

# Flexibilität der Applikationsentwicklung in Doppelkupplungsgetrieben

## *Flexibility of Attribute Engineering in Dual Clutch Transmission*

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### I. Introduction

- **1986:** Porsche introduces the „grandfather“ of DCT, the PDK (Porsche Doppelkupplungsgetriebe), into sports car racing. The goal was to avoid the loss of tractive effort during gearshifts
- Due to limited control system capability only sequential shifting was possible, thus limiting the useability in road cars.
- **2003:** State of the art mechatronic systems offer the tool box to utilize the full potential of DCT technology for everyday use, as demonstrated by the launch of VW DSG.
- **Today** I want to exemplify the versatility of DCT, based on the first applications of the GETRAG PowerShift 6DCT450/470 product line.



Fig. 1

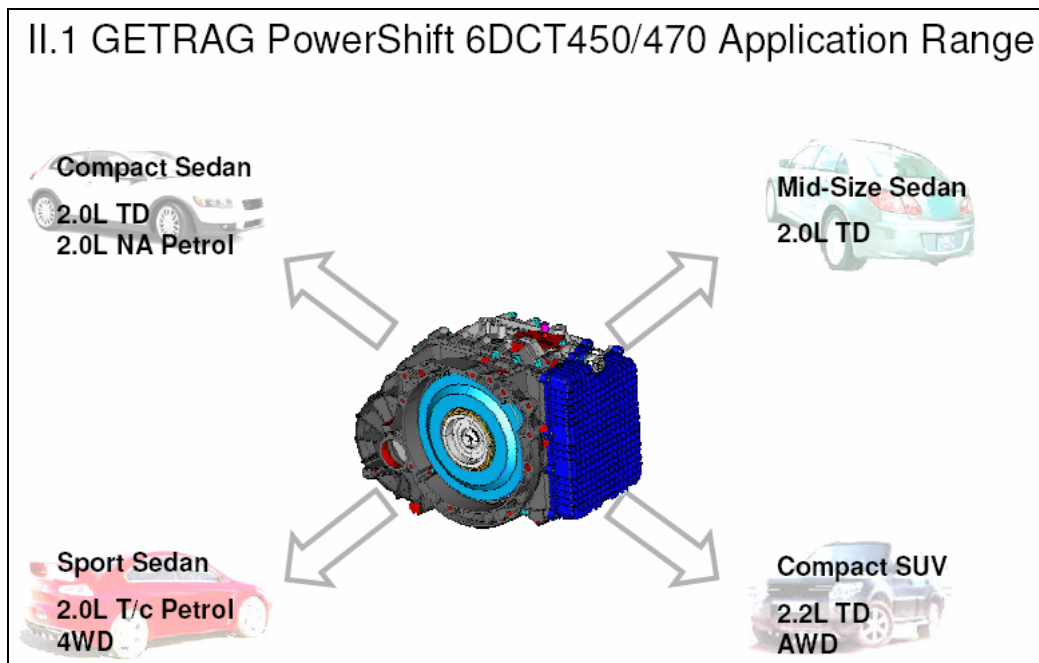


Fig. 2

### II.2 GETRAG PowerShift 6DCT450/470 Applications - Key Data

<p>■ <b>Compact Sedan</b>  <u>Weight:</u> 1625 kg            2.0L TD 100 kW / 320 Nm            2.0L Petrol 107 kW / 185 Nm  <u>Overall Ratios:</u>            1st: 14.560 / 16.228            :            6th: 2.292 / 3.144  <u>Priority:</u> - Fuel Economy                      - Shift Comfort</p>	<p>■ <b>Mid-Size Sedan</b>  <u>Weight:</u> 1882 kg            2.0L TD 103 kW / 310 Nm  <u>Overall Ratios:</u>            1st: 15.289            :            6th: 2.406  <u>Priority:</u> - Shift Comfort</p>
<p>■ <b>Compact SUV</b>  <u>Weight:</u> 1800kg            2.2L TD 115 kW / 380 Nm  <u>Overall Ratios:</u>            1st: 14.558            :            6th: 2.495  <u>Priority:</u> - Fuel Economy                      - Medium Duty Operation</p>	<p>■ <b>Sport Sedan</b>  <u>Weight:</u> 1530kg            2.0L T/c 235kW / 420 Nm  <u>Overall Ratios:</u>            1st: 14.849            :            6th: 3.148  <u>Priority:</u> - Performance (Acceleration)                      - Shift Responsiveness                      - Throttle Feedback</p>

Fig. 3

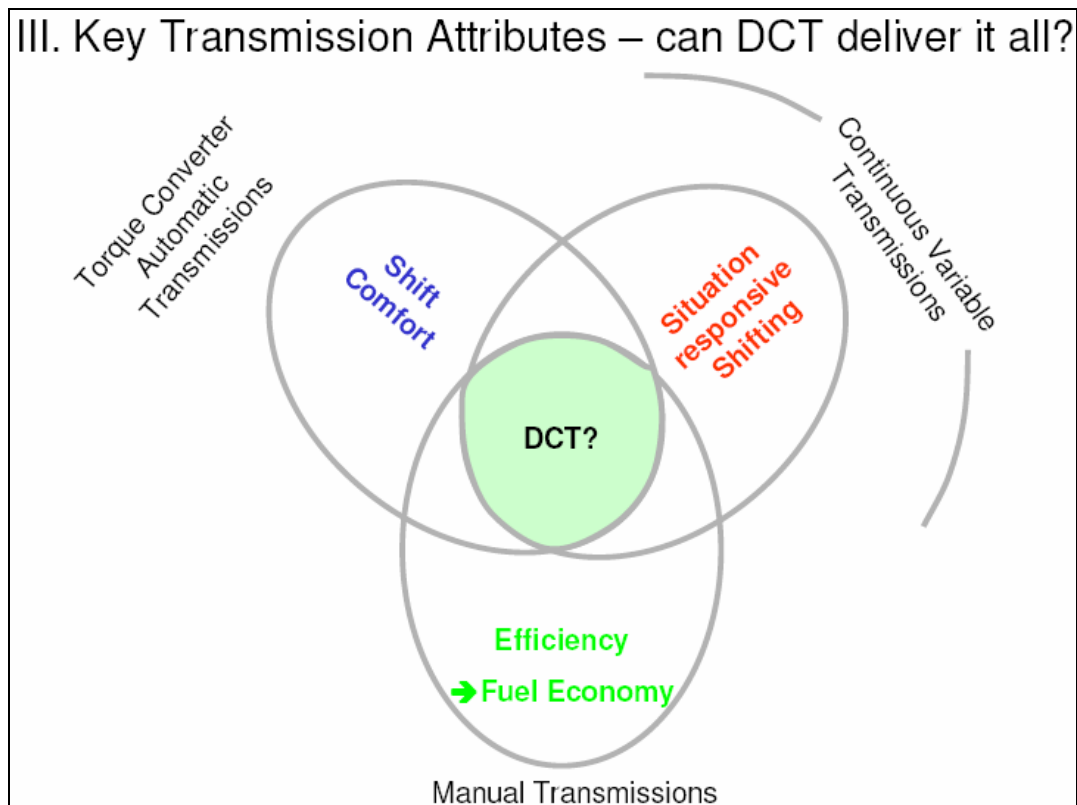


Fig. 4

### III.1 Aspect „Fuel Economy“

**What makes a transmission design concept suited for fuel economy optimization?**

- Good mechanical efficiency
- Gear Ratio Flexibility
- Shift Pattern Flexibility

