



(51) International Patent Classification:

G01R 33/54 (2006.01) A61B 5/055 (2006.01)

(21) International Application Number:

PCT/EP2024/065023

(22) International Filing Date:

31 May 2024 (31.05.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

23178018.0 07 June 2023 (07.06.2023) EP

(71) Applicant: **KONINKLIJKE PHILIPS N.V.** [NL/NL];
High Tech Campus 52, 5656 AG Eindhoven (NL).

(72) Inventors: **LEUSSLER, Christoph, Günther**; c/o Philips
International B.V. Intellectual Property and Standards, High
Tech Campus 52, 5656 AG Eindhoven (NL). **VERNICK-**

EL, Peter; c/o Philips International B.V. Intellectual Prop-
erty and Standards, High Tech Campus 52, 5656 AG Eind-
hoven (NL). **FINDEKLEE, Christian**; c/o Philips Interna-
tional B.V. Intellectual Property and Standards, High Tech
Campus 52, 5656 AG Eindhoven (NL).

(74) Agent: **PHILIPS INTELLECTUAL PROPERTY &
STANDARDS**; High Tech Campus 52, 5656 AG Eind-
hoven (NL).

(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,

(54) Title: INTERFACE FOR A MEDICAL IMAGING SYSTEM

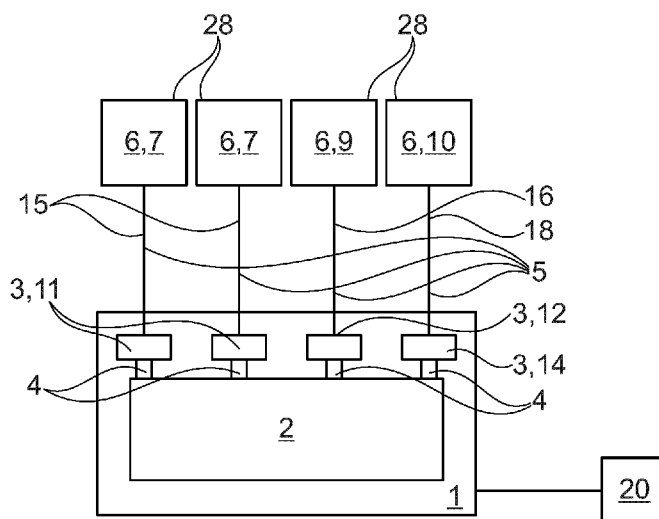


Fig. 1

(57) Abstract: According to the invention, an interface (1) for a medical imaging system (38), with a host module (2), wherein the host module (2) is adapted for providing a multitude of data connections for a multitude of peripheral devices (6) of different types, the host module (2) is adapted for identifying compatible peripheral devices (28) as well as incompatible peripheral devices (30), wherein the compatible peripheral devices (30) can be employed with the host module (2) and incompatible peripheral devices (28) cannot be employed with the host module, the host module (2) comprises a further data connection for transmitting data from the host module (2) to the medical imaging system (38) and receiving data from the medical imaging system (38) with the host module (2), the host module (2) is adapted for casting an interlock in the medical imaging system (38) when the incompatible peripheral device (30) is identified, and the host module (2) is adapted for identifying the type of compatible peripheral devices (28). In this way, an interface (1) with improved compatibility is provided.

RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*

INTERFACE FOR A MEDICAL IMAGING SYSTEM

FIELD OF THE INVENTION

The invention relates to the field of medical imaging. In particular, the present invention relates to the field of an interface for a medical imaging system.

5 BACKGROUND OF THE INVENTION

In a magnetic resonance imaging system, an interface is formed with which the signals received with the radio frequency coil can be forwarded. The radio frequency coil is part of every magnetic resonance imaging system. The radio frequency coil is used to receive the magnetic resonance signal, which is a radio frequency signal. In magnetic resonance imaging the system integrated body coil
10 generates the excitation magnetic field for the spin system. The precession of the net magnetization induces a current in the radio frequency coil via electromagnetic induction. The radio frequency coil generally comprises a conducting wire with an inductance and a coil resistance. Today's radio frequency coils are stand-alone devices connected by a cable to the interface located at the end of the patient bed. The patient bed carries a patient and is steerable in all three directions of space so that the patient can be
15 moved in and out of the opening of the magnetic resonance imaging system, the bore. The coil must be connected to the interface and the interface must also be connected to the patient table.

The prerequisite for improved image quality is that radio frequency coils can be placed and combined as desired. At the same time, there may be a need to switch between different types of radio frequency coils, such as analog radio frequency coils and digital radio frequency coils. The
20 combination of radio frequency coils means that different types of radio frequency coils of one type must be combinable for different entities, for example to enable the acquisition of a whole-body image of the patient. For this purpose, common magnetic resonance imaging systems are connected to several additional components and/or systems that provide additional signals and/or information via analog and/or digital interfaces. The compatibility of the interfaces and the compatibility with the protocols is not
25 always guaranteed.

A second source of uncertainty and also a risk is the use of spare parts or devices that are not suitable for use with the magnetic resonance imaging system and pose a risk to the patient and the functionality of the magnetic resonance imaging system. Also, the availability of additional functions or fewer functions could lead to limited compatibility and consequently to a reduction in functionality.

30 The publication '*Scalable Multichannel MRI Data Acquisition System*' by Bodurka J, et al. in Magnetic Resonance in Medicine, 51:165-171, 2004; describes a scalable multichannel digital

magnetic resonance imaging receiver system designed to achieve high bandwidth echo-planar imaging acquisitions. The modular system design allows for easy extension to an arbitrary number of channels.

