Simulation of BCCH Channel of GSM/PCN Base Station with Signal Generator SME

Application Note 1GPAN14E

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Products:

Signal Generator SME

ROHDE&SCHWARZ

Contents:

1. Overview

Propagation measurements are indispensable in the planning of digital, cellular mobile radio networks. To find the optimum sites for the base stations, a mobile test transmitter system simulating the base station is operated from a number of possible locations. The test receiver system is accommodated in a vehicle, which is driven along a test route to perform measurements. The parameters measured, such as level, bit error rate or channel impulse response, provide information on the coverage within the cell. The main problem is to minimize interference caused by multipath propagation in the reception area [1].

The SME offered by Rohde & Schwarz is a universal test generator that can be used as the core of a test transmitter system. The SME generates the GMSK-modulated signals required for GSM propagation measurements in line with the relevant standards. Thanks to its low weight of 17 kg it can be carried even to remote sites. Fitted with the new optional DM Memory Extension (SME-B12, in the following referred to as XMEM), the SME is able to store data sequences of up to 8 Mbit which are long enough for receiver measurements with test mobile stations.

A suitable test receiver system is for instance a test mobile station for measuring level and bit error rate and the Impulse Response Analyzer PCS from Rohde & Schwarz for measuring the channel impulse response [2].

The present Application Note describes how the XMEM can be loaded with suitable data (test sequence) by the GSM Radiocommunication Test Set CRTP from Rohde & Schwarz [4] and how the SME has to be adjusted for GMSK modulation of these data.

First, however, an overview is given of all functions of the XMEM and their operation supplementary to the Operating Manual (section 2.6.3.3).

Finally, it is explained how the XMEM data can be transferred between PC and SME via the IEEE-488 or RS-232 interface.

2. Overview of Functions of DM Memory Extension (Option SME-B12)

The XMEM module can be inserted into one of the three slots of the SME that are provided for options and functions as a data generator with a maximum sequence length of 8 Mbit for all digital modulation modes of the SME (GMSK, GFSK, QPSK, FSK, 4FSK, FFSK) (note: the slots may be occupied by other options).

The digital modulation source of the SME is provided on the DM CODER (Option SME-B11) and receives data from the XMEM.

(Required hardware:
The modification status of the DM CODER must be VAR2/REV4 or higher; query with UTILITIES - DIAG - CONFIG - DCOD).

(Required firmware version: 1.51 or higher)

There is also a data memory on the DM CODER which has a storage capacity for 8 kbit modulation data.

The XMEM has no clock generator. The clock for reading data in or out comes from the clock synthesizer of the DM CODER or, for read-in, from an external source connected to the CLOCK input..

Data can be loaded into the XMEM in three different ways:

1. From an external source, serially, via the inputs DATA and BURST.

2. From an external source via the RS-232 interface of the SME.

3. From an external source via the IEEE-488 bus of the SME (IEC bus).

Read-in according to method 1 is triggered manually and starts upon the first clock signal then received. Loading stops when the number of bits specified as LENGTH has been read in.

The 8-kbit memory of the DM CODER can only be loaded according to methods 2 and 3. It can however be edited with the socalled list editor, which is not possible with the XMEM. The list editor and the IEC/IEEE-bus commands for data transmission are described in sections 2.2.4 and 3.6.11.3 of the Operating Manual.

Both memories are battery-backed, ie the data will not be erased even when the instrument is switched off during read-out.

In the 8-kbit memory three channels are available (3 x 8 kbit), the DATA, LEV ATT and the BURST channel. While the DATA channel stores the modulation data, the LEV ATT channel can be used two switch the level. The BURST signal is taken to the BURST output on the rear panel and can be used as required (see also section 2.6.3.1 in Operating Manual.)

To make these three channels also available in the XMEM, the 1M*3 mode has been introduced, in which the three signals are stored in parallel with a maximum sequence length of 1 Mbit. The LEV ATT signal can be read in via the BURST input according to method 1.

For reading out the data sequence, both memories offer the choice between the AUTO mode (cyclic repeat) and the SINGLE mode in which a stop will be made at the last memory address (START ADDRESS + LENGTH - 1). The SINGLE mode is only available for the modulation modes FSK, 4FSK and FFSK and is triggered manually.

