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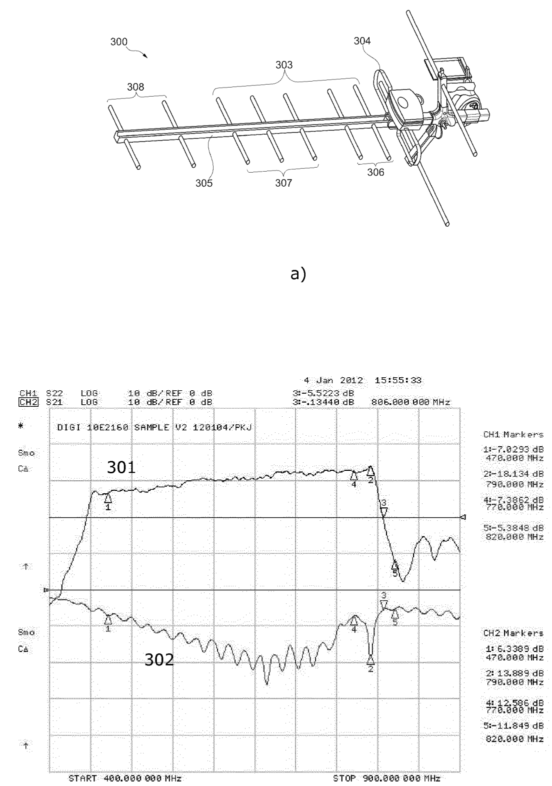
(54) **Antenna with integrated filter**

(57) The present invention relates to an antenna for separating airborne TV signals of a TV frequency band from airborne data signals of a neighbouring data frequency band. A number of the director elements (306, 307, 308) of the antenna are mutually arranged along a boom (305) of the antenna in a manner so that the antenna shows a predetermined gain curve, said predetermined gain curve involving positive gain within at least part of the TV frequency band and negative gain within at least part of the data frequency band, and wherein a gain decrease rate of at least 0.25 dB/MHz is provided around a predetermined cut-off frequency. The antenna may be tailor made for specific purposes.



a)

b)

Fig. 3

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to an antenna for receiving airborne signals, such as airborne TV signals. In particular, the present invention relates to a TV antenna comprising a plurality of director elements, wherein a number of said director elements are arranged in a manner so as to obtain a predetermined gain curve of said antenna in particular in the high frequency range.

BACKGROUND OF THE INVENTION

[0002] TV channels are typically broadcasted in the frequency range 470-862 MHz. This frequency range corresponds to TV channels 21 to 69. For that reason TV antenna designers have for decades aimed at designing TV antennas with optimal gain over this entire frequency range. Depending on the actual antenna design gain levels of between 5 dB and 18 dB are typically reported for this frequency range.

[0003] However, today other types of airborne signals, such as high speed 3G and 4G mobile broadband data communication signals, puts an upper limit to the available frequencies for TV signals. In the future TV signals will be broadcasted only at frequencies below 800 MHz or even below 700 MHz in order to ensure sufficient bandwidth for mobile broadband data communication above these frequencies.

[0004] It is evident that TV antennas optimized for the 470-862 MHz frequency range will also receive and amplify 3G and 4G mobile broadband data operated at frequencies around for example 800 MHz. For that reason it is inevitable that mobile broadband communication will interfere with and damage received TV channels at overlapping or neighbouring frequencies. To avoid such interfering effects between TV signals and mobile data communication signals electronic filters, such as low-pass filters, have been designed and inserted between TV antennas and associated televisions.

[0005] From a signal handling prospective it is a disadvantage of the above-mentioned known systems that additional electronic filters are required in order to suppress frequencies above a certain range, for example 800 MHz. Moreover, additional electronic filters add to the complexity and the overall costs of receiver systems.

[0006] Thus, there is a need and a marked for TV antennas with integrated or built- in filter properties so that the present use of additional electronic filters can be avoided.

[0007] It may be seen as an object of embodiments of the present invention to provide a TV antenna with integrated or built-in filter properties so as to damping mobile data communication signals, such as for example 3G and 4G signals.

DESCRIPTION OF THE INVENTION

[0008] The above-mentioned object is complied with by providing, in a first aspect, an antenna structure for receiving airborne TV signals, said antenna structure comprising one or more reflector elements, one or more active elements, and a plurality of director elements, wherein a number of the plurality of director elements are mutually arranged in a manner so that the antenna structure shows a predetermined gain curve.

