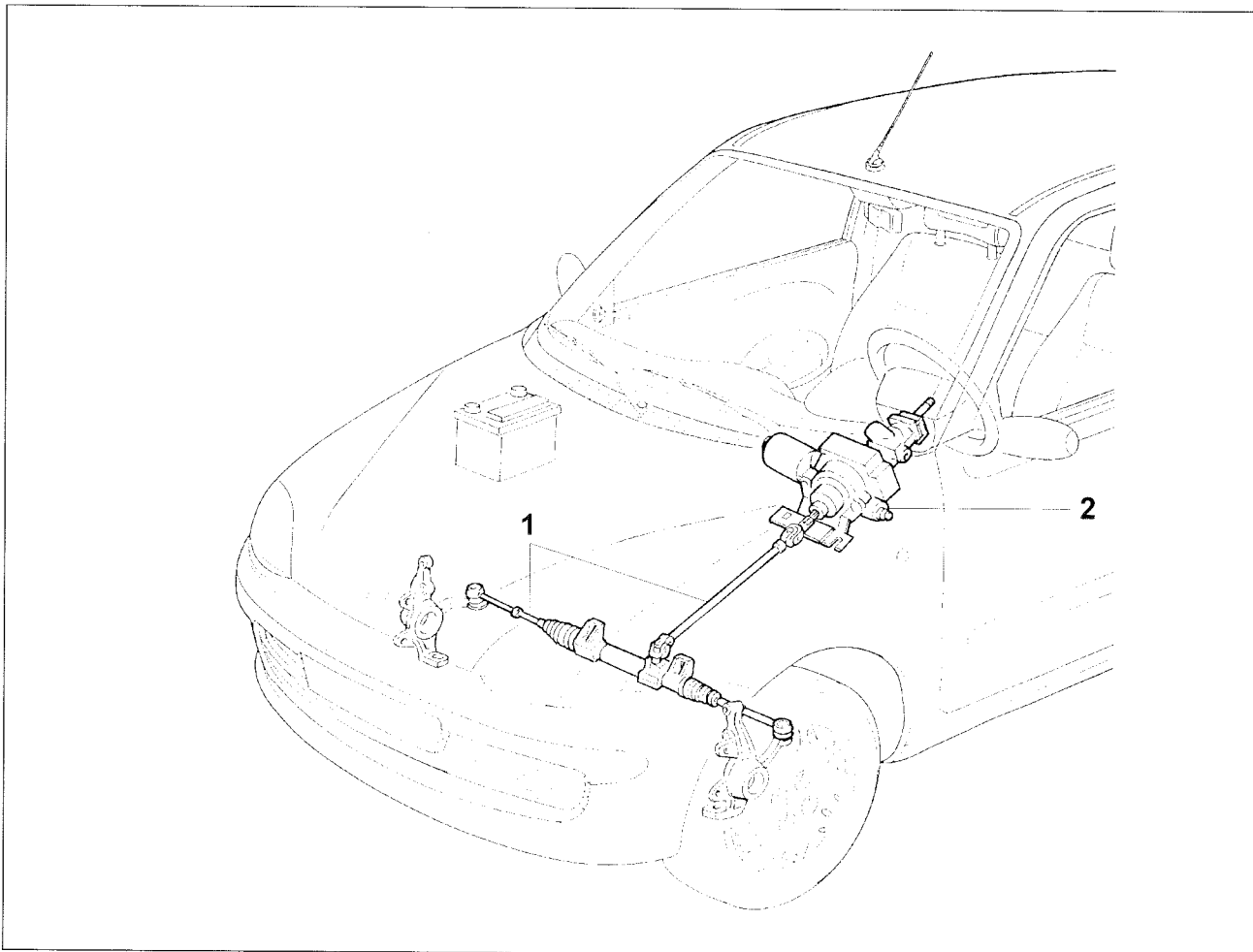


**Index of Groups****- GRAPHIC GROUP CONTENTS****- MANUFACTURING FEATURES****Index of subgroups**

Sgr.	Description	Validity
4130	POWER STEERING	

GRAPHIC INDEX OF GROUP

Ref.	Description	Grp.
1	STEERING CONTROL AND LINKAGE (*)	4110
2	POWER STEERING	4130

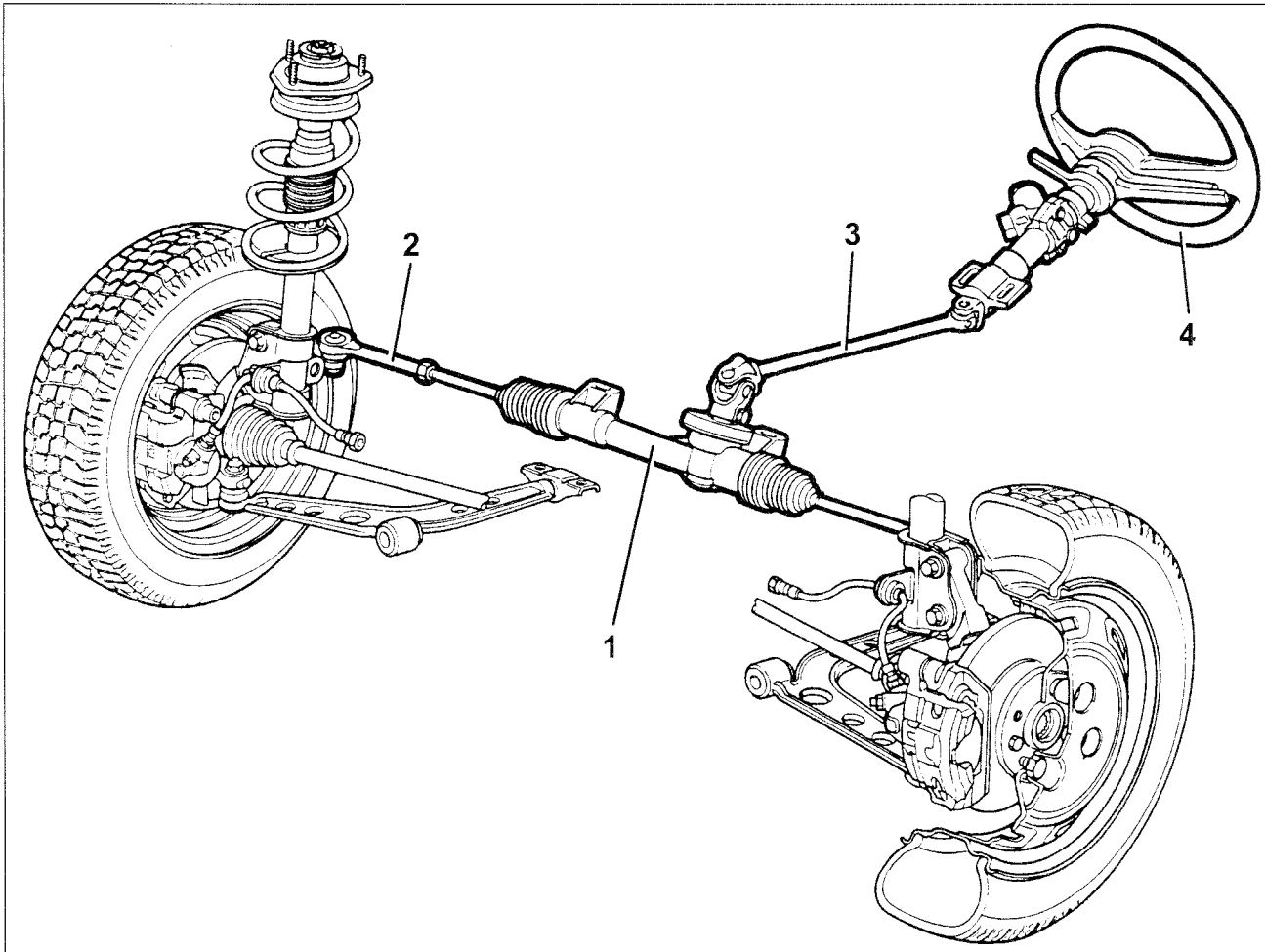
(*): Subgroup not described**MANUFACTURING FEATURES**

The steering system features a rack steering box system.

