(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 January 2016 (21.01.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/010413 A1

(51) International Patent Classification:
H04B 1/40 (2015.01) *H03H 17/06* (2006.01)
H03H 17/02 (2006.01)

(21) International Application Number:
PCT/MY2015/050070

(22) International Filing Date:
10 July 2015 (10.07.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI2014701949 17 July 2014 (17.07.2014) MY

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(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, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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).

Published:

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

(54) **Title**: BASEBAND MODULATION FOR WIRELESS COMMUNICATION PLATFORM

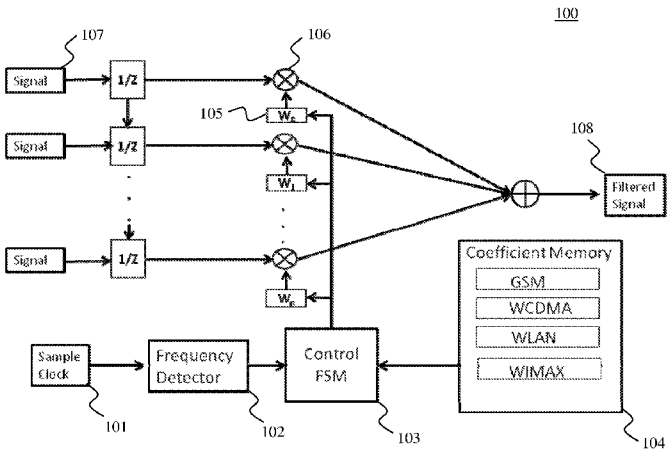

Figure 1

(57) **Abstract**: The present invention relates to a baseband modulation system for wireless communication platform, comprising: a sampling clock (101); a frequency detector (102) coupled to the sampling clock (101); a database (104) having at least one filter coefficient, wherein the filter coefficient complies with at least one wireless standards; at least one filter (106) to perform filtering operation to an input signal; at least one register (105) coupled to the filter (106); and a control module (103) coupled between the database (104) and the frequency detector (102); the arrangement being such that, when the frequency detector (102) obtain a frequency sampling from the sampling clock (101), it transmits the frequency sampling to the control module (103) for computation using a State Machine model, which retrieves a filter coefficient from the database (104) based on the computation and loads the retrieved filter coefficient to the register (105) for modulating an input signal (107) using a filter (106) in way such that a modulated output signal (108) produced. Furthermore, the frequency detector (102) may be an analogue module or digital module. Furthermore, the control module (103) may be a Finite State Machine model.

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BASEBAND MODULATION FOR WIRELESS COMMUNICATION PLATFORM

FIELD OF INVENTION

The present invention relates to a baseband filter for filtering an input signal received by a wireless communication platform, and a method thereof.

BACKGROUND ART

Baseband filters are an important part of multi-standard wireless communication systems. The rapid growth in multi-standard wireless communication system such as GSM, WCDMA, WLANa, WLANb, WLANg and WiMAX has made the traditional baseband filter less suitable for modern communication requirements. Today, a demand for reconfigurable communication systems capable of multi-standard operation is very strong. Because of this trend, reconfigurability needs to be taken into account in filter architectural design.

Multi-standard wireless communication platforms requires multi-band filters. The conventional methods using several dedicated filters to handle each system are expensive and relatively large in size. One of the most popular approaches is by using baseband processor to load the coefficient. However, it requires powerful processor to do this which could results in long configuration times in order to complete one cycle of instruction.

US Patent Application No. 20070082646 discloses a multimode communication device using two or more radio modules which share a filter, wherein a switching module is used to select a communication signal. The disadvantage of the design is that it requires a supervision to select the communication signal.

US Patent No. 7864885 discloses a framework for a direct conversion receiver, which includes a duplex filter with two inputs. A processor is used to reconfigure the coefficient parameters of the digital filters which results in long configuration times in order to complete one cycle of instruction.

US Patent Application No. 20080071846 discloses an ALU with Multiplier-Accumulator structure which is used to run the computations for all filters in the chain. However, the computations process are hampered by using these structures.

In view of the above, there is a need to tackles the foregoing limitations by not only simplifying the architecture of the baseband filter, but also providing better solution for realization and autonomous adaptation of baseband filters for multi-standard wireless system. It would be desirable to have fast configuration operations with minimal physical hardware component count and complexity while maintaining the reconfigurable features.

