

ELECTRONIC MUSIC SYNTHESIZERS
ELECTRONIC MUSIC MODULES

ARP INSTRUMENT DIVISION OF tonus, inc.

45 Kenneth Street / Newton Highlands / Massachusetts 02161 / Telephone (617) 969-0810

DISTRIBUTED BY
SYNTHESIZERS, INC.
22 KING STREET
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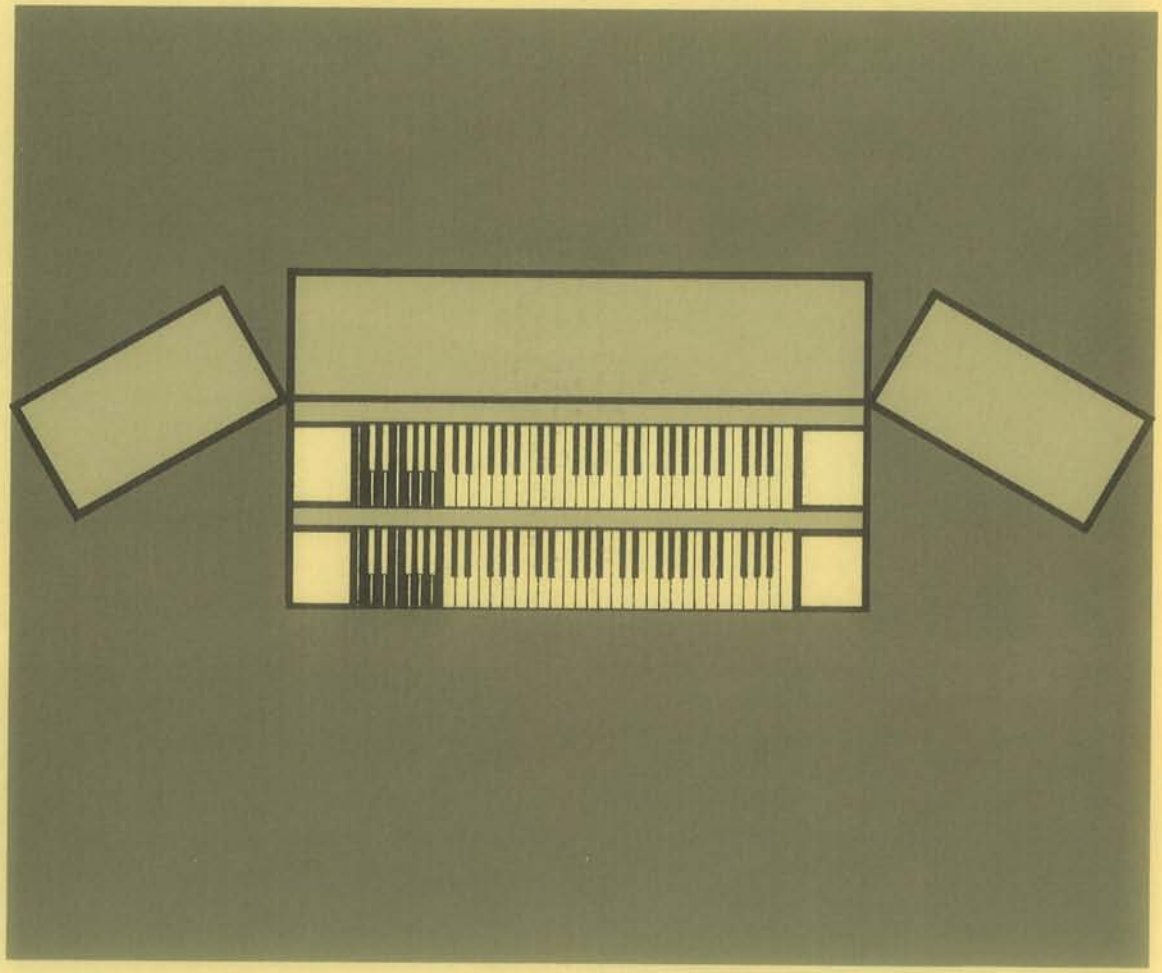
•
(212) 675-7256

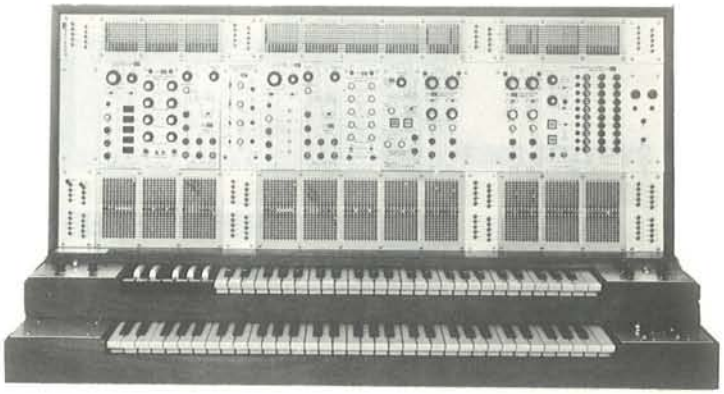
PRELIMINARY DEVELOPMENT REPORT

THE ARP SYNTHESIZER

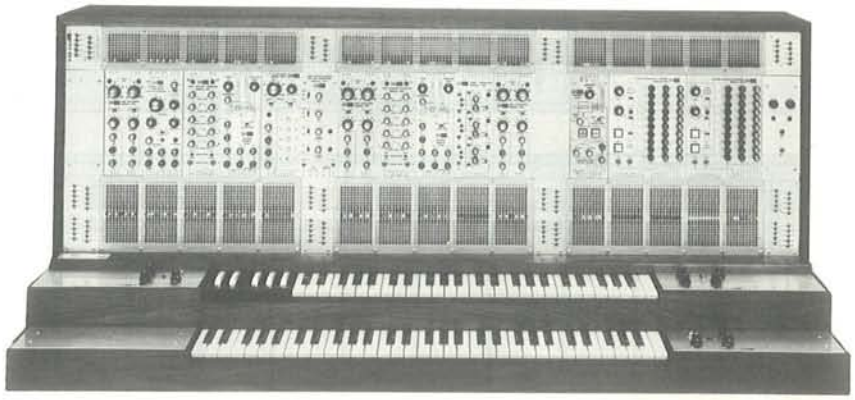


Tonus, Inc. is pleased to announce the development of the new ARP Synthesizer, an evolutionary milestone in equipment for the synthesis and performance of electronic music. The ARP is the first true "Second Generation" synthesizer incorporating all of the separate advances in synthesizer design of the last five years as well as many important innovations. The ARP Synthesizer is designed as a no-compromise, state-of-the-art system to insure quality consistent with the demands of the most discriminating composers and performers.

ELECTRONIC
MUSIC
SYNTHESIZERS

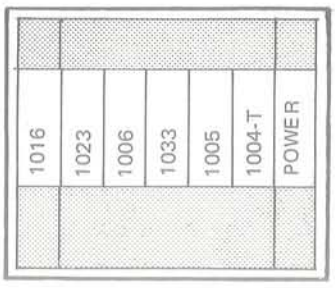


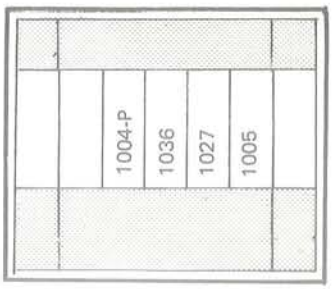
SYSTEM 2002



SYSTEM 2003

SYSTEM 2005





SERVICES

Tonus, Inc. maintains an applications engineering staff to assist prospective users in selecting ARP Synthesizer systems for their applications, and in setting up and operating electronic musical studios and live performance equipment.

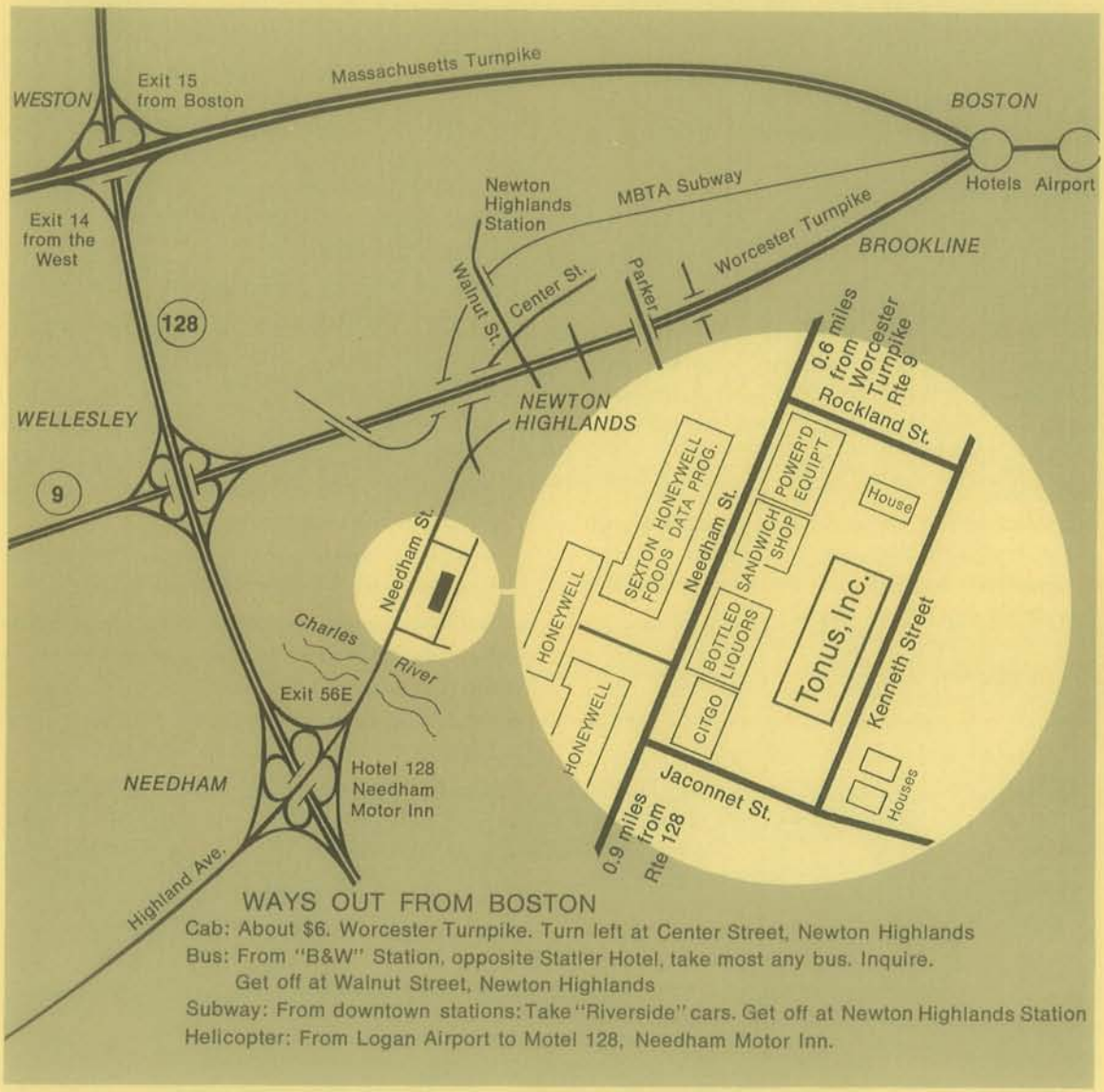
Prospective users are invited to visit Tonus in Newton Highlands, Massachusetts (a Boston suburb) and to make use of the Tonus studio facilities to familiarize themselves with the operation of the ARP Synthesizer.

DEMONSTRATIONS

Demonstrations of the ARP Synthesizer and seminars on electronic music will be scheduled during the year at various localities in the U.S.

Special demonstrations for individual or institutional prospective users can be arranged.

The Tonus, Inc. studio is equipped for the production of tape musical compositions, and arrangements can be made to permit professional users to use this studio on a rental basis.



WAYS OUT FROM BOSTON

Cab: About $6. Worcester Turnpike. Turn left at Center Street, Newton Highlands
Bus: From "B&W" Station, opposite Statler Hotel, take most any bus. Inquire.
Get off at Walnut Street, Newton Highlands
Subway: From downtown stations: Take "Riverside" cars. Get off at Newton Highlands Station
Helicopter: From Logan Airport to Motel 128, Needham Motor Inn.

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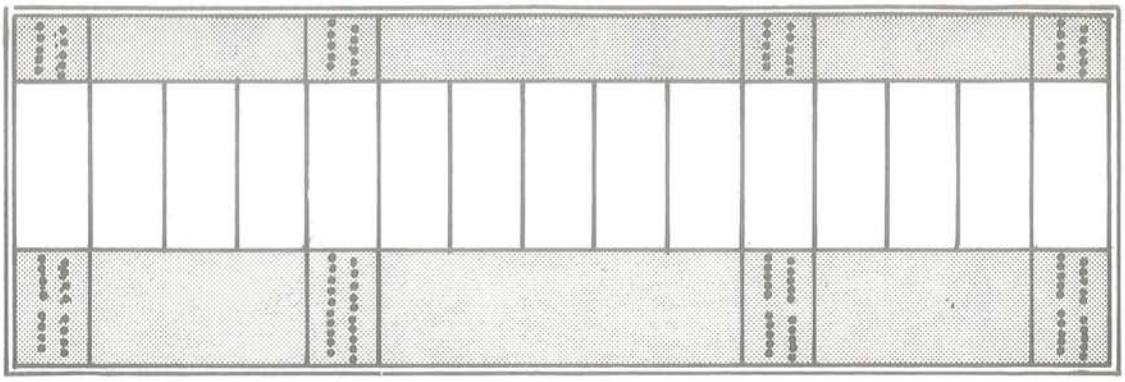
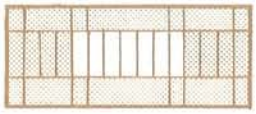
All modules are interchangeable, with the following exceptions;

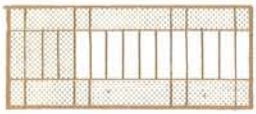
1. The position over a jack panel may be filled only with a noise generator module (1016) or a power supply, as these do not need matrix switches.
2. The sequencer module (1027) fills up two spaces.

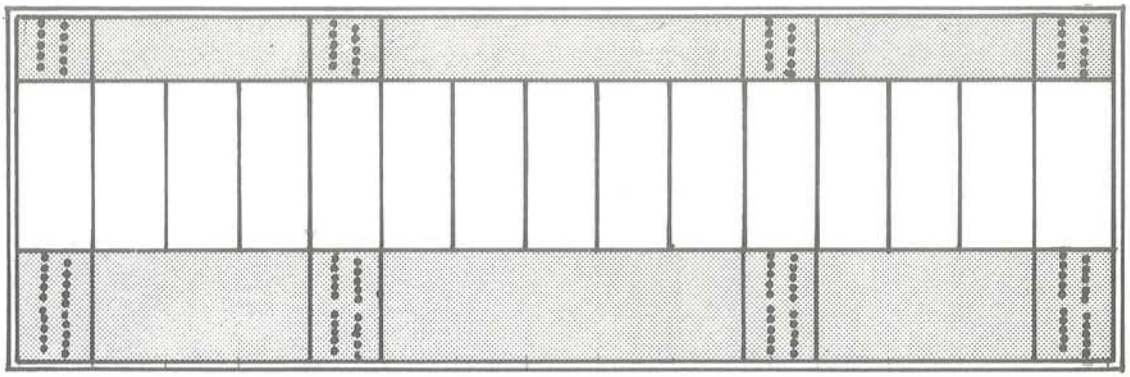


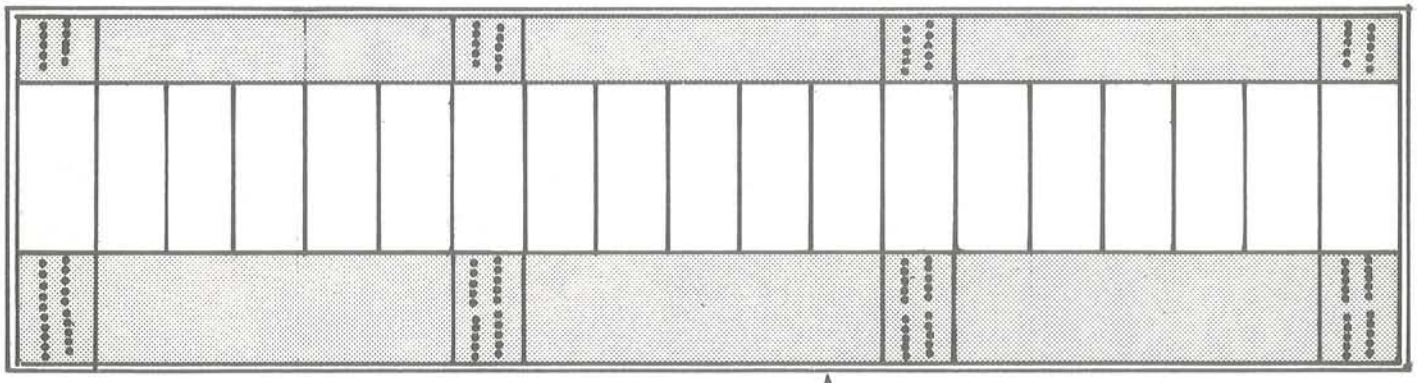
SYSTEM 2002

Systems 2000 and 2001 occupy the same size cabinet as the 2002, but contain more blank modules and fewer circuit modules.

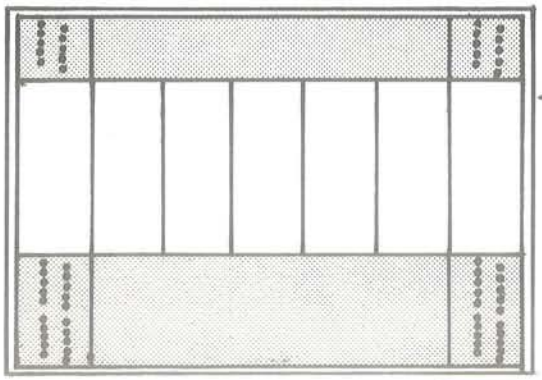




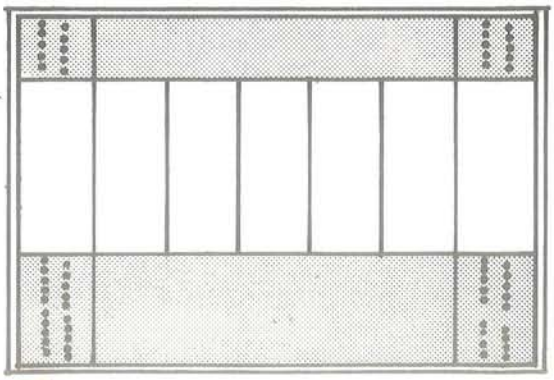




SYSTEM 2003



SYSTEM 2005



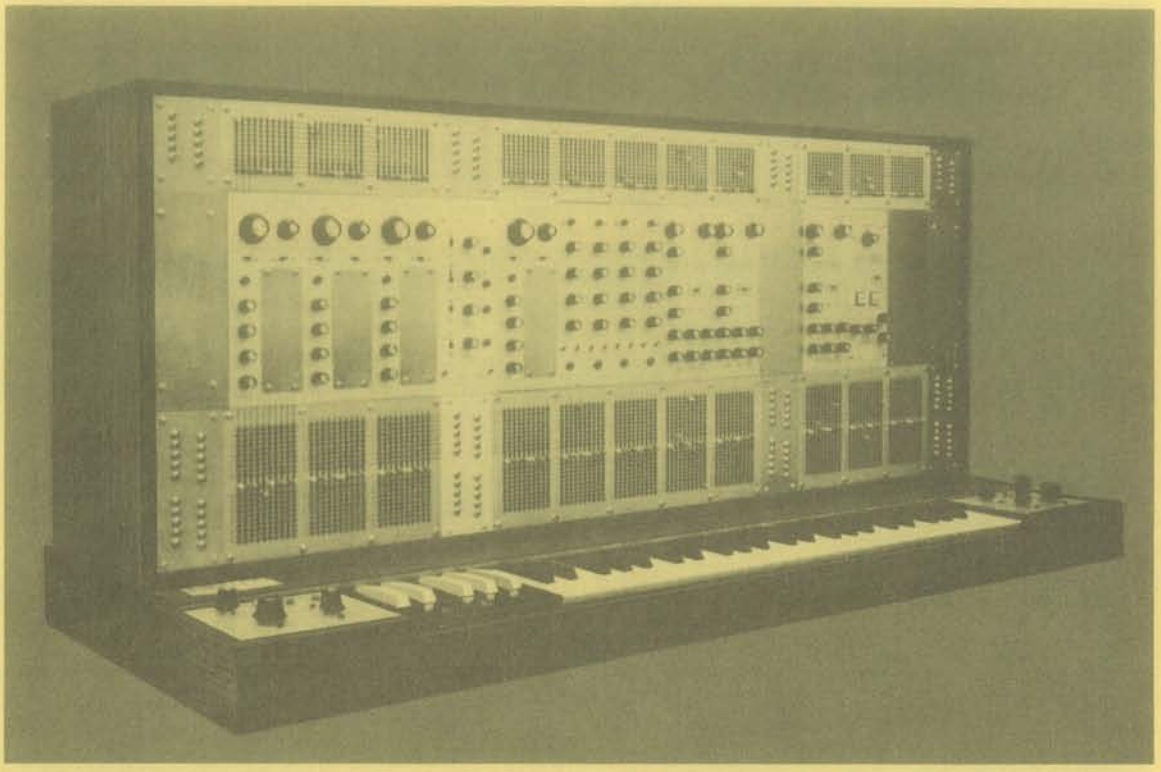
System 2004 is made up of a 2002 cabinet with two 2005 wing cabinets attached.



1/8 SIZE

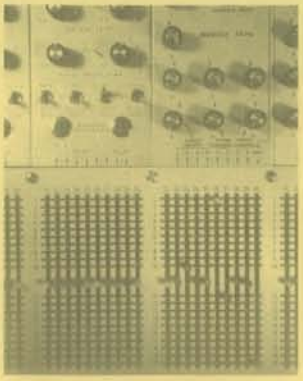
DESIGN OBJECTIVES

In approaching the design of a new Electronic Music Synthesizer, the twin objectives of improved performance and greater control flexibility have been stressed. Unique, proprietary circuits and extensive use of digital and linear I.C.'s have been combined to produce laboratory quality modules. Both stability and control range have been vastly improved over earlier systems of other makes.

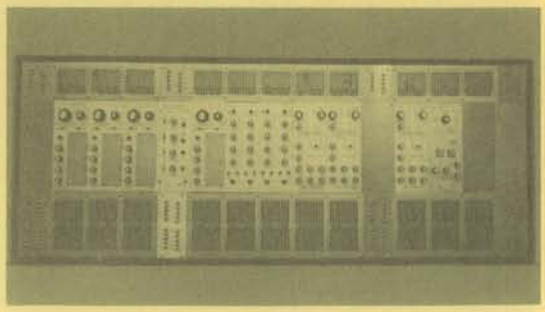


HUMAN ENGINEERING

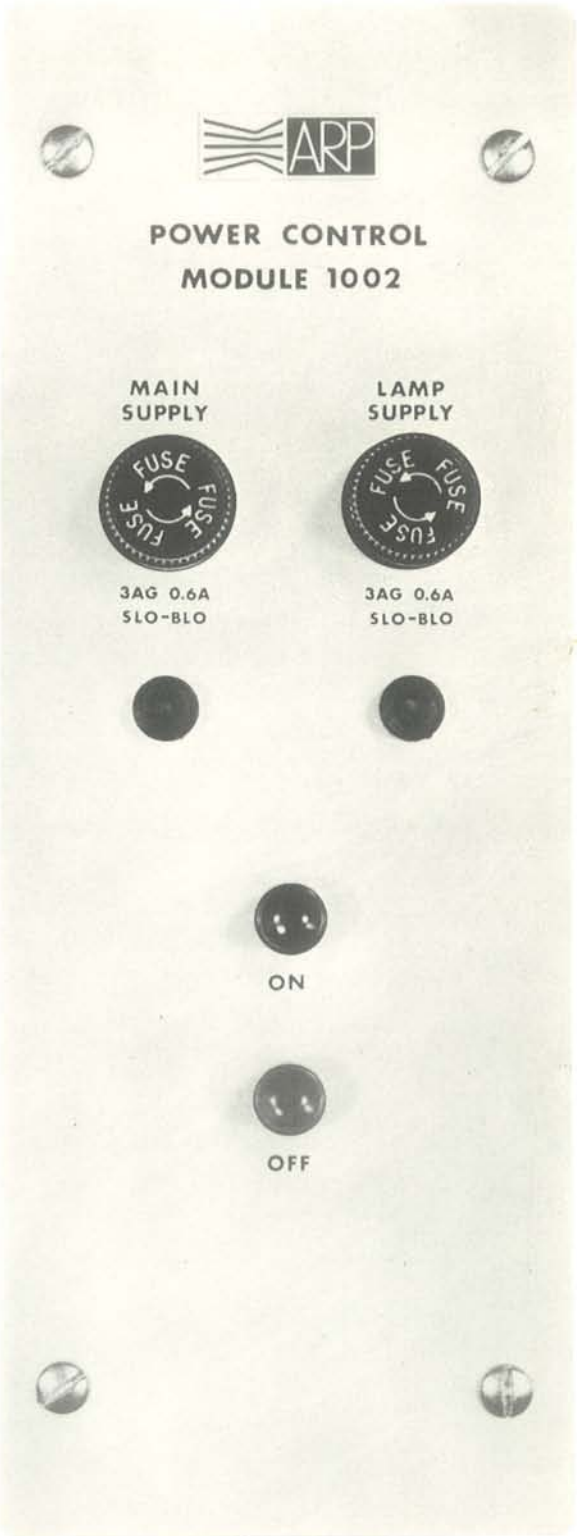
The long-overdue introduction of matrix switch interconnection of the modules allows the panel areas to remain uncluttered and accessible no matter how complex the interconnection pattern. "Patching" is performed without patchcords. In addition, set up time is drastically reduced and quick visual checks of all signal and control voltage paths are possible. Panel graphics (including functional diagrams), status indication lamps, and simplicity of operation make the ARP Synthesizer an extremely powerful educational tool, as well as a professional musical instrument.



MODULAR CONSTRUCTION



Function Modules are of a standardized size, with a panel width which exactly matches the width of a matrix switch section. The power connections and connections to the matrix switches are standardized so that the user may insert, remove, and interchange modules at will, and in any desired order. Auxiliary and portable cabinets are available to permit the user to assemble small groups of modules into special systems if so desired.



ACTUAL SIZE

ARP module 1002 contains protective circuitry designed to cut off the power supply to the rest of the synthesizer should any dangerous over-voltage or over-current condition occur.

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FUNCTION MODULES

A broad line of function modules is available incorporating the following advanced features:

- *drift compensation to keep oscillators in tune.*
- *high level (+8 dBM) oscillator waveforms usable for either audio or full range control purposes.*
- *frequency, amplitude, ring, and pulse-width modulation.*
- *sine wave outputs are truly sinusoidal without annoying harmonic distortion.*
- *certain wave forms are simultaneously available 180° out of phase for increased control flexibility.*
- *voltage-controlled envelope generators are available for rapid sequences of arbitrary envelopes or formants.*
- *voltage-controlled amplifier with over 100 dB dynamic range.*
- *voltage-controlled filter-amplifier combinations provide a complete tone modification package in a single module.*
- *voltage-controlled modulator-amplifier combinations provide independent modulation and envelope control in a single module.*
- *voltage-controlled mixers provide increased flexibility for mixing and routing audio or control signals, each mixer is capable of mixing 4 signals into one or dividing a single signal four ways, two mixers are packaged in a single module for stereo capability.*

KEYBOARDS

Modular, stackable keyboards provide unique multiplex capabilities including:

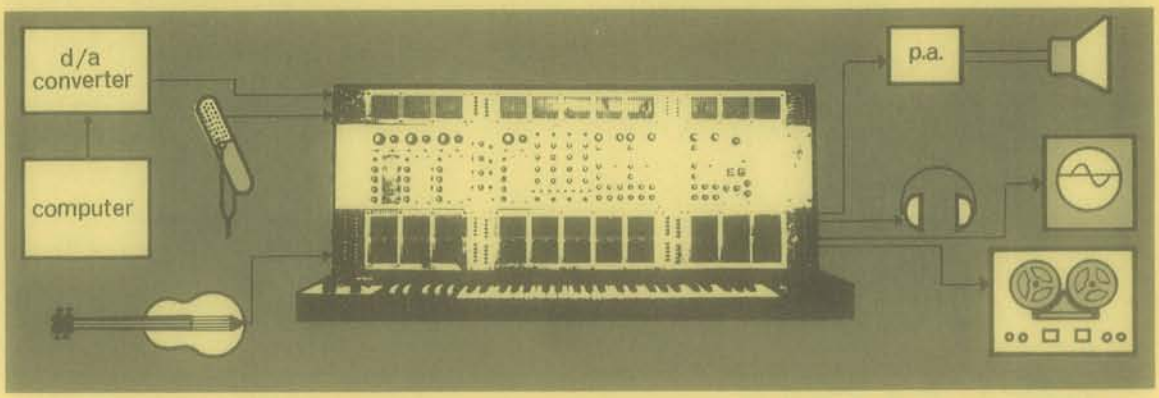
- *multi-voice control of a number of oscillators from a single keyboard.*
- *accurately tunable range of 4 to 48 divisions per octave.*
- *mode switch provides pre-tuned division in to 12 notes per octave.*
- *lowest octave can be used as a separate controller for any of several functions such as: programed keyboard, tone pallette, manual envelope generator, etc.*
- *sustain pedal.*

SEQUENCERS

A number of compact sequencer modules are available which can be installed in standard module positions in a standard ARP modular cabinet.

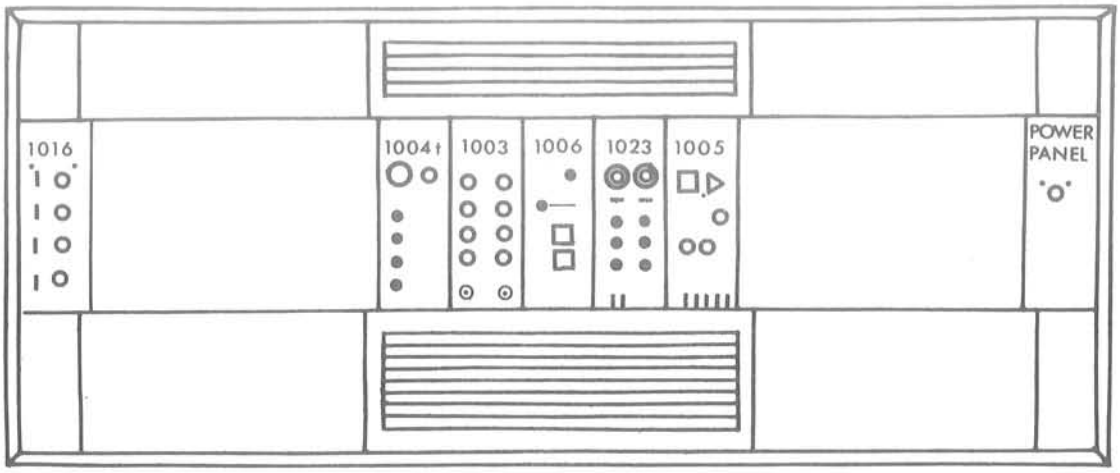
In addition, a highly sophisticated sequencer sub-system is available in an auxiliary modular cabinet which incorporates the following advanced features, hitherto unavailable in commercial synthesizers:

- *plug in, card mounted potentiometer banks for easy storage of control programs.*
- *basic, 10 position sequencer with three potentiometers per position.*
- *as many slave units as required may be added.*
- *division between any two positions to provide up to 24 (4x6) separate control voltage combinations without repetition.*
- *sequencer operation at audio frequencies for tone generation and modulation functions.*
- *built in voltage controlled envelope generator for independent control of envelope or formant at each position.*
- *random access to sequencer positions from keyboard or other external devices.*



Jack Panels for connecting system to external equipment are conveniently located to eliminate interference with operating controls.

NOTES



SCALE 1:8

ARP 2000 SYNTHESIZER

Qty	Module		List Price
1	1016	Dual Noise/Random Voltage Generator	$ 245
1	1004t	Voltage Controlled Oscillator	355
1	1023	Dual Voltage Controlled Oscillator	595
1	1003	Dual Envelope Generator	260
1	1006	V.C. Filter/Amplifier (FiltAmp)	295
1	1005	Modulator/V.C. Amplifier (ModAmp)	395
1	3001	Three Voice Keyboard Controller	695
1	2000	System Cabinet with Matrix Switches, Power Supplies, Blank Panels, etc.	1055
		List:	$3895
		Less 5% when purchased as a system:	$3698

The ARP 2000 Synthesizer is a low cost system with a standard complement of five modules. The cabinet is supplied with nine blank panels which can be replaced by other modules at the user's convenience. The ARP 2000 is supplied with one 20 x 50 matrix switch, one 10 x 50 matrix switch, power supplies capable of operating at least 10 additional modules, and jack panels for both the upper and lower matrix switches.

Certain modules such as the 1016 Dual Noise Generator may be inserted in a space in the cabinet which is not over a matrix switch. Since front panel controls of such modules permit all outputs to be switched off, these modules may be hard-wired into the matrix switch lines.

When purchasing a synthesizer, the user may specify which modules he wishes supplied with his system. The Tonus, Inc. Applications Engineering Staff will assist customers in selecting and assembling systems which best suit their musical needs and budget.

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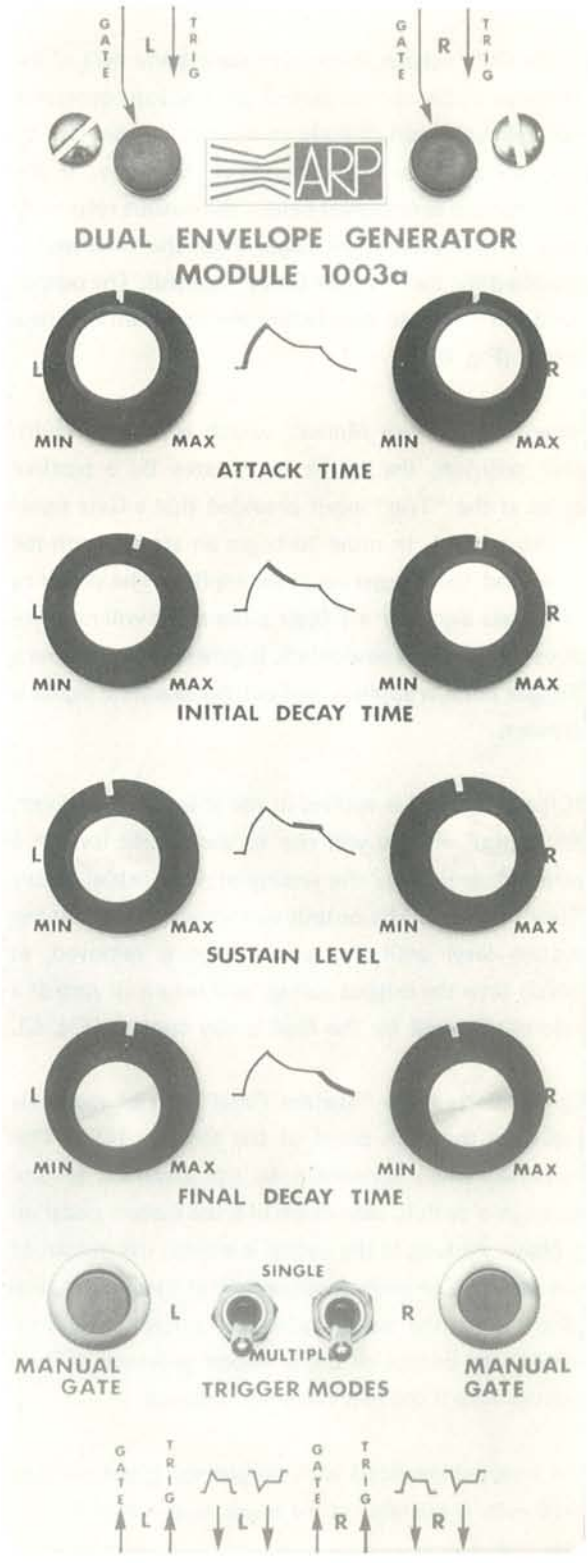
The ARP Module 1003 is a functional circuit package designed for use in the ARP Series 2000 Electronic Music Synthesizers. This module contains two identical delayed-gate exponential envelope generators.

