters matched to the material.

Resistance spot welding

The focus is traditionally on resistance spot welding, especially in car body manufacture. In particular, thin sheets with a thickness of less than 3 mm can be joined more economically and more reliably using this mass production process. However, doing so typically involves modifying the three welding parameters: welding current, welding time and electrode force. The influence of the electrode force and welding time on the welding zone is of central interest here. Higher electrode forces and longer welding times are normally required as the sheet thickness and strength increase, to ensure a sufficiently large welding zone. Similarly, the use of multi-pulse welding as per SEP 1220-2 can have a positive effect on the width of the welding zone. For zinc and zinc alloy coatings, the electrode forces, welding currents and welding times need to be increased compared to the non-alloyed base material to compensate for contraction of the welding zone due to the coating. The width of the welding zone does not only depend on the combination of sheet grade, surface and thickness; process parameters such as the current type and electrode geometry also play a significant role. The figure shows that the welding zones of conventional higher and high-strength steels are in a comparable welding current range. In addition to good welding suitability of the individual steel grades, welding suitability is also assured for combinations of the various materials offered by the steel industry today for similar welding parameter settings.

Welding zones of conventional higher-strength and high-strength steels compared



● First reproducible weld spot diameter
✕ Spatter limit

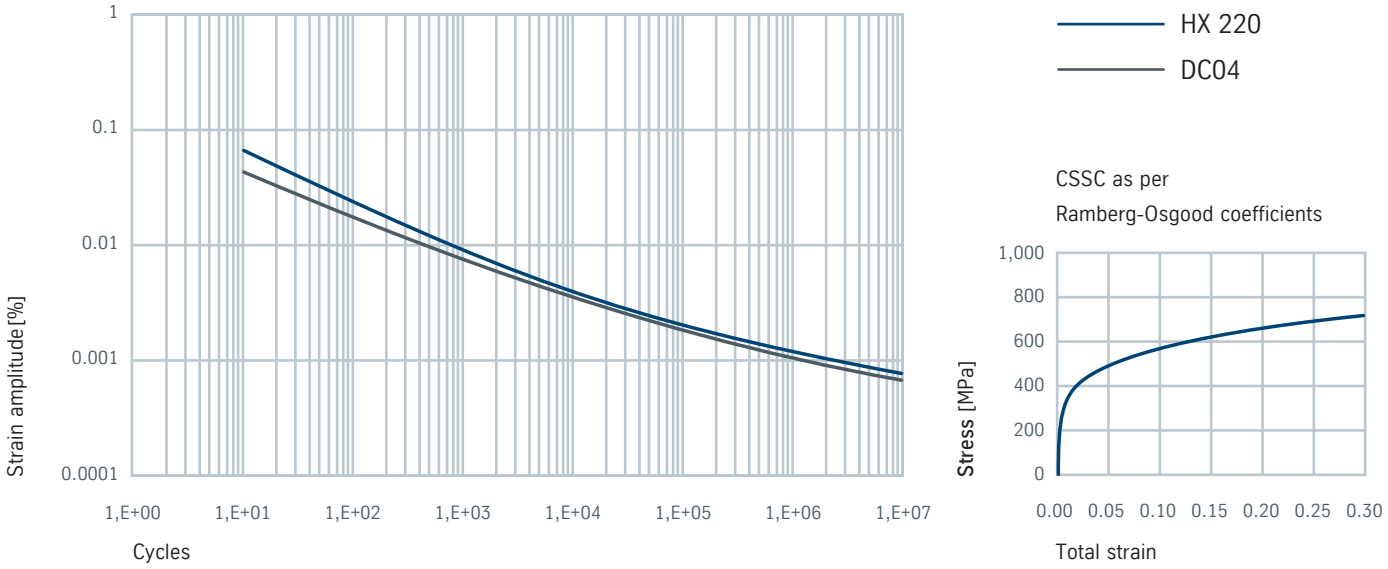
Dwell time: 5 periods
Current time: 12 periods
Electrode force: 5 kN
Electrode cooling: 6 l / min

Welding current [kA]
A16x20

Fatigue strength

Higher strength is assured for these types of steel in addition to excellent deformation properties. As the yield strength and tensile strength increase the fatigue limit also increases.