[0009] In the present context gain curve should be understood as a curve mapping the gain (dB) of the TV antenna versus frequency (Hz). Traditionally, TV signals (analogue and digital) have been broadcasted in a frequency range from 470 MHz to 862 MHz.

[0010] It is generally accepted that reflector elements of TV antennas, such as Yagi antennas, amplify TV signal at lower frequencies, whereas director elements positioned close to active elements, such as dipoles, amplify TV signals at higher frequencies.

[0011] Preferably, the predetermined gain curve shows a low- pass frequency response curve. Thus, according to the present invention director elements close to for example a dipole of the antenna are mutually arranged so as to form a cut- off frequency in order to avoid amplification, or even obtain attenuation, of any airborne signals broadcasted above that cut- off frequency.

[0012] The cut-off frequency of the TV antenna may be tailored to comply with certain demands, and it may thus be set arbitrary. Such demands may for example involve attenuation of 3G and 4G data signals. To attenuate such data signals, and thereby avoid interference with TV signals, the low-pass frequency response may show a cut-off frequency within the range 600-800 MHz, such as around 750 MHz or around 790 MHz. It should be noted however, that the cut-off frequency may be selected differently.

[0013] The actual design of the TV antenna, such as the number of director elements, widely determines the achievable gain levels of the TV antenna. Typically, gain levels of between 3 dB and 15 dB may be achieved between 450 MHz and the cut-off frequency. The number of director elements typically varies between 6 and 22 elements.

[0014] In a second aspect the present invention relates to a TV antenna adapted to receive airborne TV signals broadcasted in a first frequency band, said first frequency band comprising frequencies being lower than frequencies of a second frequency band, said second frequency band being used for mobile data communication purposes.

[0015] An integrated cut-off frequency ensures separation of the first and second frequency bands. As specified above the cut-off frequency may be selected and thereby tailored to specific purposes, such as to avoid interference between TV signals and 3G or 4G signals.

[0016] In a third aspect the present invention relates to an antenna adapted to receive airborne signals broadcasted in a first frequency band, the antenna further being adapted to attenuate airborne signals broadcasted in a second frequency band, said second frequency band comprising frequencies being higher than frequencies of the first frequency band.

[0017] The first frequency band may comprise frequencies for broadcasting TV signals, whereas the second frequency band may comprise frequencies for mobile data communication, such as 3G or 4G.

[0018] The various technical specifications mentioned in connection with the first aspect of the present invention generally also apply to the second and third aspects.

[0019] In a fourth aspect the present invention relates to an antenna for separating airborne TV signals of a TV frequency band from airborne data signals of a neighbouring data frequency band, said antenna comprising

- one or more reflector elements,
- one or more active elements, and
- a plurality of director elements,

wherein a number of the director elements are mutually arranged along a boom of the antenna in a manner so that the antenna shows a predetermined gain curve, said predetermined gain curve involving positive gain within at least part of the TV frequency band and negative gain within at least part of the data frequency band, and wherein a gain decrease rate of at least 0.25 dB/MHz is provided around a predetermined cut-off frequency.

[0020] As already specified the primary purpose of the antenna is to avoid interference between TV signals broadcasted on the TV frequency band and data signals, such as 3G/4G data signals, distributed on the data frequency band.

[0021] Generally, the predetermined cut- off frequency separates the TV frequency band and the data frequency band. The gain decrease rate is primarily implemented above the predetermined cut- off frequency whereby the antenna shows a low- pass filter characteristic. Thus, the main gain drop is provided above the predetermined cut-off frequency.

[0022] A gain decrease rate being higher than 0.25 dB/MHz may be provided if demands to require. Thus, a gain decrease rate of at least 0.5 dB/MHz, such as at least 0.75 dB/MHz, such as at least 1 dB/MHz, such as at least 1.25 dB/MHz, such as at least 1.5 dB/MHz, such as at least 1.75 dB/MHz, such as at least 2 dB/MHz, may be provided.

[0023] The cut-off frequency may be within the range 600-800 MHz, such as around 750 MHz or around 790 MHz. It should be noted however, that the cut-off frequency may be selected differently.

[0024] A positive gain level of between 3 dB and 18 dB may be provided across the TV frequency band, i.e. between 450 MHz and the cut-off frequency. The antenna of the present invention may be a Yagi-type antenna comprising between 3 and 22 director elements.