The 1003 Dual Envelope Generator is usually used with voltage-controlled filters, amplifiers, and other modules requiring triggered control signals. For instance, when used with ARP Module 1006 FiltAmp, the 1003 Envelope Generator can be used to control the amplitude envelope or timbre variations of signals passing the FiltAmp with respect to time.

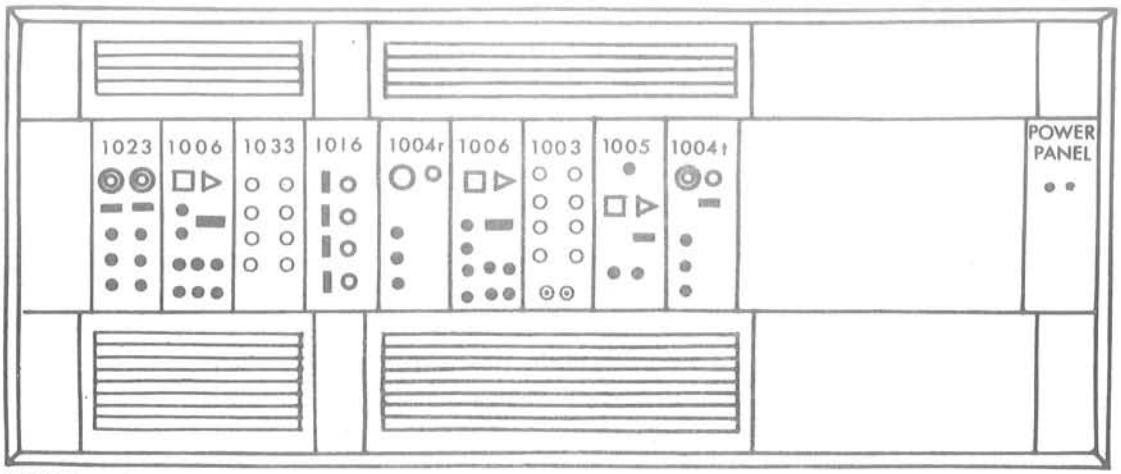
An exponential envelope generated by the ARP 1003 Module may be defined by four adjustable parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics.

The operating mode of the envelope generator is determined by the switches labelled "Trigger Modes". When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope; the Trigger inputs are not used. When the Gate signal is applied, the output of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack Time" control. When the output of the envelope generator reaches 10 volts, the attack is ended and the output decays exponentially to the "Sustain Level" at a rate determined by the "Initial Decay Time" control. The sustain level is adjustable from 0 to 10 volts. The output remains at the sustain level until the Gate is removed. When the Gate is removed, the output immediately begins an exponential decay to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).



ACTUAL SIZE



SCALE 1:8

ARP 2001 SYNTHESIZER

Qty	Module		List Price
1	1004r	Voltage Controlled Oscillator	$ 330
1	1016	Dual Noise/Random Voltage Generator	245
1	1004t	Voltage Controlled Oscillator	355
1	1023	Dual Voltage Controlled Oscillator	595
1	1003	Dual Envelope Generator	260
2	1006	V.C. Filter/Amplifier (FiltAmp)	590
1	1005	Modulator/V.C. Amplifier (ModAmp)	395
1	1033	Dual Delayed Envelope Generator	315
1	3001	Three Voice Keyboard Controller	695
1	2001	System Cabinet with Matrix Switches, Power Supplies, Blank Panels, etc.	1255
		List:	$5035
		Less 7% when purchased as a system:	$4683

The ARP 2001 Synthesizer is a moderately priced system with a standard complement of nine modules. The cabinet is supplied with five blank panels which can be replaced by ARP circuit modules at the user's convenience. The ARP 2001 is supplied with one 20 x 50 matrix switch, one 10 x 50 matrix switch, power supplies capable of operating at least five additional modules, and jack panels for both the upper and lower matrix switches.

When purchasing a synthesizer, the user may specify which modules he wishes supplied with his system. The Tonus, Inc. Applications Engineering Staff will assist customers in selecting and assembling systems which best suit their musical needs and budget.

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If the Gate voltage is removed during any part of the envelope cycle, the output of the envelope generator will always return directly to zero at the rate set by the "Final Decay Time" control. Similarly, if the Gate voltage is reapplied before the output returns to zero, a new attack will begin after the time period specified by the "Trigger Delay" control. The output need not return to zero before the initiation of a new attack (Fig. B).

When the "Trigger Modes" switch is in the "Multiple" position, the attack is initiated by a positive pulse at the "Trig" input provided that a Gate signal is also present. In order to begin an attack, both the Gate and the Trigger must be applied. The presence of a Gate signal or a Trigger pulse alone will not produce an attack. A new attack is generated each time a Trigger pulse is applied, and as long as a Gate signal is present.

If the gate signal is applied in the absence of a trigger, the output voltage will rise to the sustain level at a rate determined by the setting of the "Initial Decay Time" control. The output voltage will remain at the sustain level until the gate voltage is removed, at which time the output voltage will return to zero at a rate determined by the final decay control (Fig. C).

Connections for a "Sustain Pedal" can be made via jacks on the back panel of the Module 1003. This terminal, when connected to the electrical ground through a switch, acts much like the sustain pedal on a piano. As long as the switch is closed, the output of the envelope generator will remain at the highest level after closing the switch. When the sustain pedal is released, the output of the envelope generator will return to zero if the gate has been removed.

An inverted envelope with output voltages from 0 to −10 volts is available at the lower matrix switch.

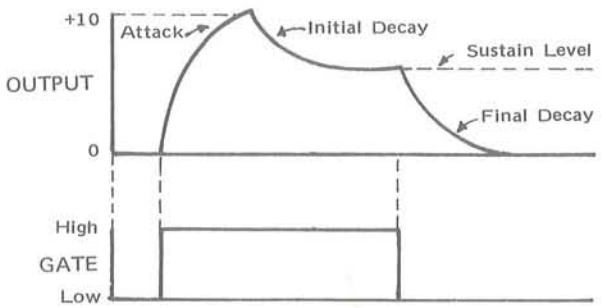


FIGURE A

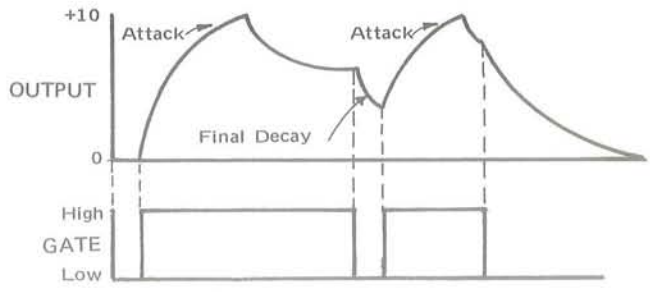
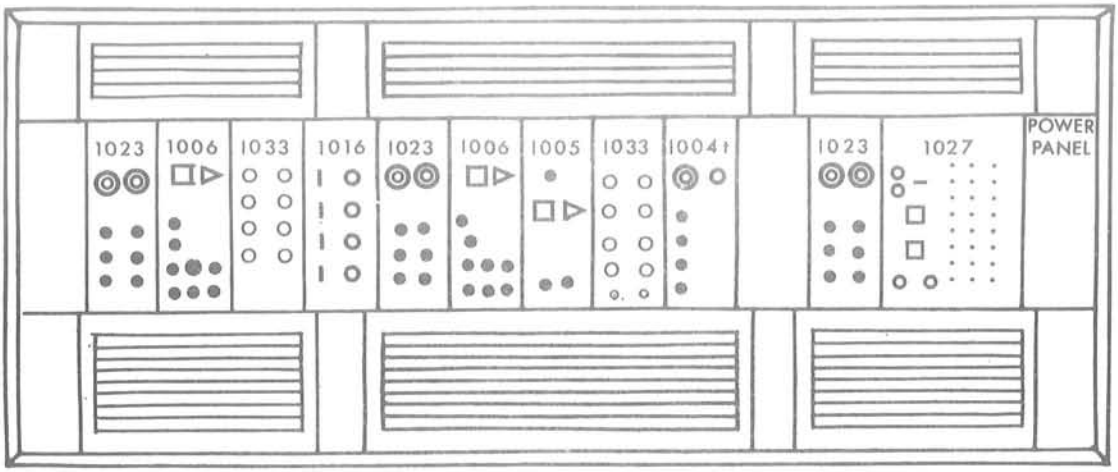


FIGURE B



SCALE 1:8

ARP 2002 SYNTHESIZER

Qty	Module		List Price
1	1027	Sequencer	$ 495
1	1016	Dual Noise/Random Voltage Generator	245
1	1004t	Voltage Controlled Oscillator	355
3	1023	Dual Voltage Controlled Oscillator	1785
2	1033	Dual Delayed Envelope Generator	630
2	1006	V.C. Filter/Amplifier (FiltAmp)	590
1	1005	Modulator/V.C. Amplifier (ModAmp)	395
1	3001	Three Voice Keyboard Controller	695
1	2002	System Cabinet with Matrix Switches, Power Supplies, Blank Panels, etc.	1395
		List:	$6585
		Less 10% when purchased as a system:	$5927

The ARP 2002 Synthesizer is a moderately priced system with a standard complement of 12 modules. The ARP 2002 is supplied with one 20 x 50 matrix switch, two 20 x 30 matrix switches, power supplies capable of operating at least 15 modules, and jack panels for both the upper and lower matrix switches. The two blank panels normally supplied with the 2002 Synthesizer may be replaced by functional modules at the user's convenience.

When purchasing a synthesizer, the user may specify which modules he wishes supplied with his system. The Tonus, Inc. Applications Engineering Staff will assist customers in selecting and assembling systems which best suit their musical needs and budget.

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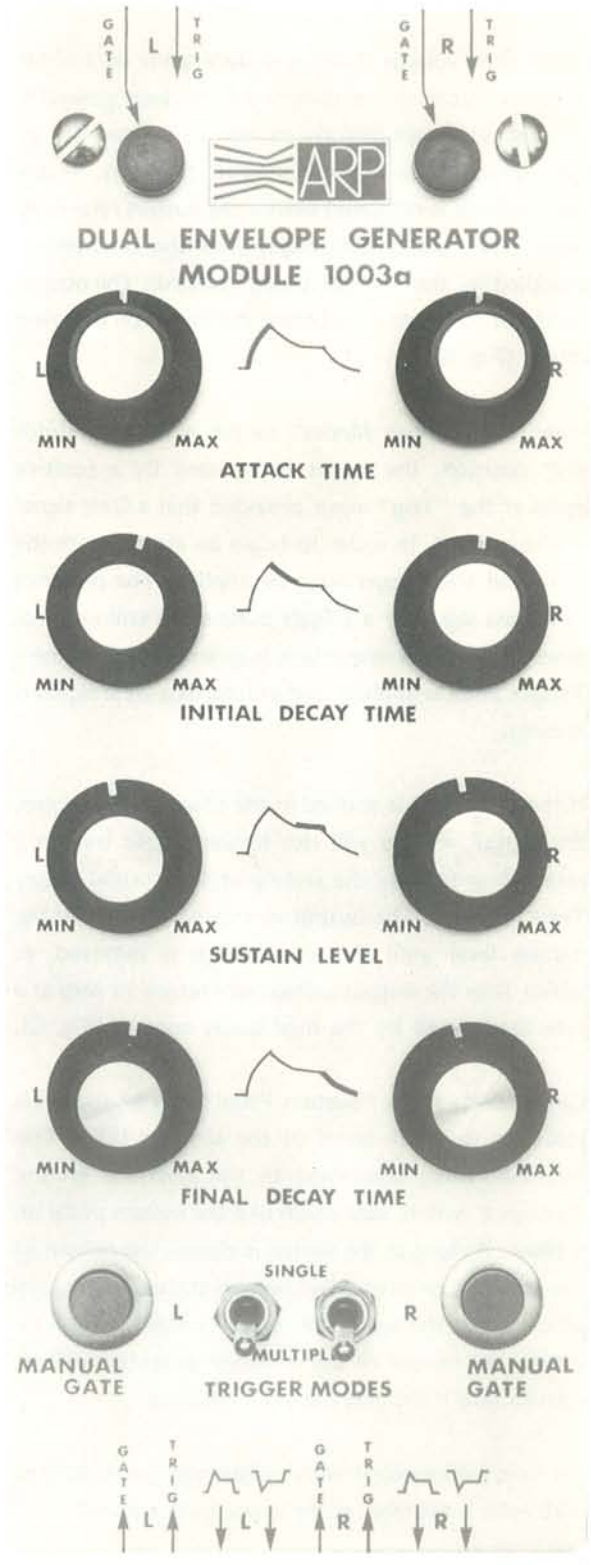
The ARP Module 1003 is a functional circuit package designed for use in the ARP Series 2000 Electronic Music Synthesizers. This module contains two identical delayed-gate exponential envelope generators.

The 1003 Dual Envelope Generator is usually used with voltage-controlled filters, amplifiers, and other modules requiring triggered control signals. For instance, when used with ARP Module 1006 FiltAmp, the 1003 Envelope Generator can be used to control the amplitude envelope or timbre variations of signals passing the FiltAmp with respect to time.

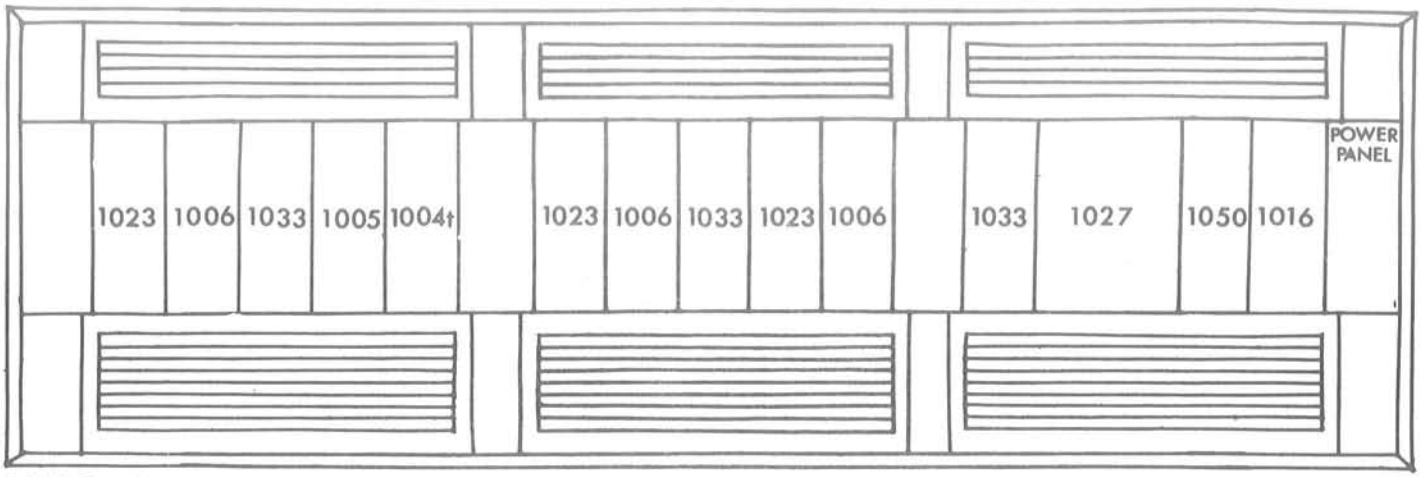
An exponential envelope generated by the ARP 1003 Module may be defined by four adjustable parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics.

The operating mode of the envelope generator is determined by the switches labelled "Trigger Modes". When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope; the Trigger inputs are not used. When the Gate signal is applied, the output of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack Time" control. When the output of the envelope generator reaches 10 volts, the attack is ended and the output decays exponentially to the "Sustain Level" at a rate determined by the "Initial Decay Time" control. The sustain level is adjustable from 0 to 10 volts. The output remains at the sustain level until the Gate is removed. When the Gate is removed, the output immediately begins an exponential decay to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).



ACTUAL SIZE



SCALE 1:8

ARP 2003 SYNTHESIZER

Qty	Module		List Price
1	1004t	V.C. Oscillator	$ 355
1	1016	Dual Noise/Random Voltage Generator	245
3	1006	V.C. Filter/Amplifier (FiltAmp)	885
1	1005	Modulator/V.C. Amplifier (ModAmp)	395
3	1023	Dual Voltage Controlled Oscillator	1785
3	1033	Dual Delayed Envelope Generator	945
1	1050	Sequential Mixer/Selector	395
1	1027	Sequencer	495
2	3001a	Three Voice Keyboard Controller	1390
1	2003	Cabinet with Matrix Switches, Power Supply, Jack Panels, etc.	1595
		List:	$8485
		Less 10% when purchased as a system:	$7637

The ARP 2003 Synthesizer is the largest basic system in the ARP Catalog. The system comes complete with a standard complement of 15 modules, three 20 x 50 matrix switches, three 10 x 50 matrix switches, power supplies, and jack panels. The three blank panels may be replaced by circuit modules at the user's convenience.

When purchasing a synthesizer, the user may specify which modules he wishes supplied with his system. The Tonus, Inc. Applications Engineering Staff will assist customers in selecting and assembling systems which best suit their musical needs and budget.

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NOTES

ARP MODULE PRICE LIST

(Preliminary pricing information, subject to change; 23 March 1970.)

		List Prices
1003*	Dual Exponential Envelope Generator	$ 260
1003a*	Dual Exponential Envelope Generator	260
1004	Voltage Controlled Oscillator (VCO)	295
1004t	VCO with Type "t" Submodule	355
1004p	VCO with Type "p" Submodule	340
1004r	VCO with Type "r" Submodule	330
1005	Modamp (Balanced Modulator and Voltage Controlled Amplifier)	395
1006	Filtamp (Voltage Controlled L.P. Filter and Voltage Controlled Amplifier)	295
1016	Dual Noise/Random Voltage Source	245
1023	Dual Voltage Controlled Oscillator	595
1026	Preset Voltage Module	260
1027	10-Position Sequencer	495
1033	Delayed Dual Exponential Envelope Generator	315
1050	Sequential Mixer	395
1001	Blank Module Package	25
3001	Three Voice Keyboard Controller	695
2001	System Cabinet with Matrix Switches, Power Supplies, etc.	1055
2002	System Cabinet with Matrix Switches, Power Supplies, etc.	1255
2003	System Cabinet with Matrix Switches, Power Supplies, etc.	1395
2004	System Cabinet with Matrix Switches, Power Supplies, etc.	1595
20-CK	Conversion Kit to provide Matrix Switches, Jack Panels, Connectors, Cable Assemblies, etc. to accommodate three extra Series 1000 modules. (One 20-CK Kit will convert a 2000 cabinet to a 2001 cabinet; two 20-CK Kits will convert a 2000 cabinet to a 2002 cabinet.)	295

*Note: Modules 1003 and 1003a are equivalent in performance and are directly interchangeable. These units differ slightly in construction, and are offered as alternate products depending on availability of certain components. Tonus, Inc. reserves the right to substitute the 1003 for the 1003a (or vice-versa) when delivering systems to purchasers.

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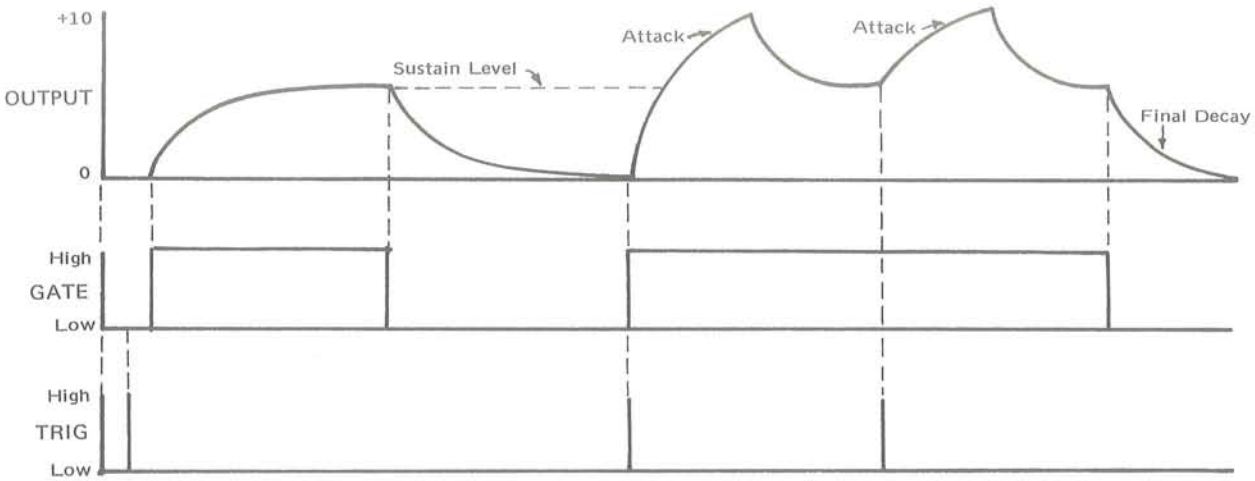

FIGURE C

ELECTRICAL SPECIFICATIONS

CONTROLS:	Attack Time: .001 secs to 2.0 secs
	Initial Decay Time: .001 secs to 2.0 secs
	Sustain Level: 0 to 10 volts
	Final Decay Time: .001 secs to 2.0 secs
INPUTS:	Gate Sensitivity: 1.8 volts, lower matrix switch, 9.6 volts upper matrix switch
	Trigger Sensitivity: 1.8 volts
	All impedances: 100K
OUTPUTS:	0 to +10 volts @ 1Kohm
	0 to -10 volts @ 1Kohm
MAXIMUM POWER REQUIREMENTS:	±15 volts @ 50ma, regulated to ±0.1%
(outputs shorted):	+12 volts to +15 volts @40ma, lamp supply

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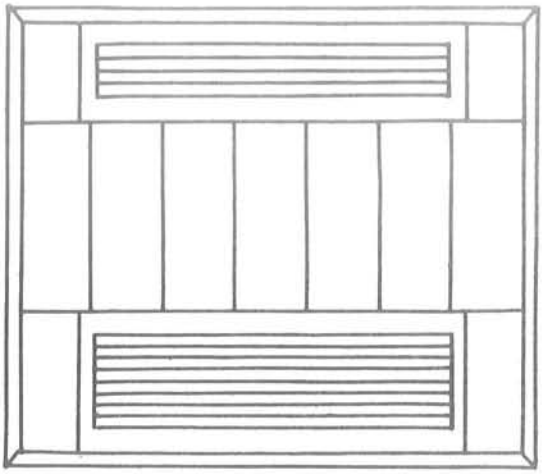

ARP SYNTHESIZERS:
2005; 2006; 2007

System 2005 is a compact music synthesizer equivalent in function to the ARP 2000, but without a keyboard controller.

System 2006 is a bank of 5 voltage controlled oscillators with matrix switches and power supply. This system is designed to augment the tonal resources of an ARP Series 2000 Synthesizer or any other system which provides 1 volt per octave control voltage signals.

System 2007 is a bank of 4 type 1023 dual voltage controlled oscillators plus one type 1004t voltage controlled oscillator. Applications are similar to System 2006.

Module		System 2005	System 2006	System 2007
1003	Dual Envelope Generator	1		
1004	Voltage Controlled Oscillator		4	
1004t	Voltage Controlled Oscillator	1	1	1
1005	Modulator/V.C. Amplifier	1		
1006	V.C. Filter/V.C. Amplifier	1		
1016	Dual Noise/Random Voltage Generator	1		
1023	Dual Voltage Controlled Oscillator	1		4
	List Prices of Modules			
List price of cabinet 2021 with matrix switches, power supply, jack panels, etc.		955	955	955
Total price, if purchased separately		3100	2490	3690
Net price, if purchased as a system		2945	2376	3506

Note: Customized systems of 4, 5, or 6 modules in a 2021 cabinet can be provided at a total price lower than that of the individual modules. Contact our Sales Department for quotations on your specific requirements.

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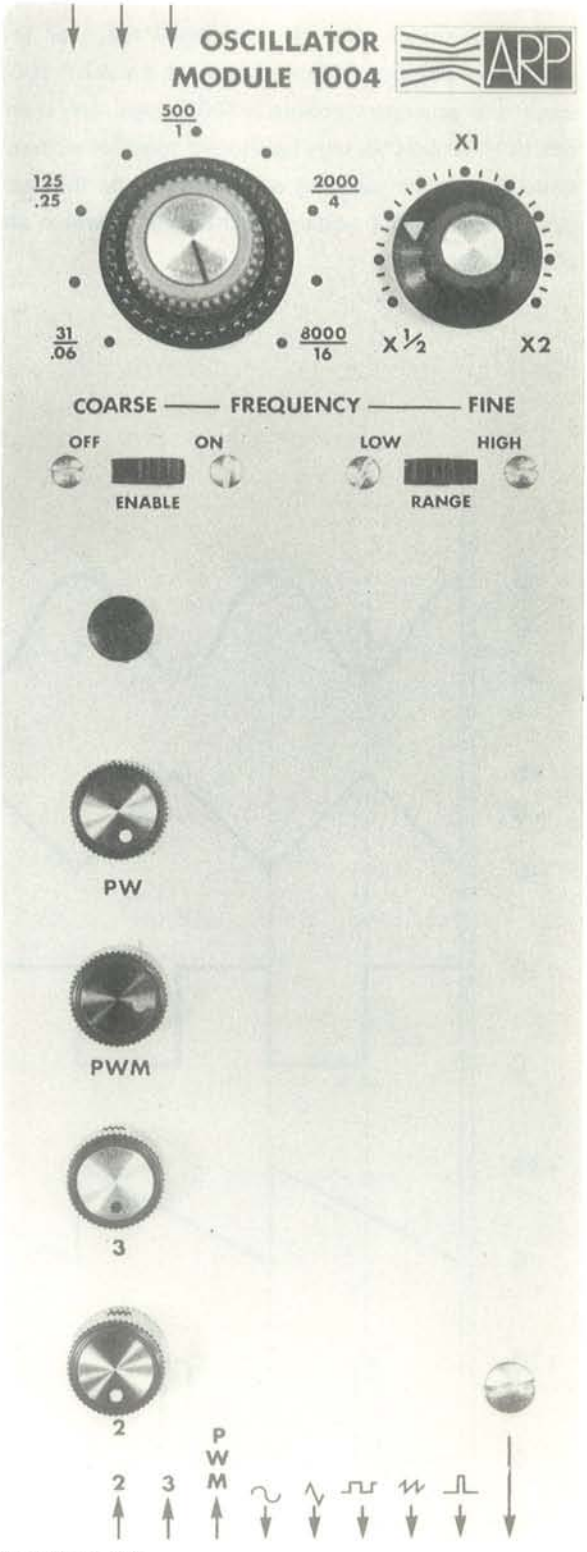
The ARP 1004 Oscillator Module is a voltage-controlled waveform generator which has five simultaneous outputs: sine, triangular, square, sawtooth, and pulse. These waveforms are derived from a basic voltage-controlled dual-slope-integrator type oscillator. The oscillator frequency is varied by one octave for each one volt in control voltage.

The output frequency range is from .03 Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizers. The three frequency modulation inputs in the upper left hand corner of the module are fixed sensitivity inputs: 1 volt/octave. The two lower frequency modulation inputs (in positions 2 and 3) are associated with two attenuators directly above the inputs. When the attenuators are rotated fully clockwise, the input sensitivity is 1 volt/octave. These controls are used to adjust frequency modulation depth.

Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.



ACTUAL SIZE



COMING SOON.....

1024 Minisequencer: A compact 8 position inexpensive sequencer in a single 3-inch wide module.

1028 Slave Module: A sequencer extender module which provides three extra voltage outputs per step. Board with miniature potentiometers may be unplugged and saved. Extra, inexpensive boards of pots plug into panel.

1019 Oscilloscope: A small oscilloscope especially designed for observing audio waveforms generated by the synthesizer.

1029 Frequency Shifter: Radical new circuit permits laboratory quality frequency shifting at dramatically reduced cost.

1013 Octave Fixed Filter Bank: Set of octave wide filters covering the entire audio spectrum in a compact and efficient format.

1015 Half-Octave Fixed Filter Bank: 19 fixed frequency band-pass filters designed for minimum phase shift.

1031 Dual Multipurpose Filter: A combination high-pass, low-pass, band-pass, notch, and peaking filter with voltage controlled f_t and Q.

1025 Dual Reverberation Module: High quality reverberation systems designed specifically for the ARP Synthesizers.

1045 Voltage Controlled Voice: Combination module containing a voltage controlled oscillator, a dual envelope generator, a voltage controlled low pass filter, and a voltage controlled amplifier. The module is designed to function as a compact pre-set voice, although the functions can be used separately since functional circuits are not hard-wired internally.

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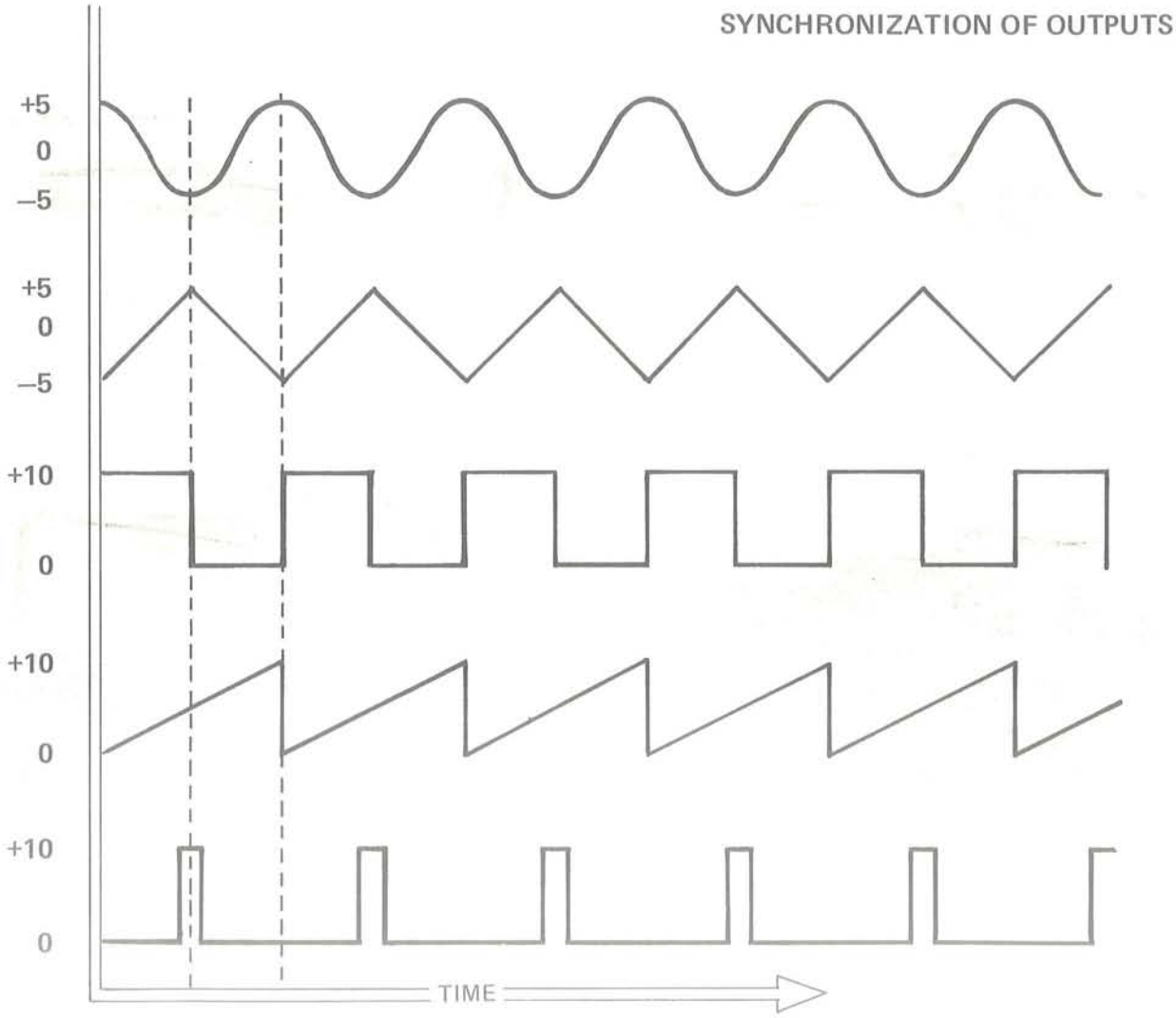
The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.

NOTE: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator.

SYNCHRONIZATION OF OUTPUTS



1032 Mixer/Distributor: Eight voltage controlled amplifiers in a voltage controlled mixer/distributor; 8 in, 1 out --- 1 in, 8 out.

1035 Triple Modulator: Three balanced modulators and control circuitry in a single module package.

1037 Dual Voltage Controlled Envelope Generator: Dual envelope generator has all voltage controlled parameters and generates both linear and exponential envelopes.

1036 Dual Random Voltage Source/Sample & Hold: Two uncorrelated noise sources followed by sample and hold circuitry produces random voltage output. Internal clocks determine sample rate. Sample and hold function may be isolated.

1038 Dual Preset Envelope Generator: Dual envelope generator has eight preset envelopes.

1042 Triple Voltage Controlled Amplifier: Three voltage controlled amplifiers in a compact module.

3002 Four Voice Keyboard Controller: Keyboard controller capable of four-part polyphonic playing.

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ELECTRICAL SPECIFICATIONS

OUTPUTS:
Frequency: .03Hz–16KHz in two ranges without external inputs.
Sine: –5 volts to +5 volts P-P.
Triangle: –5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

INPUTS:
Frequency Modulation: 1 volt/octave
Pulse Width Modulation: 10%/volt
Input Impedances: 100 K.

CONTROLS:
Frequency Range: Low (.03 Hz–32 Hz); High (31 Hz–16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0–100%
Pulse Width Modulation

LONG TERM FREQUENCY DRIFT: Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

POWER REQUIREMENTS: ±15 volts @50 ma, regulated to ±0.1%.
+12 to +15 volts @20 ma unregulated, lamp supply.

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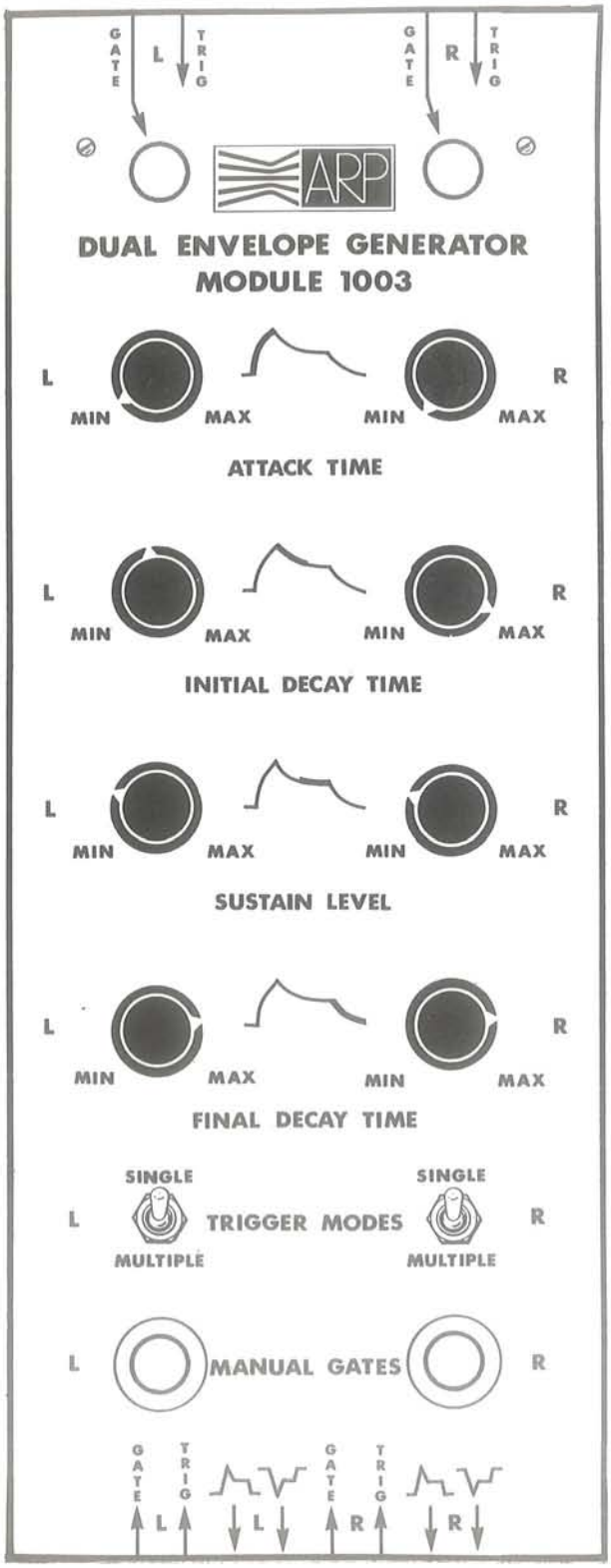
This module is electrically identical to Module 1003A

A-1003-001-3-70
PRELIMINARY DATA
Subject to Revision

ELECTRONIC MUSIC MODULES



DUAL EXPONENTIAL ENVELOPE GENERATOR — Module 1003

The ARP Module 1003 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical exponential envelope generators.

