Integrated Vehicle Tire Pressure Monitoring

Vehicle tire pressure monitoring system

System functions
System configuration
Instructions for installation and diagnostics

1st. edition

Revisions of this document are not set up.
New versions could be found in INFORM website
www.wabco-auto.com

WABCO

Vehicle Control Systems
An American Standard Company

Changes are reserved
Version 001/04.03(en)
Wabcodruck 815 000 452 3

FCC Notice

This device consists of Wheelmodul 960 730 XXX X (SA4-WM730) and Electronic Control Unit 446 220 XXX X (SA4-ECU220)

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for the compliance could void the user's authority to operate the equipment.

Contents

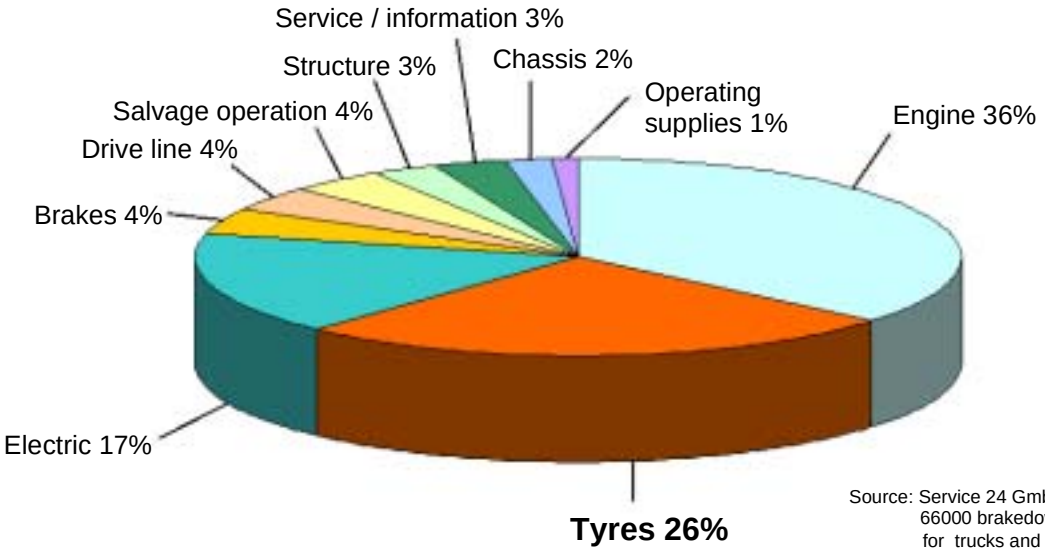
1. System functions

IVTMstands for Integrated Vehicle Tire Pressure Monitoring. It is the tire pressure monitoring system, which is installed in the vehicle. **IVTM** continuously monitors the pressure in all tires. This monitoring is performed by the pressure sensors in all tires, which relays information to the display in the cabin and warns driver about critical pressure drop. **IVTM** makes transport safer and more efficient, because more than 80 % of tire damage could be recognized before serious damage occurs, which requires repair. **IVTM** thus cuts down operational costs, as continually maintained optimized pressure in all tires results in minimal fuel consumption and extension of service life of tires.

Let us present some information:
Tire manufacturers estimate that total losses caused by improper maintenance of tires of commercial vehicles are more than 10 millions of Euro in Germany. Lot of vehicle users unfortunately tend to overlook this important factor of operational costs. By selecting correct tires and proper maintenance it is possible to save up to 2500.- €per vehicle for one year. The unnecessary expanses are further increased by widely spread carelessness of driving with under-inflated tires. Tires with 20 % lower pressure are no exception in everyday life. This under-inflation reduces service life of tires by 20 % and unnecessarily increases fuel consumption.

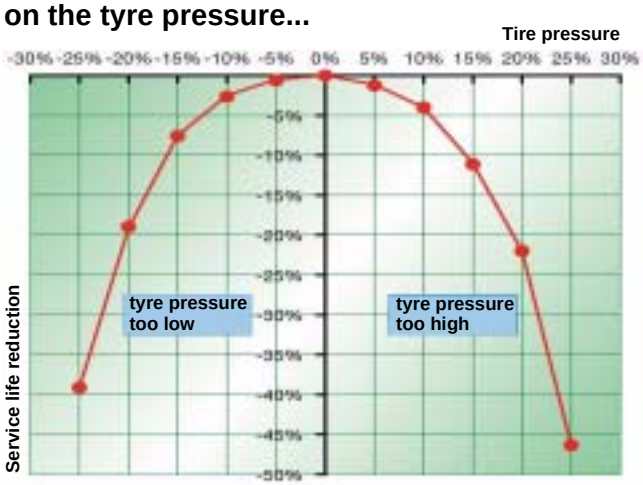
In order to minimize these costs WABCO company designed new system IVTM, which also increases traffic safety.

Main reasons for brakedowns at commercial vehicles are:

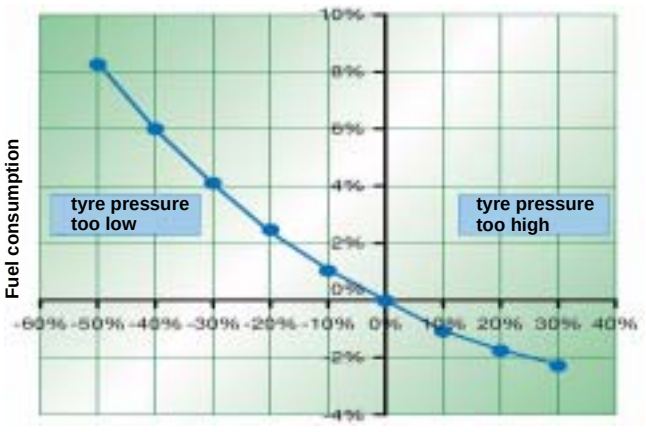


Source: Service 24 GmbH & Co. KG
66000 brakedown missions
for trucks and busses in 1999

The mileage of tyres significantly depends on the tyre pressure...



and fuel consumption also depends on the tyre pressure.



Checks of the car fleets show:

Every second tire is under-inflated by more than 10 %.

Using of new IVTM system increases **profitability** :

- reduced **fuel consumption** due to lower rolling resistance
- smaller tire wear owing to lower deformation losses => longer **tire life cycle**
- Saving costs of **manual tire pressure check** (up to 30 minutes for one vehicle)
- spare tire is not needed due to low probability of rupture
  => higher vehicle load.

tyre pressure too low

IVTM warns driver about sneak pressure drop early, i.e. before the tire could burst.

IVTM enhances **safety** of passengers, driver, vehicle and traffic :

- The driver may react to sneak pressure drop early and prevent up to 85 % of tire bursts.
- Additionally, properly maintained pressure in tires ensures safe driving properties of vehicle and short braking distance.

IVTM ensures **travel efficiency:**

- Prevents unnecessary delays and idle time.
- No backup vehicles/emergency actions needed
- Prevents loss of confidence from unsatisfied customers and resulting drop of turnover.

Which types of pressure monitoring are available?

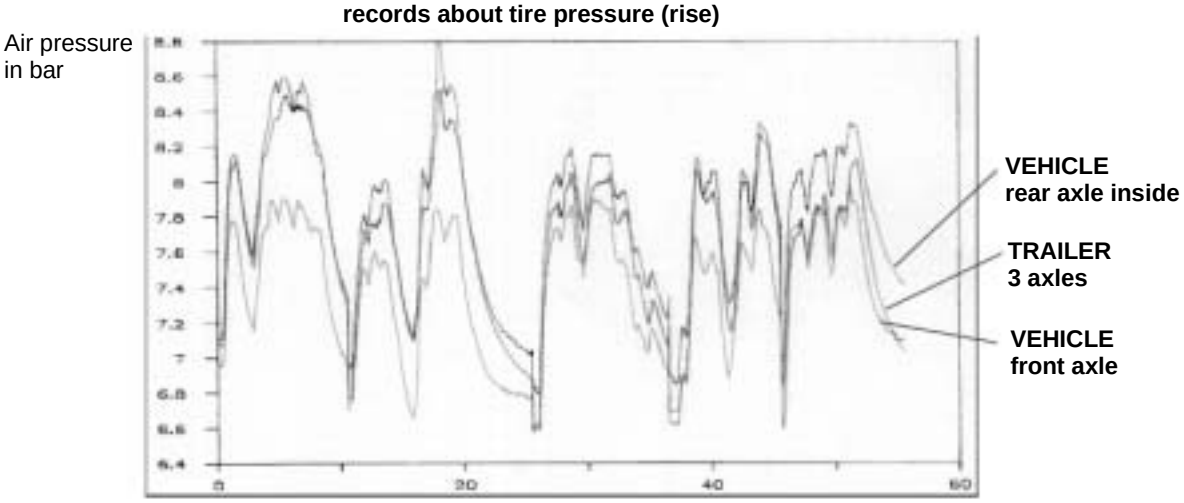
Permanent tire pressure monitoring during driving could be performed in several ways:

- **direct tire pressure measurement**
  permanent on-line pressure monitoring is possible. Extremely precise and effective, very expensive.
- **direct tire pressure measurement with limit value monitoring**
  not so precise.
- **indirect tire pressure measurement**
  moderately expansive, not nearly as precise and reliable. The pressure is calculated from drive slip, measured by ABS turning sensors.

WABCO IVTM uses direct pressure measurement and in comparison with systems using ABS presents these advantages:

1. pressure monitoring during parking or before driving start; diagnostics memory
2. able to distinguish uniform diffusion losses
3. fast detection of pressure drop, reaction time in order of several seconds.
4. display of current tire pressure
5. higher precision
6. identification of leaking tire
7. measurement is not affected by driving on low quality road
8. measurement is not affected by uneven vehicle loading

records about tire pressure (rise)



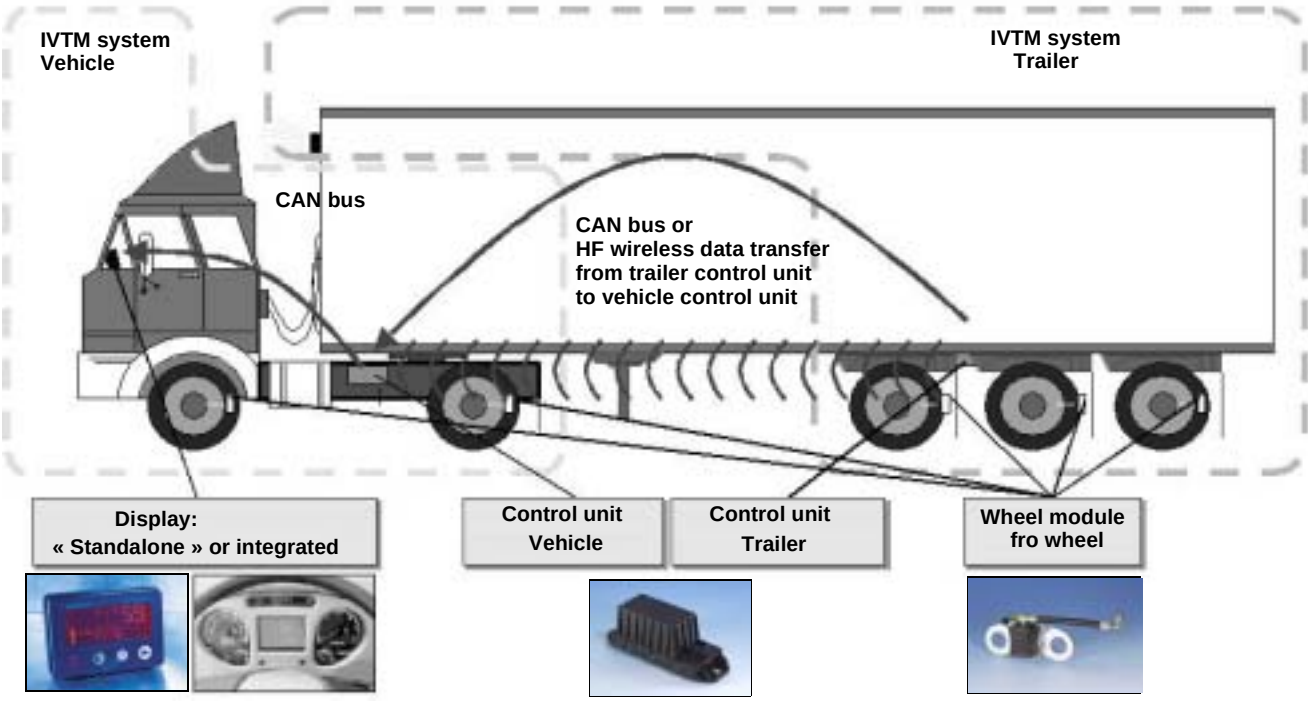
The range of tire pressure oscillation for utility vehicles is far higher then for passenger car.

