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Current Conveyor based RC Oscillators-A Review & Bibliography

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Abstract: This review paper presents a study of current conveyor based RC oscillators. This study includes only those oscillators which are fully coupled or have independently controllable condition of oscillations. All the variants of current conveyors have been included in this paper. The result of this study have been shown in tabular forms where proposed oscillators have been compared on the basis of following parameters; type of oscillator, mode of oscillator, type and numbers of current conveyor used, number of resistances, number of capacitances, availability of electronic control, sensitivity values and availability of high impedance outputs.

Introduction

Current Conveyor is a more than four decade old active element emerged as potential element with numerous applications in the analog signal processing. The first Current Conveyor was proposed by Sedra in 1968 and was called the first generation Current Conveyor (CCI). With different modifications in CCI structure some new current conveyors such as CCII, CCIII, CCCII, DVCC, DCC, DDCC, DVCCC, FDCCII, DXCCII etc have been introduced. Current Conveyors find application in all the major signal generation/processing circuits such as filters, oscillators, inductor simulators, integrators, differentiators and many more. Several paper available in the literature has revealed the applicability of current conveyors and research is still continue in this area.

The importance of RC Oscillators in signal generation is well known. Several research papers on RC-oscillator realizations using various active elements, are available in literature but in this study only those works are included in which current conveyor (& its variants) are used to realize RC oscillators. current conveyor based RC oscillators have a long history and in last four decades a number of research papers have been published on them but there is no such paper available, which gives the review of all major work on "current conveyor based RC oscillator" at one place. This review paper, is an attempt to fill this empty space.

In this paper attempts has been made to compile literature of current conveyor based fully coupled/ independent CO (condition of oscillation) RC-oscillators at one place. About 35 major references related to fully coupled/ independent CO realized using different variants of current conveyor have been included here.

Literature Categorization

An oscillator is characterized by two major parameters, Frequency of Oscillation (FO) & Condition of Oscillation (CO) and become very useful if FO and CO are independently controllable. Controllability of FO is desired feature for applications requiring variable frequency source and controllability of CO provides very precise control over amplitude of oscillation as well as total harmonic distortion. In this paper the available literature on CC based RC-oscillators has been categorized into four major categories on the basis of capability of independent control of FO and CO.

Category -1- This category includes those oscillators in which FO and CO are fully coupled to each other so none of them is independently controllable. The FO and CO both are fixed so oscillator oscillates on a single frequency. Such oscillators are called SFO-FC (Single frequency oscillator- Fully Coupled).

Category -2- This category covers those oscillator in which CO is independently controllable but FO is not. These oscillators are also single frequency oscillator but not fully coupled as CO is independently controllable. Such oscillator are called SFO (Single frequency oscillator).

Literature Review

Each category is reviewed in a tabular form, which gives a comparative analysis of Oscillator circuits of that particular category. The review has been done on following points.
Type - Type of oscillator-SFO, SFO-FC, VFO, SRCO, SECO, ECO etc.
Mode - Mode of Oscillator current mode (CM), voltage mode (VM), Dual or mixed mode (CM/VM)
Current Conveyor Used- Type and numbers of current conveyor elements used.
Resistors- Numbers of grounded resisters / floating resisters- R (G) / R (F)
Capacitors-Numbers of grounded capacitors / floating capacitors- C (G) / C (F)
Electronic control- Electronic control of CO (Condition of Oscillation) and FO (Frequency of Oscillation)
Sensitivities- Magnitudes of ideal active and passive sensitivities of FO (Frequency of Oscillation)
High impedance outputs - Whether all the Current outputs are high impedance explicit outputs (Yes-Y/No-N).

