

TV/FM receiver for multi-media applications.

The invention relates to a receiver for receiving first type of reception signals, for example TV signals, and second type of reception signals, for example FM-radio signals. The invention also relates to a multi-media apparatus incorporating such a receiver. The receiver may enhance the functionality of the multi-media apparatus with TV and FM-radio reception, for example. The multi-media apparatus may be in the form of a personal computer (PC) having slots in which add-on cards are plugged in. The receiver may be implemented on one of these add-on cards. Accordingly, the PC can access information transmitted by FM-radio and TV stations.

A receiver capable of receiving TV and FM-radio signals is described in US-A 5,148,420. The prior art receiver comprises a single tuner for both TV and FM-radio reception. The single tuner frequency converts both a selected FM-radio signal, and a selected TV signal, to a fixed intermediate frequency (IF) signal of approximately 40 MHz. An IF of approximately 40 MHz is common for TV reception.

The IF signal produced by the tuner, is processed differently for TV or FM-radio reception. For TV reception, the IF signal is processed in a manner which is very similar to IF signal processing in most present-day receivers. The IF signal is applied to a TV IF demodulation unit via a surface acoustic wave (SAW) filter. The TV IF demodulation unit provides a baseband composite video signal and a TV sound carrier signal. The TV sound carrier signal is further processed in a TV sound channel which provides, in response, baseband audio signals.

For FM reception, the IF signal is supplied to a single chip FM-radio integrated circuit (IC) via a filter unit which includes a 43,3 MHz band-pass filter and a 48,65 MHz trap. In the FM-radio IC, the IF signal is frequency converted to obtain a nominal 10,7 MHz FM IF signal. The FM IF signal is filtered by a ceramic filter arrangement and amplified, detected and decoded in the FM-radio IC. Thus, for FM reception, the prior art receiver employs a double conversion scheme. The tuner performs

a first frequency conversion and the FM-radio IC performs a second frequency conversion.

The filter unit, which is coupled between the tuner and the FM-radio IC, has to satisfy relatively strict requirements in order to avoid excessive distortion of the FM-radio signal to be received. First, the pass-band of the filter unit needs to be sufficiently close to 43,3 MHz. This requirement follows, amongst other things, from the frequency characteristic of the tuner, which is haystack-like, and the characteristics of the signals to be received. Second, the 46,85 MHz trap included in the filter unit needs to be accurately tuned to that frequency, to avoid an image reception problem in the second frequency conversion.

Although the receiver described in US-A 5,148,280 uses a single tuner for both TV and FM-radio reception, implementations of the prior art receiver will be relatively spacious. The filter unit, which is coupled between the tuner and the FM-radio IC, is build up with discrete capacitors and inductors. In order for the filter unit to satisfy the above described requirements, the inductors need have a certain size. If not, the quality factor of the inductors will be too low to achieve an adequate selectivity and accuracy.

An object of the invention is to provide a receiver which, with reference to the above described prior art receiver, is more suited for small-size implementations.

According to one aspect of the invention, there is provided a receiver as defined in Claim 1.

According to another aspect of the invention, a multi-media apparatus comprises such a receiver.

Yet an other aspect of the invention provides a tuning method as defined in Claim 11.

Yet an other aspect of the invention provides a shielded metal box as defined in Claim 12.

The invention may be used in reception of both TV and FM-radio signals. In an example of such a use, a single tuner converts TV signals to a first IF of approximately 40 MHz, and converts FM-radio signals to a second IF of approximately

10,7 MHz. The 10,7 Mhz IF signal is processed in an FM IF signal processing section, and the 40 Mhz IF signal is processed in a TV IF signal processing section.

The invention takes the following into consideration. A tuner which is capable of providing two different intermediate frequencies, in accordance with the invention, can be implemented such that its size is relatively small. Referring to the above example, the tuner which provides the 40 MHz and 10,7 MHz IF, can be implemented such that its size is comparable with that of a conventional TV tuner.

The above example may be compared with the prior art receiver. Due to the fact that the tuner in the example can provide both 40 MHz and 10,7 MHz IF, a second frequency conversion, as in the prior art receiver, is not needed. Consequently, filter circuits for preventing signal distortion as a result of the second frequency conversion, as in the prior art receiver, are not needed. Consequently, this leaves room for other circuitry so that the receiver of the present invention is more suited for small-size implementations. Furthermore, in an implementation, the size of the tuner in the above example, may in fact be smaller than the size of the tuner in the prior art receiver.

A further advantage is the relatively low-cost of implementations in accordance with the invention. Yet a further advantage is the relatively good performance, notably in FM-radio reception.

The invention is particularly suited for multi-media applications. Many multi-media applications use add-on cards of a standard size. As indicated in the opening paragraph, a receiver in accordance with the invention, may be implemented on a standard-size add-on card. The relatively small size of the receiver leaves room on the standard-size add-on card for other circuitry, which may further enhance the functionality of the add-on card. It should also be noted that a part of the receiver is preferably housed in a shielded metal box, to counter interference produced by digital signals in a multi-media apparatus. The smaller the receiver, the less space the shielded metal box will consume, which makes that the receiver can be applied in a great variety of multi-media applications.

