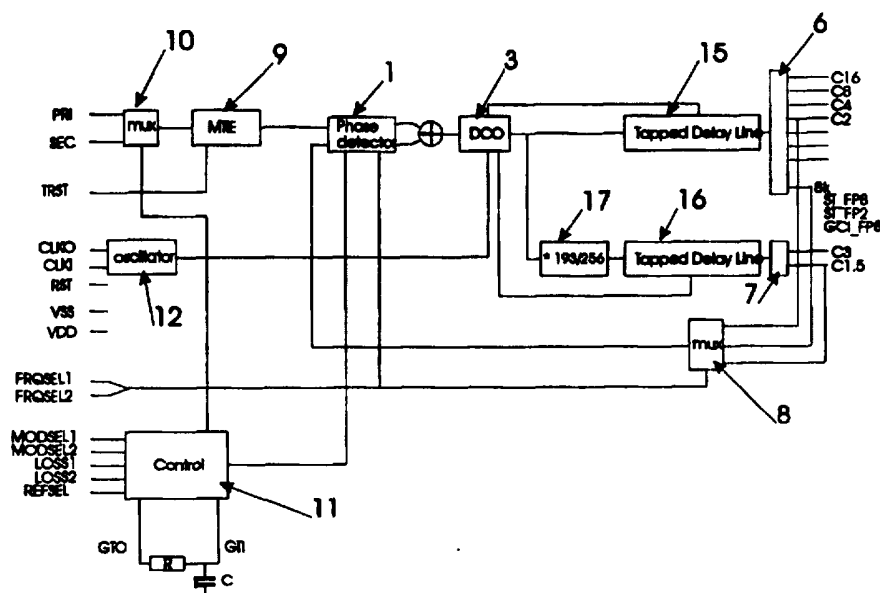




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(21) International Application Number: PCT/CA95/00432 (22) International Filing Date: 20 July 1995 (20.07.95) (30) Priority Data: 9414729.5 21 July 1994 (21.07.94) GB 08/440,939 15 May 1995 (15.05.95) US (71) Applicant: MITEL CORPORATION [CA/CA]; 350 Legget Drive, P.O. Box 13089, Kanata, Ontario K2K 1X3 (CA). (72) Inventors: WIECZORKIEWICZ, Jerzy; 46 Ipswich Terrace, Kanata, Ontario K2K 2R4 (CA). SHETTY, Krishna; 10 Ayton Lane, Kanata, Ontario K2K 2H4 (CA). KENNEY, Terry; 29 Downsview Crescent, Nepean, Ontario K2G 0A4 (US). VAN DER VALK, Robert, L.; Hoevestraat 17B, NL-3033 GA Rotterdam (NL). SPIJKER, Menno, T.; Doklaan 69-C, NL-3082 RD Rotterdam (NL). (74) Agent: MITCHELL, Richard, J.; Marks & Clerk, P.O. Box 957, Station B, Ottawa, Ontario K1P 5S7 (CA).		(81) Designated States: CA, DE, GB, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i> (88) Date of publication of the international search report: 14 March 1996 (14.03.96)

(54) Title: DIGITAL PHASE LOCKED LOOP



(57) Abstract

A digital phase locked loop is for recovering a stable clock signal from at least one input signal subject to jitter is disclosed. The loop comprises a digital input circuit receiving at least one input signal, a digital controlled oscillator for generating an output signal at a desired frequency and a control signal representing the time error in said output signal, a stable local oscillator for providing clock signals to the digital controlled oscillator, and a tapped delay line for receiving the output signal of the digital controlled oscillator. The tapped delay line comprises a plurality of buffers each introducing a delay of less than one clock cycle of the digital controlled oscillator. The tapped delay line produces an output signal from a tap determined by the control signal. A digital phase comparator receives at least one input signal from the input circuit and the output signal from the tapped delay line to generate a digital input signal controlling the digital controlled oscillator.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 95/00432

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H03L7/099 H03L7/081 G06F1/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H03L

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 299 724 (RCA LICENSING CORP.) 18 January 1989 see page 2, line 35 - line 36 see page 3, line 44 - page 4, line 43 see page 5, line 29 - page 7, line 41 see figures 2,3A-3D ---	1,3,6, 8-11
A	US,A,4 489 342 (STRUTHOFF ET AL.) 15 September 1982 see column 2, line 18 - column 3, line 24; figure 1 --- -/--	1,10

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- * "O" document referring to an oral disclosure, use, exhibition or other means
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- * "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- * "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- * "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * "&" document member of the same patent family

Date of the actual completion of the international search

27 September 1995

Date of mailing of the international search report

24. 01. 96

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BALBINOT H.

INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/CA 95/00432

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>PROCEEDINGS OF THE 40TH ANNUAL FREQUENCY SYMPOSIUM, , IEEE, NEW YORK pages 355 - 365 V. REINHARDT ET AL. 'A SHORT SURVEY OF FREQUENCY SYNTHESIZER TECHNIQUES' see page 360 section entitled "Direct Digital Synthesis" see pages 361, 362, the section entitled "Phase Interpolation DDS" see figures 7,8,13,14 ---</p>	1,3,10
A	<p>US,A,4 577 163 (CULP) 18 March 1986 cited in the application see column 2, line 54 - column 4, line 15; figures 2,3 -----</p>	1,3,10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA95/00432

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see continuation sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-3, 6, 8-11

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/CA95/00432

FURTHER INFORMATION CONTINUED FROM PCT/ISA/210

1. Claims: 1-3,6,8-11
2. Claims: 4,5,13-15
3. Claims: 7,12

Reasons for raising a lack of unity objection a posteriori (Article 17(3)(a) PCT and Rule 13 PCT):

The subject-matter of independent product claim 1 and the corresponding method claim 10 is lacking novelty in view of document EP-A-0 299 724(D1) cited in the partial search report. It is furthermore noted that D1 also deprives dependent claims 3 and 11 (respectively dependent on claims 1 and 10) of novelty.

Consequently, neither claims 2,4,5,6,7,8 and 9 (all dependent on claim 1) nor claim 12 (dependent on claim 10) nor independent claim 13 and its dependent claims 14 and 15 are so linked as to form a single general inventive concept.

The various inventions are listed below:

- 1) Claim 2 (taken in combination with claim 1) is directed to a digital PLL provided with means for doubling the output frequency of a DCO included in the loop, thus addressing a first problem.
- 2) Claims 4 and 5 on the one hand and claims 13-15 on the other hand are respectively directed to a digital PLL comprising a particular type of digital controlled oscillator (DCO) and to this particular type of oscillator per se. They are not concerned with the previous problem of doubling the DCO frequency.
- 3) Claims 7 and 12 are respectively directed to a digital PLL having means for minimizing phase jump when switching the input signal to said digital PLL and to a corresponding method. Consequently, these claims address a still different problem.

Although dependent claims 6,8 and 9 would formally constitute three additional inventions (in the sense that they are neither linked to each other nor to any other claim by a common inventive concept), these claims have however been searched during the search for the first invention specified in the claims because they appear to be trivial.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 95/00432

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0299724	18-01-89	US-A- 4802009 DE-D- 3853897 FI-B- 92122 JP-A- 1036184	31-01-89 06-07-95 15-06-94 07-02-89
US-A-4489342	18-12-84	EP-A- 0059802 JP-A- 57159121	15-09-82 01-10-82
US-A-4577163	18-03-86	NONE	