Electronic System for influencing cellular functions in a warm-blooded mammalian subject

FIELD OF THE INVENTION

This invention relates to an electronic system for influencing cellular functions in a warm-blooded mammalian subject. More particularly, the invention concerns research findings related to how earlier electronic systems may be modified and programmed to achieve both improved and additional therapeutic effects.

BACKGROUND OF THE INVENTION

Reference is made to European Patent EP 0 592 851 B1 and corresponding Patents and Patent Applications and to the various publications referred to therein. Since the time of the priority Application filed in the USA on 25 September 1992 (US Serial No 951563 now USP 5,441,528), a number of further publications related to effects of very low energy electromagnetic fields on patients suffering from insomnia and/or anxiety disorders have taken place:

Koziol JA, Erman M, Pasche B, Hajdukovic R, Mitler MM (1993) Assessing a changepoint in a sequence of repeated measurements with application to a low-energy emission therapy sleep study. *J Applied Statistics* **20**: 393-400

Amato D, Pasche B (1993) An evaluation of the safety of low energy emission therapy. *Compr Ther* **19**: 242-247

Higgs L, Reite M, Barbault A, Lebet JP, Rossel C, Amato D, Dafni U, Pasche B (1994) Subjective and Objective Relaxation Effects of Low Energy Emission Therapy. *Stress Medicine* **10**: 5-13

Reite M, Higgs L, Lebet JP, Barbault A, Rossel C, Kuster N, Dafni U, Amato D, Pasche B (1994) Sleep Inducing Effect of Low Energy Emission Therapy. *Bioelectromagnetics* **15**: 67-75

Lebet JP, Barbault A, Rossel C, Tomic Z, Reite M, Higgs L, Dafni U, Amato D, Pasche B (1996) Electroencephalographic changes following low energy emission therapy. *Ann Biomed Eng* **24**: 424-429

Pasche B, Erman M, Hayduk R, Mitler M, Reite M, Higgs L, Dafni U, Amato D, Rossel C, Kuster N, Barbault A, Lebet J-P (1996) Effects of Low Energy Emission Therapy in chronic psychophysiological insomnia. *Sleep* **19**: 327-336

Kelly TL, Kripke DF, Hayduk R, Ryman D, Pasche B, Barbault A (1997) Bright light and LEET effects on circadian rhythms, sleep and cognitive performance. *Stress Medicine* **13**: 251-258

Pasche B, Barbault A (2003) Low-Energy Emission Therapy: Current Status and Future Directions. In *Bioelectromagnetic Medicine*, Rosch PJ, Markov MS (eds) pp 321-327. Marcel Dekker, Inc.: New York, New York.

The above publications are related to an earlier device, system and use thereof described in said EP 0 592 851 B1. The improved electronic system and programmed control thereof in accordance with the present invention, however, has been determined to find therapeutic application not only for influencing cellular functions (or malfunctions) leading to central nervous system (CNS) disorders, but more particularly for influencing other cellular functions (or malfunctions) including directly or indirectly influencing cancerous cell growth or proliferation thereof in warm-blooded mammalian subjects. The direct or indirect influence on cancerous cell growth may involve but is not necessarily limited to any of prophylactic avoidance of cancerous cell formation, influencing of cell functions such as for exampleinfluencing leukocyte cell functions which can lead to inhibition of cancerous cell growth or proliferation thereof, and/or killing of cancerous cells harboured by a warm-blooded mammalian subject.

Electromagnetic energy generating devices and use of electromagnetic energies for treating living mammalian subjects harbouring cancerous cells described in the literature include: USP 5,908,441 issued June 1, 1999 to Bare; James E. and the references cited therein and so-called "NovoCure technology" involving in vivo implantation of electrodes to either side of tumorous growths. This literature however does not contemplate very low energy emissions of electromagnetic energy involving amplitude-modulated high frequency carrier signals as required in terms of the present invention.

US Patent 5,690,692 issued on November 25, 1997 entitled "Bio-Active Frequency Generator and Method" describes a programmable control which instructs a frequency synthesizer to enable generation of an electrical current at a specific precise frequency signal or at a series of specific precise frequencies signals having a square wave form to within an accuracy of 0.001 Hz. This Patent contemplates amplifying the voltage of the generated signals and applying the signals to a subject at the specific precise frequency or sequentially at the series of specific precise frequencies by means of electrodes held by or otherwise connected to the subject (which may be a mammal or a food). Once again, this Patent does not contemplate very low energy emissions involving amplitude-modulated high frequency carrier signals as required in terms of the present invention.

SUMMARY OF THE INVENTION

In one aspect of the invention, an electronic system is provided which is activatable by electrical power. The system is employed to influence cellular functions or malfunctions in a warm-blooded mammalian subject. The system comprises one or more controllable low energy electromagnetic energy generator circuits for generating one or more high frequency radio frequency RF carrier signals. One or more microprocessors or integrated circuits comprising or communicating with the one or more generator circuits are provided which are also for receiving control information from a source of programmed control information. The one or more generator circuits include one or more amplitude modulation control signal generators for controlling amplitude modulated variations of the one or more high frequency carrier signals. The one or more generator circuits furthermore include one or more programmable amplitude modulation frequency control signal generators for controlling the frequency at which the amplitude modulations are generated. The one or more amplitude modulation frequency control generators are, in terms of an important improvement of the present invention, adapted to accurately control the frequency of the amplitude modulations to within an accuracy of at least 1000

ppm relative to one or more determined or predetermined reference amplitude modulation frequencies selected from within a range of 0.01 Hz to 150 kHz. The system furthermore comprises a connection or coupling position for connection or coupling to or being connected or coupled to an electrically conductive applicator for applying to the warm-blooded mammalian subject the one or more amplitude-modulated low energy emissions at said accurately controlled modulation frequencies.

As used herein, the term, "accurately controlled" means that the modulated low energy electromagnetic emissions should be modulated to within a resolution of at most about 1 Hz of intended higher frequencies (greater than about 1000 Hz) determined or predetermined modulation frequencies. For example, if one of the one or more determined or predetermined modulation frequencies to be applied to the warm-blooded mammalian subject is about 2000 Hz, the accurate control should lead to such modulated low energy emission being generated at a frequency of between about 1999 and about 2001 Hz. However, and in terms of what has been determined from experiences in treating human subjects harbouring cancerous cells with the aim of arresting proliferation or killing of such cells, it is preferable thatthe accurate control should lead to a resolution of about 0.5, more preferably about 0.1, yet more preferably about 0.01 and indeed most preferably about 0.001 Hz of the intended determined or predetermined modulation frequency.

Of importance is the requirement for emissions to be at a very low and safe energy level and result in low levels of absorption, the reason believed to be that physiological exchanges or flow of electrical impulses within warm-blooded animals (which are to be affected by application of the emissions of the present invention) are similarly at very low energy levels. In any event, in the region (at or near to the position of contact or close-by induction of the electrically conductive applicator with a subject receiving treatment),

the specific absorption rate (SAR) should be and is most preferably substantially less than 1.6 milliW/g weight of living tissue.

Furthermore of importance to achieve the the intended biological therapeutic effect is that the stability of the emissions be maintained during emission, and that such stability should preferably be of the order of 10^{-5}, more preferably 10^{-6}, and most preferably 10^{-7}, stability being determined as the relative deviation of frequency divided by the desired frequency, e.g. 0,01 Hz (deviation) / 1'000 Hz (desired freq.) = 10^{-5}.

As already described in said EP 0 592 851 B1, the system includes a microprocessor (which may more recently be replaced by an integrated circuit) into which control information is loaded from an application storage device. The microprocessor (or now alternatively integrated circuit) then controls the function of the system to produce the desired therapeutic emissions. Also described is the provision in the system of an impedance transformer connected intermediate the emitter of low energy electromagnetic emissions and a probe (here more broadly described as an electrically conductive applicator) for applying the emissions to the patient. The impedance transformer substantially matches the impedance of the patient seen from the emitter circuit with the impedance of the output of the emitter circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an exemplary casing structure for the electronic circuit shown in Figure 2, an applicator 13 (exemplified as a probe suitable for being placed in the mouth of a patient) and an interface 16 (which may be replaced by a receiver) for receiving information from a source of information 52 such as may be comprised

in an information storage device, e.g. of the nature described and illustrated in Figures 12 to 17 of EP 0 592 851 B1..

FIG. 2 is a block diagram of exemplary circuitry which may be comprised in the exemplary casing structure of FIG. 1. This Figure 2 differs essentially from Figure 2 of EP 0 592 851 B1 by comprising a highly accurate modulation frequency generator 31 (named a Digital Direct Synthesizer or DDS), which enables accurate control of modulatable oscillator represented by dotted line block 106.

Reference is made to the various Figures of EP 0 592 851 B1 and the detailed description thereof, a number of which are exemplary of components which may be comprised in the circuit of Figure 2.