This steering system ensures:

- light handling for parking and at low speeds.
- accuracy and safety at high speeds.

The steering column is collapsible and keeps the position of the steering wheel fixed in the event of frontal crashes.

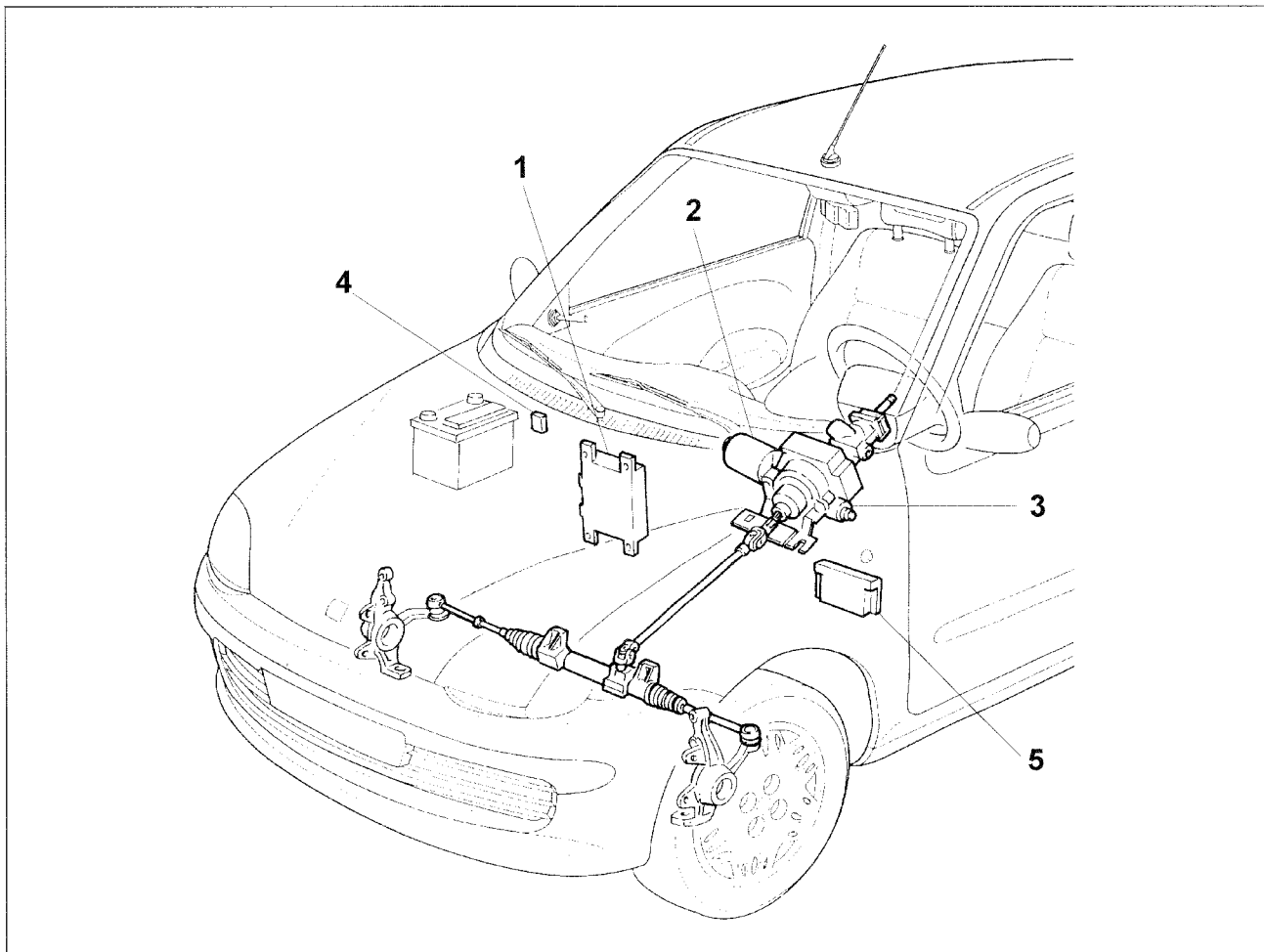


187B41T02H

<i>Ref.</i>	<i>Description</i>
1	STEERING BOX
2	STEERING TRACK RODS
3	STEERING COLUMN
4	STEERING WHEEL

**Subgroup contents**

- GRAPHIC SUBGROUP CONTENTS
- DESCRIPTION
- COMPONENTS
- OPERATION
- WIRING DIAGRAM
- TROUBLESHOOTING

GRAPHIC SUBGROUP CONTENTS

187B4130P01H

Ref.	Description
1	POWER STEERING CONTROL UNIT
2	POWER STEERING MOTOR
3	POTENTIOMETER
4	POWER PROTECTION FUSE
5	FUSEBOX

DESCRIPTION

The NSK EPAS (Electrical Power Assisted Steering) system has the purpose of reducing the effort applied on the vehicle steering wheel by exploiting the torque of an electrical motor.

This system is a modern and reliable alternative to traditional HPS (Hydraulic Power Steering) systems and introduces a series of advantages.

The HPS system was created to assist steering in medium to high class vehicles and over the past

years has commonly been installed in city cars. This system presents some disadvantages:

- it is not easy to fit in vehicles, especially those of smaller size;
- the system is heavy;
- the system includes a high number of components (a hydraulic pump, hydraulic cylinders, reservoir and pipes);



- it has the undesirable effect of subtracting power from the engine at all speeds and in all driving conditions.

