



Contents

| | |
|--|-----------|
| 00 - Technical data | 1 |
| 1 Safety information | 1 |
| 1.1 Safety precautions when working on the fuel supply system | 1 |
| 1.2 Safety measures when working on vehicles with start/stop system | 2 |
| 1.3 Safety precautions when using testers and measuring instruments during a road test | 2 |
| 1.4 Safety precautions when working on the cooling system | 2 |
| 1.5 Safety precautions when working on SCR system | 3 |
| 1.6 Safety precautions when working on the ignition system | 3 |
| 1.7 Safety precautions when working on the exhaust system | 4 |
| 2 Identification | 5 |
| 2.1 Engine number/engine data | 5 |
| 3 Repair notes | 7 |
| 3.1 Rules for cleanliness | 7 |
| 3.2 General information | 7 |
| 3.3 General repair instructions | 8 |
| 3.4 Foreign material in engine | 8 |
| 3.5 Contact corrosion | 8 |
| 3.6 Routing and attachment of lines | 9 |
| 3.7 Fitting radiator and condensers | 9 |
| 3.8 Checking vacuum system | 9 |
| 3.9 Instructions for checking Delphi injection system for suspected damage to high-pressure pump | 10 |
| 10 - Removing and installing engine | 15 |
| 1 Removing and installing engine | 15 |
| 1.1 Removing motor | 15 |
| 1.2 Separating engine and gearbox | 23 |
| 1.3 Securing engine on engine and gearbox support | 25 |
| 1.4 Installing motor | 26 |
| 2 Assembly mountings | 30 |
| 2.1 Assembly overview – assembly mountings | 30 |
| 2.2 Removing and installing engine mounting | 40 |
| 2.3 Removing and installing engine mounting | 45 |
| 2.4 Removing and installing gearbox mounting | 46 |
| 2.5 Removing and installing damper weight | 47 |
| 2.6 Supporting engine in installation position | 47 |
| 3 Engine cover panel | 51 |
| 3.1 Assembly overview – engine cover panel | 51 |
| 3.2 Removing and installing engine cover | 51 |
| 13 - Crankshaft group | 52 |
| 1 Cylinder block, pulley end | 52 |
| 1.1 Assembly overview – cylinder block, pulley end | 52 |
| 1.2 Assembly overview – sealing flange, pulley end | 57 |
| 1.3 Removing and installing poly-V belt | 58 |
| 1.4 Removing and installing poly V-belt tensioner | 61 |
| 1.5 Removing and installing vibration damper | 62 |
| 1.6 Removing and installing bracket for ancillaries | 64 |
| 1.7 Removing and installing engine support | 67 |
| 1.8 Removing and installing sealing flange, pulley end | 75 |
| 1.9 Renewing caps in cylinder block, pulley end | 77 |
| 2 Cylinder block, gearbox side | 79 |