The invention will hereinafter be described in greater detail with reference to examples shown in the drawings. Furthermore, advantageous implementation details which are defined in the dependent Claims, will also be described with reference to the

examples shown.

In the drawings:

5 Fig. 1 illustrates the principle of the invention in the form of a conceptual block diagram;

 Fig. 2 shows an example of a tuner in accordance with the invention in the form of a block diagram;

10 Fig. 3 is a simplified equivalent circuit diagram of resonant circuits for the Fig. 2 tuner;

 Fig. 4 is an equivalent circuit diagram of preferred switchable oscillator resonant circuits for the Fig. 2 tuner;

 Fig. 5 shows, in a circuit diagram form, an example of a preferred switchable oscillator resonant circuit for the Fig. 2 tuner;

15 Fig. 6a is an equivalent circuit diagram of switchable band-pass filters for the Fig. 2 tuner;

 Fig. 6b shows, in a circuit diagram form, an example of a switchable band-pass filter implementation in the Fig. 2 tuner;

20 Fig. 7 illustrates the filter characteristic of the Fig. 6 circuit by means of gain against frequency plots; and

 Fig. 8 shows, in an abstract diagram form, an example of a multi-media apparatus comprising the Fig. 2 tuner.

25 First, the principle of the invention will further be explained with reference to Fig. 1. Secondly, the invention will be exemplified by means of the Fig. 2 tuner, which tuner can receive both TV and FM-radio signals. To that respect, implementation aspects of the Fig. 2 tuner will also be discussed with reference to Figs. 3 to 7, and an example of a multi-media application of the Fig. 2 tuner will be discussed with reference to Fig. 8. Thirdly, advantageous implementation details, which are defined in the

30 dependent Claims, will be highlighted with reference to the examples shown in the Figures. Finally, some remarks are made so as to indicate that the scope of the invention claimed, is well beyond the examples shown in the Figures.

In the Fig. 1 conceptual block diagram, a reception signal RFS may be a first type of reception signal, for example a TV signal, located within a frequency band B1. Alternatively, the reception signal RFS may be a second type of reception signal, for example an FM-radio signal, located within a frequency band B2. The frequency bands B1 and B2 overlap. A tuner TUN frequency converts the reception signal RFS into an intermediate frequency signal IFS.

Referring to Fig. 1, the principle of the invention can be explained as follows. The receiver is a single conversion receiver for both types of reception signals, the single conversion being effected in the tuner TUN. Depending on whether a first type or second type of reception signal is desired, the tuner TUN provides the intermediate frequency signal IFS at a first intermediate frequency IF1 or a second intermediate frequency IF2, respectively. The intermediate frequency signal IFS at intermediate frequency IF1 is processed in a first intermediate frequency signal processor IFSP1. Alternatively, the intermediate frequency signal IFS at the second intermediate frequency IF2 is processed in a second intermediate frequency signal processor IFSP2.

Referring now to the Fig. 2 tuner, which is suitable for reception of TV and FM-radio signals. The TV and FM-radio signals may be applied at inputs TVIN and FMIN, respectively. The Fig. 2 tuner receives tuning control data TCD relating to a desired reception signal, for example the frequency and the type of signal: TV or FM. In response to the desired reception signal, the Fig. 2 tuner provides an intermediate frequency signal IFS at an output IFOUT.

The Fig. 2 tuner can operate in two modes: a TV-mode if the desired reception signal is a TV signal, or an FM-mode if the desired reception signal is an FM-radio signal. In TV-mode, the intermediate frequency signal IFS is at an intermediate frequency of 38,9 MHz, hereinafter abbreviated to TV-IF. In FM-mode, the intermediate frequency signal IFS is at an intermediate frequency of 10,7 MHz, hereinafter abbreviated to FM-IF.

The Fig. 2 tuner is based on a so-called three band concept. This means that the Fig. 2 tuner comprises three separate branches for processing the TV signals in three respective frequency bands: high-band, medium-band and low-band. Each branch comprises the following parts: an input filter RFI-H/-M/-L, an input amplifier RFA-H/-M/-L, a band-pass filter BPF-H/-M/-L, a mixer MIX-H/-M/-L, an oscillator

circuit OSC-H/-M/-L and an oscillator resonance circuit ORC-H/-M/-L. The suffixes -H, -M and -L used in the reference signs for these parts, indicate whether a relevant part belongs to the high-, medium- or low-band branch. The Fig. 2 tuner may be implemented using a mixer-oscillator integrated circuit MOIC, for example of the type TDA 5736 manufactured by Philips Semiconductors, which comprises the parts present within the dotted rectangle designated MOIC in Fig. 2.

