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Dear Sirs

European Patent Application No. 02759732.7.2415
"A digital implementation of multi-channel demodulators"
Broadlogic Network Technologies, Inc.

In response to the outstanding Examination Report relating to the above-mentioned application please find enclosed a new set of claims (replacing all pending claims) and new pages 2 and 2a (replacing page 2) of the description.

Amendment

In the description the introduction has been amended, as requested by the Examiner, to include reference to documents D1 and D2 and to introduce statements of invention corresponding directly to the remaining independent claims.

In response to the Examiner's unity objection Claims 20 and 22 and their respective dependent claims have been deleted and independent method Claim 32 has been amended to form a dependant claim based on original independent method Claim 27. The claims now include a single independent apparatus claim (Claim 1) and method claim (newly numbered Claim 16). Both independent claims relate to the same inventive concept of selecting one or more separate digital RF channels and as such relate to the same inventive concept. The new set of claims thus complies with the unity of invention requirements of the EPC.

Dependent Claims 16 to 19 have also been deleted. The remaining claims have been renumbered and their dependencies altered accordingly.

The only further amendment to the claims is the introduction of reference numerals as requested by the Examiner in Section 3.2.

The Examiner's request for the claims to be classed in the two part form is noted. However, it is submitted that the two part form would compromise the clarity of the claims and is therefore inappropriate in the present case. Moreover, in the application as amended the indication of prior art made in the description is sufficiently clear for the requirement of Rule 27(1)(b) to be met (see new pages 2 and 2a). Thus, the two-part form should not be insisted upon (Part C, Chapter III, paragraph 2.3b).

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Patentability

It is noted that the Examiner has not completed a detailed examination of the application in respect of novelty and inventive step and has therefore not been able to formulate any meaningful opinion on patentability. It is submitted that the Examiner's reasons for not carrying out a full examination have been addressed by the amendments referred to above and in view of this we request that a full examination be carried out and, in the event of objections, full reasoning be given.

For the convenience of the Examiner the Applicant makes the following submissions in relation to the two documents D1 and D2 cited against Claim 1 and newly re-numbered Claim 16. D1 discloses an OFDM (Orthogonal Frequency Division Multiplexing) modulation scheme which simultaneously demodulates multiple RF channels of the OFDM signal. As seen in figure 1, for example, D1 shows an OFDM demodulator which receives the multi-channel RF signal directly from a down converter and then demodulates the signal to produce data distributed over all the received RF channels. The demodulated data is then decoded before being fed into a transport stream demultiplexer (12) (page 6, lines 14 to 20).

D1 does not, therefore, disclose "a selector configured to receive the separate digital RF channels and to select one or more separate digital RF channels" as recited in Claim 1. Furthermore, D1 does not disclose "one or more demodulators **configured to receive one or more of the selected digital RF channels from the selector...**". Indeed the provision of a selector/demodulator combination as claimed in Claim 1 is not possible in the apparatus disclosed in D1 because it completes the demodulation step before demultiplexing and therefore before any selection could potentially take place. It would not, therefore, be obvious to include the selector/demodulator combination into the architecture disclosed in D1.

As discussed above the architecture of D1 does not include a selector for selecting one or more separate digital RF channels. Hence, D1 does not disclose a method comprising the step of selecting one or more selected RF channels from at least one of the digital RF channels as required in newly numbered Claim 16.

Turning now to D2, no selector is provided for allowing only a selection of the signals to be demodulated. Instead, D2 requires the provision of a complex switching matrix such that each sample (a to m) of each respective output signal (13₁ to 13_n) is provided to a set of Hilbert transform filters at a proper timing and input position, taking into account the number of taps in each filter, the number of filters, and the number of branches from the demultiplexer. Each branch from the demultiplexer is thus processed and no selection is allowed for.

The subject-matter of Claim 1 and newly numbered Claim 16 is therefore novel over D2 for the reasons discussed in relation to D1.

The provision of a selector allows the selection of specific RF channels for demodulation dependant on the specific application in which the apparatus is implemented (paragraph 37 of the application) this allows for power consumption to be optimised because only the selected channels are later demodulated unlike systems which demodulate all of the



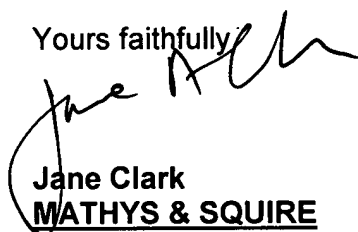
RF channels (e.g. D1 and D2). Thus, the invention provides apparatus which is not only faster, but also dissipates less heat, than systems such as those in D1 and D2, because fewer resources are required when demodulating only the selected RF channels (paragraph 25).