Stress-strain curve of a higher-strength IF steel HX 220 compared to a deep-drawing steel DC04

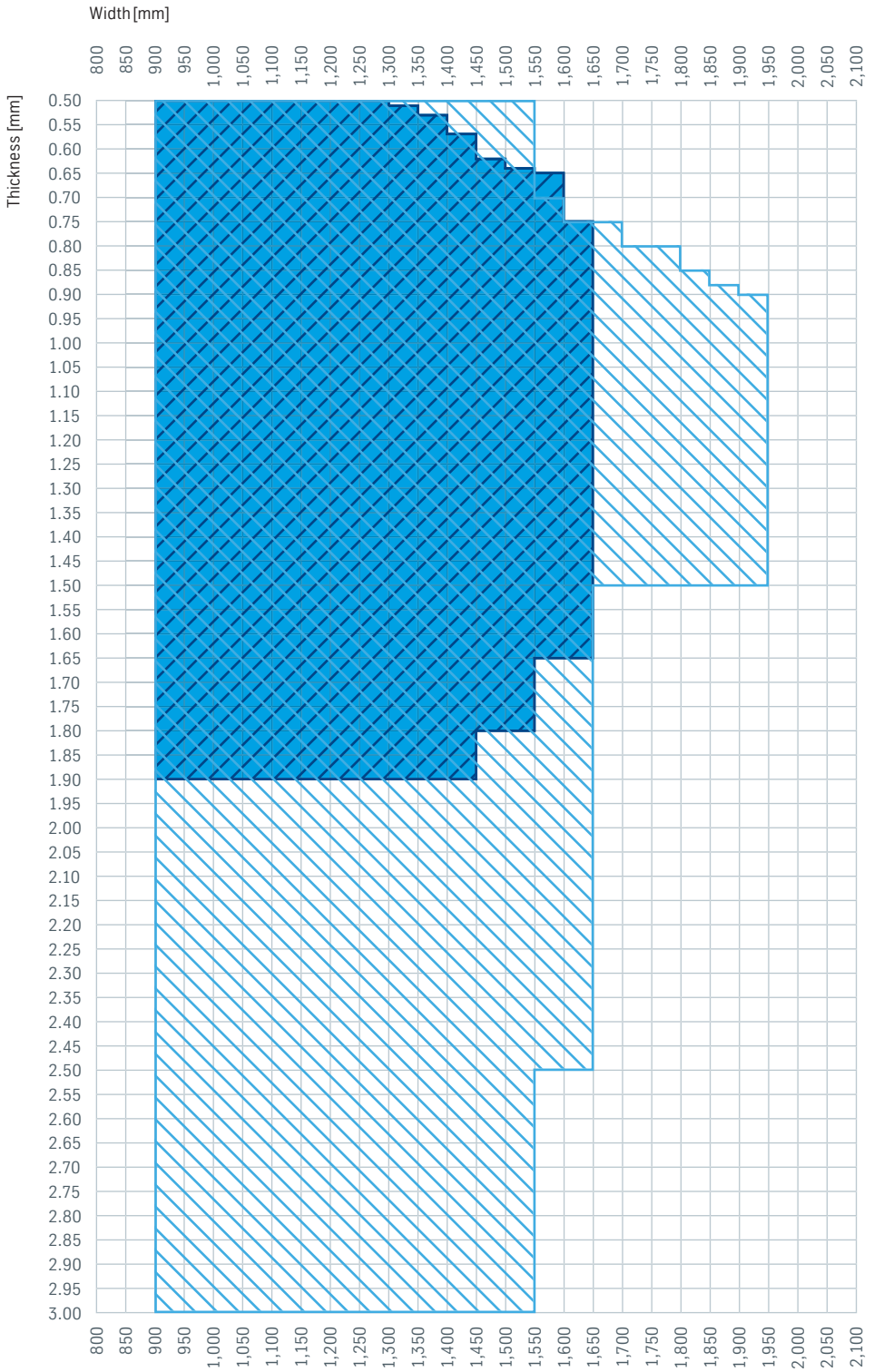


HX 220
Manson-Coffin parameters
σ_f' = 662 MPa
b = –0.101
ε_f' = 0.218 mm/mm
c = –0.473

