Technical Documentation

SSO 688

Externally modulated optical transmitter

Standard System Configuration

pcs.	item
1	preamplifier SVK 685
1	ext. mod. transmitter SSO 688
1	power supply converter 230VAC or 60V to 24 VDC
1	sub-rack
1	IEC-connection cable

BK 600

Optical transmissionsystem 1550 nm

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1. Technical Description

1.1 Introduction

This document describes an optical line termination (OLT) based on the usage of several FUBA-BK units. The applications is the transmission of typically up to about 60 analog TV channels (depending on required transmission performance) within the frequency band 47 ... 862 MHz. The electrical input signal of nominal 90 dBµV/carrier is translated into an optical intensity modulated signal at a wavelength of 1555 nm. The signal is available at two outputs with +4 dBm output power at each output.

The optical line termination is composed of several FUBA-BK units mounted on a 19´´-sub-rack:

Figure 1 shows an example of an assembled OLT sub-rack.

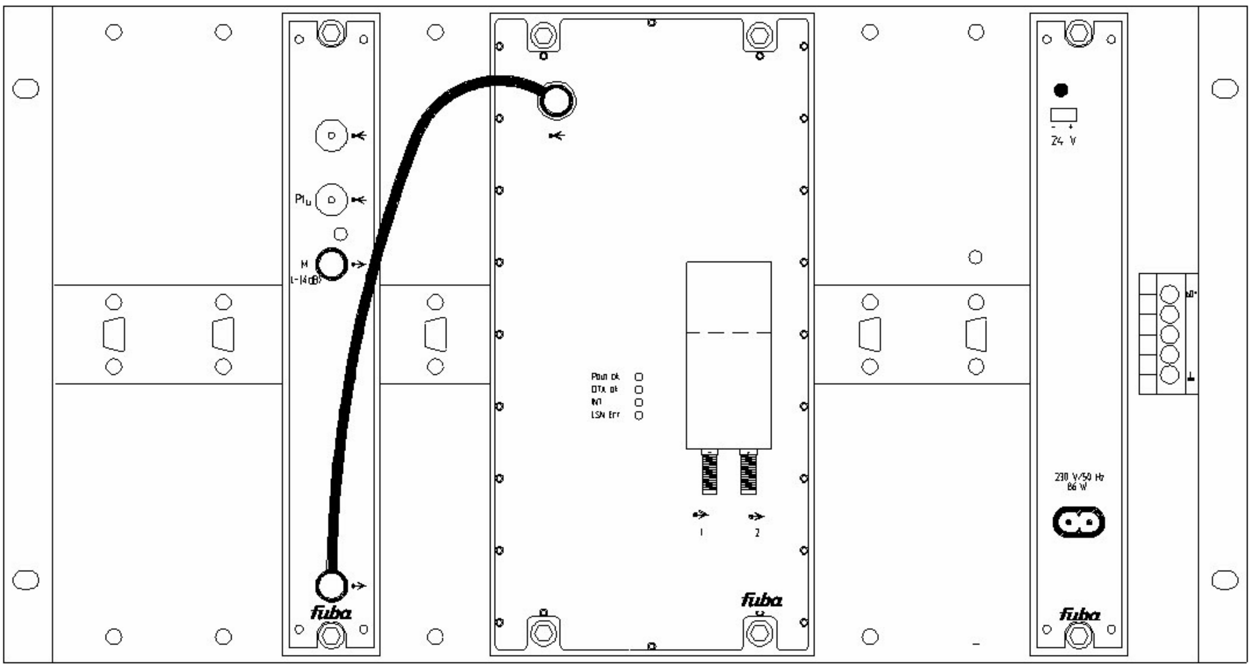

Figure 1: Front view of an assembled sub-rack of an OLT

1.2 Preamplifier FUBA SVK 685

The unit FUBA SVK 685 is used as a preamplifier for the optical transmitter SSO 688.

Figure 2 shows the front view and the block diagram of the preamplifier. The size of the SVK 685 is equivalent to a standard BK-module (250 mm x 100 mm x 40 mm, h x d x w)

The upper IEC-socket allows to feed in the broadband RF signal, the second input socket is allocated to an optional pilot input signal at 80.15 MHz, which would allow to use the pilot controlled optical receivers. An adjustment of the pilot gain by ±1 dB can be performed by using the adjustment screw close to the pilot input socket.

The combined RF and pilot signal may be monitored on the monitor socket (3rd socket). The monitor output level is -14 dB related to the RF-input signal and approximately -18 dB (±1 dB) related to the pilot input socket. In case of non use the monitor output has to be terminated properly with a 75Ω termination. Otherwise the frequency response of the RF signal would be deteriorated.

The nominal RF input level for 60 analog TV carriers is 90 dBµV. The nominal pilot level is 104 dBµV for a pilot signal with - 0dB, related to the TV signals.

