EXHIBIT D-4

Invalidity of U.S. Patent No. 9,641,204 by "A new approach for concurrent Dual-Band IF Digital PreDistortion: System design and analysis," to Cidronali ("Cidronali")

The Asserted Claims of U.S. Patent No. 9,641,204 ("the '204 Patent") are anticipated and/or rendered obvious in view of "A new approach for concurrent Dual-Band IF Digital PreDistortion: System design and analysis," ("Cidronali") alone or in combination with other prior art. Cidronali was published in the *2008 Workshop on Integrated Nonlinear Microwave and Millimetre-Wave Circuits*, Malaga, Spain, in 2008, pp. 127-130, doi: 10.1109/INMMIC.2008.4745733. Cidronali, thus, is prior art to the '204 Patent at least under 35 U.S.C. § 102(b).

As described in detail below, Cidronali anticipates Asserted Claims 1–15 of the '204 Patent. In addition, to the extent that Smart RF asserts that Cidronali or citations below are insufficient, every limitation set forth in the claim was predictable and obvious in view of the knowledge and progression of the art. As such, it would have been obvious to one of ordinary skill in the art at the time of the alleged invention, based on the explicit and implicit teaching of this reference and the prior art, the knowledge of one of ordinary skill in the art, and/or the nature of the claimed invention and the problem(s) purportedly being solved to take the purportedly missing element from the art and combine it with the other elements in prior art identified in the cover pleading or herein.

This claim chart is based on Defendants' present understanding of the asserted claims, Smart RF's vague and overbroad infringement contentions (and corresponding, implicit claim constructions), and Defendants' investigations to date. Defendants are not adopting Smart RF's apparent constructions, nor are Defendants admitting to the accuracy of any particular construction. Defendants reserve all rights to amend this invalidity claim chart in light of any claim-construction developments or any amendment to Smart RF's infringement contentions. Further, as discovery is ongoing and Defendants continue to seek discovery from third parties regarding the references identified in Defendants' invalidity contentions as well as other potential prior art, Defendants reserve the right to amend or supplement this claim chart identified in connection with Defendants' continuing investigation. At minimum, Defendants intend to revise their invalidity contentions as appropriate to include discovery from third parties as discovery progresses. The claim chart below identifies where each limitation of the asserted claims of the '204 Patent can be found in Cidronali. The citations provided below are exemplary, rather than exhaustive, and Defendants reserve the right to rely upon any other portion of the cited references.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
1[pre]	A transmitter comprising:	To the extent the preamble is limiting, Cidronali discloses and/or renders obvious a transmitter. *See*, *e.g.*,

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		"*Abstract* — In this paper we propose a Dual Band Digital Predistorter (DB-DPD), suitable for concurrent dual-band power amplifiers. A sub-sampling receiver is at the basis of the feedback path, while the vectorial gain adjuster is achieved at the proper digital intermediate frequency. The proposed method adopts a conventional memory polynomial DPD for linearization. The approach is tested by system-level simulations and it was proven to be able to correct most of the nonlinearity, with only a modest performance loss with respect to single-band architectures." Abstract. "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1.
1[a]	a power amplifier configured to amplify modulated concurrent multi-band signals to provide amplified concurrent multi-band signals;	Cidronali discloses and/or renders obvious a power amplifier configured to amplify modulated concurrent multi-band signals to provide amplified concurrent multi-band signals. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of

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		the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim '(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim '(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim '(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim '(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.” Pg. 2.

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		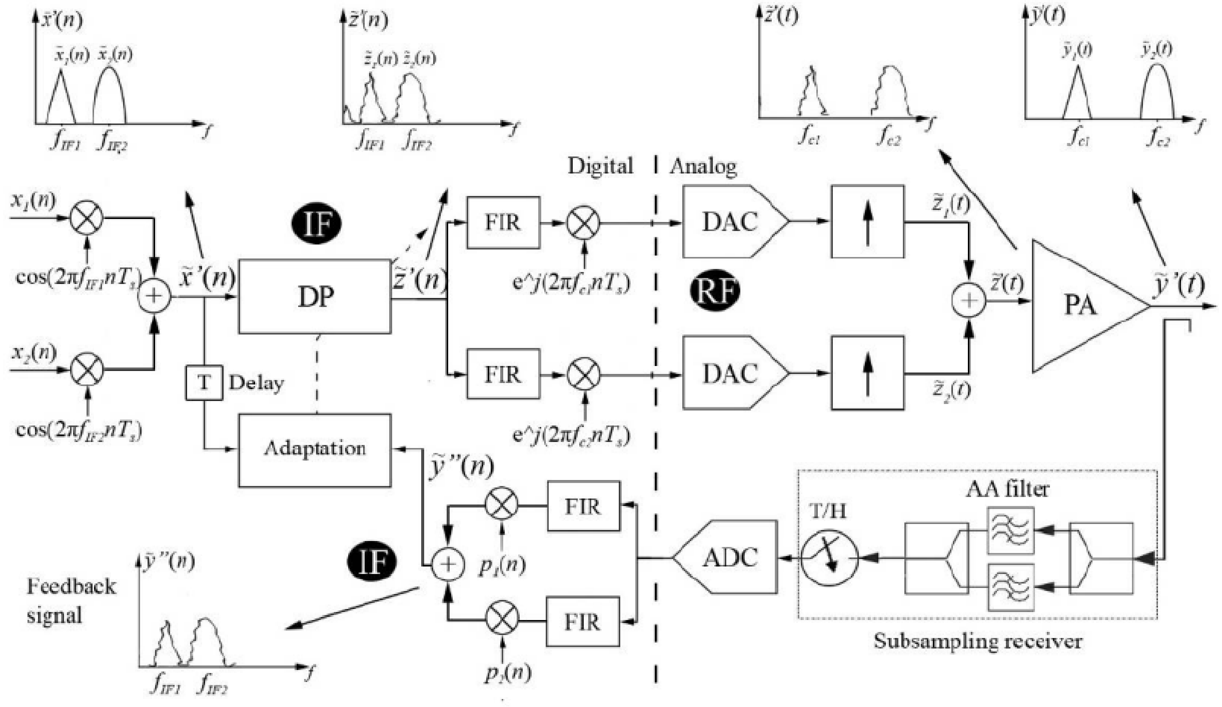 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4. “II. DUAL-BAND POWER AMPLIFIER ARCHITECTURES The main objective of the present paper is the evaluation of a new concept of DB-DPD consistent with two possible architectures of dual-band PA both suitable for their involvement in the concurrent dual-band systems. The first is based on two dedicated PAs combined by a diplexer while the second is specifically designed to be operated in dual-band state. In the next paragraphs a brief discussion of this PA topologies is given.” Pg. 1.

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		"*A) Combined dedicated PAs* One out of the two dual-band architectures considered in this work is based on the schematic representation reported in Fig. 1. It represents the most straightforward solution which makes use of two dedicated PAs combined by a diplexer. While for the PA units the designer can access to the most mature and advances design methodologies and technologies, the passive diplexer still represents a very critical part of the entire PA structure. Indeed, this component must guarantee an almost lossless behavior in the transmission paths and an as much as possible isolation. In particular the former feature is required to preserve the combined efficiency of the entire structure, while the latter is a required feature to avoid the cross-modulation between the two dedicated PAs. The constraints on the diplexer become more critical in the case of closer operative spectrum bands. During the two dedicated PAs design, the eventual combination with the diplexer doesn't require specific additional PA design consideration, only an accurate evaluation of the out-of band termination which might degrade the output power and efficiency of the two units." Pg. 1. "*B) Dual-band single PA* The PA architecture under investigation in this paper is represented by the dual-band single PA, i.e. a circuit designed around a single active device and able to simultaneously operate at two different frequency bands. The schematic of the concurrent PA is reported in Fig. 2, where the dual-tuned matching networks are synthesized by either passive and\or distributed elements properly dimensioned, without external tuning controls. The basic principle discussed in [5]-[6], for the development of dual-tuned matching network can be effectively considered for the concurrent dual-band PA. In this configuration the two signal sources are combined prior to be applied to the PA input. The design method of concurrent dual-band PA based on multi-tuned networks composed of lumped elements is discussed in detail in [7]." Pg. 1-2.

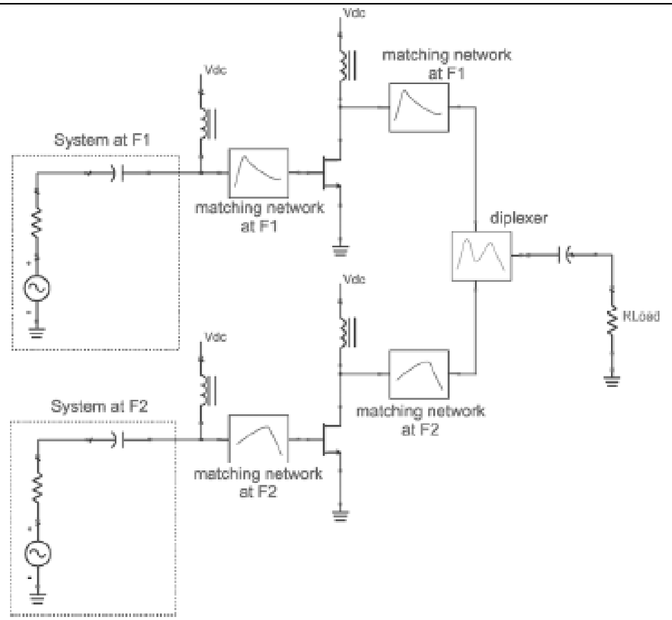

Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

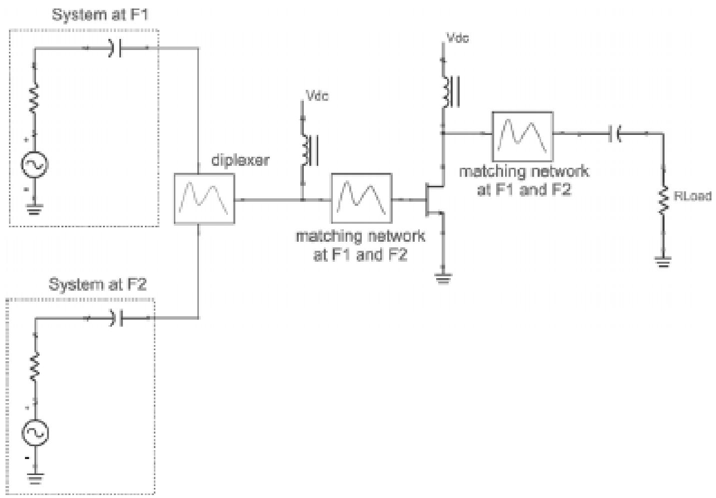

Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

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		Figs. 1-2.
1[b]	a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multi-band signals to compensate for a non-linearity of the power amplifier; and	Cidronali discloses and/or renders obvious a concurrent digital multi-band predistortion block configured to effect predistortion of the modulated concurrent multi-band signals to compensate for a non-linearity of the power amplifier. *See*, *e.g.*, “In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver

<table>
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<tr><td></td><td></td><td>discussed in the previous section. The two bands composing *y*~ '(*t*) are aliased side-by-side in the baseband, then digitized by a single ADC.

