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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fadhel	M.	GHANNOUCHI	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Calgary	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	2500 University Drive, NW		
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302		
City	Calgary	**State/Province**	AB
Postal Code	T2N 1N4	**Country** i	CA

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Aiden		BASSAM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

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Mailing Address of Inventor:

Address 1	2500 University Dr.		
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City	Calgary	**State/Province**	AB
Postal Code	T2N 1N4	**Country** i	CA

Inventor 3 Remove

Legal Name

Exhibit 1002
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000001

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Prefix	Given Name	Middle Name	Family Name	Suffix
	Mohamed		HELAOUI	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

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City	Calgary	State/Province	AB
Postal Code	T2N 1N4	**Country** i	CA

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrew		KWAN	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

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Mailing Address of Inventor:

Address 1	2500 University Dr. NW
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302

City	Calgary	State/Province	AB
Postal Code	T2N 1N4	**Country** i	CA

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	43563		
Email Address	kevin.pillay@moffatco.com	Add Email	Remove Email

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Application Information:

Title of the Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP		
Attorney Docket Number	4207-113	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	1

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
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Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
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Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13274290	2011-10-14

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) [i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix
	Fadhel	M.	GHANNOUCHI	

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Mailing Address Information:			
Address 1	c/o University of Calgary, 2500 University Dr. N.W		
Address 2	Electrical and Computer Engineering Dpt. ICT 302		
City	Calgary	**State/Province**	AB
Country i	CA	Postal Code	T2N 1N4
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

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Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

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Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

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	Application Number	
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Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications					
Signature	/KEVIN PILLAY/			Date (YYYY-MM-DD)	2014-08-25
First Name	Kevin	Last Name	Pillay	Registration Number	41559
Additional Signature may be generated within this form by selecting the Add button. Add					

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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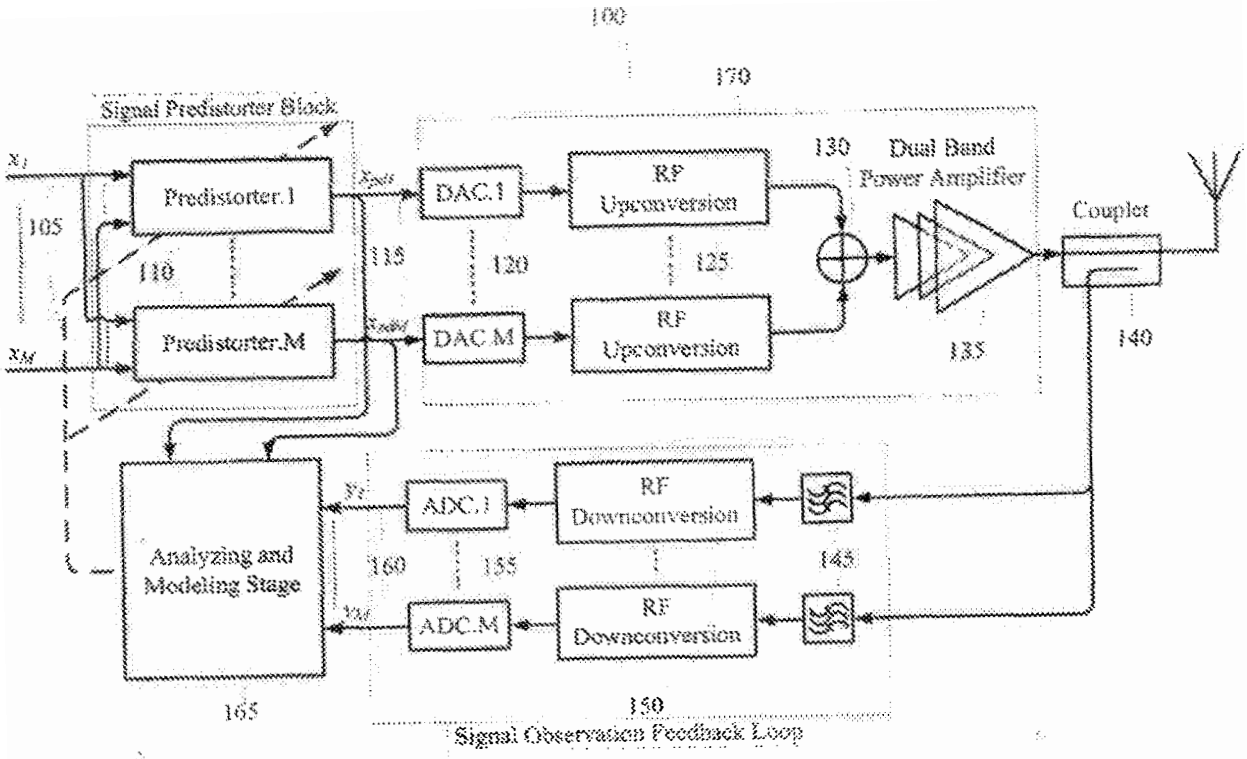

100
170
Signal Predistorter Block
Predistorter.1
Predistorter.M
105
110
115
120
125
130
Dual Band
Power Amplifier
DAC.1
DAC.M
RF
Upconversion
RF
Upconversion
Coupler
135
140
Analyzing and
Modeling Stage
ADC.1
ADC.M
RF
Downconversion
RF
Downconversion
145
155
160
165
150
Signal Observation Feedback Loop

Figure 1

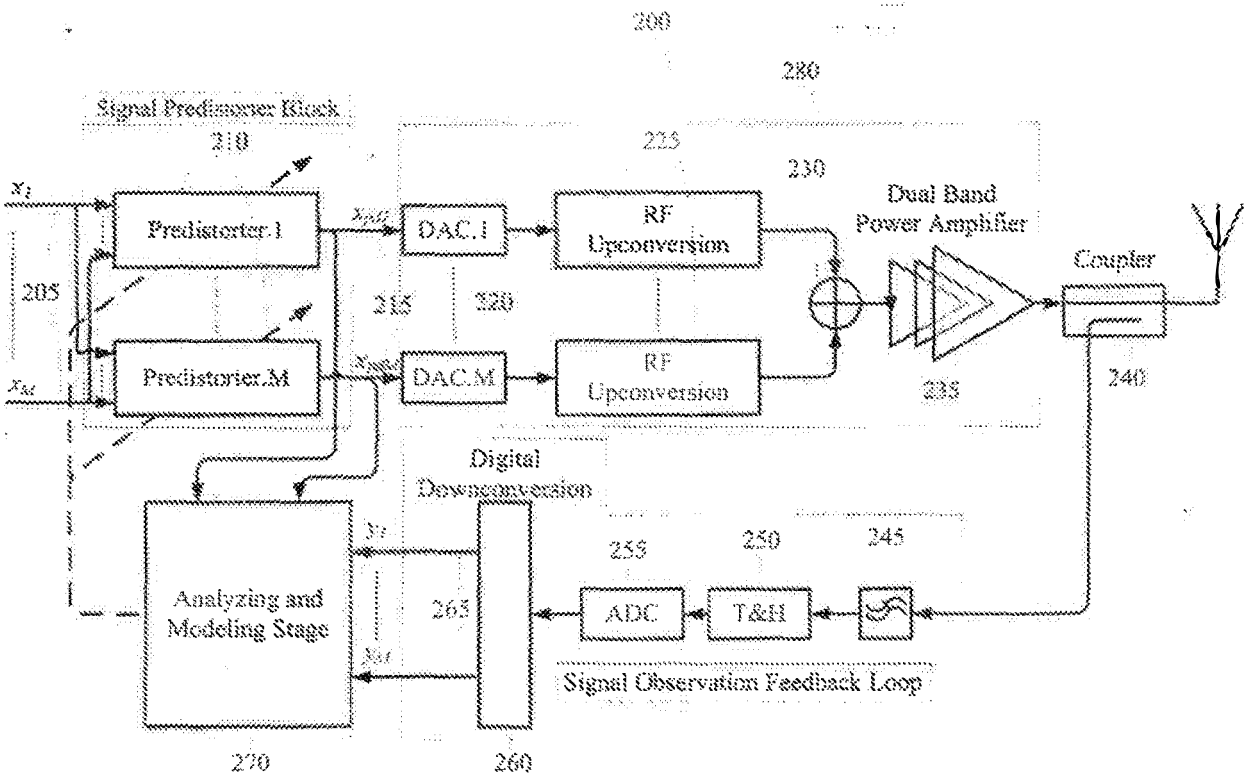


Figure 2

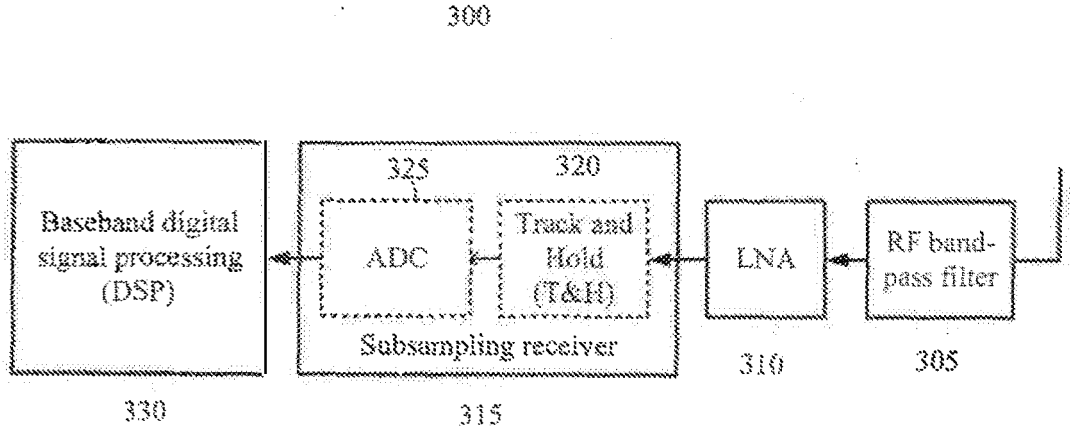


Figure 3

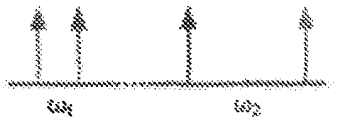


Figure 4A

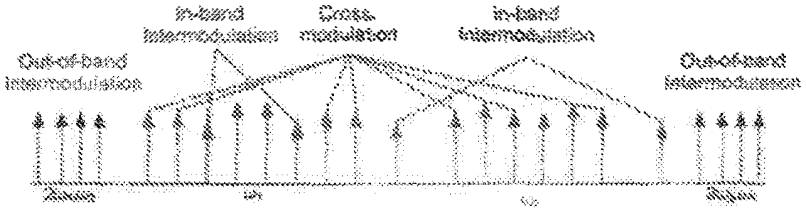


Figure 4B

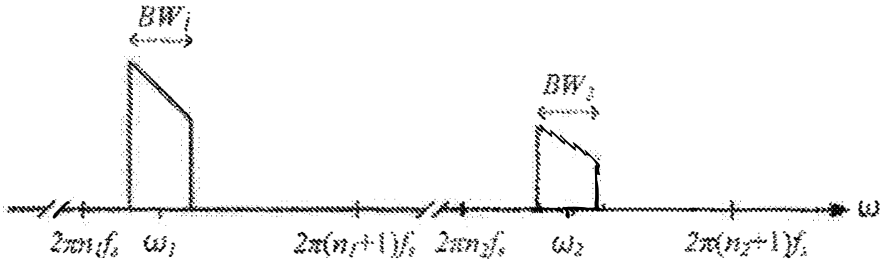


Figure 5

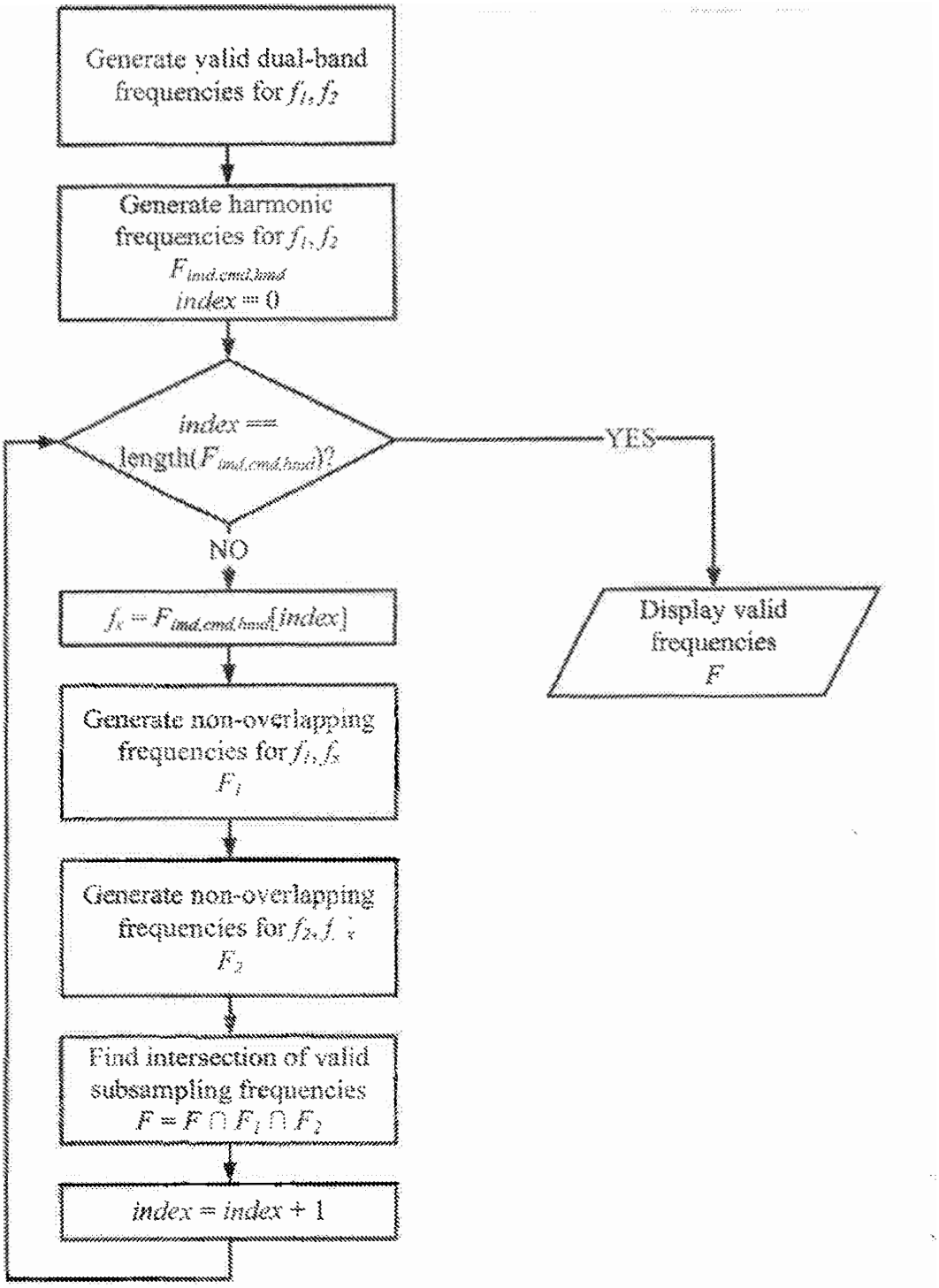

Generate valid dual-band frequencies for f_1, f_2
Generate harmonic frequencies for f_1, f_2
$F_{lmd,cmd,hmd}$
$index = 0$
$index ==$ length($F_{lmd,cmd,hmd}$)?
YES
NO
$f_x = F_{lmd,cmd,hmd}[index]$
Display valid frequencies
F
Generate non-overlapping frequencies for f_1, f_x
F_1
Generate non-overlapping frequencies for f_2, f_x
F_2
Find intersection of valid subsampling frequencies
$F = F \cap F_1 \cap F_2$
$index = index + 1$

Figure 6

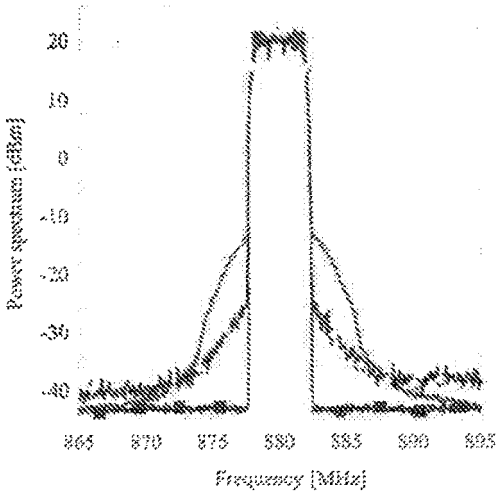


Figure 7A

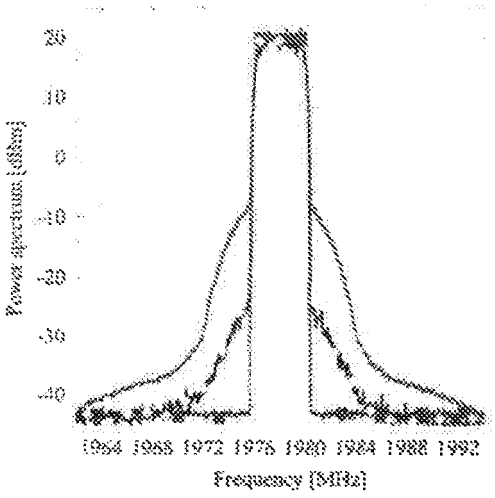
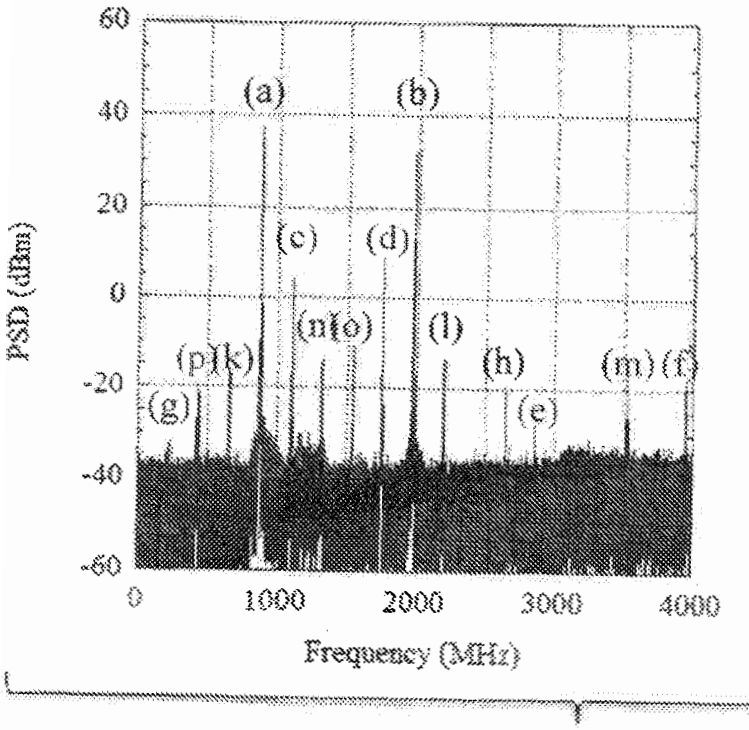


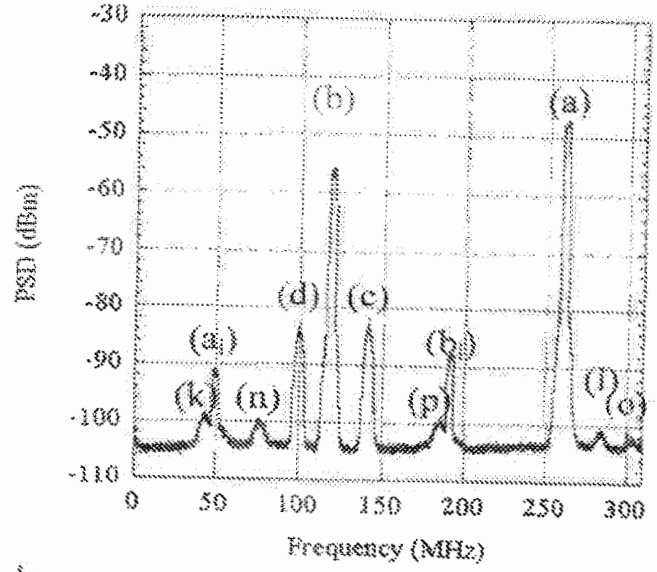
Figure 7B



RF SIGNALS AT THE TRANSMITTER OUTPUT

	Harmonic	RF Freq. (MHz)
a	f_1	880
b	f_2	1978
c	$f_2 - f_1$	1098
d	$2f_1$	1760
e	$f_1 + f_2$	2858
f	$2f_2$	3956
g	$f_2 - 2f_1$	218
h	$3f_1$	2640
i	$2f_2 - f_1$	3076
j	$2f_1 + f_2$	3738
k	$3f_2 - f_1$	4836
l	$2f_2 - 2f_1$	3196
m	$4f_1$	3520
n	$2f_2 - 3f_1$	1316
o	$4f_2 - f_1$	6782

Figure 8



BASEBAND FREQUENCIES USING A SUBSAMPLED FREQUENCY OF 619.8 MHz

	Harmonic	Subsampled Freq. (MHz)
a	f_1	260.20
b	f_2	118.40
c	$f_2 - f_1$	141.60
d	$2f_1$	99.40
e	$f_1 + f_2$	241.00
f	$2f_2$	237.20
g	$f_2 - 2f_1$	218.00
h	$3f_1$	160.80
i	$2f_2 - f_1$	33.00
j	$2f_1 + f_2$	19.20
k	$3f_2 - f_1$	42.80
l	$2f_2 - 2f_1$	285.20
m	$4f_1$	198.80
n	$2f_2 - 3f_1$	76.40
o	$4f_2 - f_1$	302.40

Figure 9

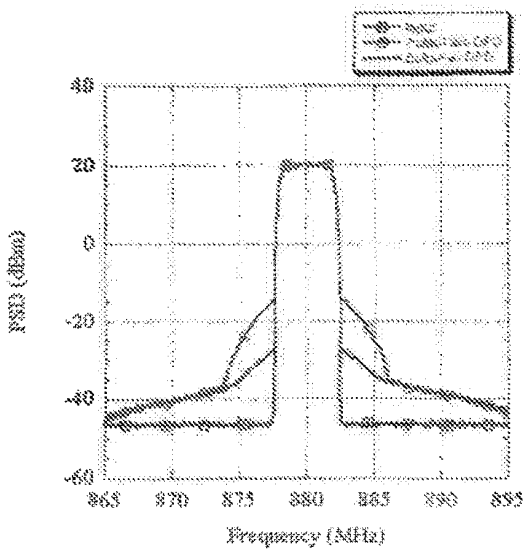


Figure 10A

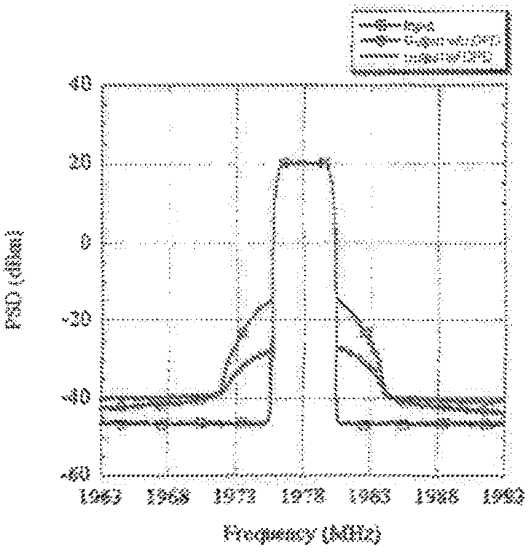


Figure 10B

Digital Multi-band Predistortion Linearizer with Nonlinear Subsampling Algorithm in the Feedback Loop

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation of US Serial No. 13/274,290 filed October 14, 2011 the entirety of which is incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

[0002] Not Applicable.

APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to multi-band digital predistortion linearization.

RELATED ART

[0002] Power-efficient, low-complex, and reconfigurable radio system requires the design of energy-efficient transmitter and receiver architectures. At the transmitter side, the power consumption is mainly dominated by the RF power amplification (PA) unit. Generally, PAs are the most power consuming and the least power efficient components of the RF chain. Moreover, their nonlinear behavior and non-flat frequency response introduce unwanted

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intermodulation distortions into the system, which could significantly degrade the output signal quality

[0003] An efficient and proper approach to linearize the transmitter nonlinearities, including the frequency up-conversion and power amplification units, is digital predistortion (DPD) linearization technique. The DPD technique is based on developing a reverse model of the nonlinear behavior and predistorted the input signals accordingly in order to compensate for the distortions and nonlinearities introduced by the transmitter.

[0004] In dual-band system, the nonlinear behavior of the device will introduce intermodulation, cross modulation, and harmonic products caused by the two fundamental signals. This can be extended to multi-band systems where more than two active signals are transmitted simultaneously.

[0005] The linearization of multi-band transmitter is based on the digital predistortion linearization. The DPD technique compensates for the transmitter nonlinearity while operating in the high efficiency and nonlinear region. As an example presented here in this patent, two signal processing blocks are employed to deal and compensate for the unwanted distortions and intermodulation products of the dual-band transmitter. In the scenario of multi-band transmitter (dual-band or more) this processing architecture can be expanded to multiple processing block for linearization and distortion compensation of multi-band transmitter.

[0006] In order to obtain samples of the signal from the output of the multi-band system, multi-branch or multi-band down converter is required in the feedback loop. This feedback loop can be developed using multi-band down conversion unit, multi-branch down conversion unit, or using subsampling based down conversion unit.

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[0007] In one case, an energy-efficient and low-complex subsampling receiver is adopted in the feedback loop of the multi-band linearization architecture. The subsampling receiver architecture is designed to concurrently down-convert the multiple RF signals through single receiver chain. Using subsampling technique simplifies the feedback loop topology, requires fewer number of RF components, and reduces the power consumption.

[0008] Substituting the multi-band or multi-branch receiver feedback loop of the linearization topology with subsampling receiver architecture reduces the complexity of the system. The subsampling down conversion is not very common as receivers because of its insufficient performance in the presence of uncontrolled interfering signals. However, in the case of a DPD feedback loop, the problem is different and the interfering signals can be controlled such that they will not affect the signal quality. The different intermodulation, cross modulation and harmonic products make choosing the sampling frequency a complex task in order to avoid any overlap between the down-converted desired signals and their intermodulation and cross modulation products. Therefore, it is imperative to develop an algorithm to select the sampling frequency so that it takes into account all the possible frequencies such that the target signals will not be interfered with the undesired product terms.

SUMMARY OF THE INVENTION

[0009] In one aspect of the present invention, a concurrent digital multi-band linearizer compromises a baseband signal preprocessing block, the baseband signal processing block including a digital predistortion unit; a signal up-conversion block, an RF power amplification block, the RF power amplification block including the concurrent multi-band power amplifier; and an RF power combining network.

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[0010] In the description of the invention, a concurrent dual-band amplifier will be used. It is noted that a concurrent dual-band power amplifier which includes one amplification unit for two frequency bands may be considered in one sense a simple and special case of multi-band power amplifiers.

[0011] In one aspect of the present invention, the feedback loop of the digital predistortion consists of multiple RF down-conversion units associated with each of the frequency band of operation.

[0012] In another aspect of the present invention, a single feedback loop based on subsampling receiver technique is used to down-convert and extract the RF signals form all the frequency band at the same time.

[0013] Further areas of applicability of the present invention will become apparent with reference to the following drawings, description and claims. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0015] Figure 1 is a block diagram of the dual-band digital predistortion architecture according to an exemplary embodiment of the present invention.

[0016] Figure 2 is an alternate embodiment illustrating a detailed block diagram of the architecture of Figure 1, using subsampling based feedback loop.

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[0017] Figure 3 is one embodiment illustrating a detailed block diagram of the subsampling receiver architecture of Figure 2.

[0018] Figure 4 is the signal representation at the input and output of the dual-band transmitter. It consists of the fundamental signals at the input and the fundamental and intermodulation terms at the output of the nonlinear transmitter.

[0019] Figure 5 is dual-band RF signal and the frequency position of the subsampling harmonics.

[0020] Figure 6 is a flowchart illustrating the steps of the execution of finding the possible subsampling frequencies.

[0021] Figure 7 is the power spectrum of the predistortion results using dual-band digital prediction technique with dual-branch feedback loop.

[0022] Figure 8 is the Power spectrum of the output of the dual-band nonlinear transmitter including the two fundamental RF signals and their inter-modulation products and harmonics.

[0023] Figure 9 is the Power spectrum of the captured signal using an ADC operating at 619.8 MHz sampling frequency.

[0024] Figure 10 is the power spectrum of the predistortion results of using dual-band digital prediction technique with subsampling feedback loop.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

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[0026] Broadly, an embodiment of the present invention provides multiple branch digital predistortion linearization architecture and digital signal processing algorithms for impairments-free operation and linearized multi-band transmitter.

[0027] Referring to Figure 1, the system block diagram of the dual-band linearization architecture 100 is displayed. The input signals, x1 and x2, 105 are fed into two distinct predistorters blocks 110. The predistorted signals 115 are converted from digital to analog 120 and up-converted 125 to RF frequencies. Then the two RF signals are combined 130 and amplified by the power amplifier 135.

[0028] For digital predistortion linearization and identify the inverse model, the sample of the RF signal are captured using dual-band coupler 140. Then the RF signals are bandpass filtered 145, frequency down converted 150, digitized using analog-to-digital converters 155. The digital output samples 160, the input signals 105 and predistorted signals 115 are used in the analyzing stage 165 for nonlinear model identification and reverse modeling.

[0029] The feedback path of the dual-band linearizer requires the use of two down-conversion stages 150, as well as bandpass filters 145 to remove most of the imperfections caused by the power amplifier. The predistorted inputs, x_{pd1} and x_{pd2}, 115 as well as the output of each band of the PA, y_1 and y_2, 160 are used to generate the predistorter signal processing model 110. The processing model equations of the linearization processing algorithm 165 for prediction and compensation of the distortions and intermodulations is as follows:

$$x_{pd1}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{1,j,k,m} x_1(n-m)\left|x_1(n-m)\right|^{k-j}\left|x_2(n-m)\right|^{j}$$

$$x_{pd2}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{2,j,k,m} x_2(n-m)\left|x_2(n-m)\right|^{k-j}\left|x_1(n-m)\right|^{j} \quad (1)$$

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[0030] Where $x_1(n)$ and $x_2(n)$ are the input signals, $x_{pd1}(n)$ and $x_{pd2}(n)$ are the predistorted signals to the input of the dual-band transmitter, $c_{1,j,k,m}$ and $c_{2,j,k,m}$ are the indentified model's coefficients, and finally M is the order of the memory effect and K is the order of nonlinearity.

[0031] Concurrent multi-band receiver architectures require a bandpass filter 145, down-conversion stage 150, and ADC 155 for the translation of each RF frequency bands to baseband. Using subsampling with a high speed ADC allows the elimination of all these components; however, the user needs to make sure that the signals don't overlap in the subsampled spectral domain.

[0032] Sampling multi-bands at the same time also eliminates the time delay taken between different band paths caused by the filters. Figure 2 displays the dual-band predistortion architecture with a subsampling feedback loop 200. At the feedback loop, it consists of optional bandpass filters 245, a track and hold 250, an analog-to-digital converter 255, a digital conversion unit 260, and analyzing stage 270.

[0033] Sampling the band-limited RF signal at frequency rates much lower than the carrier frequency, but higher than signal bandwidth folds the RF signal to the lower frequencies, where these replicates of the RF signal at baseband or intermediate frequencies can be used to reconstruct the baseband signal. To make sure that there is no aliasing between the replicas, the subsampling rate should be chosen in the following range:

$$\frac{2f_U}{n} \le f_s \le \frac{2f_L}{n-1} \quad where \quad 1 \le n \le \left\lfloor \frac{f_U}{B} \right\rfloor \qquad (2)$$
$$f_s \ge 2 \times B \quad Nyquist\ rate$$

[0034] where f_L and f_U are the lower and upper frequencies of the band-limited RF signal, $B = f_U - f_L$ is the signal bandwidth, and n is an integer value.

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[0035] Figure 3 shows a general block diagram of subsampling-based receiver 300. It consists of RF bandpass filter 305, low-noise amplifier (LNA) 310, subsampling receiver 345 including the track and hold (T&H) 320, and ADC 325 followed by baseband digital signal processing (DSP) unit 330. The T&H 320 is required to expand the analog bandwidth of the receiver and defines the RF range of receiver operation. The sampling clock of the T&H 320 and ADC 325 are chosen from (2) to avoid any aliasing with the other RF signals.

[0036] In dual-band operation transmitter with nonlinearity, the first and second bands will produce intermodulation, cross modulation and harmonic products. Figure 4 shows the power spectrum of the input signal, and the output signal when passed through a third order nonlinear system. The input signals as two-tone signal around carrier frequencies of ω_1 and ω_2 (Figure 4(a)) the output signals are around carrier frequencies of ω_1 and ω_2 and the 3rd order intermodulation frequencies of $2\omega_1-\omega_1$ and $2\omega_2-\omega_1$ (Figure 4(b)). The unwanted intermodulation can be classified into three groups of cross-modulation, in-band intermodulation, and out-of-band intermodulation terms. This latter is usually filtered out before transmission using RF filter to avoid signal quality degradation and interference with the signals at the adjacent channels.

[0037] Now considering two RF signals at carrier frequencies of ω_2 and ω_2, with their respective bandwidths B1 and B2 as shown in Figure 5, the subsampling frequency, fs, must be chosen to ensure that the two signals do not overlap in the subsampled domain. Taking into account the subsampling theorem for sampling the multi-band signals and following the neighbor and boundary constraints, an iterative process is used to find all the valid subsampling frequencies for the two fundamental frequencies.

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[0038] The, out-of-band intermodulation-modulation, and harmonics generated by the fundamental signals are not required for the predistortion application; therefore, an iterative subsampling algorithm has been developed to subsample the RF signals without any overlap with the other unwanted RF signals. Figure 6 is the flowchart of the developed iterative subsampling algorithm to find the valid subsampling frequencies so that the replicas of the wanted RF signals have no overlap with the harmonics and intermodulation frequency terms.

[0039] Referring to Figure 7, there is shown the measured output spectrum of the dual-band transmitter 170 for three cases: 1) without using the dual-band digital pre-compensator 110, 2) using the dual-band digital pre-compensator 110 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 110 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter nonlinearity.

[0040] Referring to Figure 8, there is an example of the power spectrum at the output of the concurrent dual-band nonlinear transmitter which contains two fundamental RF frequencies and their corresponding harmonics and inter-modulation products.

[0041] As an example for the application of this invention, Figure 9, points up the power spectrum after the subsampling feedback loop which shows the two fundamental RF signals at 260.2 MHz and 118.6 MHz when the subsampling frequency of 619.8 is used following is determination by the developed iterative subsampling algorithm illustrated in Figure 6. The spectrum in Figure 9 shows that the harmonics and inter-modulation terms have no interference with the two desired fundamental signals.

[0042] Referring to Figure 10, there is shown the measured output spectrum of the dual-band transmitter 280 for three cases: 1) without using the dual-band digital pre-compensator 210,

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2) using the dual-band digital pre-compensator 210, 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 210 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter dynamic nonlinearity with memory effects.

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CLAIMS

What is claimed is:

1. A concurrent multi-band linearized transmitter comprising:

a concurrent digital multi-band predistortion block;

a concurrent multi-band transmitter connected to said concurrent digital multi-band predistortion block.

2. The concurrent multi-band linearized transmitter of claim 1, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks;

an analyzing and modeling stage; and

a signal observation feedback loop.

3. The concurrent multi-band linearized transmitter of claim 2, wherein said plurality of digital baseband signal predistorter blocks further comprises:

a plurality of inputs, each input corresponding to a single frequency channel;

a plurality of outputs, each output corresponding to a single frequency channel, and each output connect to an input of said concurrent multi-band transmitter.

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4. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage further comprises:

a plurality of outputs connected to and updating the parameters of said digital baseband signal predistorter blocks; and

a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop, and (b) to said outputs of said digital baseband signal predistorter blocks.

5. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage is further adapted to:

perform time alignment of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitter; and

perform the reconstruction of the complex baseband signals from sampling said outputs of the said concurrent multi-band transmitter; and

compute the parameters of said digital baseband signal predistorter blocks.

6. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop is further adapted to:

down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1; and

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extract from said down-converted samples a baseband equivalent for all frequency channels.

7. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises for each channel an RF filter:

a signal down conversion block; and

an analog-to-digital converter (ADC).

8. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises:

a single subsampling-based receiver to down-convert samples of said outputs of said concurrent multi-band transmitter.

9. The concurrent multi-band linearized transmitter of claim 8, wherein said single subsampling-based receiver further comprises:

an RF filter;

a track and hold (T&H) block; and

an analog-to-digital converter (ADC).

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Abstract

A concurrent multi-band linearized transmitter (CMLT) has a concurrent digital multi-band predistortion block (CDMPB) and a concurrent multi-band transmitter (CMT) connected to the CDMPB. The CDMPB can have a plurality of digital baseband signal predistorter blocks (DBSPBs), an analyzing and modeling (A&M) stage, and a signal observation feedback loop. Each DBSPB can have a plurality of inputs, each corresponding to a single frequency band of the multi-band input signal, and its output corresponding to a single frequency band; each output connect corresponding to an input of the CMLT. The A&M stage can have a plurality of outputs connected to and updating the parameters of the DBSPBs, and a plurality of inputs connected to either both outputs of the signal observation loop or the output of the subsampling loop and to outputs of the DBSPBs. The A&M stage can perform signals' time alignment, reconstruction of signals and compute parameters of DBSPBs.

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Digital Multi-Band Predistortion Linearizer with Nonlinear Subsampling Algorithm in the Feedback Loop
First Named Inventor/Applicant Name:	Fadhel Ghannouchi
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	70	70
Utility Search Fee	2111	1	300	300
Utility Examination Fee	2311	1	360	360
Pages:				
Claims:				
Miscellaneous-Filing:				
Late Filing Fee for Oath or Declaration	2051	1	70	70
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**800**

Electronic Acknowledgement Receipt

EFS ID:	19956306
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	Digital Multi-Band Predistortion Linearizer with Nonlinear Subsampling Algorithm in the Feedback Loop
First Named Inventor/Applicant Name:	Fadhel Ghannouchi
Customer Number:	46093
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	25-AUG-2014
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Time Stamp:	15:57:27
Application Type:	Utility under 35 USC 111(a)

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Payment was successfully received in RAM	$800
RAM confirmation Number	2481
Deposit Account	
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Application Data Sheet	4207-113_2014-08-25_ApplicationDataSheet.pdf	1561619 39b[illegible]2[illegible]2b65ecbccabe497e262c7c164bff991e9e	no	8
Warnings:					
Information:					
2	Drawings-only black and white line drawings	4207-113_Drawings.pdf	293094 [illegible]7b026f937e392ce126348195f1bc1b77a74b77e	no	7
Warnings:					
Information:					
3		4207-113_Specification.pdf	474154 1e814e7faff3f6005ac0bf97e39a550e54a88b4f	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	10
	Claims	11	13
	Abstract	14	14

Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	36597 2a09cb974bcc60bfb9ba13e5a7334fc9b805[illegible]0ff[illegible]	no	2
Warnings:					
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			Total Files Size (in bytes):	2365464	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

43563
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CANADA

FORMALITIES LETTER

OC000000070504417

Date Mailed: 09/04/2014

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application contains drawings, but the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9).
- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 1,2.
  - More than one figure is present and each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.)(see 37 CFR 1.84(u)(1)). See Figure(s) 4,7,10. A brief description of the several views of the drawings (see 37 CFR 1.74) should be added or amended to correspond to the corrected numbering of the figures. See also 37 CFR 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

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- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Fadhel M. GHANNOUCHI
  Aiden BASSAM
  Mohamed HELAOUI
  Andrew KWAN

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

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P.O. Box 1450
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Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/467,642

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	9 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/467,642	08/25/2014	2843	800	4207-113	9	1

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

FILING RECEIPT

OC000000070504416

Date Mailed: 09/04/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA;
Aiden BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

Applicant(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/274,290 10/14/2011 PAT 8817859

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 09/02/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/467,642**
Projected Publication Date: To Be Determined - pending completion of Corrected Papers
Non-Publication Request: No

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000038

Early Publication Request: No
**** SMALL ENTITY ****
Title

DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Preliminary Class

330

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

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Title 35, United States Code, Section 184

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Nokia of America Corporation, et al. v. Smart RF Inc.
000040

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Fadhel Ghannouchi et al		
Assignee:			
Title:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP		
Serial No.:	14/467,642	Filing Date:	08/25/2014
Examiner:		Group Art Unit:	
Docket No.:	4207-113	Customer No.:	43563

January 5, 2015

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

This is in response to the Notice dated 09/04/2014. Please consider the following:

Amendments to the Specification begin on page 2;

Remarks begin on page 4.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000041

Amendments to the Specification:

Please amend the specification as set forth below.

On page 5;

Please replace paragraph 18 with the following two paragraphs:

Figure 4A is the fundamental signal representation at the input of the dual-band transmitter.

Figure 4B is the fundamental signal representation at the output of the dual-band transmitter and intermodulation terms at the output of the nonlinear transmitter.

Please replace paragraph 21 with the following two paragraphs:

Figure 7A is the power spectrum of the predistortion results for 880 MHz, using dual-band digital prediction technique with dual feedback loop. Spectrums marked with circles are the output without linearization, those marked with diamonds are the output after linearization, and those marked with solid rectangles are the inputs signals.

Figure 7B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with dual-branch feedback loop, using the same codes as described for Figure 7A.

Please replace paragraph 24 with the following two paragraphs:

Figure 10A is the power spectrum of the predistortion results for 880 MHz, using dual-band digital prediction technique with subsampling feedback loop.

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Figure 10B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with subsampling feedback loop.

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REMARKS

Applicant provides herewith seven (7) sheets of replacement figures to be substituted for the seven sheets of drawings filed with the application on August 25, 2014. The specification has been amended above so that the Brief Descriptions of the Drawings section corresponds now with the replacement sheets of figures.

