

UNITED STATES BANKRUPTCY COURT
SOUTHERN DISTRICT OF NEW YORK

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In re :
: Chapter 11 Case No.
: MOTORS LIQUIDATION COMPANY, *et al.*, : 09-50026 (REG)
: f/k/a General Motors Corp., *et al.* :
: Debtors. : (Jointly Administered)
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: MOTORS LIQUIDATION COMPANY, :
: *et al.*, :
: Plaintiffs, : Adversary No. _____
: vs. :
: BAYERISCHE MOTOREN WERKE :
: AKTIENGESELLSCHAFT, :
: Defendant. :
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ADVERSARY COMPLAINT

Motors Liquidation Company (f/k/a General Motors Corporation) (“MLC”) and its affiliated debtors, as debtors in possession (collectively, the “Debtors” or “Plaintiffs”), allege against Bayerische Motoren Werke Aktiengesellschaft (“BMW”) as follows:

PRELIMINARY STATEMENT

General Motors Corporation (“GMC”) entered into a contract with BMW for the development, production, and sale of transmissions in May 2004. The contract and its exhibits provide extensive specifications regarding the technical requirements for the transmissions. GMC, its Powertrain Group (“GMPT”), and its subsidiary GM Strasbourg SAS (“GM Strasbourg”), located in Strasbourg, France, fully complied with their obligations under the contract, developing and thereafter supplying transmissions to BMW in compliance with the

specifications. For its part, BMW was obligated, under the terms of the contract, to purchase a minimum of 1.9 million transmissions from GMC by December 31, 2015.

In late 2008, BMW requested an amendment to the contract under which GMC would supply different transmissions incorporating new technology that is not required by or provided for in the contract. GMC—and later MLC—negotiated in good faith with BMW, offering technological solutions and terms that, if accepted, would have met BMW’s requests. BMW, however, repeatedly rejected every solution proposed by GMC and MLC, and ultimately informed MLC that it did not intend to comply with its purchase obligations under the contract, but rather that it would shift production of transmissions to an alternate supplier. Remarkably, BMW further threatened to seek, through this Court, to recover damages from MLC.

Accordingly, a substantial controversy exists between the parties regarding MLC’s performance under the contract that warrants declaratory judgment. Moreover, because MLC has fully performed its obligations under the contract, the Court, applying German law, should order BMW to specifically perform its obligations under the contract. In the alternative, the Court should find that BMW, through its repudiation of the agreement, has breached the contract and caused MLC to incur significant and substantial damages, leaving MLC with no alternative but to seek redress from this Court.

PARTIES

1. Plaintiffs are Debtors in the above-captioned bankruptcy proceeding by virtue of having filed a voluntary petition for relief under chapter 11 of title 11, United States Code (the “**Bankruptcy Code**”) on June 1, 2009.

2. Defendant BMW is, upon information and belief, a German corporation doing business in Munich, Germany.

JURISDICTION & VENUE

3. This Court has jurisdiction to hear this matter under 28 U.S.C. §§ 157 and 1334.

This is a core proceeding under 28 U.S.C. § 157(b)(2)(A) and (O).

4. Venue is proper in this Court under 28 U.S.C. § 1409.

5. This proceeding is initiated pursuant to Rule 7001(1) of the Federal Rules of Bankruptcy Procedure.

6. This Court has personal jurisdiction over BMW because BMW has continuous and systematic contacts in the United States and in this federal judicial district.

BACKGROUND

7. GMC and BMW entered into the 6L45 Development and Delivery Agreement (the “**Delivery Agreement**”) on May 6, 2004. A true and correct copy of the Delivery Agreement is attached hereto as Exhibit A. General Motors Corporation thereafter changed its name to Motors Liquidation Company; MLC accordingly is the entity entitled to enforce the Delivery Agreement.

8. From its opening paragraphs, the Delivery Agreement makes clear its specific subject matter, a 6-speed automatic transmission to be developed and produced by GMPT and MLC’s subsidiary, GM Strasbourg:

1.1 Subject of the agreement is the development, design, production and supply, by GMPT to BMW, of a 6-speed automatic transmission system, specifically the 6L45 transmission. The system ... is to include an integrated electronic controller and related software as described in the list of specifications

(Exhibit A § 1.1.) The “list of specifications” for the transmissions is the “Lastenheft,” a 101-page, detailed recitation of technical requirements, attached as Exhibit I to the Delivery Agreement. (*Id.* at Exhibit I.)

9. The Delivery Agreement required BMW to pay GMC 19 million euros for development of the 6L45 transmissions between 2003 and 2006. (*Id.* § 6.1.1.) The Delivery Agreement also set forth a cost structure for the transmissions BMW was required to purchase from 2007 to 2010. (*Id.* § 6.3.3.1.)

10. Starting in 2008, the Delivery Agreement required that BMW purchase an average of 200,000 to 220,000 transmissions per year from GMC. (Exhibit A § 3.2.) In addition to the annual purchase requirements, the Delivery Agreement requires that BMW purchase a total of at least 1.9 million transmissions from GMC before the contract expires on December 31, 2015. (Exhibit A §§ 4, 5.1.1.) GMC fully complied with its obligations to design, develop, and produce the 6L45 transmission. From time to time during the design and development process, BMW initiated discussions with GMC concerning potential additional requirements for the 6L45 transmission, but the Lastenheft was never amended and BMW ultimately directed GMC to use the Lastenheft, in its original form, as the specifications for the transmission. In particular, in 2006 BMW expressed interest in incorporating into the 6L45 a technology commonly known as “ETRS,” or “shift-by-wire” and GMC responded by devoting technical resources to developing ETRS solutions as requested by BMW. Thereafter, however, BMW informed GMC that it was no longer interested in implementing ETRS technology into the 6L45, and at BMW’s direction GMC ceased its efforts to develop such a solution.

11. To enable GMC to accomplish the complex planning and capacity utilization necessary to meet its substantial obligations, the Delivery Agreement also requires BMW to provide GMPT with annual forecasts regarding the number of transmissions it will require for the following three-year period. (Exhibit A § 3.3.) Since 2007, BMW has ignored this requirement, consistently failing to provide GMPT with the required forecast.

12. In late 2008, BMW changed course, and informed GMC that it would like to add ETRS and, in addition, “Start-Stop” technology, neither of which is required by the Delivery Agreement. GMC met with BMW concerning these new technological requirements, and worked diligently to prepare a commercial solution for what would have constituted an amendment to the Delivery Agreement. By letter dated December 11, 2008, BMW escalated its requests into a demand that ETRS and Stop-Start technology be incorporated into all future 6L45 transmissions. A true and correct copy of the December 11, 2008 letter is attached hereto as Exhibit B.

13. Although GMC provided multiple proposals in an attempt to satisfy BMW’s continuously-changing demands for new technology so that the Delivery Agreement could be amended, BMW rebuffed each such proposal.

14. Ultimately, BMW sent MLC a letter repudiating the contract (the “**November 19, 2009 Letter**”). A true and correct copy of the November 19, 2009 Letter is attached hereto as Exhibit C. In the November 19, 2009 Letter, BMW informed MLC that it does not intend to purchase the number of transmissions required by the Delivery Agreement in 2010 or thereafter. (Exhibit C at 2.) This repudiation of its obligations under the Delivery Agreement means that BMW will fall short—by more than 1 million transmissions—of the 1.9 million transmission minimum purchase requirement contained in section 5.1.1 of the Delivery Agreement.

15. MLC responded to the November 19, 2009 Letter with a letter dated December 2, 2009 (the “**December 2, 2009 Letter**”). A true and correct copy of the December 2, 2009 Letter is attached hereto as Exhibit D.

16. In the December 2, 2009 Letter, MLC reiterated the obvious, that it had fully complied with the Delivery Agreement by providing transmissions with the technical

specifications required by the contract. (Exhibit D at 2-3.) MLC further stated that it has the ability to continue fulfilling its obligations under the Delivery Agreement and that it intends to continue fulfilling its obligations under the Capacity Guarantee section of the Delivery Agreement. (*Id.*; Exhibit A § 5.2.)

17. In addition to explaining that it has not breached the Delivery Agreement and assuring BMW that it will continue to satisfy its contractual duties, MLC also refuted BMW's attempt to blame MLC for its repudiation of the Delivery Agreement. (Exhibit D at 3.) MLC noted that BMW ordered fewer transmissions from MLC *solely because of BMW's business decision to switch away from the 6L45 automatic transmission*—the transmission MLC agreed to produce and BMW agreed to purchase under the Delivery Agreement. (*Id.*) The parties did not contract for such a change, and BMW's decision to switch to a different transmission is not a valid basis for repudiating and breaching the Delivery Agreement.

18. After exchanging these letters, representatives from MLC and BMW met in person to discuss their future relationship under the Delivery Agreement. At the December 10, 2009 meeting (the “**December 10, 2009 Meeting**”), BMW informed MLC that it intends to terminate the Delivery Agreement and stop purchasing transmissions from MLC in 2010. BMW's representatives also said that a final letter regarding the termination will be provided to MLC in February 2010.

19. By its actions, including the sending of the November 19, 2009 Letter, BMW has repudiated and committed an anticipatory breach of the Delivery Agreement. MLC is informed, and on the basis of such information believes, that BMW intends to shift its purchases of a six-speed automatic transmission from MLC to another supplier—and to continue to purchase transmissions without the ETRS and Start-Stop technology that supposedly were requirements

for future purchases of 6L45 transmissions from MLC. BMW's supposed negotiations with MLC for an amendment to the Delivery Agreement, and its subsequent stated reasons for canceling and repudiating the Delivery Agreement, were a pretext for an impermissible decision to terminate a contract with an entity involved in proceedings under Chapter 11 of the Bankruptcy Code.

20. Remarkably, BMW, having repudiated its obligations to purchase six-speed transmissions from one of its two suppliers of such transmissions, has actually threatened to seek "remuneration" from MLC for its additional cost of acquiring substitute transmissions from the other, now-single-source supplier, which—having been freed of competition from MLC—is able to dictate pricing terms to BMW. BMW has further threatened MLC that it will "take appropriate action in the Bankruptcy Court to protect its interests." (Exhibit C at 3.)

21. BMW is attempting to excuse its performance under the Delivery Agreement based on its allegations that MLC has not fully complied with the Delivery Agreement. Thus, MLC seeks declaratory judgment that it has satisfied its obligations under the agreement.

22. Moreover, because MLC has fully complied with the Delivery Agreement, the Court may order BMW to specifically perform its obligations to continue purchasing 6L45 transmissions under the Delivery Agreement. Specifically, BMW should be ordered to fulfill its obligation to purchase more than one million additional transmissions from MLC before December 31, 2015.

23. In the alternative, the Court should find that BMW has anticipatorily breached and unequivocally repudiated the Delivery Agreement by, among other actions, sending the November 19, 2009 Letter and orally informing MLC at the December 10, 2009 Meeting that it intends to stop purchasing transmissions under the Delivery Agreement in 2010. Accordingly,

MLC is not required to wait until BMW fails to purchase transmissions during the remaining term of the Delivery Agreement to seek damages for BMW's breach.

COUNT I

Declaratory Judgment

24. Plaintiffs repeat and re-allege each and every allegation contained in the preceding paragraphs.

25. A substantial and actual justiciable controversy exists between the parties regarding whether MLC has fully performed its obligations under the Delivery Agreement.

26. MLC and BMW have adverse legal interests.

27. The dispute regarding MLC's performance under the Delivery Agreement is of sufficient immediacy and reality to warrant the issuance of a declaratory judgment.

28. Accordingly, MLC seeks an order that it has fully satisfied its obligations under the Delivery Agreement.

COUNT II

Specific Performance

29. Plaintiffs repeat and re-allege each and every allegation contained in the preceding paragraphs.

30. The Delivery Agreement is a valid and enforceable contract.

31. MLC has substantially performed its obligations under the Delivery Agreement and is willing and able to perform its remaining obligations under the Agreement.

32. BMW's obligation to accept the goods is governed by German law according to the Delivery Contract. (Exhibit A § 12.1.) German law, in contrast to common law legal systems, provides for a claim for specific performance regardless of the satisfaction of further elements.

33. Accordingly, MLC seeks an order that BMW specifically perform its obligations under the Delivery Agreement.

COUNT III

Breach of Contract

34. Plaintiffs repeat and re-allege each and every allegation contained in the preceding paragraphs.

35. In the alternative, if the Court does not order BMW to specifically perform under the Delivery Agreement, it should find that BMW breached the agreement by repudiating it and award MLC damages.

36. MLC and its predecessors in interest have fully satisfied their obligations under the Delivery Agreement.

37. BMW has breached the Delivery Agreement by repudiating the contract and refusing to purchase the number of transmissions required pursuant to sections 3.2 and 5.1.1 of the Delivery Agreement.

38. As a result of BMW's repudiation and breach, MLC has suffered and continues to suffer monetary damages.

39. Accordingly, MLC seeks an award of damages, including interest, arising from BMW's repudiation and breach of the Delivery Agreement.

PRAYER

WHEREFORE, Plaintiffs request the entry of a judgment: (i) declaring that MLC has fully complied with the Delivery Agreement; (ii) ordering BMW to specifically perform its obligations under the Delivery Agreement or, in the alternative, to pay damages relating to its breach and repudiation of the Delivery Agreement; and (iii) granting such other and further relief as may be just.

Dated: New York, New York
January 25, 2010

/s/ Stephen Karotkin

Harvey R. Miller

Stephen Karotkin

Joseph H. Smolinsky

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Motors Liquidation Company, et al.

EXHIBIT A

6L45
Development
and
Delivery Agreement

Between: Bayerische Motoren Werke
Aktiengesellschaft
Petuelring 130
80788 München
Bundesrepublik Deutschland
- hereafter referred as "BMW"

And: General Motors Corporation
Acting through its
Powertrain Group
777 Joslyn Road
Pontiac, MI 48340-2920
United States of America
- hereafter referred as "GMPT"

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DEVELOPMENT AND DELIVERY AGREEMENT

This agreement made and entered into this 6th day of May 2004 ("the effective day") by and between Bayerische Motoren Werke Aktiengesellschaft, a company organized and existing under the laws of Germany, located at Petuelring 130, 80788 Munich, Federal Republic of Germany, hereinafter referred as "BMW", and General Motors Corporation, acting through its Powertrain Group, a corporation organized and existing under the laws of the state of Delaware, United States of America, with its headquarter located at 777 Joslyn Rd, Pontiac, Michigan 48340-2920, USA, hereinafter referred as "GMPT".

Whereas, GMPT is engaged in the business, among other things, of manufacturing and selling transmissions for use in vehicles;

Whereas, BMW is engaged in the business, among other things, of manufacturing and selling passenger cars;

Whereas, BMW desires to purchase from GMPT, and GMPT desires to manufacture and sell to BMW, transmissions for use in BMW's passenger cars, all in accordance with the terms and conditions of this agreement;

Whereas, BMW and GMPT on February 23, 2004 entered into a Confidentiality Agreement, on March 3, 2004, entered into a Memorandum of Understanding and on February 9, 2004 entered into a Warranty Agreement;

Now therefore, intending to be legally bound, the parties hereto agree as follows;



1. **Purpose and Requirements of the Agreement:**

- 1.1 Subject of the agreement is the development, design, production and supply, by GMPT to BMW, of a 6-speed automatic transmission system, specifically the 6L45 transmission. The system (hereinafter referred to as "Contract Goods") is to include an integrated electronic controller and related software as described in the list of specifications (see **Exhibit I** "Lastenheft"). GMPT may fulfill all or part of its obligations under this agreement through its subsidiary GM Strasbourg SAS, a company organized and existing under the laws of France, located at 81 Rue de la Rochelle, Strasbourg, France which shall be authorized to act on behalf of GMPT.
- 1.2 The purpose of this agreement is to enhance efficiency and speed up the processes of product development, production, logistic, avoiding redundant procedures, and achieving and maintaining optimum quality. The parties to this agreement are committed to principle of self-responsibility and are open to exchange of information to the extent to which this promotes the project, and to amicable cooperation in a spirit of genuine partnership.
- 1.3 The details of specific features of the works to be done and services rendered by GMPT, on one hand, and BMW, on the other, as well as a list of the specifications jointly completed by the parties hereto and describing the project in terms of technical specifications, dates and deadlines, weight and quality targets are set forth and determined in **Exhibit I** which shall form an essential and integral part of this agreement.

BMW shall be entitled, during usual official hours and without impairing GMPT's business operations, prior to GMPT's agreement, to obtain information in GMPT's offices on the overall status of project development and test results.

- 1.4 GMPT ensures that Contract Goods fulfill all worldwide homologation and certification requirements imposed by law as well as the safety and testing requirements set forth in the list of specifications (**Exhibit I**).
- 1.5 For direct product supply to BMW subsidiaries plants (i.e. Spartanburg, Pretoria, etc) the country specific conditions will be included in a separate agreement.

2. **Development (see Exhibit I):**

2.1 **Confidentiality:**

The provisions of the confidentiality agreement attached as **Exhibit V** apply to this agreement.

2.2 **Protective Rights, Exclusivity:**

GMPT shall remain the holder and owner of protective rights already in force at the time of conclusion of the agreement ("Vested Protective Rights") and shall inform BMW – to the extent to which such rights may be used in the development project – of the generation of the rights involved. In the event of protective rights held by third parties, GMPT shall inform BMW of such rightholders and/or applicants.

GMPT shall furthermore inform BMW whether and to what extent third parties are entitled to participate in the use of Vested Protective Rights, and to what extent GMPT itself is restricted in the use of such rights.

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- 2.2.1 To the extent to which the results of the development and design work done are protectable ("New Protective Rights"), such new protective rights shall be allocated to the party hereto whose employees performed the work and achieved the results involved.

BMW shall receive the right to use any and all New Protective Rights held by GMPT for production in BMW own works, such right of use being free of charge and not subject to any time related or geographical restrictions.

This provision shall also apply to protective rights held by third parties and used by GMPT within the context of sub-contracted services rendered by GMPT under this agreement. GMPT undertakes in such cases to ensure that BMW is entitled to use such protective rights. This provision shall also apply for GMPT in case of new protective rights held by BMW.

- 2.2.2 Should an application for New Protective Rights result from development work conducted jointly by GMPT and BMW, such application shall be made and maintained jointly on behalf of both parties unless one of the parties hereto waives its share therein.

In the event of such waiver by one of the parties hereto, the other party shall be entitled to submit and maintain the registration for protective rights in its own name and at its own expense.

- 2.2.3 Each party shall receive a simple entitlement to use such joint protective rights free of charge for the respective party's own requirements and shall pay the employee's invention fee required for this purpose by law.

Licenses for such New Protective Rights may be issued only with the due consent of the other party hereto and at appropriate terms and conditions of the type usual in industry. The parties hereto undertake to agree on such licensing conditions whenever such circumstances arise.

- 2.2.4 Should either of the parties hereto choose not to register an invention for New Protective Rights, not to further pursue a registration for New Protective Rights, or not to maintain or subsequently register New Protective Rights already granted, such party shall inform the other party immediately of such decision and, provided there are no fundamental objections, offer the inventions, the registration for protective rights, or the patent granted, to such other party. The party taking over an invention, a registration for protective rights as such, or share therein in the manner specified above, shall offer such rights or invention once again to the original rightholder before waiving and giving up the legal position obtained in this way.

Such offer shall in all cases be made in good time, enabling the other party hereto to take the measures required for the purpose of maintaining its rights, in particular for claiming priority of registration in the event of registrations made abroad.

- 2.2.5 The party ceding rights under such circumstances shall remain entitled to use such rights itself. In such an event the party ceding rights shall be responsible for paying the inventor(s) in its employment the usual compensation for inventions by employees.

- 2.2.6 All protective right release described in this section should be forwarded by the releasing party in writing to the patent department of the contract partner.

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2.3 Quality Planning:

- 2.3.1 GMPT undertakes to conduct quality planning in accordance with ISO/TS 16949 recommendation.
- 2.3.2 GMPT undertakes to inform BMW of any and all deviation from the quality planned as well as any indication that a quality problem will arise.
- 2.3.3 An essential prerequisite to this agreement is the competitiveness of GMPT's product regarding quality, technical functions and price at least compared to suitable competitors. Another such prerequisite is GMPT ability to provide sufficient production and delivery capacities.

3 Purchase and Supply:

- 3.1 BMW and its affiliated companies (§ 15 AktG) shall purchase and GMPT shall supply the Contract Goods in accordance with purchase orders placed by BMW and its affiliated companies in accordance with sections 3.2, 3.3 and 3.4 below, and accepted by GMPT. GMPT shall also supply Contract Goods to BMW subcontractors as named by BMW.
- 3.2 The average purchase and supply volume per calendar-year, commencing calendar-year 2008, is expected by both parties to be between 200,000 – 220,000 Contract Goods. This volume assumption shall be deemed as the basis of this agreement.
- 3.3 BMW shall provide GMPT with a rolling three calendar year forecast for capacity and budget planning no later than June 15th every year beginning in 2005.
 - 3.3.1 BMW shall provide GMPT with a six-months material release and include therein a three-months production release as shown in **Exhibit III** no later than the last working day of each months. The release orders shall clearly indicate the delivery points.
 - 3.3.2 In the event that BMW cancels more than 10 % within months four to six of six months material release order and does not subsequently reschedule the Contract Goods within the following three months, BMW shall be liable to GMPT, such liability being limited to the reimbursement of expenses for materials demonstrably and reasonably incurred by GMPT.
 - 3.3.3 In the event that BMW cancels any part of the three months production release order and does not subsequently reschedule the Contract Goods within the following three months, BMW shall be liable to GMPT for costs and expenses demonstrably and reasonably incurred by GMPT in reliance on the three months production release order up to a maximum payment of the then prevailing purchase price of the transmissions.
 - 3.3.4 In the event that BMW should reasonably postpone the introduction of the 6L45 in its vehicle models planned for model-year 2007 due to GMPT's inability to fulfill its obligations under this agreement, resulting in a failure to achieve the planned annual volume as set out in section 5.1.4, then BMW shall still be granted such prices in accordance with section 6.3.3.1 of this agreement that correspond to the annual volume that BMW would have achieved if no postponement due to GMPT's inability had occurred.
- 3.4 The parties shall agree on suitable delivery arrangements for periods of national holidays in Austria, the Federal Republic of Germany, France, United States of America and the Republic of South-Africa and schedule plant shutdowns in each party's respective plants.



- 3.5 GMPT undertakes to inform BMW in good time prior to any planned changes or modifications liable to have repercussions relevant to quality (e.g. organization, job procedure, production process, logistics, sub-suppliers). The approach to be taken in such a case shall be kept on record.

4 Contract Terms:

This agreement shall become effective upon signature. It shall expire on December 31, 2015. If BMW wishes to extend this agreement beyond such expiry date, then BMW shall notify GMPT in writing. Upon such notification GMPT and BMW shall enter into good faith discussions on the pricing for such extension period.

5 Volume and Capacity Guarantee:

5.1 Volume Guarantee:

- 5.1.1 BMW guarantees to purchase from GMPT a minimum of 1,900,000 Contract Goods over the duration of the agreement.
- 5.1.2 On BMW request, GMPT shall provide BMW with development services for ongoing series support and future development subject to a separate agreement (in particular on pricing) between the Parties. However, for the avoidance of doubt this section 5.1.2 shall not put any obligation on GMPT to develop new goods, i.e. different from the functionality of the Contractor Goods (Lepelletier concept).
- 5.1.3 In the event BMW terminates this agreement for reasons attributable to BMW prior to start of production, BMW shall reimburse and compensate GMPT for any cost and expenses reasonably incurred and resulting from the performance under this agreement, however, provided that such costs etc. did not result in investments, assets etc. which can be used by GMPT for other purposes. Apart from that, GMPT shall not be entitled to any additional reimbursements, costs or the compensation of damages or losses in relation to its performance under this agreement.
- 5.1.4 During the supply start-up period of calendar year 2006 to calendar year 2008, the purchased volume (+/- 10%) shall be as follows:

CY 2006	CY 2007	CY2008
20,000	150,000	200,000

- 5.1.5 For annual volume below 140,000 units in 2007 and 180,000 units after 2007, BMW and GMPT shall re-negotiate the pricing.
- 5.1.6 If the loss of volume is the result of GMPT's inability to deliver Contract Goods to BMW in sufficient quantity (see section 5.2) or quality (see section 2.3), section 5.1.1 shall not apply.

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5.2 Capacity Guarantee:

GMPT guarantees to be in the position to produce at least 200,000 units per calendar year, or at least 905 units per day. The capacity flexibility GMPT guarantees is 200,000 units + 20 %. If BMW would like GMPT to produce volume greater than the mentioned capacity flexibility, GMPT requires two years prior notification to ascertain whether it will have the capability to meet such volume requirements. Additional capacity may be put in place by GMPT provided the parties reach agreement on reimbursement of any additional cost associated with such capacity increase (See also **Exhibit III**).

6 Payment:

6.1 Development Work Cost:

- 6.1.1 Cost for the development work for the BMW applications listed in section 1.2 of the "Lastenheft" (see **Exhibit I**) rendered by GMPT and preceding standard production shall be paid separately as follows:

CY 2003	CY 2004	CY 2005	CY 2006
1.40 M €	9.10 M €	6.10 M €	2.40 M €

Overall amount of development cost payable by calendar years: 19.0 M €

Calendar year payment shall be effected on a quarterly basis. The quarterly payment amount shall be agreed separately.

December 2003: 1,400,000 Euros already paid.

- 6.1.2 Should BMW, after start of production of the final application envisaged in the "Lastenheft" section 1.2 (see **Exhibit I**), require additional applications, GMPT shall not charge the related extra application costs under the condition that the new applications are within the validated specifications as described in the "Lastenheft" (see **Exhibit I**).

6.2 Unit Prices for Prototypes:

6.2.1 Alpha Series for Prototype Units:

For units purchased in calendar year 2004: 60,000 Euros / unit
 For units purchased starting calendar year 2005: 50,000 Euros / unit

6.2.2 Beta Series for Prototype Units: 45,000 Euros / unit

6.2.3 Gamma Series for Prototype Units: 30,000 Euros / unit

- 6.2.4 Tooling costs for Prototype Units are included in the development work costs as described in section 6.1.1 of this agreement.

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6.3 Unit Prices for Production Units and Tools:

6.3.1 Tooling:

6.3.1.1 BMW's International Purchasing Terms and Conditions for the Purchase of Production Material and Automotive Components and Accessories shall apply to the manufacture, use and storage of production means (see **Exhibit III**).

6.3.1.2 Title in means of production shall be transferred to BMW in accordance with Exhibit III upon full payment of the relevant investment cost.

6.3.1.3 Specific BMW Tools (list below):

BMW specific tooling cost for annual volume capacity of 200, 000 units are:

- 4 Main Case Die Castings	2.300 M €
- 3 Converter Housing Die Castings	0.870 M €
- 1 Technical Module (TECHM)	0.680 M €
- 2 Output Shafts	0.500 M €
- 1 Output Flange	0.025 M €
- Upper Valve Body	0.740 M €
- Manual shaft Detent Lever Assembly	0.160 M €
- Park Pawl Actuator Assembly	0.160 M €
- Par Pawl Actuator Guide Assembly	0.160 M €
- Oil Pan	0.340 M €
- Torque Converter with Turbine damper	2.970 M €
- Contactless Internal Mode Switch	0.750 M €
- Towing	0.250 M €

Total rebillable tooling costs: 9.900 M €

6.3.1.4 Tooling Payment Conditions:

Payment shall occur as follows: 50 % after release of pilot sample
50 % after Start of Production

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6.3.2 Unit Prices for Production Units:

6.3.2.1 With exception to the aluminium content, the following unit production prices are firm prices over the life of this agreement as long as the annual inflation rate for the Euro zone, which is published by Eurostat, does not exceed 3.5%. If the inflation rate exceeds 3.5%, pricing shall be open for negotiation.

6.3.2.2 The prices include all the specifications included in the "Lastenheft" (see **Exhibit I**) except for the following items:

- QV 240 testing:

Cost and payment conditions shall be reviewed separately to this agreement.

- Shift-by-Wire (ETRS):

Both parties agreed that the Shift-by-Wire feature shall not be part of the technical content for initial start of production September 2006 date, but its implementation is mandatory for September 2008 (= vehicle launch). Incremental piece price and cost compensation for Shift-by-Wire shall be:

Piece price :	45 €
Tooling cost:	3.0 M €
Engineering cost:	2.8 M €

Note:

BMW target price: 40 € expected to be achieved by 2010.

6.3.2.3 Prices shall be adjusted, up or down; for engineering and/or design changes (i.e. section 6.3.2.2) provided BMW and GMPT have reached agreement on an appropriate price adjustment.

6.3.2.4 Prices are FCA Free Carrier GMPT Strasbourg plant, according to Incoterms 2000.

6.3.2.5 Cost decrease achieved by joint analysis shall result in shared price reductions.

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6.3.3 Production Unit Pricing:

6.3.3.1 Production unit pricing shall be based on calendar year (CY) volume including BMW affiliated company's volume and subcontractors (i.e. Magna Fahrzeugtechnik).

Calendar year 2006: Start-up price 1,260 €, volume approx. 20K, S.O.P. Sept. 2006

Volume (K)	140,000 – 180,000	180,001 – 200,000	200,001 – 220,000	220,001 – 240,000	240,001 – 260,000	260,001 – 280,000	280,001 – 300,000
CY 2007	1,215 €	1,210 €					
CY 2008		1,210 €	1,200 €	1,185 €	1,180 €*		
CY 2009		1,200 €	1,170 €	1,165 €	1,160 €*	1,155 €*	1,150 €*
CY 2010		1,195 €	1,170 €	1,165 €	1,160 €*	1,155 €*	1,150 €*

Prices marked with "*" are indications for prices which could apply should BMW require annual volume greater than 240,000 units. Prices shall be confirmed upon BMW's commitment to the related capacity increase and the conditions described in section 5.2. Additionally, the contract length and the minimum volume requirements would have to be increased to meet GMPT investments recovery rules.

Both parties agree that prices after calendar year 2010 are open for negotiation. Negotiations shall take place based on 2010 prices.

Target prices are the base prices mentioned in above pricing chart; market dynamics and economics have to be taken into consideration.

6.3.3.2 Incremental Prices:

In addition to the unit prices stated under section 6.3.3.1 BMW shall pay

For "All Wheel Drive": 45 € / unit

For converter with turbine damper:

- Calendar year 2006: + 45 €
- Calendar year 2007: + 40 €
- Calendar year 2008: + 40 €
- Calendar year 2009: + 35 €
- Calendar year 2010: + 30 €

Note:

BMW target price for converter: 20 € expected to be achieved by 2011.

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6.3.3.3 Price Adjustment for Volume Change:

The prices to be used are listed in section 6.3.3.1 of this agreement. The BMW annual production forecast for the following calendar year shall be forwarded to GMPT no later than October 15th of each year. Such forecast shall be the basis for the following calendar year prices.

If at the end of a given calendar year the actual purchased volume for that year exceeded or was less than the forecasted volume, then both parties shall adjust the prices in accordance with section 6.3.3 retroactively for the entire calendar year. Any payments resulting there from shall be due by the end of January of the following year latest.

For example, if BMW actual purchase volume for 2009 amounted to 230,000 units instead of 210,000 units as forecasted, then the price for a standard 6L45 transmission shall be reduced from € 1,170 to € 1,165 with retroactive effect for the entire year 2009.

6.3.3.4 Price Adjustment for Aluminium:

The prices for Contract Goods shall be subject to adjustment due to aluminium price fluctuations. The reference for aluminium price shall be the one reported in the German "Materialwirtschaft" newspaper. Adjustments to the agreed prices shall be yearly jointly considered with regard to the alloy prices movements. Movements in the yearly average aluminium alloy price exceeding +/- 10 % compared to the previous year price shall result in appropriate adjustments to the agreed prices for the Contract Goods. The new price adjustment shall be effective from the beginning of the year following the revision, and shall not be retrospective to the previous period.

Basis for this agreement:

Aluminum Alloy:	Aluminum 226
Aluminum weight:	22 Kgs
Aluminium Price:	1.84 € / Kg

6.3.3.5 Return of Excess Inventory, or Obsolete models:

In the exceptional event of excess inventory or obsolete models at one (or more) of the contractor plant(s), BMW and GMPT shall agree on the quantity of excess inventory and/or obsolete models, and GMPT shall re-purchase from BMW's the agreed quantity of excess-inventory or obsolete models at 60% of the Original Equipment Price as defined on the price chart section 6.3.3 and if appropriate, the units shall be used as service parts.

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6.3.4 Payment Terms:

Invoices shall be paid in full to GMPT's (GM Strasbourg) Banque CIAL bank account, on the payment terms of Net 30 days from the date of invoice or, GMPT's shipping document date.

Account holder: GM Strasbourg SAS
Bank name: CIC Banque CIAL
SWIFT: CMCIFR2S
Account Number: 10001167803
IBAN: FR76 10037 00100 10001167803 1

7 Service Parts:

GMPT commits to supply BMW, on request from BMW, with service parts for a period of fifteen (15) years after stop of series production.

8 Logistic:

Logistics integration of the contractor in BMW's system requires coordinated planning of logistics, taking into account any and all requirements of information and material flow, in particular the frequency of delivery and the condition of product upon delivery, the handling of transport and transport containers used, packaging, waste removal, handling of empties, and establishment of direct link to BMW's production plant and facilities.

BMW's logistics requirements are set forth in the list of specifications (see **Exhibit IV**). GMPT undertakes to plan and process its flow of information and materials in accordance with these requirements.

BMW shall advise GMPT also for the duration of this agreement in the interest of further development of the flow of information and material. GMPT shall endeavour to further develop and improve its logistics in agreement with BMW, and adjust its logistics system to new requirements.

9 Packaging:

The cost of packaging and racks shall be determined and agreed separately, then being recorded on the packaging sheet.

10 Warranty:

The provisions of the warranty agreement attached as **Exhibit II** apply to this agreement.

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11 Termination:

11.1 BMW shall be entitled to terminate this agreement if:

- the project can no longer be carried out at all or only at an unreasonably great additional effort, or
- there is a change in statutory provision, for example regarding the environment requiring new or follow-up developments or
- BMW wishes for other important reasons to cease work on the project or
- the parties are unable to agree on the exact scope and magnitude (e.g. costs, dates and deadline, scope of development) of individual project phases.

In the event of the agreement being prematurely terminated in accordance with section 11.1 above, BMW shall reimburse GMPT for substantiated expenditure resulting from the performance of this agreement and incurred up to the time of termination, including costs resulting from obligations assumed which may no longer be cancelled or turned down. GMPT shall not be entitled to any further claims for fulfilment or damages in the event of termination.

11.2 A party intending to terminate this agreement shall first notify the other party in writing of the grounds for the termination. In the event the other party fails to remedy such grounds for termination within ninety (90) days after receipt of such notice, then the terminating party may terminate this agreement effective immediately upon notice to other party.

11.3 Wherever the effect of specific provisions of this agreement extends beyond the term of the agreement as such, such provisions shall remain in force for such purpose after the agreement has expired. This applies in particular to the provisions set forth under sections 2.1 (confidentiality), 2.2 (protective rights), and 10 (warranty).

11.4 In the event of the agreement being terminated or ending for any other reason, any and all objects, drawings, other items, facilities, and tool placed at the disposal of one of the parties shall be returned to the party of origin regardless of whether work has been conducted on such object, etc or not.

12 Applicable Law and Forum:

12.1 This agreement and the rights and obligations of the parties hereto shall be construed and enforced in accordance with the Laws of the Federal Republic of Germany.

12.2 The parties shall carry out their respective obligations with diligence and good faith, and shall use their best efforts to settle amicably by negotiation any disagreement, which may result from the interpretation or the execution of this agreement (which shall include all the **Exhibits** thereto).

12.3 If the parties fail to settle such disagreements amicably by negotiations, despite using their best efforts, they agree to submit to the exclusive jurisdiction of the Landgericht Frankfurt.

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13 No Inducement:

The parties hereto represent to each other and each agrees that, neither it nor any person acting on its behalf has, in contravention of any applicable law, given or offered to give or will give or offer to give any sum of money or other material consideration to any person, directly or indirectly, as an inducement to obtain business hereunder or to influence the granting of licenses or other governmental permissions to enter into this agreement or perform obligations hereunder.

14 Amendments:

This agreement supersedes all previous agreements, written or oral, between GMPT and BMW with respect to the subjected matter hereof. No amendment or modification to this agreement shall be binding upon either party unless it is in writing and is signed by both parties.

15 Severability:

In the event any provision of this agreement shall be determined to be invalid or unenforceable under applicable law, all other provisions of this agreement shall continue in full force and effect. The parties are, in this event, obligated to replace the invalid provision with a valid one, which corresponds as far as possible to the spirit and purpose of the invalid provision.

16 Final Provision:

Unless agreed otherwise in the foregoing, the agreement shall be subject to BMW's Group International Purchasing Terms and Conditions for the Purchase of Production Materials and Automotive Components and Accessories.

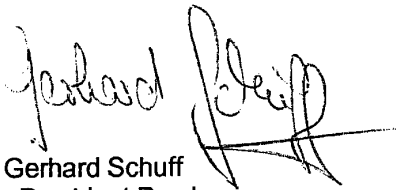


IN WITNESS WHEREOF, BMW and GM Powertrain Group have caused this Agreement to be executed in duplicate by their duly authorized representatives.

Strasbourg, this 6th day of May 2004

BMW GROUP AG

By: Prof. Dr. Burkhard Göschel
Member of the Managing Board



By: Dr. Gerhard Schuff
Vice President Purchasing



By: Klaus Borgmann
Director, Drive-Train Engineering


GM POWERTRAIN GROUP



By: Homi Patel
Group Vice-President



By: Michael Headly
Director International Sales



By: Marc Schiff
GM Strasbourg Président

	<p>LH/ Automatikgetriebe GM6 Specifications 6L45 A/T State of Requirements</p>	<p>LH 7 542 226.4 24.00 xxxxx.x</p>
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Notice :

The user of this document is required to check for the latest valid version

These specifications are an obligatory requirement for the construction, testing and reliability of the above trs, where its use is stipulated in contracts or in published documents.

They describe the requirements for the trs system and control the collaboration between the suppliers and BMW during its development.

Where significant aspects of the requirements set out in the specifications are not complied with by the suppliers then BMW may terminate the development at the end of a appropriate period of time, without any cost repercussions.

Seite 1 von 101

BMW			GMPT		
Abteilung Department	Datum Date	Name/ Unterschrift Name/ Signature	Abteilung Department	Datum Date	Name/ Unterschrift Name/ Signature
EA-71		Mischnick			Kiefer
EA-71		Müller			Ellahie
EA-7		Hall			Mirabitor-Spitza
EA		Borgmann			Lanzon

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Change log					
NÄL-#	Drawing index	Part Number	Short description	Date	Responsible
	A		Neuerstellung	01.01.2004	Mischnick
	B				

The data and changes not available at the time of lastenheft writing will be added as they become available, in agreement with GM and followed using the change log.

General

The specifications are a written summary of requirements that must be considered when developing individual vehicle components. They describe the required product characteristics and form amongst other things the basis for requests and negotiations, in particular for purchasers and suppliers (including sub-contractors). The specifications will not be modified after the production of the QV (quality requirements). The specifications form part of the development contract. The contractor confirms the validity when he signs the development contract. If there is no contract of this type, then the contractor confirms the validity through signing the specifications.

The requirements described in the specifications refer principally to the functional characteristics and life time demands. Further details can be found in the release documents
Requirements regarding the delivery and field quality are an explicit part of these specifications.

The implementation of the functions that are described in the specifications is to be carried out in close collaboration with BMW. The BMW technical departments are to be informed from the beginning on all aspects of the development in its various phases.

The appropriate documents and media (drawings, CAD files, etc.) are to be handed over to them
Components that are to be built into BMW vehicles can only be approved by the BMW technical department responsible for them.

Changes and extensions to these specifications will be agreed, evaluated and documented in the project team and will take the form of an "update list". Should BMW desire changes to the specifications during the course of the development then details of any costs arising therefrom (engineering and investment costs and prices of parts) are to be sent to BMW directly in writing, and without waiting for a request from them. There is also a duty of notification on cost savings which may result from changes in the requirements in the specifications or from improvements in construction and preparation details.

1.1 General targets

Boundary conditions

Tightening of the requirements regarding the product quality as a natural pre-condition for the maintenance and strengthening of competitiveness.

- Tightening of the emission law regulations both in Europe and worldwide.
- Increasing customer requirements regarding fuel consumption, driving dynamics (agility, spontaneity), acoustics, comfort and "cost of ownership".
- Drive towards cost reductions through increasingly intense competition.