In the digital domain, the bands are separated and shifted to IF, composing the signal *y*~"(*n*) that is compared to *x*~ '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.

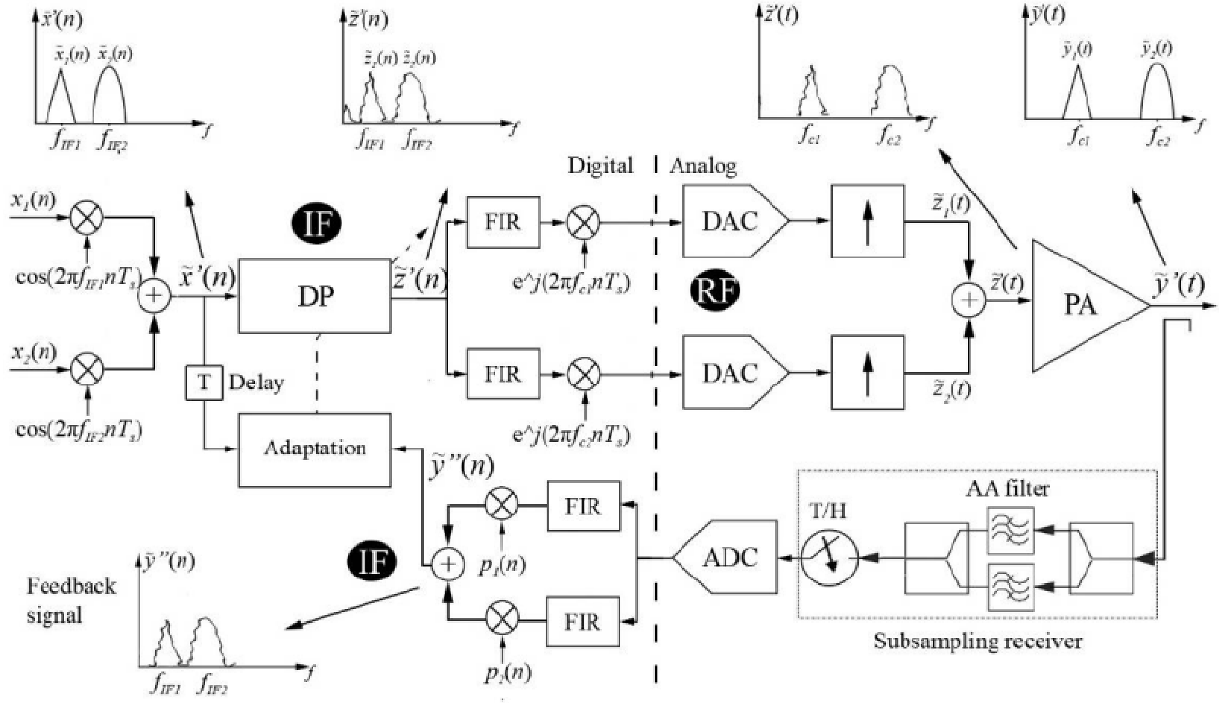

Fig. 4.DB-DP system with IF predistortion and subsampling feedback

Fig. 4.</td></tr>
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Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
1[c]	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.	Cidronali discloses and/or renders obvious 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. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver

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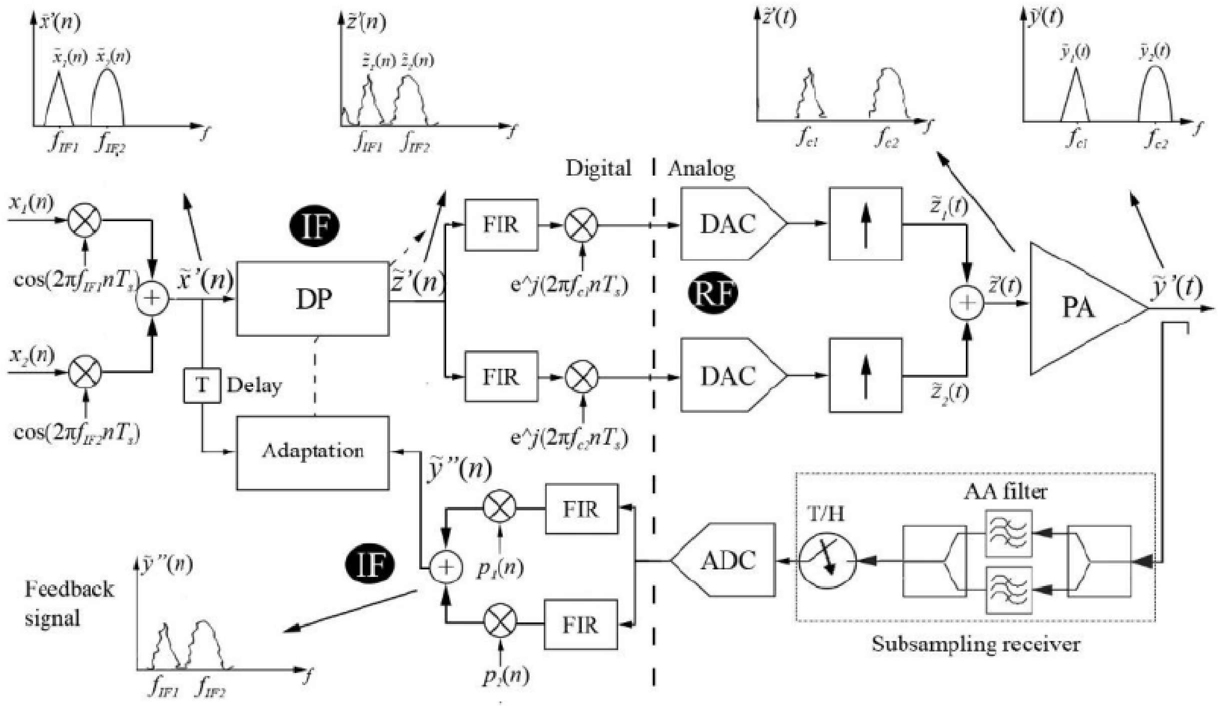
		discussed in the previous section. The two bands composing y~ '(t) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal y~"(n) that is compared to x~ '(n) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		“The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted.” Pg. 4.
2	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.	Cidronali discloses and/or renders obvious 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. *See* claim 1, *supra*, which is incorporated by reference herein. *See also*, *e.g.*, “In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “IV. Dual Band Digital PreDistortion

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		In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim '(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim '(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim '(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim '(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal $y\sim ''(n)$ that is compared to $x\sim '(n)$ by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.

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		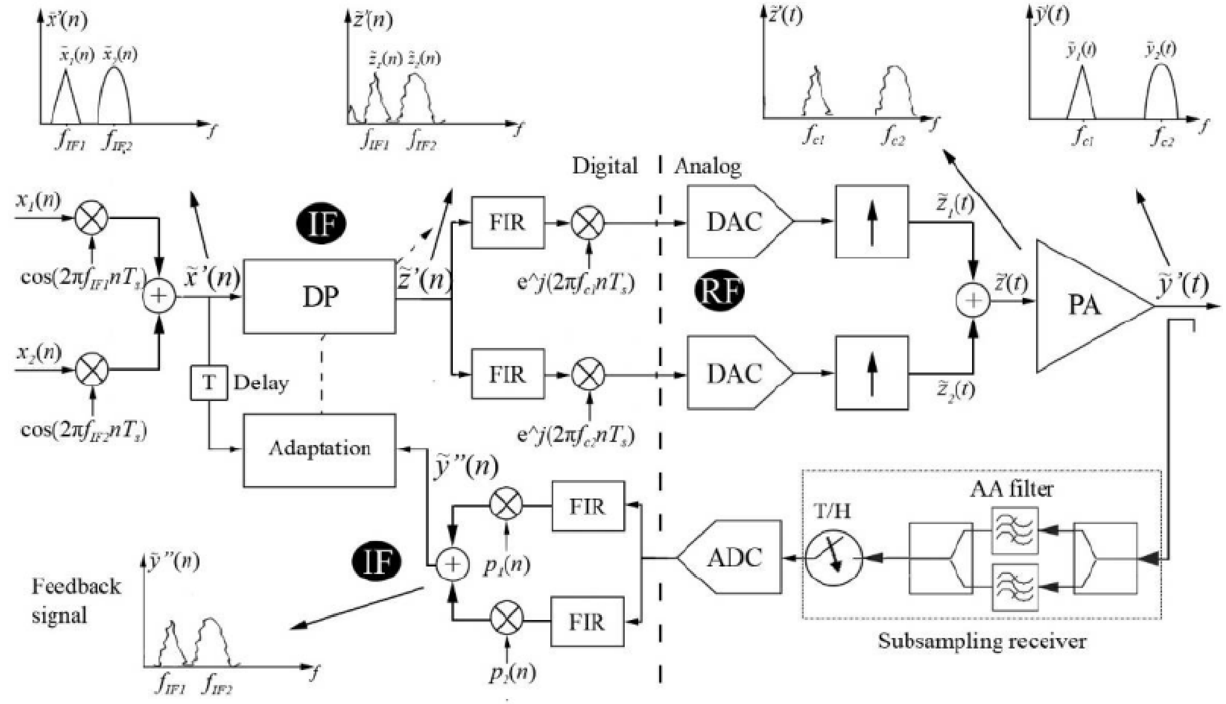 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
3[a]	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	Cidronali discloses and/or renders obvious 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. *See* claim 2, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them.