In the Fig. 2 tuner, FM-radio signals are processed in the low-band branch. A switch SWIN either couples the low-band branch to the input TVIN or to the input FMIN. In the first case, TV signals are supplied to the low-band branch, in the other case FM-radio signals are supplied to the low-band branch.

In each branch, the input filter RFI-H/-M/-L attenuates signals which are relatively frequency distant from the desired reception signal, to prevent overload of the input amplifier RFA-H/-M/-L. The amplifier RFA-H/-M/-L is controlled by a gain control voltage V_gc. The band-pass filter BPF-H/-M/-L provides a further attenuation of undesired signals. The mixer MIX-H/-M/-L effects a frequency shift of the desired reception signal, by multiplying the desired reception signal with an oscillator signal OSS-H/-M/-L. The oscillator signal OSS-H/-M/-L is generated by the oscillator circuit OSC-H/-M/-L and the oscillator resonance circuit ORC-H/-M/-L, which determines the frequency of the oscillator signal OSS-H/-M/-L. The mixer provides, via an intermediate frequency amplifier IFAMP, the intermediate frequency signal IFS.

In each branch, a phase-lock circuit PLL controls the oscillator signal OSS-H/-M/-L of the relevant branch. The phase-lock circuit PLL derives, in a conventional manner, a tuning voltage V_tun from the tuner control data TCD and the oscillator signal OSS-H/-M/-L received via an oscillator signal amplifier OSSA. The tuning voltage V_tun is applied to the oscillator resonance circuit ORC-H/-M/-L. In TV-mode, the oscillator signal OSS-L in the low band-branch, is set to a frequency which is the sum of the desired reception signal and the TV-IF (38,9 MHz). In FM-mode, the oscillator signal OSS-L is set to a frequency which is the sum of the desired reception signal and the FM-IF (10,7 MHz).

In each branch, the tuning voltage V_tun is also used to vary the respective pass bands of the input filter RFI-H/-M/-L and the band-pass filter. Preferably, the pass bands should encompass the desired reception signal. If not, the desired reception signal

is distorted and undesired signals may not be sufficiently attenuated. In TV-mode, the pass bands should encompass the difference of the oscillator signal frequency and the TV-IF. In FM-mode, the pass bands should be centred at the difference of the oscillator signal frequency and the FM-IF. The position of the pass bands with respect to the frequency of the oscillation signal, while tuning over the reception bands, is hereinafter referred to as tracking.

The phase-lock circuit PLL also provides a mode switch signal TV/FM. In the low-band branch, the mode switch signal TV/FM is used to switch the oscillator resonant circuit ORC-L. The oscillator signal OSS-L is switched to a higher frequency in TV mode than in FM-mode, for a given value of the tuning voltage V_{tun} . Respective pass-bands of the input filter RFI-L and the band-pass filter BPF-L, remain substantially constant for a given value of the tuning voltage V_{tun} . Thus, the frequency offset between the input filter RFI-L and the band-pass filter BPF-L, on the one hand, and the oscillator signal OSS-L, on the other hand, is switched. The frequency offset preferably switched to the TV-IF in TV-mode and to the FM-IF in FM-mode.

In addition, the mode control signal TV/FM preferably switches pass-bandwidth of the band-pass filter BPF-L in the low-band branch. In TV-mode, the pass band of the band-pass filter BPF-L is preferably relatively wide, for example 10 MHz, whereas in FM-mode the pass band is preferably relatively narrow, for example 1 MHz.

Fig. 3 shows a basic resonant circuit for implementations of the input filter RFI-L, the band-pass filter BPF-L and the oscillator resonant circuit ORC-L in the low-band branch of the Fig. 2 tuner. The Fig. 3 basic resonant circuit comprises an inductance L_p , a controllable capacitance C_{var} , a so-called padder capacitance C_{pad} and a parallel capacitance C_{par} . The value of the controllable capacitance depends on the tuning voltage V_{tun} . The controllable capacitance may be a varicap diode to which the tuning voltage V_{tun} is applied in a conventional manner.

In an implementation of the Fig. 2 tuner, identical varicap diodes are used in the input filter RFI-L, the band-pass filter BPF-L and the oscillator resonance circuit ORC-L in the low-band branch. The capacitance of the identical varicap diodes can be varied between 2,5 pF and 61,5 pF in function of the tuning voltage V_{tun} . The values of the other elements are preferably chosen such, that good tracking is obtained, both in TV-

mode and in FM-mode.

Table 1 shows the preferred values for the other elements in the Fig. 3 basic resonant circuit. The column titled RF lists the preferred element values for the input filter RFI-L and the band-pass filter BPF-L in the low-band branch. The column titled RF+38,9MHz lists the preferred element values for the low-band oscillator resonance circuit ORC-L in TV-mode. The column RF+10,7MHz lists the preferred element values for the low-band oscillator resonance circuit ORC-L in FM-mode. The row titled F(res) indicates the frequency bands over which respective basic resonant circuits can be tuned. For example, the band-pass filter BPF-L in the low band branch is tunable over a frequency-band from 46 to 175 Mhz.