With the XMEM, a SINGLE sequence can also be started by a trigger signal at the TRIGGER input; this is possible for all modulation modes, however for QPSK and 4FSK with some restrictions which will be explained below.
External triggering can for instance be used for synchronizing the XMEM to the frame or time-slot clock of a system or for synchronizing several SME units with the XMEM [3].

The 8k memory of the DM CODER cannot be triggered externally.
The polarity of the active edge of the clock and trigger signal can be switch-selected.

In case of the four-level modulation modes QPSK and 4FSK it has to be considered that one symbol is coded by two bits, the X bit and the Y bit. For storing data lists for these modulation modes in the XMEM, there is a choice between three operating modes providing for different storage of the X and Y bits in the XMEM. Without changing the XMEM data it is therefore not possible to alternate the operating mode:

1. CLOCK MODE BIT
   MEM MODE 8M*1

X and Y bits are stored serially in the XMEM and transmitted via the DATA line. The X bit is at the start address.

2. CLOCK MODE BIT
   MEM MODE 1M*3

X and Y bits are also stored serially in the XMEM and transmitted via the DATA line. The X bit is at the start address. The LEV ATT and the BURST channel can be used.

3. CLOCK MODE SYMB
   MEM MODE 1M*3

(Required hardware: Modification status of DM CODER is VAR4/REV1 or higher)
(Required firmware version: 1.80 or higher)
X and Y bits are stored in parallel in the XMEM and are transmitted in parallel via the DATA or BURST line. The LEV ATT channel can be used for level reduction.

In the serial modes 1 and 2 (bit clock), DM CODER and XMEM are synchronized to each other in terms of the X and Y bits if the setting is changed (eg BIT RATE or LENGTH). Since this synchronization is made via the trigger input of the XMEM, this input is not available for external triggering of the XMEM (EXT TRIGGER - ON causes error message).

In the parallel mode 3 (symbol clock) this synchronization is not necessary and the XMEM can be externally started via the TRIGGER input (EXT TRIGGER - ON is permissible).

Overview of applications:

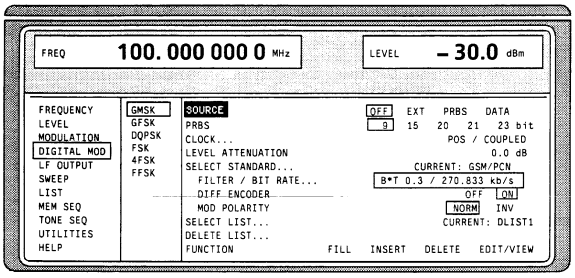
Function	Characteristics	Example
Read-in via DATA input.	8 Mbit max. Bit rate < 3 Mbps	Read-in of CRTP data as described in section 4.
Read-in via DATA and BURST inputs.	1 Mbit max. per channel Bit rate < 3 Mbps	Read-in of GSM data signal via DATA input and of LEV ATT signal for amplitude shift keying via BURST input from an external source.
Read-in via RS-232 interface using MCARD.EXE program.	Optimal baud rate 19200 bps Transmission time: 8 Mbit/8M*1 mode: ca. 15 min 1 Mbit/1M*3 mode: ca. 6 min	Read-in of GSM test sequence available as disk file as described in section 6.
Read-in via IEEE-488 interface using R&S BASIC program XMEM_PRG.BAS	Transmission time: 8 Mbit/8M*1 mode: ca. 7 min 1 Mbit/1M*3 mode: ca. 3 min	Read-in of GSM test sequence available as disk file as described in section 5.
Cyclic read-out of a data sequence	Bit rate according to BIT RATE setting in digital modulation menu.	Read-out of CRTP data as described in section 4.
Externally triggered single read-out of a data sequence.	Bit rate according to BIT RATE setting in digital modulation menu. Setup time of trigger signal to active clock edge of XMEM: 700 ns	Synchronization of SME to frame or time-slot clock of a system [3].