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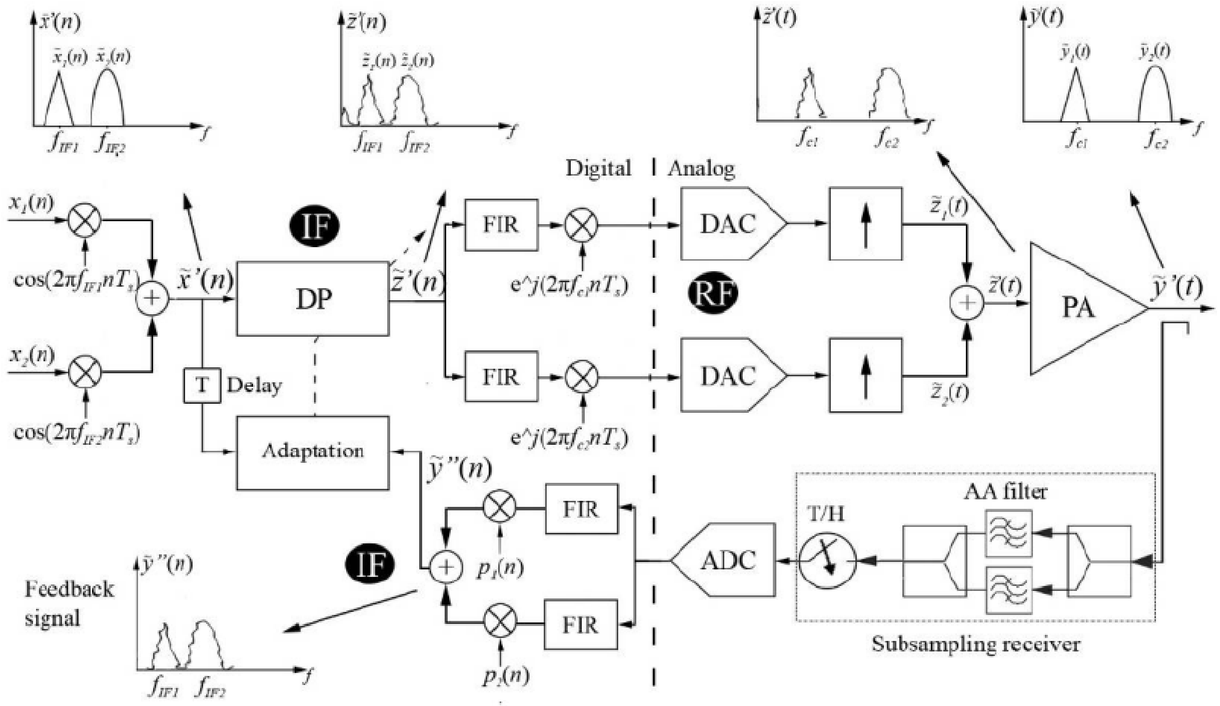
		The PA output *y*~'(*t*) , is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing *y*~ '(*t*) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal *y*~"(*n*) that is compared to *x*~ '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		Fig. 4. “The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted.” Pg. 4.
3[b]	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.	Cidronali discloses and/or renders obvious the transmitter of claim 2, 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.. *See* claim 2, *supra*, which is incorporated by reference herein. *See*, *e.g.*, “In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “IV. Dual Band Digital PreDistortion

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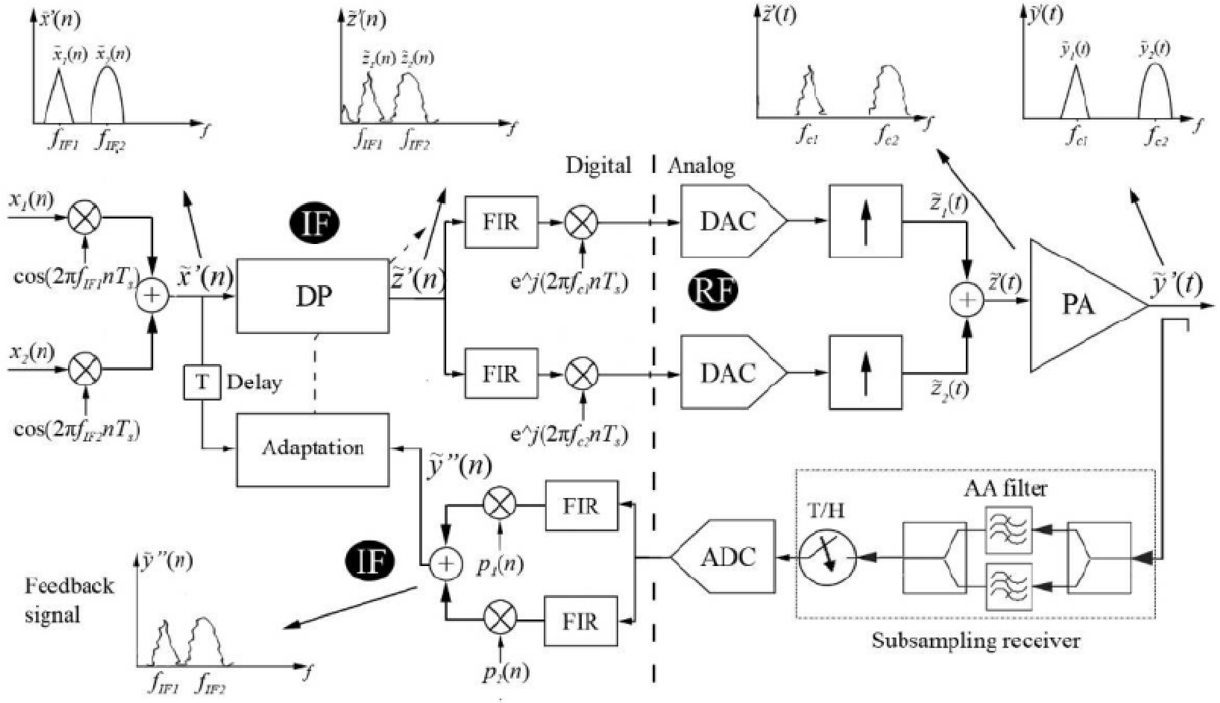
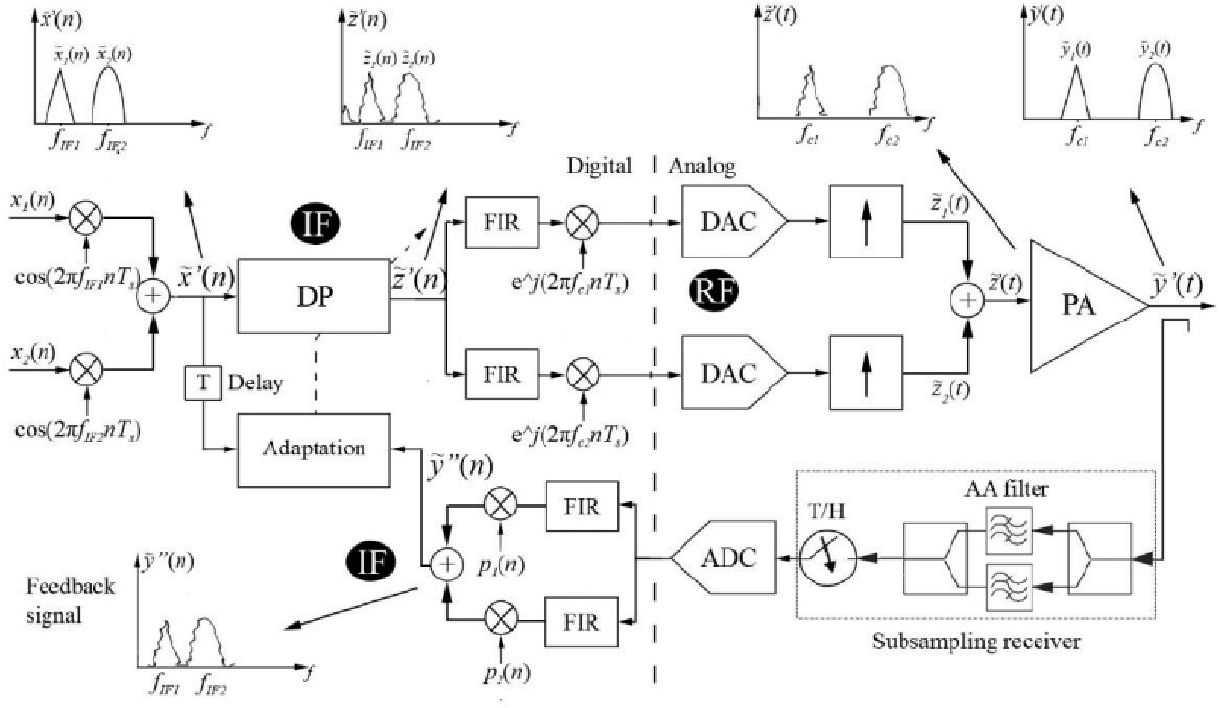
		 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4. “The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted.” Pg. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
4[a]	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;	Cidronali discloses and/or renders obvious 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. *See* claim 3, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		discussed in the previous section. The two bands composing *y*~ '(*t*) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal *y*~"(*n*) that is compared to *x*~ '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		"The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
4[b]	a plurality of inputs connected to said outputs of said signal observation feedback loop.	Cidronali discloses and/or renders obvious the transmitter of claim 3, wherein said analyzing and modeling stage further comprises: a plurality of inputs connected to said outputs of said signal observation feedback loop. *See* claim 3, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		summed thus creating $x\sim'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and $fc\,2$, and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal $y\sim''(n)$ that is compared to $x\sim'(n)$ by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.