	RF	RF+38,9MHz	RF+10,7MHz
Lp	190 nH	100,3 nH	159,6 nH
Cpad	4,7 nF	68 pF	184 pF
Cpar	1,926 pF	3,237 pF	2,22 pF
Fres(MHz)	46..175	84,9..213,9	56,7..185,7

Table 1.

In the oscillator resonance circuit ORC-L, the value of the inductance Lp of should be higher in FM-mode than in TV-mode. The same applies for the padder capacitance Cpad. However, the parallel capacitance Cpar should be lower in FM-mode than in TV-mode.

To obtain preferred element values in the oscillator resonance circuit ORC-L in FM-mode and in TV-mode, three switches can be used. Referring to Fig. 3, a series arrangement of a switch and a capacitance, not shown, can be coupled in parallel to the padder capacitance Cpad. The same can be coupled in parallel to the parallel capacitance Cpar. The inductance Lp can be split up into two inductances in series, not shown, and a switch can be coupled in parallel to one of these inductances. Referring to Fig. 2, the switches may be controlled by the mode switch signal TV/FM.

Fig. 4 shows an equivalent circuit diagram of preferred implementations of the oscillator resonant circuit ORC-L in the low-band branch of the Fig. 2 tuner. These

preferred implementations comprise one switching element, which is represented as a switch S in the Fig. 4 equivalent circuit diagram. The Fig. 4 equivalent circuit diagram comprises a primary inductance L1 and a secondary inductance L2. A series arrangement of a padder capacitance Cpad and a controllable capacitance Cvar is coupled between a node of each of these inductances L1 and L2.

The switch S is coupled in parallel to the secondary inductance L2. Furthermore, in Fig. 4, an auxiliary capacitance Caux is coupled in series with the switch S. The auxiliary capacitance Caux is optional. That means that other preferred implementations of the oscillator resonance circuit, may have an equivalent circuit diagram in which switch S is directly coupled in parallel to the secondary inductance L2, shown in Fig. 4.

Referring to Figs. 2 and 4, the switch S is controlled by the mode switch signal TV/FM. In FM-mode, the switch S is opened, whereas in TV mode the switch S is closed. Thus, in FM-mode both the primary and the secondary inductance L1 and L2, will influence the frequency of the oscillator signal, whereas in TV-mode the primary inductance L1 will substantially influence the frequency. Preferably, the value of the primary inductance L1 and the value of the secondary inductance L2, have a ratio of approximately 1,5 to 1.

Fig. 5 shows an example of a preferred implementation of the oscillator resonance circuit ORC-L in the Fig. 2 tuner. In the Fig. 5 example, a switching diode Dsw effectively corresponds to the switch S in the Fig. 4 equivalent circuit diagram. The switching mode signal TV/FM is applied to the switching diode Dsw via a network comprising resistors Rdn1 and Rdn2 and a capacitor Cdn. The network constitutes a frequency dependent damping network which is coupled in parallel to the secondary inductance L2. The tuning voltage Vtun is applied to the varicap diode Cvar via a resistor Rtun. The Fig. 5 example further includes two capacitors Cc1 and Cc2 for coupling to the mixer oscillator integrated circuit MOIC, for example of the type TDA 5736 produced by Philips Semiconductors.

The values for the following components in the Fig. 5 example, provided a satisfactory tracking:

Cc1, Cc2 : 2,7 pF

Cpad : 120 pF

Caux : 180 pF

Cvar : type BB 132 or type HVU 300A

L1 : approximately 100 nH (adjustable value)

L2 : approximately 67 nH (adjustable value)

5 **The values of some other components, which are less crucial to tracking, are as follows:**

Cdn : 3,3 pF

Rdn1 : 220 Ω

Rdn2 : 750 Ω

10 **Fig. 6a is an equivalent circuit diagram of a band-pass filter for use in the low-band branch of the Fig. 2 tuner. In the Fig. 6a circuit diagram, there are two resonant circuits. A first resonant circuit includes an inductance LB1, a controllable capacitance CBvar1 and a capacitance CBpad1. A second circuit includes an inductance LB2, a controllable capacitance CBvar2 and a capacitance CBpad2. The Fig. 6a circuit diagram further includes auxiliary capacitances CBaux1 and CBaux2, an auxiliary variable**
 15 **capacitance CBvar3 and an image suppression capacitance Cim.**

The two resonant circuits in Fig. 6a, are mutually coupled by means of top-coupling capacitance CBtop and by means of a primary foot-coupling inductance Lfc1. Furthermore, a series arrangement of a secondary foot-coupling inductance Lfc2 and a switch SB, is coupled in parallel to the primary foot-coupling inductance Lfc1.
 20 **Accordingly, a switchable inductive foot-coupling is obtained. When the switch SB is closed, the inductive foot-coupling is weaker than when the switch SB is opened.**