The combined signals are nominally amplified by +5 dB in case of 60 unmodulated carriers. After the amplifier a small amount of the output signal is tapped and used to operate the amplifier in constant output power mode. To enhance the temperature stability of the controlled output power the detection scheme for the output power is kept on constant temperature. The total RF output power of the preamplifier is limited to +3.5 dBm.

Via the sub-D9 connector on the rear side the power supply is fed from the sub-rack to the unit.

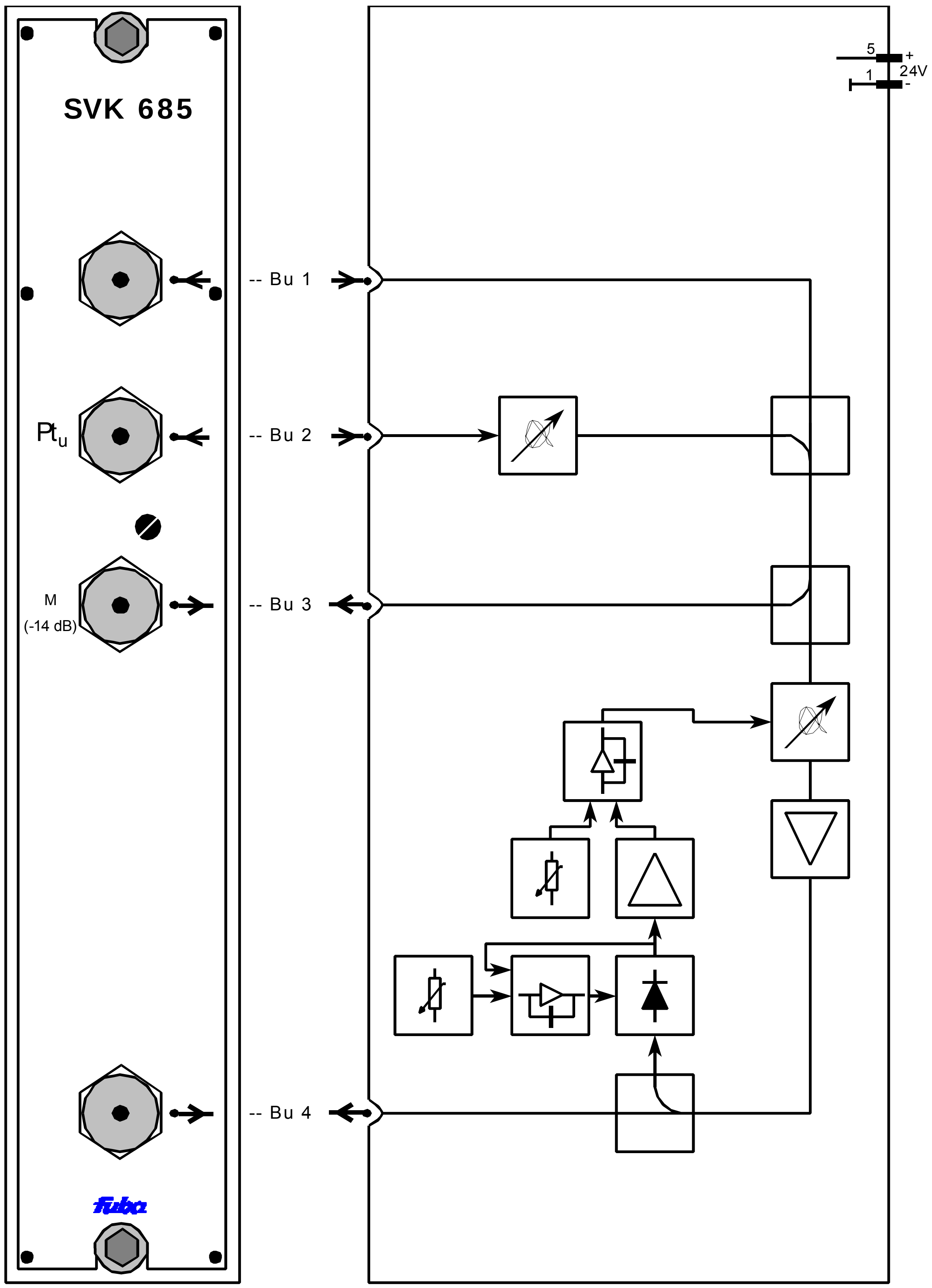

Figure 2: Front view and blockdiagram of the preamplifier SVK 685

1.3 Optical Transmitter FUBA SSO 688

1.3.1 Introduction

The unit FUBA SSO 688 is an externally modulated optical broadband transmitter. The size is equivalent to a triple BK module (250 mm x 100 mm x 120 mm, h x d x w). Figure 3 shows the front view of the SSO 688.

The transmitter is based on 5 functional blocks: RF-path, CW-DFB-Laserdiode, integrated optical modulator, control electronics and power supply.

