Televes

TRANSMISOR ÓPTICO

CANAL DIRECTO

y

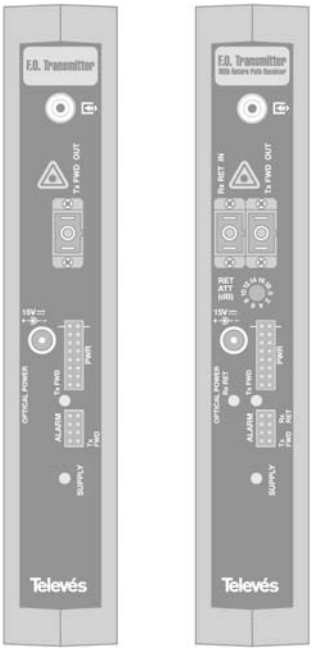
CANAL DE RETORNO

OPTICAL TRANSMITTER

DIRECT PATH

&

RETURN PATH



Manual de instrucciones - User manual

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1.- TECHNICAL SPECIFICATIONS

1.1.- OPTICAL TRANSMITTER (Direct path) Refs. 8674, 8676

RF input	RF input connector	F female
	Bandwidth	47 MHz a 2150 MHz.
	Impedance	75 Ohm
	Return losses	>= 12dB
	Max. input level for two tones in TV band **(Note 1)**	106 dBµV / tone
	Max. input level for 40 channels in TV band **(Note 2)**	90 dBµV / channel
	Max. input level for two tones in SAT band **(Note 1)**	99 dBµV / tone
	Max. input level for a complete transponder in SAT band **(Note 2)**	83 dBµV / channel
	Max. input level for 40 channels in TV band and a complete transponder in SAT band **(Note 3)**	88 dBµV / channel in TV band 78 dBµV / channel in SAT band
Optical output	Laser type	MQW-DFB
	Wave length	1310 ± 20 nm
	Optical output power	2 mW
	Optical output connector	SC/APC

Note 1: Band **TV**: 47 MHz – 860 MHz Band **SAT**: 950 MHz – 2150 MHz

Note 2:

The maximum input level (V_{in} max) for N channels (all of them with the same level) is obtained from the maximum input level for two tones through this formula:

V_{in} max (N channels) = V_{in} max (2 tones) – 10 log (N-1).

Example: for 10 channels the decrease is 10 dB, for 20 channels is 13 dB and for 40 channels is 16 dB.

Note 3:

The level of the channels in the SAT band at the input of the optical transmitter must be at least 10 dB lower than channels in TV band.

1.2.- OPTICAL RECEIVER (Return Path) Ref. 8676

Optical input	Wave length	1200 to 1600 nm
	Detection band width	1 to 3000 MHz
	Maximum optical input power	2 mW
	Optical input connector	SC/APC
RF output	RF output connector	F female
	Bandwidth	5 MHz to 30 MHz.
	Impedance	75 Ohm
	Return losses	>= 12dB
	Maximum output level (2 tone, IMD >= 45dBc) **(Note 4)**	104 dBµV / tone

Note 4: IMD = Intermodulation distance.

For a higher number of channels, the formula to obtain the decrease in the output level is the next.

The maximum input level (V_{in} max) for N channels (all of them with the same level) is obtained from the maximum input level for two tones through this formula:

V_{in} max (N channels) = V_{in} max (2 tones) – 10 log (N-1).

Example: for 10 channels the decrease is 10 dB, for 20 channels is 13 dB and for 40 channels is 16 dB.

1.3.- GENERAL

Consumption	15V / 320 mA
Working temperature	- 10ºC to + 45ºC
Power LED	ON: Powering OK OFF: Powering failure
LED- received power in return path (only ref. 8676)	ON: Received optical power OK OFF: Optical attenuation > 15 dB
LED- transmitted power in direct channel	ON: Transmitted power OK OFF: Transmitted optical power wrong
Alarms (Open contacts of rele free of potencial)	Alarm of lack of received power in return path (open contacts in alarm situation) (only ref. 8676) Alarm of wrong transmitted power in direct path (open contacts in alarm situation)

