OPTICAL TRANSMITTER
1550 NM

SSO 688-19"
SSO 689-19"

Technical Manual

TABLE OF CONTENTS

1. DOCUMENT STATUS

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Revision	Date	Responsible	Remarks
00	07.04.98	Manten	Document created
01	14.09.98	Seidenberg	PAL-D version included
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2. GENERAL DESCRIPTION

2.1 Introduction

The optical transmitter SSO 688/689 represents a family of externally modulated 1550 nm DFB laser transmitters. These products have been developed to fulfil the requirements of modern Hybrid Fibre Coax networks for the transmission of CATV, cable phone and cable data signals. There are currently 3 different base versions available:

- SSO 688 (M) for applications with moderate fibre length of about < 25 km
- SSO 688 (L) for applications with long fibre lengths of about 50 km
- SSO 689 (XL) for applications with very long fibre lengths exceeding 50 km

The versions differ in the capability to suppress Stimulated Brillouin Scattering (SBS), the optical output power and in the typical laser line-width which is determining the noise performance in long distance fibre transmission links.

The three base versions are available for 4 different standard frequency plans. The specifications for other frequency plans are available on request.

The optical transmitter comes in a 2 unit high 19“ housing.

Fig. 2.1 shows the view of an SSO 689.

Figure 2.1: View of SSO 689

2.2 Principle of Operation

The transmitter is based on 5 functional blocks: RF-path, CW-DFB-Laserdiode, integrated optical modulator, control electronics and power supply. The functional diagram is given in fig. 2.2.

The RF input signal is fed into a preamplifier, comprising an automatic gain control circuitry. The AGC stabilises the output signal of the preamplifier to maintain a stable RMS- (root-mean-square) optical modulation index (OMI) of the optical modulator. Input level variations are compensated as long as the AGC circuit is working in its nominal gain range (ref. to chapter 3).

The RMS-OMI can be adjusted via the service PC interface in order to tailor the CNR/CTB performance to the used frequency plan and the requirements of the customer.

The electrical RF-signal is fed via a high-pass circuit to the input of a pre-distortion circuit, which is foreseen to linearize the squared sine wave transmission function of the electro-optical modulator. The pre-distortion circuit is requested to minimise 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 the optical output signal.

The central core of the transmitter is the Electro-optical modulator working as a Mach-Zehnder-interferometer. The light from the laser-diode is coupled to an optical strip wave-guide. An integrated optical splitter divides the light into two identical portions, which are phase modulated by a RF signal applied to the electrodes of the modulator. The concept of the electrodes results in a 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.

The necessary CW input light for the modulator is produced by a DFB laser-diode working with a wavelength around 1550 nm. There are two control loops for operating the laser-diode at constant optical output power as well as at constant temperature by means of a thermoelectric cooler. The laser-diode drive current is measured to detect an increase to 120% of the initial value, which could be caused e.g. due to ageing of the laser-diode. The temperature of the laser-diode 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 laser-diode drive current a B-grade alarm which indicates a warning is generated. At 100% cooler drive current the laser-diode drive current is switched off to protect the laser-diode against irregular temperature conditions and an A-grade alarm indicating a severe malfunction is generated. Both types of alarms are

causing the corresponding LED on the front plate of the optical transmitter to emit. In case of a B-grade alarm the yellow LED is lighting since the unit is still working properly, however close to its limits. In case of an A-grade alarm the red LED is emitting. The messages to the network management system are of course more detailed. They include the actual values of the currents and temperature as well as alarm flags.

To suppress the Stimulated Brillouin Scattering (SBS) the optical signal is broadened. Two technologies are used:

- Broadening the optical spectrum by modulating the laser-diode with a microwave signal
- Broadening the optical spectrum by driving a optical phase modulator with a microwave signal

These circuits are mandatory to avoid stimulated Brillouin scattering (SBS) in optical fibres and allow operating with optical amplifiers feeding at least +13 dBm of optical power into standard single mode fibres (ref. to chapter 3.1). All microwave signals can be adjusted in frequency and amplitude via the Service PC interface to optimise the SBS and SPM (self phase modulation) performance.