SUMMARY OF INVENTION

The present invention provides a baseband modulation system for wireless communication platform, comprising: a sampling clock (101); a frequency detector (102) coupled to the sampling clock (101); a database (104) having at least one filter coefficient, wherein the filter coefficient complies with at least one wireless standards; at least one filter (106) to perform filtering operation to an input signal ; at least one register (105) coupled to the filter (106); and a control module (103) coupled between the database (104) and the frequency detector (102); the arrangement being such that, when the frequency detector (102) obtain a frequency sampling from the sampling clock (101), it transmits the frequency sampling to the control module (103) for computation using a State Machine model, which retrieves a filter coefficient from the database (104) based on the computation and loads the retrieved filter coefficient to the register (105) for modulating an input signal (107) using a filter (106) in way such that a modulated output signal (108) produced.

Preferably, the frequency detector (102) of the baseband modulation system is a digital module.

Preferably, the frequency detector (102) of the baseband modulation system is an analogue module.

Preferably, the control module (103) of the baseband modulation system is a Finite State Machine model.

A further aspect of the present invention provides a method of baseband modulation for wireless communication platform using baseband filter, comprising steps of: receiving a sampling clock (201) from the input sampling clock (101); reading frequency sampling (202) of the sampling clock using a frequency detector (102); transmitting the frequency sampling (203) to a control module (103); computation on the frequency sampling (204) to determine a filter coefficient from a database (104) using the control module (103); retrieving the filter coefficient that complies with at least one wireless standards from the database (104) using a State Machine model of the control module (103); loading the selected filter coefficient to a register (105) for modulation process (206); and modulating an input signal (107) based on

the filter coefficient loaded into the register (105) to obtain a filtered output signal (108) using a filter (106).

Preferably, the frequency detector (102) of the baseband modulation uses an analogue module for reading sampling clock (202).

Further, the frequency detector (102) of the baseband modulation uses a digital module for reading sampling clock (202).

Preferably, the control module (103) of the baseband modulation uses a Finite State Machine model.

The present invention consists of features and a combination of parts hereinafter fully described and illustrated in the accompanying drawings, it being understood that various changes in the details may be made without departing from the scope of the invention or sacrificing any of the advantages of the present invention.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENT

To further clarify various aspects of some embodiments of the present invention, a more particular description of the invention will be rendered by references to specific embodiments thereof, which are illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail through the accompanying drawings in which:

Figure 1 illustrates the System Architecture of self-configurable baseband filter.

Figure 2 illustrates the Process Flow of self-configurable baseband filter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in Figure 1, a self-configurable baseband filter for multi-standard wireless communication comprising: An input sampling clock (101), A Frequency Detector module (102) to determine frequency of the input sampling clock. A Coefficient Memory (104) to store pre-calculated filter coefficient response that comply with multiple wireless standards. A Control FSM module (103) to control the modules that adapt to each protocol by selecting corresponding filter coefficient (for each input sampling frequency) from Coefficient Memory (104) and transmit to Coefficient Registers (105). Coefficient Registers (W_{0-n}) (105) to read and reload the corresponding filter coefficients to Self-Configurable baseband Filter (106). Baseband Filter (F_{0-n}) (106) to configure according to the corresponding filter coefficients, wherein the Input signal (107) will be filtered using the Baseband Filter to produce a filtered output signal (108).

As illustrated in Figure 2, the process is initiated (201) by reading the sampling clock generated (202) from the input sampling clock signal generator or any other input triggering a sampling clock using a frequency detector. The signal can be in analogue or digital, the frequency detector also may incorporate an Analogue to Digital Converter or Digital to Analogue Converter to read the sampling clock. The input sampling frequency maybe in the range of 1MHz to 150MHz. The sampling clock will be then verified (203) if there are any new sampling clock value is generated using Control Finite-State-Machine (FSM) module, if the sampling clock is not a new sampling clock value, the control module awaits next sampling clock is triggered or generated. If a new sampling clock is triggered or generated, the Control Finite-State-Machine (FSM) module will calculate the frequency from the triggered or generated sampling clock (204) in order to select a corresponding filter coefficients parameter (205) which are pre-loaded or stored into a database memory that matches the multi-standard wireless communication system such as GSM, WCDMA, WLANa, WLANb, WLANg and WiMAX.

The selected filter coefficients parameter from the memory is then loaded to at least one registry (206) by the Control Finite-State-Machine (FSM) module for filtering process of an input signal to obtain a filtered signal output and meets the wireless communication standards such as Institute of Electrical and Electronics Engineers Standards (IEEE-SA) or IEEE

802.11. The filter is a digital Finite Impulse Response (FIR) filter which can be discrete-time finite impulse response filter. The FIR filters can be discrete-time or continuous-time, and digital or analog. The process is reinitiated again to obtain a new sampling clock and load another corresponding filter coefficient for filtering process that complies different wireless communication standards.