Aims

- Exceptional driving comfort in all operating conditions at a constant and high level. Decline of a max. one "ATZ" point over the whole lifetime.
- Acoustics / Vibrations
Assuring the increased acoustical requirements of the PL2. This particularly for the following points:
 - Noise emissions of pump and planetary sets;
 - Extended ECCC operation, improved regulation compared to 6HP19, use of a turbine torsion damper for an effective reduction of rotational discontinuities in the powertrain (with closed TCC) starting from a speed of 1050 /min,
 - High bending stiffness of the powertrain (Natural frequency powertrain in vertical direction >190 Hz)
- With the implementation of a turbine damper, reduction of the fuel consumption by 3% compared with the 6HP19 with N52 MY05 in KV01 (ECE Fuel eco test) :
 - Measures to improve efficiency and reduce drag torques
 - Extension of the TCC control and closing area

- Consumption-optimised trs ratios

- Without implementation of a turbine damper converter, reduction of fuel consumption by 1% compared to 6HP19 with N52 MY05 in KV01 cycle through :
 - Measures to improve efficiency and reduce drag torques
- Driving performance which is customer-orientated and stall speed start perf at least as for E90/N52B30 MY05 with 6HP19
- Shift comfort (see annex 3-4) according to BMW evaluation system (Annex 3-5)
- Time optimised shift processes taking into consideration the aim of improving gear-shift comfort.
 - 3 levels (standard, quickshift 1 and 2)
 - Quick shift to distinguish the shift speed for down-shifting by one and by several gears, and also for up-shifting
 - During downshifts the turbine speed must take effect within 100 ms after the shift order
 - „Best in Class“ regarding possibility to abort shifts (through additional request, abortion of gear change or by multiple shifts, abortion of a part of the shift). The “compression” (here the shift as combination of single shifts, which are seamless executed, must end) of multiple downshifts should allow execution of further driver wishes as quick as possible.
 - Double downshifts must be executed either compressed in a raw without any engine speed gradient discontinuity or as direct downshift. 3 or 4 down steps must be executed completely compressed in a raw and as a combination of compressed direct and simple downshifts.
- Consistent lightweight construction to reduce the weight (target : 76.5 kg wet N52B30 4x2, W240 with TTD, 77 kg wet N52B30 4x4 W240 with TTD). Further mass reduction are wished to reach “Best in Class” stand.
- Consistent development and use of simulation tools and rapid prototyping
- Cooling: Compliance with BMW VR 17001 (volume flow to Cooler and transmission losses must guarantee compliance with VR17001). Future rework of the VR17001 procedure are to be jointly agreed by GM and BMW.
- Fill for life
- Safety mode strategy : 3. and 5th gear, i.e. v_{max} in the 5th gear
- Consideration of all actual laws and regulations valid at the start of series production and of the (date of start of series production (information from BMW)
- Recycling: No use of materials on the red list or of PVC
- Stabilisation of the product quality in terms of:
 - Fulfilling the Q target values for customer complaints
 - Achieving the Q target values for improvements
- to have electrical (ETRS) and mechanical shift option (ETRS option availability 09/2008)
- As small as possible number of variants (TRANSMISSION BROADCAST CODE)

1.2 SOP

- First use in the vehicle: 09/2006

The GM6 (6L45) is planned to be used for the first time in the following range of applications:

- 6 cyl. N52B30OLTÜ engine with max. torque of 300 Nm in E92 and E83MÜ to 09/2006
- 6 cyl. N52B30ULTÜ, N52B25OLTÜ, N51B30UL engine with max. torque of 250 Nm in E92 and E83MÜ to 09/2006
- 6 cyl. N52B25ULTÜ engine with max. torque of 230 Nm in E92 to 09/2006

Further uses in the PL2 (E9X) from 12/2006 on (Annex 1-5).

1.3 Quality and Reliability

Separate guarantee agreements are to be concluded between the client and the contractor (see also BMW guideline 018 "Guarantee" and "Guarantee agreement").

The quality test on the trs unit forms part of the system check and is to be made in compliance with the BMW quality regulations (QV). The QV is part of the transmission customer drawing to release transmission and must be available at the latest with the GAMMA phase.

1.3.1 Warranty target

Basically the aim is: No defects

The following numerical guarantee values for first complaints and first removals are not to be seen as targets but as response limits. They refer to the whole automatic system (including the controls) and apply both to new and replacement trs. The target for the overall complaints 24 months after production is 2%.

1.3.2 1st complaints and 1st trs exchange

First complaints are settled cases of guarantee claims with the lowest km at the time of repair per vehicle chassis number.

First removals are settled cases of guarantee claims with the lowest km at the time of repair per vehicle chassis number in which the had to be completely replaced.

The response limits for the whole automatic system at 20,000 km travelled after the year of production are ranked as follows

	2006	2007	2008	2009
First complaint till 20000 km	-	10000 ppm	6000 ppm	4000 ppm
First trs change till 20000 km	-	5000 ppm	3000 ppm	2000 ppm
Total	15000 ppm	15000 ppm	9000 ppm	6000 ppm

Since the GM6 trs mainly appears on the US market, the checks are made using US vehicles, and also through evaluations of the GM hotline and the mobile service. The requirements apply world wide.

1.3.3 Breakdowns

Breakdowns are cases which lead to the vehicle being left standing (these guarantee cases are given the number 99 in the BMW guarantee system, and are calculated to the 9th and 10th place of the complaint number).

No breakdowns caused by the scope of the automatic trs system are permitted within the first 15,000 km or 300 ppm up to 12 months after production.

In principle all registered breakdowns in the BMW guarantee system must be subjected to a cause analysis and suitable countermeasures should be implemented. An aid for this is provided by the analysis of all cases of breakdowns, which occur within the stated period of time. This information is to be made available from the BMW guarantee database.

The check is made based on the production volume for the US and German market. The reference size is thus the number of BMW registrations in the USA and Germany.

The requirements apply world wide.

Assessment and boundary conditions:

The stated targets apply for every trs-related inspection of vehicle types as well as for production periods up to a maximum of 3 months. Summaries can only be made within a vehicle or engine construction series.

Standard: Vehicle or engine construction series, 1st production quarter

The data to be evaluated must come only from the BMW guarantee database.

All GW data from the development of the automatic will be regularly (and at least monthly) made available to the supplier and the works quality departments Only those cases are valid which are of GW-type 1 und GW-stage 1-3.

- GW-type 1: Defect on the vehicle and sets of parts
 GW-stage 1: Guarantee according to purchase and delivery conditions
- GW-stage 2: Defect from the list "extended guarantee regulation"
 GW-stage 3: Act of fair dealing

The investigation of the actual course of events is made in accordance with the median level and the hazard procedure. The number of candidates will be assessed based on a given distribution of driving sections from the BMW comparison vehicles.

The investigated actual course of events must lie completely before the response limit. Where the response limits are exceeded then after a joint problem analysis the causes of the problem are to be assessed in accordance with the Pareto distribution by each possible person who might be affected (BMW and / or supplier).

The scope of the system includes the following complaint number range of the BMW-complaint number catalogue: 24000000 - 24610199: Automatic trs

Investigation of Plant and field rejects

All plant and field returns are to be checked in accordance with the latest state of technology. The investigation can be made with the assistance of BMW employees. Results of the investigation are to be sent to BMW development and to the works' Q-safety departments.

1.3.4 Werksrückläufer / Plant returns

Plant returns are es which are subject to problems or have to be removed within the BMW plants and before their delivery (km travelled = 0).
 The reference size is the volume of deliveries from the BMW inland plants.

The edge values are as follows :

	2006	2007	2008	2009
Works returns	< 1000 ppm	< 500 ppm	< 300 ppm	< 250 ppm

The share of plant returns in ppm are to be regularly (monthly) assessed and described by the supplier with the plant quality departments.

1.3.5 Application of targets

The targets are valid from SE (SOP).

1.3.6 Ensuring the quality targets

1.3.6.1 Undertaking risk analyses during the development

To fulfil the quality requirements the developer/supplier is to produce appropriate system FMEA's (product, process and construction) in accordance with VDA brochure no. 4 part 2 - ensuring the quality of series production - together with a software support like IQ-FMEA, these must be regularly checked and rolled over as appropriate to the progress of development and in case of changes.

Partial systems and processes are to be defined and must be evaluated in terms of their critical points using an appropriate analysis procedure. The assessment and the sequence and scope of the implementation are to be agreed with BMW. The procedure, measures and state of the implementation are to be presented in regular reviews. Corresponding documents need not be handed over, however BMW will be allowed to view them on request.

1.3.6.2 Quality plan to secure SOP

GM are to produce detailed time schedules and flow charts for the test planning, the pre-series and start of series planning, and for measures for preventative quality assurance. These are to be produced during the whole development phase, are to be agreed with BMW, and must show the current status.

1.3.6.2.1 Definition of tooling representative parts

To ensure the desired quality and reliability at start-up, 100% of the system components which are produced with series tools and machines (tool-related components) System components for the "Gamma" (availability of Gamma transmission at BMW in 10/2005). transmission must be available. The degree of readiness of the components up to the PPP series is to be demonstrated by the supplier. Here individual extents can be made in special or side processing, these must however be agreed with BMW.

Completeness of the testing means and test plans in the test and series start-up phases
BMW demands the following completeness quotas for testing means and plans for the component parts of the system:

Beta (BG1)	Gamma (BG2)	Pilot NS (VS)	Pilot S process series
40 % ¹	80 %	Aim: 100%	100 %

¹ Suitable prototype test means are permitted as replacements

Scope and level of performance for test means and plans are to be tested and determined in the corresponding teams before delivery.

At the latest, trs in the pre-series must be taken from the acceptance test stands intended for the series. The acceptance test stands must by this point in time be completely equipped.

The control software for the test stands must correspond to the state for the series, from the beginning of the pre-series.

The data end deadline (DET) must be at the latest 3 months before the start of series production (SOP).

1.3.6.2.2 Quality info in the dev., Pilot and SOP phases

From the beginning of the BG2 tests up to 3 months after start of series production all quality-related data must be made available to the project management of BMW and the supplier.

1.3.6.2.3 Pilot phase

To ensure the required readiness for start-up a pilot phase is to be planned in covering a representative production charge (100 to 150 pieces). The trs in the process series must demonstrably be in a saleable condition. The review and determination of the scope of equipment is to take place after joint agreement (for details see the BMW guideline for process series).

1.3.6.2.4 Functional and durability demonstration of pilot trs

Before the first start of series production and as part of the first samples of first sample trs (for definition see DIN 55250 part 15), evidence of functionality and reliability is to be provided.

The tests will be carried out on the test stand and in the vehicle. The BMW lead works is responsible for the testing.

The detailed requirements are defined in the corresponding quality regulation.

Test sets, engines and vehicles have to be approved in writing by the responsible technical development department of BMW.

The provision of engines and vehicles will be ensured by the BMW technical departments.

Evidence of the reliability of the first sample es is to be carried out based on the following requirements :

Combustion engine test stand :

Carried out by the supplier.

In general, the following guide line applies : A serial dyno bench test in the production start phase is not necessary if sufficient tests have taken place in the development phase.

Vehicle :

Carried out by GM

Boundary conditions

Test procedure: Customer-oriented operation (analogous to DE08)

Design: N52B30OLTÜ in relevant vehicles

Number of vehicles: Corresponding to the planning for the pre-series

Minimum test duration: 15.000 km/ trs

Requirements

In any verification test should appear failures that :

Are safety relevant.

Would lead to a walk home in a vehicle.

Would lead to a not planned dealer visit.

Every end of test transmission must be torn down and investigated with responsivles from BMW engineering and Plant quality. A tear down investigation report must be issued and communicated to people designated above.

1.3.6.3 Additional serial trs dura demonstration at the supplier

Accompanying reliability tests beginning with the pre-series are to be made without any gaps up to the start of series production. The audit checks from the start of series production will be set out in a quality regulation. Test procedure, engines and vehicles have to be approved in writing by the responsible technical development department of BMW.

Vehicles and engines are to be made available by BMW at the specified time.

The following describes the scope of the accompanying reliability tests.

In the serial production beginning phase

A start-up phase is:

- In general at the start-up of a new trs
- In particular with volume, functional and process-relevant changes in the trs
- And with volume and functional relevant changes in vehicles and engines

As given following joint determination by:

- The BMW development department
- The BMW works quality departments
- The suppliers.

On Dyno bench:

In general, the following guide line applies : A serial dyno bench test in the production start phase is not necessary if sufficient tests have taken place in the development phase.

In the vehicle:

Test procedure: Operation working closely with the client in accordance with the route details issued by BMW

Vehicle: According to the approval

Number/test duration/time period:

- At least 1 per week for at least 5000 km in the 1st to the 6th month.
- At least 0.7 % of the number of production units for at least every 100 km in the 1st to the 6th month
- At least 0.5 % of the number of production units for at least every 100 km in the 7th to the 10th month

In the production phase (starting 11 months after SOP)

Dyno bench:

On request

Im Fahrzeug / vehicle

Procedure: ORT

Vehicle: up to date released version

Number, date and length of tests:

- Up to 100,000 units/year. At least 0.25 % of the number of production units for at least 100 km each
- Above 100,000 units/year. At least 1 transmission per day of production for at least 100 km each

Tear down and evaluation

The following procedure is to be used with the trs tested:

Vehicle trs: Disassembly and assessment in case of complaint, and also during running performances over 1,000 km

Dyno trs (DP4, see. chapter 6.4.1.4): general disassembly and inspection

Production audits are also allowed.

The features catalogue (checklist) used to note the results of the inspection of the and to document the features tested, is to be agreed with the BMW development department and the factory's quality centres.

Assessment: Any deviation from the planned state must be corrected immediately.

Trs used for the 100 km test can be delivered as new trs once they have been externally cleaned, the oil level brought to the standard level for the series and once they have been given a special marking to indicate they are new trs. Trs from vehicle audits with more than 1,000 km operational performance are to be prepared for use as replacement trs.

1.3.6.4 Mobiler Service durch den Lieferanten / Mobile service

An intensive support service is to be provided by means of a mobile service unit to allow early recognition and correction of any problems, which may occur in the field. There must be a comprehensive duty of reporting by the dealer to the central BMW offices in cases of complaints and in cases where a -transmission has to be taken out.

For this purpose, and for approximately 12 months, the supplier is to make available 3 employees to cover all the BMW/GM projects as a mobile service (the decision on the place where they are to be based is left to the supplier). The supplier is also to provide an employee for the BMW hotline (customer service centre in Munich or the contact office of the supervising works).

Where necessary BMW will support the mobile service in identifying faults and in correcting problems. Specific contact persons are to be nominated before the start of series production.

1.4 General requirements

1.4.1 Documentation of releases

As a minimum the following documents (per annex 1-0) will be required for the release. They must be available in the German and / or the English languages.

- Drawings (as requested by BMW)
- Calculations (as requested by BMW)
- Quality regulations (BMW)
- Results / documentation on the safeguards for the test (BMW/supplier)
- Documentation on the faults, possibility and influence analyses (BMW/supplier)
- Mechatronics (TEHCM+VB)

1.4.2 Service parts and release and availability

The service release becomes applicable at the start of production according to the following guideline

Stage 1: Parts which can be replaced without having to remove the trs (e.g. oil sump)

Stage 2: Parts which can be replaced without having to disassemble the trs (e.g. torque converter)

Stage 3: Parts of the trs which can be replaced only after the trs has been taken out (clutches, etc.)

Only specifies the way service parts release must be documented (documentation of service level)

To ensure the availability of spare parts the last valid approval stock must be kept available as spare parts for a period of 15 years after the end of sales.

As an alternative, - and provided that the evidence of proper function in accordance with the specifications or the quality regulations has been provided by the suppliers, and provided it can be assured that the replacement can be competently carried out by the customer service - a newer system can be used following approval by the responsible BMW technical department.

1.4.3 Business economics

The costs of the parts of the have to be calculated by the suppliers and tendered to the BMW purchasing department. The comparison with the cost target developed by BMW will be made within a short period of time thereafter, together with the departments responsible for purchasing, development and product control. The development partners are called upon to demonstrate all possible cost reduction possibilities during the whole development and implementation time of the project (see also chapter 1.“General”). Cost alterations are to be demonstrated by the application of the change management system.

1.4.4 Liability

The manufacturer's liability is based on the current legal regulations – including those of other countries. The contracts with development partners and/or suppliers and with the BMW AG form part of these specifications.

Breaches of one or more paragraphs will lead to consequences in both criminal and civil law.

1.4.5 Environmental regulations and recycling

The requirements on the environmental impact of BMW products are to be complied with (see annex 1-2, note on the environmental impact of BMW products dated the 01.01.2002).

The GM internal specifications regarding environmental compatibility and recycling GMW-3059 and GMW-3116 and the ISO 14.000 cover 95% of the BMW requirements. If, during the development or the lifecycle of the product, any issue would occur in this field, then GM will propose countermeasures to fulfill BMW norms.

Appropriate to the materials delivered, the re-use of materials (recycling concept) and in particular the preparation and high-quality re-use of materials from old vehicles – where possible for use in new vehicles – is to be ensured.

Trs, which show defects within the guarantee period, are to be taken back by the suppliers and to be re-used or reprocessed at the highest possible level of recycling.

The proportion of production waste, which has to be disposed of, shall not exceed 10% of the (Mass) of materials used.

The details to be entered in the drawing text field for the trs order drawing must show the recycling class in accordance with BMW standard 11399.0. The supplier is required to present material information sheets at any time on request from BMW.

The use of halogenous materials (PVC, fluoropolymers etc.) and of lead, cadmium, mercury and hexavalent chromium (CrVI) in the transmission (incl. Dress items, protection caps, etc.) is not permitted.

The use of PTFE and Viton is allowed.

Part specific requirement for the trs

- Recommended means of re-utilisation: shredder
- Recycling rate in accordance with BMW standard 113 99.0: R1 or R2 (metal parts)
- Instructions on disassembly: none
- Selection of material:
 - Intensify use of light construction, replace secondary materials wherever possible
 - Minimise the diversity of materials used
 - Note separation of materials for key material connections
 - Where possible always use the same material alloys
 - Avoid functional coatings on metals which are not compatible with recycling OK
- Miscellaneous

For the economic and environmental-friendly recycling of operating materials (oils), a simple and rapid means for their complete extraction is to be provided. Recesses and pockets, in which lubricating materials may remain, are to be avoided. With the GM6 the oil drainage is made by means of a drain plug in the oil sump.

Use of environmental-friendly, lifetime lubricating materials (i.e. capable of being recycled and conforming to BMW GS93008-2). It must be possible to reprocess them in existing circuits.

The non-destructive disassembly of the Mechatronics module as fitted into the transmission must be ensured in order to permit recycling.

Specific requirements for components in the Mechatronics (Valve body + TEHCM) module

See chapter 4.2.1

1.4.6 Logistics

Suitable transport containers (transmissions racks) shall be designed and validated jointly between BMW and GM. These racks must be able to prevent any damage or deformation during transportation.

The requirements for recycling should also be complied with for the transport containers (see chapter 1.4.5). Further, the packing conditions are to be based on the BMW "packing handbook" (supplied on request).

1.4.7 CAD-Daten

In order to ensure a consistent flow of data compulsory for all users, the CAD files must be prepared in a way such that they can easily be re-used. In particular reference here is made to the BMW brochures

- Specific agreements on process chains from E46 on
- Performance agreements for a successful project

It is sensible to apply these to the preparation of files as well.

The drawings (e.g. design, control, single component, assembly and layout drawings), together with the incorporation and documentation of alterations to them, are to be produced by the supplier concerned, in accordance with GS 91005 and GS 91006, in agreement with the approval department in BMW.

The exchange of CAD files with BMW is to be made in STEP format

The construction and process-specific details are to be additionally set out in a CAD performance agreement.

Current information on the BMW systems environment and on the general aspects of CAD technology can be found on the Internet server <http://zulieferer.bmw.de>.

1.4.8 Confidentiality

The present document is subject to the duty of confidentiality in accordance with BMW guideline 6 "Security and confidentiality".

The supplier is bound to confidentiality in accordance with the guideline of the E-department E-8 "Confidentiality agreement and development contract".

1.4.9 Language

Technical regulations are as a rule to be prepared in the German and English languages, and where a special agreement exists, also in other languages. The basis for the translated version is the original language.

1.4.10 Distribution and archiving

The distribution and archiving of specifications is set out in GS 900000-1 and GS 90000-10.

1.5 Development agreement

1.5.1 Miscellaneous

The development of the GM6 automatic trs is to be made within a project structure which has been specifically drawn up for it and which is to be supported by the supplier and BMW % (see annex 1-2).

The project team works on the whole of the product development and implementation as well as on its integration into the BMW vehicle projects.

In the frame of system supply strategy, the supplier is responsible for the entire transmission system supply.

As a precondition for this the composition of the project team was selected in such a way as to represent the technical competences of all the departments of all the companies involved in the full discussion.

The co-operation is to take place in an open and friendly basis as partners, in accordance with the principles of Simultaneous Engineering.

The supplier and BMW will each nominate one project leader, who will be responsible for the tasks leading to project implementation.

Other valid documents are the confidentiality agreement, the development agreement and separate performance agreements for the GM6 as made between BMW and the supplier.

A joint development and test plan is to be agreed between all companies involved.

% The outline timetable (annex 1-3) and the scope of the tests (chapter 6) are designed to be a basis for this. From this basis the project management is to arrange for the production and maintenance of a project plan for the series development phase.

The project teams are to use these in developing the timetables for the detailing of the development processes and the preparation of the series, and they are to agree them with the project management.

Requests for changes, which may arise in the course of the development and production phase, are to be reported immediately, giving detailed reasons for them (duty of information). All changes arising during the whole course of the project - and in particular those relating to construction, timetable and cost – are subject to the obligation of agreement by all the departments responsible for the project.

The possibility for BMW to check all of the execution of all Lastenheft requirements must be provided all time.

Before delivery of the Beta trs , BMW is to be provided with the following calculation documents (per Annex 1-0) and results for the following components and parameters:

- Layout of gears
- Lifetime of the bearings
- Shafts
- Layout of the clutch, measurements of the geometry of the multiplate clutches
- Moment of inertia of the rotating parts :
- Efficiency and drag torque :

When the test trs is to be ordered (F2 release), BMW is to be given construction documents on request (e.g. component drawings, section drawings, parts lists, CAD files and Hydraulic/electric circuit diagrams) for the unit to be developed. Procedures for the exchange of files following start of series production are described elsewhere. From this point on they are subject to the change management.

1.6 Test

Detailed information on the method and scope of this can be found in chapter 4“Testing” of these specifications.

1.7 Notice on Specs and regulations

GS 91005	Technical drawings
BMW N 113 79.0	Technical regulations
BMW N 113 99.0	Recycling of vehicles, construction of vehicles as optimised for recycling purposes
GS 93008-2	Substances for use in components and materials, and which are forbidden or which have to be declared
GS 91006	CAD product description for vehicles
BMW guideline 018	Warranty / warranty agreement
BMW guideline 6	Security and confidentiality
BMW guideline E-8	Confidentiality agreement and development contract
BMW brochure “Specific agreements on process chains from E46 on	
BMW purchasing conditions for production material and vehicle components	
BMW packing handbook	
BMW manual on process series	
DIN 55350 part 15	First samples on first sample trs
DIN V 19250	Control technology, basic safety considerations for MSR -protective devices
DIN V VDE 0801/A1	Principles for computers in systems with safety-related tasks

TÜV-report

BM51647 revision 2.0

VDA brochure no.4 T2 Ensuring quality before series introduction

2 Agreement on interfaces performance

See annex 2-1.

3 Mechanical

3.1 Trs specific input data

3.1.1 Description of the trs

GM	BMW	
6L45	GA6L45R	Automatic
		<u>6</u> gears
		<u>L</u> longitudinal installation
		<u>45</u> size
		<u>R</u> GM

3.1.2 Trs shema

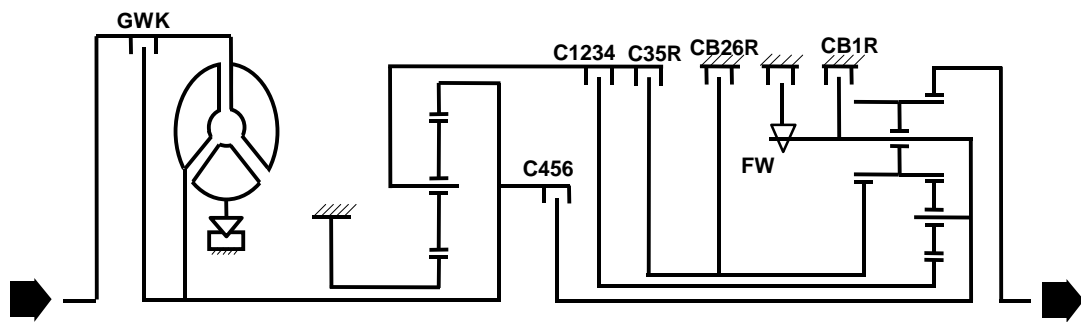


Fig. 3-1: Transmission shema 6L45

3.1.3 Construction art

- Eigendiagnose / self diag
- 6 automatically shifting forward gears
- 1 selectable reverse gear
- Planetary drive in coaxial construction
- Hydrodynamic torque converter with controlled converter clutch (ECCC)
- Hydraulic shifting device with integrated EGS (TEHCM)
- Electronic-hydraulic control of the shift point and the shift processes
- Mechanical shift option with 4 gear lever positions
- Selectable electrical shift option (ETRS) from 09/2008 onwards.
- Steptronic (stepwise gear shift)
- Self diagnostics

3.1.4 Ratios

Gear	<u>1</u> gear	<u>2</u> gear	<u>3</u> gear	<u>4</u> gear	<u>5</u> gear	<u>6</u> gear	R gear
Ratio	4,065	2,371	1,551	1,157	0,853	0,674	-3,2

3.1.5 Torque and speed capacity

	GM proposal	BMW request	Units
T_{\max} / at n_{Eng}	350/4000		Nm / 1/min
T_{\max} turbine forward gears 1-4	550	560	Nm
T_{\max} turbine forward gears 5.6	405		
T_{\max} turbine reverse	500		Nm
P_{\max} / at n_{Eng}	190 / 6500		kW/ /1/min
n_{\max} 1.-4. gear	7000		1/min
n_{\max} in 5. gear	6775	7000	1/min
n_{\max} in 6. gear	5200		
n_{\max} KD-gear change	7000		1/min
n_{\min} gear insert	540		1/min

*) planned value for future engines (NG6)

The layout of the trs is based on nominal engine values. Allowance is to be made for a short-term increase resulting from climatic conditions and production tolerances of altogether +14% (see also chapter 3.2.1). For target engine full-load curves N52B30, B25 and N51B30UL and for the theoretical limiting design, see annex 3-1.

Regarding the engine rotational discontinuities, engines N51, N52 and N53 are to be allowed for.

3.1.5.1 General

Torque converters of construction size W240R for the trs . The torque converters are fitted with a slip-controlled converter clutch (ECCC).

The converter clutch must meet the following requirements:

- o 500 1/min slippage for 2 s
- o 300 1/min slippage for 5 s
- o Continuous slippage of 100 1/min over the whole engine characteristics.

For the SOP 09/2006, only a W240R with turbine damper is going to be implemented. For the SOP after 09/2006, the damper technology must be flexible enough to choose the adequate one to meet the expectations of the applications. GM to check the feasibility of such an alternate damper technology and to inform BMW about the earliest possible SOP (at the latest SOP 09/2008).

Permissible total imbalance of the torque converter with oil: 200 g.mm. (According to LuK balancing procedure for converter cover including driveplate and pump).

The characteristics of the torque converter (see Annex 3-0) will be determined separately, in agreement between BMW and GM, and must be demonstrated by measurements.

In general BMW and the supplier are to agree jointly on the development of the various torque converter characteristics for all future vehicle/engine combinations. BMW is to specify the special requirements concerning driving performance, fuel consumption, driving comfort and cooling for every application, and also to take these into consideration when selecting the characteristics. The primary characteristic curves for the torque converter are to be presented and these are to be demonstrated by the supplier by means of measurements

A transport safety feature is to be provided for the torque converter, in agreement with BMW, for use during its transport. It should be easily dismountable and secure (blocking and centering the torque converter).

Type	Torque converter weight $m_{\text{ges_max}}$ (with oil)	Torque converter Moment of inertia*) $J_{\text{ges_max}}$ (with oil)
W240R	12,80 kg	0,0978 kg.m ²
W24R TD	14,34 kg	0,104 kg.m ²
W240R TTD	14.37 kg	0.104 kgm ²

*) Estimated values, the construction are still being worked on.

The inertia figures are to be reduced to the minimum technically acceptable.

Use of converter per engine:

Engine:	Max. engine moment [Nm]	Torque converter	Turbine torsion damper	Characteristic Mp2000 [Nm]	Stall Torque Ratio
N52B25UL	230	240R	with	154	2,01
N52B25OL N51B30UL N52B30UL	250	240R	with	154	2,01
N52B30OL	300	240R	with	171	1,9

Max allowed tolerances are defined as following :

v	μ	M_{P2000}
0	$\pm 5\%$	$\pm 5\%$
0,5	$\pm 3\%$	$\pm 5\%$
0,85	$\pm 3\%$	$\pm 5\%$

A tolerance of max $\pm 2\%$ is allowed on the speed ratio of the coupling point

[Die Toleranzen der Wandlerkennungen sind in der laufenden Produktion entsprechend den Angaben der QV zu überprüfen.](#)

3.1.5.2 ECCC

The behavior of the TCC must fulfill following criterias :

- Short reaction times at throttle tip-in or tip-out, to avoid engine over or underswing (Reaction time at least as quick as engine torque build up or down time).
- No feelable TCC transitions
- Driving dynamic function must be flexibly calibrated for BMW driving dynamic requirement. No negative engine speed gradients allowed.

ECCC operation the torque converter must fulfil the following requirements:

- The component test is to investigate the temperature of the friction surfaces for critical driving conditions (continuous operation) :
- The fatigue resistance of the oil / friction material is to be demonstrated
- The continuous test is to be made in accordance with the requirements from DE08, including the trailer component.
- The driving dynamics function/driving performance quality must be covered by the long-term stability area.
- Control range to $T_{Sumpf} = 130^{\circ}\text{C}$
- The following GWK operating points must be considered :

W240R :

Example	Gear	M_T [Nm]	Δn [1/min]	N_{mot} [1/min]
Full load acceleration	1 u. 2	VL	0-10	from 2000
City driving/consumption cycle	2/3/4/5/6	35 – 150	100	from 1000 (drive) down to 800 (coast)
Hill driving with trailer	2 and 3	200-220	80	from 2300
Motorway driving with trailer	<u>4/5/6</u>	350	50	from 1050

The number of ECCC transitions on the whole vehicle life will be defined jointly by BMW & GM.

GWK (ECCC) control range:: +10°C ... +130°C oil temperature.

The control and controlled closing of the converter clutch is proposed for all gears as defined in previous table and annex 3-2

The drag torques are to be measured and demonstrated, based on temperature, for the operating state with GWK open. Measures should be developed to minimise the drag torques.

The ECCC function is to be ensured in all gears from $n_{Eng} = 1050$ 1/min according to the data in the annex 3-2 until 130°C.

Above 110°C sump temperature, the heat dissipation capability of the ECCC system in regulation mode is decreased. Detailed power capability will be provided by GM when available.

3.1.6 Wet trs mass

The weight for the complete trs , including oil and converter (and including TTD) must not exceed the following values for the start of series production:

Standard drive (4x2): 76.5 kg with W240R-2GWK
All-wheel drive (4x4): 77.0 kg with W240R-2GWK

Depending on the stage of development the supplier is to state the weight as:

Estimated weight	Planned/actual
Weight of experimental parts	Planned/actual
Weight of standard parts	Planned/actual

Should the actual weight exceed what is presently the agreed target weight, then the supplier has to propose countermeasures to achieve the target. The implementation in production of these countermeasures will be decided together with BMW.

The supplier also undertakes to present possibilities for the reduction of the weight of the after start of series production, target being a “best in Class” transmission mass.

3.1.7 Trs length

The construction lengths of the trs –are to be documented by the supplier early enough in customer drawings. The following construction lengths apply (torque converter bell flange/ output flange and converter bell / flange transfer case.

Engine:	4x2 / 4x4	Length (flange to flange)
N5X	4x2	677.0 mm
N5X	4x4	639.1 mm

*) The tolerances will be documented in the installation drawing.

Installation position PL2:

Lengthwise: 2°28'

Transverse: 0°

Fitting position E83:

Lengthwise: 3°24'

Transverse: 0°

3.2 Engine and vehicle data

3.2.1 Engine data

Engine:		N52B25UL	N51B30UL	N52B25OL	N52B30UL	N52B30OL
Max. torque $\pm 5\%$	Nm	230	250	250	250	300
At speed	revs/ min	3500	3000	2900	3000	2750
Max. engine performance	kW	130	157	160	157	190
At speed	revs/ min	5800	6250	6500	6250	6600
cut-off speed ± 50	1/min	6500	7000	7000	7000	7000
min. idling speed	1/min	540	540	540	540	540
max. moment of inertia ¹⁾		0,115	0,118	0,115	0,118	0,118
$n_{\max \text{ KD}}$		6500	7000	7000	7000	7000

1) Engine with all ancillary units.

In principle, increased idling speeds of up to 1200 /min are possible and should be taken into consideration (NIC clutch,..)

The details for torque represent standardised type test values (990mbar, 25°C ambient temperature). Production, air-pressure and temperature-related variations in torque may appear during driving operation: GAS engines: - 27% to + 14%

A trs oil temperature of 90°C is to be assumed for the upper limit of the engine torque increase of 14%.

3.2.2 Vehicle data

Vehicle data see Annex 1-5.

3.2.3 Vehicle specific requirements

The requirements are valid for specific vehicles described in Annex 1-5

Max allowed gradient while driving :	50%
Max allowed lateral slope:	32%
Max allowed starting grade (Forward and Rev):	32% at GVW
Start of the vehicle after Park:	32% all round slope
Fording depth:	$\leq 500\text{mm}$ at $v \leq 8\text{km/h}$ for E83
	$\leq 450\text{mm}$ at max. crossing speed (E9X)

3.2.4 Lifetime

A max total failure probability of 2.5% is permitted for a mileage of 150.000 km. This is based on a representative time@torque/speed including 10% with trailer. In principle the time@torque/speed set is to be agreed with BMW.

3.3 Operating temperature

The maximum permitted oil sump temperature and the test conditions in the vehicle are governed by BMW test guideline VR 17001 (status: 2004). The location of the temperature measuring points for the prototype and the series trs is to be agreed between BMW and the supplier.

3.3.1 Temperature operating range

The permitted range of operating temperature lies between -30°C and +130°C sump temperature (analogous with test guideline VR 17001, status: 2004).

No damage to the trs should occur down to sump temperatures of -40°C.

The test of components for all non-metallic parts should be made at 160°, the exception being for the TCM, see below. In these tests the components of the trs are to be heated to a max. 160°, maintained at this temperature for 1h and finally cooled to a temperature of $T \leq 100^\circ\text{C}$. The full cycle is to be repeated 50 times.

The working of the TCM on the side is to be ensured for the temperature set given below, up to 143°C. (T measured in the oil sump).

An exceeding of the temperature of 143°C must be prevented by vehicle and trs -related hot modes.

Permitted temperature distribution:

Duration	At a temperature of
4600 h	110°C
1200 h	125°C
150 times 1 h over the full life cycle	135°C
100 times 0.5 h over the full life cycle....	143°C

Sonderfälle / special cases / Special circumstances:

An oil temperature of 140°C is to be allowed for in case of breakdown of the thermostat in the heating/cooling system. Should this happen it must not lead either to malfunctioning of or to damage to the trs. CounterMeasures must be developed to ensure the proper functioning of the trs in this case (e.g. temperature monitoring and subsequent service measures).

With the TCM switched off (transmission safety mode), there must be no damage to the TCM for a sump temperature of up to 150°C.

3.3.2 Cooler (water/oil)

The following cooling systems are proposed:

PL2 (E9X/E81, 82,87): heating/cooling concept with oil/water heat exchanger

E83: heating/cooling concept with oil/water heat exchanger

Max. pressure loss with an oil cooler flow of about 11 l/min (oil temperature 100°C):

PL2 / E83: 800 mbar incl. cooler tubes

The supplier is to state the maximum trs heat rejects -for the test conditions set out in VR17001.

3.4 Construction and design requirements

3.4.1 General

All the components are to be so formed that, during the prescribed lifecycle no changes take place which lead to deterioration in function.

Parts from subcontractors are to be tested by the supplier. The results are to be documented and made available to BMW on request. Any subsequent changes in parts are to be agreed with BMW.

All the components from the subcontractors which are presently with the supplier and which require approval in accordance with the following table are, for the defined test trs, to be registered and their main characteristics are to be documented: Only tested parts from the subcontractors can be approved. Any subsequent change without the agreement of BMW is not permitted.

List of those parts, which currently require approval:

Type of part	Complete (all parts)	Selected parts ¹
Sintered parts		x
Rolling bearing	x	
Sliding bearing (bushings)	x	
Gaskets ²	x	
O rings ²		x
Shaft sealing rings	x	
Piston rings	x	
Plastic mouldings		x
Friction plates	x	
Spring discs (wave plate)	x	
Spacer discs		x
Disc springs (belleville springs)	x	
Electrical sets	x	
E module (TEHCM)	x	
Hydraulic switch device (VB)	x	
Screens, filters		x
Range shifting system and parking lock components		x
Standard parts		x

Notes: ¹ controlled by GMS via the project-related list "supplier-related parts"

² only in relation to materials

The basic rule is that for every alteration which could have an effect on function or durability, (even for an alteration in the production process), a check should be made as to whether the construction- production FMEA should be rolled over, and which tests should be carried out again.

Constructional and / or production-related measures should be taken to avoid errors in assembly. Assembly and disassembly procedures are to be explained and demonstrated by the supplier before the provision of the test components for the various structural components. Devices for assembly and disassembly are to be prepared by the supplier before the provision of the test components and are to be made available to BMW. A manual on assembly and disassembly is to be developed, agreed with BMW and then to be fully complied with by both companies. Deviations from this are only permitted when jointly agreed and confirmed in writing.

All the test materials needed for monitoring the series are to be defined by the supplier during the development phase, and their suitability is to be demonstrated to BMW.

The location of the ID-plate on the trs and the contents of the ID-plate are to be agreed with BMW. In addition a barcode adhesive label is to be provided.

Replacement trs must be marked as such with the BMW AT # intended for this purpose.

3.4.2 Mechanical parts

3.4.2.1 Interfaces in general

BMW will make available for the development of the units the necessary constructional data on the trs interfaces (engine connection, support bracket, exhaust unit fittings, oil supply, vehicle cable harness, external wiring, output etc.), and will update this information should any changes occur.

3.4.2.2 Engine connection

The flange pictures for the following engines are to be considered for the external connection:

Flange picture: NG6 (N51, N52, N52TU)

Drive via connecting flywheel with 3 connection points, each with 1 no hexagonal bolt type M10.

- Division: 3 x 120 degrees
- Pitch diameter: NG6 234 mm

The connecting parts (flywheel/flexplate) of the torque converter will be constructed and tested by BMW.

BMW will agree the torque converter construction with the supplier, will hand over to the supplier all the concerned drawings, and will replace these should any changes be made (only affecting the interface).

3.4.2.3 Output flange for 4x2

Proposed for flexible discs with bolt circle diameter: 96 mm

3.4.2.4 Interface to transfer box

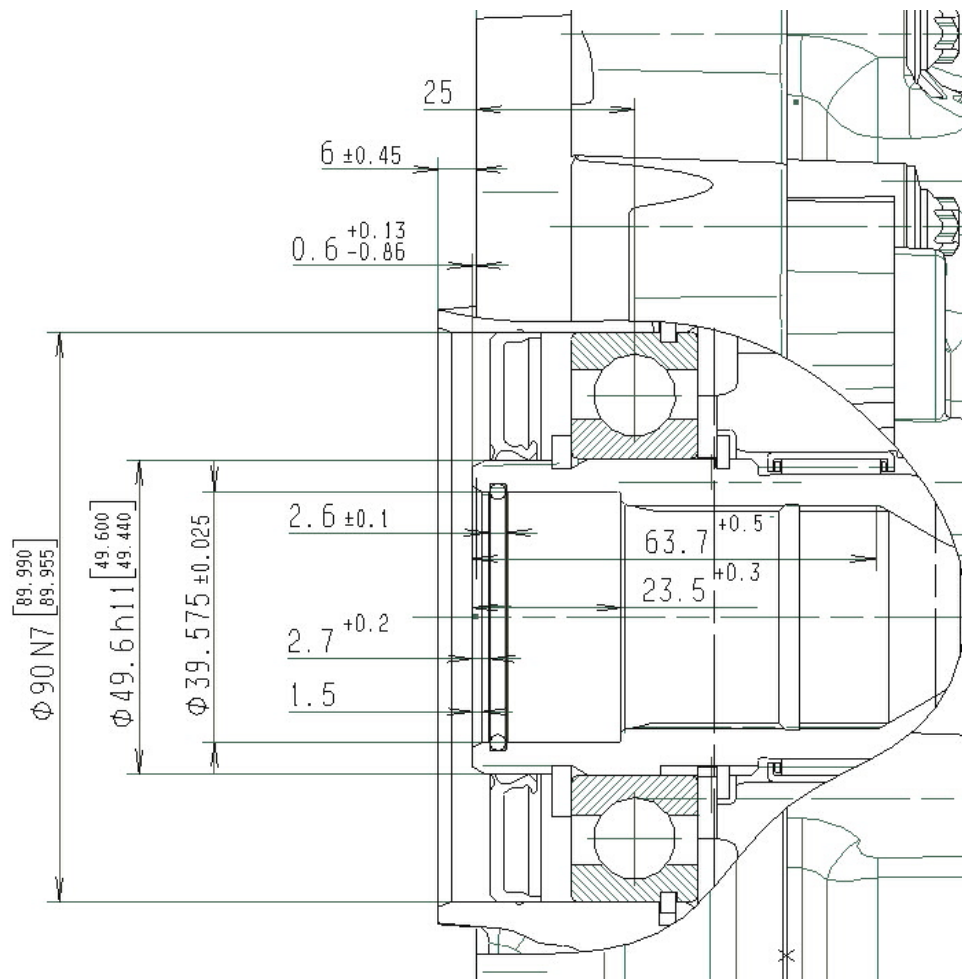
The 6L45 4x4 enters production in E83 and E9X/16 with the following transfer boxes :

E9X / 16: ATC300
E83: ATC400

The interface to the automatic transmission is the same for both transfer boxes.

