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Masthead and Indoor Amplifiers for TV Signal Reception and Distribution

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Executive summary

Ofcom has commissioned Mandercom, consultants with specialist experience in broadcast signal reception and distribution, to develop this report, which

- provides a commentary on the uses of masthead amplifiers and indoor amplifiers used in UHF TV reception systems in individual homes in the UK;

- provides technical data on over 230 models of masthead amplifiers and indoor amplifiers currently on the market. These data are intended to assist Ofcom with modelling the effects of interference from LTE systems that will use the 800MHz band.

We estimate that about 4m homes use masthead amplifiers, and about 4-5m homes use some form of indoor amplifier. These products are all potentially vulnerable to interference from LTE systems, and we have shown that this vulnerability varies significantly from one model to another.

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Introduction

Masthead amplifiers have been used for many years to raise the level of signals delivered to TV receivers. When located ahead of losses in a receiving system, the effect of a masthead amplifier can be to improve the quality of signals, resulting in a more satisfactory viewing experience for users of either digital or analogue TV signals. Used improperly, they can make the quality of signals worse.

With the increase in the average number of televisions per household, demand has arisen for internal signal distribution systems in homes, allowing a single aerial to feed multiple receivers. Indoor amplifiers are often needed for this, and a wide range of models is now available for installation either by the householder or by the aerial trade.

An amplifier used properly can under normal conditions improve the quality of the signals being received, but is also likely to make the reception system more vulnerable to interference from signals on nearby frequencies, either by overloading the receiver, or by itself being overloaded.

The planned introduction over the next few years of LTE represents a risk to TV receiving systems in some people's homes, as it will use TV channels currently being released as part of the digital dividend, one of the benefits of converting the terrestrial TV system to being entirely digital. LTE base station signals will come from relatively small masts with a typical service radius in the region of 2km. As a result, in many instances LTE base station signals will be considerably stronger than the wanted TV signals, and TV receivers will not be able to operate without appropriate measures being taken.

This report provides a commentary on the use of masthead amplifiers and indoor amplifiers, and estimates their numbers. It also provides a range of technical data about masthead amplifiers and indoor amplifiers currently on the market to aid with modelling the performance of TV receivers in systems using these amplifiers.

Amplifiers

UHF amplifiers in domestic TV reception systems are used for a variety of purposes, principally:

- raising signal levels from an aerial to overcome losses in the feed to a receiver;
- providing multiple outputs to feed several receivers around the home.

In this report, we divide amplifiers into two classes:

- masthead amplifiers where the amplifier is mounted externally, close to the UHF aerial. This includes active aerials, where the amplifier is integrated into the aerial, but excludes devices intended to be located in lofts.
- indoor amplifiers, whether intended to be located in lofts or in living areas.

Masthead amplifiers

As a general principle, where signals are poor it is best to locate an amplifier ahead of any attenuation that exists between the aerial and receiver. The benefits are illustrated in the table below[1], which shows calculated signal to noise ratios for a simple system comprising an aerial, a feeder and a receiver, firstly without an amplifier, then with an amplifier at the aerial, and finally with an amplifier at the receiver.

	No amplifier	Amplifier next to aerial	Amplifier next to receiver
Signal to noise ratio at receiver demodulator	22dB	27dB	23dB

Clearly the best result is achieved when the amplifier is next to the aerial, ahead of the feeder losses[2]. Nonetheless, some improvement can be achieved when the amplifier is next to the receiver, if the amplifier's noise figure is lower than that of the receiver.

Masthead amplifiers should only be used where they are needed to achieve a suitable level of signal at all outlets in the home. In practice they are more commonly installed than is strictly necessary by this criterion, but this can have a beneficial effect in the presence of impulsive interference. DVB-T is vulnerable to impulsive interference[3], and investigations in the early days of DTT services showed that in many cases impulsive interference would enter the system via the outlet and fly lead. The effects of such interference could often be eliminated by raising the signal level ahead of the outlet, which would improve the signal to interference ratio. On the other hand, the installation of a masthead amplifier can also have negative effects, where either the amplifier or the receiver to which it is connected is overloaded.

The proper use of masthead amplifiers is widely misunderstood, with a common perception being that more gain is necessarily better. Early models of DTT receivers tended to be quite sensitive to overload, and many could only be made to work by removing the masthead amplifier or using an attenuator. Later models of receiver were less critical in this regard, but installers are eventually learning that excess gain can be trouble, and often either taken out masthead amplifiers, or replaced them with low or variable gain devices.

1 Aerial noise temperature 290K and signal level 35dBµV, feeder loss 5dB, receiver noise figure 4.5dB, amplifier gain 10dB and noise figure 3dB. Man-made noise and interference has been ignored.

2 Feeder losses include not only loss in the cable from the aerial, but also an outlet, a fly lead from the outlet to the receiver, any splitters and the effects of RF loop though on possibly several devices.

3 DVB-T2 is much more rugged in this respect.

Most masthead amplifiers have one input and one output. However models are available with up to four inputs, allowing for direct connection of two UHF aerials, and an FM and a DAB aerial. Models are also available with up to six outputs. These can be used to feed outlets around the home.

Post digital switch-over when transmitted power levels increased significantly, there has been a noticeable trend towards the use of passive splitters to feed multiple outlets, rather than active devices. Both screened and unscreened passive splitters are available, although the use of the unscreened type is declining.