Review of "Category-1" Oscillators

Table-1- Review of "Category-1" Oscillators

Ref.	Type	Mode	Current Conveyors Used	Resisters	Capacitors	Electronic Control	Sensitivities	High Impedance O/P.
[1].	SFO-FC	VM	a) 1-CCII(+) b) 1-CCII(+)	a)1-R(G)+ 1-R(F) b)1-R(G)+ 1-R(F)	a)1-C(G)+1-C(F) b)1-C(G)+1-C(F)	a)none b)none	a) 0 .5 b) 0.5	a)N b)N
[2]	a)SFO-FC b)SFO-FC c)SFO-FC d)SFO-FC e)SFO-FC f)SFO-FC	VM	a)1-CCII(+) b)1-CCII(+) c)1-CCII(+) d)1-CCII(+) e)1-CCII(+) f)1-CCII(+)	a)1-R(G)+ 1-R(F) b) 1-R(G)+ 1-R(F) c) 1-R(G)+ 1-R(F) d) 1-R(G)+ 1-R(F) e) 1-R(G)+ 1-R(F) f) 2-R(G)	a)1-C(G)+1-C(F) b)1-C(G)+1-C(F) c) 2-C(G) d)1-C(G)+1-C(F) e)1-C(G)+1-C(F) f) 1-C(G)+ 1-C(F)	a)none b)none c)none d)none e)none f)none	a) 0.5 b) 0.5 c) 0.5 d) 0.5 e) 0.5 f) 0.5	a)N b) N c)N d)N e)N f)N

[3]	SFO-FC	CM	a)2-CCII(+)	a)3-R(G)	a) 3-C(G)	a)none	a) ≤ 0.5	a)Y
[4]	QSFO-FC	VM	2-CCII(+)	4-R(F)	2-C(F)	none	≤0.5	N
[5]	a)SFO-FC b)SFO-FC	VM	a)1-ICCII(-) b)1-ICCII(-)	a)1-R(G)+1-R(F) b)1-R(G)+1-R(F)	a)1-C(G)+1-C(F) b)1-C(G)+1-C(F)	a)none b)none	a) -0.5 b) -0.5	a)N b)N
[6]	SFO-FC	VM	1-DVCC(+)	2-R(G)	2-C(G)	none	-0.5	N
[7]	QSFO-FC	CM	2-DVCC	4-R(G)	2-C(F)	none	1	Y
[8]	MP-SFO-FC	VM	1-CCII(+)	a)2-R(G) b)1R(G)+1-R(F)	a)1-C(G)+1-C(F) b)2-C(G)	a)none b)none	a) 0.5 b) 0.5	a)N b)N
[9]	QSFO-FC	CM	2-CCCII(-) + 1-CCCII(+)	No resister	1-C(G)	FO,CO	> ≤ 0.5	N
[10]	MP-SFO(8phse) –FC	CM	4-MOCCII	2-R(G)	2-C(G)	None	0.5	Y
[11]	MP-SFO(8 phase) -FC	CM	4-MOCCII	2-R(G)	2-C(G)	none	-0.5	Y
[12]	Q-SFO-FC	CM	2-DVCC(modified)	2-R(G)	2-C(G)	none	-0.5	N
[13]	Q-SFO-FC	CM	2-CCCII	No resister	2-C(G)	FO,CO	-0.5	N
[14]	Q-SFO-FC	CM	2-CCCII	No resister	2-C(G)	CO,FO	-0.5	Y
[15]	Q-SFO-FC	CM	2-CCIII	3-R(G)+1-R(F)	1-C(G)+1-C(F)	None	-0.5	Y
[16]	Q-SFO-FC	CM	2-DVCC	2-R(G)	2-C(G)	none	-0.5	Y
[17]	SFO- FC	CM	3-DO-CCII	2-R(G)	2-C(G)	none	-0.5	Y
[18]	SFO-FC	VM	1-CCCII(+)	1-R(G)	1-C(G)+1-C(F)	CO,FO	≥ 0.5	N
[19]	SFO- FC	VM	a)1-ICCII(-) b)1-ICCII(-)	a)1-R(G)+1-R(F) b)1-R(G)+1-R(F)	a)1-C(G)+1-C(F) b)1-C(G)+1-C(F)	a) none b)none	a) 0.5 b) 0.5	a)N b)N
[20]	QSFO-FC	VM	2-DDCC	1-R(G)+1-R(F)	2-C(G)	none	-0.5	N

[21]	QSFO-FC	VM	1-DO-DDCC(+)	2-R(G)	2-C(G)	none	-0.5	N
[22]	SFO- FC	VM	1-CCII(+)	2-R(G)	1-C(G)+1-C(F)	none	0.5	N
[23]	QSFO-FC	CM	3-CCCII	No resister	2-C(G)	CO, FO	≥ 0.5	Y
[24]	QSFO-FC	VM/CM	2-DVCC	2-R(G)	2-C(G)	none	-0.5	Y
[25]	QSFO-FC	VM	1-DXCCII	1-R(G)+1-R(F)	1-C(G)+1-C(F)	none	-0.5	N