Fig. 5

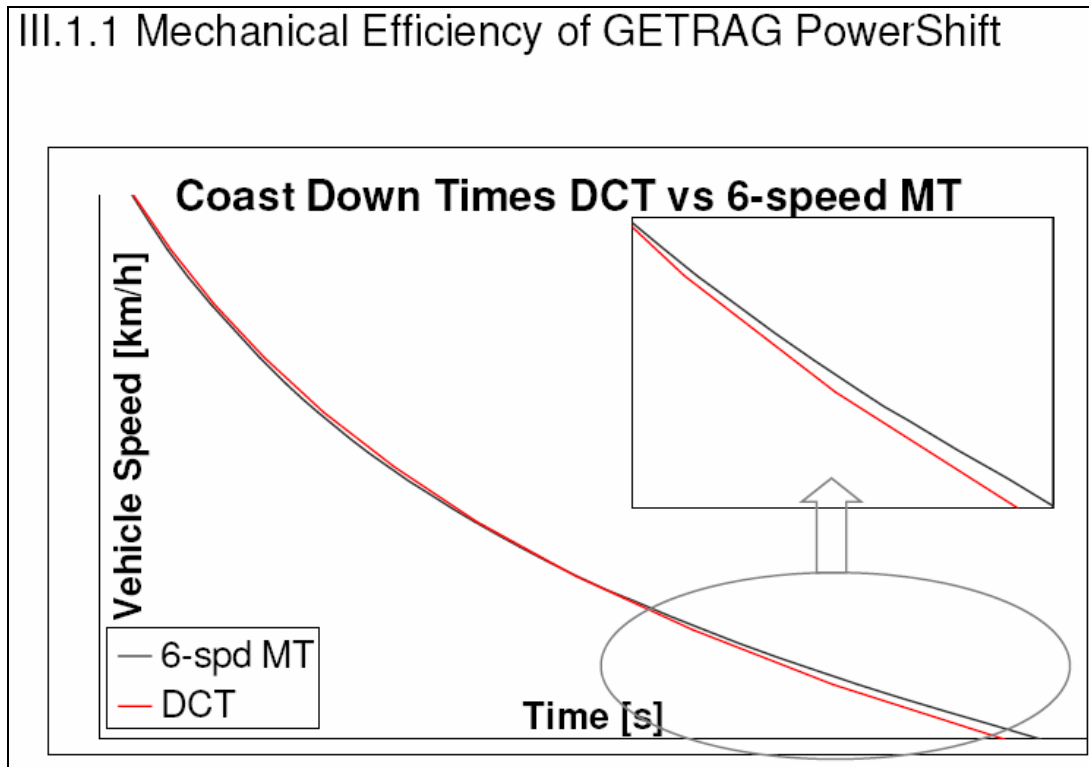


Fig. 6

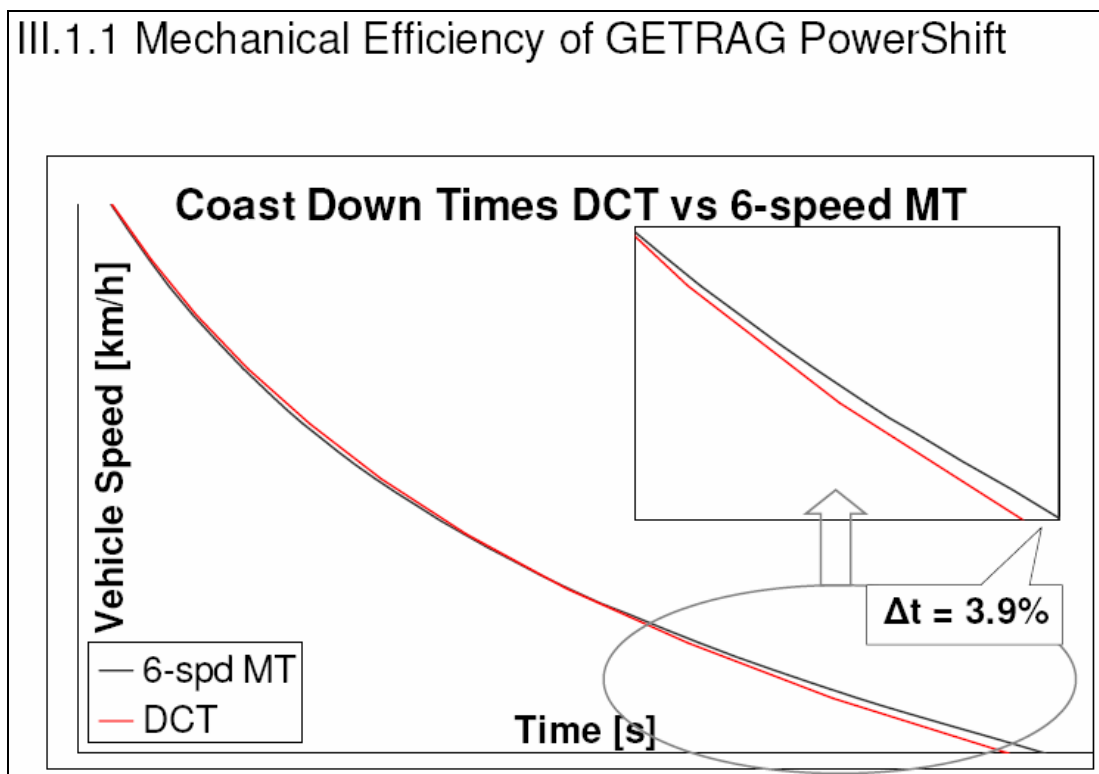


Fig. 7

## III.1.2 Gear Ratio Flexibility of 6DCT450/470

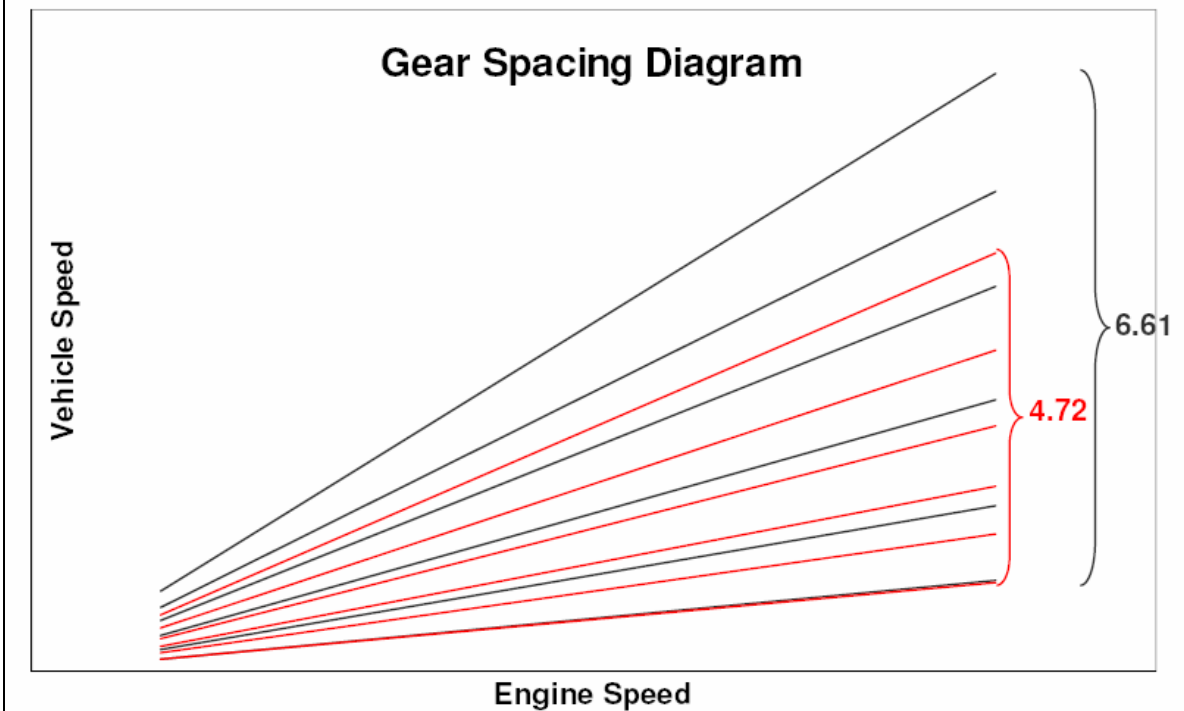


Fig. 8

## IV. Aspect „Shift Comfort“

- The perceived quality of a gear shift is mainly influenced by the amount of disturbance in the lateral vehicle acceleration, combined with acoustic sensations (e.g. audible engine speed change, shift noise, driveline clonk noise)
- A key metric to compare shift quality is the Vibration Dose Value (vdv)

$$vdv = \left[ \int a(t)^4 dt \right]^{1/4}$$

- The following graphs show samples of different shift tuning, example 1-2 upshift WOT:
  1. Sport Sedan „Normal“ Mode
  2. Sport Sedan „Sport“ Mode
  3. Sport Sedan „Race“ Mode