3. Function and Operation of DM Memory Extension for General Applications

Before entering the memory extension menu for parameter setting with CONFIG - XMEM, it is recommended to make preparatory settings in the digital modulation menu using the following five steps:

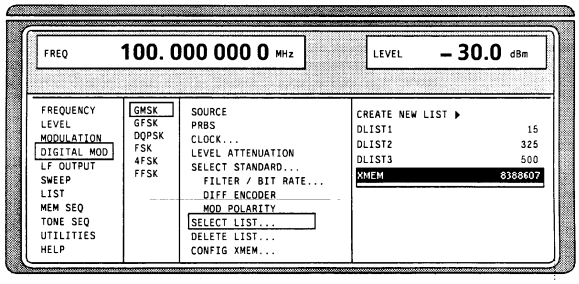
1. Selection of digital modulation mode:

DIGITAL MOD - GMSK, GFSK, QPSK ...



2. Selection of memory extension:

- SELECT LIST - XMEM 8388480



3. Selection of clock source:

- CLOCK - CLOCK SOURCE - COUPLED
Clock from external source
(only possible for read-in)

- CLOCK - CLOCK SOURCE - INT
Clock from DM CODER
(for read-in and read-out)

4. Setting the active clock edge:

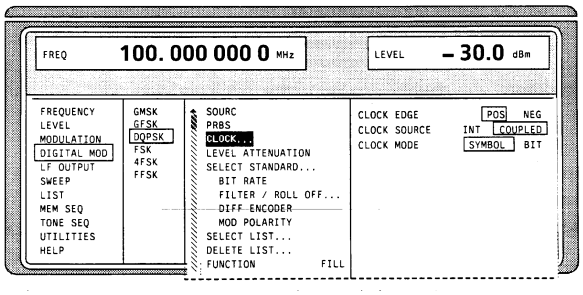
- CLOCK - CLOCK EDGE - POS
Data are read in with the positive clock edge. Upon read-out from the XMEM, data change with the negative clock edge.

- CLOCK - CLOCK EDGE - NEG
Data are read in with the negative clock edge. Upon read-out from the XMEM, data change with the positive clock edge.

5. Setting the clock mode:

- CLOCK MODE -BIT
XMEM is operated with a bit clock.

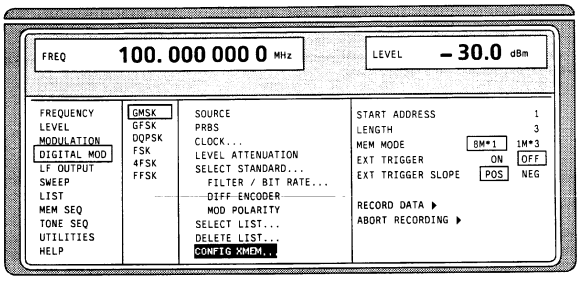
- CLOCK MODE - SYMB
XMEM is operated with a symbol clock (only possible for QPSK and 4FSK modulation and in 1M*3 mode).



6. Selection of read-in or read-out:

- SOURCE EXT: Read into XMEM
- SOURCE DATA: Read out from XMEM

Following these preparatory steps, the XMEM parameters can be set in the CONFIG - XMEM menu.



The start address and the sequence length can be set within the following ranges:

START ADDRESS = 1 to 8M - 130
LENGTH = 3 to 8M - 128
(8M = 2^23 = 8388608, 1M = 2^20 = 1048576)

Since the maximum stop address (START ADDRESS - 1 + LENGTH) is 8M - 128, the error message "data out of range; XMEM length or address vs. 1M*3 mode" is output if (START ADDRESS - 1 + LENGTH) exceeds this value.

In the 1M*3 mode, which is selected with - MEM MODE - 1M*3, the maximum stop address is 1M - 16 and the above error message is output if (START ADDRESS - 1 + LENGTH) exceeds this value.

If EXT TRIGGER is ON, the XMEM halts at the stop address and is only started again if a positive or negative trigger slope - depending on the setting of EXT TRIGGER SLOPE - is applied to the TRIGGER input. After the trigger signal the XMEM is started upon the next clock phase (neg. edge with CLOCK EDGE - POS), if a setup time of 700 ns is adhered to.

A SINGLE sequence can be manually triggered in the digital modulation menu by EXECUTE SINGLE if MODE has been set to SINGLE and one of the modulation modes FSK, 4FSK or FFSK has been selected.

Recording of a data sequence applied to the DATA input is started by RECORD DATA. As soon as the stop address is reached, DONE is displayed. Read-in can be aborted by ABORT RECORDING.