Input shaft spline data of the ATC 300 / ATC 400:

Number of teeth	Z	43
Module	m_n	0,7938
Meshing angle	α_n	30°
Head diameter	d_a	33,35 ^{+0,2}
Foot diameter	d_f	35,2 ^{+0,2}
Dia on balls	max act min act	31,132 31,034
Ball Diameter	D_M	1,75
Aktuelle Bogenzahn­lücke	max act min act	1,3523 1,3029
Effektive Bogenzahn­lücke	min eff	1,247



Cross section of the ATC 300/400

The centering of the transfer box is done by the way of a centering diameter 90. On the 6L45, the external diameter will be machined. On the transfer box, the inner diameter. A dowel pin is helping the assembly. The dimensions and position of the dowel pin will be handed over to the supplier.

3.4.2.5 Park System

The parking lock is to be designed so that a secure blocking of the vehicle can always be assured for all the planned vehicle and trailer masses, and for up and down following gradients and a speed of $v < 2.0$ km/h.

4x2 vehicles :	4x4 vehicles :
12% at GCVW	17% at GCVW
32% at GVW	35% at GVW

The loosening moment on the selected shaft may in no circumstances exceed 8Nm.

The parking lock should not be able to engage at speeds of $v > 5.0$ km/h.

After setting the parking lock at the selection lever the trs must not be able to exceed a defined turning angle before locking in (measured at the output) (max. permitted movement : 150mm).

The park system of the transmission is to be designed so that in the target applications as known today (according to Annex 1-4), the removal and engagement of Park shall be evaluated with BI ≥ 8 on a level road. In a gradient the decrease of comfort evaluation is at the maximum of 1 point.

3.4.2.6 ETRS

The trs is to be designed both for electrical and for mechanical gearshifts.

The ETRS Lastenheft will be defined later and does not belong to the present Lastenheft for SOP 09/2006.

3.4.2.7 **Manual shaft / Detent lever**

With mechanical gear change there are 4 possible positions for the selected shaft (Torque profile of P-R-N-D in the trs). Related to the selection lever, 5 positions (P - R - N - D – S) as well as the Steptronic +/- are possible.

The torque profile on the trs selector shaft must not exceed 2.8 ± 0.7 Nm.

The torque profile on the trs is to be arranged so that the intermediate positions, and in particular P - R, R - N, N - D are not possible.

The excess and restoring torque between the positions, in particular between R and P, must not > 1,0 Nm.

The total angle from P to D is 34 degrees 9 minutes (P is fully forward with the gear level moving downwards). The angle between the individual positions is the same as for the 5L40-E.

In Mechanical safety mode (TEHCM fail), all driving positions must be selectable , commanded and available.

The activation is to be so arranged that the torque profile of the is the determining factor for the positioning (should not be transferred through external forces and shocks)

The selector shaft is to be provided as far forwards as possible on both sides. Each arrangement will be set out separately as needed.

The manual shaft exit and the manual shaft bracket bosses are on the left side for the standard applications and on the right hand side for the 4x4 applications. The coordinates of the manual shaft bracket attachment points as well as the position of the manual shaft will be defined together with the supplier.

The position switch (IMS) is integrated into the and can recognise the positions P, R, N, D.

Position switch: Signal P is transmitted only when P has been safely operated.

3.4.2.8 **Pump**

- The oil pump is to be so arranged that from an engine idling speed (see chapter 3.2.1) a secure transfer of the torque becomes possible.
- For TCC closing see chapter.3.1.5.2

The power loss is to be reduced to the minimum technically acceptable. This is to be demonstrated by the supplier on the basis of measured performance data (parameters to be determined by agreement). Regarding the acoustics at least the level of 5L40-E is to be achieved.

3.4.2.9 **ATF**

The use of a viscosity-optimised lifetime oil is to be provided for.

The supplier is to list any possible additional costs for the oil and its introduction.

Refilling in the service department and the oil level is made by means of the same rear right opening. A reclosable oil drain plug is to be provided in the oil pan.

The oil level is to be controlled dynamically in the service department:

In position P for an engine speed of 700 ± 100 1/min, a temperature between 30 and 50°C and with the vehicle standing horizontally.

The oil level is to be so arranged, that taking into consideration the tolerances and with the oil level set correctly then a secure operation of the trs under all occurring operating conditions can be assured.

$T_{\text{Sumpf}} \leq 150^{\circ}\text{C}$ No oil reject

$T_{\text{Sumpf}} \geq -10^{\circ}\text{C}$ No inlet suction noise during WOT take off on 32% slope

No inlet suction noise during idle stall in D or R on a 12% slope for 2,5 min

$T_{\text{Sumpf}} \geq -20^{\circ}\text{C}$ No inlet suction noise during WOT take off on 12% slope
No inlet suction noise during idle stall in D or R for 2,5 min

$T_{\text{Sumpf}} \geq -30^{\circ}\text{C}$ No powerflow interruption during WOT take off on 12% slope

The supplier's filling procedure must ensure for each type that the trs that the requirement mentioned above are fulfilled.

Permanent magnets are to be provided for on the oil quiet spots.

3.4.2.10 Hydraulic connections on trs housings and the converter housing

Oil cooler lines: Attachment of the to- and from cooler by means of a holding "eye" on the left side of the torque converter housing.

Pressure taps:

Up to and including BG2: Basically all taps are for all clutches, p_{WD} (converter pressure), p_{SM} (lub pressure), p_{WK} (pressure in the torque converter clutch), p_{Mod} (Modulierdruck), and Provide for p_{H} line pressure. The specific requirement and the arrangement is to be agreed between BMW and the supplier in each case.

Pre-series/series: For the test on the series test rig, only the pressure tap on the trs for $p_{\text{TCC OFF}}$ is proposed.

For future test trs all pressure taps must be supported.

The cooler lines connections on the are to be secured with closing plugs during delivery. A grease plug is to be used to prevent oil running out during assembly of the leads.

3.4.2.11 Sealing

The trs must be sealed towards the outside. All sealing parts are to be designed so that the working and temperature stability is given for the lifetime of the .

Testing of the ventilator primarily takes place during the vehicle test. During this a check should be made that any oil mist coming out from the ventilator does not lead to the formation of drops on the trs . In addition the test rig trial should include a check of whether all the areas of the trs are being ventilated by the ventilator.

It is possible that where there is a greatly increased water content, misdiagnosis and the reject of oil will occur. A test will demonstrate the effect on the quality of gear changing. There should not however occur any of the following functions :

- No loss drive or no reverse powerflow
- No miscommunication of the selected position
- Insure full function of Park System
- Correct engagement of selected positions and gears
- Correct communication of positive engine torque management
- Correct communication with LDM function (Enhanced ACC)
- Prevention of transmission tie-up
- Prevention of engine start with powerflow

The evaluation of the above mentioned function failure occurrence risk will be carried out and agreed jointly in the interface FMEA. Countermeasures will be defined and agreed jointly if necessary.

The max allowed water content in ATF will be defined by GM in tests and communicated to BMW. See also Chapter 4.4.3.

4x4 specific requirements for the breather:

The extended requirements for the E83 compared to the E9X/16 for the fording depth may lead to have a specific remote vent. The necessity of such a device can first be determined during the course of the development phase. Should a remote vent tube become necessary, the connection will be defined together with BMW and a protecting cap stays necessary. The remote vent tube will be designed and tested by BMW. The assembly is done at BMW. The breather connection will be designed and tested by BMW.

3.4.2.12 Transmission efficiency

CounterMeasures should be taken at the trs to reduce trs losses, in order to achieve the target of reduced consumption. Particular attention must be paid to the lower partial load area (reduction of slipping loss, pump drive performance). In any case, the requirements of the BMW Cooling guideline VR17001 must be fulfilled.

This should be demonstrated by the supplier using measurements of trs total losses and of efficiency (performance data: losses/efficiency as a function of load, speed, gear and temperature). For boundary conditions for the measurements see annex 3-3.

The constant trs loss behavior for the whole series production are to be demonstrated by means of audits.

Max allowed limits and procedures for the losses are to be set out in the QV. The definition of the audit frequency and the countermeasures to apply in case of violation of the max allowed limits will also be described in the QV.

3.4.2.13 Temperature sensors

The location and the arrangement of the temperature measuring points for the prototype and the series trs are to be agreed between BMW and the supplier.

3.4.2.14 Crash

Forces (resulting from the 5 miles crash and the travel), which are applied through the output flange and the housing, must be taken up by the trs without any resulting damage. 40 kN axial forces must be carried by the main case and the output shaft without damage in the case of a 5 miles crash.

3.4.2.15 Steptronic / Dual gate tap-up/tap-down

In the "Steptronic" operating mode, the manual gear selection, called up by a bi-directional touch switch on the outer selector lever is proposed. The requirement relates to up shifts and downshifts by one gear in each case.

The following operating range for the stepwise gear change is defined:

Starting process in gears 1, 2 or 3

Up shifting in gears 2 and 3 above 0 km/h

Up shifting in 4th gear above 20 km/h

Up shifting in 5th gear above 35 km/h

Up shifting in 6th gear above 45 km/h

Downshift in gears 1 and 2 above 0 km/h

Downshift in 3rd gear above 20 km/h

Downshift in 4th gear above 35 km/h

Downshift in 5th gear above 45 km/h

A forced downshift takes place for the return shift in gears 5, 4 and 3, at the limits given above.

For the stated operating range, gear changes in the full load range are permitted. The engine moment range corresponding the limiting design has to be allowed for.

In addition to the manual gear selection, forced up shifts are to be implemented where the upper limit of revolutions per minute is exceeded.

As an escape function, for the Kick down load position, down shifts will be carried out corresponding to the defined areas for KD shifts (including multiple reverse shifts)..

3.5 Hydraulic control

The hydraulic control of the transmission must be designed in a way that both mechanical and ETRS system can be handled.

3.5.1 Shift description

For the Garage shift reaction times (=time between command at TCU and reaction at the output), the following targets are given as a function of temperature, at zero vehicle speed and with idling engine :

		SSTS/Lastenheft						
ms		N/P-R	R-N/P	N/P-D	D-N/P	R-D	D-R	
Garage shifts	-25°C	t_Füll						
		t_Über						
		t_Verzug ges	2200	1800	2200	1800	2000	2000
		t_Synch	to be defined					
		Schaltzeit						
	-15°C	t_Füll						
		t_Über						
		t_Verzug ges	1500	1500	1500	1500	1500	1500
		t_Synch	to be defined					
		Schaltzeit						
	-10°C	t_Füll						
		t_Über						
		t_Verzug ges	1000	1000	1000	1000	1200	1200
		t_Synch	to be defined					
		Schaltzeit						
	0°C	t_Füll						
		t_Über						
		t_Verzug ges	<800	<250	<450	<250	<600	<600
		t_Synch	<300	<150	<300	<150	<600	<600
		Schaltzeit						
>20°C	t_Füll							
	t_Über							
	t_Verzug ges	<500	<200	<450	<200	<500	<500	
	t_Synch	<300	<150	<300	<150	<500	<500	
	Schaltzeit							

For SOP 09/2006 up- and Downshifts must be calibrated for 3 levels (comfort, Quickshift1 and 2).

For shifts level 1 and 2, the values in the following tables are valid. The Level 3 is at this time in the known vehicle powertrain combinations not to be used. It must anyway be available for SOP 09/2006. This level would be used upon request with less severe values of the following tables (valid for special sport applications to enter production after SOP 09/2006).

SSTS/Lastenheft: Level/Ebene 1 (Comfort modus)							
ms		Step 0% low speed	Step 0% high speed	Mid-trq lower Neng (Step)	Mid-trq higher Neng (Step)	WOT lower Neng	WOT higher Neng
1-2	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<500	<500	<500	<500
	t_Synch	<550	<650	<300	<400	<300	<500
	Schaltzeit						
2-3	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<500	<500	<500	<500
	t_Synch	<350	<500	<300	<400	<300	<400
	Schaltzeit						
3-4	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<500	<500	<500	<500
	t_Synch	<350	<500	<300	<350	<300	<400
	Schaltzeit						
4-5	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<500	<500	<500	<500
	t_Synch	<300	<450	<300	<350	<300	<400
	Schaltzeit						
5-6	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<500	<500	<500	<500
	t_Synch	<300	<450	<200	<250	<250	<350
	Schaltzeit						

SSTS/Lastenheft: Level/Ebene 2 (Quickshift 1 w. FDC)							
		Step 0% low speed	Step 0% high speed	Mid-trq lower Neng (Step)	Mid-trq higher Neng (Step)	WOT lower Neng	WOT higher Neng
1-2	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<400	<400	<400	<400
	t_Synch	<500	<600	<250	<250	<200	<350
	Schaltzeit						
2-3	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<400	<400	<400	<400
	t_Synch	<300	<450	<250	<250	<200	<300
	Schaltzeit						
3-4	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<400	<400	<400	<400
	t_Synch	<300	<450	<150	<200	<150	<250
	Schaltzeit						
4-5	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<400	<400	<400	<400
	t_Synch	<250	<400	<150	<200	<150	<250
	Schaltzeit						
5-6	t_Füll						
	t_Über						
	t_Verzug ges	200	200	<400	<400	<400	<400
	t_Synch	<250	<400	<100	<150	<100	<200
	Schaltzeit						

SSTS/Lastenheft: Level/Ebene 3 (Quickshift 2 - in Step)							
		Step 0% low speed	Step 0% high speed	Mid-trq lower Neng (Step)	Mid-trq higher Neng (Step)	WOT lower Neng	WOT higher Neng
1-2	t_Füll						
	t_Uber						
	t_Verzug ges	100	100	<300	<300	<300	<300
	t_Synch	<450	<550	<200	<200	<150	<250
	Schaltzeit						
2-3	t_Füll						
	t_Uber						
	t_Verzug ges	100	100	<300	<300	<300	<300
	t_Synch	<250	<400	<200	<200	<150	<200
	Schaltzeit						
3-4	t_Füll						
	t_Uber						
	t_Verzug ges	100	100	<300	<300	<300	<300
	t_Synch	<250	<400	<100	<150	<150	<150
	Schaltzeit						
4-5	t_Füll						
	t_Uber						
	t_Verzug ges	100	100	<300	<300	<300	<300
	t_Synch	<250	<350	<100	<150	<150	<150
	Schaltzeit						
5-6	t_Füll						
	t_Uber						
	t_Verzug ges	100	100	<300	<300	<300	<300
	t_Synch	<250	<350	<100	<100	<100	<150
	Schaltzeit						

Downshifts will be executed in a row in a seamless strategy or as direct double downshifts. Shift delays and shift times must respect the numbers given above.

SSTS/Lastenheft: Level/Ebene 1 (Comfort)									
ms		Step 0%	Step 0% Ausroll low Neng	Step 0% high Neng	InBetween lower Neng (Step)	InBetween higher Neng (Step)	WOT lower Neng	WOT higher Neng	
Rückschaltungen	2-1	t_Füll							
		t_Uber							
		t_Verzug ges	<350	<350	<350	tbd	tbd	<200	<200
		t_Synch	<500	<500	<550	tbd	tbd	<250	<350
		Schaltzeit							
	3-1	t_Füll							
		t_Uber							
		t_Verzug ges						<200	<200
		t_Synch						<200	<200
		Schaltzeit							
	4-1	t_Füll							
		t_Uber							
		t_Verzug ges						<200	<200
		t_Synch						<300	<300
		Schaltzeit							
	3-2	t_Füll							
		t_Uber							
		t_Verzug ges	<350	<350	<350	tbd	tbd	<200	<200
		t_Synch	<500	<500	<550	tbd	tbd	<250	<350
		Schaltzeit							
4-2	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<350	<500	
	Schaltzeit								
5-2	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<700	<800	
	Schaltzeit								
6-2	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<1000	<1000	
	Schaltzeit								
4-3	t_Füll								
	t_Uber								
	t_Verzug ges	<350	<350	<350	tbd	tbd	<200	<200	
	t_Synch	<400	<400	<400	tbd	tbd	<200	<300	
	Schaltzeit								
5-3	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<400	<500	
	Schaltzeit								
6-3	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<700	<850	
	Schaltzeit								
5-4	t_Füll								
	t_Uber								
	t_Verzug ges	<350	<350	<350	tbd	tbd	<200	<200	
	t_Synch	<400	<400	<400	tbd	tbd	<200	<300	
	Schaltzeit								
6-4	t_Füll								
	t_Uber								
	t_Verzug ges						<200	<200	
	t_Synch						<500	<600	
	Schaltzeit								
6-5	t_Füll								
	t_Uber								
	t_Verzug ges	<350	<350	<350	tbd	tbd	<200	<200	
	t_Synch	<300	<300	<300	tbd	tbd	<250	<300	
	Schaltzeit								

halten

		SSTS/Lastenheft: Level/Ebene 3 (Quickshift 2 - in Step)						
		Step 0%	Step 0% Ausroll low Neng	Step 0% high Neng	InBetween lower Neng (Step)	InBetween higher Neng (Step)	WOT lower Neng	WOT higher Neng
Rückschaltungen	2-1	t_Füll						
	t_Über							
	t_Verzug ges	<100	<100	<100	tbd	tbd	<100	<100
	t_Synch	<200	<200	<200	tbd	tbd	<150	<150
	Schaltzeit							
	3-1	t_Füll						
	t_Über							
	t_Verzug ges							<100
	t_Synch							<150
	Schaltzeit							
	4-1	t_Füll						
	t_Über							
	t_Verzug ges							<100
	t_Synch							<200
	Schaltzeit							
	3-2	t_Füll						
	t_Über							
	t_Verzug ges	<100	<100	<100	tbd	tbd	<100	<100
	t_Synch	<200	<200	<200	tbd	tbd	<150	<150
	Schaltzeit							
4-2	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<200	<300	
Schaltzeit								
5-2	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<400	<500	
Schaltzeit								
6-2	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<800	<800	
Schaltzeit								
4-3	t_Füll							
t_Über								
t_Verzug ges	<100	<100	<100	tbd	tbd	<100	<100	
t_Synch	<150	<150	<150	tbd	tbd	<150	<150	
Schaltzeit								
5-3	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<250	<300	
Schaltzeit								
6-3	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<600	<700	
Schaltzeit								
5-4	t_Füll							
t_Über								
t_Verzug ges	<100	<100	<100	tbd	tbd	<100	<100	
t_Synch	<150	<150	<150	tbd	tbd	<150	<150	
Schaltzeit								
6-4	t_Füll							
t_Über								
t_Verzug ges						<100	<100	
t_Synch						<350	<450	
Schaltzeit								
6-5	t_Füll							
t_Über								
t_Verzug ges	<100	<100	<100	tbd	tbd	<100	<100	
t_Synch	<150	<150	<150	tbd	tbd	<150	<150	
Schaltzeit								

Ebene 2: Verzugs- und Schaltzeiten zwischen Ebene 1 und 3

In the level 2 (Quickshift 1), the shift delays and shift times must be between level 1 and level 3.

Misuse shifts (for Ex. N-D or N-R with Nengine < 4000 RPM) will be handled with engine torque management up to 50% performed through the engine controller. Garage shift at engine speed > 4000 RPM and zero vehicle speed will be prevented.

3.5.2 Transmission protection functions

Safety for reverse shift, excessive speed and reverse gear are to be provided for by supplier. Engine speed over 4000 RPM in Park and Neutral will be prevented.

3.5.3 Neutral idle

The trs is NIC compatible. The description is to be found in chapter 6.4.1.7_

Neutral idle must be available at least from temperatures higher than 7°C, with and without A/C and by engine idle speeds up to 1200 RPM. The BMW AGS software can deactivate this function.

The D to Ni or Ni to D transitions must not be felt by the driver. The driver should not be able to differentiate the operation in Neutral idle from operation in Drive. This is particularly true for take off. The performance 0 to 100 km/h (starting with zero throttle) should not get worse by more than 0,1s with neutral idle. In case of reverse rolling of the vehicle, an exit of the neutral idle should happen as quick as possible, according to the requirements described in Chapter 4.2.5.2.1.

The influence of the neutral idle on the transmission "engine torque consumption" must be delivered properly by the transmission controller.

In order to achieve the start off comfort (rolling backwards on a hill), today's point of view is that a brake pressure signal should be made available. When applicable, the recognition of a trailer must lead to adequate reactions

3.5.4 Degraded or safety modes

In case of failure in the electronics (Power interruption) for forward movement the following gear changes will be made:

Failure in 1-3 gears	Emergency gear 3. gear
Failure in 4-6 gears	Emergency gear 5. gear

The Mechatronics including the hydraulic control is to be so arranged that no safety-critical issues according to the following list can arise :

- Wrong position (D instead of R or the contrary)
- Loss of powerflow in either D or R
- No Park engagement although demanded by the driver
- Unwished loss of Park
- Unwished shift to D or P (out of P or N)
- Display P when P is not engaged
- Display of the wrong position with powerflow in any position
- Keep of one driving direction while other direction has been engaged
- Failure of the positive engine torque management function
- Failure of the communication with LDM (enhanced ACC)
- Engine strat with Powerflow

The evaluation of the above mentioned function failure occurrence risk will be carried out and agreed jointly in the interface FMEA. Countermeasures will be defined and agreed jointly if necessary.

Trs with Manual gearshift:

With a mechanical gear shift the new start takes place in the 3rd gear.

Trs with e-gearshift / ETRS:

For E-gear shifts see LH E-gear shifts.

For countermeasures on the vehicle see LH-E gearshift (ETRS Lastenheft)

The ETRS Lastenheft will be defined later and does not belong to the present Lastenheft for SOP 09/2006.

3.5.5 Comfort evaluation

The assessment of comfort is made with ATZ values (see annex 3-5).

3.6 NVH

The investigations described in the following section are to be carried out by the supplier. The results of these are to be presented to BMW.

3.6.1 Execution

The measurements from the investigations of the acoustics and vibrations are to be recorded so that they are available as analog file forms later (up to half a year after start of series production) for follow-up investigations and comparisons.

The supplier is to retain one reference trs for acoustic reference, for each development level, and these should be available for later comparison tests. This trs represents the current state in acoustic development; its acoustic characteristics are to be adequately analysed and documented.

3.6.2 Share of NVH trs relevant properties

The supplier specifies the series of causes in BG1 from interlocking teeth, oil pump excitation and other predictable causes (e.g. speed of revolution of components and assembly groups).

From this point in time the supplier is to make available to BMW on request a trs model with the necessary and relevant data for the purpose of torsion vibration calculations for the and for the full drive ~~etrain~~ to be made available.

- Moments of inertia (building components both separately and altogether, ratio-dependent, related to input and output for fixed gear)
 - Torsional stiffness (building components both separately and altogether, -ratio-dependent, related to input and output for fixed gear)
 - Stiffness of shafts,
 - Total trs losses (load-dependent, e.g. full load / 50% partial load /Coast) for the full range of revolutions) and oil pump characteristic curve (moment vs. Revolutions),
 - Torque converter characteristic curve,
 - Control dynamics and properties of the torque converter clutch
- Friction coefficient for the clutches (in particular boundary conditions where needed).

3.6.3 Share of dynamic system properties of the engine transmission group

The supplier is to provide BMW with a finite element model of the trs in the form required by BMW for the purpose of making vibration calculations. This will be extended by the addition of the appropriate engine model to allow investigation of the powertrain dynamics.

3.6.4 Acoustic

Bei der Entwicklung des Getriebes ist auf Laufruhe und Geräuschoptimierung besonders zu achten. Dabei sind u.a. folgende Akustikthemen zu berücksichtigen:

During dev of the trs, attention should be paid to silent operation and noise optimization. In this frame, the following acoustic areas have to be taken into account (among others) :

In developing the trs particular attention is to be paid to silent running and the optimisation of noise. In doing this the following acoustic themes must be taken into account:

- “booming” resonances as a result of bending vibrations in the powertrain
- Gear noises
- Synchronicity of adjacent frequencies caused by excitation and natural resonances
- Noises from bearings. Particular attention should be paid to the bearings on the output shaft (e.g. avoidance of humming interferences)
- Oil flow sounds in the area of the converter and the oil pump
- Noises from the pump
- Buzzing and wailing sounds from the hydraulic components
- Air (inlet) suction from the pump (e.g. when running cold)
- Jamming (Shudder) in the clutches
- Rattling sounds in the parts with restricted play and which are not in the power train

- Noise radiation from the surface of the housing
- Limited vibration of the support bracket for the manual cable / emergency unlock device
- Noises during start up
- Adequate isolation from torsional oscillations from the torsional distortions in the engine through the torsion turbine damper and the ECCC.
- No gear noises when stationary

The connection of the switch cable / emergency unlock device is to include sound isolation. BMW is to be informed in every case where there is a worse acoustic result when compared with the preceding.

3.6.5 Noise evaluation

The vehicle applications to be investigated will be determined at the planning stage between BMW and the supplier.

The assessment of the noises is to be made both subjectively (assessment based on the ATZ assessment system, see annex 3-5) and through measurements made inside the vehicle. The boundary conditions stated in 3.6.5.2 are to be complied with.

In addition, in the early development phase and to allow the assessment of noise, measurements are to be made of the structure-borne noise from the trs housing (in the vehicle and on the test bed) and the airborne noise (on the test bed). The conditions in 3.6.5.3 are to be complied with.

3.6.5.1 Operating points

The following operating conditions are to be tested:

Case	Gear	Load	TCC mode	Speed range	Test method
a	1, 2, 3, 4, 5, 6, R	Part throttle, WOT, coast ^{1,2}	Open, closed	idle to n_{\max}^3	Subjective and technical measurement
b	N	Standing Rev-up		idle to 5000 1/min	Subjective and technical measurement
c	D	All customer relevant vehicle states	Based on pattern	Full range of revolutions and speed	Subjective, Technical measurement where needed

- 1 Unless otherwise agreed, for the test bed the test will drive to a partial load for an input moment of 75Nm/ 70 Nm and in coast an engine-based braking moment of 50 Nm.
- 2 Full load wherever possible.
- 3 Possible reduction of the max. revolutions in the 5th and 6th gear where safety risks may occur, in agreement with BMW.
- 4 The driving profile is to be documented in an appropriate manner.
- 5 Implementation in agreement with BMW; $v_{\min} = 10$ km/h.

In order to be able to measure all resonances without any difficulty, the measurements for (case a/b) are to be made when driving in a quasi-stationary state (change in the speed of revolutions of the turbine ≤ 100 1/min per second).

Other operating conditions, which need to be tested by measurements, may arise. In this case the additional procedure is to be agreed between BMW and the supplier.

3.6.5.2 Vehicle interior noise

The supplier investigates the airborne noise inside the vehicle at one measuring point or at a measuring point, which is relevant to trs noise. In doing this it must be ensured that the airborne noise requirements are complied with also at the measuring points defined in the BMW quality guidelines. Measurements at the points described in the BMW quality guidelines are only to be made by the supplier on request by BMW. All measuring points are to be precisely documented.

Any cases where the target values are exceeded are to be reported to BMW without delay. Should characteristics of the or unfavourable characteristics, which relate to the , be the cause for target values being exceeded, then countermeasures must be made to the and these must be agreed with BMW.

3.6.5.2.1 Requirement concerning transmission participation to vehicle interior noise

See also 3.6.5.1

Requirement type	Purpose
1. The trs must not draw disruptive attention to itself through conspicuous noises (based on the grading scheme see annex 3-5).	General qualitative req
2. Noise from the trs may exceed 3 dB in the neighbouring spectrums to the frequency spectrum (narrow band) (see annex 3-6).	Quantitative requirement for "does not make itself felt to an annoying extent"
3. The trs noise should not cause the required course of the speed related (tertiary) spectra to be exceeded (see annex 3-7)*. Measurement and evaluation to be made where needed at BMW.	Balanced general impression of drive noise, quantitative requirement

)* The fundamental spectra described for an engine revolution speed of $n_{\text{Motor}} = 3000$ 1/min is representative for the whole range of speeds above 1000 1/min. for every other speed the summed level of the spectrum will be adapted to the corresponding permissible total level of the inner noise. The frequencies of the motor arrangements with their corresponding harmonics and sub harmonics will be adjusted with the speed of revolution. The profile of the remaining fundamentals (spectra progression) stays the same.

The requirements on the (total) vehicle internal noise are related to the engine speed. This means that all the other requirements on noise are to be related to the engine speed. Minor deviations between transmission and engine speed (converter slip) can be ignored; in these cases $n_{\text{trsinput}} = n_{\text{Engine}}$ can be used. For greater converter slip the deviations in the target values in relation to the speed of the transmission input are to be taken into consideration.

3.6.5.3 Noise and vibration measurements (on the unit) on the transmission

3.6.5.3.1 Airborne noise radiation from the surface of the transmission

Der vom Getriebe abgestrahlte Luftschall ist zu ermitteln.

Eine gleichmäßige Schallintensität über die gesamte Gehäuseoberfläche ist anzustreben.

Die Ergebnisse werden BMW zur Verfügung gestellt.

The airborne noise reflected from the transmission is to be measured.

The intensity of noise to be evenly distributed over the whole surface of the transmission.

The results are to be made available to BMW.

Purpose of this tests is to recognize early enough if transmission participation to vehicle interior noise will lead to overcome vehicle interior noise targets

The measurements are to be made so that they can be compared with measurements made on known transmissions. The measurement and evaluation processes are to be agreed with BMW (measurement of noise intensity, operating conditions based on 3.6.5.1)

3.6.5.3.2 Measurement of structure-borne noise at the transmission

The transmission noise is to be measured directly on the transmission housing in the form of measurements of structure-borne noise. This makes an early recognition of possible problems possible (e.g. even with series production vehicles), it is not however sufficient to reveal all problems relating to transmission noise. For this reason the requirements in chapter 3.6.5.1 continue to apply without any restrictions.

Measuring points are to be chosen which are close to the connection points to the chassis (provisional, the final details will be made after the first checks on the transmission).

- Transmission rear end : On the transmission cross member, rear and transmission side for 4x2
- Transferbox rear end: Transmission support bracket on the A/T side for the 4x4.

Optional for the development phase :

- Manual shaft cable bracket: Measurement point close to the manual shaft cable bracket
- Measurement point in the area RS3

If the Measurement point on the transfer box support bracket is not accessible, then a point at the transmission flange at the rear right end will be defined. It must be verified that the measurement done at this replacement point are representative of the values that would be recorded on the support bracket.

The structure-borne noise is to be measured on three axis (longitudinal, transverse and vertical axis in relation to the vehicle coordinates system).

Exception: Measurement point "manual bracket" and RS3 – here only measure perpendicularly to the upper surface of the housing.

The frequency components will be assessed by means of the trs participation (e.g. gear meshing, oil pump etc.).

As **preliminary** boundary values gear mesh orders related to turbine revolution speed, linearised form) the values for accelerations at the measurement points are those listed in annex 3-8. Should these boundary values be exceeded then, then further steps should be discussed with BMW.

Operating condition See chapter 3.6.5.1

3.6.5.3.3 Noise at cranking

A combination of transmission housing resonance with the starter excitation frequencies must be avoided. Here, the change in speed of the starter from $n_{\text{starter}} = 1000$ 1/min to 2800 1/min at different boundary conditions (temperature, battery voltage) is to be taken into consideration.

In subjective assessment of the starter noise the airborne noise given off by the transmission on activation of the starter is to be ascertained. The structure-borne noise caused by the starter at the ends of the transmission is to be measured. The measurements and evaluations will be carried out by BMW where necessary.

Measuring point: See chapter 3.6.5.3.1.

Operating state: Starter operation without engine ignition

3.6.5.4 Transmission noise while stationary

With a stationary vehicle the following assessments are to be carried out:

- transmission noise whilst running idle with (electrical) consumers switched on and off (e.g. light, rear-window defroster and air conditioning)
- Consideration should also be given to trs noise during and after the change between various driving positions, in particular between the driving position changes N-D, D-N, N-R and R-N. The rapid gear changes D-R and R-D should also be considered here.
- trs noises and noises at the output length during engaging and releasing the parking lock.
- trs noises in driving position N for a range of speeds up to $n_{\text{Engine}} = 5000$ 1/min
- No gearing noises when stationary

Where loudness occurs corrective measures are to be suggested and these agreed jointly with BMW.

3.6.6 Vibrations of the of the powertrain

As it is part of the powertrain the trs and its vibration-related characteristics influences the vibrational behaviour of the whole powertrain /vehicle.

- Bending vibrational behaviour (e.g. bending resonances in the propeler shaft)
- Torsional vibrational behaviour (e.g. torsional resonance in the powertrain)

For this reason in each stage of the development in the trs design consideration is to be given to vibrations in the whole powertrain.

In particular the torsional vibrational behaviour of the powertrain is influenced by the layout of the trs (e.g. layout of the torsional damper in the torque converter) and must therefore be checked at every development stage. Should problems of noise arise which are related to the trs design , then corrective measures are to be developed together with BMW.

3.6.6.1 Controlled converter clutch (ECCC)

The ECCC is to be laid out for optimal vehicle acoustics. Should other requirements of these specifications be breached through such a layout, Further steps must be agreed with BMW. The following operating conditions are to be met:

- In all operating ranges attention must be paid to a sufficient isolating effect regarding engine speed oscillations.
- A short-term "brummen" during load change (changeover from drive/coast & coast/drive throttle operation) cannot be tolerated and is to be avoided by the use of appropriate measures (control strategy, turbine torsion damper etc.).
- With changes in load there should not appear any over- or underswing in the slip-
- An additional dynamic excitation from the ECCC is to be avoided (e.g. Overlay of firing order with system natural frequencies)
- The control dynamics of the converter clutch are to be demonstrated to BMW. Interactions with the engine control should not give rise to undesired phenomena (vibrations, load change phenomena etc.).

3.6.6.2 Imbalance

The details in DIN ISO 1940 apply. Guidelines for the static and dynamic imbalance were given to GM. Measurements will be done at BMW EA-73 to give concrete targets of imbalance for the transmission output. These targets will discussed and agreed with GM. For imbalances, which are more distant from the powertrain centre of gravity, i.e. in the area of the ends of the , further restrictions related to the sensitivity of the vehicle can be agreed to.

3.6.6.3 Powertrain bending vibrations

The lowest bending frequency for the - powertrain should be so far outside the covered frequency range of the dominant engine excitation, so that it does not get excited nor any noise disturbance increase appears due to transmissibility increase close to the resonance.

The following should be taken into consideration as dominant engine excitations:

- 1.5th engine order for 6-cylinder engine (NG6)

Under no circumstances however may the bending resonance in a vertical direction in the vehicle operation (with maximum fittings through ancillary units) lie below the following frequency:

- 190 Hz in vertical direction (N52) for standard applications
- 135 Hz in vertical direction (N52) for 4x4

In the transverse direction as stiff as possible is to be aimed for for standard applications. For the 4x4 applications, the target for the first lateral mode is 110 Hz

In all directions of oscillation, balanced, so-called „flat“ bending lines are to be aimed for.

The dominant acceleration level at the transmission cross member engine order, 1.5th engine order, firing order –must never exceed the values in attachment 3-8 during a vehicle standing rev-up.

3.6.6.4 Load change

The noise and perceptible changes in acceleration (jolt, jerk, clunk noise etc.) during load change (e.g. from drive to coast) are to be tested with BMW shift pattern. They are to be tested in the lower 2 gears at low driving speeds and in the upper gears with closed converter clutch and to be compared with the evaluation system in annex 3-5. Should problems occur the next steps are to be agreed with BMW.

3.6.7 Subjective assessment of noise

A subjective assessment of the noise in driving operation is to be carried out. In this particular attention should be made to conspicuous noises, which were not identified by the measurements described in sections 3.6.5.1 and 3.6.5.2. The result of this assessment is to be given to BMW. The individual noises are to be assessed in accordance with the evaluation system in annex 3-5.

The aim of the development is for all occurrences of noise and vibration:

Evaluation index ≥ 8

Should problems occur then appropriate measures should be suggested and these agreed jointly with BMW.

3.6.8 Preparation for additional acoustic countermeasures

A rubber flexible disc is proposed at the transmission output flange.

At the end of the transmission the possibility of a vibration absorbing system support is to be provided for.

As a maximum loading for the connecting points a vibrating force (inertial force of the vibration absorber) at a distance of around 50 mm behind the end of the transmission (distance from the rear vibration absorption connecting points against the driving direction) of around 500 N can be used as a basis. As a direction of the inertia force any desired direction in the plane vertical to the transmission output shaft is to be considered. The supplier, in agreement with the BMW technical construction department, is to suggest suitable connecting points for this. On completion of the conceptual development or once the characteristic bending frequencies of the powertrain have been identified, then BMW will decide whether it is necessary to develop an antiresonance mass.

3.6.9 Potential for improving the acoustics

In conjunction with the development the supplier is to demonstrate potential for improving the acoustics of the critical acoustic and vibration ranges. The measures are to be roughly estimated in terms of costs, deadlines, and development effort and target conflicts.

3.6.10 Long-term noise quality

Die Einhaltung der Geräuschanforderungen ist über die gesamte Lebensdauer hinweg sicherzustellen. Compliance with the requirements for noise is to be ensured for the whole lifetime.

3.7 Hinweis auf Normen und Vorschriften / Note on standards and regulations

BMW VR 17001	cooling guide line
%LH xxxxxx	ETRS
DIN ISO 1940	Imbalance items
GM-balancing regulation 0000701 912	

4 Electrical monitoring for 6L45

4.1 General information

Chapter 4 describes the electrical and electronic hardware extent for the transmission 6L45 of the company GMPT.

When errors with the transmission occur it must be brought into a safe condition for the vehicle.

Mechatronik is the objective solution, with TCU integrated in the transmission (TEHCM with external sensors (TISS, TOSS, CIM)).

4.1.1 Sample definition

A- Sample

- Operating model in order to test the technical feasibility of the projected series production part based on the A-sample-Spec.
- First function tests are possible.
- HW structure independently of the series technology.
- SW extent for first function tests has been merged.
- Project-specific requirements towards vehicle aptitude.

B- Sample

- like A- Sample, plus
- Representation of the function range in accordance with b-sample-Spec (tested).
- Function of the HW and SW within the demanded operating range.
- Endurance and environmental testing-suited/ability, also inside the vehicle.
- series near HW circuits/ circuitry, manufactured by the series supplier with auxiliary tools.
- Timing, Interrupt, Program structure, Running times pre-series status, if the underlying function is defined to accomplish pre-series status
- Housing / Case measurements as planned for series.
- EOL-programming possible.

C- Sample

- like B- Sample, plus
- A new edition of this specification sheet statement is provided to the C-sample of the controller, reflecting the current condition/s of the requirements.
- Fulfillment of all specification sheet requirements, HW and SW.
- The construction units/parts have to suit/withstand continuous endurance and environmental testing without any reservation and/or restriction.
- substantial work/production procedures as during quantity series production. The components are equipped with tool-falling construction units/parts.
- Supply of the demanded documentation in accordance with specification sheet statement and time schedule.
- Modifications and suggestions for improvement are treated as with series production.

Sample for process series of EGS

- like C- Sample, additional:
- Production on same production line as standard production sets.
- Delivery of all test reports of the hard and software investigations as demanded in the specification sheet statement.

4.1.2 Abbreviations and formula symbols

Tension and temperature specifications

T_U	Ambient temperature related to the clamping surface to the hydraulic controller. As far as nothing else has been explicitly defined, (293 ± 5) K applies.
T_ü	ExcessTemperature (time limited)
U_B	Operating voltage. The actual tension applied between VP and VM.
U_P	Testing voltage. Tension, with which the examination of certain characteristic values takes place.
V_M	Negative connection at the transmission plug.
V_P	Positive connection at the transmission plug.
V_A	Common power supplies for BS and ON/OFF.
V_S	Supply for TCU external sensors.
V_{CC}	Control-unit internal supply.

Abbreviations

TCU	Transmission control unit (ECU part of the TEHCM). Reference Name is GS19.12
TISS	Transmission input speed sensor (turbine number of revolutions / r.p.m.sensor)
TOSS	Transmission output speed sensor (driving gear number of revolutions / r.p.m sensor)
IMS	Internal mode switch (Position registration)
VBS	Pressure control valve (proportional valve)
ON/OFF	Single solenoid valve
tbd	still "to be defined"
P/N-hw line	Start locking line to the CAS
TEHCM	TCU + connection technique (plug/s, lead frame) + housings + Actuator system without TISS; TOSS, IMS. Reference Name is T43a.
E-Module	TCU + connection technique (plug/s, lead frame) + housings + Actuator system +TISS + TOSS + IMS
Mechatronics	E-Modul + valve body (hydraulic switchgear)
High Side 1	High Side driver (Supply switch able) for transmission internal sensors and actuators
High Side 2	High Side driver (Supply switch able) for Shiftlock und Interlock –Magnet.

4.1.3 Term, Definitions, Requirements

Mechatronics

The term Mechatronics summarizes all components which take the input signals needed for the transmission, accomplish the evaluation of the input signals, implement the controlling and regulating algorithms, the control of the actuator, accomplish communication with the periphery and maintain the electrical and mechanical connections to the signal generators and actuators.

The vehicle-installed interfaces are connected through the transmission plug; transmission-installed, the actuators represent the electrical interface to the Mechatronics.