Table 1 below describes various input sampling frequency for each multi-standard wireless communication system that may be loaded into the memory or a database as a pluralities of coefficients parameter. These data's can be loaded or updated at any time in order to meet the need of the filtering process.

Standards	Frequency range (GHz)	Channel Spacing (MHz)	Symbol rate / Chip rate	OSR	Input sampling frequency, F_s (MHz)	Pass band edge (MHz)	Stop band edge (MHz)	Passband ripple (dB)	Stopband attenuation (dB)
GSM	DL:0.935-0.96 UL:0.89-0.915	0.2	270.833 Ksymbols/s	128	34.667	0.08	0.1	0.1	65
WCDMA	DL:2.11-2.17 UL:1.92-1.98	5	3.84 Mchips/s	16	61.44	2	2.5	0.5	55
WLANa	5.15-5.35	20	12 Msymbols/s	8	96	8	10	0.5	44
WLANb	2.4-2.4835	25	11 Mchips/s	12	132	10	12.5	0.5	42
WLANg	2.4-2.4835	25	12 Msymbols/s	12	144	10	12.5	0.5	44
WiMAX	10-66	20	16.704 Msymbols/s	8	133.632	8	10	0.5	39

Table 1

In telecommunications and signal processing, baseband is an adjective that describes signals and systems whose range of frequencies is measured from close to 0 hertz to a cut-off frequency (a maximum bandwidth or highest signal frequency); it is sometimes used as a noun for a band of frequencies starting close to zero. Baseband can often be considered a synonym to lowpass or non-modulated, and antonym to passband, bandpass, carrier-modulated, intermediate frequency, or radio frequency (RF). The term is often used in contrast to passband, which refers to a signal which has been translated to a higher frequency, often for transmission by frequency division multiplexing.

A baseband bandwidth is equal to the highest frequency of a signal or system, or an upper bound on such frequencies, for example the upper cut-off frequencies of a passband filter. By contrast, passband bandwidth is the difference between a highest frequency and a nonzero lowest frequency.

The present invention provides a system and method for self-configurable baseband filter by selecting corresponding filter coefficient that complies with multiple wireless standards from stored memory and transmits to register to reconfigure the baseband filter. Hence, the present invention does not require an external processor, therefore, giving fast configuration operations with minimal physical hardware component count and complexity while maintaining the reconfigurable features.

The present invention may be embodied in other specific forms without departing from its essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore indicated by the appended claims rather than by the foregoing description. All changes, which come within the meaning and range of equivalency of the claims, are to be embraced within their scope.

CLAIMS

1. A baseband modulation system for wireless communication platform, comprising:
   a sampling clock (101);
   a frequency detector (102) coupled to the sampling clock (101);
   a database (104) having at least one filter coefficient, wherein the filter coefficient complies with at least one wireless standards;
   at least one filter (106) to perform filtering operation to an input signal ;
   at least one register (105) coupled to the filter (106); and
   a control module (103) coupled between the database (104) and the frequency detector (102);
   the arrangement being such that, when the frequency detector (102) obtain a frequency sampling from the sampling clock (101), it transmits the frequency sampling to the control module (103) for computation using a State Machine model, which retrieves a filter coefficient from the database (104) based on the computation and loads the retrieved filter coefficient to the register (105) for modulating an input signal (107) using a filter (106) in way such that a modulated output signal (108) produced.

2. A baseband modulation system according to claim 1, wherein the frequency detector (102) is an analogue module.

3. A baseband modulation system according to claim 1, wherein the frequency detector (102) is a digital module.

4. A baseband modulation system according to claim 1, wherein the control module (103) is a Finite State Machine model.

5. A method of baseband modulation for wireless communication platform using baseband filter, comprising steps of:
   receiving a sampling clock (201) from the input sampling clock (101);
   reading frequency sampling (202) of the sampling clock using a frequency detector (102);

transmitting the frequency sampling (203) to a control module (103);

computation on the frequency sampling (204) to determine a filter coefficient from a database (104) using the control module (103);

retrieving the filter coefficient that complies with at least one wireless standards from the database (104) using a State Machine model of the control module (103);

loading the selected filter coefficient to a register (105) for modulation process (206); and

modulating an input signal (107) based on the filter coefficient loaded into the register (105) to obtain a filtered output signal (108) using a filter (106).

