

Bosch Motorsport

Telemetry System FM 40

System Overview



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1 Preamble

1.1 Safety instructions



To comply with FCC RF exposure compliance requirements, the following separation distances must be maintained between the antenna of the devices and all persons:

Device	Power	min. Distance
FM 40	10 W	0,78 m / 31 in

This is valid for the use of the Bosch-antenna B 261 208 862 or B 261 208 888.

1.2 Restrictions for usage

Bosch Telemetry Unit FM40 has been designed to operate in certain frequency ranges in the 70 cm band.

The permitted frequencies may differ from one region or country to another. The user must take care that the radio is operated complying to the local regulations.



Users of FM40 radio modem in North America should be aware, that due to the allocation of the frequency band 406.0 – 406.1 MHz for government use only, the use of radio modem on this frequency band without a proper permit is strictly forbidden.

FCC-Certification

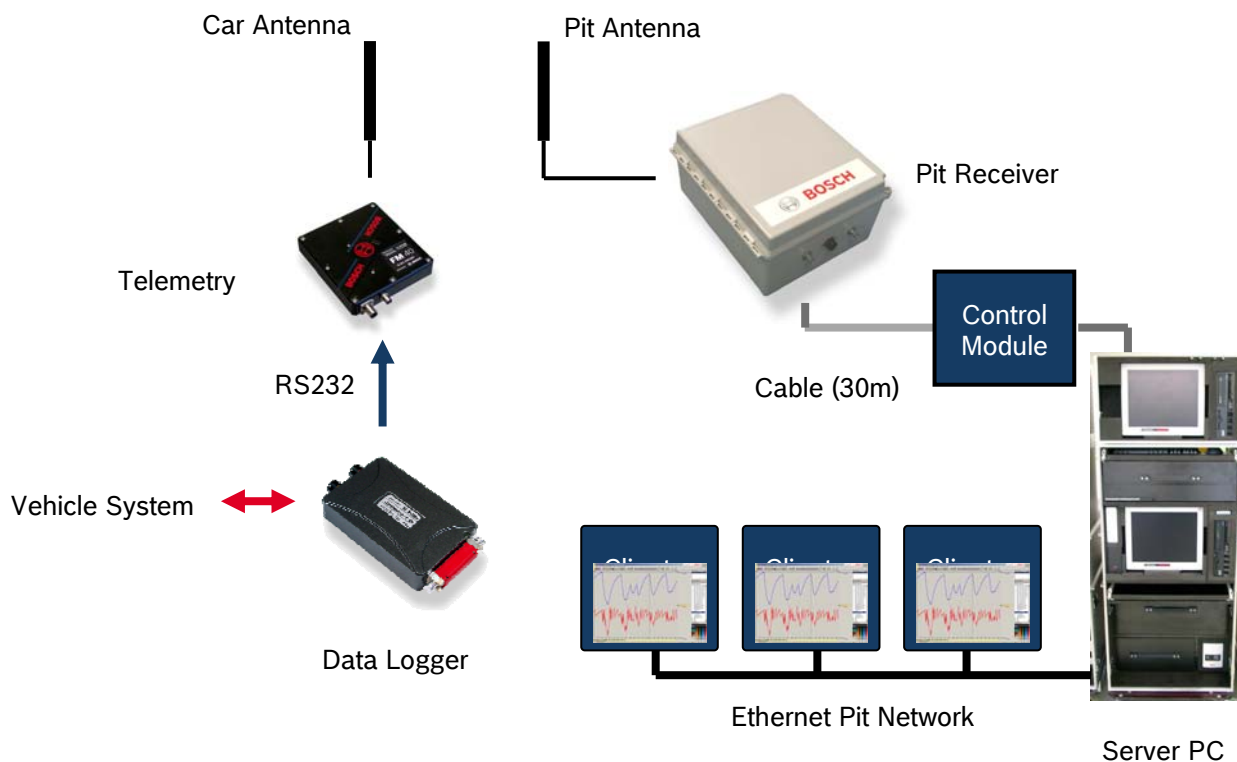
EC Certificate of Conformity

2 System Overview

The Bosch Motorsport Online Telemetry System enables the transmission of online measurement data from a car on a racetrack. The vehicle part of the system consists of a data logger (C 40, C 55 or C 60) and the FM 40 telemetry transmitter. From the data logger data is sent via a RS232 connection to the FM 40. The FM 40 adds framing and error correction information to the data stream and modulates its RF output which is fed via an antenna cable to the TX antenna.

