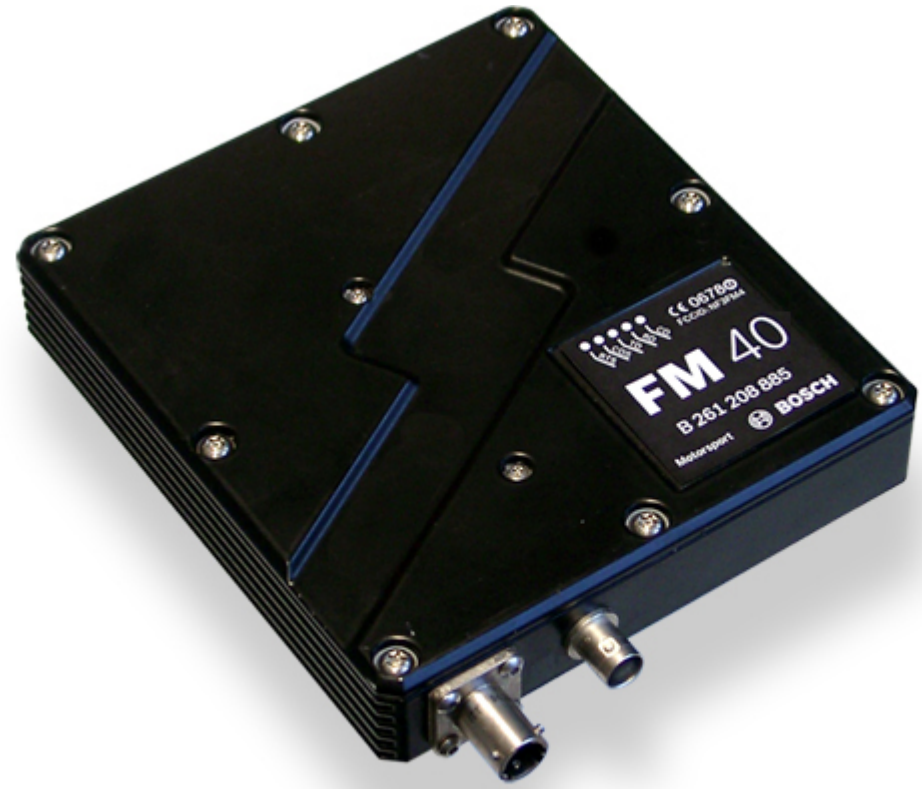
BOSCH



Telemetry System FM 40

System Overview

V1.2 12/10/2012

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1 Safety Instructions

⚠ Warning

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 261 208 888-01.