WO 2006/103591 A1 discloses a magnetic resonance imaging system, a method for operating the magnetic resonance imaging system and a computer program for operating the magnetic resonance imaging system. The system comprises: an examination zone arranged to receive a body for examination; magnetic field generating means for generating a magnetic field in the examination zone; a receiving unit located in the examination zone or in the vicinity of the examination zone; an interface unit located in the examination zone or in the vicinity of the examination zone, and arranged separately from the receiving unit; and a signal processing unit disposed at a location remote from the receiving unit and the interface unit; wherein the receiving unit comprising a receiver) adapted to receive a spin resonance signal generated in the examination zone, and a transmitter adapted to transmit the spin resonance signal to the interface unit; and wherein the interface unit comprises a receiver for receiving the spin resonance signals, an analog to digital converter adapted to generate a digital signal in response to the received spin resonance signal, and a transmitter for transmitting the digitized signal to the signal processing unit.

Interfaces often have the disadvantage that only radio frequency coils of a certain type can be connected. At the same time, there is no way to ensure that only radio frequency coils compatible with the magnetic resonance imaging system are used. Other peripheral devices, such as contrast medium pumps or similar, must be integrated with additional components, which also disadvantage the coordination of the peripheral devices together with the imaging system.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an interface with improved compatibility.

According to the invention, this object is addressed by the subject matter of the independent claims. Preferred embodiments of the invention are described in the dependent claims.

Therefore, according to the invention, an interface for a magnetic resonance imaging system is provided, with a host module, wherein the host module is adapted for providing a multitude of data connections for a multitude of peripheral devices of different types, the host module is adapted for identifying compatible peripheral devices as well as incompatible peripheral devices, wherein the compatible peripheral devices can be employed with the host module and incompatible peripheral devices cannot be employed with the host module, the host module comprises a further data connection for transmitting data from the host module to the magnetic resonance imaging system and receiving data from the magnetic resonance imaging system with the host module, the host module is adapted for casting an interlock in the magnetic resonance imaging system when the incompatible peripheral device is identified, and the host module is adapted for identifying the type of compatible peripheral devices.

Although the invention is disclosed in relation to magnetic resonance imaging system, it should be understood that it is applicable for any medical imaging system whether is used for diagnostic purposes or in conjunction with treatment.

The host module is adapted to establish a bidirectional connection between the magnetic resonance imaging system and the peripheral devices. This allows data to be received from the peripheral devices. In addition, data can be sent to these peripheral devices so that peripheral devices which are compatible with the host module as well as their type can be identified. This generally eliminates a source of uncertainty in magnetic resonance imaging by ensuring that only compatible peripheral devices are connected to the interface. Compatibility of peripheral devices can be verified, for example, via electronic certificates included with the respective peripheral devices. When incompatible peripheral devices are connected to the interface, the interface detects them and preferably casts an interlock in the magnetic resonance imaging system.

For this purpose, it may be provided that the interlock has different severity levels. For example, the peripheral device connected to the interface may be incompatible with the magnetic field of the magnetic resonance imaging system and the respective peripheral device may pose a hazard to personnel as well as the patient. In such a case, the interlock would inhibit image acquisition. If the peripheral device is a peripheral device that exclusively affects the image quality as such, the interlock may consist in issuing a warning. The host module can be used to provide any number of the multitude of data connections for the corresponding number of peripheral devices of the multitude of peripheral devices. It is not necessary that each data connection is always provided to a peripheral device. Rather, the interface is designed to be scalable so that it can be adapted to the number of data connections provided with the corresponding number of peripheral devices.

In principle, it is possible to connect the peripheral devices to the interface in various ways. According to a preferred embodiment of the invention, however, the interface further comprises a multitude of submodules of different types, wherein the submodules are interconnected between the host module and the type corresponding peripheral device, wherein the submodules have a peripheral device connector and a host module connector, the peripheral device connector of the submodule corresponding to the type of the peripheral device has the type of the submodule and the peripheral device accordingly and connects the peripheral device to the submodule for transmitting data, and the host module connectors are identical across types of submodules such that each submodule is connectable to each of the data connections provided with the host module for transmitting data, such that the host module is connected to the peripheral devices with the submodules for transmitting data from the host module to the peripheral devices and from the peripheral devices to the host module.

This makes it possible to swap the submodules with the host module connectors at the data connections. It is not necessary that a particular submodule has a host module connector that is type-specific, as is the peripheral device connector. Rather, preferably, it is possible that each submodule can be connected via the host module connection to each data connection provided by the host module, so that the interface is modular. Preferably, the peripheral device connections of the submodules are differentiated and exclusively compatible with the type of peripheral device corresponding to the submodule.

The invention provides solution to the problem of compatibility and connectivity for different peripheral devices to be compatible and safe for patient and for medical imaging systems in general, and for magnetic resonance imaging systems in particular. This is solved by individual submodules connected to the interface and the compatibility management by the integrated host module, which provides a communication channel to the individual connectable submodules (e.g., medical devices, therapy, monitoring). If compatibility and safety is in compliance, then the diagnostic system is not any more blocked from scanning or calibration processes, such as in a nonlimiting example where the interface is connected to the patient bed.

In general, the host module can be formed in different ways. According to a preferred embodiment of the invention, however, the host module is configured for controlling the peripheral devices. If the peripheral devices are designed as radio frequency coils, for example, the host module can be employed to coordinate the acquisition with the respective radio frequency coil. Similarly, if one of the peripheral devices is a contrast medium pump, the host module can control the delivery of the contrast medium.

According to a preferred embodiment of the invention, the host module is adapted for controlling a preselection of an imaging sequence based on the type of the compatible peripheral devices connected to the host module, wherein the preselection of the imaging sequence is the selection of imaging-specific parameters, wherein with the imaging sequence images are acquired with the magnetic resonance imaging system. For example, when the radio frequency coil for imaging the head, e.g. a birdcage coil, is connected to the host module, the host module is used to preselect the imaging sequence based on parameters such as field of view or similar.

It is possible to configure the connection between the host module and peripheral devices in different ways. According to a preferred embodiment of the invention, however, electrical power is supplied to the identified peripheral devices via the host module by employing the connection. For this purpose, coaxial cables can be provided to supply electrical power to the peripheral devices connected to the host module. This leads to a reduction in the number of cables in the magnetic resonance imaging system.