| | | |
|-----------|---|------------|
| 2.1 | Assembly overview – cylinder block, gearbox side | 79 |
| 2.2 | Removing and installing flywheel | 80 |
| 2.3 | Removing and installing sealing flange on gearbox side | 81 |
| 2.4 | Renewing caps in cylinder block (gearbox end) | 96 |
| 3 | Crankshaft | 98 |
| 3.1 | Assembly overview - crankshaft | 98 |
| 3.2 | Crankshaft dimensions | 100 |
| 3.3 | Renewing needle bearing in crankshaft | 100 |
| 3.4 | Measuring axial clearance of crankshaft | 102 |
| 3.5 | Measuring radial clearance of crankshaft | 102 |
| 3.6 | Removing and installing crankshaft | 103 |
| 4 | Pistons and conrods | 105 |
| 4.1 | Assembly overview – pistons and conrods | 105 |
| 4.2 | Removing and installing pistons | 107 |
| 4.3 | Measuring piston projection at TDC | 108 |
| 4.4 | Checking piston and cylinder bore | 111 |
| 4.5 | Separating new conrod | 113 |
| 4.6 | Checking radial clearance of conrods | 113 |
| 4.7 | Removing and installing oil spray jets | 113 |
| 15 | Cylinder head, valve gear | 115 |
| 1 | Cylinder head | 115 |
| 1.1 | Assembly overview – cylinder head | 115 |
| 1.2 | Assembly overview – camshaft housing | 117 |
| 1.3 | Assembly overview - cylinder head cover | 119 |
| 1.4 | Removing and installing cylinder head | 122 |
| 1.5 | Removing and installing cylinder head cover | 129 |
| 1.6 | Removing and installing injector seals | 130 |
| 1.7 | Removing and installing camshaft housing | 131 |
| 1.8 | Checking compression | 136 |
| 2 | Toothed belt drive | 138 |
| 2.1 | Assembly overview – toothed belt cover | 138 |
| 2.2 | Assembly overview – toothed belt | 138 |
| 2.3 | Removing and installing toothed belt guard | 141 |
| 2.4 | Removing and installing toothed belt | 145 |
| 2.5 | Removing toothed belt from camshaft | 156 |
| 3 | Valve gear | 161 |
| 3.1 | Assembly overview – valve gear | 161 |
| 3.2 | Measuring axial play of camshaft | 163 |
| 3.3 | Removing and installing camshaft oil seal | 164 |
| 3.4 | Checking hydraulic compensation elements | 165 |
| 3.5 | Removing and installing valve stem oil seals | 166 |
| 3.6 | Removing and installing roller rocker fingers and hydraulic compensation elements | 177 |
| 4 | Inlet and exhaust valves | 178 |
| 4.1 | Checking valve guides | 178 |
| 4.2 | Checking valves | 179 |
| 4.3 | Valve dimensions | 179 |
| 17 | Lubrication | 180 |
| 1 | Sump, oil pump | 180 |
| 1.1 | Assembly overview – sump/oil pump | 180 |
| 1.2 | Engine oil | 186 |
| 1.3 | Removing and installing sump | 186 |
| 1.4 | Removing and installing oil pump | 191 |
| 1.5 | Removing and installing oil level and oil temperature sender G266 | 192 |



| | | |
|-----------|---|------------|
| 1.6 | Removing and installing oil pump drive pulley | 193 |
| 2 | Engine oil cooler | 198 |
| 3 | Oil filter, oil pressure switch | 199 |
| 3.1 | Assembly overview - oil filter housing, oil pressure switch | 199 |
| 3.2 | Removing and installing oil pressure switch F1 | 201 |
| 3.3 | Removing and installing oil pressure switch for reduced oil pressure F378 | 202 |
| 3.4 | Checking oil pressure | 203 |
| 3.5 | Removing and installing oil filter housing | 204 |
| 3.6 | Removing and installing valve for oil pressure control N428 | 205 |
| 4 | Oil circuit | 207 |
| 4.1 | Assembly overview - oil circuit | 207 |
| 4.2 | Removing and installing oil supply line | 210 |
| 4.3 | Removing and installing oil return line for turbocharger | 213 |
| 19 | Cooling | 217 |
| 1 | Cooling system/coolant | 217 |
| 1.1 | Connection diagram – coolant hoses | 217 |
| 1.2 | Draining and filling cooling system | 241 |
| 1.3 | Checking coolant level and topping up if necessary | 247 |
| 1.4 | Checking cooling system for leaks | 248 |
| 1.5 | Removing and installing coolant expansion tank | 249 |
| 1.6 | Assembly overview - coolant expansion tank | 253 |
| 2 | Coolant pump, regulation of cooling system | 255 |
| 2.1 | Assembly overview – coolant pump/thermostat | 255 |
| 2.2 | Assembly overview – electric coolant pump | 257 |
| 2.3 | Assembly overview – coolant temperature sender | 264 |
| 2.4 | Assembly overview – coolant valves, 3/2-way valve | 267 |
| 2.5 | Removing and installing electric coolant pump | 268 |
| 2.6 | Removing and installing coolant pump | 274 |
| 2.7 | Removing and installing thermostat housing | 275 |
| 2.8 | Checking thermostat | 278 |
| 2.9 | Removing and installing coolant valve for cylinder head N489 | 278 |
| 2.10 | Removing and installing coolant temperature sender G62 | 279 |
| 2.11 | Removing and installing radiator outlet coolant temperature sender G83 | 280 |
| 2.12 | Removing and installing coolant temperature sender 3 G812 | 282 |
| 2.13 | Removing and installing 3/2-way valve | 285 |
| 3 | Coolant pipes | 290 |
| 3.1 | Assembly overview – coolant pipes | 290 |
| 3.2 | Removing and installing coolant pipes | 297 |
| 4 | Radiator, radiator fan | 299 |
| 4.1 | Assembly overview - radiator/radiator fan | 299 |
| 4.2 | Assembly overview - radiator cowl and radiator fans | 302 |
| 4.3 | Removing and installing radiator | 303 |
| 4.4 | Removing and installing radiator cowl with radiator fans | 316 |
| 4.5 | Removing and installing radiator fan V7 | 317 |
| 21 | Turbocharging/supercharging | 318 |
| 1 | Turbocharger | 318 |
| 1.1 | Assembly overview – turbocharger | 318 |
| 1.2 | Removing and installing turbocharger | 327 |
| 1.3 | Renewing vacuum unit for turbocharger | 337 |
| 1.4 | Removing and installing connecting pipes | 350 |
| 1.5 | Removing and installing compressor housing and turbine housing, biturbo | 355 |
| 2 | Charge air system | 356 |
| 2.1 | Assembly overview – charge air system | 356 |