2 Restricitons 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.

⚠ Warning

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

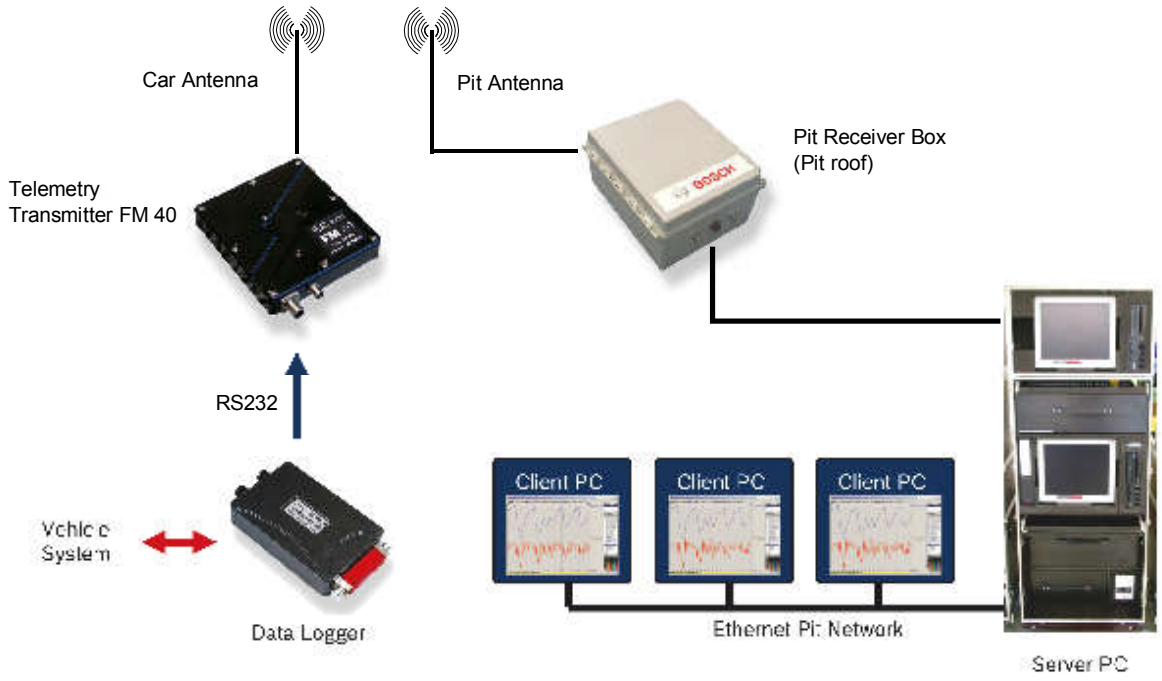
EC Certificate of Conformity

3 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 wire to the TX antenna.

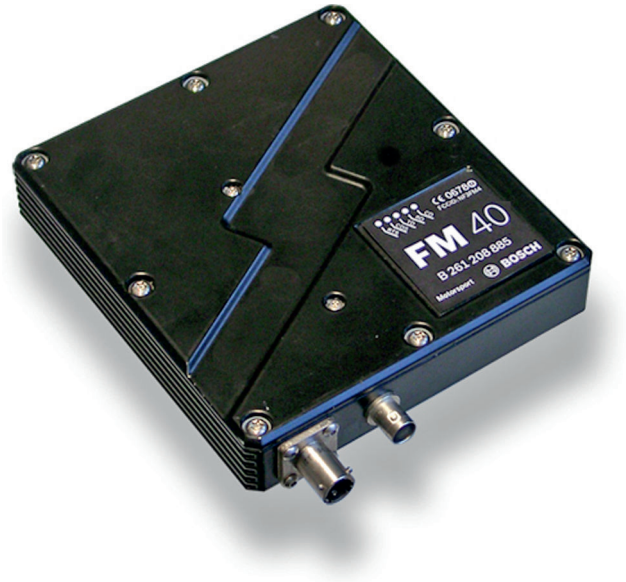
In the pits, the RF signal is picked up by an RX antenna connected to the pit receiver box. Inside the receiver box, the signal is filtered and amplified by a low noise filter amplifier. It is then sent to a UHF modem. The modem demodulates the data stream and performs error correction, if necessary. The output stream passes the data converter and is transferred via a connection wire 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 to 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.



4 Technical Data

4.1 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 to 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.

International standard	I-ETS 300 220, ETS 300 113, FCC

Mechanical Data

Size	151 x 138 x 28 mm
Weight	720 g
Housing with LED indicators	
Car antenna compatible to existing Bosch telemetry systems.	
Max. vibration	60 m/s^2 at 20 Hz to 2 kHz

Electrical Data

Half duplex radio modem (bidirectional)	
Internal data buffer and protocol management	
Frequency range	430 to 470 MHz (hardware adjustable)
	F(center) ± 1 MHz (software programmable)

Transmission power	1 to 10 W
Receiver sensitivity	-116 dBm error detection and forward error correction (FEC)
RF channel bandwidth	12,5 kHz at 9.6 kbps 25 kHz at 19.2 kbps
Data interface	RS232
Data rate	9.6 / 19.2 kbps
Required power supply	10 to 18 V
Max. power consumption	25 W at 14 V
Max. current	< 2,5 A
Operation temperature range	0 to 60°C

Connectors and Wires

RF	BNC female
Power / data	CGK SOT 8N35 PN

4.2 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 weather-proof 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 wire to the receiving PC in the garage, which can be up to 50 m long, also supplies power to the Pit Receiver Box.