Thus, Figure 3 of EP 0 592 851 B1 is a detailed schematic of a modulation signal generator 31, replaced by a DDS modulation frequency generator 31 comprised in the circuit of present Figure 2;

Figure 4 of EP 0 592 851 B1 is a detailed schematic of a modulation signal buffer and carrier oscillator circuit which may be employed in the circuit of the present FIG. 2;

FIG. 5 of EP 0 592 851 B1 is a detailed schematic example of an amplitude modulation (AM) and power generator 34 and output filter 39 which could be comprised in the circuit of the present FIG. 2;

FIG. 6 of EP 0 592 851 B1 is a detailed schematic example of an impedance transformer 14 which may be comprised in the circuit of the present FIG. 2;

FIG. 7 of EP 0 592 851 B1 is a detailed schematic example of an emission sensor 53 which may be comprised in the circuit of the present FIG. 2;

FIG. 8 of EP 0 592 851 B1 is a detailed schematic example of an output power sensor circuit 54 which may be employed in the circuit of the present FIG. 2.

FIG. 9 of EP 0 592 851 B1 is a detailed schematic example of a display module or information output 17 which may be included in the circuit of the present FIG. 2.

FIG. 10 of EP 0 592 851 B1 is a detailed schematic example of a power supply control circuit including battery charger 57 which may be comprised in the circuit of the present FIG. 2.

FIGS. 11 a-d of EP 0 592 851 B1 are exemplary flow charts of the method of operation of the system of FIG's 1 and 2.

DETAILED DESCRIPTION

Referring to FIG. 1, presented is a modulated low energy electromagnetic emission application system 11, in accordance with the present invention. As described in prior U.S. Pat. Nos. 4,649,935 and 4,765,322, such a system has proven to be useful in the practice of *Low Energy Emission Therapy* (LEET, a trademark of Symtonic S.A. or a successor of this Company), which involves application of emissions of low energy radio frequency (RF) electromagnetic waves to a warm-blooded mammalian subject. The application has proven to be an effective mode of treating a warm-blooded mammalian subject suffering from central nervous system (CNS) disorders such as, for example, generalized anxiety disorders, panic disorders, sleep disorders including insomnia, psychiatric disorders such as depression, obsessive compulsive disor-

ders, disorders resulting from substance abuse, sociopathy, post traumatic stress disorders or other disorders of the central nervous system and combinations thereof.

The system includes an electrically conductive applicator 12, 13 for applying one or more electromagnetic emissions to the warm-blooded mammalian subject. One form of applicator may consist of an electrically conductive probe or mouthpiece 13 which is inserted into the mouth of a subject undergoing treatment. Probe 13 is connected to an electromagnetic energy emitter (see also FIG. 2), through coaxial cable 12 and impedance matching transformer 14.

It has previously been considered that an efficient connection of an electrically conductive applicator to a subject could only be achieved by means of a probe which is adapted to be applied to any mucosa of the subject, such as by being located within oral, nasal, optical, urethral, anal, and/or vaginal cavities or surfaces. It has however now been determined that in fact satisfactory application of emissions to a patient can be achieved by simpler physical contact of the electrically conductive applicator with the skin of the patient. Emissions to the patient may, for example be achieved by a conductive, inductive, capacitive or radiated coupling to the patient. An example of a coupling found to be effective involving indirect physical contact with the skin of a patient, is an insulated applicator to be placed over or within an ear of the patient. The emissions thus passed to the patient may be either by capacitive or radiated means or by a combination of both. An important advantage of a device which does not need to be placed in the mouth of a patient is that the patient is able to speak clearly during a time of treatment and can receive treatment during activities of daily living. The treatment is accordingly more user-friendly, can be administered for longer periods of time and can lead to enhanced patient compliance.

Electronic system 11 also includes a connector or coupler for connection to a programmable device such as a computer or an interface or receiver 16 which is adapted to receive an application storage device 52 such as, for example, magnetic media, semiconductor media, optical media or mechanically encoded media, or programmed emissions programmed with control information employed to control the operation of system 11 so that the desired type of *low energy emission therapy* is applied to the patient.

Application storage device 52 can be provided with a microprocessor which, when applied to interface 16, operates to control the function of system 11 to apply the desired *low energy emission therapy*. Alternatively, application storage device 52 can be provided with a microprocessor which is used in combination with microprocessor 21 within system 11. In such case, the microprocessor within device 52 could assist in the interfacing of storage device 52 with system 11, or could provide security checking functions.

System 11 may also include a display 17 which can display various indications of the operation of system 11. In addition, system 11 may include on and off power buttons 18 and 19, optionally replaced by user interface 21A (refer to Figure 2).

Referring to FIG. 2, presented is a block diagram of exemplary electronic circuitry of system 11, in accordance with the present invention. A data processor, such as for example, microprocessor or integrated circuit 21, operates as the controller for electronic system 11, and is connected to control the various components of the system 11, for example, through address bus 22, data bus 23 and input/output lines 25. The block diagram ofFIG. 2 is modified as compared to FIG.2 of EP 0 592 851 B1 by including what is known as a digital direct synthesizer (DDS) 31 which operates as a

accurate and stable modulation frequency generator within the system 11. An exemplary DDS device is available from Analog Devices of Norwood, MA 02062-9106, USA, Part No AD9835. The device is a numerically controlled oscillator and modulation capabilities are provided for phase modulation and frequency modulation. As represented by dotted line block 102, entitled "PROCESSOR WITH DAC", the functionality of the DDS may also be combined with microprocessor 21 with digital to analogue converter (DAC).

Microprocessor 21 preferably includes internal storage for the operation of a coded control program, and temporary data. In addition, microprocessor 21 may include input/output ports and internal timers. Microprocessor 21 may be a microcontroller, for example microcontrollers 8048 or 8051 available from Intel Corporation of Santa Clara, CA 95054-1549, USA.

The timing for microprocessor 21 is provided by system clock oscillator 26A which may be run at any clock frequency suitable for the particular type of microprocessor used. An exemplary clock frequency is about 8.0 MHz. Oscillator 26A may be replaced by reference frequency oscillator 26 which secures the stability of the accurate modulation frequency. RF (radio frequency) oscillator 32 may also be employed for this purpose. A combination of oscillators is represented by dotted line block 104, entitled "OSCILLATOR".

An exemplary operating program for microprocessor 21 is presented in flow chart form with reference to FIGS. 11 a-d of EP 0 592 851 B1. In general, microprocessor 21 functions to control controllable electromagnetic energy generator circuit 29 to produce a desired form of modulated low energy electromagnetic emission for application to a subject through applicator or probe 13.

Dotted line block 29, entitled CONTROLLABLE GENERATOR, includes DDS modulation frequency generator 31 and carrier signal oscillator 32. Microprocessor 21 operates to activate or deactivate controllable generator circuit 29 through oscillator disable line 33, as described in greater detail in EP 0 592 851 B1. Controllable generator circuit 29 also includes an AM modulator and power generator 34 which operates to amplitude modulate a carrier signal produced by carrier oscillator 32 on carrier signal line 36, with a modulation signal produced by modulation signal generator circuit 31 on modulation signal line 37. The combination of the functionality of the DDS modulation frequency generator 31, with processor 21 with DAC, represented by dotted line block 102, enables output lines 33 and 37 to be combined to produce a single signal. The combination furthermore enables arbitrary or periodic wave forms of any shape to be generated, as similarly described in EP 0 592 851 B1.

AM modulatorand power generator 34 produces an amplitude modulated carrier signal on modulated carrier signal line 38, which is then applied to emitter output filter circuit 39. The filter circuit 39 is connected to probe or applicator 13 via power emission sensor 54, coaxial cable 12 and impedance transformer 14.

Microprocessor 21 controls DDS modulation signal generator circuit 31 of controllable generator circuit 29 via interface lines 25.

As is illustrated and described in EU 0 592 851 B1, microprocessor 21 may select a desired waveform stored in a modulation waveform storage device 43 and also controls a waveform address generator 41 to produce on waveform address bus 42 a sequence of addresses which are applied to modulation signal storage device 43 in order to retrieve the selected modulation signal. In the embodiment described in EP 0 592 851 B1, the desired modulation signal is retrieved from modulation signal storage device 43 and

applied to modulation signal bus 44 in digital form. Modulation signal bus 44 is applied to wave form generator and DAC 46 which converts the digital modulation signal into analogue form. This analogue modulation signal is then applied to a selective filter 47 which, under control of microprocessor 21, filters the analogue modulation signal by use of a variable filter network including resistor 48 and capacitors 49 and 51 in order to smooth the wave form produced by DAC 46 on modulation signal line 20.

A further embodiment possibility is a combination of PROCESSOR WITH DAC dotted line block 102 with OSCILLATOR dotted line block 104 or with a combination of oscillators 26 and 26A. With such a combination, the hardware solution described in EP 0 592 851 B1 can be realized internally in the processor 102 with multiple outputs 33 and 37 or a single output combining these signals.

The above embodiment from EP 0 592 851 B1 is in part replaced by the functionality of the DDS modulation frequency modulator 31. However, if it is determined that emissions of different wave forms is desirable, it would be desirable to include the modulation signal storage device 43 and wave form generator 46 described in EP 0 592 851 B1. Various modulation signal wave forms may then be stored in modulation signal storage device 43. Wave forms that have been successfully employed include square wave forms or sinusoidal wave forms. Other possible modulation signal wave forms include rectified sinusoidal, triangular, or other wave forms and combinations of all of the above.