Respectfully submitted,

Kevin Pillay
Registration No. 41559
Agent of Record

Moffat & Co.
Macera & Jarzyna
427 Laurier Ave W.
Suite 1200
Ottawa, Ontario, Canada
K1R 7Y2
(613) 232-7302

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000044

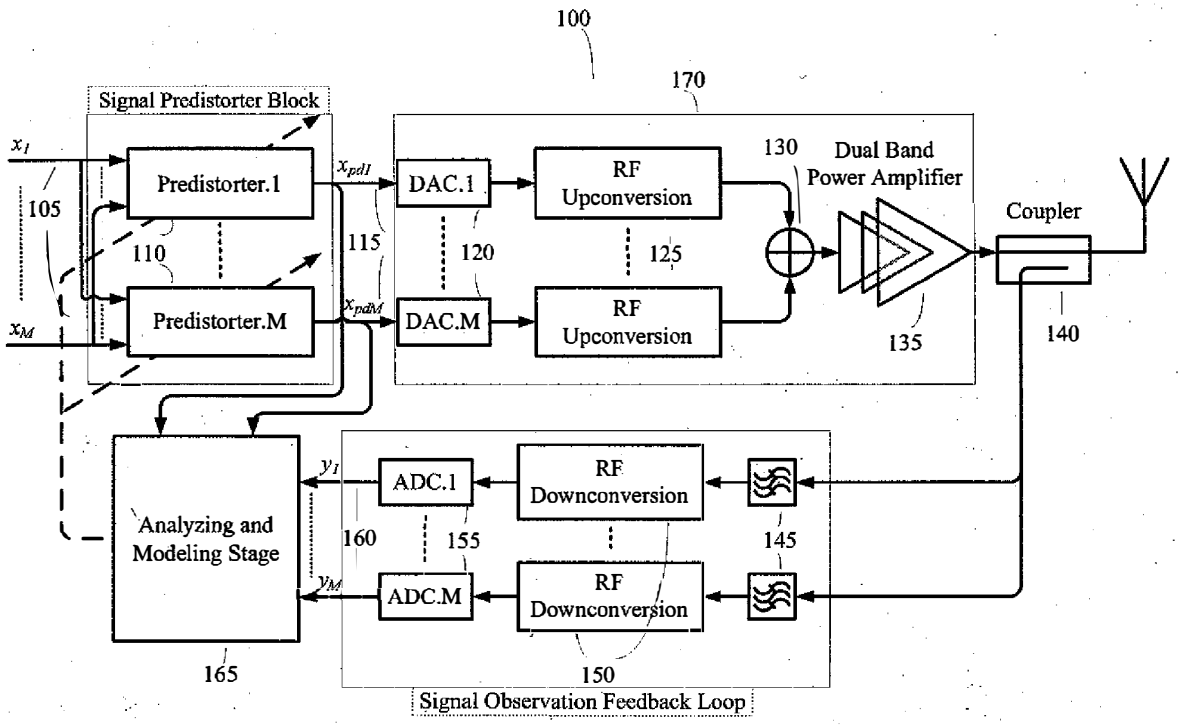

100
170
Signal Predistorter Block
x_1
x_M
105
Predistorter.1
Predistorter.M
110
x_{pd1}
x_{pdM}
115
DAC.1
DAC.M
120
RF Upconversion
RF Upconversion
125
130
Dual Band Power Amplifier
135
Coupler
140
Analyzing and Modeling Stage
165
y_1
y_M
160
ADC.1
ADC.M
155
RF Downconversion
RF Downconversion
145
150
Signal Observation Feedback Loop

Figure 1

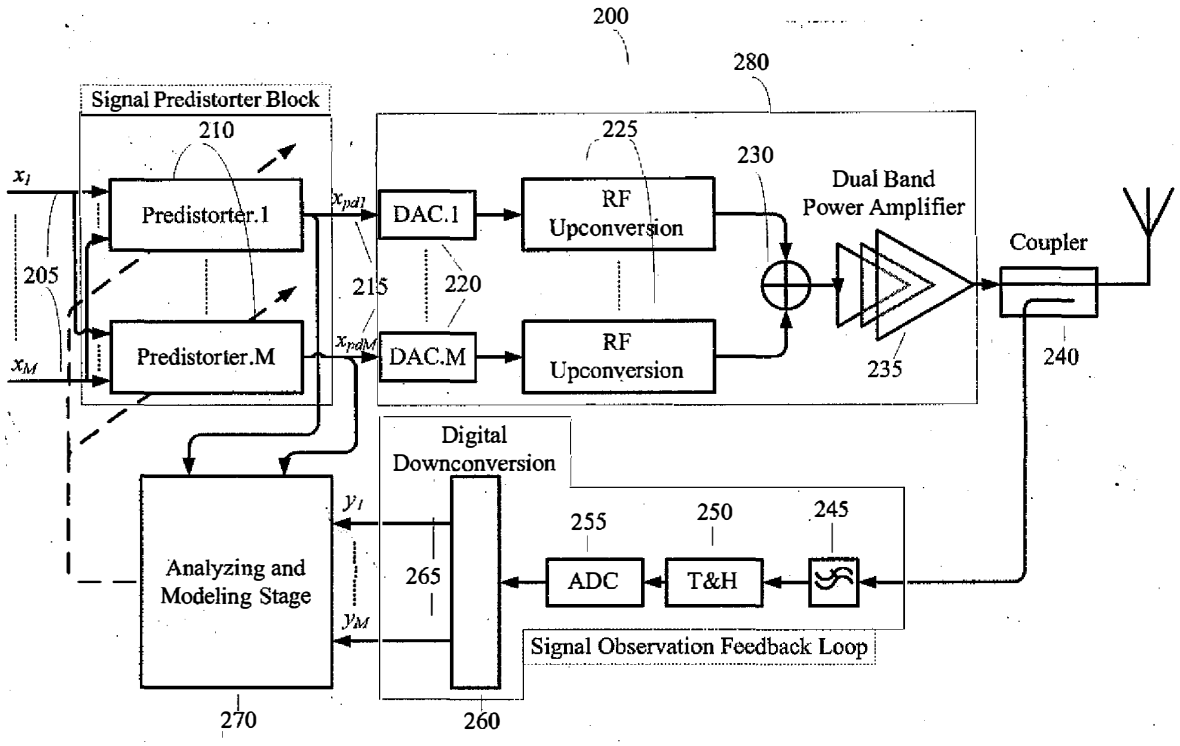


Figure 2

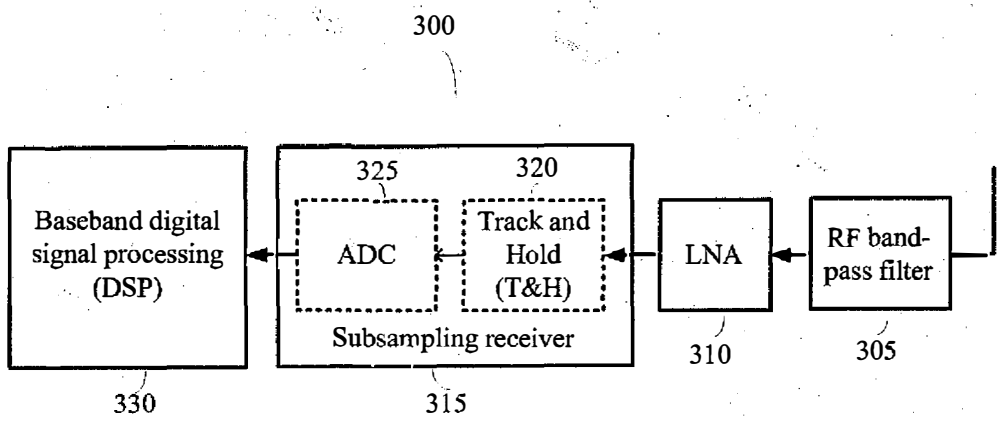


Figure 3



Figure 4A

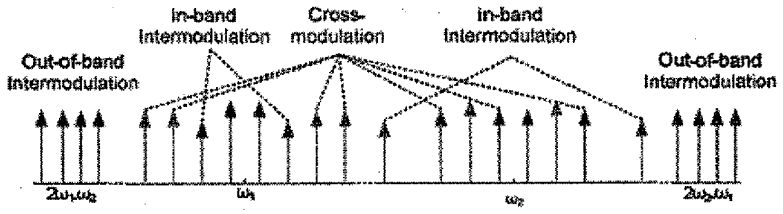


Figure 4B

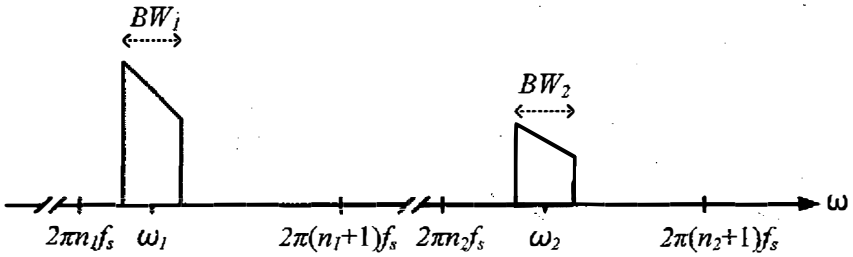


Figure 5

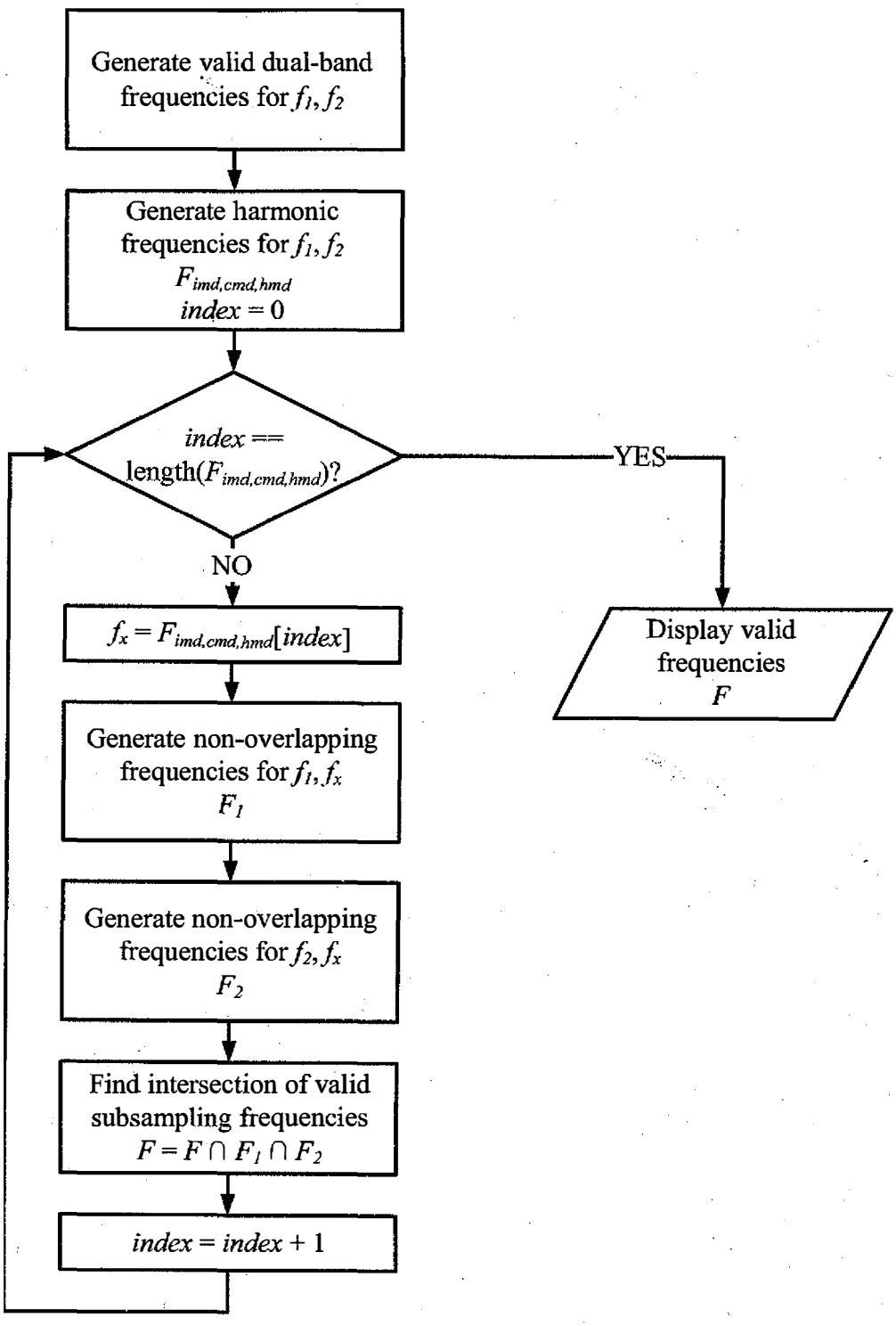

Generate valid dual-band frequencies for f_1, f_2
Generate harmonic frequencies for f_1, f_2
$F_{imd,cmd,hmd}$
$index = 0$
$index ==$ length($F_{imd,cmd,hmd}$)?
YES
NO
Display valid frequencies
F
$f_x = F_{imd,cmd,hmd}[index]$
Generate non-overlapping frequencies for f_1, f_x
F_1
Generate non-overlapping frequencies for f_2, f_x
F_2
Find intersection of valid subsampling frequencies
$F = F \cap F_1 \cap F_2$
$index = index + 1$

Figure 6

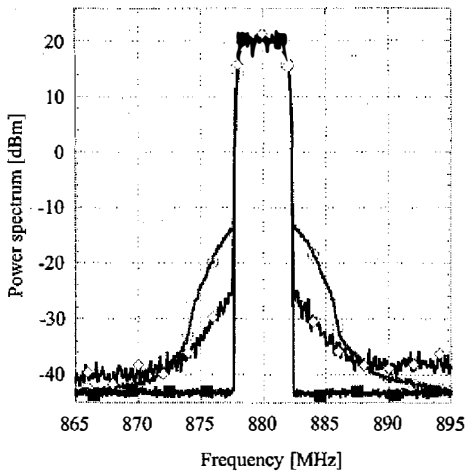


Figure 7A

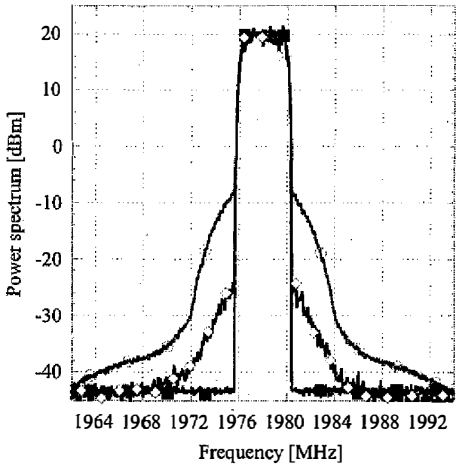
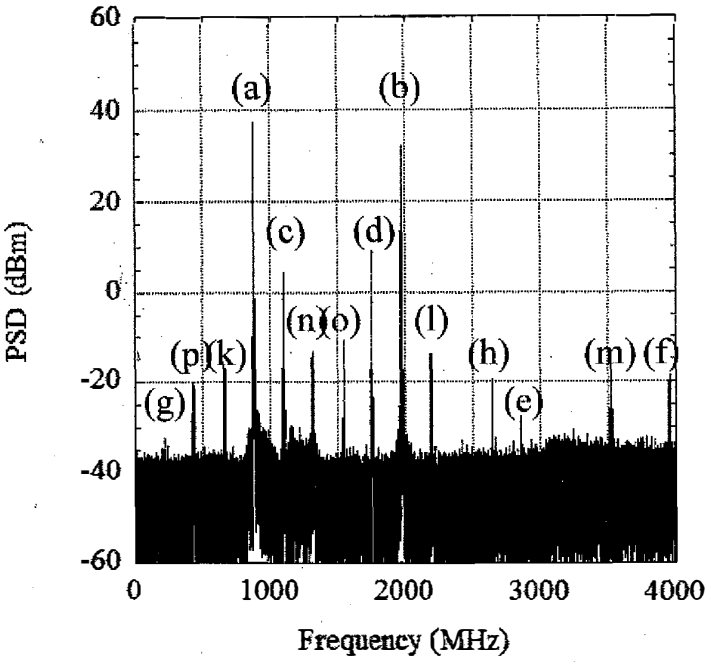


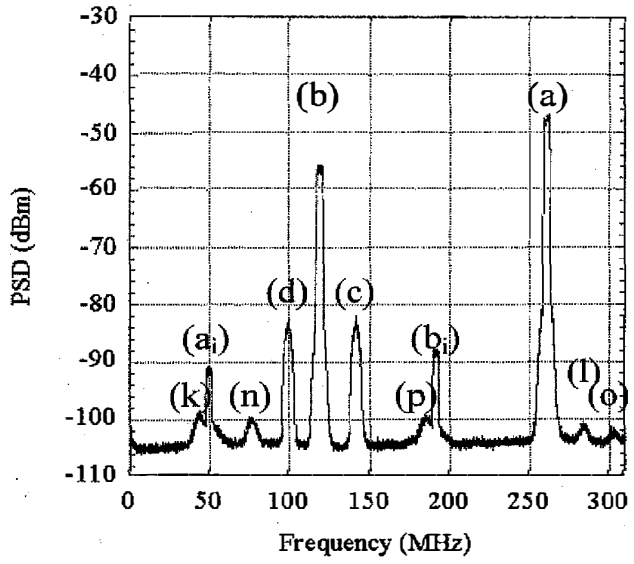
Figure 7B



RF SIGNALS AT THE TRANSMITTER OUTPUT

	Harmonic	RF Freq. (MHz)
a	f_1	880
b	f_2	1978
c	$f_2 - f_1$	1098
d	$2f_1$	1760
e	$f_1 + f_2$	2858
f	$2f_2$	3956
g	$f_2 - 2f_1$	218
h	$3f_1$	2640
i	$2f_2 - f_1$	3076
j	$2f_1 + f_2$	3738
k	$3f_1 - f_2$	662
l	$2f_2 - 2f_1$	2196
m	$4f_1$	3520
n	$2f_2 - 3f_1$	1316
o	$4f_1 - f_2$	1542

Figure 8



BASEBAND FREQUENCIES USING A SUBSAMPLED FREQUENCY OF 619.8 MHz

	Harmonic	Subsampled Freq. (MHz)
a	f_1	260.20
b	f_2	118.60
c	$f_2 - f_1$	141.60
d	$2f_1$	99.40
e	$f_1 + f_2$	241.00
f	$2f_2$	237.20
g	$f_2 - 2f_1$	218.00
h	$3f_1$	160.80
i	$2f_2 - f_1$	23.00
j	$2f_1 + f_2$	19.20
k	$3f_1 - f_2$	42.20
l	$2f_2 - 2f_1$	283.20
m	$4f_1$	198.80
n	$2f_2 - 3f_1$	76.40
o	$4f_1 - f_2$	302.40

Figure 9

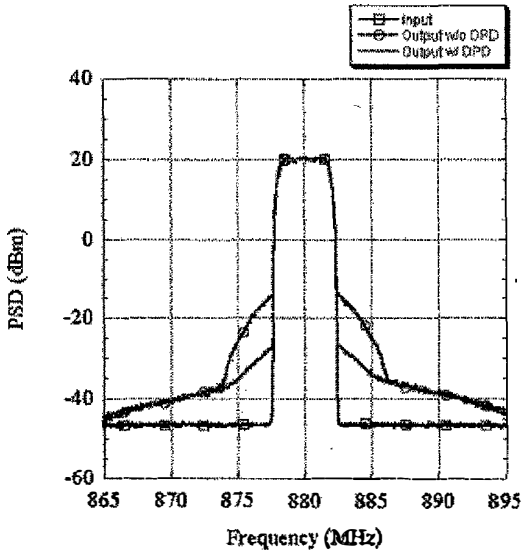


Figure 10A

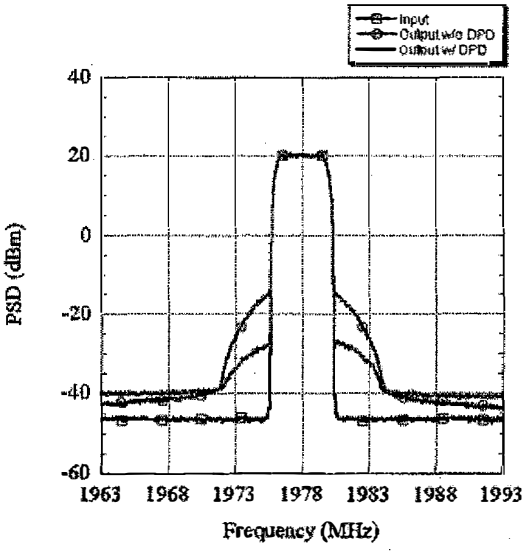


Figure 10B

PTO/AIA/22 (03-13)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 4207-113

Application Number: 14/467,642

Filed: August 25, 2014

For: DIGITAL MULTI-BAND PREDISTORTION LINEARLIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Art Unit:

Examiner:

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑ Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 300.00
☐ Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐ Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐ Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☑ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____.

☐ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 41559.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/KEVIN PILLAY/ — Signature

January 5, 2015 — Date

Kevin Pillay — Typed or printed name

613-232-7302 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
		Total in USD ($)		**300**

Electronic Acknowledgement Receipt

EFS ID:	21122055
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	05-JAN-2015
Filing Date:	25-AUG-2014
Time Stamp:	17:18:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$300
RAM confirmation Number	4029
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Certification and Request for Missing Parts	4207-113_2015-01-05_Resp_to_Notice.pdf	93376 67794731713dd86475af490170ed41e50bdee8be	no	4
Warnings:					
Information:					
2	Drawings-only black and white line drawings	4207-113ReplacementDrawings.pdf	1194220 f0221c314ee2201e5454386fe9b59fc93b2bf5ad	no	7
Warnings:					
Information:					
3	Extension of Time	4207-113_2015-01-05_ExtensionOfTime.pdf	162275 b8c1ee2ace84faa596aaf75e2942a4a1048d3166	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30676 83e4248e033687c55ca074156b3cc2cd3e5948fb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1480547		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

WITHDRAWAL NOTICE

OC000000073758343

Date Mailed: 03/05/2015

Letter Regarding a New Notice and/or the Status of the Application

If a new notice or Filing Receipt is enclosed, applicant may disregard the previous notice mailed on 09/04/2014. The time period for reply runs from the mail date of the new notice. Within the time period for reply, applicant is required to file a reply in compliance with the requirements set forth in the new notice to avoid abandonment of the application.

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web. https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If the reply is not filed electronically via EFS-Web, the reply must be accompanied by a copy of the new notice.

If the Office previously granted a petition to withdraw the holding of abandonment or a petition to revive under 37 CFR 1.137, the status of the application has been returned to pending status.

/wtsige/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000058

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

FORMALITIES LETTER

OC000000073758368

Date Mailed: 03/05/2015

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125, is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). The specification, claims, and/or abstract page(s) submitted is not acceptable and cannot be scanned or properly stored because:
  - The application contains drawings, but the specification does not contain a brief description of the several views of the drawings as required by 37 CFR 1.74 and 37 CFR 1.77(b)(9).
- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - The drawings must be reasonably free from erasures and must be free from alterations, overwriting, interlineations, folds, and copy marks. See Figure(s) 1, 2.
  - More than one figure is present and each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.)(see 37 CFR 1.84(u)(1)). See Figure(s) 4, 7, 10. A brief description of the several views of the drawings (see 37 CFR 1.74) should be added or amended to correspond to the corrected numbering of the figures. See also 37 CFR 1.77(b)(9).

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

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000059

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Fadhel M. GHANNOUCHI
  Aiden BASSAM
  Mohamed HELAOUI
  Andrew KWAN

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

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Alexandria VA 22313-1450

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For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/467,642

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	9 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/467,642	08/25/2014	2843	800	4207-113	9	1

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

FILING RECEIPT

OC00000073758366

Date Mailed: 03/05/2015

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA;
Aiden BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

Applicant(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/274,290 10/14/2011 PAT 8817859

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 09/02/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/467,642**
Projected Publication Date: To Be Determined - pending completion of Corrected Papers
Non-Publication Request: No

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Nokia of America Corporation, et al. v. Smart RF Inc.
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Early Publication Request: No
**** SMALL ENTITY ****
Title

DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Preliminary Class

330

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

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000063

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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Nokia of America Corporation, et al. v. Smart RF Inc.
000064

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Fadhel Ghannouchi et al		
Assignee:			
Title:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP		
Serial No.:	14/467,642	Filing Date:	08/25/2014
Examiner:		Group Art Unit:	
Docket No.:	4207-113	Customer No.:	43563

May 5, 2015

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

This is in response to the Notice dated 03/05/2015. Please consider the following:

Amendments to the Specification begin on page 2;

Amendments to the Drawings begin on page 4;

Remarks begin on page 5.