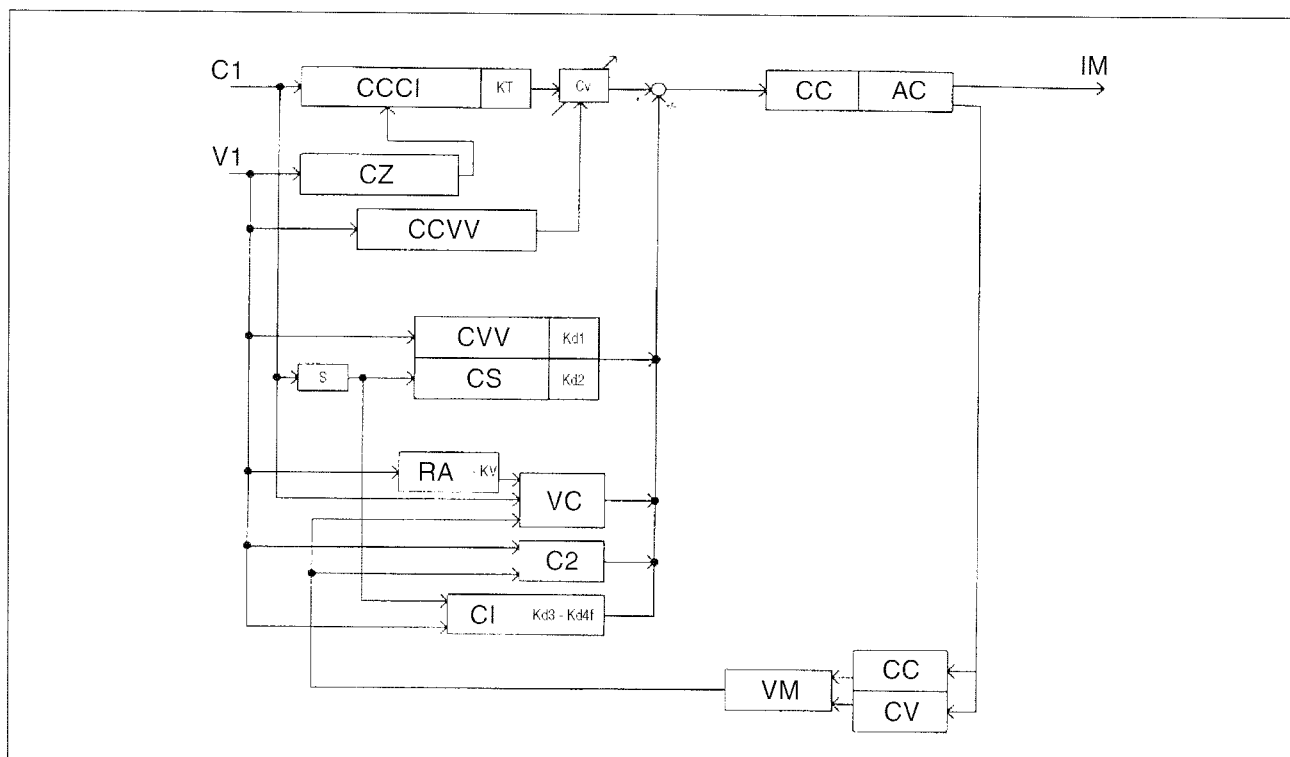
The NSK EPAS system was created as an answer to these problems. This system consists of only two components: a steering column with a built-in electric motor and an ECU (Electronic Control Unit). The use of only two components means fast fitting times, weight reduction of 30% with respect to HPS systems and, above all, an energy consumption proportional to the demand.

The latter aspect means that power is not wasted to constantly power a hydraulic pump even when the power assisted steering is not required, ensuring, as a consequence, lower fuel consumption and

higher efficiency. Furthermore, the EPAS is controlled by a programmable ECU which cuts development times and checks during installation in vehicles, ensuring the possibility of checking stored parameters and rapid maintenance interventions by displaying the stored faults.

Other important aspects concern the reduction of noise, which ensures a high riding comfort, and pollution related to the use of hydraulic oil.

The ECU (with data suitably mapped according to the features of the vehicle) considers the applied steering torque, vehicle speed and estimated engine speed signals and controls the current provided to the electrical motor to offer the required power assisted torque.



187B4130P02G

Ref.	Description
CCCI	TORQUE CURVE / INPUT TORQUE
CZ	DEAD AREA CURVE / VEHICLE SPEED
V1	VEHICLE SPEED
C1	INPUT TORQUE
IM	ENGINE CURRENT
CC	CURRENT CONTROL
AC	CURRENT AMPLIFICATION
CV	VOLTAGE CONTROL
VM	COMPUTED ENGINE SPEED
CI	INERTIA COMPENSATION

Ref.	Description
C2	KF CONVERGENCE
VC	MIN. SPEED/ MIN. TORQUE
RA	ACTIVE RETURN
CS	STEERED SPEED CURVE
CVV	VEHICLE SPEED CURVE
CCVV	GENERATED TORQUE CURVE / VEHICLE SPEED

The system presents a self-test feature to detect connection problems, incorrect connections, short-circuits are incorrect signals from the speed and torque sensors. Furthermore, two torque sensors are employed to ensure parameter reliability. The values of the sensors are constantly monitored and compared by the ECU.



In the event of faults, the system allows steering without the power assisted system.

Power assisted steering is not available when the engine is not running to prevent depleting the battery.

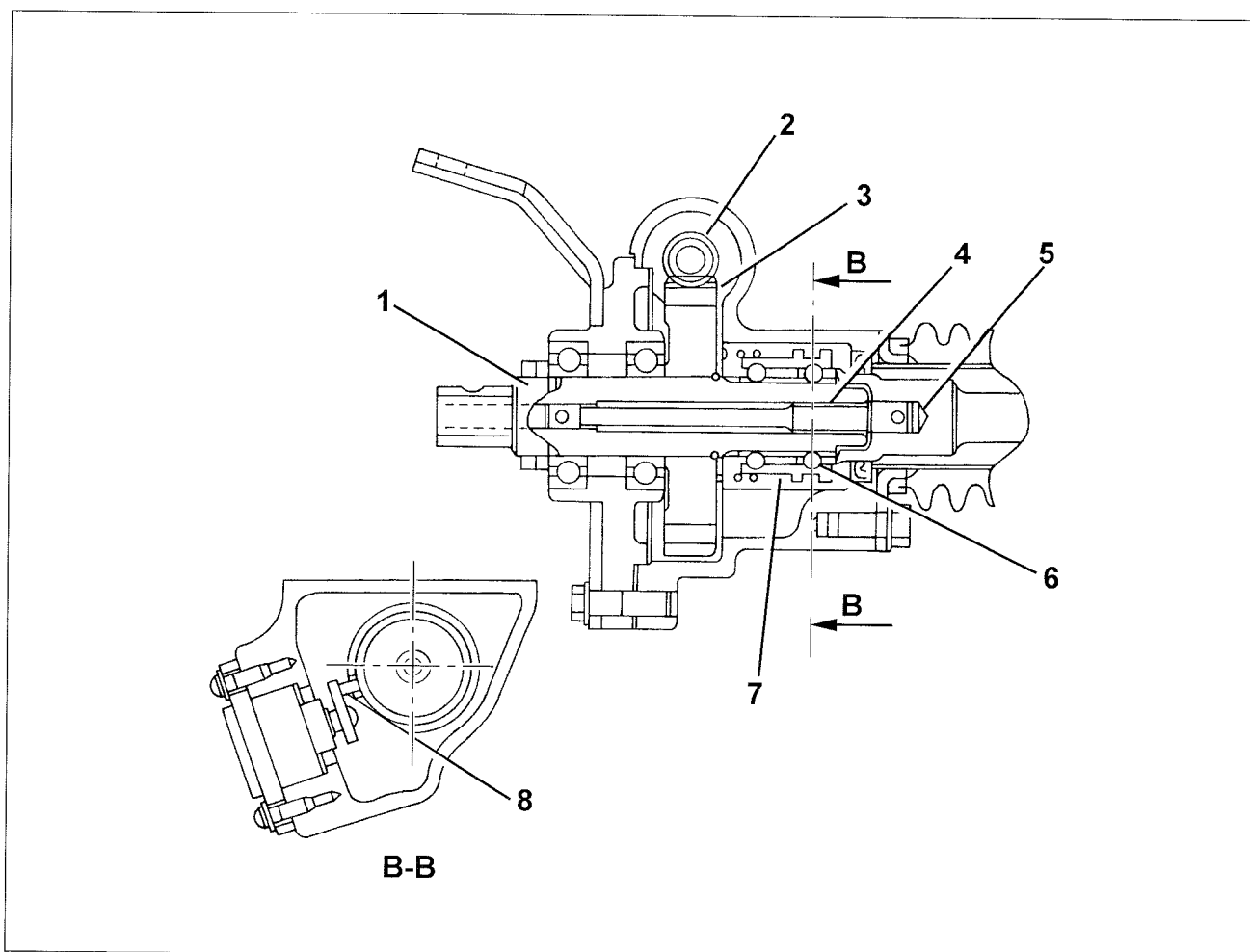
COMPONENTS

STEERING COLUMN AND ELECTRICAL MOTOR

The motor and the worm screw are fitted perpendicularly to the steering column. The helicoid wheel