2.- LINK CALCULATIONS

2.1.- DIRECT PATH

Bandwidth	30 MHz to 2150 MHz
Flatness	< 2dB
System gain (for optical losses = 1 dB) **(Note 5)**	-8 dB to +12 dB
Regulation gain	Manual, in steps of 2 dB
Normalized equivalent input noise **(EINn)** in 800 MHz (for optical losses = 1 dB) **(Note 6)**	< -147 dBm / Hz
Normalized equivalent input noise **(EINn)** in 2 GHz (for optical losses = 1 dB) **(Note 6)**	< -143 dBm / Hz
Equivalent input noise **(EIN)** for an analogue TV signal (for optical losses = 1 dB) **(Note 7)**	-80 dBm (29 dBµV)
Equivalent input noise **(EIN)** for a DTT signal (for optical losses = 1 dB) **(Note 7)**	-78 dBm (31 dBµV)
Equivalent input noise **(EIN)** for a digital satellite channel of 27 MHz in QPSK (for optical losses = 1 dB) **(Note 7)**	-69 dBm (40 dBµV)
Minimum input level **(V_{in}min)** for analogue TV channels (C/N= 46 dB) (for optical losses = 1 dB) **(Note 8)**	75 dBµV per channel
Minimum input level **(V_{in}min)** for DTT channels (C/N= 35 dB) (for optical losses = 1 dB) **(Note 8)**	66 dBµV per channel
Minimum input level **(V_{in}min)** for digital satellite channels in QPSK (C/N= 15 dB) (for optical losses = 1 dB) **(Note 8)**	55 dBµV per channel
Maximum optical losses of the link for 40 analogue TV channels and a complete transponder in SAT band **(Note 9)**	12,5 dB

Note 5: System Gain

The value in the table has been measured for optical losses of 1 dB, equivalent to a two-meter optical fiber link between transmitter and receiver with two connectors SC/APC in the ends of the link.

The gain is reduced 2dB per each dB of additional optical losses.

RF losses = 2 x optical losses

Then, the maximum gain for optical losses higher than 1 dB will be:

Maximum gain = 12 dB – 2 x (Optical losses – 1 dB)

So, the maximum gain of the link for 7dB of optical losses is:

Maximum gain = 12 dB – 2 x (7 – 1) = 0 dB

The following approximate values can be considered when **calculating the optical losses**:

Losses of the fiber:	0,5 dB/Km
Losses of a two-way optical splitter:	3,6 dB
Losses of a three-way optical splitter:	5,8 dB
Losses of a four-way optical splitter:	7,4 dB
Losses per each optical connector:	0,5 dB / connector

For example, a link of 30 Km without optical splitters will have return losses that will be the addition of the losses due to the fibre and the losses due to the optical connectors.

In the case that only two optical connectors are used, the losses will be:

(30 Km x 0,5 dB/Km) + (2 x 0,5 dB) = 16 dB

A link that uses a four-way optical splitter at the output of a optical transmitter and four ways of 5 Km of optical fibre, will have the following optical losses in each way:

7,4 dB + (5 Km x 0,5 dB/Km) + (2 x 0,5 dB) = 10,9 dB

Note 6: Normalized equivalent input noise (EINn)

It is the normalized input noise for 1 Hz.

The value –147 dBm/Hz is only valid for optical losses equal or lower than 2 dB, i.e., it is the minimum equivalent input noise level of the link **(EINn minimum)**

For optical losses higher than 2 dB, the equivalent input noise is not constant, but it increases with the optical losses, due to the noise coming from the optical transmitter.

For TV band (up to 860 MHz), depending on the optical attenuation, the following formulas can be applied to calculate the increase of the noise:

1.- For optical losses between 3dB and 7dB (both included):

EINn = EINn minimum + (optical losses –2dB)

For instance, -144 dBm/Hz in 800 MHz for return losses of 5 dB

2.- For optical losses between 8 dB and 13 dB (both included):

EINn = EINn minimum + 5 dB + 1,5 x (optical losses – 7 dB)

For instance, for optical losses of 12 dB, the equivalent input noise will be -134,5 dBm/Hz

3.- For optical losses higher than than 13 dB:

EINn = EINn minimum – 12 dB + 2 x optical losses

For instante, for optical losses of 15 dB, the equivalent input noise will be -129 dBm/Hz

For SAT band (900 MHz – 2150 MHz), the increase of the noise is slightly lower. These values are shown in the table of Note 7.