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Amendments to the Specification:

Please amend the specification as set forth below.

On page 5:

Please replace paragraph 18 with the following two paragraphs:

Figure 4A is the fundamental signal representation at the input of the dual-band transmitter.

Figure 4B is the fundamental signal representation at the output of the dual-band transmitter and intermodulation terms at the output of the nonlinear transmitter.

Please replace paragraph 21 with the following two paragraphs:

Figure 7A is the power spectrum of the predistortion results for 880 MHz, using dual-band digital prediction technique with dual feedback loop. Spectrums marked with circles are the output without linearization, those marked with diamonds are the output after linearization, and those marked with solid rectangles are the inputs signals.

Figure 7B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with dual-branch feedback loop, using the same codes as described for Figure 7A.

Please replace paragraph 24 with the following two paragraphs:

Figure 10A is the power spectrum of the predistortion results for 880 MHz, using dual-band digital prediction technique with subsampling feedback loop.

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Figure 10B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with subsampling feedback loop.

A clean version of the specification including the amendments is submitted herewith. A marked up copy of the specification showing the amendments is also enclosed. No new matter has been added by the amendments.

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Amendments to the Drawings:

Please replace the drawing sheets containing Figures 1, 2 and 3 with corresponding new drawing sheets, each labelled, "Replacement sheet" and submitted herewith. The replacement sheets are remove the copy marks contained in the previous sheets. No new matter has been added.

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REMARKS

Applicant provides herewith seven (2) sheets of replacement figures containing Figure 1, 2 and 3 to be substituted for the corresponding drawing sheets on file. The specification has been amended above so that the Brief Descriptions of the Drawings section corresponds now with the figures presently on file. A substitute specification in compliance with 37 CFR 1.52, 1.121(b)(3) and 1.125 I submitted herewith with marking and is accompanied by a clean version. The substitute specification contains no new matter.

Respectfully submitted,

/Kevin Pillay/

.....

Kevin Pillay
Registration No. 41559
Agent of Record

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Ottawa, Ontario, Canada
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(613) 232-7302

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Digital Multi-band Predistortion Linearizer with Nonlinear Subsampling Algorithm in the Feedback Loop

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation of US Serial No. 13/274,290 filed October 14, 2011 the entirety of which is incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

[0002] Not Applicable.

APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to multi-band digital predistortion linearization.

RELATED ART

[0002] Power-efficient, low-complex, and reconfigurable radio system requires the design of energy-efficient transmitter and receiver architectures. At the transmitter side, the power consumption is mainly dominated by the RF power amplification (PA) unit. Generally, PAs are the most power consuming and the least power efficient components of the RF chain. Moreover, their nonlinear behavior and non-flat frequency response introduce unwanted

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intermodulation distortions into the system, which could significantly degrade the output signal quality

[0003] An efficient and proper approach to linearize the transmitter nonlinearities, including the frequency up-conversion and power amplification units, is digital predistortion (DPD) linearization technique. The DPD technique is based on developing a reverse model of the nonlinear behavior and predistorted the input signals accordingly in order to compensate for the distortions and nonlinearities introduced by the transmitter.

[0004] In dual-band system, the nonlinear behavior of the device will introduce intermodulation, cross modulation, and harmonic products caused by the two fundamental signals. This can be extended to multi-band systems where more than two active signals are transmitted simultaneously.

[0005] The linearization of multi-band transmitter is based on the digital predistortion linearization. The DPD technique compensates for the transmitter nonlinearity while operating in the high efficiency and nonlinear region. As an example presented here in this patent, two signal processing blocks are employed to deal and compensate for the unwanted distortions and intermodulation products of the dual-band transmitter. In the scenario of multi-band transmitter (dual-band or more) this processing architecture can be expanded to multiple processing block for linearization and distortion compensation of multi-band transmitter.

[0006] In order to obtain samples of the signal from the output of the multi-band system, multi-branch or multi-band down converter is required in the feedback loop. This feedback loop can be developed using multi-band down conversion unit, multi-branch down conversion unit, or using subsampling based down conversion unit.

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[0007] In one case, an energy-efficient and low-complex subsampling receiver is adopted in the feedback loop of the multi-band linearization architecture. The subsampling receiver architecture is designed to concurrently down-convert the multiple RF signals through single receiver chain. Using subsampling technique simplifies the feedback loop topology, requires fewer number of RF components, and reduces the power consumption.

[0008] Substituting the multi-band or multi-branch receiver feedback loop of the linearization topology with subsampling receiver architecture reduces the complexity of the system. The subsampling down conversion is not very common as receivers because of its insufficient performance in the presence of uncontrolled interfering signals. However, in the case of a DPD feedback loop, the problem is different and the interfering signals can be controlled such that they will not affect the signal quality. The different intermodulation, cross modulation and harmonic products make choosing the sampling frequency a complex task in order to avoid any overlap between the down-converted desired signals and their intermodulation and cross modulation products. Therefore, it is imperative to develop an algorithm to select the sampling frequency so that it takes into account all the possible frequencies such that the target signals will not be interfered with the undesired product terms.

SUMMARY OF THE INVENTION

[0009] In one aspect of the present invention, a concurrent digital multi-band linearizer compromises a baseband signal preprocessing block, the baseband signal processing block including a digital predistortion unit; a signal up-conversion block, an RF power amplification block, the RF power amplification block including the concurrent multi-band power amplifier; and an RF power combining network.

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[0010] In the description of the invention, a concurrent dual-band amplifier will be used. It is noted that a concurrent dual-band power amplifier which includes one amplification unit for two frequency bands may be considered in one sense a simple and special case of multi-band power amplifiers.

[0011] In one aspect of the present invention, the feedback loop of the digital predistortion consists of multiple RF down-conversion units associated with each of the frequency band of operation.

[0012] In another aspect of the present invention, a single feedback loop based on subsampling receiver technique is used to down-convert and extract the RF signals form all the frequency band at the same time.

[0013] Further areas of applicability of the present invention will become apparent with reference to the following drawings, description and claims. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0015] Figure 1 is a block diagram of the dual-band digital predistortion architecture according to an exemplary embodiment of the present invention.

[0016] Figure 2 is an alternate embodiment illustrating a detailed block diagram of the architecture of Figure 1, using subsampling based feedback loop.

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[0017] Figure 3 is one embodiment illustrating a detailed block diagram of the subsampling receiver architecture of Figure 2.

Figure 4A is the fundamental signal representation at the input of

[0018] ~~Figure 4 is the signal representation at the input and output of the dual-band transmitter. It consists of the fundamental signals at the input and the fundamental and~~ the dual band transmitter.

Figure 4B is the fundamental signal representation at the output of the

~~intermodulation terms at the output of the nonlinear transmitter.~~ dual-band transmitter and intermodulation terms at the output of the non-linear amplifier.

[0019] Figure 5 is dual-band RF signal and the frequency position of the subsampling harmonics.

[0020] Figure 6 is a flowchart illustrating the steps of the execution of finding the possible subsampling frequencies.

Figure 7A is the power spectrum of the predistortion results for 880 MHz using dual-band digital

[0021] ~~Figure 7 is the power spectrum of the predistortion results using dual-band digital~~ prediction technique with dual feedback loop. Spectrums marked with circles are the output without

~~prediction technique with dual-branch feedback loop.~~ linearization and those marked with triangles are the output after linearization, and those marked with solid rectangles are the input signals.

[0022] Figure 8 is the Power spectrum of the output of the dual-band nonlinear transmitter including the two fundamental RF signals and their inter-modulation products and harmonics.

[0023] Figure 9 is the Power spectrum of the captured signal using an ADC operating at 619.8 MHz sampling frequency.

Figure 10A is the power spectrum of the predistortion results for 880 MHz, using dual band digital prediction

[0024] ~~Figure 10 is the power spectrum of the predistortion results of using dual-band~~ technique with subsampling feedback loop.

~~digital prediction technique with subsampling feedback loop.~~

Figure 7B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with dual-branch feedback loop, using same codes as described for Figure 7A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

Figure 10B is the power spectrums of the predistortion results for 1978 MHz, using dual band digital prediction technique with subsampling feedback loop.

[0026] Broadly, an embodiment of the present invention provides multiple branch digital predistortion linearization architecture and digital signal processing algorithms for impairments-free operation and linearized multi-band transmitter.

[0027] Referring to Figure 1, the system block diagram of the dual-band linearization architecture 100 is displayed. The input signals, x1 and x2, 105 are fed into two distinct predistorters blocks 110. The predistorted signals 115 are converted from digital to analog 120 and up-converted 125 to RF frequencies. Then the two RF signals are combined 130 and amplified by the power amplifier 135.

[0028] For digital predistortion linearization and identify the inverse model, the sample of the RF signal are captured using dual-band coupler 140. Then the RF signals are bandpass filtered 145, frequency down converted 150, digitized using analog-to-digital converters 155. The digital output samples 160, the input signals 105 and predistorted signals 115 are used in the analyzing stage 165 for nonlinear model identification and reverse modeling.

[0029] The feedback path of the dual-band linearizer requires the use of two down-conversion stages 150, as well as bandpass filters 145 to remove most of the imperfections caused by the power amplifier. The predistorted inputs, x_{pd1} and x_{pd2}, 115 as well as the output of each band of the PA, y_1 and y_2, 160 are used to generate the predistorter signal processing model 110. The processing model equations of the linearization processing algorithm 165 for prediction and compensation of the distortions and intermodulations is as follows:

$$x_{pd1}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{1,j,k,m}\, x_1(n-m)\left|x_1(n-m)\right|^{k-j}\left|x_2(n-m)\right|^{j}$$

$$x_{pd2}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{2,j,k,m}\, x_2(n-m)\left|x_2(n-m)\right|^{k-j}\left|x_1(n-m)\right|^{j} \quad (1)$$

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[0030] Where $x_1(n)$ and $x_2(n)$ are the input signals, $x_{pd1}(n)$ and $x_{pd2}(n)$ are the predistorted signals to the input of the dual-band transmitter, $c_{1,j,k,m}$ and $c_{2,j,k,m}$ are the indentified model's coefficients, and finally M is the order of the memory effect and K is the order of nonlinearity.

[0031] Concurrent multi-band receiver architectures require a bandpass filter 145, down-conversion stage 150, and ADC 155 for the translation of each RF frequency bands to baseband. Using subsampling with a high speed ADC allows the elimination of all these components; however, the user needs to make sure that the signals don't overlap in the subsampled spectral domain.

[0032] Sampling multi-bands at the same time also eliminates the time delay taken between different band paths caused by the filters. Figure 2 displays the dual-band predistortion architecture with a subsampling feedback loop 200. At the feedback loop, it consists of optional bandpass filters 245, a track and hold 250, an analog-to-digital converter 255, a digital conversion unit 260, and analyzing stage 270.

[0033] Sampling the band-limited RF signal at frequency rates much lower than the carrier frequency, but higher than signal bandwidth folds the RF signal to the lower frequencies, where these replicates of the RF signal at baseband or intermediate frequencies can be used to reconstruct the baseband signal. To make sure that there is no aliasing between the replicas, the subsampling rate should be chosen in the following range:

$$\frac{2f_U}{n} \le f_s \le \frac{2f_L}{n-1} \quad where \quad 1 \le n \le \left\lfloor \frac{f_U}{B} \right\rfloor \qquad (2)$$
$$f_s \ge 2 \times B \quad Nyquist\ rate$$

[0034] where f_L and f_U are the lower and upper frequencies of the band-limited RF signal, $B = f_U - f_L$ is the signal bandwidth, and n is an integer value.

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[0035] Figure 3 shows a general block diagram of subsampling-based receiver 300. It consists of RF bandpass filter 305, low-noise amplifier (LNA) 310, subsampling receiver 345 including the track and hold (T&H) 320, and ADC 325 followed by baseband digital signal processing (DSP) unit 330. The T&H 320 is required to expand the analog bandwidth of the receiver and defines the RF range of receiver operation. The sampling clock of the T&H 320 and ADC 325 are chosen from (2) to avoid any aliasing with the other RF signals.

[0036] In dual-band operation transmitter with nonlinearity, the first and second bands will produce intermodulation, cross modulation and harmonic products. Figure 4 shows the power spectrum of the input signal, and the output signal when passed through a third order nonlinear system. The input signals as two-tone signal around carrier frequencies of ω_1 and ω_2 (Figure 4(a)) the output signals are around carrier frequencies of ω_1 and ω_2 and the 3rd order intermodulation frequencies of $2\omega_1-\omega_1$ and $2\omega_2-\omega_1$ (Figure 4(b)). The unwanted intermodulation can be classified into three groups of cross-modulation, in-band intermodulation, and out-of-band intermodulation terms. This latter is usually filtered out before transmission using RF filter to avoid signal quality degradation and interference with the signals at the adjacent channels.

[0037] Now considering two RF signals at carrier frequencies of ω_2 and ω_2, with their respective bandwidths B1 and B2 as shown in Figure 5, the subsampling frequency, fs, must be chosen to ensure that the two signals do not overlap in the subsampled domain. Taking into account the subsampling theorem for sampling the multi-band signals and following the neighbor and boundary constraints, an iterative process is used to find all the valid subsampling frequencies for the two fundamental frequencies.

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[0038] The, out-of-band intermodulation-modulation, and harmonics generated by the fundamental signals are not required for the predistortion application; therefore, an iterative subsampling algorithm has been developed to subsample the RF signals without any overlap with the other unwanted RF signals. Figure 6 is the flowchart of the developed iterative subsampling algorithm to find the valid subsampling frequencies so that the replicas of the wanted RF signals have no overlap with the harmonics and intermodulation frequency terms.

[0039] Referring to Figure 7, there is shown the measured output spectrum of the dual-band transmitter 170 for three cases: 1) without using the dual-band digital pre-compensator 110, 2) using the dual-band digital pre-compensator 110 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 110 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter nonlinearity.

[0040] Referring to Figure 8, there is an example of the power spectrum at the output of the concurrent dual-band nonlinear transmitter which contains two fundamental RF frequencies and their corresponding harmonics and inter-modulation products.

[0041] As an example for the application of this invention, Figure 9, points up the power spectrum after the subsampling feedback loop which shows the two fundamental RF signals at 260.2 MHz and 118.6 MHz when the subsampling frequency of 619.8 is used following is determination by the developed iterative subsampling algorithm illustrated in Figure 6. The spectrum in Figure 9 shows that the harmonics and inter-modulation terms have no interference with the two desired fundamental signals.

[0042] Referring to Figure 10, there is shown the measured output spectrum of the dual-band transmitter 280 for three cases: 1) without using the dual-band digital pre-compensator 210,

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2) using the dual-band digital pre-compensator 210, 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 210 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter dynamic nonlinearity with memory effects.

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CLAIMS

What is claimed is:

1. A concurrent multi-band linearized transmitter comprising:

a concurrent digital multi-band predistortion block;

a concurrent multi-band transmitter connected to said concurrent digital multi-band predistortion block.

2. The concurrent multi-band linearized transmitter of claim 1, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks;

an analyzing and modeling stage; and

a signal observation feedback loop.

3. The concurrent multi-band linearized transmitter of claim 2, wherein said plurality of digital baseband signal predistorter blocks further comprises:

a plurality of inputs, each input corresponding to a single frequency channel;

a plurality of outputs, each output corresponding to a single frequency channel, and each output connect to an input of said concurrent multi-band transmitter.

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4. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage further comprises:

a plurality of outputs connected to and updating the parameters of said digital baseband signal predistorter blocks; and

a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop, and (b) to said outputs of said digital baseband signal predistorter blocks.

5. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage is further adapted to:

perform time alignment of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitter; and

perform the reconstruction of the complex baseband signals from sampling said outputs of the said concurrent multi-band transmitter; and

compute the parameters of said digital baseband signal predistorter blocks.

6. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop is further adapted to:

down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1; and

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extract from said down-converted samples a baseband equivalent for all frequency channels.

7 The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises for each channel an RF filter:

a signal down conversion block; and

an analog-to-digital converter (ADC).

8. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises:

a single subsampling-based receiver to down-convert samples of said outputs of said concurrent multi-band transmitter.

9. The concurrent multi-band linearized transmitter of claim 8, wherein said single subsampling-based receiver further comprises:

an RF filter;

a track and hold (T&H) block; and

an analog-to-digital converter (ADC).

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Abstract

A concurrent multi-band linearized transmitter (CMLT) has a concurrent digital multi-band predistortion block (CDMPB) and a concurrent multi-band transmitter (CMT) connected to the CDMPB. The CDMPB can have a plurality of digital baseband signal predistorter blocks (DBSPBs), an analyzing and modeling (A&M) stage, and a signal observation feedback loop. Each DBSPB can have a plurality of inputs, each corresponding to a single frequency band of the multi-band input signal, and its output corresponding to a single frequency band; each output connect corresponding to an input of the CMLT. The A&M stage can have a plurality of outputs connected to and updating the parameters of the DBSPBs, and a plurality of inputs connected to either both outputs of the signal observation loop or the output of the subsampling loop and to outputs of the DBSPBs. The A&M stage can perform signals' time alignment, reconstruction of signals and compute parameters of DBSPBs.

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Digital Multi-band Predistortion Linearizer with Non-linear Subsampling Algorithm in the Feedback Loop

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation of US Serial No. 13/274,290 filed October 14, 2011 the entirety of which is incorporated herein by reference.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

[0002] Not Applicable.

APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to multi-band digital predistortion linearization.

RELATED ART

[0002] Power-efficient, low-complex, and reconfigurable radio system requires the design of energy-efficient transmitter and receiver architectures. At the transmitter side, the power consumption is mainly dominated by the RF power amplification (PA) unit. Generally, PAs are the most power consuming and the least power efficient components of the RF chain. Moreover, their nonlinear behavior and non-flat frequency response introduce unwanted intermodulation distortions into the system, which could significantly degrade the output signal quality.

[0003] An efficient and proper approach to linearize the transmitter nonlinearities, including the frequency up-conversion and power amplification units, is digital predistortion (DPD) linearization technique. The DPD technique is based on developing a reverse model of the nonlinear behavior and predistorted the input signals accordingly in order to compensate for the distortions and nonlinearities introduced by the transmitter.

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[0004] In dual-band system, the nonlinear behavior of the device will introduce intermodulation, cross modulation, and harmonic products caused by the two fundamental signals. This can be extended to multi-band systems where more than two active signals are transmitted simultaneously.

[0005] The linearization of multi-band transmitter is based on the digital predistortion linearization. The DPD technique compensates for the transmitter nonlinearity while operating in the high efficiency and nonlinear region. As an example presented here in this patent, two signal processing blocks are employed to deal and compensate for the unwanted distortions and intermodulation products of the dual-band transmitter. In the scenario of multi-band transmitter (dual-band or more) this processing architecture can be expanded to multiple processing block for linearization and distortion compensation of multi-band transmitter.

[0006] In order to obtain samples of the signal from the output of the multi-band system, multi-branch or multi-band down converter is required in the feedback loop. This feedback loop can be developed using multi-band down conversion unit, multi-branch down conversion unit, or using subsampling based down conversion unit.

[0007] In one case, an energy-efficient and low-complex subsampling receiver is adopted in the feedback loop of the multi-band linearization architecture. The subsampling receiver architecture is designed to concurrently down-convert the multiple RF signals through single receiver chain. Using subsampling technique simplifies the feedback loop topology, requires fewer number of RF components, and reduces the power consumption.

[0008] Substituting the multi-band or multi-branch receiver feedback loop of the linearization topology with subsampling receiver architecture reduces the complexity of the system. The subsampling down conversion is not very common as receivers because of its insufficient performance in the presence of uncontrolled interfering signals. However, in the case of a DPD feedback loop, the problem is different and the interfering signals can be controlled such that they will not affect the signal quality. The different intermodulation, cross modulation and harmonic products make choosing the sampling frequency a complex task in order to avoid any overlap between the down-converted desired signals and their intermodulation and cross modulation products. Therefore, it is imperative to develop an algorithm to select the sampling frequency so that it takes into account all the possible frequencies such that the target signals will not be interfered with the undesired product terms.

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SUMMARY OF THE INVENTION

[0009] In one aspect of the present invention, a concurrent digital multi-band linearizer compromises a baseband signal preprocessing block, the baseband signal processing block including a digital predistortion unit; a signal up-conversion block, an RF power amplification block, the RF power amplification block including the concurrent multi-band power amplifier; and an RF power combining network.

[0010] In the description of the invention, a concurrent dual-band amplifier will be used. It is noted that a concurrent dual-band power amplifier which includes one amplification unit for two frequency bands may be considered in one sense a simple and special case of multi-band power amplifiers.

[0011] In one aspect of the present invention, the feedback loop of the digital predistortion consists of multiple RF down-conversion units associated with each of the frequency band of operation.

[0012] In another aspect of the present invention, a single feedback loop based on subsampling receiver technique is used to down-convert and extract the RF signals form all the frequency band at the same time.

[0013] Further areas of applicability of the present invention will become apparent with reference to the following drawings, description and claims. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0015] Figure 1 is a block diagram of the dual-band digital predistortion architecture according to an exemplary embodiment of the present invention.

[0016] Figure 2 is an alternate embodiment illustrating a detailed block diagram of the architecture of Figure 1, using subsampling based feedback loop.

[0017] Figure 3 is one embodiment illustrating a detailed block diagram of the subsampling receiver architecture of Figure 2.

[0018] Figure 4A is the fundamental signal representation at the input of the dual-band transmitter.

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[0019] Figure 4B is the fundamental signal representation at the output of the dual-band transmitter and intermodulation terms at the output of the nonlinear transmitter.

[0020] Figure 5 is dual-band RF signal and the frequency position of the subsampling harmonics.

[0021] Figure 6 is a flowchart illustrating the steps of the execution of finding the possible subsampling frequencies.

[0022] Figure 7A is the power spectrum of the predistortion results for 880 MHz, using dual-band digital prediction technique with dual-branch feedback loop. Spectrums marked with circles are the output without linearization, those marked with diamonds are the output after linearization, and those marked with solid rectangles are the inputs signals.

[0023] Figure 7B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with dual-branch feedback loop, using the same codes as described for Figure 7A.

[0024] Figure 8 is the Power spectrum of the output of the dual-band nonlinear transmitter including the two fundamental RF signals and their inter-modulation products and harmonics.

[0025] Figure 9 is the Power spectrum of the captured signal using an ADC operating at 619.8 MHz sampling frequency.