This requires using sophisticated evaluation algorithm, instead of using simple identification of limit value.

Other requirements for tire pressure monitoring systems of utility vehicles:

- exact wheel identification for vehicles with more than 10 wheels or with double wheels
- high efficiency of wireless data transport
- pressure range 2 - 14 bars
- Identification of tire pressure fluctuation based on load and tire wear.
  This function requires complicated "evaluative algorithm".
- Wheel modules must be mounted flexible with respect to different types and locations of tire valves on rims, different rim designs and frequent wheel changes and must allow easy exchange.

1.1 System architecture



WABCO system is based on one electronic circuit 446 220 00x 0, so called control unit, which receives wireless data transmitted by wheel modules. Wheel modules 960 730 00x 0 are connected to the wheel valves by hoses. Pressure information is processed by algorithms stored in control unit.

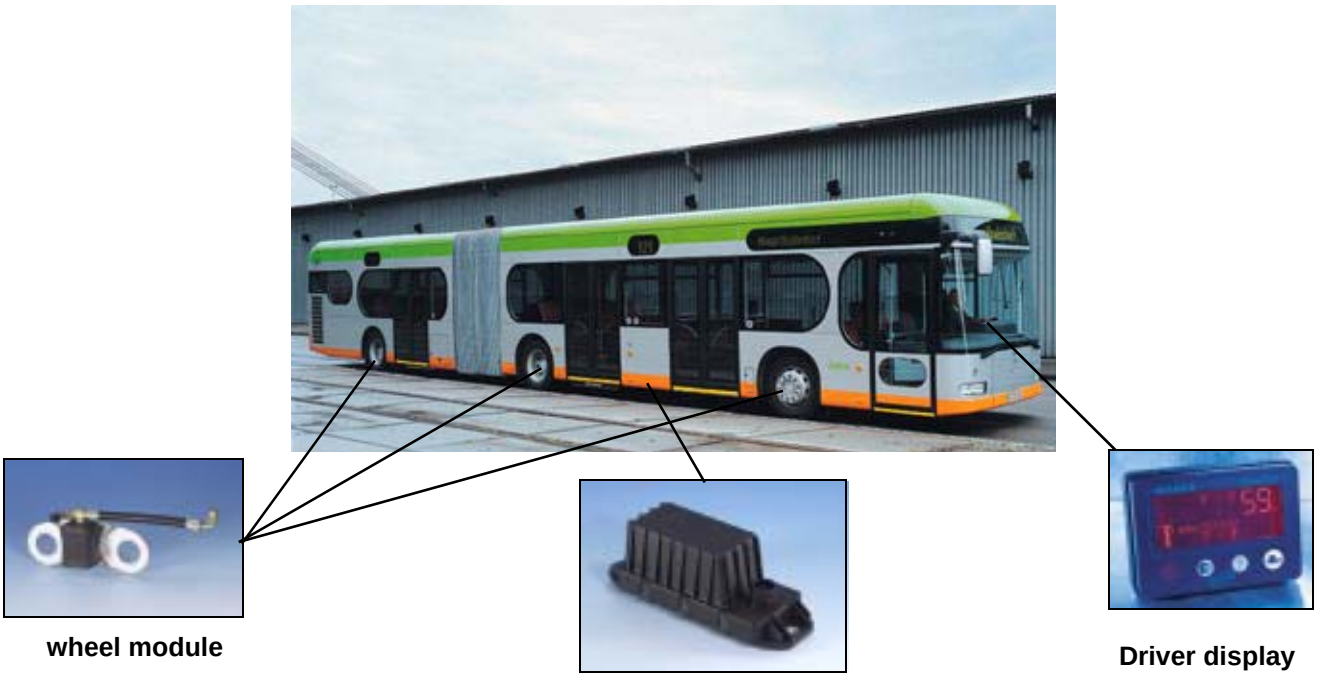
The information is sent through CAN bus to display unit 446 221 000 0. Display unit consists of one display, two indicators, one buzzer and two buttons.

Warning massages of different levels are displayed; indicator colour and type of audio signal shows seriousness of the problem:

- Red light and 1 minute long audio signal indicates serious defect; the vehicle must be stopped immediately (possible threat to lives and vehicle).
- Yellow light and 10 minutes long audio signal indicates smaller defect; the vehicle should be slowed down and lower pressure adjusted.

Defects found by IVTM system are stored in electronic memory (EEPROM) for diagnostic purposes.

1.1.1 Example of installation in the bus:



1.1.2 Example of installation in the trailer:

2. Configuration

In order to display tire pressure and trailer warnings to driver during driving it is in general case necessary to install IVTM to both parts of vehicle, i.e. one control unit to trailer and one unit to motor vehicle. Any vehicle equipped with IVTM could be connected to any trailer equipped with IVTM. Control unit of vehicle identifies control unit of trailer automatically: Synchronization is ensured through the break lights wiring, data are transported wirelessly.

As trailers are usually not permanently powered, it is possible that due to the frequency of wheel modules transmission the tire pressure data for all the wheels could be available after up to 15 minutes after the drive start.

In combination with WABCO-TCE (Trailer Central Electronics) or EBS systems the information about the pressure could be transmitted into control unit through standardized bus connection CAN according to 11992.

Future vehicles will be able to display the data from CAN bus on multifunction display on the dashboard. If such vehicles will not be available, data will be transferred to the vehicle control IVTM unit wirelessly.

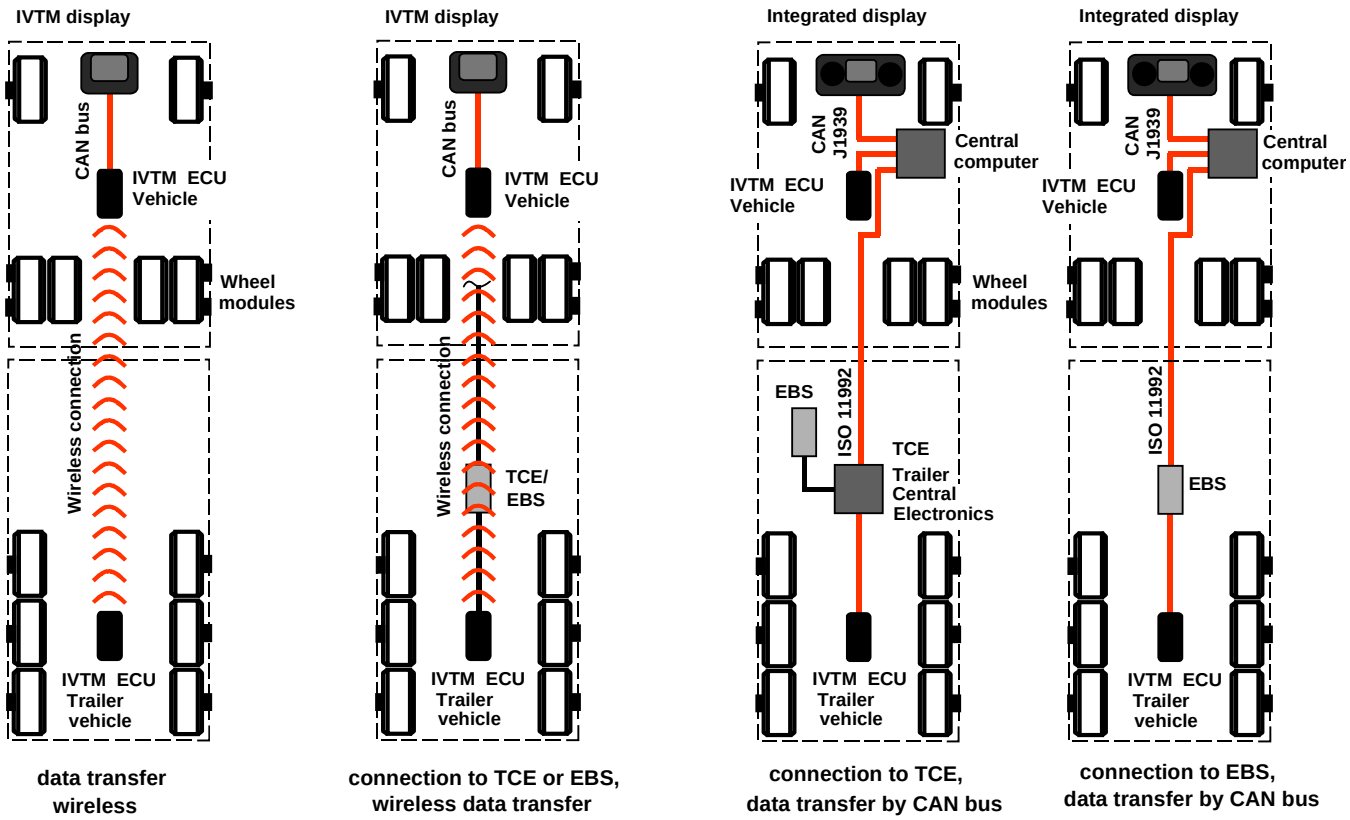
Certificates

Certificates for mounting and additional mounting of IVTM are available, which significantly facilitate approval of vehicle registration papers. Certificates are not part of this booklet, however in case of need they could be ordered in WABCO or by Internet at www.wabco-auto.com :

Ordering number 815 000 414 3 (D) / 815 000 415 3 (GB)
Contents: Expertise
TÜH ATC - TB 2002-108.00 and
Certificate part of TÜH ATC - TB 2003-023.00

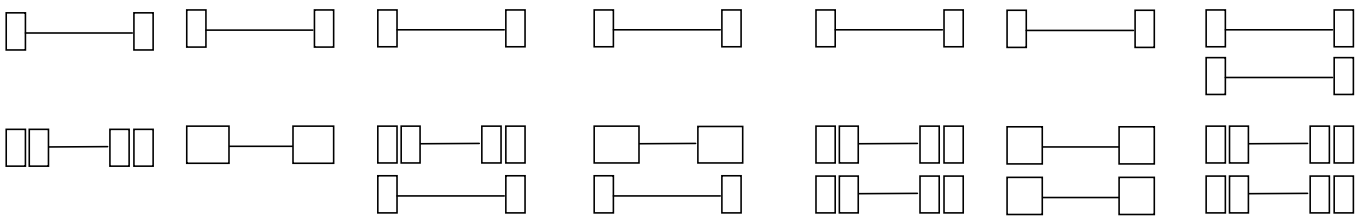
Ordering number 815 000 441 3 (D)
Contents: Model verification 94/9/EG
CE 0032, TÜV03 ATEXxxxx
Aplication range εx II 2G EEx ib IIC T4

System structure



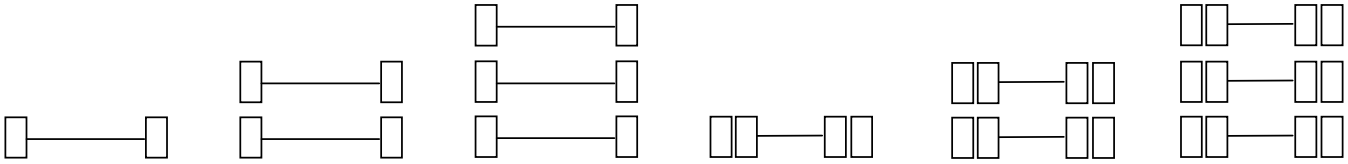
Possible vehicle configuration:

Motor vehicle



4 x 2 | 4 x 2 Super-Single | 6 x 2 with Steering-/ Loading axle | 6 x 2 with Steering-/lifting axle Super-Single | 6 x 2 / 6 x 4 | 6 x 2 / 6 x 4 Super-Single | 8 x 4

Trailer vehicles



1-axle trailer vehicle | 2-axles trailer vehicle | 3-axles trailer vehicle | 1-axle trailer vehicle with double tires | 2-axles trailer vehicle with double tires | 3-axles trailer vehicle with double tires

2.1 Parts

2.1.1 Wheel module

Wheel module is cast in plastic enclosure and is composed of:

- pressure sensor 2-14 bars
- electronic circuits for data procession
- electronic circuits for data transmission
- lithium-battery
- 24 bit identification code

Life cycle of the battery > is five years under normal operating conditions.