Active aerials are effectively aerials with a masthead amplifier built in. Compared to the large number of models of passive aerials, there are relatively few models of active aerial, and these are mostly log-periodic aerials which are wideband with very clean polar patterns – that is, they provide good rejection of unwanted signals from directions away from the wanted signals. They therefore tend to be used where co-channel interference from a distant transmitter causes excessive levels of interference when received by an aerial with a less clean polar pattern.

Some aerial manufacturers offer active dipoles, which can be used to replace the corresponding element on their passive models.

The demand for active aerials has never been strong (the aerial benchmarking scheme operated by the Confederation of Aerial Industries does not have a category for active aerials), and with the transmitter power increases happening at digital switch-over, it is unlikely that this market will grow significantly in the foreseeable future.

Masthead amplifiers are invariably powered by DC supplied via the coaxial cable connected to their output socket. Some indoor amplifiers will supply power in this way, but otherwise a power supply that allows the signals to pass in the opposite direction is used. Some receivers are also able to power masthead amplifiers. There is a trend towards powering at 5V, whereas previously it was common to find 12V, 16V and even 24V.

There is also a trend towards models with filtering to help protect against interference from Tetra and other services outside the broadcast bands.

Through discussions with manufacturers and trade distributors, we estimate that there are about 4m homes using masthead amplifiers.

Indoor amplifiers

The term “indoor amplifier” is intended to cover amplifiers normally located inside the home, including in the loft, and sold under a variety of descriptions such as set-back amplifiers, distribution amplifiers, signal amplifiers, signal splitter amplifiers, multi-output amplifiers, aerial amplifiers, aerial boosters, etc. It does not include launch amplifiers for communal aerial systems[4].

Indoor amplifiers are much easier for the householder to install than masthead amplifiers. This is reflected in the much greater numbers of models of indoor amplifiers available from retailers. Smart modern styling is used to attract the non-specialist buyer, as technical specifications are unlikely to be understood.

4 Individual aerial systems are those intended to provide signals within one home, while communal systems supply more than one home. The boundary between individual and communal aerial systems is somewhat indistinct; some individual systems use components intended for communal systems, and vice versa, although these represent a small part of the market.

The majority of indoor amplifiers have multiple outputs, and are intended to be able to drive several receivers. However, many use just one output to drive a nearby receiver. Some models are advertised as improving signal quality, but we have shown above that the quality improvement is small unless the amplifier is located ahead of losses. One way of achieving this is to locate the amplifier in the loft, connected via a short cable to the aerial, and feeding cables to outlets around the home (see Figure 1).

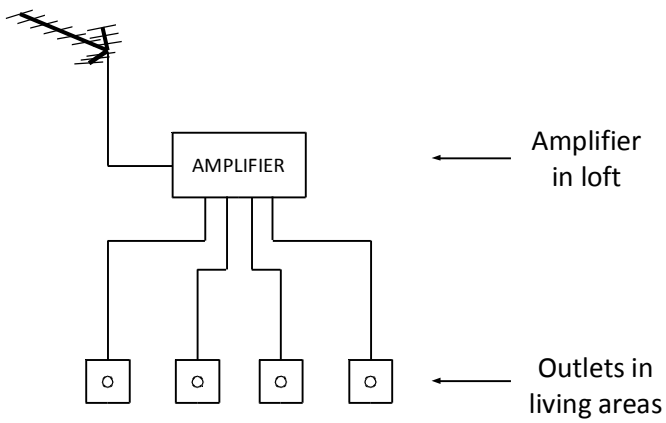

Figure 1: Typical use of an amplifier in a loft

Another class of amplifiers is known as *return path amplifiers*. These not only allow UHF signals to be delivered from one room to other rooms in the home, but also allow the central receiver (typically a satellite receiver) to be operated from the other rooms by an infra-red remote control. However, as far as the UHF forward path is concerned, there is no significant difference between return path amplifiers and other types of indoor amplifier.

An even more complex distribution arrangement is offered by devices sold under names such as Loftbox, Starbox, Atticbox[5], etc. These provide the facility to send satellite signals to a satellite receiver, and to make its output available to other receivers in the home via the receiver's UHF analogue modulated output (see Figure 2). The sales window for such devices is coming to an end, because it requires receivers with analogue inputs. Recognising this, the latest generation of receivers from Sky no longer have a UHF output; distribution to other TVs in the home must use the SCART or HDMI outputs.

