ROHDE&SCHWARZ
TEST AND MEASUREMENT DIVISION

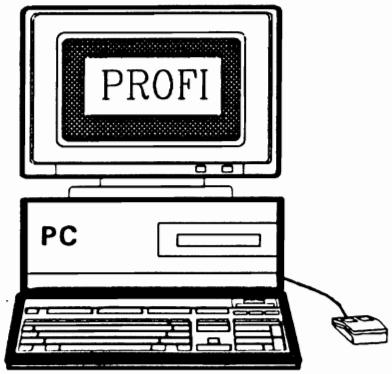
Application note (preliminary)

SMT (SME) with RDS Coder DMC01

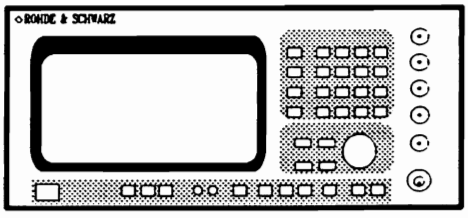
A powerful signal generator system for any STEREO/RDS application

Products:

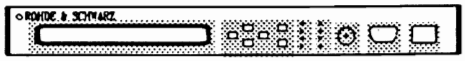
SMT, SME, DMC01



SMT/SME



DMC01



1. Introduction

The SMT (respectiveley SME) in conjunction with the RDS coder/decoder DMC01 represents an unexpensive and powerful system for STEREO modulation with RDS/VRF data generation according to standard specifications.

The stereo modulation is done by the SMT. The RDS/VRF coded subcarrier (57kHz) is generated by the DMC01 and modulated on the (already stereo modulated) RF carrier by the SMT again.

With this system the user is able to generate stereo and RDS coded signals with any variation possibilities regarding the RF carrier (frequency, level), structure of the modulation signal (stereo signal, pilot signal, RDS, VRF), modulation depth and RDS data.

In the following description there is mostly only the SMT mentioned. However the SME is as well as the SMT suitable for this application. The settings on the SME are the same as on the SMT.

2. Hardware equipment

2.1 Hardware requirements of SMT/SME and DMC01

Basically the signal generator has to provide frequency modulation. That means that the SME needs the option FM/φM Modulator SM-B5. The FM modulator on the SMT ist standard fitting.

For the generation of the STEREO MPX signal the option Multifunction Generator SM-B6 is needed for both generators.

Signal Gen.	SMT02/03	SME02/03
Output frequency:	1.5/3GHz	1.5/3GHz
Option **SM-B5**:	-	needed
Option **SM-B6**:	needed	needed

The DMC01 is available with various hardware and software fittings (see Sales Circular 1304-E). For this application the standard models DMC01C or DMC01 are sufficient. The DMC01 is recommended because of its chassis and operating possibilities via the front panel.

2.2 Technical Features of SMT/SME

SMT and SME provide excellent capabilities regarding STEREO MPX modulation. Due to the highly accurate FM modulators and the complex functions of the Multifunction Generator SM-B6 both generators are suitable even for highly demanding measurements on FM stereo receivers.
In conjunction with the RDS/VRF coder DMC01 SMT and SME will complete to allround genies.

Main specifications of the FM modulators of SMT and SME

	SMT	SME (with SM-B5)
STEREO modulation at 40kHz deviation, AF=1kHz:		
Stereo separation	>50dB	>50dB
Unweighted S/N ratio (RMS)	>73dB	>76dB
Weighted S/N ratio (RMS)	>66dB	>76dB
Distortion	<0.2%	<0.1%
Basic specifications:		
Max. deviation	up to 20MHz	up to 2MHz
Modulation frequency range with maximum deviation	DC to 8MHz	DC to 500kHz

Operating modes: Internal, external AC/DC, two tone with two separate channels FM1 and FM2.