Wheel module is mounted by the standard nuts from outside to the shank to rim and is connected to valve. Result is:

- ☞ easy installation, tire dismounting is not necessary
- ☞ high quality of wireless data transfer
- ☞ Modules remain in their place even during tire change, i.e. the system does not have to be newly setup.

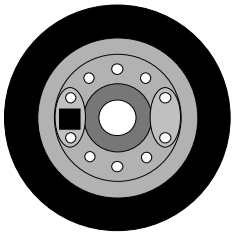
The wheel module must not disrupt wheel balance; therefore the counter weight is mounted on the opposite side.

Evaluation and data transfer is provided by 433 MHz signal. If the pressure is constant, measured values are transmitted every 15 minutes, if the pressure is changing, frequency of data transfers is faster.

Special identification code of each wheel allows unique assignment of modules to particular wheels. Possibility of receptions of signals from another vehicle is excluded.

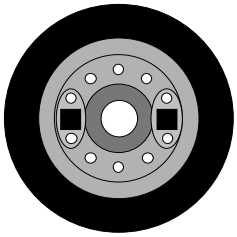
Installation instructions:

– Single tires (front axle, lifting axle, trailer axle, Super-Single):



1 wheel module + 1 weight

– Double tires (rear axle):



2 standard wheel modules for outer wheel.
Please do not use plastic valve extensions, as these parts are not designed for permanent pressure load. Use instead brass extensions (i.e. Alligator V 153-MS-R, length 177 mm, type 332 903) or flexible valve extensions with clamps.

Remark:
During hose installation ensure that wheel module connection is not exposed to excessive mechanical load or excessive pressure.

Do not use excessive force when tightening cup nut of tire inflation valve. Check connection seal with test spray.

Replace damaged O rings of wheel module connection: 4.47 x 1.78 EPDM 70

Wheel module mounting on front and lifting axle

For wheels 22.5 x 7.5, 22.5 x 8.25, 22.5 x 9 10 holes, pitch circle diameter 335 mm, ET 160

Wheel with protective nut circle:
L-Shape wheel module 960 730 001 0 with hose 960 730 056 4. Install counter weight on opposite side.

Wheel with axle cap:
Wheel module 960 730 001 0 with module 960 730 057 4. Counter weight 960 730 820 4 on opposite side.

Wheel module installation on rear axle with double tires

For wheels 22.5 x 7.5, 22.5 x 8.25, 22.5 x 9 10 holes, pitch circle diameter 335 mm, ET 160

2 wheel modules 960 730 001 0
Hose for outer wheel: 960 730 054 4 (22.5 x 7.5, 22.5 x 8.25 und 22.5 x 9)
Hose for inner wheel: 960 730 055 4 (22.5 x 7.5) respectively 960 730 058 4 (22.5 x 8.25 and 22.5 x 9)
Counter weight is not needed.

Wheel module installation on axle of trailer with single tires and Super-Single

For trailer wheels 22.5 x 11.75 ET 0 and 120; Super-Single wheels 22.5 x 11.75, 22.5 x 15, 22.5 x 17, 10 holes pitch circle diameter 335 mm

ET 0

ET 120

Wheel module 960 730 001 0
Hose for trailer wheel 22.5 x 11.75 ET 0:
960 730 055 4

Hose for trailer wheel 22.5 x 11.75 ET 120:
960 730 053 4

Hose for Super-Single wheel 22.5 x 11.75 and 22.5 x 15: 960 730 055 4

Hose for Super-Single wheel 22.5 x 17: 960 730 052 4
Install counter weight 960 730 820 4 on opposite side.

2.1.2 Electronic control unit (ECU)

Three different types of electronic control unit (ECU) are used:

1. Motor vehicle (truck) 446 220 000 0
2. Attached vehicle (trailer) 446 220 001 0
3. Attached vehicle with TCE (trailer with TCE) 446 220 002 0

Electronic units differ by HF signal structure and connection to CAN bus (ID). Externally could be recognized by type label.

Technical parameters

Operational temperature range: - 40°C to + 80°C
Storage temperature range: - 40°C to + 90°C
max +100°C for 2h
Voltage: 24V ± 8V DC
Protection: IP 69K DIN 40050/IEC 529
Torque: 15 Nm ± 10%

Electronic control unit is mounted in central part of vehicle to chassis, so that perfect HF connection with all wheel modules and connection between vehicle control unit and trailer control unit is ensured. For control units preferentially use mounting system 960 730 350 4.

Wireless connection is provided by aerial inside control unit housing, which guarantees pressure signal reception from all wheels even for most difficult operating conditions.

All changes from pre-programmed required values of tire pressure are immediately recognized by comparison with limit pressure values and pressure changes.

Incorrect values of tire pressures are displayed immediately during start of the drive (if the unit is permanently powered).

The system may be extended up to 12 wheel modules for one control unit.

Performance of the system may be checked by internal diagnostics memory.

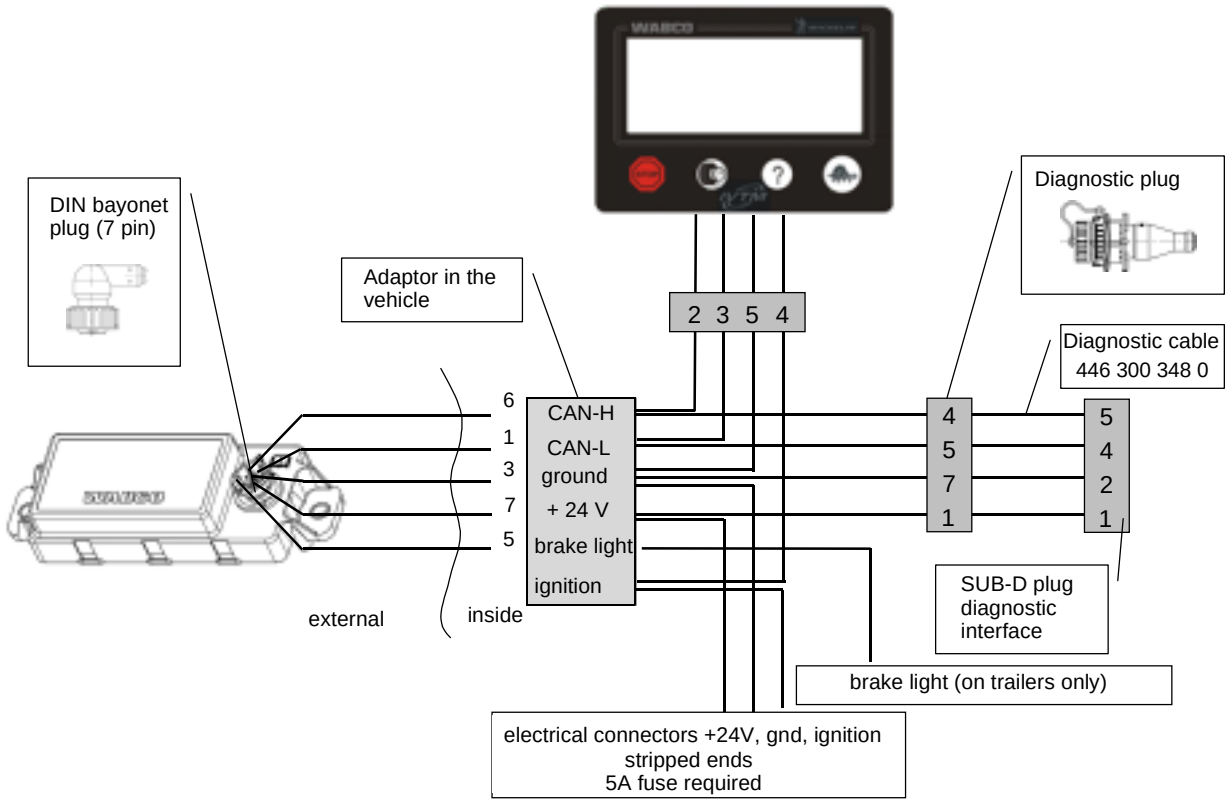
2.1.3 Display

red indicator light STOP | **button Manometer symbol** | **button „?“** | **yellow indicator light Turtle symbol**

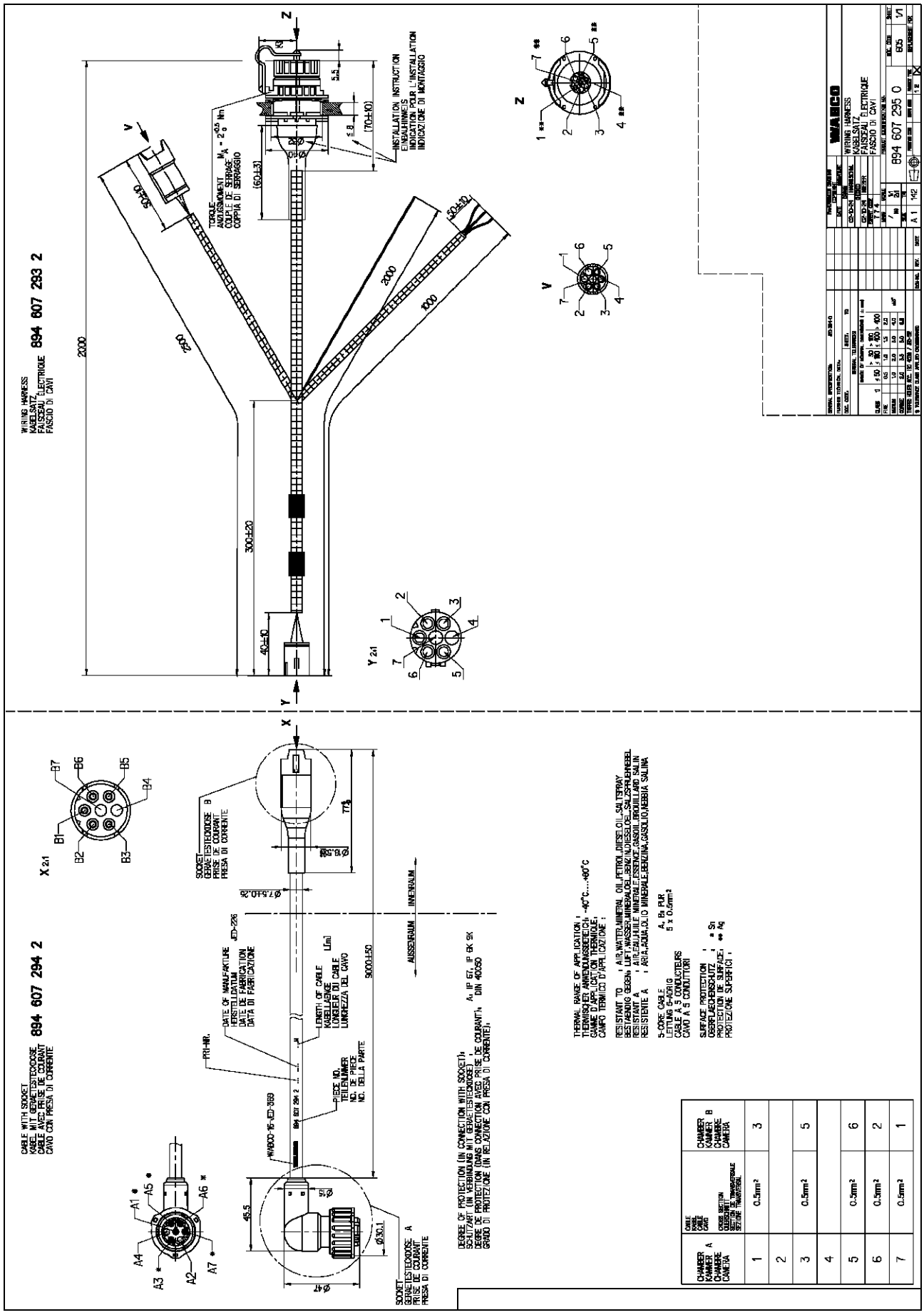
All necessary information of IVTM system is shown on display. Connected to particular control unit by CAN bus.