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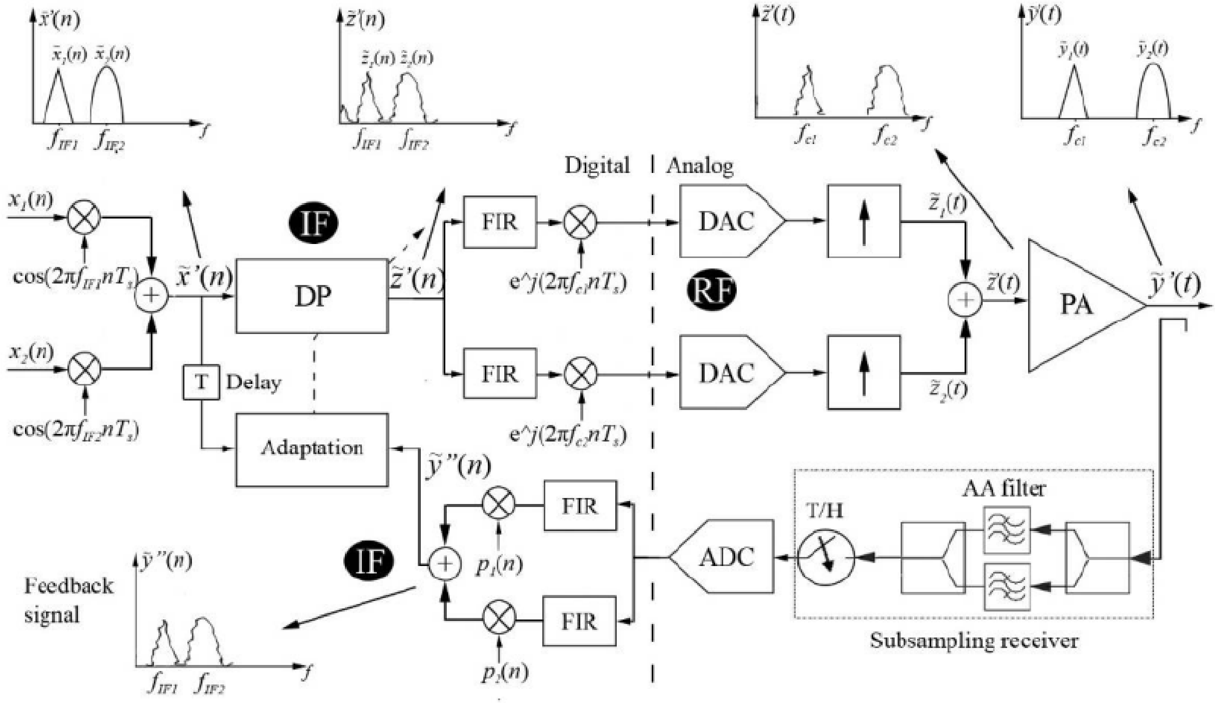
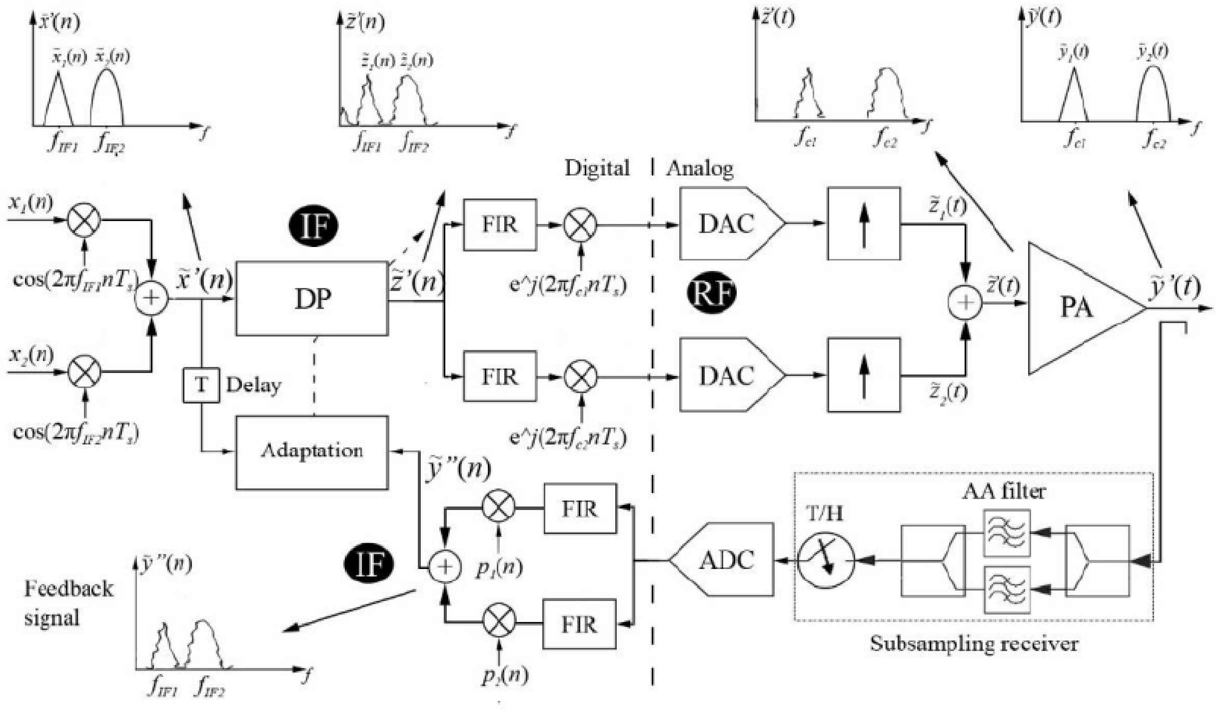
		 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
5	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.	Cidronali discloses and/or renders obvious 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. *See* claim 3, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing *y~* '(*t*) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal *y~*"(*n*) that is compared to *x~* '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		"The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
6	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.	Cidronali discloses and/or renders obvious 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. *See* claim 2, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent

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		systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating x~ '(n) , which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal z~'(n) . The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input z~'(t) is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output y~'(t) , is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing y~ '(t) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal y~"(n) that is compared to x~ '(n) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.

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		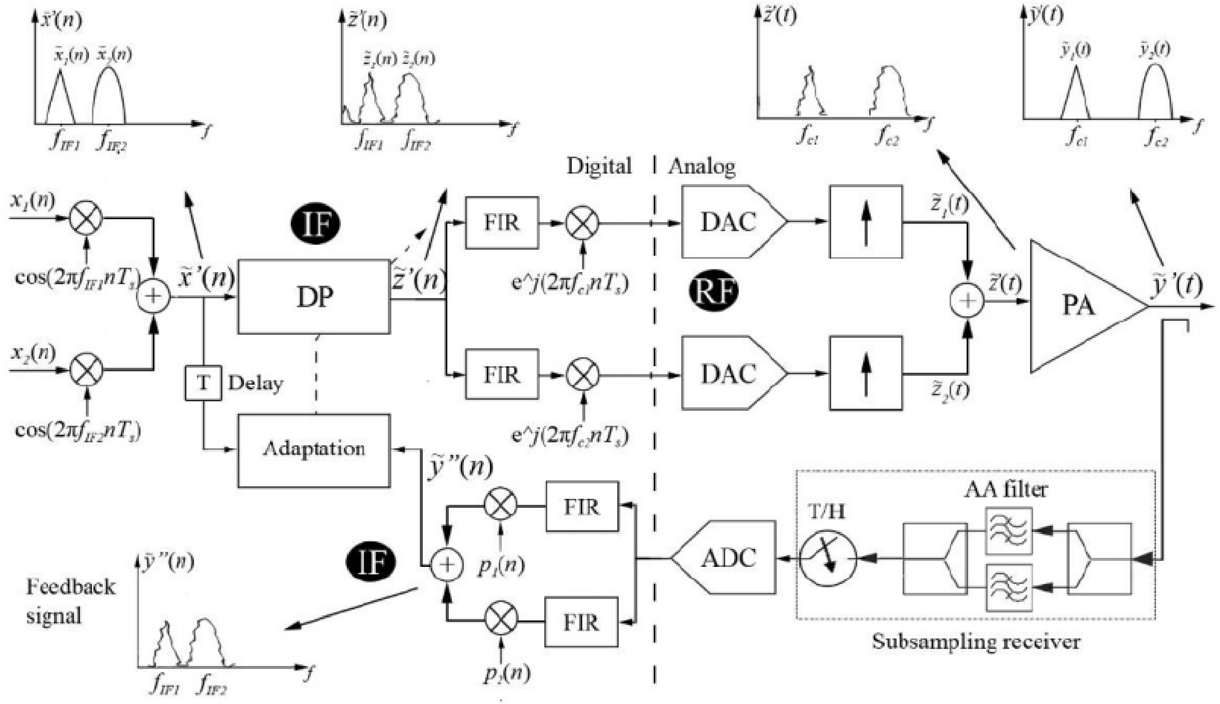 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
7	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).	Cidronali discloses and/or renders obvious 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). *See* claim 2, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver

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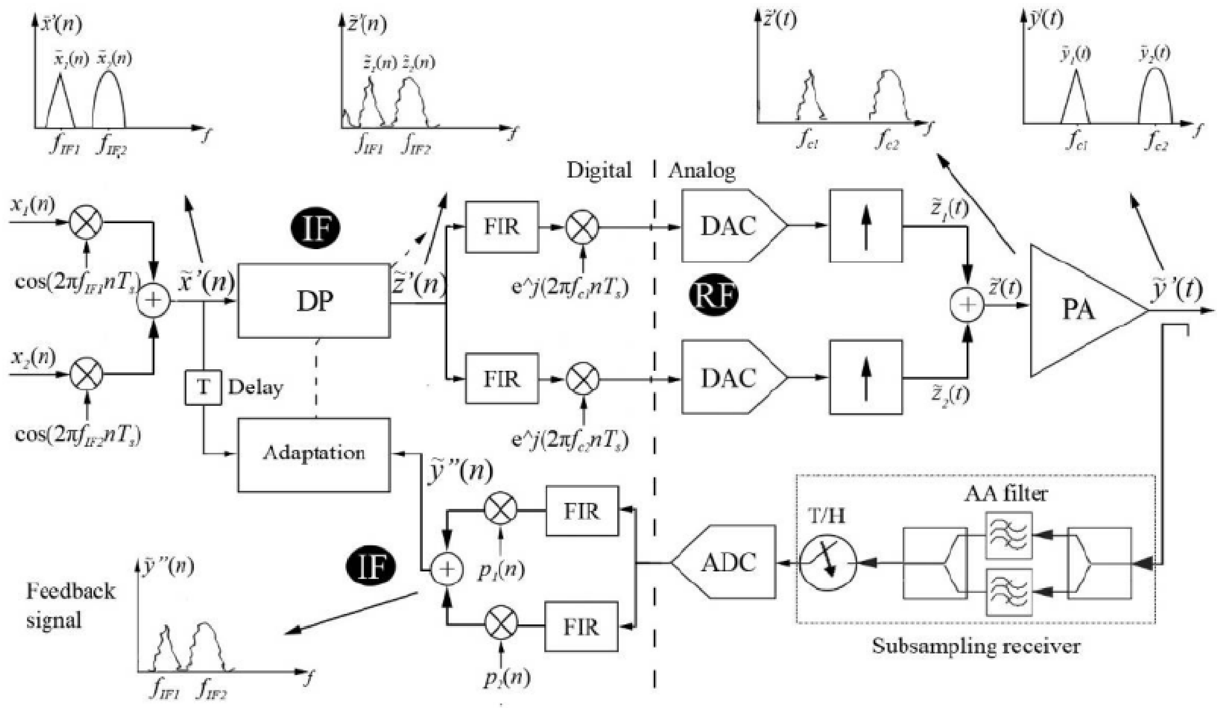
		discussed in the previous section. The two bands composing *y*~ '(*t*) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal *y*~"(*n*) that is compared to *x*~ '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		"The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
8	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.	Cidronali discloses and/or renders obvious 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. *See* claim 2, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "The paper is organized as follows: in Section II is recalled a brief review of the main PA topologies target of the linearization procedure herein analysed. In Section III is described the sub-sampling receiver design and the technique for the sampling frequency calculation. Section IV reports the operating principle of the DB-DP system, while in Section V simulation results are showed, highlighting performance differences over single band DPD systems." Pg. 1.

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		"IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating x~ '(n) , which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal z~'(n) . The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input z~'(t) is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output y~'(t) , is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing y~ '(t) are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal y~"(n) that is compared to x~ '(n) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.

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		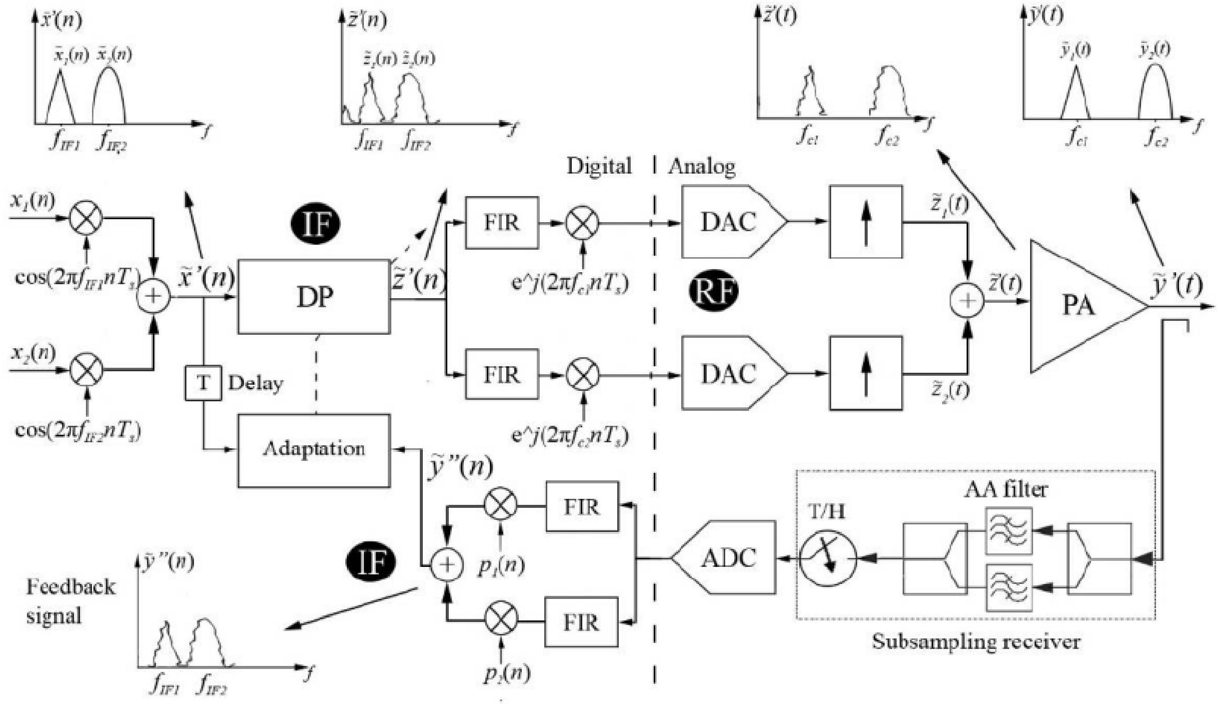 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

applied to the PA input. The design method of concurrent dual-band PA based on multi-tuned networks composed of lumped elements is discussed in detail in [7].

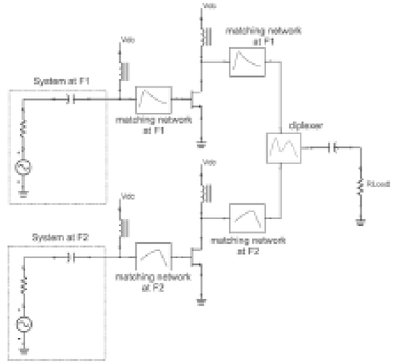

Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

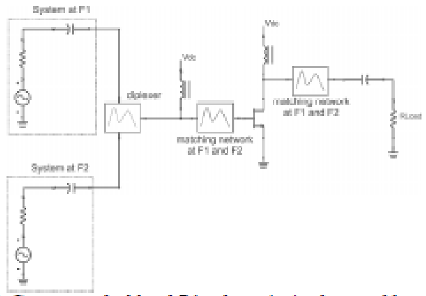

Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

III. SUBSAMPLING RECEIVER

The subsampling adopted in the DB-DPD feedback recalls somehow the receivers adopted in the multiband radios and is based on the bandpass sampling theorem. This principle can be adapted to down-convert two (or more) band-limited signals s_1 and s_2, located at different centre frequencies f_{c1} and f_{c2}, with bandwidths B_1 and B_2. Selecting the proper sampling frequency there will be aliases of the two signals located side-by-side in the first Nyquist zone with no overlap, as shown in Fig. 3. The sampling frequency must respect the condition:

$$f_s \geq 2(B_1 + B_2)$$

that is, the Nyquist zone must be wider than the sum of the two bands.

Form the Fig. 3 is evident that the two band-pass signals have to be down-converted at IF rather than both at base-band to make them suitable for the DP training. In the full paper a detailed discussion about the constraints and the proper selection of the intermediate frequency for the down conversions is given.

IV. DUAL BAND DIGITAL PREDISTORTION

In the full paper we will discuss about the proposed DB-DPD system which is an extension of a single band DPD (SB-DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x_1(n)$ and $x_2(n)$ are shifted to f_{IF1} and f_{IF2} then summed thus creating $\tilde{x}'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $\tilde{z}'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down-conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $\tilde{z}'(t)$ is obtained by frequency shifting to the RF frequencies f_{c1} and f_{c2}, and combining them. The PA output $\tilde{y}'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $\tilde{y}'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

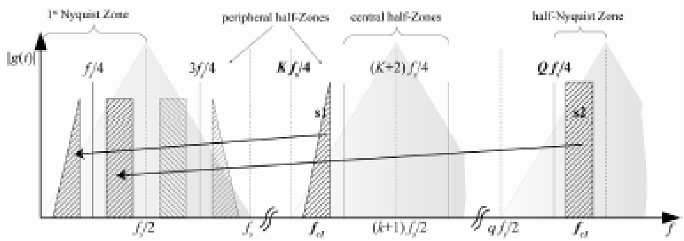

Fig. 3. Dual band subsampling

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		Pg. 2. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
9	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).	Cidronali discloses and/or renders obvious 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). *See* claim 8, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "The paper is organized as follows: in Section II is recalled a brief review of the main PA topologies target of the linearization procedure herein analysed. In Section III is described the sub-sampling receiver design and the technique for the sampling frequency calculation. Section IV