[0025] In a fifth aspect the present invention relates to a method for separating airborne TV signals of a TV frequency band from airborne data signals of a neighbouring data frequency band, said method comprising the step of providing an antenna according to any of the preceding aspects and connecting said antenna to a receiving device, such as a TV, a set top box, an amplifier, a TV signal splitter etc.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] The present invention will now be explained in further details with reference to the accompanying figures, where

Fig. 1 shows a first traditional broadband TV antenna and an associated gain curve,

Fig. 2 shows a second traditional broadband TV antenna and an associated gain curve,

Fig. 3a shows a first TV antenna with integrated filter function, and Fig. 3b shows a corresponding gain curve,

Fig. 4a shows a second TV antenna with integrated filter function, and Fig. 4b shows a gain curve of a third TV antenna with integrated filter function, and

Fig. 5 shows an even further modified gain curve.

[0027] While the invention is susceptible to various modifications and alternative forms, specific embodiments have been shown by way of examples in the drawings and will be described in detail herein. It should be understood, however, that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims

DETAILED DESCRIPTION OF THE INVENTION

[0028] In its broadest aspect the present invention relates to an antenna or an antenna structure having a predetermined gain curve, i.e. antenna gain level versus frequency, so as to avoid signal interference between airborne TV signals and data signals, such as high speed mobile broadband data communication signals, such as 3G and 4G.

[0029] Fig. 1 shows a traditional TV antenna 100 optimized for receiving airborne TV signals in the 470-862 MHz frequency range corresponding to TV channels 21-69. As seen in Fig. 1a the TV antenna 100 comprises a dipole 101, reflector elements 102, 103 and director elements 104 positioned in front of the dipole 101. A 75 ohms cable is connected to the dipole 101 for leading received TV signals to associated television receivers.

[0030] It is well-known in the field of antenna design that the reflector elements 102, 103 amplify TV signals in the low frequency range, whereas the director elements closest to the dipole 101 amplify TV signals at higher frequencies.

[0031] A typical gain curve 105 over a frequency range of 400-900 MHz is shown in Fig. 1b. Zero gain is indicated by line 107. Moreover, a measure for the impedance matching between the dipole 101 and a 75 ohms cable connected thereto is illustrated by curve 106. A complete mismatch, i.e. no match, of impedance between dipole and cable is illustrated by line 108.

[0032] Returning now to gain curve 105 of the traditional TV antenna, gain levels of 6 dB and 11.3 dB are seen at 470 MHz and 862 MHz, respectively. The impedance match curve 106 varies between -6 dB and -36 dB within the same frequency range which is acceptable.

[0033] As already indicated a gain level of 11.3 dB at 862 MHz is problematic due to the existence of high speed mobile broadband data communication signals around 800 MHz. The reason for this being that the TV antenna will amplify these unwanted data signals as well as the wanted TV signals. Thus, the risk of disturbing the TV signals is imminent.

[0034] Fig. 2 shows another type of traditional antenna 200 including X-shaped director elements having a similar gain curve 201. To be more specific gain levels of 8.1 dB and 9.8 dB are seen at 470 MHz and 862 MHz, respectively. The impedance match curve 202 varies within an acceptable range.

[0035] Returning now to Fig. 3a a TV antenna 300 according to the present invention is shown. Moreover, a corresponding gain curve 301 and impedance matching curve 302 is shown Fig. 3b - the latter still falling within an acceptable range.

[0036] As previously stated the directors 303 positioned closest to the dipole 304 determine the shape of the gain curve in the high frequency range, i.e. above 600 MHz. Thus, by braking or disturbing the uniform positioning of directors (near the dipole) of traditional TV antennas the shape of the gain curve at high frequencies can be altered.

[0037] Compared to traditional TV antennas the directors 303, i.e. five directors, have been rearranged along the antenna boom 305. As seen in Fig. 3a two directors 306 have been spatially isolated from three directors 307 which are again spatially isolated from directors 308. It should be noted that the number of rearranged directors may differ from five. Also, it should be noted that gain curve modification of a standard antenna may involve a rearrangement of all directors or a rearrangement of just a portion of the directors.

[0038] The rearrangement of the directors 303 along the boom may appear small, but it has a huge influence on the gain curve of the antenna, cf. Fig. 3b.

[0039] As seen in Fig. 3b the gain curve 301 falls rapidly above 790 MHz. In fact the antenna gain drops from 14 dB at 790 MHz to 0 dB at 806 MHz. At 820 MHz an attenuation of 12.0 dB is reached. Thus, by rearranging a number of directors - here exemplified with rearrangement of five directors - a pronounced low-pass filter behaviour may be achieved without applying any kind of electronics.