Fig. 9

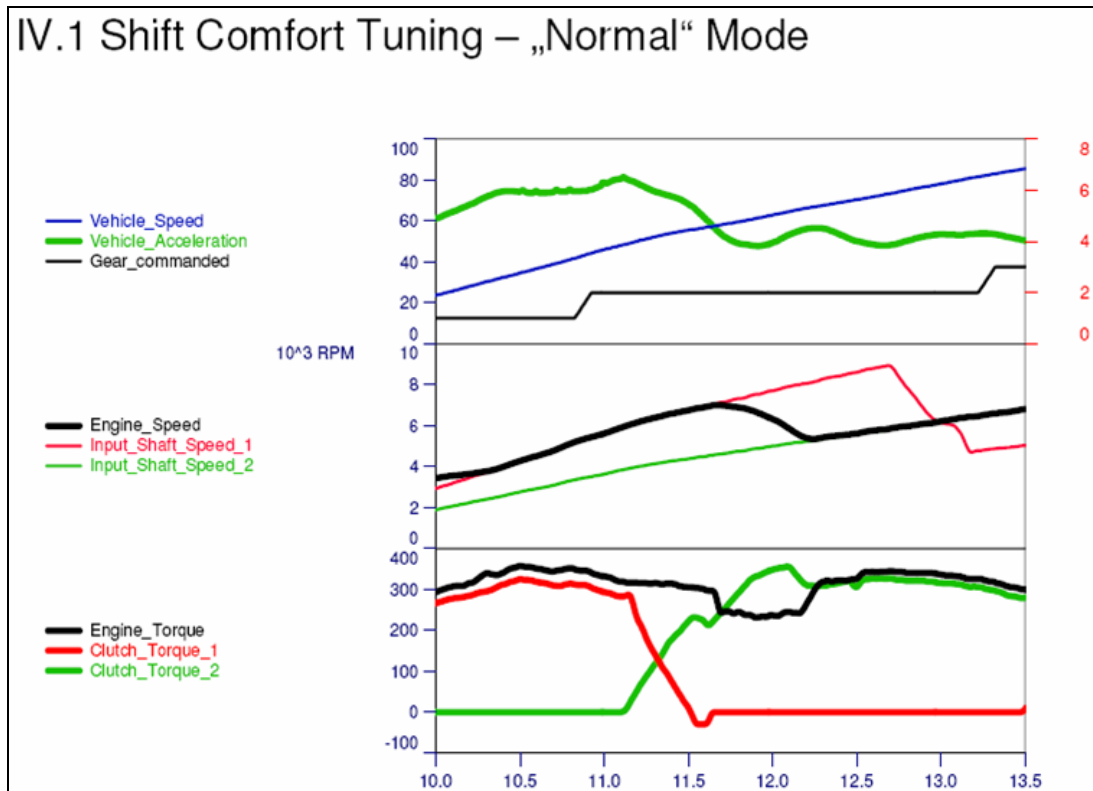


Fig. 10

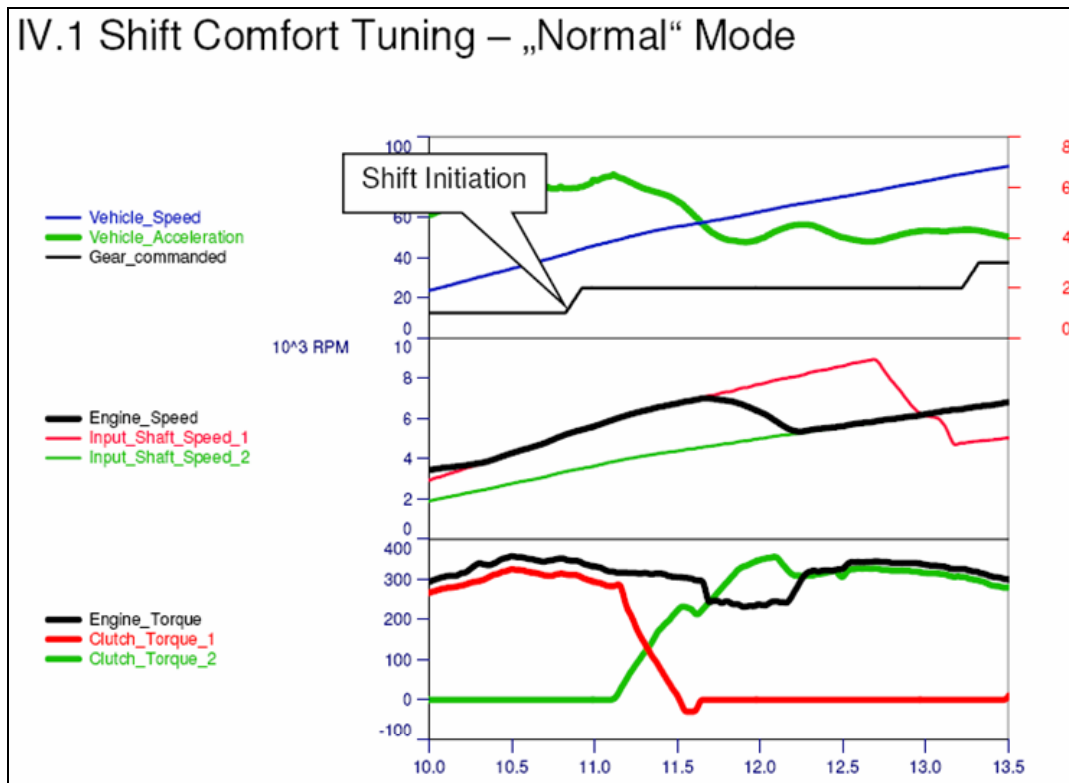


Fig. 11

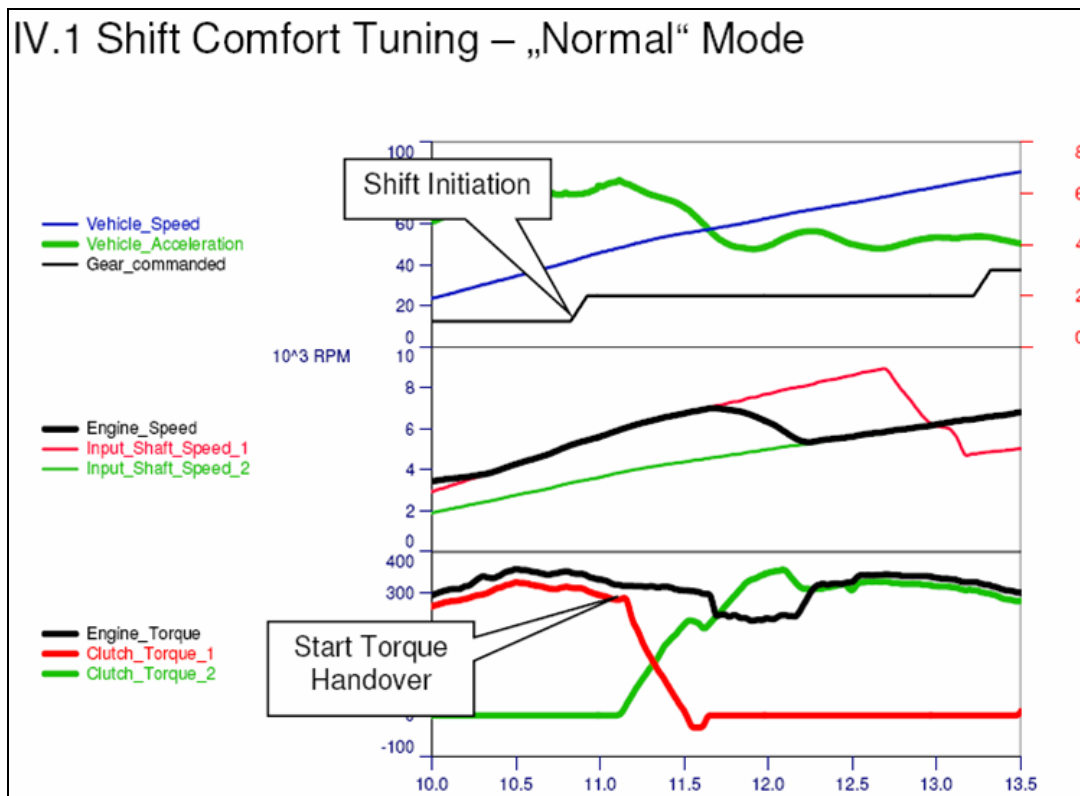


Fig. 12

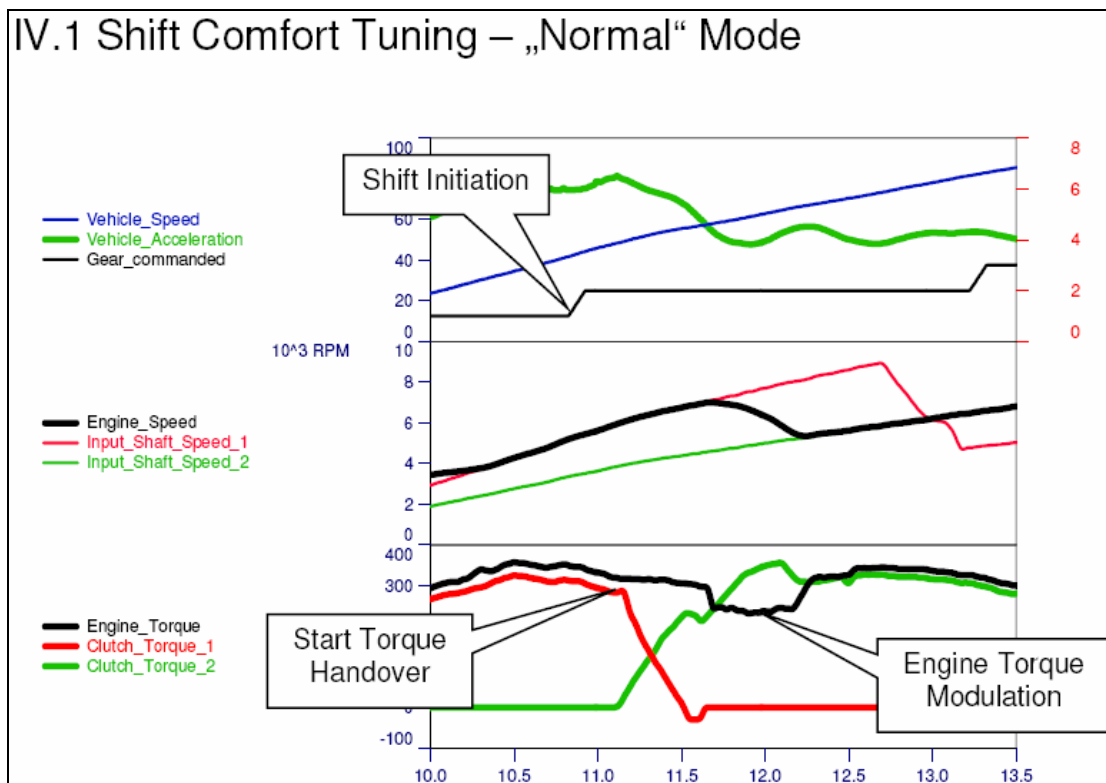


Fig. 13

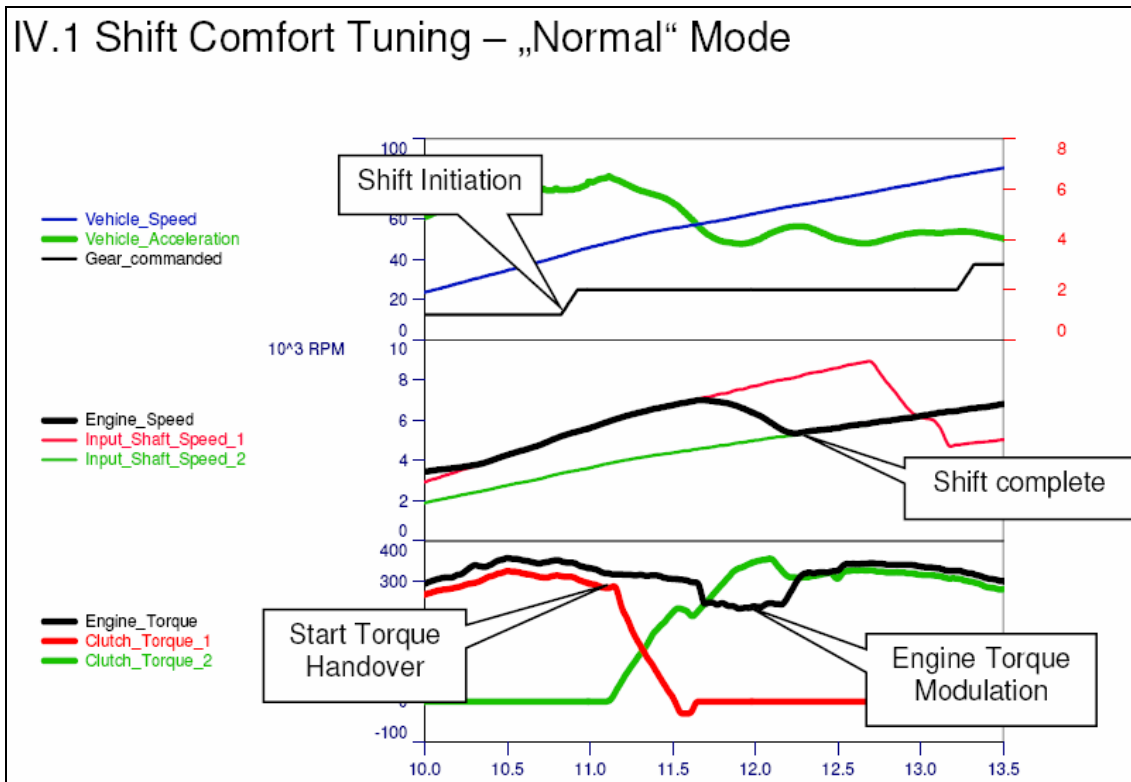


Fig. 14

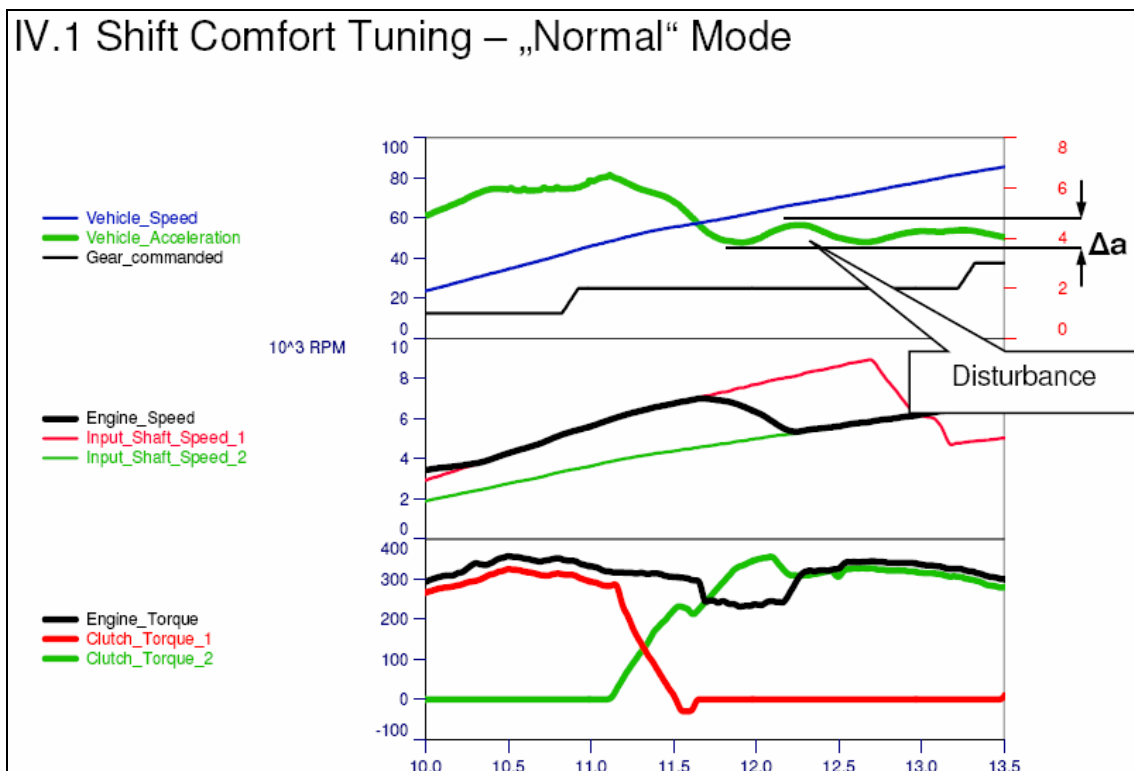


Fig. 15



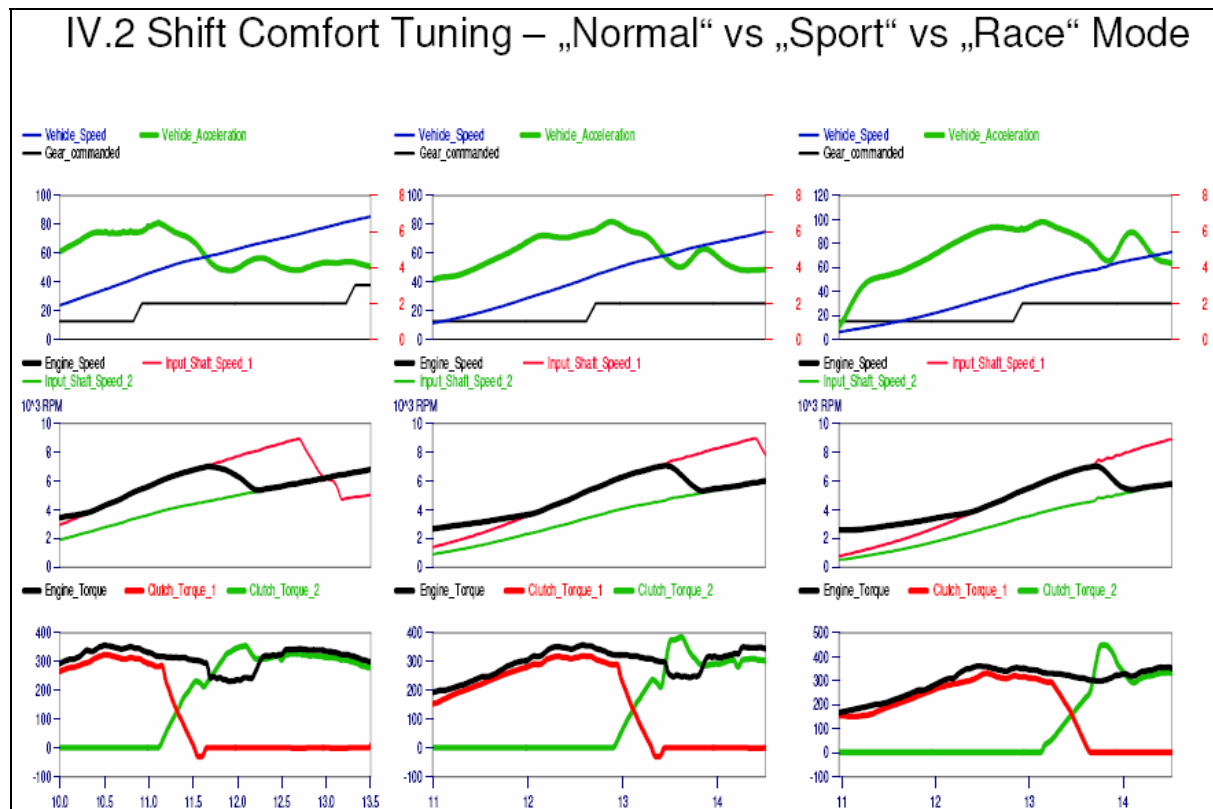


Fig. 16

## V. Aspect „Responsive Shifting“

- The execution of a gear shift involves a complex sequence of operations of the transmission control system. In most situations these operations happen in the background unnoticed by the driver of the vehicle.
- In specific situations, however, the driver expects quick responses to his input, such as
  - Throttle pedal movements, e.g. kick-down
  - Manual shift commands, e.g. paddle shift
- To accelerate the system response, DCT technology offers special features which can be activated on the passive path:
  - **Gear pre-selection**
  - **Clutch pre-fill**

Fig. 17

## VI. Other special functional Features

- **Creep function:**
  - Emulating the idle output torque situation of a conventional torque converter automatic transmission
  - Tuneable from „no creep“ over „soft“ to strong“ depending on preference
- **Hill hold & Roll-back inhibition**
  - Both of them extensions of the idle creep function
- **„Torque break“ shifting**
  - Option to accelerate downshifting by cutting out the torque hand-over step
  - Can be used in „Sport“ mode to accelerate 2-step downshifting or downshifts during braking
- **Race Start**
  - Feature to maximize acceleration from standstill