The 1003 Exponential Envelope Generator is usually used with voltage-controlled filters, and other modules requiring triggered control signals. For instance, when used with the ARP Module 1006 FiltAmp, the 1003 Envelope Generator can be used to control the amplitude envelope and timbre variations of signals passing through the FiltAmp.

An exponential envelope generated by the ARP 1003 Module may be defined by four parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics.

When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope, and the Trigger inputs are not used. When the Gate signal (>+10v) is applied, the output voltage of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack

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NOTES

ELECTRONIC MUSIC MODULES

Time" control. When the output reaches 10 volts, the attack is ended and the output falls to the "Sustain Level" at an exponential rate determined by the "Initial Decay Time" Control. The sustain level is adjustable from 0 to 10 volts. The output will remain constant at the sustain level until the Gate signal is removed, at which time the output returns exponentially to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).

If the Gate voltage is removed during any part of the cycle, the output will always return directly to zero at the exponential rate set by the "Final Decay Time" control (Fig. B). If the Gate voltage is reapplied before the output returns to zero, a new attack will begin immediately without the output voltage returning to zero (Fig. C).

When the "Trigger Modes" switch is in the "Multiple" position, the operation of the envelope generator is the same as above, except that the attack is initiated by a positive pulse at the "Trig" input rather than by the Gate signal. In order to begin an attack, both the Gate and the Trigger must be applied. The presence of a Gate signal or a Trigger pulse alone will not produce an output. A new attack is generated each time a Trigger pulse is applied, and as long as a Gate signal is present (Fig. D).

Connections for a "Sustain Pedal" can be made via jacks on the back panel of the Module 1003. This wire, when connected to the electrical ground through a switch, acts much like the sustain pedal on a piano. As long as the switch is closed, the output of the envelope generator will remain at the sustain level, regardless of other inputs. When the sustain pedal is released, the output voltage will decay to 0 volts at a rate determined by the "Final Decay Control" setting. An inverse envelope output from 0 to -10 volts is available at the lower matrix switch.

The ARP 1003 Dual Envelope generator operates from ±15v supply voltages, at about 24 ma from each supply. In addition, 12 volts at 40 ma is required for the lamps.

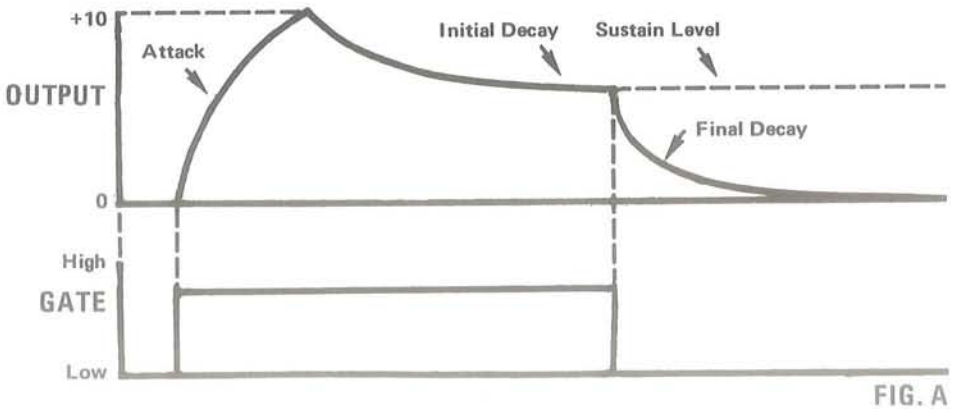


FIG. A

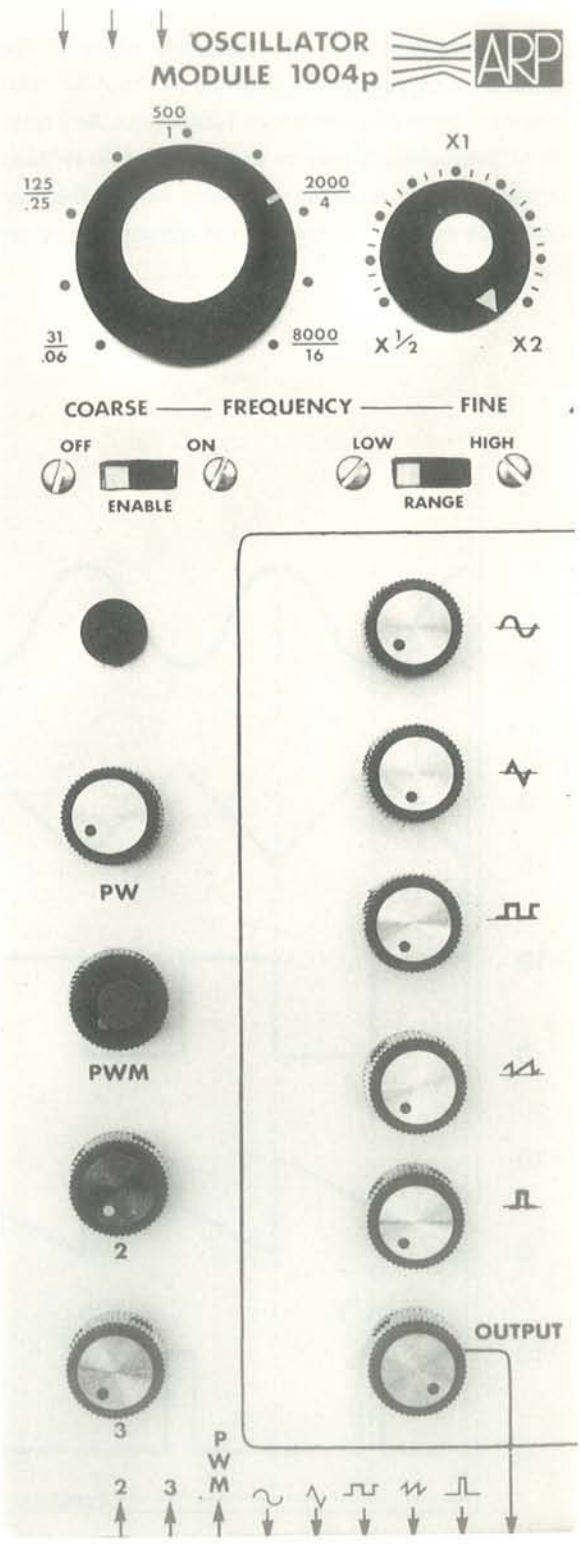
The ARP 1004-P Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic 1004 oscillator and a type "P" oscillator submodule. Sine, triangular, square, sawtooth, and pulse outputs are available simultaneously. In addition, five potentiometers can be used to mix or algebraically sum these waveforms into an additional output. This module is particularly recommended for generating control waveforms and complex audio signals in the studio.

The output frequency range is from .03 Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

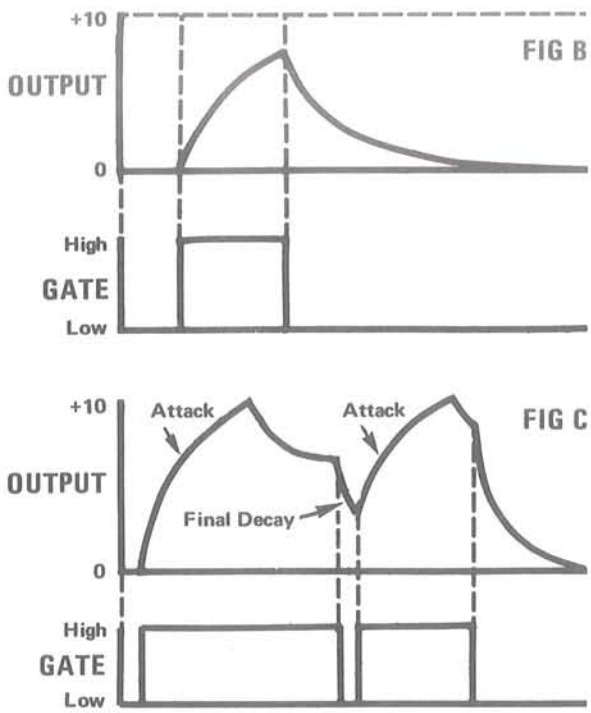
Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizers. The three frequency modulation inputs in the upper left hand corner of the module are fixed sensitivity inputs: 1 volt/octave. The two lower frequency modulation inputs (in positions 2 and 3) are associated with two attenuators directly above the inputs. When the attenuators are rotated fully clockwise, the input sensitivity is 1 volt/octave. These controls are used to adjust frequency modulation depth.

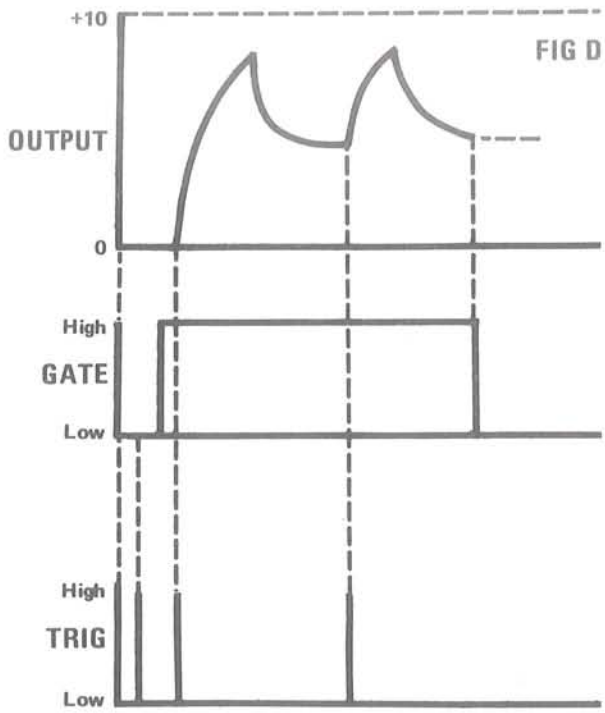
Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.



ACTUAL SIZE

ELECTRONIC MUSIC MODULES





Electrical Specifications

Controls: Attack Time: .001 secs to 2.0 secs
Initial Decay Time: .001 secs to 2.0 secs
Sustain Level: 0 to 10 volts
Final Decay Time: .001 secs to 2.0 secs

Inputs: Gate Sensitivity: 1.8 volts, lower matrix switch. 9.6 volts upper matrix switch
Trigger Sensitivity: 1.8 volts
All impedances: 100K

Outputs: 0 to +10 volts @ 1Kohm
0 to -10 volts @ 1Kohm

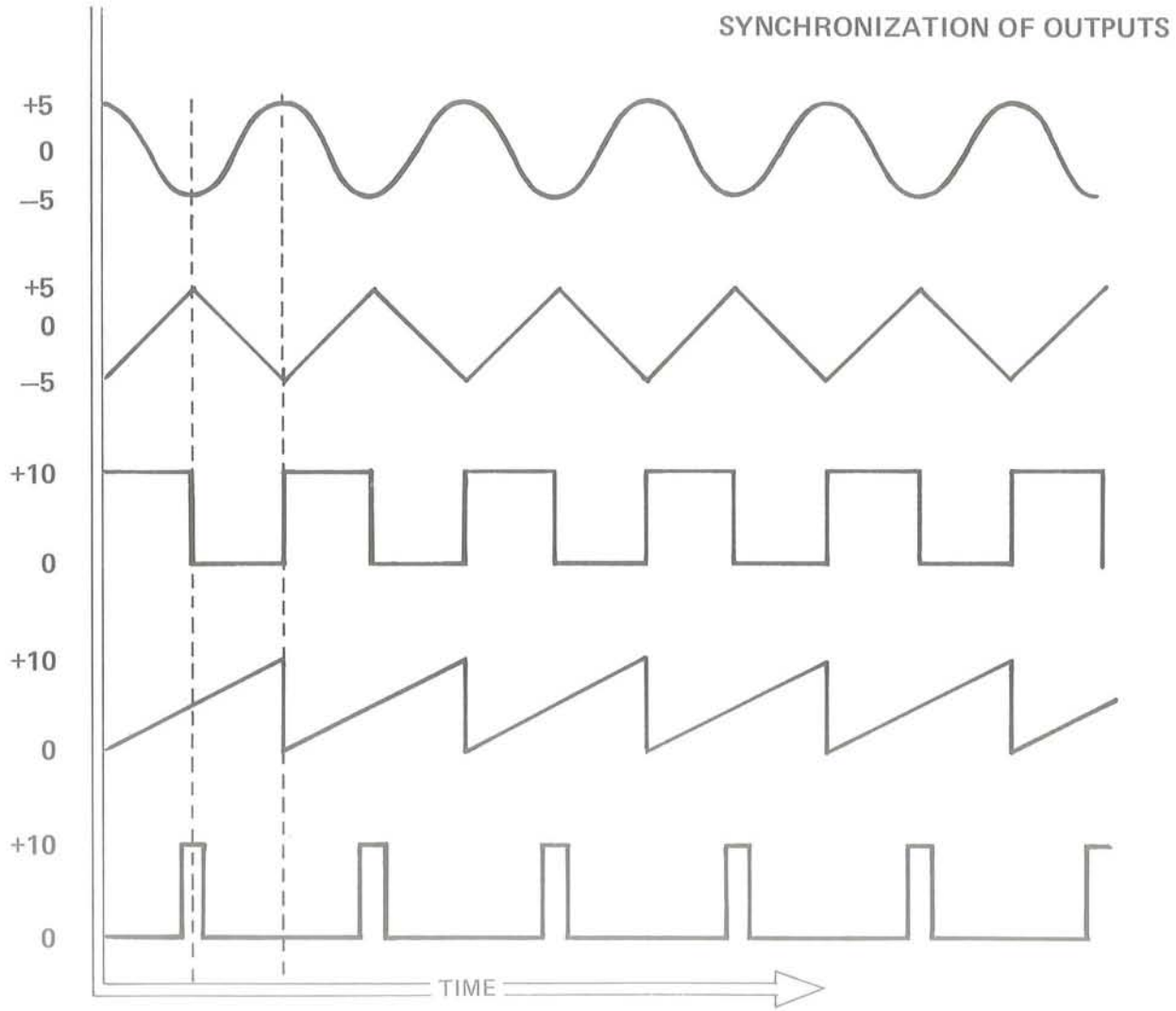
Maximum Power Requirements (outputs shorted):

±15 volts @ 50ma, regulated to ±0.1%
+12 volts to +15 volts @40ma, lamp supply

The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.

NOTE: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator.

SYNCHRONIZATION OF OUTPUTS





TYPICAL WAVEFORMS PRODUCED BY MODULE 1004-P

ELECTRICAL SPECIFICATIONS

OUTPUTS:
Frequency: .03Hz–16KHz in two ranges without external inputs.
Sine: –5 volts to +5 volts P-P.
Triangle: –5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

INPUTS:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

CONTROLS:
Frequency Range: Low (.03 Hz–32 Hz); High (31 Hz–16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0–100%.
Pulse Width Modulation

LONG TERM FREQUENCY DRIFT: Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

POWER REQUIREMENTS: ±15 volts @50 ma, regulated to ±0.1%.
+12 to +15 volts @20 ma unregulated, lamp supply.

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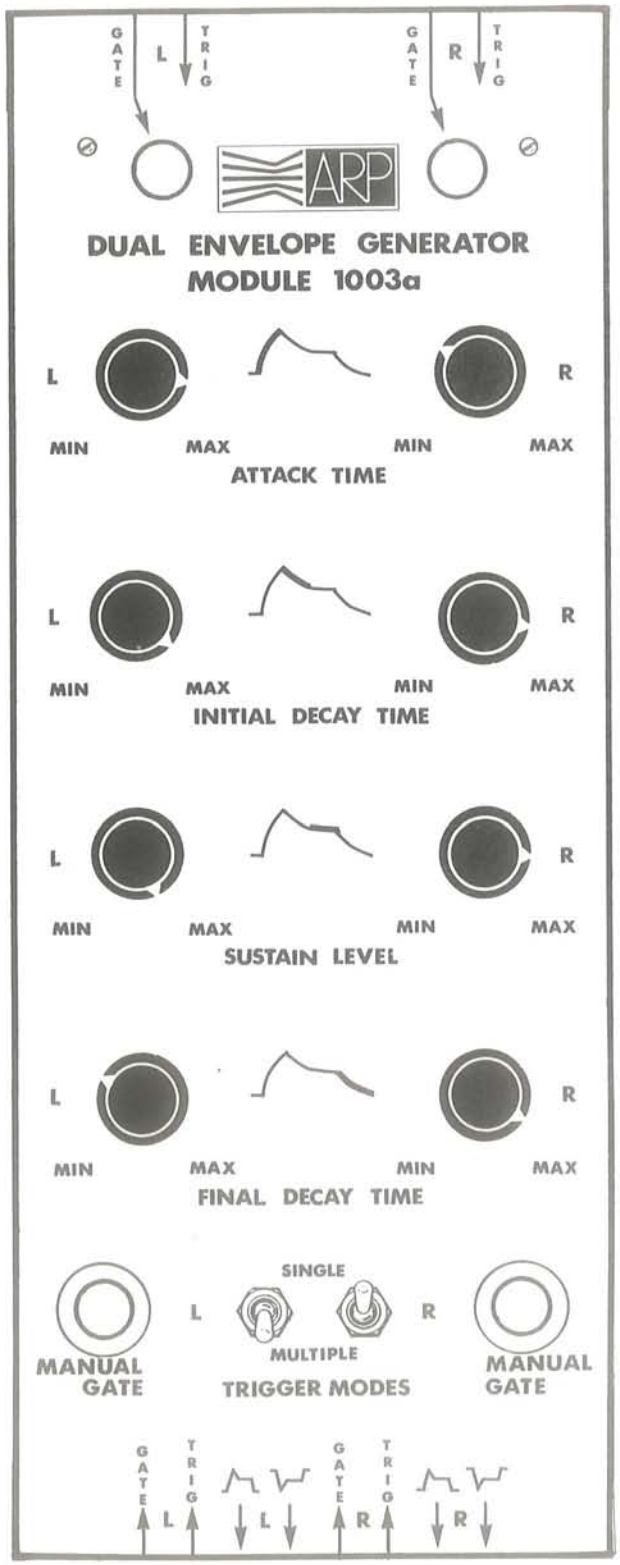


DUAL ENVELOPE GENERATOR — Module 1003a

The ARP Module 1003a is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical exponential envelope generators.

The 1003 Exponential Envelope Generator is usually used with voltage-controlled filters, and other modules requiring triggered control signals. For instance, when used with the ARP Module 1006 FiltAmp, the 1003 Envelope Generator can be used to control the amplitude envelope and timbre variations of signals passing through the FiltAmp.

An exponential envelope generated by the ARP 1003 Module may be defined by four parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics.

When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope, and the Trigger inputs are not used. When the Gate signal (+10v) is applied, the output voltage of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack

NOTES

ELECTRONIC MUSIC MODULES

Time" control. When the output reaches 10 volts, the attack is ended and the output falls to the "Sustain Level" at an exponential rate determined by the "Initial Decay Time" Control. The sustain level is adjustable from 0 to 10 volts. The output will remain constant at the sustain level until the Gate signal is removed, at which time the output returns exponentially to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).

If the Gate voltage is removed during any part of the cycle, the output will always return directly to zero at the exponential rate set by the "Final Decay Time" control (Fig. B). If the Gate voltage is reapplied before the output returns to zero, a new attack will begin immediately without the output voltage returning to zero (Fig. C).

When the "Trigger Modes" switch is in the "Multiple" position, the operation of the envelope generator is the same as above, except that the attack is initiated by a positive pulse at the "Trig" input rather than by the Gate signal. In order to begin an attack, both the Gate and the Trigger must be applied. The presence of a Gate signal or a Trigger pulse alone will not produce an output. A new attack is generated each time a Trigger pulse is applied, and as long as a Gate signal is present (Fig. D).

Connections for a "Sustain Pedal" can be made via jacks on the back panel of the Module 1003a. This wire, when connected to the electrical ground through a switch, acts much like the sustain pedal on a piano. As long as the switch is closed, the output of the envelope generator will remain at the sustain level, regardless of other inputs. When the sustain pedal is released, the output voltage will decay to 0 volts at a rate determined by the "Final Decay Control" setting. An inverse envelope output from 0 to -10 volts is available at the lower matrix switch.

The ARP 1003a Dual Envelope generator operates from ±15v supply voltages, at about 24 ma from each supply. In addition, 12 volts at 40 ma is required for the lamps.

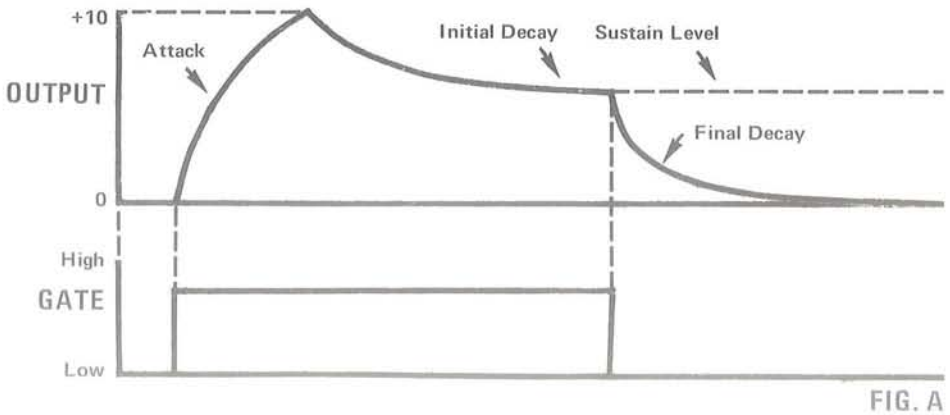


FIG. A

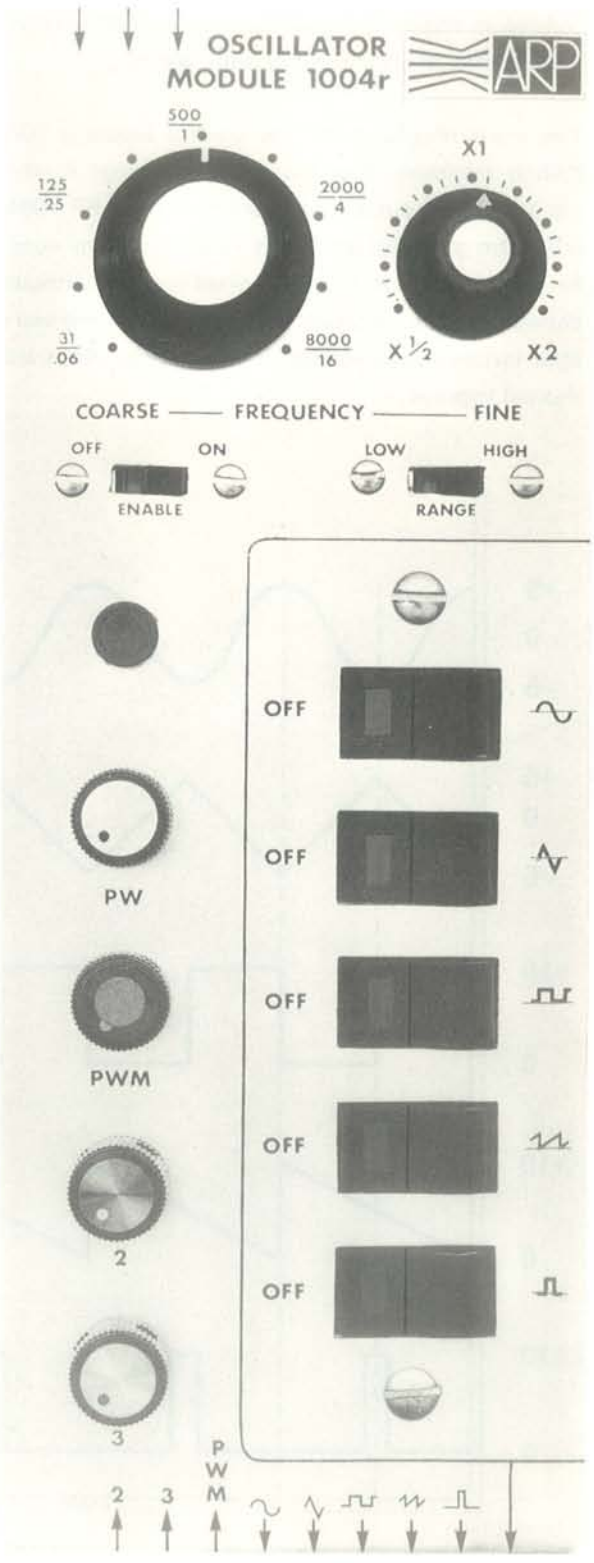
The ARP 1004-R Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic type 1004 oscillator and a type "R" oscillator submodule. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition, five rocker-type switches permit any of these waveforms to be selected to an additional output at a touch. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. This feature is especially useful in live performance where rapid output waveform changes are needed.

The output frequency range is from .03 Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

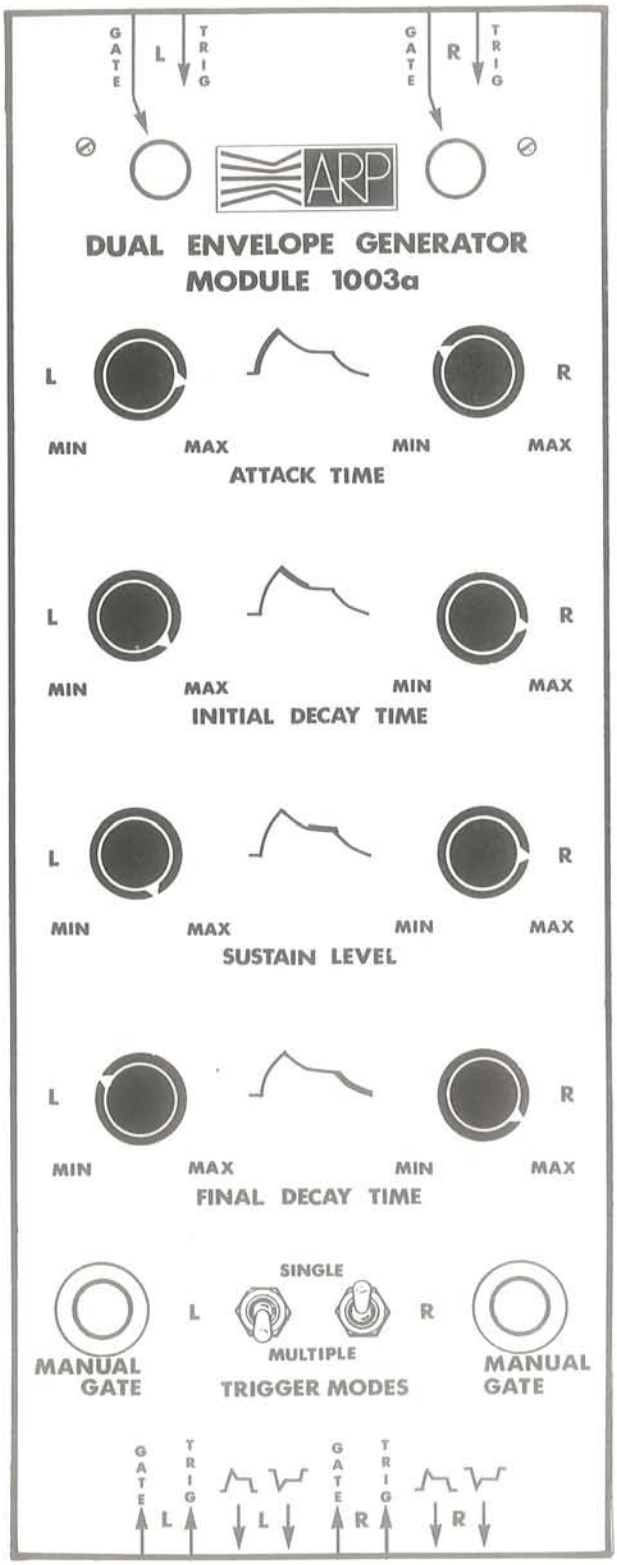
Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizers. The three frequency modulation inputs in the upper left hand corner of the module are fixed sensitivity inputs: 1 volt/octave. The two lower frequency modulation inputs (in positions 2 and 3) are associated with two attenuators directly above the inputs. When the attenuators are rotated fully clockwise, the input sensitivity is 1 volt/octave. These controls are used to adjust frequency modulation depth.

Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth



ACTUAL SIZE

ELECTRONIC MUSIC MODULES



DUAL ENVELOPE GENERATOR — Module 1003a

The ARP Module 1003a is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical exponential envelope generators.

The 1003 Exponential Envelope Generator is usually used with voltage-controlled filters, and other modules requiring triggered control signals. For instance, when used with the ARP Module 1006 FiltAmp, the 1003 Envelope Generator can be used to control the amplitude envelope and timbre variations of signals passing through the FiltAmp.

An exponential envelope generated by the ARP 1003 Module may be defined by four parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics.

When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope, and the Trigger inputs are not used. When the Gate signal (+10v) is applied, the output voltage of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack

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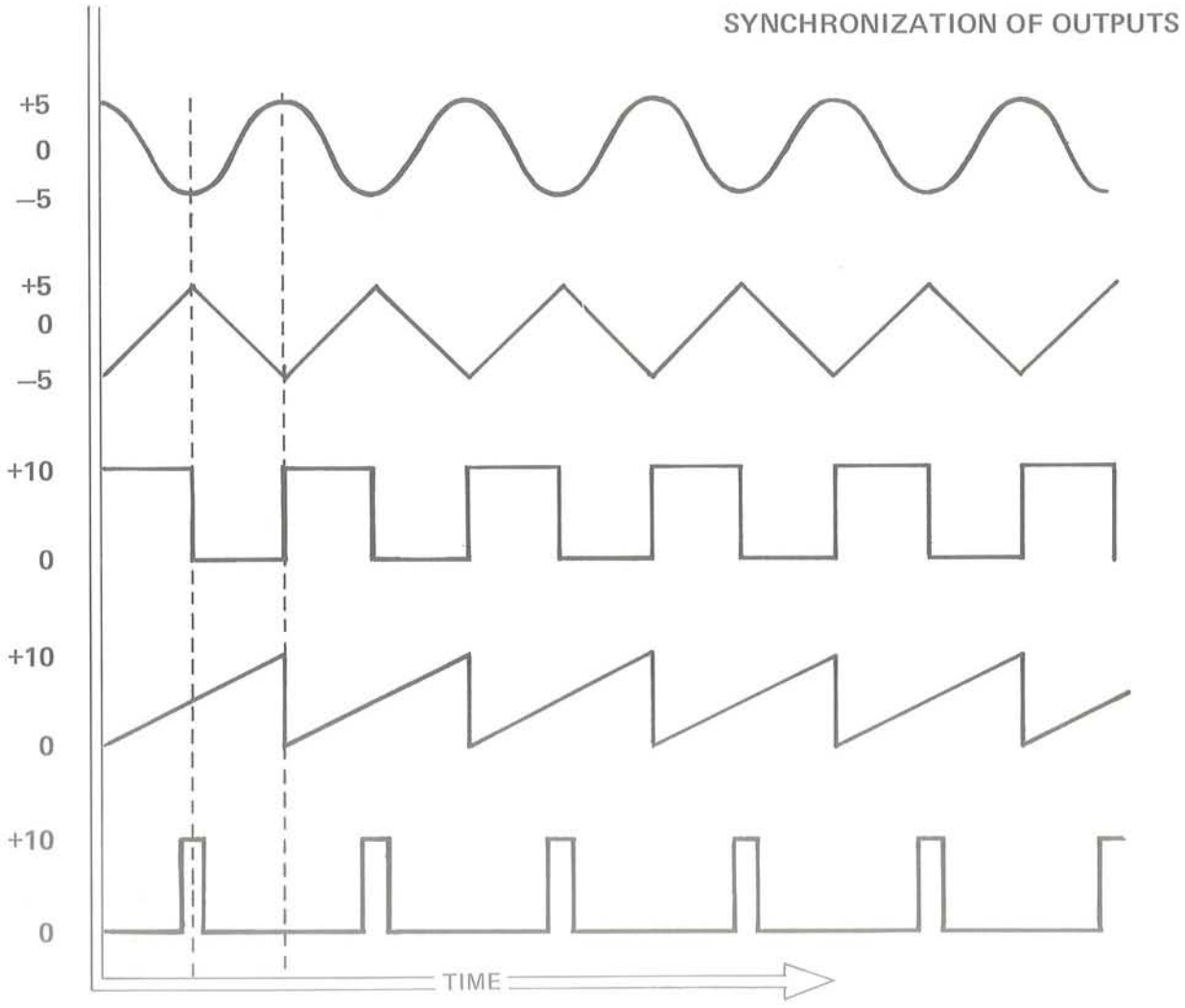
control. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.

The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.

NOTE: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator.