The central core of the transmitter is the electro-optic modulator working as a Mach-Zehnder-interferometer. The light from the laserdiode is coupled to an optical strip wave-guide. An integrated optical splitter splits the light into two identical portions which are phase modulated by an RF signal applied to the electrodes of the modulator. The concept of the electrodes results in an push pull phase modulation of both branches. Following the modulating section the signals of both arms are combined and interfere. The interference of the phase modulated signals results in an amplitude modulation of the output light signal which is available on both outputs of the combiner.

1.3.2 Functional description

Fig. 4 shows the block diagram of the externally modulated optical transmitter.

The electrical RF-signal is fed via a high-pass circuit to the input of a pre-distortion circuit which is foreseen to linearise the squared sine wave transmission function of the electro-optical modulator. The pre-distortion circuit is requested to minimize 3rd order intermodulations (CTB = composite triple beat). The output signal of the pre-distortion circuit is amplified to proper input level for the electro-optical modulator, to establish a sufficient modulation depth of optical output signal.

The necessary CW input light for the modulator is produced by a DFB-laserdiode working with a wavelength around 1550 nm. There are two control loops for operating the laserdiode at constant optical output power as well as at constant temperature by means of a thermoelectric cooler. The laserdiode drive current is measured to detect an increase to 120% of the initial value which could be caused e.g. due to aging of the laserdiode. The temperature of the laserdiode is supervised by measuring the required drive current for the thermoelectric cooler. At 90% of the available cooler drive current and/or >120% of the initial laserdiode drive current a B-grade alarm which indicates a warning is generated. At 100% drive current the laserdiode drive current is switched off to protect the laserdiode against irregular temperature conditions and an A-grade alarm indicating a severe malfunction is generated. Both types of alarms are causing the yellow LED on the front plate of the optical transmitter "INT" to emit. In case of a B-grade alarm the green "O.K" LED is lighting since the unit is still working properly, however close to its limits. In case of an A-grade alarm only the "INT"-LED is emitting. Both alarms are also available as TTL-signals via the sub-D9 connector on the sub-rack interface bus. For details please refer to the alarm table in chapter 3.2.

To broaden the optical spectrum of the laserdiode a microwave signal is applied to the laser-diode to generate an amplitude modulation of the optical light at around 1.9 GHz. This circuit is mandatory to avoid stimulated brillouin scattering (SBS) in optical fibers and allows to operate with optical amplifiers feeding at least +13 dBm of optical power into standard single mode fibers.

The coupling of light from the laserdiode to the modulator is performed using a polarization maintaining optical fiber. The optical modulator provides two optical outputs. The signal of one of these outputs is tapped and led to an InGaAs photo-diode. The electrical signal of this photo-diode is evaluated for two reasons:

1) To supervise a proper working of the CW laserdiode. In case of an optical output power failure (output power < 70% of nominal power) an A-grade alarm is generated and the laser is switched off.

2) A detector circuit measures CSO and CTB distortions to optimize the bias point of the electro-optical modulator. For a proper operation of the detection circuit at least two TV carriers with a frequency spacing of 16 MHz have to be present. Using this standard software setting of the detection scheme almost all European frequency plans are supported: CENELEC frequency plan, all regular 8 MHz spacing frequency plans as well as the German 7/8 MHz frequency plan. Additional software is available to change the standard software setting to work with regular 6 MHz frequency plans (NTSC) or purely 7 MHz frequency plans. This software requires a standard IBM-compatible PC with a RS-232 interface. Further details are given in chapter 1.6.