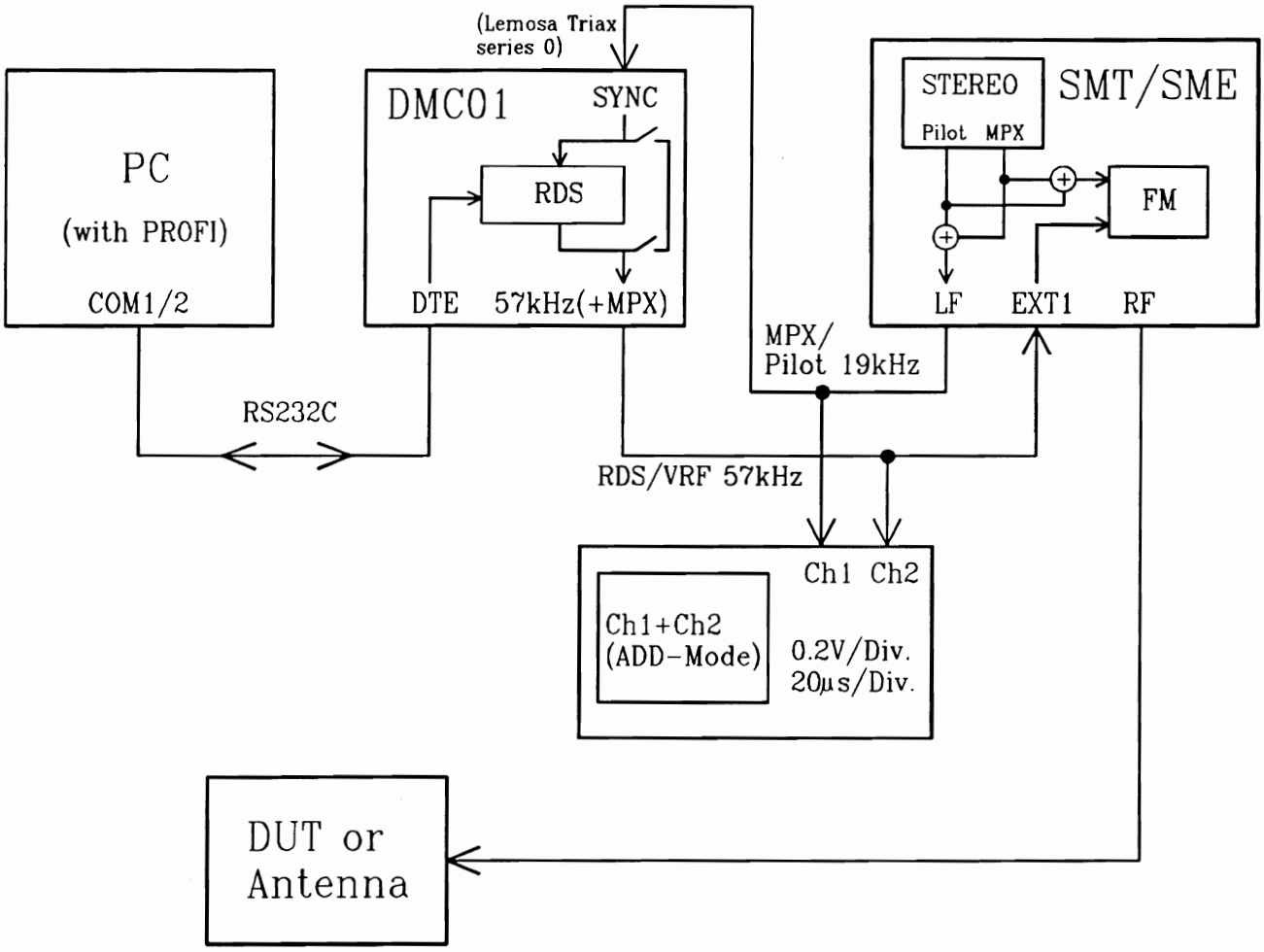
Main Specifications and Features of the Multifunction Generator SM-B6

STEREO MPX signal:	
Stereo operating modes	R, L, R=L, R=-L, ARI (Pilot tone or MPX signal can be connected to LF socket)
Frequency range of L, R signal	0.1Hz to 15kHz
Preemphasis	50µs, 75µs
Pilot tone frequency	19kHz ±1Hz
Pilot tone phase	0 to 360°, 0.1° resolution
Stereo separation	>60dB
Distortion	<0.1% (L, R = 1kHz)
Carrier suppression (38kHz)	>65dB
Settings selectable for ARI (German traffic information broadcast service):	
Area identification signal	A, B, C, D, E, F
Traffic announcement identification	on/off
Additional signals	RDS, RDS+ARI via EXT1 input
Basic specifications:	
Waveforms:	sinewave, triangular, sawtooth, squarewave, noise, stereo MPX signals, VOR/ILS modulation signals.
Frequency range for sinewave, noise	0.1Hz to 1MHz
Frequency range for triangular, sawtooth, squarewave	0.1Hz to 50kHz
Level (EMF) at LF socket	1mVp to 4Vp (R_{out} = 10Ω, R_L > 200Ω)