SYNCHRONIZATION OF OUTPUTS



ELECTRONIC MUSIC MODULES

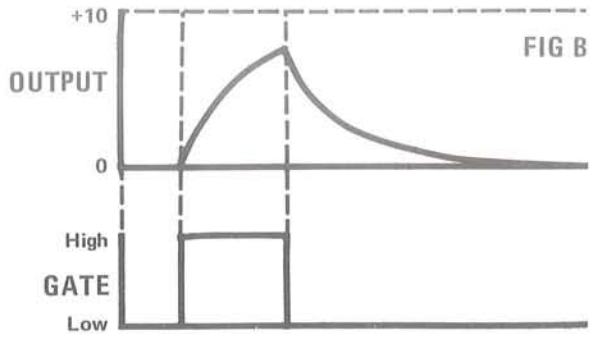


FIG B

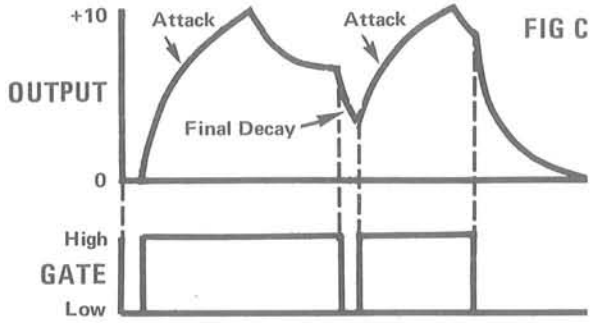


FIG C

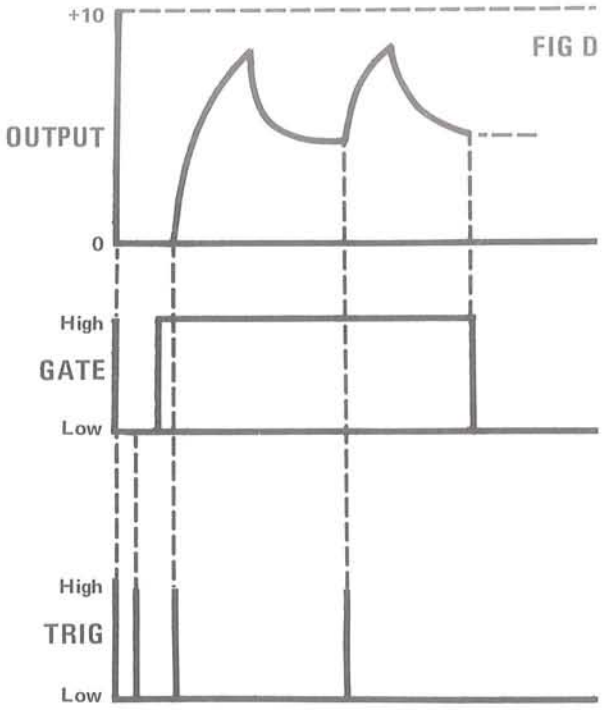


FIG D

Electrical Specifications

Controls: Attack Time: .001 secs to 2.0 secs
Initial Decay Time: .001 secs to 2.0 secs
Sustain Level: 0 to 10 volts
Final Decay Time: .001 secs to 2.0 secs

Inputs: Gate Sensitivity: 1.8 volts, lower matrix switch. 9.6 volts upper matrix switch
Trigger Sensitivity: 1.8 volts
All impedances: 100K

Outputs: 0 to +10 volts @ 1Kohm
0 to -10 volts @ 1Kohm

Maximum Power Requirements (outputs shorted):

±15 volts @ 50ma, regulated to ±0.1%
+12 volts to +15 volts @40ma, lamp supply

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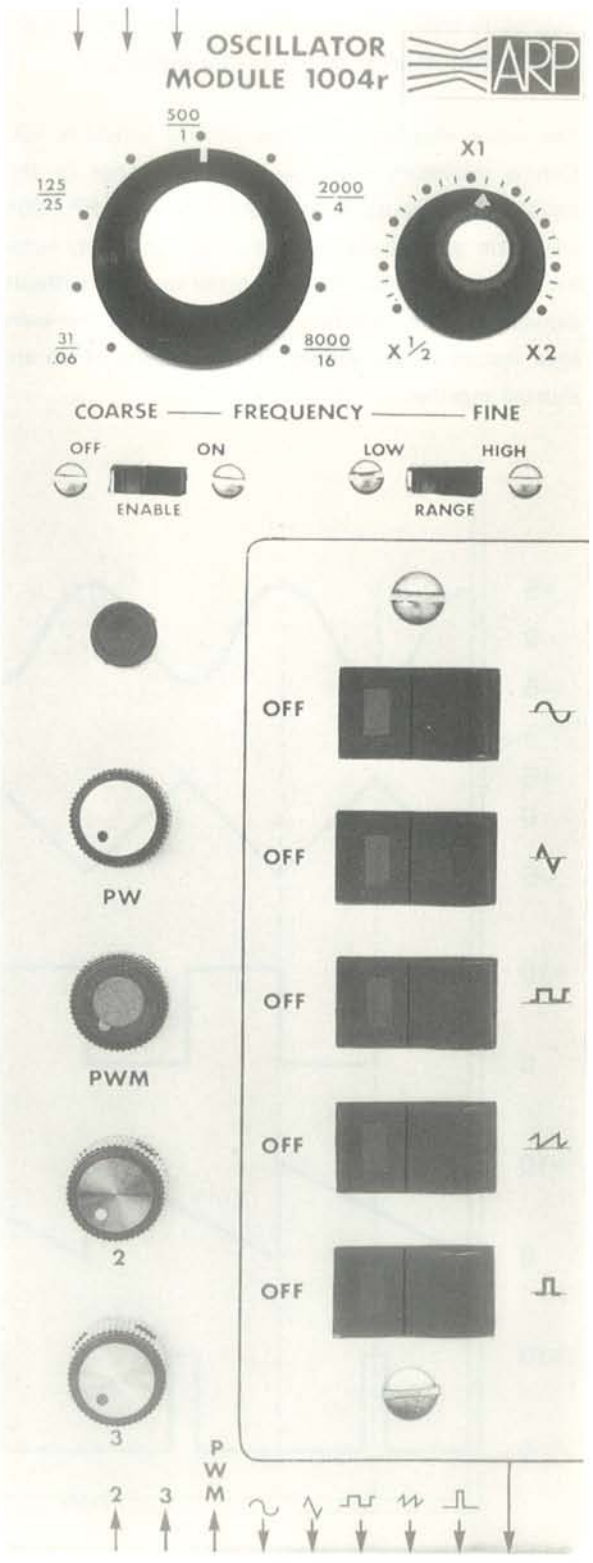
The ARP 1004-R Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic type 1004 oscillator and a type "R" oscillator submodule. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition, five rocker-type switches permit any of these waveforms to be selected to an additional output at a touch. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. This feature is especially useful in live performance where rapid output waveform changes are needed.

The output frequency range is from .03 Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

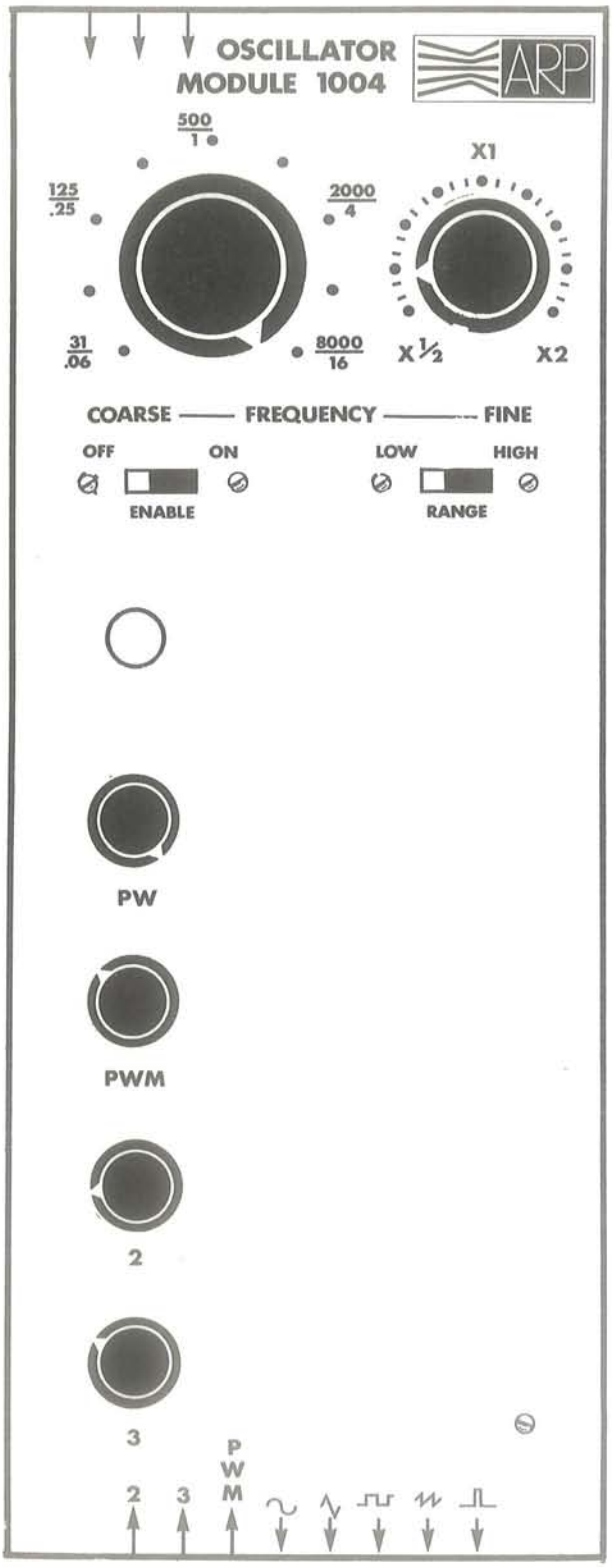
Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizers. The three frequency modulation inputs in the upper left hand corner of the module are fixed sensitivity inputs: 1 volt/octave. The two lower frequency modulation inputs (in positions 2 and 3) are associated with two attenuators directly above the inputs. When the attenuators are rotated fully clockwise, the input sensitivity is 1 volt/octave. These controls are used to adjust frequency modulation depth.

Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth



ACTUAL SIZE

ELECTRONIC MUSIC MODULES



OSCILLATOR Module 1004

The ARP 1004 Oscillator Module is a voltage-controlled waveform generator which has five simultaneous outputs: sine, triangular, square, sawtooth, and pulse. These waveforms are derived from a basic voltage-controlled dual-slope-integrator type oscillator with exponential control voltage versus frequency characteristics, so that the oscillator frequency is raised by an octave, per one volt positive increment of control voltage.

The output frequency range is from .03 Hz to 16,000 Hz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided for frequency-modulation signals from other modules or external sources, and knob-actuated panel controls are provided to permit convenient adjustment of modulation depth. Another control input,

ELECTRICAL SPECIFICATIONS

OUTPUTS:
Frequency: .03Hz–16KHz in two ranges without external inputs.
Sine: –5 volts to +5 volts P-P.
Triangle: –5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

INPUTS:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

CONTROLS:
Frequency Range: Low (.03 Hz–32 Hz); High (31 Hz–16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0–100%.
Pulse Width Modulation

LONG TERM FREQUENCY DRIFT:
Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

POWER REQUIREMENTS:
±15 volts @50 ma, regulated to ±0.1%.
+12 to +15 volts @20 ma unregulated, lamp supply.

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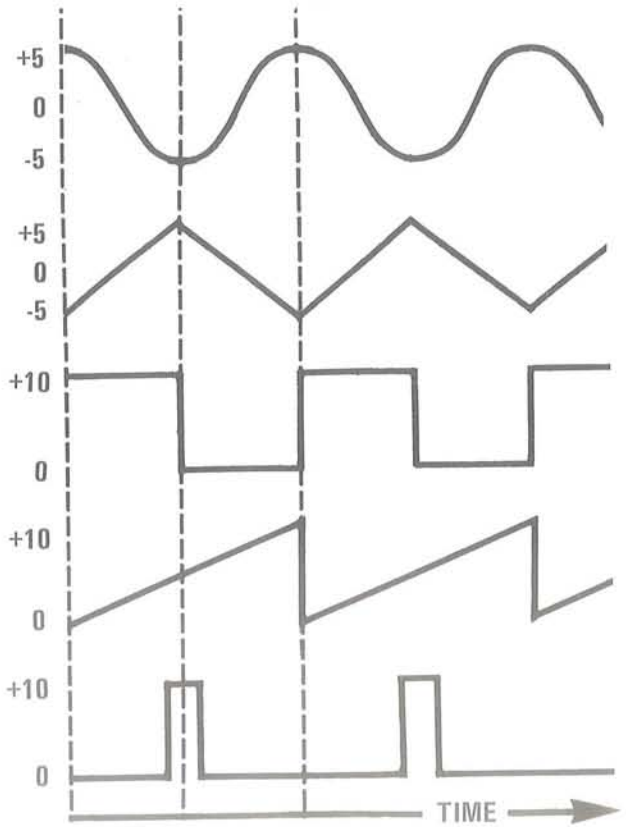
ELECTRONIC MUSIC MODULES

designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition another panel-knob control (PW) permits manual adjustment of pulse width.

The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.



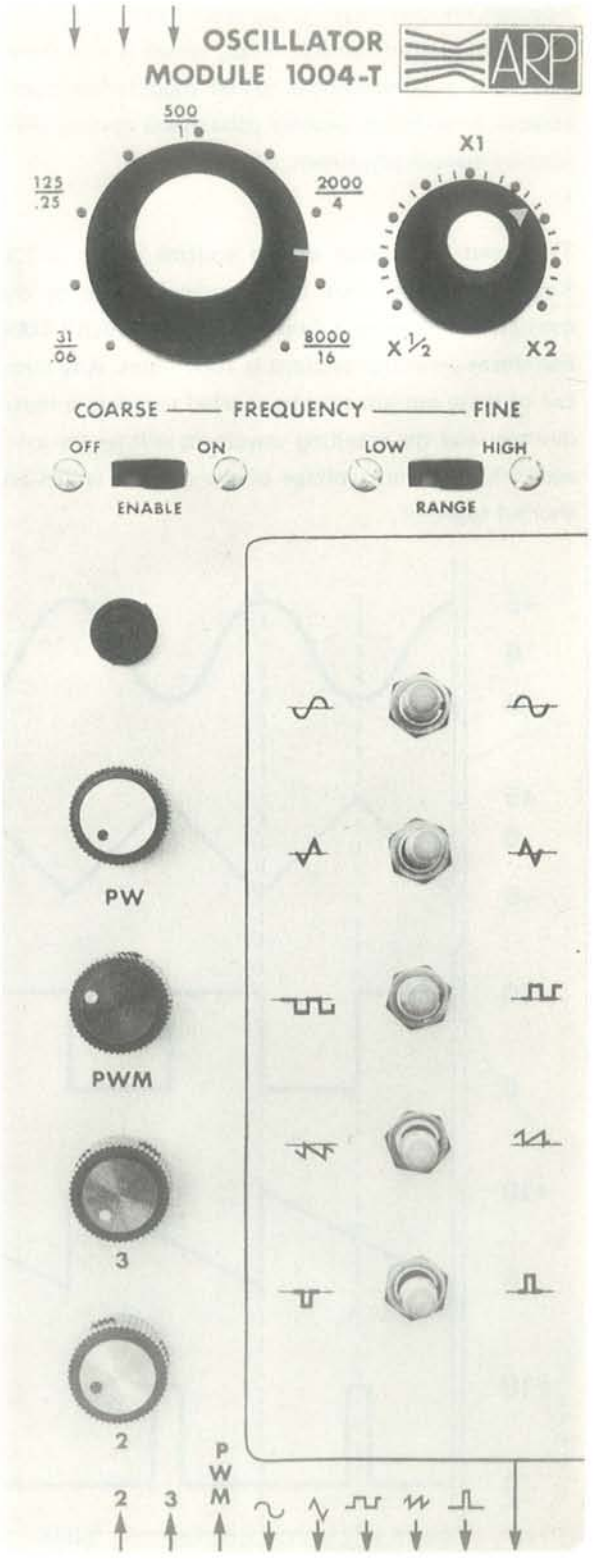
SYNCHRONIZATION OF OUTPUTS

The ARP 1004-T Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic 1004 oscillator and a type "T" oscillator submodule. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition, five center-off miniature toggle switches allow any of these waveforms or their inverses to be selected to an additional output. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. The ARP 1004-T is the only module of the 1004 oscillator series to offer inverted and non-inverted waveform outputs simultaneously, and is therefore particularly recommended for generating control signals.

The output frequency range is from .03 Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizers. The three frequency modulation inputs in the upper left hand corner of the module are fixed sensitivity inputs: 1 volt/octave. The two lower frequency modulation inputs (in positions 2 and 3) are associated with two attenuators directly above the inputs. When the attenuators are rotated fully clockwise, the input sensitivity is 1 volt/octave. These controls are used to adjust frequency modulation depth.



ACTUAL SIZE

ELECTRONIC MUSIC MODULES

Electrical Specifications

Outputs:
Frequency: .03 Hz - 16 KHz in two ranges without external inputs.
Sine: -5 volts to +5 volts P-P.
Triangle: -5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

Inputs:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

Controls:
Frequency Range: Low (.03 Hz - 32 Hz); High (31 Hz - 16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 - 100%.
Pulse Width Modulation

Long Term Frequency Drift:
Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

Power Requirements: ±15 volts @ 50 ma, regulated to ±0.1%.
+12 to +15 volts @ 20 ma unregulated, lamp supply.

Note: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator. See price list for details.

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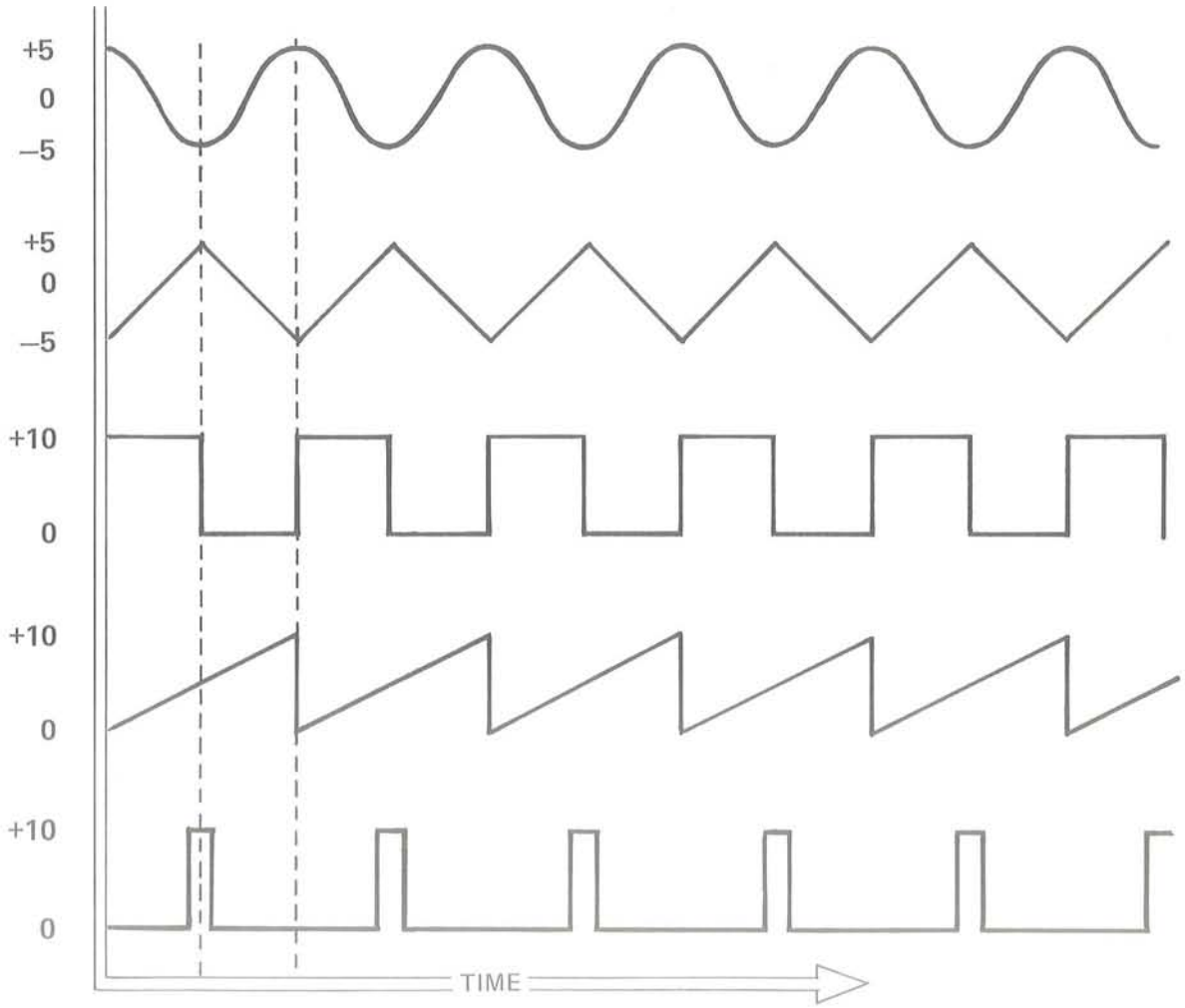
Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.

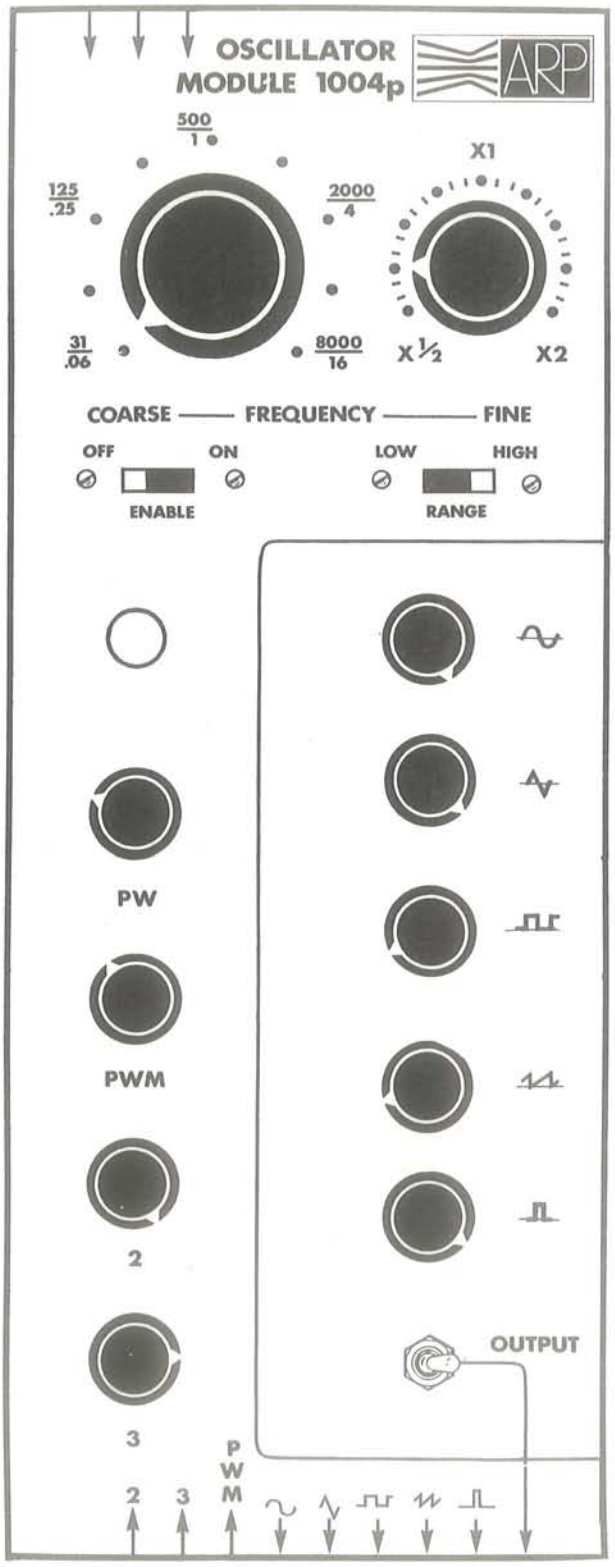
The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.

NOTE: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator.

SYNCHRONIZATION OF OUTPUTS



ELECTRONIC MUSIC MODULES



OSCILLATOR Module 1004p

The ARP 1004p Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic 1004 oscillator and a type "t" oscillator sub-module. Sine, triangular, square, sawtooth, and pulse outputs are available simultaneously. In addition five potentiomenter can be used to mix or algebraicly sum these waveforms into an additional output. This module is particularly recommended for generating control waveforms and complex audio signals in the studio.

The output frequency range is from .03 Hz to 16,000 Hz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided for frequency-modulation signals from other modules or external sources, and knob-actuated panel controls are provided to permit convenient adjustment of modu-

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ELECTRICAL SPECIFICATIONS

OUTPUTS:
Frequency: .03Hz–16KHz in two ranges without external inputs.
Sine: –5 volts to +5 volts P-P.
Triangle: –5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

INPUTS:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

CONTROLS:
Frequency Range: Low (.03 Hz–32 Hz); High (31 Hz–16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0–100%
Pulse Width Modulation

LONG TERM FREQUENCY DRIFT:
Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

POWER REQUIREMENTS:
±15 volts @50 ma, regulated to ±0.1%.
+12 to +15 volts @20 ma unregulated, lamp supply.

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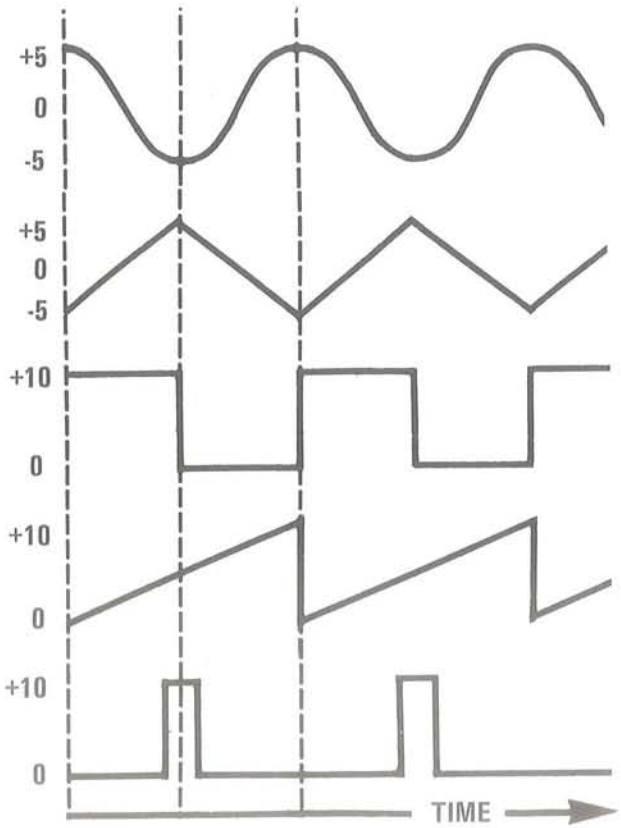
ELECTRONIC MUSIC MODULES

lation depth. Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition another panel-knob control (PW) permits manual adjustment of pulse width.

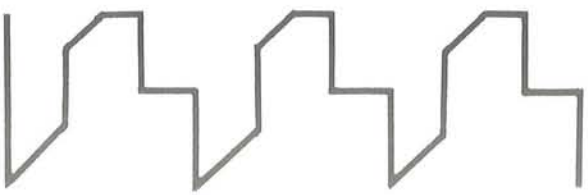
puts is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.



SYNCHRONIZATION OF OUTPUTS



Addition of triangle, sawtooth, and square wave functions



Addition of sawtooth, pulse, and triangle functions

TYPICAL WAVEFORMS PRODUCED BY MODULE 1004p

ARP Module 1005 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This unit contains a balanced modulator, a voltage controlled amplifier, and certain associated circuitry.

The balanced modulator can accept two input signals *A* and *B* in the frequency range from D.C. to 20 KHz, and will produce the output function *(A x B/10)*.

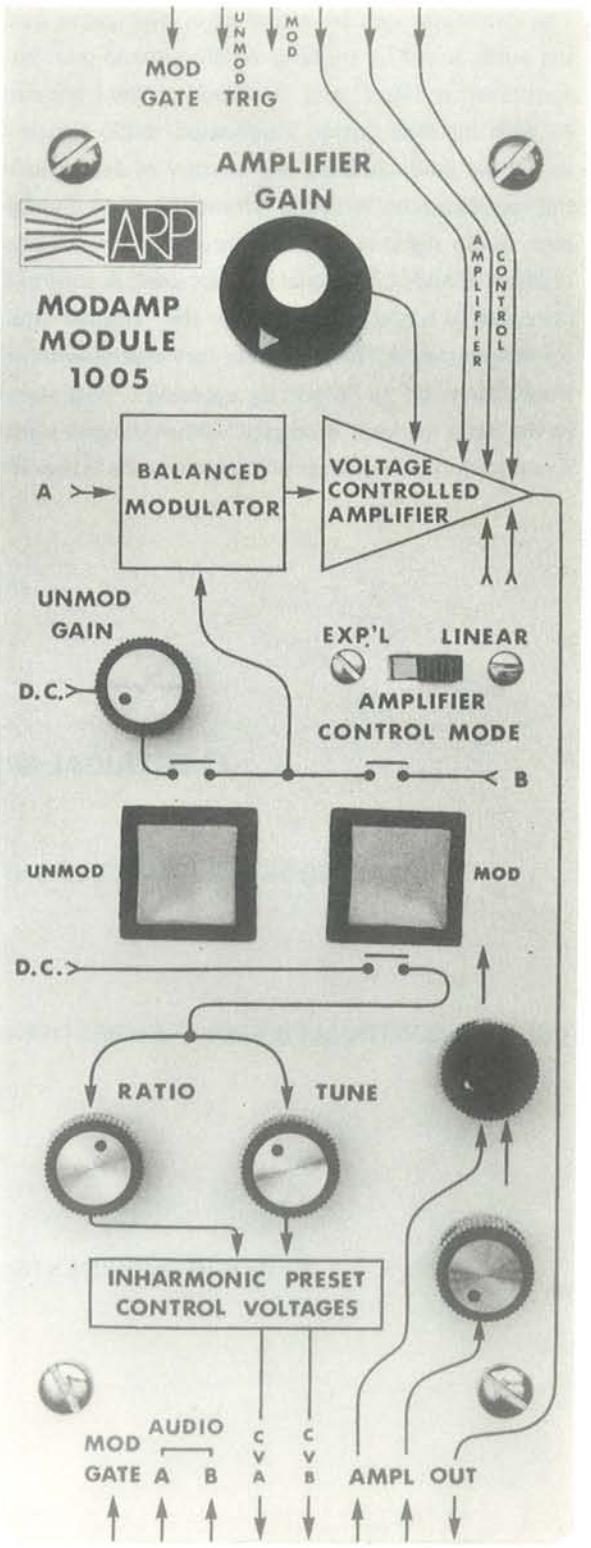
If *A* and *B* are both sine waves of equal amplitude with respective frequencies f_1 and f_2, the output will consist of the sum and difference frequencies $(f_1 + f_2)$ and $(f_1 - f_2)$ only. The original frequencies f_1 and f_2 will be suppressed.

If *A* is a complex wave with harmonics f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$, etc. and *B* is a sine wave of frequency f_2, the resulting output will consist of the frequencies $(f_1 + f_2)$, $(f_1 - f_2)$, $(2f_1 + f_2)$, $(2f_1 - f_2)$, $(3f_1 + f_2)$, $(3f_1 - f_2)$, etc.

If f_1 and f_2 are chosen properly, the output will be a complex wave with inharmonic overtones. In electronic music this is extremely useful in simulating gong timbres, etc.

For the users' convenience, Module 1005 contains circuits which produce two D.C. output control voltages, V_a and V_b, which may be used to control two voltage-controlled oscillators which are supplying audio signals *A* and *B* respectively.

With exponentially controlled oscillators such as the ARP 1004 and 1023 modules, the difference voltage $V_a - V_b$ controls the frequency ratio and the average voltage $(V_a + V_b)/2$ controls the tuning of the input signals *A* and *B*. For the users' convenience, ratio and tuning control knobs are located on the panel of the 1005 module.



ACTUAL SIZE

ELECTRONIC MUSIC MODULES

Electrical Specifications

Outputs:
Frequency: .03 Hz - 16 KHz in two ranges without external inputs.
Sine: -5 volts to +5 volts P-P.
Triangle: -5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

Inputs:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

Controls:
Frequency Range: Low (.03 Hz - 32 Hz); High (31 Hz - 16 KHz).
Frequency, Coarse
Frequency, Fine: $\pm$1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 - 100%.
Pulse Width Modulation

Long Term Frequency Drift:
Ambient 50°F to 90°F $\pm$5°F, drift is typically 0.1% per hour.

Power Requirements: $\pm$15 volts @ 50 ma, regulated to $\pm$0.1%.
+12 to +15 volts @ 20 ma unregulated, lamp supply.

Note: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator. See price list for details.

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The modulator can be activated or disengaged from the audio signal by pushing the illuminated push-buttons labelled "Mod" and "Unmod" on the front panel. With the Mod button illuminated, audio signals *A* and *B* are modulated by one another as described in the specifications. With the "Unmod" button illuminated, audio signal *A* is passed through the modulator unaffected and audio signal *B* is not used. A control is provided to adjust the gain when the "Unmod" button is illuminated. The modulator may also be switched from "Unmod" to "Mod" by applying a Gate signal to the input marked "Mod gate". When the gate signal is removed, the modulator will return to the "Unmod" mode. On the other hand, the upper inputs labelled "Unmod" and "Mod" are latching and a pulse applied to either input will switch the operating mode to either "Unmod" or "Mod". The mode will remain as set until a pulse is applied to switch to another mode or until the mode is changed by using the front panel push-buttons.

The 1005 also contains a voltage controlled amplifier which may be controlled with external signals from either the upper or lower matrix switch section, or manually by means of a panel knob. A panel slide switch gives the user the choice of linear or exponential control modes.

ELECTRICAL SPECIFICATIONS

BALANCED MODULATOR SECTION:

Output: $V_{out} = (IN_A \times IN_B)/10$ ±1.0%.
Audio Inputs: ±10 volts maximum.
100 Kohm impedance.

VOLTAGE CONTROLLED AMPLIFIER SECTION:

(Input attenuators fully clockwise)
$V_{out} = (V_{in} \times V_{control})/10$, Linear Mode.

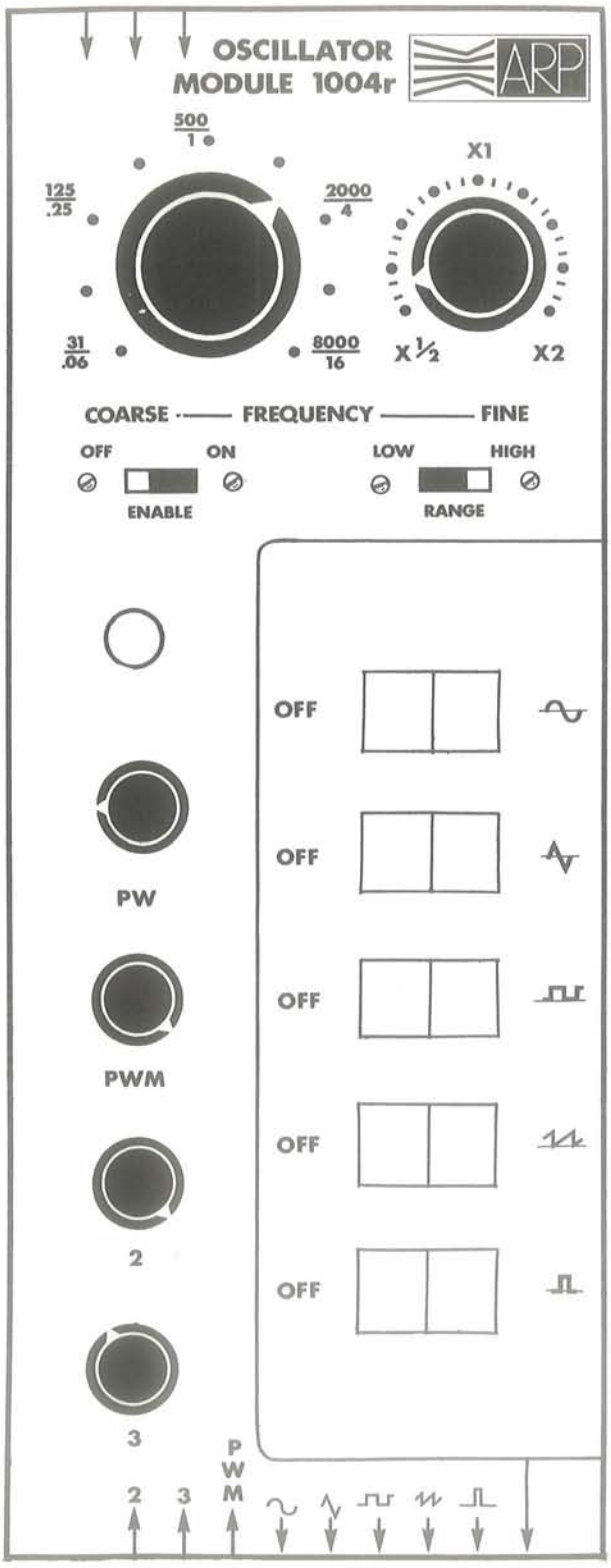
$V_{out} = V_{in}10^{(V_{control} - 10)/2}$ Exponential Mode.

Control Input Impedance = 100 K.

POWER REQUIREMENTS:

±15 volts @ 35 ma, regulated to ±0.1%.
+12 to +15 volts @ 20 ma, unregulated.

ELECTRONIC MUSIC MODULES



OSCILLATOR Module 1004r

The ARP 1004r Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic type 1004 oscillator and a type "r" oscillator submodule. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition, five rocker-type switches permit any of these waveforms to be selected to an additional output at a touch. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. This feature is especially useful in live performance where rapid output waveform changes are needed.