TEHCM

Electronic module (TCU + oil temperature sensor + electrical and electronic communication +Synthetic housing + Actuator system (VBS;ON:OFF)
TEHCM without TISS; TOSS, IMS

E-Module

TEHCM with sensors (TISS; TOSS, IMS)

Valve body (Hydraulic-switchgear)

Valve housing + shim + valve plate

Mechatronics-Module

TEHCM + TISS; TOSS, IMS + valve body

BN 2000

Electrical system for PL2 and following vehicle projects. Contains PT-CAN Data Dictionary for BN2000 and diagnosis/Programming/OBD over PT-CAN

CAN11

Electrical system for E83. Contains PT-CAN Data Dictionary for CAN11 and Diagnosis/Programming/OBD over PT-CAN for 6L45 applications

4.2 E-Module- Hardware

4.2.1 Repair concept Mechatronics

A 3-step repair concept is demanded.

Step 1: Exchange of Mechatronics unit
Step 2: Exchange of TEHCM e.g.: E-Module
Step 3: Exchange of TISS; TOSS, IMS

A repair concept must be developed by GM, for those individual stages which, in case of service and the possible replacement of individual components, do not lead to a degradation of the switching quality for the customer. This concerns, amongst others, the transmission of adapts data set related to solenoid and transmission / adapts data set (when transmission is implemented inside car) .

The production of a repair matrix is demanded by GM. This matrix contains an overview of all error codes and which service steps / Repair stages must be followed and accomplished by the BMW service in each error / failure case respectively.

4.2.2 Requirements/ Interface overview

4.2.2.1 Function description of interface with car

- CAN interface PT-CAN
 - All information and requirements to PT-CAN. See Chapter 5 Software
 - an expandable terminal resistance is to be planned.
 - CAN throttle (EMC) is necessary
- BN 2000: Programming/OBD and diagnosis via PT-CAN and central gateway module.
- BN CAN11: Programming/OBD and diagnosis via PT-CAN and DME/DDE.

- Inputs for step by step shifting/Steptronic
 - the positioning the selector lever into the manual position must be recognized.
 - the mode Tip+ and Tip- must be recognized.
- Output for Shiftlock
 - the output commands an electrical lifting magnet, which can block in position P and N the selector lever.
 - the selector lever barrier is inactive when no current applied (no locking without current)
- Output for Interlock
 - Only with the selector lever in position P is it possible to take the ignition key out off the lock and/or the transmission is being locked in pos. P by taking the ignition key out of the lock. Selector lever release from P only with ignition key inserted into lock.
 - the selector lever barrier is active when no current is applied (no current is applied – it locks in that state)
- Output for starter barrier, PN-signal
 - prevent engine starting with power flow
 - normal function: in transmission position P/N is engine starting allowed

4.2.2.2 Supply

- 2x continuous plus (Ubatt) for normal and Caster function (power supply)
- 2x Ground (KL. 31)

The voltage supply of the TCU can be performed in BMW vehicles in two ways:

- 1) TCU at KI30 (concept E65, TCU durably under voltage supply, Power module disconnection with critical battery charge possible)
- 2) TCU at KI30g (concept PL2, disconnection of voltage supply after power latch phase over relays in the CAS)

Requirements in accordance with BMW LH Energy Bordnet Part 1 and Part 2 are to be converted for both concepts. These requirements are to be considered explicitly for the handling of nonvolatile data (error memory, Adaptation values etc. in EEPROM emulation)

4.2.2.3 Outputs for M-Shifting (Car interface)

- 1x tension output On-Board net, source, High Side Driver 2 (only used to supply Shiftlock and Interlock)
- 1x digital output On-Board net, source
P/N line to CAS (direct HW path, active high in case of P/N)
- 2x digital outputs On-Board net, sink (Shiftlock, Interlock):
for ON/OFF-outputs, tension-stabilized (ON/OFF, freewheel diode to V_A) (OK for GM)

4.2.2.4 Inputs for M-shifting (Car interface)

- 3x digital input as pull UP (Tip+, Tip -, Manual shifting)
- Wake up line, signal line, one direction (capability to wake up is not requested)

4.2.2.5 EMC-Requirements

The EMC requirements apply according to LH EMV for GS19.12 and BMW Group Standard GS 95002 and GS95009-1.

4.2.2.6 Reliability/ Life time electronics

Life time:	6000 h / 15 Years
Failure out of plant:	see agreement for whole transmission
Failure in field for exposition duration of 3 years:	see agreement for whole transmission

4.2.2.7 Operating temperature range

The E Module must be design good enough that no function restriction or component damage occur during whole lifetime for a defined oil temperature range/cooler VR17001
See Chapter 3.3.

4.2.2.8 System configuration/ TCU pin-Out

See GM Hardware description document. Only for information

4.2.3 Electrical operating range

4.2.3.1 General requirements

Interpretation according to LH EMV for GS19.12 and BMW Group Standard GS 95003-1, GS 95003-2, GS 95003-3, GS 95003-4, GS 95003-5, GS95009-1 as well as the applicable standards.

BN 2000: The electronic module is activated via the wake up line (waking impulse 500ms-1000ms) and deactivated via PT-CAN network management.

GM must warranty that the system stays all the time into a defined state and that it will not be damage by the following malfunctions:

- Over voltage on the V_{CC} - supply
- Low voltage on the V_{CC} - supply. Internal protection.

The operating voltage is being measured at the Mechatronik (Mechatronics) between the power supplies at the transmission plug.

Voltage fluctuations during the starting procedure may not lead to inadvertent error storage.

The full operability of the Mechatronik must be established and available after the initiation time has expired.

Initiation time until CAN communication

BMW requests: $\leq 100\text{ms}$

GM design: $\leq 150\text{ms}$

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Fully operational after 400ms

Using suitable TCU measures guarantees that, through the self check of the TCU, Actuators and Sensor do not lead to default modes and do not cause error storage.

When slowly lowering the operating voltage from U_{max} to 0 V and returning to the operating voltage, no undefined conditions of the TCU and no implausible error storage in the Diagnosis may arise. A return to normal operation is to be accomplished after a under voltage reset has occurred.

4.2.3.2 Upper limits of supply voltage

Test parameter:

Supply voltage:

$U_{max} = 15.5\text{ V}$ with $U_{ss} = \pm 1\text{V}$

Amplitude:

$U_{ss} = \pm 1\text{V}$ with frequency from 50Hz up to 20kHz

Test temperature:

$T_P = T_R$

During this test the full functionality is requested. No impacts on lifetime (Ok for GM)

Type of frequency sweep: Linear

Requirement for new platform (not for PL2 or E83)

Transient over voltage up to 18,0 V during 100ms can occur. During this test the full functionality is requested. No impacts on lifetime. See Chapter 3.1.3 of LH Electrical Energy Bordnet Part 1 for over voltage characteristics.

4.2.3.3 Lower limits for supply voltage

Following function needed during engine start must be provide with full functionality for $U_B \geq 7.0\text{ V}$:

P/N line

$U_B \geq 7.0\text{ V}$

Interlock HSD and LSD are commanded but due to temperature range the available current will perhaps not be enough.

$U_B \geq 7.0\text{ V}$

All functions are requested when $U_B \geq 9.0 \text{ V}$.

4.2.3.4 Power Consumption

with U_P :		14+/- 0,2 V
BMW target		
Quiescent/ Standby power consumption:		< 0.1 mA
tion during power latch (KL15 OFF, Bus active):	0,5 A	Power consump-
Power consumption full load (Kl. 30):		< 6.5 A
Peak power on ignition (for ex. overvoltage regulator):		$\leq 1 \text{ A}$ (typ. 400 mA)
Maximum power consumption (wake up line / Kl.15 line):	$\leq 10 \text{ mA}$	
GM design:		
Quiescent/ Standby power consumption:		< 0.1 mA
Maximum power consumption (wake up line / Kl.15 line):	$\leq 10 \text{ mA}$	

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Peak power consumption during the ignition phase should not exceed peak ignition power. During initialisation and power up, care must be taken that not all power output stages are switched at the same time as far as the process of the function allows.

BMW target:

In order to avoid large amounts of transit power at Kl. 30, all pulse-driven power output stages are to be commanded with a delay. The purpose of this is to obtain an even power input from the on-board network.

GM design: no special measure to avoid large amounts of transit power

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

4.2.3.5 Inverse Polarity Protection

BMW target:

Test voltage: $U_B = -16 \text{ V}$ (Programming inverse polarity protection outside the vehicle.)

Test voltage: $U_B = -4 \text{ V}$ (Programming inverse polarity protection inside the vehicle.)

Test duration: 1 h

Function status: C

All input and output pins connected to Kl. 30, 31 or 15 over another path must be with protected against inverse polarity.

GM design: as requested in BMW standard GS95003-2 (5.2.3)

Test voltage: $U_B = -16 \text{ V}$

Test duration: 60 s

BMW accept GM design for M shifting.

4.2.3.6 Protection against Short Circuits

All the input and output pin of the TCU on the transmission connector must be protected against short circuits to $U_B (\leq 16.0 \text{ V})$ and short to ground.

Remarks:

- Slow short circuits are to be covered

- Protection against short circuits will not be required when service voltage is not connected as well as in the range of $U_B < 7$ volts.
- A slow short circuit means that the output should be capable to supply power, which is just below the short circuit recognition threshold. This power may lead to an error storage (thermal switching off), but not to the destruction of the power output stage.
- This only affects power outputs at the whiring hardness (for ex., shiftlock, interlock)

4.2.3.7 Ground offset

Number of ground connections: 2
 Both ground connections should be brought together at a **single** ground point in the vehicle body.

Allowable ground adjustment in relation to other ECU's: $\leq \pm 1.0$ V

4.2.3.8 Control Units Inputs

Interpretation according to LH EMV for GS19.12, BMW Group Standard GS 95003-1, GS 95003-2, GS 95003-3, GS 95003-4, GS 95003-5, GS95009-1 as well as the applicable standards.

4.2.3.9 Control-Unit Outputs

Interpretation according to LH EMV for GS19.12, BMW Group Standard GS 95003-1, GS 95003-2, GS 95003-3, GS 95003-4, GS 95003-5, GS95009-1 as well as the applicable standards

- Current/Power limiting with retarded switching off at overload/Short-circuit. Diagnostic functions can activated the switching off.
-
- Feedbacks for Diagnose
- Overvoltage protection for signal outputs

4.2.3.10 Free wheel/ Recovery

- Freewheel diodes to V_A for ON/OFF SHIFT LOCK and Interlock
- Freewheel diodes to V_A for VBS (OK for GM)

4.2.3.11 Diagnostic Internal features

The following controller-internal features are to be supplied to the μ C for diagnostic purposes:

- On-Board Net power supply Kl. 30
- Power supply for VBS / ON/OFF(V_A)
- Power supply for Shiftlock/Interlock (V_A)
- Power supply for sensors (V_S)
- Actuator output signal read back for current monitoring (signal for VBS and ON/OFF outputs)
- 2x Substrate temperature

4.2.4 Requirements for TCU

When errors occur the electronic installation must be brought into a condition which is safe for the vehicle.

4.2.4.1 Components

See GM hardware description document Only for information

4.2.4.1.1 Microcontroller

Motorola MPC 562 "Silver Oak" or similar
 Minimal Quarz-Frequency : **40MHz**

4.2.4.1.2 Program memory (external)

For T43a : **at least 2MB**

Data-retention must be guaranteed over the necessary writing cycles (minimum 64 write able) throughout the total service life.

The programming of the TCU must be enabled for series controller devices up to transmission oil temperatures of $\leq 130^{\circ}\text{C}$.

4.2.4.1.3 RAM (on-chip μC)

- at least KByte Fast RAM **t.b.d.**
- at least KByte TPU RAM **t.b.d.**

In order to optimize the TCU quiescent current consumption, no Battery back-up buffer which could restrict or worsen the quiescent current consumption may be used for RAM.

4.2.4.1.4 Non-volatile Write-/Read-out memory

E²PROM Emulation in external Flash. When failure occur, e.g.: Interruption during the writing of the update due to external influences (Diagnose-KWP2000 services, Low voltage etc..) the last valid stored data must be available for the next operating cycle again. The correct writing of data into the EEPROM emulation must be supervised via Diagnose.
All extents must be supervised by Checksum.

4.2.4.1.5 CAN (on-chip μC)

BMW request is: 3 Full CAN Controller with 16 Message buffer each and Basic CAN
GM design: 2 Full Can Controller with 16 messages buffer each and Basic CAN

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Can driver to be used: for EMC and function features at least so good as CF175

1Main

4.2.4.1.6 Power Supply and Watchdog - CG122

See GM hardware description document Only for information

4.2.4.1.7 Current Controller - CG207

See GM hardware description document Only for information

4.2.4.1.8 Multi I/O ASIC - CG117

See GM hardware description document. Only for information

4.2.4.2 Security concept/ Monitoring control circuit

Functions of the protection circuit (Watchdog):

- Power-on-Reset, power-on-delay-time: **< 30ms**
- Periodical Triggering of the Watchdogs
- Monitoring of the quartz frequency by time windows, Tolerance: **t.b.d.**
- processor-independent switching off the High-Side 1 and 2 and Reset the Micro controller in the event of an error
- the function of the Watchdogs must be testable during the initialization phase (incl. Switching off channel)
- possibility of test the Watchdog during the operating phase (excluding switching off channel)
- switching off of High Side 1 and 2 and Low-Side via Watchdog and μC separately possible.
- Watchdog must guarantee Processor-Reset in case of low voltage
- Watchdog must check of μC function groups (arithmetic problem, Question/Answer test of μC of the command-set)
- _ 1 test able switching off path (V_a) which can be activated through security reactions
- design of the circuit for the recognition of all single errors, as far as technically realizable (single errors may not lead to undefined conditions)
- ability of examination of all signal paths within the error allowable time (tolerance)(hardware filtering: < 10 ms).
- mutual monitoring Micro controller * \leftrightarrow monitoring circuit

The monitoring control circuit (definition: Hardware & associated software) must be designed at least in such a way that the signals needed for the safety-relevant functions can be read in/uploaded and evaluated.

When a implausibility occurs in the main control circuit, the monitoring control circuit must be able to accomplish alone and independently measures, to shift the gearbox and the car into a condition which is safe for the vehicle (switching off power output stage and HighSide and CAN).

Safety relevant functions are:

- Torque increase request
- LDM Interface
- Transmission Tie up
- Prevent loss of power flow in position D and R
- Prevent engine start in case of power flow
- Display information
- HW - close monitoring for all safety-relevant functions indicated above is requested. This includes::
 - Memory test e.g.: Flash- and RAM Check)
 - AD converter monitoring
 - program flow control of all SW modules
 - Redundant memory storage of features for all functions indicated above
 - Double calculation with result comparison for all functions indicated above

4.2.4.3 End of line and field programming

see specification Car flash prog/ verification/Sw logistic Part 1: Car flash programming 6941764.6.
see this Spec. part 5 Software

4.2.4.4 HW diagnosis of controllers/ Outputs

Following diagnostic functions are to be planned:

- All TCU-outputs must be diagnosed at any time on short circuit, open circuit and reverse powering:
 - a) Short-circuit to V_P resp reverse powering with power output stage switched on.

- b) Short-circuit to V_M and o open circuit with power output stage switched off, difference able.
- c) Open circuit with power output stage switched on. (hardware or software ("toggling") solution)
- d) Safety-sensitive deviations of the current control (VBS) must be recognized -tolerance window **t.b.d.**

- all transmission electronics inputs must be controllable and diagnosed at any time on short-circuit, open circuit and reverse powering:

- Both Substrate temperature sensors must be controllable and diagnosed at any time on short-circuit and open circuit: Difference between shorts to Vbat and open circuits can not be detected.

Decoupling of the interfaces

Inputs and Outputs, in use by other devices, are to be decoupled in such a way, that no inadmissible balancing currents flow, if the TCU controller is switched on and/or switched off, although other equipment is switched on and/or switched off.

4.2.4.5 .Development aids

For laboratory tests are suitable printed circuit board devices and/or hybrid adapter and needed transmission component to be provided.

4.2.5 E-Module requirements

4.2.5.1 Plugging and unplugging of the transmission plug

Plugging and/or unplugging of the transmission plug with the power on transmission may not lead to the destruction of the controller

4.2.5.2 Inputs

4.2.5.2.1 TOSS Sensor frequency input, Resonance sensor (numbers of revolutions)

Electrical parameter

See GM hardware description document Only for information

Function range:

Recognition of the output speed . The Rolling (roll-on) of the Vehicle must be recognized. If the vehicle stands still no numbers of revolutions may be recognized due to vehicle influences. SW filtering is not permissible.

During travel a signal disruption may not occur due to vehicle influences.

Functional area:

BMW target:

requirement on TOSS sensor concept

- Requirements are set in km/h and, apply to GM6 transmission for all wheels radius and transmission ratio.
- Measurements accuracy ranges are including all tolerances as life time, temperature, EMC, etc.. .
- Important remark: accuracy values are also including absolute difference with real car speed due to timing delay during the signal processing (tacked date for impulse)
- Requirements are due to following functions:
 - Neutral Idle (NIC) switching ON/OFF
 - Park locking
 - Shiftlock
 - Parking phase (drive<--->reverse)
 - E shifting Interlock
- **Memory storage during parking**
- **Memory storage during park locking**

Request requirements for output speed**Make a proposal for low speed and acceleration limitation****Required measurements accuracy (difference between absolute car speed and sensed car speed)**

For car speed between 0 and 5 km/h the accuracy is +/- 0,5km/h

For car speed between 5 and 15 km/h the accuracy is +/-1.0 km/h

For car speed between 15 and 250km/h the accuracy is +/- 2,5km/h

Important remark: those requirements don't include the internal transmission requirement due to sensor concept (TBD by GM)

GM design: t.b.d.

Diagnosis:

Operating point-independent and hardware near examination of the sensor lines on interruption, Short-circuit to mass and short-circuit to U_Batt must be ensured.

BMW request is: A possible error must be recognizable with the still stationary vehicle.

GM design: currently not possible

Plausibility diagnoses concerning ghost speed and signal interruption are to be planned. CAN signals are to be used for that .

4.2.5.2.2 TISS Sensor frequency input, Resonance sensor (numbers of revolutions)

Electrical parameter

See GM hardware description document. Only for information

Function range:

Recognition of the transmission input speed Functional area:

TISS sensor signal must be able to be used by the transmission, in position P or N, as a default value for Engine speed in case of failure.

Diagnosis:

Operating point-independent and hardware near examination of the sensor lines on interruption, Short-circuit to mass and short-circuit to U_Batt must be ensured. Plausibility diagnoses are to be planned.

4.2.5.2.3 transmission oil temperature sensor analogue input, resistor

Electrical parameter

See GM hardware description document Only for information

Function range:

In case of substrate temperature failure, the software is using transmission oil temperature sensor signal. In this case the availability of the E Module related to allowed temperature range must not be reduced (no early hot mode TCU switching off in comparison with availability when substrate sensor is used). GM will use Substrate temperature sensor in case of Oil temperature sensor is not available. GM can only guarantee the full transmission functionality after thermal measurements on transmission (offset value).

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Diagnosis:

Operating point-independent and hardware near examination of the sensor lines on interruption, Short-circuit to ground and short-circuit to U_Batt must be ensured.

A possible error must be recognizable as soon as KL15 is ON.

Plausibility diagnoses for the substrate temperature sensors are to be planned.

4.2.5.2.4 Substrate temperature sensor analogue input, Resistance

Electrical parameter

See GM hardware description document Only for information

Function range:

BMW request is: A "hot mode switching off of the transmission control may not take place below T_SUB= 145°C(Cut-off threshold TCU)

Measure error tolerance: T_ABSCHALT_SUB = +/- 1.0°C(T_CUTOFF_SUB = °C)

Minimal requirement: T_SUB= 143°C(Cut-off threshold TCU)

Measure error tolerance: T_ABSCHALT_SUB = +/- 1.0°C(T_CUTOFF_SUB = °C)

GM design: A "hot mode switching off of the transmission control may not take place below T_SUB= 141,6°C (Cut-off threshold TCU)

Measure error tolerance: T_ABSCHALT_SUB = +/- 1.5°C(T_CUTOFF_SUB = °C)

Diagnosis:

Operating point-independent and hardware near examination of the sensor lines on interruption, Short-circuit to mass and short-circuit to U_Batt must be ensured. A possible error must be recognizable as soon as KL15 is on.

Plausibility diagnoses for the substrate temperature sensors are to be planned.

4.2.5.2.5 Tip+, Tip-, M-lane digital input signal

lower switching threshold

:BMW request is: $\geq 3,0$ V
GM design is: $\geq 2,0$ V

BMW accept GM design

upper switching threshold

: $\leq 4,0$ V

Hysteresis

: $> 0,5$ V

Pull up / down / Load current:

: ≥ 10 mA (load to clear contacts) is guarantee over valid temperature and voltage range

Smoothing time constant

: < 1 ms

Interference impulse resistance

: see LH EMC

Function range:

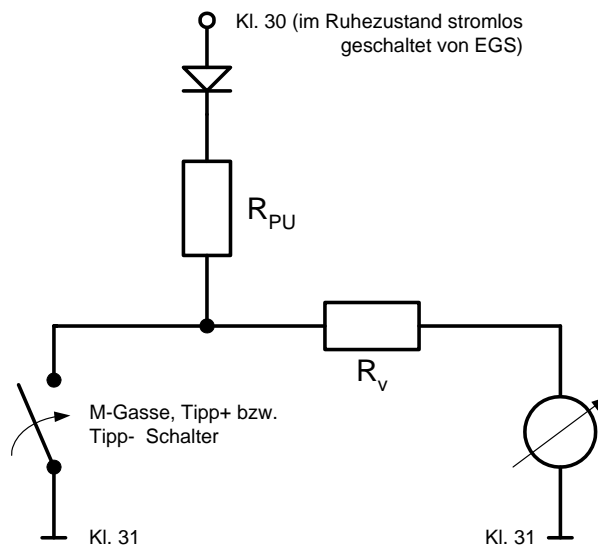
see LH for M-Shifting for software function description

Diagnosis:

A Plausibility between M-Shifting and Tip+/- and IMS is to be planned

4.2.5.2.6 Steptronic/M-Shifting:

- The signal is related to vehicle mass.
- The signal source is a mechanical switch system, which is designed as open contact (active condition)
- contact resistances in the entire temperature range:
 - closed : $\leq 0,5 \Omega$
 - open: $\geq 1 M\Omega$



Kl. 30 (no current applied by TCU)
M-Shifting, Tip+ e.g.: Tip- switch

Fig. 4-1: Circuit schematic of the Signal evaluation for the Steptronic

Parameter of the Steptronic-Inputs

Parameter	Designation	min.	type	max.	Unit	Remark
Pull-Up-Resistance against Kl. 30	R_{PU}		1		$k\Omega$	
Input voltage-Low	$U_{in\ low}$		Grnd.		V	
Input voltage-High	$U_{in\ high}$		U_B		V	

4.2.5.2.7 Position switches of IMS

HardwareContact less Hall sensor system

Function range:

An intermediate position is not regarded as an error but is a valid Gear lever position, to which the requirements below apply likewise.

see also LH for M-Shifting

IMS Requirements

2 ways communication (HW-Line + PT-CAN) between EGS and CAS (exception CAN11 where only hardware line is requested). For CAN11 BMW needs at least same security level as GM5
P/N CAN signal has highest priority but if IMS electrical failure occurs then CAS switches to hardware signal (TCU must detect single IMS failure, fault memory entry must be possible, in this case TCU must send signal invalid to CAS)
No engine start in drive position (security: avoid to engine start with 1 electrical failure on IMS) . Fulfilled but in case of Confort access car (no key only a card) when engine is allowed to start only in P position.
With 1 electrical failure in IMS allow safe engine start and stop (for comfort access) in P,N (availability).
Vehicle-Availability of D, R, N in case of 1 electr IMS fault (R would be preferred)
In drive: not switch to N because of 1 electrical failure on IMS (overtaking situation)
No change of direction caused by 1 electrical failure on IMS (D to R or R to D)
In N, P: No powerflow caused by 1 electrical IMS failure
If a diagnostic test of 1 electrical failures is not possible, sleeping fault+ second fault must be safe and available (handled as one electrical failure)

4.2.5.2.8 Optional Input/s (if available)

Not optional inputs are available

4.2.5.3 Outputs

All outputs must have the capability to be durably connected over arbitrary time in accordance with their specification

Chapter power consumption in part 4.2.5.2 must be considered.

4.2.5.3.1 High Side Driver 1: Digital outputs, Bordnetz level

Electrical parameter

See GM hardware description document Only for information

4.2.5.3.2 SHIFT LOCK digital output, On-Board net) system level, sink

Temperature values are substrate temperature

Shiftlock low Side driver:

Maximal allowed current on Low Side switch:	-40°C to 25°C: 1,5 A. (OK for GM) between 20°C and 140°C: tbd. At 140°C: BMW request is 1,3 A GM design is 1,0 A
Maximal internal resistance at 140°C:	1,17 Ohm
Maximal internal resistance at 20°C	1,0 Ohm
Residual current incl. Diagnose (in Work mode):	1 mA
Operation mode :	Continuous current.
Recovery:	Free wheel diode to VA

Function range:

It is to be guaranteed, that over the total possible temperature- and voltage range in the control-unit and at the magnet, the necessary minimum current for the magnet is made available by the power output stage, e.g.: the maximum current doesn't lead to a destruction and / or to a switching -off of the High side driver and Low side driver power output stage within the TCU.

For the function Shiftlock please see LH M-Shifting

Control of ON/OFF in continuous-wave operation

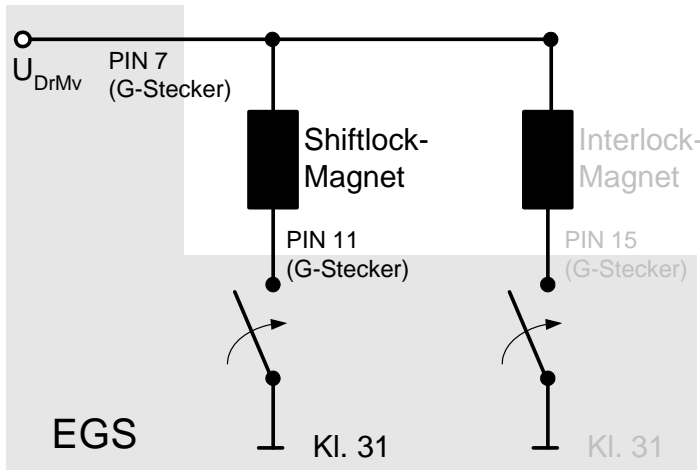
Diagnosis:

The Shift-Lock-Magnet is electrically supervised.

The single solenoid valve monitoring recognizes an electrical error of the single solenoid valves/ Magnets.

The following errors are recognized and registered as own error symptom in the error memory :

- short-circuit to ground
- short-circuit to battery
- open circuit



PIN number HSD2 (14), SL(16), IL(13))

Shift-Lock Magnet:

Parameter	Designation	min.	type	max.	Unit	Remark
Ohms Resistance at 20°C and 0 V	R	15.7	16.7	17.7	Ω	
	L		215		mH	
	L		180		mH	
inductance in stroke end position	L		180		mH	
inductance in stroke initial position	L		180		mH	
nominal current	Inenn	360 1)	720 2)	1330 3)	mA	
Nominal power consumption	Pnenn		8.6		W	

- 1) min.: 9V at 100°C electrical coil temperature
- 2) typ.: 12V at 20°C electrical coil temperature
- 3) max.: 16V at -40°C electrical coil temperature

ambiental temperature for Shiftlock Magnet: -40°C to +100°C

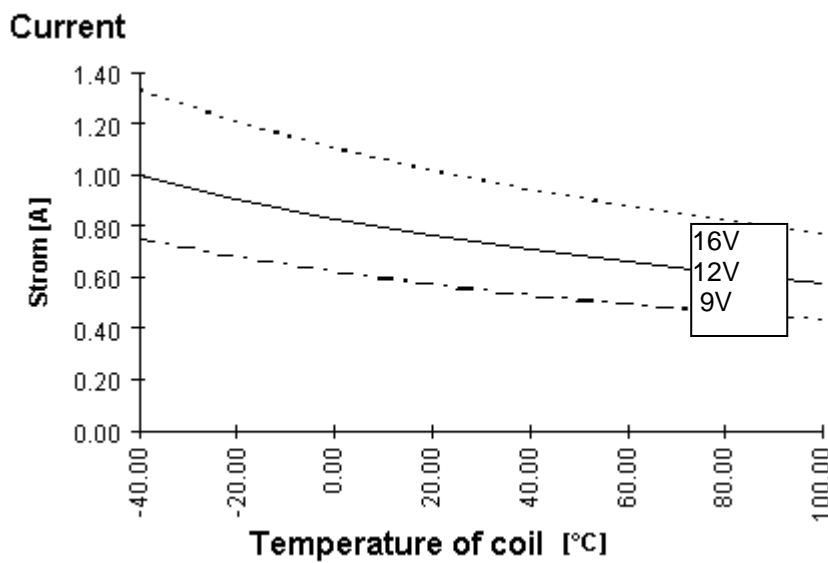


Abb. 4-2: Electrical coil current as function of the electrical coil temperature and the voltage at the coil for R = 15.7 Ω

4.2.5.3.3 Inter-Lock digital output, Electrical system level, sink:

t

Temperature values are substrate temperature

Interlock low Side driver:

Maximal allowed current on Low Side switch:

-40°C to 25°C: 1,5 A. (OK for GM)

between 20°C and 140°C: tbd.

At 140°C: BMW request is 1,2 A

GM design is 1,0 A

Maximal internal resistance at 140°C:

1,17 Ohm

Maximal internal resistance at 20°C

1,0 Ohm

Residual current incl. Diagnose (in Work mode):

1 mA

Operation mode:

Continuous current.

Recovery:

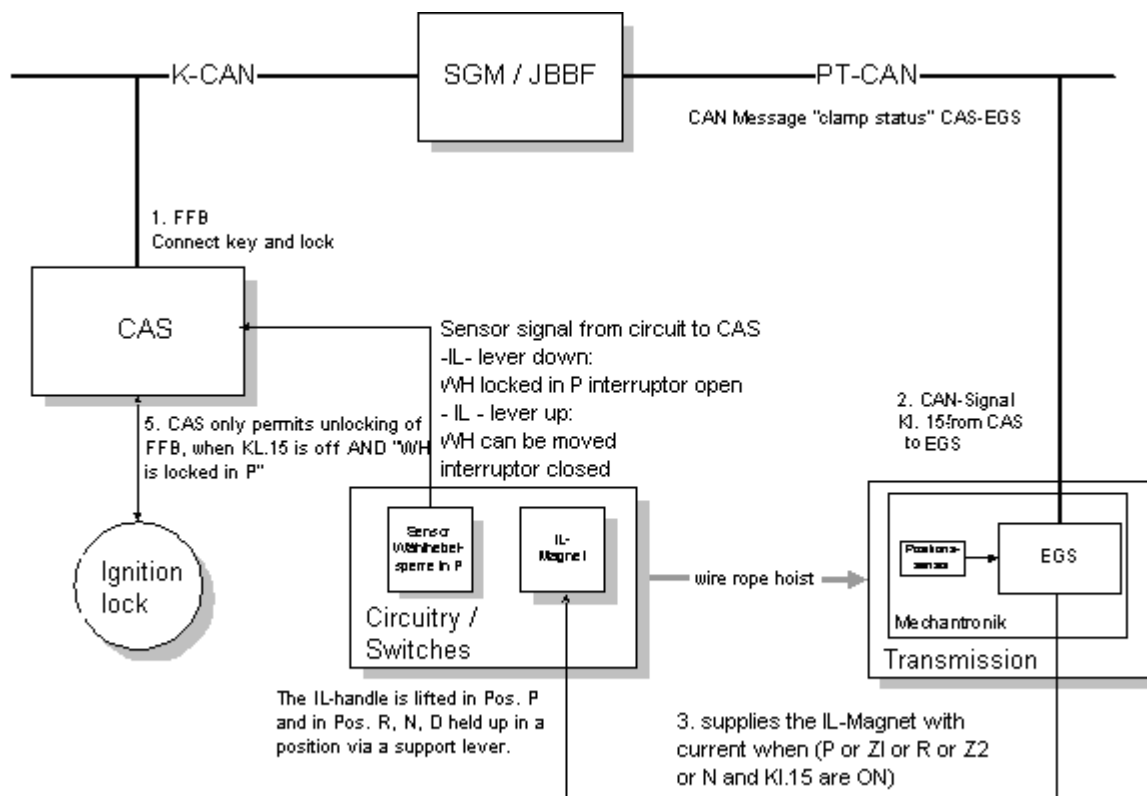
Free wheel diode to VA

Function range:

It is to be guaranteed, that over the total possible temperature- and voltage range in the control-unit and at the magnet, the necessary minimum current for the magnet is made available by the power output stage, e.g.: the maximum current doesn't lead to a destruction and / or to a switching -off of the High side driver and Low side driver power output stage within the TCU.

For the function Interlock please see LH M-Shifting

Control of ON/OFF in continuous-wave operation



Mistake on Z1 and Z2 names

Diagnosis:

The Shift-Lock-Magnet is electrically supervised/monitored.

The single solenoid valve monitoring recognizes an electrical error of the single solenoid valves/ Magnets.

The following errors are recognized and registered as own error symptom in the error memory :

- short-circuit to ground
- short-circuit to battery

- open circuit

Inter-Lock Magnet:

Resistance tolerance at 0V and 20°C : 18,58+/-0,75 Ohm

max. resistance at 16V at the magnet and T=110° Ambient temperature = (incl. inclusive Self-heating) :32,3 Ohm

min. resistance at 8,3V at the magnet and T=-40° Ambient temperature : 14,42 Ohmmin. pull up current with 8,3V

at the magnet and Ambient temperature = 110°C (incl. inclusive Self-heating) : BMW target is 295mA
GM design can 259 mA

BMW accepts GM design.

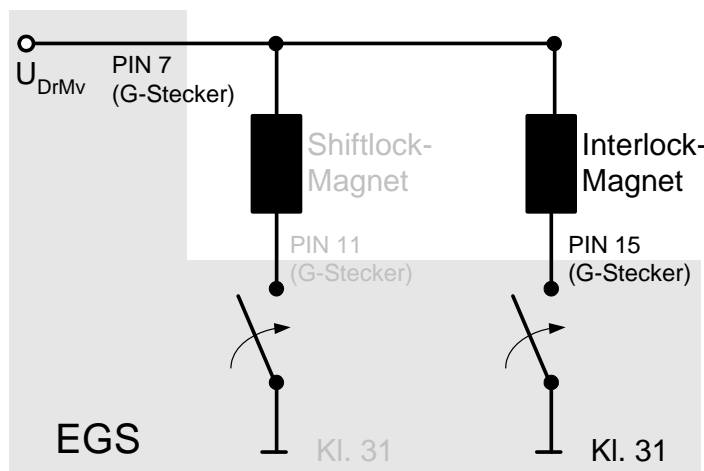
Inductance tightened: : 340mH

Inductance dropped: : 125mH

Parameter of the Shift-Lock-Magnets:

Parameter	De-signation	0V	16V	Unit
Ohm's resistance (at 20°C)	R	18,58	27,9	Ω
Ohm's resistance (at -40°C)	R	14,42		Ω
Ohm's resistance (at 110°C)	R	24,73	32,3	Ω

Ambience temperature Interlock: -40°C to +110°C



Pin number HSD2 (14) SL (16) IL(13)

Fig. 8-2: Circuit schematic of the Interlock-monitoring

4.2.5.3.4 Optional digital output (if available).

No optional digital output is available in T43a

4.2.5.3.5 Starter unlock signal (P/N-signal)

P/N signal is provided directly from IMS (function is also requested in case of µC failure)

Level : active high

minimum operating voltage for function : U_B ≥ 7 V

Load inductance : $\leq 250 \text{ mH} \rightarrow$ no inductance
 Recovery
 BMW accept GM design

max. Low-Pegel (high impedance) with 10kOhm pull down in CAS : $\leq 1,0 \text{ V}$
 min. High-Pegel ($I \leq 500 \text{ mA}$) : BMW request is $\Rightarrow 0,8 U_{bat}$
 GM design is $\geq 7\text{V}$ (up to 9V)

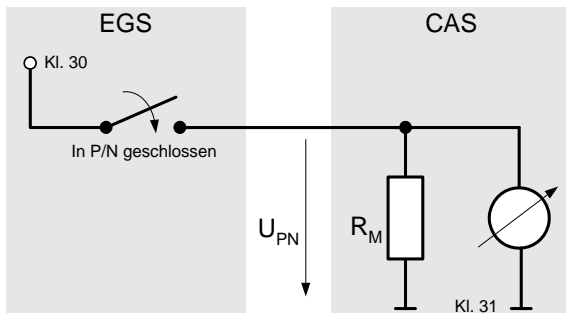
BMW accept GM design
 Bypass time for voltage drops minimum : BMW request is: 200 ms
 : GM design is: 0 ms

maximum wake-up-time (from wake up signal HW to KL15 High):BMW request is: 100 ms
 typical wake-up-time) : GM design : 150ms BMW
 accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Parameter P/N-Line Output:

Parameter	Desig.	min.	typ.	max.	Unit.	Obse.
Output signal Position P (or N)	U_{PN}		U_B Not KL30 but IMS output between 7 and 9 V high ohm		V	
Output signal others Power load	U_{PN}			40	V mA	

Characteristics Receiver (CAS):



Not KL30 but IMS output between 7 and 9 V

Fig. 4-2: diagram of connection for EWS3-Input

Parameter of CAS-Inputs:

Parameter	Desig.	min.	typ.	max.	Unit.	Observ.
Input tension-Low	$U_{PN \text{ Low}}$			$0,3 U_B$	V	
Input tension -High	$U_{PN \text{ High}}$	$0,7 U_B$			V	
Input resistance	R_{PD}		10,0		$k\Omega$	

4.2.5.3.6 Voltage supply outputs (6x EDS and 2 ON/OFF)

See GM Hardware description document Only for information EMV for 6L45

4.2.5.3.7 tension output electrical on-board net system level Highside 1, source

See GM Hardware description document Only for information
 HSD1 can be switched independently of HSD2.

4.2.5.3.8 tension output electrical on-board net system level Highside 2, source

Temperature values are substrate temperature

Maximal allowed current on High Side switch:	-40°C to 25°C:5,0 A. (OK for GM)
.	between 20°C and 140°C: tbd.
	At 140°C: 2,7 A (OK for GM)
Maximal internal resistance at 140°C:	0,24 Ohm (OK for GM)
Maximal internal resistance at 20°C	tbd
Residual current incl. Diagnose (in Work mode):	<= 1.7 mA

4.2.5.3.9 Tension output (sensor supply)

See GM Hardware description document. Only for information

4.2.5.3.10 Application interface (additional PT-CAN)

Only for development controllers Communications protocol CCP

4.2.5.4 CAN interface

- 1xPT-CAN:BMW request is: 3 CAN-Driver connected in parallel on one CAN HW output
 - GM design is: 2 CAN-Driver connected in parallel on one CAN HW output
 BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

CAN terminal resistance: 2x 60 Ohm: can be implemented in option

CAN Shock: 2x25mH

- Only for development TCU's: 1xPT-CAN (for CCP application) linked to additional RAM. Enough space for application data.

CAN driver to be at least as good as CF175 for EMC and functional features

Full-CAN

Baud rates (alternatively) : 500 KBit/s

Shielding : none

4.2.5.4.1 Wake up line (BN 2000)

Wake up line one directional interface (

TCU can only be waked, can not wake up other ECU's.

permissible signal voltage	: - 3 V... 19 V
U _{LOW} as Sender	: ≤ 1,2 V
U _{LOW} as Receiver	: ≤ 3,55 V
U _{HIGH} as Sender	: ≥ 5,0 V
U _{HIGH} as Receiver	: ≥ 4,77V
Input capacity	: ≤ 2,7 nF
pull down	: BMW request is: 56kOhm
	: GM design is: 24 to 35kOhm
BMW accept GM design	
Residual current	: ≤ 100 µA

Function range:

See LH PT-CAN System description

General Characteristics:

- Digital signal with battery voltage-dependent High level
- The signal is related to vehicle mass.
- The signal source is a controller with an electronic switch to B_{attery} and a Pull Down Resistance.
- The signal is not synchronous to other signals
- the maximum number of participants is 30, a maximum of 4 participants can't actively wake and are decoupled by a serial protection resistance
- permitted participants are all controllers/control units at the PT-CAN, as well as the devices CAS and the power module

Signal processing:

The signal input wake up line is to be realized in accordance with BMW Group standard as Digital Input.

If KL 30 can be switched off (e.g.: for quiescent current sinking) then the absence of reaction is to be guaranteed on the controller while triggering the wake up line. This takes place, for example, via an uncoupling diode in the addressing path of the wake up line, whereby this diode also can be cancelled by other measures (e.g.: CAS), when the absence of reaction can be guaranteed.

Diagnosis:

A monitoring of the voltage levels is at present not necessary.

A diagnosis of the time delay between CAN KL 15 and the wake up line has to be implemented as described below.