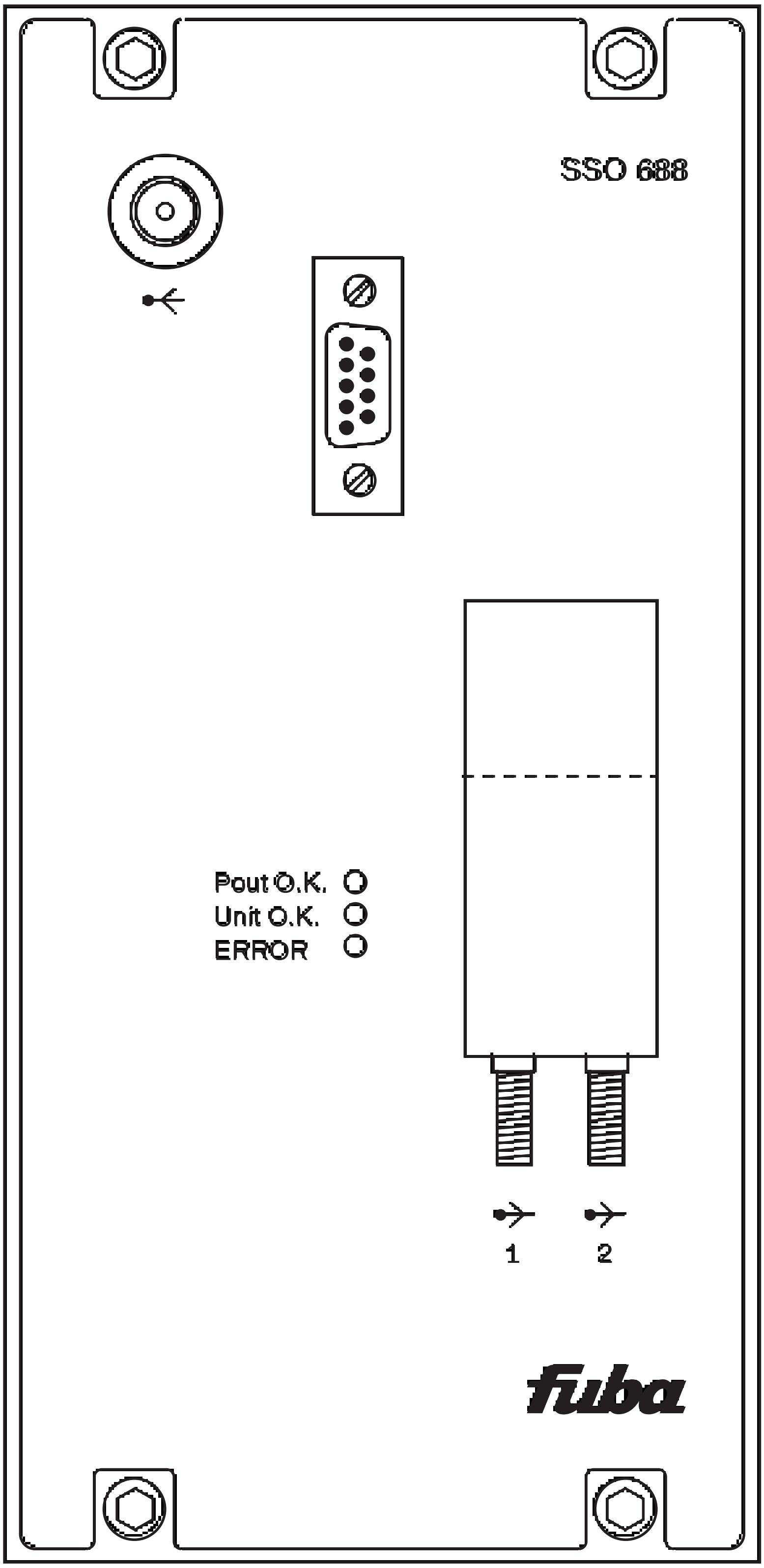

Figure 3: Front view of the optical transmitter

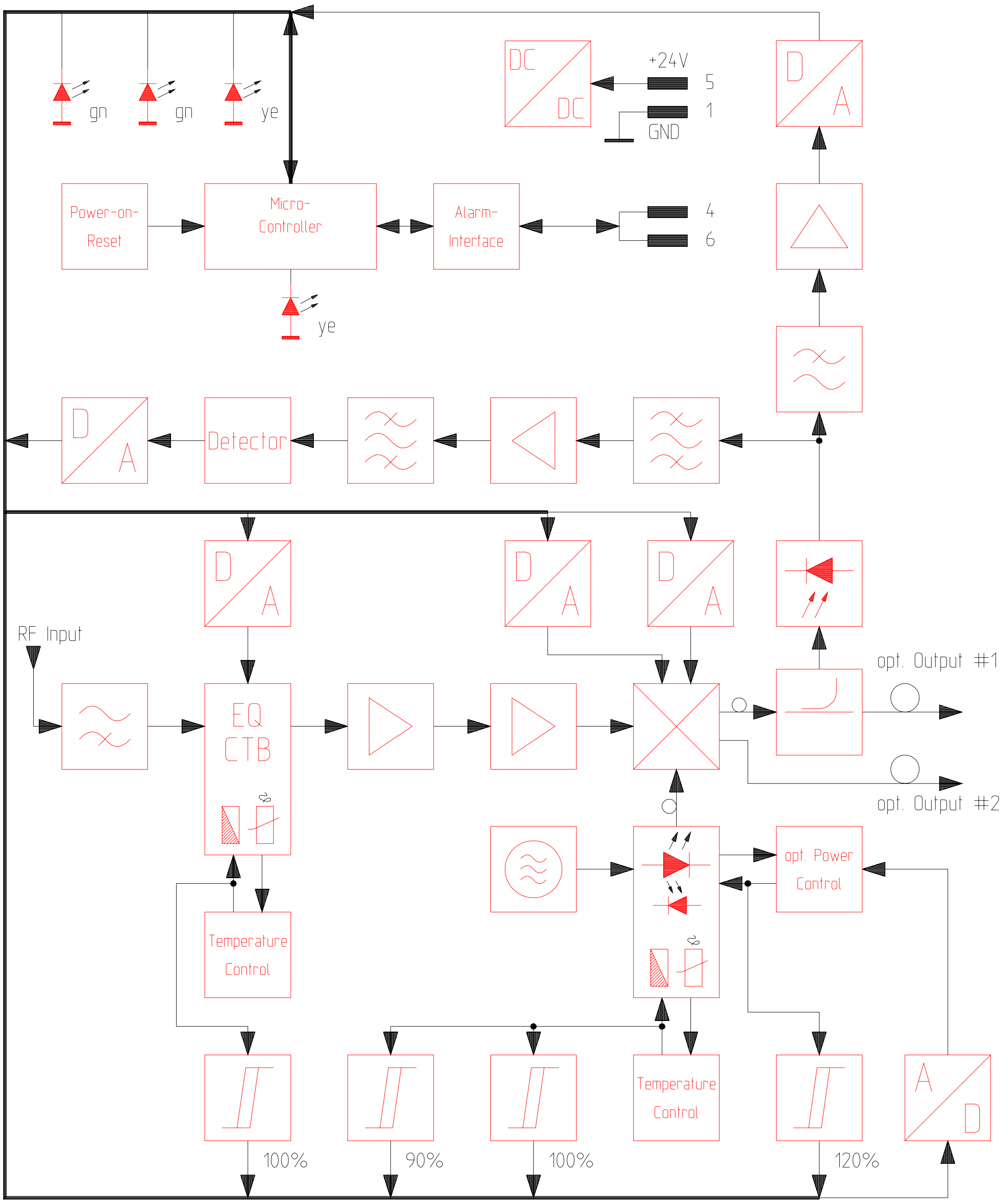

Figure 4: Block diagram of the optical transmitter

1.4 Sub-rack Power Supply FUBA SMN 134

The power supply SMN 134 is used to power a sub-rack carrying several FUBA-BK modules directly from mains. With an input voltage of 230Veff/50 Hz an constant electrical output voltage of 24 VDC is generated. The output voltage is short circuit protected and galvanically isolated from earth ground.

To increase the reliability it is possible to parallel two SMN 134. All SMN 134 units are always mounted on the slots 9 and 10 of the sub-rack. The 230VAC input voltage is fed by the mains cable offering a standard EURO-mains connector.