[0040] Another example is shown in Fig. 4a where five directors 401 have been rearranged along the boom. This rearrangement of directors alters the high frequency behaviour of the antenna, i.e. alters the gain curve of the antenna at the upper TV channels.

[0041] A gain curve 403 for a TV antenna with eight X-shaped director elements (modified Triax UNIX32 antenna) is shown in Fig. 4b. As seen, the antenna gain drops from 10.4 dB at 790 MHz to around 0 dB at 812 MHz. Thus, a pronounced low-pass filter behaviour have been achieved without applying any kind of electronics. Again, the impedance matching curve 404 falls within an acceptable range.

[0042] Fig. 5 shows an even more distinct gain curve 501 where the antenna gain drops from 11.1 dB at 750 MHz to around 0 dB at 768 MHz. The impedance matching curve 502 still falls within an acceptable range.

[0043] From the gain curves shown in Figs. 3b, 4b and 5 it is evident that by rearranging a number of directors along the antenna boom specific frequency properties may be obtained. Thus, by applying the present invention TV antennas may be tailored specific applications, such as avoiding interference between TV signals and mobile data communication signals, such as 3G and 4G.

[0044] The process of obtaining the desired gain curve of a given TV antenna may be reached in various ways. Advanced computer simulations are one opportunity. Another approach may be to modify a standard TV antenna which is optimized for maximum gain in the full 470-862 MHz frequency range. This standard TV antenna may be mounted in a testing/laboratory setup. The directors positioned closets to the dipole are then rearranged until the desired gain curve in the high frequency range is obtained. Finally, the individual positions of the directors on the antenna boom is measured/registered so that TV antennas with the desired gain curve can be mass produced.

Claims

1. An antenna for separating airborne TV signals of a TV frequency band from airborne data signals of a neighbouring data frequency band, said antenna comprising

   - one or more reflector elements,
   - one or more active elements, and
   - a plurality of director elements,

   wherein a number of the director elements are mutually arranged along a boom of the antenna in a

manner so that the antenna shows a predetermined gain curve, said predetermined gain curve involving positive gain within at least part of the TV frequency band and negative gain within at least part of the data frequency band, and
wherein a gain decrease rate of at least 0.25 dB/MHz is provided around a predetermined cut-off frequency.

2. An antenna according to claim 1, wherein the gain decrease rate is provided above the predetermined cut-off frequency.

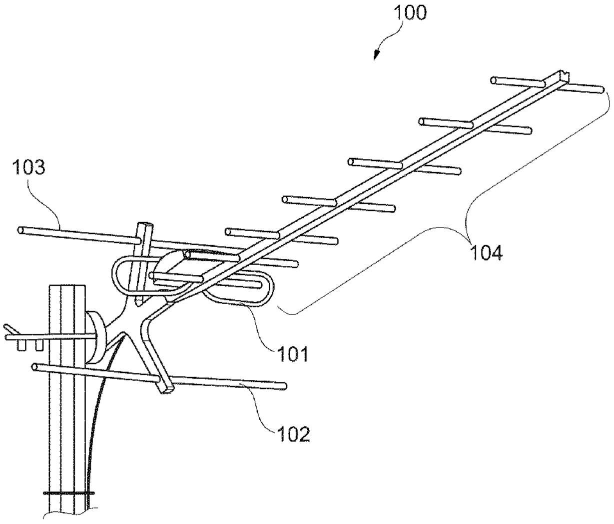
3. An antenna according to claim 1 or 2, wherein a gain decrease rate of at least 0.5 dB/MHz, such as at least 0.75 dB/MHz, such as at least 1 dB/MHz, such as at least 1.25 dB/MHz, such as at least 1.5 dB/MHz, such as at least 1.75 dB/MHz, such as at least 2 dB/MHz, is provided.

