RHYTHM GENERATOR

PART 1

N.A. COOKE

With twelve rhythms that can be superimposed and eight sound generators

THIS Rhythm Generator design compacts eight percussion instruments and a percussionist into a neat professionally styled case measuring some 300 × 130 × 60mm.

The advantage of this unit over many others is that rhythms are selected directly and can be superimposed to create new and musically more interesting patterns. There are 12 basic rhythms and these are as follows:—Tango, Waltz, Shuffle, March, Slow Rock, Swing, Pop Rock, Rumba, Beguine, Cha Cha, Samba and Bossa Nova. By simply selecting two or more, their patterns will be superimposed and a blend of the selected rhythms will result.

CIRCUIT BREAKDOWN

The block diagram (Fig. 1) shows the complete Rhythm Generator. The various circuits can be placed within four main groups:

1. Rhythm pattern generation.
2. Musical instrument simulators.
3. Pre-amplification.
4. Power supply.

To assist in understanding the complete circuit it is best to deal with each of the above groups in turn.

RHYTHM PATTERN GENERATION

The object of this circuit is to provide the instrument simulators with rhythmically pulsed information which in turn is transformed into recognisable percussion sounds.

The heart is the M253AA chip which contains a read only memory matrix pre-programmed with the 12 basic rhythm patterns. All that is required to obtain this information is to provide the chip with a square wave at the clock input, pin 24. By varying the frequency of this square wave the tempo of the rhythm may be controlled.

Fig. 2 shows the circuit diagram of the Rhythm Generator with rhythm selection stop and reset switches and downbeat indicator.

To select a rhythm the desired input must be clamped to the 0V rail (logic 0) with the other inputs tied to 4·7V (logic 1). Change-over switches S1-12 are required for this function. Here the other change over section of the switches is used to select Claves or Snare Drum as appropriate for the particular rhythm.

The square wave for the clock input is generated by a simple astable multivibrator using two CMOS NAND gates together with the associated timing components C2, R2 and VR1 which control the operational frequency. This frequency may be adjusted from approximately 5 to 50Hz

COMPONENTS . . .

Resistors

R1	22kΩ	R31	150kΩ
R2	100kΩ	R32	68kΩ
R3	22kΩ	R33	68kΩ
R4	10kΩ	R34	27kΩ
R5	22kΩ	R35	12kΩ
R6	2·2MΩ	R36	47kΩ
R7	510kΩ	R37	10kΩ
R8	2·7kΩ	R38	470kΩ
R9	220kΩ	R39	390kΩ
R10	150kΩ	R40	390kΩ
R11	68kΩ	R41	390kΩ
R12	68kΩ	R42	10kΩ
R13	27kΩ	R43	22kΩ
R14	12kΩ	R44	1MΩ
R15	47kΩ	R45	100kΩ
R16	10kΩ	R46	470kΩ
R17	150kΩ	R47	1MΩ
R18	68kΩ	R48	22kΩ
R19	68kΩ	R49	2·2kΩ
R20	27kΩ	R50	1MΩ
R21	12kΩ	R51	1MΩ
R22	47kΩ	R52	1MΩ
R23	10kΩ	R53	4·7kΩ
R24	150kΩ	R54	4·7kΩ
R25	68kΩ	R55	22kΩ
R26	68kΩ	R56	10kΩ
R27	27kΩ	R57	390kΩ
R28	12kΩ	R58	10kΩ
R29	47kΩ	R59	2·2kΩ
R30	10kΩ	R60	22kΩ
		R61	33kΩ

All ¼W 5% Carbon Film

Potentiometers

VR1	1MΩ lin	
VR2	25kΩ lin	
VR3	10kΩ log	
VR4	470kΩ	All 0·1W sub min. horizontal preset
VR5	470kΩ	
VR6	470kΩ	
VR7	470kΩ	
VR8	100kΩ	
VR9	220kΩ	
VR10	10kΩ	