The output frequency range is from .03 Hz to 16,000 Hz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

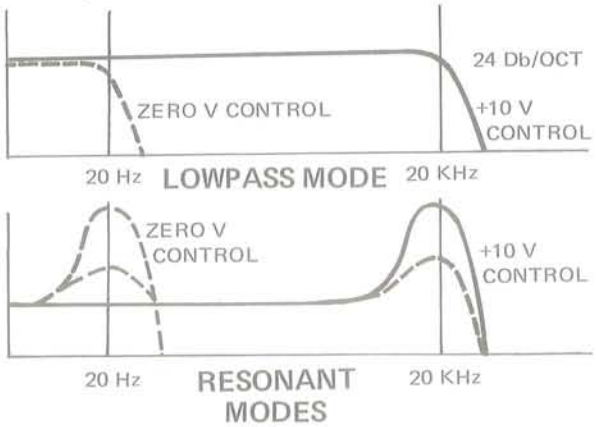
Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided for frequency-modulation signals from other mod-

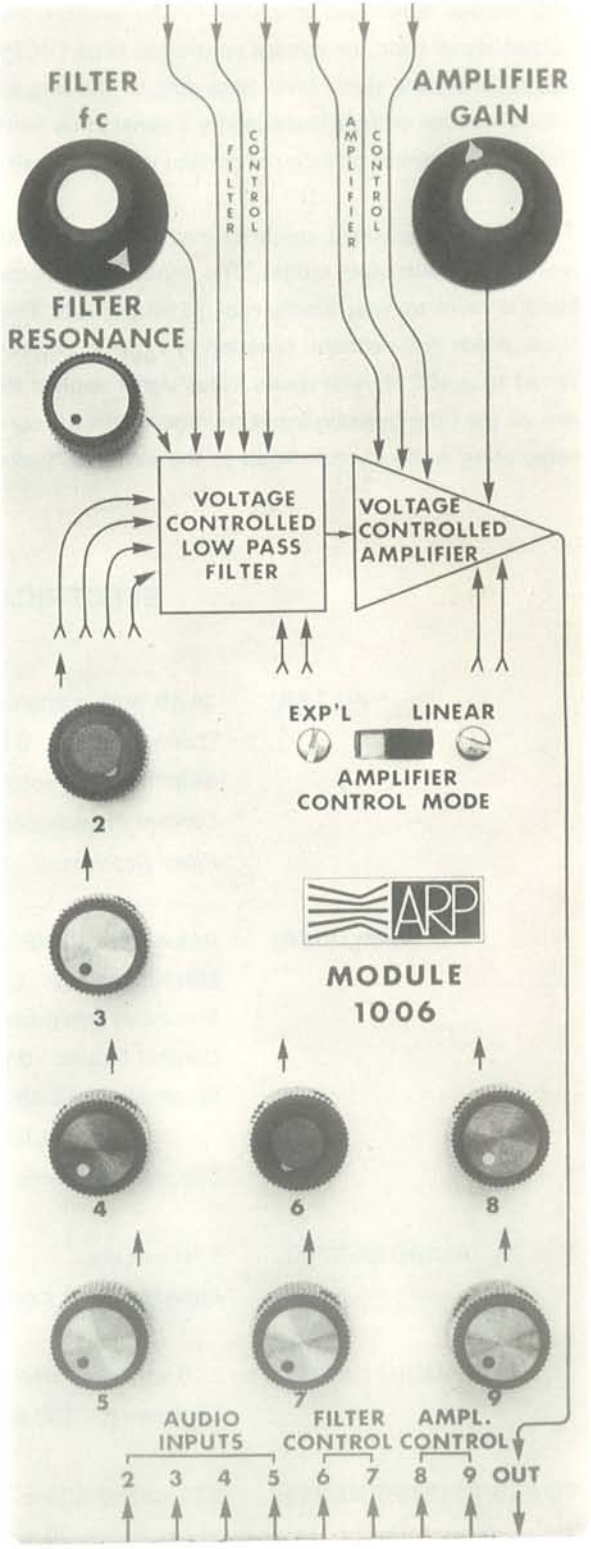
ARP Module 1006 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This unit contains a four-input mixer, a voltage controlled low-pass filter (VCLPF) plus a voltage controlled amplifier with associated circuitry.

The cutoff frequency of the filter may be varied by external voltages or by the front panel f_c control. There are three separate filter control inputs at the top of the module and two at the bottom. The three at the top are fixed in sensitivity (like the 1004 oscillator) at 1 volt/octave. The inputs from the bottom of the module are each associated with an attenuator. With the attenuators rotated fully clockwise, the sensitivity of these inputs is also 1 volt/octave. The voltages appearing at each control input are summed internally and the cutoff frequency of the filter will be determined by this sum. Although the sum of all the control inputs may exceed the effective input range of the filter, (i.e., +10v) no damage can be done to the circuitry by such overdrive.

A resonance or "peaked" response at the cutoff frequency may be obtained if so desired. This is useful for creating certain types of formants, such as "wa-wa" or "yeow" effect. A knob control permits adjustment of the height of the resonant peak.

Up to four audio signal inputs to the filter may be mixed and their relative amplitudes adjusted by means of four panel knobs.

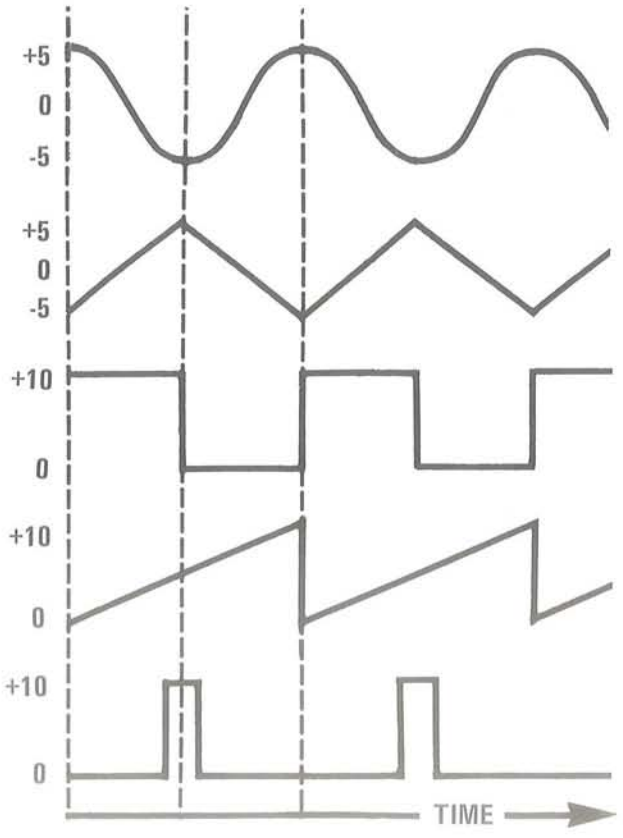




ACTUAL SIZE

ules or external sources, and knob-actuated panel controls are provided to permit convenient adjustment of modulation depth. Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition another panel-knob control (PW) permits manual adjustment of pulse width.

The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.



SYNCHRONIZATION OF OUTPUTS

The voltage controlled amplifier (VCA) accepts the output signal from the voltage controlled filter (VCF) and modifies the signal level according to the sum of a local control voltage (supplied by a panel knob control) and a number of external control voltage signals.

The voltage controlled amplifier may be operated in one of two selectable modes. The exponential mode has a control transfer function of 10 dB per volt. The linear mode has a control function of $v_{out}=V_{cs}v_{in}$ referred to a 400 Hz sine audio input signal applied to one of the filtamp audio input terminals with the corresponding audio control knob in the extreme clockwise position, the filter in the wideband condition (sum of control voltages = +10v) with the filter cutoff frequency knob in the extreme clockwise position and the resonance control knob in the extreme counter-clockwise position.

The range of the voltage controlled amplifiers is over 100 dB, which permits the VCA to be used as a squelch gate control device. By proper adjustment of controls no discernible output should be obtained in the absence of control voltages, even when the audio inputs are operated at maximum levels.

ELECTRICAL SPECIFICATIONS

FILTER: 24 dB/octave attenuation, 20 Hz—20 KHz unity gain in passband.
Control Inputs: 0 to +10 operating range.
Sensitivity: 1 volt/octave, 0 volts = 20 Hz.
Control Impedance: 50 K min.
Filter Resonance: 0 to 20 dB peak.

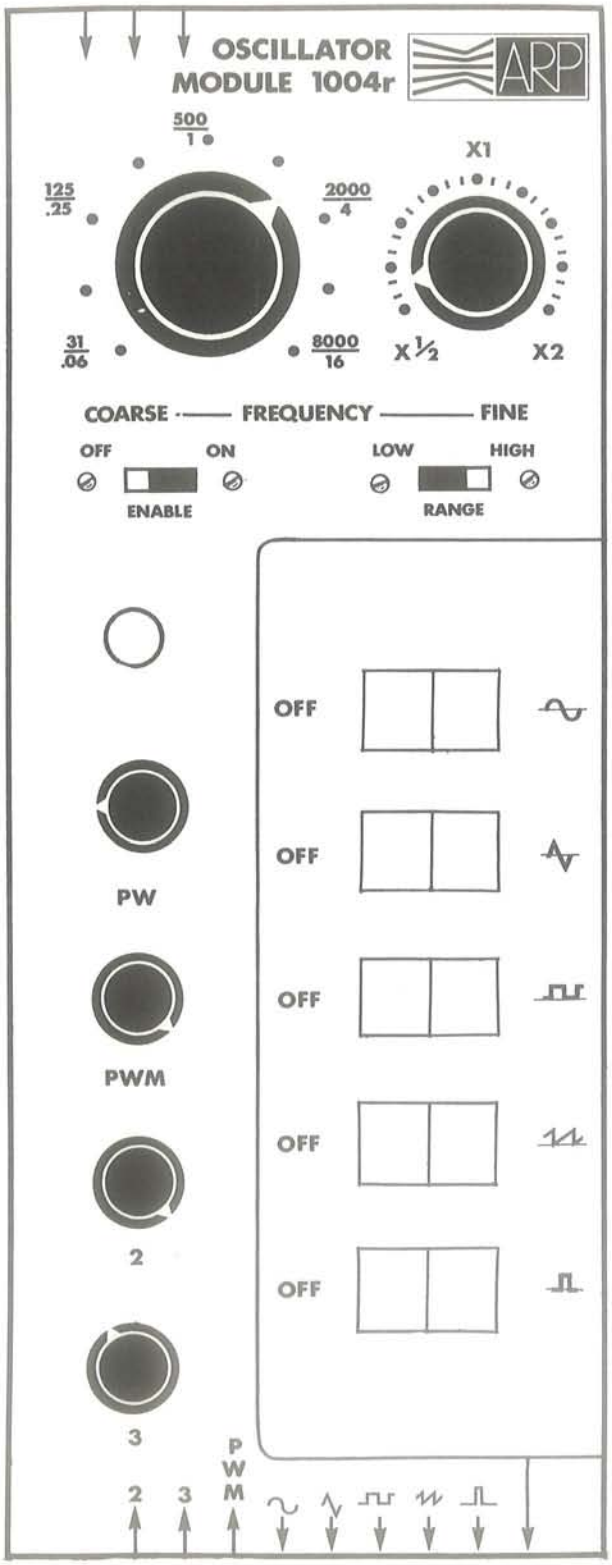
AMPLIFIER: *Response:* ±3 dB, 2 Hz to 30 KHz.
Maximum Gain: Unity.
Maximum Attenuation: 100 dB.
Control Inputs: 0 to +10 operating range.
Sensitivity: 10 dB attenuation per volt (Amplifier Control in Exponential Mode).
In Linear Control Mode, $e_{out}= e_{in}e_{control}/10$.
Control Impedance: 50 K min.

AUDIO OUTPUT: ±10 volt max.
Impedance: 1 Kohm.

AUDIO INPUTS: ±10 volt max. after attenuators.
Impedance: 100 K min.

POWER REQUIREMENTS: ±15 volts @ 50 ma, regulated to ±0.1%.
+12 to +15 @ 20 ma, lamp supply.

ELECTRONIC MUSIC MODULES



OSCILLATOR Module 1004r

The ARP 1004r Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic type 1004 oscillator and a type "r" oscillator submodule. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition, five rocker-type switches permit any of these waveforms to be selected to an additional output at a touch. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. This feature is especially useful in live performance where rapid output waveform changes are needed.

The output frequency range is from .03 Hz to 16,000 Hz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided for frequency-modulation signals from other mod-

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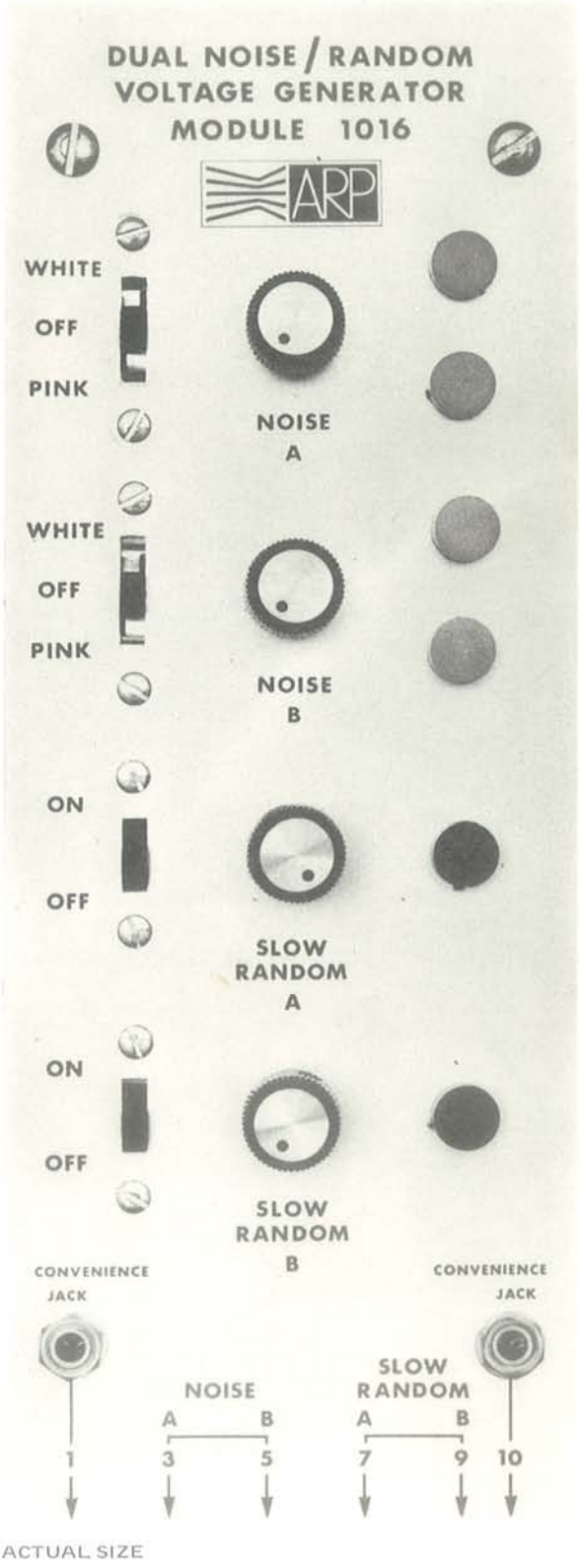
The ARP Module 1016 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical White/Pink Noise and Random Voltage Generators.

The two noise outputs, *A* and *B*, are generated from two independent diode noise sources. Through successive filtering, the white noise is transformed into pink noise and finally into a slow random voltage. Output attenuators and on/off switches are provided for the two noise sources and the random voltage outputs.

The maximum amplitude of all the outputs is adjusted so that an output voltage will exceed ±5 volts about 1% of the time. This insures a paucity of excursions past ±10 volts.

The White Noise generator produces a flat power bandwidth from 5 Hz to 20 KHz. The Pink Noise is filtered to attenuate highs and boost the low frequencies, resulting in equal energy per octave. The Slow Random output has peak signal power between 1 Hz and 10 Hz.

Two convenience jacks are located on the front panel and permit a user to have direct access to the lower matrix switch of an ARP 2000 Synthesizer.



ACTUAL SIZE

ELECTRICAL SPECIFICATIONS

Power Requirements:

±15 volts @ 50 ma, regulated.
+12 to +15 volts @ 80 ma, unregulated.

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ELECTRONIC MUSIC MODULES

Electrical Specifications

Outputs:
Frequency: .03 Hz - 16 KHz in two ranges without external inputs.
Sine: -5 volts to +5 volts P-P.
Triangle: -5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

Inputs:
Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/ volt.
Input Impedances: 100 K.

Controls:
Frequency Range: Low (.03 Hz - 32 Hz); High (31 Hz - 16 KHz).
Frequency, Coarse
Frequency, Fine: $\pm$1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 - 100%.
Pulse Width Modulation

Long Term Frequency Drift:
Ambient 50°F to 90°F $\pm$5°F, drift is typically 0.1% per hour.

Power Requirements: $\pm$15 volts @ 50 ma, regulated to $\pm$0.1%.
+12 to +15 volts @ 20 ma unregulated, lamp supply.

Note: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator. See price list for details.

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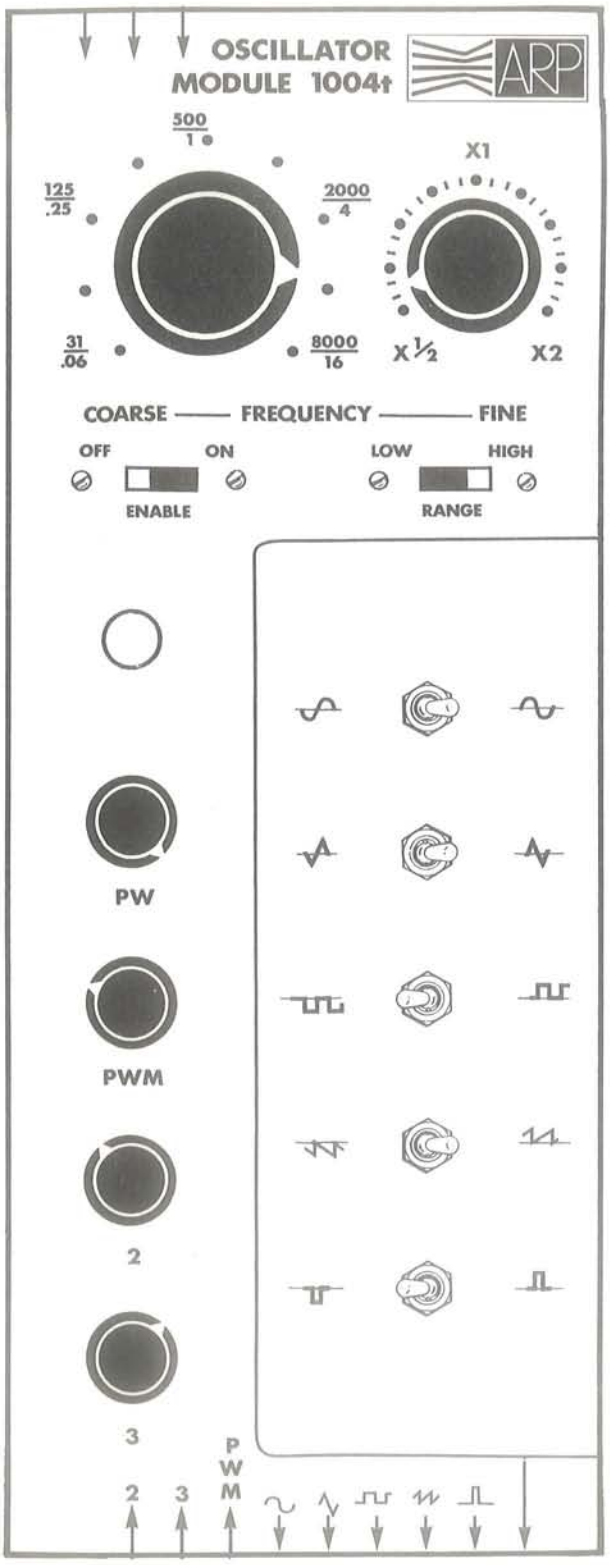
NOTES

ELECTRONIC MUSIC MODULES



OSCILLATOR Module 1004t

The ARP 1004t Oscillator Module is a voltage-controlled waveform generator. The module contains both a basic 1004 oscillator and a type "t" oscillator sub-module. Sine, triangle, square, sawtooth, and pulse outputs are available simultaneously. In addition five center-off miniature toggle switches allow any of these waveforms or their inverses to be selected to an additional output. When more than one waveform is selected, the output is the instantaneous average of the selected waveforms. The ARP 1004t is the only module of the 1004 oscillator series to offer inverted and non-inverted waveform outputs simultaneously and is therefore particularly recommended for generating control signals.

The output frequency range is from .03 Hz to 16,000 Hz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from key-

The ARP 1023 Dual Oscillator Module is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical voltage-controlled oscillators.

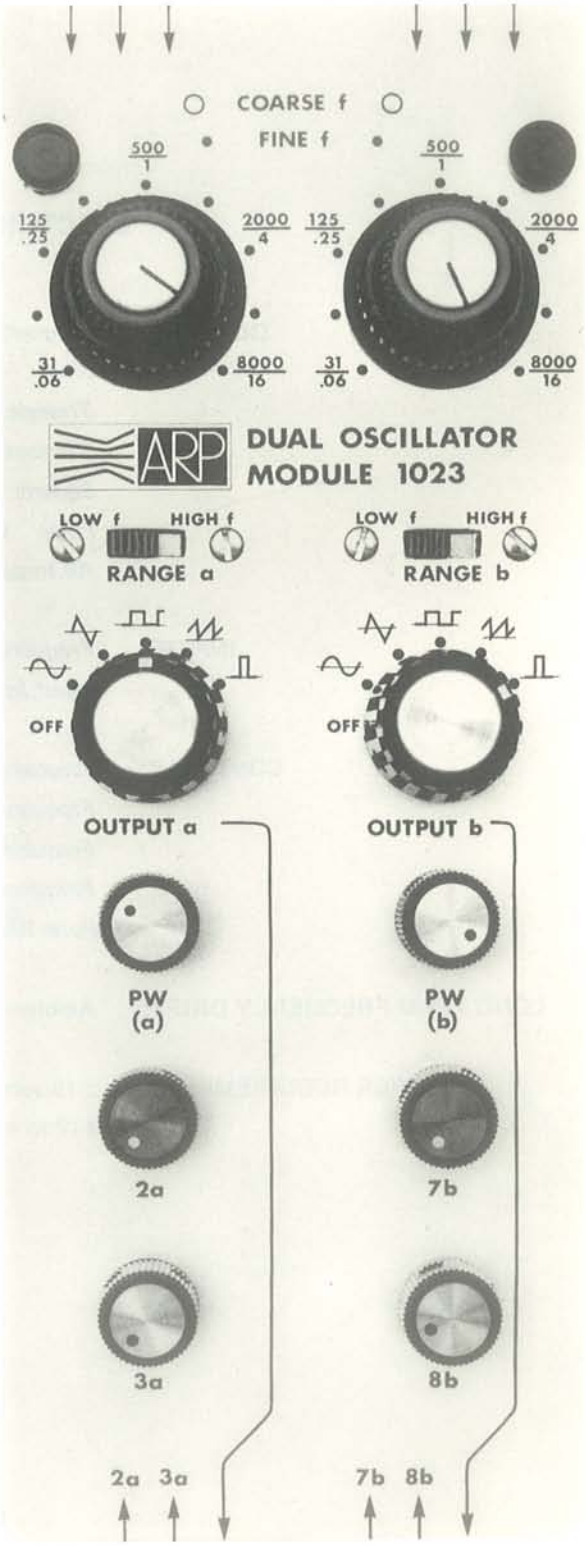
The output frequency range is from .03Hz to 16,000 Hz in two ranges without external control voltages, and the control voltage range is 10 octaves on each range. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within either of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. These upper switch inputs are provided for each oscillator for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided for each oscillator to permit convenient adjustment of modulation depth. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.

Any one of five basic output waveforms may be selected by front panel rotary switches. Selecting the "Off" position on these switches disables the oscillator.

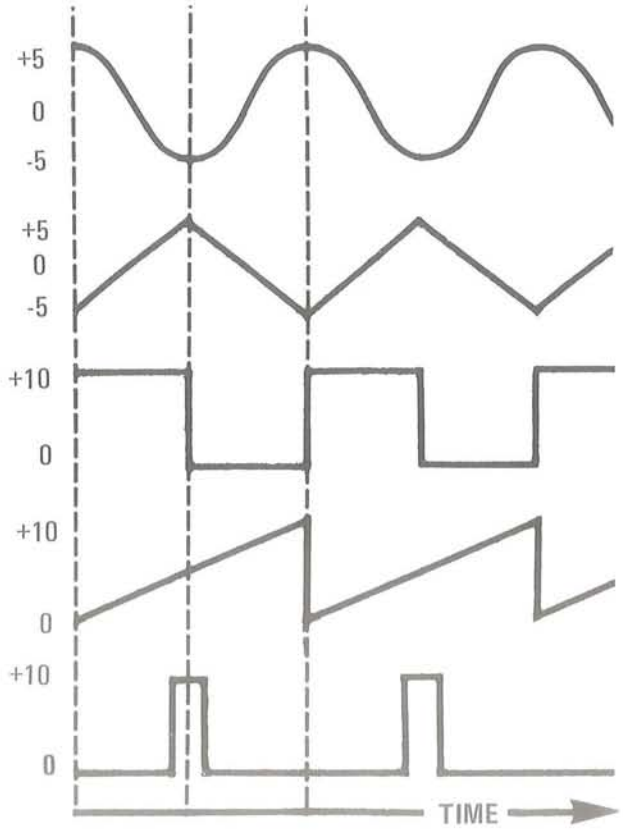
The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances are 1000 ohms, and any number of these outputs may be shorted together without damage; the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.



ACTUAL SIZE

boards, sequencers, etc. Two lower switch inputs are provided for frequency-modulation signals from other modules or external sources, and knob-actuated panel controls are provided to permit convenient adjustment of modulation depth. Another control input, designated PWM, is a pulse-width modulation control input, which is also provided with a panel-knob-actuated modulation depth control. In addition another panel-knob control (PW) permits manual adjustment of pulse width.

The input impedance of the control inputs is 50,000 ohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.



SYNCHRONIZATION OF OUTPUTS

ELECTRICAL SPECIFICATIONS

OUTPUTS:
Frequency: .03 Hz–16 KHz in two ranges without external inputs.
Sine: –5 volts to +5 volts P-P.
Triangle: –5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

INPUTS:
Frequency Modulation: 1 volt/octave. (Attenuators fully clockwise)
Input Impedances: 100 K.

CONTROLS:
Frequency Range: Low (.03 Hz–32 Hz); High (31 Hz–16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 – 100%.

LONG TERM FREQUENCY DRIFT: Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

POWER REQUIREMENTS: ±15 volts @ 50 ma, regulated to ±0.1%.
+12 to +15 volts @ 20 ma unregulated, lamp supply.

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Electrical Specifications

Outputs: Frequency: .03 Hz - 17 KHz in two ranges without external inputs.
Sine: -5 volts to +5 volts P-P.
Triangle: -5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

Inputs: Frequency Modulation: 1 volt/octave.
Pulse Width Modulation: 10%/volt.
Input Impedances: 100 K.

Controls: Frequency Range: Low (.03 Hz - 32 Hz); High (31 Hz - 16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 - 100%.
Pulse Width Modulation

Long Term Frequency Drift:
Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

Power Requirements: ±15 volts @ 50 ma, regulated to ±0.1%.
+12 to +15 volts @ 20 ma unregulated, lamp supply.

Note: This oscillator module requires one ARP 4001 Negative Exponential Function Module and one ARP 4002 Positive Exponential Function Module for exponential control of oscillator frequency. ARP 4003 Linear Function Modules can be supplied upon request and either will be factory-installed at no charge. Unless otherwise specified, the factory will include 4001 and 4002 modules with each oscillator. See price list for details.

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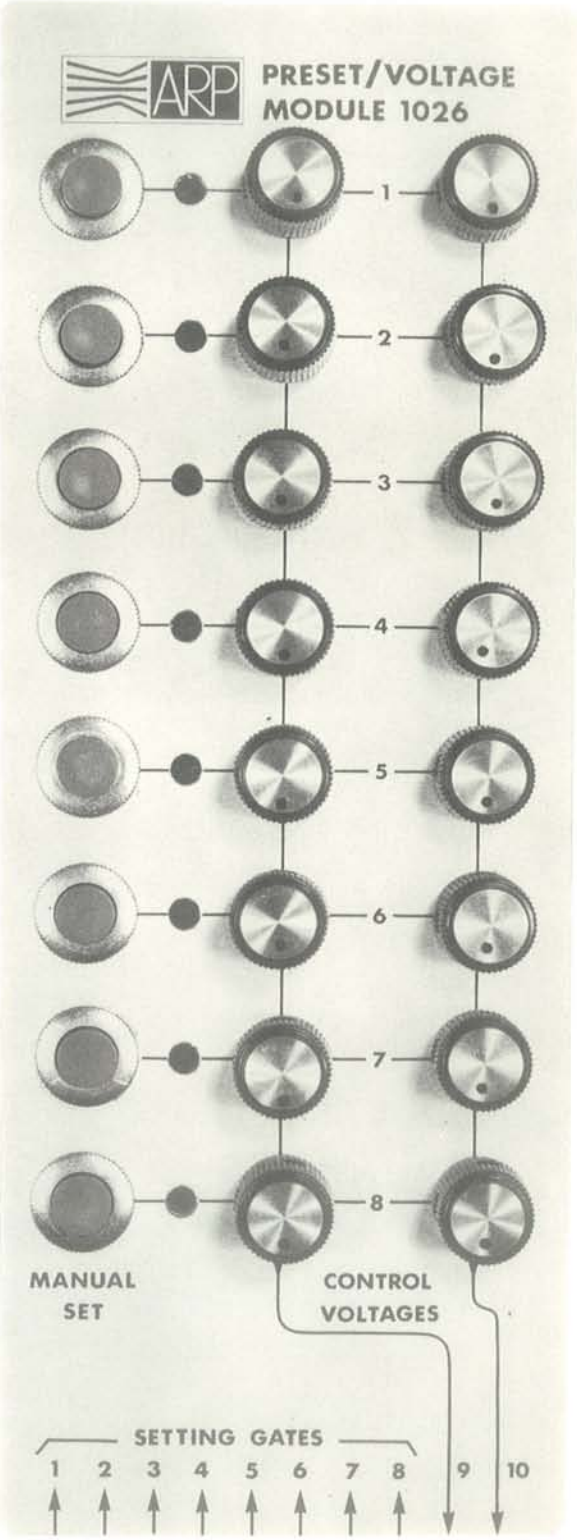
The ARP 1026 Preset Voltage Module is a functional circuit package designed for use in the ARP series 2000 electronic music synthesizers. The Module 1026 provides sixteen preset voltages which are chosen in pairs by push-buttons. When a push-button is depressed, the two potentiometers associated with that button then control the two output voltages which appear at lines 9 and 10 on the lower matrix switches. A lamp next to each push-button indicates which pair of potentiometers is controlling the output voltages.

The Module 1026 may be used to control other modules in the ARP Sequencer family or may be "slaved" from other modules, such as the 1027 Sequencer or the 1050 Mix-sequencer. Cable connectors are provided on the rear panel for these purposes.



ACTUAL SIZE

ELECTRICAL SPECIFICATIONS

OUTPUT VOLTAGES: 0 to +10 volts.

OUTPUT IMPEDANCES: 1000 ohms.

INPUT IMPEDANCES: 100 Kohms.

POWER REQUIREMENTS:
±15 volts @ 20 ma, regulated to ±0.1%.

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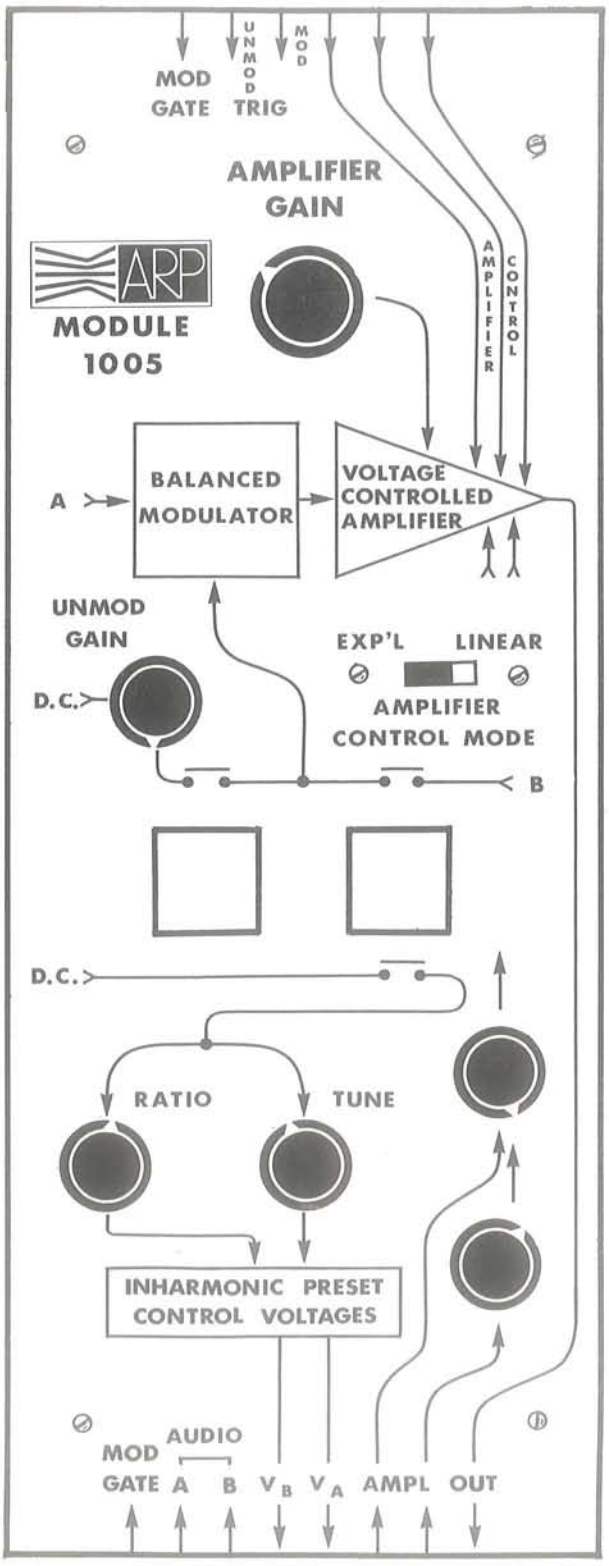


MODAMP Module 1005

ARP Module 1005 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This unit contains a balanced modulator, a voltage controlled amplifier, and certain associated control circuitry.

The balanced modulator can accept two input signals A & B in the frequency range from D.C. to 20 KHz, and will produce the output function (A x B/10).

