

ISO 10303-209:2001-10 (E)

Industrial automation systems and integration - Product data representation and exchange - Part 209: Application protocol: Composite and metallic structural analysis and related design

Contents		Page
1	Scope	1
2	Normative references	3
3	Terms, definitions and abbreviations	5
3.10	Other terms and definitions	9
3.11	Abbreviations	10
4	Information requirements	11
4.1	Units of functionality	11
4.1.1	activity_control	12
4.1.2	advanced_boundary_representation	13
4.1.3	analysis_report	13
4.1.4	assembly	13
4.1.5	authorization	14
4.1.6	composite_constituent_representation	14
4.1.7	effectivity	15
4.1.8	end_item_identification	16
4.1.9	faceted_boundary_representation	16
4.1.10	fe_analysis_control	16
4.1.11	fe_analysis_results	17
4.1.12	fea_model	18
4.1.13	manifold_surface_with_topology	20
4.1.14	material	20
4.1.15	non_topological_surface_and_wireframe	21
4.1.16	part_composite_constituents	22
4.1.17	part_identification	22
4.1.18	part_laminate_table	23
4.1.19	part_shape	24
4.1.20	wireframe_with_topology	24
4.1.21	zone_composite_constituents_and_their_representation	24
4.2	Application objects	26
4.3	Application assertions	117
5	Application interpreted model	151
5.1	Mapping table	151
5.2	AIM EXPRESS short listing	352
6	Conformance Requirements	445
Annex A (normative) AIM EXPRESS expanded listing		448
Annex B (normative) AIM short names		640
Annex C (normative) Implementation method specific requirements		659
Annex D (normative) Protocol Implementation Conformance Statement (PICS) proforma		660
Annex E (normative) Information object registration		662

E.1	Document identification	662
E.2	Schema identification	662
Annex F (informative) Application activity model		663
F.1	Application activity model background	663
F.2	Information exchange scenario	664
F.3	Application activity model abbreviations	666
F.4	Application activity model definitions	667
F.5	Application activity model diagrams	702
Annex G (informative) Application reference model		747
Annex H (informative) AIM EXPRESS-G		763
Annex J (informative) Computer-interpretable listings		858
Annex K (informative) ARM EXPRESS listing		859
Bibliography		879
Index		880
Figures Figure 1 - Data planning model		xii
Figure 2 - Composite_assembly_table		39
Figure 3 - Discontinuous_fiber_assembly		46
Figure 4 - Filament_assembly		60
Figure 5 - Filament_laminate		61
Figure 6 - Flat_pattern_ply_shape		63
Figure 7 - Laid_ply_shape		68
Figure 8 - Ply		86
Figure 9 - Ply_laminate		87
Figure 10 - Ply_laminate_table		89
Figure 11 - Processed_core		94
Figure 12 - Projection_method		98
Figure 13 - Surface_ply_shape		109
Figure 14 - View_ply_shape		113
Figure F.1 - PAS-C Suite Concept		664
Figure F.2 - AP209 scenario from a structural designer's viewpoint		665
Figure F.3 - AP209 scenario from an analysis viewpoint		667
Figure F.4 - A-0 Develop, procure, build, use and maintain an SP		703
Figure F.5 - A0 Develop, procure, build, use and maintain an SP		704