Note 7: Equivalent input noise (EIN) for signals with bandwidth > 1Hz

The equivalent input noise **(EIN)** for a signal with a bandwidth higher than 1Hz is:

EIN = EINn + 10log (Bw), being BW the bandwidth of the channel in Hz.

For instance, for an analogue TV signal (Bw = 5MHz) and link losses lower than 2 dB, the noise power at the input will be:

EIN = -147 + 10 log (5 exp6) = -80 dBm (29 dBµV)

For a DTT signal (Bw = 8 MHz), the equivalent noise will be:

EIN = -147 + 10 log (8 exp6) = -78 dBm (31 dBµV)

For a digital TV signal in satellite band (Bw = 27 MHz), the noise power at the input will be:

EIN = -143 + 10 log (27 exp6) = -69 dBm (40 dBµV)

The value of EIN for link losses higher than 2 dB will increase according to the formulas in Note 6.

To sum up, in the following table it is shown the equivalent input noise for different optical losses, for both TV analogue signals in TV band (frequency=800 MHz, BW=5 MHz) and digital QPSK signals in satellite band (frequency = 2GHz, BW= 27MHz).

Optical losses	Maximum gain of the link	Equivalent input noise (analogue PAL TV) (800 MHz)	Equivalent input noise (digital QPSK TV) (2 GHz)
1 dB	16 dB	-80 dBm (29 dBµV)	-69 dBm (40 dBµV)
2 dB	14 dB	-80 dBm (29 dBµV)	-69 dBm (40 dBµV)
3 dB	12 dB	-79 dBm (30 dBµV)	-68 dBm (41 dBµV)
4 dB	10 dB	-78 dBm (31 dBµV)	-67,5 dBm (41,5 dBµV)
5 dB	8 dB	-77 dBm (32 dBµV)	-67 dBm (42 dBµV)
6 dB	6 dB	-76 dBm (33 dBµV)	-66,5 dBm (42,5 dBµV)
7 dB	4 dB	-75 dBm (34 dBµV)	-66 dBm (43 dBµV)
8 dB	2 dB	-73,5 dBm (35,5 dBµV)	-65 dBm (44 dBµV)
9 dB	0 dB	-72 dBm (37 dBµV)	-64 dBm (45 dBµV)
10 dB	-2 dB	-70,5 dBm (38,5 dBµV)	-63 dBm (46 dBµV)
11 dB	-4 dB	-69 dBm (40 dBµV)	-61,75 dBm (47,25 dBµV)
12 dB	-6 dB	-67,5 dBm (41,5 dBµV)	-60.5 dBm (48,5 dBµV)
13 dB	-8 dB	-66 dBm (43 dBµV)	-59 dBm (50 dBµV)
14 dB	-10 dB	-64 dBm (45 dBµV)	-57,5 dBm (51,5 dBµV)
15 dB	-12 dB	-62 dBm (47 dBµV)	-56 dBm (53 dBµV)
16 dB	-14 dB	-60 dBm (49 dBµV)	-54,5 dBm (54,5 dBµV)
17 dB	-16 dB	-58 dBm (51 dBµV)	-53 dBm (56 dBµV)

Note 8: Minimum input level to the link (V_{in} min)

It is the addition of the noise power at the input and the required C/N.

V_{in} min = EIN + C/N required

The C/N that must be considered for a correct analysis of the link; are the following:

Analogue TV signals in TV band (up to 860 MHz): 46 dB

DTT signals in TV band (up to 860 MHz): 35 dB

QPSK digital signals in SAT band: 15 dB

The minimum input levels to the link for analogue TV in TV band and digital TV in SAT band for different optical losses are shown in the following table.