4. An antenna according to any of claims 1-3, wherein the cut-off frequency is within the range 600-800 MHz.

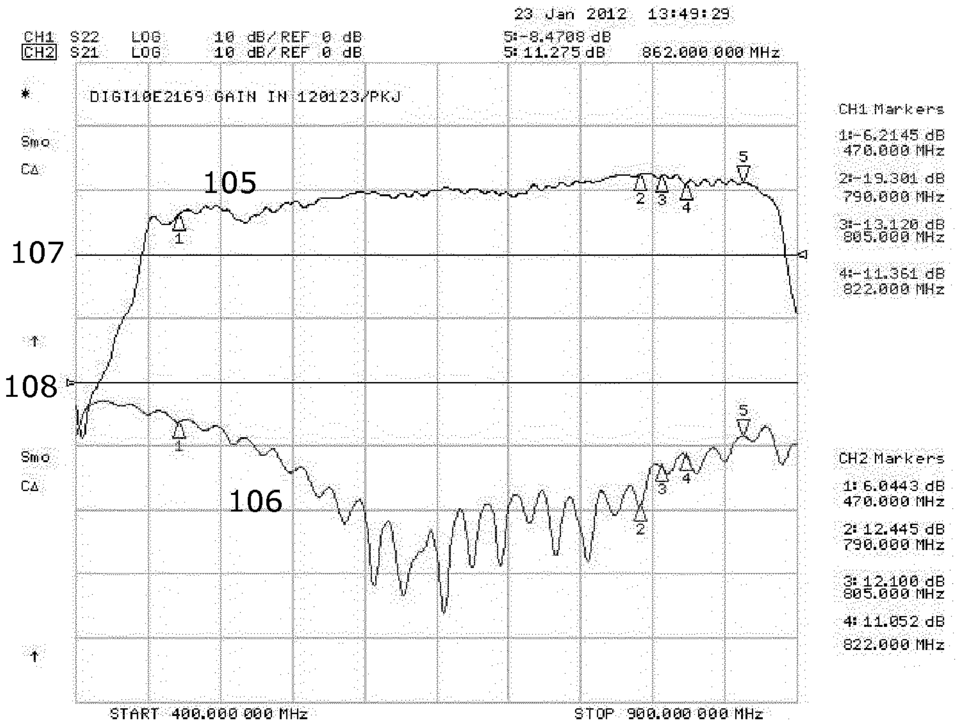
5. An antenna according to claim 4, wherein a positive gain level of between 3 dB and 18 dB is provided between 450 MHz and the cut-off frequency.

6. An antenna according to any of the preceding claims, comprising between 3 and 22 director elements.

7. A method for separating airborne TV signals of a TV frequency band from airborne data signals of a neighbouring data frequency band, said method comprising the step of providing an antenna according to any of the preceding claims.

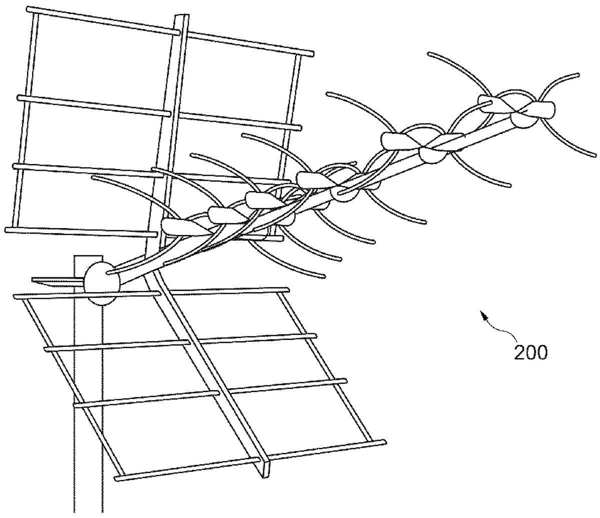


a)