The particular modulation control information employed by microprocessor 21 to control the operation of controllable generator circuit 29, is stored in application storage device 52. The application storage device is conveniently a computer comprising or being for receiving the information. Alternatively, application storage de-

vices illustrated and described in EP 0 592 851 B1, with reference to FIGS. 12, 13, 14 and 15, may be selected.

Interface 16 is configured as appropriate for the particular application storage device 52 in use. Interface 16 translates the control information stored in application storage device 52 into a usable form for storage within the memory of microprocessor 21 to enable microprocessor 21 to control controllable generator circuit 29 to produce the desired modulated low energy emission.

Interface 16 may directly read the information stored on application storage device 52, or it may read the information through use of various known communication links. For example, radio frequency, microwave, laser, telephone, internet or optical based communications links may be employed to transfer information between interface or receiver 16 and application storage device or computer 52.

The system 11 may comprise a user identification device, included in block 21a in Figure 2. Conveniently, such a device communicates with the one or more data processors or integrated circuits 21 via interface 16, as shown. The user identification device may be of any type, a finger print reader being an example. Such a reader is for example available from Lenovo, 70563 Stuttgart, Germany, Part No. 73P4774.

The control information stored in application storage device or computer 52 specifies various controllable parameters of the modulated low energy RF electromagnetic emission to be applied to a subject through applicator or probe 13. Such controllable parameters include, for example, but are not necessarily limited to, the frequency and amplitude of the carrier, the amplitudes and frequencies and wave forms of the modulation of the carrier, the duration of the emission, the power level of the emission, the duty

cycle of the emission (i.e., the ratio of on time to off time of pulsed emissions applied during a treatment), the sequence of application of different modulation frequencies for a particular application, and the total number of treatments and duration of each treatment prescribed for a particular subject, and combinations thereof.

For example, the carrier signal and modulation signal may be selected to drive the applicator or probe 13 with an amplitude modulated signal in which the carrier signal includes spectral frequency components below about 1 GHz, and preferably between about 1 MHz and about 900 MHz, and in which the modulation signal comprises spectral frequency components between about 0.01 Hz and 150 KHz. The one or more modulation frequencies may be simultaneously emitted or sequenced to form the modulation signal.

As an additional feature, an electromagnetic emission sensor 53 may be provided to detect the presence of electromagnetic emissions at the frequency of the carrier oscillator 32. Emission sensor 53 provides microprocessor 21 with an indication of whether or not electromagnetic emissions at the desired frequency are present. Microprocessor 21 then takes appropriate action, for example, by displaying an error message on display 17, disabling controllable generator circuit 29, or the like.

A power sensor 54 is preferably included which detects the amount of power applied to the subject through applicator or probe 13 compared to the amount of power returned or reflected from the subject. This ratio is indicative of the proper use of the system during a therapeutic session. Power sensor 54 applies to microprocessor 21, through power sensor line 56, an indication of the amount of power applied to patient through applicator or probe 13 relative to the amount of power reflected from the patient.

The indication provided on power sense line 56 may be digitalized and employed by microprocessor 21, for example, to detect and control a level of applied power, and to record on application storage device 52 information related to the actual treatments applied to and received by the patient. Such information may then be used by a physician or other clinician to assess patient treatment compliance and effect. Such treatment information may include, for example: the number of treatments applied for a given time period; the actual time and date of each treatment; the number of attempted treatments; the treatment compliance (i.e., whether the applicator or probe was in place or not during the treatment session); and the cumulative dose of a particular modulation frequency.

The level of power applied is preferably controlled to cause the specific absorption rate (SAR) of energy absorbed by the patient to be from about 1 microWatt per kilogram of tissue to about50 Watts per kilogram of tissue. Preferably, the power level is controlled to cause an SAR of from about 100 microWatts per kilogram of tissue to about 10 Watts per kilogram of tissue. Most preferably, the power level is controlled to cause an SAR of from about 1 milliWatt per kilogram of tissue to about 100 milliWatts per kilogram of tissue. These SARs may be in any tissue of the patient, but are preferably in the tissue of the central nervous system or the diseased tissue.

System 11 may also include powering circuitry including battery and charger circuit 57 and battery voltage change detector 58.

The RF carrier oscillator 32 produces a RF carrier frequency of about 27 MHz. Other embodiments of the invention contemplate RF carrier frequencies of about 48 MHz, about 433 MHz or about 900 MHz. In general, the RF carrier frequency produced by carrier

oscillator 32 has spectral frequency components less than about 1 GHz and preferably between about 1 MHz and about 916 MHz. Although the described embodiment contemplates that once set, the carrier oscillator frequency remains substantially constant, the carrier frequency produced by carrier oscillator 32 may be variable and controllable by microprocessor 21 by use of stored or transmitted control information.

Carrier oscillator 32 produces on carrier signal line 36 a carrier signal which is then modulated by the modulation signal carried on signal line 37.

Oscillator disable line 33 enables microprocessor 21 to disable the signal from oscillator 32 by applying an appropriate disable signal to oscillator disable line 33.

The output of the AM modulator and power generator 34 appears on signal line 38. This modulated signal is applied through emitter output filter 39 which substantially reduces or eliminates the carrier harmonics resulting from side effects of the modulator and power generator circuit 34.

The output of the AM modulator and power generator 34 and emitter output filter 39 may be designed to possess a 50 Ohm output impedance to match a 50 Ohm impedance of coaxial cable 12.

It has been determined through impedance measurements that when a probe 13 is applied within the mouth of a subject, the probe/subject combination exhibits a complex impedance of the order of about 150+j200 Ohms. Impedance transformer 14 serves to match this complex impedance with the 50 Ohm impedance of coaxial cable 12 and therefore the output impedance of the AM modulator 34 and output filter 39. This promotes power transmission, and minimizes reflections.

The arrangement described above has been optimized for a contact probe with coupling to the mucosa of the mouth. In a further example, a conductive, isolated probe has been used at a frequency around 433 MHz coupling to the outer ear channel. Due to the different probe design in such a frequency band and with this coupling method, the values of matching elements (79 and 81 described in EP 0592 851 B1) would be different or could even be omitted. Applicator or probe 13 may then be regarded as a capacitive coupler or as an antenna matched to the capacitive load.

As described in EP 0 592 851 B1, with reference to the flow charts of FIGS. 11 a-d, microprocessor 21 may operate to analyse the signal appearing on power sense line 56 to determine and control the amount of power applied to the patient, and to assess patient treatment compliance, and possibly to record indicia of the patient treatment compliance on application storage device 52 for later analysis and assessment by a physician or other clinician.

Exemplary of treatments performed on patients have included brain, bladder, colorectal, kidney, mesothelium, neuroendocrine, liver, lung, breast, ovary, pancreas, prostate and thyroid tumour types. The treatments involved applying an about 27.12 MHz RF signal, amplitude modulated at specifically defined frequencies ranging from about 0.2 to about 23,000 Hz at very high precision and stability. Further Examples of treatment modes (at specific accurately controlled AM frequencies) for specified types of tumours are described in detail below.

The following are synopses of abstracts for future publications related to uses of electronic devices of the present invention:

A

Example A

A phase I study of therapeutic amplitude-modulated electromagnetic fields (THERABIONIC) in advanced tumors

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Background: *In vitro* studies suggest that low levels of amplitude-modulated electromagnetic fields may modify cell growth. Specific frequencies have been identified specific frequencies that may block cancer cell growth. A portable and programmable device capable of delivering low levels of amplitude-modulated electromagnetic fields has been developed. The device emits a 27.12 MHz radiofrequency signal, amplitude-modulated at cancer-specific frequencies ranging from 0.2 to 23,000 Hz with high precision. The device is connected to a spoon-like coupler, which is placed in the patient's mouth during treatment.

Methods: A phase I study was conducted consisting of three daily 40 min treatments. From March 2004 to September 2006, 24 patients with advanced solid tumors were enrolled. The median age was 57.0 ± 12.2 years. 16 patients were female. As of January 2007, 5 patients are still on therapy, 13 patients died of tumor progression, 2 patients are lost to follow-up and one patient withdrew consent. The most common tumor types were breast (7), ovary (5) and pancreas (3). 22 patients had received prior systemic therapy and 16 had documented tumor progression prior to study entry.

Results: The median duration of therapy was 15.7 ± 19.9 weeks (range: 0.4-72.0 weeks). There were no NCI grade 2, 3 or 4 toxicities. Three patients experienced grade 1 fatigue during and immediately after treatment. 12 patients reported severe pain prior to study entry. Two of them reported significant pain relief with the treatment. Objective response could be assessed in 13 patients, 6 of whom also had elevated tumor markers. 6 additional patients could only be assessed by tumor markers. Among patients with progressive disease at study entry, one had a partial response for > 14.4 weeks associated with > 50% decrease in CEA, CA 125 and CA 15-3 (previously untreated metastatic breast

cancer); one patient had stable disease for 34.6 weeks (add info); one patient had a 50% decrease in CA 19-9 for 12.4 weeks (recurrent pancreatic cancer). Among patients with stable disease at enrollment, four patients maintained stable disease for 17.0, > 19.4, 30.4 and > 63.4 weeks.

Conclusions: The treatment is a safe and promising novel treatment modality for advanced cancer. A phase II study and molecular studies are ongoing to confirm those results.