Fig. 18

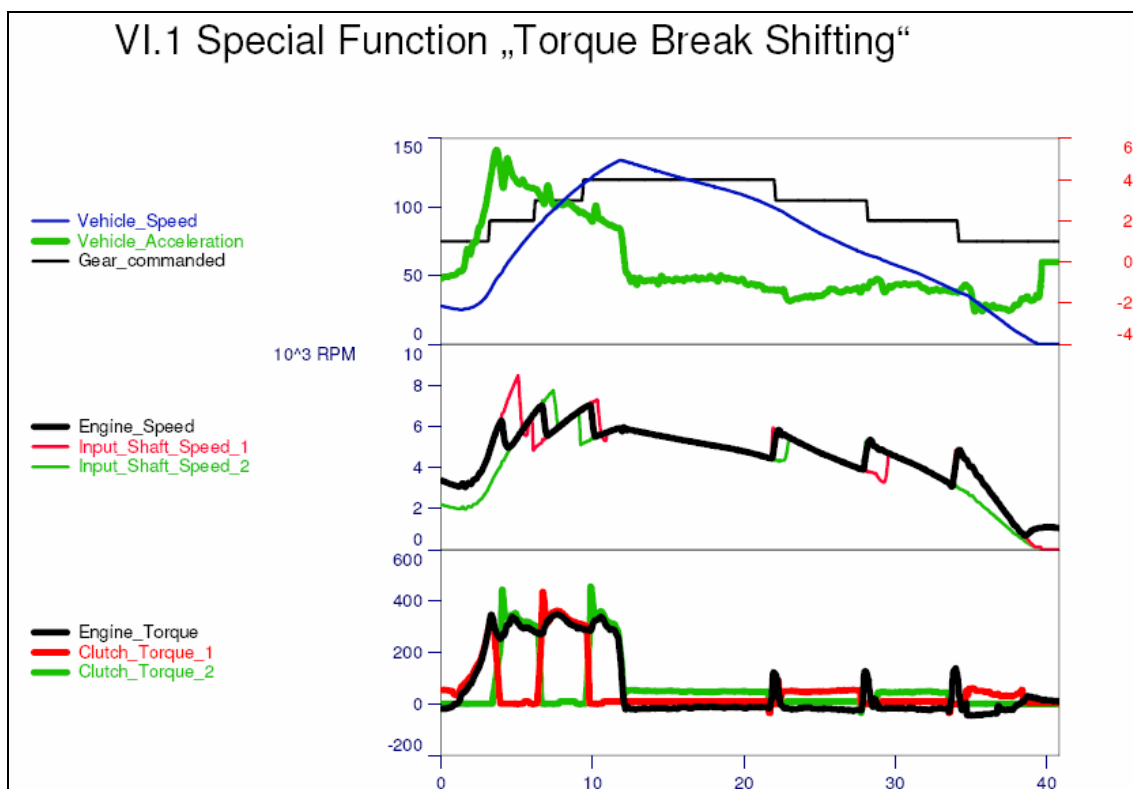


Fig. 19

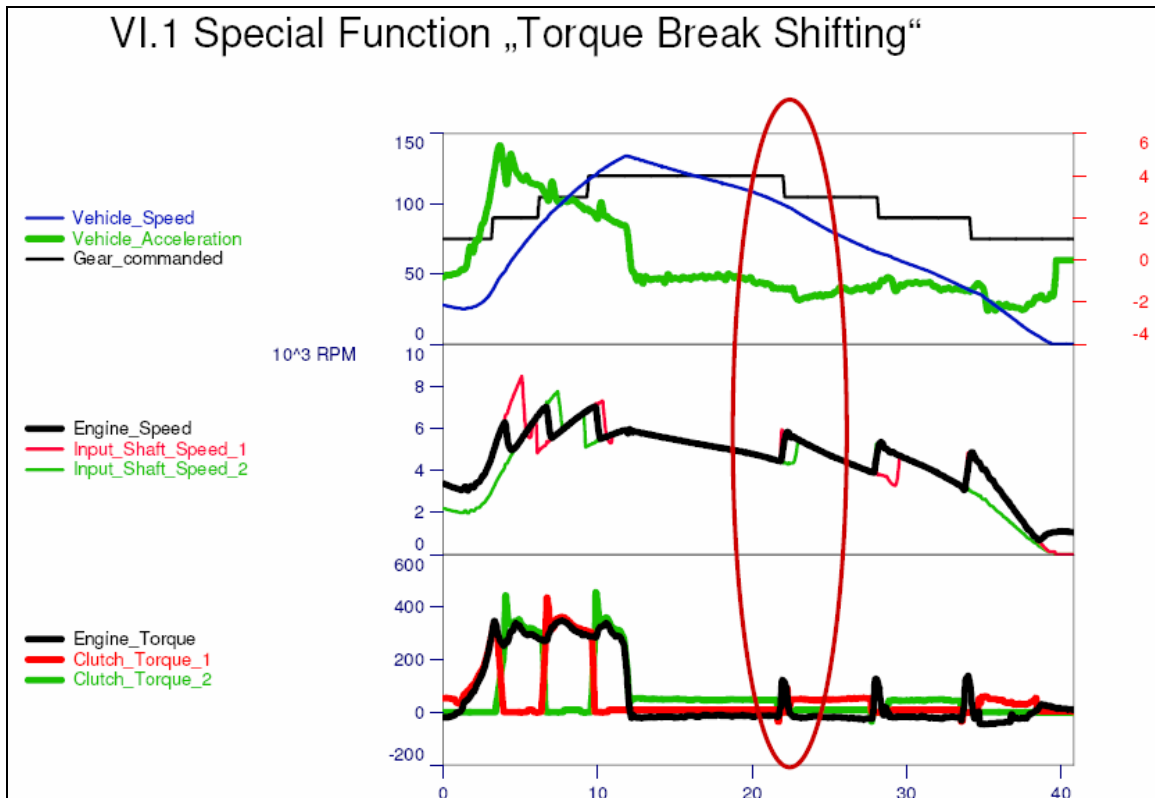


Fig. 20

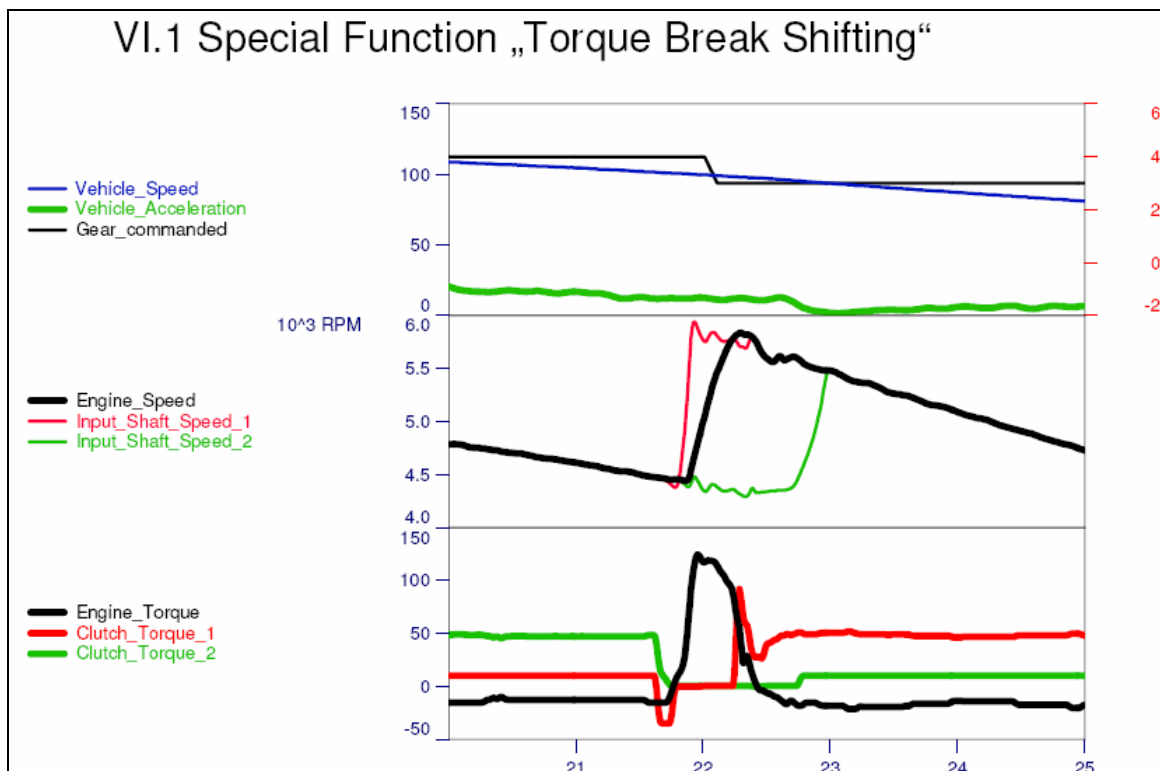


Fig. 21

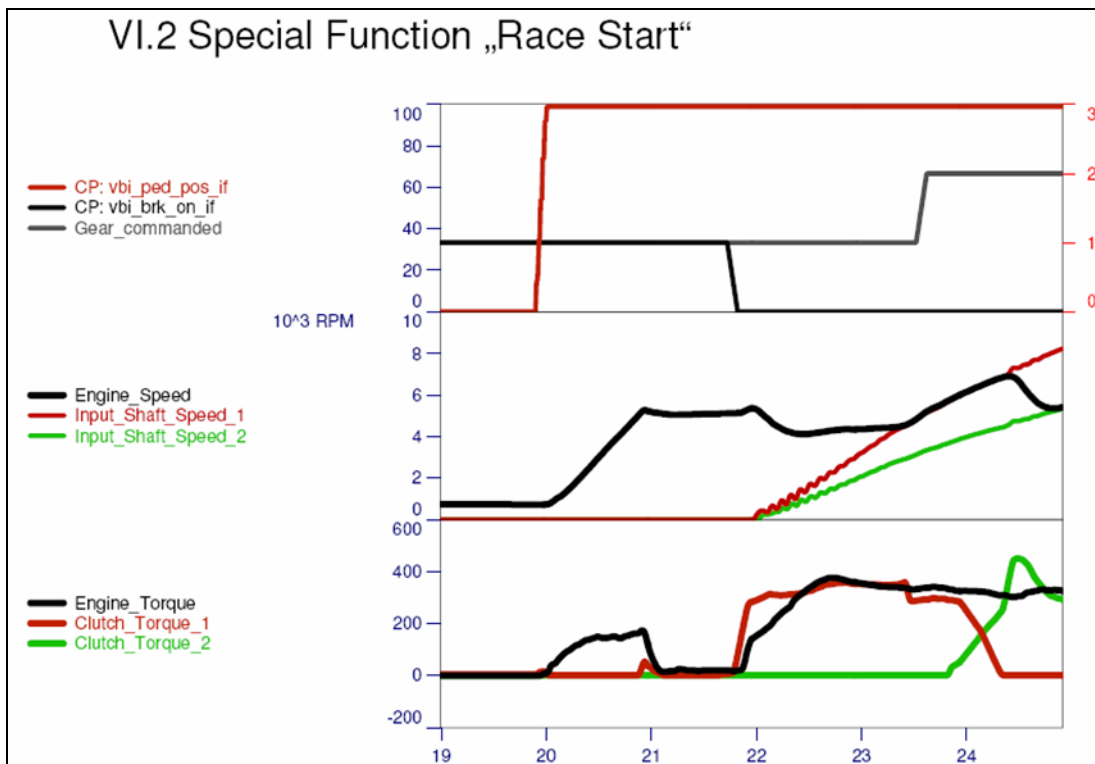


Fig. 22

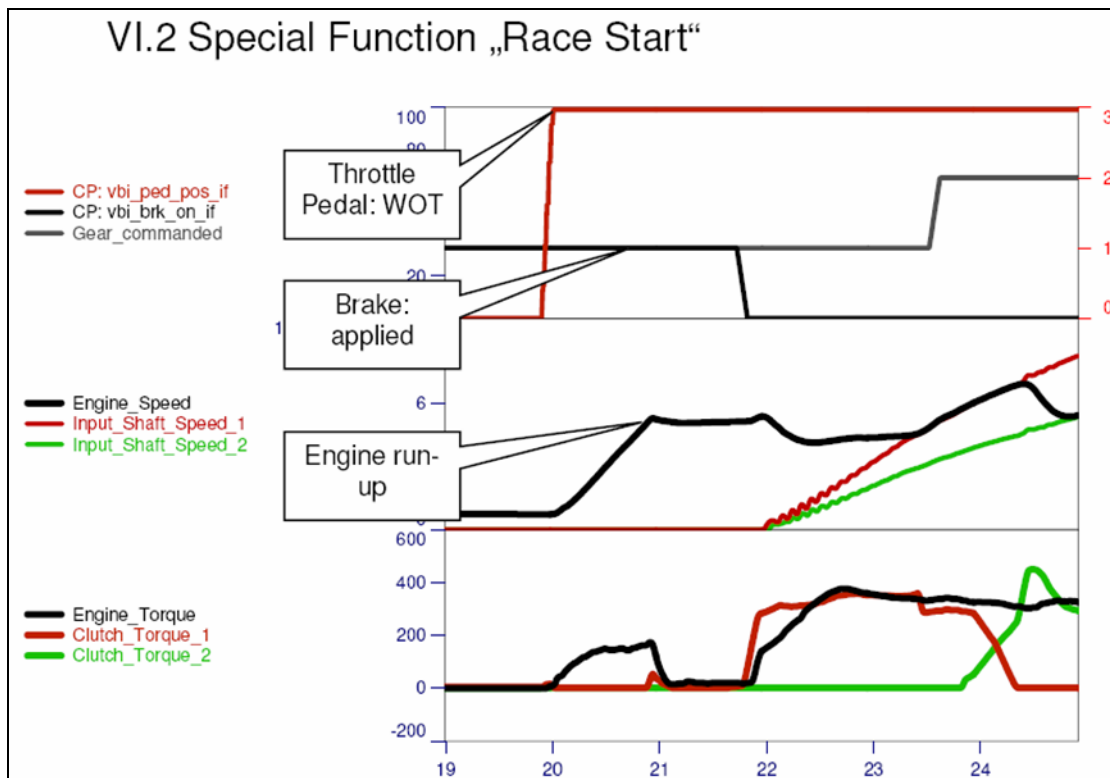


Fig. 23