The Pit Receiver Box contains 1 to 4 UHF receivers fed by a single RX antenna and low noise filter amplifier (LNA). This enables parallel telemetry data reception from up to 4 cars, provided transmitters need to operate in the same 2 MHz frequency band.

The Box is equipped with dual Ethernet port for redundant Ethernet wire to the pit or for connection to a directional link (relay station).

Mechanical Data

Weight	4.2 kg
Size	330 x 280 x 180 mm
Max. distance receiver box to PC (with F 020 V01 440-01	50 m
Working temperature range	-20 to 50°C

Electrical Data

Frequency range	400 to 470 MHz
Working frequency band	fc ±1 MHz
Channel spacing	12.5/25 kHz
Sensitivity	≤ -116 dBm at 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	20 to 50 V
Communication	2 x 10 / 100 Mbit ethernet
Power consumption	10 W

Connectors and Wires

Data and power connector	Motorsports type
Antenna connector	BNC (Jack) 50 Ω

Package Parts

Box
48 V power supply

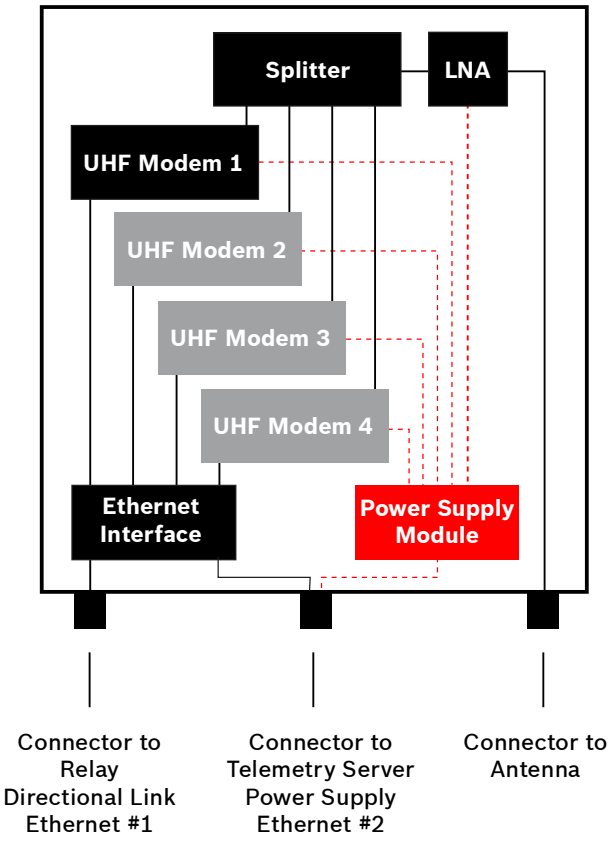
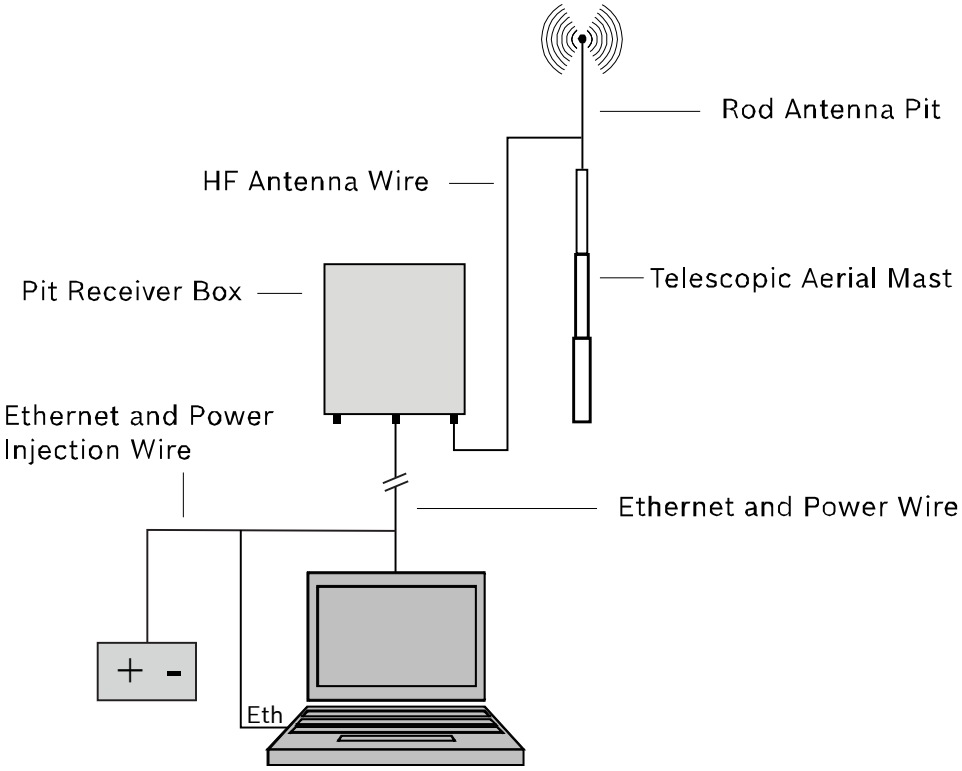