In view of this, the invention claimed in both Claim 1 and newly numbered Claim 16 clearly solves a technical problem which is neither disclosed in nor solved by D1 or D2. The claimed subject-matter is therefore both novel and inventive over the prior art cited by the Examiner.

Any subject-matter removed from the application in response to the Examination Report is deleted without prejudice to its possible later reinstatement either in the current application or an application derived from it.

It is submitted that the application is now in a fit state for allowance. Nevertheless, should the Examiner be minded to refuse the application we hereby make a precautionary request for Oral Proceedings by video conference. If the Examiner is minded to maintain any of the objections, or to raise new one, it is requested that he contact the undersigned by telephone to discuss the matter informally.

Yours faithfully,



Jane Clark
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Enc: New set of claims
Amended pages from description

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CLAIMS

1. A digital multi-channel demodulator circuit (200, 600) for processing a multi-channel analog RF signal, the multi-channel demodulator comprising:
 - a frequency-block down-converter (310, 610) configured to receive the analog RF signal and to shift the analog RF signal to a lower frequency band;
 - an analog-to-digital converter (ADC) (220, 620) configured to receive the analog RF signal from the frequency-block down-converter and to convert the analog RF signal to a multi-channel digital RF signal;
 - a digital channel demultiplexer (230, 300, 400, 630) configured to receive the digital RF signal from the ADC and to demultiplex the digital RF signal into separate digital RF channels ($C_1 \dots C_n$);
 - a selector (240, 500, 620) configured to receive the separate digital RF channels and to select one or more separate digital RF channels ($D_1 \dots D_m$); and
 - one or more demodulators (250 (1...m)) configured to receive one or more of the selected digital RF channels ($D_1 \dots D_m$); from the selector and to demodulate the one or more selected digital RF channels.
2. The circuit of claim 1 wherein each separate digital RF channel comprises one or more data streams to be accessed or used by a subscriber.
3. The circuit of claim 1 or 2 wherein the one or more demodulators demodulate only the RF channels that are selected by the selector.
4. The circuit of any preceding claim further comprising a digital transport interface configured to receive the selected RF channels from the one or more demodulators and to output the selected RF channels.
5. The circuit of any preceding claim further comprising a bandpass filter to reduce aliasing from unwanted signals.
6. The circuit of any preceding claim wherein the ADC is a high-speed ADC

7. The circuit of any preceding claim wherein the ADC converts an entire signal band, the signal band including the multi-channel analog RF signal.
8. The circuit of any preceding claim wherein the one or more demodulators share resources.
9. The circuit of any preceding claim wherein the digital channel demultiplexer includes a digital tuner.
10. The circuit of claim 9 wherein the digital tuner comprises:
a numeric control oscillator (NCO) configured to generate a select frequency, the select frequency being associated with a corresponding RF channel;
a complex multiplier configured to receive the digital RF signal and to multiply the digital RF signal with the select frequency; and
a low-pass filter (LPF) configured to receive the digital RF signal and to pass the corresponding RF channel.
11. The circuit of claim 10 wherein the LPF is a high-speed finite impulse response (FIR) filter.
12. The circuit of any preceding claim wherein the digital multi-channel demodulator circuit processes downstream signals in at least one of a satellite system, a terrestrial TV system, and a cable system.
13. A system using the circuit of any of claims 1 to 12 in combination with memory.
14. A system using the circuit of any of claims 1 to 12 in combination with a processor.
15. The circuit of any of claims 1 to 12 wherein the digital channel demultiplexer is a polyphase channel demultiplexer.

16. A method for demultiplexing a digital multi-channel RF signal into a plurality of separate content channels, the method comprising:
down converting the multi-channel analog RF signal to a lower frequency band;
converting the multi-channel analog RF signal into a multi-channel digital RF signal;
demultiplexing the multi-channel digital RF signal into separate digital RF channels; and
selecting one or more selected RF channels from at least one of the digital RF channels, each selected RF channel being an RF channel containing one or more content channels to be accessed or used by a subscriber.

17. The method of claim 16 further comprising receiving a plurality of multi-channel analog RF signals.

18. The method of claim 16 or 17 further comprising demodulating the one or more selected RF Channels.

19. The method of claim 18 further comprising demodulating only the one or more selected RF channels.

20. The method of claim 17 wherein the plurality of multi-channel analog RF signals can be from at least one of a satellite system, a terrestrial TV system, and a cable system.

21. The method of claim 16 wherein the demultiplexing further comprises:
providing a plurality of select frequencies, each select frequency being associated with a corresponding and separate RF channel; and
multiplying the at least one multi-channel RF signal with each of the select frequencies to obtain separate RF channels.