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

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

2) A detector circuit measures CSO and CTB distortions to optimise 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 all known European and Chinese 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 pure 7 MHz frequency plans. This software requires a standard IBM-compatible PC with an RS-232 interface.

The SSO 689 is equipped with 2 serial interfaces at the front to connect it to a network management system (optionally available also on the rear side) and a service laptop.

The standard equipment socket at the rear allows applying an 85 VAC to 265 VAC mains powering. Two redundant fans provide a sufficient heat sinking of the device. Each fan

can be simply removed without disturbing the operation of the transmitter by removing 2 screws.

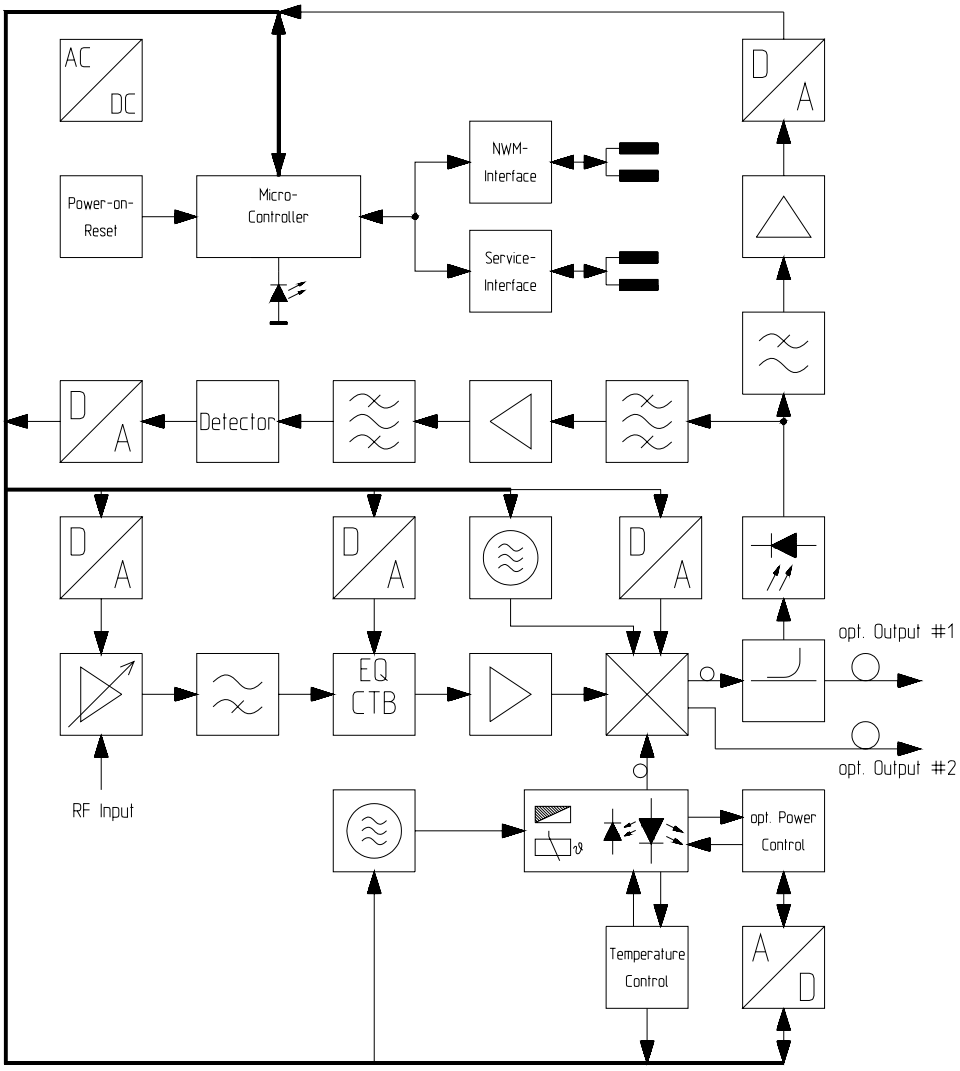

Figure 2.2: Main functions of SSO 689

3. TECHNICAL SPECIFICATIONS

3.1 Optical Properties

Wavelength	[nm]	1555±5		
Side mode suppression	[dB]	>30		
Relative intensity noise (opt. return loss < -40 dB)	[dBc/Hz]	<-156 (-159, XL version)		
		Base Version*)		
		SSO 688-M	SSO 688-L	SSO 689
CW optical power	[dBm]	2 x 4±1	2 x 4±1	2 x 7±1
SBS-Suppression-capability maximum optical power	[dBm]	13	13	16.5
Laser line-width (typ.)	[MHz]	3	1	0.3

Opt. connector		any type of high return loss connectors**
Optical fibre		standard singlemode 9/125 µm

*) Please specify frequency plan!

**) Please specify connector!

3.2 Electrical Properties

RF-Frequency Range	[MHz]	47 - 862			
flatness	[dB]	<±0.75			
Specified frequency plan for CSO/CTB measure-ments		CENELEC (Europe)	PAL-B/G (Germany)	PAL-D (China)	NTSC (America, Asia)
number of TV / radio channels		42 / 0	50 / 30	59 / 0	77 / 0