[0026] Figure 10A is the power spectrum of the predistortion results for 880 MHz. using dual-band digital prediction technique with subsampling feedback loop.

[0027] Figure 10B is the power spectrum of the predistortion results for 1978 MHz, using dual-band digital prediction technique with subsampling feedback loop.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

[0029] Broadly, an embodiment of the present invention provides multiple branch digital predistortion linearization architecture and digital signal processing algorithms for impairments-free operation and linearized multi-band transmitter.

[0030] Referring to Figure 1, the system block diagram of the dual-band linearization architecture 100 is displayed. The input signals, x1 and x2, 105 are fed into two distinct predistorters blocks 110. The predistorted signals 115 are converted from

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digital to analog 120 and up-converted 125 to RF frequencies. Then the two RF signals are combined 130 and amplified by the power amplifier 135.

[0031] For digital predistortion linearization and identify the inverse model, the sample of the RF signal are captured using dual-band coupler 140. Then the RF signals are bandpass filtered 145, frequency down converted 150, digitized using analog-to-digital converters 155. The digital output samples 160, the input signals 105 and predistorted signals 115 are used in the analyzing stage 165 for nonlinear model identification and reverse modeling.

[0032] The feedback path of the dual-band linearizer requires the use of two down-conversion stages 150, as well as bandpass filters 145 to remove most of the imperfections caused by the power amplifier. The predistorted inputs, x_{pd1} and x x_{pd2}, 115 as well as the output of each band of the PA, y_1 and y_2, 160 are used to generate the predistorter signal processing model 110. The processing model equations of the linearization processing algorithm 165 for prediction and compensation of the distortions and intermodulations is as follows:

$$x_{pd1}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{1,j,k,m}x_1(n-m)|x_1(n-m)|^{k-j}|x_2(n-m)|^{j}$$

$$x_{pd2}(n) = \sum_{m=0}^{M-1}\sum_{k=0}^{K-1}\sum_{j=0}^{k} c_{2,j,k,m}x_2(n-m)|x_2(n-m)|^{k-j}|x_1(n-m)|^{j} \quad (1)$$

[0033] Where $x_1(n)$ and $x_2(n)$ are the input signals, $x_{pd1}(n)$ and $x_{pd2}(n)$ are the predistorted signals to the input of the dual-band transmitter, $c_{1,j,k,m}$ and $c_{2,j,k,m}$ are the indentified model's coefficients, and finally M is the order of the memory effect and K is the order of nonlinearity.

[0034] Concurrent multi-band receiver architectures require a bandpass filter 145, down-conversion stage 150, and ADC 155 for the translation of each RF frequency bands to baseband. Using subsampling with a high speed ADC allows the elimination of all these components; however, the user needs to make sure that the signals don't overlap in the subsampled spectral domain.

[0035] Sampling multi-bands at the same time also eliminates the time delay taken between different band paths caused by the filters. Figure 2 displays the dual-band

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predistortion architecture with a subsampling feedback loop 200. At the feedback loop, it consists of optional bandpass filters 245, a track and hold 250, an analog-to-digital converter 255, a digital conversion unit 260, and analyzing stage 270.

[0036] Sampling the band-limited RF signal at frequency rates much lower than the carrier frequency, but higher than signal bandwidth folds the RF signal to the lower frequencies, where these replicates of the RF signal at baseband or intermediate frequencies can be used to reconstruct the baseband signal. To make sure that there is no aliasing between the replicas, the subsampling rate should be chosen in the following range:

$$\frac{2f_U}{n} \le f_s \le \frac{2f_L}{n-1} \; where \; 1 \le n \le \left\lfloor \frac{f_U}{B} \right\rfloor \qquad (2)$$
$$f_s \ge 2 \times B \; Nyquist \; rate$$

[0037] where f_L and f_U are the lower and upper frequencies of the band-limited RF signal, $B = f_U - f_L$ is the signal bandwidth, and n is an integer value.

[0038] Figure 3 shows a general block diagram of subsampling-based receiver 300. It consists of RF bandpass filter 305, low-noise amplifier (LNA) 310, subsampling receiver 345 including the track and hold (T&H) 320, and ADC 325 followed by baseband digital signal processing (DSP) unit 330. The T&H 320 is required to expand the analog bandwidth of the receiver and defines the RF range of receiver operation. The sampling clock of the T&H 320 and ADC 325 are chosen from (2) to avoid any aliasing with the other RF signals.

[0039] In dual-band operation transmitter with nonlinearity, the first and second bands will produce intermodulation, cross modulation and harmonic products. Figure 4 shows the power spectrum of the input signal, and the output signal when passed through a third order nonlinear system. The input signals as two-tone signal around carrier frequencies of ω_1 and ω_2 (Figure 4(a)) the output signals are around carrier frequencies of ω_1 and ω_2 and the 3rd order intermodulation frequencies of $2\omega_1 - \omega_1$ and $2\omega_2 - \omega_1$ (Figure 4(b)). The unwanted intermodulation can be classified into three groups of cross-modulation, in-band intermodulation, and out-of-band intermodulation terms. This latter is usually filtered out before transmission using RF filter to avoid signal quality degradation and interference with the signals at the adjacent channels.

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[0040] Now considering two RF signals at carrier frequencies of ω_2 and ω_2, with their respective bandwidths B1 and B2 as shown in Figure 5, the subsampling frequency, fs, must be chosen to ensure that the two signals do not overlap in the subsampled domain. Taking into account the subsampling theorem for sampling the multi-band signals and following the neighbor and boundary constraints, an iterative process is used to find all the valid subsampling frequencies for the two fundamental frequencies.

[0041] The, out-of-band intermodulation-modulation, and harmonics generated by the fundamental signals are not required for the predistortion application; therefore, an iterative subsampling algorithm has been developed to subsample the RF signals without any overlap with the other unwanted RF signals. Figure 6 is the flowchart of the developed iterative subsampling algorithm to find the valid subsampling frequencies so that the replicas of the wanted RF signals have no overlap with the harmonics and intermodulation frequency terms.

[0042] Referring to Figure 7, there is shown the measured output spectrum of the dual-band transmitter 170 for three cases: 1) without using the dual-band digital pre-compensator 110, 2) using the dual-band digital pre-compensator 110 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 110 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter nonlinearity.

[0043] Referring to Figure 8, there is an example of the power spectrum at the output of the concurrent dual-band nonlinear transmitter which contains two fundamental RF frequencies and their corresponding harmonics and inter-modulation products.

[0044] As an example for the application of this invention, Figure 9, points up the power spectrum after the subsampling feedback loop which shows the two fundamental RF signals at 260.2 MHz and 118.6 MHz when the subsampling frequency of 619.8 is used following is determination by the developed iterative subsampling algorithm illustrated in FIGURE 6. The spectrum in FigureE 9 shows that the harmonics and inter-modulation terms have no interference with the two desired fundamental signals.

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[0045] Referring to Figure 10, there is shown the measured output spectrum of the dual-band transmitter 280 for three cases: 1) without using the dual-band digital pre-compensator 210, 2) using the dual-band digital pre-compensator 210, 3) the input signal. The output spectrum of case-2 with digital pre-compensator shows that the digital pre-compensator 210 can compensate for the cross-modulation and in-band inter-modulation terms introduced by the transmitter dynamic nonlinearity with memory effects.

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Claims

What is claimed is:

1. A concurrent multi-band linearized transmitter comprising:

a concurrent digital multi-band predistortion block;

a concurrent multi-band linearized transmitter connected to said concurrent digital multiband predistortion block.

2. The concurrent multi-band linearized transmitter of claim 1, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks;

an analyzing and modelling stage; and

a signal observation feedback loop.

3. The concurrent multi-band linearized transmitter of claim 2, wherein said plurality of digital baseband signal predistorter blocks further comprises:

a plurality of inputs, each input corresponding to a single frequency channel;

a plurality of outputs, each output corresponding to a single frequency channel, and each output connected to an input of said concurrent multi-band transmitter.

4. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage further comprises:

a plurality of outputs connected to and updating the parameters of said digital baseband signal predistorter block;

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a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop, and (b) to said outputs of said digital baseband signal predistorter blocks.

5. The concurrent multi-band linearized transmitter of claim 2, wherein said analyzing and modeling stage is further adapted to:

perform time alignment of complex baseband signals from sampling said outputs of said concurrent multi-band transmitter; and

perform the reconstruction of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitter.

6. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further is further adapted to:

down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1; and

extract from said down-converted samples a baseband equivalent for all frequency channels.

7. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises for each channel an RF filter;

A signal down conversion block; and

an analog-to-digital converter (ADC).

8. The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further comprises:

a single subsampling-based receiver to down-convert samples output from a concurrent multi-band transmitter.

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9. The concurrent multi-band linearized transmitter of claim 8, wherein said single subsampling-based receiver further comprises:

an RF filter; a track and hold (T&H) block; and an analog-to-digital converter (ADC).

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ABSTRACT

A concurrent multi-band linearized transmitter (CMLT) has a concurrent digital multi-band predistortion block (CDMPB) and a concurrent multi-band transmitter (CMT) connected to the CDMPB. The CDMPB can have a plurality of digital baseband signal predistorter blocks (DBSPBs), an analyzing and modeling (A&M) stage, and a signal observation feedback loop. Each DBSPB can have a plurality of inputs, each corresponding to a single frequency band of the multi-band input signal, and its output corresponding to a single frequency band; each output connect corresponding to an input of the CMLT. The A&M stage can have a plurality of outputs connected to and updating the parameters of the DBSPBs, and a plurality of inputs connected to either both outputs of the signal observation loop or the output of the subsampling loop and to outputs of the DBSPBs. The A&M stage can perform signals' time alignment, reconstruction of signals and compute parameters of DBSPBs.

Exhibit 1002
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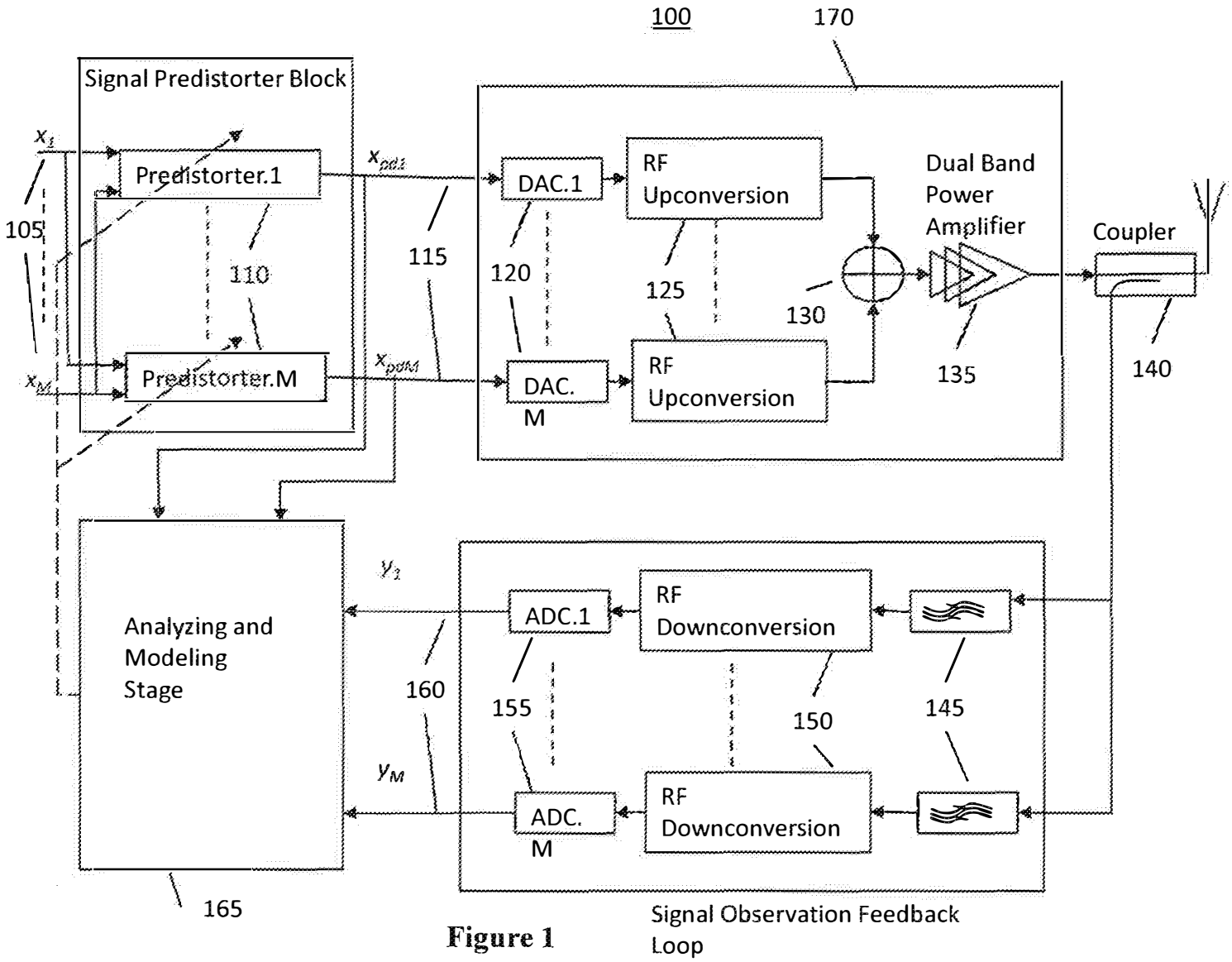


Figure 1

Replacement Sheet

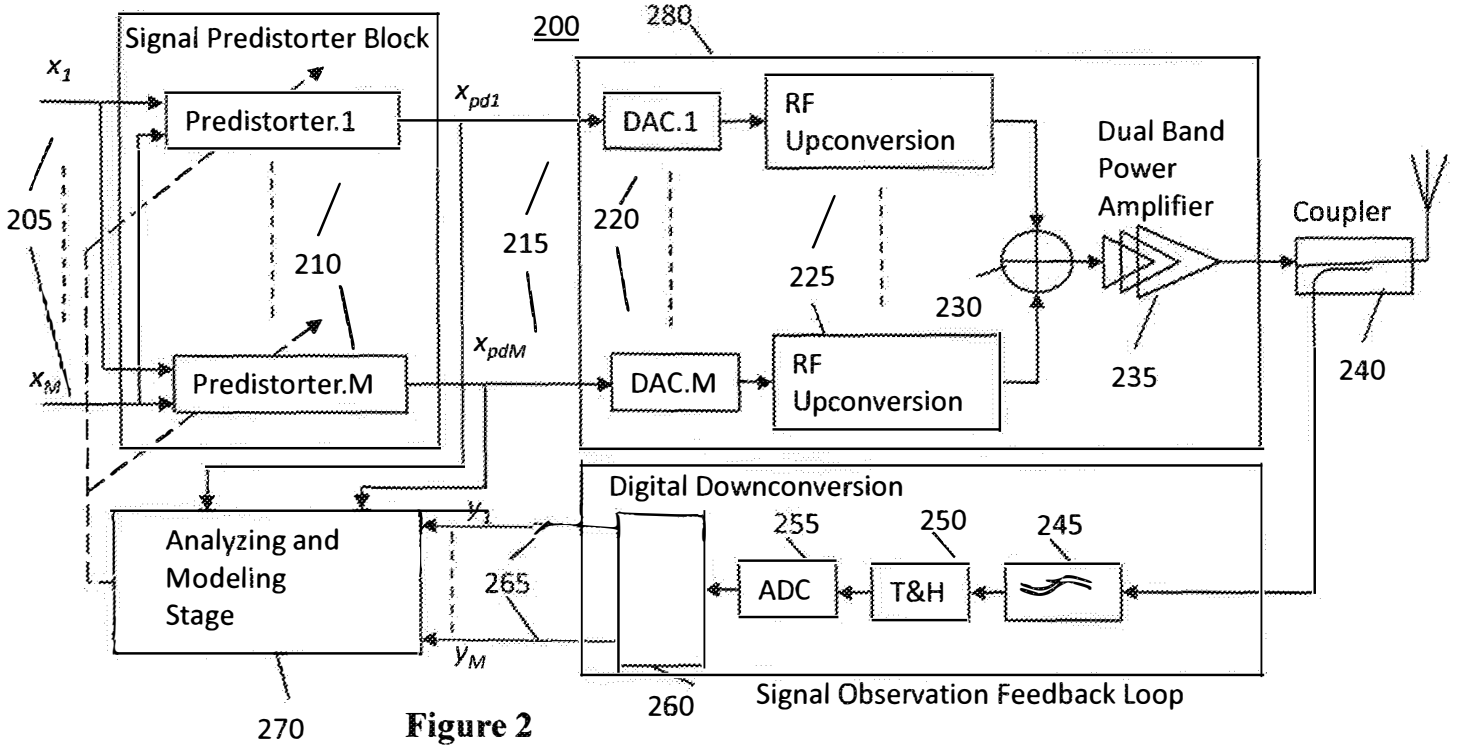


Figure 2

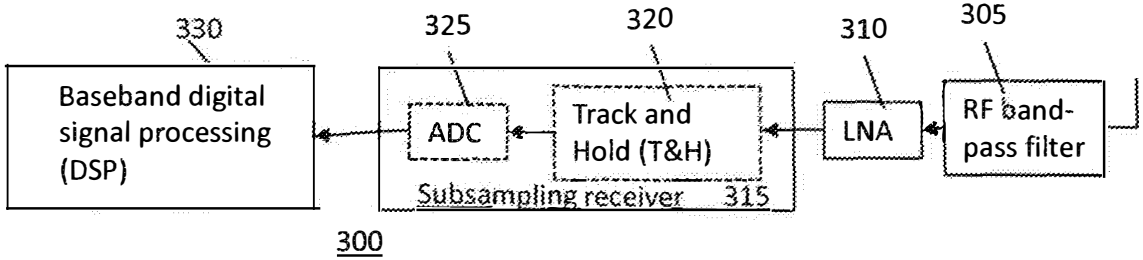


Figure 3

Replacement Sheet

Electronic Acknowledgement Receipt

EFS ID:	22264053
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	05-MAY-2015
Filing Date:	25-AUG-2014
Time Stamp:	18:47:01
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	4207-113_2015-05-05_Resp_to_Notice.pdf	488387 4a6183bf5584ca147121b433607f07318de348bf	no	5

Warnings:	
Information:	

2	Applicant Response to Pre-Exam Formalities Notice	MarkedUpSpec.pdf	543515 4a6e857d4abfe51a0d89e93bb6c0099aab474bc9	no	14
Warnings:					
Information:					
3	Applicant Response to Pre-Exam Formalities Notice	SubstituteSpec.pdf	484767 8e795720664f3593c8f8b588a9814ccfbfeb8011	no	12
Warnings:					
Information:					
4	Applicant Response to Pre-Exam Formalities Notice	ReplacementFigure1and2.pdf	96107 a9524def1caf7e7d5557d75bb9afbe110985f1db	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1612776		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/467,642

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	300		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	360		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	9 minus 20 =	*	x 40 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x 210 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	730		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

NOTICE

OC000000075081318

Date Mailed: 05/11/2015

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Fadhel M. GHANNOUCHI
  Aiden BASSAM
  Mohamed HELAOUI
  Andrew KWAN

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/467,642	08/25/2014	2843	800	4207-113	9	1

CONFIRMATION NO. 1866

UPDATED FILING RECEIPT

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

OC00000075081317

Date Mailed: 05/11/2015

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA;
Aiden BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

Applicant(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/274,290 10/14/2011 PAT 8817859

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 09/02/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/467,642**
Projected Publication Date: 08/20/2015
Non-Publication Request: No

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Nokia of America Corporation, et al. v. Smart RF Inc.
000102

Early Publication Request: No
**** SMALL ENTITY ****
Title

DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Preliminary Class

330

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

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Nokia of America Corporation, et al. v. Smart RF Inc.
000104

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

43563 7590 06/19/2015

MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
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CANADA

EXAMINER
JOSEPH, JAISON

ART UNIT	PAPER NUMBER
2633	

NOTIFICATION DATE	DELIVERY MODE
06/19/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

joe.ulvr@moffatco.com

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000105

Office Action Summary	Application No. 14/467,642	Applicant(s) GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	Art Unit 2633	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *08/25/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-9* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-9* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *8/25/2014* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

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000106

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 – 6 are rejected under pre-AIA 35 U.S.C. 102b as being anticipated by Suzuki et al (US 2005/0168283).

Regarding claim 1, Suzuki et al teach a concurrent multi-band linearized transmitter comprising: a concurrent digital multi-band predistortion block (see figure 6, component 100); a concurrent multi-band linearized transmitter connected to said concurrent digital multi-band predistortion block (see figure 6).

Regarding claim 2, which inherits the limitations of claim 1, Suzuki et al further teach wherein said concurrent digital multi-band predistortion block further comprises: a plurality of digital baseband signal predistorter blocks (see figure 6, component 100); an analyzing and modeling stage (see figure 6, component 31)); and a signal observation feedback loop (see figure 6, feedback loop).

Regarding claim 3, which inherits the limitations of claim 2, Suzuki et al further teach wherein said plurality of digital baseband signal predistorter blocks further comprises: a plurality of inputs (see figure 6), each input corresponding to a single

frequency channel (see figure 6); a plurality of outputs, each output corresponding to a single frequency channel, and each output connect to an input of said concurrent multi-band transmitter (see figure 6).

Regarding claim 4, which inherits the limitations of claim 2, Suzuki et al further teach wherein said analyzing and modeling stage further comprises: a plurality of outputs connected to and updating the parameters of said digital baseband signal predistorter block (see figure 6, component 31); and a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop (see figure 6), and (b) to said outputs of said digital baseband signal predistorter blocks (see figure 6).

Regarding claim 5, which inherits the limitations of claim 2, Suzuki et al further teach wherein said analyzing and modeling stage is further adapted to: perform time alignment of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitter (see figure 6); and perform the reconstruction of the complex baseband signals from sampling said outputs of the said concurrent multi-band transmitter (see figure 6).

Regarding claim 6, which inherits the limitations of claim 2, Suzuki et al further teach wherein said signal observation feedback loop is further adapted to: down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1; and extract from said down-converted samples a baseband equivalent for all frequency channels (see figure 6 and paragraph 0028).

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1 – 9 are rejected under pre-AIA 35 U.S.C. 102(e) as being anticipated by Fuller (US 8,391,809).

Regarding claim 1, Fuller teaches a concurrent multi-band linearized transmitter (see figure 1 and 2) comprising: a concurrent digital multi-band predistortion block (see figure 1, component 101); a concurrent multi-band linearized transmitter connected to said concurrent digital mulfiband predistortion block (see figure 1).