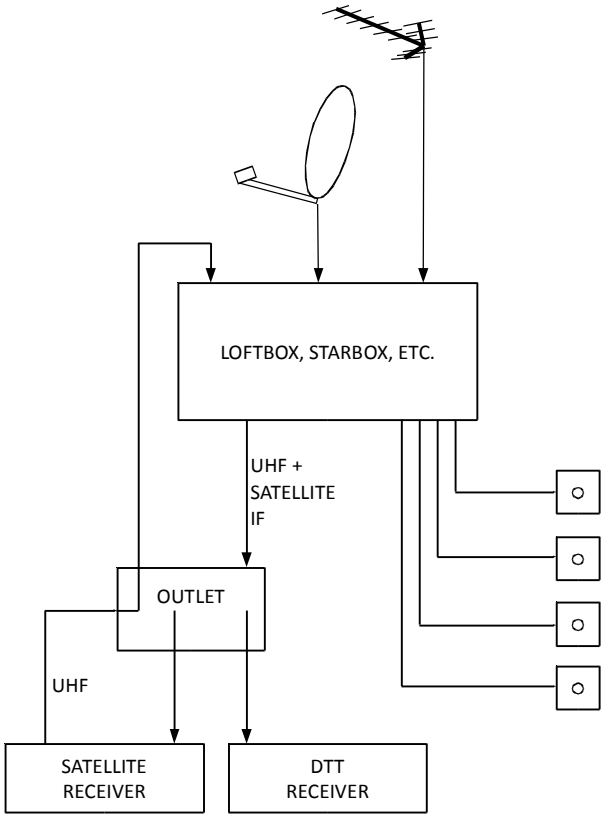

Figure 2: Typical use of the generic "loftbox"

Most indoor amplifiers have fixed gain and have been designed to handle the most commonly occurring range of signals. Normally householders are not equipped to make measurements of signal levels; even using a DTT receiver's signal indications gives only limited help. Therefore if the installation of an indoor amplifier doesn't work properly, the householder must generally seek professional advice.

Through discussions with manufacturers and trade distributors, we estimate that there are about 4-5m homes using indoor amplifiers.

5 These names are registered trade marks. However, the term “Loftbox” has entered generic use.

Survey of amplifiers

Data have been collected on ranges of models of masthead and indoor amplifiers on the market in the UK. This is not an exhaustive survey, but covers models available from the principal trade distributors and retail outlets, and therefore should be reasonably representative of the majority of models sold.

Masthead amplifiers

The full data for masthead amplifiers in the survey are given in Annex A, but in summary:

- 106 models are listed.
- 102 models give some information about maximum signal.
- Gains range from 4.5dB to 40dB, and average 17.8dB[6].
- 37 models (35%) have adjustable gain.
- 11 models cover significantly less than the whole of the frequency range 470-862MHz; 8 models reduced coverage at the top end of this frequency range.
- Noise figures are claimed from 0.8dB to 6.5dB.
- The average of the maximum stated or calculated input signal levels is 80.5dBµV.

A small number of the amplifiers state the maximum input signal level, and for the remainder this has been calculated from the specified maximum output level and gain. It is possible, particularly with amplifiers having variable gain, that this is not valid in all situations, for example when the gain is set to minimum and input stage non-linearity dominates. However, this effect should not make a large difference to the results.

The figures given for maximum signal level state a variety of types of measurement method (or none), and where this is available, it has been given in Annex A. The implication is that some degree of caution should be observed when comparing one figure with another. Nonetheless, the calculations reveal a wide range of values for maximum input, from 70dBµV to 94dBµV (-39dBm to -15dBm).

Indoor amplifiers

Similarly, data have been collected for indoor amplifiers. The full data are shown in Annex B, but in summary:

- 128 models are listed.
- 116 models give some information about maximum signal.
- Gains range from 4dB to 28dB, and average 10.8dB[7]
- 21 models (16%) have adjustable gain.
- All models cover the whole of the frequency range 470-862MHz.
- Noise figures are claimed from 2.5dB to 6dB.
- The average of the maximum stated or calculated input signal levels is 79.4dBµV.

Noting the reservations above about comparing the maximum signal levels among different models, nonetheless the data have been used to create a chart showing the relative occurrence of values of maximum input signal level in nine bands, for both masthead and indoor amplifiers (see Figure 3). This shows a broadly similar profile for the two types of device, and a spread of values of about 27dB.

6 This is the average of the values stated by manufacturers in dB. For amplifiers with adjustable gain, the mid-value of the stated gain range has been used.

7 See footnote 6.

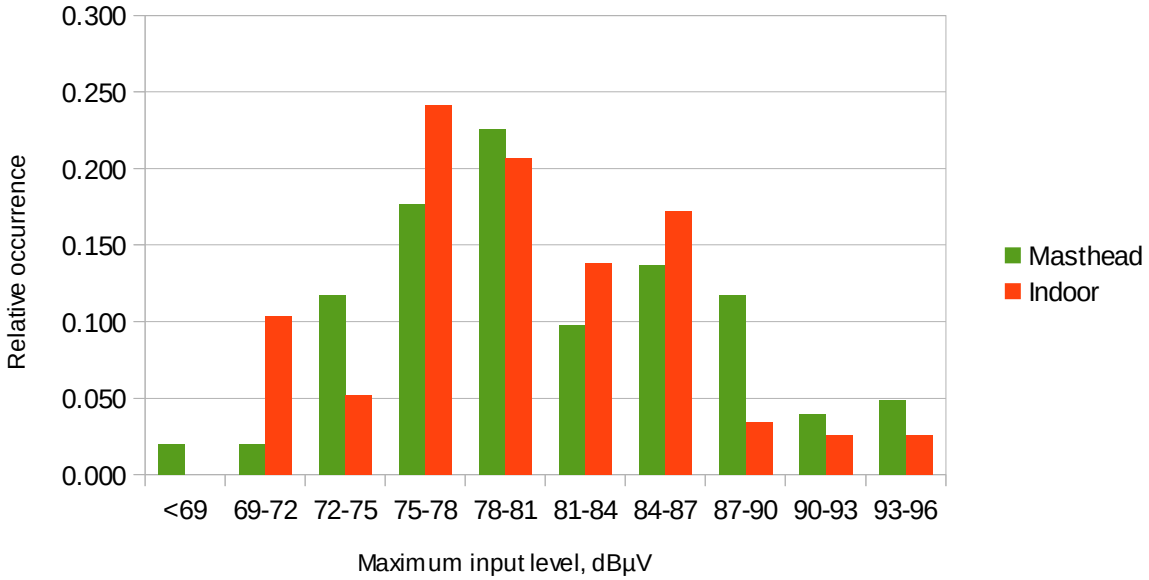

Figure 3: Relative occurrence of values of maximum input signal level for masthead and indoor amplifiers