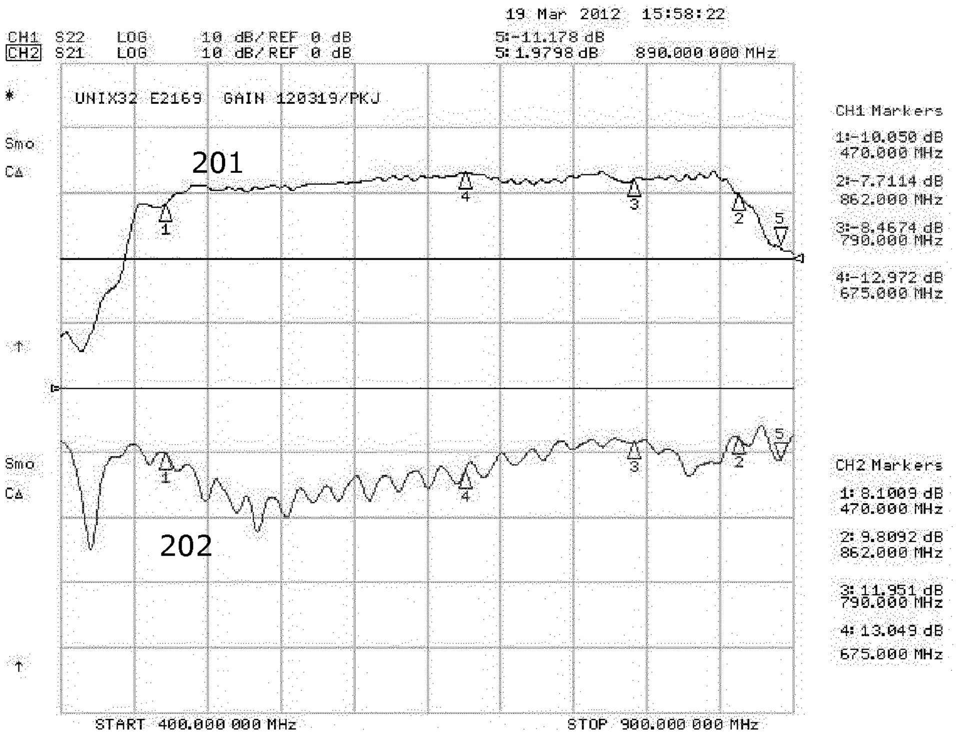


b)

Fig. 1
(PRIOR ART)

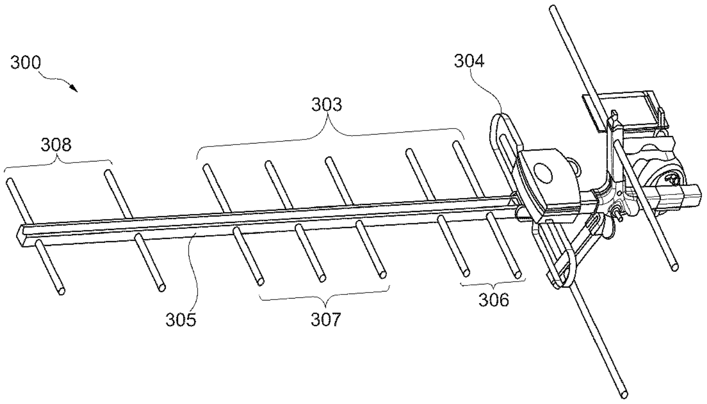


a)

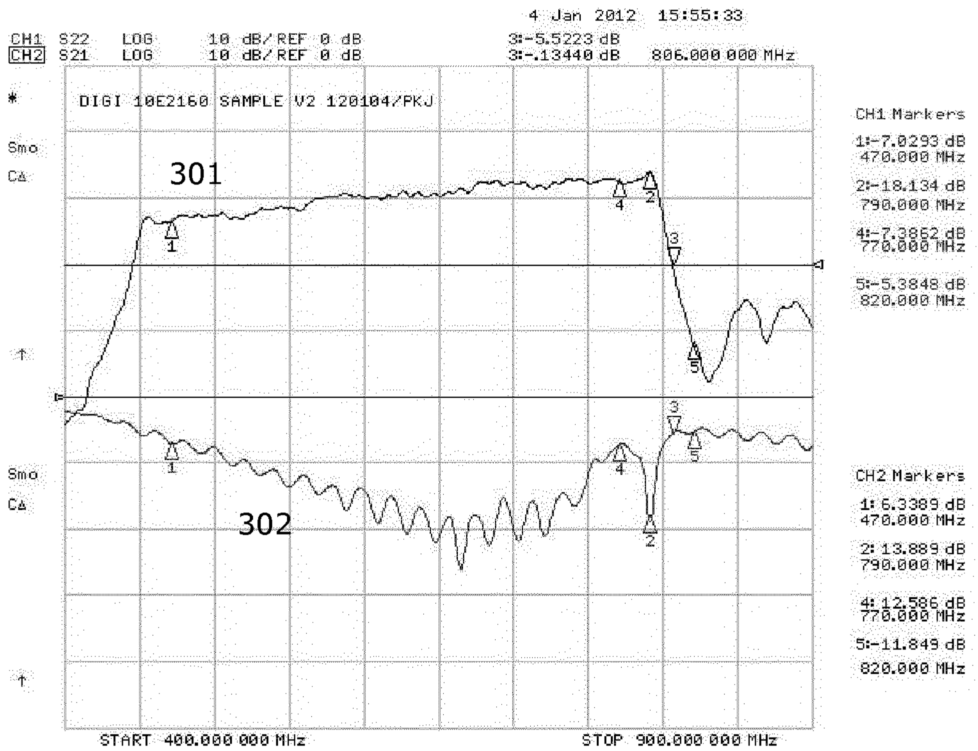


b)