On the front plate of the SMN 134 a measurement point is available to check the 24VDC output voltage with a voltmeter providing an input resistance of at least 50kOhm/V. A green LED indicates the proper operation of the SMN 134.

Mounting and de-mounting of the SMN 134 is feasible during operation of the sub-rack. That means: It is not required to switch off the complete sub-rack to replace a power supply unit.

Figure 5 shows the front view and the block diagram of the SMN 134.

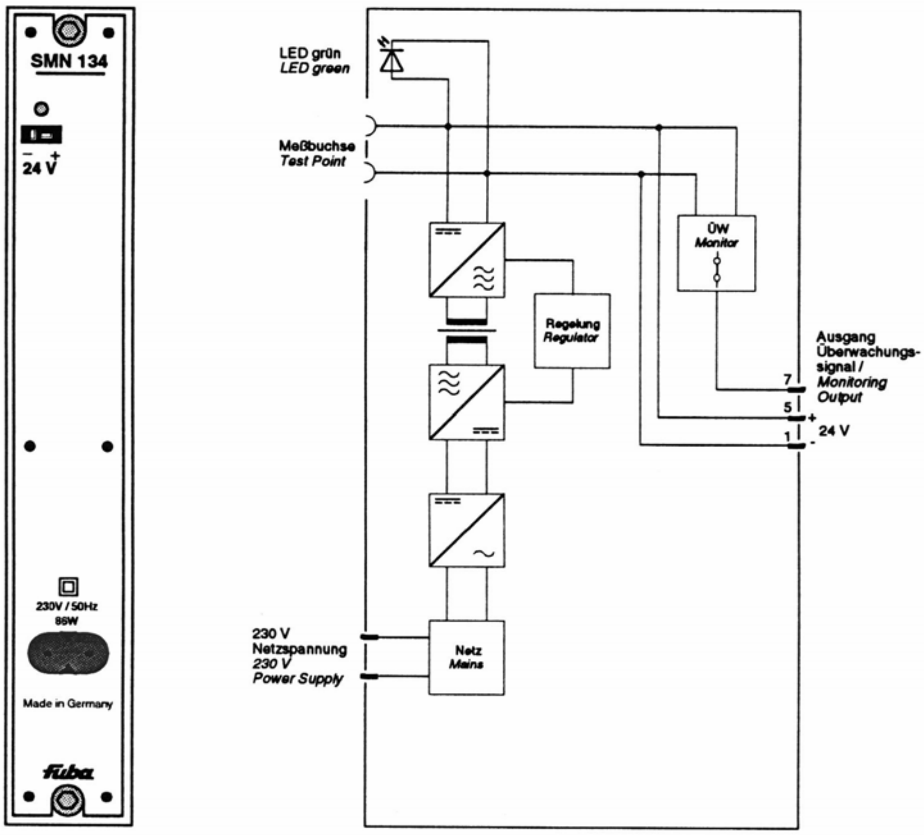

Figure 5: Front view and block diagram of the sub-rack power supply SMN 134

1.5 Sub-rack for installation into 19" racks

All units are mounted on a 19"-sub-rack. A sub-rack bus provides all electrical connections required for the operation of the modules except the RF connections.