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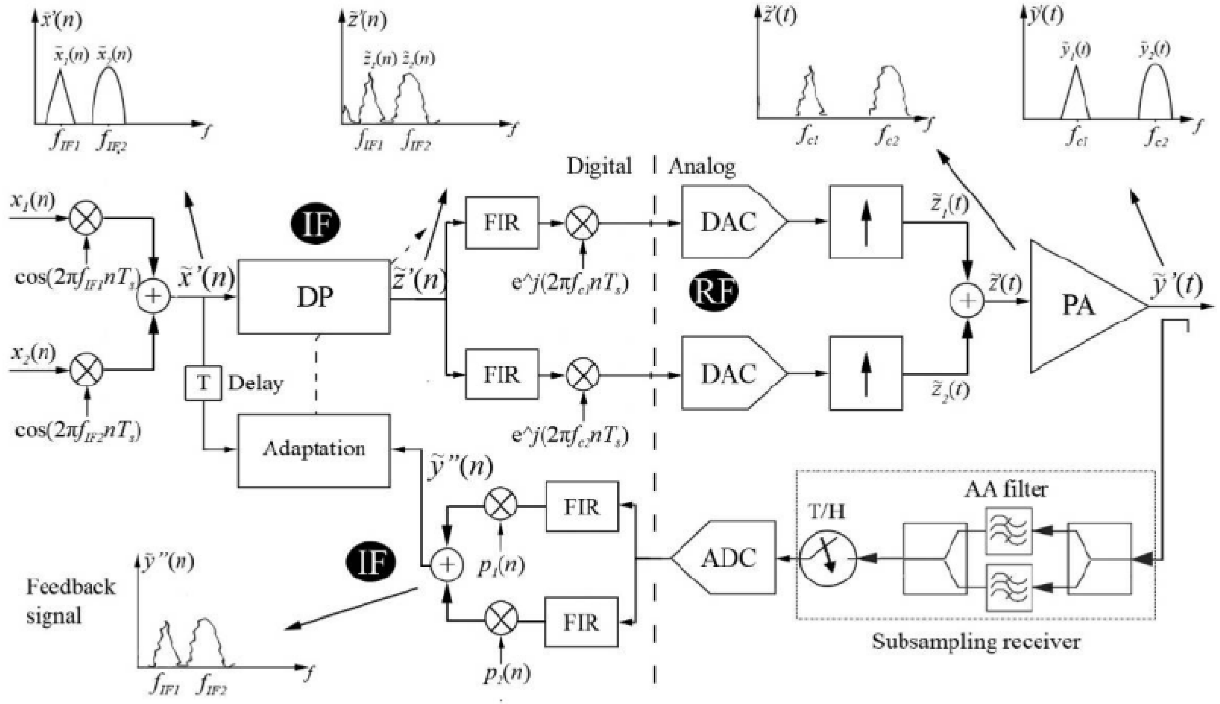
		reports the operating principle of the DB-DP system, while in Section V simulation results are showed, highlighting performance differences over single band DPD systems." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim '(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim '(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim '(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim '(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal $y\sim ''(n)$ that is compared to $x\sim '(n)$ by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

applied to the PA input. The design method of concurrent dual-band PA based on multi-tuned networks composed of lumped elements is discussed in detail in [7].

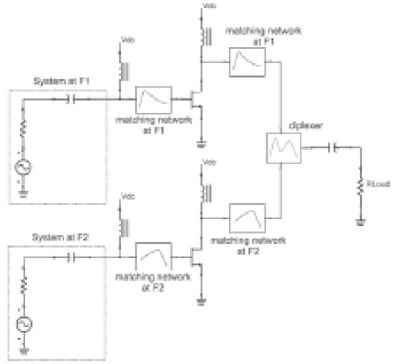


Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

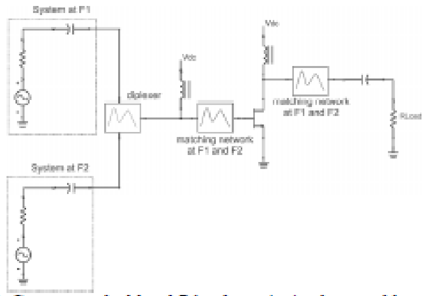


Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

III. SUBSAMPLING RECEIVER

The subsampling adopted in the DB-DPD feedback recalls somehow the receivers adopted in the multiband radios and is based on the bandpass sampling theorem. This principle can be adapted to down-convert two (or more) band-limited signals s_1 and s_2, located at different centre frequencies f_{c1} and f_{c2}, with bandwidths B_1 and B_2. Selecting the proper sampling frequency there will be aliases of the two signals located side-by-side in the first Nyquist zone with no overlap, as shown in Fig. 3. The sampling frequency must respect the condition:

$$f_s \geq 2(B_1 + B_2)$$

that is, the Nyquist zone must be wider than the sum of the two bands.

Form the Fig. 3 is evident that the two band-pass signals have to be down-converted at IF rather than both at base-band to make them suitable for the DP training. In the full paper a detailed discussion about the constraints and the proper selection of the intermediate frequency for the down conversions is given.

IV. DUAL BAND DIGITAL PREDISTORTION

In the full paper we will discuss about the proposed DB-DPD system which is an extension of a single band DPD (SB-DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x_1(n)$ and $x_2(n)$ are shifted to f_{IF1} and f_{IF2} then summed thus creating $\tilde{x}'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $\tilde{z}'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down-conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $\tilde{z}'(t)$ is obtained by frequency shifting to the RF frequencies f_{c1} and f_{c2}, and combining them. The PA output $\tilde{y}'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $\tilde{y}'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

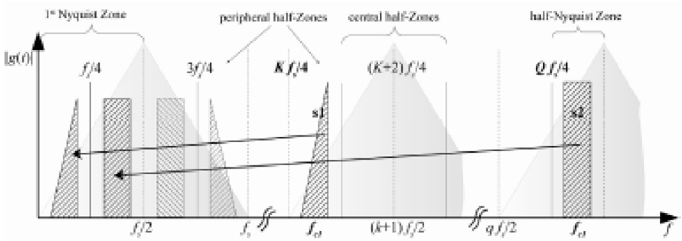
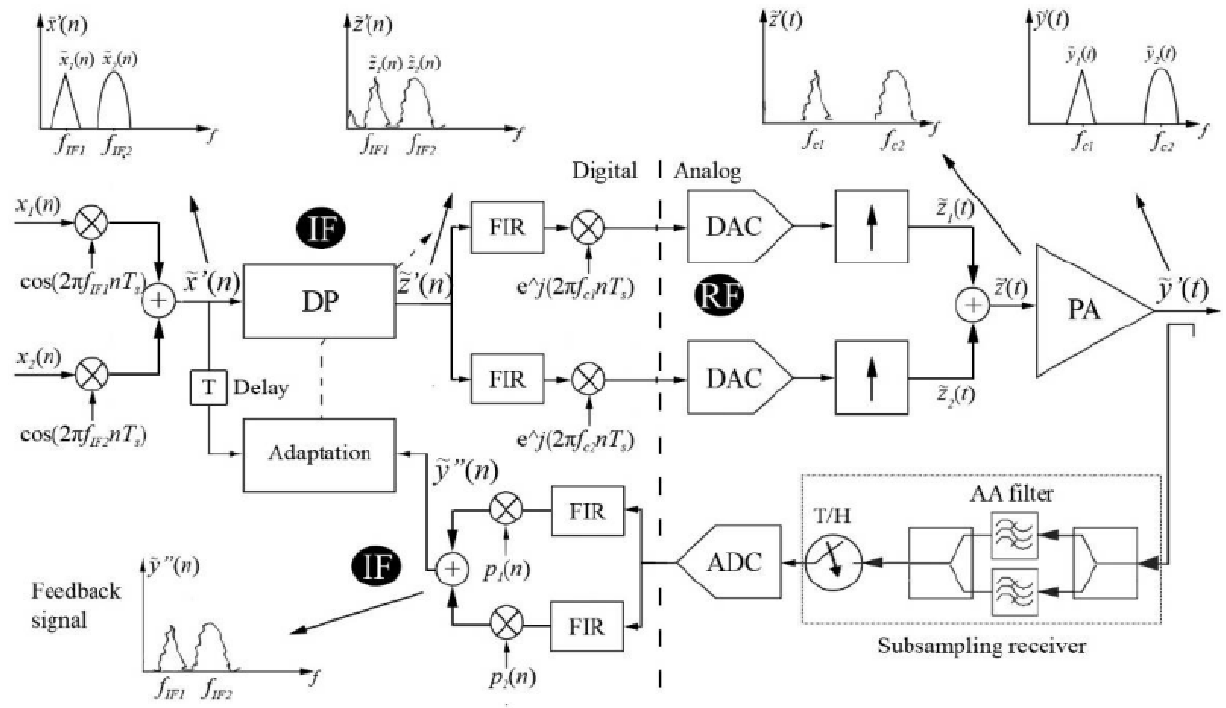


Fig. 3. Dual band subsampling

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		Pg. 2. “The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted.” Pg. 4.
10	The transmitter of claim 1, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signals.	Cidronali discloses and/or renders obvious the transmitter of claim 1, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signals. *See* claim 1, *supra*, which is incorporated by reference herein. *See*, *e.g.*, “In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “The paper is organized as follows: in Section II is recalled a brief review of the main PA topologies target of the linearization procedure herein analysed. In Section III is described the sub-sampling receiver design and the technique for the sampling frequency calculation. Section IV

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		reports the operating principle of the DB-DP system, while in Section V simulation results are showed, highlighting performance differences over single band DPD systems." Pg. 1. "IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim '(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC. In the digital domain, the bands are separated and shifted to IF, composing the signal $y\sim''(n)$ that is compared to $x\sim '(n)$ by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4." Pgs. 2-3.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

applied to the PA input. The design method of concurrent dual-band PA based on multi-tuned networks composed of lumped elements is discussed in detail in [7].

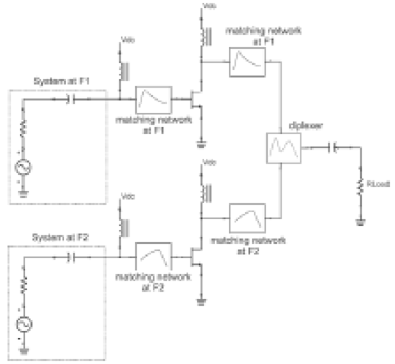


Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

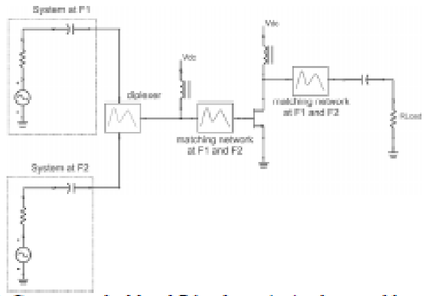


Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

III. SUBSAMPLING RECEIVER

The subsampling adopted in the DB-DPD feedback recalls somehow the receivers adopted in the multiband radios and is based on the bandpass sampling theorem. This principle can be adapted to down-convert two (or more) band-limited signals s_1 and s_2, located at different centre frequencies f_{c1} and f_{c2}, with bandwidths B_1 and B_2. Selecting the proper sampling frequency there will be aliases of the two signals located side-by-side in the first Nyquist zone with no overlap, as shown in Fig. 3. The sampling frequency must respect the condition:

$$f_s \geq 2(B_1 + B_2)$$

that is, the Nyquist zone must be wider than the sum of the two bands.