Referring to the Figs. 2 and 6a, the mode control signal TV/FM controls the switch SB. In the TV-mode, the switch SB is opened so as to obtain an over-critical coupling between the two resonant circuits in Fig. 6a. In the FM-mode, the switch SB is
 25 **closed so as to obtain an under-critical coupling between the two resonant circuits in Fig. 6a.**

Fig. 6b shows an implementation of the band-pass filter BPF-L which is coupled between the input amplifier RFA-L and the mixer MIX-L in the low-band branch of the Fig. 2 tuner. The Fig. 6b implementation has the following particularities
 30 **compared to the Fig. 6a circuit. First, in the Fig. 6b implementation, the primary foot-coupling inductance Lfc1 is implemented by means two foot-coupling inductors Lfc1a and Lfc1b. Each of the two foot-coupling inductors Lfc1a and Lfc1b has one end which is**

coupled the inductors LB1 and LB2, respectively, and to the other coupling inductor via a foot-coupling capacitance Cfc. The impedance of the foot-coupling capacitance Cfc is relatively low at frequencies with the low-band and may, by approximation, be regarded as a short circuit.

5 A second particularity of the Fig. 6b implementation, compared to the Fig. 6a circuit, is that a single capacitor CBpc in Fig. 6b provides the two separately shown capacitances CBpad1 and CBpad2 in Fig. 6a. The reason for using the single capacitor CBpc is component-efficiency and the fact that the filter characteristics are hardly affected by this. In an implementation of the Fig. 6a circuit as band-pass filter BPF-L in the Fig. 10 2 tuner, the preferred values of capacitances Cpad1 and Cpad2 are relatively high. The capacitor CBpc in the Fig. 6b implementation effectively provides the two high-value capacitances Cpad1 and Cpad2, shown in Fig. 6a, which are present between the controllable capacitances CBvar1 and CBvar2, respectively, and signal ground. Due to the fact that the capacitor CBpc in the Fig. 6b implementation has a high value and, 15 consequently, the impedance thereof is relatively low, there is little coupling between the resonance circuits as a result of the capacitor CBpc, which coupling could affect the filter characteristics.

In the Fig. 6b implementation varicap diodes form the controllable capacitances CB1var1, CBvar2 and CBvar3. The varicap diodes receive the tuning voltage Vtun via at least one of resistors CBR2 and CBR3. A resistor CBR1 is 20 coupled in series with the auxiliary capacitor CBaux2, to optimize the coupling with the mixer MIX-L.

In the Fig. 6b implementation, a switching diode DBsw effectively constitutes the switch S shown in Fig. 6a. In TV-mode, the switching diode Dsw is non-conductive, so as to obtain an over-critical coupling between the resonant circuits. In 25 FM-mode the switching diode Dsw is conductive, so as to obtain an under-critical coupling between the resonant circuits. In addition, the following elements are used for switching the coupling between over-critical and under-critical. An auxiliary capacitor CBaux3 couples the switching diode DBsw to the secondary foot-coupling inductance Lfc2. The mode switch signal TV/FM in the Fig. 2 tuner, is applied to the switching diode via a resistor CBR4. An auxiliary capacitor CBaux4 suppresses unwanted 30 feed-through of signals from the inductive foot-coupling onto the line conveying the TV/FM mode switch signal.

In the Fig. 6b implementation, the following component values provided a satisfactory performance:

Cim : 0.06 pF
 CBaux1 : 2 pF
 CBtop : 0.1 pF
 Cfc : 680 pF
 CBpc : 4,7 nF
 LB1, LB2 : 175 nH
 Lfc1a, Lfc1b : 32 nH
 Lfc2 : 6 nH

Values of components which are not listed above, are less critical for the filter characteristics.

Not all the electrical elements shown in Fig. 6b, need to be realized with discrete components. In particular, the image capacitance Cim, the top-coupling capacitance CBtop and the secondary foot-coupling inductance Lfc2, may be obtained by a suitable lay-out of a printed circuit board (PCB) used to realise the Fig. 6b circuit. For example, a PCB-track may constitute the foot-coupling inductance Lfc2. In addition, a stray inductance of the switching diode DBsw, may also effectively contribute to the foot-coupling inductance Lfc2. Capacitive coupling between relevant PCB-tracks may provide the image capacitance Cim and, likewise, the top-coupling capacitance CBtop can be obtained, as well as any other capacitance of relatively small value.

Fig. 7 illustrates filter characteristics of the Fig. 6b implementation, with the values listed above and for a certain value of the tuning voltage V_{tun} . In Fig. 7, gain G expressed in decibels (dB) is set out on the vertical axis, and frequency expressed in MegaHertz (Mhz) is set out on the horizontal axis. Fig. 7 includes two plots of gain against frequency: one plot denoted as TV and one denoted as FM, which illustrate the filter-characteristics in TV-mode and FM-mode, respectively.