HX 220
Ramberg-Osgood parameters
K' = 916
n' = 0.214

Available dimensions

HX 160, CR160IF



EG Electrogalvanized zinc coating
GI Hot-dip zinc coating

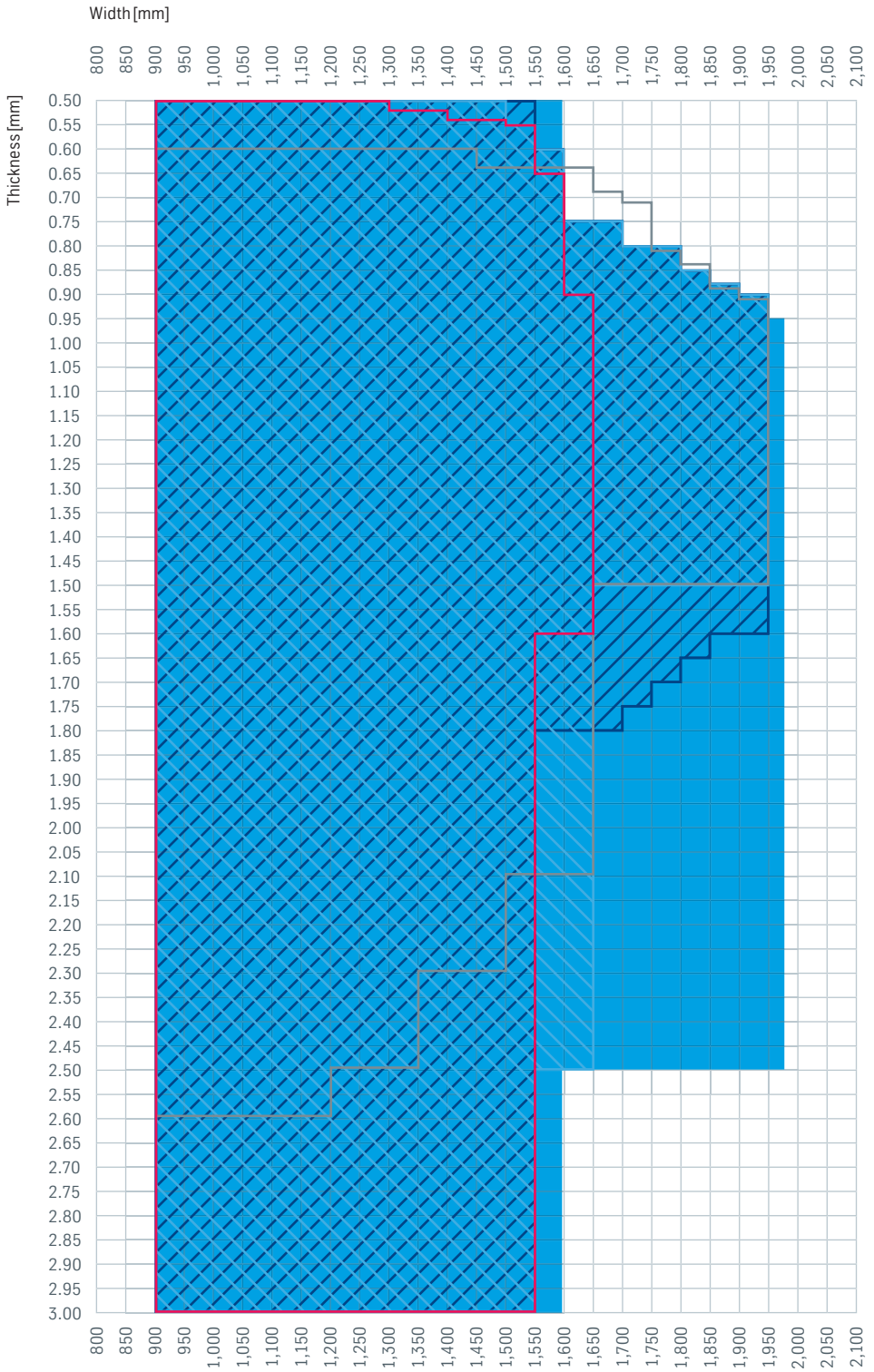
GI trimmed
EG trimmed
Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

For exterior parts
Similar to figure in the ranges:
Thickness 0.50 to 1.20 mm
Width 900 to 1,600 mm

Further dimensions on request.