Example B

A phase II study of therapeutic amplitude-modulated electromagnetic fields (THERABIONIC) in the treatment of advanced hepatocellular carcinoma (HCC)

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Background : Phase I data suggest that low levels of electromagnetic fields amplitude-modulated at specific frequencies administered intrabucally with the device of Example A are a safe and potentially effective treatment for advanced cancer. The device emits a 27.12 MHz RF signal, amplitude-modulated with cancer-specific frequencies ranging from 0.2 to 23,000 Hz with high precision. The device is connected to a spoon-like coupler placed in the patient's mouth during treatment. Patients with advanced hepatocellular carcinoma HCC and limited therapeutic options were offered treatment with a combination of HCC-specific frequencies.

Methods: From October 2005 to October 2006, 38 patients with advanced HCC were recruited in a phase II study. The patients received three daily 40 min treatments until disease progression or death. The median age was 64.0 ± 14.2 years. 32 patients were male and 29 patients had documented progression of disease (POD) prior to study entry.

Results: As of January 2007, 12 patients are still on therapy, 20 patients died of tumor progression, 2 patients are lost to follow-up and 3 patients withdrew consent. 27 patients are eligible for response. The overall objective response rate as defined by partial response (PR) or stable disease (SD) in patients with documented POD at study entry was 31.6%: 3 PR and 9 SD. The median survival was 20.7 weeks with a median duration of therapy of 17.5 weeks. 13 patients have received therapy for more than six months. The median duration of response is 12.9 weeks. 12 patients reported pain at study entry: 8 of them (66%) experienced decreased pain during treatment. There were no NCI grade 2/3/4 toxicities. One patient developed grade 1 mucositis and grade 1 fatigue.

Patient characteristics (n = 38)		
Cirrhosis	36	
Portal vein thrombosis	9	
Elevated AFP	25	
Extra-hepatic metastases	12	
Previous intrahepatic/systemic therapy	30	
Previous hepatic resection/RFA or ethanol	8	
CLIP	0/1: 12	≥ 2: 22
Okuda	I: 14	II/III: 20
Child-Pugh	A: 15	B: 19
MELD	Median: 10	

Conclusion: In patients with advanced HCC the treatment is a safe and effective novel therapeutic option, which has antitumor effect and provides pain relief in the majority of patients.

Thus, it is seen that the electronic device of the present invention, comprising means for the accurate control over the frequencies and stability of amplitude modulations of a high frequency carrier signal, provides a safe and promising novel treatment modality for the treatment of patients suffering from various types of advanced forms of cancer.

Exemplary of above accurately controlled amplitude modulated frequencies controlling the frequency of amplitude modulations of a high frequency carrier signal are set forth below along with the type of cancer or tumour harboured by a subject to be treated.

Example 1. AM Frequencies employed for treatment of breast cancer (188 frequencies so far included):

78,76 Hz	3434,693 Hz	5426,323 Hz
181,821 Hz	3594,231 Hz	5431,542 Hz
414,817 Hz	3647,619 Hz	5521,621 Hz
440,933 Hz	3742,957 Hz	5739,422 Hz
628,431 Hz	3753,382 Hz	5745,218 Hz
721,313 Hz	3830,732 Hz	5821,975 Hz
813,205 Hz	3855,823 Hz	6037,432 Hz
818,342 Hz	3916,321 Hz	6044,333 Hz
891,901 Hz	3935,218 Hz	6086,256 Hz
929,095 Hz	3975,383 Hz	6208,932 Hz
929,1 Hz	3993,437 Hz	6212,808 Hz
1021 Hz	4153,192 Hz	6231,031 Hz
1372,207 Hz	4194,968 Hz	6280,321 Hz
1372,934 Hz	4241,321 Hz	6329,391 Hz
1588,721 Hz	4243,393 Hz	6476,896 Hz
1670,699 Hz	4253,432 Hz	6497,319 Hz
1821,729 Hz	4314,444 Hz	6504,983 Hz
1836,219 Hz	4318,222 Hz	6651,276 Hz
2193,937 Hz	4375,962 Hz	6757,901 Hz
2221,323 Hz	4393,419 Hz	6758,321 Hz
2278,312 Hz	4417,243 Hz	6855,286 Hz
2357,832 Hz	4481,463 Hz	6858,121 Hz
2381,443 Hz	4482,223 Hz	6898,489 Hz
2417,323 Hz	4495,138 Hz	7092,219 Hz
2431,334 Hz	4549,808 Hz	7120,218 Hz
2450,332 Hz	4558,306 Hz	7127,311 Hz
2551,313 Hz	4779,451 Hz	7156,489 Hz
2556,221 Hz	4838,674 Hz	7208,821 Hz
2598,853 Hz	4871,513 Hz	7282,169 Hz
2621,322 Hz	4895,296 Hz	7376,329 Hz
2740,191 Hz	4962,213 Hz	7488,742 Hz
2851,347 Hz	4969,224 Hz	7541,319 Hz
2885,322 Hz	4979,321 Hz	7577,421 Hz
2919,273 Hz	5027,231 Hz	7621,085 Hz
3074,333 Hz	5059,792 Hz	7627,207 Hz
3115,188 Hz	5118,094 Hz	7650,939 Hz
3249,529 Hz	5176,287 Hz	7691,212 Hz
3405,182 Hz	5365,222 Hz	7842,184 Hz
3432,274 Hz	5376,392 Hz	7849,231 Hz

7915,423 Hz	9012,282 Hz	11840,323 Hz
7932,482 Hz	9012,896 Hz	11925,089 Hz
7949,196 Hz	9060,323 Hz	12123,281 Hz
7967,311 Hz	9072,409 Hz	12267,281 Hz
8021,229 Hz	9131,419 Hz	12294,283 Hz
8070,181 Hz	9199,232 Hz	12611,288 Hz
8114,032 Hz	9245,927 Hz	12629,222 Hz
8149,922 Hz	9270,322 Hz	12633,372 Hz
8194,19 Hz	9279,193 Hz	12648,221 Hz
8245,801 Hz	9393,946 Hz	13315,335 Hz
8328,322 Hz	10227,242 Hz	13331,358 Hz
8330,534 Hz	10340,509 Hz	13735,241 Hz
8355,987 Hz	10363,313 Hz	13826,325 Hz
8408,121 Hz	10449,323 Hz	13853,232 Hz
8431,184 Hz	10456,383 Hz	13990,123 Hz
8452,119 Hz	10468,231 Hz	14122,942 Hz
8548,324 Hz	10470,456 Hz	14162,332 Hz
8749,383 Hz	10472,291 Hz	14519,232 Hz
8782,421 Hz	10689,339 Hz	14543,128 Hz
8784,424 Hz	10832,222 Hz	15651,323 Hz
8923,1 Hz	11525,121 Hz	17352,085 Hz
8923,361 Hz	11541,915 Hz	18785,463 Hz
8935,752 Hz	11812,328 Hz	30182,932 Hz
8936,1 Hz	11812,419 Hz	

Example 2. AM Frequencies employed for treatment of liver cancer (162 frequencies so far included):

423,321 Hz	1975,196 Hz	2743,995 Hz
427,062 Hz	2017,962 Hz	2744,211 Hz
470,181 Hz	2083,419 Hz	2831,951 Hz
560,32 Hz	2190,731 Hz	2843,283 Hz
642,932 Hz	2221,323 Hz	2859,891 Hz
668,209 Hz	2324,393 Hz	2873,542 Hz
677,972 Hz	2353,478 Hz	2886,232 Hz
811,924 Hz	2362,309 Hz	3042,012 Hz
842,311 Hz	2419,309 Hz	3078,983 Hz
843,22 Hz	2425,222 Hz	3086,443 Hz
1250,504 Hz	2430,219 Hz	3127,232 Hz
1755,402 Hz	2431,094 Hz	3160,942 Hz
1873,477 Hz	2471,328 Hz	3206,315 Hz
1924,702 Hz	2478,331 Hz	3267,433 Hz