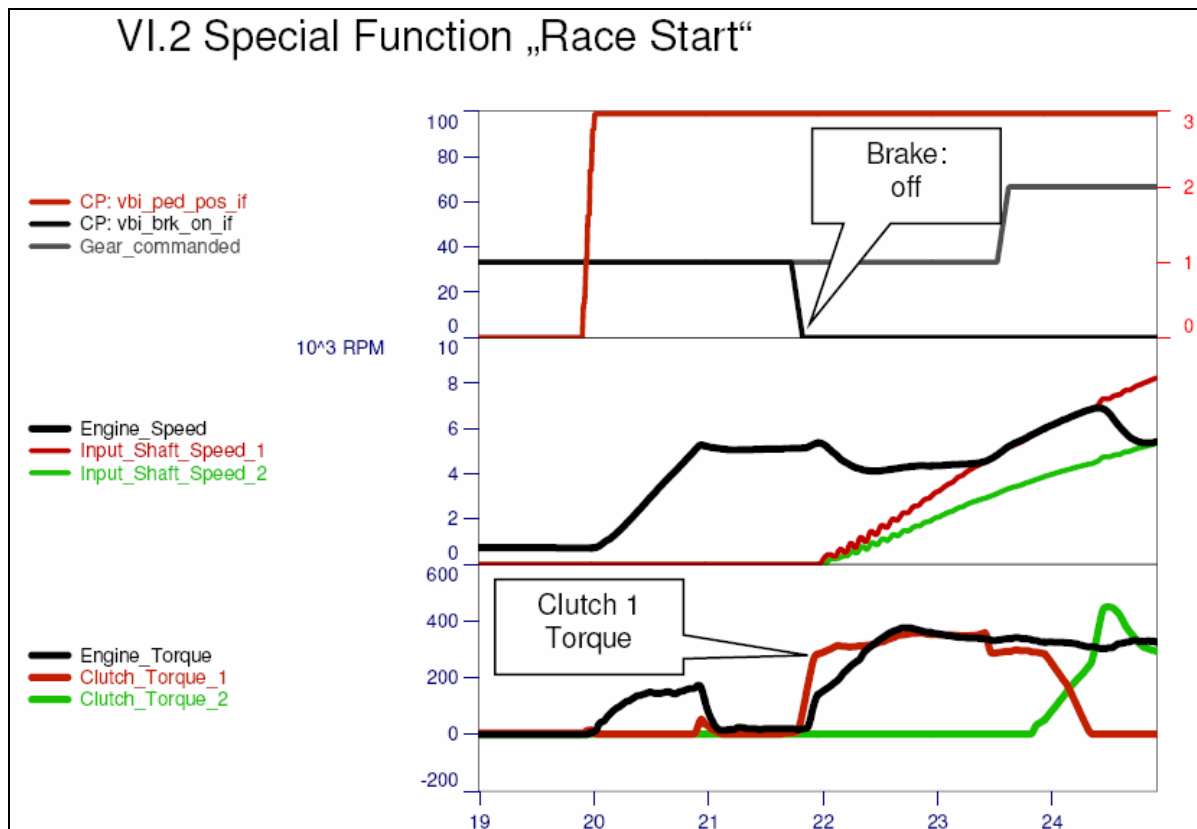


Fig. 24

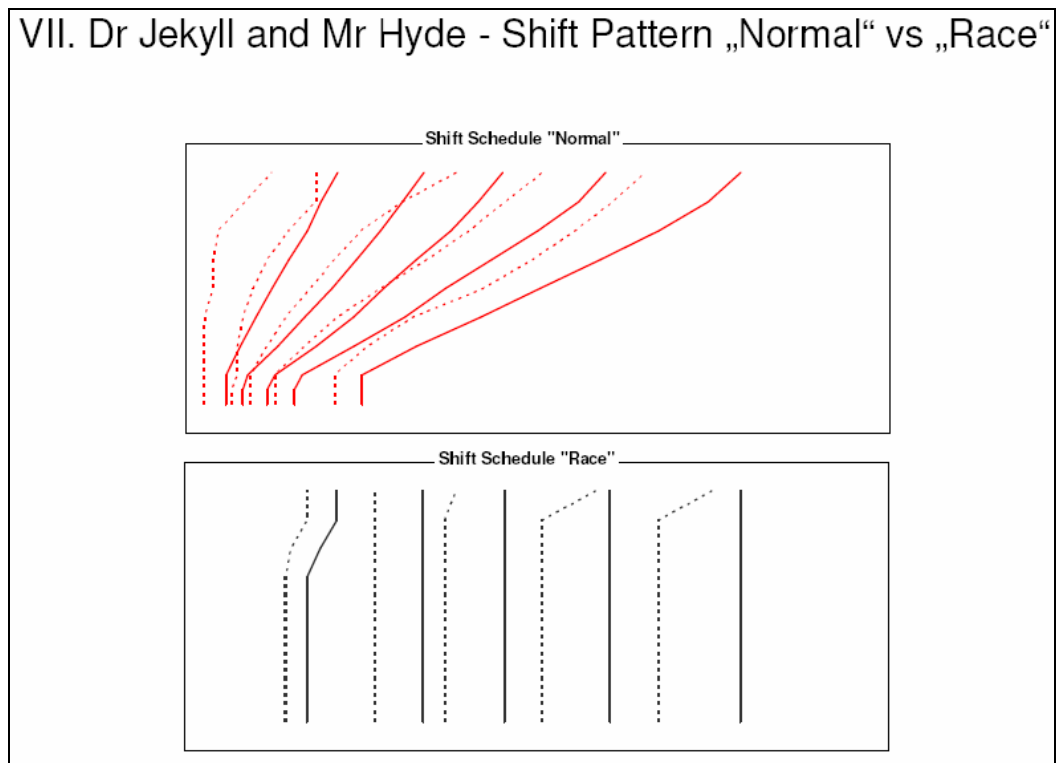


Fig. 25

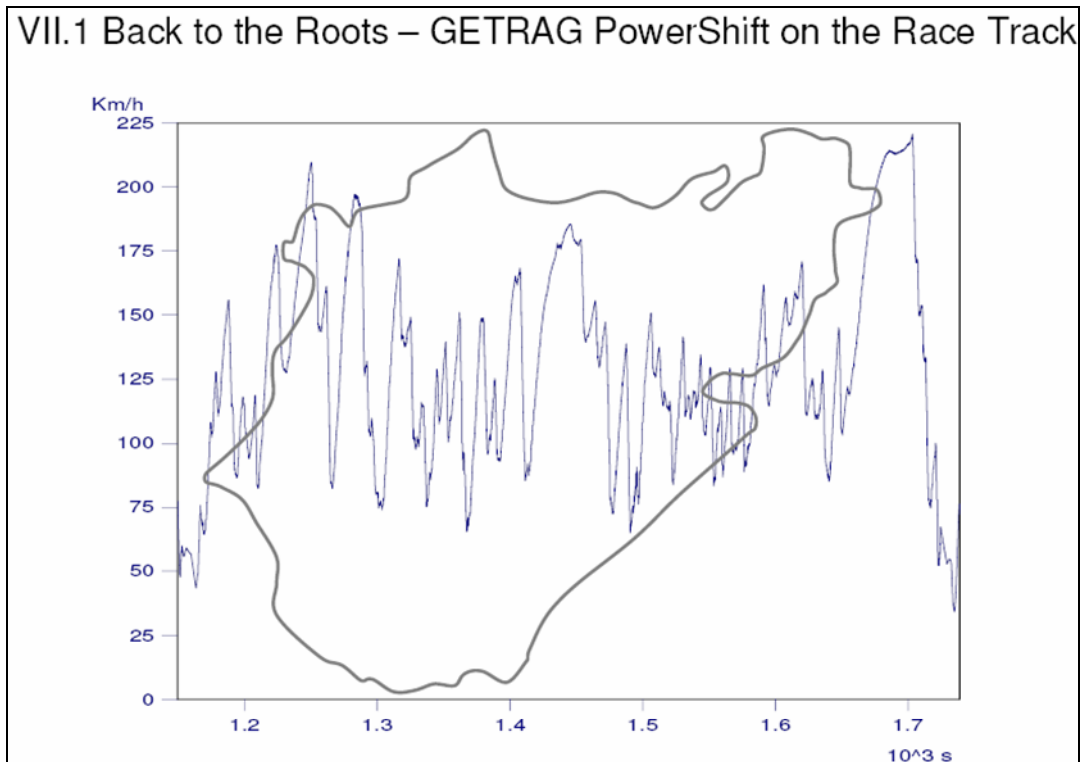


Fig. 26

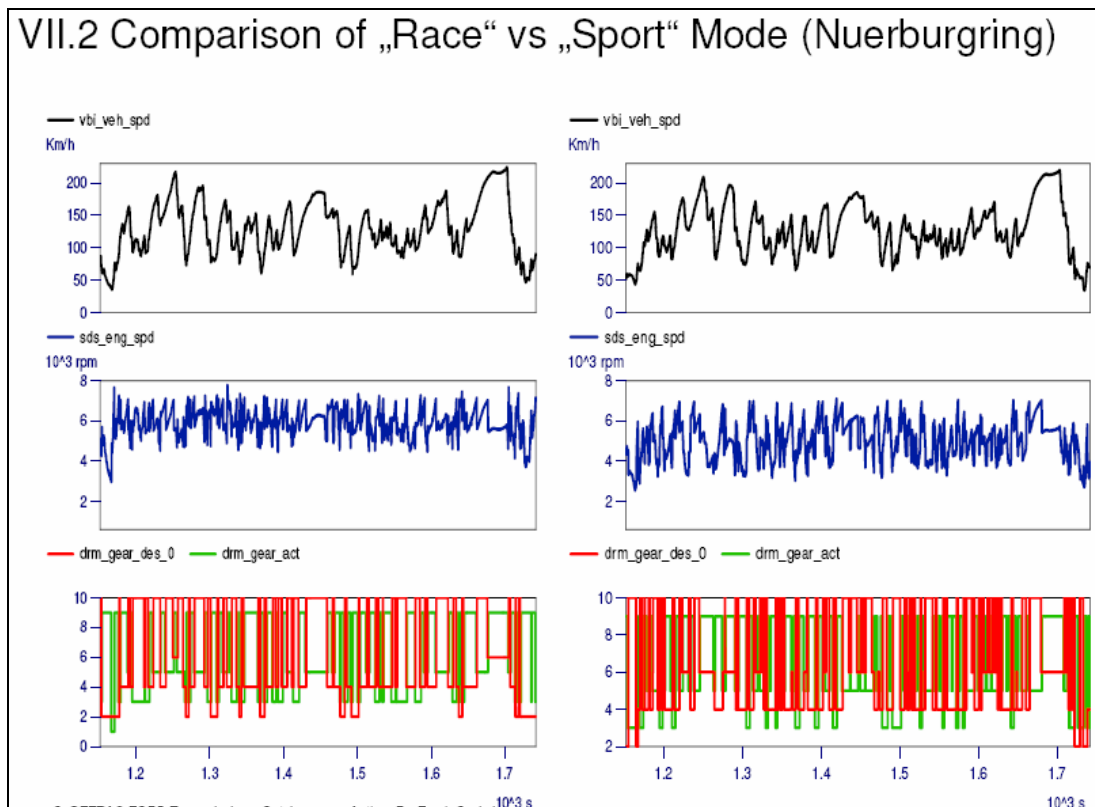


Fig. 27

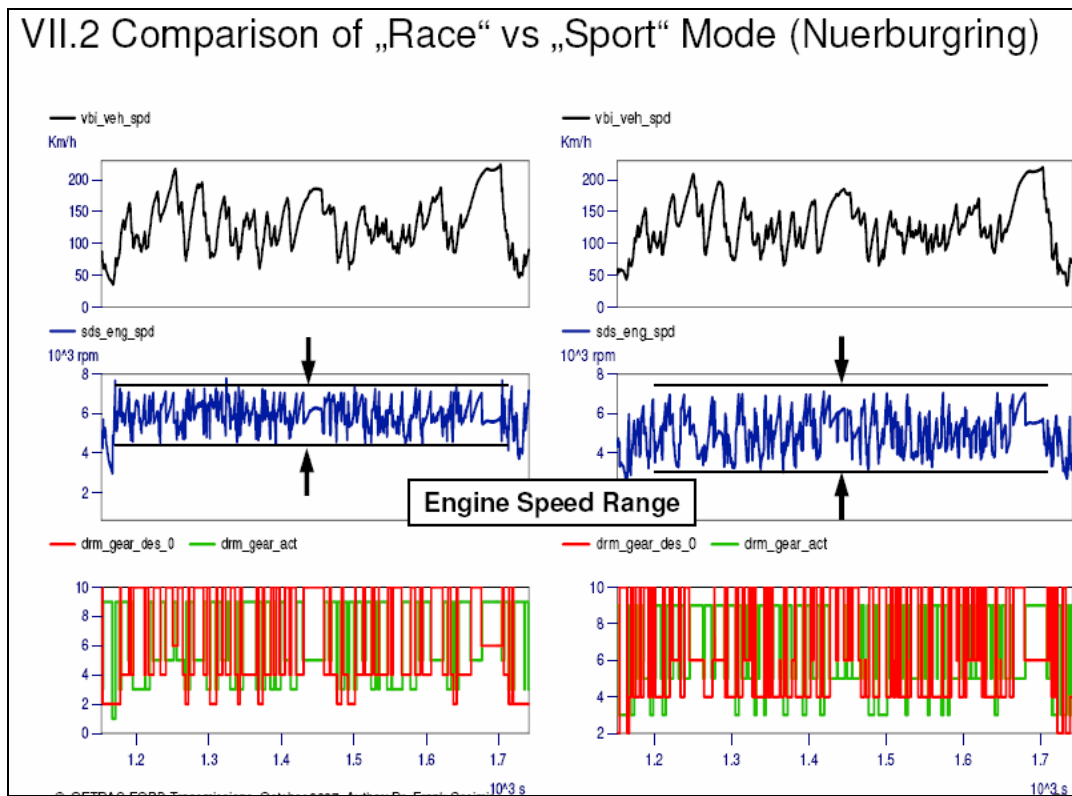


Fig. 28

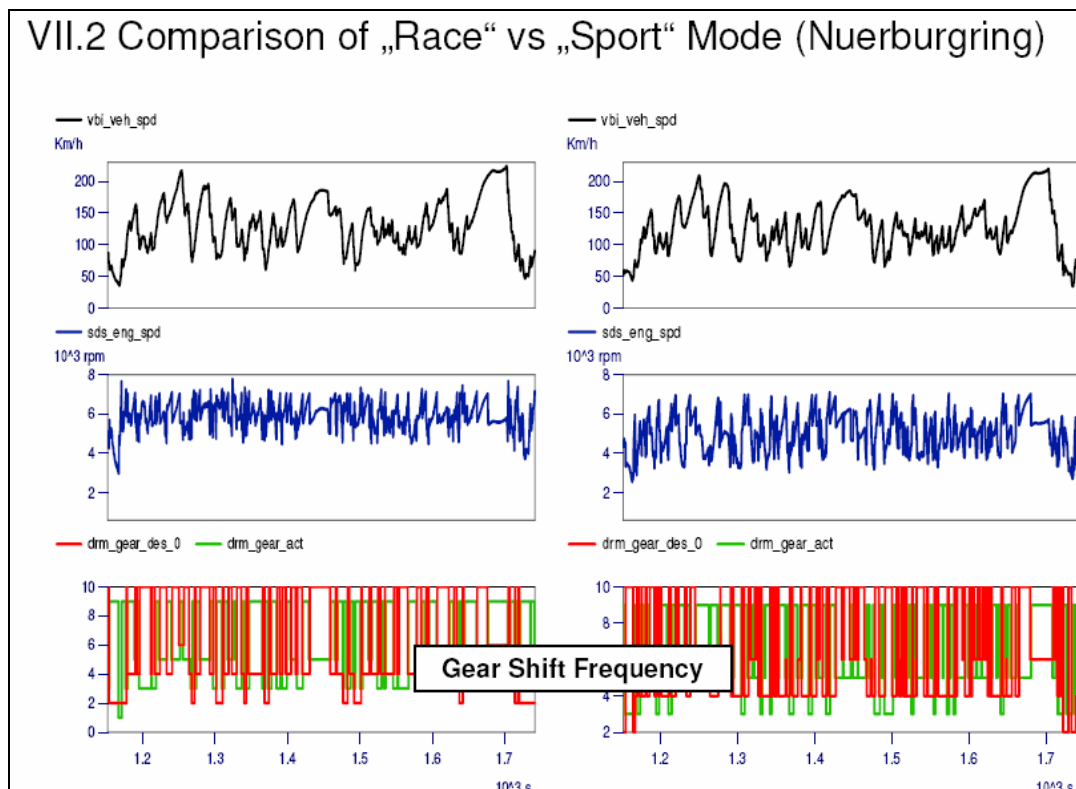


Fig. 29

VII.3 Key Statistics of the Race vs Sport Mode Comparison

Number of Gear Shifts

From Gear → To Gear ↓	1	2	3	4	5	6
1						
2	1		2 6			
3		2 9		15 17	1	
4		1	17 19		22 12	4
5				24 12		11 2
6					13 2	

Fig. 30

## VIII. Summary

**Dual Clutch Transmissions provide a high level of flexibility in the hand of any vehicle development team due to**

- Ratio flexibility
- Good mechanical efficiency
- Automatic shift characteristics tuneable to any desired shift comfort level
- Versatility of the control system allowing design and use of special features

Fig. 31