Conclusions

The great majority of models of masthead amplifiers in the survey are available only from trade outlets, and so presumably are installed by professional aerial installers. In contrast, indoor amplifiers are widely available through retail outlets, and are clearly intended to be installed by non-specialists. Accordingly, the installation process must be straightforward, and not involve any test equipment; only 16% of indoor amplifiers have adjustable gain, for example.

The two types of amplifier have quite similar characteristics in many respects. While masthead amplifiers have on average 7dB more gain than indoor amplifiers, the maximum input levels for the two types of device are on average very similar, with a wide spread of values from model to model.

98 of the 106 masthead amplifiers surveyed covered to the top of the current broadcast band (862MHz), as did all the indoor amplifiers. They will therefore not be protected against the ingress of signals in the 800MHz band to be used by LTE systems. The wide range of signal handling capabilities of both types of amplifiers means that some models will be significantly more vulnerable to high levels of LTE signals than others.

Annex A – Table of masthead amplifiers

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Antiference	UXF1/25U	470-862	25dB	1	1	3.5dB	102dBµV output, DIN 45004B 3 carriers, IMD3 – 60dB
Antiference	UXF1/15U	470-862	15dB	1	1	3.0dB	98dBµV, DIN 45004B 3 carriers, IMD3 – 60dB
Antiference	UP15WB	470-862	15dB	1	1	3.0dB	98dBµV, DIN 45004B 3 carriers, IMD3 – 60dB
Antiference	UPF15U	470-862	15dB	1	1	3.0dB	98dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UPF25U	470-862	25dB	1	1	3.5dB	102dBµV output, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UXFR1	470-862	1-25dB	1	1	2.5dB	102dBµV output, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UPFR25U	470-862	1-25dB	1	1	3.5dB	102dBµV output, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UPFR21-30U	40-300, 470-862	20-30dB	2	1	3.5dB	102dBµV
Antiference	UXF2	470-862	10dB	1	2	3.5dB	94dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UXFR2-20	470-862	1-20dB	1	2	2.5dB	94dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UXF4	85-230, 470-862	10dB	2	4	3.5dB	92dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UXFR4-20	85-230, 470-862	1-20dB	2	4	2.5dB	94dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	UXFR5-20	470-862	1-20dB	1	5	2.5dB	94dBµV, DIN 45004B 3 carriers, IMD3 – 60dB, Tetra filter
Antiference	MX240	85-230, 470-862	8dB	2	4	4dB	80dBµV max. output
Antiference	UX2	470-862	10dB	1	2	3dB	94dBµV at -46dB signal to cross modulation ratio with 2 channels
Antiference	UX3	470-862	10dB	1	3	3dB	94dBµV at -46dB signal to cross modulation ratio with 2 channels
Antiference	UX4	470-862	10dB	1	4	3dB	94dBµV at -46dB signal to cross modulation ratio with 2 channels
Fracarro	JS2RT	47-862	7-22dB	1	1	4dB	108dBµV max. output
Fracarro	MAP105	UHF	33dB	1	1	6dB	108dBµV max. output

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Fracarro	MAP106	VHF+UHF	34dB	1	1	5dB	108dBµV max. output
Fracarro	MAP109	VHF+UHF	17dB	1	5	4dB	5 x 92dBµV max. output
Fracarro	MAP310	FM, DAB, UHF	14dB	3	1	4dB	108dBµV max. output
Fracarro	MAP311	FM, DAB, UHF	9-24dB	3	1	5dB	105dBµV max. output
Fracarro	MAP3171	BI+FM, BIII, UHF	23-33dB	3	1	3dB	107dBµV
Fracarro	MAP401	Bands I+III, FM, UHF, SAT	15-30dB	4	1	6dB	108dBµV max. output
Fringe	SDR13	470-862	13dB	1	1	2.1dB	94dBµV max. input, 107dBµV max. output
Fringe	SDR14-2	470-862	14dB	1	2	2.2dB	88dBµV max. input, 102dBµV max. output
Fringe	SDR16	470-862	16dB	1	1	2.2dB	88dBµV max. input, 104dBµV max. output
Fringe	SDR2-13-2	470-862	2-13dB	1	2	2.2dB	88dBµV max. input, 101dBµV max. output
Fringe	SDR5-15	470-862	5-15dB	1	1	2.2dB	88dBµV max. input, 102dBµV max. output
Fringe	SDR9-2	470-862	9dB	1	2	2.1dB	94dBµV max. input, 103dBµV max. output
Fringe	Outdoor 4	470-862	11dB	1	4	3dB	84dBµV max. output
Fringe	A1230	470-606	30dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	B1228	582-734	28dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	CD1225	686-862	25dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	WB1225	470-862	25dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	A1228	470-606	28dB	1	1	2.8dB	DIN45004 98dBµV output max.
Fringe	B1226	582-734	26dB	1	1	2.8dB	DIN45004 98dBµV output max.
Fringe	CD1223	686-862	23dB	1	1	2.8dB	DIN45004 98dBµV output max.
Fringe	WB1222	470-862	22dB	1	1	2.8dB	DIN45004 98dBµV output max.