Noise bandwidth for CNR specification	MHz	5	5	5	4
CNR with RX*) at 0 dBm	dB	55.5	54.5	54.0	53.0
CNR with 65 km link**) + RX*) at 0 dBm (in all chan-nels)	dB	53.0	53.5	53.0	52.0
CSO	[dBc]	63	67	65	65
CTB	[dBc]	60	66	65	65
Spurious Signals with 65 km link**)	[dBc]	65	65	65	65
input level per TV channel	[dBµV]	80±1			
dynamic range of AGC	[dB]	+2 ... -4 ***)			
RF-connector/ impedance		IEC 169-2 / 75 Ω or F / 75 Ω			
return loss	[dB]	> 20 (47 MHz) – 1,5 dB/oct., min. > 15			

*) RX with 7 pA/√Hz input noise current density

**) 65 km of fibre + EDFA with 16 dBm of output power and 5 dB noise figure

***) Referring to the nominal modulation index

3.3 Displays and Alarms

Standard Operation	LED green
urgent alarm	LED red
non urgent alarm (warning)	LED yellow

nominal output power	LED green
lack of output power	LED yellow
loss of output power	LED red

standby – operation	LED yellow
fan 1 ok	LED green
fan 2 ok	LED green

3.4 Power Supply

Input Voltage		85 ... 265 VAC / 47 ... 63 Hz
Power Consumption	[W]	<72

3.5 Climatic Specifications

Operation	ETS 300 019, class 3.1
Warehousing	ETS 300 019, class 1.2

3.6 Network-Management-Interface

Connector	Sub-D9 male
Interface	RS232
Configurations	9600 baud, 8 Databits, 1 Stopbit, Parity no
Pinning	Pin 2: Rx Pin 3: Tx Pin 5: Gnd Pin 1, 4, 6, 7, 8, and 9: n.c.

3.7 Service-PC-Interface

Connector	Sub-D9 male
Interface	RS232
Configuration	9600 baud, 8 Databits, 1 Stopbit, Parity no
Pinning	Pin 2: Rx Pin 3: Tx Pin 7: Gnd Pin 9: Set-up enable Pin 1, 4, 5, 6, 8: n.c

3.8 EMC

Screening efficiency (DIN VDE 0855/T110)	> 75dB
radiation (DIN VDE 0855/T110)	< 20dBpW
hum-modulation	> 70dB

3.9 Mechanical Dimensions / Weight

Dimensions	[mm]	B	H	T
		483	88	448
Weight	[kg]	10		