Optical losses	Minimum input level for analogue TV signals (C/N = 46 dB)	Minimum input level for digital satellite signals (C/N = 15 dB)
1 dB	75 dBµV	55 dBµV
2 dB	75 dBµV	55 dBµV
3 dB	76 dBµV	56 dBµV
4 dB	77 dBµV	56,5 dBµV
5 dB	78 dBµV	57 dBµV
6 dB	79 dBµV	57,5 dBµV
7 dB	80 dBµV	58 dBµV
8 dB	81,5 dBµV	59 dBµV
9 dB	83 dBµV	60 dBµV
10 dB	84,5 dBµV	61 dBµV
11 dB	86 dBµV	62,25 dBµV
12 dB	87,5 dBµV	63,5 dBµV
13 dB	89 dBµV	65 dBµV
14 dB	91 dBµV	66,5 dBµV
15 dB	93 dBµV	68 dBµV
16 dB	95 dBµV	69,5 dBµV
17 dB	97 dBµV	71 dBµV

Note 9: Maximum optical losses supported by the link

The maximum value of the optical losses supported by the optical fiber link is that when the minimum input level and the maximum input level are the same.

The maximum input level depends on the number and type of the channels to be distributed.

The minimum input level depends on the optical losses and the required C/N of the channels to be transmitted.

Generally, the worst case is when analogue TV signals are transmitted in TV band, as these are the ones that require the highest C/N.

Example 1.- Transsmision of 20 analogue TV channels

V_{in} maximum (*see Note 2*) = 106 dBµV – 10 log (20 – 1) = 96 dBµV / channel

To have V_{in} min = V_{in} maximum = 96 dBµV, optical losses must be 16.5 dB (*see Note 8*)

These losses are equivalent to either a 30 Km link with two optical connectors and no optical splitter, or a 4-way optical splitter and a 14 Km link with its optical connectors.

Example 2.- Transmission of 40 analogue TV channles in TV band and a complete transponder of digital channels in SAT band

V_{in} maximum (*see Note 3*) = 88 dBµV / channel for analogue TV channels

78 dBµV / channel for digital satellite TV

To have V_{in} min = V_{in} maximum = 88 dBµV, optical losses must be 12.5 dB (*see Note 8*).

For this value of optical losses the minimum input level for digital channels is 64 dB, value that is much lower than the minimum input level for analogue channels.

These losses are equivalent to either a 23 Km link with two optical connectors and no optical splitter, or a 4-way optical splitter and a 6 Km link with its optical connectors.

2.2.- RETURN PATH

Bandwidth	5 MHz a 30 MHz
Flatness	< 3dB
System gain (for optical losses = 1 dB)	-8 dB a +12 dB
Regulation gain	Manual, in 2 dB steps
Normalized equivalent input noise **(EINn)** for optical losses < 5 dB **(Note 10)**	< -149 dBm / Hz
Normalized equivalent input noise **(EIN)** for an analogue TV signal (for optical losses < 5 dB)	-82 dBm (27 dBµV)
Minimum input level **(V_{in}min)** for TV analogue channels (C/N= 46 dB) (for optical losses < 5 dB) **(Note 11)**	73 dBµV per channel

Note 10: Normalized equivalent input noise (EINn)

It is the normalized input noise for 1 Hz.

The value –149 dBm/Hz is only valid for optical losses equal or lower than 5 dB, i.e., it is the minimum equivalent input noise level of the link **(EINn minimum)**

For optical losses higher than 2 dB, the equivalent input noise is not constant, but it increases with the optical losses, due to the noise coming from the optical transmitter.

This increase can be calculated with the following formula:

EINn = EINn minimum + -10 dB + (2 x optical losses)

For example, -139 dBm/Hz for 10 dB of optical losses

Note 11: Minimum input level to the link

The noise in the return path is lower than noise in the direct path. For example, for 10 dB of optical losses, the input noise level for a analogue TV signal (Bw = 5 MHz) will be

-149 dBm/Hz –10 dB + (2 x 10 dB) + 10 log (5 exp 6)= -72 dBm = 37 dBµV

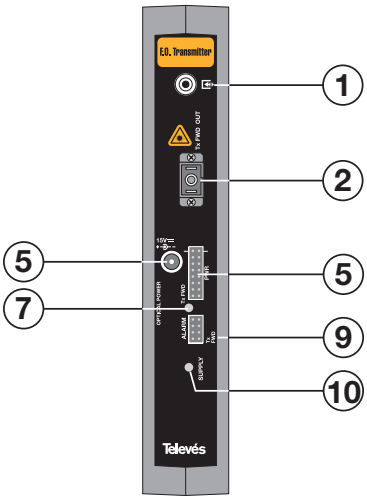
against 38.5 dBµV for direct path (*see table in Note 7*)

The minimum input level for ths same signal with a requested C/N of 46 dB will be 83 dBµV against 84.5 dBµV for direct path.