In principle, it is also possible for the connection between the host module and the magnetic resonance imaging system to be formed in different ways, e.g. by a wire connection or optical connection. According to an embodiment of the invention, however, the host module is connected wirelessly to the magnetic resonance imaging system.

According to a further embodiment of the invention, it is preferred that the host module connectors of the submodules and the host module are adapted for transmitting data wirelessly. The wireless connection is generally used to reduce the amount of cables. On the other hand, wired connections can be used. Such wired connections may be more advantageous, especially for the transmission of data obtained with radio frequency coils, since they are less susceptible to interference in

the magnetic resonance imaging system. Optical signal transmission can be used for this purpose. In this case, the data is transmitted through an optical fiber.

Likewise, in another preferred embodiment according to the invention, it may be provided that the peripheral device connectors of the submodules and the peripheral devices are adapted for transmitting the data wirelessly or wired.

In another preferred embodiment according to the invention, the host module has an optical or acoustic feedback sensor to signal to an operator if the submodule and the host module interact with each other or when the setup is ready for use. It may take some time to load up a software driver or to check interoperability and patient safety.

According to preferred embodiment of the invention, the host module is adapted for enabling the identified peripheral devices to interact with each other via the host module. This enables cardiac gating image acquisition, for example. One of the peripheral devices is an electrocardiography device, which coordinates the image acquisition with the host module and the radio frequency coil, which is also connected, taking into account the data acquired with the electrocardiography device. The same can also be provided for respiratory gating, in that an abdominal belt as a peripheral device measures the expansion and contraction of a patient's chest and, together with the host module, coordinates the image acquisition with the radio frequency coil, which is also connected, taking into account the data from the abdominal belt. For this purpose, it is particularly advantageous that this control can be carried out directly by the host module, which enables a faster overall response time and simpler handling of these acquisition techniques.

According to another preferred embodiment of the invention, the host module is configured for extending types, such that the host module is compatible to an undefined-type peripheral device with a corresponding undefined-type submodule, wherein the undefined-type peripheral device and the undefined-type submodule cannot be identified by the host module and require configuration of the host module. Configuration of the host module in this case means updating the host module. This makes it possible to flexibly extend the compatibility of the host module to other peripheral devices and to ensure the compatibility of the host module with newer, more recent peripheral devices, so that the interface is not limited to the type of peripheral devices that existed at the time the interface was developed.

In general, different types of submodules and peripheral devices can be connected to the host module. According to a preferred embodiment of the invention, however, the interface is connectable with first-type submodules and second-type submodules. Preferably, the first-type submodules are connectable to first-type peripheral devices which are analog radio frequency coils and the second-type submodules are connectable to second-type peripheral devices which are digital radio frequency coils. This refers to all radio frequency coils, such as birdcage coils or body coils or other radio frequency coils of one type. The type itself only defines the differences between analog and digital radio frequency coils. The host module is designed to recognize the types of peripheral devices. Based on the detected types of

the peripheral devices, a preselection of the imaging sequence can be performed using the radio frequency coils connected to the host module. Different radio frequency coils are provided in the different types. That is, birdcage coils or body coils or other radio frequency coils preferred for individual examination entities may be provided. Likewise, radio frequency coils can be provided that are designed for different magnetic fields in the different types.

According to a preferred embodiment of the invention, the interface further comprises third-type submodules and a fourth-type submodules, wherein the third-type submodules are connectable to third-type peripheral devices that are sensors for measuring vital parameters, and the fourth type submodules are connectable to fourth type peripheral devices that are software-defined radios. The sensors for measuring vital parameters can be the electrocardiogram device mentioned above and the abdominal belt. Further sensors can be provided, which measure vital parameters like a respiratory rate, a temperature and/or a pulse of the patient. The software-defined radio platform is typically used for signal processing and transmitting and receiving signals. A basic software-defined radio architecture consists of a radio front end, an analog-to-digital converter, a digital-to-analog converter and a digital signal processor. Software-defined radio-based systems can operate reliably and accurately over a large bandwidth and frequency spectrum, making them a good platform to host ultra-wideband wireless technology, which is becoming increasingly popular in hospital environments. A medical imaging system is considered ultra-wideband when the range of its operating frequency is greater than 500 MHz. The higher frequencies resolve the finer structures, while the lower frequencies resolve larger structures and provide contrast to the reconstructed image.

According to a preferred embodiment of the invention, the interface additionally comprises further types of submodules, wherein the further-type submodules are connectable to corresponding peripheral devices that are, for example, data carriers, contrast agent pumps, respirators, perfusers, a connection unit, wherein the connection unit is connectable to a wearable health monitor, a patient communication system, an entertainment system and/or service tooling. The configured interface should be safe for the patient and be electromagnetically compatible. Therefore, according to a preferred embodiment of the invention, new submodules or new combinations of submodules with the host device are checked for patient safety and/or image quality. Thus, in case of concern, a dedicated compatibility check may be initiated by an operator or a remote control service to proof and certify patient safety.

In a further preferred embodiment of the invention, the interface comprises a remote control, whereby the remote control is connected to the host module via the further data connection and is adapted for controlling the host module and to retrieve data from the peripheral devices. In principle, the remote control can be designed in different ways. With the remote control, the patient's vital parameters can be viewed if the third-type peripheral devices are connected to the host module in an interactive mode during image acquisition. According to a preferred embodiment of the invention, however, the remote control comprises a quick response code scanner. This allows patients wearing a corresponding wristband with a quick response code to be identified.

Preferably, the interface further comprises a fluidic connection with which a connection is established analogously to the further data connection and the data connection between the magnetic resonance tomography system and the peripheral device, wherein a fluid is provided to the peripheral device via the host module with the fluidic connection. This enables the supply of oxygen to a respirator that is connected to the interface as a further-type peripheral device.