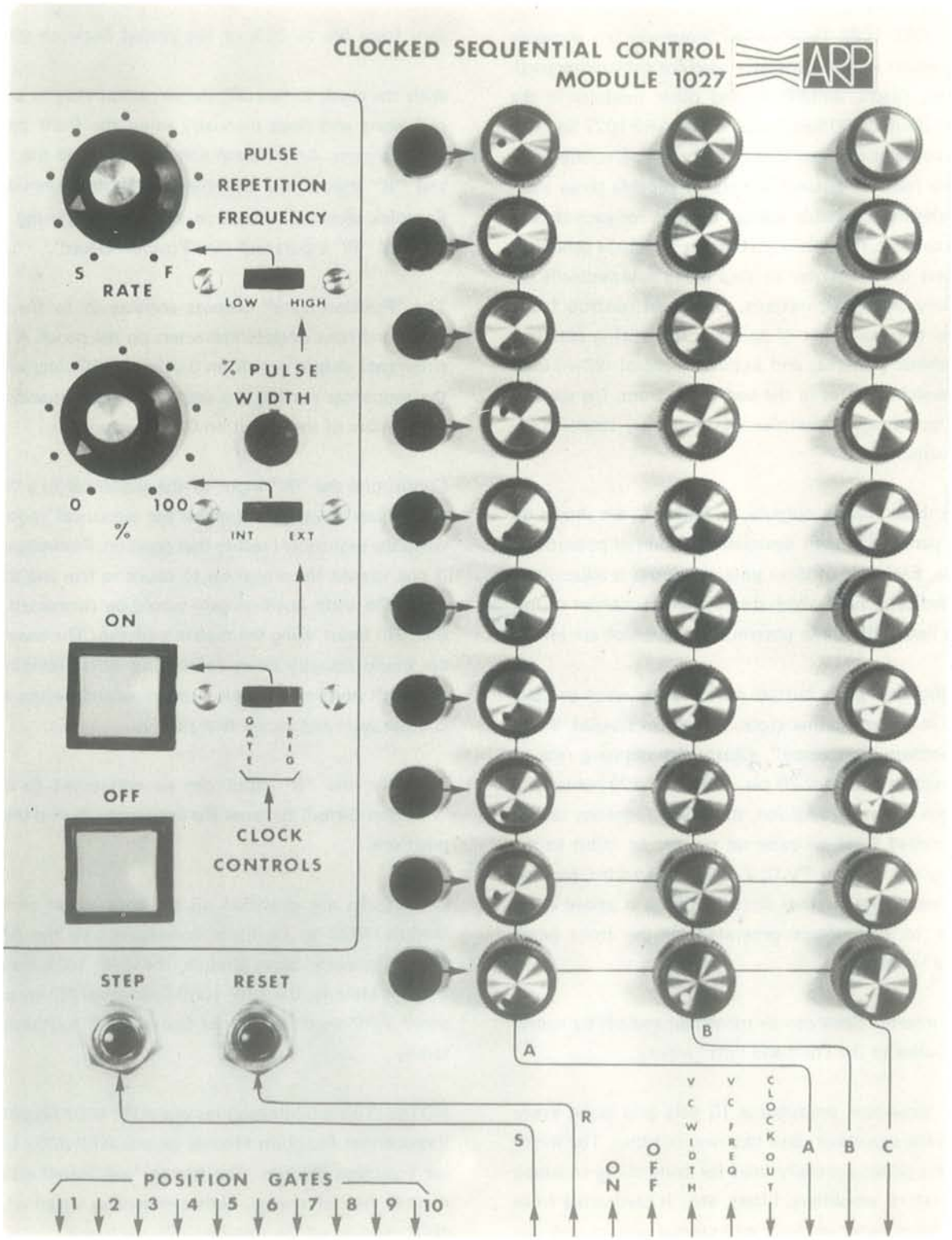
If A and B are both sine waves of equal amplitude with respective frequencies f_1 and f_2, the output will consist of the sum and difference frequencies $(f_1 + f_2)$ and $(f_1 - f_2)$ only. The original frequencies f_1 and f_2 will be suppressed.

If A is a complex wave with harmonics f_1, $2f_1$, $3f_1$, $4f_1$, $5f_1$, etc. and B is a sine wave of frequency f_2, the resulting output will consist of the frequencies $(f_1 + f_2)$, $(f_1 - f_2)$, $(2f_1 + f_2)$, $(2f_1 - f_2)$, $(3f_1 + f_2)$, $(3f_1 - f_2)$, etc.

If f_1 and f_2 are chosen properly, the output will be a complex wave with inharmonic overtones. In electronic music this is extremely useful in simulating gong timbres, etc.

For the user's convenience, Module 1005 contains circuits which produce two D.C. output control voltages, V_a and V_b, which may be used to control two voltage-controlled oscillators which are supplying signals A and B respectively.

With exponentially controlled oscillators such as the ARP 1004 and 1023 modules, the difference voltage $V_a - V_b$ controls the frequency ratio and the aver-



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ELECTRONIC MUSIC MODULES

age voltage $(V_a + V_b)/2$ controls the tuning of the input signals A and B. For the user's convenience, ratio and tuning control knobs are located on the panel of the 1005 module.

In addition, illuminated push button controls are provided which combine the function of status indication (modulated or unmodulated operation) and local manual control. Remote switching of the 1005 between the modulated (mod) and unmodulated (unmod) modes is available via the upper matrix switch input section. Either a control gate (0 in = unmod, + in = mod) or a set/reset trigger pulse pair may be used for this remote control function.

The 1005 also contains a voltage controlled amplifier, which may be controlled with external signals from either the upper or lower matrix switch section, or manually by means of a panel knob. A panel slide switch gives the user the choice of linear or exponential control modes.

Electrical Specifications

Balanced Modulator Section

Output: $V_{out} = (IN_A \cdot IN_B)/10 \pm 1.0\%$

Audio Inputs: ±10 volts max.

100 Kohm impedance

Voltage Controlled Amplifier Section

$V_{out} = (V_{in} \cdot V_{control})/10$, Linear Mode.

$V_{out} = V_{in}\, 10^{(V_{control} - 10)/2}$, Exp'l Mode.

Control Input Impedance = 100 K.

Power Requirements:

±15 volts @ 35 ma, regulated to ±0.1%

+12 to +15 volts @ 20 ma, unregulated

The ARP 1027 Ten-Position Sequencer is a compact sequential voltage generator used for controlling oscillators, filters, amplifiers, and other modules in the ARP Series 2000 Synthesizers. The ARP 1027 Sequencer contains an integrated circuit ten-step counter and three rows of potentiometers to provide three independently adjustable voltage outputs for each step of the counter. In addition, a built-in time base generator allows the sequencer to step along automatically. A variety of inputs, outputs, and panel controls facilitates the execution of complex sequencing patterns, rhythmic patterns, and external control. When used at switching rates in the audio spectrum, the sequencer can generate complex waveforms by stepwise approximations.

The three voltage outputs, A, B, and C, are shown on the panel with their associated column of potentiometers. Each row of three potentiometers is adjacent to an indicator light which displays the sequencer count, and hence the three potentiometers which are active.

Illuminated push button switches are used to start and stop the internal clock. A control labeled "Pulse Repetition Frequency" adjusts the stepping rate of the sequencer from 20 per minute to 400 per second in two ranges. In addition, the clock frequency can be controlled from an external source; an input to the sequencer labeled "V.C. Freq." is provided for this purpose. This external control voltage is added internally to the voltage generated by the front panel "rate" control.

The internal clock can be turned on and off by applying pulses to the "on" and "off" inputs.

The sequencer produces a 10 volt gate pulse every time the sequencer steps to a new position. The width of this pulse, normally used for controlling envelope generators, amplifiers, filters, etc., is controlled from the front panel or from an external voltage and can vary from 5% to 95% of the period between steps.

With the clock turned off, the sequencer may be stepped along and reset manually using the front panel push buttons. An external voltage applied to the "S" and "R" inputs will accomplish the same functions. Complex sequential patterns are generated using the "S" and "R" inputs and the "Position Gates".

The "Position Gate" outputs correspond to the ten lamps and rows of potentiometers on the panel. A position gate output goes from 0 volts to +10 volts when the sequencer reaches the step which corresponds to the number of the "Position Gate" output.

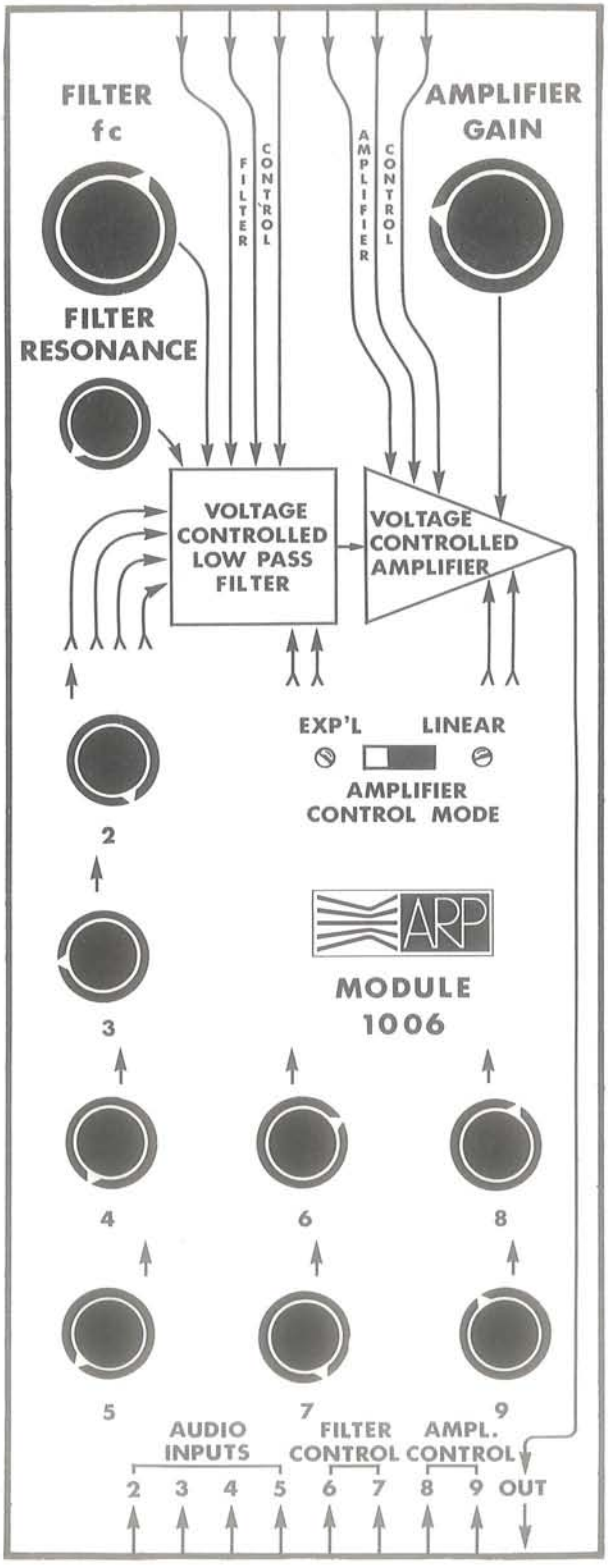
Connecting the "R" input of the sequencer to a "Position Gate" output will cause the sequencer to reset when the sequencer reaches that position. For instance, if one wished the sequencer to count to five and then reset, the sixth position gate would be connected to the "R" input using the matrix switches. The sequencer would actually count to six, but would remain in the sixth position for only a microsecond before the counter was reset to the first position.

Similarly, the "S" input can be connected to any "Position Gates" to cause the sequencer to skip those positions.

Cable jacks are provided on the back panel of the Module 1027 to facilitate connections to the ARP 1028 Sequencer Slave Module, the ARP 1026 Preset Voltage Module, the ARP 1050 Sequential Mixer, and other ARP modules in the Series 2000 synthesizer family.

NOTE: This module requires one ARP 4001 Negative Exponential Function Module or one ARP 4003 Linear Function Module. The factory will install either module free of charge. Unless otherwise specified, a 4001 module will be supplied with each unit.

ELECTRONIC MUSIC MODULES

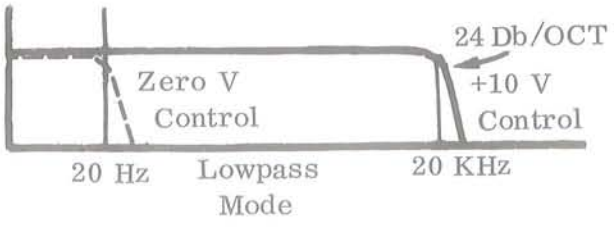


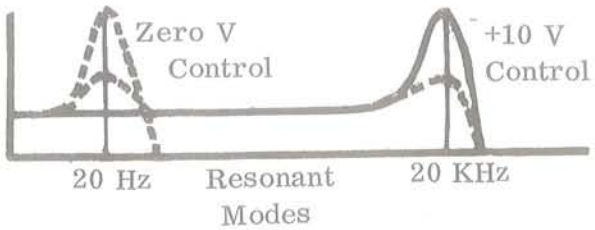
FILTAMP Module 1006

ARP Module 1006 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This unit contains a voltage controlled low-pass filter (VCLPF) plus a voltage controlled amplifier with associated circuitry.

The low-pass filter may be varied by external control voltage signals, or by means of a knob control, over a frequency cutoff range from 20 Hz to 20 KHz. The control vs. frequency cutoff (f_c) characteristic is 1.0 volt per octave. The total control voltage is effectively the sum of the local control voltage supplied by the knob control and the input control voltages. Although the sum of all these may exceed the effective input range, no damage will be done to the circuitry by such overdrive.

A resonance or "peaked" response at the cutoff frequency may be obtained if so desired. This is useful for creating certain types of formants, such as "wa-wa" or "yeow" effect. A knob control permits adjustment of the height of the resonant peak.





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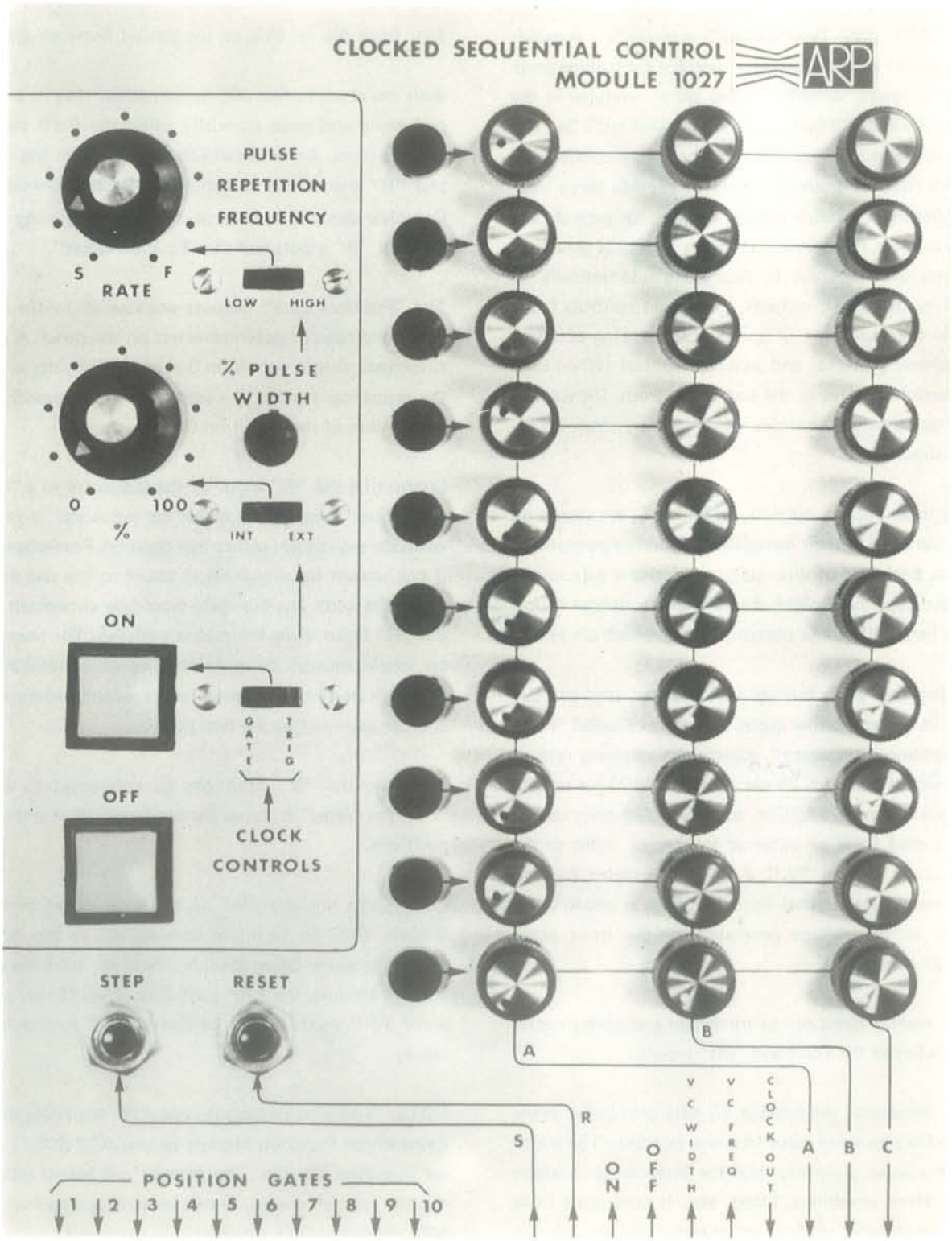

ACTUAL SIZE

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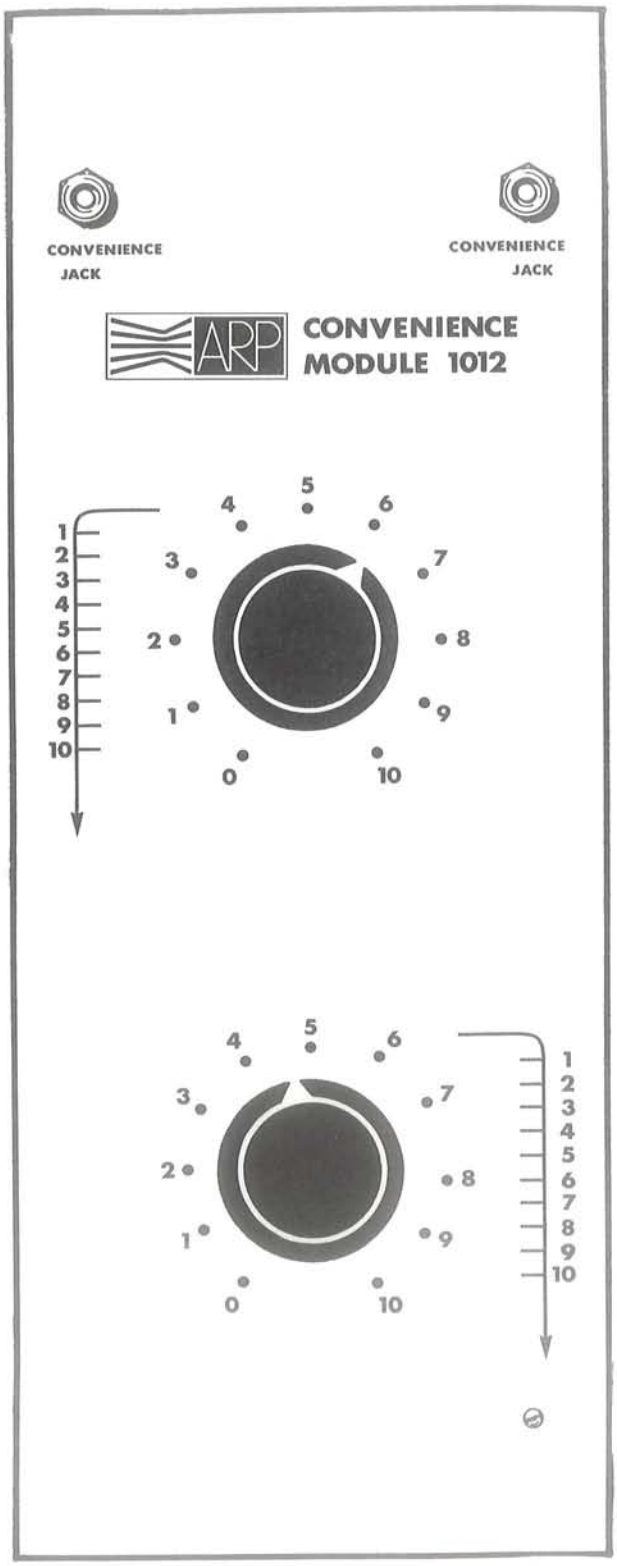

CONVENIENCE Module 1012

The ARP 1012 Convenience Module is designed for use in the ARP Series 2000 electronic music synthesizers. The module facilitates access to the lower matrix switch from external lines or patches from the upper matrix switches. A lead plugged into the jack in the upper left hand corner of the panel may be connected to any of the upper ten positions of the lower matrix switch. The jack in the upper right-hand corner of the panel may be similarly connected to any of the upper 10 lines of the lower matrix switch.

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Replaces Preliminary Data Sheet B-1027-002-3-70

ELECTRICAL SPECIFICATIONS

OUTPUT IMPEDANCES:	1 Kohm all outputs.
INPUT IMPEDANCES:	100 Kohms minimum, all inputs.
INPUT SENSITIVITY:	"S", "R", "ON", "OFF" inputs, +8.0 volts. "V.C. Width", "V.C. Freq." inputs, 0-10 volts.
PULSE REPETITION FREQUENCY:	20 pulses/minute to 400 pulses/second, without external control.
POWER REQUIREMENTS:	+15 volts @ 150 ma, regulated to ±0.1%.
	−15 volts @ 75 ma, regulated to ±0.1%.
	+12 to +15 volts @ 100 ma, unregulated.

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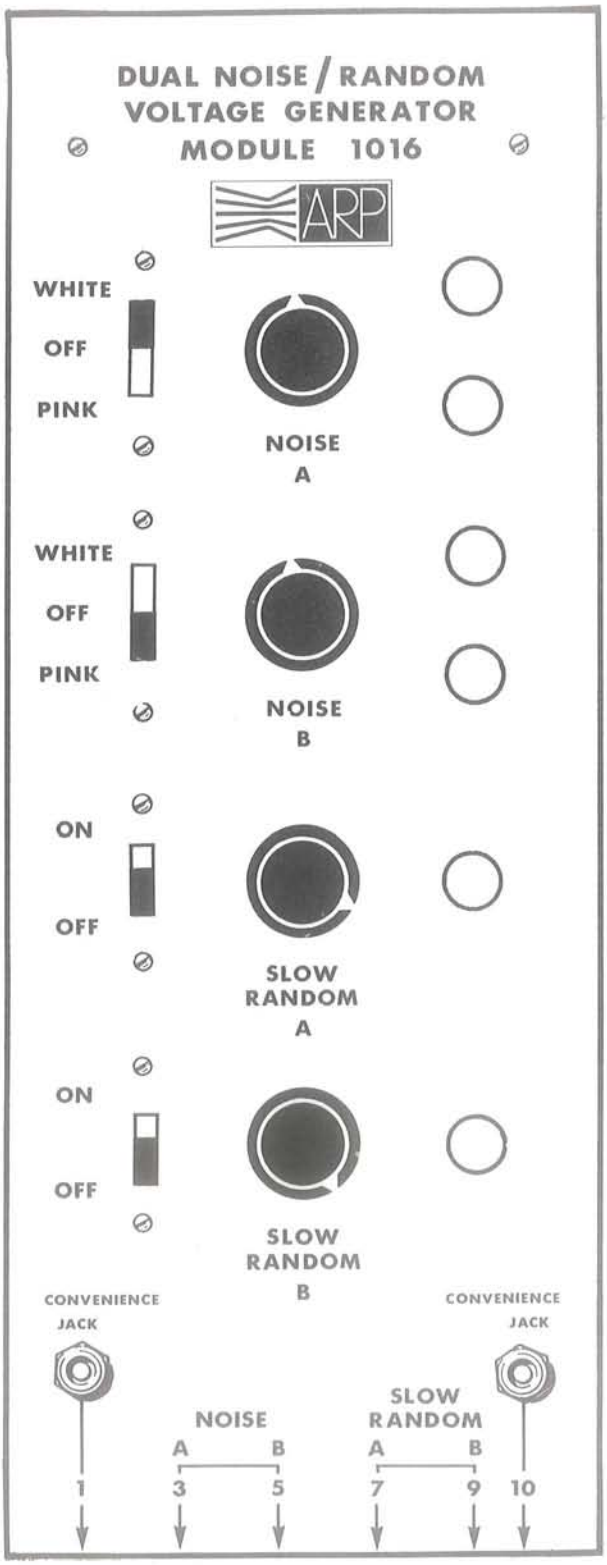
ELECTRONIC MUSIC MODULES



DUAL NOISE/RANDOM VOLTAGE GENERATOR — Module 1016

The ARP Module 1016 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical White/Pink Noise and Random Voltage Generators.

The two noise outputs, A and B, are generated from two independent diode noise sources. Through successive filtering, the white noise is transformed into pink noise and finally into a slow random voltage. Output attenuators and on/off switches are provided for the two noise sources and the random voltage outputs.

The maximum amplitude of all the outputs is adjusted so that an output voltage will exceed ±5 volts about 1% of the time. This insures a paucity of excursions past ±10 volts.

The White Noise generator produces a flat power bandwidth from 5 Hz to 20 KHz. The Pink Noise is filtered to attenuate highs and boost the low frequencies. The Slow Random output has a peak signal power at 1 Hz.

Two convenience jacks are located on the front panel and permit a user to have direct access to the lower matrix switch of an ARP 2000 Synthesizer.

Electrical Specifications

Power Requirements:

±15 volts @ 50 ma, regulated.
+12 to +15 volts @ 80 ma, unregulated.

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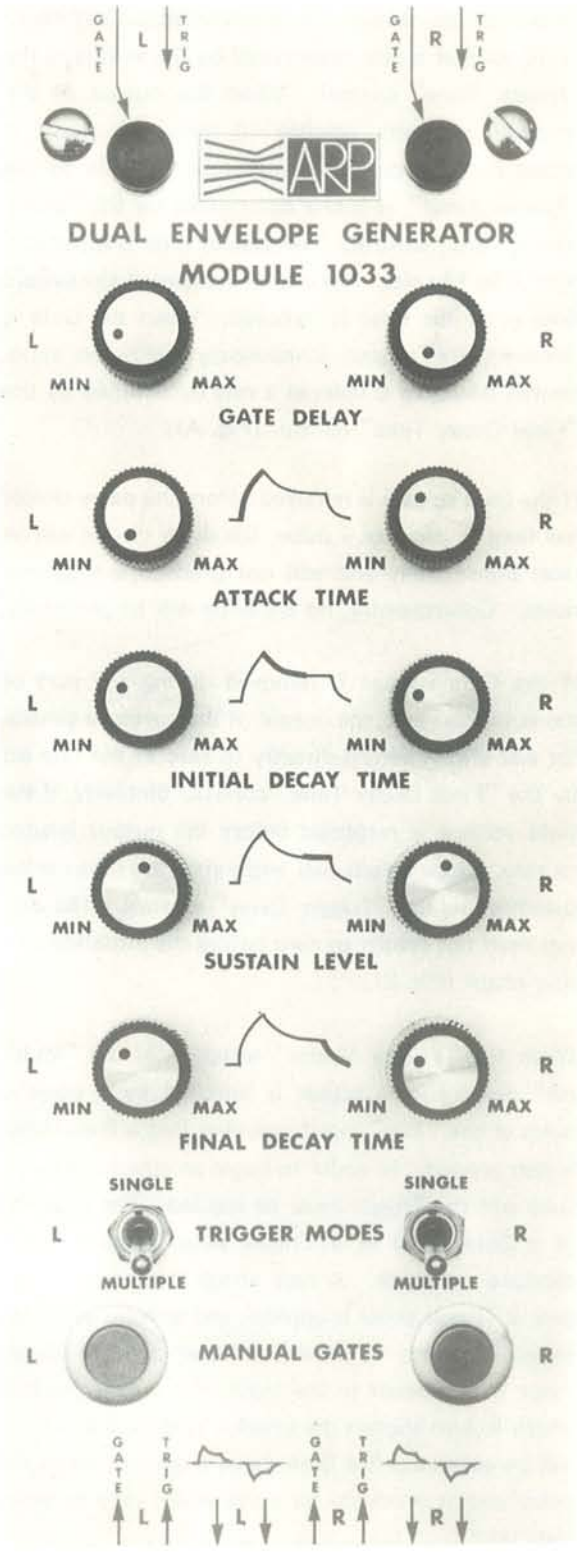
The Arp Module 1033 is a functional circuit package designed for use in the ARP Series 2000 Electronic Music Synthesizers. This module contains two identical delayed-gate exponential envelope generators.

The 1033 Dual Delayed Gate Envelope Generator is usually used with voltage-controlled filters, amplifiers, and other modules requiring triggered control signals. For instance, when used with ARP Module 1006 FiltAmp, the 1033 Envelope Generator can be used to control the amplitude envelope or timbre variations of signals passing the FiltAmp with respect to time. The delayed-gate feature permits the user to delay the beginning of an envelope so that complex amplitude and timbre characteristics may be synthesized.

An exponential envelope generated by the ARP 1033 Module may be defined by four adjustable parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

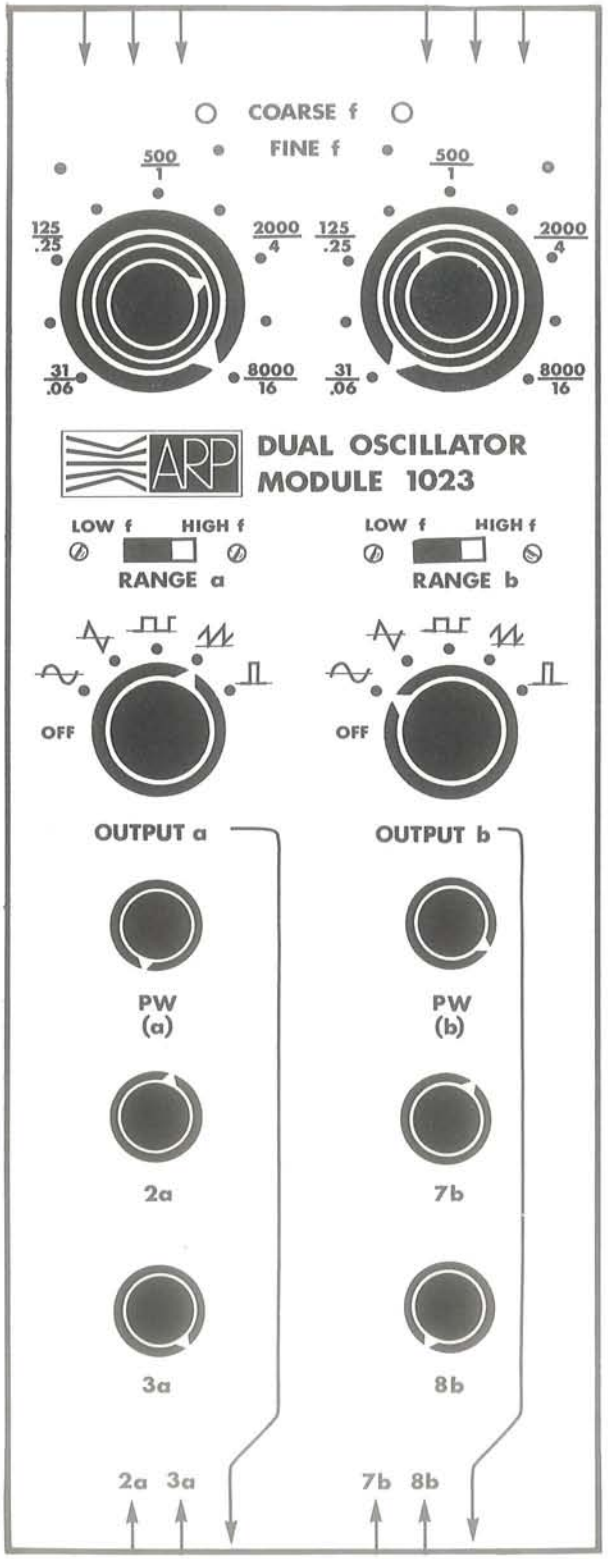
An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower matrix switches, as shown on the panel graphics. In the Module 1033 the control signal which starts the envelope always passes through a delay circuit which allows the user to postpone the beginning of an attack from 3 milliseconds to 3 seconds by adjusting the "Gate Delay" panel control.

The operating mode of the envelope generator is determined by the switches labelled "Trigger Modes." When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope; the Trigger inputs are not used. When the Gate signal is applied, the delay circuit is activated; after a time period selected by the front panel "Delay Time" control, the delay circuit produces a pulse which initiates the attack. During the attack, the



ACTUAL SIZE

ELECTRONIC MUSIC MODULES



DUAL OSCILLATOR Module 1023

The ARP 1023 Dual Oscillator Module is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical voltage-controlled oscillators.

The output frequency range of each oscillator is from .03 Hz to 16 KHz without external control voltage, and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within one of two ranges. The high range is the audio-frequency band, and the low range is a subsonic band. A fine adjust knob with a ±1 octave range is provided for accurate tuning.

Outputs and inputs are arranged to be compatible with the matrix switches of the ARP Series 2000 music synthesizer systems. Three upper switch inputs are provided for control signals from keyboards, sequencers, etc. Two lower switch inputs are provided to permit convenient adjustment of modulation depth. In addition, another panel-knob control (PW) permits manual adjustment of pulse width.

Any one of five basic output waveforms may be selected by front panel rotary switches. Selecting the "Off" position

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output of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack Time" control. When the output of the envelope generator reaches 10 volts, the attack is ended and the output decays exponentially to the "Sustain Level" at a rate determined by the "Initial Decay Time" control. The sustain level is adjustable from 0 to 10 volts. The output remains at the sustain level until the Gate is removed. When the Gate is removed, the output immediately begins an exponential decay to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).

If the Gate voltage is removed before the delay circuit has time to produce a pulse, the delay circuit will be reset immediately and will not produce a triggering pulse. Consequently, no envelope will be produced.

If the Gate voltage is removed during any part of the envelope cycle, the output of the envelope generator will always return directly to zero at the rate set by the "Final Decay Time" control. Similarly, if the Gate voltage is reapplied before the output returns to zero, a new attack will begin after the time period specified by the "Trigger Delay" control. The output need not return to zero before the initiation of a new attack (Fig. B).

When the "Trigger Modes" switch is in the "Multiple" position, the attack is initiated by a positive pulse at the "Trig" input provided that a Gate signal is also present. In order to begin an attack, both the Gate and the Trigger must be applied. The presence of a Gate signal or a Trigger pulse alone will not produce an attack. A new attack is generated each time a Trigger pulse is applied, and as long as a Gate signal is present. It should be noted that the Trigger input is connected to the input of the delay circuit which in turn triggers the attack. Therefore an attack can be generated if a Gate signal is present when the delay circuit produces its pulse which may be some time later than the initial trigger pulse.

If the gate signal is applied in the absense of a trigger, the output voltage will rise to the sustain level at a rate determined by the setting of the "Initial Decay Time" control. The output voltage will remain at the sustain level until the gate voltage is removed, at which time the output voltage will return to zero at a rate determined by the final decay control. (Fig. C).

Connections for a "Sustain Pedal" can be made via jacks on the back panel of the Module 1033. This terminal, when connected to the electrical ground through a switch, acts much like the sustain pedal on a piano. As long as the switch is closed, the output of the envelope generator will remain at the highest level after closing the switch. When the sustain pedal is released, the output of the envelope generator will return to zero if the gate has been removed.

An inverted envelope with output voltages from 0 to -10 volts is available at the lower matrix switch.

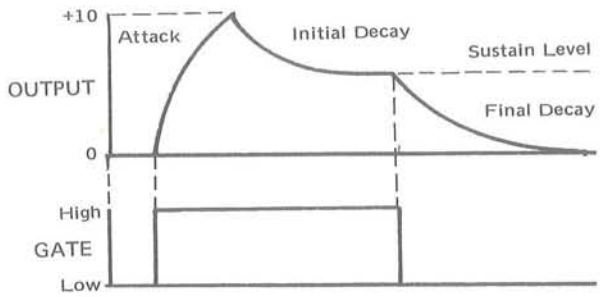

FIGURE A

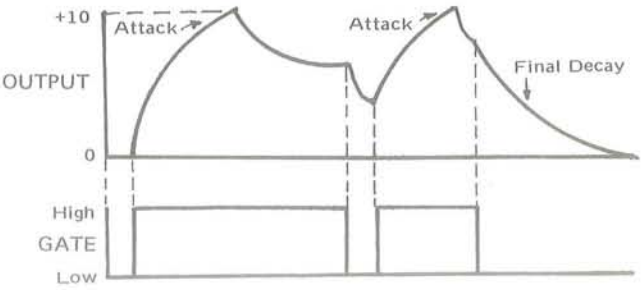

FIGURE B

ELECTRONIC MUSIC MODULES

on these switches disables the oscillator.

The input impedance of the control inputs is 100 Kohms minimum over the frequency range of the oscillator. The output impedances of the ARP 1004 waveform generator sections is 1000 ohms. Any number of these outputs may be shorted together without damage, and the resulting waveform will be the averaged instantaneous voltage of the outputs which are shorted together.

Electrical Specifications

Outputs: Frequency: .03 Hz - 16 KHz in two ranges without external inputs.
Sine: -5 volts to +5 volts P-P.
Triangle: -5 volts to +5 volts P-P.
Sawtooth: 0 volts to +10 volts P-P.
Square: 0 volts to +10 volts P-P.
Pulse: 0 volts to +10 volts P-P.
All Impedances: 1 Kohm.

Inputs: Frequency Modulation: 1 volt/octave.
Input Impedances: 100 K.

Controls: Frequency Range: Low (.03 Hz - 32 Hz); High (31 Hz - 16 KHz).
Frequency, Coarse
Frequency, Fine: ±1 octave.
Frequency Modulation Depth (2)
Pulse Width: 0 - 100%.

Long Term Frequency Drift:
Ambient 50°F to 90°F ±5°F, drift is typically 0.1% per hour.