Because of the circuitry, adjacent memory areas will be erased upon read-in via the DATA input: :

8M*1 mode (worst case):
START ADDRESS-7 to START ADDRESS-1
and
STOP ADDRESS+1 to STOP ADDRESS+15
will be erased.

1M*3 mode (worst case):
STOP ADDRESS+1 will be erased

(STOP ADDRESS cannot be set directly, but results from START ADDRESS - 1 + LENGTH).

4. Reading in CRTP Data for GSM Propagation Measurements via DATA Input

For performing GSM propagation measurements with a special test mobile, a data sequence with a length of 6,630,000 has to be loaded into the XMEM. This data sequence, which contains the

BCCH and TCH signal in time slot 0 and 3, can be loaded from the GSM Radiocommunication Test Set CRTP via the DATA input of the SME.

Since after 156 bits of a time slot the CRTP supplies a quarter bit in line with the GSM standard, a phase adjustment has to be made between the SME data clock used to clock the XMEM and the CRTP data clock. The XMEM then does not supply a quarter bit upon reading, but an additional bit every four time slots.

The test setup and the settings are described and illustrated in the following:

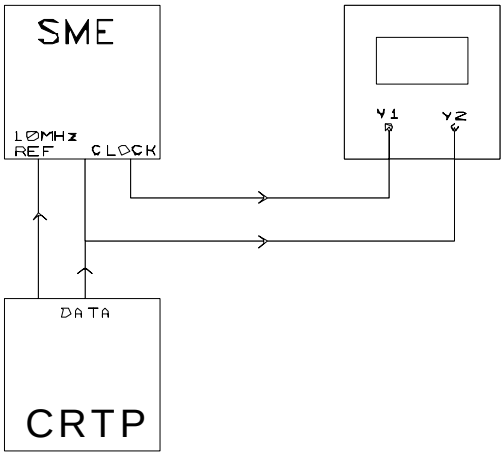


Fig.: Test setup for CRTP data read-in via DATA input

- Connect data output of the CRTP to the DATA input (1-kΩ TTL input) of the SME and to an oscilloscope (1 MΩ).

- Connect the REF input of the SME to the 10-MHz reference output of the CRTP.

- Connect the second channel of the oscilloscope to the CLOCK input of the SME.

- Press the PRESET key on the SME and go to the menu DIGITAL MOD - GMSK.

- Select CLOCK - CLOCK SOURCE - INT (clock from DM CODER of SME).

- Select SELECT LIST - XMEM 8388480.

- Select SOURCE - EXT (external data source).

- Go to menu UTILITIES - REF OSC and select SOURCE - EXT. The clock (270.833 kHz) and the data signal (4*270.833 kbps eye pattern) should now be synchronous on the oscilloscope.

- By changing between SOURCE EXT and INT (switching synchronization on and off via the 10-MHz reference) the phase between clock and data signal must be adjusted so that the data are stable on the positive clock edge.

- Go to menu DIGITAL MOD - GMSK - CONFIG XMEM and set LENGTH to 7.000.000 (length of data sequence to be read in).

- Start read-in with RECORD DATA. Read-in is completed after 30 seconds and DONE is displayed.

- The data are stored in memory locations 1 to 7,000,000; storage is nonvolatile.

Transmission of stored data sequence:

- Interrupt the connection to the data output of the CRTP.

- Set the sequence length to LENGTH = 6,630,000 (suitable length for the test transmitter mode of the CRTP)

- Return to menu DIGITAL MOD - GMSK and select SOURCE - DATA.

- Select DIFF ENCODER - OFF (the data of the CRTP are already differentially coded).

- Select MOD POLARITY - INV (the data output of the CRTP supplies inverted data).

At the selected carrier frequency the data are now cyclically repeated (24.6-s period) and the GMSK-modulated data applied to the RF output.

Since data recording starts at a random point of the CRTP sequence, it is possible that it starts within a BCCH sequence. In this case the BCCH sequence has been inadmissibly divided and the START ADDRESS has to be increased by at least 157. The probability that this case will occur is 1:8 since one frame has eight time slots.

5. Data Transfer from PC to SME via IEEE-488 Bus (IEC-Bus)

(Required firmware version: 1.80 or higher)

The R&S BASIC program XMEM_PRG.BAS allows the complete XMEM contents to be written on the hard disk or floppy of a PC and read out from there.