For the time delay t_{Diag} the following values (suggestion of BMW) apply:

Time delay between t_{Diag} (0..1000ms) [ms]

CAN KL 15 "off" after wake up line is "low" < 150

Wake up line is "low" after CAN KL 15 is "off" < 150

Wake up line is "high" after CAN KL 15 is "on" < 150

4.2.6 Power interface/ Documentation

Connection (circuit) diagram/ layout diagram and parts list

The following documents are to be delivered with each prototype status (and also intermediate states):

- connection diagram with bill of material and parts list
- block diagram
- pin allocation

With the distribution of the C-sample prototype the following documents are to be handed over to BMW:

- interface description with limit values
- description of function for partial modules
- data sheets of all integrated elements in particular for customized construction units (ASIC, Hybrid etc..)
- an unloaded substrate carrier

Until at the latest 3 months before series start the following documents are to be handed over to BMW:

- test reports for the demanded operational stability and EMV-examinations of production items/parts

A preview of the construction and FMEA process must be made available to BMW as required.

Starting from the C-sample all changes of/ to the hardware (also changes like other/new suppliers of the construction units) are to be documented at the controller and to be handed over in form of a product specification sheet to BMW. All changes of/to the hardware must be communicated in time to BMW and its supplier/s and must have been approved by BMW. BMW and the supplier specify together the range of the tests and investigations regarding operational stability necessary for a change of hardware.

4.3 Connector

4.3.1 Connector system

The sensors and actuators in the transmission are connected by a housing-fixed connector with the vehicle-lateral wiring harness which has to be co-ordinated previously with BMW. The situation of the connector is as horizontal as possible, to plan above the oil-sump.

Pin allocations

Transmission plug		
Nr.	Allocation	Comment
1	KL 30	TCU supply redundant
2	KL 31	Mass redundant
3	P/N-Line	Starter unlock
4	Kl. 30	TCU supply
5	Kl. 31_1	Ground
6	Tip_Up	Tip +
7	Manual Mode	switch manual shift
8 *)	ICANLO_T	Applikations-CAN Low for INCA CCP
9	Tip_Down	Tip -
10	CANHI	PT-CAN-High
11	CANLO	PT-CAN-Low
12	Kl.15	Wake-Up Signal Kl.15
13	Interlock	Low side driver Interlock
14	HSD(SL/IL	voltage supply for Shift- and Interlock
15 *)	ICANHI_T	Applications-CAN High for INCA CCP
16	Shiftlock -	Low side Shiftlock

*) only for development TCU's.

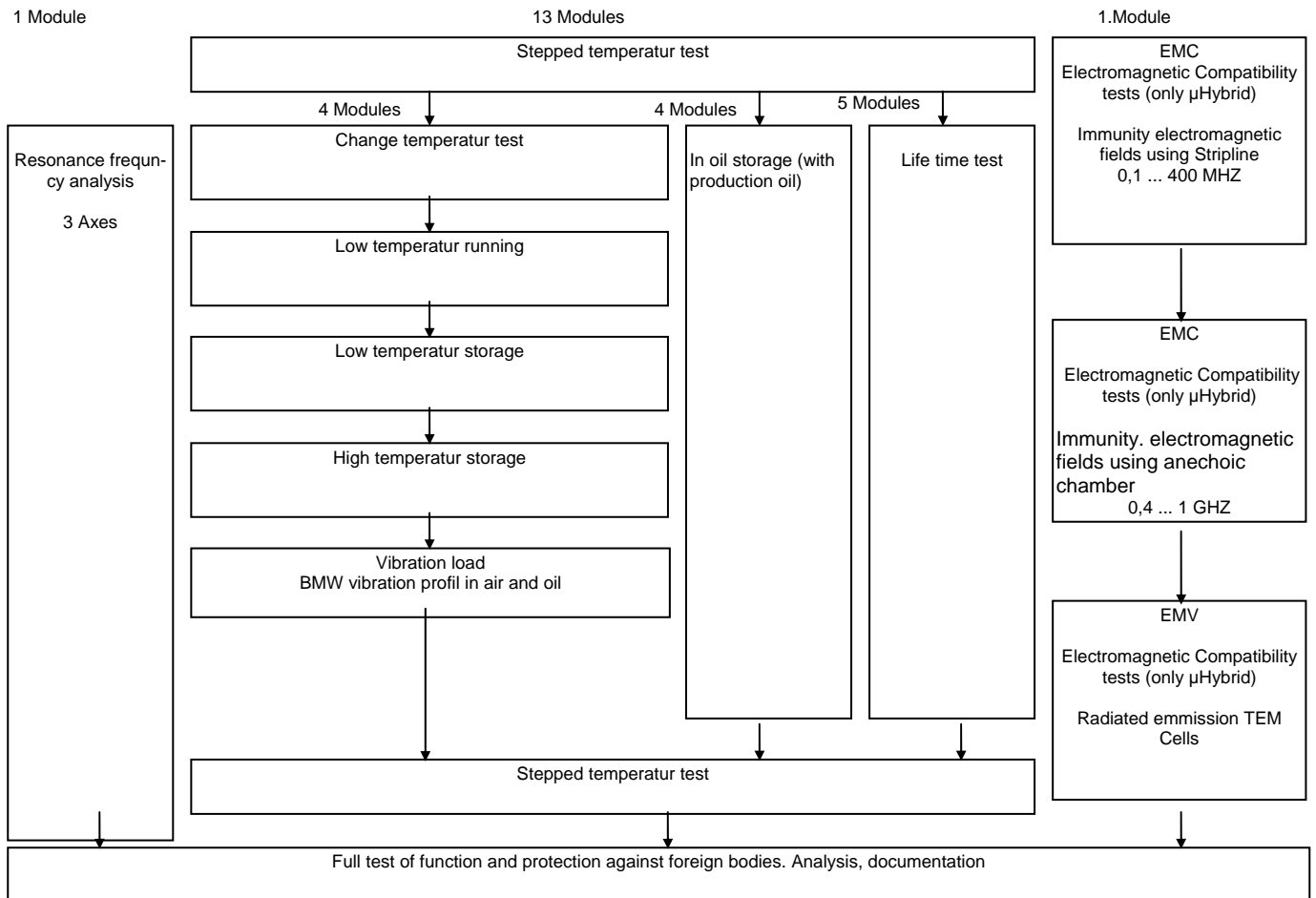
4.4 Design validation test for E-Module for 6L45

4.4.1 Design validation flow chart for E-Module for 6L45

- Environmental- and EMC-Tests must be performed following BMW Group Standard specifications GS 95003-1 to 95003-5 (released in October 2001) and GS 95002.
- Below are described tests required by BMW for design release.
- Those test must be successfully performed on C sample
- C sample definition of BMW GS 95003 is applicable for environmental tests.
- Tests to focus the development are required additionally to below described tests, also for early sample state.
- TCM for Environmental tests are built-in a whole or partly transmission filled with ATF oil (production content) and put in his original vehicle environment (including connector).
- Definition: "electrical active": a cyclic functional test must be performed on powered Tehcm module+ Sensors during test process. A full set of physical sensors and actuators (Turbine speed (TISS), output speed (TOSS), Oil temperature sensor, Mode switch, solenoids, pressure switch, substrate temperature sensors, CANI/O) must be used for this purpose. Function test to be performed for: CAN I/O, Mode Switch, Turbine speed, output speed, substrate temperature sensors and oil temperature sensor, all actuators (solenoids). Results of those functional tests must be provided. BMW will get defined test procedure.
- All electrical component (TEHCM +TISS (turbine speed sensor) +TOSS (output speed sensor) + IMS (Internal mode switch) + connection technique) must be test together following below test matrix. Up now this set of electrical component is called Module for the design validation tests.

Scale- und view tests, feature test, electrical tests

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- Sample definition:

- C sample

- To fulfill all specification requirement for hardware and software
 - Parts can be used without restriction for Long time and design validation test
 - To include several features of production manufacturing. Tehcm is build with components provided by supplier production plant
 - To provide requested documentation follwing specification and time schedule
 - Modification requests are handeled as for production process.

- D sample (sample for production manufacturing): additionally to C sample

- Manufacturing on production line
 - To provide tests results as requested in hardware and software specification.

4.4.2 Project specific test description

All tests must be performed according to BMW Group Norm GS 95003. Following improvement is the application of BMW tests standard on GM6 transmission project.

- **Feature test (Functions test)**

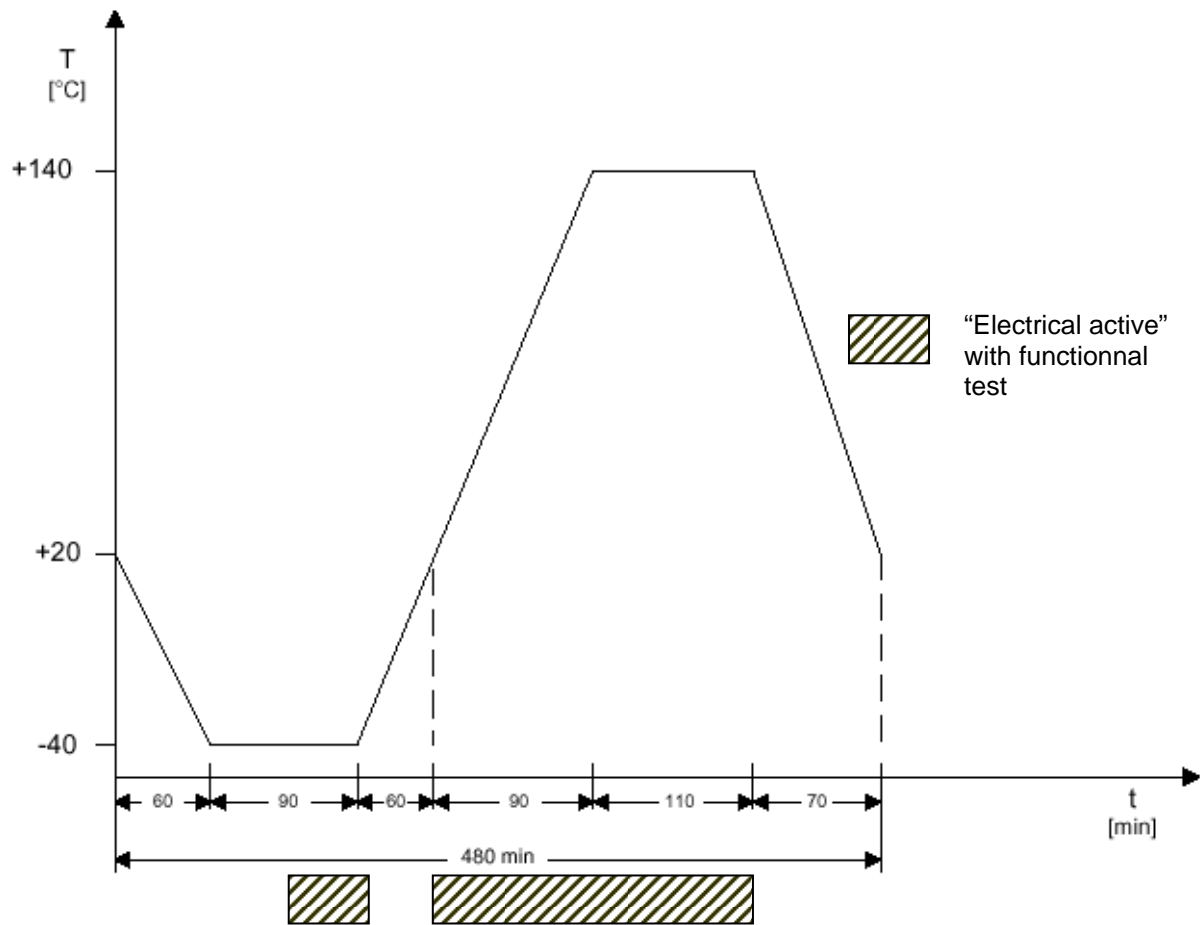
In all running phase output signals must be tested at temperatur: $T_0=140^{\circ}\text{C}$, $T_R=23\pm 5^{\circ}\text{C}$ (or $T_R=70^{\circ}\text{C}$ can be used instead of 23°C) und $T_U=-40^{\circ}\text{C}$. Whole Module is tested. Modu is run "electrical active" during this test (see definition). Temperature references to air .

- **Stepped temperatur test**

TCM must provide, at each temperatur step and after switching on (KL15 on), all requested, in gear position „P“, signals (test environment as for Feature test). Start at environmental temperatur $T_R=23\pm 5^{\circ}\text{C}$, temperatur decrease by step until -40°C , then increase by step until 140°C . Step and test impuls according GS 95003. Whole Module is tested. Module is run "electrical active" during this test (see definition). Temperature references to air.

- **Change Temperatur test:**

Change temperatur test is performed according BMW Group Standard GS 95003. 35 temperatur cycle (global temperature range -40°C to 140°C) are performed, each of 8 hour. Module is tested. Module is run "electrical active" during the test (see definition). Temperature references to air.



- **Low temperatur storage**

72 hour with -40°C, in Oil, TCM switched OFF. Whole Module is tested.

- **Low temperatur running**

72 hour with -40°C, in air, . Whole Module is tested. Module is run "electrical active" during this test (see definition). Temperature references to air.

- **High temperatur storage**

100 hour with 140°C, 50 cycle (each one of 1 hour at 150°C, then decrease from 150°C to 140°C with 1°C per minute, staying at 140°C during 10 min, then increase from 140°C to 150°C with 1°C per minute), test in Oil, TCM switched OFF. Whole Module is tested,

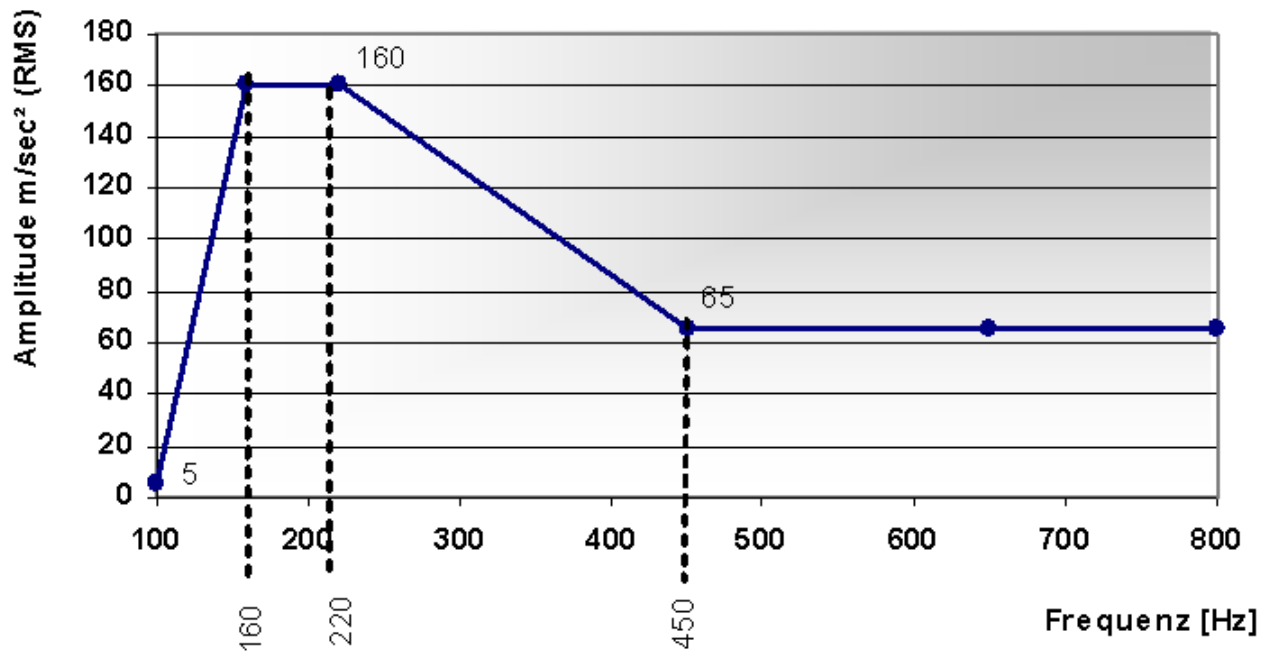
- **BMW vibration load test in Oil**

Test must be performed in production Oil. Module build in transmission main case is tested by vibration load according drawings below. Whole Module is tested. Module is run "electrical active" during this test (see definition). Temperature references to air. Following temperature profile is processed additionally to vibration stress.

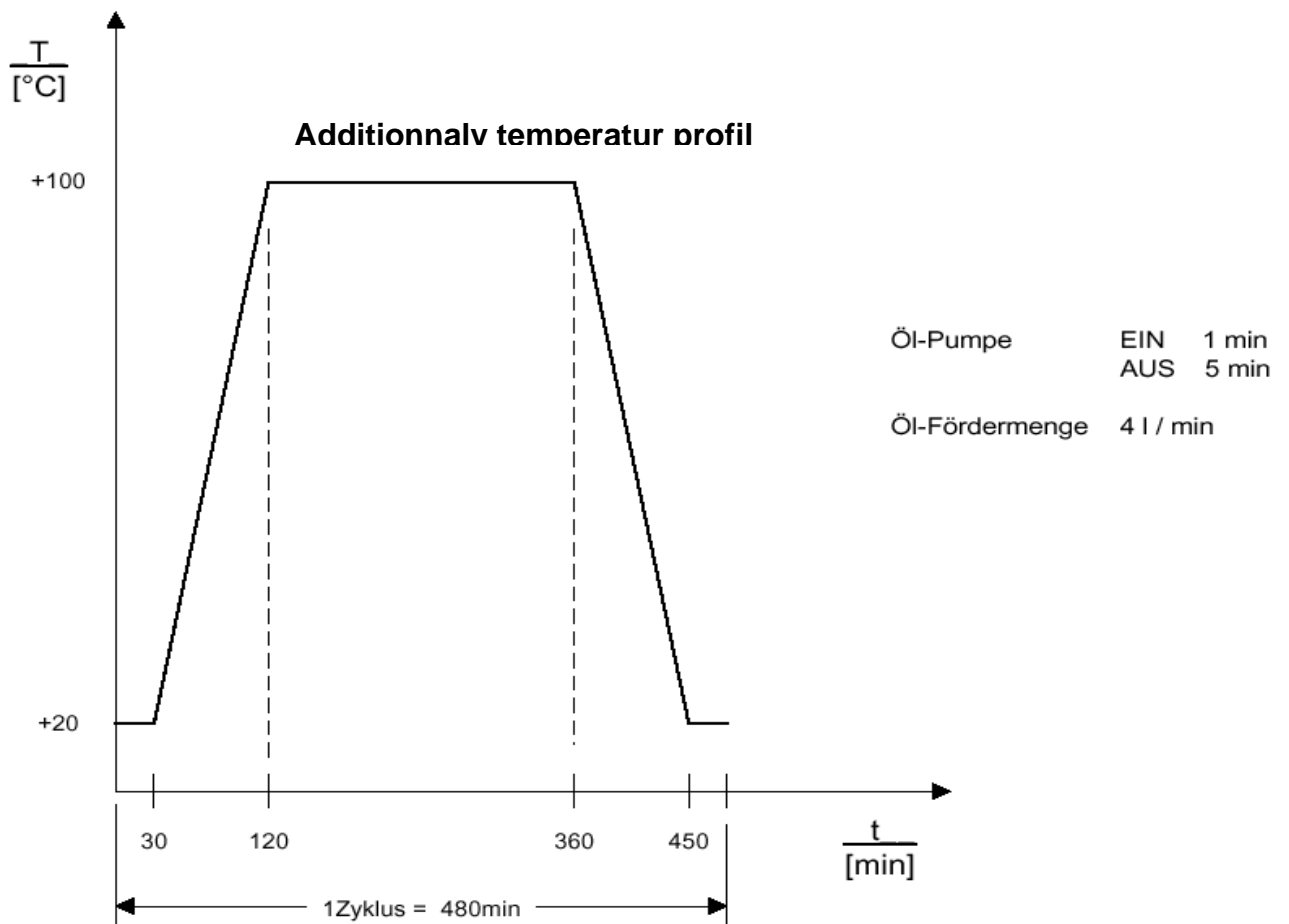
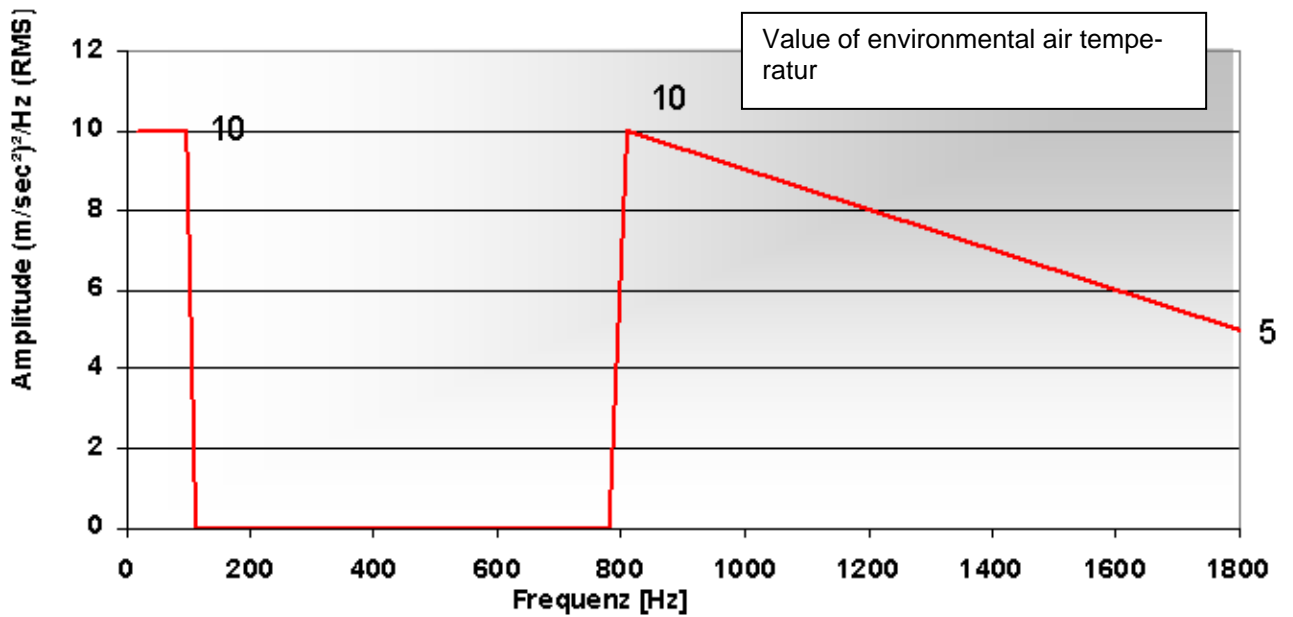
A oil pump is put in measurement installation (oil flow about 4l/min) and is monitored according to following cycle:

- 1 min ON
- 5 min OFF

Sinusprofil (100-800 Hz), alle Motoren



Randomprofil (0-1800Hz), alle Motoren



- In Oil storage**

Whole Module is tested. Module is run "electrical active" during this test (see definition).

2 oil pools, transition time < 30s

Production oil

+ 20°C / + 120°C

1500 cycle in 500 hour

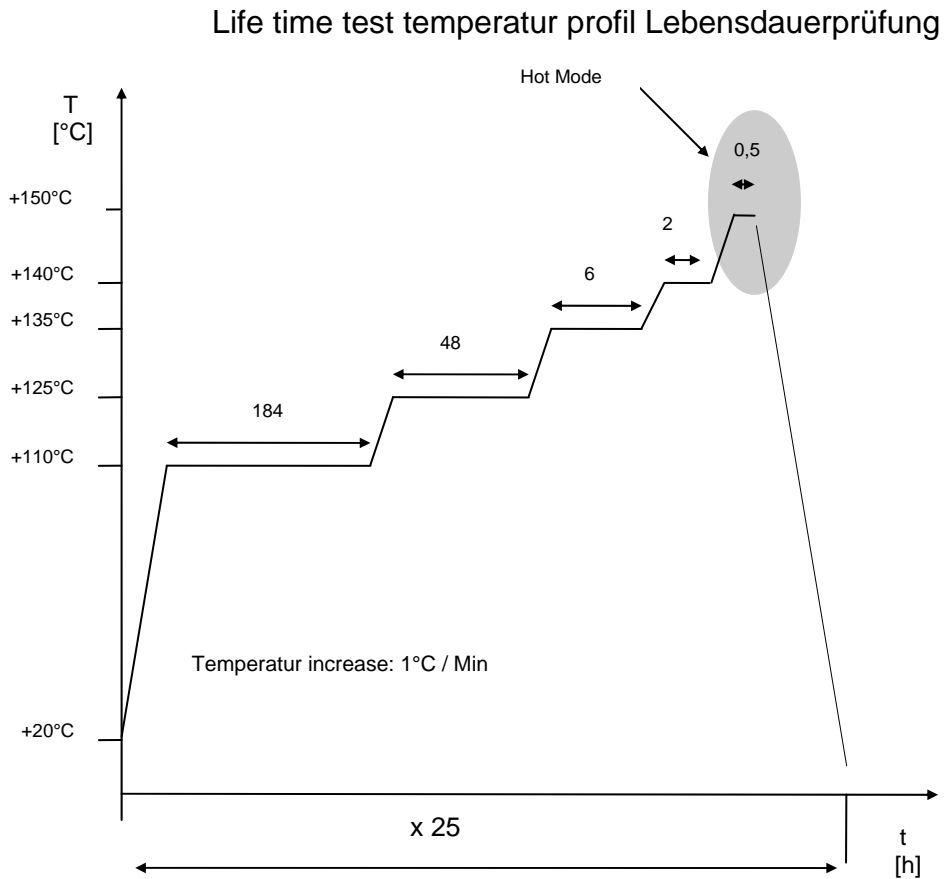
10min in each pool

- **Lifetime test**

Lifetime test must be performed in an production oil pool.

Global oil temperature moves in 244hours from + 20°C to 140°C. This cycle is processed 25 times
In each cycle TCM will reached over temperature range (+150°C oil temperatur) in order to check switching off process at hot temperature (Hot Mode). Transmission functionality impact is check at same time in case of TCM switched OFF at +150°C.

Whole Module is tested. Module is run "electrical active" during this test (see definition).



In order to reduce the test duration it is also allowed to used test profile below:

BMW Life time TestBMW Spec: (representing the actual vehicle life profile)

hours	184	48	6	2	0,5	240,5 x 25	6012,5 hours
temperature	110	125	135	140	150		

Shorter Test Time with the Arrhenius Formula

hours	71	48	6	2	0,5	127,5 x 25	3187,5 hours
temperature	125	125	135	140	150		

Using the Activation Energy of 0,836eV for PA66 as the weakest link

Test Acceleration (Arrhenius)

Activation Energy	... Ea	0,836 eV
Boltzmann Const.	... k	8,65E-05 eV/K
Temperature prax	... Tprax	383 K (v+273)
Temperature Lab	... Tlab	398 K (v+273)
Acceleration Factor	... Af	0,39
Praxis Time	Tprax	184

Lab Test Time: 71,09 hours

$$A_f = e^{-\frac{Ea}{k} \left(\frac{1}{T_{prax}} - \frac{1}{T_{lab}} \right)}$$

- **EMC validations**

EMC-validations are requested according to EMC specification for GM6 and following BMW Group Standard GS 95002. EMC validation report for C sample must be transmitted to BMW

4.4.3 Additional requirements

- **Operating voltage increase during the Lifetime test:**

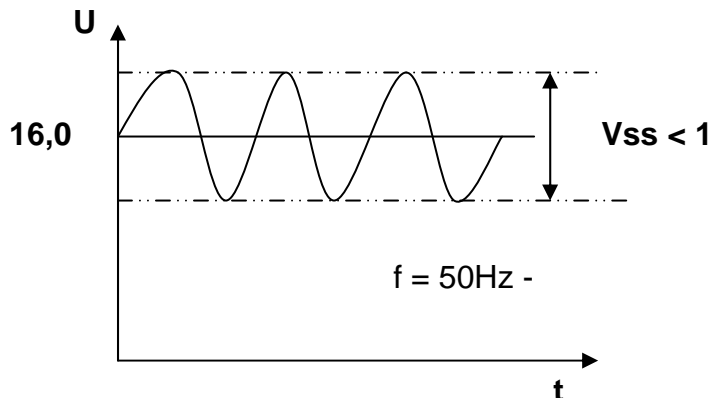
Electronic components must fulfilled the BMW GS 95003 Part 2.

Operating voltage from 9 V to 16 V.

At 16 Volt an additionally voltage wave of 1Vss must be applied

It means that maximal voltage occurring is 16,5 V.

To proof this feature it must be performed an additional test where a voltage wave 1 V_{ss} (+ 0,5 V, - 0,5V) is added to test voltage 16V following Chapter 7.5.2 of GS 95002 .



For PL4 (not for platform PL2 and E83) only. Impulses of 18V each during 100 ms are added to previous test all 20 second in order to simulate voltage wave on Bord Network.. Electronic component must guarantee full functionality during those impulse.

Lifetime test described in 4.4.2 must be therefore performed with following operating voltage:

and 80 % at U_p 14 V
 20 % at U_p 16 V
 with 1 V_{ss} added

and 100% addition of impulse at 18V for 100ms duration,
 each 20sec event triggered (not for PL2, E83)

- **Test of Module electrical function with water in oil**

BMW Minimal requirement: full electronic functionality including PT-Can function is requested as long as not mechanical damager occurs in transmission

Requirement: up to 4% Water in oil, full electronic functionality
GM design can only fulfill minimal requirement.

BMW accept GM design for first SOP but GM has to provide a plan to reach BMW request in the future.

Test definition: **t.b.d.**

4.4.4 Measurements procedure

Test results must be transmitted to BMW. Those data must be improved by table and graphics. Tests results must be available until 10 years after test report release. Times to times production control tests must be scheduled, performed and documented. Tests reports must be transmitted to BMW after report release. This kind of data must be available by BMW at least 3months before SOP for production design. Whole DV tests must be performed for C sample and for D sample (production manufacturing). Some part of the DV test must be repeated after agreement with BMW in case of modification (component design or manufacturing modifications).

4.5 Documentation

Documentation1
Documentation 2
Anlage 4-3

GM Hardware description Documentation **t.b.d. GM**
R.Bosch test process for „ electrical active test” **t.b.d. GM**
Spezifikation Interlock-Magnet

4.6 Reference to standards and regulations

The contents specified in the following documentation/s are mandatory. If, as a result of following documents, intensified requirements arise, these must be treated with priority. Exceptions are explicitly characterized.

GS95002 date Oct 2001	Electromagnetic Compatibility (EMC) requirements
GS95003-1 date Oct. 2001	Electric/electronic Assemblies in Motor Vehicle. General information
GS95003-2 date Oct. 2001	Electric/electronic Assemblies in Motor Vehicle. Electrical requirements
GS95003-3 date Oct. 2001	Electric/electronic Assemblies in Motor Vehicle. Mechanical requirements
GS95003-4 date Oct. 2001	Electric/electronic Assemblies in Motor Vehicle. Climatic requirements
GS95003-5 date Oct. 2001	Electric/electronic Assemblies in Motor Vehicle. Chemical requirements
REF GS95003 date May 2002	Supplement1 to Electrical Electronic Assemblies in Motor Vehicles – Tests
REFGS95003 date May 2002	Supplement2 to Electrical Electronic Assemblies in Motor Vehicles – Run In of electronic assemblies
LH EMV for GS19.12 date 02 March 2004	Specification for transmission development – EMC for GM6 TCM
GS95009-1 August 2002	Electrostatic discharge (ESD)
LH 6 940 599.6 – 08.2003	Elektrisches Energiebordnetz, Teil 1, Allg. Anforderungen
LH 6 940 600.6 – 08.2003	Elektrisches Energiebordnetz, Teil 2, Infrastruktur

5 Software

5.1 General Information

Software of transmission monitoring must have a structure which allow future integration of ETRS function with small workload.

5.1.1 Responsibility for the system

According to its system supplier status, GMPT is responsible for the integrated software, including the management of the program version and data.

BMW is responsible for the functional content of the AGS.

The persons carrying out the integration are respectively responsible during the intermediate phase.

5.1.2 SW-Sharing

The creation of the SW application fields will be carried out within the bounds of SW-Sharings between the E-partners (BMW/system supplier and subcontractors).

It contains the following functional divisions:

- Vehicle functions from BMW
- Transmission function from system suppliers
- Diagnosis functions from system suppliers and subcontractors
- Hardware functions (i.e. Signal acquisition and processing, interface driver (CAN, Diagnosis), Servo component triggering, transmission system) from system suppliers and subcontractors.

5.1.3 Programming language

ANSI-C is the programming language to be used or Assembler in some parts.

5.1.4 Resources required for GS19.12

A specific proportion of resources is allocated to each development partner.

	BMW	GM
RAM*	20%	80%
ROM **	20%	80%
Average elapsed-time	20 %	80%

*: These values are based on an available 32KB RAM size
There is a scheduled reserve of 35%

** : These values are based on the inbuilt Flash memory size of 2MB.
There is a scheduled reserve of 10%.

***: These values are based on the inbuilt micro controller MPC562 (with integrated Flash).
There is a scheduled reserve of 20%.

GM-Software application fields not used by BMW, for instance

- application fields covered by BMW within the framework of SW-sharings
- application fields reserved to other car manufacturers
- application fields where BMW does not fit transmissions

must be safely deactivated if they are included the overall software.

The minimal requirement is as follows: deactivation can not be removed through the application system.

5.1.5 Modification process

All modification or new requirements from GM and BMW have to be performed following the common agreed modification process.

5.1.6 Documentation and Transparency

GM-functions:

According to the Documentation on switching process **(GM t.b.d.)**

Accurate descriptions of the functionalities, parameters and application limits are found in the GM-functions description. BMW AG reserves the right to inspect the GM-functions description. In justified cases, BMW reserves the right to inspect the C-Code.

BMW-functions:

The most exact descriptions of the functionalities, parameters and applications limits are found in the BMW-function descriptions. GM has the right to investigate BMW-functions descriptions.

5.2 Software zones

5.2.1 Vehicle functions / AGS

5.2.1.1 Application fields

See Documentation on AGS interface.doc (Gear control Interface –Functional Description)

1. Target gear

Target gear (including Steptronic-mode) with adaptable functions.

2. TCC- state and slip reference request

With the TCC_state_request is requested a converter positions as to be open, controlled or closed. In controlled position, the TCC_slip_refence indicates the slip value to adjust. (GWK-slip function can also be achieved from a connection). GM-SW has the right to test the AGS request value and also to modify it. The slip_reference_request value of the converter in controlled position would be tested by GM-SW.

5.2.1.2 Responsibility

Responsibility for the different development phases and series of the vehicle functions are defined in the following table.

Activity	Requirements.	Specifications	Coding	Test	Doc.	Application
Responsibility	BMW	BMW	BMW	BMW	BMW	BMW

5.2.2 Transmission functions / Shiftching process control

5.2.2.1 Zone

The zone of transmission functions must be carried out according to the following specifications: For 6L45: **t.b.d. GM**

5.2.2.1.1 General requirements:

Following global requirement for the close to transmission function must be fulfilled

- Transposition in Real-values of the AGS requested values (within the limits indicated in LH shiftching process control (**GM t.b.d.**),) TCC_state_request and TCC_reference_slip function (as far as the "final limit" is not overstepped), gear conversion.
- Building and stopping the forward and backward power flow (with activated and non activated brakes) as well as transmission modifications in each direction and by each transmission point (within LH shiftching process control given limit values).
- Stable design of all transmission approached control circle without mutual negative influence.
- Exclusion from dangerous shifts (N-D, N-R)
- Requirements for the shiftching process and comfort - see chapter 3.5.
- BMW requirement related to security and availability must be fulfilled
- Outward transmission of information of the BMW functions (i.e. DME, Combi, CAS)
- Generation of information for other control equipment or diagnostics i.e. engine torque request for the DME, lever position for the display indicator, etc.

5.2.2.1.2 Special requirements:

- Neutral - Idle - Control (NIC), see chapter 3.5.3
- Functions of the external switch: P/N-Stop/ Shiftlock/ Interlock
- Protection functions against damage to the TCC (Hot-Mode) due to high transmission temperatures
- Exclusion of dangerous shifts

5.2.2.2 Responsibility

Responsibility for the different development phases and series of the transmission approach functions is defined in the following table.

Activity	Requirements.	Specifications	Coding	Test	Doc.	Application
Responsibility	BMW/GM	BMW / GM	GM	GM	GM	GM/BMW

5.2.3 SW-interface

5.2.3.1 Interface BMW-/GM-Software

The software interfaces are defined in below documentation.
Description of signal interface: Documentation 3 C6SR IO.xls

For each software delivery this interface description document will be provided.
Software deliveries are performed following an agreed Integration process and delivery process.
Modification to the interfaces must be approved by both partners and must be incorporated in every new release of the documents concerned (see Document 4 Integration process”).

5.2.3.2 CAN-Interfaces

5.2.3.2.1 Signal precision

Current data dictionary for BN2000 and CAN11h must be supported.

See references in chapter 5.6.

5.2.3.3 Responsibility

Responsibility for the different development phases and series of the SW-interfaces is defined in the following table. Validation and verification must follow the information channel.

Activity	Requirements.	Specifications	Coding	Test	Doc.	Application
Responsibility	BMW	GM	GM	BMW / GM	GM	-

5.2.4 Diagnosis and communication protocols

5.2.4.1 Diagnosis

Diagnostic functions are described in the diagnosis matrix. The diagnostic matrix includes function range, realisation, application value and safety / default function.

Requirement for diagnostic implementation are described in following standard or specification

- LH M-shifting for automatic transmission
- Diagnostic communication BMW - BMWfast/KWP2000&KWP2000* for GS19.12
- LH: OBD Onboard Diagnostic (OBDII) for transmission controls
-
- CAN BUS system diagnostic
- -LH Diagnostic Part 1 to 8
-

An overview of the specification and documentation providing the requirements is available in Chapter 5.6 (requirement, norms, specification)

5.2.4.1.1 General information

As a general rule, the following specifications must be implemented:

- Avoidance transmission conditions critical for security and component damage
- Robustness against diagnosis failure
- The stored information on faults must be transformed into a guide for problem solving and repairs
- The diagnosis is to be orientated towards each of the present guidelines and regulations
- A diagnosis matrix is supplied with each software delivery, containing the current implemented diagnosis functions. (diagnostic description including documentation for allowed CARB requests)
- Modification management guarantees the accurate description of which diagnostic function is available in each transmission hardware/ software variant.
- TCU description data needed for the diagnostic is written, managed and provided by the supplier at each software delivery.

)

5.2.4.1.2 Management of the Faults storage

The management of the faults storage is performed according to the requirements of the specification 8 385 769.4 Diagnosis (Part 2 of diagnostic LH, system description). Implementation of the primary, Info and Back up memory is requested (Chapter 1.2.3).

5.2.4.1.3 The test plan, PQ- Report and quality modus operandi

The test plan and quality modus operandi are defined by the suppliers.

The test plan has to provided BMW department which development BMW tester (diagnostic tool for service) with information for failure detection and recovery. Test plan must allowed this BMW department to build up service efficient repair actions.

Quality modus operandi provide the production with information for failure test and recovery in order to support the production process. Quality modus operandi are set by GM in agreement with BMW. It must include test description, failure recovery procedure which fit to production requirement.

Test plan and quality modus operandi must be available for all platform at pre production and content all information usable by the production department.

Test defined in BMW PQ report (test and quality report see chapter 5.6) must be performed and documented for each software delivery. This document must be provide to BMW at same time as software delivery.

5.2.4.1.4 OBDII / EOBD

In order to take account of OBDII requirements, the following documents must be consulted:

BMW specification

- OBDII-Data management.Rules from car maker working task N° 6, Version 5.0 release Dec 2003,.
- Onboard Diagnostic (OBDII) for transmission monitoring Rev 1.1 release Feb 2004.
-

Regulation requirement in USA and Europe

GM must provide a system conform to following regulation.

- **EOBD:** ECE-On-Board-Diagnosesysteme (OBD-Systeme) für Kraftfahrzeuge. 70/220/EWG in der Fassung 2003/76/EG vom 11. August 2003.
- **OBD:** FINAL REGULATION ORDER Title 13, California Code Regulations, Section 1968.2, Malfunction and Diagnostic. System Requirements for 2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II)

Additional documentation:

- BMW-specification requirement for data processing in control unit according to OBDII. Rules by BMW. Release September 2002. Rev 1.0
- AK/4/5 German car maker Specification for transmission controller OBDII requirement
- Presentation OBDII: rate based monitoring

5.2.4.1.5 Responsibility

Responsibility for the different development phases of the diagnosis application field is defined in the following table.

Activity	Requirements	Specification	Coding	Test	Doc.	Application
Responsibility	BMW/GM	BMW/GM	GM	BMW / GM	GM	BMW/GM

5.2.4.2 Communication protocols

5.2.4.2.1 Protocol programming Diagnosis and OBD

The following protocol for programming, Diagnosis and OBD must be followed.

Protocol	Specification therefore specification requirement
BMW-Diagnose and Flash programming	LH Diagnosis 8 385 768.4
ISO 14230-3	LH Diagnosis 8 385 769.4
BMW-KWP2000 on PT-CAN	LH Diagnosis 8 385 770.4
	LH Diagnose 8 385 771.4
OBD:	LH Diagnose 8 385 772.4
ISO 14230-4 or	LH Diagnosis 8 385 773.4
ISO15765-4/ISO15031-5	LH Diagnosis 8 386 774.4
Switch through calibration	LH car flash programming/verification 6 941764.6
BMW-KWP2000 on PT-CAN	ISO 15765-4LH

5.2.4.2.2 Protocols for measurement and application

The following protocols must be implemented:

Protocol	Specification, specification requirements
CCP on Measure -CAN (measurements purpose)	Only for development: 100% bus load for application with INCA
CCP on PT-CAN	Only for production TCU: 20-30% bus load for application with INCA
PT-CAN (measurement purposes)	Agreement BMW/GM (EDIC Mobil, AZG analog 5HP24)

5.2.4.2.3 CAN-communication

The following protocol must be implemented:

Protocol	Specification. Specification requirement
BN 2000	For PL2: BMW specification requirement Nr. 6 937 725.6
CAN11H	For E83: BMW specification requirement Nr. 7 516 058.4

The current data dictionary provided by BMW must be integrated.