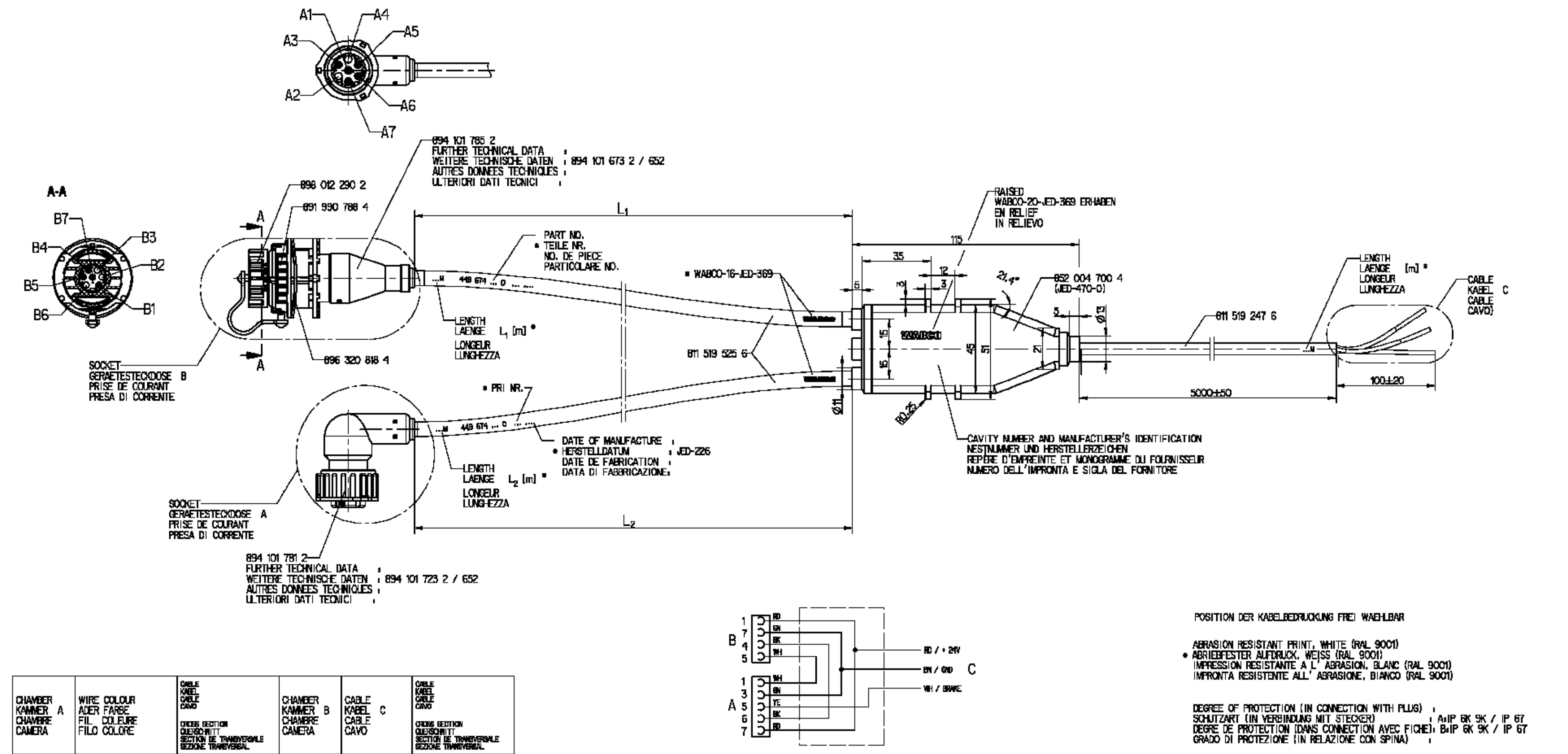
These data are among others shown on the display:

- All tire pressures could be displayed by pressing the button (Manometer). Manual tire pressure checks are not necessary.
- The driver is informed by pilot lights and audio signals:
  - Yellow light indicates slightly lower pressure or sneaking pressure drop: In such case the maximum speed of vehicle should be decreased and the tire pressure should be checked on first occasion.
  - Red light indicates critical pressure drop: The vehicle should be stopped immediately.
- Pressing button “?” displays additional information about position of defect tire and current pressure.



2.2 Cabling


WIRING HARNESS
KABELSATZ
FAISCEAU ELECTRIQUE
FASCIO DI CAVI
894 607 293 2
894 607 294 2
WABCO
894 607 295 0
INSTALLATION INSTRUCTION
EINEBAUHINWEIS
INDICATION POUR L'INSTALLATION
INDICAZIONE DI MONTAGGIO
CABLE WITH SOCKET
KABEL MIT GERÄTESTECKDOSE
CABLE AVEC PRISE DE COURANT
CAVO CON PRESA DI CORRENTE
SOCKET
GERÄTESTECKDOSE
PRISE DE COURANT
PRESA DI CORRENTE
DEGREE OF PROTECTION (IN CONNECTION WITH SOCKET)
SCHUTZART (IN VERBINDUNG MIT GERÄTESTECKDOSE)
DEGRE DE PROTECTION (AVEC PRISE DE COURANT)
GRADO DI PROTEZIONE (IN RELAZIONE CON PRESA DI CORRENTE)
IP 67, IP 6K 9K
DIN 40050
THERMAL RANGE OF APPLICATION
THERMISCHER ANWENDUNGSBEREICH
GAMME D'APPLICATION THERMIQUE
CAMPO TERMICO D'APPLICAZIONE
-40°C....+80°C
RESISTANT TO
BESTÄNDIG GEGEN
RESISTANT A
RESISTENTE A
AIR,WATER,MINERAL OIL,PETROL,DIESEL OIL,SALTSPRAY
LUFT,WASSER,MINERALÖL,BENZIN,DIESELÖL,SALZSPRÜHNEBEL
AIR,EAU,HUILE MINERALE,ESSENCE,GASOIL,BROUILLARD SALIN
ARIA,ACQUA,OLIO MINERALE,BENZINA,GASOLIO,NEBBIA SALINA
S-CORE CABLE
LEITUNG 5-ADRIG
CABLE A 5 CONDUCTEURS
CAVO A 5 CONDUTTORI
5 x 0,5mm²
SURFACE PROTECTION
OBERFLÄCHENSCHUTZ
PROTECTION DE SURFACE
PROTEZIONE SUPERFICI
= Sn
= Ag
CHAMBER A
CHAMBER B
CHAMBRE
CAMERA
CABLE
KABEL
CABLE
CAVO
CROSS SECTION
QUERSCHNITT
SECTION TRANSVERSALE
SEZIONE TRASVERSALE
1 0,5mm² 3
2
3 0,5mm² 5
4
5 0,5mm² 6
6 0,5mm² 2
7 0,5mm² 1



CHAMBER / KAMMER A / CHAMBRE / CAMERA	WIRE COLOUR / ADER FARBE / FIL COLEURE / FILO COLORE	CABLE / KABEL / CABLE / CAVO — CROSS SECTION / QUERSCHNITT / SECTION DE TRANSVERSALE / SEZIONE TRANSVERSAL	CHAMBER / KAMMER B / CHAMBRE / CAMERA	CABLE / KABEL C / CABLE / CAVO	CABLE / KABEL / CABLE / CAVO — CROSS SECTION / QUERSCHNITT / SECTION DE TRANSVERSALE / SEZIONE TRANSVERSAL
1	WHITE / WEISS / BLANC / BIANCO	811 519 525 6 / 0.5mm²	5	-	-
2					
3	GREEN / GRUEN / VERT / VERDE	811 519 525 6 / 0.5mm²	7	BROWN / BRAUN / BRUN / BRUNO	811 519 247 6 / 0.5mm²
4					
5	YELLOW / GELB / JAUNE / GIALLO	811 519 525 6 / 0.5mm²	-	WHITE / WEISS / BLANC / BIANCO	811 519 247 6 / 0.5mm²
6	BLACK / SCHWARZ / NOIR / NERO	811 519 525 6 / 0.5mm²	4	-	-
7	RED / ROT / ROUGE / ROSSO	811 519 525 6 / 0.5mm²	1	RED / ROT / ROUGE / ROSSO	811 519 247 6 / 0.5mm²

CODE OF LENGTH : ORDER NUMBER
LAENGENCODIERUNG : BESTELLNUMMER
CODE DE LA LONGUEUR : NUMERO DE COMMANDE
CODICE DEL LUNGHEZZA : NUMERO DELL'ORDINE
449 674 □□□ 0

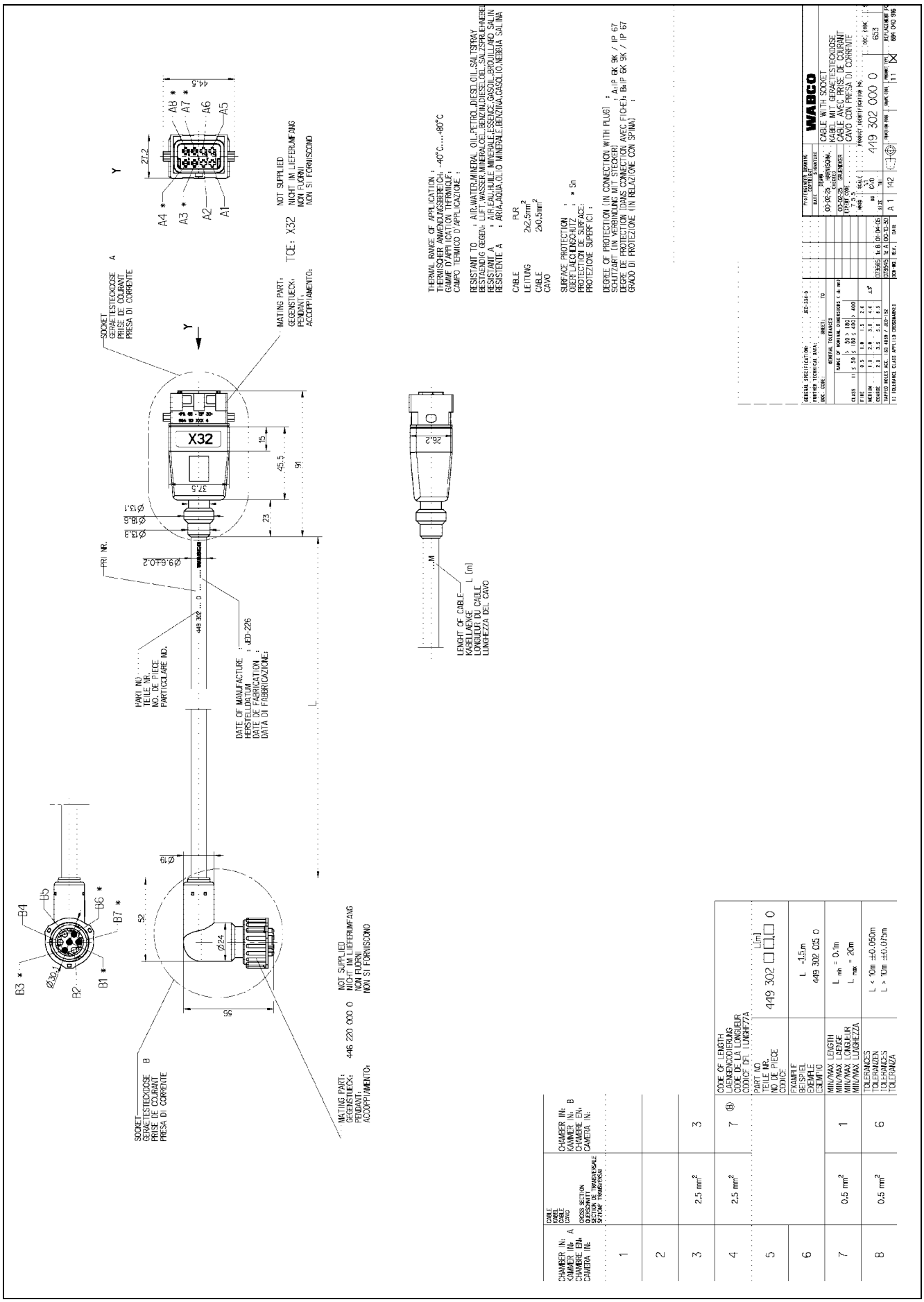
EXAMPLE / BEISPIEL / EXAMPLE / ESEMPIO: L_1 =4.5m, L_2 =0.4m — 449 674 031 0