| | | |
|-----------|--|------------|
| 2.2 | Removing and installing charge air cooler | 362 |
| 2.3 | Removing and installing charge pressure sender G31 | 370 |
| 2.4 | Removing and installing charge pressure sender 2 G447 | 371 |
| 2.5 | Checking charge air system for leaks | 372 |
| 2.6 | Removing and installing air intake pipe | 374 |
| 2.7 | Detaching and securing charge air cooler | 374 |
| 2.8 | Removing and installing bracket for charge air cooler | 380 |
| 2.9 | Checking charge air cooler for leaks | 383 |
| 23 | Mixture preparation - injection | 386 |
| 1 | Injection system | 386 |
| 1.1 | Overview of fitting locations - injection system | 386 |
| 1.2 | Filling/bleeding fuel system | 401 |
| 1.3 | Checking fuel system for leaks | 402 |
| 2 | Vacuum system | 403 |
| 2.1 | Connection diagram - vacuum system | 403 |
| 2.2 | Assembly overview - vacuum system | 407 |
| 2.3 | Removing and installing solenoid valve | 416 |
| 3 | Injectors/high-pressure reservoir (rail) | 419 |
| 3.1 | Assembly overview – injectors | 419 |
| 3.2 | Assembly overview - fuel rail | 421 |
| 3.3 | Adapting correction values for injectors | 423 |
| 3.4 | Testing injectors | 423 |
| 3.5 | Checking open injectors | 424 |
| 3.6 | Checking return flow rate of injectors with engine running | 425 |
| 3.7 | Checking return flow rate of injectors at starter speed | 429 |
| 3.8 | Removing and installing injectors | 432 |
| 3.9 | Removing and installing high-pressure lines | 436 |
| 3.10 | Removing and installing fuel rail | 442 |
| 4 | Air filter | 444 |
| 4.1 | Assembly overview – air filter housing | 444 |
| 4.2 | Removing and installing air filter housing | 448 |
| 5 | Intake manifold | 451 |
| 5.1 | Assembly overview – intake manifold | 451 |
| 5.2 | Removing and installing intake manifold | 455 |
| 5.3 | Removing and installing throttle valve module GX3 | 460 |
| 6 | Senders and sensors | 462 |
| 6.1 | Removing and installing fuel pressure regulating valve N276 | 462 |
| 6.2 | Checking fuel pressure regulating valve N276 | 464 |
| 6.3 | Removing and installing fuel pressure sender G247 | 466 |
| 6.4 | Removing and installing air mass meter G70 | 468 |
| 6.5 | Removing and installing pressure differential sender G505 | 470 |
| 6.6 | Removing and installing charge air temperature sender before charge air cooler G810 | 472 |
| 6.7 | Removing and installing charge air temperature sender after charge air cooler G811 | 472 |
| 6.8 | Removing and installing fuel temperature sender G81 | 473 |
| 6.9 | Removing and installing temperature and pressure sender for low-pressure fuel system GX20 , vehicles as of model year 2020 | 476 |
| 6.10 | Removing and installing intake manifold sender GX9 | 477 |
| 6.11 | Removing and installing control unit for sensor electronics J849 / particulate sensor G784 | 477 |
| 6.12 | Removing and installing control unit for NOx sender 2 J881 / NOx sender 2 G687 | 479 |
| 6.13 | Removing and installing control unit for NOx sender J583 / NOx sender G295 | 483 |
| 6.14 | Overview of fitting locations - exhaust gas sensors | 490 |
| 7 | Engine control unit | 493 |
| 7.1 | Removing and installing motor control unit J623 | 493 |