In the pits, the RF signal is picked up by a RX antenna connected to the pit receiver box. Inside the receiver box, the signal is filtered and amplified by a low noise filter amplifier. It is then sent to a UHF modem. The modem demodulates the data stream and performs error correction if necessary. The output stream passes the data converter and is transferred via a connection cable to the server PC in the garage. This PC decodes the car's telemetry stream and distributes the information over the pit network.

Due to the high transmission power of 1 ... 10 W of the Bosch FM 40 telemetry transmitter, near 100 % coverage is achieved on most tracks, even under race conditions with high RF interference.



3 Technical Data

3.1 Telemetry Unit FM 40

The FM 40 is a half-duplex radio modem suitable for real-time telemetry transmission from a car on the racetrack.

The unit is offered in different hardware versions for several frequency bands in the 430 ... 470 MHz range. Within the selected band, the transmission frequency is software programmable in a ± 1 MHz range. The high RF output power of up to 10 W gives excellent range and good track coverage.

From the data acquisition system transmit data is fed into the FM 40 via a RS232 interface. Typically the FM 40 is operated as an unidirectional telemetry transmitter. For other applications, half duplex bidirectional operation is also possible.



Mechanical Data	
Size	151 x 138 x 28 mm
Weight	720 g
Housing with LED indicators	
Car antenna compatible to existing Bosch telemetry systems.	

Conditions for Use	
Max. vibration	60 m/s ² @ 20 Hz ... 2 kHz
Temperature range	0 ... 60 °C
Max. power consumption	25 W at 14 V
International standard I-ETS 300 220, ETS 300 113, FCC	

Connectors	
RF	BNC female
Power / data	CGK SOT 8N35 PN

Electrical Data	
Half duplex radio modem (bidirectional)	
Internal data buffer and protocol management	
Frequency range	430 ... 470 MHz (hardware adjustable)
F(center) ± 1 MHz (software programmable)	
Transmission power	1 ... 10 W
Receiver sensitivity	-116 dBm error detection and forward error correction (FEC)
RF channel bandwidth	12,5 kHz @ 9.6 kbps 25 kHz @ 19.2 kbps
Data interface	RS232
Data rate	9.6 / 19.2 kbps
Required power supply	10 ... 18 V
Max. current	< 2,5 A

Part Number	
FM 40	B 261 208 898-01

3.2 Pit Receiver Box

The Pit Receiver Box integrates all electronic components necessary to receive telemetry data from a car equipped with a FM 40 transmitter in one weatherproof package. Typically the receiver box is mounted on the pit roof as close as possible to the RX antenna, thus minimizing cable loss. The connection cable to the receiving PC in the garage, which can be up to 50 m long, also supplies power to the Pit Receiver Box.

Different versions of the receiver box are offered to support several system configurations.



Mechanical data

Weight	4.2 kg
--------	--------

Conditions for use

Working temperature range	-20 ... + 50 °C
Max. distance receiver box to PC (with cable B 261 209 481)	50 m
Antenna connector	BNC (Jack) 50 Ω
Data and power connector	motorsports type

Electrical data

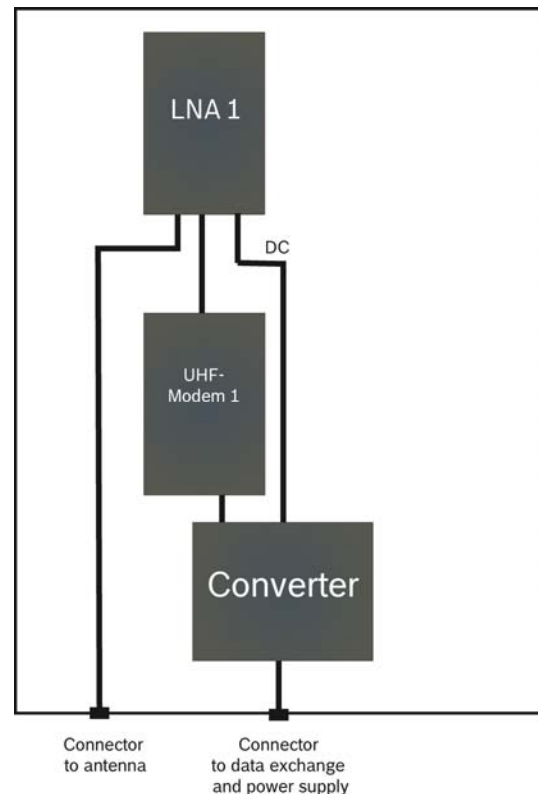
Frequency range	400 ... 470 MHz
Working frequency band	$f_c \pm 1$ MHz
Channel spacing	12.5/25 kHz
Sensitivity	≤ -116 dBm @ BER 10^{-3}
Serial interface	RS232 (19.2 kBit/s, no parity, 8 data bit, 1 stop bit, no flow control)
Radio data rate	19.2 kbps (25 kHz channel) 9.6 kbps (12.5 kHz channel)
Operating voltage	12 V (10 ... 14 V)
Power consumption	approx. 7 W