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Fringe	WB22-V	40-230, 470-862	22dB	2	1	2.9dB	DIN45004 100dBµV output max.
Fringe	A1218	470-606	18dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	B1216	582-734	16dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	CD1213	686-862	14dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	WB1214	470-862	15dB	1	1	1.9dB	DIN45004 100dBµV output max.
Fringe	WB22-2	470-862	18dB	1	2	2.9dB	96dBµV max. output
Global	X140	47-860	7dB	1	4	3dB	85dBµV max. output
Ikusi	MBS2310	FM - DAB/BIII - UHF	15-30dB	3	1	4.5dB	106dB max. output, DIN-B, -60 dB
Ikusi	SBA100	470-862	25-40dB	1	1	2dB	105dBµV max. output, DIN-B, -60dB
Labgear	PUH111	470-862	24dB	1	1	2dB	75dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PUM111	470-862	16dB	1	1	2dB	80dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PUM121	470-862	12dB	1	2	2dB	80dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PUM141	470-862	10dB	1	4	2dB	80dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PUM141BP	88-862	6dB	1	4	3dB	80dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PWH211	47-862	30dB	1	1	3dB	75dBµV max. input for 5 analogue channels. Tetra filter
Labgear	PWH224	88-470, 470-862	24dB	2	1	3dB	75dBµV max. input for 5 analogue channels. Tetra filter
Maxview	MHA26U	470-862	8-26dB	1	1	3.5dB	-
Paragon	12501	470-862	18dB	1	1	1dB	105dBµV max. output at 24v supply, 95dBµV at 12v supply
Paragon	12502	470-862	2-15dB	1	1	6dB	105dBµV max. output
Paragon	12503	470-862	11-26dB	1	1	4dB	107dBµV max. output
Paragon	12504	470-862	9-24dB	1	4	4dB	107dBµV max. output

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Paragon	12505	FM + TV + DAB	9-24dB	3	1	5dB	105dBµV max. output
Paragon	12510	TVx2, FM, DAB	25-40dB	4	1	3dB	110dBµV @60dB IMA3
Philex	SLx 27830R	470-862	15dB	1	1	5dB	-
Philex	SLx2M 27837F	470-862	12dB	1	2	-	-
Philex	SLx4 27839F	FM, UHF	-	2	4	-	-
Proception	MHD14R	470-862	4.5dB	1	4	2.8dB	84dBµV max. input, 88dBµV max. output
Proception	MHD14V	470-862	1-16dB	1	4	2.2dB	80dBµV max. input, 94dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD11V	470-862	7-22dB	1	1	2.2dB	80dBµV max. input, 102dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD11L	470-862	9dB	1	1	1.8dB	80dBµV max. input, 90dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD11M	470-862	16dB	1	1	1.7dB	75dBµV max. input, 92dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD11H	470-862	27dB	1	1	1.8dB	74dBµV max. input, 102dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD12M	470-862	10dB	1	2	1.8dB	78dBµV max. input, 89dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Proception	MHD14M	470-862	10dB	1	4	2.2dB	74dBµV max. input, 85dBµV max. output (5 analogue ch. + 6 DTT @-14dB)
Televes	5350	47-254, 470-862, 951-2150	14-29dB	3	1	2.5dB	103dBµV max. output
Televes	5351	47-254, 470-862, 951-2150	14-29dB	4	1	2.5dB	103dBµV max. output

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Televes	5352	47-254, 470-862, 951-2150	12-27dB	3	1	6.5dB	103dBµV max. output
Televes	5354	47-254, 470-862, 951-2150	20dB	2	4	2.5dB	93dBµV max. output
Televes	5573	470-862	8-28dB	1	1	-	-
Triax	TFM15W	470-862	15dB	1	1	1.8dB	105dBµV max. output
Triax	TFMV25W	470-862	10-25dB	1	1	1.8dB	105dBµV max. output
Triax	TFMV25W-VHF	47-230, 470-862	10-25dB	2	1	1.8dB	105dBµV max. output
Triax	TFMV32W-VHF	47-230, 470-862	32dB	2	1	1.8dB	105dBµV max. output
Triax	TFMV34W	470-862	25-34dB	1	1	1.8dB	105dBµV max. output
Triax	TFMV425-VHF	47-230, 470-862	15-25dB	2	4	2.5dB	97dBµV max. output
Triax	TFM22W-DAB-FM	87.5-108, 174-230, 470-862	12-22dB	3	1	2.5dB	105dBµV max. output
Triax	TFM25A	470-606	25dB	1	1	1.8dB	105dBµV max. output
Triax	TFM23B	591-733	25dB	1	1	1.8dB	105dBµV max. output
Triax	TFM25C	687-862	25dB	1	1	1.8dB	105dBµV max. output
Vision	V20-1113	470-862	13dB	1	1	0.8dB	87dBµV max. input, 100dBµV max. output, EN50083-5 (IMD3 60)
Vision	V20-1127	470-862	15-27dB	1	1	1.4dB	79dBµV max. input, 106dBµV max. output, EN50083-5 (IMD3 60)
Vision	V20-1220	470-862	8-20dB	1	2	1.4dB	79dBµV max. input, 92dBµV max. output, EN50083-3 (IMD3 60)
Vision	V20-1420	470-862	8-20dB	1	4	1.4dB	79dBµV max. input, 92dBµV max. output, EN50083-3 (IMD3 60)