Figure F.6 - A2 manage, design, build, and support an SP	705
Figure F.7 - A22 design and analyze an SP	706
Figure F.8 - A223 perform structural part detail design and analysis	707
Figure F.9 - A2232 create detail structural part design	708
Figure F.10 - A22323 prepare SP models and drawing	709
Figure F.11 - A223232 create SP geometry layouts and models	710
Figure F.12 - A2232321 receive and review SP geometry data	711
Figure F.13 - A2232322 build SP layouts and models	712
Figure F.14 - A223233 create SP drawing data	713
Figure F.15 - A2232332 prepare detail SP item drawings	714
Figure F.16 - A22323322 prepare SP details	715
Figure F.17 - A2232332233 create SP data	716
Figure F.18 - A2232332231 prepare SP composite detail	717
Figure F.19 - A22323322316 produce CSP ply stack-up	718
Figure F.20 - A223233223162 create CSP ply tables	719
Figure F.21 - A2232332232 prepare CSP core details	720
Figure F.22 - A22323322322 develop CSP core periphery	721
Figure F.23 - A22323322323 Design CPS core thickness, density, and material features	722
Figure F.24 - A2233 conduct detail SP analysis	723
Figure F.25 - A22335 conduct SP static stress analysis	724
Figure F.26 - A223352 conduct SP finite element analysis	725
Figure F.27 - A2233521 generate SP finite element models	726
Figure F.28 - A22335211 generate SP node geometry	727
Figure F.29 - A22335213 generate and assign SP element attributes	728
Figure F.30 - A223352131 generate SP geometric attributes	729
Figure F.31 - A2233521311 generate beam geometric attributes	730
Figure F.32 - A2233521312 generate contoured panel geometric attributes	731
Figure F.33 - A2233521313 generate core stiffened panel geometric attributes	732
Figure F.34 - A223352133 generate/import SP material properties	733
Figure F.35 - A2233521334 input SP anisotropic material property matrices	734
Figure F.36 - A22335213341 input beam anisotropic material property	735

Figure F.37 - A22335213342 input contoured panels anisotropic material property	736
Figure F.38 - A22335123343 input core stiffened panel anisotropic material property	737
Figure F.39 - A2233522 generate SP FE analysis environment and controls	738
Figure F.40 - A2233523 perform SP mechanical and thermo-mechanical analysis	739
Figure F.41 - A2233524 create/document SP internal loads/stress data	740
Figure F.42 - A223353 conduct SP detail stress analyses	741
Figure F.43 - A223351 conduct SP static strength analyses	742
Figure F.44 - A22335311 conduct beam static strength analysis	743
Figure F.45 - A22335312 conduct panel static strength analysis	744
Figure F.46 - A2233532 conduct SP fine grid finite element analysis	745
Figure F.47 - A4 develop and provide SP materials	746
Figure G.1 - ARM EXPRESS-G diagram 1 of 15	748
Figure G.2 - ARM EXPRESS-G diagram 2 of 15	749
Figure G.3 - ARM EXPRESS-G diagram 3 of 15	750
Figure G.4 - ARM EXPRESS- G diagram 4 of 15	751
Figure G.5 - ARM EXPRESS-G diagram 5 of 15	752
Figure G.6 - ARM EXPRESS-G diagram 6 of 15	753
Figure G.7 - ARM EXPRESS-G diagram 7 of 15	754
Figure G.8 - ARM EXPRESS-G diagram 8 of 15	755
Figure G.9 - ARM EXPRESS-G diagram 9 of 15	756
Figure G.10 - ARM EXPRESS-G diagram 10 of 15	757
Figure G.11 - ARM EXPRESS-G diagram 11 of 15	758
Figure G.12 - ARM EXPRESS-G diagram 12 of 15	759
Figure G.13 - ARM EXPRESS-G diagram 13 of 15	760
Figure G.14 - ARM EXPRESS-G diagram 14 of 15	761
Figure G.15 - ARM EXPRESS-G diagram 15 of 15	762
Figure H.1 - AIM EXPRESS-G diagram 1 of 94	764
Figure H.2 - AIM EXPRESS-G diagram 2 of 94	765
Figure H.3 - AIM EXPRESS-G diagram 3 of 94	766
Figure H.4 - AIM EXPRESS-G diagram 4 of 94	767
Figure H.5 - AIM EXPRESS-G diagram 5 of 94	768