Capacitors

C1	0·01μF mylar
C2	0·1μF polyrad
C3	0·22μF polyrad
C4	0·1μF polyrad
C5	0·15μF polyrad
C6	0·047μF polyrad
C7	0·047μF polyrad
C8	0·15μF polyrad
C9	0·033μF mylar
C10	0·01μF mylar
C11	0·01μF polyrad
C12	0·033μF mylar
C13	0·047μF polyester axial
C14	0·015μF polyester axial
C15	0·015μF polyester axial
C16	0·047μF mylar
C17	4·7nF ceramic
C18	1·5nF ceramic
C19	1·5nF ceramic
C20	4·7nF polyrad
C21	0·22μF polyrad
C22	0·1μF polyrad
C23	0·33μF polyrad
C24	0·068μF polyrad
C25	0·22μF polyrad
C26	0·1μF polyrad
C27	0·05μF ceramic
C28	4·7nF ceramic
C29	4·7nF ceramic
C30	0·02μF mylar
C31	0·1μF 16V radial electrolytic
C32	0·1μF polyrad
C33	0·22μF polyrad
C34	2500μF 25V electrolytic
C35	100μF 25V electrolytic
C36	470μF 16V electrolytic
C37	10μF 16V electrolytic
C38	1000μF 16V electrolytic
C39	1000μF 16V electrolytic
C40	100μF 16V electrolytic

All Electrolytics are vertical p.c.b. mounting types
Note: polyrad means polyester radial lead capacitors Mullard C280 Range

Semiconductors

TR1	BC108B	D11	12V 400mW Zener
TR2	BC108B	D12–D15	Bridge Rectifier 50V, 1A, type W0–005
TR3	BC108B		
TR4	BC108B	D16	0·15in l.e.d.
TR5	BC108B	IC1	M523AA
TR6	2N1132	IC2–IC4	CD4011AE
D1–10	1N4148 (10 off)	IC5	741 Op Amp
		IC6	78L12 AWC Regulator +12 Volt Bridge Rectifier 100V 1 amp
		IC7	78L05 AWC Regulator +5V

Miscellaneous

1	8 pin d.i.l. socket
3	14 pin d.i.l. socket
1	24 pin d.i.l. socket
13	D.p.d.t. sub min toggle (S1–S13)
1	S.p.s.t. sub min toggle (S14)
1	Neon indicator (LP1)
T1	12–0–12V 100ma transformer
L1, L2	SC60 100mH min choke
SK1	3·5mm jack socket
SK2	5 pin DIN socket
FS1	20mm panel fuse—holder and 250mA "quick blow" fuse
1	¼in rubber grommets
1	Earth tag; ¼in fixing lug
10	6BA nuts and bolts
7	6BA clearance spaces ⅜in
1	Wire clamp ("P" Clip)
	1 metre 22 s.w.g. tinned copper wire
	2 metres 3 core mains cable
	2 metres single screen cable
35	Veropins 0·1in pitch
2	Printed circuit boards
3	K15 knobs
1	"AWAB" case 12in × 5in × 2½in. 1½ metres stranded connecting wire
1	Foot switch press-to-break fitted with 3·5mm jack plug (optional extra)

Note: The inside cover page for Watford Electronics shows i.c.s. M252AA and MC253AA incorrectly priced. These should be 750p and 795p respectively