Fig. 7 clearly shows differences between the filter characteristics in TV-mode and in FM-mode, of the Fig. 6b implementation. First, the pass-band in the filter characteristic is narrower in FM-mode than in TV-mode. In TV-mode, the -3 dB pass-band is about 10 MHz wide, which is somewhat wider than the band-width of a TV reception signal. In FM-mode, the -3 dB pass-band is reduced to about 2,5 Mhz.

Second, in TV-mode the pass-band has two peaks, whereas in FM-mode the pass-band is a single peak. The two peaks is a clear result of the over-critical coupling, in TV-mode, between the resonant circuits in the Fig. 6b implementation. The single peak results from the under-critical coupling, in FM-mode, when the switching diode Dsw is non-conductive.

Third, the centre-frequency of the pass-band in FM-mode is slightly higher than in TV-mode. In other words, when the state of the switching diode Dsw is changed, a small de-tuning occurs. The de-tuning is caused by switching the inductive foot-coupling between the resonance circuits in the Fig. 6b implementation. The switching changes the effective inductance values in the resonance circuits, and thereby the resonance frequencies. Referring to the Fig. 2 tuner, de-tuning of the band-pass filter BPF-L when switching from TV-mode to FM-mode, or vice versa, poses no real problem. Any de-tuning can be accounted for in the alignment of the oscillator resonance circuit ORC-L, for example, which alignment is made to obtain a satisfactory tracking. It is also possible correct the input filter IPF-L in view of any de-tuning in the band-pass filter BPF-L.

Fourth, the gain in the pass-band is somewhat lower in FM-mode than in TV-mode. This effect is also related to the coupling between the resonant circuits in the Fig. 6b implementation. With under-critical coupling there is more signal loss in the Fig. 6b implementation, than with over-critical coupling.

Fifth, the filter characteristics includes notches which are different in TV-mode and in FM-mode. In TV-mode, a notch is located approximately 2 times the TV-IF above the pass-band. In FM-mode, a notch is located approximately 2 times the FM-IF above the pass-band. The notches contribute to the image suppression which is required in the reception signal path to the mixer MIX-L. The notches are highly influenced by the image capacitance Cim, which can be explained as follows.

The secondary resonant circuit, which includes inductance LB2, receives a signal via the image capacitance Cim. The secondary resonant circuit also receives a signal via the primary resonant circuit, which includes inductance LB1. At resonance frequency these signals are in phase and the image capacitor Cim contributes to the capacitive top-coupling, similar to the top-coupling capacitance CBtop. However, at a certain frequency, relatively far above the resonance frequency, the signals will be in

anti-phase and may substantially cancel each other. This manifests itself as the notches shown in Fig. 7. By properly choosing components values, it is possible to position the notches such that they substantially contribute to the image suppression, as shown in Fig. 7, both in TV-mode and in FM-mode. Thus, when switching from TV-mode to
 5 FM-mode, or vice versa, the image suppression adjusts itself in accordance with the new IF.

Fig. 8 shows an example of a multi-media apparatus comprising the Fig. 2 tuner TUN. The Fig. 2 tuner TUN is implemented on an add-on card PCAO, which add-on card PCAO is plugged into an add-on card holder HOL of the multi-media
 10 apparatus. Apart from the Fig. 2 tuner TUN, the add-on card includes TV IF signal processing circuitry TVIFC and FM IF signal processing circuitry FMIFC. The latter circuitries receive the intermediate frequency signal IFS provided by the Fig. 2 tuner TUN via an IF splitting filter IFSF. The Fig. 2 tuner TUN, the IF splitting filter IFSF and the TV IF signal processing circuitry TVIFC are housed in a shielded metal box
 15 SMB. The shielded metal box SMB with the aforementioned parts may, as such, be manufactured and sold to add-on card manufacturers.

The Fig. 8 multi-media apparatus includes a user interface UIF, a control unit CCU, a picture display device PDD, a sound reproduction unit SRU. A user selects the desired reception signal via the user interface UIF. For example, he may enter a
 20 program number on a key-board which is part of the user-interface UIF. The control unit CCU effectively controls the add-on card PCAO, such that the Fig. 2 tuner TUN selects the desired reception signal. For example, the control unit CCU provides instructions which are stored in a memory, not shown, relating to the frequency of the desired reception signal and the type of signal: FM or TV. These instructions are supplied to the
 25 Fig. 2 tuner TUN in the form of the tuner control data TCD. The add-on card PCAO provides sound and/or video information, for example, obtained from the desired reception signal, which information may be further processed in the control unit CCU. The sound and/or video information is provided to the user via the sound reproduction unit SRU and the picture display device PDD, respectively.

30 Advantageous implementation details, which are defined in the dependent Claims, are highlighted here below with reference to the above examples.