HX 180, HX 220, CR180IF, CR210IF



EG Electrogalvanized zinc coating
GI Hot-dip zinc coating
GA Galvannealed
ZM ZM EcoProtect®

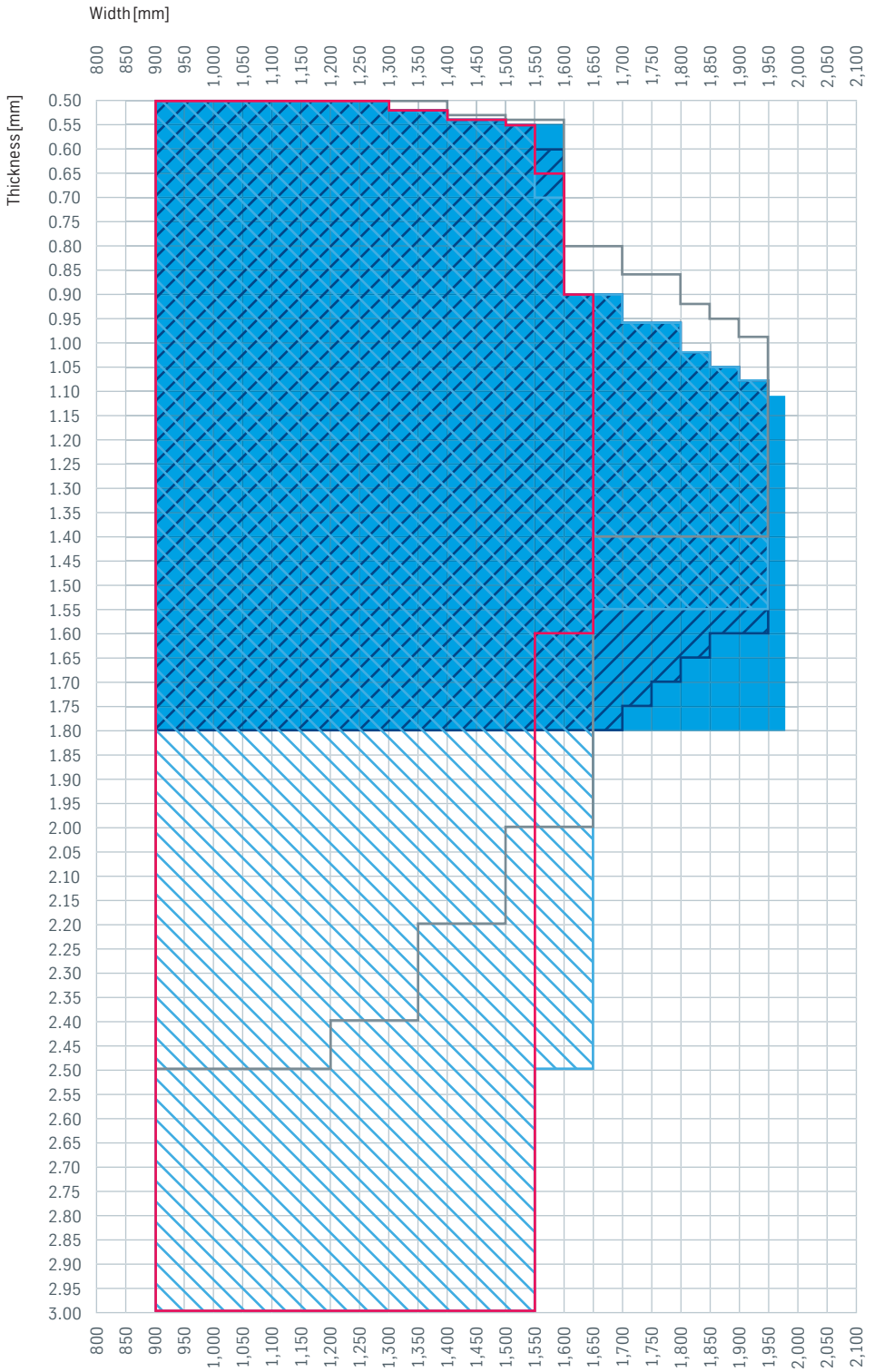
ZM trimmed
GA trimmed
GI trimmed
EG trimmed
Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

For exterior parts
Similar to figure in the ranges:
Thickness 0.50 to 1.20 mm
Width 900 to 1,600 mm

Further dimensions on request.