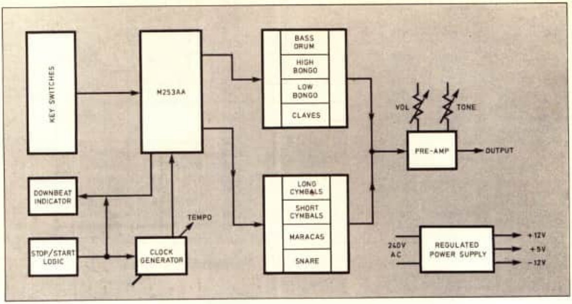


Fig. 1. Block diagram of Rhythm Generator

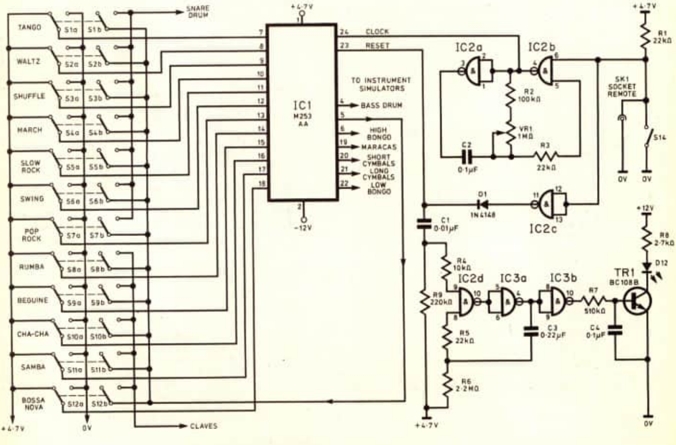


Fig. 2. Rhythm generation circuit

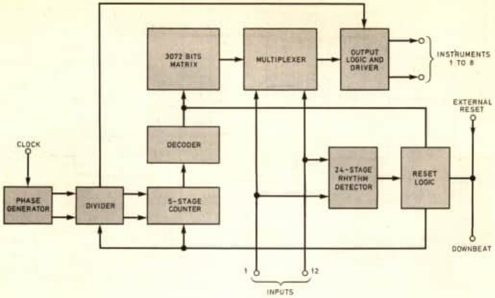


Fig. 3. Block diagram of M253AA

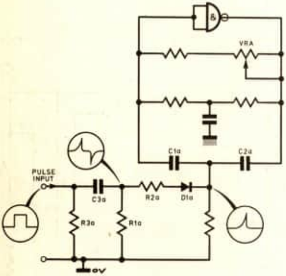


Fig. 4. The basic sinusoidal oscillator

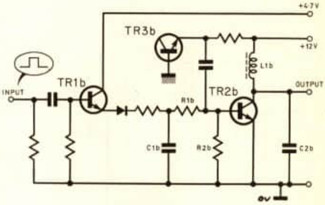


Fig. 5. Fundamental white noise circuit

by the tempo control VR1. The output of the clock generator is fed to the clock input pin 24 of the M253AA.

The rhythm stop/start switch S14 is connected through a NAND gate, operating as an inverter, to the external reset pin 23. When this switch is closed the clock generator is inhibited with its output remaining at logic 1. A pulse is also supplied via the inverter through the blocking diode D1 to reset the rhythm pattern to the beginning of the bar.

On opening the switch the output of the oscillator will immediately go to logic 0 generating the first command pulse which is the first beat in the bar.

DOWNBEAT START

The rhythm pattern always begins on the downbeat, it then lights the l.e.d. with successive downbeats until S14 is closed.

A short pulse is present at the external reset/downbeat pin of the M253AA when the internal logic resets at the end of the rhythm pattern. This pulse is of very short duration only about 2 to 3μs which is obviously too short to light the l.e.d. The lamp must also light at the beginning of the beat and not at the end of a bar which is when the downbeat pulse is present.

Two NAND gates together with R5, R6 and C3 operate as a monostable and extend this pulse to some 350ms. The third NAND gate inverts the output of the monostable in order that TR1 is switched on and this lights the l.e.d. during the set state of the monostable.