3269,321 Hz	6383,321 Hz	9332,397 Hz
3457,291 Hz	6461,175 Hz	9381,221 Hz
3505,229 Hz	6733,331 Hz	9740,219 Hz
3516,296 Hz	6758,232 Hz	9768,331 Hz
3531,296 Hz	6779,482 Hz	9797,294 Hz
3546,323 Hz	6856,222 Hz	10317,499 Hz
3572,106 Hz	6877,183 Hz	10443,311 Hz
3576,189 Hz	6980,525 Hz	10456,383 Hz
3669,513 Hz	7019,235 Hz	10579,425 Hz
3923,221 Hz	7043,209 Hz	10863,209 Hz
4013,932 Hz	7130,323 Hz	10866,382 Hz
4071,121 Hz	7144,142 Hz	11067,418 Hz
4079,951 Hz	7210,223 Hz	11149,935 Hz
4222,821 Hz	7291,21 Hz	11163,895 Hz
4238,402 Hz	7510,92 Hz	11802,821 Hz
4256,321 Hz	7529,233 Hz	11953,424 Hz
4289,296 Hz	7549,212 Hz	12223,329 Hz
4312,947 Hz	7650,028 Hz	12265,295 Hz
4435,219 Hz	7680,518 Hz	12267,233 Hz
4471,188 Hz	7692,522 Hz	12623,191 Hz
4483,889 Hz	7829,231 Hz	12685,231 Hz
4486,384 Hz	7862,209 Hz	12721,423 Hz
4629,941 Hz	7947,392 Hz	12785,342 Hz
4732,211 Hz	7979,308 Hz	14085,222 Hz
4876,218 Hz	8028,339 Hz	14333,209 Hz
5086,281 Hz	8055,942 Hz	14537,331 Hz
5124,084 Hz	8072,134 Hz	14542,432 Hz
5133,121 Hz	8141,174 Hz	14655,03 Hz
5247,142 Hz	8336,383 Hz	14828,234 Hz
5270,834 Hz	8432,181 Hz	15149,213 Hz
5340,497 Hz	8452,119 Hz	15237,489 Hz
5520,218 Hz	8460,944 Hz	16110,932 Hz
5882,292 Hz	8475,221 Hz	16144,343 Hz
5926,512 Hz	8492,193 Hz	18265,238 Hz
6037,311 Hz	8542,311 Hz	18283,323 Hz
6180,334 Hz	8818,104 Hz	18863,292 Hz
6329,195 Hz	8852,329 Hz	18930,995 Hz
6350,333 Hz	8853,444 Hz	19970,311 Hz
6361,321 Hz	8858,179 Hz	20330,294 Hz
6364,928 Hz	8939,212 Hz	20365,284 Hz

Example 3. AM Frequencies employed for treatment of ovarian cancer (273 frequencies so far included):

78,76 Hz	1552,123 Hz	2973,771 Hz
181,821 Hz	1579,212 Hz	3080,592 Hz
410,245 Hz	1624,802 Hz	3157,483 Hz
414,817 Hz	1670,699 Hz	3161,465 Hz
436,332 Hz	1696,403 Hz	3223,232 Hz
447,942 Hz	1762,938 Hz	3238,148 Hz
481,191 Hz	1771,402 Hz	3249,529 Hz
489,292 Hz	1775,313 Hz	3262,145 Hz
559,292 Hz	1821,729 Hz	3314,321 Hz
608,321 Hz	2016,323 Hz	3361,671 Hz
655,435 Hz	2034,231 Hz	3366,311 Hz
657,397 Hz	2050,282 Hz	3523,215 Hz
657,483 Hz	2053,396 Hz	3527,233 Hz
664,211 Hz	2082,234 Hz	3542,213 Hz
708,8 Hz	2089,092 Hz	3590,376 Hz
708,822 Hz	2221,323 Hz	3629,232 Hz
734,921 Hz	2228,832 Hz	3632,793 Hz
749,221 Hz	2253,704 Hz	3636,289 Hz
764,232 Hz	2254,329 Hz	3637,085 Hz
778,295 Hz	2278,312 Hz	3669,513 Hz
779,403 Hz	2332,949 Hz	3770,189 Hz
806,021 Hz	2348,233 Hz	3858,916 Hz
806,389 Hz	2381,443 Hz	3919,232 Hz
809,313 Hz	2413,193 Hz	3957,185 Hz
824,327 Hz	2425,222 Hz	3975,228 Hz
825,145 Hz	2433,321 Hz	4061,131 Hz
835,129 Hz	2439,253 Hz	4072,322 Hz
839,521 Hz	2465,23 Hz	4169,451 Hz
841,208 Hz	2477,919 Hz	4174,259 Hz
843,312 Hz	2669,177 Hz	4241,321 Hz
956,984 Hz	2715,232 Hz	4243,393 Hz
958,929 Hz	2733,843 Hz	4261,228 Hz
985,313 Hz	2802,339 Hz	4279,113 Hz
1024,208 Hz	2812,321 Hz	4309,335 Hz
1102,635 Hz	2831,386 Hz	4314,188 Hz
1121,329 Hz	2835,332 Hz	4318,222 Hz
1159,738 Hz	2851,347 Hz	4328,928 Hz
1372,207 Hz	2877,192 Hz	4380,321 Hz
1396,498 Hz	2885,322 Hz	4394,134 Hz
1502,181 Hz	2887,385 Hz	4412,252 Hz
1518,208 Hz	2894,972 Hz	4424,236 Hz

4439,341 Hz	6855,286 Hz	8779,323 Hz
4442,161 Hz	6875,232 Hz	8792,231 Hz
4447,221 Hz	6882,949 Hz	8819,127 Hz
4458,339 Hz	7206,403 Hz	8831,132 Hz
4556,322 Hz	7232,214 Hz	9028,031 Hz
4566,009 Hz	7257,489 Hz	9173,264 Hz
4682,643 Hz	7276,209 Hz	9184,338 Hz
4718,331 Hz	7281,219 Hz	9186,919 Hz
4749,302 Hz	7285,693 Hz	9393,946 Hz
4765,331 Hz	7429,212 Hz	9482,409 Hz
4917,202 Hz	7460,932 Hz	9737,211 Hz
5011,325 Hz	7480,228 Hz	9746,232 Hz
5149,331 Hz	7495,763 Hz	9922,231 Hz
5228,172 Hz	7539,432 Hz	10032,684 Hz
5237,132 Hz	7564,185 Hz	10446,028 Hz
5313,353 Hz	7650,028 Hz	10478,221 Hz
5745,218 Hz	7689,728 Hz	10545,313 Hz
5757,897 Hz	7780,294 Hz	10639,345 Hz
5762,386 Hz	8021,921 Hz	10743,118 Hz
5812,322 Hz	8038,961 Hz	10813,981 Hz
5869,321 Hz	8040,322 Hz	10832,421 Hz
5882,292 Hz	8044,233 Hz	10838,243 Hz
5921,249 Hz	8095,313 Hz	10862,429 Hz
5991,932 Hz	8143,491 Hz	10865,127 Hz
6069,458 Hz	8164,332 Hz	10917,229 Hz
6071,319 Hz	8261,121 Hz	10977,188 Hz
6083,214 Hz	8302,285 Hz	11120,209 Hz
6161,782 Hz	8309,752 Hz	11177,289 Hz
6169,341 Hz	8372,532 Hz	11177,409 Hz
6275,232 Hz	8408,121 Hz	11321,491 Hz
6294,929 Hz	8424,229 Hz	11359,093 Hz
6350,333 Hz	8428,313 Hz	11673,031 Hz
6406,891 Hz	8435,451 Hz	11793,886 Hz
6407,207 Hz	8486,421 Hz	11895,229 Hz
6450,787 Hz	8492,797 Hz	12074,531 Hz
6477,098 Hz	8548,324 Hz	12216,212 Hz
6477,929 Hz	8554,361 Hz	12253,329 Hz
6478,338 Hz	8562,965 Hz	12260,933 Hz
6543,421 Hz	8579,323 Hz	12262,853 Hz
6552,24 Hz	8579,333 Hz	12292,222 Hz
6663,955 Hz	8642,181 Hz	12357,353 Hz
6753,338 Hz	8655,818 Hz	12527,032 Hz
6851,323 Hz	8758,341 Hz	12755,333 Hz

12947,311 Hz	14947,184 Hz	17970,122 Hz
13717,221 Hz	15429,139 Hz	18337,222 Hz
13825,295 Hz	15443,309 Hz	18378,321 Hz
13829,195 Hz	15450,183 Hz	18921,415 Hz
14410,949 Hz	16144,343 Hz	18926,951 Hz
14436,201 Hz	17932,432 Hz	18931,327 Hz
14537,218 Hz	17951,395 Hz	114508,332 Hz

Example 4. AM Frequencies employed for treatment of prostate cancer (183 frequencies so far included):

331,3 Hz	847,332 Hz	3251,815 Hz
331,358 Hz	1083,309 Hz	3264,827 Hz
403,218 Hz	1102,635 Hz	3278,329 Hz
461,233 Hz	1102,71 Hz	3281,432 Hz
522,2 Hz	1240,336 Hz	3348,783 Hz
522,213 Hz	1372,934 Hz	3519,118 Hz
618,4 Hz	1444,288 Hz	3539,962 Hz
618,407 Hz	1486,322 Hz	3551,318 Hz
618,8 Hz	1563,332 Hz	3556,439 Hz
656,295 Hz	1591,322 Hz	3572,321 Hz
657,394 Hz	1670,699 Hz	3670,129 Hz
657,397 Hz	1697,321 Hz	3681,341 Hz
657,4 Hz	1743,521 Hz	3686,021 Hz
657,483 Hz	2031,448 Hz	3753,382 Hz
659,033 Hz	2050,282 Hz	3774,923 Hz
694,4 Hz	2076,519 Hz	3867,692 Hz
694,689 Hz	2156,332 Hz	3909,333 Hz
694,7 Hz	2229,515 Hz	3916,321 Hz
741,4 Hz	2243,121 Hz	4031,233 Hz
741,421 Hz	2381,443 Hz	4031,933 Hz
749,221 Hz	2440,489 Hz	4038,203 Hz
752,9 Hz	2475,912 Hz	4081,743 Hz
752,933 Hz	2477,919 Hz	4084,319 Hz
776,194 Hz	2628,324 Hz	4139,322 Hz
785,219 Hz	2669,328 Hz	4153,192 Hz
786,332 Hz	2824,832 Hz	4223,795 Hz
793,331 Hz	2887,829 Hz	4231,221 Hz
809,205 Hz	2891,331 Hz	4241,321 Hz
819,322 Hz	3081,523 Hz	4320,513 Hz
844,8 Hz	3249,529 Hz	4329,152 Hz
844,822 Hz	3250,125 Hz	4380,321 Hz