6. A method of baseband modulation according to claim 5, wherein the frequency detector (102) uses an analogue module for reading sampling clock (202).

7. A method of baseband modulation according to claims 5, wherein the frequency detector (102) uses a digital module for reading sampling clock (202).

8. A method of baseband modulation according to claims 5, wherein the control module (103) uses a Finite State Machine model.

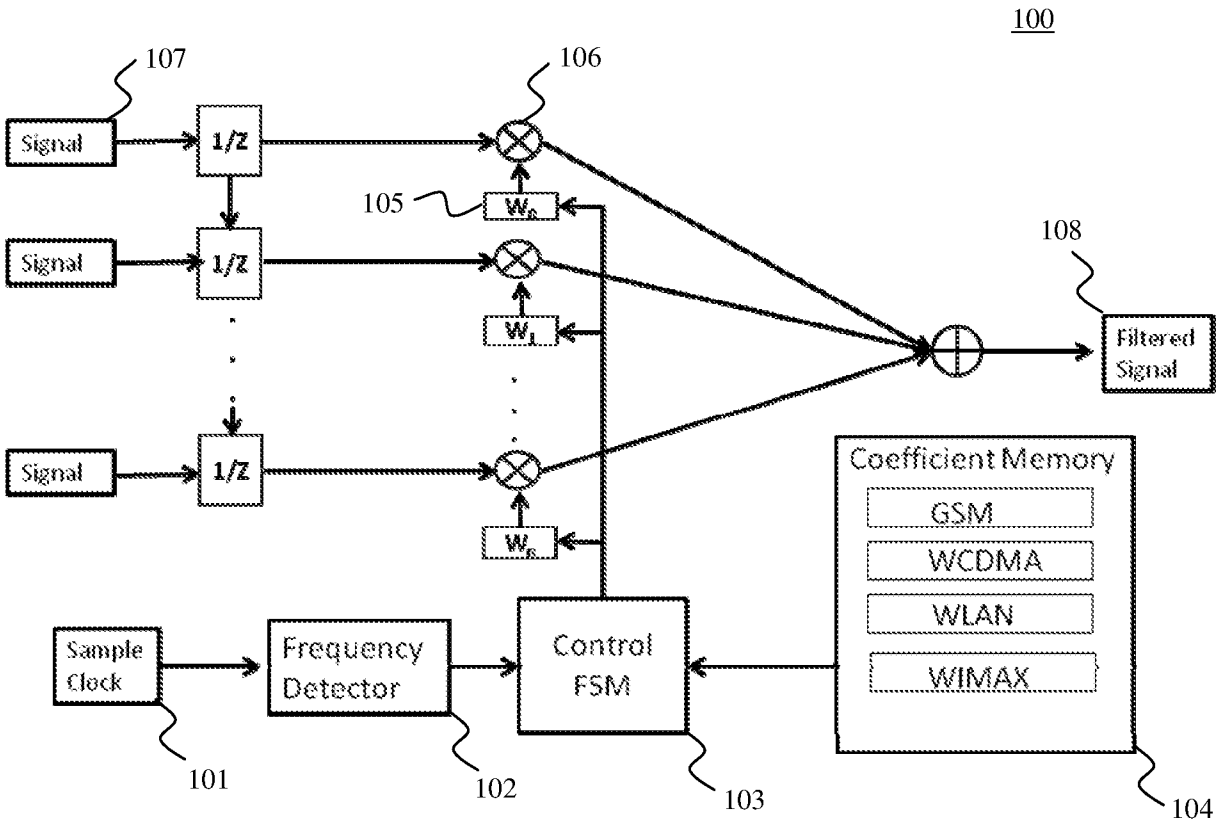
100
107
106
Signal
1/Z
105
W_n
Signal
1/Z
W_1
108
Filtered Signal
Signal
1/Z
W_0
Coefficient Memory
GSM
WCDMA
WLAN
WIMAX
Sample Clock
Frequency Detector
Control FSM
101
102
103
104