Fig. 1: Scheme Pit Receiver Box

4.3 Pit Receiver Package



The Pit Receiver Package contains everything that is required to start operation.

Package Parts

Pit Receiver Box (2 channels)	F 02U V01 460-01
HF antenna wire (8 m)	B 261 209 493
Rod antenna pit 7 dbi (2 m)	B 261 208 867
Ethernet and power wire (50 m)	F 020 V01 440-01
Ethernet and power injection wire (1.5 m)	B 261 209 744-01
Telescopic aerial mast (7.7 m)	B 261 208 873

4.4 Telemetry Accessories

4.4.1 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 wire and the antenna. The FM 40 tester indicates RF output power as well as defective RF wires or car antennas enabling quick detection of faulty components.

Electrical Data

Transmission power	1 to 15 (60) W
VSWR	1 to 6
Frequency band	VHF / UHF

Connectors and Wires

RF	BNC male / female

4.4.2 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.

Electrical Data

RF power	15 W
VSWR	1.1
Frequency band	VHF / UHF

Connectors and Wires

RF	BNC male / female

4.4.3 Telemetry Car Antenna

Rugged telemetry antenna for car mounting.

Frequency band	UHF
Type	¼ λ
Pattern (hor.)	omni
Length	150 mm

Connectors and Wires

RF	BNC male

4.4.4 Antenna Cable Kit

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

Length	Max. 2m (tbd.)
Drill hole diameter	12,5 mm
Attenuation	Max. 0.7 dB at 2 m, 450 MHz

Connectors and Wires

RF	BNC male / female

5 Installation of the FM 40 Unit

⚠ Warning

The FM 40 unit has to be mounted on shock absorbing material (e.g. foam rubber).

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

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

The FM 40 unit needs airflow for cooling.

5.1 Antenna

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

Mounting the antenna on a conductive plane (RF-ground plane) 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 sticked under the carbon having contact to the outer conductor of the plug (diameter >15 cm (6") around the antenna socket).