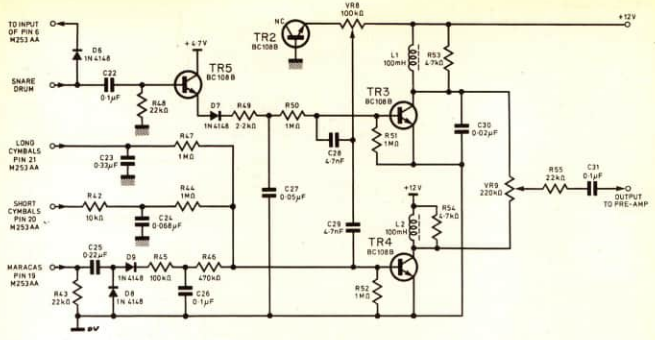


Fig. 6. The four white noise instrument simulators

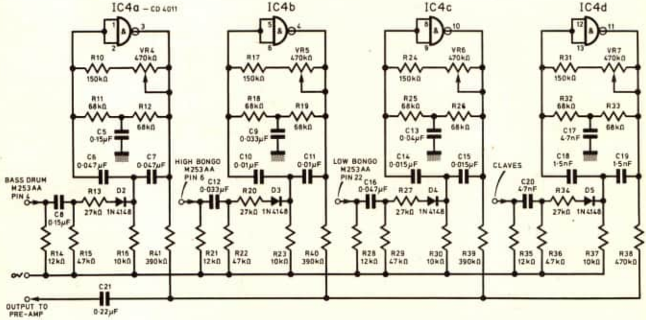


Fig. 7. The four sinusoidal oscillators

THE M253AA IC

Internal operation of the M253AA is shown in Fig. 3. Here the clock input is first divided by two and the output fed to a five-stage counter. The counter resets after 32 pulses for 4/4 time and after 24 pulses for 3/4 time. The counter states are then decoded to drive the ROM (read only memory) matrix which has been pre-programmed with the 12 different rhythm patterns. These, of course, are defined at manufacture but customer options do exist at a price!

The rhythm selection input is decoded to determine the reset point of the counter and to programme the multiplexer to read the memory matrix. Its outputs are then modified to become suitable to drive the eight instrument simulators by means of a driver stage. This driver stage also includes the logic to reset the memory output after each reading in order that successive readings occur on the correct triggering edge of the following beat.

The internal reset pulse is fed to the external pin 23 to provide downbeat indication and to allow external resetting when the generator is stopped.

PERCUSSION VOICES

The Bass Drum, High Bongos, Low Bongos and Claves are created by the use of damped sinusoidal oscillators. The long and short Cymbals and Maracas are simulated by the use of damped filtered white noise.

An example of the simple twin T oscillator used is shown in Fig. 4. The NAND gate is held just below continuous oscillation by the use of VRA.

All four oscillators in this group are identical with the exception of the values of the timing capacitors which set the frequency of oscillation (Fig. 7). The values of the capacitors are chosen to suit the instrument being simulated.

VRA regulates the decay of the oscillation and should be adjusted to give the most realistic effect. The pulsing output of the M253AA is a square wave and this is differentiated by C3a and R1a into two opposite spikes

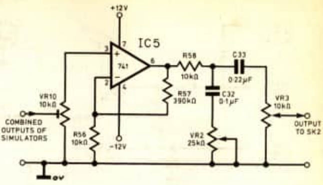


Fig. 8. Pre-amplifier circuit

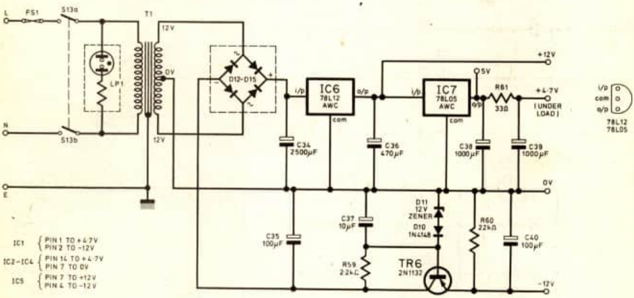


Fig. 9. Circuit of p.s.u.

which are attenuated by R2a and rectified to a single positive spike by D1a. Resistor R3a is necessary to tie the input to earth when no pulse is present as the outputs of the M253AA are open drain types.

Fig. 5 shows the basic circuit of the white noise generators. Transistor TR1b turns on during a command pulse from the M253AA. This charges capacitor C1b which then discharges through R1b to the base of transistor TR2b.

White noise is produced by the reverse biased Zener effect of TR3b which is selectively filtered by C2b and L1b. The level of the white noise at the output of the transistor follows the decaying voltage at the base until the potential across C1b has fallen to a level which causes the transistor to switch off.

The metallic timbre of the Snare Drum is produced on a real instrument by a set of steel springs—the snares which run across the diameter of the underside of the drum. It is the snares vibrating against the skin of the drum that give it its characteristic sound.

This sound is recreated in this unit by combining filtered white noise with the damped oscillation of the High Bongo. The two separate simulators are combined via a diode which prevents the Snare Drum from sounding when the High Bongo is activated.