is attached to the output shaft. A torsion bar connects the input and output steering shaft.

An angular deflection between the input shaft and the output shaft is created by steering. This is converted into an axial movement of the ring sensor by means of a ball and groove. The movement of the ball in the circular groove is recorded by a potentiometer fitted on the mechanism capsule.



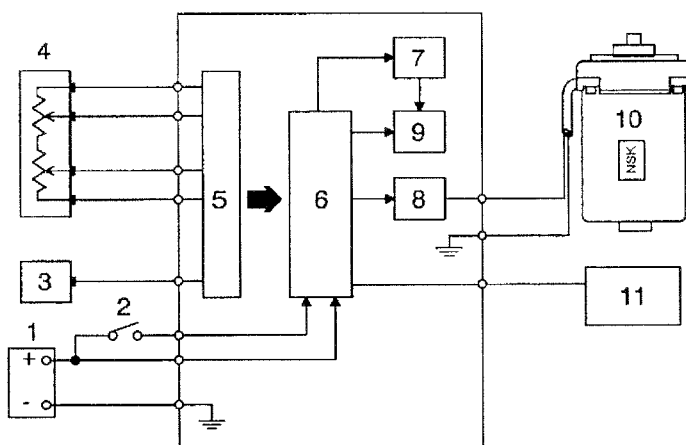
Ref.	Description
1	OUTPUT STEERING SHAFT
2	WORM SCREW
3	HELICOID WHEEL
4	TORSION BAR
5	INPUT STEERING SHAFT
6	BALL
7	RING SENSOR
8	POTENTIOMETER

The axial movement of the ring sensor is transferred to the potentiometer. Consequently, the steering torque is translated into a proportional electrical output.

**ECU**

The ECU in the NSK EPAS system pilots the motor fitted on the steering column. The main purpose of the ECU is to control steering wheel torque, i.e. the current to the motor. Other important functions include:

- speed factor, which reduces the gain according to vehicle speed;
- steering sensitivity, which reduces histerisis at the centre of the steering wheel;
- active return at low speeds;
- rocking prevention at medium and high speeds.



187B4130P04G

Ref.	Description
1	BATTERY
2	IGNITION SWITCH
3	VEHICLE SPEED SIGNAL
4	STEERING EFFORT SENSOR
5	A/D INTERFACE
6	MICROPROCESSOR
7	EMERGENCY SWITCH
8	CURRENT CONTROL CIRCUIT
9	MOTOR PILOTING CIRCUIT
10	MOTOR
11	WARNING LIGHT



OPERATION

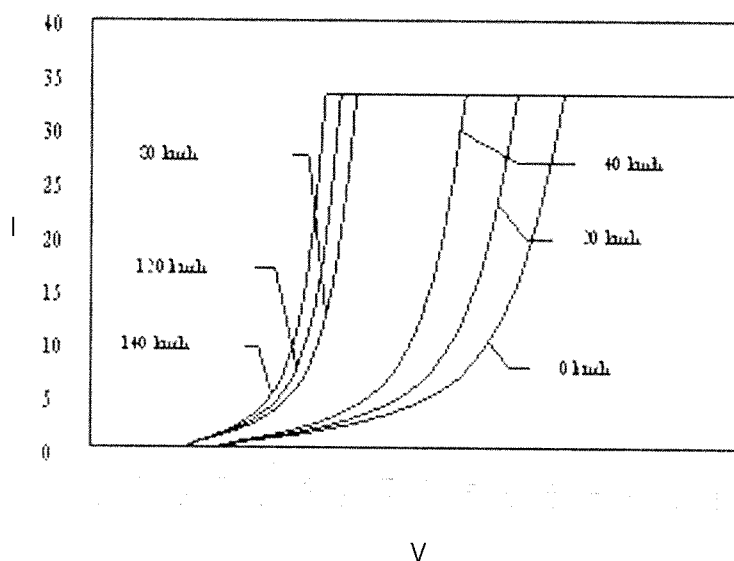
INPUT TORQUE - OUTPUT POWER CHARACTERISTIC

The input torque - output power characteristic is the basic function of the EPAS system and is achieved by applying three different parameters to the basic curve characteristic according to the ratio $CB \cdot KT \cdot CV \cdot W_{TMIN}$ for each speed, where:

- CB indicates the system basic characteristics, i.e. the output power according to the torque sensor input voltage;

- KT indicates the torque-current characteristic slant; high values indicate a lighter steering;
- CV is a factor which considers the vehicle speed to improve steering at different speeds;
- W_{TMIN} is a parameter which acts on instability by reducing steering wheel centre sensitivity, i.e. establishing the width of a dead area in which power assisted steering is inhibited.

All the listed parameters are introduced in the ECU by means of the monitor RAM according to the pre-defined torque response. 3



187B4130P05G

Ref.	Description
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V	VOLTAGE
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I	CURRENT
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STEERING SENSITIVITY

Steering sensitivity can be evaluated by observing the steering angle (15°) - steering torque (4Nm) characteristic which results from the settings of two parameters:

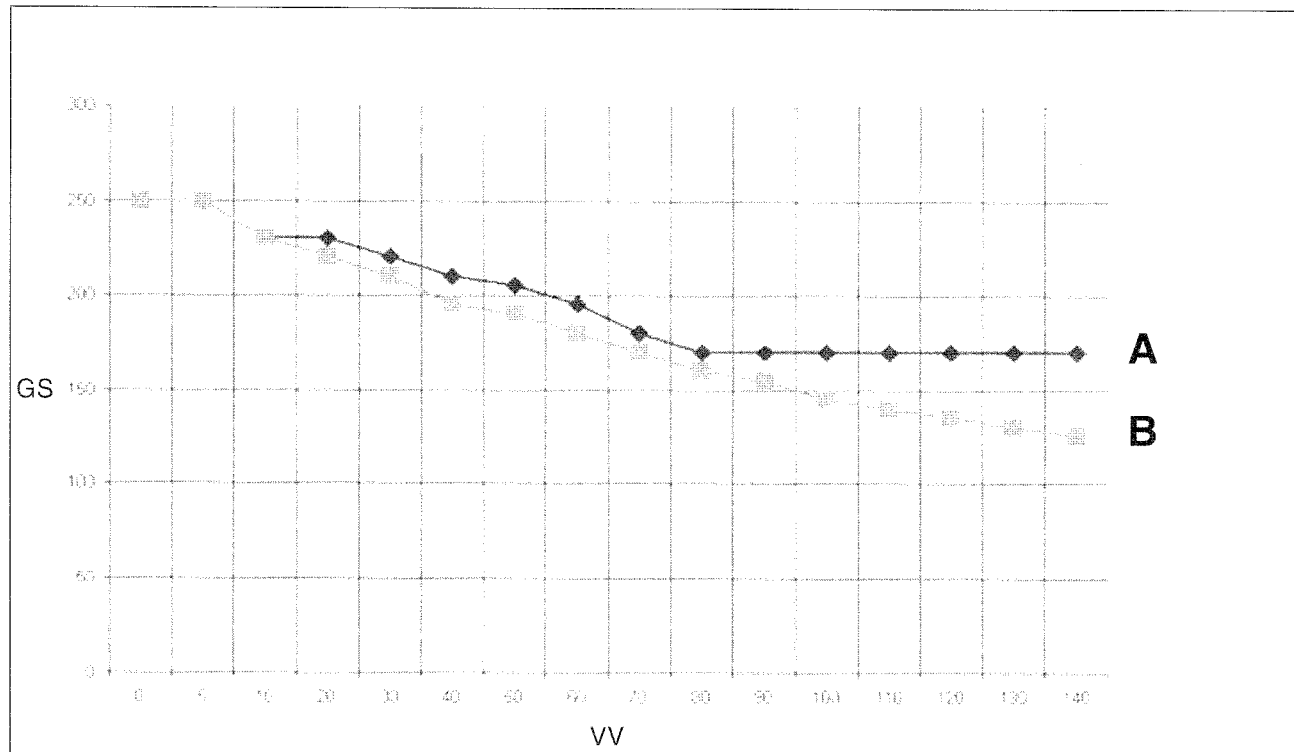
- Kd1 which reduces steering sensitivity as the vehicle speed increases and prevents the rocking

generated by the characteristics of the entire system;

- Kd2 which considers the steering speed derived from the input torque signal.

A = Value (dec)

B = Original value (dec)



167B4130P06G

Ref.	Description
VV	VEHICLE SPEED (KM/H)
GS	STEERING SENSITIVITY GAIN KD1

**ACTIVE RETURN - KV**

The active return function offers an additional torque to that normally generated by the vehicle geometry when the vehicle straightens out and the steering wheel is released. This parameter depends on three values:

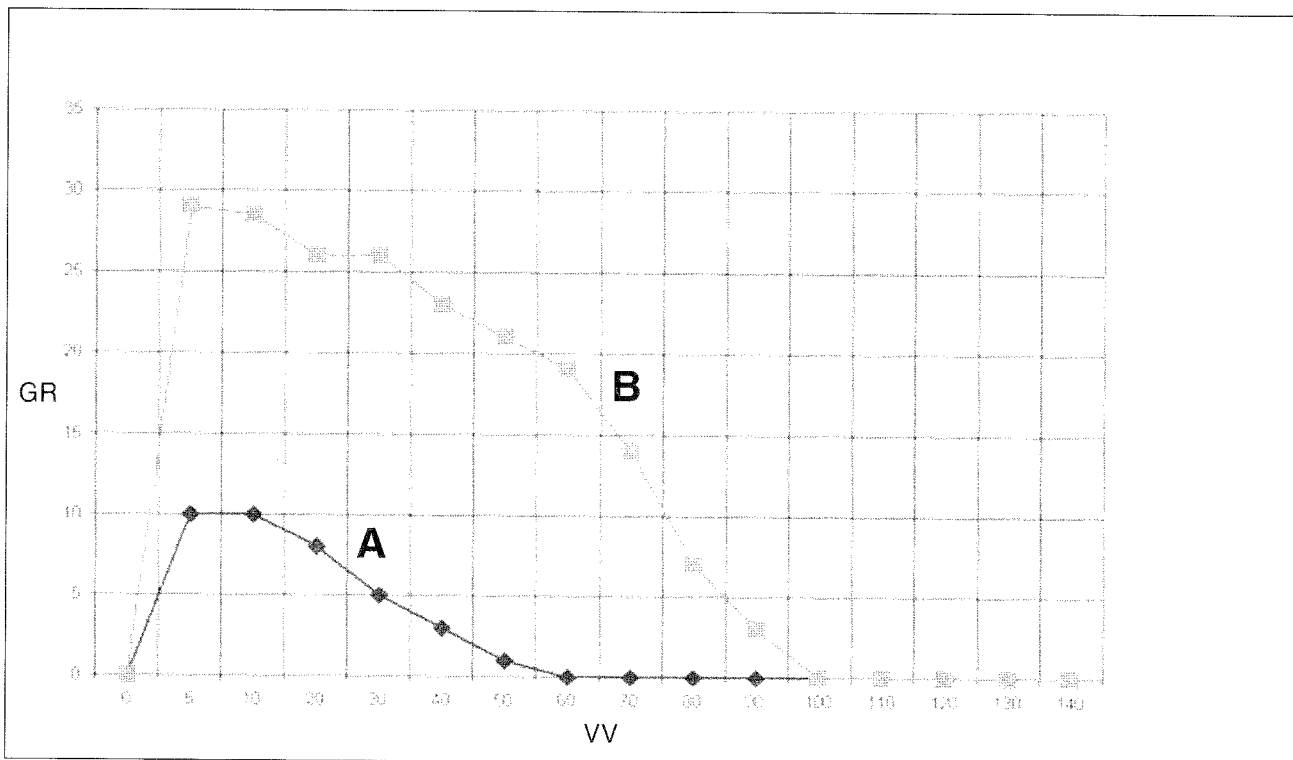
- KV - indicates the active return gain, i.e. the amount of current according to the vehicle speed;
- Minimum engine speed (ON/OFF) - indicates the engine return minimum speed limit under which the additional torque is not generated;

- Minimum input torque (ON/OFF) - indicates the input torque minimum limit under which the additional torque is not generated, e.g. when the driver straightens the steering wheel.

These parameters are introduced with the monitor RAM for each speed according to the predefined response curve.

A = Original value (dec)

B = Value (dec)