Further, according to the invention a magnetic resonance imaging system with an interface according to the above is provided, with a magnetic resonance sequencer and at least one of an illumination, a ventilation and a communication unit, wherein the magnetic resonance sequencer is adapted for executing an imaging sequence with the magnetic resonance imaging system upon the preselection of the imaging sequence determined with the host module, and the host module is adapted for controlling environmental parameters, wherein the environmental parameters are at least one of the illumination, the ventilation and an acoustic adaptation of a communication realizable with the communication unit based on a noise gradient of the magnetic resonance imaging system. The magnetic resonance sequencer is used to execute the imaging sequence with the magnetic resonance imaging system. The magnetic resonance sequencer is designed as a component of the magnetic resonance imaging system and can control the radio frequency pulse and the gradient magnets. It also processes the data received with the radio frequency coils. The magnetic resonance sequencer has an input facility that can be used to control the image sequence and the environmental parameters mentioned above. Since the host module can control the environmental parameters, there is no need for additional input into the magnetic resonance sequencer. Rather, the host module can be used to transmit a preselected imaging sequence to the magnetic resonance sequencer that requires confirmation or modification by personnel. The host module can then control the environmental parameters based on the imaging sequence executed by the magnetic resonance sequencer.

In principle, it is possible to connect different components of the magnetic resonance imaging system to the interface. According to a preferred embodiment of the invention, however, the magnetic resonance imaging system comprises a patient bed, wherein the interface is integrally formed with the patient bed, and the patient bed is a submodule and connectable to peripheral devices of corresponding types.

In general, it is possible that the patient bed can be connected to different types of peripheral devices. According to a preferred embodiment of the invention, however, the patient bed is connectable to the first-type peripheral devices and the second-type peripheral devices.

By making the interface integral with the patient bed, the number of devices and cables in the magnetic resonance imaging system is reduced. The peripheral devices can be connected with the peripheral device connectors formed in the patient bed. The patient bed is connected to the host module via the host module connectors. First-type peripheral devices and second-type peripheral devices can be plugged directly into the patient bed, reducing the distance for data transmission of data received with the

radio frequency coils. This makes the data less susceptible to interference from the radiated radio frequency fields of the magnetic resonance imaging system.

In principle, it is possible to design the patient bed in different ways. According to a preferred embodiment of the invention, however, the magnetic resonance imaging system further comprises a controller, the controller being interconnected between the patient bed and the host module, wherein the patient bed is a peripheral device and the controller corresponds to the corresponding submodule, so that the patient bed is controllable with the host module.

With the controller, it is possible to use the patient bed not only as a submodule for the peripheral devices, but rather as a peripheral device itself. This allows the patient bed to be moved with the interface to desired positions within the bore during the imaging sequence. According to a further embodiment of the invention, the patient bed comprises an interlock with which the connections to the peripheral devices can be blocked. In this way, a mechanical interlock can be cast with the patient bed so that the peripheral devices cannot be connected to the interface in the first place.

The invention further relates to a method of operating a magnetic resonance imaging system, comprising the following method steps: connecting the peripheral devices to the interface, identifying compatible peripheral devices as well as incompatible peripheral devices, casting an interlock in the magnetic resonance imaging system when an incompatible peripheral device is identified, identifying the type of the compatible peripheral devices, preselecting of an imaging sequence with the interface upon identification of the compatible peripheral devices, establishing the further data connection from the interface to the magnetic resonance imaging system, and performing the imaging sequence with the magnetic resonance imaging system if no interlock has occurred.

Further, according to the invention, a method of operating a magnetic resonance imaging system is provided, comprising the following method steps: connecting the peripheral devices to the patient bed, identifying peripheral devices connected to the patient bed, casting the interlock in the magnetic resonance imaging system when the incompatible peripheral device is identified, identifying the type of the compatible peripheral devices, preselecting of an imaging sequence with the patient bed upon identification of compatible peripheral devices, establishing the further data connection from the patient bed to the magnetic resonance imaging system, and performing the imaging sequence with the magnetic resonance imaging system if no interlock has occurred. For this purpose, it is provided that the interface is integrally formed in the patient bed.

According to a preferred embodiment of the invention, the method of operating a magnetic resonance imaging system comprises the following further step: configuring the scalable interface so that undefined submodule types and undefined peripheral devices are compatible.

In a further preferred embodiment of the invention, the method of operating a magnetic resonance imaging system comprises the following further step: transmitting the imaging sequence to the interface, wherein during step of performing the imaging sequence with the magnetic resonance imaging

system if no interlock has occurred, the following further step is executed: controlling environmental parameters with the interface.

According to a preferred embodiment of the invention, the method of operating a magnetic resonance imaging system further comprises the remote control and the following further steps: connecting the remote control to the scalable interface, and transmitting signals to the remote control with the scalable interface.

The invention further comprises a computer-readable medium comprising instructions thereon which, when executed by an interface in a magnetic resonance imaging system, cause the interface to carry out a method as described above.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to limit the scope of the claimed subject matter. A more extensive presentation of features, details, utilities, and advantages of the system, as defined in the claims, is provided in the following written description of various embodiments of the disclosure and illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. Such an embodiment does not necessarily represent the full scope of the invention.

In the drawings:

Fig. 1 schematically depicts an interface according to a preferred embodiment of the invention;

Fig. 2 schematically depicts an interface according to another preferred embodiment of the invention;

Fig. 3 schematically depicts a magnetic resonance imaging system according to a preferred embodiment of the invention; and

Fig. 4 schematically depicts a method according to a preferred embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

For the purposes of promoting and understanding the principles of the present disclosure, reference will now be made to the embodiments illustrated in the drawings, and specific language will be used to describe the same. It is nevertheless understood that no limitation to the scope of the disclosure is intended. Any alteration and further modifications to the described devices, systems, and methods, and any further application of the principles of the present disclosure are fully contemplated and included within the present disclosure as would normally occur to one skilled in the art to which the disclosure

relates. In particular, it is fully contemplated that the features, components, and/or steps described with respect to one embodiment may be combined with the features, components, and/or steps described with respect to other embodiments of the present disclosure. For the sake of brevity, however, the numerous iterations of these combinations will not be described separately. Features described in relation to a system, may be implemented in a computer implemented method and/or in a computer program product, in a corresponding manner.