3. Test setup and settings

3.1 General setup

Picture 1 shows the test setup. The STEREO MPX modulation is generated internal in the SMT. The LF output of the SMT provides the 19kHz pilot signal for synchronizing the DMC01. On the 57kHz(+MPX) output of the DMC01 is the data coded RDS signal which modulates the SMT via the EXT1 input.



Picture 1: General Test setup

3.2 NF level and FM deviation

To generate a RDS und VRF modulation on the RF carrier which meets the standard specification regarding the FM deviation a suitable output level on the DMC01 is required.
The output level of the DMC01 has to be adapted to the modulation sensitivity of the SMT. The following table shows the standard deviations for each signal and the corresponding level of the baseband signals for a modulation sensitivity at the external input EXT1 of 10kHz/1Vpeak.

Signal	Standard FM deviation	NF level of external modulation signals on EXT1 for 10kHz/1Vpeak FM deviation
Stereo MPX without pilot	±40kHz	(internal connected)
Pilot 10kHz	±6.72kHz	(i.c.)
RDS 57kHz (zero sequence)	±1.20kHz	0.120Vp = 0.240Vpp
VRF 57kHz (unmodulated)	±3.50kHz	0.350Vp = 0.700Vpp

Table 1: Standard deviations and NF levels

The NF levels for RDS and VRF must be set on the DMC01.

3.3 Settings on SMT

Preset of the SMT:

PRESET

Setting of RF frequency and level (depends on application):

FREQ 107MHz
LEVEL 50dBµV

Activating of the internal stereo modulation:

MODULATION/STEREO/MODE R
.../DEVIATION 40kHz
.../PILOT STATE ON
.../PILOT DEVIATION
6.72kHz

Switching the internal MPX signal to the LF output:

LF OUTPUT/STATE ON
.../SOURCE LFGEN2
.../STEREO OUTPUT MPX

(Please select the MPX signal and not the PILOT signal. The DMC01 synchronizes to the 19kHz pilot of the MPX signal.)

Defining the modulation input for the RDS signal:

MODULATION/FM/FM1 DEVIATION 10kHz
.../FM1 SOURCE EXT1
.../EXT1 COUPLING AC

3.4 Settings on DMC01

If the DMC01 only shall provide the RDS/VRF signal as it is realized in picture 1, the internal connection of the input signal (pilot or MPX) to the output must be opened. This hardware setting according to the individual requirements of the customer is normally done by Rohde&Schwarz.

The settings on the DMC01 can be done either via the front panel or by means of the program PROFI (see Chapter 4).
If the settings shall be done via the front panel the following action is necessary.

For selecting a submenu the cursor should be moved by the cursor keys to the target and the ENTER key should be pressed. The ESC key leads back to the previous menu.
If a value has to be changed, the cursor should be moved on the value, the ENTER key should be pressed and the value will change by using the UP and DOWN cursor keys. The ENTER key has to be pressed again to enter the new value.

Setting of the output level of the RDS and VRF signal (according to table 1):

CODER/RDS 240mVpp
CODER/VRF 700mVpp
CODER/CALIBR./LEVEL 0dB

With the above mentioned settings the SMT will produce the following warning:

WARNING 153 Input voltage out of range; EXT1 too low

This warning doesn't effect the function and the quality of the modulation signal in any way. It's just because the input voltage of EXT1 is lower than 1Vp (-3%), which is the value the FM1 DEVIATION 10kHz is related to. (In fact a deviation of 10kHz isn't desirable.)

Basically it is possible to suppress the a.m. warning by generating an output level of 1V and entering a suitable FM1 deviation. But then the user will need for each combination of RDS (ON/OFF) and VRF (ON/OFF) a new setting for the output level on the DMC01 and the FM1 deviation on the SMT.