Figure H.6 - AIM EXPRESS-G diagram 6 of 94	769
Figure H.7 - AIM EXPRESS-G diagram 7 of 94	770
Figure H.8 - AIM EXPRESS-G diagram 8 of 94	771
Figure H.9 - AIM EXPRESS-G diagram 9 of 94	772
Figure H.10 - AIM EXPRESS-G diagram 10 of 94	773
Figure H.11 - AIM EXPRESS-G diagram 11 of 94	774
Figure H.12 - AIM EXPRESS-G diagram 12 of 94	775
Figure H.13 - AIM EXPRESS-G diagram 13 of 94	776
Figure H.14 - AIM EXPRESS-G diagram 14 of 94	777
Figure H.15 - AIM EXPRESS-G diagram 15 of 94	778
Figure H.16 - AIM EXPRESS-G diagram 16 of 94	779
Figure H.17 - AIM EXPRESS-G diagram 17 of 94	780
Figure H.18 - AIM EXPRESS-G diagram 18 of 94	781
Figure H.19 - AIM EXPRESS-G diagram 19 of 94	782
Figure H.20 - AIM EXPRESS-G diagram 20 of 94	783
Figure H.21 - AIM EXPRESS-G diagram 21 of 94	784
Figure H.22 - AIM EXPRESS-G diagram 22 of 94	785
Figure H.23 - AIM EXPRESS-G diagram 23 of 94	786
Figure H.24 - AIM EXPRESS-G diagram 24 of 94	787
Figure H.25 - AIM EXPRESS-G diagram 25 of 94	788
Figure H.26 - AIM EXPRESS-G diagram 26 of 94	789
Figure H.27 - AIM EXPRESS-G diagram 27 of 94	790
Figure H.28 - AIM EXPRESS-G diagram 28 of 94	791
Figure H.29 - AIM EXPRESS-G diagram 29 of 94	792
Figure H.30 - AIM EXPRESS-G diagram 30 of 94	793
Figure H.31 - AIM EXPRESS-G diagram 31 of 94	794
Figure H.32 - AIM EXPRESS-G diagram 32 of 94	795
Figure H.33 - AIM EXPRESS-G diagram 33 of 94	796
Figure H.34 - AIM EXPRESS-G diagram 34 of 94	797
Figure H.35 - AIM EXPRESS-G diagram 35 of 94	798
Figure H.36 - AIM EXPRESS-G diagram 36 of 94	799

Figure H.37 - AIM EXPRESS-G diagram 37 of 94	800
Figure H.38 - AIM EXPRESS-G diagram 38 of 94	801
Figure H.39 - AIM EXPRESS-G diagram 39 of 94	802
Figure H.40 - AIM EXPRESS-G diagram 40 of 94	803
Figure H.41 - AIM EXPRESS-G diagram 41 of 94	804
Figure H.42 - AIM EXPRESS-G diagram 42 of 94	805
Figure H.43 - AIM EXPRESS-G diagram 43 of 94	806
Figure H.44 - AIM EXPRESS-G diagram 44 of 94	807
Figure H.45 - AIM EXPRESS-G diagram 45 of 94	808
Figure H.46 - AIM EXPRESS-G diagram 46 of 94	809
Figure H.47 - AIM EXPRESS-G diagram 47 of 94	810
Figure H.48 - AIM EXPRESS-G diagram 48 of 94	811
Figure H.49 - AIM EXPRESS-G diagram 49 of 94	812
Figure H.50 - AIM EXPRESS-G diagram 50 of 94	813
Figure H.51 - AIM EXPRESS-G diagram 51 of 94	814
Figure H.52 - AIM EXPRESS-G diagram 52 of 94	815
Figure H.53 - AIM EXPRESS-G diagram 53 of 94	816
Figure H.54 - AIM EXPRESS-G diagram 54 of 94	817
Figure H.55 - AIM EXPRESS-G diagram 55 of 94	818
Figure H.56 - AIM EXPRESS-G diagram 56 of 94	819
Figure H.57 - AIM EXPRESS-G diagram 57 of 94	820
Figure H.58 - AIM EXPRESS-G diagram 58 of 94	821
Figure H.59 - AIM EXPRESS-G diagram 59 of 94	822
Figure H.60 - AIM EXPRESS-G diagram 60 of 94	823
Figure H.61 - AIM EXPRESS-G diagram 61 of 94	824
Figure H.62 - AIM EXPRESS-G diagram 62 of 94	825
Figure H.63 - AIM EXPRESS-G diagram 63 of 94	826
Figure H.64 - AIM EXPRESS-G diagram 64 of 94	827
Figure H.65 - AIM EXPRESS-G diagram 65 of 94	828
Figure H.66 - AIM EXPRESS-G diagram 66 of 94	829
Figure H.67 - AIM EXPRESS-G diagram 67 of 94	830