3.2.1 Pit Receiver Box 1

The Pit Receiver Box 1 contains all electronic components and cables necessary to receive data from a single car, preassembled in a weatherproof box.

The external RX antenna is connected to a low noise filter amplifier (LNA 1). The amplified signal is then fed into the UHF receiver which decodes the data stream. The data converter is used to transmit the data via the connection cable to the server PC in the garage.

Part Number	
Pit Receiver Box 1	F 01T A20 451-01

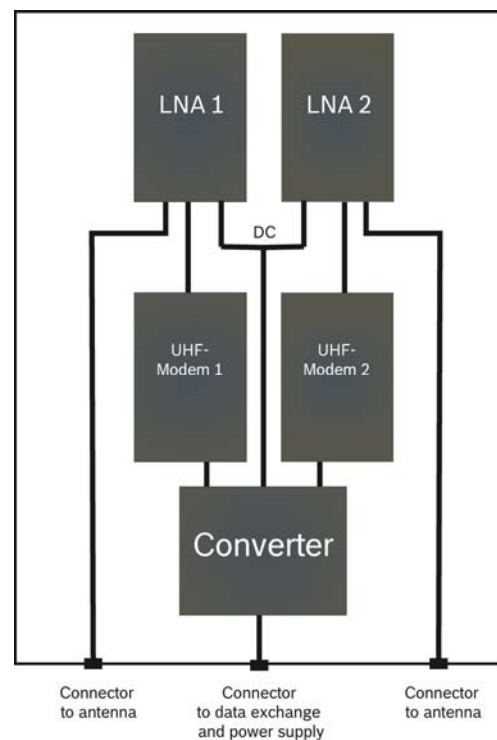


3.2.2 Pit Receiver Box 1/R

The Pit Receiver Box 1/R includes two separate receiver systems which enable the parallel reception of two telemetry data streams. Two RX antennas can be connected to the twin low noise filter amplifiers (LNA 1, LNA 2).

Typical application are the reception of telemetry data from two cars or a system configuration with one car and a telemetry relay station.

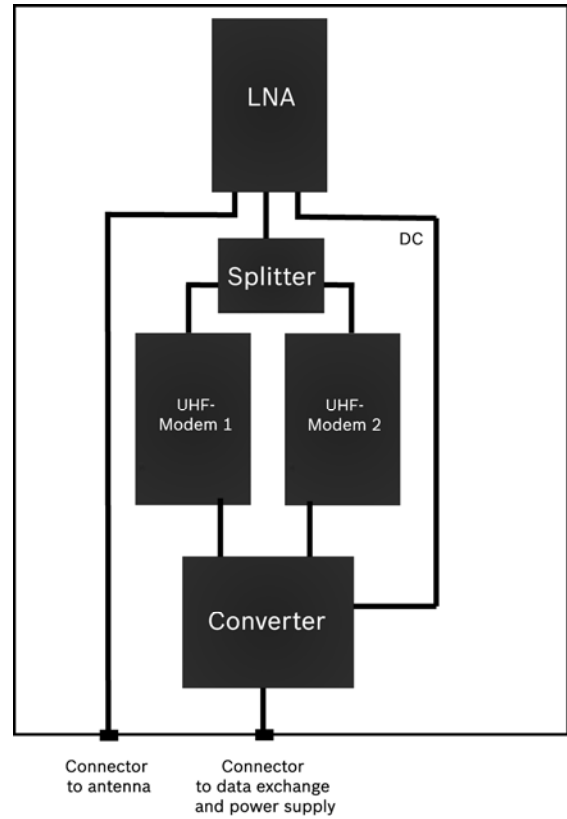
Part Number	
Pit Receiver Box 1/R	F 01T A20 453



3.2.3 Pit Receiver Box 2

The Pit Receiver Box 2 contains two UHF receivers fed by a single RX antenna and low noise filter amplifier (LNA). This enables parallel telemetry data reception from two cars, provided both transmitters operate in the same frequency band.