107B4130P07/G

Ref.	Description
VV	VEHICLE SPEED (KM/H)
GR	ACTIVE RETURN GAIN K



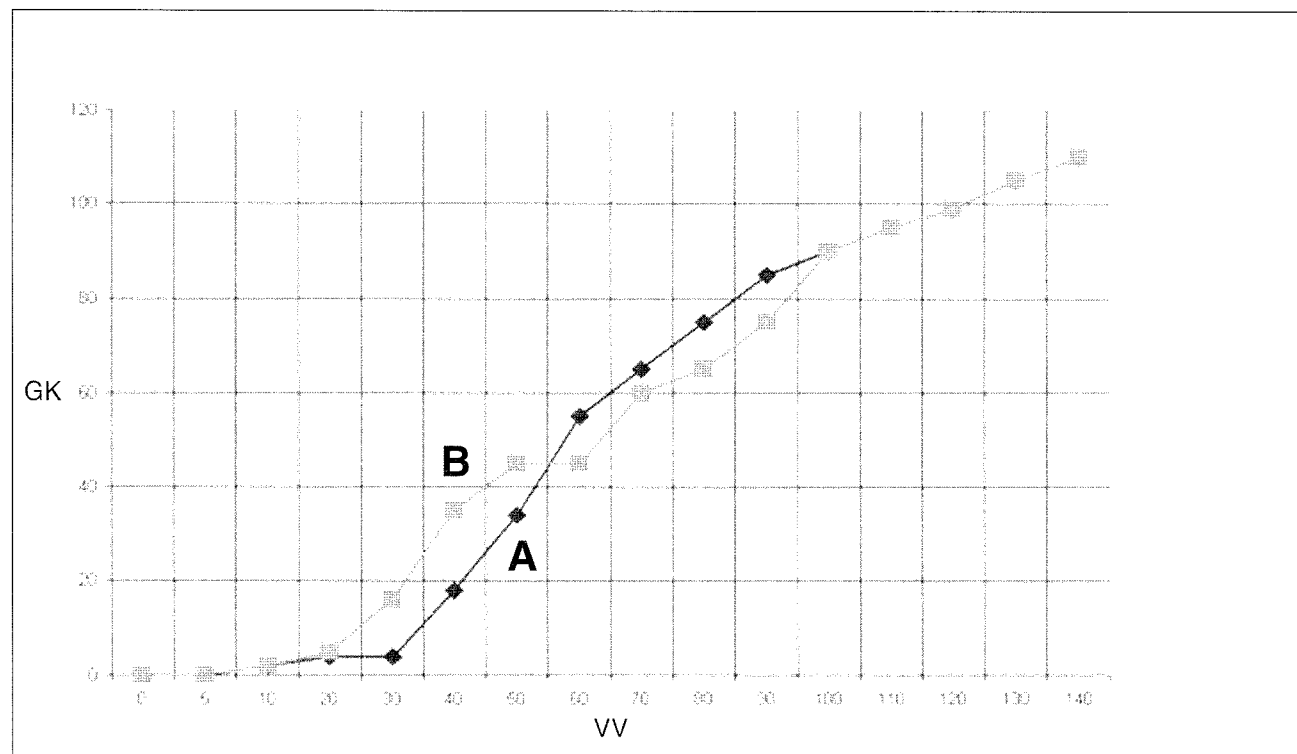
RETURN DAMPING - KF

The return damping function controls the stretching when the steering wheel is released at medium and high speeds acting as a damper with a force which can be programmed according to the vehicle speed.

This parameter is introduced with the monitor RAM for each speed according to the damping.

A = Original value (dec)

B = Value (dec)



187B4130P08G

Ref.	Description
VV	VEHICLE SPEED (KM/H)
GK	CONVERGENCE GAIN K



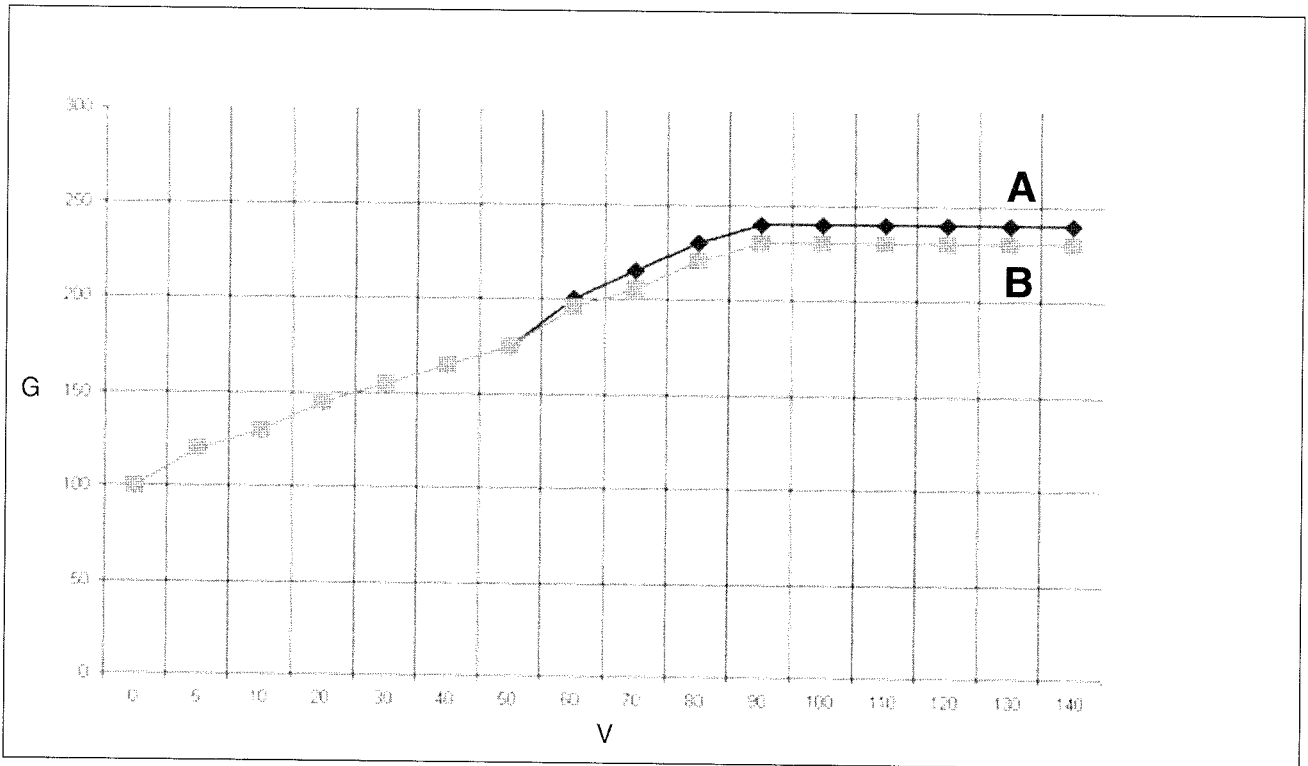
INERTIA GAIN

The inertia compensation function reduces the "free wheel" effect at medium to high speeds. It depends on the vehicle speed Kd3 and the engine data table Kd4. While the Kd3 values are introduced with the monitor RAM monitor for each speed, the Kd4 values can be entered according to either a

fixed or sensitive modality. In sensitive modality, the gain values are taken for each torque value from a specific table which values can be edited with a ROM WRITER.