Fig. 1 schematically depicts an interface 1 according to a preferred embodiment of the invention. The interface 1 has a host module 2, which is connected via host module connectors 4 to submodules 3 for transmitting data. The submodules 3 are also connected to peripheral devices 6 via peripheral device connectors 5 in such a way that data can be transmitted. The host module 2 provides corresponding data connections for connection to the peripheral devices 6 via the submodules 3. The peripheral devices 6 connected to the host module 2 via the submodules 3 are all compatible peripheral devices 28. A remote control 20 is also connected to the host module 2 shown in Fig. 1 via a further data connection. With the further data connection, the host module 2 is connected to the magnetic resonance imaging device 38 shown in Fig. 3 for data transmission. The remote control 20 can be used to view vital parameters that can be measured with the third-type peripheral device 10 connected to the host module 2. For this purpose, the third-type peripheral device 10 is connected to a third-type submodule 14 with a third-type peripheral device connector 18 corresponding to the type. The third-type submodule 14 is connected to the host module 2 via the host module connector 4. The host module 2 in Fig. 1 is also connected to two host module connectors 4 via two first-type submodules 11 and two first-type peripheral device connectors 15, each with a first-type peripheral device 7. The host module 2 is also connected to a second-type peripheral device 8 by means of a host module connector 4 via a second-type submodule 12 and a second-type peripheral device connector 16.

Fig. 2 schematically depicts the interface 1 according to another preferred embodiment of the invention. The host module 2 is connected to an undefined-type submodule 22 via the host module connector 4. The undefined-type submodule 22 is connected to an undefined-type peripheral device 24 via an undefined-type peripheral device connector 26. The host module 2 is now configurable to identify the undefined-type submodule 22 and the undefined-type peripheral device 24, and to recognize the undefined-type peripheral device 24 as a compatible peripheral device 28. The host module 2 is still connected to the third-type submodule 14 via the host module connector 4. The third-type submodule 14 is connected to an incompatible peripheral device 30 via the third-type peripheral device connector 18, whereupon an interlock is cast in the magnetic resonance imaging system.

Fig. 3 schematically depicts the magnetic resonance imaging system 38 according to a preferred embodiment of the invention. The magnetic resonance imaging system 38 includes a patient bed 32 and the interface 1, which may be integrally formed in the patient bed 32. In addition, the patient bed 32 has a controller 44 connected to the interface 1 such that the interface 1 can control the patient bed 32 as a peripheral device 6. Furthermore, the patient bed 32 is a submodule 3 and is connected via the first-

type peripheral device connector 15, the second-type peripheral device connector 16 and the third-type peripheral device connector 18 to the first-type peripheral device 7, the second-type peripheral device 8 and the third-type peripheral device 10, respectively. Via the further data connection, the interface 1 is connected to a magnetic resonance sequencer 34 as well as an illumination 36, a ventilation 40 and a communication unit 42. The interface 1 sends a preselected imaging sequence to the magnetic resonance sequencer 34 based on the connected peripheral devices 6, and controls the environmental parameters in the form of the illumination 36, the ventilation 40 and an acoustic adaptation of a communication realizable with the communication unit 42 based on a noise gradient of the magnetic resonance imaging system 38 during the image acquisition with the magnetic resonance imaging system 38.

In any of the embodiments the individual submodules (bidirectional) may have an identical connector to the interface, so that it can be connected to any of the identical sockets. The connection of the peripheral device is based on the individual connector of the dedicated peripheral device. This can also be galvanically connected or partly wireless. The socket module may contain an internal controller (analog or digital controller, microcontroller, etc.) to provide compatibility or to adapt control signals in amplitude, phase, frequency, time) and provide compatibility.

Fig. 4 schematically depicts a scheme of a method according to a preferred embodiment of the invention, wherein in a first step S1 the peripheral devices 6 are connected to the patient bed 32. Second, in a further step S2 the peripheral devices 6 connected to the patient bed 32 are identified. In a third step S3, an interlock is cast in the magnetic resonance imaging system 38, when the incompatible peripheral device 30 is identified. Fourth, in a further step S4 the types of the compatible peripheral devices 28 are identified. In a fifth step S5, an imaging sequence is preselected with the patient bed 32 upon identification of the compatible peripheral devices 28. Sixth, the further data connection from the patient bed 32 to the magnetic resonance imaging system is established. In a further step S7a, the imaging sequence is transmitted to the interface 1 in the patient bed 32. In the following step, the imaging sequence is performed with the magnetic resonance imaging system 38 if no interlock has occurred. During this step the environmental parameters are controlled with the interface 1 in the patient bed 32.

It is understood that one or more of the aforementioned embodiments of the invention may be combined as long as the combined embodiments are not mutually exclusive.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs

in the claims should not be construed as limiting the scope. Further, for the sake of clearness, not all elements in the drawings may have been supplied with reference signs.