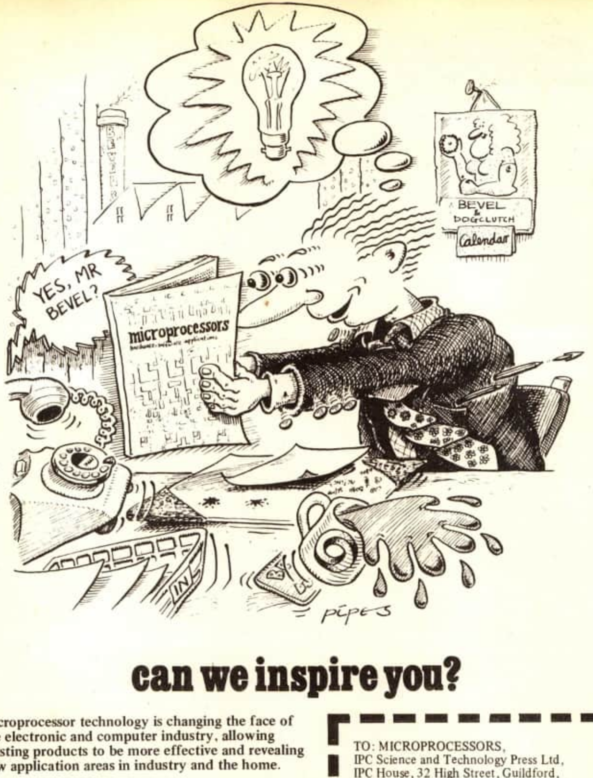
The Maracas simulator is unusual in that it is the only instrument in which the sound increases gradually and then decreases. This effect is produced by means of the integrator/differentiator circuit C25, D8, D9, R45, R46 and C26 (Fig. 6).

PRE-AMPLIFICATION AND P.S.U.

Fig. 8 shows the circuit of the pre-amplifier. All eight instruments are combined by means of a resistor, capacitor network. This composite signal is applied through a potential divider VR10 to the non-inverting input of a 741. Feedback resistors R57 and R56 set the gain and a simple high cut filter, adjusted by means of VR2, acts as a tone control. The output to the external amplifier may be varied by the potentiometer VR3.

Fig. 9 shows the complete power supply unit. A 12-0-12V miniature transformer is used, its output being rectified by the bridge rectifier D12-15. The centre tap is at 0 volts providing a dual supply. Three regulators, two of which are cascaded, are used to provide the output voltages of +12, +5 and −12 volts. The supplies must be stable and ripple free to prevent spontaneous oscillation from the sensitive instrument simulators. To prevent an earth loop, which might cause hum, the case and transformer are earthed to the mains supply and the 0V circuit line is left floating.

Next month: Construction and setting up.



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Strictly Instrumental

by K. Lenton-Smith

The British Musical Instrument Trade Fair is held at three London centres simultaneously each year. One of these concentrates on keyboard instruments and, as these interest me primarily, my visit to the Fair mainly consisted of re-exploring the veritable warren of hotel rooms to see what the Electronic Organ Distributors Association (E.O.D.A.) had been hatching over the past year.

AIDE MÉMOIRE

When the programmable calculator started to become commonplace, I wondered how long it would be before certain of its principles were applied to electronic music. The Trade Fair produced one example—the EKO Tivoli Elite Automatic Chord Organ, distributed by John Hornby Skewes of Leeds.

In many respects, this chord organ is conventional, with rhythm unit able to trigger fundamental basses and chords. For the raw beginner finding difficulty in coping with playing both keyboard and chord buttons, the Tivoli Elite provides three memory controls: Program/Play, Reset and Clear.

The sequence of chords is loaded into the memory bank by pressing Major or Minor chord buttons (but not Fundamentals) in the same order that the sheet music suggests, this being a silent operation. Once the sequence has been banked, it can be recalled by use of "Memory Play" control. Each time this control is operated, the next chord is released.

The tiro, thus armed with a memorised chord sequence, can concentrate on reading the right hand part, using "Memory Play" as a master chord button.