Fig. 2
(PRIOR ART)


300
304
303
308
305
307
306

a)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CH2 S21 LOG 10 dB/REF 0 dB
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3:-.13440 dB 806.000 000 MHz
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Smo
CΔ
301
302
CH1 Markers
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470.000 MHz
2:-18.134 dB
790.000 MHz
4:-7.3862 dB
770.000 MHz
5:-5.3848 dB
820.000 MHz
CH2 Markers
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2: 13.889 dB
790.000 MHz
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770.000 MHz
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820.000 MHz
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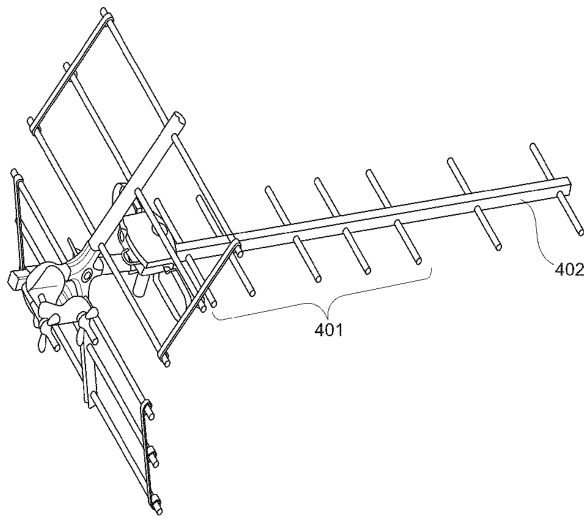
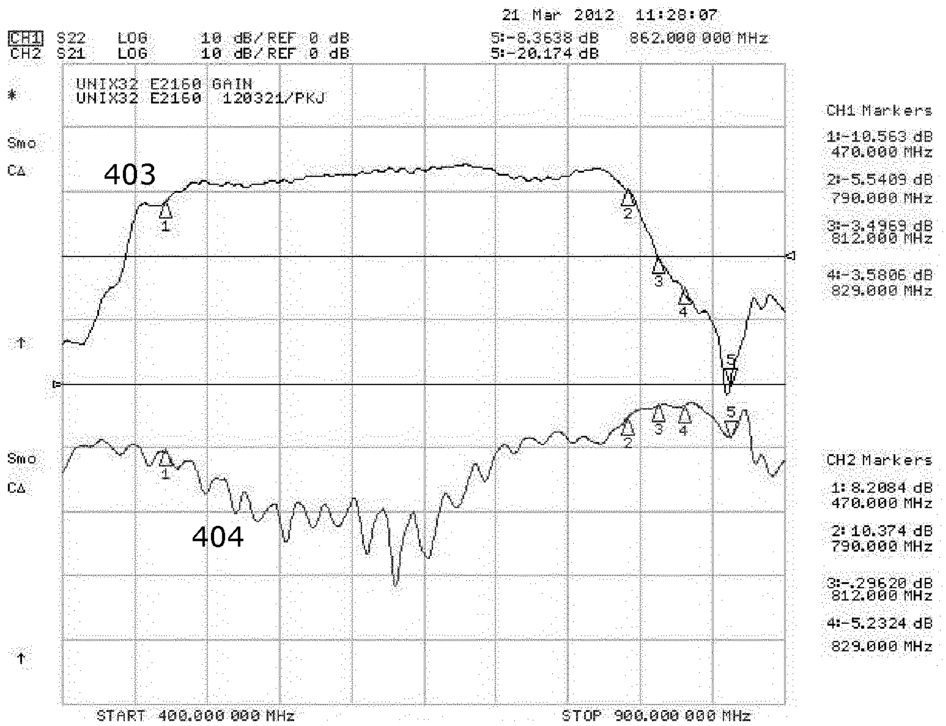
STOP 900.000 000 MHz

b)