| | | |
|-----------|---|------------|
| 8 | High-pressure pump | 494 |
| 8.1 | Assembly overview – high-pressure pump | 494 |
| 8.2 | Removing and installing high-pressure pump | 497 |
| 9 | Lambda probe | 504 |
| 9.1 | Assembly overview – lambda probe | 504 |
| 9.2 | Removing and installing Lambda probe 1 before catalytic converter GX10 | 506 |
| 26 | - Exhaust system | 510 |
| 1 | Exhaust pipes and silencers | 510 |
| 1.1 | Assembly overview – silencers | 510 |
| 1.2 | Separating exhaust pipes from silencers | 512 |
| 1.3 | Removing and installing front silencer | 513 |
| 1.4 | Removing and installing rear silencer | 514 |
| 1.5 | Aligning exhaust system free of stress | 516 |
| 1.6 | Checking exhaust system for leaks | 517 |
| 1.7 | Installation position of clamp | 517 |
| 2 | Emission control | 518 |
| 2.1 | Assembly overview – emission control | 518 |
| 2.2 | Removing and installing catalytic converter | 539 |
| 2.3 | Removing and installing particulate filter | 547 |
| 3 | SCR system (selective catalytic reduction) | 552 |
| 3.1 | Assembly overview – reducing agent tank | 552 |
| 3.2 | Assembly overview - delivery module for reducing agent | 553 |
| 3.3 | Assembly overview – filler tube for reducing agent tank | 554 |
| 3.4 | Assembly overview - injector for reducing agent N474 | 555 |
| 3.5 | Removing and installing reducing agent tank VX85 | 556 |
| 3.6 | Removing and installing reducing agent supply line | 558 |
| 3.7 | Removing and installing delivery unit for reducing agent metering system GX19 | 560 |
| 3.8 | Removing and installing injector for reducing agent N474 | 562 |
| 3.9 | Removing and installing control unit for reducing agent heater J891 | 565 |
| 3.10 | Draining reducing agent tank VX85 | 565 |
| 3.11 | Removing and installing filler pipe for tank for reducing agent | 567 |
| 4 | Exhaust gas temperature regulation | 569 |
| 4.1 | Assembly overview – exhaust gas temperature regulation | 569 |
| 4.2 | Removing and installing exhaust gas temperature sender 1 G235 | 572 |
| 4.3 | Removing and installing exhaust gas temperature sender 2 G448 | 580 |
| 4.4 | Removing and installing exhaust gas temperature sender 3 G495 | 583 |
| 4.5 | Removing and installing exhaust gas temperature sender 4 G648 | 587 |
| 5 | Exhaust gas recirculation | 589 |
| 5.1 | Assembly overview – exhaust gas recirculation | 589 |
| 5.2 | Removing and installing exhaust gas recirculation cooler | 591 |
| 5.3 | Removing and installing exhaust gas recirculation pipes | 600 |
| 5.4 | Removing and installing temperature sensor 2 for exhaust gas recirculation G690 | 603 |
| 5.5 | Checking exhaust gas recirculation cooler for leaks | 604 |
| 5.6 | Removing and installing temperature sensor 3 for exhaust gas recirculation G949 | 607 |
| 5.7 | Flushing exhaust gas recirculation cooler and exhaust gas recirculation valve 1 GX5 | 609 |
| 28 | - Glow plug system | 614 |
| 1 | Glow plug system | 614 |
| 1.1 | Assembly overview – glow plug system | 614 |
| 1.2 | Removing and installing glow plug | 616 |
| 1.3 | Checking glow plug | 621 |
| 1.4 | Removing and installing automatic glow period control unit J179 | 621 |
| 1.5 | Removing and installing knock sensor 1 G61 | 622 |
| 1.6 | Removing and installing knock sensor 2 G66 | 623 |



| | | |
|-----|---|-----|
| 1.7 | Removing and installing Hall sender G40 | 623 |
| 1.8 | Removing and installing engine speed sender G28 | 624 |