Power Requirements: ±15 volts @ 50 ma, regulated to ±0.1%.
+ 12 to +15 volts @ 20 ma unregulated, lamp supply.

ELECTRONIC MUSIC MODULES

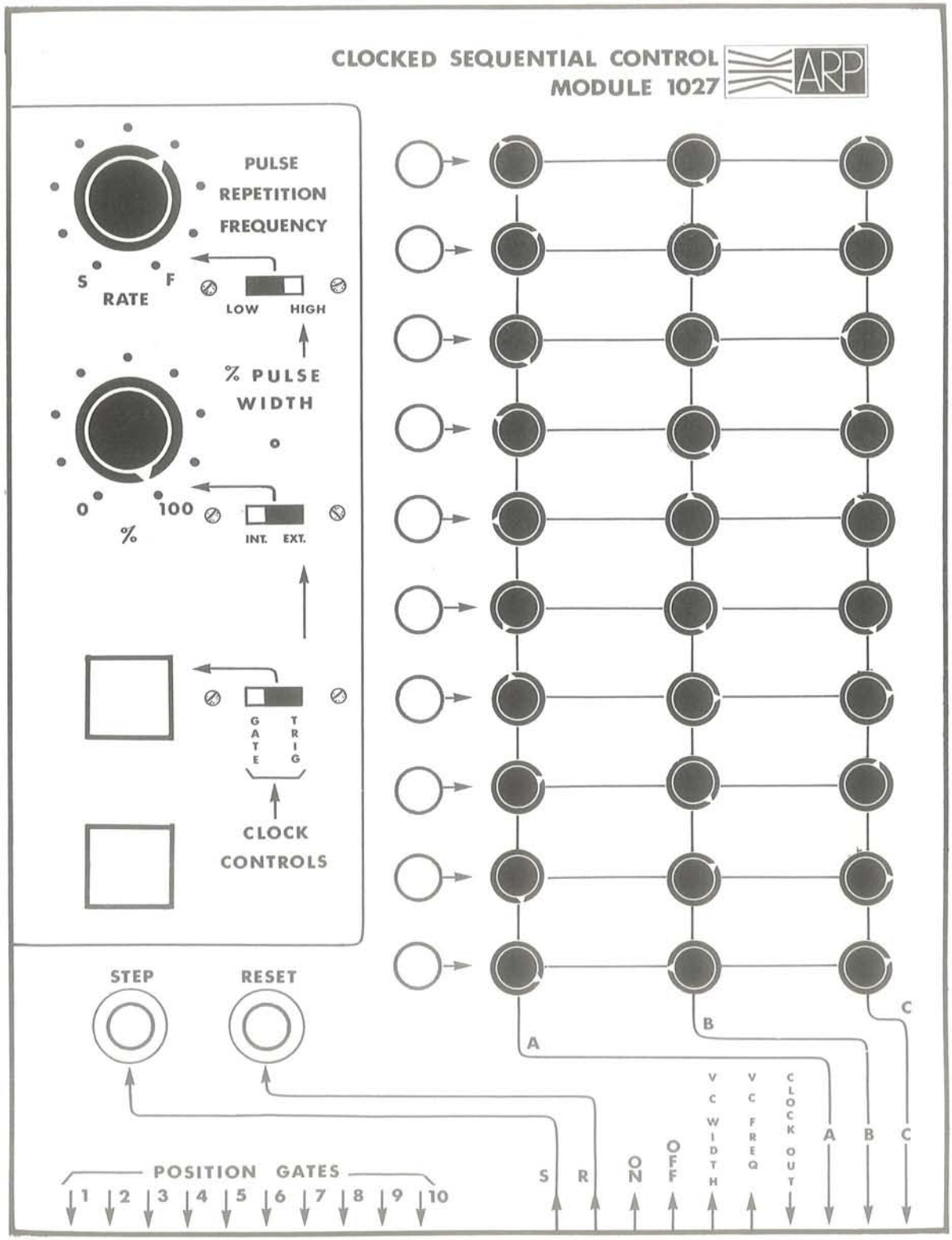

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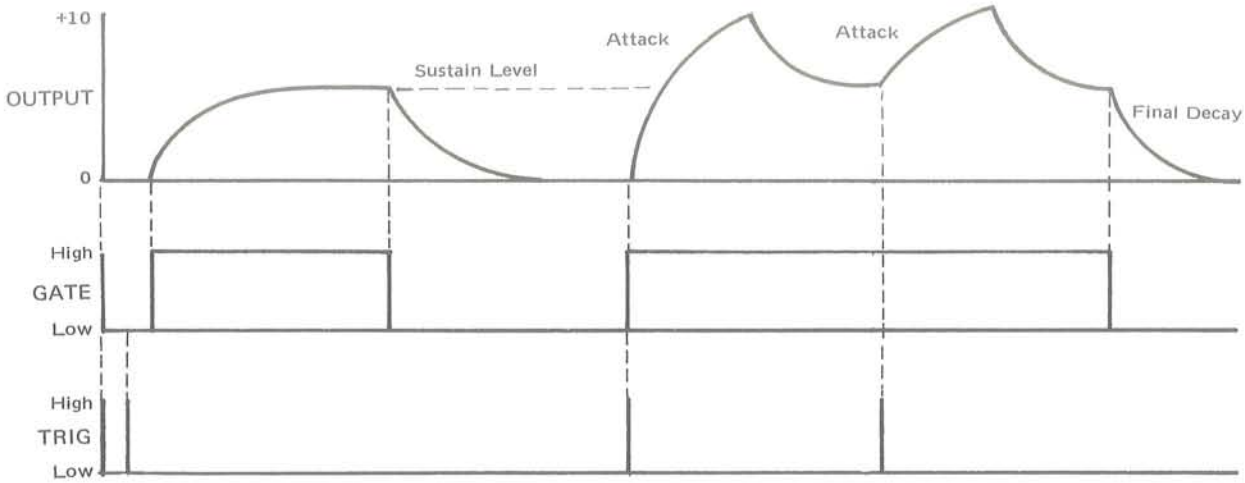
FIGURE C



ELECTRICAL SPECIFICATIONS

OUTPUT WAVEFORMS:
Attack: $E_{out} = 11.0 - 11e^{-k_a t}$
Initial Decay: $E_{out} = (10 - E_{sus})e^{-k_{id} t}$
Final Decay: $E_{out} = E_{sus}e^{-k_{fd} t}$

CONTROLS:
Attack Time: .001 secs to 2.0 secs.
Initial Decay Time: .001 secs to 2.0 secs.
Sustain Level: 0 to 10 volts.
Final Decay Time: .001 secs to 2.0 secs.
Delay Time: .003 secs to 3.0 secs.

INPUTS:
Gate Sensitivity: 1.8 volts, lower matrix switch; 8.0 volts, upper matrix switch.
Trigger Sensitivity: 1.8 volts.
All Impedances: 100 K.

OUTPUTS:
0 to +10 volts @ 1 Kohm.
0 to −10 volts @ 1 Kohm.

MAXIMUM POWER REQUIREMENTS (outputs shorted):
±15 volts @ 50 ma, regulated to ±0.1%.
+12 volts to +15 volts @ 40 ma, lamp supply.

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B-1027-002-3-70
PRELIMINARY DATA
Subject to Revision

ELECTRONIC MUSIC MODULES

TEN-POSITION SEQUENCER — Module 1027

The ARP 1027 Ten-Position Sequencer is a compact sequential voltage generator used for controlling oscillators, filters, amplifiers, and other modules in the ARP Series 2000 Synthesizers. The ARP 1027 Sequencer contains an integrated circuit ten-step counter and three rows of potentiometers to provide three independently adjustable voltage outputs for each step of the counter. In addition, a built-in time base generator allows the sequencer to step along automatically. A variety of inputs, outputs, and panel controls facilitates the execution of complex sequencing patterns, rhythmic patterns, and external control. When used at switching rates in the audio spectrum, the sequencer can generate complex waveforms by straight-line approximations.

The three voltage outputs, A, B, and C, are shown on the panel with their associated column of potentiometers. Each row of three potentiometers is adjacent to an indicator light which displays the sequencer count, and hence the three potentiometers which are active.

Illuminated push button switches are used to start and stop the internal clock. A control labeled "Pulse Repetition Frequency" adjusts the stepping rate of the sequencer from 40 per minute to 4000 per minute in two ranges. In addition, the clock frequency can be controlled from an external source; an input to the sequencer labeled "V.C. Freq." is provided for this purpose.

In addition, the clock can be turned on and off by external signals applied to the "on" and "off" inputs.

The sequencer also produces a gate pulse every time the sequencer steps to a new position. The width of this pulse, normally used for controlling envelope generators, amplifiers, filters, etc., is controlled from the front panel or from an external voltage.

With the clock turned off, the sequencer may be stepped along and reset manually using the front panel push buttons. An external voltage applied to the "S" and "R" inputs will accomplish the same functions.

Complex sequential patterns are generated using the "S" and "R" inputs and the "Position Gates."

The "Position Gate" outputs correspond to the lamps and rows of potentiometers on the panel. A position gate output goes from 0 volts to +15 volts when the sequencer reaches the step which corresponds to the number of the "Position Gate" output.

Connecting the "R" input of the sequencer to a "Position Gate" output will cause the sequencer to reset when that position gate output goes high. For instance, if one wished the sequencer to count to five and then reset, the sixth position gate would be connected to the "R" input using the matrix switches. The sequencer would actually count to six, but would remain in the sixth position for only a microsecond before the counter was reset to the first position.

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The ARP Module 1035 Triple Modulator is a functional circuit package designed for use with the ARP Series 2000 Electronic Music Synthesizers. The module contains three identical and independent balanced modulators with overvoltage indicators and six low level microphone preamplifiers.

These inputs and outputs appear at both the upper and lower matrix switch positions on this module. For each balanced modulator there are two audio inputs and one audio output. In addition, external signals from low level sources such as microphones, guitars, or other electronic instruments may be plugged directly into the front panel jacks on the Module 1035. A front panel switch associated with each low level input jack selects either high gain(x100) or low gain(x10) preamplification.

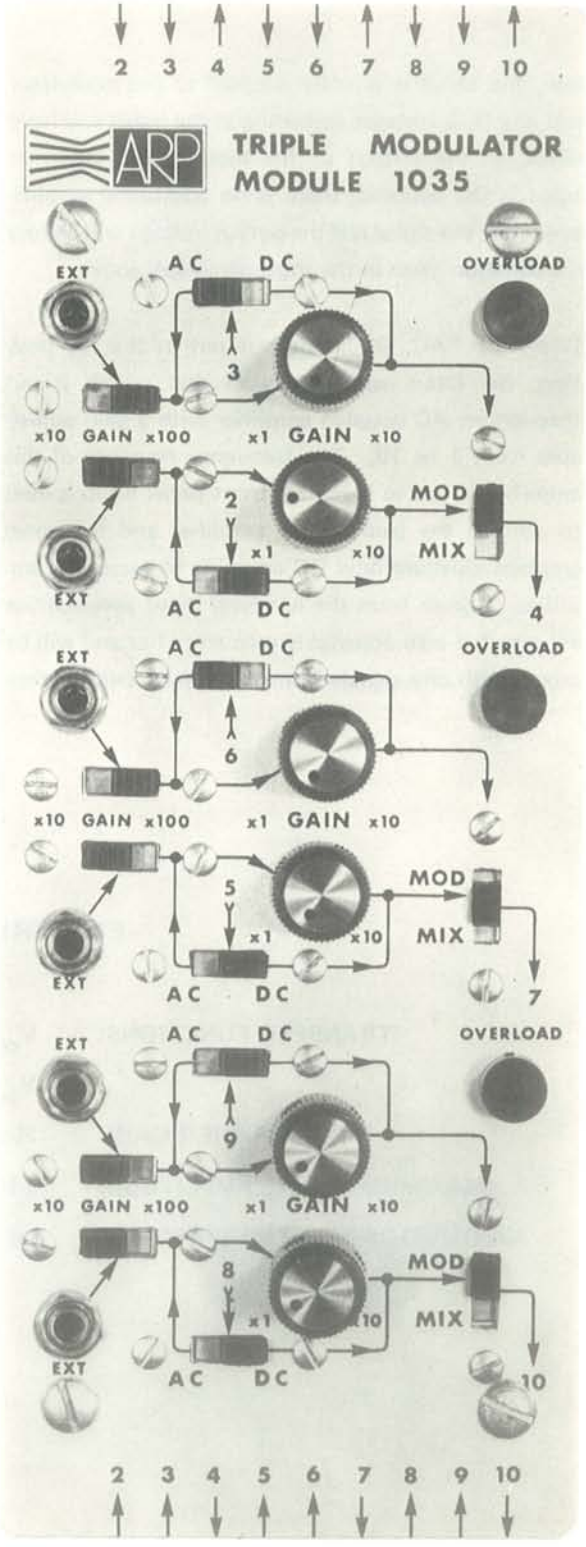
Each balanced modulator will accept two input signals in the frequency range from D.C. to 20KHz, and will produce an output function

$$V_{out} = (V_{inA} \cdot V_{inB})/10.$$

If input signals A and B are both sine waves of equal amplitude with respective frequencies f_a and f_b, the output will consist of the sum and difference frequencies (f_a+f_b) and (f_a-f_b) only. The original frequencies f_a and f_b will be suppressed.

If A is a complex wave with harmonics f_a, $2f_a$, $3f_a$, $4f_a$, etc., and B is a sine wave of frequency f_b, the resulting output will consist of the frequencies (f_a+f_b), (f_a-f_b), $(2f_a+f_b)$, $(2f_a-f_b)$, $(3f_a+f_b)$, $(3f_a-f_b)$, etc. If f_a and f_b are chosen properly, the output will be a complex wave with inharmonic overtones. In electronic music this is extremely useful in synthesizing certain timbres.

There are two signal inputs for each of the three modulators in this module. A switch labelled "AC, DC" selects either AC or DC coupling for each of the six inputs from the matrix switches. In the DC posi-



ACTUAL SIZE

ELECTRONIC MUSIC MODULES

Similarly, the "S" input can be connected to any "Position Gates" to cause the sequencer to skip those positions.

Cable jacks are provided on the back panel of the Module 1027 to facilitate connections to the ARP 1028 Sequencer Slave Module, the ARP 1028 Preset Voltage Module, the ARP 1050 Sequential Mixer, and other ARP modules in the Series 2000 synthesizer family.

Note: This module requires one ARP 4001 Negative Exponential Function Module or one ARP 4003 Linear Function Module. The factory will install either module free of charge. Unless otherwise specified, a 4001 module will be supplied with each unit.

Electrical Specifications

Output Impedances:	1 Kohm all outputs
Input Impedances:	100 Kohms min., all inputs
Input Sensitivity:	"S", "R", "ON", "OFF" inputs, +8.0 volts.
	"V.C. Width", "V.C. Freq." inputs, 0-10 volts.
Pulse Rep. Frequency:	12 pulses/minute to 500 pulses/second, without external control.
Power Requirements:	+15 volts @ 150 ma, regulated to ±0.1%.
	-15 volts @ 75 ma, regulated to ±0.1%.
	+12 to +15 volts @ 100 ma, unregulated.

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tion, the input is directly coupled to the modulator and any D.C. voltages appearing at the input will have effect on the output of the modulator. When an input is DC coupled, there is no additional amplification for the signal and the output voltage will follow the equation given in the third paragraph above.

When the "AC, DC" switch is put in the AC position, the input associated with that switch is put through an AC coupled amplifier with a gain adjustable from 1 to 10. The frequency response of this amplifier is flat to 6 Hz. A front panel knob is used to control the gain of the amplifier and the panel graphics illustrate how DC coupling bypasses the amplifier. Signals from the low-level input preamplifier are also fed into adjustable gain amplifier and will be mixed with any signals from the matrix switch when the "AC, DC" switch is in the AC position.

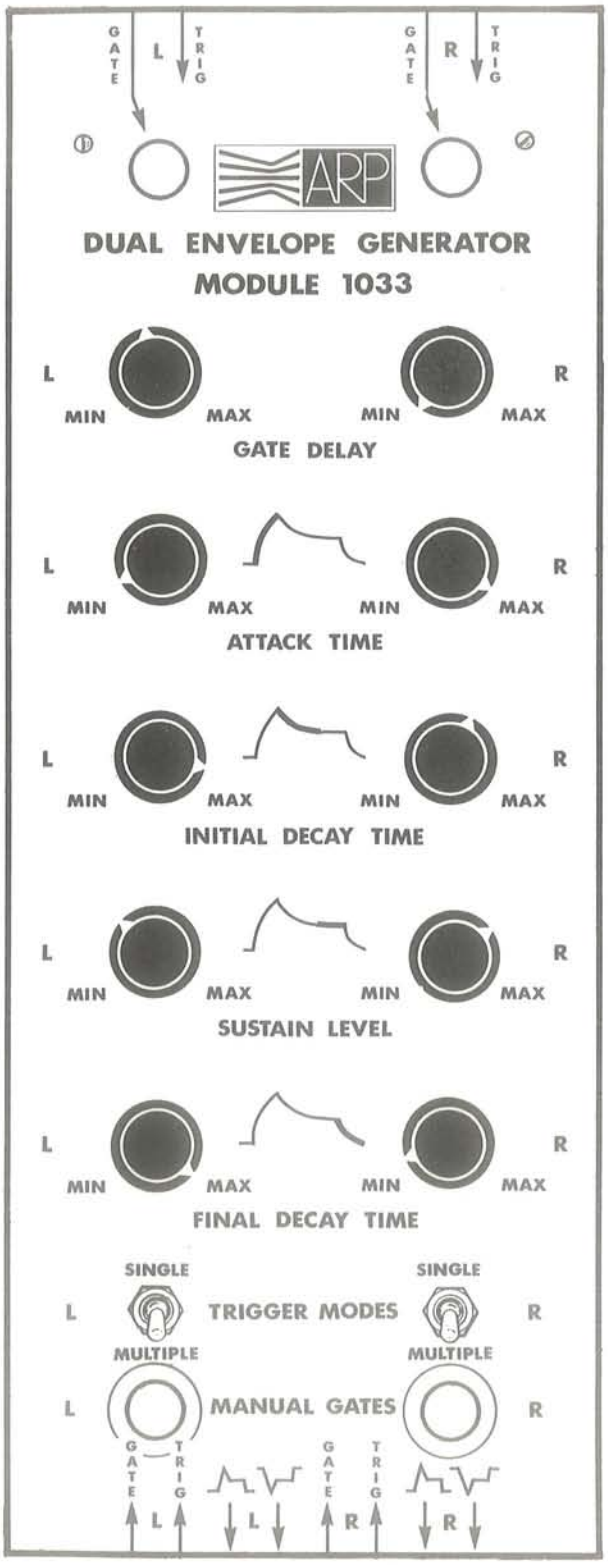
The two audio signals which are to be modulated by one another may also be simply mixed in equal proportion by sliding the "MOD/MIX" switch to the "mix" position. This switch permits easy comparison of a modulated or mixed operation on the two input signals.

The three "overload" lamps are provided to indicate the presence of voltages in excess of ± 10 volts at the outputs of the modulators. If these lamps are illuminated, the signal at the output is probably distorted and clipped. Accordingly one should reduce the amplitude of the input signals or reduce the gain of the amplifiers associated with the overloading modulator.

ELECTRICAL SPECIFICATIONS

TRANSFER FUNCTIONS:	$V_{out} = (V_{inA} \cdot V_{inB})/10$, ±1%, Mod Inputs DC Coupled
	$V_{out} = (V_{inA} + V_{inB})/2$, Mix Inputs DC Coupled
PREAMPLIFIER GAIN:	20dB or 40 db fixed. Additional 0 to 20 dB adjustable.
MAXIMUM SIGNAL AMPLITUDE:	±10 volts all inputs and outputs.
MAXIMUM CARRIER SUPPRESSION:	40 dB

ELECTRONIC MUSIC MODULES



DUAL DELAYED-TRIGGER ENVELOPE GENERATOR

Module 1033

The ARP Module 1033 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. This module contains two identical delayed-trigger exponential envelope generators.

The 1033 Delayed-Trigger Exponential Envelope Generator is usually used with voltage-controlled filters, amplifiers, and other modules requiring triggered control signals. For instance, when used with the ARP Module 1006 FiltAmp, the 1033 Envelope Generator can be used to control the amplitude envelope or timbre variations of signals passing through the FiltAmp. The delayed-trigger feature permits the user to delay the beginning of an envelope so that complex amplitude and timbre characteristics may be synthesized; for instance, summing several envelopes with different delays, or using an undelayed envelope to control amplitude and a delayed envelope to control filter characteristics.

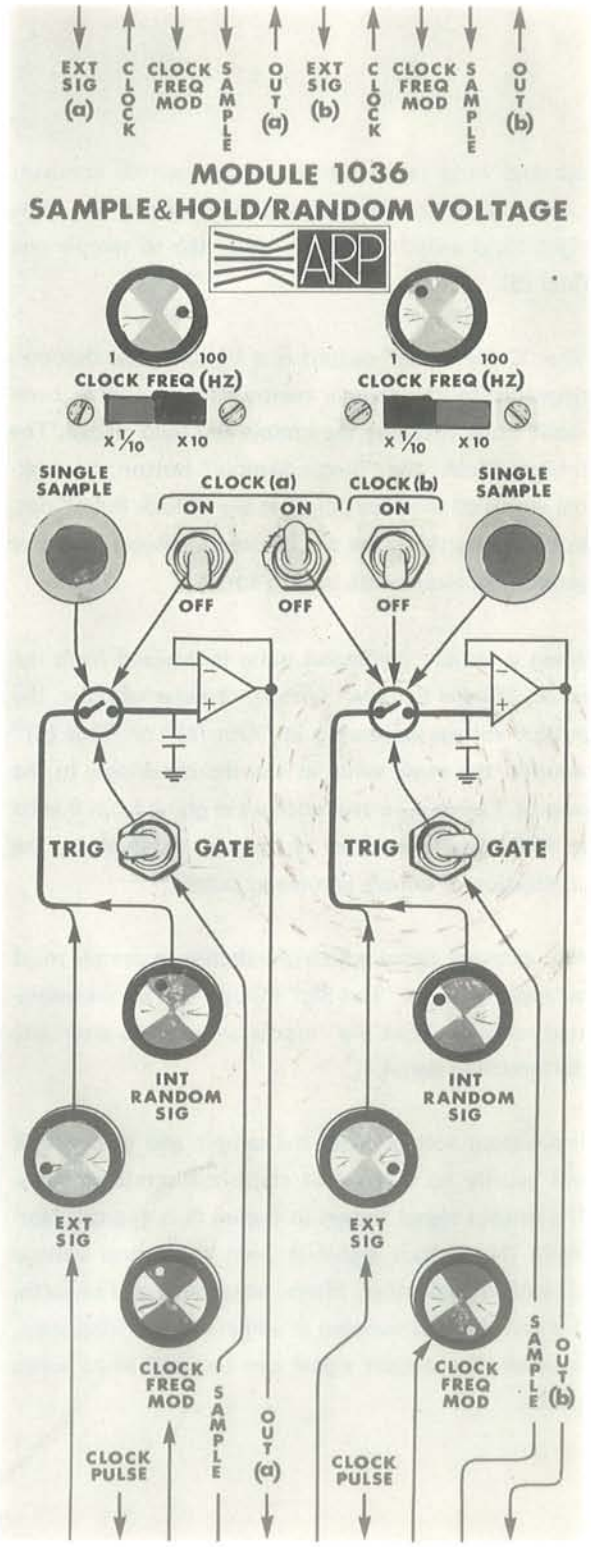
An exponential envelope generated by the ARP 1033 Module may be defined by four adjustable parameters: Attack Time, Initial Decay Time, Sustain Level, and Final Decay Time. The panel graphics emphasize the effects and use of each of these controls.

An envelope is initiated when appropriate signals are applied to the Gate and Trigger inputs. These inputs are accessible at both the upper and lower

The ARP 1036 Dual Sample & Hold/Random Voltage module is a functional circuit package designed for use in the ARP series 2000 Electronic Music Synthesizers. The module contains two sample and hold circuits, two random noise generators, and two voltage controlled pulse generators. The 1036 is usually used in conjunction with ARP voltage controlled oscillators to produce random tone sequences, scales, arpeggios and programmed melodic patterns. The module can also be used to control voltage controlled filters, amplifiers, etc.

A sample and hold circuit has a signal input, a signal output, and a sample command input. When a pulse is applied to the sample command input, the output signal voltage immediately assumes the same value as the input signal voltage. In the case of the 1036 sample and hold circuits, this process takes about 10 microseconds. After the sample command pulse, the output signal voltage will hold at that same level until another sample command pulse is applied. During the holding period between pulses, the input signal has no effect on the output signal. In the case shown in Figure A, a sawtooth waveform is applied from an external oscillator to the "Ext Sig" input of a 1036 sample and hold. Sample command pulses can be generated by pushing the "Single Sample" button, applying an external pulse (as from an oscillator or keyboard trigger) to the "Sample" input (with the "Trig/Gate" switch set to "Trig"), or by using an internal clock pulse generator.

There are two separate clock pulse generators. The frequencies of the clock pulse generators are determined by the front panel "Clock Freq" knobs and range switches. An external signal applied to the "Clock Freq Mod" inputs will also affect clock frequency. Clock (a) can be used to provide sample command pulses to both the (a) and (b) sample and hold circuits. Of the three toggle switches between the "Single Sample" buttons, two are connected to clock (a). The switch on the left connects clock (a) to sam-



ACTUAL SIZE

ple and hold (a) while the center switch connects clock (a) to the sample and hold circuit (b). The right hand switch connects clock (b) to sample and hold (b).

The "Clock Pulse" output is a 10 volt pulse that corresponds to the sample period of any sample command pulse reaching the sample and hold circuit. The internal clock, the "Single Sample" button, or external pulses all produce pulses at the "Clock Pulse" output. Usually this pulse can be used to trigger envelope generators, sequencers, and so forth.

When a sample command pulse is received from the clock, "Single Sample" button, or external pulse, the output voltage appearing at "Out (a)" or "Out (b)" assumes the same value as the input voltage. In the case of Figure A, a sawtooth wave going from 0 volts to +10 volts is sampled at irregular intervals by the application of sample command pulses.

Any external signal which one desires to sample must be applied to the "Ext Sig" inputs. The knobs associated with the "Ext Sig" inputs are used to attenuate the incoming signal.

The output voltage from the sample and hold circuit will usually be a series of steps or discrete voltages. The output signal shown in Figure A is typical. Normally this output signal is used to control voltage controlled oscillators, filters, amplifiers, and so forth. If a waveform is sampled at a high enough frequency, however, the output signal can be used as an audio source.

In addition to sampling external signals, the module 1036 has built-in random signal generators. By advancing the front panel knobs labelled "Int Random Sig", noise can be applied to the signal input of the sample and hold circuits. When this random signal is sampled by the application of a sample command pulse, the output signal is a series of stepwise random voltages, as shown in Figure B. If an external signal is also applied, the random signal and the external signal will be mixed internally before being sampled.

When an external sample command pulse (as from an oscillator) is applied to the "Sample" input, two different results can be selected by the "Trig/Gate" switch. In the "Trig" position, the input pulse is differentiated and the leading or positive-going edge of the external pulse triggers the sampling circuit for 10 microseconds. The duration of the external pulse under these conditions is immaterial. When the "Trig/Gate" switch is in the "Gate" position, the output signal of the sample and hold circuit will track the input signal as long as the external sample command pulse is positive. As soon as the pulse ends and the voltage at the "Sample" input returns to zero, the sample and hold circuit will store and hold the last value of the input signal voltage before the sample command pulse returned to zero. Figure C shows an example; when the sample command pulse is high, the output signal tracks the triangle wave at the signal input. When the sample pulse goes to zero volts, the output signal voltage holds at the voltage which was present when the sample command pulse dropped to zero.

ELECTRONIC MUSIC MODULES

matrix switches, as shown on the panel graphics. In the Module 1033 the control signal which starts the envelope always passes through a delay circuit which allows the user to postpone the beginning of the attack from 1 millisecond to 1 second by adjusting the panel control.

When the "Trigger Modes" switch is in the "single" position, the Gate inputs are used to initiate an envelope; the Trigger inputs are not used. When the Gate signal is applied, the delay circuit is activated; after a time period selected by the front panel "Delay Time" control, the delay circuit produces a pulse which initiates the attack. During the attack, the output of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack Time" control. When the output of the envelope generator reaches 10 volts, the attack is ended and the output decays exponentially to the "Sustain Level" at a rate determined by the "Initial Decay Time" control. The sustain level is adjustable from 0 to 10 volts. The output remains at the sustain level until the Gate is removed. When the Gate is removed, the output immediately begins an exponential decay to 0 volts at a rate determined by the "Final Decay Time" control (Fig. A).

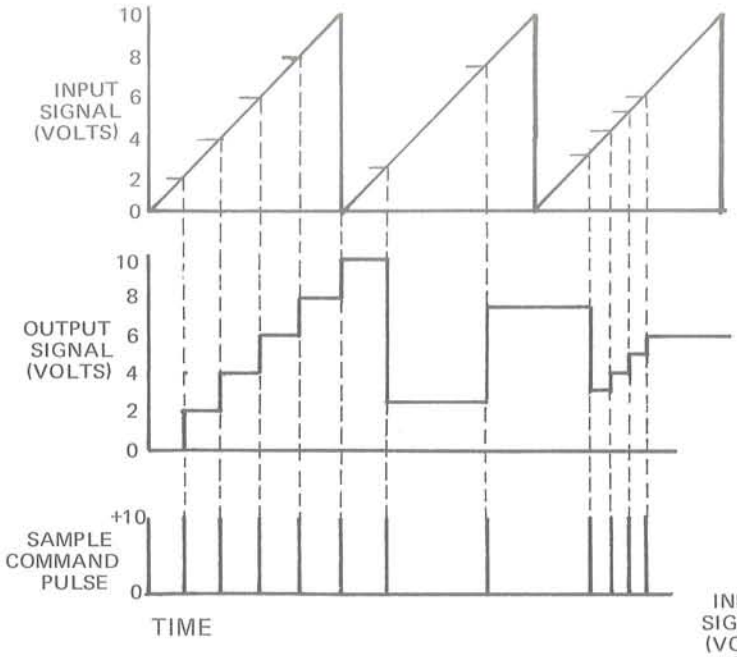
If the Gate voltage is removed before the delay circuit has time to produce a pulse, the delay circuit will be reset immediately and will not produce a triggering pulse. Consequently, no envelope will be produced.

If the Gate voltage is removed during any part of the envelope cycle, the output of the envelope generator will always return directly to zero at the rate set by the "Final Decay Time" control. Similarly, if the Gate voltage is reapplied before the output returns to zero, a new attack will begin after the time period specified by the "Trigger Delay" control. The output need not return to zero before the initiation of a new attack (Fig. B).

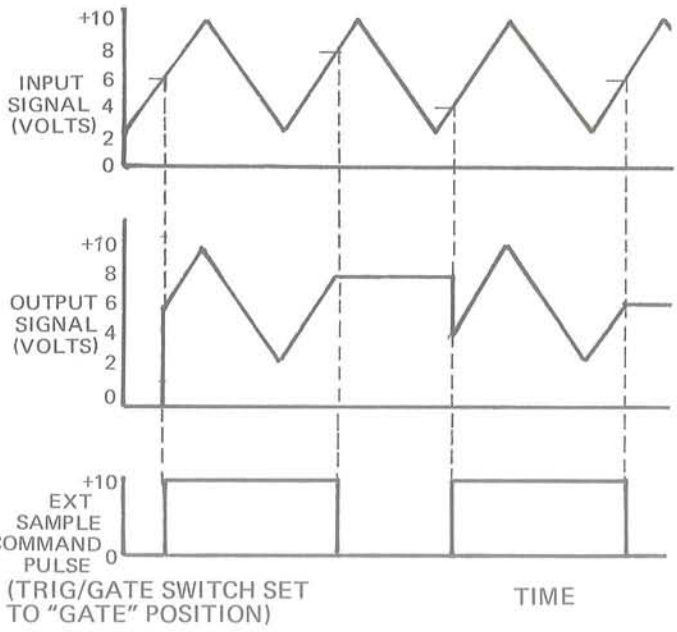
When the "Trigger Modes" switch is in the "Multiple" position, the operation of the envelope generator is the same as above, except that the attack is initiated by a positive pulse at the "Trig" input rather than by the Gate signal. In this mode, the "Trig" input is connected to the delay circuit, and as before the Gate must be present at the same time that the delay circuit produces a pulse in order to generate an attack. The presence of a Gate or Trigger pulse (and hence a delay circuit output pulse) alone will not produce an output (Fig. C).

Connections for a "Sustain Pedal" can be made via jacks on the back panel of the Module 1033. This wire, when connected to the electrical ground through a switch, acts much like the sustain pedal on a piano. As long as the switch is closed, the output of the envelope generator will remain at the sustain level, regardless of the other inputs. When the sustain pedal is released, the out voltage will decay to 0 volts at a rate determined by the "Final Decay Control" setting.

An inverted envelope output from 0 to -10 volts is available at the lower matrix switch.

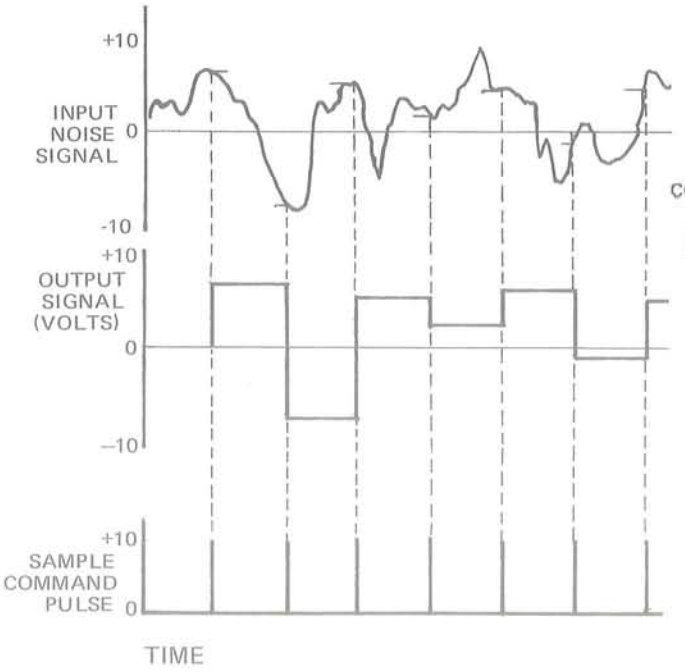


(A)



(C)

(B)



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Electrical Specifications

Output Waveforms: Attack: $E_{out} = 11.0 - 11e^{-k_a t}$

Initial Decay: $E_{out} = (10 - E_{sus})e^{-k_{id} t}$

Final Decay: $E_{out} = E_{sus} e^{-k_{fd} t}$

Controls:
Attack Time: .001 secs to 2.0 secs.
Initial Decay Time: .001 secs to 2.0 secs.
Sustain Level: 0 to 10 volts.
Final Decay Time: .001 secs to 2.0 secs.
Delay Time: .001 secs to 1.0 secs.

Inputs:
Gate Sensitivity: 1.8 volts, lower matrix switch; 9.6 volts, upper matrix switch.
Trigger Sensitivity: 1.8 volts.
All Impedances: 100 K.

Outputs:
0 to + 10 volts @ 1 Kohm.
0 to -10 volts @ 1 Kohm.

Maximum Power Requirements (outputs shorted):
±15 volts @ 50 ma, regulated to ±0.1%.
+12 volts to +15 volts @ 40 ma, lamp supply.