Regarding claim 2, which inherits the limitations of claim 1, Fuller further teaches wherein said concurrent digital multi-band predistortion block (see figure 1 and 2) further comprises: a plurality of digital baseband signal predistorter blocks (see figure 1, components 102 – 106); an analyzing and modelling stage (see figure 1, conmpoennt 108); and a signal observation feedback loop (see figure 1, Component 105, 108).

Regarding claim 3, which inherits the limitations of claim 2, Fuller further teaches wherein said plurality of digital baseband signal predistorter blocks (see figure 1)further comprises: a plurality of inputs, each input corresponding to a single frequency channel (see figure 1, plurality of inputs); a plurality of outputs, each output corresponding to a

single frequency channel, and each output connected to an input of said concurrent multi-band transmitter (see plurality of outputs Y1(n) …Ym(n)).

Regarding claim 4, which inherits the limitations of claim 2, Fuller further teaches wherein said analyzing and modeling stage further comprises: a plurality of outputs connected to and updating the parameters of said digital baseband signal predistorter block (see component 108 outputting plurality of coefficients and component 208 in figure 2); a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop, and (b) to said outputs of said digital baseband signal predistorter blocks (see figure 1 and 2).

Regarding claim 5, which inherits the limitations of claim 2, Fuller further teaches wherein said analyzing and modeling stage (see figure 2) is further adapted to: perform time alignment of complex baseband signals from sampling said outputs of said concurrent multi-band transmitter (see figure 2, component 242); and perform the reconstruction of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitter (see figure 2).

Regarding claim 6, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further is further adapted to: down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1 (see figure 2, component 230, or figure 1, component 130); and extract from said down-converted samples a baseband equivalent for all frequency channels (see figure 1 and 2).

Regarding claim 7, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further comprises for each channel an RF filter (see figure 2, component 246); A signal down conversion block (see figure 2, component 230, or figure 1, component 130); and an analog-to-digital converter (ADC) (see figure 2, component 244).

Regarding claim 8, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further comprises: a single subsampling-based receiver to down-convert samples output from a concurrent multi-band transmitter (see figure 2, component 244).

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 7 – 9 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Suzuki et al (US 2005/0168283).

Regarding claim 7, Suzuki et al does not expressly teach a single down conversion block. However using single down conversion block is within the scope of one of ordinary skilled in the art.

Regarding claim 8 and 9, Suzuki et al does not expressly teach a single subsampling receiver. However using single subsampling receiver is within the scope of one of ordinary skilled in the art.

Claim 9 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Fuller (US 8,391,809).

Regarding claim 9, which inherits the limitations of claim 2, Fuller et al further teaches wherein said single subsampling-based receiver further comprises: an RF filter (see figure 2, component 246); and an analog-to-digital converter (ADC) (see figure 2, component 244). Fuller is silent on a track and hold (T&H) block. However using a track and hold (T&H) block is within the scope of one of ordinary skilled in the art. At the time the invention was made, it would be obvious to an ordinary skilled in the art to a track and hold (T&H) block in Fullers predistortion system. Applicant has not disclosed that a track and hold (T&H) block provides an advantage, is used for a particular purpose, or solves a stated problem. Therefore it would be obvious to an ordinary skilled in the art to modify Fuller to obtain the inventions as specified in claim 9.

Conclusion

Examiner's Note: Examiner has cited particular columns and line numbers in the references applied to the claims above for the convenience of the applicants. Although the specified citations are representative of the teachings of the art and are applied to specific limitations within the individual claim, other passages and figures may apply as

well. It is respectfully requested from the applicants in preparing responses, to fully consider the references in their entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

In the case of amending the claimed invention, Applicant is respectfully requested to indicate the portion(s) of the specification which dictate(s) the structure relied on for proper interpretation and also to verify and ascertain the meets and bounds of the claimed invention.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAISON JOSEPH whose telephone number is (571)272-6041. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sam K. Ahn can be reached on (571) 272-3044. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jaison Joseph/
Primary Examiner, Art Unit 2633

Notice of References Cited	Application/Control No. 14/467,642	Applicant(s)/Patent Under Reexamination GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	Art Unit 2633	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2005/0162225 A1	07-2005	Suzuki et al.	330/149
*	B	US-2005/0168283 A1	08-2005	Suzuki et al.	330/149
*	C	US-2006/0276147 A1	12-2006	Suzuki et al.	455/114.3
*	D	US-2011/0156815 A1	06-2011	Kim et al.	330/149
*	E	US-2012/0154038 A1	06-2012	Kim et al.	330/149
*	F	US-8,294,516 B2	10-2012	Young et al.	330/149
*	G	US-8,391,809 B1	03-2013	Fuller, Arthur Thomas Gerald	455/114.3
*	H	US-8,606,197 B2	12-2013	Bai, Chunlong	455/114.3
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Exhibit 1002
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UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 1866

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/467,642	08/25/2014	375	2633	4207-113

APPLICANTS
Fadhel M. GHANNOUCHI, Calgary, CANADA;

INVENTORS
Fadhel M. GHANNOUCHI, Calgary, CANADA;
Aiden BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

**** CONTINUING DATA ***************************
This application is a CON of 13/274,290 10/14/2011 PAT 8817859

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
09/02/2014

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /JAISON JOSEPH/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CANADA	7	9	1

ADDRESS

MOFFAT & CO
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OTTAWA, ON K1R 7Y2
CANADA

TITLE

DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

FILING FEE RECEIVED		
800	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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Nokia of America Corporation, et al. v. Smart RF Inc.
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/15/2015								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	14/467642	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L2	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L3	122	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L4	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L5	8	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L6	82	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L7	2	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
L8	5	("20050162225" | "20050168283" | "20060276147" | "7183847" | "8391809").PN. OR ("8817859").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/15 12:37
S1	1	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:21
S2	2487665	multi adj2band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22

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S3	15	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22
S5	26	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/29 09:25
S6	87	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/24 18:08
S7	8	("6549067" | "6999523" | "7142615" | "7170344" | "7183847" | "7634238" | "8294516").PN. OR ("8391809").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2014/01/26 16:36
S8	28	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S9	54	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S10	88	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S11	4	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36
S12	3	"20090169213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36

EAST Search History (Interference)

< This search history is empty>

6/15/2015 1:35:48 PM
C:\Users\jjoseph1\Documents\EAST\Workspaces\14467642.wsp

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	Art Unit
	JAISON JOSEPH	2633

CPC- SEARCHED		
Symbol	Date	Examiner
H03F3/189	6/15/2015	JJ
H04L25/03	6/15/2015	JJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	296	6/15/2015	JJ

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name search	6/15/2015	JJ
East	6/15/2015	JJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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Nokia of America Corporation, et al. v. Smart RF Inc.
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

43563
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

PUBLICATION NOTICE

OC00000076989731

Title:DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Publication No.US-2015-0236731-A1
Publication Date:08/20/2015

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Fadhel M. Ghannouchi et al		
Assignee:			
Title:	DIGITAL MULTI-BAND PREDISTORION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHMS IN THE IN THE FEEDBACK LOOP		
Serial No.:	14/467,642	Filing Date:	08/25/2014
Examiner:	Joseph, Jaison	Group Art Unit:	2633
Docket No.:	4207-113	Customer No.:	43563
		Confirmation No.	1866

November 19, 2015

RESPONSE TO OFFICE ACTION

Dear Sir:

This is in response to the Office Action dated 06/19/2015. Please consider the following:

Amendments to the Claims are reflected in the Listing of Claims which begins on page 2;

Remarks begin on page 7.

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Amendments To The Claims

Listing of Claims

This Listing of Claims will replace all prior versions, and listings of claims in the application:

1. (Currently amended) A ~~concurrent multi-band linearized~~ transmitter comprising:

a power amplifier configured to amplify a modulated concurrent multi-band signal to provide an amplified concurrent multi-band signal;

a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multi-band signal to compensate for a non-linearity of the power amplifier; and

a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal.

~~a concurrent multi-band linearized transmitter connected to said concurrent digital multiband predistortion block.~~

2. (Currently amended)The ~~concurrent multi-band linearized~~ transmitter of claim 1, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks, each baseband signal predistorter block having a plurality of first inputs and a single output, the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency channel.;

~~an analyzing and modelling stage; and~~

~~a signal observation feedback loop.~~

3. (Currently amended)The ~~concurrent multi-band linearized~~ transmitter of claim 2, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks, each baseband signal predistorter block having a plurality of first inputs and a single output, the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input

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corresponding to a single frequency channel and wherein the signal observation feedback loop includes an analyzing and modeling stage directly connected to each of the plurality of outputs of said digital multi-band predistortion block for receiving the respective predistorted signals and for using said received predistored signals in controlling said digital multi-band predistortion block and whereinsaid plurality of digital baseband signal predistorter blocks further comprises:

a plurality of inputs, each input corresponding to a single frequency channel;

a plurality of outputs, each output corresponding to a single frequency channel, and each output connected to an input of said concurrent multi-band transmitter.

4. (Currently amended)The concurrent multi-band linearized transmitter of claim 2claim 3, wherein said analyzing and modeling stage further comprises:

a plurality of outputs connected to and for updating the parameters of said digital baseband signal predistorter block;

a plurality of inputs connected to both (a) said outputs of said signal observation feedback loop, and (b) to said outputs of said digital baseband signal predistorter blocks.

5. (Currently amended)The concurrent multi-band linearized transmitter of claim 2claim 3, wherein said analyzing and modeling stage is further adapted configured to:

perform time alignment of complex baseband signals from sampling said outputs of said concurrent multi-band transmitterpower amplifier; and

perform the reconstruction of the complex baseband signals from sampling said outputs of said concurrent multi-band transmitterpower amplifier.

6. (Currently amended)The concurrent multi-band linearized transmitter of claim 2, wherein said signal observation feedback loop further is further adapted configured to:

down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1power amplifier; and

extract from said down-converted samples a baseband equivalent for all frequency channels.

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7. (Currently amended)The ~~concurrent multi-band linearized~~ transmitter of claim 2, wherein said signal observation feedback loop further comprises for each channel an RF filter;

~~A~~ a signal down conversion block; and

an analog-to-digital converter (ADC).

8. (Currently amended)The ~~concurrent multi-band linearized~~ transmitter of claim 2, wherein said signal observation feedback loop further comprises:

a single subsampling-based receiver to down-convert samples output from a concurrent multi-band transmitter.

9. (Currently amended)The ~~concurrent multi-band linearized~~ transmitter of claim 8, wherein said single subsampling-based receiver further comprises:
an RF filter; a track and hold (T&H) block; and an analog-to-digital converter (ADC).

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REMARKS

Claims 1-9 has been amended to better define the subject matter.

No new matter has been added.

Claim Rejections – 35 USC § 102

i. Claims 1-6 are rejected under 35 U.S.C. 102b as being anticipated by Suzuki.

Independent claim 1 has been amended to recite amongst others the features of "a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal".

In the Action reference is made to figure 6 of Suzuki as showing a predistortion block 100 and signal observation feedback loop with an analyzing and modeling stage (component 31). Applicant has reviewed the referenced sections, and indeed the entirety of Suzuki, and cannot find teachings or suggestion of the "a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal". The sampling disclosed in FIG.6 of Suzuki is indicated by referenced ADC components 29I and 29Q. Applicant submits that these are simply sampling of quadrature components of a pilot signal. For example Suzuki col.8, lines 1-5 state "The signal detector 28 detects a pilot signal and outputs an in-phase component (I signal) and a quadrature component (Q signal). These signals are converted by analog-to-digital converters (ADC) 29I and 29Q to digital signals, which are applied to the controller 31". Accordingly Suzuki does not teach or suggest "a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal". Suzuki cannot anticpate claim 1 as amended nor claims 2-9 dependent thereon. Accordingly the rejection of claims 1-6 under 35 U.S.C. 102(b) is overcome. Withdrawal of the rejection is requested.

ii. Claims 1-9 are rejected under 35 U.S.C. 102e as being anticipated by Fuller.

Fuller does not teach or suggest a "a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal" as recited in amended claim 1. As shown in Figure 1 and Figure 2 of Fuller the feedback signals are mixed to select a particular frequency (See mixer

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130 (Fig. 1) and Mixer 230 (Fig. 2)). This is not "concurrent sampling of the amplified concurrent multi-band signal". Accordingly applicant submits that for at least the above reason claim 1 is patentable over Fuller and the rejection of claim 1 and claims 2-9 dependent thereon is overcome. Withdrawal of the rejection is requested.

Claim Rejections – 35 USC § 103

i. Claims 7-9 are rejected under 35 U.S.C. 103a as being unpatentable over Suzuki.

Based on at least the above discussion Applicant submits that amended independent claim 1 is allowable over Suzuki, therefore claims 7-9 which depend thereon are also allowable, rendering the rejection moot. Withdrawal of the rejection is requested.

ii. Claim 9 is rejected under 35 U.S.C. 103a as being unpatentable over Fuller.

Based on at least the above discussion Applicant submits that amended independent claim 1 is allowable over Fuller, therefore claim 9 which depends thereon is also allowable, rendering the rejection moot. Withdrawal of the rejection is requested.

CONCLUSION

In view of the amendments and remarks set forth herein, the application is believed to be in condition for allowance and a notice to that effect is solicited. Nonetheless, should any issues remain that might be subject to resolution through a telephonic interview, the examiner is requested to telephone the undersigned at.

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Respectfully submitted,

Kevin Pillay
Registration No. 41559
Agent of Record

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Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
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Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
			Total in USD ($)	**300**

Electronic Acknowledgement Receipt

EFS ID:	24137577
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	19-NOV-2015
Filing Date:	25-AUG-2014
Time Stamp:	16:58:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$300
RAM confirmation Number	3908
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	4207-113_2015-11-19_RESP_OA.pdf	309330 4e6ddbfec088c7cd6ba5423d9cb6ca44a331 0748	no	7
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30678 119085f1badd54bb556b283650b93b208d 1c1b7a	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	340008		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
14/467,642	08/25/2014	

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	x $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	x $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **11/19/2015**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 9	Minus	** 20	= 0	x $40 =	0
Independent (37 CFR 1.16(h))	* 1	Minus	***3	= 0	x $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/LASHAWN MARKS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

43563 7590 12/17/2015

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OTTAWA, ON K1R 7Y2
CANADA

EXAMINER
JOSEPH, JAISON

ART UNIT	PAPER NUMBER
2633	

NOTIFICATION DATE	DELIVERY MODE
12/17/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

joe.ulvr@moffatco.com

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000134

Office Action Summary	Application No. 14/467,642	Applicant(s) GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	Art Unit 2633	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/19/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-9* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-9* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000135

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Claims 1 – 9 were pending in the instant application.

With amendment filed on November 19, 2015, Applicant has amended claims 1 – 9.

Claims 1 – 9 are pending in the application.

Response to Arguments

Applicant's arguments with respect to claims 1- 9 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Regarding independent claims, Applicant's arguments directed toward newly amended limitations which was not present in the previous rejection. Furthermore newly made amendments have changed the scope of the claims. However, upon further consideration, a new ground(s) of rejection is made in view of Suzuki et al (US 2005/0162225).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claim 1 is rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Suzuki et al (US 2005/0162225).

Regarding claim 1, Suzuki et al teach a transmitter comprising: a power amplifier configured to amplify a modulated concurrent signal to provide an amplified concurrent multiband signal (see figure 5, power amplifier 28); a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multiband signal to compensate for a non-linearity of the power amplifier (see paragraph 0002 and 0026); and a signal observation of feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal (see figure 5).

Claim 1, 2, and 6 – 8 are rejected under pre-AIA 35 U.S.C. 102(e) as being anticipated by Fuller et al (US 8,391,809).

Regarding claim 1, Fuller teaches a transmitter comprising: a power amplifier configured to amplify a modulated concurrent signal to provide an amplified concurrent multiband signal (see figure 1, power amplifier 112); a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multiband signal to compensate for a non-linearity of the power amplifier (see figure 1, component 101); and a signal observation of feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal (see figure 1, feedback).

Regarding claim 2, which inherits the limitations of claim 1, Fuller further teaches wherein said concurrent digital multi-band predistortion block further comprises: a

plurality of digital baseband signal predistorter blocks (see figure 1, component 101) each baseband signal predistorter block having plurality of first inputs and a single output (see figure 1, component 101); the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency band (see figure 1).

Regarding claim 6, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further is further adapted to: down-convert samples of the RF signals at said output of the concurrent multi-band transmitter of claim 1 (see figure 2, component 230, or figure 1, component 130); and extract from said down-converted samples a baseband equivalent for all frequency channels (see figure 1 and 2).

Regarding claim 7, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further comprises for each channel an RF filter (see figure 2, component 246); A signal down conversion block (see figure 2, component 230, or figure 1, component 130); and an analog-to-digital converter (ADC) (see figure 2, component 244).

Regarding claim 8, which inherits the limitations of claim 2, Fuller further teaches wherein said signal observation feedback loop further comprises: a single subsampling-based receiver to down-convert samples output from a concurrent multi-band transmitter (see figure 2, component 244).

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 2, 6 – 9 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Suzuki et al (US 2005/0162225) in view of Fuller et al (US 8,391,809).

Regarding claim 2, which inherits the limitations of claim 1, Suzuki et al further teach wherein said concurrent digital multi-band predistortion block further comprises: a plurality of digital baseband signal predistorter blocks (see figure 5). Suzuki et al does not expressly disclose having plurality of inputs to each of the predistorion block. However in analogous art, Fuller et al teach a concurrent multiband predistorion transmitter comprise concurrent digital multi-band predistortion block further comprises: a plurality of digital baseband signal predistorter blocks (see figure 1, component 101) each baseband signal predistorter block having plurality of first inputs and a single output (see figure 1, component 101); the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency band (see figure 1). Therefore it would have been obvious to an ordinary skilled in the art at the time the invention was made to

incorporate Fuller into Suzuki et al. The motivation or suggestion to do so is to predistort the signal by taking account of all the adjacent band interferences.

Regarding claim 6, which inherits the limitations of claim 2, Suzuki et al in view of Fuller further teach wherein said signal observation feedback loop further is further configured to: down-convert samples of the RF signals at said output of the power amplifier and (see Suzuki figure 5 and Fuller figure 1) extract from said down-converted samples a baseband equivalent for all frequency channels (see Suzuki figure 5 and Fuller figure 1).

Regarding claim 7, which inherits the limitations of claim 2, Suzuki et al in view of Fuller further teach wherein said signal observation feedback loop further comprises for each channel an RF filter (see Suzuki figure 5 and Fuller figure 1 and difference is within the scope of one of ordinary skilled in the art); a signal down conversion block (see Fuller figure 1); and an analog-to-digital converter (ADC) (see Suzuki figure 5 and Fuller figure 1).

Regarding claim 8, which inherits the limitations of claim 2, Suzuki et al in view of Fuller further teach wherein said signal observation feedback loop further comprises a single subsampling- based receiver to down-convert samples output from a concurrent multi-band transmitter (see Fuller figure 2, component 244).

Regarding claim 9, which inherits the limitations of claim 8, Suzuki et al in view of Fuller teaches wherein said single subsampling-based receiver further comprises: an RF filter (see figure 2, component 246); and an analog-to-digital converter (ADC) (see figure 2, component 244). Fuller is silent on a track and hold (T&H) block. However

using a track and hold (T&H) block is within the scope of one of ordinary skilled in the art. At the time the invention was made, it would be obvious to an ordinary skilled in the art to a track and hold (T&H) block in Fullers predistortion system. Applicant has not disclosed that a track and hold (T&H) block provides an advantage, is used for a particular purpose, or solves a stated problem. Therefore it would be obvious to an ordinary skilled in the art to modify Fuller to obtain the inventions as specified in claim 9.

Claim 9 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Fuller (US 8,391,809).

Regarding claim 9, which inherits the limitations of claim 2, Fuller et al further teaches wherein said single subsampling-based receiver further comprises: an RF filter (see figure 2, component 246); and an analog-to-digital converter (ADC) (see figure 2, component 244). Fuller is silent on a track and hold (T&H) block. However using a track and hold (T&H) block is within the scope of one of ordinary skilled in the art. At the time the invention was made, it would be obvious to an ordinary skilled in the art to a track and hold (T&H) block in Fullers predistortion system. Applicant has not disclosed that a track and hold (T&H) block provides an advantage, is used for a particular purpose, or solves a stated problem. Therefore it would be obvious to an ordinary skilled in the art to modify Fuller to obtain the inventions as specified in claim 9.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the claims at issue are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); In re Vogel, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the reference application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP §§ 706.02(l)(1) - 706.02(l)(3) for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/forms/. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 1 – 9 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 – 9 of U.S. Patent No. 8,817,859. Although the claims at issue are not identical, they are not patentably distinct from each other because claims 1 – 9 of the instant application merely broadens the scope of the claims 1 – 9 of the patent by eliminating the elements and their functions of claims 1 – 9 of the patent. Therefore, it would be obvious to one having ordinary skill in the art at the time the invention was made to realize that the both invention to provide a transmitter comprising: a power amplifier configured to amplify a modulated concurrent signal to provide an amplified concurrent multiband signal; a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multiband signal to compensate for a non-linearity of the power amplifier; and a signal observation of feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signal . It has been held that the omission an element and its function is an obvious expedient if the remaining elements perform the same function as

before. In re Karlson, 136 USPQ 184 (CCPA). Also note Ex parte Rainu, 168 USPQ 375 (Bd.App.1969); omission of a reference element whose function is not needed would be obvious to one skilled in the art.

Regarding claim 1, claims 1 of the Patent recites all the limitations of claim 1 of the instant application.

Regarding claim 2, claim 2 of the Patent recites all the limitations of claim 2 of the instant application.

Regarding claim 3, claim 3 of the Patent recites all the limitations of claim 3 of the instant application.

Regarding claim 4, claim 4 of the Patent recites all the limitations of claim 4 of the instant application.

Regarding claim 5, claim 5 of the Patent recites all the limitations of claim 5 of the instant application.

Regarding claim 6, claim 6 of the Patent recites all the limitations of claim 6 of the instant application.

Regarding claim 7, claim 7 of the Patent recites all the limitations of claim 7 of the instant application.

Regarding claim 8, claim 8 of the Patent recites all the limitations of claim 8 of the instant application.

Regarding claim 9, claim 9 of the Patent recites all the limitations of claim 9 of the instant application.

