

Televés

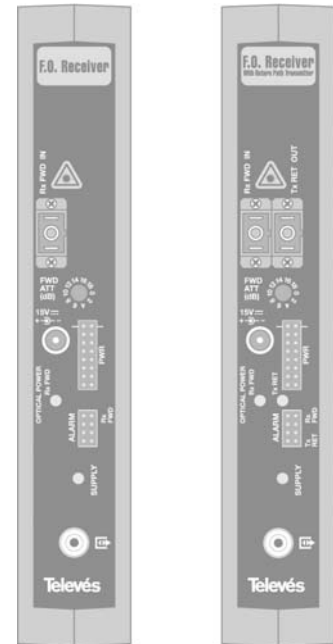
RECEPTOR ÓPTICO

CANAL DIRECTO
y
CANAL DE RETORNO

OPTICAL RECEIVER

DIRECT PATH
&
RETURN PATH

Manual de instrucciones - User manual



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1.- TECHNICAL SPECIFICATIONS

1.1.- OPTICAL RECEIVER (Direct path) Refs. 8675, 8677

Optical input	Wave length	1200 to 1600 nm
	Detection bandwidth	1 to 3000 MHz
	Maximum optical input power	2 mW
	Optical input connector	SC/APC
RF output	RF output connector	F female
	Bandwidth	47 MHz to 2150 MHz.
	Impedance	75 Ohm
	Return losses	>= 12dB
	Max. output level for 2 tones in TV band (IMD in TV band >= 60 dB, IMD in SAT band >= 52 dB)	108 dB μ V / tone
	Max. output level for 40 analogue channels in TV band (IMD in TV band >= 60 dB, IMD in SAT band >= 52 dB) (Note 1)	92 dB μ V / channel
	Max. output level for 40 DTT channels (IMD in TV band >= 56 dB, IMD in SAT band >= 50 dB) (Note 1)	92 dB μ V / channel
	Max. output level for 2 tones in SAT band (IMD in TV band >= 56 dB, IMD in SAT band >= 52 dB)	104 dB μ V / tone
	Max. output level for a complete transponder in SAT band (IMD in TV band >= 56 dB, IMD in SAT band >= 52 dB) (Note 1)	88 dB μ V / channel
Max. output level for 40 channels in TV band and a complete transponder in SAT band (IMD in TV band >= 60 dB, IMD in SAT band >= 52 dB) (Note 2)	89 dB μ V / channel in TV band 79 dB μ V / channel in SAT band	

Note 1: The maximum output level ($V_{\text{out max}}$) for N channels (all of them with the same level) is obtained from the maximum output level for two tones ($V_{\text{out max 2 tones}}$) through this formula:

$$V_{\text{out max (N channels)}} = V_{\text{out max (2 tones)}} - 10 \log (N-1)$$

In TV band (47MHz – 860 MHz) there might be analogue and DTT channels. The reduction that must be applied depends on the relative difference between them.

Generally, in collective head-ends, it is recommended that the level of DTT channels is 10 dB lower than the level of analogue TV channels.

If this difference is kept, and the number of digital channels is not higher than the number of analogue channels, only the later ones are to be considered to calculate the maximum output level at the output of the optical receiver.

So, if there are 10 analogue TV channels and 8 TDT channels, and the level of these digital channels is 10 dB lower than the level of the analogue, the maximum output level will be:

$$108 \text{ dB}\mu\text{V} - 10 \log (10 - 1)$$

To consider the TDT channels as analogue channels when calculating the reduction in the output level, their level has to be 3 dB lower.

So, if there are 10 analogue TV channels and 8 TDT channels, and the level of these digital channels is 3 dB lower than the level of the analogue, the maximum output level will be:

$$108 \text{ dB}\mu\text{V} - 10 \log (18 - 1)$$

Note 2: 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 TRANSMITTER (Return Path) Ref. 8677

RF input	RF input connector	F female
	Bandwidth	5 MHz to 30 MHz.
	Impedance	75 Ohm
	Return losses	>= 12dB
	Maximum input level	100 dB μ V / tone
Optical output	Laser type	MQW-FP Isolated
	Wave length	1310 \pm 40 nm
	Optical output power	2 mW
	Optical output connector	SC/APC

1.3.- GENERAL

Consumption	15V / 350 mA
Working temperature	- 10°C to + 45°C
Power LED	ON: Powering OK OFF: Powering failure
LED- received power in direct path	ON: Received optical power OK OFF: Optical attenuation > 15 dB
LED- transmitted power in return channel (only ref. 8677)	ON: Transmitted power OK OFF: Transmitted optical power wrong
Alarms (Open contacts of rele free of potencial)	Alarm of lack of received power in direct path (open contacts in alarm situation) Alarm of wrong transmitted power in return path (open contacts in alarm situation) (only ref. 8677)