L_2[m] \ L_1[m]	0.25	0.4	1.00	1.35	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	6.00	7.00	8.00	10.0	12.0	15.0	18.0
0.25	001	002	003	004	005	006	007	008	009	010	011	012	013	014	015	016	017	018	019
0.40	021	022	023	024	025	026	027	028	029	030	031	032	033	034	035	036	037	038	039
1.00	041	042	043	044	045	046	047	048	049	050	051	052	053	054	055	056	057	058	059
1.35	061	062	063	064	065	066	067	068	069	070	071	072	073	074	075	076	077	078	079
1.50	081	082	083	084	085	086	087	088	089	090	091	092	093	094	095	096	097	098	099
2.00	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
2.50	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139
3.00	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
3.50	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179
4.00	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199
4.50	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
5.00	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
6.00	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259
7.00	261	262	263	234	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279
8.00	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299
10.0	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319
12.0	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339
15.0	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359
18.0	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379

MIN/MAX LENGTH / MIN/MAX LAENGE / MIN/MAX LONGUEUR / MIN/MAX LUNGHEZZA	L_{min} = 0.25m / L_{max} = 18.00m
TOLERANCES / TOLERANZEN / TOLERANCES / TOLERANZA	L ≤ 10m +0.100 / -0.050; L > 10m +0.125 / -0.075

CABLE WITH SOCKET
KABEL MIT GERAETESTECKDOSE
CABLE AVEC PRISE DE COURANT
CAVO CON PRESA DI CORRENTE

WABCO — 449 674 000 0 — 652 — 1/1 — A 1 — 1:1


SOCKET
GERÄTESTECKDOSE
PRISE DE COURANT
PRESA DI CORRENTE
MATING PART:
GEGENSTECK:
PENDANT:
ACCOPPIAMENTO:
446 220 000 0
NOT SUPPLIED
NICHT IM LIEFERUMFANG
NON FLORNI
NON SI FORNISCONO
TCE: X32
X32
PRI NR.
HAHN NO.
TEILE-NR.
NO. DE PIECE
PARTICOLARE NO.:
449 302 ... 0
DATE OF MANUFACTURE : WD-226
HERSTELLDATUM
DATE DE FABRICATION :
DATA DI FABBRICAZIONE:
LENGHT OF CABLE L [m]
KABELLÄNGE
LONGUEUR DU CABLE
LUNGHEZZA DEL CAVO
THERMAL RANGE OF APPLICATION : -40°C....+80°C
TEMPERATURBEREICH FÜR ANWENDUNG
GAMME D'UTILISATION THERMIQUE
CAMPO TERMICO D'APPLICAZIONE :
RESISTANT TO : AIR,WATER,MINERAL OIL,PETROL,DIESELOIL,SALTSPRAY
BESTÄNDIG GEGEN: LUFT,WASSER,MINERALÖL,BENZIN,DIESELÖL,SALZSPRÜHNEBEL
RESISTANT A : AIR,EAU,HUILE MINERALE,ESSENCE,GASOIL,BROUILLARD SALIN
RESISTENTE A : ARIA,AQUA,OLIO MINERALE,BENZINA,GASOLIO,NEBBIA SALINA
CABLE PUR
LEITUNG 2x2.5mm²
CABLE 2x0.5mm²
CAVO 2x0.5mm²
SURFACE PROTECTION : * Sn
OBERFLÄCHENSCHUTZ : * Sn
PROTECTION DE SURFACE: * Sn
PROTEZIONE SUPERFICI : * Sn
DEGREE OF PROTECTION (IN CONNECTION WITH PLUG) : A+IP 6K 9K / IP 67
SCHUTZART (IN VERBINDUNG MIT STECKER) : A+IP 6K 9K / IP 67
DEGRÉ DE PROTECTION (DANS CONNECTION AVEC FICHE) : B+IP 6K 9K / IP 67
GRADO DI PROTEZIONE (IN RELAZIONE CON SPINA) : B+IP 6K 9K / IP 67
GENERAL SPECIFICATION: ISO 3547-1
FURTHER TECHNICAL DATA: TD
DOC. CODE:
GENERAL TOLERANCES
RANGE OF NOMINAL DIMENSIONS [in mm]
CLASS 1 | 5 30 | 30 120 | 120 400
FINE 0.5 1.0 1.5 2.4
MEDIUM 1.0 2.0 3.5 4.6
COARSE 2.0 3.5 5.5 8.5
TOLERANCE ACC. TO ISO 2768-1
(1) TOLERANCE CLASS APPLIED DIMENSIONED
PROTOKOLL-NR.
DATE
09.06.26
DRAWN
SCALE
1 : 3.5
WEIGHT
DATE
09.06.26
CHECKED
DRAWING NO.
449 302 000 0
SHEET
A 1 | 142
WABCO
CABLE WITH SOCKET
KABEL MIT GERÄTESTECKDOSE
CABLE AVEC PRISE DE COURANT
CAVO CON PRESA DI CORRENTE
PRODUCT IDENTIFICATION NO.
653
REPLACED BY
894 045 196
CHAMBER IN:
KAMMER IN:
CHAMBRE EN:
CAMERA IN:
CABLE
KABEL
CABLE
CAVO
CROSS SECTION
QUERSCHNITT
SECTION TRANSVERSALE
SEZIONE TRASVERSALE
CODE OF LENGTH
LÄNGENCODIERUNG
CODE DE LA LONGUEUR
CODICE DELLA LUNGHEZZA
PART NO.
TEILE NR.
NO DE PIECE
CODICE
EXAMPLE
BEISPIEL
ESEMPIO
MIN/MAX LENGTH
MIN/MAX LÄNGE
MIN/MAX LONGUEUR
MIN/MAX LUNGHEZZA
TOLERANCES
TOLERANZEN
TOLERANCES
TOLERANZA
449 302 □□□ 0
L min = 0.1m
L max = 20m
L < 10m ±0.050m
L > 10m ±0.07bm

3. Installation instructions

3.1 General instructions

These installation instructions are for experts, who have knowledge about installation of electronic and electro-pneumatic equipment in vehicles.

It describes on examples mounting of IVTM equipment in motor vehicle and trailer.

Respect general and special laws and regulations.

Further respect drawings in appendix and particular technical parameters.

Warning: Work on insufficiently secured vehicle may result in spontaneous movement of the vehicle.

Safety instructions

Respect valid regulations for work safety and instructions of vehicle manufacturer.

Before mounting make all necessary safety precautions, for example secure the car against spontaneous movement.

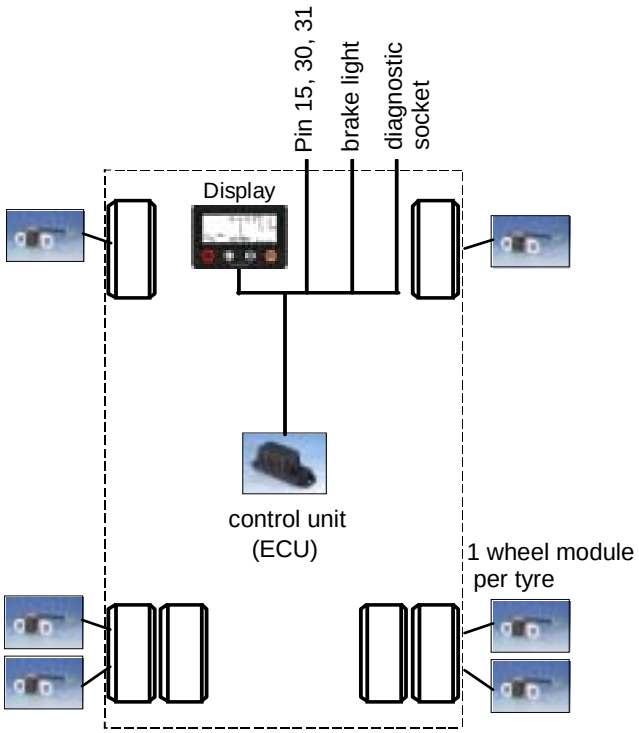
Do not clean working clothes, workplace and tools by pressure air.

Wheel nuts must be tightened with torque specified by vehicle manufacturer. Check tightness of wheel nuts after 500 km.

3.2 Overview

Additional mounting in motor vehicle/bus.

1. Wheel modules are installed first.
2. Installation of the control unit to vehicle chassis.
3. Display installation.
4. Mounting and connection of cable harness to the control unit and display.
5. Finally: IVTM system configuration with PC diagnostics.

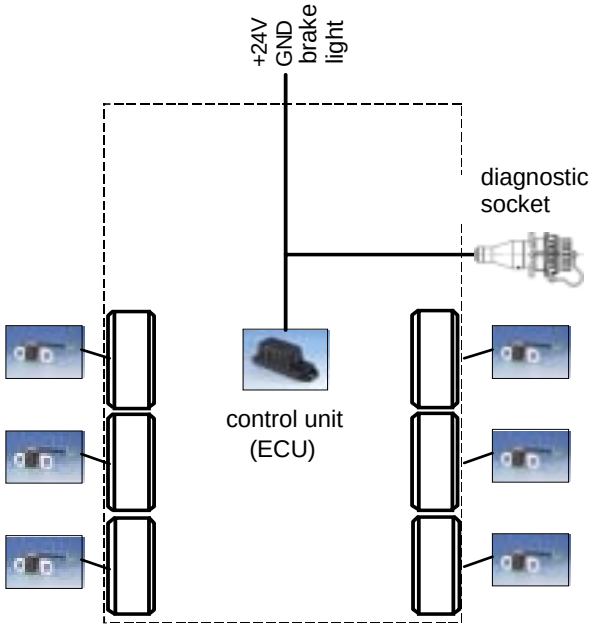


Additional mounting in trailer

1. Wheel modules are installed first.
2. Installation of the control unit to vehicle chassis. On three axles trailer preferentially in front of the first axle

3. Mounting and connection of cable harness to the control unit.

4. Finally: IVTM system configuration with PC diagnostics.



3.3 Additional mounting in motor vehicle/ bus

Wheel modules are installed first.

For the front wheels always one module with connecting hose and counter weight is necessary.
The vehicle needs not to be lifted as only four wheel nuts are dismounted.

First connect module hose to wheel module by inserting connecting segment to wheel module opening. Secure the connection by turning the connecting segment. After mounting to wheel it could not be removed.

Unscrew four nuts and remove protecting ring. Then mount the wheel module and counter weight on opposite side.

Return protection ring and tighten wheel nuts. Connect hose to tire valve.

For **installation to rear axle** of vehicle (in this example) two modules for double tires for each side with one connecting hose are needed.

Warning:
Do not use plastic valve extension

Requirements of this connection are fulfilled only by metal valve extension!

First remove four wheel nuts depending on mounting position of module (on opposite sides) as well.