5.2.4.2.4 Responsibility

Responsibility for the different development phases of the communication protocol is defined in the following table.

Activity	Modification.	Specification	Coding	Test	Doc.	Application
Responsibility	BMW/GM	BMW	GM	GM	GM	-

5.2.5 End of line and field Programming (Flash-Programming)

- The programme and data storing must be accessible to programming under CAN.
- Additional modifications to the programm and data sets must also be possible in the vehicle.
- Protection against service failures or misuse such as incorrect or unwanted programming (applies equally to the factories). The SW must implement BMW recommendations for authentication and signature (test authentication + signature verification) according to LH.
- Fault programming must be locked during normal operation.
- Transmissions will be delivered directly to BMW plant by GM with Bootblock and Programm

- It is requested for data set flash programming in BMW plant: programming time for 64kyte data direct through PT-CAN (memory layout?)
 - Target time for data set programming including authentication and signature: $t < 40S$
 - .Minimum time request for data set programming including authentication and signature: $t < 120S$
- Reaction time - 10 working days after SW-release until delivery at BMW-factory, Germany

Accurate requirements are available in specification below:

- LH for flash programming
- Diagnostic communication BMW – BMW fast/KWP200 & KWP2000* for transmission controller
- LH for authentication and signature

Overview of all specifications is available in chapter 5.6

5.3 Development process

5.3.1 Methodology

Each development partner can install its development process area regarding processing and choice of tools freely, as long as the recommendations from SW-integration processes are followed (see chapter 5.3.2.1.1) and that the same of tools are used (see chapter 5.4.1).

A description of each development process is necessary (Handbook).

BMW reserves the right to conduct external audits.

5.3.2 Working together

5.3.2.1 SW-integration

The system suppliers have the responsibility for software integration.

Both BMW and the system suppliers have made it a condition that BMW is obviously in the position to carry out software integrations and, if required, that software tools for SW-integration should be used conjointly; GM will make the necessary configuration available to BMW.

5.3.2.1.1 Integration process

The temporary agreed integration process which exists between the system suppliers and BMW is described in Document Integration process/ tbd by BMW and GM..

5.3.2.1.2 Delivery files

An official delivery contains the following data and documents:

GM t.b;d.

- Program (paf)
- Data set (daf)
- PABD
- PSBD
- SGBD
- 6L45 Diagnostic matrix
- PT-CAN Messages used
- Release letter
- asap-Data file
- PQ-report
- Nomenclature agreement for SW-Level

...

5.3.2.1.3 Modification management

Both partners should organise the management of modifications.

Software modification demands, demands for new functions or demands for defect corrections should be developed in a standardised form.

Testing contracts are to be developed in a standardised form.

The system suppliers will track a list of all the modification demands and testing contracts.

A list of all the modified functions is part of each official delivery.

After function freeze, software modifications are possible only with the agreement of the software team.
After function freeze, software modifications may only be conducted in the case of debugging. Function modifications are possible only with the agreement of the software team.

5.4 Tools

5.4.1 Tools to be used conjointly

Tool	Purpose	Version	Manufacturer
Compiler, Linker, Assembler	SW-Stands creation	4.3 ff	Diab Data

5.4.2 For tools support

WinKFP, NPS, ProF	Programming tools	WinKFP at least 4.5.x NPS at least V2.20 ProF at least V. 2.1.x	Softing, ETAS
Trace32	SW-Test, Debugging		Lauterbach
Test tools AZG, EDIC-Mobil	SW-Test, Indicator tools	Still in discussion with BMW	Softing
INCA-PC	Measurement, application	INCA-PC at least V. 4.x CCP at least 2.x	ETAS

5.4.3 Application tools

When the first control unit is put in service by BMW the application tools must be in full working condition and ready and available. The system suppliers are responsible for the guarantee of the corresponding equipped grades

INCA-PC is a specified BMW application tool

Two application processes are supported:

- Application with CCP on separate application CAN and additionally RAM for development TCU
- Application with CCP on PT CAN for production TCU. Therefore a reduced performance of this function is allowed

5.5 Deadline

5.5.1 Definition of the concept

Function freeze

(Concerning all participants in software sharing)

For this deadline

- All function definitions are available
- The document function specification is frozen

After

- No additional development for functions is planned
- No modification to the function is planned

No specification modifications are planned

Programme freeze

(Definition of the deadline in the project planning)

Software delivery with completed function set to BMW, referring to the specification at the date of the function freeze.

Data freeze

(Definition of the deadline in the project planning)

After this deadline

- No data is modified,
- The entire software pack is available,
- The production software is established through the check sum

5.6 Indication of Norms and regulations

The specific contents laid down in the following documentation is binding. The following documents are strongly recommended and have priority. Exceptions are clearly indicated.

OBD

OBDII data management working task Nr 6 Version 5.0, Ausgabe Dez 2003. (OK for GM)

Rules from car maker

Final regulation order: California Code Regulations, Section 1968.2 Malfunction und Diagnostic System Requirements for 2004

Onboard Diagnostic (OBD II) Rev. 1.1 Ausgabe Feb. 2004

for transmission monitoring

ECE-On-Board.Regulation 11. August 2003.

70/220/EWG in der Fassung

2003/76/EG

Functions

MH Mechanical Shifting M Shifting for G19.12 updated version

LH shifting process control GM tbd

Description of AGS signal interface: C6SR IO.xls

Diagnostic

LH 8 385 768.4-09.2003 Diagnosis Part 1: General requirements

LH 8 385 769.4-09.2003 Diagnosis Part 2: system description

LH 8 385 770.4-09.2003 Diagnosis Part 3: Detailed specifications

LH Diagnose 8 385 771.4-09.2003 Diagnosis Part 4: validation

LH : 8 386 692.4-09.2003 Diagnosis Part 5: SGBD file

LH 8 385 772.4-09.2003 Diagnosis Part 6:KWP2000 Physical layer

LH 8 385 773.4-09.2003 Diagnosis Part 7: Data Link Layer

LH 8 385 774.4-09.2003 Diagnosis Part 8: Diagnosis Services

LH Diagnosis protocole – 06.2003 GM6 GS19.12:BMW fast/KWP2000&KWP2000* for transmission monitoring Rev 1.0.

Specification System diagnostic for controller on CAN-02.2002 System diagnostic CAN BUS (EA/EE/EF/VS)

02.2002

Authentication and signature

LH 6 922 182.4 –12.2002 Authentication Part 1 Concept

LH 6 922 183.4–12.2002 Authentication Part 2 Overview A& S in the car

LH 6 922 184.4–11.2003 Authentication Part 3 detailed specification

LH 6 9222 185.4–06.2001 Authentication Part 4 Key management

LH Ref: 6922186.4–12.2001 Authentication & signaturePart5: production and tools

LH Ref: 6922187.4–12.2002 Rules for Authentication & signature. Part6

LH Ref: 6922188.4–12.2001 Authentication & signature. Part7:secrets

Group Standards

BMW group standard: SGBD: Generation, management and security

GS 95013 –04.2003

Flash programming

LH Flash programming Part 1: Car flash programming
6941764.6 –10.2003

LH Flash programming Part 2: verification
6945359.6-10.2003

LH Flash programming Part 3: SW logistic
6945358.6- 10.2003

Onboard: PT-CAN, BN2000

LH PT-CAN: 6 937 725.6- Part2: System description
08.2003

LH PT-CAN: 6 937 727.6- Part4: Test specification
08.2003

LH CAN11: 7 516 058.4- System description Generality
03.2001

Data dictionary BN2000- Special data dictionary EGS Mech [15] Version 5.1.0
01.2004 MCV Nr 0.13.220

Data dictionary CAN11h- Revision 1.9 for E83
03.2003

BN Architecture, PL2: Function dictionary – 04.2003
6 924 125.4

6 testing

6.1 test planning

6.1.1 Dyno tests

The supplier must ensure that sufficient test bed capacity is available for the agreed functional and long-term stationary test runs.

Scope and dates for the test bed long-term tests at the suppliers and BMW are listed in %annex 6-1.

6.1.2 Test envelop time at speed and torque

The test procedure for dyno durability runs are based on the agreed test length for steady-state conditions (see chapter 6.4.1.1.).

6.1.3 Experimental vehicles

The supplier is to procure the agreed vehicle types for the functional tests. Series production vehicles may be purchased through BMW-HO.

Test support and pre-series production vehicles can be made available via the BMW development dept at the request of the supplier. The durability vehicle test will be carried out by BMW. For deadlines see %annex 6-2.

6.1.4 Tools and testing equipment

The adequate supply of BMW with replacement parts, special tools, special testing equipment and feeler gauges is to be assured.

6.1.5 Fleet test

To ensure a problem-free start of series production E92/E83 with N51/N52 a transmission specific fleet trial is proposed. The allocation of the vehicles will be determined by BMW later.

6.2 Functional and durability tests

6.2.1 Measurement and documentation of test trs

The defined test trs are generally to be measured for their main characteristics before the test and the results are to be documented in the jointly agreed %assembly report annex 6-3

Measurement parameters are e.g.:

- Valve body data
- Clutch clearance.
- Axial play in the input and output, converter and gearsets
- Axial play in the pump

Acceptance of the trs by BMW will take place after presentation of the full documentation. Without the agreement of BMW no parts may be used which do not meet the tolerances in the drawings. The accompanying documents must clearly point out parts, which have been altered. The installation of modified parts must be agreed in advance with BMW.

Further, documentation will be carried out for transmissions specified by BMW which are proposed for durability of those dimensions which were subject to wear during the course of the durability.

Measured dimensions are:

- Surface roughness of the rectangular ring running surfaces
- Profile and face of gears
- Diameter of bearing
- Characteristic curves of wave plates and Belleville springs

- Clutch clearance

Where necessary other measured dimensions are to be defined and documented.

6.3 Test schedule

The tests are performed at both BMW and supplier. The results of the supplier are to be presented to BMW after conclusion of each test run and immediately after the appearance of failures.

6.4 Description of the test procedure

The following describes the individual test procedures to be performed

Type	Procedure	Responsibility (X) Main responsibility (X)	
		Supplier	BMW
Dyno durability	DP1 Pitting test	X	
	DP2 Trailer operation		
	DP3 High speed	X	
	DP4 mixed driving programme	X	X
	DP4/E3+ Mixed driving programme with Integrated ECCC programme	X	X
	DP5 Torque converter test programme	X	
	DP6 ECCC programme	X	
	DP7 Neutral Idle programme	X	X
Long-term test Vehicle	DE08 Mixed operation	X	X
	DE09 City traffic		X
	DE10 Motorway driving		X
	DE16 Trailer operation		X
	DG33 Northern Greece		
	DS44 Miramas		X
	DS46 Nürburgring DU 50 100,000 miles mixed use, USA		
Functional test	FP1 Trs build		X
	FP2 Converter and converter clutch	X	X
	FP3 Oil level, oil filling and "tightness"	X	X
	FP4 Oil supply and ventilation	X	X
	FP5 Engaging shocks	X	X
	FP6 Shift pattern	x	X
	FP7 Shift quality	X	x
	FP8 Special functions	x	X
	FP9 Filling and shift time measurement	X	x
	FP10 Vibrations and noise	x	X
	FP11 Temperature behaviour	x	X
	FP12 Heat and cold tests	x	X
	FP13 Efficiency	X	
	FP14 Pump flow capability	X	
	FP15 Towing	X	
	FP16 Parking lock	X	
	FP17 Mechatronics	X	x
	FP18 Switch and cable harness	x	X
	FP19 Interfaces	x	X
	FP20 Self diagnostic	X	x
Other	Pilot builds		X
	Prototypes		X
	Vehicle Release tests		X

6.4.1 Dyno durability

The following describes the long-term test programme and gives details of the test durations. The assessment of the trs following the test runs is to be made in accordance with the criteria given in chapter 4.5

To increase the statistical probability the long-term test runs which exceed the normal test times (test up to breakdown of the trs) are to be aimed for. Where a single component breaks down the test run is to be continued after the failed component has been replaced. To avoid subsequent damage it must be generally assured that the test bed is switched off at the appropriate time.

A condition for the confirmation of the product is that successful passing of 3 of the long-term test runs DP4 with the constructional state envisaged for the series.

6.4.1.1 (DP1) / Pitting test

Loading conditions: $M_{\text{Nominal}} = 300 \text{ Nm}$ (from 5HP19 LH) - $N_{\text{Eng}} = 4000 \text{ 1/min}$ - $T_{\text{Sumpr}} = 100^\circ\text{C}$

Time at torque per gear : see annex 6-3

The torque run is to be carried out with TCC closed. For boundary conditions see annex 6-3. Finally an inspection of the trs is to be carried out.

The values given above for test time, temperature and torque can be varied depending on the vehicle data, in order to give a representative test. Where changes are made the representative test bed regulations will be jointly agreed once again.

6.4.1.2 (DP2) / Tractor

300 hours after the set test programme behind the highest performance engine variants proposed for the at the combustion engine test bed with (GCVW) mass simulation. Maximum output speed corresponding to the driving speed of 120 km/h in each possible gear. In addition for those variants, which based on experience will be driven in tractor operation. Implementation of the tractor mode test preferably to take place on the road.

6.4.1.3 (DP3) / High speed

Test based on the prescribed test programme (corresponds to 50,000 km DF 44) at the combustion engine test bed with mass simulation.

6.4.1.4 DP4

Mixed driving programme based on steady-state times, chapter 6.4.1.1. For driving list see %annex 6-4. The test programme is binding for the tests of both companies.

6.4.1.5 Wandlerprüfprogramm (DP5)

The test of the converter is to be made in accordance with QV - converter W235: 1071 700 013 W245: 1071 700 014, W255: 1071 700 015

The supplier is to demonstrate positive results for:

- Static and dynamic ballooning trials
- Pressure pulse trial
- Rotational bending test for pump hub
- Temperature behaviour at long-term slipping

6.4.1.6 (DP6) / ECCC

The test programme for the ECCC trial corresponds to the loading data for the ECCC (in accordance with 3.1.5.2).

6.4.1.7 (DP7) / Neutral idle

% - Has still to be jointly agreed -.

6.4.1.8 (DP4/DP6)

Mixed driving programme DP4 with an integrated ECCC programme DP6 for 4000 cycles.

6.4.2 Vehicle durability

The test will be carried out by BMW.

6.4.2.1 (DS44) / High speed in Miramas

50.000 km based on the defined driving programme see annex 6-6.

6.4.2.2 (DE10) / Highway

100,000 km based on the defined route on German highway.

6.4.2.3 (DE08) / Mixed ORT

150,000 km based on the defined combined sections in accordance with the customer profile. This programme involves operation closely related to the customer along statistically selected routes. The sections to be driven along will include city roads, district roads, federal (german) highways and motorways. The programme also includes 10% trailer operation (DE16).

6.4.2.4 (DE09) / City driving

50.000 km based on the defined routes.

6.4.2.5 Hangererprobung (DE16) / Trailor

15,000 km to check the demands on the components at a high slippage in the converter and frequent driving in lower gears as a result of manual programme or position shifts as well as the effect of the frequent operation of the gear shift on mountains with extreme vehicle weight on the trs .

6.4.2.6 (DU50) / US mixed ORT

100 000 miles mixed driving in the USA with particular attention being paid to the emissions.

6.4.2.7 (DS46) / Nurburgring test (DS46)

10,000 km (!!!) based on the defined driving programme. Programme with high multiplication factor for loading all the components in the trs . Testing the functional safety under extreme accelerations.

6.4.2.8 (DG33) / Northern Greece test (DG33)

30,000 km based on the defined driving programme. Programme with high multiplication factor for loading all the components in the trs .

6.5 Durability EOT assesment

6.5.1 Trs function

The trs must still be fully functional after completion of the long-term run. The gearshift comfort see annex 3-4 (gear shift comfort) may not worsen by more than one ATZ point (see annex 3-5).

6.5.2 Measurement and documentation

The tested trs are to be measured after the end of the test and the results of the measurements compared and evaluated with the permissible theoretical values and the output values. The results are to be documented and handed over to BMW.

6.5.3 Gears

After completion of the test rounds the surfaces of the teeth sides must show a maximum 20% pitting. Teeth cracks and fractures are not permitted.

6.5.4 Kupplung und Bremse / Clutch packs

Only functional, good looking and acceptable wear clutch packs allowed at end of test. Only signs of wear corresponding to the running time should be visible.

6.5.5 Pump

There should be no decrease in its functioning. Signs of wear corresponding to the running time are permitted. Volume flow sufficient to ensure all functional requirements. The pump must be sealed tight to the outside; a minimal amount of sweating in the area around the sealing points is permitted.

6.5.6 Bearings

The sliding bearing must sit tight. Signs of use and heat discolouration corresponding to the running time and use are permitted. Wear in accordance with the permitted bearing tolerance.

6.5.7 Converter and converter clutch

Safe functioning of the torque converter and converter clutch following completion of the test must be ensured.

6.5.8 Connector

The safe functioning of the connector following completion of the test must be ensured. There should be no visible signs of damage on the parts of the housing, on the bayonet connection or on the surface protection of the components. The contact room must be completely dry (no traces of oil and no dampness). The isolating body must not show any signs of deformation (sources). The perfect position and layout of the contacts must be ensured following the test.

Seal against loss of oil: Leaks in this region are not permitted for the whole period of use.

6.5.9 Controls

Safe functioning of the Mechatronics following the end of the test. The inspection following the test must indicate no sign of damage and no wear, which could lead to functional disruptions under any of the permitted boundary conditions.

6.6 Tests and functional test

6.6.1 (FP1) / Build ability

All the contour and connection dimensions must correspond to the drawings and be checked. Faultless functioning of the shift components as well as compliance with the defined engaging forces over the whole temperature range is to be ensured.

6.6.2 (FP2) / Converter and converter clutch (FP2)

All the contour and connection dimensions must correspond to the drawings and be checked. The functioning of the converter and the converter clutch must be within the defined load, speed and temperature range. The characteristics of the converter must correspond to the set values. Speed range ability and capacity curves must correspond to the constructionally determined values. There may be no disruptions to functioning or any appearance of plastic deformation.

The control or regulation of the connection or the opening of the TCC must work safely over the whole load, speed and temperature range.

The turbine torsion damper is to be so arranged that load change, longitudinal and jerk vibrations are avoided as far as possible. Agreements are to be carried out with the supplier.

The defined remaining imbalance in the converter, based on the latest drawings, must be complied with and must not lead to any problems of vibration.

6.6.3 (FP3) / Oil level, oil filling and tightness (FP3)

The oil level and oil filling are to be defined by the supplier before the start of the test. It must be possible to make control checks without any problem.

The supplier is to provide an oil level / temperature diagram (!)

Any appearance of oil at the breather is not permitted under any conditions of temperature and driving dynamics and must be checked.

6.6.4 (FP4) / Oil supply and breather (FP4)

The individual bearing and lubricating points must be subject to adequate lubrication and cooling for all practical operating conditions. Proof of this is to be provided by measurement of flows. It may be necessary to develop additional cooling measures. Adequate airing and breathing is to be ensured.

6.6.5 (FP5) / Garage shifts

Forward and reverse gear changes must meet the requirements of chapter 3.5.1 and these must be maintained within these limits over the whole temperature range.

6.6.6 (FP6) / Shift point strategy

Die Fahrstrategie wird von BMW festgelegt und erprobt. The driving strategy will be determined and tested by BMW.

6.6.7 Getriebenahe Applikationen (FP7) / Trs related calibration (ECCC & Shift quality)

Die getriebenahe Applikationen für die Schaltvorgänge werden vom Lieferanten durchgeführt und nach einer gemeinsamen Überprüfung freigegeben.

Transmission related applications for the shift and ECCC quality will be carried out by the supplier and released after a joint control.

6.6.8 (FP8) / Special functions

The defined special functions are to be tested and confirmed by the supplier and BMW.

6.6.9 (FP9) / Shifting logic

The filling and shift processes must meet the jointly developed values and are to be demonstrated by means of measurements.

6.6.10 (FP10) / NVH

Subjective and technical assessments of vibrations and noise in the whole range of speed and load are to be carried out by the supplier and BMW. The limiting values as defined by BMW are to be complied with (see also chapter 3.6).

6.6.11 (FP11) / Temperature behaviour (FP11)

The bench tests must be carried out with $T_{\text{Sump}} = 100 \text{ °C} \pm 5 \text{ °C}$.

The temperature behaviour of the trs must be better than presently available, comparable trs (5L40-E).

The oil sump temperatures must not exceed the prescribed values.

Agreements concerning the temperature behaviour and the cooler are to be made between the supplier and BMW.

6.6.12 (FP12) / cold and hot tests

Bei der Kälte- und Hitzeerprobung werden getriebe-nahe Funktionen und Ölstand überprüft. Die Durchführung erfolgt gemeinsam mit dem Lieferanten.

The cold and heat test is used to test the oil level and functions related to the trs . It is carried out in conjunction with the supplier.

6.6.13 (FP13) / efficiency measurements

The supplier is to record the change in efficiency of the trs in relation to load, speed, temperature and gear (efficiency performance data) and hand the results over to BMW.

(See also chapter 3.4.2.11 and annex 3-4).

The efficiency performance data for the converter is to be recorded separately.

6.6.14 (FP14) / Pump flow capability and losses

The supplier is to register details of available flow and pump losses in relation to speed, temperature and pressure and to hand over the results. The measurement programme is to be agreed with BMW.

6.6.15 (FP15) / Towing

With the gear position neutral the trs is to be driven on the output shaft – with a stationary input – with a speed corresponding to a vehicle speed of 80 km/h. Minimum travel distance:

480 km. For the ETRS change the parking lock is to be disengaged via the vehicle-side emergency unlock feature. After the test run there should be no signs of wear. Proof of this is to be provided through on-road operation.

6.6.16 (FP16) / Park system

The working of the parking lock system must be better than that of the existing system (5L40-E). Test to be based on the test programme ‚parking lock system‘. The release jerk on release of the parking lock must, in accordance with ATZ assessment show a value of ≥ 8 (see annex 3-5).

6.6.17 (FP17) / TEHCM

All the functions in the trs control (control, measurement, regulating tasks etc.) must be checked. The results are to be documented. The test of functions in the vehicle will be carried out by BMW (BN2000, control unit connection etc.).

6.6.18 (FP18) / Switches and wiring harness

entfällt, siehe Schnittstellen (FP19). Not required, see interfaces (FP19)

6.6.19 (FP19) / Interfaces

6.6.19.1 TEHCM

The Mechatronics (internal TCM, sensors, regulating controls etc.) are connected via the trs connector with the vehicle electrics and electronics. (See pin assignment section „control“). The functioning of all inputs and outputs are to be tested and the results are to be documented.

The functional tests for the electrical switch are summarised in the specification "electrical switch" in section "test specification".

6.6.19.2 Mechanical trs range shifting

Besides testing the additional electrical interfaces (shiftlock magnet, interlock magnet, steptronic switch, Dual gate switch), the mechanical interfaces, in particular the mechanical position selection lever should also be checked.

6.6.20 (FP20) / Self diag

A query of the self-diagnostics is made via the OBD/diagnostics plug using the BMW tester (or Modic). The self-diagnostics is to be tested by means of a fault simulation (e.g. short-circuit on mass or on supply voltage of various leads and disruption to the cable connections), and the results documented.

In normal driving operation there should be a fault-free functioning of the trs and no fault report should be recorded in the fault memory of the EGS.

The threshold values for the diagnosis are to be so arranged that, whilst maintaining safety, a maximum availability of the vehicle is assured. Details are contained in chapter 5 of these specifications.

6.7 Standards and Normative References

LH 1423392	EMV for electrical connections
GS 95003-1 March 2000	BMW Group Standard, electrical and electronic groups
GS 95003-2 March 2000	BMW Group Standard, electrical and electronic groups
GS 95003-3 March 2000	BMW Group Standard, electrical and electronic groups
GS 95003-4 March 2000	BMW Group Standard, electrical and electronic groups
GS 95003-5 March 2000	BMW Group Standard, electrical and electronic groups
GS 95002 December 1999	BMW Group Standard, electromagnetic resistance
QV 1056 700 286	Transformer
DIN 19250, 19251, VDE 0801, VDE 0801 A1, IEC 65	Functional security
DIN 40 046 / 7, / 13, / 26, / 30	Environmental Tests
DIN 40 050 / 9	Protection Categories
DIN 40 839 / 1, / 4	Resistance to Directed Interferences
DIN 50 017 KFW	Climate Tests on Water Condensation
DIN 50 021	Fog Test
DIN 57 879 / 3, VDE 0879 / 2, / 3	Directed Interference Emissions
DIN 72 251	Voltage for electrical motor vehicle equipment: concepts, values
DIN 75 001	Classes of Application for Measuring Devices in Motor Vehicles
IEC 68-2-1, -2, -3, -6, -14	Basic Procedures for Environmental Tests (Electrotechnics)
ISO 4926	Road vehicles - Hydraulic brake systems - Non-petroleum base reference fluids
ISO 7309	Road vehicles - Hydraulic braking systems - ISO reference petroleum fluid
ISO 7637 / 1	EMV

WARRANTY AGREEMENT

Between:

(1) Bayerische Motoren Werke
Aktiengesellschaft
Petuelring 130
80788 Munich
Germany

- hereafter referred to as 'BMW' -

and

(2) GM-Strasbourg S.A.S.
81 Rue de la Rochelle – BP 33
67026 Starsbourg Cedex
France

- hereafter referred to as the 'Contractor' -

Subject of this agreement is the liability for material defects for all products related transmissions (hereafter referred to as the 'Products') that GM Strasbourg S.A.S. (hereafter referred to collectively as the 'Contractor') supplies to BMW or any company associated with BMW in the sense of § 15 of the Stock Corporation Act (hereafter referred to collectively as 'BMW'). Unless otherwise agreed herein, the BMW international purchase conditions dated May 23, 2003 shall apply to liability for material defects.

The current agreement shall have a retroactive effect on all products that have been delivered since 1.1.2001 or are to be delivered. The agreement has already been applied in the 2001 and 2002 annual financial statements. The implementation rules agreed therein shall continue to apply unaltered.

Upon it coming into force, this agreement shall replace the warranty agreement between BMW AG Munich and the GM-Powertrain Group dated 12.12.1995.

1. Content of material defects liability

- 1.1 The Contractor shall be liable for ensuring that all products supplied are free from defects. The legal understanding of defect shall apply (§ 434 of the German Civil Code). Irrespective of this, the Contractor shall continually make every effort to reduce such failures. Adherence to test regulations and any BMW releases in no way releases the Contractor from its obligation to deliver products free from defects.
- 1.2 Any defects reported in the products supplied must be checked for the source of those defects by the Contractor. The scope and extent of the inspection shall be agreed between the contracting parties. If no agreement can be reached, that scope and extent shall be determined by BMW at its equitable discretion and with due consideration of the interests of the Contractor. Test results must be sent without delay to BMW. Upon request by BMW, the Contractor shall present details in writing of possible corrective measures. While carrying out these corrective measures, the Contractor shall check their effectiveness at regular intervals and submit corresponding reports to BMW. If the Contractor is not ready or in a position to carry out examinations himself, the relevant examinations may be carried out or arranged by BMW at the Contractor's expense.
- 1.3 The handling and settlement of material defect claims shall be carried out between the parties or by an associated company nominated by the parties.
- 1.4 Rejected products shall be replaced by new parts in the vehicle. If the repair of failed parts is agreed on economic and / or ecological grounds, replacement parts shall be used for repairs.

2. Timeframe

- 2.1 Material defect claims against the Contractor shall lapse upon expiry of the timeframes granted by BMW to its end customers or after 100,000 miles if this total is reached at an earlier date.

The following timeframes currently apply:

- In all countries, with the exception of the USA, Canada and Puerto Rico, material defect claims shall lapse 24 months after the relevant earlier date of initial vehicle registration, vehicle release to the end customer or spare part installation.
- In the USA, Canada and Puerto Rico, material defect claims shall lapse 48 months after the relevant earlier date of initial vehicle registration, vehicle release to the end customer or spare part installation, or after 70,000 miles if this total is reached at an earlier date.

2.2 For products relating to exhausts, emissions or safety, if there are obligatory legal or otherwise mandatory conditions applicable to liability timeframes or mileages that exceed the timeframes quoted in Paragraph 2.1, these shall replace the timeframes quoted in Paragraph 2.1. These extended liability timeframes do not apply to material defects unrelated to the obligatory legal or otherwise mandatory conditions.

3. Liability for 'Zero mile' failures

3.1 Zero mile failures are defects that are determined before leaving the BMW operating site or that of a company contracted by BMW, particularly

- upon goods entry
- upon further processing of semi-finished goods
- on the assembly line or during function testing after installation.

In these cases, the Contractor shall be given the opportunity to correct defective products, remedy defects or replace the defective products before production at BMW begins (processing or installation).

In the case the Contractor decides to not remedy the defects, BMW is entitled upon coordination with the Contractor

- either to remedy the defect itself or have it remedied by a third party at the Contractor's expense
- or to cancel the purchase of the defective product and return it at the Contractor's expense. If similar parts are repeatedly supplied in a defective condition, BMW is entitled to cancel the relevant order or withdraw from the corresponding purchase agreement entirely, i.e. with regard also to products as yet undelivered, provided that the Contractor has continued to supply defective products after appropriate written notification has been sent.

In both aforementioned cases of defect remedy and goods return, BMW shall make a test report available to the Contractor, stating the costs to be repaid. Calculation of the costs to be repaid by the Contractor is activity-related and in accordance with expenses. The total costs to be repaid by the Contractor are determined in accordance with Paragraphs 3.2 and 3.3 below.

3.2 BMW and Contractor production sites on the same continent:

- (a) For reclaimed products that are being returned or scrapped, the following flat rate costs are to be repaid:

100% of the current valid purchase price
+ 1% packaging flat rate for replacement parts
+ 2% freight flat rate for replacement parts

103% of the current valid purchase price, being a flat rate factor of 1.03

The scrapping by BMW of reclaimed products is only to be carried out upon prior agreement between the contracting parties. In this case, the Contractor shall be invoiced for the scrapping costs in addition to the aforementioned flat rate payment.

- (b) Furthermore, all appropriate activity-related costs arising for BMW either internally or through contracting a third party in connection with the processing of claims and / or default remedy are to be repaid. In cases of unjustified complaints, the test report will be cancelled and the repaid costs will be credited to the Contractor.

3.3 BMW and Contractor production sites are on different continents:

- (a) For reclaimed products that are being sent abroad to the USA, South Africa or Europe to be returned or scrapped, the following flat rate costs are to be repaid:

100% of the current valid purchase price
+ 25% handling, packaging and freight costs for replacement parts

125% of the current valid purchase price, being a flat rate factor of 1.25

CKD claims

For reclaimed CKD products that are being returned or scrapped in Egypt*, Brazil*, Indonesia*, Malaysia*, Mexico*, the Philippines*, Russia*, Vietnam*, Thailand* and future as-yet undeveloped CKD markets*.

100% of the current valid purchase price

+ 110% Customs, handling, packaging and freight costs for replacement parts
210% of the current valid purchase price, being a flat rate factor of 2.10

The actual costs arising shall be applied to special offers, instead of the flat rate. Special offers apply if the consolidated flat rate sum exceeds € 50,000.

The scrapping of by BMW reclaimed products shall only be carried out after consultation with the Contractor. In this case, the Contractor shall be invoiced for the scrapping costs in addition to the aforementioned flat rate payment.

For products found by BMW to be defective in the aforementioned countries marked with an asterisk (*), the Contractor shall waive the right to receive those products for inspection.

- (b) Furthermore, all appropriate activity-related costs incurred by BMW either internally or through contracting a third party in connection with the processing of claims and / or default remedy are to be repaid. In cases of unjustified complaints, the test report will be cancelled and the repaid costs will be credited to the Contractor.

3.4 Other defects

Where agreed, as regards defects not attributable to faulty delivery by the Contractor (e.g. damages caused by BMW), the relevant products will be returned by BMW to the Contractor for repair. A lump sum for the repair costs, agreed between the parties before goods return, shall be subtracted from the value of the relevant products. The resultant lump sum residual value¹ for the part will be invoiced to the Contractor. The Contractor shall repair the products and return them to BMW, charging the current valid purchase price. All repaired products are to be marked separately.

¹ The aim is to conclude product-specific special agreements on flat rate payments; agreements already in existence apply unaltered

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4. Liability for in-service failures

In-service failure is when defective products have already been installed in vehicles and / or the products have already left the BMW operating site or that of a contracted company. In these cases, in-service failure is also considered to be when initial vehicle registration, release to end customers or sale of spare parts to the end customers have not yet been carried out.

4.1 Handling of material defect claims – countries required to return parts

4.1.1 Return

BMW shall make a defective parts chart or special tag available for the return of defective products, containing the following details:

1. Dealer identity number
2. Vehicle type
3. Chassis number
4. Mileage
5. Initial vehicle registration or spare part installation date
6. Repair date
7. Finding number
8. Claim number

4.1.2 Notification and inspection

BMW shall make available to the Contractor the products considered defective from the country listed on attachment to fulfil legal or other obligations.

BMW shall make the rejected products available at an agreed location or send the reclaimed products to the Contractor or a third party nominated by the Contractor (e.g. subcontractors). Costs arising for sending products and for parts inspection by the Contractor are to be borne by the Contractor.

The Contractor shall inspect the relevant products with all necessary care and shall inform BMW of its decision, with corresponding comments on recognition of responsibility for each product:

- i.e. Category 1 – Contractor's responsibility
- Category 2 - Defect found but BMW's responsibility
- Category 3 – No defect found
- Category 4 – Failure found but dealer / customer's responsibility

The Contractor shall use the current valid version of the BMW factory standard GS 95004 'Assessment of components (warranty position)'

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4.1.3 Claims not accepted by the Contractor

The Contractor shall return all products where he denies liability (i.e. Category 2 and 4 products) to the relevant BMW 'GWTZ' within 4 weeks at the latest after the day the products were made available to the Contractor (date of written notification or transport documents); the individual test results are to be attached to the corresponding defective parts chart or special tag for return and – except in the case of an examination in which the part was destroyed – the products are to be returned in their original condition. Costs of transport are to be borne by BMW.

4.1.4 Products that are to undergo replacement part recycling

Products that are to be examined by the Contractor or those that are being returned outside the liability and goodwill periods shall undergo replacement production – where previously agreed.

BMW shall refund defined % rates of the original goods value depending on agreement.

The % rates shall be regulated in separate agreements; those agreements already in existence shall continue to apply unaltered.

The material defect liability conditions of this agreement apply to replacement parts.

4.2 Handling material defect claims – markets where parts return is not required

Countries not required to return parts comprise all sales markets not mentioned in Paragraph 4.1.2. Rejected products from these countries may be inspected for defects by BMW itself; the obligation to send products to the Contractor does not apply. In exceptional cases, the Contractor is entitled to examine the products after prompt prior written request to do so. In this case, the Contractor is to compensate BMW for the resultant costs.

To offset consequences of defects that arise for BMW due to defective products in these countries, BMW shall receive a flat rate sum from the Contractor instead of the actual costs arising over the fiscal year. The flat rate amounts for countries not required to return parts are listed in Appendix 1.

4.3 Cost settlement and payment in terms of material defect liability

4.3.1 Settlement basis (see also Appendix 1)

The basis for settlement is the set range of recognised products in Category 1 and 'No error found' Category 3 in the sales market, as defined above in Paragraph 4.1.2, as well as the purchase price for the scope of supply to be installed in warranty cases.

4.3.2 Settlement and payment for the liability timeframe defined in Paragraph 2 of this agreement

BMW shall calculate the costs for the Contractor for the exchange of defective products and incidental costs as per the calculations set down in Appendix 1.

4.4 End of year statement

The following settlement methods apply:

Using the calculation method defined in Appendix 4.1, the Contractor shall pay the relevant instalments included in the annual statement.

In addition to the above conditions, the following costs factors are taken into account:

- 4.4.1 Purchase price of scope of supply to be installed in warranty cases that are the fault of the Contractor and are recognised as its responsibility (Categories 1 and 3 as per Paragraph 4.1.2).
- 4.4.2 Installation and disassembly costs for dealer, including actual costs for repair / exchange of other parts made necessary as a result of the defects that have been found.
- 4.4.3 Country-specific customs, packaging and freight costs etc.
- 4.4.4 Country-specific handling costs
- 4.4.5 BMW internal processing and handling costs (Appendix X)
 - 4.4.5.1 100% of 4.4.1 (total costs of quality failure)
 - 4.4.5.2 33% of 4.4.1 in bonus cases where the agreed limit value is not reached
 - 4.4.5.3 BMW waives explicitly the penalty regulation

4.5 Claims whose elimination engenders labour costs only

In the case of defect elimination measures undertaken within the BMW sales organisation for which only labour costs arise, the Contractor shall reimburse BMW for those labour costs. Labour costs shall be reimbursed after joint examination by BMW and the Contractor. Results from the mobile service or hotline used are taken into account here.

If no mobile service (hotline only) is used, a flat rate discount of 20% is guaranteed on the warranty gross value of the minor repairs (as of the 2003 annual statement), to take into account the BMW's responsibility.

5. Series damages

5.1 Principle

Series damages comprise the accumulation of defects with the same cause of error that exceed the so-called 'zero error target' (plus an allowed error rate or action control limit) applied by BMW and recognised by the Contractor. This also includes continuous existing quality defects.

The Contractor undertakes to make qualitative defect-free products available for the series and the in-service sector as quickly as possible.

With series damages, BMW shall decide, at its equitable discretion and with due consideration of the interests of the Contractor, which measures are suitable and necessary to eliminate those damages (e.g. preventative customer service measures, including call-back), the Contractor will be part of the decision processes. If parts exchange, software recoding or vehicle inspection without parts exchange are required to eliminate the series damage, the Contractor shall release BMW from all warranty costs arising from material defect liability in the sense of Paragraph 5.2. This also applies for the timeframe before customer service measures are determined by BMW or another party authorised for this purpose. If comprehensive elimination methods (e.g. call-back) are not possible on the grounds of limited parts availability or are not suggested on the grounds of limitation of damage, this type of settlement shall also apply in individual cases of repairs after customer complaints.

5.2 Material defect liability costs are basically calculated as laid out in Paragraph 4.4. The economic aspects of the Contractor shall be taken into consideration. Payment of a serial damage up-to 5 % of GM Strasbourg S.A.S. annual business with BMW is between the parties not questionable.

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5.3 Severe serial damage exchange of transmissions:
For damage greater than 2 M € the cost calculation will be done with 30% add-on cost + 5 € flat rate instead of the cost as described in chapter 4.4.5 (100% or 33%).

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Exhibit III

BMW Group International Terms and Conditions

for the Purchase of Production Materials

and Automotive Components *R*

**BMW Group International Terms and Conditions for the Purchase of
Production Materials and Automotive Components**
(Status 23.05.2003)

List of Definitions:

- **Seller**
is the party to whom the Purchase Order is addressed.
- **Buyer**
means the party which issues a Purchase Order or on whose behalf a Purchase Order is issued.
- **Call for Delivery**
means any instruction issued by Buyer to Seller specifying the required delivery quantities, place, date and (if relevant) time of delivery of Goods.
- **Goods**
means all production materials and automotive components specified in the Purchase Order and includes accessories, Tooling and, where relevant, services.
- **Tooling**
means production equipment, including, but not limited to forging dies, measuring and testing equipment (e.g. gauges), matrices, models, samples, tools, devices, drawings and similar items required for the production and examination of Goods.
- **Supply Contract**
means any contract formed by Seller's acceptance of a Purchase Order.
- **Incoterms**
means those trade terms published by the International Chamber of Commerce and entitled „Incoterms 2000“.
- **In writing or written**
means in writing signed by the issuing party and served by any means including fax and EDI.
- **Intellectual Property Rights**
means patents, design rights, copyrights, trademarks and service marks (whether registered or not and applications for any of the foregoing), know-how, and rights of a like nature, throughout the world.
- **EDI**
means Electronic Data Interchange, i. e. the transmission of data via electronic communication links between the parties or other machine-readable data media.

Provision 1: General

- 1.1 These Terms and Conditions shall apply to the purchase of production materials, automotive components and accessories by Buyer from Seller. These Terms and Conditions shall also apply to Tooling. They shall form part of every Supply Contract.
- 1.2 Seller has read and understands these Terms and Conditions and agrees that Seller's written acceptance of or its performance in relation to a purchase order (as defined in Provision 2.1) shall constitute Seller's acceptance of these Terms and Conditions.

Provision 2: Purchase Orders and Calls for Delivery

- 2.1 Buyer shall issue a purchase order (the „Purchase Order“) for Goods to Seller. Acceptance of a Purchase Order by Seller is expressly limited to the terms of the Purchase Order and to these Terms and Conditions. Any additional or different terms and conditions are expressly excluded and shall not form part of any Supply Contract. Each Purchase Order accepted by Seller pursuant to Provision 2.2 will constitute a separate and individual Supply Contract.