(Claim 2.) In the Fig. 2 example, the oscillator in the low-band branch,

formed by the oscillator circuit OSC-L and the oscillator resonant circuit ORC-L, is switchable in frequency for providing the intermediate frequency signal IFS either at the TV-IF or at the FM-IF. This is a smaller, simpler and cheaper implementation, than an alternative implementation in which the band-pass filter BPF-L and the input filter RFI-L in the low-band branch are switched. In the alternative implementation more switches would be required.

(Claim 3.) In the Fig. 4 example, the oscillator resonant circuit includes two inductances: the primary and the secondary inductance. The frequency switching of the oscillator is effected by means of the switch S, which is coupled in parallel to the secondary inductance. This is a simple and cheap implementation of switching an oscillator in frequency. Moreover, alignment of the oscillator frequency for FM-mode and TV-mode is relatively easy.

(Claim 4.) In the Fig. 4 example, the switch S is preferably conducting for receiving TV signals and non-conducting for receiving FM-radio signals. This provides a satisfactory compromise between signal-to-noise ratio for TV and FM-radio reception, which can be explained as follows. In practice, the switch S will provide a series resistance in closed condition. The series resistance, although relatively small, deteriorates to some extent the phase-noise performance of the oscillator. With respect to signal-to-noise ratio, the phase-noise performance is more critical for reception of FM signals, such as FM-radio, than for AM signals, such as TV. To achieve best phase-noise performance, the switch S is preferably opened in FM-reception.

(Claim 5.) In the Fig. 4 example, a series arrangement of the controllable capacitance Cvar and the padder capacitance Cpad is coupled between the primary inductance L1 and the secondary inductance L2. These implementation details provide very satisfactory tracking, which can be explained as follows. Opening of the switch S produces the following effects. First, the effective inductance is increased. Second, the effective parallel capacitance is decreased due to an impedance transformation. The impedance transformation depends on the ratio of the primary inductance to the secondary inductance.

Accordingly, by suitably choosing this ratio, satisfactory tracking can be achieved.

(Claim 6.) In the Fig. 4 example, the auxiliary capacitance Caux is coupled in series with the switch S, and together with the switch S it is coupled in parallel with

the secondary inductance L2. This implementation detail provides an improved tracking, which can be explained as follows. Referring to Fig. 3 and Table 1, the padder capacitance C_{pad} preferably has a higher value in FM-mode than in TV-mode. Referring again to Fig. 4, the auxiliary capacitance C_{aux} can be seen to effectively lower the value of the Fig. 3 padder capacitance C_{pad}, when the switch S is closed.

(Claim 7.) In the Fig. 5 example, the resistors R_{dn1} and R_{dn2} and the capacitor C_{dn} form a frequency dependent damping network to counter a parasitic oscillation at a frequency higher than the desired oscillation frequency. The damping network effectively increases the loss at the parasitic resonance frequency, with respect to the loss at the desired oscillation frequency.

(Claim 8.) In a tuner equipped with a Fig. 4 type of oscillator resonance circuit, there is preferably an oscillation detector for decreasing the value of the controllable capacitance C_{var} when the oscillator is not oscillating. This prevents a dead-lock in the frequency control of the oscillator, which can be explained as follows. The impedance of the Fig. 4 type of oscillator resonance circuit is relatively low, particularly when tuned to relatively low resonance frequencies and when the switch S is open (FM-mode). If the impedance is too low, the oscillator may simple not oscillate such that a frequency control cannot be effected. This problem is solved by detecting a non-oscillatory condition and, in response thereto, by increasing the value of the controllable capacitance. Accordingly, the oscillator will be pulled out of the non-oscillatory condition, such that the frequency control can be effected. Referring to the Fig.2 tuner, the phase-lock circuit PLL preferably includes an oscillation detector to that extent.

(Claim 9.) In the Fig. 2 example, the band-pass filter BPF-L in the low-band is switchable for filtering TV signals and FM-radio signals differently. This provides a better reception quality, in particular for FM-radio, than if the band-pass filter BPF-L was fixed.

(Claim 11.) The Figs. 4 oscillator resonant circuit is preferably tuned according to the following method, when it has to operate in a mode where the switch S is opened. First, the switching element S is made conducting. Second, the oscillator is tuned to a desired frequency. Third, the switching element S is made non-conducting. Fourth, and finally, the oscillator is

corrected to the desired frequency. This method counters erroneous tuning which may result from a parasitic resonance in the Fig. 4 circuit, when the switch S is opened.

Evidently, the invention may be implemented differently from the examples described above. To that respect, any reference signs in a claim cannot be construed as
5 limiting the claim concerned. To indicate that the scope of the invention claimed is well beyond the examples described above, some final remarks are made.

It should be noted that the invention is not limited to combined TV and FM-radio reception. For example, the invention can be used in TV reception only, for example, to implement a TV tuner for receiving both US and European type of TV
10 signals. In the US an IF of 45,75 MHz is preferred, whereas in most European countries an IF of 38,9 MHz is preferred. Accordingly, the principle of the invention to have a tuner capable of providing various IF frequencies, such as 45,75 and 38,9 MHz, can be used.