Fig. 3


402
401

a)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5:-20.174 dB
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UNIX32 E2160 120321/PKJ
Smo
CΔ
403
404
CH1 Markers
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2:-5.5409 dB
790.000 MHz
3:-3.4969 dB
812.000 MHz
4:-3.5806 dB
829.000 MHz
CH2 Markers
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470.000 MHz
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829.000 MHz
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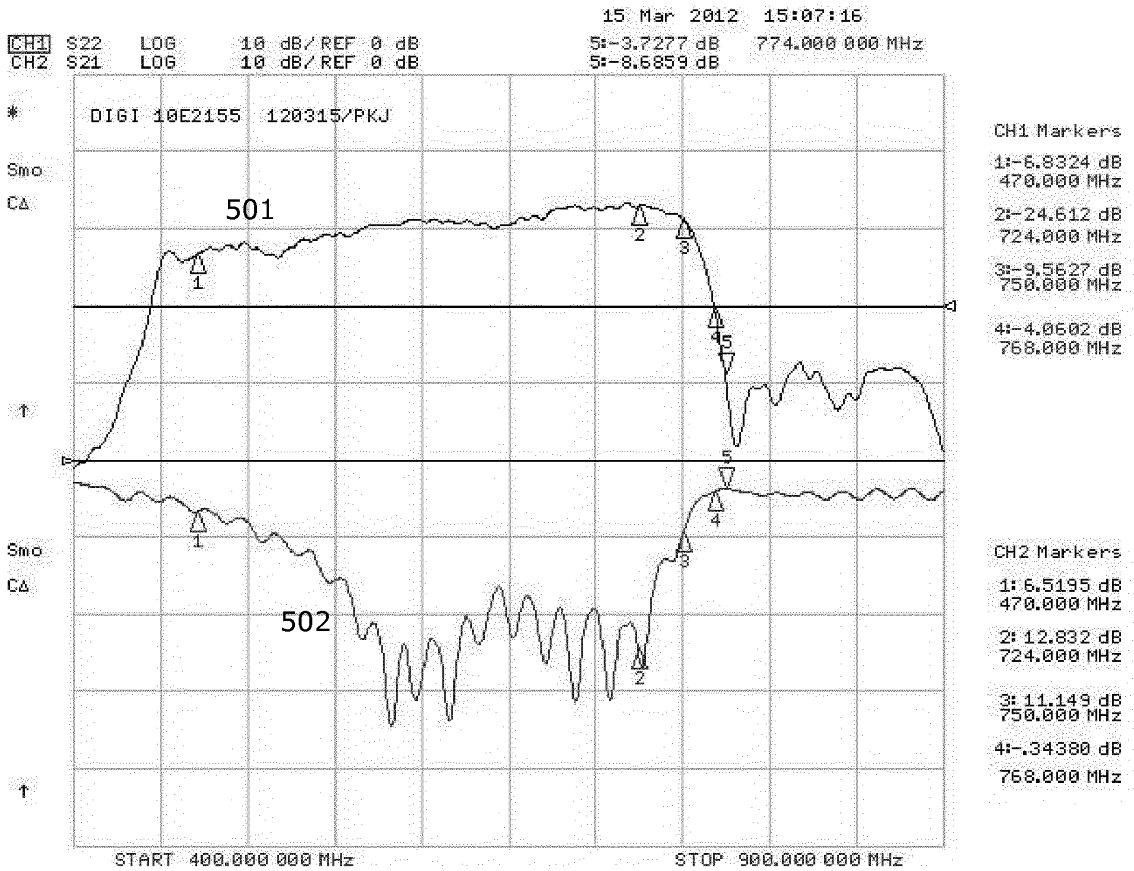
b)

Fig. 4


15 Mar 2012 15:07:16
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Smo
CΔ
501
502
CH1 Markers
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470.000 MHz
2:-24.612 dB
724.000 MHz
3:-9.5627 dB
750.000 MHz
4:-4.0602 dB
768.000 MHz
CH2 Markers
1: 6.5195 dB
470.000 MHz
2: 12.832 dB
724.000 MHz
3: 11.149 dB
750.000 MHz
4:-.34380 dB
768.000 MHz
START 400.000 000 MHz
STOP 900.000 000 MHz

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 0615

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	US 5 061 944 A (POWERS RICHARD L [US] ET AL) 29 October 1991 (1991-10-29) * column 5, line 29 - line 32; figure 2 * * column 6, line 29 - line 45; figure 3 * * column 9, line 30 - line 37; figure 7 * -----	1-7	
X	US 2 897 497 A (FINNEBURGH JR LEWIS H) 28 July 1959 (1959-07-28) * column 4 - column 7; figures 1,2 * -----	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

H01Q

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	5 July 2013	Kaleve, Abraham

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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05-07-2013

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