2.2 Seller will forward a written acceptance of the Purchase Order within fourteen (14) working days after Seller's receipt of said Purchase Order. In any event any performance by Seller in relation to a Purchase Order will constitute acceptance of such Purchase Order. In the event that Seller does not forward a written acceptance or start performance in relation to a Purchase Order within fourteen (14) working days after Seller's receipt of the Purchase Order, Buyer shall be entitled but not obliged, to revoke such Purchase Order without incurring any liability to Seller.

2.3 Buyer shall have the right at any time to amend or vary a Supply Contract or a Purchase Order in any respect including, but not limited to specifications, drawings, designs, construction, date and place of delivery, packaging, quality, quantity and means of shipment. Seller will evaluate the consequences of such change including, but not limited to, any increase or reduction in the cost to Seller or any delay of delivery, and shall immediately inform Buyer of such fact. Seller shall not action any amendment until all consequences shall have been approved by Buyer in writing.

In the event that any such amendment results in Seller compiling stock which is no longer suitable for use by Buyer in series production, Buyer will reimburse the costs actually incurred by Seller in relation to

- finished Goods, semi-finished Goods and related raw materials, for which Calls for Delivery have been issued for a delivery date within one (1) month after receipt of Buyer's request for the amendment,
- finished Goods, semi-finished Goods and raw materials included in a buffer stock, which has been required by Buyer in writing,

provided in all cases that Seller is unable to find an alternative use or buyer and save as otherwise agreed by the parties.

2.4 Any modification of the Goods shall require the prior written consent of Buyer.

2.5 Calls for Delivery will be made in writing.

2.6 Seller will be bound to comply with a Call for Delivery or an amendment thereto issued by Buyer, unless the Seller notifies his reasonable objection thereto in writing within the following periods:

- twenty-four (24) hours after receipt of the Call for Delivery or amendment thereto, if the requirements or amendments therein are to come into effect six (6) to ten (10) working days (inclusive) after the receipt of the Call for Delivery or amendment thereto.
- three (3) working days after receipt of the Call for Delivery or amendment thereto, if the requirements or amendments therein are to come into effect eleven (11) working days to three (3) months (inclusive) after the receipt of the Call for Delivery or amendment thereto.
- two (2) weeks after receipt of the Call for Delivery or amendment thereto, if the requirements or amendments therein are to come into effect more than three (3) months after the receipt of the Call for Delivery or amendment thereto.

If the Call for Delivery or an amendment thereto specifies requirements or amendments to have effect less than six (6) working days from the receipt of the Call for Delivery or amendment thereto, the delivery of the Goods will be determined by mutual negotiations.

2.7 Unless prevented by the law of the country (and if relevant the state / province) applicable to the Supply Contract, Buyer may cancel a Supply Contract at any time for any reason. In such circumstances Buyer will reimburse the costs actually incurred by Seller in relation to:

- Goods, semi-finished Goods and related raw materials, provided that the relevant Calls for Delivery have been issued indicating a delivery date within one (1) month after receipt of Buyer's notification of cancellation.
- Goods, semi-finished Goods and raw materials included in a buffer stock, which has been required by Buyer in writing.

In any event, Seller is obliged to take all reasonable steps to minimise all such costs to the greatest possible extent.

- 2.8 Unless otherwise provided by the law of the country (and if relevant the state / province) applicable to the Supply Contract, the Buyer may terminate a Supply Contract immediately by notice to the Seller, if the Seller shall:
- commit a breach of the Supply Contract, which is not (in the opinion of the Buyer) capable of remedy, or
 - commit a breach of the Supply Contract, which is capable of remedy and fail to remedy the same within thirty (30) days of a notice from the Buyer specifying the breach and requiring it to be remedied.
- 2.9 In the event that either party becomes insolvent, or bankruptcy or insolvency proceedings of any nature are commenced in relation to that party, the other party shall be entitled to terminate the Supply Contract forthwith by written notice.
- 2.10 Termination of any Supply Contract under this Provision 2 shall be without prejudice to the accrued rights and liabilities of the parties and shall not affect the coming into or continuance in force of any provision which is expressly or by implication to come into or to continue in force after such termination.

Provision 3: Delivery Times, Delay and Force Majeure

- 3.1 Delivery dates and quantities shall be as set out in the Purchase Order and/or Calls for Delivery. Seller acknowledges that delivery times and quantities are of the essence and Buyer may reject and/or return at Seller's expense any delivery of Goods or part thereof received before or after the delivery date or in excess of the quantity specified in the Purchase Order and/or Call for Delivery.
- 3.2 Upon notice set out in the Purchase Order and/or Calls for Delivery, Seller shall deliver Goods "just-in-time" that is, at an appointed time of delivery immediately prior to standard production without delay, such time and timing to be set out in Calls for Delivery, and in the correct sequence of delivery, such sequence also to be set out in Calls for Delivery.
- 3.3 Seller agrees to take all actions necessary and appropriate to ensure that Goods are received by Buyer as required under the relevant Supply Contract. Seller will inform Buyer promptly of any occurrence which will or may result in any delay of delivery at any time or which will or may result in Seller's inability to fulfil the quantities specified in the Purchase Order and/or Calls for Delivery. Seller shall also advise Buyer in writing of corrective measures which Seller is taking to minimize the effect of such occurrence.
- 3.4 Except for excusable delay (hereinafter, "Excusable Delay") as set forth in Provision 3.5 below, in the event that Seller fails for any reason whatsoever to effect delivery consistent with the delivery dates specified in the Purchase Order and/or Calls for Delivery, Buyer shall be entitled to recover from Seller all actual, consequential and incidental losses and damages, including, but not limited to, losses and damages relating to and arising out of incremental cost of labour, transportation, production changes and storage.
- 3.5 Either of the parties may suspend performance of a Supply Contract during the occurrence of an Excusable Delay, which shall mean any delay not occasioned by the fault or negligence of the delayed party and which results from (without limitation) acts of God or public enemy, restrictions, prohibitions, priorities or allocations imposed by governmental authority, embargoes, fires, floods, typhoons, earthquakes, epidemics, unusual severe weather, delays of similar natural or governmental causes, and strikes or labour disputes (of or involving the delayed party's employees of Seller's suppliers) or any other circumstances beyond such party's reasonable control. Nothing contained in this Provision 3.5 shall limit either party's rights under other Provisions of these Terms and Conditions. Further, Buyer shall be entitled to obtain the Goods covered by the Supply Contract from other sources for the duration of Seller's inability to perform due to Excusable Delay and to reduce without any obligation to Seller, the quantity of the Goods specified in the Purchase Order and / or Calls for Delivery.
- 3.6 In the event that Seller discovers any fact which may, or could with the passage of time, result in Excusable Delay, Seller will immediately advise Buyer of such fact and use its best endeavours to take all measures and precautions to reduce the effect of the Excusable Delay. In addition, at any time, at Buyer's request, Seller will furnish to Buyer such information as Buyer may request concerning matters which could result in delays and assurances or contingency plans with respect to those matters. Seller will notify Buyer immediately of any actual or potential labour dispute delaying or threatening to delay timely performance of a Supply Contract or a Call for Delivery and will include all relevant information.

- 3.7 If the parties agree on a buffer stock to be maintained by the Seller, Seller is obliged to notify Buyer at monthly intervals of the latest status of this stock.

Provision 4: Packaging, Shipping

- 4.1 Goods shall be suitably, carefully and appropriately packed in accordance with Buyer's „Packaging Manual of the BMW Group“, as the same may be amended or replaced from time to time, („the Packaging Manual“) and in accordance with the instructions of Buyer's packaging department.
- 4.2 If the Incoterm „FCA“ or „EXW“ has been agreed between Buyer and Seller in relation to Goods, all consignments will be shipped by the transport provider and by the mode of transport prescribed by Buyer.
- 4.3 Seller will provide support to the Buyer to ensure that transportation of the Goods is undertaken in the most cost-effective way.
- 4.4 The Seller will give the following data to the transport provider in writing:
- shipping location and loading depot;
 - quantity and type of loading units;
 - gross weight and storage area requirements;
 - date of delivery;
 - delivery depots.
- 4.5 In case of shipment by road Seller shall notify readiness of the Goods for dispatch to the transport provider. Such notification must arrive at the transport provider in due time to ensure compliance with the agreed delivery date. Seller will notify readiness for dispatch by 12 noon at the latest:
- two (2) days for national deliveries within Germany, United Kingdom and Austria; or
 - four (4) days for cross-border deliveries within Europe destined for Austria; or
 - three (3) days for all other cross-border deliveries within Europe;
- before the date of delivery as set out in the Call for Delivery.
- 4.6 If Seller fails to comply with Provision 4, any losses suffered by Buyer as a result of such failure shall be reimbursed in full by Seller. Unless agreed otherwise, Buyer shall bear the costs and the responsibility of the return of empty containers and pallets.
- 4.7 Delivery notes must be made in writing. With regard to documents accompanying Goods (physical or electronic documents), Seller shall comply with Buyer's „EDI Implementation Guidelines“ and the „Packaging Manual“.

Provision 5: Transfer of Risk

Save as otherwise agreed between the parties, the time at which the risk of damage to or loss of the Goods shall pass to Buyer shall be in accordance with the Incoterm agreed in the Supply Contract. If no Incoterm is specified in the Supply Contract, the Goods shall be deemed to be sold „FCA“, with named place being the premises of Seller where the Goods are ready for dispatch.

Provision 6: Notification of Deficiencies

- 6.1 Buyer shall not be obliged to conduct any inspection of incoming Goods prior to their use in production.
- 6.2 Buyer shall notify Seller in writing regarding any deficiency of Goods delivered once the deficiency has been discovered by the Buyer in the ordinary course of its business. To this extent Seller hereby waives any right to reject delayed notification of deficiencies.

Provision 7: Settlement of Accounts and Payment

- 7.1 The accounts of Seller will be settled via selfbilling invoices by way of EDI, unless otherwise agreed.

Seller does not need to send additional invoices to Buyer because payments will be made based on the receipt of Goods and the terms agreed in the Supply Contract. For customs purposes only a commercial invoice shall be attached by Seller to the shipping documents of import deliveries in duplicate. Such invoice shall include the data as set out in Provision 7.2 and additional data as described in Provision 8.

- 7.2 If the parties have agreed that Seller's accounts will not be settled via selfbilling invoices, a commercial invoice shall be submitted by Seller. The original invoice shall be sent to Buyer's Incoming Invoice Verification Department or (if specified on the relevant Purchase Order) to its payment address. Such invoice shall include the following data:

- Buyer's supplier number of the invoicing party (8-digit) and, if different:
 - Buyer's supplier number of the Seller (8-digit) and/or
 - Buyer's supplier number of the payee (8-digit);
- Buyer's Purchase Order number / Buyer's Purchase Order modification number;
- Buyer's item number;
- Specification of delivery or service rendered;
- Delivery note number indicated by Seller, date of shipping;
- In case of re-delivery relating to prior delivery by Buyer: Delivery note number indicated by Buyer with respect to the said prior delivery;
- Quantity, unit of scale;
- Value of consignment (price per item and total price);
- Price unit, currency unit;
- Price of packaging (per unit of Goods);
- Number of packages, weight (gross/net);
- Delivery address / point of unloading;
- VAT percentage rate;
- Seller's corporate name, registered office and registered number;
- In the event of cross-border deliveries within the European Union:
 - VAT Identification number of Buyer;
 - VAT Identification number of Seller;
- In the event of national deliveries within the United Kingdom:
VAT number of Seller.

- 7.3 Unless otherwise agreed, payment for Goods properly and timeously delivered will be made net by the 25th day of the month following the month of delivery or, in case of Provision 7.2, by the 25th day of the month following the month of Buyer's receipt of a verifiable invoice.

- 7.4 Payment remittances shall either be made by bank transfer or by cheque, as specified by Buyer.

- 7.5 Where Goods are not supplied in accordance with the Supply Contract, Buyer shall be entitled to withhold payment of the respective amount of the price until Seller has fulfilled its obligations in full.

- 7.6 Seller may not assign its payment rights hereunder without the prior written consent of Buyer.

- 7.7 Payment by Buyer for any Goods does not indicate nor constitute acceptance of such Goods.

- 7.8 Should the addresses of the place of shipment, the recipient of payment or the party making out the invoice deviate from the address of the party receiving the Purchase Order, such deviation has to be expressly agreed in writing by Buyer in advance.

Provision 8: Customs and Origin

- 8.1 For customs purposes Seller will attach a commercial invoice to the shipping documents in duplicate. Any simplification of that procedure is only permitted, if agreed in advance by Buyer.

In the case of customs dutiable deliveries the invoice shall specify as separate items:

- cost of items not included in the price (such as commissions, brokerage, cost of licenses, cost of means of production, Buyer's contributions);
- cost of items included in the price (such as cost of assembly and freight cost);
- value of repairs carried out, broken down into cost of materials and wages.

Even if deliveries are made free of charge, an indication of value is still required with the additional note „Only for customs duty“. Either the invoice or the delivery note must include the reason why the delivery is made free of charge (e.g. sample deliveries).

Should further official documents be required in the case of imports or exports for the intended use of the Goods delivered, Seller shall procure such documents for Buyer without delay and make them available to Buyer at Seller's cost.

8.2 Seller shall be obliged to provide a declaration of origin for the Goods being supplied:

- Buyer will provide Seller with a set of preprinted forms „Jahreslieferantenerklärung“ (Annual Supplier Declaration) to be filled in, signed by Seller's authorised representatives and submitted to Buyer within fourteen (14) days after Seller's receipt of the forms (or in the case of the first delivery of Goods, no later than the date of delivery).
- Seller may not submit a declaration of origin on its own business forms, unless this has been agreed with Buyer.
- Seller shall inform Buyer immediately in writing of any change of origin of Goods.
- If Seller supplies Goods which get a preferential treatment in the import country, Seller must provide a declaration of origin suitable to that supply (e. g. Form sheet A for GSP Goods, EUR 1). This certificate is required with every such shipment.

8.3 Seller shall be liable for any losses suffered by Buyer due to Seller's failure to comply with this Provision 8. Seller shall provide Buyer with all such support as may be necessary to enable Buyer to reduce or minimise its liability to customs duties.

If Seller supplies Goods from a country which benefits from a trade credit scheme, Seller shall transfer that benefit to Buyer in the country of export.

8.4 For any and all questions and instructions arising out of or required in connection with customs and declaration of origin, Seller shall contact Buyer's respective customs department.

Unless otherwise agreed, customs clearance shall be the responsibility of Buyer. If Seller assumes responsibility for customs clearance without Buyer's prior written approval, Seller shall bear the costs of such clearance.

Provision 9: Quality

9.1 Unless stated otherwise in the Supply Contract, Seller shall comply with the quality standards set out in the Technical Specifications ISO/TS 16949 „Quality systems - automotive suppliers - Particular requirements for the application of ISO 9001 : 1994“, as the same may be amended or replaced from time to time (hereinafter called „ISO/TS 16949“).

9.2 A series process quality evaluation (as defined in this Provision 9.2) („Series Process Quality Evaluation“) must be successfully completed by Seller before Goods are supplied:

- for the first time; or
- under a new part number; or
- after any process modification.

For the purposes of this Provision 9 a Series Process Quality Evaluation is a performance test of Seller's manufacturing process, including its production plants, equipment and machines and its production logistics processes, under series conditions and according to the requirements of Buyer, to prove that Seller is able to produce the required quantity and quality of Goods with the plant, personnel and machine capacity.

Seller will use the Series Process Quality Evaluation to produce initial samples of the Goods. Seller will inspect initial samples in accordance with the VDA (Federation of German Automobile Manufacturers) publication „Quality Management in the Automotive Industry,

Volume 2: Quality Assurance of Supplies", as the same may be amended or replaced from time to time.

- 9.3 In case of a conflict between the Supply Contract and ISO/TS 16949 or the above mentioned VDA publication the Supply Contract shall prevail.
- 9.4 Seller shall permit a designated representative of Buyer to visit Seller's premises to observe and monitor the development and production of the Goods to verify compliance with ISO/TS 16949.
- 9.5 In the event that any authorities responsible for vehicle safety standards demand inspection of the manufacturing process and disclosure of the test records of Buyer, Seller shall, upon request of Buyer, give such authorities access to such records and provide them with such support as may reasonably be expected.
- 9.6 Upon Buyer's request Seller shall make available to Buyer all quality records. Quality records are documents and any other data, which relate to specified requirements and the effectiveness of Seller's quality system.
- Seller shall retain such quality records for at least ten (10) years after creation relating to Goods with specially marked drawings („D“ or „L“) or for at least five (5) years in any other case, unless a longer period is otherwise required by law.
- 9.7 Seller shall procure that all and any of its sub-contractors are contractually bound to comply with the terms of this Provision 9.

Provision 10: Warranty

- 10.1 Seller warrants that for the period detailed in Provision 10.2 (the „Warranty Period“) Goods shall be free of defects in material and workmanship, conform to the agreed specifications, drawings, samples or descriptions, be free from design defects, of satisfactory quality and fit for the particular purpose intended by Buyer. Seller further warrants that it shall comply with all laws and regulations in the relevant sales markets relating to the production and, if applicable, to the development of the Goods, and to the performance of Seller's duties and responsibilities.
- 10.2 For all Goods the Warranty Period begins on the date of delivery and ends on the sooner of:
- (i) the expiry of any warranty provided to end-customers of the Goods, or products, into which the Goods are incorporated; or
 - (ii) the fifth (5th) anniversary of the delivery date.
- The terms of this Provision 10.2 are subject to any longer warranty period prescribed by the national law of any sales market, into which Goods or products into which the Goods have been incorporated are supplied.
- 10.3 Where defective Goods are delivered, Seller will be given the opportunity to sort out, rework or replace such defective Good only if:
- the defect is discovered before Buyer has started to use it for production (processing or fitting); and
 - Seller is able to sort out, rework or replace the defective Good; and
 - such sorting out, rework or replacement does not cause any delay in Buyer's production process.
- 10.4 In circumstances other than those specified in Provision 10.3 Buyer is entitled either to rework the defective Goods itself or have such Goods reworked by a third party at Seller's cost or return Goods to Seller at Seller's cost and terminate the Supply Contract. Seller shall indemnify Buyer against all and any costs and expenses incurred by the Buyer in complying with the terms of this Provision 10.4.
- 10.5 If the same Goods are repeatedly supplied in a defective condition, Buyer shall upon notice be entitled to terminate not only the Supply Contract, but also any other Supply Contract for the same or similar Goods.
- 10.6 At Seller's request the defective Goods will be made available to Seller, at Seller's cost.

Provision 11: Indemnify

- 11.1 Seller will indemnify and hold Buyer, its agents, servants, officers, directors and employees, Buyer's distributors, dealers and all entities which sell Goods or products into which the Goods are incorporated, and their respective customers, harmless against liability, costs, damages, losses, claims and expenses (including legal expenses) occasioned by or arising out of any claim for death, personal injury or property damage, which results from (a) any defect or alleged defect in the Goods; (b) the Seller's breach of any term of the Supply Contract; or (c) the fault or negligence of Seller.
- 11.2 In connection with the Goods or otherwise, if Seller's employees, agents, sub-contractors or other representatives (hereinafter „Seller's Agents“) are on or present at any premises of Buyer, Seller shall be and is responsible for the acts and omissions of Seller's Agents within or about Buyer's premises and agrees to indemnify and hold Buyer harmless against liability for damage to property or injury or death to persons arising out of acts or omissions of Seller's Agents whether pursuant to a Supply Contract or otherwise. The indemnity in this Provision 11.2 shall not apply insofar as the claim is caused by the negligence or fraud of Buyer.
- 11.3 Seller will hold Buyer, its agents, servants, officers, directors and employees, Buyer's distributors, dealers and all entities which sell Goods or products into which the Goods are incorporated, and their respective customers, harmless against liability, costs, damages, losses, claims and expenses (including legal expenses) occasioned by or arising out of any action to recall any vehicle, Goods, or any product into which Goods have been incorporated.
- 11.4 In the event of a claim by a third party against Buyer (hereinafter, „Third Party Claim“), which may be the subject of indemnification provided for in this Provision 11 the Buyer shall provide written notification thereof to Seller. Seller shall provide Buyer with such reasonable assistance in the response and prosecution of any defence as Buyer may request.
- 11.5 In the event of any claim against Buyer by a third party for death, personal injury and/or property damage alleging a defect in Seller's Goods or any product into which the Goods are incorporated, Seller and Buyer shall, in good faith, promptly attempt to reach an agreement (hereinafter, „Defence Agreement“) specifying the terms under which Seller and Buyer would apportion responsibility and liability for the defence of any such Third Party Claim or suit and the financial burdens arising therefrom. The purpose of the Defence Agreement is to foster cooperation between Seller and Buyer in the defence of a Third Party Claim or suit and thus should, to the greatest extent possible, cover such matters as:
- the roles, responsibilities, and obligations of Buyer and Seller and their respective counsel in the defence of the Third Party Claim or suit;
 - the payment of legal and other reasonable defence expenses, and
 - the payment of any settlement or judgment amounts.
- Notwithstanding the foregoing, but subject to the provisions of any applicable Defence Agreement, Seller will, in respect of any Third Party Claim or suit, reimburse Buyer for the legal and other reasonable defence expenses paid by Buyer and/or Buyer's insurance carriers, and for the amount of any reasonable settlement or final judgment award paid by Buyer and/or Buyer's insurance carriers.
- 11.6 The provisions of this Provision 11 shall survive the termination or expiry of any Supply Contract.

Provision 12: Designation of Goods; Publications

- 12.1 Seller shall mark the Goods as required by Buyer. This does not affect Seller's freedom to place effectively and in an easily visible manner its trade mark or logo on the Goods.
- 12.2 Seller shall not sell, transfer, loan to any person except Buyer, or otherwise make use of Goods identified with Buyer's proprietary names, logos, tradenames, trademarks or service marks, or of Goods contained in wrappings or containers so identified. Should Goods marked or designated in this way be rejected as defective, such Goods shall be rendered unusable by Seller at Seller's expense.
- 12.3 Seller shall not use any of Buyer's proprietary names, logos, trade names, trademarks or service marks without the prior written consent of Buyer.

Tooling &
Intellectual
Property

- 12.4 Without Buyer's prior written consent, Seller shall not publish in any manner through any marketing or other medium that Seller has contracted with or has been supplying Goods to Buyer, unless such publication is required by mandatory law.
- 12.5 Infringement of any of the obligations set out in this Provision 12 shall entitle Buyer to terminate any Supply Contract and/or demand surrender of anything which is obtained by way of such infringement and/or to claim indemnification of such loss as has been suffered by Buyer.

Provision 13: Tooling

- 13.1 Once the agreed total costs for an item of Tooling has been paid for by Buyer in full, title to such Tooling and any and all Intellectual Property Rights with respect to such Tooling will immediately be transferred to Buyer. Seller shall mark such Tooling as Buyer's property. In the event of cancellation or termination for any reason of a Supply Contract for the supply of Tooling where, at the date of cancellation or termination, title to the Tooling is not vested in Buyer, Buyer may obtain title to such Tooling by paying to Seller (i) (in relation to finished Tooling) the outstanding portion of the agreed total costs; or (ii) (in relation to unfinished Tooling) such proportion of the outstanding costs as is represented by the costs actually incurred by Seller in the supply of the Tooling as at the date of cancellation or termination.
- 13.2 Any and all Tooling belonging to Buyer which is in Seller's possession or possession of Seller's Agents shall remain the property of Buyer. Seller shall mark such Tooling as the property of Buyer. Such Tooling shall not be reproduced, sold, assigned by way of security, pawned, mortgaged, charged or otherwise encumbered or disposed of nor used for the manufacture of goods for parties other than Buyer without the express prior written consent of Buyer.
- 13.3 Tooling owned by Buyer will be insured by Buyer.
- 13.4 Within a period of four (4) weeks after delivery of first Goods for Buyer's series production, Seller shall send Buyer a complete list of all Tooling items utilized by Seller with respect to the Goods and a document identifying the exact location of the respective Tooling items. Seller has to prove and substantiate that there is adequate insurance cover for the Tooling owned by Seller. Maintenance by Seller of such insurance coverage shall be without prejudice to Seller's liability under any Supply Contract.
- 13.5 Seller shall treat all Tooling, regardless of ownership, with due care and diligence, constantly keeping it ready for operation and in compliance with the latest design status. Seller shall be responsible in particular for the correct and accurate dimensions of the Tooling especially of gauges. Buyer agrees to help Seller in examining and correcting the gauges made available to Seller, insofar as such items are not used as check gauges.
- 13.6 Unless otherwise agreed in writing, the cost for the continuing repair, maintenance and readiness of the Tooling in immaculate condition shall be borne by Seller in all respects.
- 13.7 Notwithstanding Buyer's right to demand surrender of Tooling, Seller shall be entitled to retain Tooling owned by Buyer to the extent to which Seller requires the same for executing a Purchase Order for Buyer. In all other cases Seller shall be obliged forthwith upon the request of Buyer to surrender the Tooling owned by Buyer.
- 13.8 Seller shall maintain Tooling used to manufacture Goods in good working condition for the continued supply of Goods for a period of fifteen (15) years after termination of Seller's supply of the Goods for Buyer's series production. Seller's obligation to retain such Tooling shall expire once the foresaid fifteen years retention period has ended and Seller has notified Buyer in writing. Seller shall ensure that any and all sub-contractors are contractually bound to adhere to the requirements under this Provision 13.
- 13.9 Fourteen (14) years after termination of Seller's supply of the Goods for Buyer's series production, Seller shall submit a written proposal for an economic supply of Spare Parts after the period specified in Provision 13.8, Sentence 1. Seller's proposal shall be based on Buyer's estimated future demands, which will be provided by Buyer on Seller's written notice.

Provision 14: Spare Parts

- 14.1 Whether or not a Supply Contract remains in effect, Seller will at the request of Buyer provide Buyer or Buyer's nominee(s) with sufficient quantities of Goods for use as spare parts for a

period of fifteen (15) years after termination of Seller's supply of the Goods for Buyer's series production or for such lesser period of time as Buyer shall require in writing. The Seller shall ensure that its sub-contractors comply with this Provision 14.1.

- 14.2 During the term of a Supply Contract, the price of the Goods used as spare parts shall be as agreed in the Supply Contract. However, during the extended term as set out in Provision 14.1 above, the price shall be determined by mutual negotiation.

Provision 15: Intellectual Property Rights

- 15.1 Seller shall indemnify Buyer and its sub-contractors from and against all liabilities, costs, damages, claims and expenses (including legal expenses) that may be awarded or paid to any third party in respect of any claim or action that the Goods or their use by Buyer infringe the Intellectual Property Rights of such third party, save to the extent that Seller has manufactured the Goods in accordance with instructions received from Buyer and Seller having taken all reasonable precautions could not have known that following these instructions would result in an infringement of a third party's Intellectual Property Right.
- 15.2 The Parties will inform each other forthwith of all such infringements or suspected infringements of which they became aware. Buyer will give Seller sole conduct of the defence of any such claims or actions.
- 15.3 Upon Buyer's request, Seller shall specify any and all Intellectual Property Rights known or becoming known to him, which are used in the design or manufacture of, or which otherwise affect or relate to the Goods.

Provision 16: Electronic Data Interchange („EDI“)

- 16.1 Prior to the first delivery of Goods to Buyer, Seller shall ensure full compliance with Buyer's EDI requirements including (without limitation):
- EDI standards (e.g. VDA, Odette, EDIFACT, webEDI etc.)
 - EDI messages (e.g. Delivery notes, shipping schedules, CA data etc.)
 - Infrastructure (transmission, protocol and links - e.g. ISDN, X.26, Internet)
- as set out in a separate EDI agreement as well as in Buyer's „EDI Implementation Guidelines“, as the same may be amended or replaced from time to time.
- 16.2 Buyer's EDI requirements may be changed by Buyer due to changing business conditions or technological advances.
- Buyer is entitled to terminate the Supply Contract and the EDI agreement (in whole or in part), if Seller does not meet Buyer's EDI requirements.

Provision 17: Confidentiality

- 17.1 Seller and Buyer each commit themselves to treat as business secrets and to keep confidential all commercial and technical information of the other party which comes to their knowledge during the course of their business relationship unless such information is or becomes public knowledge without fault of the party receiving such information.
- 17.2 Drawings, models, patterns, samples and similar objects shall not be disclosed or otherwise made available to third parties without the prior written consent of the party, which owns them. Reproduction of such items is permitted only if agreed in writing with the party, which owns them and is in all cases subject to compliance with the applicable laws of copyright.
- 17.3 Seller shall include obligations equivalent to Provision 17.1 and 17.2 in all contracts with sub-contractors and will ensure that all sub-contractors are contractually obliged to comply with the same.
- 17.4 The terms of this Provision 17 shall survive the expiration or termination of any Supply Contract.

Provision 18: Insurance

- 18.1 Seller shall procure and maintain at its sole expense insurances with reputable and financially responsible insurance companies, which adequately cover Seller's liability against Buyer and third parties. Buyer is entitled to require certain insurance coverages and amounts to be taken out by Seller.

Seller shall provide to Buyer certificates or memoranda of such insurances and renewals thereof signed by the issuing company or agent or other information respecting such insurance at any time promptly upon Buyer's request. Such policies shall provide for cancellation only upon 30 days prior written notice to Buyer.

- 18.2 Buyer's examination of, or failure to request or demand any evidence of insurance hereunder, shall not constitute a waiver of any requirement of this Provision 18 and the existence of any insurance shall not limit Seller's obligation under any Provision hereof.
- 18.3 Save to the extent to which the Seller is not obliged to do so pursuant to any applicable Incoterm under Provision 5, Seller will cause any carrier engaged by Seller to insure all shipments of Goods.

Provision 19: Environment

- 19.1 The environmental compatibility of a vehicle is its ecological effect and that of its components on human beings and the environment during its entire life cycle. The life cycle of a vehicle includes product development, the production of materials, components and the vehicle itself and its use and reuse/recycling/disposal. Buyer aims to minimize the negative effects of products on human beings and the environment according to ecological criteria, while taking technical and economic factors into account. During the process of product development, the overall requirements of environmental compatibility are to be implemented in a manner appropriate to each specific component. The main categories for assessing the environmental compatibility of vehicles are: resources, materials and component substances, recycling and emissions.

- 19.2 Energy and raw materials are to be used effectively throughout the entire life cycle of the Goods, with minimum outlay on logistics and transport. For the quantitative assessment of resource efficiency using ecological balance sheets for components the following information is to be provided by Seller on request of Buyer for each Good during its manufacturing phase:

- Use of materials (raw materials) in kg
- Water consumption in l
- Total use of energy in MJ
- Transportation distances (raw materials) in km
- Emissions (gaseous, liquid, solid) in g

Based on this information and the ecological balance sheet for components, a process of overall ecological/economic product optimization will be implemented by Buyer. The results of the balance sheet will be used as a decision criterion in the selection of a design concept. In the process of selecting materials, their potential for economical recycling is to be considered by Seller (suitability for recycling, see Provision 19.3). Preference is to be given to the use of secondary raw materials which are suitable for recycling (approved recycled materials). Seller shall in addition to the case of Goods having the same shape or function, aim for the standardization of raw materials between different manufacturers. Seller shall design Goods according to weight saving principles with a view to reducing fuel consumption and emission in the use phase.

- 19.3 Seller shall provide the most environmentally friendly and most economical recycling concept in terms of state-of-the-art technology for each Good and/or component group. This should also include the possibility for re-use of materials in vehicles. Seller shall undertake to assess suitability for technically feasible and economical recycling according to BMW Standard 113 99.0. Seller's design must ensure that recyclable components/materials can be removed/separated (joining technology, modular construction). The assessment is to be carried out by Seller by means of dismantling analysis on the complete vehicle in accordance with Buyer's method. Composite structures are to be designed using materials which are compatible in terms of recycling. The use of non-recyclable materials irrespective of individual Goods must be reduced. Goods made of polymeric materials and high-value non-ferrous metals are to be marked by Seller in accordance with the relevant standards VDA 260 or BMW

Group Standard 91003. The removal of all service fluids before disassembly, which is compulsory, must be taken into account at the design stage by ensuring accessibility and scope for opening all liquid and gas bearing systems.

- 19.4 Seller shall comply with the requirements stated in BMW Group Standard 93008 throughout the Goods' life cycle for material and component substances. Seller shall send electronic material data sheets via the International Material Data System - IMDS (<http://www.mdssystem.com>) to provide Buyer with the component and material information necessary for initial sample inspection. For materials and chemical products Seller shall provide Buyer with material safety data sheets.
- 19.5 Seller shall minimize exhaust, noise and solids emissions (e.g. fogging) during the production, use and recycling phases according to state-of-the-art technologies.
- 19.6 To achieve high process environmental performance, Seller shall introduce and maintain an effective environmental management system.

Provision 20: Social Responsibility

For Buyer it is of paramount importance that corporate activities take account of the social responsibility to employees and society as a whole. This applies both to Buyer itself and to its suppliers. Buyer's and Seller's aim must be to comply with the Directives of the UN initiative Global Compact (Davos, 01/99) and the principles and rights set approved by the International Labour Organisation (IAO) in its "Declaration on fundamental principles and rights at work" (Geneva 06/98). The following principles are of particular importance:

- Preservation of human dignity, Ban on child and forced labour,
- Implementation of equal opportunities and family-friendly policies,
- No discrimination on the basis of religion, origin, nationality, age, handicap, marital status, sexual orientation, political affiliation, membership of a trade union or the like,
- The protection of indigenous rights,
- Ban on bribery and blackmail,
- Maintenance of adequate social working conditions,
- Protection from individual arbitrary personnel measures,
- Provision of conditions that enable employees to enjoy a reasonable standard of living,
- Positive and negative freedom of association,
- Maintenance of employability by basic and advanced training,
- Provision of information to personnel on the objectives, economic situation and current topics that affect the company and the personnel,
- Responsible action by all personnel in relation to the environment,
- Compliance with industrial health and safety standards, Compliance with current laws and regulations.

Provision 21: General/Miscellaneous

- 21.1 No amendment, modification, termination or waiver of any provision of these Terms and Conditions or of any Supply Contract, and no consent to any departure by either party therefrom, shall under any circumstances be effective unless the same shall be in writing and signed by both parties, and then such waiver or consent shall be effective only in the specific instance and for the specific purpose for which given. No notice to or demand on Seller in any event, case or occurrence, shall of itself entitle Seller to any other or further notice or demand in any similar or other circumstances.
- 21.2 The headings of the various Provisions of these Terms and Conditions are solely for convenience and shall not be used for the purposes of interpreting the same.
- 21.3 If any provision hereof or any part provision is or is held by any competent court or authority to be invalid or unenforceable, such provision or part provision will be deemed severed and omitted, the remaining portions hereof continuing in full force and effect. If required, Buyer and Seller shall replace such invalid or unenforceable provision with a valid and enforceable provision having similar economic consequences, provided that the content of the Terms and Conditions is not materially altered.

- 21.4 No course of dealings between Seller and Buyer or any delay or omission of Buyer to exercise any right or remedy granted under these Terms and Conditions shall operate as a waiver of such rights, and every right and remedy of Buyer provided herein shall be cumulative, concurrent and in addition to any other further rights and remedies available at law or in equity.
- 21.5 Seller agrees to permit Buyer or its representatives to inspect all documents, instruments, books and records relating to any Supply Contract or the Goods which are the subject of such Supply Contracts during regular business hours upon forty-eight (48) hours notice. Save as provided in Provision 9.6, Seller agrees to maintain all such records for at least ten (10) years after the last delivery of the Goods to Buyer, unless otherwise agreed or unless a longer period is otherwise required by law.
- 21.6 Seller shall not assign the benefit or the burden of any Supply Contract, in whole or in part to any third party without the prior written consent of Buyer.

Provision 22: Governing Law; Place of Venue and Jurisdiction

- 22.1 The terms of any Supply Contract (including these Terms and Conditions) shall be governed by and construed in accordance with the laws of the country (and state/province, if applicable) of Buyer's principal place of business. The terms and conditions set out in the United Nations Convention for the International Sale of Goods (CISG) and the Unidroit-Agreement dated May 28th, 1988 are hereby expressly excluded.
- 22.2 The parties agree that, save as to matters dealt with in Provision 11, and save in relation to the enforcement of judgements, the prosecution of insolvency proceedings or the taking of injunctive relief, the courts having jurisdiction over Buyer's principal place of business shall have exclusive jurisdiction for any action or proceedings commenced under any Supply Contract.

For matters dealt with in Provision 11, Buyer may, at its discretion, choose to bring claims against Seller either at the place of Buyer's principal place of business or in the venue in which the respective Third Party Claim is or has been pending.

KOVP

The customer-oriented sales and production process of the BMW Group

Planning principles for the design of supply processes, based on the BMW vehicle production system





Speed and flexibility as critical success factors in the automotive industry

The rapid progress presently being made in electronics and information technology is opening up tremendous potential for innovation within the automotive industry – for products and processes alike. With its “Customer-oriented sales and production process” (KOVV) re-engineering project, BMW is making the most of the opportunities. Our objective is to provide our customers with even more impressive overall service in the future.

In an abbreviated form, KOVP means “built to order” with the shortest process times possible and with maximum flexibility for change.

BMW is undertaking significant preliminary work in the implementation of the KOVP objectives. On the plus side, we see the development of a positive image, sales and profits, increased planning security and the advantages of a universal network process chain of all value-added partners – in particular a gain in time as well as the reduction of process, interface and capital costs.

Changes such as those which accompany KOVP require consistency and staying power from everyone involved. We are therefore asking you to actively support the ideas and measures which are being developed and implemented by KOVP.



Dr. Norbert Reithofer
Production

Dr. Burkhard Goeschel
R&D, Purchasing



1

What does BMW want to achieve with the customer-oriented sales and production process project?

The project basically has the following three customer-related objectives (Fig. 1):

Meeting deadlines:

The customer receives his/her individual vehicle on an agreed date, if possible on the date requested by the customer.

Decreased throughput time:

The minimum cycle period between an order being placed and customer delivery is 10 working days* (process time).

Change flexibility:

The customer can change the exterior color, options and engine type in the vehicle ordered up to 6 days* before vehicle delivery from the factory (F2 point).

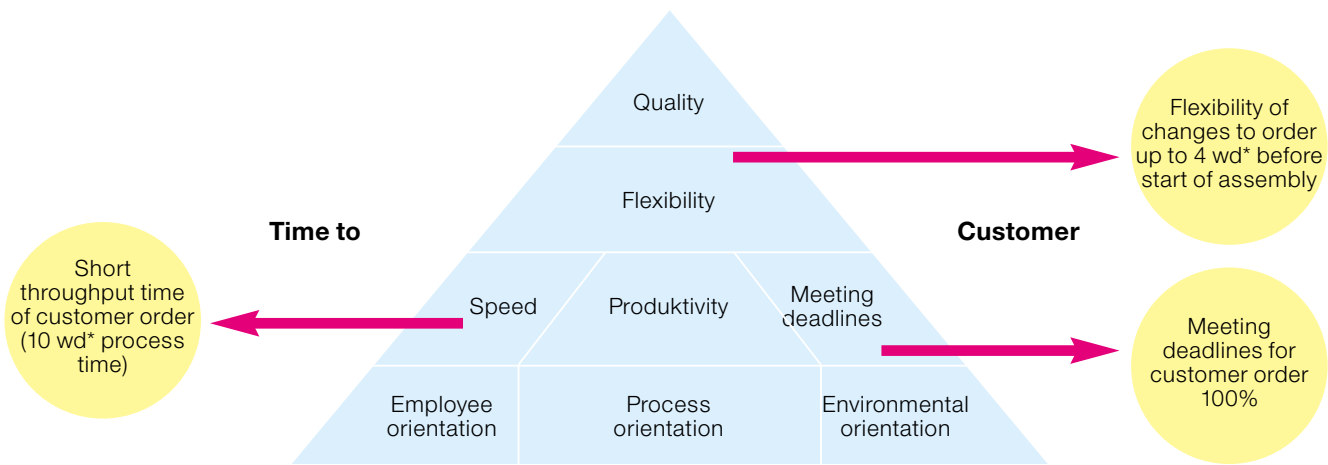


Fig. 1: KOVP breakthrough objectives. Orientation is concentrated towards customer requests and time so that the success of the BMW Group as a premium brand manufacturer can be developed.

2

Key elements of the customer-oriented sales and production process

KOVP requires a new orientation and acceleration of customer-related procedures within the distribution sector, order control, production and logistics. BMW has been gradually implementing the KOVP philosophy since 1998 when it launched Online Ordering (in Germany) and through a new production system (Fig. 2) begun in 2001. The key elements for attaining the objectives set are:

- Online Ordering at the BMW dealerships, featuring the following
 - Web-based (Extranet)
 - Order system which includes feasibility and deadline check
 - Changes to specification, ability to provide details and status information using real-time processing with a response time of < 5 seconds

* For breakthrough objectives; individual, project-related temporal information, refer to section 9.