Figure H.68 - AIM EXPRESS-G diagram 68 of 94	831
Figure H.69 - AIM EXPRESS-G diagram 69 of 94	832
Figure H.70 - AIM EXPRESS-G diagram 70 of 94	833
Figure H.71 - AIM EXPRESS-G diagram 71 of 94	834
Figure H.72 - AIM EXPRESS-G diagram 72 of 94	835
Figure H.73 - AIM EXPRESS-G diagram 73 of 94	836
Figure H.74 - AIM EXPRESS-G diagram 74 of 91	837
Figure H.75 - AIM EXPRESS-G diagram 75 of 94	838
Figure H.76 - AIM EXPRESS-G diagram 76 of 94	839
Figure H.77 - AIM EXPRESS-G diagram 77 of 94	840
Figure H.78 - AIM EXPRESS-G diagram 78 of 94	841
Figure H.79 - AIM EXPRESS-G diagram 79 or 94	842
Figure H.80 -AIM EXPRESS-G diagram 80 of 94	843
Figure H.81 - AIM EXPRESS-G diagram 81 of 94	844
Figure H.82 - AIM EXPRESS-G diagram 82 of 94	845
Figure H.83 - AIM EXPRESS-G diagram 83 of 94	846
Figure H.84 - AIM EXPRESS-G diagram 84 of 94	847
Figure H.85 - AIM EXPRESS-G diagram 85 of 94	848
Figure H.86 - AIM EXPRESS-G diagram 86 of 94	849
Figure H.87 - AIM EXPRESS-G diagram 87 of 94	850
Figure H.88 - AIM EXPRESS-G diagram 88 of 94	851
Figure H.89 - AIM EXPRESS-G diagram 89 of 94	852
Figure H.90 - AIM EXPRESS-G diagram 90 of 94	853
Figure H.91 - AIM EXPRESS-G diagram 91 of 94	854
Figure H.92 - AIM EXPRESS-G diagram 92 of 94	855
Figure H.93 - AIM EXPRESS-G diagram 93 of 94	856
Figure H.94 - AIM EXPRESS-G diagram 94 of 94	857
Tables Table 1 - Mapping table for activity_control UoF	153
Table 2 - Mapping table for advanced_boundary_representation UoF	161
Table 3 - Mapping table for analysis_report UoF	162
Table 4 - Mapping table for analysis_report UoF	165

Table 5 - Mapping table for authorization UoF	177
Table 6 - Mapping table for composite_constituent_representation UoF	182
Table 7 - Mapping table for effectivity UoF	201
Table 8 - Mapping table for end_item_identification UoF	211
Table 9 - Mapping table for faceted_boundary_representation UoF	212
Table 10 - Mapping table for fe_analysis_control UoF	213
Table 11 - Mapping table for fe_analysis_results UoF	232
Table 12 - Mapping table for fea_model UoF	251
Table 13 - Mapping table for manifold_surface_with_topology UoF	280
Table 14 - Mapping table for material UoF	281
Table 15 - Mapping table for non_topological_surface_and_wireframe UoF	288
Table 16 - Mapping table for part_composite_constituents UoF	289
Table 17 - Mapping table for part_identification UoF	316
Table 18 - Mapping table for part_laminate_table UoF	327
Table 19 - Mapping table for part_shape UoF	333
Table 20 - Mapping table for wireframe_with_topology UoF	338
Table 21 - Mapping table for zone_composite_constituents_and_their_representation UoF	339
Table 22 - Conformance Classes	447
Table B.1 - AIM short names of entities	640