The sub-rack provides 10 slots with sub-D9 interfaces to the internal sub-rack bus. Positions #9 and #10 are dedicated exclusively to power supply units since they provide electrical connections to the interface socket right to the sub-D9 connector of slot #10. Slots #1 to #8 are reserved for all other types of units, the sub-rack bus connects all pins of the sub-D9 sockets transparently.

The main task of the sub-rack is heat-sinking of all active units mounted to this sub-rack. The thermal resistance of the heat-sink is in the order of 0.2 °K/W assuming a homogeneous thermal dissipation to the heat-sink. Figure 6 shows the front view of the sub-rack.

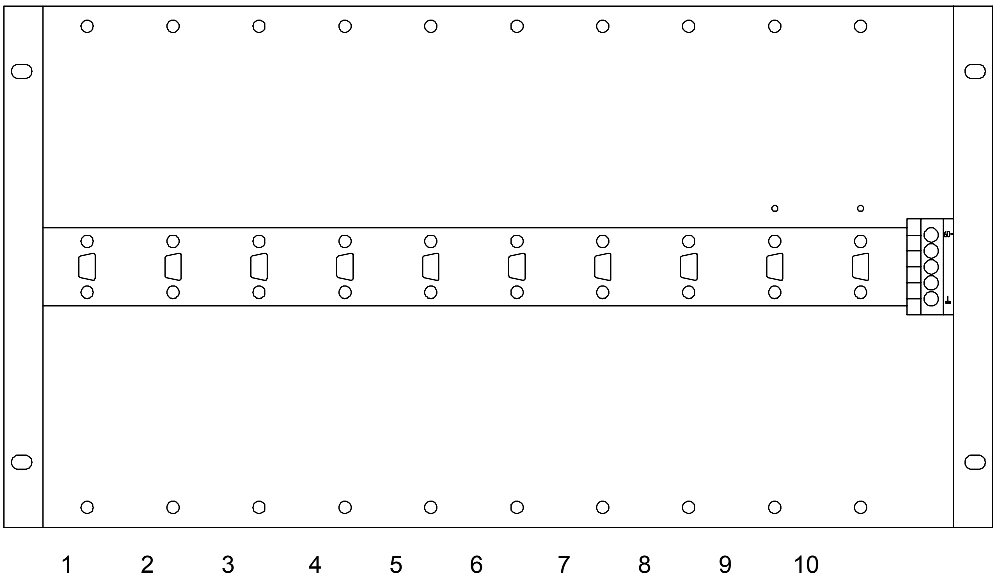

Figure 6: Front view of the sub-rack

1.6 Terminal Program

Optionally a PC-program is available, which enables to program the optical transmitter to operate with certain frequency plans. Since the optical transmitter does not introduce any RF pilot signals to optimize the bias point of the electro-optical modulator, it has to measure CSO distortions directly. However, the locations of CSO beats in the RF band are depending on the frequency plan. As a standard setting the transmitter is preset to work with 8 MHz frequency plans like the CENELEC 42 or Deutsche Telekom BK450 and OPAL 94 frequency plans. To get a stable behavior of the electro-optical modulator at least two carriers with nominal input level and a frequency difference of 16 MHz are required.

Alternatively the transmitter can be programmed to operate with the NTSC frequency plan (6 MHz frequency spacing) or the purely 7 MHz frequency spacing (like the old Deutsche Telekom BK 300 frequency plan). In these cases two carriers with 24 MHz offset or 21 MHz offset are required to get a stable operation of the transmitter.

In case of mixed frequency plans like the mixed 7 and 8 MHz spacing frequency plan from Deutsche Telekom the setting for 7 MHz or 8 MHz spacing might be applied.

The program is delivered on a 3.5" diskette. Additionally a interconnection cable from the PC to the sub-D port on the front panel of the optical transmitter is attached. It is important to put the connector which is labeled ES-8 to the transmitter and the other one to the PC.

The program runs on IBM-compatible PCs with a free accessible COM1 or COM 2 port serial interface (RS232) providing a sub-D9 socket, 3.5" diskette drive, MS-DOS 3.x or higher.

2. Turn on Procedure

The sub-rack including all units (refer to figure 7) is mounted to a 19" rack located in a temperature controlled environment (ambient temperature max. 40°C).

The RF input of the preamplifier SVK 685 has to be connected to the signal source using a proper input level (90 dBuV per carrier for 60 TV carriers). All carriers should have the same input level in order to obtain a good carrier to noise ratio for all carriers. An input level tolerance of +/- 1 dB results in an output carrier to noise of +/-1 dB!

The RF output of the preamplifier is connected to the input of the optical transmitter SSO 688 using the attached IEC-cable.