Connect hoses to modules and mount modules on prepared location (removed nuts). Then mount back wheel nuts.

Connect hoses to valves.

3.3.1 Additional mounting in trailer.

For additional mounting in trailer follow installation instructions for motor vehicle/bus. Proceed according to the same instructions.

In accordance with mounting instructions for vehicle, first connect proper hose to the module. Further in accordance with mounting instructions for motor vehicle, in case of single front vehicle tires install counter weight.

After removing of four nuts install both parts and return back the nuts.

Finally connect hoses to tire valves.

3.4 Inflation pressure

Actual tire pressures and pressures stored in diagnostics should correspond with values given by vehicle or tire manufacturer.

Inflation pressure in tires should ideally be set up in ambient drive temperature, i.e. strictly **before** drive on **"cold"** tires. In this manner you will be operating your tires with optimum inflation pressure and achieve optimum life cycle with minimum fuel consumption.

It is common that for example during longer drive on highway the tires are heated and their pressure rises. Such higher pressure should under no circumstances be lowered to standard value. Inflation pressure of "cold" tires would then be significantly lower.

In following situations the inflation pressure set on cold tires is not correct:

1. Inflation pressure was adjusted in very cold night and during drive in day the tires are heating up. In this case the tire pressure during day is too high.

Example:
Required inflation pressure: 8 bars
Ambient temperature
during tire inflation: -10°C
Ambient temperature
during day drive: +20°C

☞ Effective tire pressure during day rises above 9 bars.

☞ Inflation pressure during could night should therefore be 7.1 bar.
The tire pressure before day drive would in this example be
8 bars.

2. Inflation pressure in cold weather is adjusted in heated workshop. In this example the tire inflation pressure is too low during drive.

Example:
Required inflation pressure: 8 bars
Ambient temperature
during tire inflation: +20°C
Ambient temperature during drive: -10°C

☞ Effective tire pressure drops to approximately 7.1 bar.

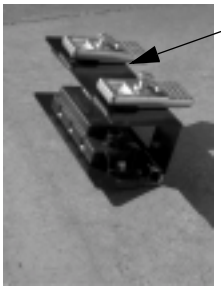
☞ Inflation pressure for heated workshop should be set to 9 bars.
Tire pressure would reach correct values outside before the start of the drive.
8 bars.

3.5 Installation of electronic control unit to motor vehicle

The control unit should be installed on such place, which is in same distance from all wheels. It is usually installed in the centre of vehicle. For trailer the control unit should be installed ahead of front axle.

Install electronic control unit in such position, that longitudinal axis of unit is parallel with longitudinal axis of vehicle. Apart from that only installation ”terminals up” is allowed. This mounting position is necessary for optimum reception of signal.

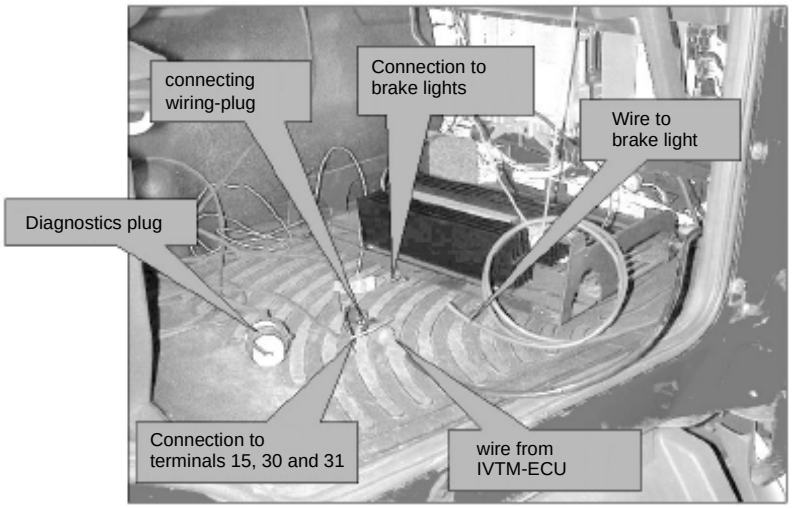
Use body shell clams for mounting of control unit 960 730 350 4, because welding is not allowed on **chassis** of vehicle.



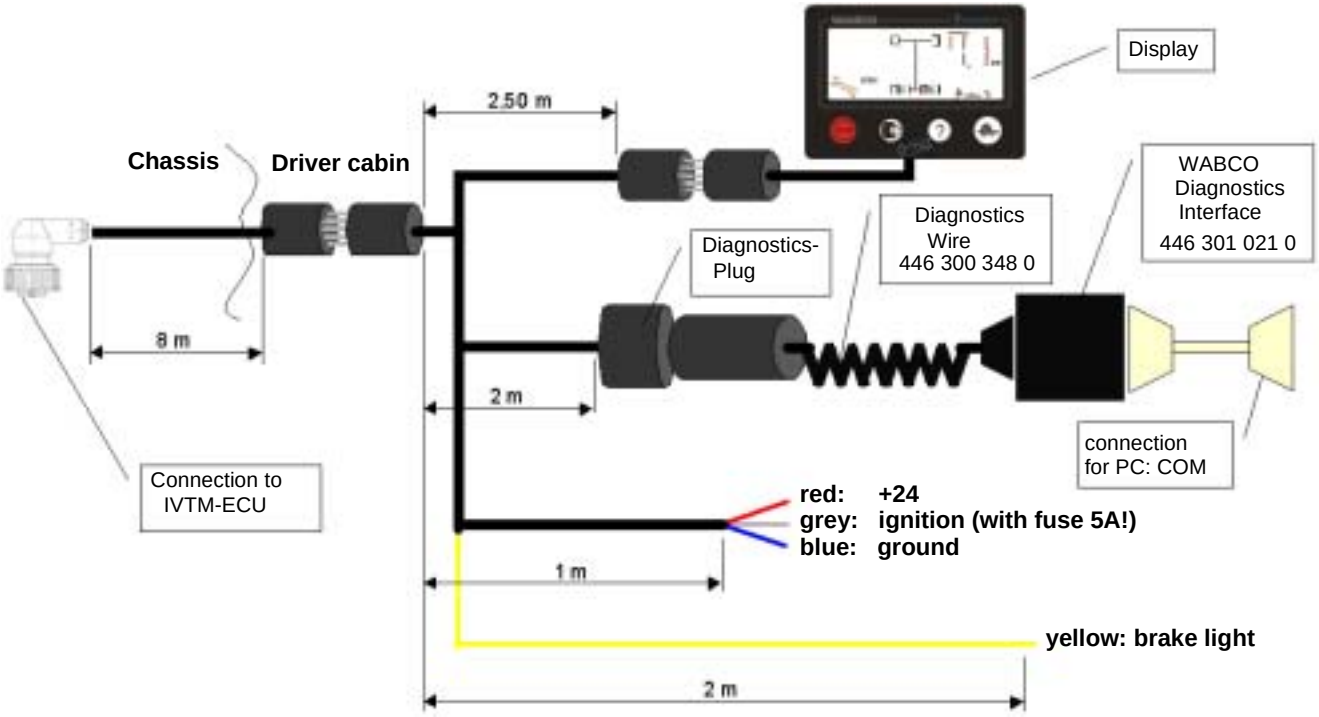
3.5.1 Cable harness installation Motor vehicle

For installation of electronic units into motor vehicle use prepared cable harnesses WABCO. IVTM parts are connected by installed plug-in modules. Adjust location of cables to individual vehicle situation. Respect relevant law regulations.

Connection to battery (permanent, plus) and ignition must be fused 5A.



Example of motor vehicle wiring with connectors to brake lights, plus terminal of Batt, chassis and ignition.



Break lights wiring should be connected only in case of vehicles with trailers, i.e. for example not for buses. Connection provides synchronisation of signals from trailer to motor vehicle.

Break lights cable could be connected for example through the connector for brake pedal. Conditions of particular vehicle may and must be taken into account.

Install display on favourable position on dashboard. Due to audio signals it is not necessary to install display directly in front of driver.

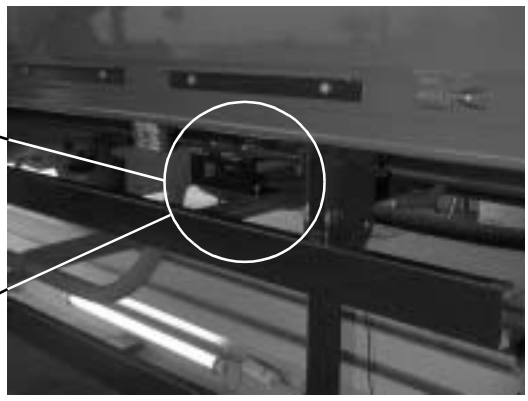
.

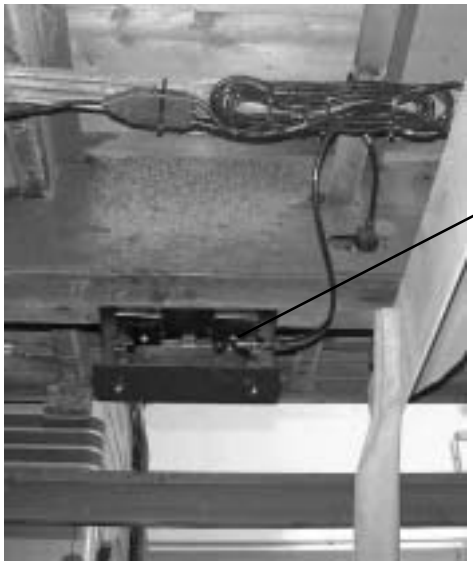
If possible install IVTM diagnostics plug close to other diagnostics terminals of vehicle.

3.5.2 Cable harness installation Trailer

For installation of electronic units into motor vehicle use prepared cable harnesses WABCO. IVTM parts are connected by installed plug-in modules. Adjust location of cables to individual vehicle situation. Respect relevant law regulations.

Wiring + 24V must be fused 5A.





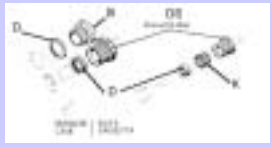
Install electronic control unit in such position, that longitudinal axis of unit is parallel with longitudinal axis of vehicle. Apart from that only installation ”terminals up” is allowed. This mounting position is necessary for optimum reception of signal.

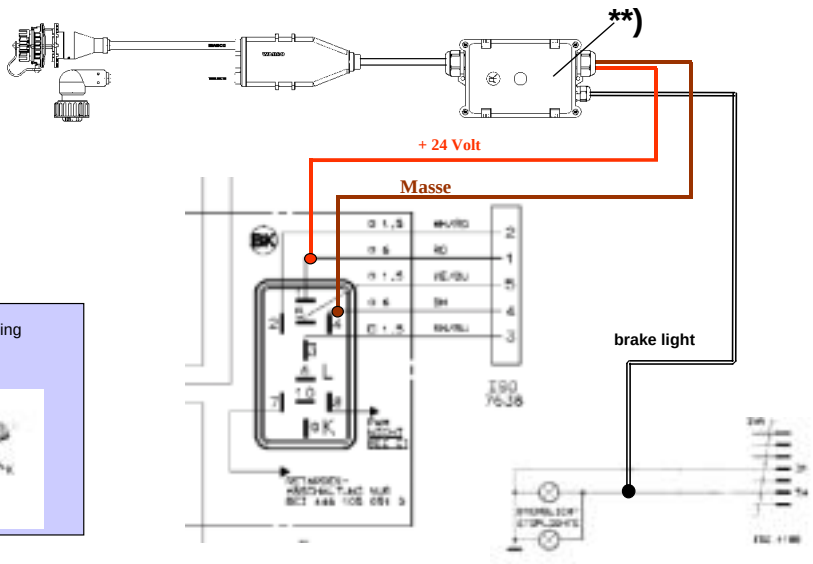
Use body shell clams for mounting of control unit 960 730 350 4, because welding is not allowed on **chassis** of vehicle.