Part Number	
Pit Receiver Box 2	F 01T A20 455



3.2.4 Pit Receiver Package 1/R and 1

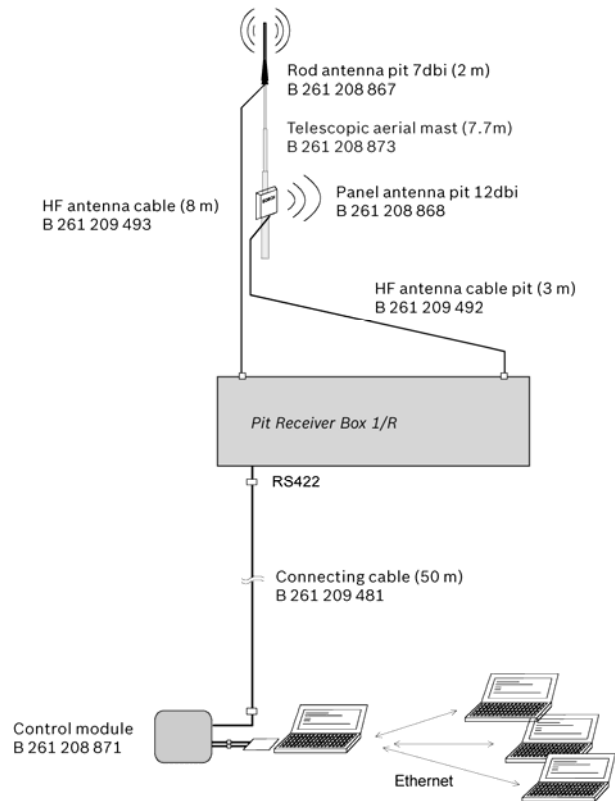
The Pit Receiver Packages 1/R and 1 contain antennas, rf cables, data cables and the controller box, i.e. everything that is required to start operation.

Part Number	
Pit Receiver Package 1/R	F 01T A20 454

Content Pit Receiver Package 1/R	
Pit Receiver Box 1/R	F 01T A20 453
HF antenna cable (8 m)	B 261 209 493
Rod antenna pit 7 dbi (2 m)	B 261 208 867
HF antenna cable pit (3 m)	B 261 209 492
Panel antenna pit 12 dBi	B 261 208 868
Connecting cable (50 m)	B 261 209 481
Control module RS232/RS422 pit	B 261 208 871
Telescopic aerial mast (7.7 m)	B 261 208 873

Part Number	
Pit Receiver Package 1	F 01T A20 452

Content Pit Receiver Package 1	
Pit Receiver Box 1	F 01T A20 451
HF antenna cable (8 m)	B 261 209 493
Rod antenna pit 7 dbi (2 m)	B 261 208 867
Connecting cable (50 m)	B 261 209 481
Control module RS232/RS422 pit	B 261 208 871
Telescopic aerial mast (7.7 m)	B 261 208 873