Figure 1

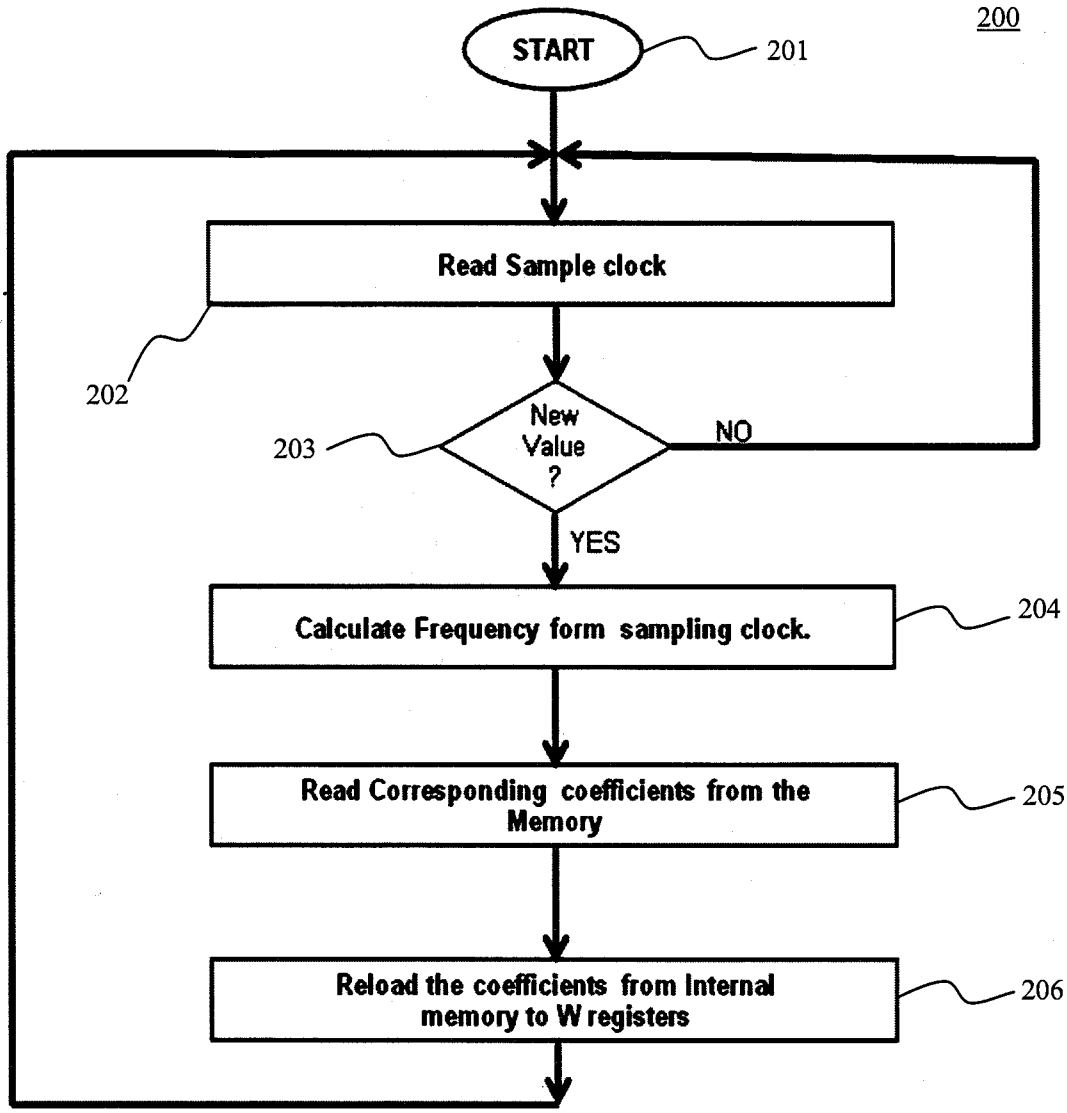
200
START
201
Read Sample clock
202
New Value ?
203
NO
YES
Calculate Frequency form sampling clock.
204
Read Corresponding coefficients from the Memory
205
Reload the coefficients from Internal memory to W registers
206

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2015/050070

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H04B1/40(2015.01)i, H03H17/02(2006.01)i, H03H17/06(2006.01)i

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)

Int.Cl. H04B1/40, H03H17/02, H03H17/06

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2015
Registered utility model specifications of Japan 1996-2015
Published registered utility model applications of Japan 1994-2015

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

IEEE Xplore

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/0003844 A1 (Markus DOETSCH et al.) 2002.01.10, [0055]-[0057],[0065],Fig.1,2 & JP 2002-534896 A & WO 2000/041322 A1 & DE 59907756 D & CN 1332910 A	1-8
A	US 2006/0045212 A1 (Hirotake ISHII et al.) 2006.03.02, [0080],FIG.2 & JP 2006-60721 A & CN 1741399 A	1-8

☐ 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

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"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

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"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

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Date of the actual completion of the international search	Date of mailing of the international search report
30.09.2015	13.10.2015

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