SALES

The E.O.D.A. is in business to sell musical instruments and, perhaps surprisingly, the majority of organs are sold to private individuals, rather than groups or clubs. Any demonstrator will confirm that he can sell an instrument if it sounds good in the hands of a prospective purchaser, however inexperienced. Today's instruments are bristling with gadgets to this end and it is difficult to find a "straight" organ on sale anywhere; attempting to buy such an organ inevitably will mean taking a number of non-optional extras.

BAFFLED

Rotating-baffle speaker systems and the name of Leslie are synonymous, their addition on an organ system giving a new and exciting dimension. These cabinets are a difficult proposition for the home-constructor, who usually ends up buying the commercial article.

If considering a purchase, I suggest the Sharma range of speakers is studied. These are manufactured in England despite the Japanese-sounding name (derived from Sharon and Mark, children of the company's owner) and represent very good value.

Two ranges of cabinet are available, for professional and home use, with power outputs ranging between 30W and 300W.

All but the least expensive model in each range is fitted with a treble pressure driver, revolving horns and bass rotor giving tremolo, chorale or straight signals. The technical details are less important than the end result, which is excellent throughout the range.

THE LEADER

The Allen RMI Keyboard Computer has been mentioned previously in this column, but has since been re-designed in some respects. It is neither piano, synthesiser nor organ and contains no oscillators, dividers or filters. It is a musical digital computer and unique in its field.

The present model includes presets for instant changes of contrasting sounds through its stereo system, though a single manual instrument, left and right channel volume pedals allow delicate answering between "Alto Recorder" and "Harpsichord", for example. "Organ" and "Bells" or "Jazz Flute" and "Clavichord" can also be obtained by use of the stereo presets.

This highly expressive instrument has eight foot-controls and, apart from volume, are used for percussion length, sustain, attack/decay, pitch bending, staccato and vibrato. One of the new presets, "Electric Organ", imitates to perfection the drawbars, third harmonic percussion and two-speed doppler speakers of a well known competitor company! All told, this is the perfect keyboard for modern jazz group with money no object.

The Allen organs use digital techniques for tone generation in their instruments. Musical waveshapes, often those of wind-blown pipes, are stored in digital form and can be re-created at any frequency by a high-speed signal processor. Scaling is even across the keyboards and, though complex, the microcircuits are extremely reliable and never need adjustment or tuning. The Digital Theatre Compact organ has its complete generator on a single plug-in board about 25 × 50cm in size.

In addition to the usual tabs round the horseshoe console, most Allen models (including the RMI) have card readers; inserting punched cards will give an endless variety of extra tone colours. The transposer, through five semitones upward and seven downward, provides brilliant key changes without involvement in double flats! This facility might be useful for accompanying singers with a poor sense of pitch.

A feature of the Theatre Compact is the reality of its 16′ solo voices, usually a weak point with electronic organs. Pipe organ realism is enhanced by the "Chiff" stoptab. This makes upper harmonic pitch components speak slightly in advance of the fundamental.

Though expensive by most standards owing to the complexity of the digital generator, the Allen organ is the leader in its field both for serious music or the theatre organ enthusiast.

SYNTHESISERS

The small performance keyboard is now commonplace and selling at a price within reach, often being part of an organ's circuitry. A tab found on many organs this year is "Auto Wah" implying that a v.c.f. is included in the tone forming department even if the specification does not include a complete synthesiser.

The complexity of arpeggiators and automatic chord systems seems to have grown over the past year. Used sparingly and with good taste, these can be a definite performance asset. The Yamaha D Series of organs have an interesting "walking bass", where the pedal notes go through a sequence. This is useful for twelve bar blues and, linked to the rhythm unit, can be made to follow any dance pattern.

Electronic vibrato of the "motorphaser" type appears to be popular in certain quarters, giving a good imitation of the run-up and run-down of a mechanical rotor. However, the high-frequency modulation is never as deep as could be wished for and is more characteristic of a v.c.o. modulated phase-shift system according to my experiments with such circuitry.

The E.O.D.A. might like to consider a gimmick for the 1978 show—a straightforward organ! They may be assured that there is a market for a realistic instrument at a sensible price, as there are plenty of musicians who can already read fluently and are prepared to take up organ-playing as a new venture.