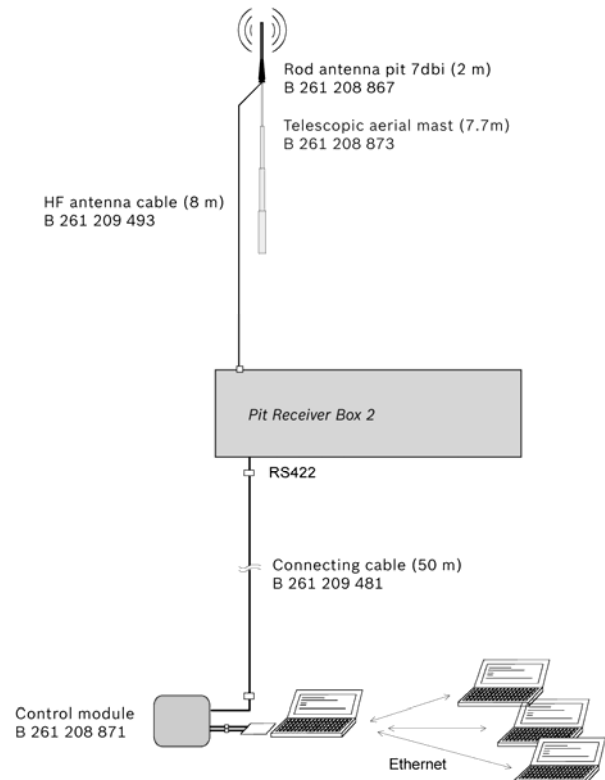


3.2.5 Pit Receiver Package 2

The Pit Receiver Package 2 contains antennas, rf cables, data cables and the controller box, i.e. everything that is required to start operations.

Part Number	
Pit Receiver Package 2	F 01T A20 456

Content Pit Receiver Package 2	
Pit Receiver Box 2	F 01T A20 455
HF antenna cable (8 m)	B 261 209 493
Rod antenna pit 7 dBi (2 m)	B 261 208 867
Connecting cable (50 m)	B 261 209 481
Control module RS232/RS422 pit	B 261 208 871
Telescopic aerial mast (7.7 m)	B 261 208 873



3.3 Telemetry Accessories

3.3.1 FM 40 Tester

The FM 40 Tester is used to check the performance of telemetry components installed in the car which includes the FM 40 in conjunction with the RF cable and the antenna. The FM 40 tester indicates RF output power as well as defective RF cables or car antennas enabling quick detection of faulty components.



Measurement range	
Transmission power	1 ... 15 (60) W
VSWR	1 ... 6
Frequency band	VHF / UHF

Connectors	
RF	BNC male / female

Part number	
FM 40 Tester	B 261 208 894-01

3.3.2 Telemetry Antenna Dummy Load

The telemetry antenna dummy load replaces the telemetry car antenna when running the FM 40 transmitter in the workshop or the garage. It reduces high power RF radiation.



Measurement range	
RF power	15 W
VSWR	1.1
Frequency band	VHF / UHF

Connectors	
RF	BNC male / female

Part number	
Telemetry Antenna Dummy Load	B 261 208 900-01

3.3.3 Telemetry Car Antenna

Rugged telemetry antennas for car mounting.



Dual Band Single Band

Parameter	
Single Band Car Antenna	
Frequency band	UHF
Type	1/4λ
Pattern (hor.)	omni
Length	150 mm
Dual Band Car Antenna	
Frequency band	VHF / UHF
Gain	1/4λ / 5/8λ
Pattern (hor.)	omni
Length	440 mm

Connectors	
RF	BNC male

Part number	
Single Band Car Antenna	B 261 208 888
Dual Band Car Antenna	B 261 208 862-01

3.3.4 Antenna Cable Kit

For car mounting

RF cable for the installation of telemetry antennas in the car. Intended for single hole mounting.



Measurement range	
Length	max. 2 m (tbd.)
Drill hole diameter	12,5 mm
Attenuation	max. 0.7 dB @ 2 m, 450 MHz

Connectors	
RF	BNC male / female

Part number	
Antenna Cable Kit	B 261 209 490-01

4 Important mounting Instructions

4.1 Installation of the FM40-Telemetry modem



The modem has to be mounted on shock absorbing material (e.g. foam rubber).

Please do not allow a vibration level greater than 6 g for proper function.

Do not install the modem near the engine (temperature and vibration may cause damage or malfunction).

FM40 needs airflow for cooling.

4.1.1 Antenna

For optimum radiation mount the antenna as high as possible in vertical position. Keep distance to all vertical conductive materials having a length of more than 25 cm (10").

Mounting the antenna on a conductive plane (RF-groundplane) ensures good radiation. However, mounting on carbon fibre materials also works good if the mounting hole is closely fit to the coax-BNC-socket (antenna attachment). This is for the conductive carbon fibre to get contact to the outer conductor of the coax plug, which is RF-ground. An enhancement is possible using copper or aluminium foil stucked under the carbon having contact to the outer conductor of the plug (diameter >15cm (6") around the antenna socket).

4.1.2 Cables

Keep all RF-cables as short as possible to reduce losses in transmit power.