4417,312 Hz	6871,943 Hz	9351,931 Hz
4489,452 Hz	6973,393 Hz	9393,946 Hz
4549,808 Hz	7120,932 Hz	9694,179 Hz
4558,306 Hz	7146,509 Hz	9984,405 Hz
4638,293 Hz	7192,505 Hz	10226,223 Hz
4740,322 Hz	7251,309 Hz	10390,232 Hz
4854,318 Hz	7251,322 Hz	10514,768 Hz
4882,322 Hz	7278,124 Hz	10689,339 Hz
4978,822 Hz	7279,335 Hz	10772,419 Hz
5237,152 Hz	7299,119 Hz	10818,452 Hz
5264,222 Hz	7527,229 Hz	11165,239 Hz
5289,195 Hz	7589,925 Hz	11985,353 Hz
5426,323 Hz	7699,193 Hz	12209,329 Hz
5431,542 Hz	7842,184 Hz	12308,321 Hz
5455,593 Hz	8023,32 Hz	12583,339 Hz
6345,332 Hz	8096,939 Hz	13820,329 Hz
6347,433 Hz	8245,801 Hz	14013,123 Hz
6363,284 Hz	8315,291 Hz	14171,434 Hz
6418,331 Hz	8357,305 Hz	14681,329 Hz
6496,231 Hz	8408,121 Hz	14759,131 Hz
6538,295 Hz	8432,209 Hz	14986,794 Hz
6577,421 Hz	8535,238 Hz	15930,249 Hz
6590,328 Hz	8552,431 Hz	16026,623 Hz
6651,276 Hz	8585,224 Hz	17880,954 Hz
6706,431 Hz	8935,752 Hz	18247,532 Hz
6743,322 Hz	9015,253 Hz	18282,211 Hz
6783,282 Hz	9018,233 Hz	18629,328 Hz
6850,197 Hz	9068,231 Hz	19469,318 Hz
6855,286 Hz	9137,232 Hz	19766,218 Hz
6864,896 Hz	9156,321 Hz	60317,352 Hz

Example 5. AM Frequencies employed for treatment of kidney cancer (36 frequencies so far included):

628,321 Hz	2254,329 Hz	7054,279 Hz
631,141 Hz	3555,209 Hz	7074,429 Hz
643,312 Hz	3928,343 Hz	7254,343 Hz
812,512 Hz	4420,932 Hz	8041,289 Hz
826,321 Hz	4819,228 Hz	8727,224 Hz
1372,934 Hz	4828,321 Hz	8760,983 Hz
2082,241 Hz	5314,322 Hz	8831,132 Hz
2156,931 Hz	6007,332 Hz	8870,228 Hz

10565,321 Hz	11421,933 Hz	12631,331 Hz
10586,229 Hz	11523,212 Hz	12693,272 Hz
10634,293 Hz	11561,221 Hz	14411,321 Hz
10687,949 Hz	11846,212 Hz	20178,941 Hz

Example 6. AM Frequencies employed for treatment of thyroid cancer (110 frequencies so far included):

493,442 Hz	3475,216 Hz	7534,221 Hz
517,202 Hz	3509,522 Hz	7623,184 Hz
618,927 Hz	3533,328 Hz	7725,339 Hz
621,321 Hz	3637,085 Hz	7920,879 Hz
648,252 Hz	3682,489 Hz	8013,953 Hz
663,407 Hz	4154,301 Hz	8019,912 Hz
821,202 Hz	4243,393 Hz	8040,231 Hz
874,341 Hz	4261,228 Hz	8078,955 Hz
914,429 Hz	4330,289 Hz	8082,173 Hz
941,311 Hz	4340,833 Hz	8147,1 Hz
983,429 Hz	4358,333 Hz	8281,259 Hz
1587,811 Hz	4366,294 Hz	8309,752 Hz
1723,389 Hz	4426,387 Hz	8311,371 Hz
2179,231 Hz	4458,339 Hz	8435,094 Hz
2315,888 Hz	4479,113 Hz	8525,789 Hz
2341,312 Hz	4744,424 Hz	8744,527 Hz
2445,123 Hz	4865,421 Hz	9009,329 Hz
2454,232 Hz	5323,192 Hz	9070,809 Hz
2723,302 Hz	5324,123 Hz	10020,521 Hz
2740,384 Hz	5548,879 Hz	10039,109 Hz
2749,323 Hz	5711,283 Hz	10127,279 Hz
2856,253 Hz	5754,332 Hz	10134,161 Hz
2859,495 Hz	6455,131 Hz	10257,324 Hz
2886,232 Hz	6620,132 Hz	10498,339 Hz
3021,122 Hz	6666,839 Hz	11537,292 Hz
3078,275 Hz	6714,189 Hz	11559,292 Hz
3080,592 Hz	6745,333 Hz	11913,222 Hz
3198,323 Hz	6766,281 Hz	11927,934 Hz
3248,321 Hz	6884,432 Hz	11955,949 Hz
3271,329 Hz	7036,122 Hz	12120,049 Hz
3284,192 Hz	7230,838 Hz	12139,222 Hz
3335,332 Hz	7323,209 Hz	13636,082 Hz
3434,911 Hz	7355,378 Hz	13654,272 Hz
3440,212 Hz	7432,143 Hz	13677,211 Hz

14014,941 Hz	16048,391 Hz	17881,709 Hz
14445,214 Hz	17323,196 Hz	17911,323 Hz
16023,119 Hz	17577,221 Hz	

Example 7. AM Frequencies employed for treatment of bladder cancer (28 frequencies so far included):

623,243 Hz	3438,109 Hz	8235,21 Hz
757,084 Hz	3692,319 Hz	8749,232 Hz
870,4 Hz	3952,308 Hz	9354,812 Hz
2454,423 Hz	5230,227 Hz	12532,729 Hz
2480,191 Hz	6022,942 Hz	13467,209 Hz
2581,101 Hz	6061,711 Hz	13777,9 Hz
2715,232 Hz	6710,899 Hz	14015,241 Hz
3042,012 Hz	6721,912 Hz	18524,419 Hz
3196,194 Hz	7181,784 Hz	
3265,323 Hz	7458,209 Hz	

Example 8. AM Frequencies employed for treatment of colon cancer (100 frequencies so far included):

78,76 Hz	3373,892 Hz	5386,212 Hz
796,562 Hz	3390,925 Hz	5407,192 Hz
841,541 Hz	3409,179 Hz	5426,323 Hz
842,783 Hz	3432,274 Hz	5496,434 Hz
914,429 Hz	3509,522 Hz	5555,212 Hz
1162,117 Hz	3531,422 Hz	5572,032 Hz
1372,207 Hz	3533,328 Hz	5634,933 Hz
1372,934 Hz	3766,296 Hz	5724,231 Hz
1718,532 Hz	4040,839 Hz	5758,378 Hz
2243,169 Hz	4081,022 Hz	5787,342 Hz
2278,312 Hz	4123,953 Hz	5948,897 Hz
2286,5 Hz	4146,274 Hz	5967,448 Hz
2286,519 Hz	4233,822 Hz	5976,825 Hz
2334,178 Hz	4282,332 Hz	6182,322 Hz
2423,292 Hz	4318,222 Hz	6292,379 Hz
2454,423 Hz	4344,082 Hz	6324,493 Hz
2464,229 Hz	4416,221 Hz	6341,248 Hz
2598,853 Hz	4481,242 Hz	6471,322 Hz
2623,048 Hz	4724,263 Hz	6477,218 Hz
3131,123 Hz	4751,319 Hz	6558,342 Hz
3161,465 Hz	4755,323 Hz	6855,286 Hz
3175,313 Hz	4788,485 Hz	7129,843 Hz
3249,529 Hz	5149,331 Hz	7140,187 Hz
3363,229 Hz	5217,402 Hz	7162,422 Hz

7368,222 Hz
7645,859 Hz
7829,234 Hz
7866,229 Hz
7877,334 Hz
8013,314 Hz
8374,942 Hz
8384,228 Hz
8408,121 Hz
8534,111 Hz
8568,033 Hz
8573,122 Hz
9226,222 Hz
9351,9 Hz
9737,211 Hz
9744,193 Hz
9942,321 Hz
10301,371 Hz
10401,515 Hz
10872,693 Hz
11220,222 Hz
11283,378 Hz
12256,432 Hz
13749,858 Hz
15231,548 Hz
15248,324 Hz
58191,928 Hz
60317,352 Hz

Example 9. AM Frequencies employed for treatment of pancreas cancer (166 frequencies so far included):