Form the Fig. 3 is evident that the two band-pass signals have to be down-converted at IF rather than both at base-band to make them suitable for the DP training. In the full paper a detailed discussion about the constraints and the proper selection of the intermediate frequency for the down conversions is given.

IV. DUAL BAND DIGITAL PREDISTORTION

In the full paper we will discuss about the proposed DB-DPD system which is an extension of a single band DPD (SB-DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x_1(n)$ and $x_2(n)$ are shifted to f_{IF1} and f_{IF2} then summed thus creating $\tilde{x}'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $\tilde{z}'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down-conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $\tilde{z}'(t)$ is obtained by frequency shifting to the RF frequencies f_{c1} and f_{c2}, and combining them. The PA output $\tilde{y}'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $\tilde{y}'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

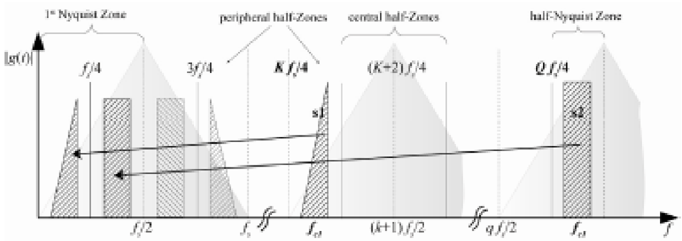


Fig. 3. Dual band subsampling

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		Pg. 2. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
11	The transmitter of claim 1, wherein the subsampling frequency f_s is in a range $2fu/n \leqq f_s \leqq 2h/(n-1)$ where $1 \leqq n \leqq \|fu/B\|$, 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.	Cidronali discloses and/or renders obvious the transmitter of claim 1, wherein the subsampling frequency f_s is in a range $2fu/n \leqq f_s \leqq 2h/(n-1)$ where $1 \leqq n \leqq \|fu/B\|$, 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. *See* claim 1, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation." Pg. 1. "The paper is organized as follows: in Section II is recalled a brief review of the main PA topologies target of the linearization procedure herein analysed. In Section III is described the sub-sampling receiver design and the technique for the sampling frequency calculation. Section IV

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		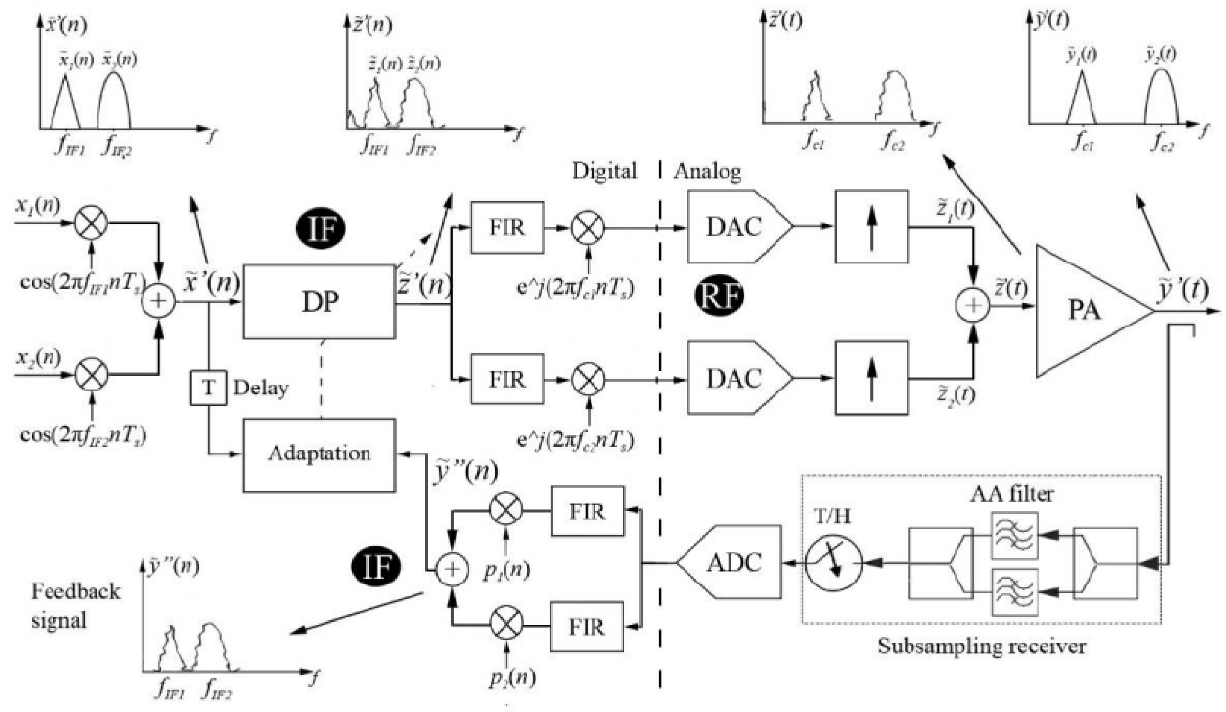 Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

applied to the PA input. The design method of concurrent dual-band PA based on multi-tuned networks composed of lumped elements is discussed in detail in [7].

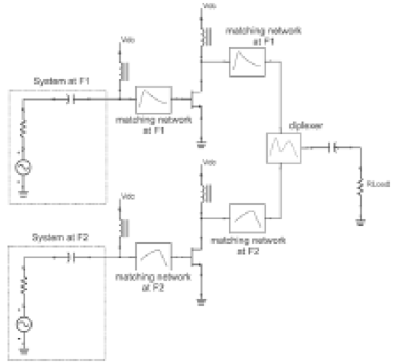

Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

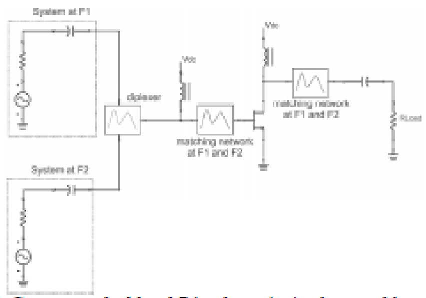

Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

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Form the Fig. 3 is evident that the two band-pass signals have to be down-converted at IF rather than both at base-band to make them suitable for the DP training. In the full paper a detailed discussion about the constraints and the proper selection of the intermediate frequency for the down conversions is given.

IV. DUAL BAND DIGITAL PREDISTORTION

In the full paper we will discuss about the proposed DB-DPD system which is an extension of a single band DPD (SB-DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x_1(n)$ and $x_2(n)$ are shifted to f_{IF1} and f_{IF2} then summed thus creating $\tilde{x}'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $\tilde{z}'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down-conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $\tilde{z}'(t)$ is obtained by frequency shifting to the RF frequencies f_{c1} and f_{c2}, and combining them. The PA output $\tilde{y}'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $\tilde{y}'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

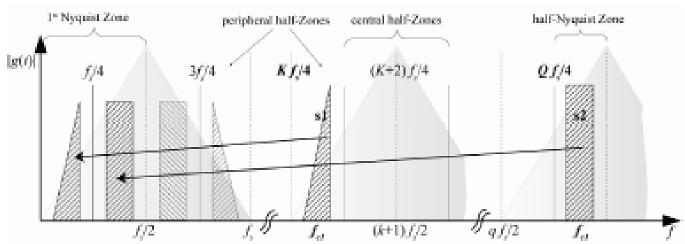
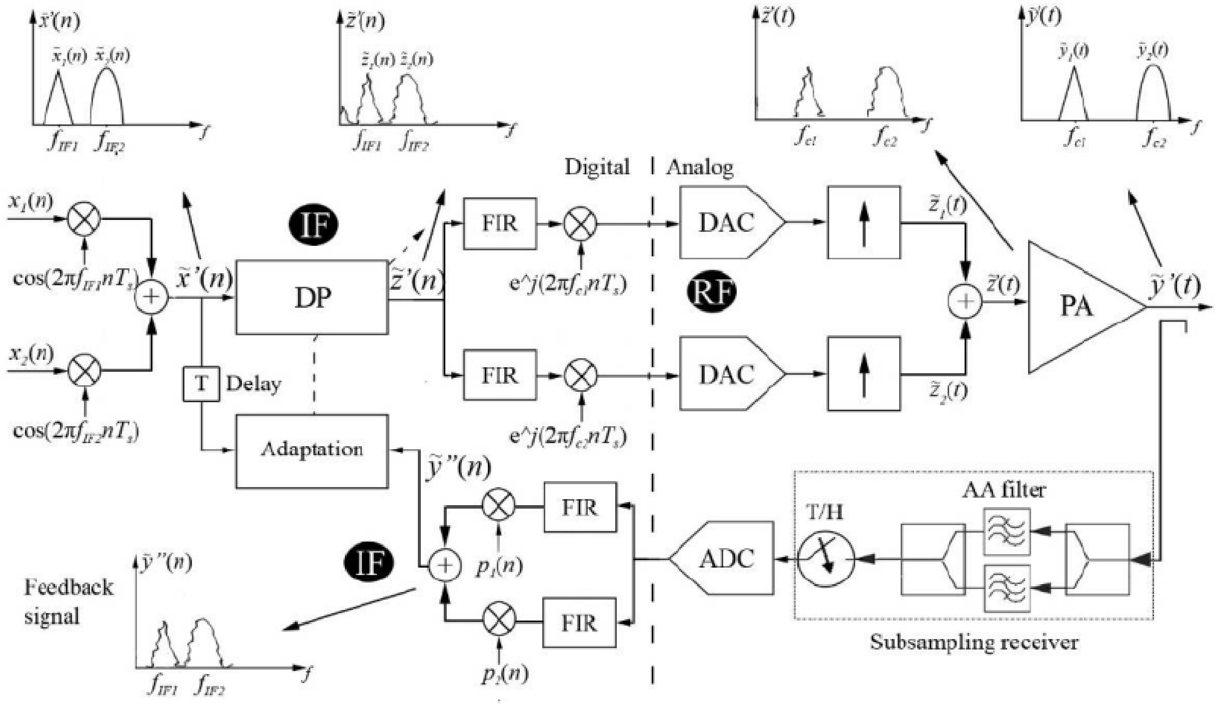