3.5 Phase adjustment

To get a minimal FM deviation due to the sum of the 19kHz pilot and the 57kHz RDS signal the phase between them both has to be adjusted.
It is sufficient to do the adjustment on each test setup just one time (after a warm up time of about 15 minutes).

Settings on the Oscilloscope

Sensitivity	0.2V/Div.
Sweep Time	10µs/Div.
ADD Mode:	CH1 + CH2

Settings on the SMT

see 3.3
Furthermore:

Switch the NF signals of the MPX signal in the following way off:

MODULATION/STEREO/DEVIATION 0kHz

Settings on the DMC01

Level settings as in 3.4 described
Furthermore:

Switch the RDS signal off:

CODER/RDS/STATE OFF

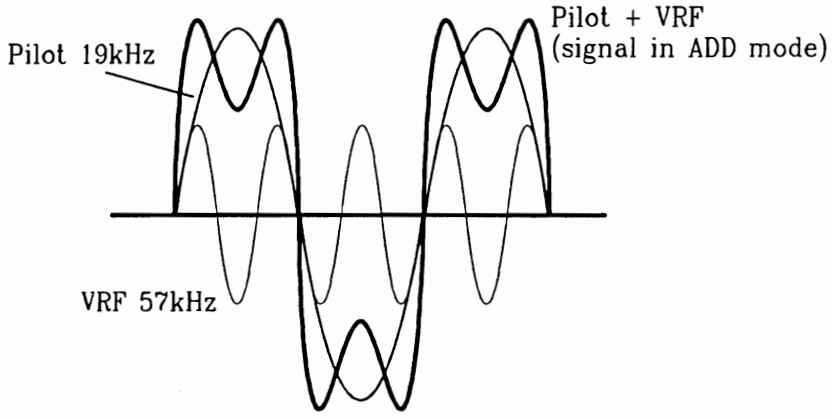
Switch the unmodulated VRF signal on:

CODER/VRF/VRF ON
/DK/TA OFF
/BK OFF

Adjust the phase for minimum FM deviation:

CODER/PHASE/αPILOT/*adjustment value*

The phase between 19kHz (CH1) and 57kHz (CH2) must be such that the maxima of the 19kHz signal lies on the minima of the 57kHz signal and vice versa. In the ADD mode of the oscilloscope the following symmetrical signal has to be watched:



Picture 2: Oscillogram of summing signal 19kHz pilot and 57kHz VRF.

The symmetry of the two peaks (which means that the FM deviation is minimal) must be reached by varying the pilot phase on the DMC01.

For compensating the delay time difference (in the SMT) between the internal pilot and the 57kHz signal on the EXT1 input a phase offset of 13° has to be taken into account.
The phase offset has to be added to the adjustment value for the symmetrical summing signal according picture 2.

So the actual setting for the 57kHz phase yields:

CODER/PHASE/αPILOT/*adjustment value + 13°*

With that the summing signal of picture 2 becomes a little bit unsymmetrical again. But now the corresponding modulation signal in the SMT on the RF carrier is symmetrical and the FM deviation is minimal.

After phase adjustment the NF signals can be activated again:

MODULATION/STEREO/DEVIATION 40kHz

The test setup is now adjusted and operational.

3.6 Switching and selecting of data signals

Switching the RDS signal:

CODER/RDS/STATE ON(OFF)

Switching the VRF signal:

CODER/VRF/VRF ON(OFF)

Selecting a data signal for RDS:

CODER/DS/DS DS1(DS2 to DS8,DSIB)

The data signal registers DS is programmed by means of the program PROFI (see Chapter 4).

4. Data programming of the DMC01 using PROFI

4.1 Overview on PROFI

The program PROFI represents a powerful instrument for controlling the data and function of the DMC01. It is able to control up to 256 DMC01 in a wide and complex structured broadcasting network as well as just one DMC01 in a test setup of a laboratory

All analog setups, data and transmission structures will be generated by PROFI. The customer gets PROFI free of charge when he purchases a DMC01.

There are two versions of PROFI available: One which needs 3MByte of extension memory, another which just needs 580kByte of DOS memory. For the second version a fast CPU and harddisk is recommended, because of the numerous harddisk accesses.