A = Value (dec)

B = Original value (dec)



187B4130P09G

Ref.	Description
V	SPEED (KM/H)
G	GAIN

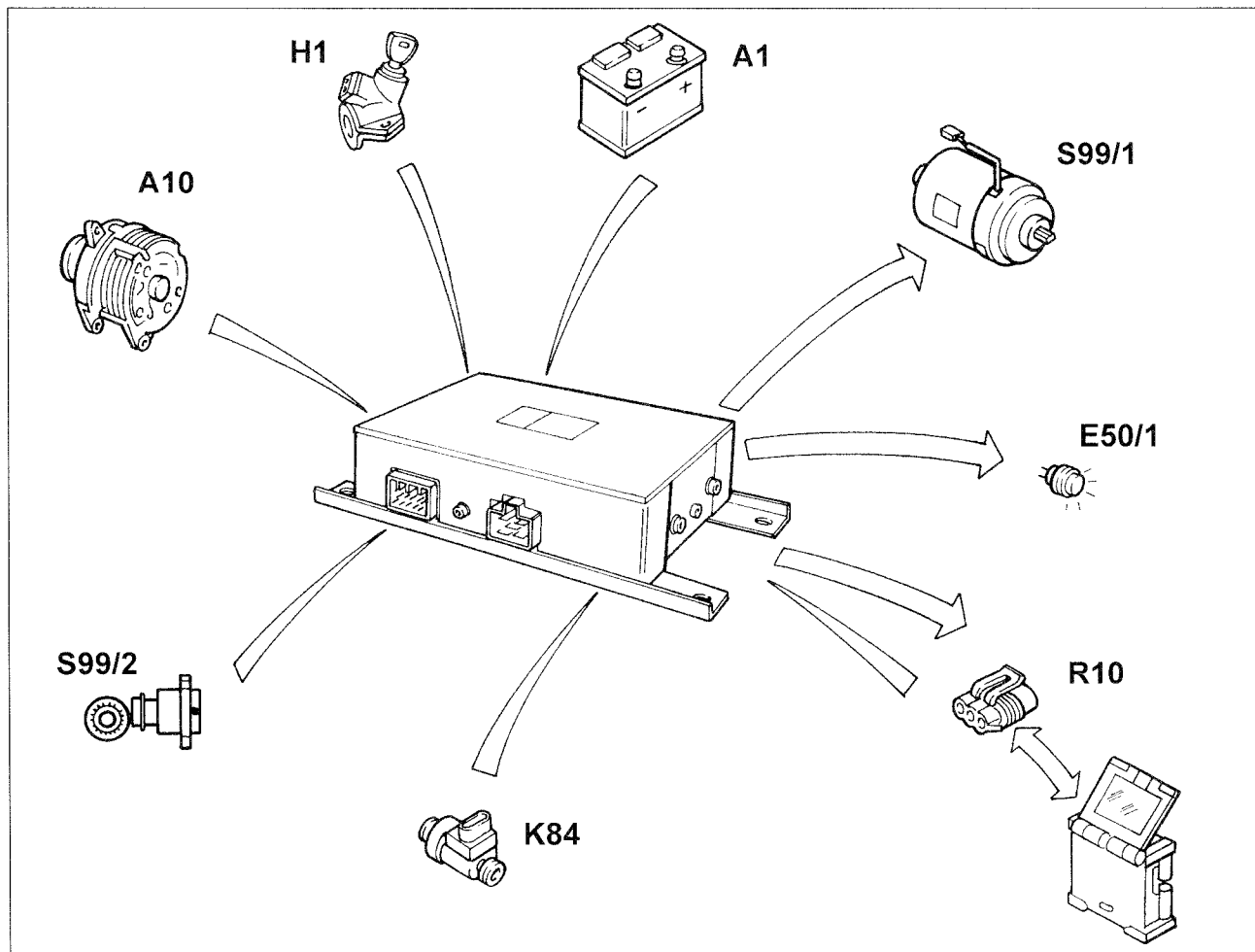


WIRING DIAGRAM

The NSK system wiring diagram consists of an ECU (S98) and a wiring harness which connects it to the steering column where the motor (S99/1) and the potentiometer (S99/2) are fitted, to the battery (A1), to the speed sensors (K84), to the alternator signal A10 (for i.c. engine vehicles only), to the key lock

(H1), to the warning LED (E50/1) and to the diagnostic and setting system (R10), where relevant.

There are two versions of the ECU, one for electrical vehicles (EAWCEC-G02) and the other for i.c. engine vehicles (EAWCEC-G04). The difference is that in the first case there is no signal from the alternator.



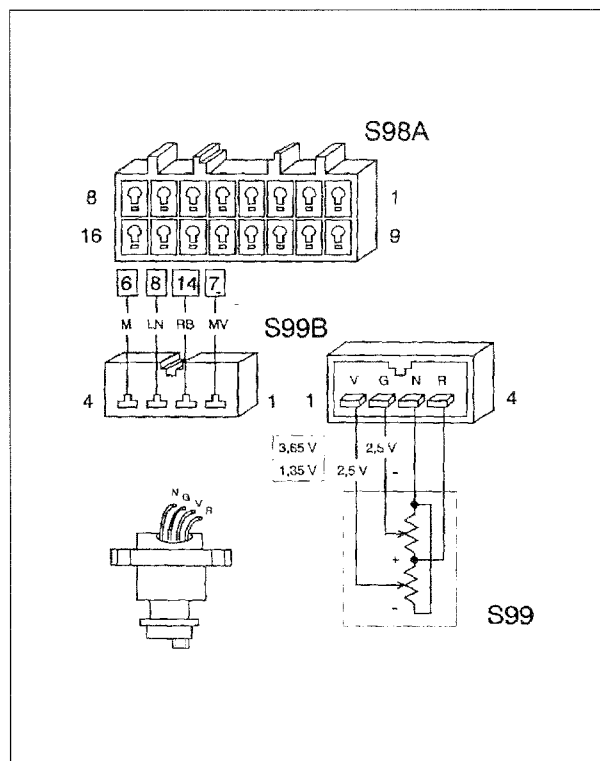
197B4130P10H

Ref.	Description
A10	D+ SIGNAL FROM ALTERNATOR TO ENABLE SYSTEM OPERATION (FOR I.C. ENGINES ONLY)
A1	BATTERY
E50/1	POWER STEERING SYSTEM WARNING LIGHT
S98	ECU
H1	IGNITION SWITCH
S99/1	POWER ASSISTED SYSTEM MOTOR
S99/2	POTENTIOMETER (EFFORT SENSOR)
R10	DIAGNOSTIC SOCKET
K84	VEHICLE SPEED SENSOR



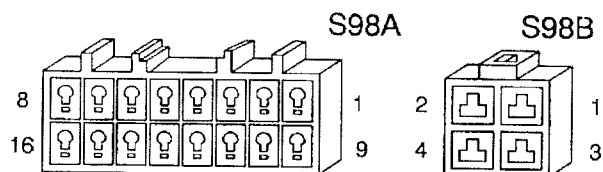
POTENTIOMETER (EFFORT SENSOR)

The potentiometer signal informs the ECU of the effort which the driver is exerting on the steering wheel, the speed and the direction of steering. The potentiometer signals reach the ECU S98 via connectors S99B and S98A.