Review of "Category-2" Oscillators

Table-2- Review of "Category-2" Oscillators

REF	Type	Mode	Current Conveyors Used	Resister	Capacitors	Electronic control	Sensitivities	High Impedance O/P
[2]	a)SFO b)SFO c)SFO d)SFO e)SFO f)SFO	VM	a)1-CCII(+) b)1-CCII(+) c)1-CCII(+) d)1-CCII(+) e)1-CCII(+) f)1-CCII(+)	a) 2-R(G)+1-R(F) b) 3-R(G) c) 3-R(G) d) 1-R(G)+ 2-R(F) e) 2-R(G)+1-R(F) f) 1-R(G)+2-R(F)	a)1-C(G)+1-C(F) b)1-C(G)+1-C(F) c) 1-C(G)+ 1-C(F) d) 1-C(G)+1-C(F) e)1-C(G)+1-C(F) f) 1-C(G)+ 1-C(F)	a)none b)none c) none d) none e)none f)none	a) ≤ 0.5 b) ≤ 0.5 c) ≤ 0.5 d) ≤ 0.5 e) ≤ 0.5 f) ≤ 0.5	a)N b)N c) N d) N e)N f) N
[26]	a)Wien SFO	a)CM	a)2-CCII	a)3-R(G)+1-R(F)	a)1-C(G)+1-C(F)	a)none	a) ≤ 0.5	a)Y
[27]	Wien Type SFO	VM	a)1-CCII b)1-CCII(+)	a)1-R(G)+3-R(F) b)1-R(G)+3-R(F)	a)1-C(G)+1-C(F) b)2-C(G)	a)none b)none	a) ≤0.5 b) ≤0.5	a)N b)N
[28]	a)SF b)SFO c)SFO d)SFO	VM	a)2-ICCII(-) b)2-ICCII(-) c)2-ICCII(-) d)2-ICCII(-)	a) 3-R(G) b) 3-R(G) c) 3-R(G) d) 3-R(G)	a) 3-C(G) b) 3-C(G) c) 3-C(G) d) 3-C(G)	a)non b)none c)none d)none	a) ≤0.5 b) ≤0.5 c) ≤0.5 d) ≤0.5	a)N b)N c)N d)N
[29]	Q-SFO	CM	2-CCII	3-R(G)+2-R(F)	2-C(G)+1-C(F)	none	≤1	Y
[30]	c)SFO	CM	c)ICCII(-)	c)1-R(G)+	c)3-C(G)	c) none	c)) ≤0.5	c)Y

				1-R(F)				
[31]	a)MP-SFO(4phs) b)MP-SFO(8phs) c)MP-SFO(8 phSe)	a) VM b) VM c) VM	a)2-CCII(-) 2-CCII(+) b)4-DO-CCII c)1-MO-CCII + 2-DO-CCII	a)7-R(G) b)11-R(G) c) 10-R(G)	a)5-C(G) b)8-C(G) c)8-C(G)	a)none b)none c)none	a) ≤0.5 b) ≤0.5 c) ≤0.5	a)N b)N c)N
[32]	Wien-bridge oscill-SFO	CM	a)2-CCII(+) b)2-CCII(+)	a)2-R(G)+ 2-R(F) b)1-R(G)+ 3-R(F)	a)1-C(G)+1-C(F) b)2-C(G)	a)none b)none	a) ≥0.5 b) ≥0.5	a)Y b)Y
[33]	SFO	CM	1-CCI(+) + 1-CCII(-)	2-R(G)+1-R(F)	2-C(G)	none	≥0.5	Y
[34]	SFO (Three Phase)	Mix mode	3-DXCCII+ 3-MOSFET	2-R(G)	3-C(G)	CO	≥0.5	Y
[35]	SFO (3-phase)	VM	1-CCII(+) +1-ECCII(-)	2-R(G)+2-R(F)	2-C(G)	CO	≥0.5	N

Conclusion

The given compilation can be a very important source of information for researchers as it provides

1) A up-to date year-wise list of standard references related to current conveyor RC oscillator applications.

2) Comparative review of previously published current conveyor based RC oscillator circuits so that a reader can compare published work and find the new possibilities as well as future scope in this particular area.

The authors try to compile as much standard references as possible with best of their knowledge but the period of coverage being almost more than four decade so there may have been some omissions. Authors would appreciate if any references, not included in given list, brought to their knowledge.

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