HX 260, CR240IF



EG Electrogalvanized zinc coating
GI Hot-dip zinc coating
GA Galvannealed
ZM ZM EcoProtect®

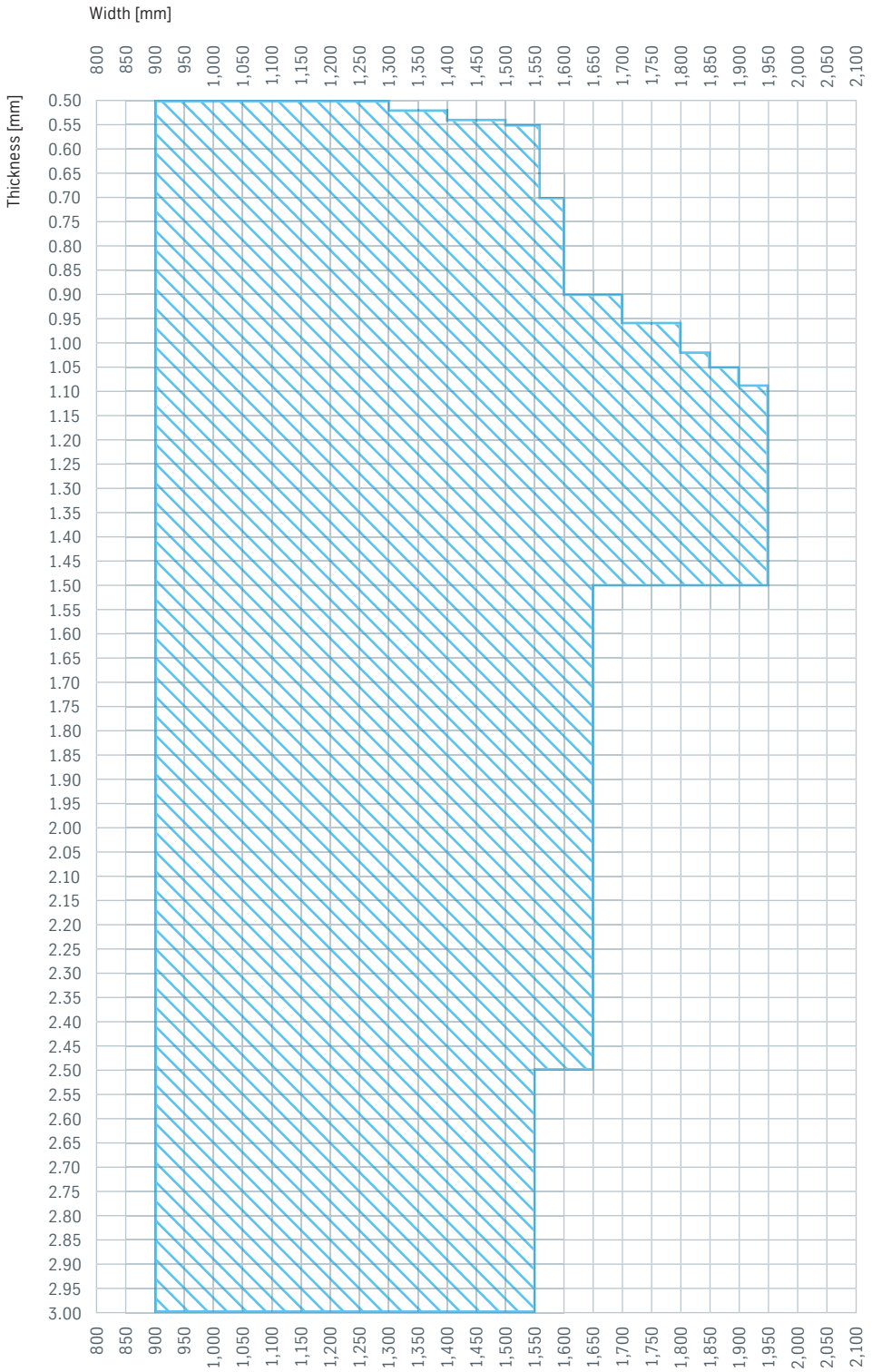
ZM trimmed
GA trimmed
GI trimmed
EG trimmed
Uncoated with mill edge

For interior parts
Typical dimensions for automotive customers. Restrictions may apply to steel grades as per VDA 239-100.

For exterior parts
Similar to figure in the ranges:
Thickness 0.50 to 1.20 mm
Width 900 to 1,600 mm

Further dimensions on request.

HX 280



GI Hot-dip zinc coating

GI trimmed

For interior parts
Typical dimensions for automotive customers.

Further dimensions on request.

Special mill grades are supplied subject to the special conditions of thyssenkrupp. Other delivery conditions not specified here will be based on the applicable specifications. The specifications used will be those valid on the date of issue of this product information brochure.

General information

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