REFERENCE SYMBOL LIST

	Interface	1
	host module	2
5	submodule	3
	host module connector	4
	peripheral device connector	5
	peripheral device	6
	first-type peripheral device	7
10	second-type peripheral device	8
	third-type peripheral device	10
	first-type submodule	11
	second-type submodule	12
	third-type submodule	14
15	first-type peripheral device connector	15
	second-type peripheral device connector	16
	third-type peripheral device connector	18
	remote control	20
	undefined-type submodule	22
20	undefined-type peripheral device	24
	undefined-type peripheral device connector	26
	compatible peripheral device	28
	incompatible peripheral device	30
	patient bed	32
25	magnetic resonance sequencer	34
	illumination	36
	magnetic resonance imaging system	38
	ventilation	40
	communication unit	42
30	controller	44

CLAIMS

1. An interface (1) for a medical imaging system (38), with a host module (2) and a multitude of submodules (3) of different types, wherein

the host module (2) is adapted for providing a multitude of data connections for a multitude of peripheral devices (6) of different types,

5 the submodules (3) are interconnected between the host module (2) and the type corresponding peripheral device (6),

the host module (2) is adapted for identifying compatible peripheral devices (28) as well as incompatible peripheral devices (30), wherein the compatible peripheral devices (30) can be employed with the host module (2) and incompatible peripheral devices (28) cannot be employed with the host
10 module,

the host module (2) comprises a further data connection for transmitting data from the host module (2) to the medical imaging system (38) and receiving data from the medical imaging system (38) with the host module (2),

the host module (2) is adapted for casting an interlock in the medical imaging system (38)
15 when the incompatible peripheral device (30) is identified, and

the host module (2) is adapted for identifying the type of compatible peripheral devices (28).

2. The interface (1) according to claim 1, wherein

20 the submodules (3) have a peripheral device connector (5) and a host module connector (4),

the peripheral device connector (5) of the submodule (2) corresponding to the type of the peripheral device (6) has the type of the submodule (3) and the peripheral device (6) accordingly and connects the peripheral device (6) to the submodule (3) for transmitting data, and

25 the host module connectors (4) are identical across types of submodules (3) such that each submodule (3) is connectable to each of the data connections provided with the host module (2) for transmitting data, such that the host module (2) is connected to the peripheral devices (6) with the submodules (3) for transmitting data from the host module to the peripheral devices (6) and from the peripheral devices (6) to the host module (2).

30 3. The interface (1) according to claim 2, wherein the host module (2) is configured for controlling the peripheral devices (6).

4. The interface according to claim 3, wherein the host module (2) is adapted for controlling a preselection of an imaging sequence based on the type of the compatible peripheral devices (28) connected to the host module (2), wherein

the preselection of the imaging sequence, is the selection of imaging-specific parameters, wherein with the imaging sequence images are acquired with the medical imaging system (38).

5. The interface (1) according to one of the claims 2 to 4, wherein the host module (2) is configured for extending types, such that the host module (2) is compatible to an undefined-type peripheral device (24) with a corresponding undefined-type submodule (22), wherein

the undefined-type peripheral device (24) and the undefined-type submodule (22) cannot be identified by the host module and require configuration of the host module.

6. The interface (1) according to any one of the preceding claims, with first-type submodules (11) and second-type submodules (12), wherein

the first-type submodules (11) are connectable to first-type peripheral devices (7) which are analog radio frequency coils and the second-type submodules (12) are connectable to second-type peripheral devices (8) which are digital radio frequency coils.

7. The interface (1) according to any one of the preceding claims, with a remote control (20), whereby the remote control (20) is connected to the host module (2) via the further data connection and is adapted for controlling the host module (2) and to retrieve data from the peripheral devices (6).

8. A magnetic resonance imaging system (38) with an interface (1) according to any one of the preceding claims, with a magnetic resonance sequencer (34) and at least one of an illumination (36), a ventilation (40) and a communication unit (42), wherein

the magnetic resonance sequencer (34) is adapted for executing an imaging sequence with the magnetic resonance imaging system (38) upon the preselection of the imaging sequence determined with the host module (2), and

the host module (2) is adapted for controlling environmental parameters, wherein the environmental parameters are at least one of the illumination (36), the ventilation (40) and an acoustic adaptation of a communication realizable with the communication unit (42) based on a noise gradient of the magnetic resonance imaging system (38).

9. The magnetic resonance imaging system (38) according to claim 8, with a patient bed (32), wherein

the interface (1) is integrally formed with the patient bed (32), and

the patient bed (32) is one submodule (3) and is connectable to peripheral devices (6) of corresponding types.

10. The magnetic resonance imaging system (38) according to claim 9, wherein the patient
5 bed (32) is connectable to the first-type peripheral devices (7) and the second-type peripheral devices (8).

11. The magnetic resonance imaging system (38) according to claim 9 or 10 with a controller
(44), the controller (44) being interconnected between the patient bed (32) and the host module (2),
wherein the patient bed (32) is a peripheral device (6) and the controller (44) corresponds to the
10 corresponding submodule (3), so that the patient bed (32) is controllable with the host module (2).

12. A method of operating a medical imaging system (38) according to any one of claims 8 to
11, comprising:

connecting (S1) the peripheral devices (6) to the interface (1),
15 identifying (S2) the compatible peripheral devices (28) as well as incompatible peripheral
devices (30),

casting (S3) the interlock in the medical imaging system (38) when the incompatible
peripheral device (30) is identified,

identifying (S4) the types of the compatible peripheral devices (28),

20 preselecting (S5) an imaging sequence with the interface (1) upon identification of the
compatible peripheral devices (28),

establishing (S6) the further data connection from the interface (1) to the medical imaging
system (38), and

performing (S7) the imaging sequence with the medical imaging system (38) if no
25 interlock has occurred.

13. A method of operating a medical imaging system (38) according to any one of claims 8 to
11, comprising:

connecting (S1) the peripheral devices (6) to the patient bed (32),

30 identifying (S2) the peripheral devices (6) connected to the patient bed (32),

casting (S3) the interlock in the medical imaging system (38) when the incompatible
peripheral device (30) is identified,

identifying (S4) the types of the compatible peripheral devices (28),

35 preselecting (S5) an imaging sequence with the patient bed (32) upon identification of the
compatible peripheral devices (28),

establishing (S6) the further data connection from the patient bed (32) to the medical
imaging system (38), and

performing (S7) the imaging sequence with the medical imaging system (38) if no interlock has occurred.

14. The method according to claim 12 or 13, further comprising:

5 transmitting (S7a) the imaging sequence to the interface (1), and wherein during step S7 the following further step is executed:

controlling (S8) environmental parameters with the interface (1).