Conclusion

Examiner's Note: Examiner has cited particular columns and line numbers in the references applied to the claims above for the convenience of the applicants. Although the specified citations are representative of the teachings of the art and are applied to specific limitations within the individual claim, other passages and figures may apply as well. It is respectfully requested from the applicants in preparing responses, to fully consider the references in their entirety as potentially teaching all or part of the claimed invention, as well as the context of the passage as taught by the prior art or disclosed by the Examiner.

In the case of amending the claimed invention, Applicant is respectfully requested to indicate the portion(s) of the specification which dictate(s) the structure relied on for proper interpretation and also to verify and ascertain the meets and bounds of the claimed invention.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAISON JOSEPH whose telephone number is (571)272-6041. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sam K. Ahn can be reached on (571) 272-3044. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JAISON JOSEPH/
Primary Examiner, Art Unit 2633

Notice of References Cited	Application/Control No. 14/467,642	Applicant(s)/Patent Under Reexamination GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	Art Unit 2633	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2005/0162225 A1	07-2005	Suzuki, Yasunori	H03F1/3241	330/149
	B	US-				
	C	US-				
	D	US-				
	E	US-				
	F	US-				
	G	US-				
	H	US-				
	I	US-				
	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000147

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L6	136	multi near2 band with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 15:44
L7	66	concurrent with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:03
L8	63	dual near2 band with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:04
L9	3	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:13
S1	1	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:21
S2	2487665	multi adj2band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22
S3	15	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22
S5	26	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/29 09:25
S6	87	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/24 18:08
S7	8	("6549067" | "6999523" | "7142615" | "7170344" | "7183847" | "7634238" | "8294516").PN. OR ("8391809").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2014/01/26 16:36

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000148

S8	28	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S9	54	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S10	88	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S11	4	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36
S12	3	"20090169213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36
S13	0	14/467642	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S14	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S15	122	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S16	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S17	8	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S18	82	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S19	2	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36

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S20	5	("20050162225" | "20050168283" | "20060276147" | "7183847" | "8391809").PN. OR ("8817859").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/15 12:37

EAST Search History (Interference)

< This search history is empty>

12/ 10/ 2015 6:11:40 PM
C:\ Users\ jjoseph1\ Documents\ EAST\ Workspaces\ 14467642.wsp

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	Art Unit
	JAISON JOSEPH	2633

CPC- SEARCHED		
Symbol	Date	Examiner
H03F3/189	6/15/2015	JJ
H04L25/03	6/15/2015	JJ
Updated Search	12/10/2015	JJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	296	6/15/2015	JJ

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name search	6/15/2015	JJ
East	6/15/2015	JJ
East Updated	12/10/2015	JJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/15/2015	12/10/2015							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							

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Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	14467642	Filing Date	2014-08-25	Docket Number (if applicable)	4207-113	Art Unit	2633
First Named Inventor	Fadhel M. GHANNOUCHI			Examiner Name	Joseph, Jaison		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☐ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No _____

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Kevin Pillay/	Date (YYYY-MM-DD)	2016-05-17
Name	Kevin Pillay	Registration Number	41559

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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PTO/SB/22 (03-13)
Approved for use through 3/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 4207-113

Application Number: 14467642

Filed: 08/25/2014

For: Digital Multi-band Predistortion Linearizer with nonlinear subsampling algorithm in the Feedback Loop

Art Unit: 2633

Examiner: Joseph, Jaison

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 300.00
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. 37 CFR 3.73(b) statement is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration number 41559.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Kevin Pillay/ — Signature

May 17, 2016 — Date

Kevin Pillay — Typed or printed name

613 232-7302 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☑ * Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
Request for Continued Examination	2801	1	600	600
		Total in USD ($)		**900**

Electronic Acknowledgement Receipt

EFS ID:	25806074
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	17-MAY-2016
Filing Date:	25-AUG-2014
Time Stamp:	18:09:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$900
RAM confirmation Number	5066
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment Submitted/Entered with Filing of CPA/RCE	4207-113_2016-03-17_RespFOA2.pdf	348571 3d2b68f519265e23d70688c49c51030551fcfbfd	no	8
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	4207-113_RESP_FOA2_RCE.pdf	697808 6ae1ccd32e547e79d074dcb9c2bd566e09cf60a2	no	3
Warnings:					
Information:					
3	Extension of Time	4207-113_RESP_OA2_ext_of_time.pdf	187505 3bdb3197d935aeeee73b1f4eb03ae7b74321fc76	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32720 741c755d502c27cce65bc3c19366fa6494ca8aa5	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1266604		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	Fadhel M. Ghannouchi et al		
Assignee:			
Title:	DIGITAL MULTI-BAND PREDISTORION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHMS IN THE IN THE FEEDBACK LOOP		
Serial No.:	14/467,642	Filing Date:	08/25/2014
Examiner:	Joseph, Jaison	Group Art Unit:	2633
Docket No.:	4207-11 3	Customer No.:	43563
		Confirmation No.	1866

May 17, 2016

RESPONSE TO FINAL OFFICE ACTION

Dear Sir:

This is in response to the Final Office Action dated 12/17/2015. A request for continued examination is submitted herewith. Please consider the following:

Amendments to the Claims are reflected in the Listing of Claims which begins on page 2;

Remarks begin on page 6.

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Amendments To The Claims

Listing of Claims

This Listing of Claims will replace all prior versions, and listings of claims in the application:

1. (Currently amended) A transmitter comprising:

a power amplifier configured to amplify ~~a~~ modulated concurrent multi-band ~~signal~~ signals to provide ~~an~~ amplified concurrent multi-band signals;

a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multi-band ~~signal~~ signals to compensate for a non-linearity of the power amplifier; and

a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signals at a subsampling frequency lower than twice a highest signal frequency in the amplified concurrent multi-band signals.

2. (Previously presented) The transmitter of claim 1, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks, each baseband signal predistorter block having a plurality of first inputs and a single output, the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency channel.

3. (Previously presented) The transmitter of claim 2, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks, each baseband signal predistorter block having a plurality of first inputs and a single output, the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency channel and wherein the signal observation feedback loop includes an

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analyzing and modeling stage directly connected to each of the plurality of outputs of said digital multi-band predistortion block for receiving the respective predistorted signals and for using said received predistored signals in controlling said digital multi-band predistortion block and wherein

4. (Previously presented) The transmitter of claim 3, wherein said analyzing and modeling stage further comprises:

a plurality of outputs connected to and for updating the parameters of said digital baseband signal predistorter block;

a plurality of inputs connected to said outputs of said signal observation feedback loop.

5. (Previously presented) The transmitter of claim 3, wherein said analyzing and modeling stage is further configured to:

perform time alignment of complex baseband signals from sampling said outputs of said power amplifier; and

perform the reconstruction of the complex baseband signals from sampling said outputs of said power amplifier.

6. (Previously presented) The transmitter of claim 2, wherein said signal observation feedback loop further is further configured to:

down-convert samples of the RF signals at said output of the power amplifier; and

extract from said down-converted samples a baseband equivalent for all frequency channels.

7. (Previously presented) The transmitter of claim 2, wherein said signal observation feedback loop further comprises for each channel an RF filter;

a signal down conversion block; and

an analog-to-digital converter (ADC).

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8. (Previously presented) The transmitter of claim 2, wherein said signal observation feedback loop further comprises:

a single subsampling-based receiver to down-convert samples output from a concurrent multi-band transmitter.

9. (Previously presented) The transmitter of claim 8, wherein said single subsampling-based receiver further comprises:

an RF filter; a track and hold (T&H) block; and an analog-to-digital converter (ADC).

10. (New) The transmitter of claim 1, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signals.

11. (New) The transmitter of claim 1, wherein the subsampling frequency f_s is in a range $2f_0/n \leq f_s \leq 2f_1/(n-1)$ where $1 \leq n \leq \lfloor f_0/B \rfloor$,

and where B is a bandwidth of the amplified concurrent multi-band signals, and f_L, f_U are respective lower and upper frequencies of the bandwidth, and *n* is an integer.

12. (New) A method at transmitter comprising:

amplifying a modulated concurrent multi-band signal to provide an amplified concurrent multi-band signal;

predistorting the modulated concurrent multi-band signal to compensate for a non-linearity of the power amplifier;

subsampling of the amplified concurrent multi-band signals at a subsampling frequency lower than twice a highest signal frequency in the amplified concurrent multi-band signal; and

controlling the predistorting by the subsampled concurrent multi-band signal.

13. (New) The method of claim 12, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signal.

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14. (New) The method of claim 12, wherein the subsampling frequency is chosen to avoiding aliasing
between replicas.

15. (new) The method of claim 14, wherein the chosen subsampling frequency fs for a given signal bandwidth and carrier frequency fc is in the range $2f_L/n \leq fs \leq 2f_L/(n-1)$ where $1 \leq n \leq \lfloor f_U/B \rfloor$, and where B is a bandwidth of the amplified concurrent multi-band signal, and f_L, f_U are respective lower and upper frequencies of the bandwidth, and n is an integer.

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REMARKS

Claims 1 has been amended to better define the subject matter. New claims 10-11 have been added. Support for the amendments and new claims are found *inter alia* in paragraphs [0041]-[0042] of the description and Figure 6 of the drawings.

Furthermore, new method claims 12-15 corresponding to the device claims have been added.

No new matter has been added.

Claim Rejections – 35 USC § 102

i. Claims 1 is rejected under 35 U.S.C. 102(b) as being anticipated by newly cited Suzuki (US 2005/0162225).

The present claims relate in general to subsampling in a feedback loop of modulated concurrent multi-band signals. Applicant submits that it is well known in the art of signal communication that subsampling is the process of sampling at a frequency less than the Nyquist rate.

Accordingly, independent claim 1 has been amended to recite amongst others the features of:

"a power amplifier configured to amplify modulated concurrent multi-band signals to provide amplified concurrent multi-band signals";

"a signal observation feedback loop configured to effect concurrent sampling of the amplified concurrent multi-band signals";

"a subsampling frequency lower than twice a highest signal frequency in the amplified concurrent multi-band signals".

Suzuki does not teach or suggest "subsampling" nor does Suzuki teach or suggest sampling of the "modulated concurrent multi-band signals" (i.e. the modulated "amplified concurrent multi-band signals") as recited in amended claim 1. Suzuki discloses AD conversion of a demodulated portion of the output signal. See for example Suzuki para. [0037] which states "*The monitor signal SM is demodulated by a monitoring receiver 31, and the* ***demodulated monitor signal is converted*** *by analog-to-digital converters (ADC) 32-1 and 32-2 to I and Q signals (i.e., an in-phase signal and a quadrature signal) in digital form*".

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Suzuki cannot anticipate claim 1 as amended. Accordingly, the rejection of claim 1 under 35 U.S.C. 102(b) is overcome. Withdrawal of the rejection is requested.

ii. Claims 1, 2 and 6-8 are rejected under 35 U.S.C. 102€ as being anticipated by Fuller.

Fuller similar to the discussion of Suzuki does not teach or suggest "subsampling" nor does Fuller teach or suggest sampling of the "modulated concurrent multi-band signals" (i.e. the modulated "amplified concurrent multi-band signals") as recited in amended claim 1.

For example, Fuller in reference to FIG. 2 states at col 6, lines 26-30 "A portion of the output energy of amplifier **212** is coupled via coupler **251** and downconverted to a suitable intermediate frequency by mixer **230**".

Further Fuller does not teach or suggest a "concurrent sampling of the amplified concurrent multi-band signal" as recited in amended claim 1. As shown in Figure 1 and Figure 2 of Fuller the feedback signals are mixed to select a particular frequency (See mixer 130 (Fig. 1) and Mixer 230 (Fig. 2)). This is not "concurrent sampling of the amplified concurrent multi-band signal".

Accordingly, applicant submits that for at least the above reasons claim 1 is patentable over Fuller and the rejection of claim 1 and claims 2, 6-8 dependent thereon is overcome. Withdrawal of the rejection is requested.

Claim Rejections – 35 USC § 103

i. Claims 2, 6-9 are rejected under 35 U.S.C. 103a as being unpatentable over Suzuki in view of Fuller.

Based on at least the above discussion Applicant submits that amended independent claim 1 is allowable over Suzuki and Fuller, therefore claims 2, 6-9 which depend thereon are also allowable, rendering the rejection moot. Withdrawal of the rejection is requested.

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Based on at least the above discussion Applicant submits that amended independent claim 1 is allowable over Fuller, therefore claim 9 which depends thereon is also allowable, rendering the rejection moot. Withdrawal of the rejection is requested.

Double patenting

Claims 1-9 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-9 of US Patent No. 8,817,859.

Applicant submits that claim 1 of the Patent does not recite all the limitations of amended claim 1 of the instant application. Furthermore, as the claims in the instant application are still pending, Applicant requests the rejection be held in abeyance subject to allowance of the present claims.

Conclusion

In view of the amendments and remarks set forth herein, the application is believed to be in condition for allowance and a notice to that effect is solicited. Nonetheless, should any issues remain that might be subject to resolution through a telephonic interview, the examiner is requested to telephone the undersigned at.

Respectfully submitted,

/Kevin Pillay/

Kevin Pillay
Registration No. 41559
Agent of Record

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/467,642	Filing Date 08/25/2014	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	x $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	x $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **05/17/2016**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 15	Minus	** 20	= 0	x $40 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	x $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/TARA WITCHER/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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NOTICE OF ALLOWANCE AND FEE(S) DUE

43563 7590 06/21/2016

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CANADA

EXAMINER
JOSEPH, JAISON

ART UNIT	PAPER NUMBER
2633	

DATE MAILED: 06/21/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

TITLE OF INVENTION: DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	09/21/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

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PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

43563 7590 06/21/2016
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

TITLE OF INVENTION: DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	09/21/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
JOSEPH, JAISON	2633	375-296000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

43563 7590 06/21/2016

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OTTAWA, ON K1R 7Y2
CANADA

EXAMINER	
JOSEPH, JAISON	
ART UNIT	PAPER NUMBER
2633	

DATE MAILED: 06/21/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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Notice Requiring Inventor's Oath or Declaration	Application No. 14/467,642	Applicant(s) Fadhel M. GHANNOUCHI	
	Examiner JOSEPH, JAISON	Art Unit 2633	

This notice is an attachment to the Notice of Allowability (PTOL-37), or the Notice of Allowability For A Design Application (PTOL-37D).

An inventor's oath or declaration in compliance with 37 CFR 1.63 or 1.64 executed by or with respect to each inventor has not yet been submitted.

An oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each inventor (for any inventor for which a compliant oath, declaration, or substitute statement has not yet been submitted) MUST be filed no later than the date on which the issue fee is paid. See 35 U.S.C. 115(f). Failure to timely comply will result in ABANDONMENT of this application.

A properly executed inventor's oath to declaration has not been received for the following inventor(s):

If applicant previously filed one or more oaths, declarations, or substitute statements, applicant may have received an informational notice regarding deficiencies therein.

The following deficiencies are noted:

INFORMAL ACTION PROBLEMS

- A properly executed inventor's oath or declaration has not been received for the following inventor(s): **Fadhel M. GHANNOUCHI**, **Aiden BASSAM**, **Mohamed HELAOUI**, and **Andrew KWAN**.
  Applicant may submit the inventor's oath or declaration at any time before the Notice of Allowance and Fee(s) Due, PTOL-85, is mailed.

Questions relating to this Notice should be directed to the Application Assistance Unit at 571-272-42●●.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
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OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 14/467,642	Applicant(s) GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	Art Unit 2633	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *RCE filed May 17, 2016.*
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-15.* As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JAISON JOSEPH/
Primary Examiner, Art Unit 2633

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	Art Unit
	JAISON JOSEPH	2633

CPC- SEARCHED		
Symbol	Date	Examiner
H03F3/189	6/15/2015	JJ
H04L25/03	6/15/2015	JJ
Updated Search	12/10/2015	JJ
Updated Search	6/12/2016	JJ

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
375	296	6/15/2015	JJ

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name search	6/15/2015	JJ
East	6/15/2015	JJ
East Updated	12/10/2015	JJ
East Updated	6/12/2016	JJ

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	Same as Above	6/12/2016	JJ

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000177

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
14467642	GHANNOUCHI ET AL.
Examiner	**Art Unit**
JAISON JOSEPH	2633

CPC						
Symbol					**Type**	**Version**
H04B		1	/	0475	F	2013-01-01
H04L		25	/	03343	I	2013-01-01
H04B		2001	/	0425	A	2013-01-01
H04L		2025	/	03356	A	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633	06/12/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000178

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	4	L	25 / 03 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633	06/12/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000179

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633 (Primary Examiner)	06/12/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000180

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	14/467642	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/12 22:58
L2	18	subsampling same multi near2 band	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2016/06/12 23:23
S1	1	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:21
S2	2487665	multi adj2band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22
S3	15	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/26 17:22
S5	26	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2013/07/29 09:25
S6	87	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/01/24 18:08
S7	8	("6549067" | "6999523" | "7142615" | "7170344" | "7183847" | "7634238" | "8294516").PN. OR ("8391809").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2014/01/26 16:36
S8	28	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S9	54	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000181

S10	88	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/11 15:41
S11	4	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36
S12	3	"20090169213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2014/04/14 09:36
S13	0	14/467642	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S14	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S15	122	multi adj2 band near32 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S16	46	multi adj2 band adj2 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S17	8	"20090126213"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S18	82	multi adj2 band near3 predistort$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S19	2	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/06/15 12:36
S20	5	("20050162225" | "20050168283" | "20060276147" | "7183847" | "8391809").PN. OR ("8817859").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2015/06/15 12:37
S21	136	multi near2 band with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 15:44

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Nokia of America Corporation, et al. v. Smart RF Inc.
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S22	66	concurrent with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:03
S23	63	dual near2 band with predistort$5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:04
S24	3	13/274290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2015/12/10 16:13

EAST Search History (Interference)

< This search history is empty>

6/12/2016 11:52:06 PM
C:\Users\jjoseph1\Documents\EAST\Workspaces\14467642.wsp

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000183

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/15/2015	12/10/2015	06/12/2016						
1	1	✓	✓	=						
2	2	✓	✓	=						
3	3	✓	✓	=						
4	4	✓	✓	=						
5	5	✓	✓	=						
6	6	✓	✓	=						
7	7	✓	✓	=						
8	8	✓	✓	=						
9	9	✓	✓	=						
10	10			=						
11	11			=						
12	12			=						
13	13			=						
14	14			=						
15	15			=						

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000184

Issue Classification

Application/Control No.	Applicant(s)/Patent Under Reexamination
14467642	GHANNOUCHI ET AL.
Examiner	**Art Unit**
JAISON JOSEPH	2633

CPC

Symbol					Type	Version
H04B		1	/	0475	F	2013-01-01
H04L		25	/	03343	I	2013-01-01
H04B		2001	/	0425	A	2013-01-01
H04L		2025	/	03356	A	2013-01-01
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CPC Combination Sets

Symbol					Type	Set	Ranking	Version
			/					
			/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633	07/01/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000185

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
		H	0	4	L	25 / 03 (2006.01.01)						

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633	07/01/2016	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000186

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14467642	GHANNOUCHI ET AL.
	Examiner	**Art Unit**
	JAISON JOSEPH	2633

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 15	
/JAISON JOSEPH/ Primary Examiner.Art Unit 2633 (Primary Examiner)	07/01/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000187

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

43563 7590 07/11/2016
MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

EXAMINER
JOSEPH, JAISON

ART UNIT	PAPER NUMBER
2633	

NOTIFICATION DATE	DELIVERY MODE
07/11/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

joe.ulvr@moffatco.com

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000188

Corrected Notice of Allowability	**Application No.** 14/467,642	**Applicant(s)** GHANNOUCHI ET AL.	
	Examiner JAISON JOSEPH	**Art Unit** 2633	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *RCE filed May 17, 2016.*
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-15.* As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date *6/29/2016 .*
5. ☒ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/JAISON JOSEPH/
Primary Examiner, Art Unit 2633

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000189

The present application is being examined under the pre-AIA first to invent provisions.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Kevin Pillay on 06/29/2016.

The application has been amended as follows:

Rewrite Claim 3: The transmitter of claim 2, wherein said concurrent digital multi-band predistortion block further comprises:

a plurality of digital baseband signal predistorter blocks, each baseband signal predistorter block having a plurality of first inputs and a single output, the plurality of first inputs corresponding in number to the multiple bands of the multi-band transmitter and each first input corresponding to a single frequency channel and wherein the signal observation feedback loop includes an analyzing and modeling stage directly connected to each of the plurality of outputs of said digital multi-band predistortion block for receiving the respective predistorted signals and for using said received predistored signals in controlling said digital multi-band ~~**predistortion block and wherein**~~ **predistortion block.**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAISON JOSEPH whose telephone number is (571)272-6041. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sam K. Ahn can be reached on (571) 272-3044. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JAISON JOSEPH/
Primary Examiner, Art Unit 2633

Applicant-Initiated Interview Summary	**Application No.**	**Applicant(s)**	
	14/467,642	GHANNOUCHI ET AL.	
	Examiner	**Art Unit**	
	JAISON JOSEPH	2633	

All participants (applicant, applicant's representative, PTO personnel):

(1) *JAISON JOSEPH*. (3)_____.

(2) *Kevin Pillay*. (4)_____.

Date of Interview: *29 June 2016*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *3*.

Identification of prior art discussed: *None.*

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Examiner called the applicant to correct the typographical error in the claims.Aplicant agreed to Examiners proposal. Examiner will incorporate the changes in the form of Examiners amendment .

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/JAISON JOSEPH/ Primary Examiner, Art Unit 2633	

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000192

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

As the below named inventor, I hereby declare that:

This declaration is directed to: The attached application, or

United States application or PCT international application number 14/467,642

filed on August 25, 2014

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

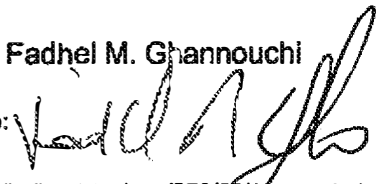
I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Fadhel M. Ghannouchi

Signature: 

Date (Optional) April 27, 2015

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALOGRITHM IN THE FEEDBACK LOOP

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ■ United States application or PCT international application number 14/467,642 filed on August 24, 2014

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Seyed Aidin Bassam Date (Optional): Apl/24/2015

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Andrew Kwan

Date (Optional) Apr 24/15.

