In 2010, BMW Motorcycles is entering the segment of super-sporty motorbikes with the BMW S 1000 RR. Performance at the highest level is achieved by the innovative 1000 cm³ four-cylinder inline engine with 142 kW power, as well as a very compact overall concept with a dry weight of 183 kg. The ambitious weight and aerodynamic targets combined with development of a powertrain suitable for racing whilst maintaining all the criteria for load registration presented the development team with extremely exacting challenges.
OVERARCHING OBJECTIVE

BMW has a long tradition of sport success with motorbikes. For many years, however, the commitment to the boxer engine and the driveshaft concept kept the door to the sportiest segment, that of the superbikes, closed to competitive concepts. A gradual approach taking in the successful K 1200 S and HP2 Sport models has now smoothed the path. Acceptance by customers as well as the commitment to international road racing is absolutely essential in this segment. Therefore, the objective was clear for the development team: to achieve the benchmark in road-registered superbikes from a standing start and to see the motorbike placed several times in the top 10 in the world championship – irrespective of the lack of experience on road-racing courses – even before the start of sales.

The focus of the technical concept was directed towards implementing the specified performance, weight and aerodynamic targets. At the same time, the machine was once again to demonstrate typical BMW virtues such as perfect ergonomics, outstanding handling properties and the best active safety in the competitive environment. Technical highlights include the rider assistance systems such as traction control, racing ABS, automatic gearshifts as well as an innovative digital cockpit with adjustable ride modes.

SPECIAL ASPECTS OF THE DEVELOPMENT PROCESS

These demanding targets and the development period limited to four years – the clock started ticking when the first diagram was made – called for lean project management and a team of extremely highly qualified engineers and designers. The project always took absolute priority within the overall development programme.

BASIC ENGINE CONCEPT

The main objective of the basic engine, was to achieve the lightest possible construction, smallest dimensions as well as a shaft configuration that would permit a long swing arm despite the relatively short wheelbase. In spite of its extremely short-stroke configuration, the engine with a 32° angle has a minimum design width.

The horizontally split cylinder crankcase weighing 16 kg is made from heat-treated AlSi7MgCu0.5 T6 using the chill casting process. The one-piece forged crankshaft is produced from heat-treated and annealed 31CrMoV9 at the BMW Motorcycles plant, and is gas-nitrided. The gears for the primary drive and for the starter drive are located on the crankshaft.

The forged 3-ring pistons have fully machined upper piston surfaces, and weigh only 253 g each together with the ring pack and pin. The piston is cooled by means of oil spray nozzles bolted into the crankcase, which obtain their oil from the main gallery on the outlet end. The steel conrods made from 36MnVS4BY are cracked at the big end.

The cylinder head is a casting made from AlSi7MgCu0.5 T6 and weighs only 8.3 kg. It is heat-treated and has been configured with great delicacy for geometrical rigidity. The asymmetrical undercut valve seat rings and the machined transitional zones in the induction duct ensure that fresh gas can flow optimally into the fully machined combustion chamber.

The timing mechanism has an underslung intermediate gear. This means the timing chain is very short, whilst at the same time the diameters of the camshaft drive gears can be kept very small. The plasma nitrided camshafts are produced from 31CrMoV9, whilst the forged finger followers are DLC-coated. The large titanium valves are supported on a single spring at the exhaust end, and a double spring on the induction end.

The mechanically operated wet clutch with ten friction discs is arranged on the right in the riding direction, and is actuated and lubricated with oil through the gearbox primary shaft by means of pressure rods. As is typical of the class, the clutch has a back-torque limiter system (BTL) which automatically restricts the torque transmitted by the clutch when there are high braking torques at the rear wheel. The constant-mesh 6-speed gearbox is fully integrated in the crankcase. For package and weight reasons, this configuration was deliberately preferred over that of a cassette gearbox.

Particular attention was paid during the design of the engine peripherals to achieving good vehicle and aerodynamic properties. Intensive simulations combined with