331,3 Hz
331,365 Hz
436,3 Hz
436,332 Hz
447,942 Hz
476,127 Hz
559,292 Hz
589,187 Hz
624,218 Hz
727 Hz
734,921 Hz
809,313 Hz
845,309 Hz
870,4 Hz
963,221 Hz
1156,79 Hz
1157 Hz
1179 Hz
1360,133 Hz
1372,207 Hz
1372,934 Hz
1804,126 Hz
1816,221 Hz
1873,477 Hz
1967,211 Hz
1990,482 Hz
2278,312 Hz
2315,921 Hz
2320,315 Hz
2334,178 Hz
2381,443 Hz
2469 Hz
2477,919 Hz
2542,221 Hz
2598,853 Hz
2647,938 Hz
2685,081 Hz
2716,095 Hz
2721,331 Hz
2732,231 Hz
2809,849 Hz
2823,428 Hz
2835,332 Hz
3134,313 Hz
3241,461 Hz
3255,219 Hz
3263,432 Hz
3286,255 Hz
3330,935 Hz
3373,892 Hz
3438,109 Hz
3449,219 Hz
3535,219 Hz
3549,215 Hz
3564,419 Hz
3619,412 Hz
3622,312 Hz
3638,432 Hz
3696,424 Hz
3943,214 Hz
3976,929 Hz
4014,889 Hz
4041,219 Hz
4044,195 Hz
4056,384 Hz
4085,971 Hz
4144,592 Hz
4153,192 Hz
4161,889 Hz
4243,393 Hz
4332,498 Hz
4341,423 Hz
4355,327 Hz
4417,885 Hz
4422,322 Hz
4451,297 Hz
4486,384 Hz
4558,306 Hz
4580 Hz
4685,082 Hz
4839,589 Hz
5151,402 Hz
5209,911 Hz
5262,282 Hz
5271,312 Hz
5387,73 Hz
5494,928 Hz
5521,221 Hz
5573,209 Hz
5609,382 Hz
5929,616 Hz
5948,897 Hz
5966,112 Hz
5976,825 Hz
6064,197 Hz
6086,256 Hz

6157,253 Hz
6215,298 Hz
6333,917 Hz
6365,242 Hz
6558,342 Hz
6568,278 Hz
6823,194 Hz
6853,391 Hz
6855,286 Hz
7213,204 Hz
7228,528 Hz
7238,232 Hz
7277,921 Hz
7280,422 Hz
7320,494 Hz
7366,412 Hz
7534,221 Hz
7548,713 Hz
7567,127 Hz
7620,851 Hz
7663,209 Hz
7725,203 Hz
7852,233 Hz
7920,879 Hz
7985,122 Hz
8008,323 Hz
8013,312 Hz
8045,484 Hz
8242,332 Hz
8351,622 Hz
8408,121 Hz
8455,894 Hz
8551,231 Hz
8743,321 Hz
8789,631 Hz
8868,809 Hz
9012,241 Hz
9028,994 Hz
9131,232 Hz
9658,296 Hz
9663,495 Hz
9680,737 Hz
9824,442 Hz
9942,321 Hz
10279,122 Hz
10388,49 Hz
10438,495 Hz
10518,311 Hz
10528,239 Hz
10582,095 Hz
10926,111 Hz
10948,411 Hz
10955,558 Hz
11538,193 Hz
11904,741 Hz
12255,229 Hz
12613,341 Hz
12819,942 Hz
13674,482 Hz
13731,322 Hz
14525,312 Hz
14537,218 Hz
14549,331 Hz
14845,453 Hz
14944,989 Hz
15246,315 Hz
18668,239 Hz
19321,231 Hz
19347,208 Hz
30182,932 Hz

Example 10. AM Frequencies employed for treatment of lung cancer (80 frequencies so far included):

304,148 Hz
694,7 Hz
694,727 Hz
708,8 Hz
708,841 Hz
1587,811 Hz
1759,318 Hz
1873,477 Hz
2253,704 Hz
2391,312 Hz
2454,232 Hz
2729,929 Hz
2741,261 Hz
2761,312 Hz
2784,491 Hz
2812,443 Hz
2855,218 Hz
2859,495 Hz
3128,822 Hz
3139,297 Hz
3193,212 Hz
3348,783 Hz
3360,971 Hz
3366,311 Hz
3373,892 Hz
3440,212 Hz
3461,322 Hz
3682,489 Hz
3727,231 Hz
3749,882 Hz
3769,942 Hz
4131,235 Hz
4158,393 Hz
4243,393 Hz
4347,733 Hz
4373,411 Hz
4378,321 Hz
4416,221 Hz
4481,242 Hz
4777,521 Hz
4798,422 Hz
4837,241 Hz
4959,842 Hz
5013,321 Hz
5047,523 Hz
5068,322 Hz
5371,922 Hz
5538,432 Hz
5548,879 Hz
5679,309 Hz
5734,143 Hz
5787,342 Hz
6445,309 Hz
6838,434 Hz

6870,955 Hz	8442,473 Hz	10424,908 Hz
6879,216 Hz	8773,916 Hz	10452,913 Hz
7079,411 Hz	8935,752 Hz	10824,609 Hz
7216,288 Hz	9121,223 Hz	11656,329 Hz
7376,089 Hz	9181,434 Hz	12748,919 Hz
7761,289 Hz	9317,913 Hz	15774,291 Hz
8082,173 Hz	9363,896 Hz	15798,333 Hz
8281,259 Hz	9736,919 Hz	16510,321 Hz
8352,189 Hz	9753,321 Hz	

Example 11. AM Frequencies employed for treatment of leiomyosarcoma (36 frequencies so far included):

836,923 Hz	4241,321 Hz	6651,276 Hz
843,181 Hz	4266,591 Hz	7168,892 Hz
1411,241 Hz	4337,322 Hz	7406,309 Hz
2073,721 Hz	4424,112 Hz	7452,528 Hz
2381,443 Hz	4436,111 Hz	7649,209 Hz
2711,019 Hz	4485,22 Hz	7808,352 Hz
2911,329 Hz	5545,521 Hz	9040,313 Hz
3232,185 Hz	5577,841 Hz	9074,294 Hz
3518,321 Hz	5631,422 Hz	9189,092 Hz
3544,209 Hz	5696,184 Hz	9484,512 Hz
3569,219 Hz	6472,098 Hz	9943,972 Hz
4233,822 Hz	6558,342 Hz	12086,394 Hz

Example 12. AM Frequencies employed for treatment of mesothelioma (16 frequencies so far included):

958,929 Hz	3319,945 Hz	6516,793 Hz
1713,913 Hz	3449,219 Hz	7224,197 Hz
1736,782 Hz	3622,312 Hz	9471,152 Hz
2334,178 Hz	5151,402 Hz	14617,393 Hz
2607,193 Hz	5887,022 Hz	
3112,974 Hz	5965,922 Hz	

Example 13. AM Frequencies employed for treatment of neuro-endocrine (30 frequencies so far included):

1766,335 Hz	2741,261 Hz	3296,431 Hz
2408,225 Hz	3020,212 Hz	3348,783 Hz
2441,502 Hz	3128,822 Hz	3360,971 Hz
2647,938 Hz	3238,742 Hz	3440,212 Hz

3533,328 Hz	5548,879 Hz	7482,245 Hz
3666,283 Hz	5739,422 Hz	7575,393 Hz
4079,282 Hz	5849,241 Hz	8359,932 Hz
4243,393 Hz	6291,631 Hz	9073,418 Hz
4426,387 Hz	6406,891 Hz	
5245,818 Hz	6780,679 Hz	
5536,242 Hz	7151,264 Hz	

Example 14. AM Frequencies employed for treatment of leukemia and chronic lymphoid cancer (17 frequencies so far included):

814,413 Hz	3361,671 Hz	7629,318 Hz
825,145 Hz	5245,452 Hz	8172,405 Hz
2415,243 Hz	5557,333 Hz	8272,338 Hz
2436,316 Hz	6850,197 Hz	8438,453 Hz
2874,432 Hz	6919,322 Hz	12950,331 Hz
2891,029 Hz	7587,224 Hz	

Example 15. AM Frequencies employed for treatment of myeloma, multiple cancer (20 frequencies so far included):

765,196 Hz	2883,618 Hz	5249,331 Hz
2336,238 Hz	2919,273 Hz	7967,311 Hz
2372,122 Hz	3265,323 Hz	7973,125 Hz
2381,443 Hz	3564,455 Hz	8049,952 Hz
2425,394 Hz	3580,25 Hz	8283,329 Hz
2656,339 Hz	3584,291 Hz	10351,323 Hz
2741,261 Hz	3674,292 Hz	

Example 16. AM Frequencies employed for treatment of Hodgkin disease (lymphoma) (19 frequencies so far included):

752,5 Hz	3371,216 Hz	5724,231 Hz
976,3 Hz	3605,432 Hz	6358,194 Hz
1558,223 Hz	3623,198 Hz	7472,211 Hz
2310,912 Hz	3838,281 Hz	8062,121 Hz
2477,919 Hz	3838,48 Hz	8222,222 Hz
2560,843 Hz	5102 Hz	
3348,783 Hz	5696,932 Hz	

Example 17. AM Frequencies employed for treatment of brain cancer (57 frequencies so far included):