The optical outputs of the transmitter are providing high return loss connectors. It is very important to ensure that all components used in the following optical network are of the high return loss type!

After turning on the supply voltage the optical transmitter starts its operation with a turn on sequence:

1) During a self test the LEDs "Pout ok", "OTX ok" and "INT" are lighting.

2) After the self test the control loop of the electro-optic modulator is searching for the optimum bias point. This is done in a two step, a draft and a fine approach:

2.1) In case of no proper RF signal present at the RF input only a draft bias point of the modulator is set close to the quadrature point. By measuring the output power of one output during cycling the bias voltage the bias voltage for the quadrature point is calculated and preset. However, due to thermal drift the output power might fluctuate by approximately ±1 dB as long as there is no proper RF signal present at the input.

2.2) In case of a proper RF signal at the RF input, after the draft searching for the quadrature operating point the fine tuning by activating the CSO detection circuit is started. After some seconds the CSO loop has typically found the optimum bias point. Now the output power on both outputs remains constant, the transmitter has finalized the initialization procedure.

The fine tuning procedure is also started if the RF input is removed for some time. The draft initialization procedure is only started after powering up the transmitter or after the transmitter has been turned on for some time without any RF signal.

It is very important that the frequency plan matches with the internal CSO loop setting. A wrong CSO loop setting gives a bad intermodulation performance of the transmitter. (Refer also to section 1.6!)

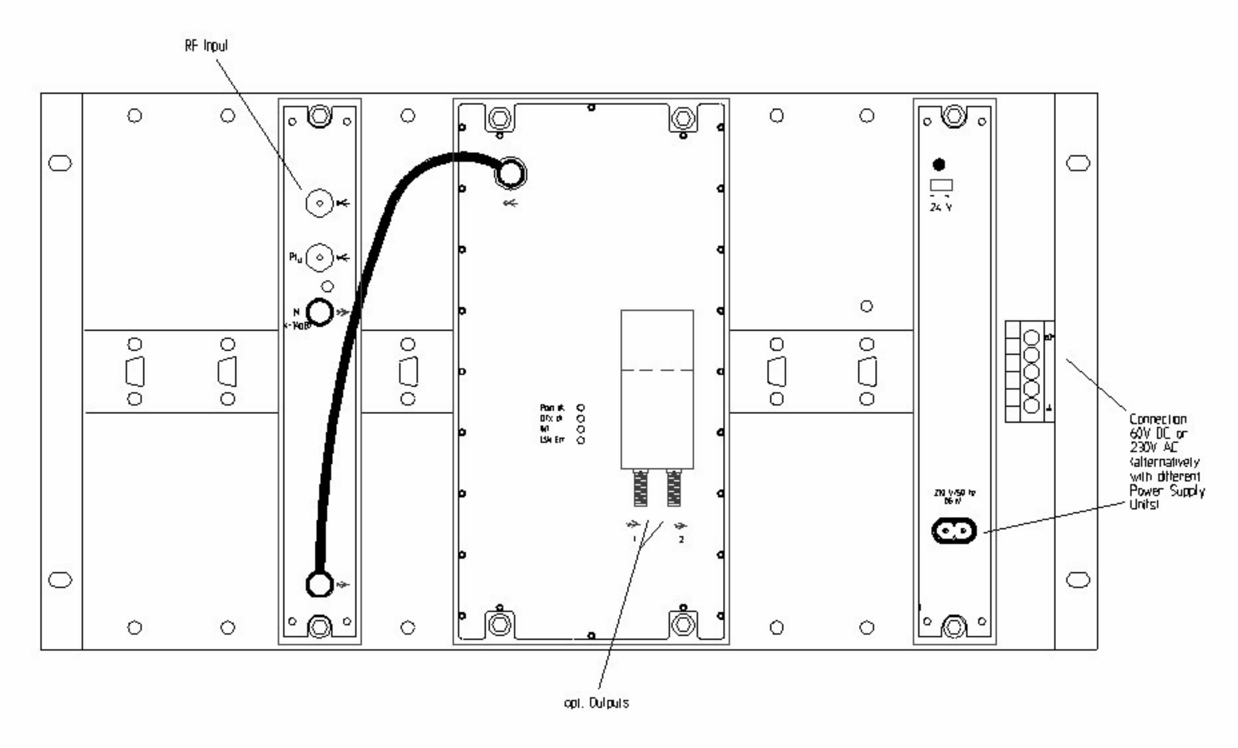

Figure 7: Electrical and optical connections to the OLT

3. Technical Data of OLT units

3.1 FUBA SVK 685

RF Properties

Number of RF Inputs	2
Input level per 1 carrier*	90dBµV ±1dB
Input level for optional pilot (pilot frequency: 80.6 MHz)	100dBµV nom., ±1dB adjustable
RF monitor output	-14dB ±0,5dB, related to input level
Return Loss	> 20dB (47MHz), -1.5dB/oct., >15dB (f > 376MHz)
Connectors	IEC 75 Ω