It should be noted that the invention is not limited to two different IF
15 frequencies provided by a single tuner. For example, the single tuner may provide the following three different IF frequencies: 38,9 MHz IF for European TV signals, 45,75 MHz for US TV signals and 10,7 MHz for FM-radio signals.

It should be noted that the invention is not limited to a 3 band tuner concept, as shown in Fig. 2. The invention may, in principle, be applied in any tuner
20 concept, for example in a 2 band tuner concept.

It should be noted that the invention is not limited to multi-media applications. The invention may be used in any apparatus comprising a receiver, such as TV receivers and video-tape recorders.

It should be noted that the parallel capacitance C_{par} shown in the Figs. 3
25 and 4 examples, need not to be a discrete capacitor. The parallel capacitance may be formed by parasitic capacitances of one or more elements which are, in practice, coupled to the Fig. 3 and 4 circuits, but not shown. To that respect reference is made to the Fig. 5 example, in which no discrete capacitor is present which is directly related to the parallel capacitance C_{par} in Figs. 3 and 4.



Claims:

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1. A receiver for receiving first type of reception signals and second type of reception signals, the receiver comprising:

a tuner (TUN) for providing an intermediate frequency signal (IFS) in response to a reception signal;

5 a first intermediate frequency signal processing arrangement (IFSP1) coupled to process said intermediate frequency signal (IFS) when receiving said first type of reception signals; and

a second intermediate frequency signal processing arrangement (IFSP2) coupled to process said intermediate frequency signal (IFS) when receiving said second
10 type of reception signals,

characterized in that said receiver is a single conversion receiver, and in that said tuner (TUN) is arranged to provide said intermediate frequency signal (IFS) at a first intermediate frequency (IF1) for processing in said first intermediate frequency signal processing arrangement (IFSP1), and to provide said intermediate frequency signal (IFS)
15 at a second intermediate frequency (IF2) for processing in said second intermediate frequency signal processing arrangement (IFSP2).

2. A receiver as claimed in Claim 1, characterized in that said tuner comprises an oscillator (OSC-L, ORC-L) which is switchable in frequency for providing
20 said intermediate frequency signal (IFS) either at the first intermediate frequency or at the second intermediate frequency.

3. A receiver as claimed in Claim 2, characterized in that the oscillator (OSC-L, ORC-L) comprises a resonance circuit (ORC-L) which incorporates a primary
25 inductance (L1), a secondary inductance (L2) and, coupled in parallel to the secondary inductance (L2), a switching element (S) for switching the frequency of the oscillator.



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4. A receiver as claimed in Claim 3, characterized in that the switching element (S) is conducting for receiving an AM reception signal and which is non-conducting for receiving an FM reception signal.

5. A receiver as claimed in Claim 3, characterized in that the resonance circuit (ORC-L) incorporates a series arrangement of a controllable capacitance (Cvar) and a padder capacitance (Cpad), which series arrangement is coupled between the primary inductance (L1) and the secondary inductance (L2).

6. A receiver as claimed in Claim 5, characterized in that the resonance circuit (ORC-L) incorporates an auxiliary capacitance (Caux) which is coupled in series with the switch (S) and which, together with the switch (S), is coupled in parallel, with the secondary inductance (L2).

7. A receiver as claimed in Claim 5, characterized in that the resonance circuit (ORC-L) incorporates a frequency dependent damping network (Rdn1, Rdn2, Cdn).

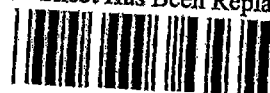
8. A receiver as claimed in Claim 5, characterized in that the receiver comprises an oscillation detector (PLL) for decreasing the value of the controllable capacitance (Cvar) when the oscillator (OSC-L, ORC-C) is not oscillating.

9. A receiver as claimed in Claim 1, characterized in that the tuner comprises a switchable band-pass filter (BPF-L) for filtering the first and second type of reception signals differently.

10. A multi-media apparatus comprising:
a receiver as claimed in Claim 1; and
a control unit (CCU) for controlling said receiver and for processing data signals.

11. A method of tuning a receiver as claimed in Claim 5, characterized by the steps of:

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making the switching element (S) conducting;
tuning the oscillator (OSC-L, ORC-L) to a desired frequency;
making the switching element (S) non-conducting;
correcting the oscillator (OSC-L, ORC-L) to the desired frequency.

5

12. A shielded metal box (SMB) comprising a tuner (TUN) for providing an intermediate frequency signal (IFS) in response to a reception signal, characterized in that said tuner (TUN) is a single conversion tuner arranged to provide said intermediate frequency signal (IFS) at a first intermediate frequency (IF1) for processing in said first
10 intermediate frequency signal processing arrangement (IFSP1), and to provide said intermediate frequency signal (IFS) at a second intermediate frequency (IF2) for processing in said second intermediate frequency signal processing arrangement (IFSP2).

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