Examples of Vario C wiring:

Vario C wiring without additional electronics

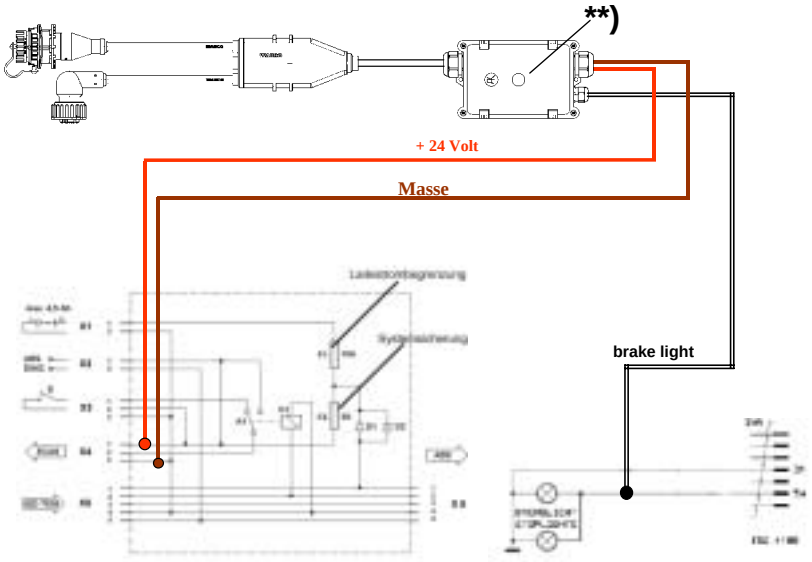
For connection in Vario C housing are needed auxiliary thread connections :





Vario C wiring with auxiliary electronics ECAS

with power module
446 107 530 0

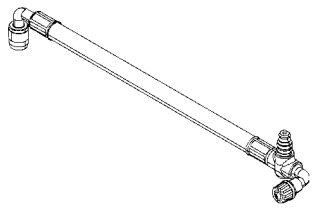
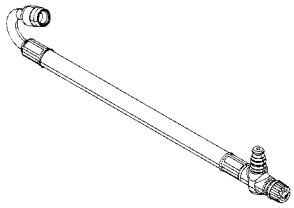
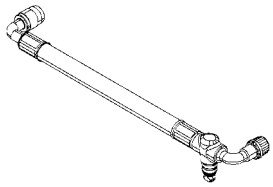
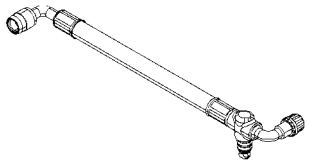
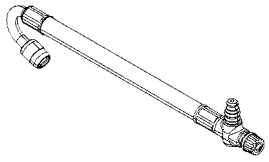
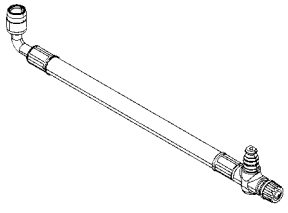
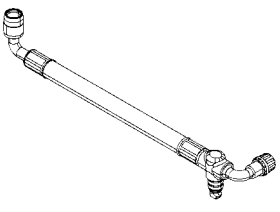


) **Remark:
For installation of connecting cable IVTM in trailer WABCO is recommending cable socket AK 192 from:
Apparatebau Kirchheim-Teck GmbH & Co.
Alleenstraße 36
D 73230 Kirchheim-Teck

Situation in the beginning of 2003

	Prototypes	Series	Necessary parts for 4x2-		Necessary parts for 6x2-		Necessary Parts for 6x2- Swivel bus		Necessary Parts for 3 axles trailer		Necessary Parts for 2 axles Trailer		4x2 Super Single	
			truck	bus	truck	bus	double tires	Super Single	ET 120	ET 0	ET 120	ET 0	truck	bus
Truck ECU	884 906 939 0	446 220 000 0	1	1	1	1	1	1					1	1
Trailer ECU	884 906 940 0	446 220 001 0							1	1	1			
Display	884 650 161 0	446 221 000 0	1	1	1	1	1	1					1	1
Truck cable		894 607 295 0	1	1	1		1	1					1	1
Trailer cable		449 674 051 0							1	1	1	1		
wheel module Standard	884 623 605 0	960 730 001 0	4	4	4	4	8	4	6	6	4	4	2	2
wheel module L-Shape (front axle)	884 014 985 0	960 730 007 0	2	2	4	4	2	2					2	2
Counter weight		960 730 820 4	2	2	4	4	2	6	6	6	4	4	4	4
L-shape hose		960 730 056 4	2	2	4	4	2	2					2	2
External hose for rear axle		960 730 054 4	2	2	2	2	4							
Internal hose for rear axle		960 730 058 4	2		2									
Single tire hose		960 730 052 4											2	
ET 120 trailer hose		960 730 053 4							6		4			
ET 0 trailer hose external hose for bus rear axle Super Single for bus		960 730 055 4		2		2	4	4		6		4		2

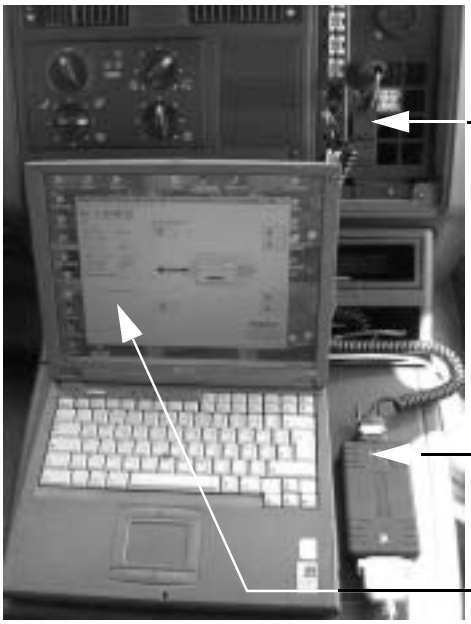
Review of connecting hoses:

Super Single	**22.5 x 17**	**960 730 052 4**	
Trailer	**22.5 x 11.75 ET 120**	**960 730 053 4**	
Double tires – external	**22.5 x 7.5 ET 160** **22.5 x 8.25 ET 160** **22.5 x 9 ET 160**	**960 730 054 4**	
Trailer **Double tires – internal** **Super Single**	**22.5 x 11.75 ET 0** **22.5 x 7.5 ET 160** **22.5 x 11.75** **22.5 x 15**	**960 730 055 4**	
Independent L-shape wheel with protecting ring	**22.5 x 7.5** **22.5 x 8.25 ET 160** **22.5 x 9**	**960 730 056 4**	
Independent wheel with axle cap	**22.5 x 7.5** **22.5 x 8.25 ET 160** **22.5 x 9**	**960 730 057 4**	
Double tires – internal	**22.5 x 8.25 ET 160** **22.5 x 9**	**960 730 058 4**	

4. Diagnostics

4.1 System configuration

Newly installed IVTM system is configured, i.e. set up, by PC diagnostics of IVTM system.
Parts necessary for configuration:



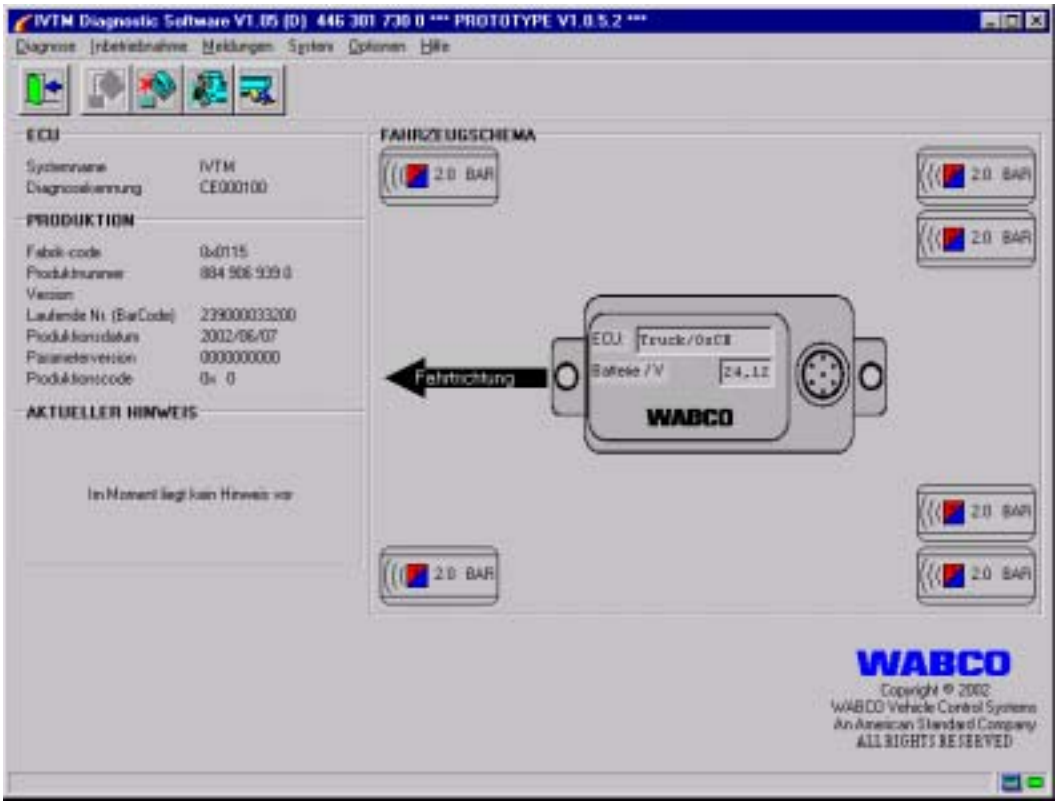
Diagnostics connecting cable: 446 300 348 0

Diagnostics interface with cable: 446 301 021 0

Diagnostics software: 446 301 730 0

Remark: Diagnostic could be done only with special diagnostics cable for IVTM, other diagnostics cables WABCO (i.e. cables for EBS, ECAS etc.) could not be used.

4.2 Diagnostic structure



4.3 OPERATING INSTRUCTIONS

The system consists of one electronic unit, so called electronic control unit, which receives wireless information from wheel modules. Wheel modules are permanently connected by hoses to tire valves. Pressure information is processed by algorithms stored in control unit.

Data are relayed by CAN bus to display. Display unit consists of one display, two indicators, one buzzer and two buttons.

Warnings of different levels are signalised; importance could be recognised by colour of indicator light and audio signal:

- Red light (STOP) and 1 minute long audio signal indicates serious defect; the vehicle must be stopped immediately (possible threat to lives and vehicle).
- Yellow light (turtle) and 10 minutes long audio signal indicates smaller defect; the vehicle should be slowed down and lower pressure adjusted.

Defects found by IVTM are stored in electronic memory for diagnostic purposes.

4.3.1 Display operation

Cable harness is connected to display by 4-pole plug. It is powered only if the ignition is on.

After the ignition is switched on, internal check procedure is performed, when all internal functions are tested: all symbols are displayed for one second, all pilot lights and audio signals are switched on; this procedure is repeated twice.

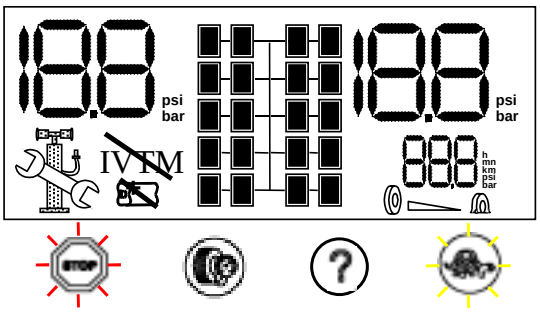


Fig. 1

If the tire pressures are not exceeding specified values, following data are displayed after initialisation:

Two buttons on front panel are used to control different functions.

Left button with symbol of manometer displays vehicle tire pressure.

Right button with question mark symbol shows detected defects. If pressed longer, the error messages are deleted (after correction of tire pressure).