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Vision	V20-2127	85-240, 470-862	15-27dB	2	1	1.4dB	79dBµV max. input, 100dBµV max. output
Vision	V20-3127	85-108, 174-240, 470-862	15-27dB	3	1	1.4dB	79dBµV max. input, 100dBµV max. output
Vision	V21-1406	85-862	6dB	1	4	4dB	85dBµV max. input
Vision	V21-2420	85-862	16-26dB	2	4	1.4dB	80dBµV max. input
Wolsey	WFA10	470-862	10dB	1	1	2.2dB	94dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFA15	470-862	15dB	1	1	2.2dB	96dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFA25	470-862	25dB	1	1	2.2dB	102dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV25	470-862	25dB	1	1	2.2dB	102dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV225	470-862	25dB	1	2	2.2dB	97dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV410	470-862	10dB	1	4	2.2dB	85dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV425	470-862	25dB	1	4	2.2dB	85dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV610	470-862	10dB	1	6	2.2dB	83dBµV max. output, DIN45004B 3 carriers IMD3 -60dB
Wolsey	WFAV622	470-862	22dB	1	6	2.2dB	83dBµV max. output, DIN45004B 3 carriers IMD3 -60dB

Annex B – Table of indoor amplifiers

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Antiference	A1100R	45-860	20dB	1	1	4.5dB	100dBµV at -46dB signal to cross mod. ratio, 2 channels
Antiference	A1200R	45-860	12dB	1	2	3.5dB	95dBµV at -46dB signal to cross mod. ratio, 2 channels
Antiference	A1300R	45-860	11dB	1	3	4dB	95dBµV at -46dB signal to cross mod. ratio, 2 channels
Antiference	A1400R	45-860	11dB	1	4	4dB	95dBµV at -46dB signal to cross mod. ratio, 2 channels
Antiference	A110-PRO	85-862	15dB	1	1	3.5dB	100dBµV DIN 45004B 3 carriers IMD3 -60dB
Antiference	A120-PRO	85-862	12dB	1	2	3.5dB	95dBµV DIN 45004B 3 carriers IMD3 -60dB
Antiference	A240L-PRO	85-240, 470-862	10dB	2	4	3.5dB	92dBµV DIN 45004B 3 carriers IMD3 -60dB, Tetra filter
Antiference	A241LRPRO	85-240, 470-862	0-10dB	2	4+1	3.5dB	92dBµV DIN 45004B 3 carriers IMD3 -60dB, Tetra filter
Antiference	A261L-PRO	85-240, 470-862	8/16dB	2	6+1	4dB	6 at 83dBµV, 1 at 91dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A261LRPRO	85-240, 470-862	8/16dB	2	6+1	4dB	6 at 83dBµV, 1 at 91dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A281L-PRO	85-240, 470-862	8/16dB	2	8+1	4dB	8 at 83dBµV, 1 at 91dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A281LRPRO	85-240, 470-862	8/16dB	2	8+1	4dB	8 at 83dBµV, 1 at 91dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A120D	45-862	8dB	1	2	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A240D	45-230, 470-862	8dB	2	4	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A260D	45-230, 470-862	8dB	2	6	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A280D	45-230, 470-862	8dB	2	8	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A2120D	45-230, 470-862	8dB	2	12	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	A2160D	45-230, 470-862	8dB	2	16	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	LPA120D	88-862	7dB	1	2	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB
Antiference	LPA140D	88-862	6dB	1	4	3.5dB	78dBµV, DIN 45004B 3 carriers IMD3 -60dB

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Commtel	42525000	470-860	20.8dB	1	1	3dB	98dBµV max. output
Commtel	42525100	470-860	16.8dB	1	2	3dB	98dBµV max. output
Commtel	42525300	470-860	13dB	1	4	3dB	98dBµV max. output
Fringe	High Output	47-860	28dB	1	1	3.4dB	107dBµV max. output
Fringe	Split High Output	47-860	24dB	1	2	3.4dB	103dBµV max.output
Fringe	Mini4-2	88-108, 470-860	6.5dB	2	4	4.9dB	84dBµV max. output
Fringe	Super 1	40-860	22dB	1	1	3.9dB	98dBµV max. output
Fringe	Super 2	40-860	19dB	1	2	3.9dB	95dBµV max. output
Fringe	1 Set	470-860	14dB	1	1	2.5dB	98dBµV max. output
Fringe	2 Set	470-860	9dB	1	2	3.3dB	94dBµV max. output
Fringe	3 Set	470-860	8dB	1	3	3.9dB	85dBµV max. output
Fringe	4 Set	470-860	7dB	1	4	3.9dB	84dBµV max. output
Global	T120	47-860	7dB	1	2	3dB	85dBµV max. output
Global	T140	47-860	7dB	1	4	3dB	84dBµV max. output
Global	T180	47-860	8dB	1	8	4dB	85dBµV max. output
Global	F120	47-860	7dB	1	2	3dB	85dBµV max. output
Global	F140	47-860	7dB	1	4	3dB	85dBµV max. output
Global	F180	47-860	8dB	1	8	3dB	85dBµV max. output
Global	F280	47-860	8dB	1	16	3dB	85dBµV max. output
Global	4 Way Loftbox	FM, DAB, UHF, SAT	6dB	Multiple	1+4		60-75 dBµV recommended input levels for analogue carriers