Interface SVK 685<->SSO 688	95,1dBµV * (unmodulated)
Total Channel Load	+3,5dBm (no FM Channels)
Connectors	IEC 75 Ω

*) Assuming 50 TV channels + 30 FM radio channels (-4dB) according to the OPAL 94 frequency plan of Deutsche Telekom

Intermodulation Performance	see technical data ES8

Power Consumption

Voltage	24V DC ±2%
Current	< 0.4A

Climatic Conditions

Operating	ETS 300 019-1-3, class 3.1
Storage	ETS 300 019-1-1, class 1.1
Transport	ETS 300 019-1-2, class 2.2

EMC

Screening Factor (DIN VDE 0855/T110)	> 75dB
Radio Interference (DIN VDE 0855/T110)	< 20dBpW
Hum Modulation Factor	> 70dB

Pinning

Rear Side Sub-D-Interface	Pin 1: Ground Pin 2..4: n.c. Pin 5: +24V Pin 6..9: n.c.i

Dimensions

W	40 mm
H	250 mm
D	100 mm

3.2 FUBA SSO 688

Optical Performance

Wavelength	1549 ...1559nm
Opt. Output Power	2 x ≥+2dBm
Standard optical connector others on request	Diamond E2000
Fiber	Single-mode , 9/125µm
Opt. Return Loss	> 50dB
RIN	< -154dB/Hz

RF Performance

Nom. Input Level m = 4%	95.1dBµV
Frequency Range	47 - 862MHz
Frequency Response	±0.5dB for 47 ... 606MHz ±0.75dB for 606 ... 862MHz
RF Connector	IEC 75Ω
Return Loss	20dB - 1dB/Okt., > 17dB
Intermodulation Performance *	
CSO	>68dB
CTB	>65dB
CXM	>51dB

*) Assuming 50 TV channels + 30 FM radio channels (-4dB) according to the OPAL 94 frequency plan of Deutsche Telekom

Monitoring

Alarm / Message	LED		
	ES8 O.K. LED green	INT LED yell	Pout O.K. LED green
Normal Operation	on	off	on
Output Power LOW	X	X	off
Laser switched off	X	X	off
Laser Aging	X	on	X
Laser Temperature	X	on	X
Internal Failure A	off	on	X
Internal Failure B	X	on	X

Alarms

A-Alarm	- IPeltLas = 100% (Laser switched off) - Pout < 70%
B-Alarm	- IPeltLas > 90% - IBiasLas > 120%

Alarminterface

Interface	rear side Sub-D-9pol.: Pin 4: B-Alarm (non urgent) Pin 6: A-Alarm (urgent)
Alarm-Polarity	active low
Low-Level (Iout = -1.6mA)	< 800mV
High-Level (Iout = 0.8mA)	> 3.6V

Power Consumption

Voltage	24V DC ±2%
Current	< 1.1A

Climatic Conditions

Operating	ETS 300 019-1-3, class 3.1
Storage	ETS 300 019-1-1, class 1.1
Transport	ETS 300 019-1-2, class 2.2

EMC

Screening Factor (DIN VDE 0855/T10)	> 75dB
Radio Interference (DIN VDE 0855/T10)	< 20dBpW
Hum Modulation Factor	> 70dB

Pinning

rear side Sub-D9-Interface	Pin 1: Ground Pin 2,3: n.c. Pin 4: B-Alarm Pin 5: +24V Pin 6: A-Alarm Pin 7..9:n.c.

front-side Sub-D9-Interface	Pin 1:free Pin 2: Rx Pin 3: Tx Pin 4..6: free Pin 7: Masse Pin 8: free Pin 9: Setup enable

Dimensions

W	125 mm
H	250 mm
D	100 mm

3.3 Power Supply

Input Voltage (SMN 134, 230V-Version only)

Supply Voltage	min. 187V AC typ. 230V AC max. 253 V AC
Supply Current	typ. 380mA for max. Load

Input Voltage (SMR 136, 60V-version only)

Input Voltage DC	min. 48V typ. 60V max. 75V
Input Voltage AC	min 38V_{eff} typ 60V_{eff} max 65V_{eff}

Output Voltage

Output Voltage	24V DC ±2%
Output Current	0.2 - 3.0A
Max. Output Power	72W
Current Limit	typ 3.4A
Surge Protection	26V ±2.4%

Climatic Conditions

Operating	ETS 300 019-1-3, class 3.1
Storage	ETS 300 019-1-1, class 1.1
Transport	ETS 300 019-1-2, class 2.2

EMC

Shield Factor (DIN VDE 0855/T110)	> 75dB
Radio Interference (DIN VDE 0855/T110)	< 20dBpW
Hum Modulation Factor	> 70dB

Pinning

rear side Sub-D-Interface	Pin 1: Ground Pin 2..4: n.c. Pin 5: +24 V Pin 6..9: n.c.

Dimensions

W	40 mm
H	250 mm
D	100 mm