4.4 DIFFERENT VALUES ON DISPLAY

4.4.1. Normal values

After initialisation the top view of vehicle is displayed (driving direction upward) for 12 seconds. For example 4x2 truck is shown like:

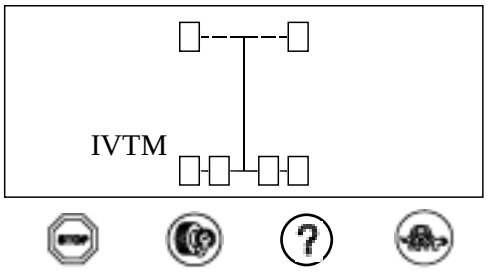


Fig. 3

If the trailer with IVTM system is connected to motor vehicle, both vehicles are shown alternatively in one second intervals for 12 seconds.

Example: If the three axles trailer is connected to shown vehicle, Fig. 3 is changed to:

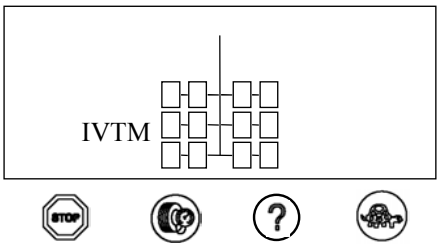


Fig. 4

The display shows IVTM logo (Fig. 2) and stays without change till the button is pressed or the defect is found.

If the defect is found on one of the vehicle wheels, symbol of particular wheel is blinking in corresponding image (vehicle or trailer). Depending on seriousness of defect, control lights and audio signals are switched on.

If the defect is found on more than one wheel of vehicle or trailer, symbols of all defect wheels are blinking.

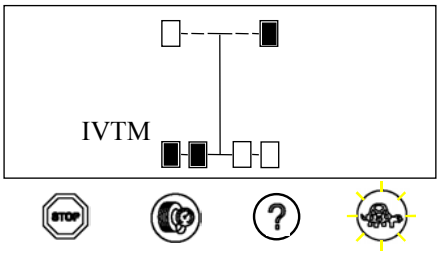


Fig. 5

If the defects are found in both vehicle and trailer wheels, images of both vehicles are changing each ten seconds, and all defect wheels are blinking.

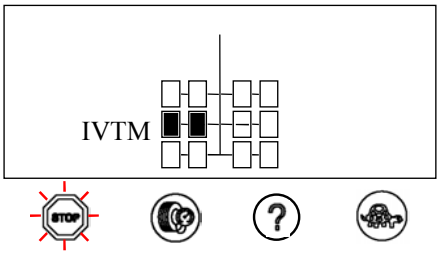


Fig. 6

In all cases the indicator light and audio signal corresponding with the worst defect is switched on.

If the defect is found on one tire of double tires, the system activates error message for both tires.

4.4.2 Pressure display

This manometer function shows the tire pressures measured by IVTM system, and completely replaces manual pressure measurement through tire valves.

The values are displayed after pressing left button ”manometer” in normal mode.

The axle, whose pressures are displayed, is marked.

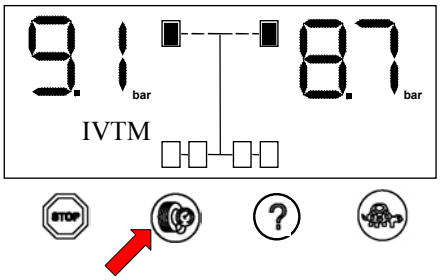


Fig. 7

Tire pressures on following axle could be displayed by repeatedly pressing button ”manometer”.

If one of the axles is equipped with double tires, individual pressures are displayed in sequence.

Display of pressure in outer tires of double tires:

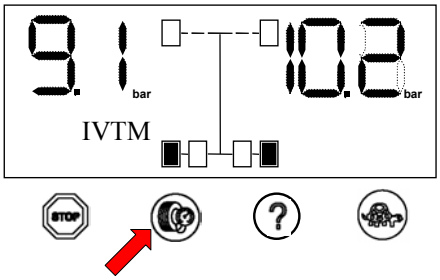


Fig. 8

The pressure of inner tires could be displayed by repeatedly pressing button ”manometer”:

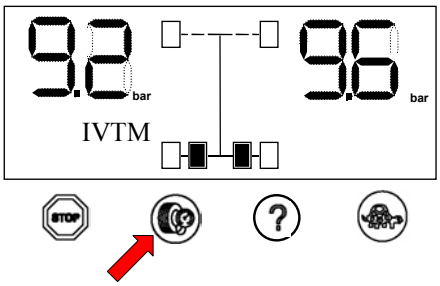


Fig. 9

If the trailer is connected the pressure in the tires of trailer is displayed in the same way.

After display of tire pressure in last axle and pressing the button ”manometer” the display switches to normal mode.

If the button ”manometer” is not pressed for 20 seconds, the display also switches to normal display mode.

4.4.3 Error messages

All defects found by system could be displayed in order of their importance.

This function could be activated by pressing button ”question mark - ?”.

Symbol of defect wheel blinks in particular vehicle image (both tires in case of double tires), symbol of detected defect and particular indicator are lighted.

By successive pressing the button ”?” it is possible to display all defects. After another press of button the user is asked to reset data (see 4.4.2).

If button ”pump” is not pressed for 20 seconds, display switches to normal mode.

If no defect is found the system does not react to pressing button ”?”.

Different types of defects, which could be found by IVTM system, are described below. Let us start with the most dangerous.

4.4.3.1 Extremely low pressure

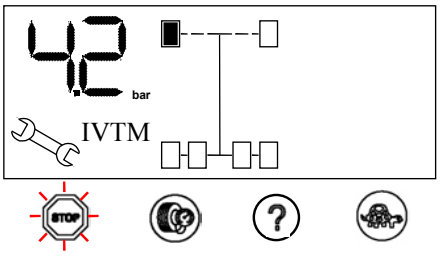


Fig. 10

Display informs about position and current pressure of defect tire. The symbols of wrench and red light are displayed.

Action:

Drive should immediately stop the vehicle and check the pressure drop. Generally, it is necessary to change the tire because of the damage.

4.4.3.2 Extremely high pressure

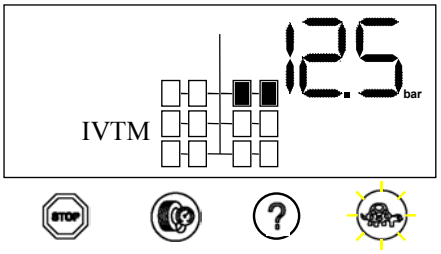


Fig. 11

Display informs about position and current pressure of defect tire. Yellow indicator is on.

Action:

Driver should slow down the vehicle to prevent bursting of tire. The cause of high pressure should be found out (for example heated brake).

4.4.3.3 Sneaking pressure drop

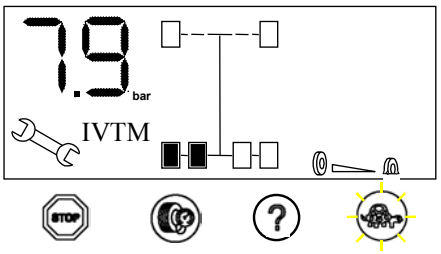


Fig. 12

Display informs about position and current pressure of tire, where the drop was detected. The symbols of wrench and soft tire are displayed. Yellow indicator is on.

Action:

Driver should slow down the vehicle and on first occasion find out the cause of pressure drop, or change the tire.

4.4.3.4 Low pressure

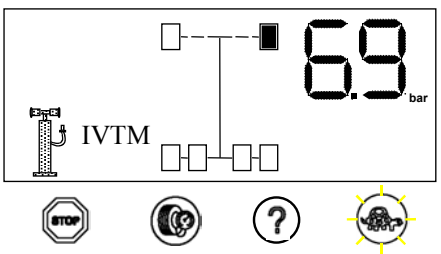


Fig. 13

Display informs about position and current pressure of defect tire. Symbol ”pump” is displayed. Yellow indicator is on.

Action:
Drive should slow down the vehicle and on first occasion adjust the tire pressure.

4.4.3.5 High pressure

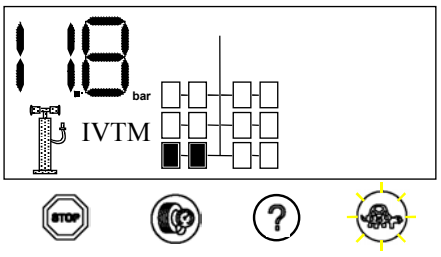


Fig. 14

This defect could be found only for cold tires, i.e. if the vehicle stand for more than four hours with ignition switched off.

In this case the defect is displayed two minutes after the ignition is switched on.

Display informs about position and current pressure of defect tire. Symbol ”pump” is displayed. Yellow indicator is on.

Action:
The pressure in tires should be adjusted before starting the engine.

4.4.4 Reset

This function allows resetting all information about tire pressure and possible defects of IVTM system.

Reset is necessary for example after adjustment of the tire pressure, because otherwise the system may report false defect. Repeatedly press right button ”?”, until all defects of vehicle are displayed. All wheels are lighted. This image of vehicle is displayed for five seconds. After that, if IVTM system recognizes trailer, it displays image of trailer for another five seconds.

If the image of vehicle is displayed and you press the button ”pump” for 5 seconds, the control unit of this vehicle is reset.

Switching off of the display confirms successful reset.

If the unit is not reset, the display changes to normal operating mode.

As all data about defects and tire pressures of particular vehicle are deleted, new information about tire pressure may be displayed after up to 15 minutes.

4.5 SYSTEM ERROR DISPLAY

4.5.1 Connection of the wheel module is interrupted

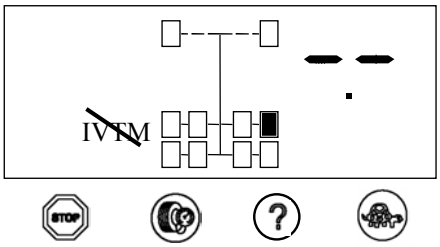


Fig. 16

This error message is shown when there are no data received from one of the wheel modules for more than one hour.

Display shows position of wheel, which is not transmitting data. Two lines are displayed instead of pressure value. IVTM logo is crossed.

Action:
- Optimize mounting position of control unit
- ECU and/or wheel module is excessively dirty

If this error shows after several years of operation of wheel module, it is likely, that the module battery is discharged. Change the wheel module (it is necessary to perform new setup
using system diagnostics).

4.5.2 System error

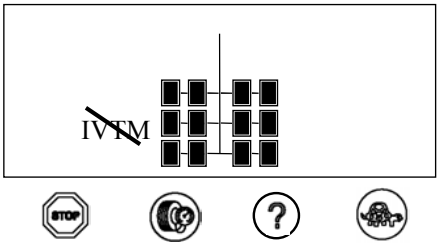


Fig. 17

This error message is displayed when IVTM functions or regular tire pressure monitoring fails.

All wheels are blinking on display. IVTM logo is crossed.

In certain cases the type of vehicle equipped with IVTM is not recognized. In this case following data are displayed:

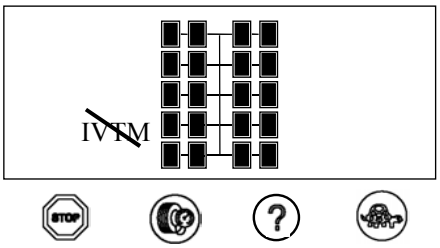


Fig. 18

Action:
System diagnostics, check of the control unit wiring

4.5.3 Interrupted connection between control unit and display

If the connection between IVTM and display is interrupted, following information is shown and white line on IVTM logo is flashing.

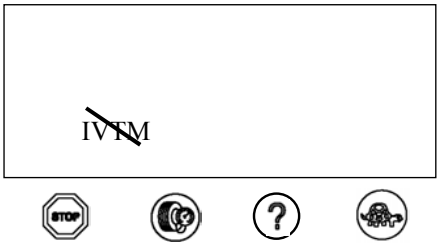


Fig. 19

Action:
- Check plugs: ECU, connecting plug
- Check connection to harness 30
- Plugs from harnesses 15 and 30 could have been interchanged (display is on even after ignition is switched off)
- Check cable connections
- Diagnostics