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Global	8 Way Loftbox	FM, DAB, UHF, SAT	6dB	Multiple	1+8		60-75 dBµV recommended input levels for analogue carriers
Global	IRS Loftbox	FM, DAB, UHF, SAT	6dB	2	4		70-75dBµV, all analogue and IF carriers in an IRS feed
Global	IRS Loftbox	FM, DAB, UHF, SAT	6dB	2	8		70-75dBµV, all analogue and IF carriers in an IRS feed
Labgear	MSA111/S	44-862	14dB	1	1	3dB	-
Labgear	MSA121/S	44-862	11dB	1	2	3.5dB	-
Labgear	MSA262/S	40-270, 470-862	8dB	2	6+1	5dB	75dBµV max. input (5 analogue ch. + 6 DTT @-14dB)
Labgear	MSA263LP	47-300, 470-862	8dB	2	6	4dB	83dBµV max output for 5 analogue channels, cross-mod. -46dB. Tetra filter
Labgear	MSA283LP	47-300, 470-862	8dB	2	6	4dB	83dBµV max output for 5 analogue channels, cross-mod. -46dB. Tetra filter
Labgear	66762	40-862	12dB	2	4	4dB	102dBµV max. output
Labgear	99617	40-862	16dB	2	6	4dB	102dBµV max. output
Labgear	67269	40-862	16dB	2	8	4dB	102dBµV max. output
Labgear	CA121/S	88-862	8dB	1	2	4dB	94dBµV max. output
Labgear	CA141/S	88-862	7dB	1	4+1	4dB	89dBµV max. output
Labgear	DA222BP/S	87.5-230, 470-862	7dB	2	2	6dB	90dBµV max. output, IMD 60dB, with Tetra filter
Labgear	DA242BP/S	87.5-230, 470-862	7dB	2	4	6dB	90dBµV max. output, IMD 60dB, with Tetra filter
Labgear	DA282/S	87.5-230, 470-862	7dB	2	8	6dB	90dBµV max. output, IMD 60dB, with Tetra filter
Nikkai	A50JA	47-863	9-12dB	1	2	3.5dB	90dBµV max. output

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Nikkai	A80HT	47-863	9-12dB	1	4	3.5dB	90dBµV max. output
Nikkai	L22AG	47-230, 470-863	9-12dB	1	2	3.5dB	94dBµV max. output
Nikkai	TB07H	470-860	20dB	1	1	4dB	95dBµV max. output
Nikkai	L23AG	47-230, 470-863	9-12dB	1	4	3.5dB	90dBµV max. output
Nikkai	L24AG	47-230, 470-863	12-15dB	2	6	3.5dB	87dBµV max. output
Nikkai	L25AG	47-230, 470-863	12-15dB	2	8	3.5dB	83dBµV max. output
Nikkai	A71JH	47-863	12dB	2	2	3.8dB	-
Nikkai	A72JH	47-863	10dB	2	4	3.8dB	-
Nikkai	A73JH	47-863	10dB	2	6	3.8dB	-
Nikkai	A74JH	47-863	10dB	2	8	3.8dB	-
One for All	SV9512	FM, VHF, UHF	10dB	1	1	-	-
One for All	SV9542	FM, VHF, UHF	10-20dB	1	4	-	-
Optima	DA2	40-862	5-15dB	1	2	-	72-77dBµV max. input, 87dBµV max. output, IMD3 -60dB
Optima	DA4	40-862	10-20dB	1	4	-	72-82dBµV max. input, 92dBµV max. output, IMD3 -60dB
Optima	DA6	40-862	6-18dB	1	6	-	72-78dBµV max. input, 90dBµV max. output, IMD3 -60dB
Optima	DA8	40-862	6-16dB	1	8	-	72-78dBµV max. input, 88dBµV max. output, IMD3 -60dB
Paragon	12102	UHF	18dB	1	2	-	93dBµV max. output, EN50083-3 IMA3
Paragon	12104	VHF, 470-862	12dB	2	4	5dB	90dBµV max. output @ 60dB IMA3
Paragon	12106	47-230, 470-862	12dB	2	6	5dB	89dBµV max. output @ 60dB IMA3
Paragon	12108	47-230, 470-862	12dB	2	8	5dB	89dBµV max. output @ 60dB IMA3
Paragon	12402	47-230, 470-862	12dB	1	2	5dB	90dBµV max. output @ 60dB IMA3
Paragon	12404	47-230, 470-862	12dB	1	4	5dB	90dBµV max. output @ 60dB IMA3