Operating instructions and file structure are described in detail in XMEM_DOC.TXT. In the following it is merely described how the R&S BASIC program has to be installed for this specific application and how a certain memory area can be read into the PC and then written again into any location of the XMEM.

For the installation, the following files have to be copied into a separate directory:

BASIC.COM (Version 2.52)	R&S BASICc
BASINST.BAT	Installation program
CONF.ASC	R&S driver callup
IECX.SYS (Version 1.40)	R&S driver
STRINX.SYS (Version 1.40)	R&S driver
XMEM_PRG.BAS (Version 1.02)	Transfer program
XMEM_DOC.TXT DOC	File to transfer progr.
XMEM_902.SVE	CRTP test sequence

After calling up the installation program BASINST.BAT, the directory RS-DRIV is installed and the two R&S drivers are copied into this directory. Moreover, the CONFIG.RSB file supplemented by the contents of CONFIG.SYS with the following driver callup:

device=\rs-driv\strinx.sys
device=\rs-driv\iecx.sys /A:2E1,22E1 /D:1 /I:7

The parameters of the driver iecx.sys have the following functions:

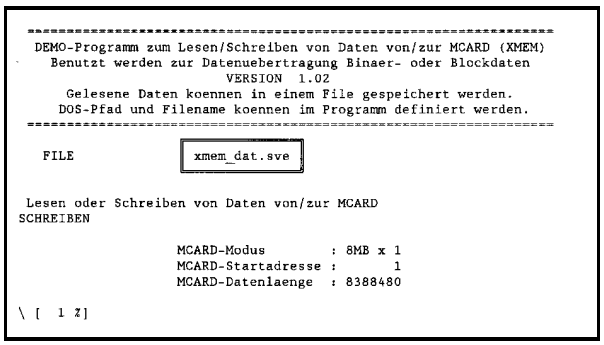
A: Address of IEC/IEEE-bus card
D: DMA channel of IEC/IEEE-bus card
I: Interrupt level or line of IEC/IEEE-bus card.

Should an IEC/IEEE-bus card be used that is not from Rohde & Schwarz, it has to be checked whether the parameters agree with the values set on the card with the aid of jumpers. If necessary, the values have to be corrected in the CONF.ASC file.

To complete the installation, CONFIG.RSV has to be copied to CONFIG.SYS after the old installation CONFIG.SYS has been saved.

To prepare reading from the XMEM to the PC it is only necessary to enter START ADDRESS, LENGTH and mode (8M*1/1M*3) on the SME either manually or via IEC/IEEE bus.

After calling up BASIC XMEM_PRG and entering L for read, the selected memory location is transferred from the XMEM to the file XMEM_DAT.SVE.



Before reading the data back into the XMEM, the start address START in the header of the data file can be changed if the data are to be stored in another location of the XMEM.

After entering S for write in the XMEM_PRG.BAS program, the XMEM_DAT.SVE file is read into the XMEM again. In this way it is possible to save data and to load various sequences into any locations of the XMEM.

The XMEM_902.SVE file contains the data of a 6,630,000-bit test sequence from the CRTP for GSM propagation measurements. Upon generation of this sequence, the parameters of the test sequence had been set as follows:

NETWORK COLOUR CODE	= 0
BS COLOUR CODE	= 0
CELL IDENTITY	= 0
LOCATION AREA CODE	= 0
MOBILE NETWORK CODE	= 0
MOBILE COUNTRY CODE	= 0

If this sequence is to be read in, XMEM_902.SVE must first be copied to XMEM_DAT.SVE.

The transfer of the complete memory contents takes approx. 7 min for read, 3 min for write in the 8M*1 mode and 3 min for read and 3 min for write in the 1M*3 mode.

The XMEM_DAT.SVE file then has 1,068,126 bytes or 400,615 bytes.

The Application Program SME-K1, which enables data transfer to the XMEM and to the 8k-memory of SME from a convenient PC user interface and allows simple editing on the PC, will soon be available free of charge. Inquiries on this product should be directed to the product marketing group 1GPP in Munich.

The software will be available together with the Application Note in the R&S bulletin board GLORIS.

6. Data Transfer from PC to SME via RS-232 Interface

(Required firmware version: 1.85 or higher)

For the connection between PC and SME a crossed cable provided with connectors at both ends (a socalled null modem, standard cable for the RS-232 interface) is required.