15. A computer-readable medium comprising instructions thereon which, when executed by
10 an interface (1) in a medical imaging system (38), cause the interface (1) to carry out a method according to any one of claims 12 to 14.

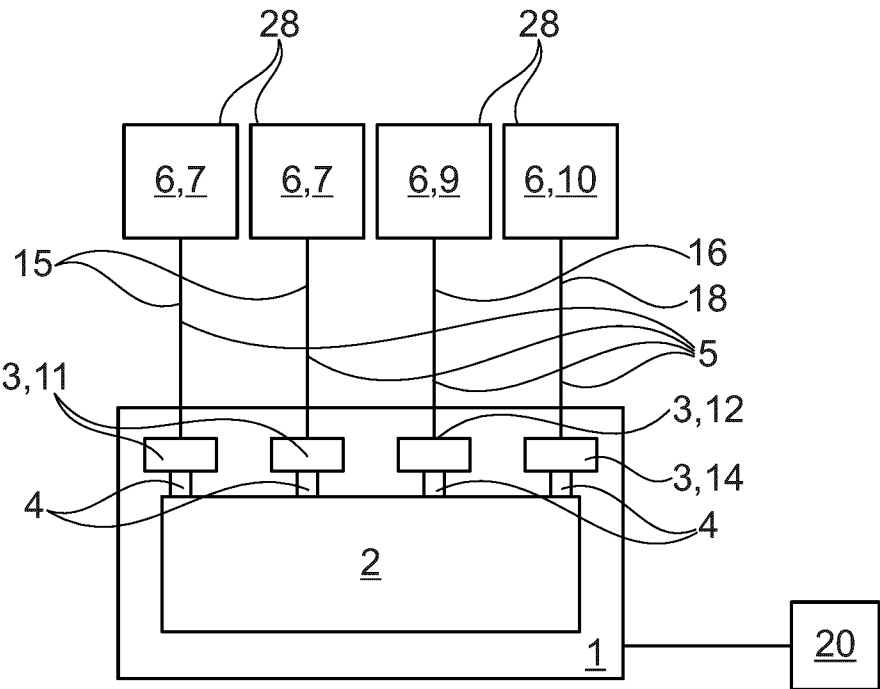


Fig. 1

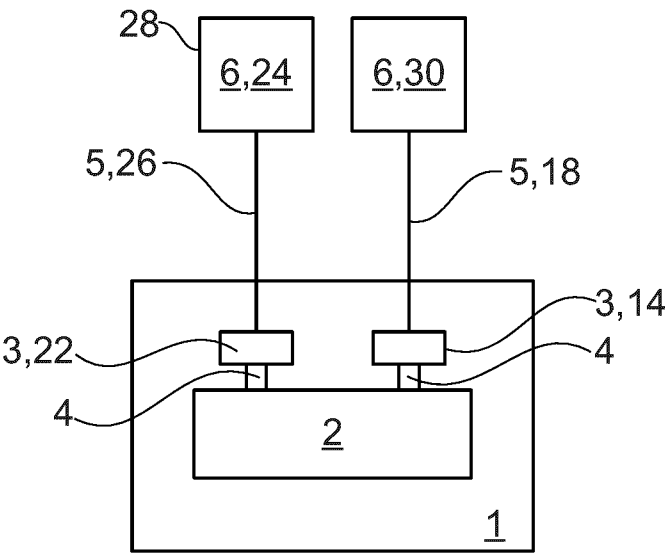


Fig. 2

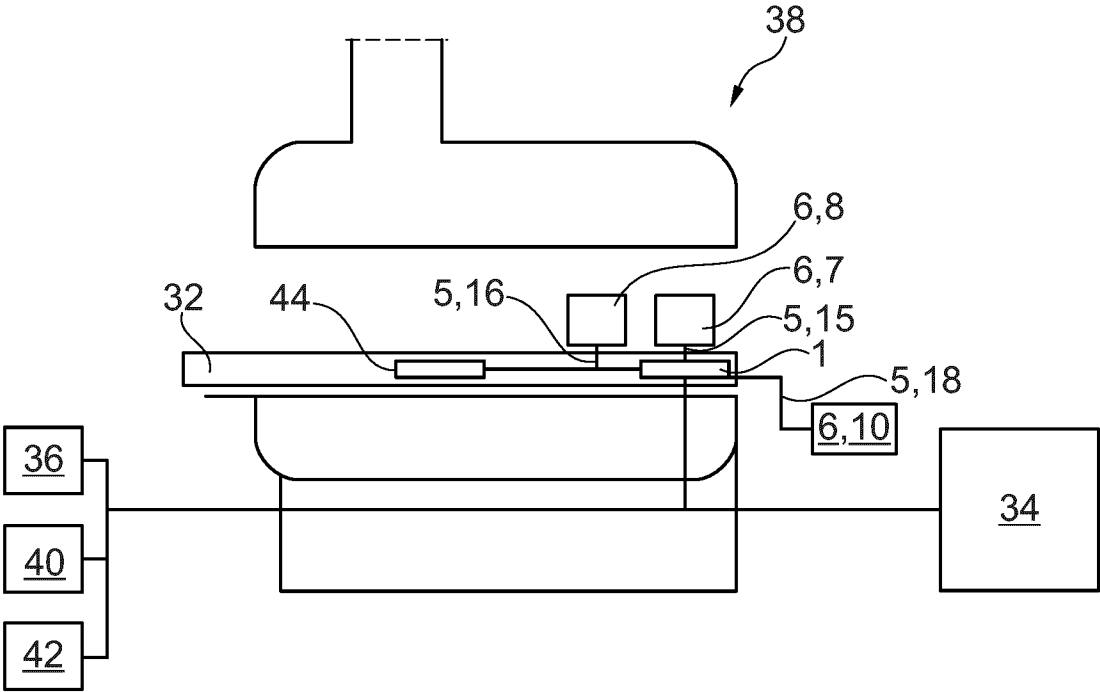


Fig. 3

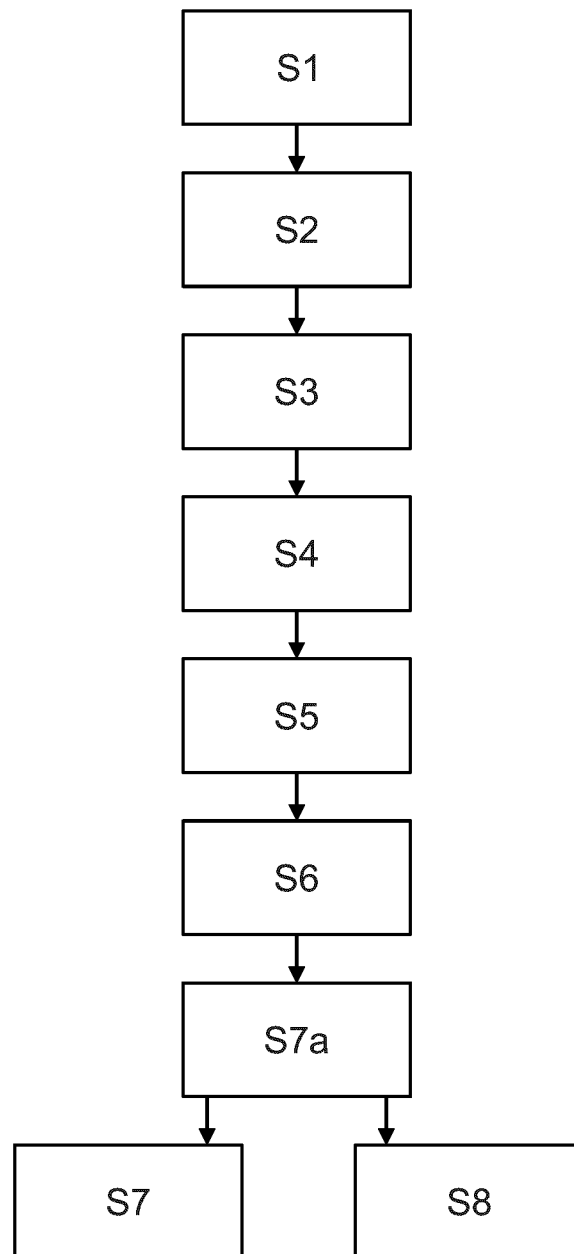


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/065023

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01R33/54 A61B5/055
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01R A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, BIOSIS, COMPENDEX, EMBASE, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 356 780 B1 (LICATO PAUL E [US] ET AL) 12 March 2002 (2002-03-12)	1, 6, 7, 12, 15
Y	column 9, line 42 - line 51; figures 1, 2, 4	8, 14
A		2-5, 9-11, 13
Y	----- US 2013/154647 A1 (YANG WHOE SUN [KR]) 20 June 2013 (2013-06-20) paragraph [0045]; claim 1	8, 14
Y	----- US 5 355 885 A (TSUDA MUNETAKA [JP] ET AL) 18 October 1994 (1994-10-18) figures 1, 2	8, 14
Y	----- US 2022/151494 A1 (BIBER STEPHAN [DE]) 19 May 2022 (2022-05-19) claims 1, 8, 9	8, 14
	----- - / - -	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

4 September 2024

Date of mailing of the international search report

13/09/2024

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Skalla, Jörg

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/065023

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 9 545 497 B2 (WENDEROW TAL [US]; BROMANDER THOMAS [US]; CORINDUS INC [US]) 17 January 2017 (2017-01-17) column 20, line 63 - column 21, line 30; figures 13,14 -----	1