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Paragon	12406	47-230, 470-862	12dB	1	6	5dB	90dBµV max. output @ 60dB IMA3
Paragon	12408	47-230, 470-862	12dB	1	6	5dB	90dBµV max. output @ 60dB IMA3
Philex	SLx 27874R	47-230, 470-862	12dB	2	4	3.5dB	90dBµV max. output
Philex	SLx 27875R	47-230, 470-862	6dB	2	4	4dB	90dBµV max. output
Philex	SLx 27828HS	47-230, 470-862	0-14dB	1	1	4dB	94dBµV max. output
Philex	SLx 27824F	VHF, UHF	12/18dB	2	8+1	4dB	83dBµV max. output
Philex	SLx 27822HS	47-230, 470-862	0-18dB	1	2	3.5dB	94dBµV max. output
Philex	SLx 28101HS	47-862	0-12dB	1	2	4dB	-
Philex	SLx 28103	47-300, 470-862	12dB	2	4	4dB	-
Philex	SLx 27843HS	47-862	0-12dB	1	4	5dB	-
Proception	STR5M	FM, DAB, UHF, SAT	5dB	Multiple	1+5	-	75dBµV max. input (5 analogue ch. + 6 DTT @-14dB)
Proception	STR5S	FM, DAB, UHF, SAT	4dB	Multiple	1+5	-	75dBµV max. input (5 analogue ch. + 6 DTT @-14dB)
Proception	STR10S	FM, DAB, UHF, SAT	4dB	Multiple	1+10	0	75dBµV max. input (5 analogue ch. + 6 DTT @-14dB)
Televes	5372	47-230, 470-862	15/27dB	2	7+1	2.5dB	89dBµV max. output (DIN45004B, outputs 1-7), 101dBµV on high level output
Televes	5514	47-862	8dB	1	4	3.5dB	94dBµV max. output (DIN45004B)
Televes	5517	47-232, 470-862	4-16dB	2	4	4.5dB	105dBµV max. output (DIN45004B)

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Televes	5518	47-862	25dB	1	1	5dB	114dBµV max. output (DIN45004B)
Televes	552301	47-862	13/16dB	1	4+1	4dB	106dBµV max. output (DIN45004B)
Televes	5532	47-862	20dB	1	2	5dB	110dBµV max. output (DIN45004B)
Televes	553101	47-862	16dB	1	6+1	4dB	102dBµV max. output (DIN45004B)
Televes	552701	47-862	13-25dB	1	1	5dB	112dBµV max. output (DIN45004B)
Televes	552801	47-862	20/14dB	1	2+1	4dB	106dBµV max. output (DIN45004B)
Televes	552901	47-862	16/13dB	1	4+1	4dB	102dBµV max. output (DIN45004B)
Triax	370402	88-862	8dB	1	2	5dB	94dBµV max. output
Triax	370403	88-862	7dB	1	4	5dB	89dBµV max. output
Triax	333112	FM, DAB, UHF, SAT	8dB	Multiple	6+1	-	-
Vision	V65-202	85-240, 470-862	10dB	2	2	-	80dBµV max. input
Vision	V65-204	85-240, 470-862	10dB	2	4	-	80dBµV max. input
Vision	V65-206	85-240, 470-862	10dB	2	6	-	80dBµV max. input
Vision	V65-208	85-240, 470-862	10dB	2	8	-	80dBµV max. input
Vision	V65-212	85-240, 470-862	10dB	2	12	-	80dBµV max. input
Vision	V65-216	85-240, 470-862	10dB	2	16	-	80dBµV max. input
Wolsey	334031	47-862	10-20dB	1	1	4dB	92dBµV max. output
Wolsey	334032	47-862	7-17dB	1	2	4dB	95dBµV max. output
Wolsey	334034	47-230, 470-862	11dB	2	4	5dB	83dBµV max. output
Wolsey	334035	47-862	0-10dB	1	4	4dB	89dBµV max. output
Wolsey	334036	47-230, 470-862	11/18dB	2	6+1	5dB	83dBµV max. output (6), 96dBµV max. output (1)

Manufacturer	Model	Frequency range, MHz	UHF Gain	Inputs	Outputs	Noise	Comments
Wolsey	334043	47-862	13/23dB	1	6+1	5dB	97dBµV max. output (6), 102dBµV max. output (1)
Wolsey	334038	47-230, 470-862	11/18dB	2	8+1	6dB	83dBµV max. output (8), 96dBµV max. output (1)
Wolsey	334044	47-862	13/23dB	1	8+1	5dB	97dBµV max. output (8), 102dBµV max. output (1)
Wolsey	334054	47-230, 470-862	11dB	2	6	4dB	90dBµV max. output
Wolsey	334055	47-230, 470-862	8.5dB	2	8	5dB	90dBµV max. output
Wolsey	334056	47-862	8dB	1	2	4dB	92dBµV max. output
Wolsey	334057	47-230, 470-862	8dB	2	4	4dB	92dBµV max. output
Wolsey	334058	47-862	10dB	1	6	5dB	92dBµV max. output
Wolsey	334059	47-862	10dB	1	8	5dB	93dBµV max. output
Wolsey	334060	47-862	7.5dB	1	4	5dB	92dBµV max. output
Wolsey	334064	47-230, 470-862	10dB	2	12	5dB	93dBµV max. output
Wolsey	334065	47-230, 470-862	10dB	2	16	5dB	93dBµV max. output