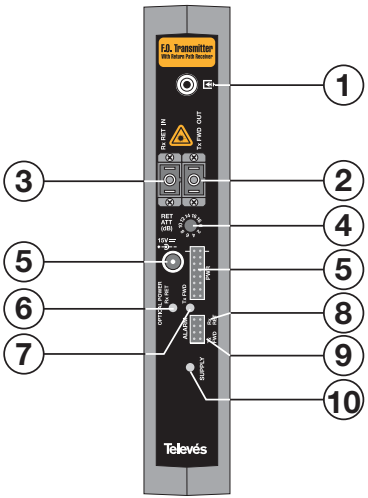
Furthermore, the requested C/N for the return path will be, in most cases, lower than the direct path.

As a conclusion, the limit of the link concerning the maximum optical losses that can be supported comes always from the direct path.

3. - ELEMENTS DESCRIPTION



Ref. 8674



Ref. 8676

1.- RF input 47 - 2150 MHz (Direct path)
5 - 30 MHz (Return path)
2.- Optical output Direct path
3.- Optical input Return path
4.- RF attenuation Return path
5.- Power supply
6.- Optical power Return path
7.- Optical power Direct path
8.- Relay alarm of received power in return path
9.- Relay alarm of transmitted power in direct path
10.- ON LED

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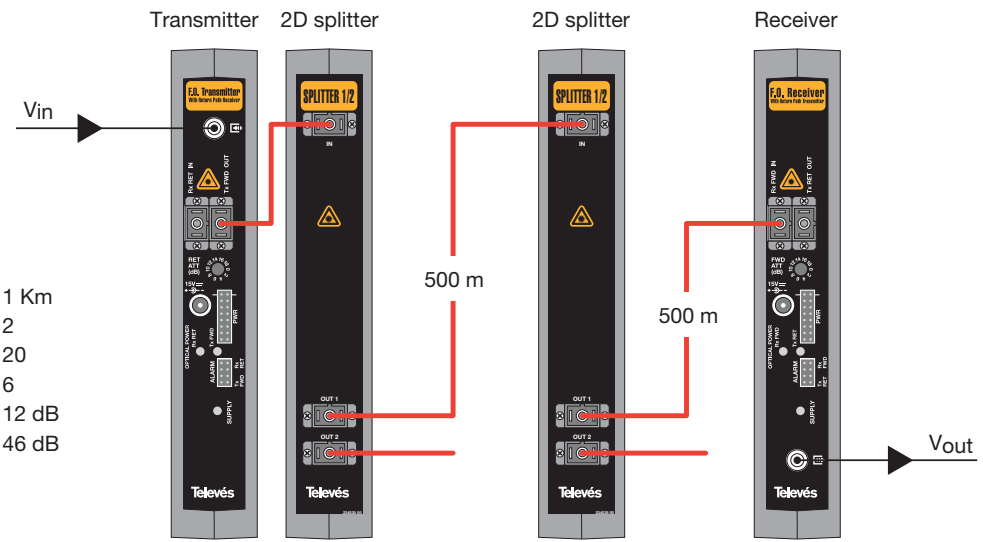
4. - LINK CALCULATIONS EXAMPLE



Fiber lengh:	1 Km
No. of 2D splitters:	2
No. of analog channels:	20
No. of Digital Mux:	6
D (Analog/Digital):	12 dB
C/N out:	46 dB

Popt = (0,5 x 1) + (2 x 3,6) + 2 + 1 = 10,70 dB
EINn = -147dBm/Hz + 5dB + 1,5 (Popt - 7dB) = -136,45 dBm
EIN = EINn + 10 log BW = -136,45dBm + 10 log(5MHz) = -69,46 dBm = 39,29 dBµV
V_{in}min = 46dB + 39,29dBµV = **85,29 dBµV**
V_{in}max = 106dBµV - 10 log(20-1) = **93,21 dBµV**
V_{out}max = 108dBµV - 10 log(20-1) = **95,21 dBµV**