S98A AND S98B ECU CONNECTORS IDENTIFICATION



187B4130P12H

CONNECTOR S98A

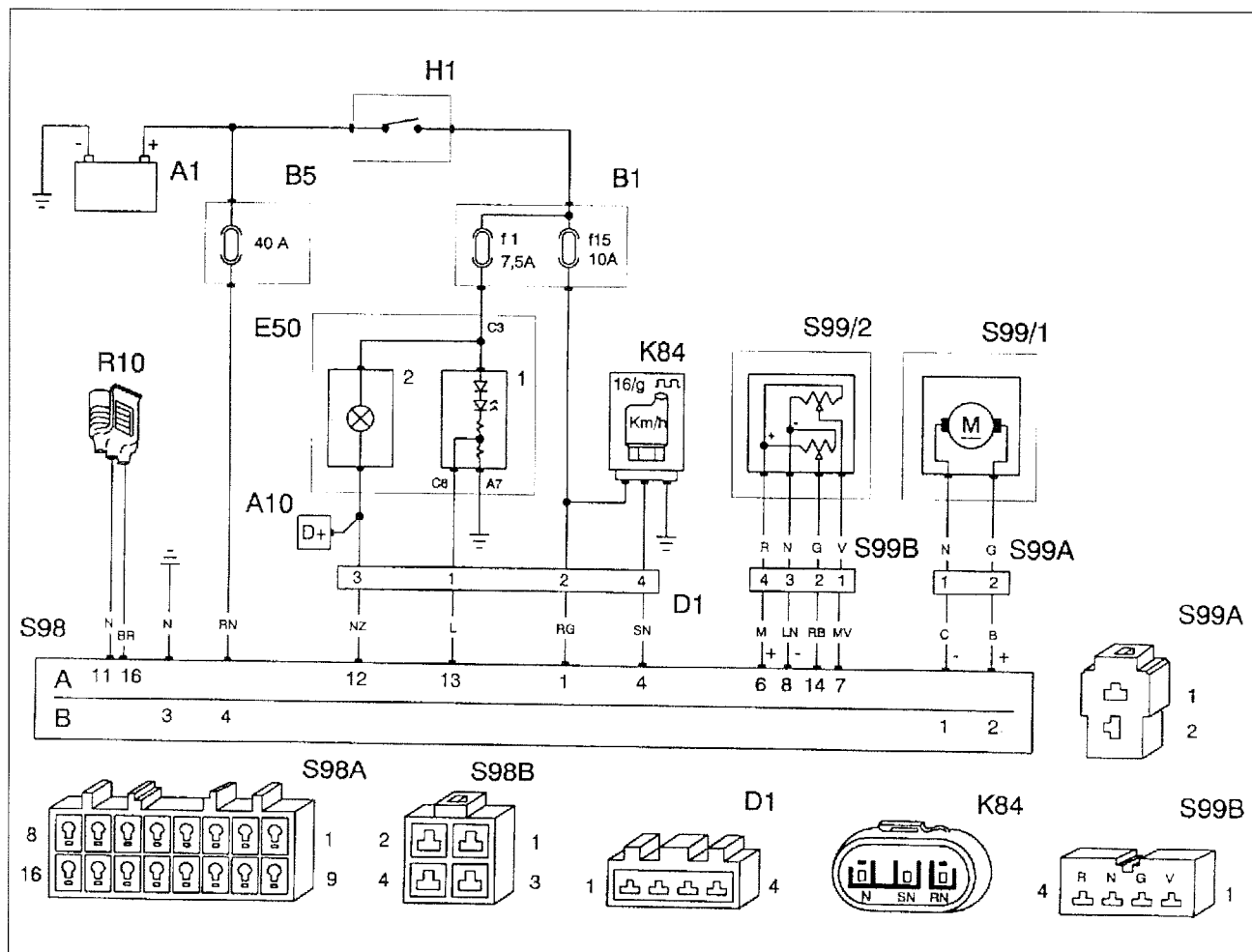
1	Power + input from 15/54 for ECU operation
1-3	NC
1-3	NC
4	Vehicle speed signal input (from tachometer sensor for i.c. engine vehicles and from alternator for electrical motor vehicles)
1-3	NC
6	Steering wheel effort sensor power +5V output
7	Steering wheel effort signal comparative signal input
8	Steering wheel effort sensor power output -
1-3	NC
1-3	NC
11	Diagnostic socket earth output
12	Battery recharging signal (only for i.c. engine vehicles)
13	System warning light output -
14	Steering wheel effort sensor signal input
1-3	NC
16	Diagnostic socket signal output/input (K line)

CONNECTOR S98/B

1	Motor earth output
2	Motor + output
3	ECU earth - output
4	ECU +12V battery power input



I.C. ENGINE VEHICLE DIAGRAM



Key:

- A1 Battery
- A10 D+ Alternator
- B1/f1 Fusebox / 7.5A f1 fuse protecting LED on instrument panel from 15/54
- B1/f15 Fusebox / 10A f15 fuse protecting ECU power line and tachometer sensor from 15/54 for vehicles with i.c. engines
- B5 30A fuse protecting ECU direct battery power line
- E50 Instrument panel
- E50/1 Power steering warning light
- E50/2 Battery recharge warning light

- D1 Instrument panel connector / power steering system ECU
- H1 Ignition switch
- K84 Tachometer sensor
- R10 Diagnostic socket
- S02 Inverter
- S98 Power steering unit
- S98A 16 pin ECU connector
- S98B 4 pin ECU connector
- S99/1 Motor
- S99/2 Potentiometer
- S99A Motor connector
- S99B Potentiometer connector



187B4130P14H

E50/2 Battery recharge warning light

S99B Potentiometer connector



TROUBLESHOOTING

The system diagnostic features allow a comprehensive parameter check. All the troubleshooting activities should be performed with the vehicle stationary. The diagnostic function is interrupted when:

- it is switched off
- the diagnostic phase is ended
- the instrument does not receive a command for more than 5 seconds
- the vehicle speed exceeds 5 km/h

ADDRESS ASSIGNMENT TABLE

The input torque - output current characteristic, steering sensitivity, return damping, inertia compensation, active return parameters and any generated errors are mapped in the ECU in dedicated addresses which can be accessed by the repairer by means of a diagnostic tool. Some of these parameters can only be read in the monitor RAM to prevent accidental ECU mapping deletion. The table illustrates the error meaning corresponding to the high logical levels of the bit set of the respective addresses from FE06 to FE14.

MONITOR RAM

The monitor RAM is used to check and correct the various parameters, when required.

Note: *The monitor RAM must be used by skilled personnel who are informed of the various settings. Improper use of the tool can alter the ECU setting parameters and compromise device operation.*

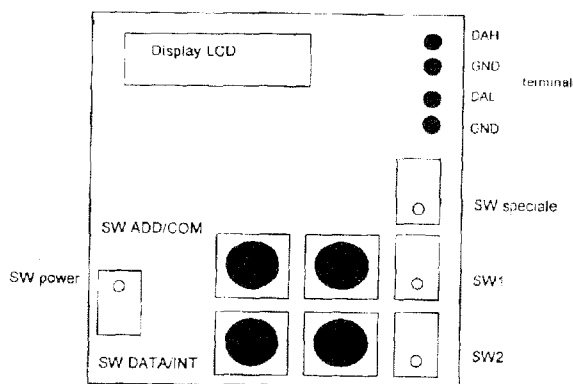
The monitor RAM switches perform the following functions:

- Power SW
- Special SW: select high addresses;
- SW2: enter data
- ADD/COM: select address
- DATA/INT: data to be entered

Observe the following procedure when using the tool:

- Power the monitor RAM by means of the power SW.
- Set addresses FE00_FEFF with the special SW to high; otherwise, for FD00_FDFF addresses the special SW should be set to low.
- Select the byte address with the ADD/COM SW: byte high with left-hand switch and byte low with right-hand switch.
- Select the data with the DATA/INT SW: byte high with the left-hand switch and byte low with the right-hand switch.
- Key in the data with SW2 and enter with DATA/INT at the DATA/COM address
- Save the data (which after entry are active but volatile) as follows:
- Select the FE22h address (special SW high and ADD/INT=22)
- DATA/INT=6F
- SW2
- DATA/INT=63
- SW2
- DATA/INT=10
- SW2

The sequence of these operations must be followed carefully to set the monitor RAM correctly.



187B4130P11C