- Order control and production planning taking the following into consideration
 - Deadline requested by customer or deadline agreed upon
 - Flexibility for change until just before the start of production
 - Limit capacities in-house and with the suppliers
- New production system, featuring the following
 - Late order assignment
 - Painted body as purchased item (without customer reference)
 - Stable assembly sequence

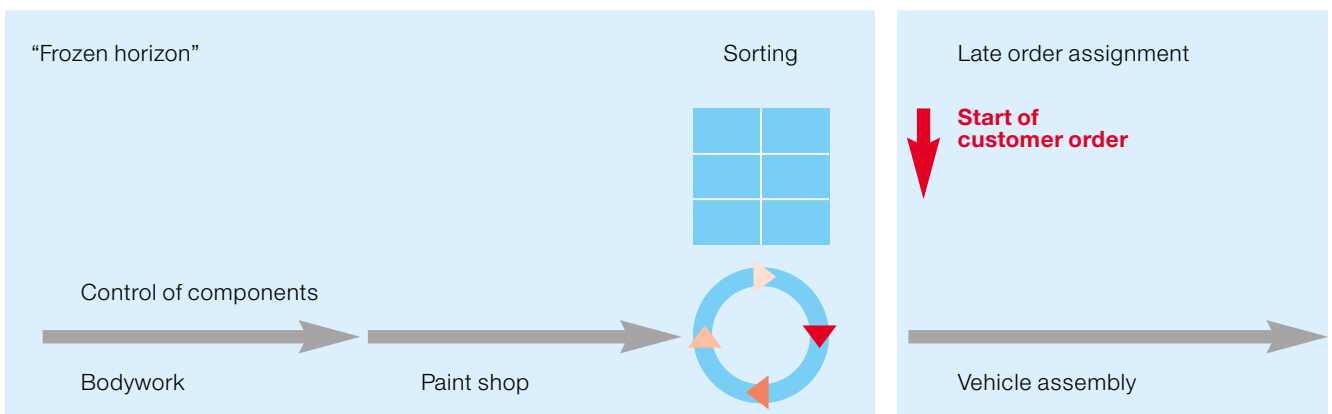


Fig. 2: The new BMW production system operates in accordance with the pull principle. The individual customer order controls not only the components supplied and the engine but also body and paint production

The KOVP objectives – meeting deadlines, decreased throughput time and flexibility for change – will inevitably affect the supply of materials. For example, model-related engine components and equipment are affected.

Short throughput times and the meeting of delivery deadlines for the end product are only possible if all the components required are available and can be used in the assembly department by the date required. It is therefore imperative that exclusively quality components are delivered by the correct date, i.e. the nominal incoming goods date (SWET).

Customer requests for changes received just before daily planning (status 50) are usually compensated for by the law of averages (i.e. the volumes involved are so large that the small number of changes requested can easily be accommodated). If however such changes accumulate in individual instances, they can only be implemented if the suppliers involved are able to adapt their production in the short-term.

The degree of flexibility required may vary from component to component, but generally remains within defined bandwidths. If required in individual instances, these are co-ordinated and agreed with the suppliers. The standard production capacity agreed with the BMW purchasing department serves as a basis here (basis: maximum 15 operating shifts a week).

Requirements resulting from KOVP for suppliers

4

Beneficial effects provided by KOVP

After the phase of great flexibility for change, a longer stable horizon for planning and production exists within the KOVP processes. This primarily benefits suppliers who supply just-in-time within the framework of a standard production request (SPAB) for whom the stable horizon for planning, production and delivery is extended considerably – from a few hours to four days* or more (Fig. 3).

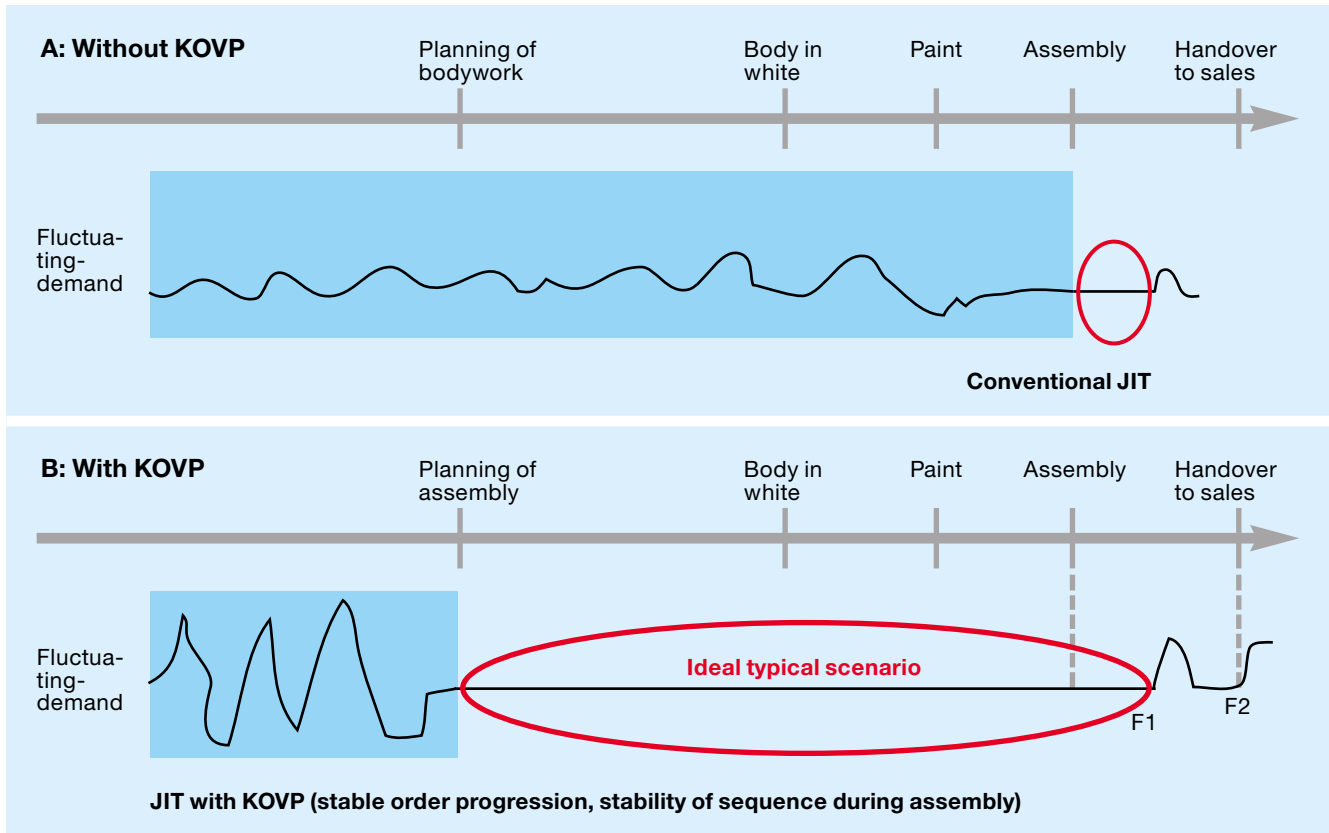


Fig. 3: Flexibility and stability phases before and after introduction of KOVP.

The longer stable sequence horizon available in the value-added chain opens up a number of benefits which should be utilized:

- Longer planning horizon for staff, material and systems
- Reduction in stock held as a result of continuous sequential deliveries
- Reduction in backup stock levels
- Reduction in number of containers and size of areas used
- Stable, precise information with regard to the nominal incoming goods date
- Widening of the JIT radius for sequential deliveries
- Greater independence from BMW working hours models

Additional advantages and requirements are documented in the supply concepts of the respective parts families.

* For breakthrough objectives; individual, project-related temporal information, refer to section 9.

5

BMW material planning and request procedure for bought-out components

The BMW material planning system provides suppliers to the BMW Group with provisional information on future component requirements (Fig. 4). The long-term requirement characteristics are formed using the supplier request system (LAB) which extends up to 10 months in advance. It gives suppliers the opportunity to have sufficient time to orientate their capacities to the BMW plans and is an appropriate request instrument, most in particular, for small components, DIN and standard components (with a value of approx. 20% of total volume).

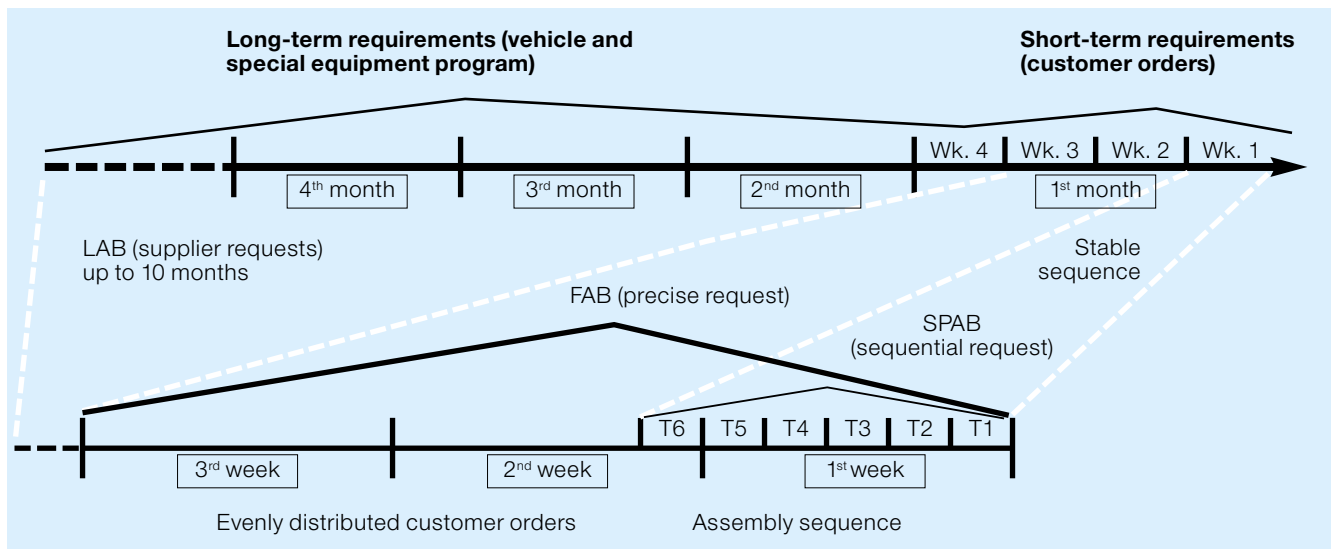


Fig. 4: Material requirements and request procedure. Approx. 80 % of production material is controlled on a precise daily, sub-daily or sequential basis. The tools for this are the precise request (FAB) and the standard production request (SPAB).

The majority of the production material requirement (approx. 80 %) is planned and controlled on a precise daily, sub-daily or precise sequential basis. The information required for this comes from short-term program planning (basis: weekly production packages), especially the daily planning of customer orders. This planning is conducted taking KOVP aspects into consideration five working days* before the start of assembly and therefore creates a stable request horizon of four working days* or more before the start of assembly.

According to expert assessment, the BMW production system which separates body production from vehicle assembly and makes a stable order horizon of e.g. four working days* possible, is not totally stable (Fig. 5-A). Depending on the model range and internal objectives, it is thought that this system runs with a sequence stability of approx. 95 or 98 % of the production volume (Fig. 5-B).

In case of JIT-/JIS-supply of components based on status 50 requests, small, i.e. short-term variances are handled within the BMW production plant. Therefore they do not have any effect on the parts deliveries (Fig. 5-A).

If however status 53 requests have been agreed with a supplier individually he has to handle variances himself (Fig. 5-B).

6

Potential variances

* For breakthrough objectives; individual, project-related temporal information, refer to section 9.

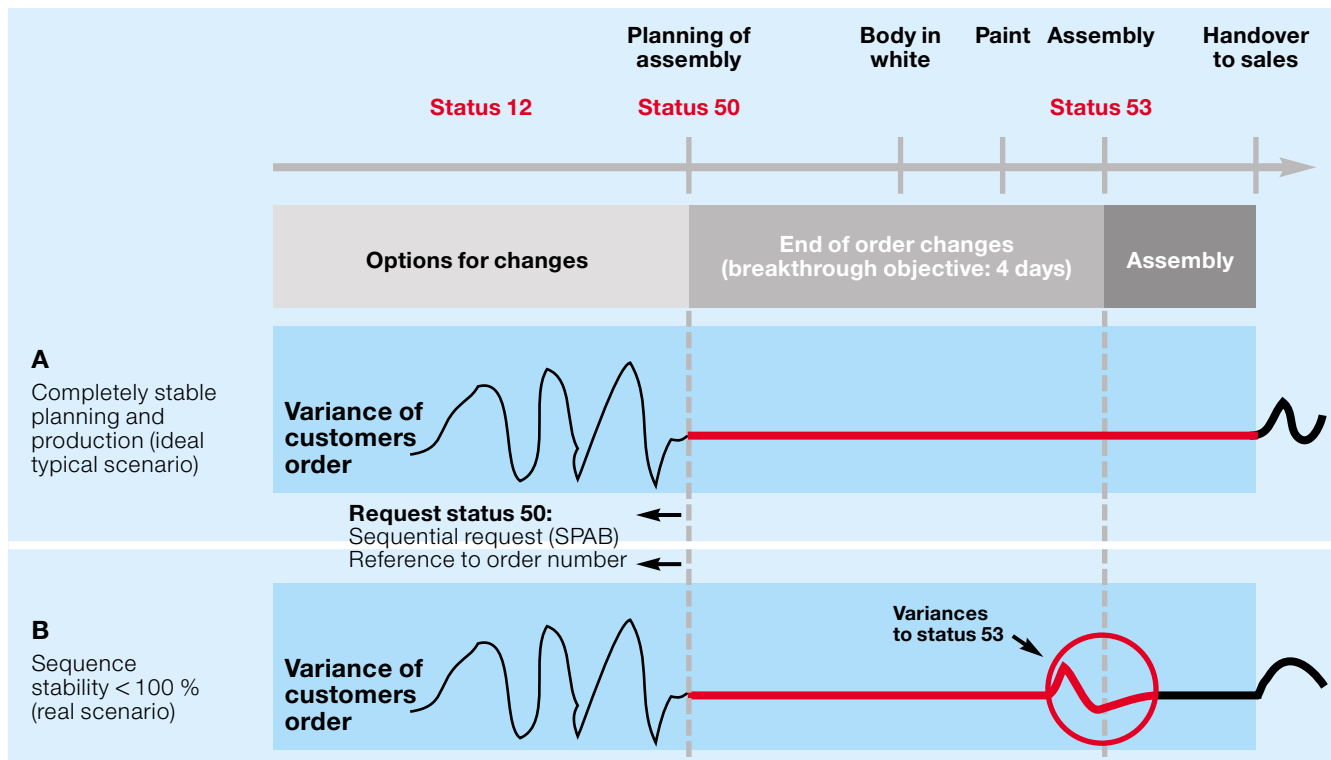


Fig. 5: Planning and production characteristics, ideal typical scenario (A) and real scenario (B)

Process related exceptions within the status 50 und 53 refer to:

- Multi-hour production disruptions, leading to a postponing of parts delivery – as far as technically feasible – however without any change of production sequence
- Errors concerning the Technical Order Data – leading to a subsequent data change and the related delivery requests as well
- Supply of non-quality parts that have to be replaced by the supplier.

7 Production planning and supplier requests, taking the example of the BMW 7 Series

The standard procedure for 2002 envisages a stable production sequence based on status 50 requests with a time horizon of six days for the production of the BMW 7 Series (Fig. 6-A). This stable sequence horizon is continually retained through rolling daily planning and ensures that the suppliers are provided with an appropriate planning basis for component production.

If replanning of the production sequence is required as a result of procedural faults, BMW will only conduct this for the day packages 5 and 6 in relation to the status 50 request (and if necessary also take the changes into account when forming new daily packages outside of the 6 day horizon) (Fig. 6-B). The sequential requests for daily packages 1–4 remain stable and unaffected by this. When using the status 53 request procedure (refer to Item 6), the changed contents are immediately taken into account.

Since not only deviations within vehicle assembly itself but also faults within the supply chain can affect vehicle production, it is imperative for the suppliers affected to immediately inform the material planner responsible in such instances so that the consequences for the entire process can be kept to a minimum. The “Logistic requirements” instructions on the BMW supplier homepage contain more information on this matter (www.zulieferer.bmw.de).

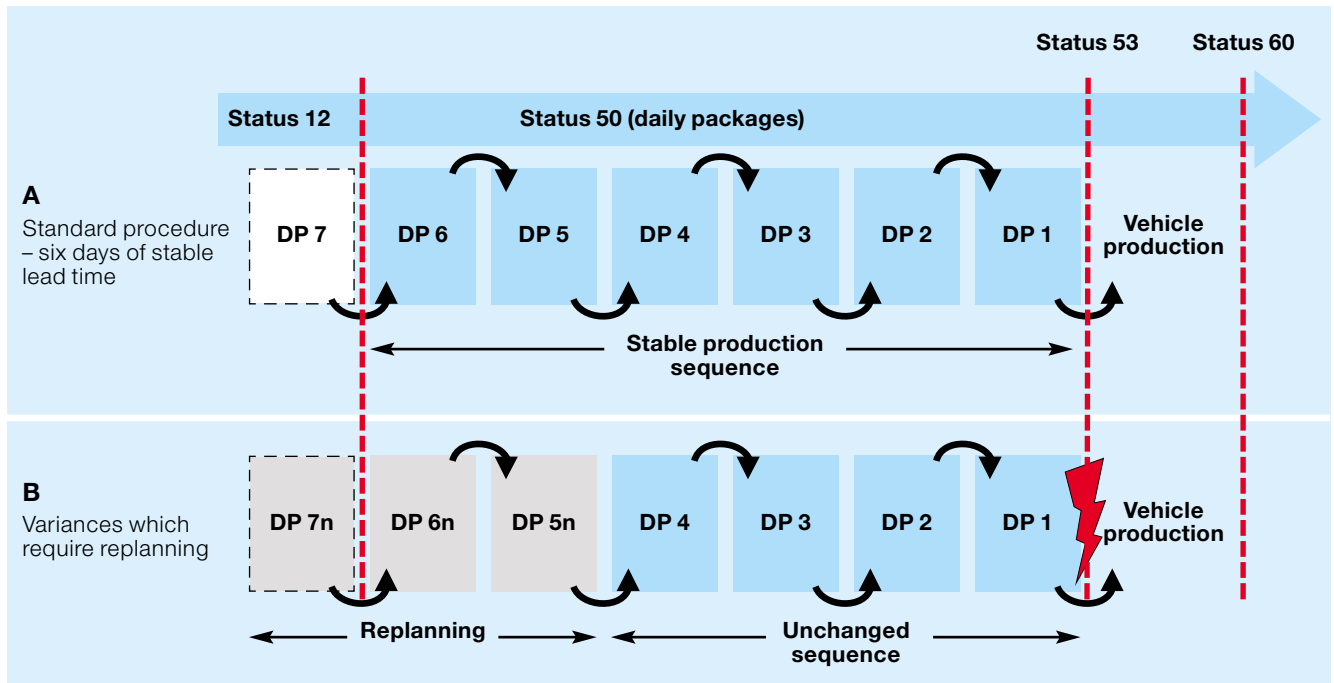


Fig. 6: Daily planning, taking the example of the BMW 7 Series: regular (A) and with variances (B)

A = Regular planning and production characteristics for BMW 7 Series: stable production sequence with a horizon of six days. Minor variances handled internally by BMW.

B = Even with variances from the planned procedure which require replanning of the daily vehicle production, BMW guarantees an unchanged supply sequence for daily packages 1–4. Only days 5 and 6 are re-planned within the 6-day horizon and result in changed requests. Exceptions from that procedure are specified in section 6 respectively – in case that status 53 requests are in use – mutually agreed with the supplier.

In future model series this process underlies individual settlements.

Implementation of the KOVP strategy requires the process chain to be in up-and-running status without any capacity bottleneck problems. The KOVP objectives and procedures therefore have limited usage for **vehicle start-ups**. In special situations, e.g. **model revisions**, separate co-ordination is required in each instance. Please consult the BMW material planning department for information regarding which models are affected.

Running technical changes require a well defined transition from the previous to the revised component, i.e. the compliance with the agreed technical release status, delivery dates and quantities. The implementation date of a running change has to be agreed upon exclusively with the responsible BMW material planning department. Running changes, which will increase in future, referring to a specific order number, will be covered by specific information from Material Planning.

Vehicle start-ups, model revisions and running technical changes

Main implementation areas and throughput times

The KOVP processes are being introduced in sequence and may vary for specific plants and models. The specified nominal throughput times valid as of 2002 (Fig. 7) represent intermediate objectives towards obtaining the breakthrough objective (6 days throughput time from production planning to the completion of the vehicle and the hand-over to sales). BMW will inform you in good time of any changes which affect you. In case there are any questions please consult your contact in the BMW material planning department.

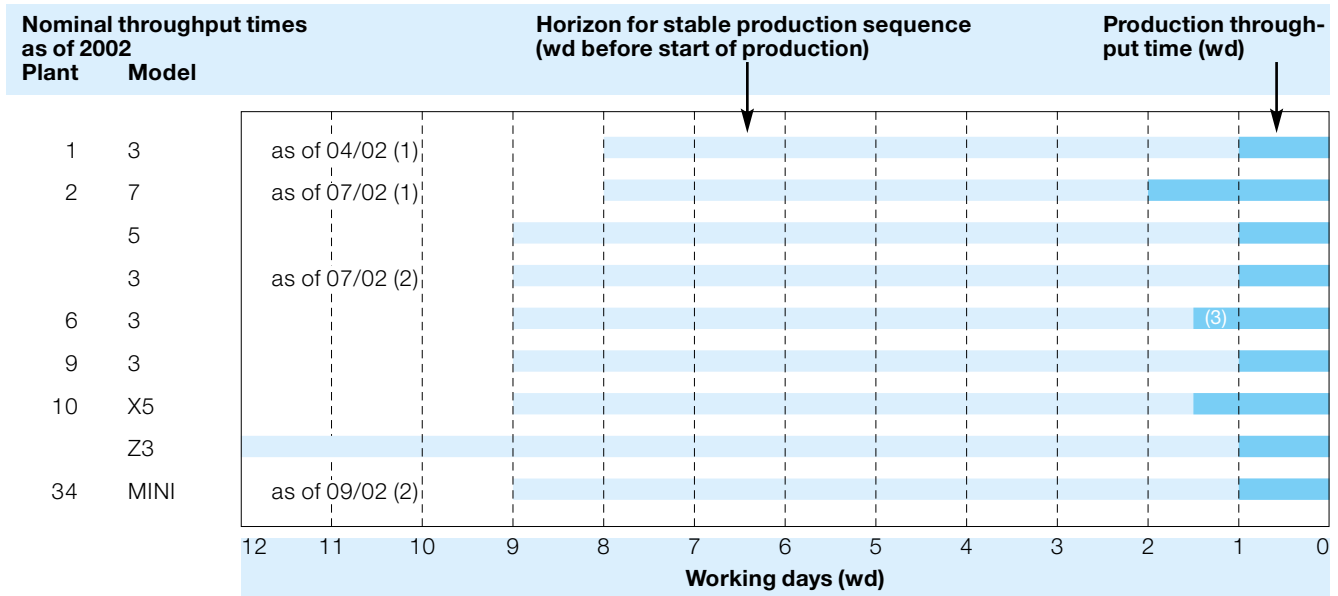


Fig. 7: KOVP main implementation points – The throughput times planned as of 2002 for planning and production are only temporary. A stable production sequence is being aspired successively on all products. The breakthrough objectives are not affected by this.

- (1) before: 9 working days
- (2) before: 10 working days
- (3) Varies depending on the model



Abbreviations

FAB	Precise request; parts request on a daily basis with a time horizon of 15 WD
F1, F2	see status 55 resp. 60
JIS	Just-in-sequence; in-sequence control and supply of components
JIT	Just-in-time; sub-daily control and supply of components, not necessarily in-sequence
KOVP	Customer-oriented sales and production process; BMW project for the business process re-engineering – with main aspects being on-time delivery, throughput time and change flexibility
LAB	Delivery request; parts request on a weekly or monthly basis with a time horizon of up to ten months
Online Ordering	Web-based vehicle order at the BMW dealership with immediate feasibility and deadline check and the opportunity of specification changes and status checks
Plants	Plant 1: Munich; Plant 2: Dingolfing; Plant 6: Regensburg; Plant 9: Rosslyn; Plant 10: Spartanburg; Plant 34: Oxford
Replanning	– Change of technical order data – Update of SWET – concerning future deliveries – Re-scheduling of the delivery sequence at status 50 or 53 for a time period defined for each model series individually
SPAB	Standard production request ; parts request on a sub-daily or in-sequence basis with a time horizon referring to the daily production planning (status 50)
Status 12	Confirmation of delivery date for received orders
Status 50	Time period in which daily production packages exist
Status 53	Starting point of vehicle assembly
Status 55	End point of vehicle assembly (complies with F1)
Status 60	Status signal for the handover of the finished vehicle to sale (complies with F2)
SWET	Nominal incoming goods date; supply date at the factory contained in the parts request (LAB, FAB or SPAB)
WD	Working days

- 6L45 -

CONFIDENTIALITY AGREEMENT

between

Bayerische Motoren Werke Aktiengesellschaft
Petuelring 130
80788 München
Federal Republic of Germany

- hereinafter referred to as "**BMW**" -

and

General Motors Corporation
Acting through its
Powertrain Group
895 Joselyn Road
Pontiac, MI 48340-2920
United States of America

- hereinafter referred to as "**Partner**" -

PREAMBLE

Whereas the Parties hereto

- intend to exchange confidential information
- wish to avoid any misuse of such information,

The Parties hereto agree as follows:

1. BMW and the Partner intend to provide with confidential information regarding the following project ("the Project"):

6L45 Automatic Transmission System
2. BMW and the Partner hereby undertake to keep strictly confidential all and any information that he directly or indirectly have received or shall receive from each other. BMW and the Partner shall not use such information in connection with any other project than the one described in Section 1 above and shall ensure that this information shall neither be released to any third party nor misused in any other way.
3. Information as used in Section 2 above covers particularly
 - know-how as well as any and all result which has been or will be achieved or used in connection with the Project,
 - the description of the Project,
 - the envisaged time schedules, target requirements and ideas for the execution of the Project,
 - any other information which is not publicly available and which BMW and the Partner have received or will receive in connection with the Project.
4. The confidentiality obligations under this Agreement shall also apply to all employees of BMW and the Partner and any other person who may be involved in the Project on behalf of BMW and the Partner, regardless of kind and legal basis of the respective cooperation. BMW and the Partner undertake to impose respective confidentiality obligations on those employees and persons (if that is not the case yet).

5. The confidentiality obligations under this Agreement shall remain binding beyond the termination of this Project.

6. The confidentiality obligations under this Agreement shall not apply to the extent that the respective information
 - is publicly available, or
 - becomes publicly available without fault of BMW or the Partner, or
 - was lawfully received by BMW or the Partner from any third person, or
 - is known to or independently developed by BMW or the Partner.

If BMW and the Partner rely on one or more of the exceptions as laid down in this Section 6 they will have to prove the alleged underlying facts.

7. Exclusive jurisdiction for all and any disputes arising out of or in connection with this Agreement is Munich. All and any disputes arising out of or in connection with this Agreement are subject to the laws of the Federal Republic of Germany.

Munich, this day of

Bayerische Motoren Werke
Aktiengesellschaft

Strasbourg, this 23th day of February 2004

Partner

Marc Schiff p.o. Yves Bachmann
President

Jean-Luc Sonntag
Sales

EXHIBIT B

BMW Group

BMW AG, 80788 München

GM Powertrain
Mr. Jean-Luc Sonntag
81 rue de la Rochelle
BP33
67026 Strasbourg Cedex
France

Ihre Zeichen
Ihre Nachricht vom

Abt./Absender MA-32 / Dr. Christoph Caesar
Telefon 089-382-30809
Fax 089-382-7030809
E-Mail Christoph.Caesar@bmw.de
Datum 11.12.2008
Thema **GMPT 6L45 ETRS and Start-Stop Price Proposal 12.11.2008**

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Harald Krüger
Herbert Diess
Klaus Draeger
Friedrich Eichinger
Ian Robertson

Sitz und
Registergericht
München HRB 42243

Dear Mr. Sonntag,

We refer to your price proposal for 6L45 ETRS and Start-Stop dated 12.11.2008 as well as the various telephone conferences (17.09.2008 and 02.12.2008).

The technologies ETRS and Start-Stop are binding prerequisites for all future vehicle/engine applications at BMW and therefore non-negotiable requirements for any 6L45 application beyond the L2 platform.

The GMPT proposal was discussed and evaluated during the telephone conference on 02.12.2008 as following:

Implementation of ETRS demands the development of a new Transmission Control Unit (incl. BN2020). Supplier for this new TEHCM is DELPHI. These major changes must be evaluated with regards to the fulfillment of all requirements during a concept confirmation phase. Furthermore the proposed technical maturity and timely part availability for EBG, BBG and PVL build phases does not fit to the L7 platform requirements.

The technical concept for Start-Stop functionality proposed by GMPT with an electronic oil pump can not be integrated into the L7 package and is on the basis of the proposal from GMPT not commercially competitive. Due to the fact that the function of the external oil pump can not



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Datum **11.12.2008**
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be actuated by the transmission, the GMPT concept requires highly complex changes to the vehicle Electrical and Electronic Architecture.

In order to be able to continue to utilise the 6L45 we require a revision of the GMPT proposal from 12.11.2008 with the appropriate technical and commercial developments for ETRS and Start-Stop.

GMPT is requested to issue a revised offer to BMW in January 2009. Afterwards the offer will be technically and economically re-evaluated by BMW.

Yours sincerely,

Bayerische Motoren Werke Aktiengesellschaft

ppa.

Benedikt Hartmann

i.V.

Jan Kretschmer



EXHIBIT C

BMW Group

BMW AG, 80788 München

MLC / Motors Liquidation Company
Mr. Albert A. Koch
Chief Executive Officer
14th floor
500 River East Center
Detroit, MI 48243
U. S. A

Your reference
Your message dated
Department/From
Telephone
Fax
E-mail
Date
Subject

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+49-89-382-44076
+49-89-382-38924
Rudolf.Bencker@bmw.de
19.11.2009
Utilization of 6L45 in L7, UKL and Sales of Strasbourg Plant

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Joachim Milberg

Board of Management
Norbert Reithofer
Chairman of the Board
Frank-Peter Arndt
Herbert Diess
Klaus Draeger
Friedrich Eichiner
Harald Krüger
Ian Robertson

Registered in Germany
München HRB 42243

Dear Mr. Koch,

With reference to your letter dated 04.11.2009 and the information you provided during our meeting on 27.10.2009 in Munich we would like to respond as follows.

In your letter you address several issues concerning timing (SoP), technology and your recent efforts to reach a solution for the implementation of Shift-by-Wore (ETRS) and Start-Stop into the 6L45 transmission for further utilization in L7. With reference to this letter we would like to make some comments. Furthermore we would like to address issues related to the potential risk of winding down operations in Strasbourg as mentioned from you during our last meeting and the resulting effects to our current business. Finally we want to give you an update on the recent investigations to source 6-speed transmissions from Strasbourg for our UKL project.

Bayerische Motoren Werke AG ("BMW") stated in several preceding discussions ETRS and Start-Stop are prerequisites due to legal CO-2 requirements for all future automatic transmissions beyond the L2 platform and therefore essential for any future utilization of the 6L45 in L7. It is stated in your latest letter dated 04.11.2009 that BMW is looking for a combined ETRS and Start-Stop feature. However, here we would like to refer back to our letter dated 09.03.2009 where

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Date 19.11.2009

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BMW summarized previously discussed and agreed issues starting with our investigations to utilize an 8-speed transmission including ETRS and Start-Stop from MLC and the incapability of MLC to provide BMW a competitive solution regarding timing, technology and cost. Due to this unfortunate outcome BMW was forced to investigate a further utilization of the 6L45 including ETRS and Start-Stop.

Motors Liquidation Company's, f/k/a General Motors Corporation ("MLC") failure to offer BMW technologically advanced products at competitive pricing has been discussed frequently and documented in correspondence by and between representatives of BMW and MLC over a lengthy time period. Enclosed are the following relevant written communications:

1. Correspondence dated December 11, 2008 from BMW
2. Correspondence dated January 30, 2009 from MLC
3. Correspondence dated February 6, 2009 from BMW
4. "Minutes" dated February 13, 2009 prepared by BMW
5. Correspondence dated February 19, 2009 from MLC
6. Correspondence dated March 9, 2009 from BMW
7. Correspondence dated November 4, 2009 from MLC

After several severe and in-depth discussions between all the involved engineering teams MLC finally confirmed during the conference call on 11.02.2009 that ETRS and Start-Stop technology will not be available for BMW's SoP L7 in 08/2011. This is why BMW was forced by MLC to revise the 6L45 volume planning as the 6L45 transmission cannot be utilized in the L7. Even your latest proposal related to ETRS and Start-Stop does not meet the binding prerequisite of the SoP L7 in 08/2011. Neither the proposed MLC SoP in 07/2012 nor the proposed technical solution which is probably commercially not competitive and can only be integrated with further extensive changes to the BMW vehicle architecture is acceptable for BMW.

As noted in the 6L45 Development and Delivery Agreement dated 06.05.2004, ("Agreement") between MLC and BMW, it is an essential prerequisite that MLC produces and delivers BMW technologically advanced products at competitive pricing. It is clear in the Agreement that MLC's inability to do so would result in a decrease in volume. Therefore BMW is also formally notifying MLC that MLC should expect a reduction of volume relative to the Agreement. The volume loss is due to MLC's inability to meet the "quality, technical functions and price at least compared to suitable competitors" as required in Section 2.3.3 of the Agreement.

The new MLC does not take into account BMW's requirements and cannot be considered anymore. BMW had to revise its planning after your final statement of



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refusal to protect its interests and to warrant the start of production of new vehicles.

As presented during the last meeting by MLC there is the risk of the termination of the plant Strasbourg if the selling process is not successful. However the contractual Agreement partner of BMW is MLC and not the plant Strasbourg. Additionally we conclude from your documents that without further business the termination of Strasbourg will happen latest in 2013, although we have a contract to supply goods until 2015.

As noted above, it seems that MLC may be unable to "provide sufficient production and delivery capacities" as required in Section 2.3.3. Therefore BMW requests that MLC provide adequate assurance upfront to our next meeting that MLC has the ability to continue supplying Contract Goods, as defined in and by the Agreement, to BMW.

BMW is not attempting to unilaterally terminate the Agreement. However, if MLC is unable to provide adequate assurance of MLC's future performance on the Agreement, BMW will take appropriate action in the Bankruptcy Court to protect its interests.

Finally we want to refer to recent discussions to utilize a MLC 6-speed transmission produced in Strasbourg for our UKL project. BMW and MLC have enjoyed a good business relationship with the sourcing of 4-speed and 5-speed transmissions followed by the 6L45 business. Consequent extension of this has been to investigate the feasibility for utilization of a GMPT 8-speed transmission including ETRS and Start-Stop with the above stated unfortunate outcome. As an alternative to the 8-speed programme and further utilization of the 6-speed transmission BMW was willing to jointly investigate to source transmissions for UKL from MLC believing in engineering capabilities of MLC. Therefore we had several joint technical and commercial investigations until 11/2008. Unfortunately we must state that MLC could not meet our requirements regarding technology. The proposed transmission is compared to competitors the worst regarding CO-2 which is technically the most important issue for future applications due to latest legal regulations and requirements to OEM.

Therefore we want to thank you for your contribution you have done so far but also have to inform you that BMW cannot consider your quote during further supplier selection for UKL project.

We look forward to hearing from you as soon as possible and to be able to discuss these points in person with you during our upcoming meeting on December, 10th in Strasbourg.



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Date 19.11.2009
Page 4

Yours sincerely,

Bayerische Motoren Werke Aktiengesellschaft

ppa

i.V.



Dr. Johann Wieland

Dr. Rudolf Bencker

Copies to:

BMW

Mr. Fröhlich, Mr. Langen, Dr. Breitfeld, Dr. Curtius, Dr. Kluebing, Mr. Rauberger, Mr. Schmidt-Troje, Mr. Kretschmer, Mr. Westermeier, Mr. Lichtenberger, Mr. Lederbauer

MLC

Mr. Cook, Mr. Jenkins, Mr. Sonntag

EXHIBIT D



Motors Liquidation Company
500 Renaissance Center
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Detroit, MI 48243

Phone: 313.486.4044
Fax: 313.486.4258

BMW AG
Attn.: Dr. Johann Wieland / Dr. Rudolf Bencker
80788 Munich
Germany

December 2, 2009

Utilization of 6L45 in L7, UKL and Sales of Strasbourg Plant
Your letter dated November 19, 2009

Dear Dr. Wieland and Dr. Bencker,

We disagree very strongly with your statements in your letter dated November 19, 2009 alleging that we are not in compliance with our contractual obligations under the 6L45 Development and Delivery Agreement dated May 6, 2004 (the "**Agreement**"). The contrary is correct.

We are in full compliance with our contractual obligations and are not obliged to include a start-stop feature in the 6L45 automatic transmission or to develop and supply BMW with an 8-speed transmission technology so that BMW can fulfill its obligations under the Agreement. Rather, BMW is not complying with its contractual obligations since BMW is falling short of the minimum volume guarantee under the Agreement. Accordingly, in the absence of an acceptable commercial arrangement, we intend to seek appropriate remuneration.

Under the Agreement, we are to develop, design, produce and supply to BMW the 6L45 automatic transmission, a 6-speed automatic transmission without start-stop feature, as defined by the "**Contract Goods**" in the Agreement. We are not obliged to develop new goods which are different from the functionality of the 6L45 automatic transmission (see Section 5.1.2 of the Agreement). The start-stop feature as well as the 8-speed transmission technology are totally new technical features outside the scope of the definition of Contract Goods, which is exhaustively defined in Exhibit I, "Lastenheft." In contrast to Section 6.3.2.2 of the Agreement dealing with ETRS, the Agreement contains no right of BMW according to which BMW could demand the implementation of start-stop feature by an agreed date although the start-stop technology was known to the parties when they signed the Agreement in 2004. Since such technology was already known and used in car production since the 1980's, it would have been possible for BMW to demand the implementation of similar provisions for the start-stop technology when negotiating the 6L45 Agreement. In addition, although BMW stated in several discussions that ETRS and start-stop are prerequisites for all future automatic transmissions beyond the L2 platform, this did not lead to an amendment of the Agreement, in particular with respect to the scope of Contract Goods.

Furthermore, your reference to Section 2.3.3 of the Agreement is misleading. The clause "(...) prerequisite (...) is the competitiveness of GMPT's product regarding quality, technical functions and price (...)" does not constitute an obligation for us to include the start-stop feature in the 6L45 automatic transmission. In this context, "prerequisite" means that the competitiveness of our products was a pre-condition for concluding the Agreement, but not a condition for its entire term. On the contrary, Section 2.3.3 of the Agreement stipulates only the general requirement that, at the time of concluding the Agreement, we were capable of producing competitive products in general since no reference is made to Contract Goods under Section 2.3.3 of the Agreement. Nevertheless, the 6L45 automatic transmission indeed represents state of the art technology and, thus, a competitive product; a start-stop feature cannot be considered as market standard for 6-speed automatic transmissions. The second supplier of the 6-speed automatic transmission, ZF Friedrichshafen AG, does not make available the 6-speed automatic transmission system with a start-stop function. Rather, the start-stop function is only available in

a different model, a newly developed 8-speed automatic transmission unit which is a totally new and different product from the Contract Goods defined in the Agreement.

Further, we also have the ability and fully intend to provide sufficient production and delivery capacities of the Contract Goods through the GM Strasbourg transmission business. At the time of your November 19, 2009 letter, neither MLC nor GM Strasbourg have failed to fulfill their obligations in the supply of Contract Goods. Per the 6L45 Agreement, the GM Strasbourg facility has sufficient capacity to fulfill BMW's "200,000 units +20%" of annual production, despite BMW's recent volume shortfalls and November 19th notice that we should "expect a reduction of volume relative to the Agreement" (we have yet to receive a forecast). Therefore, we believe your request for adequate assurance is without basis.

Additionally, while in the provided correspondence between BMW and GM Corp, BMW stated that the start-stop and ETRS technologies would be required for future platforms (i.e.: L7), the 6L45 agreement does not call out specific platforms. The Agreement simply states a minimum volume requirement of "1,900,000 Contract Goods" or "200,000 – 220,000" Contract Goods per year. Therefore, your assertion that BMW is unable to use the 6L45 on future platforms because of missing technologies is a condition that is being imposed by BMW itself and is therefore irrelevant to discussion regarding BMW's breach of the 6L45 Agreement.

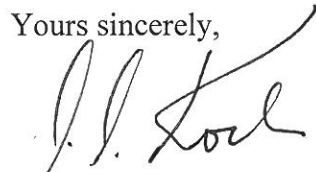
In this context, we would like to emphasize that the decrease in volume under the Agreement is a result of the business decision of BMW to switch from the 6L45 automatic transmission to an 8-speed transmission. It is not based on our inability to perform the Agreement or on non-compliance with our contractual obligations. Neither is it a result of an alleged failure on our part to offer BMW advance competitive products. To the contrary, it is BMW that is solely responsible for the decrease in volume under the Agreement.

Notwithstanding the foregoing, BMW and MLC have enjoyed a very good business relationship since the sourcing of the 4-speed and 5-speed transmission followed by the 6L45 automatic

transmission. Thus, we would like to jointly explore with BMW a strategy to maintain and broaden our business relationship.

Under separate cover I have suggested a meeting in Munich on December 11th. I hope that we are able to arrange a meeting and look forward to devising a mutually acceptable solution with you.

Yours sincerely,

A handwritten signature in black ink, appearing to read "A. A. Koch". The signature is fluid and cursive, with a long, sweeping underline that extends to the right.

Albert A. Koch
Chief Executive Officer
Motors Liquidation Company