1372,934 Hz	4318,222 Hz	6943,386 Hz
2318,182 Hz	4334,33 Hz	7151,264 Hz
2381,443 Hz	4358,333 Hz	7182,922 Hz
2425,394 Hz	4393,419 Hz	7194,897 Hz
2442,423 Hz	4454,194 Hz	7323,209 Hz
2478,973 Hz	4515,789 Hz	7390,343 Hz
2654,513 Hz	4619,324 Hz	7796,221 Hz
2661,324 Hz	4723,937 Hz	7961,122 Hz
2686,105 Hz	4853,286 Hz	8128,942 Hz
2690,179 Hz	5289,231 Hz	8245,109 Hz
3249,332 Hz	5378,099 Hz	8272,281 Hz
3277,509 Hz	5426,323 Hz	8358,154 Hz
3335,279 Hz	5640,981 Hz	8408,121 Hz
3348,783 Hz	6316,211 Hz	9138,82 Hz
3436,211 Hz	6459,203 Hz	10719,318 Hz
3916,321 Hz	6474,332 Hz	11556,241 Hz
4031,933 Hz	6626,572 Hz	12828,633 Hz
4086,091 Hz	6855,286 Hz	14515,962 Hz
4241,321 Hz	6915,886 Hz	14586,765 Hz

The above Examples reflect AM frequencies determined by a bio-feedback procedure involving very substantial observations and measurements of physiological responses (at certain well defined AM frequencies) by subjects exposed to low energy electromagnetic emission excitation. In general, it is recommended that all of the listed frequencies be applied in the treatment of subjects suffering from the indicated form of cancer. However, a limited number of the listed frequencies also lead to beneficial effects.

Of note in respect of the above listed frequencies, in particular those Examples including a large number of frequencies, it has earlier on been determined that beneficial therapeutic effects are achieved by application of some but not all of the frequencies listed. However, following on more extended trials, it has been determined that application to subjects of further frequencies enhance the efficacy of treatment and yields therapeutic effects in patients whose tumours have become resistant to therapy. It is accordingly preferred that all of the determined listed frequencies be applied to the subject. The mechanism of including additional frequencies is attributed to either or both of inter-active synergism

between applied frequencies or between cells which have been influenced by the treatment and additive effects of the additional frequencies.

Of further note is the fact that different patients suffering from the same type of tumour cell growth practically invariably exhibit the above-mentioned physiological responses at the same well defined AM frequencies. Furthermore, AM frequencies which differ only very slightly (less than 0.0001 % at higher frequencies) from the frequencies listed, in general elicit no physiological response by subjects exposed to excitation at such very slightly different frequency. In view of these determinations, the electronic system of the present invention may be adapted to screen a subject for physiological responses over a broad range of frequencies to determine the presence or absence tumour cells and, if positive, then to note at which defined frequencies physiological responses are elicited. These frequencies will in general match with the defined frequencies listed in one or other of the Examples above or such further examples as may be developed and hence the nature of the tumour will be known. The electronic system of the invention is therefore a valuable diagnostic tool for diagnosing the presence or absence and identities of types of tumour cell growths or cancers. Furthermore, the electronic system of the invention is of value for predicting whether a patient will benefit from the application of a given series of modulation frequencies. The system therefore possesses a capability of predicting responses to treatment, thereby enhancing the possibility to select optimal modes of treatment.

The sequence of well defined frequencies are preferably applied sequentially for determined periods of time, e.g. 3 seconds for each frequency, but several frequencies may also be applied simultaneously. This means that a cycle of application involving 180 frequencies would take nearly 10 minutes time. Advantageous effects may however also arise from applying individual well defined

frequencies for differing time periods, e.g. some for 3 seconds, some for 6 seconds, etc...

Therapeutic dosages to be applied to a subject suffering from the presence of tumour cell growth or cancer are determined by the time of application of the low energy electromagnetic emissions to the subject and will depend on the nature of the cancer and the overall condition of the subject. In general, however, greatest experience has been gained in treating terminally ill subjects expected to survive no longer than about three months and who have agreed to discontinue alternative forms of cancer treatments such as chemo-therapy or radioactive treatment. In these severe cases, lengthy times of treatment are recommended, e.g. 3 times 1 hour daily treatment. However, with the development of alternative forms of application, i.e. other than by means of a mouth probe, continuous application is possible and is likely to enhance compliance and the efficacy of the treatment.

While the invention has been described with specific embodiments, other alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it will be intended to include all such alternatives, modifications, and variations within the spirit and scope of the appended claims.

What is claimed is:

1. An electronic system (11) activatable by electrical power and being for influencing cellular functions or malfunctions in a warm-blooded mammalian subject, comprising one or more controllable low energy electromagnetic energy generator circuits (29) for generating one or more high frequency carrier signals, one or more data processors or integrated circuits (21) comprising or communicating with the one or more generator circuits (29) and being for receiving control information from a source of control information (52), said one or more generator circuits (29) including one or more amplitude modulation control signal generators (34) for controlling amplitude modulated variations of the one or more high frequency carrier signals, said one or more generator circuits (29) furthermore including one or more programmable amplitude modulation frequency control signal generators (31) for controlling the frequency at which the amplitude modulations are generated, the system (11) furthermore comprising a connection or coupling position (12a) for connection to an electrically conductive applicator (12, 13) for applying to the warm-blooded mammalian subject the one or more amplitude-modulated low energy emissions at a program-controlled frequency, **characterized in that** said one or more programmable amplitude modulation frequency control generators (31) are adapted to accurately control the frequency of amplitude modulations to within an accuracy of at least 1000 ppm relative to one or more determined or predetermined reference amplitude modulation frequencies selected from within a range of 0.01 Hz to 70 kHz, and **furthermore in that** said source of control information (52) includes reference amplitude modulation frequency control information which comprises at least a significant proportion (in excess of 50 %) of accurately defined reference amplitude modulation frequencies listed in any one of the Examples 1 to 17, or all of said accurately defined frequencies, or combinations thereof.

2. A system (11) according to claim 1, in which the frequency of the one or more amplitude modulations generated are controllable to within an accuracy of 100 ppm relative to the one or more determined or predetermined reference amplitude modulation frequencies.

3. A system (11) according to claim 2, in which the frequency of the one or more amplitude modulations generated are controllable to within an accuracy of 10 ppm relative to the one or more determined or predetermined reference amplitude modulation frequencies.

4. A system (11) according to claim 3, in which the frequency of the one or more amplitude modulations generated are controllable to within an accuracy of about 1 ppm relative to the one or more determined or predetermined reference amplitude modulation frequencies.

5. A system (11) according to any one of the preceding claims, in which the amplitude modulated low energy electromagnetic emissions generated are maintained at a stability during emission of at least 10^{-5}.

6. A system (11) according to claim 5, in which a stability of at least 10^{-6} is maintained.

7. A system according to claim 6, in which a stability of at least 10^{-7} is maintained.

8. A system (11) according to any one of the preceding claims, in which the one or more controllable generator circuits (29) are controllable by amplitude modulation control signals which lead

to various forms of amplitude modulation wave forms being generated.

9. A system (11) according to claim 8, in which the amplitude modulation wave forms are selected from sinusoidal, square, triangular or multiple combinations thereof.

10. A system (11) according to claim 8 or claim 9, in which the one or more generator circuits (29) are controllable by amplitude modulation control signals which generate a plurality of amplitude modulation wave forms, either sequentially or simultaneously.

11. A system (11) according to any one of the preceding claims, in which the high frequency carrier signals to be generated by the one or more generator circuits (29) are selected from one or more high frequencies selected from about 27 MHz, 433 MHz and 900 MHz

12. A system (11) according to any one of the preceding claims, in which the system (11) comprises one or more interfaces or receiver means (16) communicating with the one or more data processors or integrated circuits (21), and in which the control information is transferable to the one or more interfaces or receiver means (16) and hence to the one or more data processors or integrated circuits (21) to enable command signals responsive to received control information to be communicated to the one or more generator circuits (29) by the one or more data processors or integrated circuits (21).

13. A system (11) according to claim 12, in which the control information is transferable or transmittable over the telephone, internet, radio or other means, to the one or more data processors or integrated circuits (21) via the one or more interfaces

or receiver means (16) communicating with the one or more data processors or integrated circuits (21).

14. A system (11) according to claim 12 or claim 13, in which the control information is stored in an information storage device (52) and in which the control information is transferable to the one or more data processors or integrated circuits (21) via one or more interfaces (16) communicating with the one or more data processors or integrated circuits (21).

15. A system (11) according to any one of the preceding claims, in which the system comprises a user identification device (21a) communicating with at least one of the one or more data processors or integrated circuits (21) enabling the system (11) to be activated or employed for use only by the user.

16. A system (11) according to any one of the preceding claims, which includes a monitor (54) comprising monitoring software for monitoring the amplitude and amplitude modulation frequency of the amplitude modulated low energy electromagnetic emissions generated by the one or more generator circuits (29).

17. A system (11) according to any one of the preceding claims, in which the determined or predetermined amplitude modulation frequency control information is determined or predetermined by means of a bio-feedback process involving observations or measurements of physiological reactions by the subject when or during the time that cellular functions of the subject are excited by exposing the subject to emissions of high frequency carrier signals amplitude modulated at a series of amplitude modulation frequencies.

18. A system (11) according to claim 17, in which the determined or predetermined frequencies are employed as a mode to identify the nature of a tumour or cancer harboured by a warm-blooded mammalian subject.