22. The method of claim 21 wherein the multiplying is achieved with a complex multiplier.

23. The method of claim 21 or 22 further comprising shifting the target RF channel to a baseband.

24. The method of any of claims 21 to 23 further comprising filtering undesired RF channels and passing only the target RF channel.

25. The method of claim 24 wherein the filtering is achieved with a low-pass filter (LPF).

26. The method of claim 25 wherein the LPF is a finite impulse response (FIR) filter.

27. The method of claim 26 wherein the FIR filter is a high-speed filter.

28. The method of any of claims 21 to 27 wherein the select frequencies are generated by numeric control oscillators.

29. The method of any of claims 16 to 20 wherein the demultiplexing further comprises:
synchronizing samples of multi-channel RF signal using LPFs; and
shifting the frequencies of the RF channels.

[05] Each RF channel requires one analog tuner and analog band-pass or low-pass filters. The problem with this approach is that the cost, power consumption, and complexity go up as the required number of RF channels goes up.

5 GB2326070A discloses a demodulator suitable for implementation in a single chip for demodulating digital video broadcast signals comprising data on a plurality of spaced carrier frequencies. US 6263195 B1 discloses a wide band digital tuner having an analog front end section, a high speed analog to digital converter, a demultiplexer and a plurality of filters arranged in a parallel input architecture to process wideband digital data received at extremely high sampling rights. However, both GB 2326070A and US 6263195 B1 are characterised by a relatively high cost, high power consumption and high complexity which increases as the number of channels requiring processing increases.

BRIEF SUMMARY OF THE INVENTION

15 [06] The present invention provides a method and circuitry for demodulating signals such as downstream signals. At least some embodiments are characterized by lower cost, lower power consumption, and/or lower complexity.

20 According to one aspect of the present invention there is provided a digital multi-channel demodulator circuit for processing a multi-channel analog RF signal the multi-channel demodulator comprising: a frequency-block down-converter configured to receive the analog RF signal and to shift the analog RF signal to a lower frequency band; an analog-to-digital converter (ADC) configured to receive the analog RF signal from the frequency-block down-converter and to convert the analog RF signal to a multi-channel digital RF signal; a digital channel demultiplexer configured to receive the digital RF signal from the ADC and to demultiplex the digital RF signal into separate digital RF channels; a selector configured to receive the separate digital RF channels and to select one or more separate digital RF channels; and one or more demodulators configured to receive one or more of the selected digital RF channels; from the selector and to demodulate the one or more selected digital RF

channels.

According to another aspect of the invention there is provided a method for demultiplexing a digital multi-channel RF signal into a plurality of separate content channels, the method comprising: down converting the multi-channel analog RF signal to a lower frequency band; converting the multi-channel analog RF signal into a multi-channel digital RF signal; demultiplexing the multi-channel digital RF signal into separate digital RF channels; and selecting one or more selected RF channels from at least one of the digital RF channels, each selected RF channel being an RF channel containing one or more content channels to be accessed or used by a subscriber.

[07] A digital multi-channel demodulator circuit according to an embodiment of the invention includes a frequency-block down-converter that receives a multi-channel analog RF signal and shifts the multi-channel analog RF signal to a lower frequency band. An ADC receives the multi-channel analog RF signal from the frequency-block down-converter and converts the multi-channel analog RF signal to a multi-channel digital RF signal. A digital channel demultiplexer receives the multi-channel digital RF signal from the ADC and demultiplexes the multi-channel digital RF signal into separate digital RF channels.

[08] Other embodiments include a digital selector that receives the separate RF channels and selects one or more RF channels, and a plurality of demodulators that receive one or more of the RF channels from the digital selector and demodulate one or more of the RF channels.

[09] Other embodiments include a digital tuner for use in multi-channel demodulation. The digital tuner includes a numeric control oscillator (NCO) that generates a select frequency, the select frequency being associated with a corresponding and separate RF channel. A complex multiplier receives the multi-channel digital RF signal and multiplies the multi-channel digital RF signal with the select frequency and passes the result through a low-pass filter LPF to extract the signal that is superimposed on the corresponding RF channel.

[10] Other embodiments include a polyphase channel demultiplexer for use in multi-channel demodulation. The polyphase channel demultiplexer includes at least one low-pass filter (LPF) configured to receive the multi-channel digital RF signal and to synchronize the RF channels. Also included is a discrete Fourier transform circuit (DFT) that demultiplexes the multi-channel digital RF signal into separate digital RF channels.

[11] Embodiments of the present invention achieve their purposes and benefits in the context of known circuit and process technology and known techniques in the electronic and process arts. Further understanding, however, of the nature, features, and