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Mohamed Helaoui Date (Optional): April 24, 2015

Signature: _____

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Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	1051	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**140**

Electronic Acknowledgement Receipt

EFS ID:	26979867
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	20-SEP-2016
Filing Date:	25-AUG-2014
Time Stamp:	15:20:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$140
RAM confirmation Number	2076
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	F_Ghannouchi_Signed_Declaration.pdf	101218 b28050392838b9c9e72ae465e1080fa5a82d7fc2	no	2

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Information:

2	Oath or Declaration filed	A_Bassan_Declaration.pdf	454079 a268cf44bcfdd266587418d375c14bca141f6822	no	2

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Information:

3	Oath or Declaration filed	A_Kwan_Signed_Declaration.pdf	90382 839758f8fa8fee71a6381fbf694c8c86a8778170	no	2

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Information:

4	Oath or Declaration filed	M_Helaoui_Signed_Declaration.pdf	102444 a376e2ff7ea7073b6b6770ec3344447e776eafc0	no	2

Warnings:

The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing

Information:

5	Fee Worksheet (SB06)	fee-info.pdf	30185 957a14fe10ba43561887dcfcaf3e4c19600363cd	no	2

Warnings:

Information:	
Total Files Size (in bytes):	778308

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Moffat & Co
427 Laurier Avenue W., Suite 1200
Ottawa, ON, K1R 7Y2
Canada

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

TITLE OF INVENTION:

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480			$480	09/21/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Kevin Pillay
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☑ Issue Fee

☐ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

☐ A check is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Kevin Pillay/ Date 20-09-2016

Typed or printed name Kevin Pillay Registration No. 41559

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000207

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	480	480

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**480**

Electronic Acknowledgement Receipt

EFS ID:	26982743
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	20-SEP-2016
Filing Date:	25-AUG-2014
Time Stamp:	17:09:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$480
RAM confirmation Number	4324
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	ptol85b.pdf	71455 80b3a18aa800d83993381445673761f15b8fe21fb	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30545 ca68a1f89c1a7cbf1e0a14713d570c4298125625	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	102000		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/122 (04-15)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

CHANGE OF CORRESPONDENCE ADDRESS
Application

Address to:
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	14467642
Filing Date	08-25-2014
First Named Inventor	Fadhel M. Ghannouchi
Art Unit	2633
Examiner Name	Joseph, Jaison
Attorney Docket Number	4207-113

Please change the Correspondence Address for the above-identified patent application to:

(●) The address associated with Customer Number: 46093

OR

( ) Firm or Individual Name

Address

City | State | Zip

Country

Telephone | Email

This form cannot be used to change the data associated with a Customer Number. To change the data associated with an existing Customer Number use "Request for Customer Number Data Change" (PTO/SB/124).

I am the:

( ) Applicant/Inventor

( ) Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

(●) Attorney or agent of record. Registration Number 41559.

( ) Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number_____.

Signature	/Kevin Pillay/
Typed or Printed Name	Kevin Pillay
Date	21-09-2016
Telephone	613 232-7302

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[✓] *Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	26997731
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	43563
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	21-SEP-2016
Filing Date:	25-AUG-2014
Time Stamp:	19:07:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Change of Address	sb012.pdf	46647 b330482a8a277e7d11e2372019c08003d9f3da68	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	46647

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

7590 09/23/2016

MOFFAT & CO
427 LAURIER AVEUE W., SUITE 1200
OTTAWA, ON K1R 7Y2
CANADA

EXAMINER	
JOSEPH, JAISON	
ART UNIT	PAPER NUMBER
2633	
NOTIFICATION DATE	DELIVERY MODE
09/23/2016	ELECTRONIC

Notice of Abandonment

This application is abandoned in view of:

1. ☐ The applicant's failure to timely file a proper reply to the Office letter mailed on _____.
   (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission date _____), which is after the expiration of the period for reply (including a total extension of ____ month(s)) which expired on _____.
   (b) ☐ No reply has been received.
2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission date _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $_____ is insufficient. A balance of $_____ is due.
   The issue fee required by 37 CFR 1.18 is $_____.
   The publication fee, if required by 37 CFR 1.18(d), is $_____.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.
3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
   (b) ☑ No corrected drawing have been received.
4. ☑ Applicant's failure to timely file the inventor's oath or declaration no later than the date on which the issue fee was paid as required by the Notice Requiring Inventor's Oath or Declaration (PTO-2306).
   (a) ☐ An inventor's oath or declaration was received on _____ (with a Certificate of Mailing or Transmission date _____), which is after the date on which the issue fee was paid.
   (b) ☑ While an oath or declaration (or substitute statement) for one or more inventors was received, an oath or declaration (or substitute statement) for at least one other inventor has not been received.
   (c) ☐ No inventor's oath or declaration has been received.
5. ☐ Drawings received on _____ were disapproved by examiner. See examiner's response dated _____.
6. ☐ Corrected drawings were received on _____ , which is after the expiration of the one-month period for reply set in examiner's response dated _____.
7. ☐ No corrected drawings have been received in reply to one-month period set in examiner's response dated _____.
8. ☑ The reason(s) below: Need oath for Aiden Bassam.

Petitions to revive under 37 CFR 1.137(a) or (b), or request to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.

/AHL for/

(571)-272-4200 or 1(888)-786-0101
Patent Publication Branch
Office of Data Management

FORM PTO-ABN0 (Rev. 06/09)

Doc Code: PET.OP
Document Description: Petition for Review by the Office of Petitions

PTO/SB/64 (12-13)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR REVIVAL OF AN APPLICATION FOR PATENT ABANDONED UNINTENTIONALLY UNDER 37 CFR 1.137(a)

Page 1 of 2

Docket Number (Optional): 4207-113

First named inventor: Fadhel M. Ghannouchi

Application No.: 14/467,642 Art Unit: 2633

Filed: 08/25/2014 Examiner: Jaison Joseph

Title: Digital Multi-band Predistortion Linearizer With Nonlinear Subsampling Algortithm in the Feeback Loop

Attention: Office of Petitions
Mail Stop Petition
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
FAX (571) 273-8300

NOTE: If information or assistance is needed in completing this form, please contact the Office of Petitions at (571) 272-3282.

The above-identified application became abandoned for failure to file a timely and proper reply to a notice or action by the United States Patent and Trademark Office. The date of abandonment is the day after the expiration date of the period set for reply in the Office notice or action plus any extensions of time actually obtained.

APPLICANT HEREBY PETITIONS FOR REVIVAL OF THIS APPLICATION.

NOTE: A grantable petition requires the following items:

(1) Petition fee;
(2) Reply and/or issue fee;
(3) Terminal disclaimer with disclaimer fee – required for all utility and plant applications filed before June 8, 1995, and for all design applications; and
(4) Statement that the entire delay was unintentional.

1. **Petition fee**

☑ Small entity fee $ 850 (37 CFR 1.17(m)). Applicant asserts small entity status. See 37 CFR 1.27.

☐ Undiscounted fee $ _____ (37.CFR.1.17(m)).

2. **Reply and/or fee**

A The reply and/or fee to the above-noted Office notice or action in the form of

Correction of inventorship under 37 CFR 1.48, Oath and updated ADS (identify the type of reply):

☐ has been filed previously on _____.

☑ is enclosed herewith.

B The issue fee and publication fee (if applicable) of $ 480

☑ has been paid previously on 20-sep-2016.

☐ is enclosed herewith.

This collection of information is required by 37 CFR 1.137(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11, 1.14 and 41.6. This collection is estimated to take 1 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PET.OP
Document Description: Petition for Review by the Office of Petitions

PTO/SB/64 (12-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR REVIVAL OF AN APPLICATION FOR PATENT ABANDONED UNINTENTIONALLY UNDER 37 CFR 1.137(a)

3. **Terminal disclaimer with disclaimer fee**

☑ Since this utility/plant application was filed on or after June 8, 1995, no terminal disclaimer is required.

☐ A terminal disclaimer (and disclaimer fee (37 CFR 1.20(d)) of $ _____) disclaiming the required period of time is enclosed herewith (see PTO/SB/63).

4. **STATEMENT:** The entire delay in filing the required reply from the due date for the required reply until the filing of a grantable petition under 37 CFR 1.137(a) was unintentional. [NOTE: The United States Patent and Trademark Office may require additional information if there is a question as to whether either the abandonment or the delay in filing a petition under 37 CFR 1.137(a) was unintentional (MPEP 711.03(c), subsections (III)(C) and (D)).]

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

/Kevin Pillay/	2016-10-11
Signature	Date
Kevin Pillay	41559
Typed or Printed Name	Registration Number, if applicable
1200-427 Laurier Ave. W	613 232-7302
Address	Telephone Number
Ottawa, ON, Canada, K2A 2L1	
Address	

Enclosures:

☑ Fee Payment

☑ Reply

☐ Terminal Disclaimer Form

☐ Additional sheet(s) containing statements establishing unintentional delay

☑ Other: CORRECTION OF INVENTORSHIP UNDER 37 CFR 1.48, Declaration and ADS

CERTIFICATE OF MAILING OR TRANSMISSION [37 CFR 1.8(a)]

I hereby certify that this correspondence is being:

☐ Deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Petition, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450.

☑ Transmitted by EFS-Web or facsimile on the date shown below to the United States Patent and Trademark Office at (571) 273-8300.

2016-10-11	/kevin pillay/
Date	Signature
	Kevin Pillay
	Typed or printed name of person signing certificate

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	14467642
Filing Date:	25-Aug-2014
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Filer:	Kevin Pillay
Attorney Docket Number:	4207-113

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	2830	1	70	70
Petition:				
PET. REVIVE ABANDON APP, DELAY PYMT-RESP	2453	1	850	850
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**920**

Electronic Acknowledgement Receipt

EFS ID:	27180170
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	46093
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	11-OCT-2016
Filing Date:	25-AUG-2014
Time Stamp:	15:51:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$920
RAM confirmation Number	2911
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	Correction_of_inventorship.pdf	55790 d5443f87fd13ef9a71d367e4edbd22aa4bbef1b8	no	2
Warnings:					
Information:					
2	Application Data Sheet	4207-113_2014-08-25_ApplicationDataSheet_updated.pdf	1573090 5fcca9250a096f0df9a3de15bccf531cd4b53735	no	8
Warnings:					
Information:					
3	Oath or Declaration filed	A_Bassam_Declaration.pdf	454079 a268cf44bcfdd266587418d375c14bca141f6822	no	2
Warnings:					
The page size in the PDF is too large. The pages should be 8.5 x 11 or A4. If this PDF is submitted, the pages will be resized upon entry into the Image File Wrapper and may affect subsequent processing					
Information:					
4	Petition for review by the Office of Petitions	4207_113_sb0064.pdf	218813 c8c6c59636ed60916c9d911319a4f65262ef5bbb	no	3
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	32281 f61f121c33f3115479179ab5d340fe5e1dc8c121	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2334053		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Fadhel M Ghannouchi
Serial No.:	14/467,642
Filed:	08/25/2014
Title:	**DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP**
Art Unit:	2633
Docket No.:	4207-113

October 6, 2016

Mail Stop Amendments
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

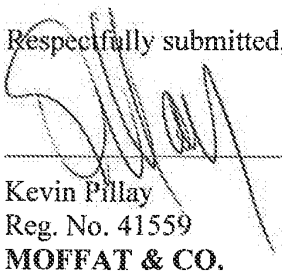
REQUEST FOR CORRECTION OF INVENTORSHIP UNDER 37 CFR 1.48

Dear Commissioner:

Pursuant to 37 CFR 1.48, the applicant requests the inventorship be corrected in the above-captioned application. In particular, one of the inventor's names was misspelt as Aiden Bassam on the Application Data Sheet filed concurrently with the application when the correct spelling of the name should have been **Seyed** Aidin Bassam.
The applicant submits herewith an amended Application Data Sheet, a Declaration executed by Seyed Aidin Bassam and the processing fee under 37 CFR 1.17(i).

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000226

Respectfully submitted,



Kevin Pillay
Reg. No. 41559
MOFFAT & CO.
427 Laurier Ave. W., Suite 1200
Ottawa, ON K1R 7Y2
(613) 232-7302

Encls.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000227

PTO/AIA/14 (12-13)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fadhel	M.	GHANNOUCHI	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Calgary	Country of Residence [i]	CA

Mailing Address of Inventor:

Address 1	2500 University Drive, NW
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302

City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country [i]	CA

Inventor 2 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Seyed	Aidin	BASSAM	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Calgary	Country of Residence [i]	CA

Mailing Address of Inventor:

Address 1	2500 University Dr.
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302

City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country [i]	CA

Inventor 3 — Remove

Legal Name

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000228

PTO/AIA/14 (12-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Mohamed		HELAOUI	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Calgary	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	2500 University Dr. NW		
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302		
City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country i	CA

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrew		KWAN	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Calgary	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	2500 University Dr. NW		
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302		
City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country i	CA

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	4069		
Email Address	kevin.pillay@moffatco.com	Add Email	Remove Email

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
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PTO/AIA/14 (12-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Application Information:

Title of the Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP		
Attorney Docket Number	4207-113	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	1

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	46093		

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13274290	2011-10-14

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (12-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fadhel	M.	GHANNOUCHI	

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000232

PTO/AIA/14 (12-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Mailing Address Information For Applicant:			
Address 1	c/o University of Calgary, 2500 University Dr. N.W		
Address 2	Electrical and Computer Engineering Dpt. ICT 302		
City	Calgary	**State/Province**	AB
Country i	CA	Postal Code	T2N 1N4
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000233

PTO/AIA/14 (12-13)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature	/KEVIN PILLAY/			Date (YYYY-MM-DD)	2016-10-06
First Name	Kevin	Last Name	Pillay	Registration Number	41559

Additional Signature may be generated within this form by selecting the Add button. Add

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent C o o p eration Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000235

PTO/AIA/01 (05-13)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALOGRITHM IN THE FEEDBACK LOOP

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ■ United States application or PCT international application number 14/467,642 filed on August 24, 2014

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Seyed Aidin Bassam Date (Optional): Apl/24/2015

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

IMPROPER CFR REQUEST

46093
Kevin Pillay -MOFCO
1200-427 Laurier Ave. W.
Ottawa, ON K1R 7Y2
CANADA

OC000000086518643

Date Mailed: 10/17/2016

RESPONSE TO REQUEST FOR CORRECTED FILING RECEIPT

Power of Attorney, Claims, Fees, System Limitations, and Miscellaneous

In response to your request for a corrected Filing Receipt, the Office is unable to comply with your request because:

- The ADS submitted on 10/11/16 was not properly marked up to show the desired changes. For information being changed relative to the information already of record, additions must be shown with underlining, and deletions must be shown with strike-through or brackets. See 37 CFR 1.76(c)(2)

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/sstephanos/

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fadhel	M.	GHANNOUCHI	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Calgary	Country of Residence	CA

Mailing Address of Inventor:

Address 1	2500 University Drive, NW		
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302		
City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country	CA

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	~~Aiden~~ SEYED	AIDIN	BASSAM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Calgary	Country of Residence	CA

Mailing Address of Inventor:

Address 1	2500 University Dr.		
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302		
City	Calgary	State/Province	AB
Postal Code	T2N 1N4	Country	CA

Inventor 3 Remove

Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Mohamed		HELAOUI	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Calgary	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	2500 University Dr. NW
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302

City	Calgary	State/Province	AB
Postal Code	T2N 1N4	**Country** i	CA

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrew		KWAN	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Calgary	Country of Residence i	CA

Mailing Address of Inventor:

Address 1	2500 University Dr. NW
Address 2	Elec and Comp Eng Dept. Univ of Calgary, ICT 302

City	Calgary	State/Province	AB
Postal Code	T2N 1N4	**Country** i	CA

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence information of this application.**

Customer Number	~~43563~~ 46093
Email Address	kevin.pillay@moffatco.com Add Email Remove Email

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4207-113
	Application Number	
Title of Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP	

Application Information:

Title of the Invention	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP		
Attorney Docket Number	4207-113	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	1

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 C FR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	46093		

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Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13274290	2011-10-14

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date o f filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee ○ Legal Representative under 35 U.S.C. 117 ○ Joint Inventor

○ Person to whom the inventor is obligated to assign. ○ Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix
	Fadhel	M.	GHANNOUCHI	

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Mailing Address Information For Applicant:			
Address 1	c/o University of Calgary, 2500 University Dr. N.W		
Address 2	Electrical and Computer Engineering Dpt. ICT 302		
City	Calgary	**State/Province**	AB
Country	CA	Postal Code	T2N 1N4
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

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Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature	/KEVIN PILLAY/			Date (YYYY-MM-DD)	2016-10-25
First Name	Kevin	Last Name	Pillay	Registration Number	41559

Additional Signature may be generated within this form by selecting the Add button.

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent C o o p eration Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	27315643
Application Number:	14467642
International Application Number:	
Confirmation Number:	1866
Title of Invention:	DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP
First Named Inventor/Applicant Name:	Fadhel M. GHANNOUCHI
Customer Number:	46093
Filer:	Kevin Pillay
Filer Authorized By:	
Attorney Docket Number:	4207-113
Receipt Date:	25-OCT-2016
Filing Date:	25-AUG-2014
Time Stamp:	15:07:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	4207_113_revised_ADS.pdf	602452 fde579b6cd76fc22be280c0f76f884eb272bc5a2	no	8

Warnings:

Information:	
This is not an USPTO supplied ADS fillable form	
Total Files Size (in bytes):	602452

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/467,642	08/25/2014	2633	940	4207-113	9	1

CONFIRMATION NO. 1866

UPDATED FILING RECEIPT

46093
Kevin Pillay -MOFCO
1200-427 Laurier Ave. W.
Ottawa, ON K1R 7Y2
CANADA

OC000000088947818

Date Mailed: 02/02/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA;
Seyed Aidin BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

Applicant(s)

Fadhel M. GHANNOUCHI, Calgary, CANADA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/274,290 10/14/2011 PAT 8817859

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted:

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000249

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/467,642**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

DIGITAL MULTI-BAND PREDISTORTION LINEARIZER WITH NONLINEAR SUBSAMPLING ALGORITHM IN THE FEEDBACK LOOP

Preliminary Class

375

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000250

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113

CONFIRMATION NO. 1866

46093
Kevin Pillay -MOFCO
1200-427 Laurier Ave. W.
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CANADA

37 CFR 1.48(f)
ACKNOWLEDGEMENT LETTER

OC000000088947822

Date Mailed: 02/02/2017

NOTICE OF ACCEPTANCE OF REQUEST UNDER 37 CFR 1.48(f)

This is in response to the applicant's request under 37 CFR 1.48(f) submitted on 10/25/2016.

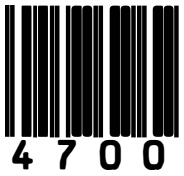
The request under 37 CFR 1.48(f) to correct the inventorship, to correct or update the name of an inventor, or to correct the order of names of joint inventors is accepted.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/ggasgedom/

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000252

Office of Petitions: Routing Sheet



Application No. 14467642

This application is being forwarded to your office for further processing. A decision has been rendered on a petition filed in this application, as indicated below. For details of this decision, please see the document PET.OP.DEC filed on the same date as this document.

- [X] **GRANTED**
- [ ] **DISMISSED**
- [ ] **DENIED**

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000253

Office of Petitions: Decision Count Sheet

Mailing Month: 3

Application No.: 14467642

14467642

For US serial numbers: enter number only, no slashes or commas. Ex: 10123456
For PCT: enter "51+single digit of year of filing+last 5 numbers", Ex. for PCT/US05/12345, enter 51512345

Deciding Official: BRITTON, PAULA

Count (1) - Palm Credit 14/467,642

Decision: GRANT

FINANCE WORK NEEDED
☐ Select Check Box for YES

GRANT

Decision Type: 510 - 37 CFR 1.137(b) FOR REVIVAL TO ACCEPT LATE

510

Notes:

Count (2)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Count (3)

Decision: n/a

FINANCE WORK NEEDED
☐ Select Check Box for YES

Decision Type: NONE

Notes:

Initials of Approving Official (if required)

If more than 3 decisions, attach 2nd count sheet & mark this box ☐

Printed on: 3/31/2017

Office of Petitions Internal Document - Ver. 5.0

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	08/25/2014	Fadhel M. GHANNOUCHI	4207-113	1866

46093 7590 04/03/2017

Kevin Pillay -MOFCO
1200-427 Laurier Ave. W.
Ottawa, ON K1R 7Y2
CANADA

EXAMINER
JOSEPH, JAISON

ART UNIT	PAPER NUMBER
2633	

MAIL DATE	DELIVERY MODE
04/03/2017	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000255

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Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

In re Application of	:	
Ghannouchi, et al.	:	
Application No. 14/467,642	:	DECISION ON PETITION
Filed: August 25, 2014	:	
Attorney Docket No. 4207-113	:	

This is a decision on the petition under CFR 1.137(a), filed October 11, 2016, to revive the above-identified application.

The petition is **GRANTED**.

The above-identified application became abandoned for failure to timely file inventor's oath or declarations, no later than the date on which the issue fee was paid, as required by the Notice Requiring Inventor's Oath or Declaration ((PTO-2306). The issue fee was paid on September 20, 2016, the application became abandoned by operation of law September 21, 2016. The Office mailed a Notice of Abandonment on September 23, 2016.

The petition satisfies the requirements of 37 CFR 1.137(a) in that the petitioner has supplied (1) the inventor's oath or declaration for Seyed Aidin Bassam; (2) the petition fee of $850.00; and (3) a statement of unintentional delay.

It is noted that the Request to Correct Inventorship under 37 CFR 1.48(f) submitted with the instant petition has been approved.

This application is being forwarded to the Office of Data Management for processing in due course.

Telephone inquiries related to this decision should be directed to Paralegal Specialist Paula Britton at 571-272-1556. All other inquiries concerning the examination or status of the application is accessible in the PAIR system at http://portal.uspto.gov/.

/Irvin Dingle/ for
Andrea Smith
Lead Paralegal Specialist
Office of Petitions

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/467,642	05/02/2017	9641204	4207-113	1866

46093 7590 04/12/2017

Kevin Pillay -MOFCO
1200-427 Laurier Ave. W.
Ottawa, ON K1R 7Y2
CANADA

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Fadhel M. GHANNOUCHI, Calgary, CANADA;
Fadhel M. GHANNOUCHI, Calgary, CANADA;
Seyed Aidin BASSAM, Calgary, CANADA;
Mohamed HELAOUI, Calgary, CANADA;
Andrew KWAN, Calgary, CANADA;

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Exhibit 1002
Nokia of America Corporation, et al. v. Smart RF Inc.
000258