4.2 Requirements of the PC/Installation

Required Hardware:

IBM PC, AT or 100% compatible system

either:
- 520kByte free DOS memory
- 3MByte extended memory (PROFI Version X.XX for extended memory)

or:
- 580kByte of free DOS memory (PROFI Version X.XXs for DOS memory)

4MByte harddisk memory
Colour monitor
Mouse
Serial interface (COMx) for PROFI

RS232C cable

Required Software:

MS-DOS 3.3 or further
PROFI (either version for extended memory or version for DOS memory)

Installation:

In the CONFIG.SYS FILES =40 is needed.
PROFILHA.EXE has to be copied to the harddisk. After entering PROFILHA the file will be unpacked into several program and control files.
To start the main program PROFI has to be entered.

For changing the setup see the operating manual of PROFI.

4.3 Serial interface

After starting PROFI the user has to ensure that the correct serial interface of the PC is used by PROFI. The actual settings depends on the PC of the user:

SERVICES/PC COM

☞	COM:	COM1
☞	BAUD RATE:	9600
☞	PARITY:	N
☞	DATA:	8
☞	STOP	1
	OK	

(☞ Item will be edited by selecting it with the mouse and entering a new value via keyboard respectively by toggling it with the space bar. You can select the item also with the TAB key.)

4.4 Programming of the Data Registers (DS) of the DMC01

The DMC01 provides 8 independed data registers (DS 1 to 8) which each can be selected to be transmitted.

At first the data source for PROFI must be selected. Since in this application note only one DMC01 in a single test setup is used the data source is the DMC01 itself (and not a data base for a network):

SERVICES/DATA SOURCE
☞ ENCODER
OK

Reading and editing a data set:

PROG. SERV./MAIN
⇨ flashing "REQUEST".

PROFI reads the data of the DMC01 and lists them. At the first time after program start the listed data set is the actual transmitted data set of the DMC01.

☞	DS:	number of the listed data set (0 means the active DS in the encoder)
☞	PI:	program identification
☞	PS:	program service name
☞	PTY:	program type
☞	TA:	traffic announcement identification
☞	TP:	traffic program identification
	...	
☞	RT:	radio text
☞	AF:	alternative frequencies in MHz
☞	Group sequence	

With the DS number the desired data set can be selected.

Sending of data set DS: SEND
Reading of data set DS: READ
Back to the menu: CANCEL

With Ctrl + s a single data item can be send directly to data set DS in the DMC01.

4.5 Selecting of a data set DS in the DMC01

Switching over to another active data set in the DMC01:

TRANSFER/SEND DS
DATA SET: number of the new DS which shall be transmitted
OK

5. The remote control interface of the DMC01

There are applications conceivable for which a fast and immediate switching of elementary functions is required.
In order to test the switching behaviour of the built in cassette recorder in a car radio (when receiving a traffic anouncement) eg it is necessary to toggle the TA bit of the RDS data stream by hand.
This is possible by connecting a switch to the REMOTE CONTROL INTERFACE of the DMC01.

The following functions are prepared to be controlled direct via the REMOTE CONTROL INTERFACE on the rear side of the DMC01:

Connector of the remote control interface: Sub-D, female, 37 contacts
Active pins are fitted with pullup resistors.

Active pin (active low)	Corresponding GND pin	Input designation	Function
2	20	E1	TA on
3	21	E2	TA off
4	22	E3	VRF on
5	23	E4	VRF off
6	24	E5	Data set 1 and Ref. Table 1
7	25	E6	Data set 2 and Ref. Table 2
8	26	E7	Data set 3 and Ref. Table 3
9	27	E8	Data set 4 and Ref. Table 4
10	28	E9	Data set 5 and Ref. Table 5
11	29	E10	Data set 6 and Ref. Table 6
12	30	E11	Data set 7 and Ref. Table 7
13	31	E12	Data set 8 and Ref. Table 8
14	32	E13	
15	33	E14	DCF77 Time clock
16	34	E15	DCF77 Data clock
17	35	E16	DCF77 Data (serial)

For the functions TA on/off and VRF on/off you can connect either two keys each for on and off or a switcher. The selecting of the data sets can be done each by a simple key.

6. Further applications and features

Besides pure RDS applications the DMC01 with PROFI offers further important features like
full RDS paging capabilities,
Traffic message channel,
Card check.