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WIDE-BAND FREQUENCY MULTIPLIER

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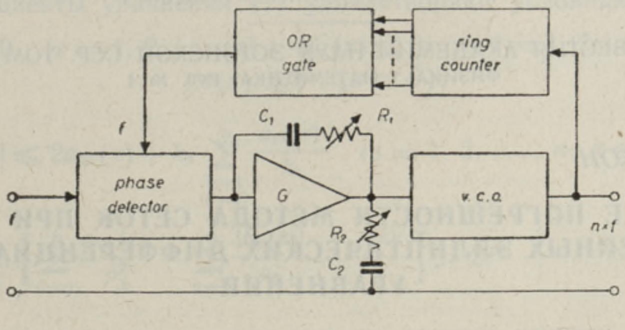
The problem of multiplying a variable frequency can be solved by full-wave rectifying techniques, but only for multiplication factors of 2^n, n being any integer [1]. Quadrature signal processing techniques give the same result [2]. Alternatively, all multiplication factors can be obtained from a phase-locked loop (p. l.l), which also locks at harmonic frequencies, for a phase detector is somewhat sensitive to harmonics. Such circuits, including pulsed p. l.l., do not have satisfactory wide-band performance due to the small output of a phase detector at a desired harmonic. A serious shortcoming of a p. l.l is its tendency to lock at the fundamental frequency or at a lower harmonic rather than the correct one.

We have overcome these difficulties by placing a wide-band frequency divider in the p. l.l between a voltage-controlled oscillator (v. c. o.) and a phase detector (see Fig.). Now both inputs to the phase detector are of the same fundamental frequency, and full output voltage is available.



For division ratios up to 10 or even 20, the frequency divider can be a ring counter, while higher division ratios can be obtained from more sophisticated circuits [3]. Simple switching to various division ratios is possible in the ring counter having the sequence "one — on, the others — off". A diode OR gate is provided to maintain symmetrical waveform for even division ratios and minimally unsymmetrical waveform for odd ratios (i. e. 2 : 1; 3 : 2; 4 : 3; etc. for division ratios 3; 5; 7; etc.). A two-diode gate without switching is required for division ratios up to 5.

The essential performance parameters of the multiplier are: spurious content of the other frequencies in the output voltage, response time, frequency range without switching, and static phase error. The first effect is due to phase modulation of a v. c. o. by the pulsations at the output of a phase detector. This spurious modulation and response time depend in a contradictory way on the parameters of the filter (R_1C_1, R_2C_2), and suitable compromise between them is adjusted according to the user's requirements. Such a four-element filter is suitable for d. c. amplifier with high output impedance; if this impedance is low, R_2C_2 is omitted. A full-wave phase detector should be used rather than a half-wave one, because the former has less spurious modulation and faster response.

We used a voltage-controlled astable multivibrator as v. c. o. giving continuous frequency variations over a range of one decade. This range can be extended even more by the use of a proper voltage-to-frequency converter. Static phase error is kept in predetermined limits by the d. c. amplifier with a sufficient gain, G.

A multiplier having continuous frequency ranges 5—50 Hz, 10—100 Hz, etc. up to 2 kHz — 20 kHz has been constructed. While acting as a frequency quintupler at 500 Hz/2.5 kHz, it has response time 50 msec for certain filter settings. For the same settings, the rejection ratio for spurious frequencies is at least —57 db, while fundamental frequency is —85 db down at the output.

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Р. ЮРГЕНСОН

ОБ ОЦЕНКЕ ПОГРЕШНОСТИ МЕТОДА СЕТОК ПРИ РЕШЕНИИ НЕЛИНЕЙНЫХ ЭЛЛИПТИЧЕСКИХ ДИФФЕРЕНЦИАЛЬНЫХ УРАВНЕНИЙ

R. JÜRGENSON. VÕRKUDE MEETODI VEAHINNANGUST MITTELINEAARSETE ELLIPTILIST TÜÜPI DIFERENTSIAALVÕRRANDITE LAHENDAMISEL

R. JÜRGENSON. ON THE ERROR ESTIMATION OF THE DIFFERENCE METHOD IN SOLVING NONLINEAR ELLIPTIC DIFFERENTIAL EQUATIONS

В известных работах по основным теоретическим вопросам разностного метода (применительно к эллиптическим уравнениям второго порядка) — оценка погрешности, вопросы сходимости итерационного процесса решения конечно-разностной системы — как правило, ограничиваются уравнением, где смешанные производные отсутствуют (см., напр., [1-3]). В настоящей заметке даются оценки погрешности метода сеток при наличии в уравнении смешанных производных. При этом, смешанные производные аппроксимируются такими разностными выражениями, что к получаемой конечно-разностной системе применим известный принцип максимума (см. [2], гл. II, § 4).