The following Table shows the wiring of the cable both for a 25-pin and a 9-pin connector:

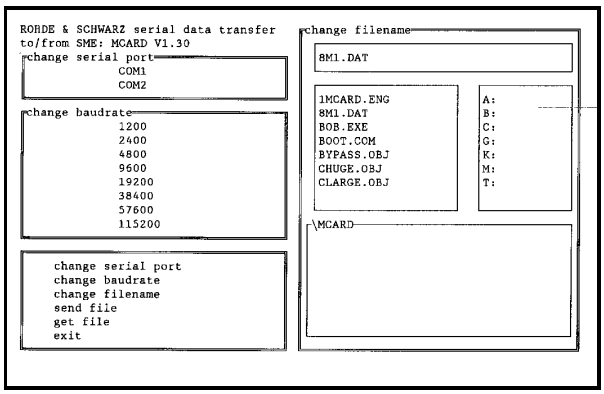
PC		SME	
9-pin	or 25-pin	9-pin	
5	7	5	(GND - GND)
3	2	2	(TxD - RxD)
7	4	8	(RTS - CTS)
6	6	4	(DSR - DTR)
2	3	3	(RxD - TxD)
8	5	7	(CTS - RTS)
4	20	6	(DTR - DSR)

If a mouse is connected to the PC interface provided for the data transfer, the PC should be restarted after disconnecting the mouse in order to avoid conflicts with the mouse driver.

To prepare the data transfer, various files have be loaded into a separate directory on the hard disk. The transfer program can then be called up with XMEM.BAT. The necessary driver X00 is automatically loaded. Operating instructions and various settings are described in detail in file 1MCARD.DOC.

The memory location and the mode of the XMEM have to be set on the SME prior to the read-in exactly as for the IEEE-488 data transfer.

After setting of the baud rate which has to agree with that of the SME (SME menu UTILITIES - SYSTEM - RS232 - BAUD RATE), selection of COM1 or 2 and of the file name, the transfer can be started. The fastest transfer is performed at a baud rate of 19200 bps.



For reading the data into the XMEM, the data can be stored under any start address - in the same way as with the IEEE-488 transfer - by changing the address in the file header accordingly.

The transfer of the complete memory contents at 19200 bps takes 15 min for read and 12 min for write in the 8M*1 mode and 6 min for read and 5 min for write in the 1M*3 mode.

The file structure is identical with that of the IEEE-488 transfer.

After successful data transfer the checksum of the read or written DATA signal is displayed.

The software will be available together with the Application Note in the R&S bulletin board GLORIS.

7. Data Integrity

To ensure that data have been properly transferred to the XMEM, there are two ways of checking:

1. Calculating the checksum of the data selected with START ADDRESS and LENGTH by entering UTILITIES - TEST - GENERATE XMEM CHECKSUM. In the 1M*3 mode four hexadecimal numbers are displayed, the checksum of all bits and the checksum of the DATA, LEV ATT and BURST bits.

2. Reading the written sequence back onto the disk and comparing the written and read file with the DOS program COMPARE (COMP file1 file2).

A memory test program can be called up by entering UTILITIES - TEST - TEST XMEM. If one of the eight RAMs is faulty, this will be indicated after the test run.

The battery voltage of the XMEM can be checked under load with the aid of testpoint 1500 (UTILITIES - DIAG - TPOINT - 1500). If the voltage drops below 2.0 V, data may be lost upon switching the instrument off. If the voltage drops below 2.1 V (0.1 V reserve), the error message "XMEM battery voltage lower then 2.1V" is displayed on power-up.

References:

[1] Klier, J.: GSM propagation measurements with Signal Generator SME. News from Rohde & Schwarz (1994) No. 145, p. 36

[2] Bues, D.; Riedel, P.: Planning digital radio networks using Impulse Response Analyzer PCS and test transmitter system. News from Rohde & Schwarz (1993) No. 141, pp. 26-27

[3] Tiepermann, K.: Application Note 1G18-03-0294-e, SME with Option DM CODER, Hints for Using the Data Generator

[4] Schubert, W: Digital Radiocommunication Test Set CRTP 04 - Test set for base stations to new PCN/DCS 1800 mobile phone standard. News from Rohde & Schwarz (1993) No. 143, pp. 8-10.