Fig. 3. Dual band subsampling

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		Pg. 2. “The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted.” Pg. 4.
12[pre]	A method at transmitter comprising:	To the extent the preamble is limiting, Cidronali discloses and/or renders obvious a method at [sic] transmitter. *See*, claim 1[pre], *supra*, which is incorporated by reference herein.
12[a]	amplifying a modulated concurrent multi-hand signal to provide an amplified concurrent multi-band sinal;	Cidronali discloses and/or renders obvious amplifying a modulated concurrent multi-hand signal to provide an amplified concurrent multi-band sinal [sic]. *See*, claim 1[a], *supra*, which is incorporated by reference herein.
12[b]	predistorting the modulated concurrent multi-hand signal to compensate for a non-linearity of the power amplifier:	Cidronali discloses and/or renders obvious predistorting the modulated concurrent multi-hand signal to compensate for a non-linearity of the power amplifier. *See*, claim 1[b], *supra*, which is incorporated by reference herein.

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
12[c]	subsampling of the amplified concurrent multi-band signals at a subsampling frequency lower than twice a highest signal frequency in the amplified multi-band signal: and	Cidronali discloses and/or renders obvious subsampling of the amplified concurrent multi-band signals at a subsampling frequency lower than twice a highest signal frequency in the amplified multi-band signal. *See*, claim 1[c], *supra*, which is incorporated by reference herein.
12[d]	controlling the predistorting by the subsampled concurrent multi-band signal.	Cidronali discloses and/or renders obvious controlling the predistorting by the subsampled concurrent multi-band signal. *See*, claim 1[c], *supra*, which is incorporated by reference herein.
13	The method of claim 12, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signal.	Cidronali discloses and/or renders obvious the method of claim 12, wherein the subsampling frequency is greater than two times a signal bandwidth of the modulated concurrent multi-band signal. *See* claims 10 and 12, *supra*, which is incorporated by reference herein.
14	The method of claim 12, wherein the subsampling frequency is chosen to avoiding aliasing between replicas.	Cidronali discloses and/or renders obvious the method of claim 12, wherein the subsampling frequency is chosen to avoiding aliasing between replicas. *See* claims 10 and 12, *supra*, which is incorporated by reference herein. *See*, *e.g.*, "In this paper we propose a novel method of Dual Band DPD (DB-DPD), capable of a simultaneous predistortion of a concurrent dual-band power amplifier at both frequency bands. The proposed method uses a single band memory polynomial DP for linearization, operating at a proper IF. As feedback path the system adopts a subsampling receiver, which allows extreme flexibility

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		and coherent dual-band down-conversion. With the selection of an appropriate sample rate, the RF channels are translated side-by-side at a low IF with no spectral overlap. At this section of the system a low-pass ADC digitizes the entire baseband range, and after DSP channelization of the signals an indirect learning algorithm is adopted to train the DPD. The memory polynomial DB-DPD system was simulated with Matlab-Simulink®, and performance was compared with those achieved from the same system operating in single band operation.” Pg. 1. “The paper is organized as follows: in Section II is recalled a brief review of the main PA topologies target of the linearization procedure herein analysed. In Section III is described the sub-sampling receiver design and the technique for the sampling frequency calculation. Section IV reports the operating principle of the DB-DP system, while in Section V simulation results are showed, highlighting performance differences over single band DPD systems.” Pg. 1. “IV. Dual Band Digital PreDistortion In the full paper we will discuss about the proposed DB- DPD system which is an extension of a single band DPD (SB- DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x1(n)$ and $x2(n)$ are shifted to fIF 1 and fIF 2 then summed thus creating $x\sim '(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $z\sim'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down- conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $z\sim'(t)$ is obtained by frequency shifting to the RF frequencies $fc1$ and fc 2 , and combining them. The PA output $y\sim'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $y\sim '(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

Claim No.	’204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		In the digital domain, the bands are separated and shifted to IF, composing the signal *y*~"(*n*) that is compared to *x*~ '(*n*) by the direct learning training algorithm. The block diagram of the whole system is shown in Fig. 4.” Pgs. 2-3.  Fig. 4.DB-DP system with IF predistortion and subsampling feedback Fig. 4.

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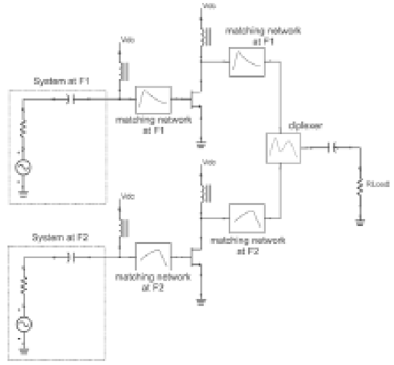

Fig. 1. Schematic of the concurrent dual-band PA implemented by two combined dedicated PAs.

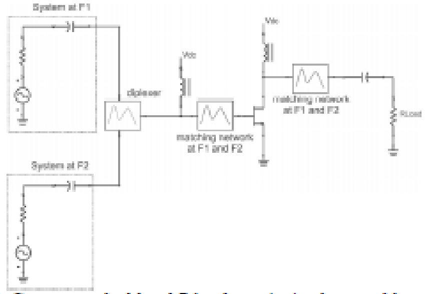

Fig. 2. Concurrent dual-band PA schematic, implemented by a dual-band PA.

III. Subsampling Receiver

The subsampling adopted in the DB-DPD feedback recalls somehow the receivers adopted in the multiband radios and is based on the bandpass sampling theorem. This principle can be adapted to down-convert two (or more) band-limited signals s_1 and s_2, located at different centre frequencies f_{c1} and f_{c2}, with bandwidths B_1 and B_2. Selecting the proper sampling frequency there will be aliases of the two signals located side-by-side in the first Nyquist zone with no overlap, as shown in Fig. 3. The sampling frequency must respect the condition:

$$f_s \geq 2(B_1 + B_2)$$

that is, the Nyquist zone must be wider than the sum of the two bands.

Form the Fig. 3 is evident that the two band-pass signals have to be down-converted at IF rather than both at base-band to make them suitable for the DP training. In the full paper a detailed discussion about the constraints and the proper selection of the intermediate frequency for the down conversions is given.

IV. Dual Band Digital Predistortion

In the full paper we will discuss about the proposed DB-DPD system which is an extension of a single band DPD (SB-DPD) system. In this case, the predistortion is usually realized in the digital baseband, while a baseband predistortion with a unique DP is not possible in dual band concurrent systems. In DB-DP, baseband digital signals $x_1(n)$ and $x_2(n)$ are shifted to f_{IF1} and f_{IF2} then summed thus creating $\tilde{x}'(n)$, which is about a proper IF and passed through the gain adjuster; the output of this process is the numeric signal $\tilde{z}'(n)$. The next step is operated by a numeric diplexer which separates again the two frequency bands. A pair of numeric frequency down-conversions translates to baseband the two signal which are then converted in the analogue domain. This latter numeric process is required when the ADC clock frequency is an issue. The analogue PA input $\tilde{z}'(t)$ is obtained by frequency shifting to the RF frequencies f_{c1} and f_{c2}, and combining them. The PA output $\tilde{y}'(t)$, is spilled and a portion of it is used to create the feedback signals. The feedback path proposed in this paper consists of the coherent dual-band subsampling receiver discussed in the previous section. The two bands composing $\tilde{y}'(t)$ are aliased side-by-side in the baseband, then digitized by a single ADC.

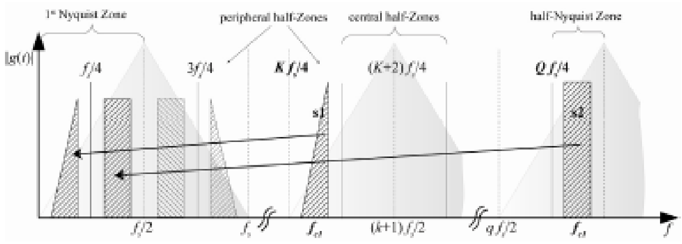

Fig. 3. Dual band subsampling

Claim No.	'204 Patent	Exemplary Evidence of Anticipation and/or Obviousness
		Pg. 2. "The proposed DB-DPD system architecture exploits a memory polynomial predistorter and a subsampling receiver as a feedback path. The DB-DP implements a memory polynomial predistorter and a direct learning training method similar to those involved in single band DP. It operates at a proper digital IF and it is able to correct most NLs, even those due to memory effect, both in single and dual band operation. The introduced technique can be effectively used in conjunction with concurrent dual-band PAs. Comparison with conventional DPD shows that the performance decreases slightly when a concurrent dual band signal is predistorted." Pg. 4.
15	The method of claim 14, wherein the chosen subsampling frequency fs for a given signal bandwidth and carrier frequency fc is in the range $2fu/n \leqq f_s \leqq 2h/(n-1)$where $1 \leqq n \leqq \|fu/B\|$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.	Cidronali discloses and/or renders obvious the method of claim 14, wherein the chosen subsampling frequency fs for a given signal bandwidth and carrier frequency fc is in the range $2fu/n \leqq f_s \leqq 2h/(n-1)$where $1 \leqq n \leqq \|fu/B\|$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. *See* claims 11 and 14, *supra*, which is incorporated by reference herein.