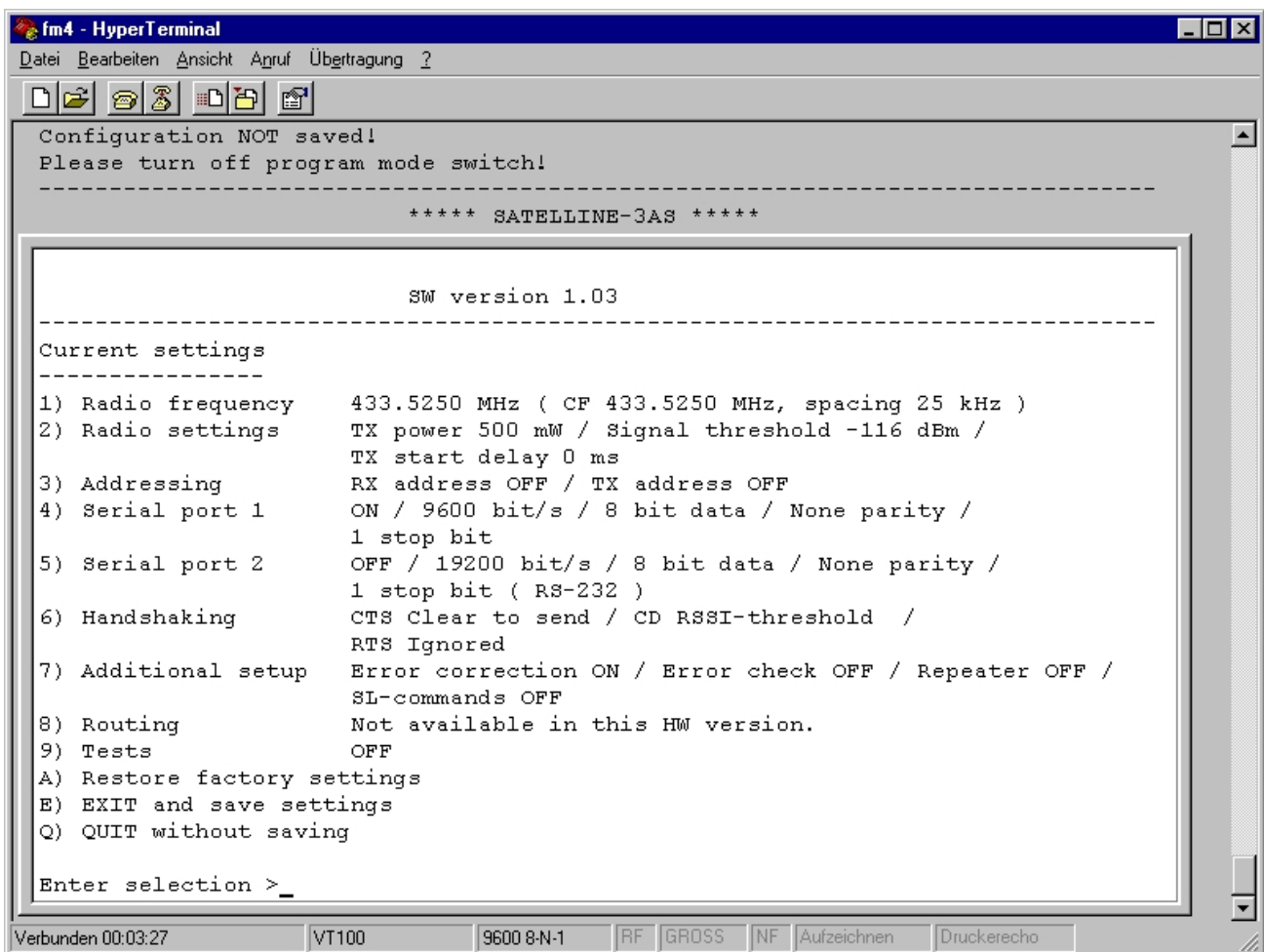
As reference value, the length of all coax cables from modem output to antenna shall not exceed 2 m (80").

5 Configuration

All FM40 devices are configured the same way by using a terminal program (e.g. Windows HyperTerminal), connected to the FM40 via RS232.

The RS232 interface is set up as follows: 9600 bit/s, 8-bit data, no parity, 1 stop bit (Data rate for configuration is always 9600 bit/s, even if a different transmission data rate is configured).