2.- LINK CALCULATIONS

2.1.- DIRECT PATH

Bandwidth	30 MHz to 2150 MHz
Flatness	< 2dB
System gain (for optical losses = 1 dB) (Note 3)	-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 4)	< -147 dBm / Hz
Normalized equivalent input noise (EINn) in 2 GHz (for optical losses = 1 dB) (Note 4)	< -143 dBm / Hz
Equivalent input noise (EIN) for an analogue TV signal (for optical losses = 1 dB) (Note 5)	-80 dBm (29 dBμV)
Equivalent input noise (EIN) for a DTT signal (for optical losses = 1 dB) (Note 5)	-78 dBm (31 dBμV)
Equivalent input noise (EIN) for a digital satellite channel of 27 MHz in QPSK (for optical losses = 1 dB) (Note 5)	-69 dBm (40 dBμV)
Minimum input level (V _{inmin}) for analogue TV channels (C/N= 46 dB) (for optical losses = 1 dB) (Note 6)	75 dBμV per channel
Minimum input level (V _{inmin}) for DTT channels (C/N= 35 dB) (for optical losses = 1 dB) (Note 6)	66 dBμV per channel
Minimum input level (V _{inmin}) for digital satellite channels in QPSK (C/N= 15 dB) (for optical losses = 1 dB) (Note 6)	55 dBμV per channel
Maximum optical losses of the link for 40 analogue TV channels and a complete transponder in SAT band (Note 7)	12,5 dB

Note 3: 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:

$(30 \text{ Km} \times 0,5 \text{ dB/Km}) + (2 \times 0,5 \text{ dB}) = 16 \text{ dB}$

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:

$7,4 \text{ dB} + (5 \text{ Km} \times 0,5 \text{ dB/Km}) + (2 \times 0,5 \text{ dB}) = 10,9 \text{ dB}$

Note 4: 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):

$$\text{EINn} = \text{EINn minimum} + (\text{optical losses} - 2\text{dB})$$

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):

$$\text{EINn} = \text{EINn minimum} + 5 \text{ dB} + 1,5 \times (\text{optical losses} - 7 \text{ dB})$$

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:

$$\text{EINn} = \text{EINn minimum} - 12 \text{ dB} + 2 \times \text{optical losses}$$

For instance, 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 5.

Note 5: Equivalent input noise (EIN) for signals with bandwidth > 1Hz

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

$$\text{EIN} = \text{EINn} + 10\log(\text{Bw}), \text{ being Bw the bandwidth of the channel in Hz.}$$

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

$$\text{EIN} = -147 + 10 \log(5 \text{ exp}6) = -80 \text{ dBm} \quad (29 \text{ dB}\mu\text{V})$$

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

$$EIN = -147 + 10 \log (8 \text{ exp}6) = -78 \text{ dBm} (31 \text{ dB}\mu\text{V})$$

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

$$EIN = -143 + 10 \log (27 \text{ exp}6) = -69 \text{ dBm} (40 \text{ dB}\mu\text{V})$$

The value of EIN for link losses higher than 2 dB will increase according to the formulas in Note 4.

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 dB μ V)	-69 dBm (40 dB μ V)
2 dB	14 dB	-80 dBm (29 dB μ V)	-69 dBm (40 dB μ V)
3 dB	12 dB	-79 dBm (30 dB μ V)	-68 dBm (41 dB μ V)
4 dB	10 dB	-78 dBm (31 dB μ V)	-67,5 dBm (41,5 dB μ V)
5 dB	8 dB	-77 dBm (32 dB μ V)	-67 dBm (42 dB μ V)
6 dB	6 dB	-76 dBm (33 dB μ V)	-66,5 dBm (42,5 dB μ V)
7 dB	4 dB	-75 dBm (34 dB μ V)	-66 dBm (43 dB μ V)
8 dB	2 dB	-73,5 dBm (35,5 dB μ V)	-65 dBm (44 dB μ V)
9 dB	0 dB	-72 dBm (37 dB μ V)	-64 dBm (45 dB μ V)
10 dB	-2 dB	-70,5 dBm (38,5 dB μ V)	-63 dBm (46 dB μ V)
11 dB	-4 dB	-69 dBm (40 dB μ V)	-61,75 dBm (47,25 dB μ V)
12 dB	-6 dB	-67,5 dBm (41,5 dB μ V)	-60,5 dBm (48,5 dB μ V)
13 dB	-8 dB	-66 dBm (43 dB μ V)	-59 dBm (50 dB μ V)
14 dB	-10 dB	-64 dBm (45 dB μ V)	-57,5 dBm (51,5 dB μ V)
15 dB	-12 dB	-62 dBm (47 dB μ V)	-56 dBm (53 dB μ V)
16 dB	-14 dB	-60 dBm (49 dB μ V)	-54,5 dBm (54,5 dB μ V)
17 dB	-16 dB	-58 dBm (51 dB μ V)	-53 dBm (56 dB μ V)