5.2 Cables

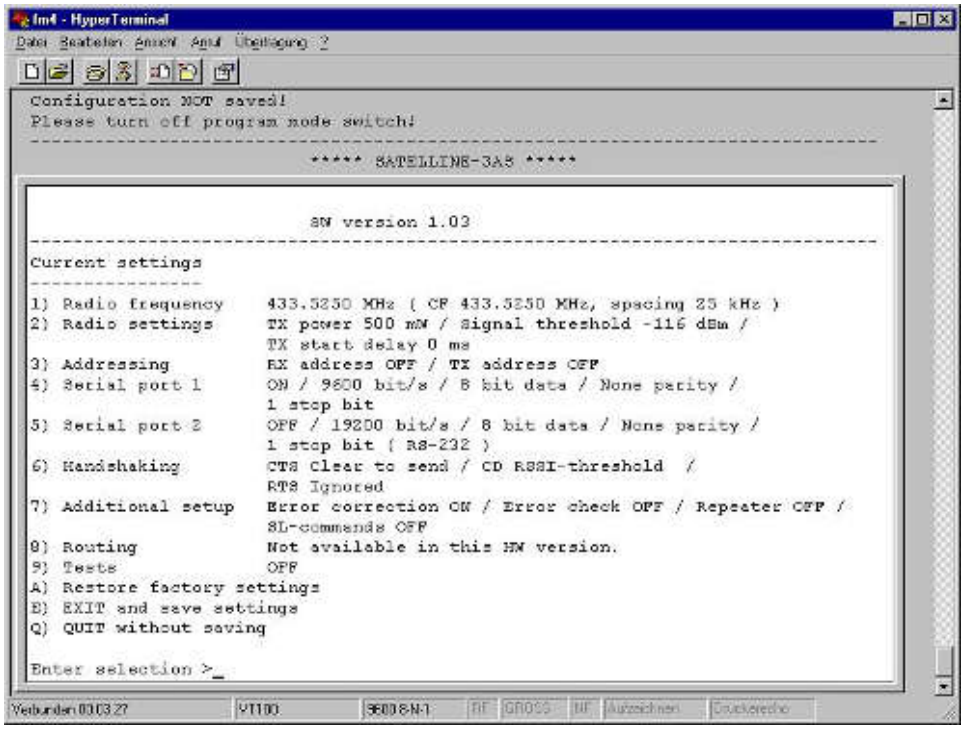
Keep all RF-cables as short as possible to reduce losses in transmit power. As reference value, the length of all coax cables from modem output to antenna shall not exceed 2 m (80").

6 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 progmode the settings menu is entered. Now the user can make changes: by typing the number of the menu item, submenus are displayed.



7 Recommended Setup of the FM 40

Item	Comment		Standard setting
1) Radio frequency	The frequency channel is set by typing ***.**** <RETURN> The entered numbers are not echoed, check the frequency displayed after hiding the return key. If the frequency typed in is out of the channel grid, the FM 40 automatically selects the closest possible frequency.		Centre frequency (fc) 430 - 470 MHz by order 81 Channels in the interval fc +/- 1.0 MHz by user selectable Channel spacing 0.025 MHz Between two operated transmitters the time keeps 0.050 MHz minimum separation.
			Rx Threshold –115 dBm, Tx Start Delay 0 ms
3) Addressing	Could be used when operating more than one transmitter on the same channel, do not use for race car telemetry		Rx address OFF, Tx address OFF
4) Serial Port 1	Setup the RS232 interface.		ON, 19,200 Bit/s, 8 bit Data, no Parity 1 Stop bit
5) Serial Port 2	Not used		OFF
6) Handshaking	Handshaking settings of the RS232 interface		CTS Line Property: Clear to send CD Line Property: Data on channel RTS Line Property: Ignored
7) Additional Set-up	Error-correction or error-detection coding for RF-link, repeater-function (FM 40 will repeat all incoming messages), enable SL-commands, set priority function	Error correction	ON
		Error Check	OFF
		Repeater	OFF
		SL-Commands	On if needed, else OFF
		Priority	TX
8) Routing	FM 40 repeats data on the same channel but with different addressing, do not use.		OFF

Item	Comment	Standard setting
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.

8 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.

⚠ Warning

Make sure, that if SL-commands are activated, the data stream does not contend 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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Status: 10 December 2012