By changing the switch (configuration cable B 261 209 430 or controller B 261 208 871) to prog-mode the settings menu is entered. Now the user can make changes: by typing the number of the menu item, submenus are displayed.



```
fm4 - HyperTerminal
Datei Bearbeiten Ansicht Anruf Übertragung ?
-----
Configuration NOT saved!
Please turn off program mode switch!
-----
***** SATELLINE-3AS *****
-----
SW version 1.03
-----
Current settings
-----
1) Radio frequency      433.5250 MHz ( CF 433.5250 MHz, spacing 25 kHz )
2) Radio settings      TX power 500 mW / Signal threshold -116 dBm /
                       TX start delay 0 ms
3) Addressing          RX address OFF / TX address OFF
4) Serial port 1       ON / 9600 bit/s / 8 bit data / None parity /
                       1 stop bit
5) Serial port 2       OFF / 19200 bit/s / 8 bit data / None parity /
                       1 stop bit ( RS-232 )
6) Handshaking         CTS Clear to send / CD RSSI-threshold /
                       RTS Ignored
7) Additional setup    Error correction ON / Error check OFF / Repeater OFF /
                       SL-commands OFF
8) Routing             Not available in this HW version.
9) Tests               OFF
A) Restore factory settings
E) EXIT and save settings
Q) QUIT without saving

Enter selection >_
-----
Verbunden 00:03:27  VT100  9600 8-N-1  RF  GROSS  NF  Aufzeichnen  Druckerecho
```

6 Recommended set up of the FM40

Item :	Comment		Standard setting
1) Radio Frequency	<p>the frequency channel is set by typing * * * . * * * * <RETURN></p> <p>The entered numbers are not echoed, check the frequency displayed after hitting the return key.</p> <p>If the frequency typed in is out of the channel grid the FM40 automatically selects the closest possible frequency.</p>		<p>Center frequency (fc) 430 - 470 MHz by order</p> <p>81 Channels in the interval fc +/- 1,0 MHz by user selectable</p> <p>Channel spacing 0,025MHz</p> <p>between two transmitters being operated the time keep 0.050 MHz minimum separation.</p>
			<p>Rx Threshold -115dBm,</p> <p>Tx Start Delay 0 ms</p>
3) Addressing	could be used when operating more than one transmitter on the same channel, do not use for racecar-telemetry		<p>Rx address OFF,</p> <p>Tx address OFF</p>
4) Serial Port 1	set up the RS232 interface.		<p>ON, 19200 Bit/s,</p> <p>8 bit Data, no Parity 1 Stop bit</p>
5) Serial Port 2	not used		OFF
6) Hand-shaking	handshaking settings of the RS232 interface		<p>CTS Line Property : Clear to send</p> <p>CD Line Property : Data on channel</p> <p>RTS Line Property : Ignored</p>
7) Additional Setup	<p>Error-correction or error-detection coding for RF-link, repeater-function (FM40 will repeat all incoming messages), enable SL-commands (refer to chapter 7), set priority function</p>	<p>Error correction</p> <p>Error Check</p> <p>Repeater</p> <p>SL-Commands</p> <p>Priority</p>	<p>ON</p> <p>OFF</p> <p>OFF</p> <p>only if needed ON,else OFF</p> <p>TX</p>
8) Routing	FM40 repeats data on the same channel but with different addressing, do not use.		OFF

9) Tests	several test modes for hardware checks	OFF
A) Factory Setup	reset all settings to factory standard	do not select
E) Exit and save	save settings and return to normal operation (after release of the progmode switch)	
Q) Quit without save	cancel all changes and return to normal operation (after release of the progmode switch)	

→ **STORE** the changes by pressing “**e**”

→ **CANCEL** the changes by pressing “**q**”

After setting the switch back to data mode the FM40 is ready to receive or transmit data.

7 Changing parameters using the SL-COMMANDS

If the SL-command function has been activated active radio channel and addresses can be changed without switching the radio modem into configuration mode.



Make sure, that if SL-commands are activated, the data stream does not contain any bit stream being identical to a SL-command. Unwanted change of a parameter would be the result.

Command	Effect and description of command
SL&F=nnn.nnnn	Set frequency to nnn.nnnn MHz
SL&+=nn	Set frequency nn channels above center frequency Frequency=Center frequency+nn*Channel spacing, where nn=[0...Number of channels/2]
SL&-=nn	Set frequency nn channels below center frequency Frequency=Center frequency-nn*Channel spacing, where nn=[0...Number of channels/2]
SL**>	Save current settings as permanent settings

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