Note 6: Minimum input level to the link ($V_{in \text{ min}}$)

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

$$V_{in \text{ min}} = E_{IN} + C/N \text{ required}$$

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 dB μ V	55 dB μ V
2 dB	75 dB μ V	55 dB μ V
3 dB	76 dB μ V	56 dB μ V
4 dB	77 dB μ V	56,5 dB μ V
5 dB	78 dB μ V	57 dB μ V
6 dB	79 dB μ V	57,5 dB μ V
7 dB	80 dB μ V	58 dB μ V
8 dB	81,5 dB μ V	59 dB μ V
9 dB	83 dB μ V	60 dB μ V
10 dB	84,5 dB μ V	61 dB μ V
11 dB	86 dB μ V	62,25 dB μ V
12 dB	87,5 dB μ V	63,5 dB μ V
13 dB	89 dB μ V	65 dB μ V
14 dB	91 dB μ V	66,5 dB μ V
15 dB	93 dB μ V	68 dB μ V
16 dB	95 dB μ V	69,5 dB μ V
17 dB	97 dB μ V	71 dB μ V

Note 7: 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.- Transmision of 20 analogue TV channels

V_{in} maximum (see Note 1) = $106 \text{ dB}\mu\text{V} - 10 \log(20 - 1) = 96 \text{ dB}\mu\text{V}$ / channel

To have $V_{in \text{ min}} = V_{in \text{ maximum}} = 96 \text{ dB}\mu\text{V}$, optical losses must be 16.5 dB (see Note 6)

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 2) = $88 \text{ dB}\mu\text{V}$ / channel for analogue TV channels

$78 \text{ dB}\mu\text{V}$ / channel for digital satellite TV

To have $V_{in \text{ min}} = V_{in \text{ maximum}} = 88 \text{ dB}\mu\text{V}$, optical losses must be 12.5 dB (see Note 6).

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 to 30 MHz
Flatness	< 3dB
System gain (for optical losses = 1 dB)	-8 dB to +12 dB
Regulation gain	Manual, in 2 dB steps
Normalized equivalent input noise (EINn) for optical losses < 5 dB (Note 8)	< -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 9)	73 dBμV per channel

Note 8: 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:

$$\text{EINn} = \text{EINn minimum} + -10 \text{ dB} + (2 \times \text{optical losses})$$

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

Note 9: 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

$$-149 \text{ dBm/Hz} - 10 \text{ dB} + (2 \times 10 \text{ dB}) + 10 \log (5 \times 10^6) = -72 \text{ dBm} = 37 \text{ dB}\mu\text{V}$$

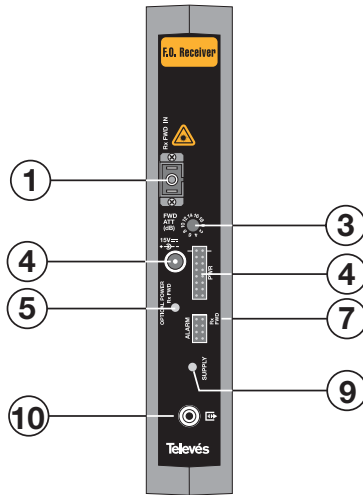
against 38.5 dB μ V for direct path (see table in Note 5)

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

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

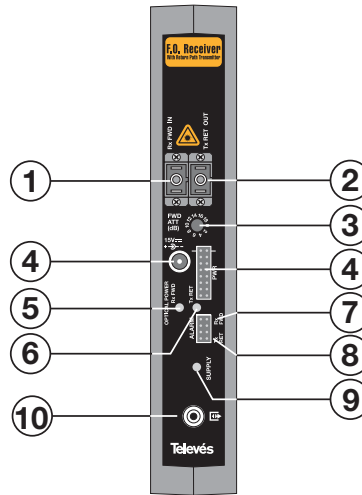
As a conclusion, the limit of the link concerning the maximum optical losses that can be supported comes always from the direct path.

3. - ELEMENTS DESCRIPTION



Ref. 8675

- 1.- Optical input Direct path
- 2.- Optical output Return path
- 3.- RF attenuation Return path
- 4.- Power supply
- 5.- Optical power Direct path
- 6.- Optical power Return path



Ref. 8677

- 7.- Alarm of received power in direct path
- 8.- Alarm of transmitted power in return path
- 9.- Powered indication
- 10.- RF output 47 - 2150 MHz (Direct path)
5 - 30 MHz (Return path)

4. - LINK CALCULATIONS EXAMPLE