A	DE 10 2015 202795 A1 (SIEMENS HEALTHCARE GMBH [DE]) 18 August 2016 (2016-08-18) paragraph [0043] - paragraph [0048] -----	1
A	US 5 551 430 A (BLAKELEY DOUGLAS M [US] ET AL) 3 September 1996 (1996-09-03) claim 1 -----	1
A	US 10 290 371 B1 (PEKARSKE MATTHEW RICHARD [US] ET AL) 14 May 2019 (2019-05-14) column 10, line 48 - column 11, line 19 -----	1
A	US 10 251 531 B2 (SONY CORP [JP]) 9 April 2019 (2019-04-09) claim 7; figure 2 -----	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2024/065023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6356780	B1	12-03-2002	DE 60026003 T2 28-09-2006
		EP 1110504 A2 27-06-2001	
		JP 2001245868 A 11-09-2001	
		US 6356780 B1 12-03-2002	
US 2013154647	A1	20-06-2013	KR 20130067433 A 24-06-2013
		US 2013154647 A1 20-06-2013	
US 5355885	A	18-10-1994	JP 3192453 B2 30-07-2001
		JP H05161626 A 29-06-1993	
		US 5355885 A 18-10-1994	
US 2022151494	A1	19-05-2022	CN 114515145 A 20-05-2022
		DE 102020214467 A1 19-05-2022	
		US 2022151494 A1 19-05-2022	
US 9545497	B2	17-01-2017	EP 2376175 A1 19-10-2011
		US 2011238082 A1 29-09-2011	
		US 2017319824 A1 09-11-2017	
		US 2020316340 A1 08-10-2020	
		WO 2010068783 A1 17-06-2010	
DE 102015202795	A1	18-08-2016	CN 105891748 A 24-08-2016
		DE 102015202795 A1 18-08-2016	
		KR 20160101685 A 25-08-2016	
US 5551430	A	03-09-1996	US 5551430 A 03-09-1996
		US RE36495 E 11-01-2000	
US 10290371	B1	14-05-2019	NONE
US 10251531	B2	09-04-2019	DE 112016002273 T5 08-02-2018
		JP 2016214490 A 22-12-2016	
		US 2018078116 A1 22-03-2018	
		US 2019183317 A1 20-06-2019	
		WO 2016185910 A1 24-11-2016	