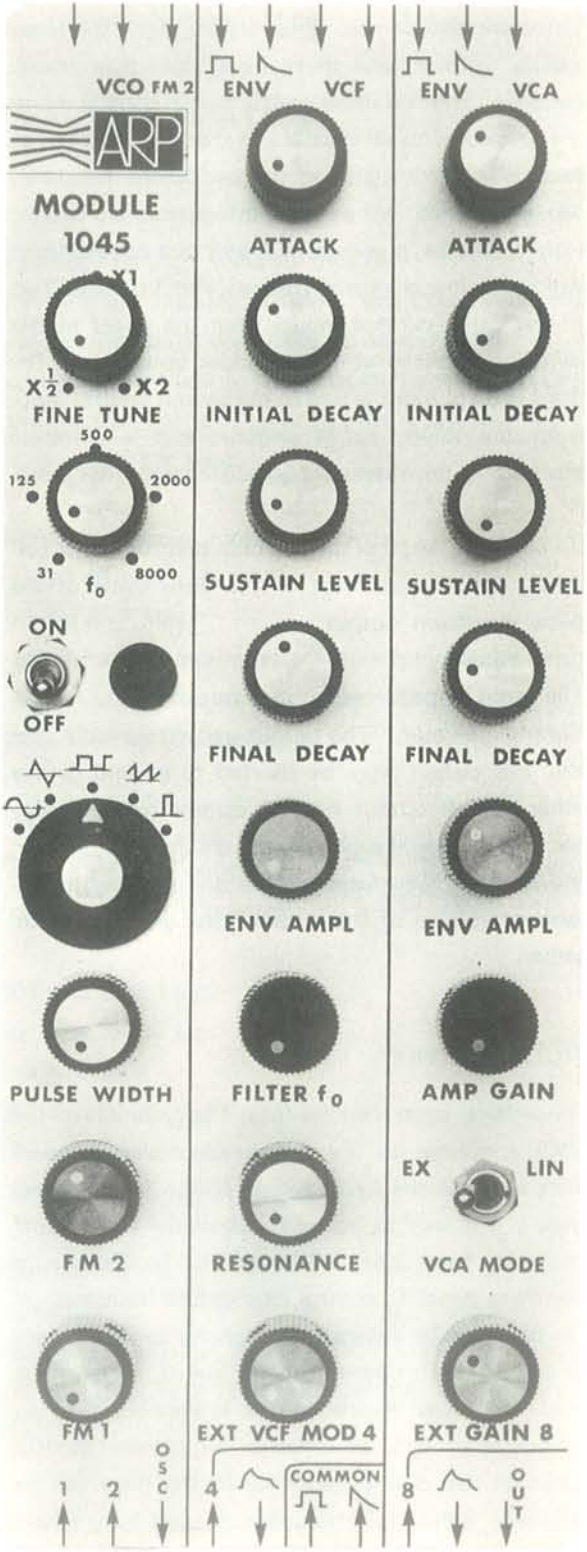
The ARP Module 1045 is a functional circuit package designed for use in the ARP Series 2000 Synthesizers. The module contains a voltage controlled oscillator, a voltage controlled low pass filter, a voltage controlled amplifier, and a dual exponential envelope generator.

Fig. A shows a block diagram of the module 1045. The output of the Voltage Controlled Oscillator is coupled through a switch permitting waveform selection to the input of the voltage controlled low pass filter. The output of the filter is in turn connected to the input of the voltage controlled amplifier. The final signal is obtained at the output of the voltage controlled amplifier. Exponential envelope generators are coupled through attenuators to the control inputs of both the filter and amplifier. The module 1045 is a small self-contained synthesizer, offering the user control over pitch, timbre, amplitude, and combinations of time-variant functions of pitch, timbre, and amplitude. Outputs and inputs are arranged so that the oscillator, filter-amplifier, or envelope generators may be used separately or in various combinations.

OSCILLATOR SECTION

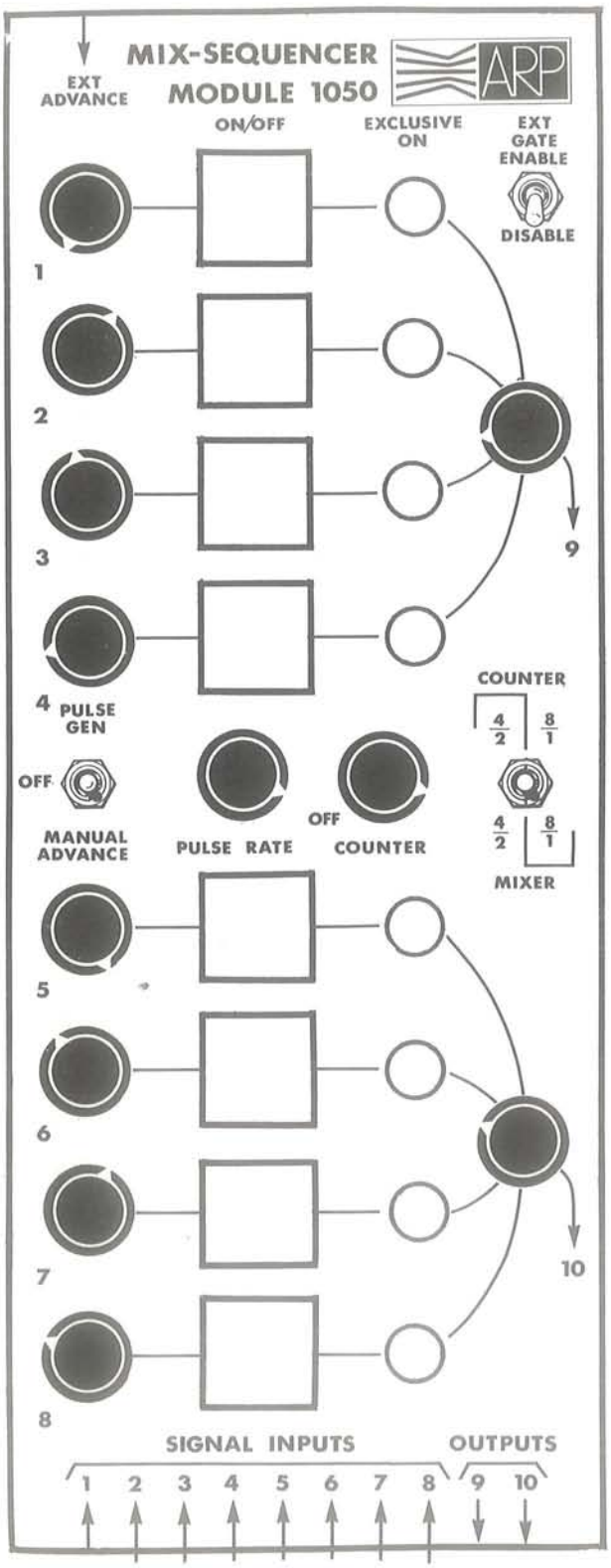
The voltage controlled oscillator used in the module 1045 is electrically similar to the ARP 1004 Voltage controlled Oscillator. The oscillator output is connected to a rotary switch which permits the selection of sine, triangle, square, sawtooth or pulse output waveforms. The output frequency range of the oscillator is 16Hz to 16,000 Hz without external control voltages and the control voltage range is 10 octaves. Control signals may be either positive or negative, provided that the sum of the control voltages does not drive the oscillator frequency beyond the above limits.

A coarse panel adjustment knob permits setting the zero-control-voltage frequency to anywhere within the frequency range. A fine adjust knob with a ± 1 octave range is provided for accurate tuning.



ACTUAL SIZE

ELECTRONIC MUSIC MODULES



MIX-SEQUENCER Module 1050

The ARP Module 1050 Sequential Mixer is a multi-functional circuit package designed for use in the ARP Series 2000 Synthesizers. The Module 1050 incorporates sequential switching functions necessary for rapid selection of preset waveforms and signals into a conventional audio mixer format. The Module 1050 contains two four-input mixers with electronically gated inputs, an eight step counter and clock, and associated logic and switching capabilities. Each input has its own attenuator and each output has a master gain control.

The ARP Module 1050 may be used as an eight input mixer with two adjustable outputs. A toggle switch at the right center of the panel couples the audio circuitry to provide either the 1x8 or two 1 x 4 mixer configurations.

A column of illuminated push-buttons indicates which inputs are gated on. The switches are pushed to change the state of an input, push-on/push-off. A column of "Exclusive-on" push-buttons will turn on a particular input while simultaneously turning all others off. This function is particularly useful for quick and convenient selection of preset signals. When the mixer is being used as two four-input mixers, the "Exclusive-on" switches affect only four inputs at a time. When the mixer is being used as one eight-input mixer, the "Exclusive-on" button affects all eight inputs. In other words, when the "Counter/Mixer" switch is in one of the 4/2 positions, any of the upper four "Exclusive-on" buttons will turn on one input and

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ELECTRONIC MUSIC MODULES

turn off all three others without affecting the lower four inputs.

The panel symbols around the "Counter/Mixer" switch indicate how the switching logic (upper symbols) and audio circuitry (lower symbols) are set for the three selectable mixer functions. In the right position, the audio circuitry is coupled to form one eight-input mixer with two adjustable outputs. The logic is also set so that an "Exclusive-on" button will affect all eight inputs.

In the center position, the audio circuitry is again set up as an eight-input mixer. The logic, on the other hand, is set up in such a way that "Exclusive-on" switches will affect either the upper or lower set of four inputs without interaction between sets. This permits two inputs, one from the upper set of four inputs, the other from the lower set, to be mixed to one audio signal and distributed by the two outputs.

With the "Counter/Mixer" switch in the left position, both the audio circuitry and the logic circuitry are arranged as if the module were two separate four-input mixers. This position of the "Counter/Mixer" switch also permits "parallel step" operation of the sequencer, as shall be discussed below.

In addition to the manual switching operations described in the preceding paragraphs, the Module 1050 contains a clock pulse generator and an eight step counter. A toggle switch at the left center of the panel enables or disables the clock. When this switch is in the "Pulse Gen" position, the counter will sequentially enable inputs to the mixer (and illuminate the appropriate indicator lamps) one at a time, resetting at the end of every cycle. The length of the cycle, i.e., the number of counts in a cycle, is determined by the rotary switch at the center of the panel. Setting this switch to the "off" position disables the counter. The stepping rate is adjusted by the "pulse rate" control.

The counter may be manually advanced by either the front panel toggle switch or an External Advance pulse. The counter is disabled and all its outputs are low for the duration of the advance pulse.

The "parallel step" operation mentioned earlier permits the upper and lower sets of four inputs to be sequenced in tandem. In other words, the counter would actuate inputs in pairs: (1,5), (2,6), (3,7), (4,8).

The outputs of the counter or the front panel push-buttons can actuate a mixer input. Inputs can be held on by setting the appropriate push-buttons even though the counter may be operating.

A cable connector on the rear panel of the Module 1050 permits the inputs of the mixer to be enabled from an external control. For instance, the Module 1050 may be slaved from sequencers and other preset modules. Another rear panel connector permits other modules to be controlled by the Module 1050. The panel "Ext. Gate Enable" switch permits the user to disengage any external control of the Module 1050 without disconnecting cables.

There are two control signal inputs along the lower matrix switches and three along the upper matrix switches. The two lower matrix switch control inputs are connected to attenuators so that the effect of an external control signal on the oscillator's frequency can be adjusted. When these attenuators are rotated fully clockwise, a change of 1 volt at a control input will result in a change of frequency of 1 octave. Two of the three control inputs from the upper matrix switches are fixed at 1 volt/octave sensitivity. The third control input is tied to the second control input from the lower matrix switches and is therefore affected by the attenuator associated with that input.

In addition, another panel-knob control (PW) permits manual adjustment of the duty cycle of the pulse waveform output.

The input impedances of the control inputs is 100-Kohms minimum. The output impedance is 1Kohm and this output may be shorted to ground or any other module output without damage to the oscillator. When several such outputs are shorted together, the resulting waveform will be the averaged instantaneous voltage of the outputs that are shorted together.

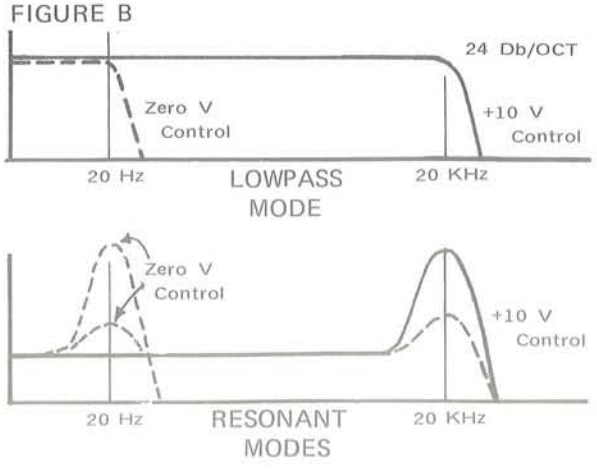
FILTER SECTION

The voltage controlled low-pass filter section of the 1045 is similar to the voltage controlled low-pass filter found in the ARP Module 1006. A front panel knob (f_c) is used to manually adjust the filter cutoff frequency from 20Hz to 20,000Hz. In addition to the front panel f_c control, the cutoff frequency of the filter can be changed by applying control signals to any of the external control inputs. The input from the lower matrix switch is connected to an attenuator so that the effect of an external control signal on the cutoff frequency of the filter can be adjusted. With the attenuator rotated fully clockwise, a change of 1 volt at the control input will result in a change of 1 octave in cutoff frequency. The sensitivity of the control input from the upper matrix switch is fixed at 1 volt/octave.

In addition to the external control signals and the front panel f_c control, the cutoff frequency of the filter may also be varied by the application of the 1045's internal envelope generator to the filter control. A front panel knob (Env. Ampl) directly above the F_c control permits the output of the envelope generator to be connected directly into the control input of the filter. By a clockwise rotation of this knob, the effect of the envelope generator output on the cutoff frequency of the filter is increased. When this knob is turned fully counterclockwise, the envelope generator output is fully attenuated and will not affect the filter. Since the output voltage of the envelope generator can reach +10 volts, it is possible to change the cutoff frequency of the filter by 10 octaves when the "Env Ampl" knob is rotated fully clockwise.

By adjusting the "resonance" control on the front panel, a "peaked" response at the cutoff frequency may be obtained if so desired. This type of response is useful for creating certain types of formants, such as "wa-wa" and "yeow" effects. The panel knob adjusts the height of the resonant peak with respect to the pass-band characteristics of the filter. Figure (B) demonstrates the effect of this control.

FIGURE B



ELECTRONIC MUSIC MODULES

Electrical Specifications

Audio Inputs: ±10 volts @ 50 Kohms

Audio Outputs: ±10 volts @ 1 Kohm

Input Attenuation: 100 dB max.

External Advance: Sensitivity 1.3 volts @ 100 Kohms

Power Requirements: ±15 volts @ 60 ma, regulated to ±0.1%
+12 volts to +15 volts @ 170 ma, unregulated

ELECTRICAL SPECIFICATIONS

OSCILLATOR SECTION

OUTPUTS:	Frequency range: 16Hz to 16,000Hz
	Sine, Triangle, Square, Sawtooth, and Pulse waveforms.
INPUTS:	Frequency modulation: fixed 1v/octave (2)
	Frequency modulation: Adjustable, 1v/octave maximum (3)
LONG TERM FREQUENCY DRIFT:	Ambient 50°F to 90°F, $\pm 5^{o}$F, drift is typically less than 1/6 semitone per hour.

FILTER SECTION

ROLLOFF:	24dB/octave above cutoff frequency
FILTER RESONANCE:	0 to 20 dB peak.
MAX AUDIO SIGNAL LEVEL:	20 volts P–P Max
CONTROL INPUT SENSITIVITY:	1 volt/octave all inputs (attenuators fully clockwise); 0v = 20Hz

AMPLIFIER SECTION

RESPONSE:	$\pm$3dB, 2Hz to 30KHz.
MAX GAIN:	0dB
MAX ATTENUATION:	100dB
TRANSFER FUNCTION:	$V_{out} = (V_{in} \cdot V_{control})/10$, Linear mode
	$V_{out} = V_{in} \cdot 10^{(V_{control}-10)/2}$, Exp'l mode

ENVELOPE GENERATOR SECTION

ATTACK TIME:	.001 secs to 2.0 secs
INITIAL DECAY TIME:	.001 secs to 2.0 secs
SUSTAIN LEVEL:	0 to +10 volts
FINAL DECAY TIME:	.001 secs to 2.0 secs
GATE SENSITIVITY:	8.0 volts, upper matrix switch
	1.8 volts lower matrix switch

GENERAL

INPUT IMPEDANCES:	100Kohms min.
OUTPUT IMPEDANCES:	1Kohm
MAXIMUM POWER REQUIREMENTS:	$\pm$15 volts @ 120 ma, regulated to $\pm$ 0.1%.
	+12 to +15 volts @ 20 ma unregulated, lamp supply

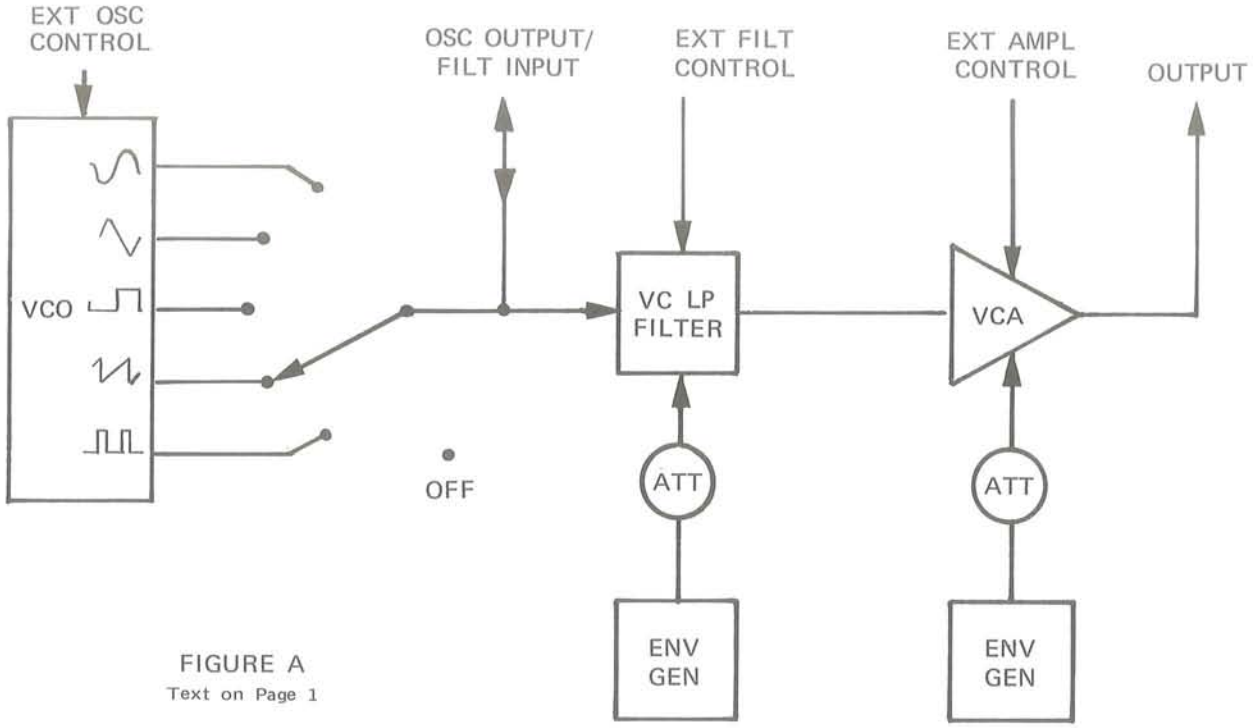


FIGURE A

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FIGURE C

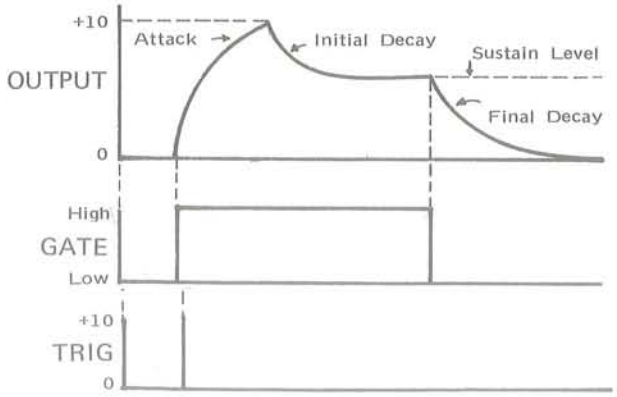
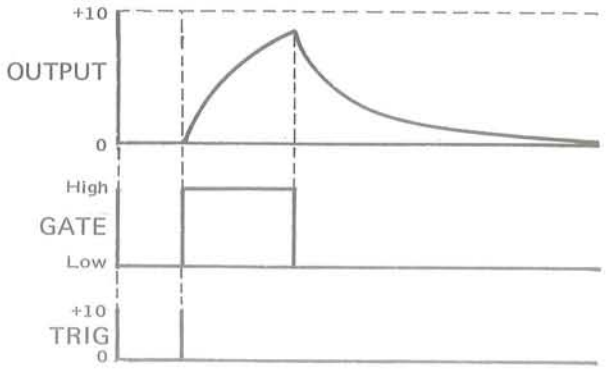


FIGURE D



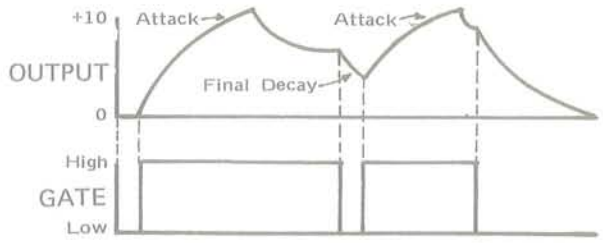


FIGURE E

If it is desirable to operate the envelope generator from a gate signal alone, the Trigger input is connected to the Gate Input by positioning the matrix switches for these two inputs to the same horizontal line.

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OSCILLATOR SECTION

OUTPUTS:	Frequency range: 16Hz to 16,000Hz
	Sine, Triangle, Square, Sawtooth, and Pulse waveforms.
INPUTS:	Frequency modulation: fixed 1v/octave (2)
	Frequency modulation: Adjustable, 1v/octave maximum (3)
LONG TERM FREQUENCY DRIFT:	Ambient 50°F to 90°F, $\pm 5^{o}$F, drift is typically less than 1/6 semitone per hour.

FILTER SECTION

ROLLOFF:	24dB/octave above cutoff frequency
FILTER RESONANCE:	0 to 20 dB peak.
MAX AUDIO SIGNAL LEVEL:	20 volts P–P Max
CONTROL INPUT SENSITIVITY:	1 volt/octave all inputs (attenuators fully clockwise); 0v = 20Hz

AMPLIFIER SECTION

RESPONSE:	$\pm$3dB, 2Hz to 30KHz.
MAX GAIN:	0dB
MAX ATTENUATION:	100dB
TRANSFER FUNCTION:	$V_{out} = (V_{in} \cdot V_{control})/10$, Linear mode
	$V_{out} = V_{in} \cdot 10^{(V_{control}-10)/2}$, Exp'l mode

ENVELOPE GENERATOR SECTION

ATTACK TIME:	.001 secs to 2.0 secs
INITIAL DECAY TIME:	.001 secs to 2.0 secs
SUSTAIN LEVEL:	0 to +10 volts
FINAL DECAY TIME:	.001 secs to 2.0 secs
GATE SENSITIVITY:	8.0 volts, upper matrix switch
	1.8 volts lower matrix switch

GENERAL

INPUT IMPEDANCES:	100Kohms min.
OUTPUT IMPEDANCES:	1Kohm
MAXIMUM POWER REQUIREMENTS:	$\pm$15 volts @ 120 ma, regulated to $\pm$ 0.1%.
	+12 to +15 volts @ 20 ma unregulated, lamp supply

If you would like additional information on the ARP Synthesizer line, just detach this page, fill in your name, address and a few items of information, fold where indicated, seal or staple, and drop into a mailbox. No postage is necessary when mailed in the U.S.

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Interest in Music: (Please check appropriate boxes)

☐ Composer ☐ Arranger ☐ Educator ☐ Student ☐ Performer ☐ Amateur ☐ _____

Please describe principal type of music in which interested (such as classical, avant-garde, rock, etc.)

_____

Do you now own or have access to an electronic music synthesizer?

☐ Yes ☐ No If so, what make? _____

Are you satisfied with the electronic music synthesizer equipment you have, or have seen or used?

☐ Yes ☐ No If not, please describe your reasons for dissatisfaction.

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If you or your organization are contemplating the purchase of electronic music synthesizer equipment, approximately when would delivery be required?

☐ Immediately ☐ Within 6 months ☐ Within 12 months ☐ Within 24 months ☐ Eventually

AMPLIFIER SECTION

The voltage controlled amplifier (VCA) accepts the output signal from the voltage controlled filter (VCF), and modifies the signal level according to the sum of a local control voltage (provided by the panel knob marked "gain"), a number of external control voltages and the output of the internal envelope generator.

The voltage controlled amplifier may be operated in one of two selectable modes. The exponential mode has a control transfer function of 10 dB per volt. In other words, a change of 1 volt in the sum of the control signals will result in a change of 10 dB in gain. When the sum of the control voltages is +10 volts (maximum usable control voltage), the gain of the amplifier is 0 dB. When the sum is 9 volts, for instance, the VCA would attenuate the audio signal by 10 dB. In the linear mode the gain (V_{out}/V_{in}) of the amplifier is directly proportional to the control voltage. Again, when the sum of the control signal is +10 volts, the gain of the amplifier is unity.

The range of the voltage controlled amplifier is over 100 dB, which permits the VCA to be used as a squelch gate device. By proper adjustment of controls, no discernible output should be obtained in the absence of control voltages, even when the audio input entering the amplifier is at very high levels.

The gain of the VCA may be controlled by the internal envelope generator by advancing the control marked "Env Ampl" directly over the "gain" control. When this control is rotated fully clockwise, the full 10 volt amplitude of the envelope generator output is applied to the control input of the VCA.

In addition, external control inputs are provided from both the upper and lower matrix switches. The input from the upper matrix switch is of fixed sensitivity (10 volts = 0dB gain) while the input from the lower matrix switch is connected to an attenuator so that the effect of the external control signal on the gain of the amplifier can be adjusted.

ENVELOPE GENERATOR SECTION

The envelope generators in the 1045 module produce exponential functions with four adjustable parameters: Attack time, Initial Decay Time, Sustain Level, and Final Decay Time. For each of the two envelope generators, there is a panel knob to adjust each of these parameters.

An envelope is initiated when signals are applied to both the Gate and Trigger inputs. The Gate input is symbolized by a rectangular pulse (⎍) and the Trigger input by an exponentially decaying impulse (⌐). When a gate pulse and a trigger pulse are applied at the same time (as they would be if derived from a keyboard) the output voltage of the envelope generator rises exponentially to 10 volts at a rate determined by the setting of the "Attack Time" control. When the output reaches 10 volts, the attack is ended and the output falls to the "Sustain Level" at an exponential rate determined by the "Initial Decay Time" Control. The sustain level is adjustable from 0 to 10 volts. The output will remain constant at the sustain level until the Gate signal is removed, at which time the output returns exponentially to 0 volts at a rate determined by the "Final Decay Time": control, (Fig. C).

If the Gate voltage is removed during any part of the cycle, the output will always return directly to zero at the exponential rate set by the "Final Decay Time" control, (Fig. D). If the Gate and trigger signals are reapplied before the output returns to zero, a new attack will begin immediately without the output voltage returning to zero, (Fig. E).

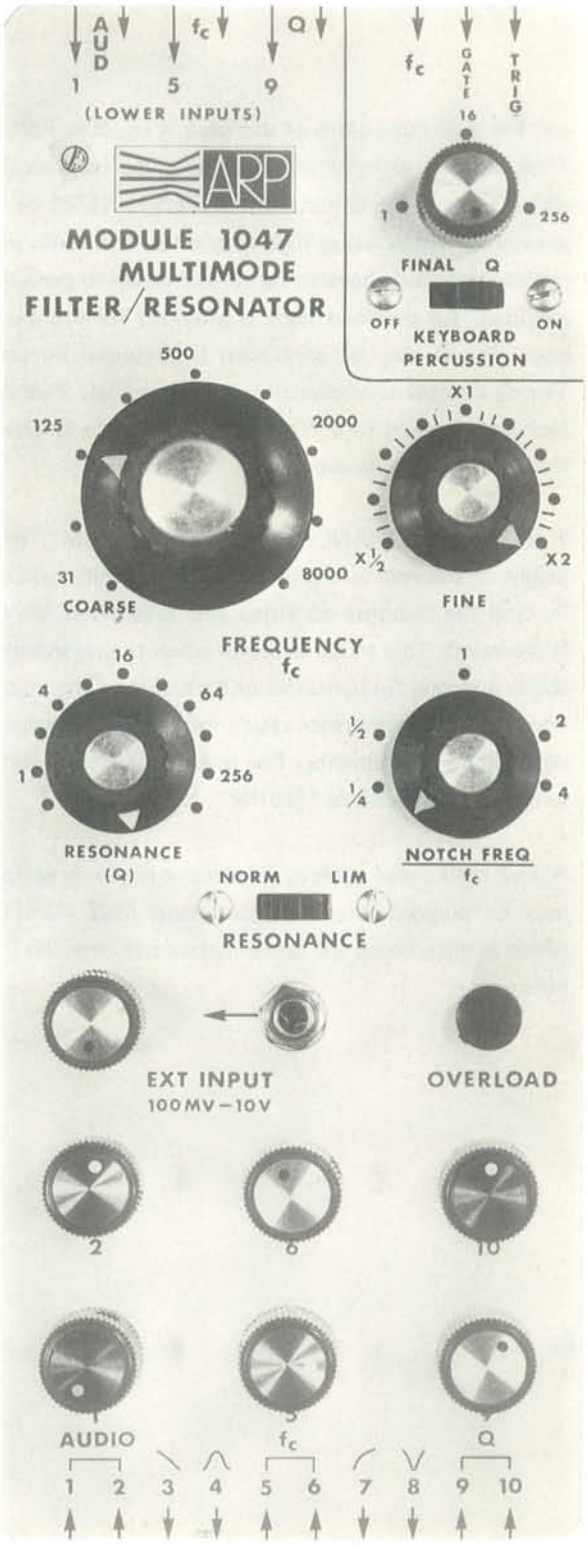
If at any time a Gate signal is applied in the absence of a trigger pulse, the output voltage will rise exponentially to the sustain level at a rate determined by the Initial Decay Time control. When the Gate is removed, the output will return to zero according to the Final Decay Time control setting.

ARP Module 1047 is a functional circuit package designed for use in the ARP Series 2000 electronic music synthesizers. The unit consists of a highly resonant filter with voltage controlled frequency and resonance, and simultaneously provides highpass, bandpass, lowpass, and notch outputs. The filter is capable of providing a wide variety of formant shaping and tonal modulation. The bandpass response is that of a natural acoustic resonator, and is most useful in synthesizing instrumental timbres. In addition, the high degree of stable resonance and frequency tracking accuracy attainable enables the filter to perform precise, narrowband spectrum analysis of audio signals.

The center frequency of the bandpass output is the cutoff frequency of the highpass and lowpass outputs, and is referred to as "Fc". Fc may be set by the coarse and fine frequency knobs over the range of 16 Hz to 16 KHz. Control signals applied to any Fc input will change the center frequency from the knob setting by 1 octave per volt when the knob above the control input is at maximum. Control signals from the individual inputs are summed with the Fc knob controls, and may be positive, negative, or audio.

With the RESONANCE (Q) knob at minimum and the RESONANCE switch set to "NORM", the bandpass output has a gain of 0.5 at Fc and attenuates 6 db per octave above and below Fc. The highpass output has unity gain from Fc to 20 KHz and attenuates 12 db per octave below Fc. The lowpass output has unity gain from DC to Fc and attenuates 12 db per octave above Fc. The notch output has flat response everywhere except for a deep (40 db) notch at a frequency determined by the $\frac{\text{NOTCH FREQ}}{\text{Fc}}$ knob. With this knob set to 1, the notch occurs at Fc. NOTE: The notch output is effective only at low Q.

As the RESONANCE (Q) knob is turned up, a resonant peak occurs at Fc in all four outputs, except in the notch output when the notch frequency is at Fc. The gain at this peak is numerically equal to the "Q",



ACTUAL SIZE

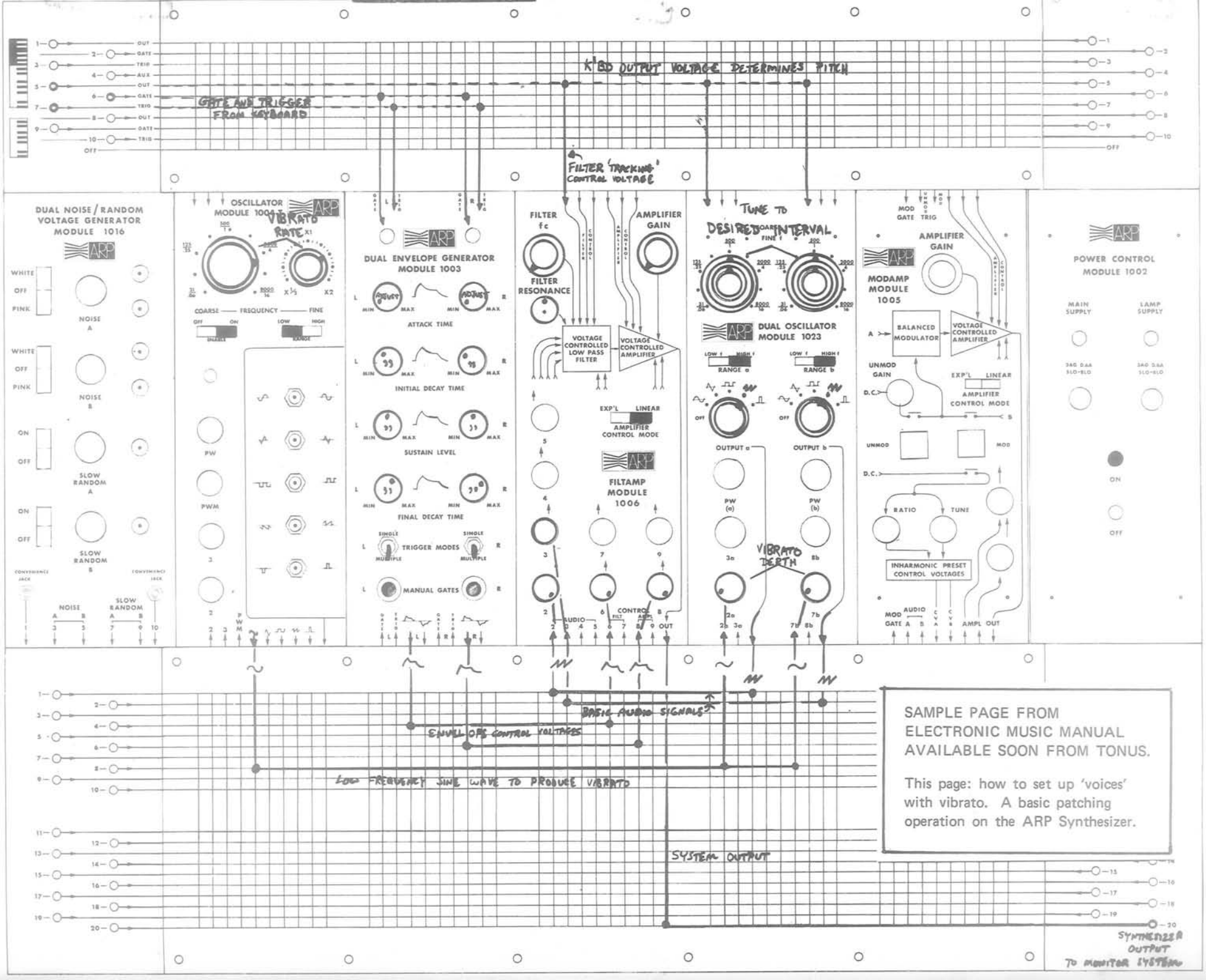
and the 3 db bandwidth of this peak is equal to Fc/Q. Thus, as Q is varied from ½ to 512, the bandwidth varies from 2 Fc (2 octaves) to Fc/512 (1/32 of a semitone). When using high resonance, the audio input controls may have to be turned down to prevent overload. An overload light is provided for this purpose. The Q may be controlled by external signals. The Q control characteristic is exponential; that is, each volt applied to a "Q" input doubles the Q when the input knob is at maximum.

With the RESONANCE switch set to "LIM", the height of the resonant peak is limited to unity gain at Fc, and the response on either side falls off as the Q is increased. This mode is useful when tuning sharply about a strong fundamental or harmonic of the input signal, but will otherwise result in a very low output signal at high resonance. For most applications, this switch should be set to "NORM".

A low level signal such as an electric organ or guitar may be plugged into the front panel EXT INPUT, which is mixed with the lower matrix switch audio inputs.

Upper matrix switch inputs for audio, Fc, and Q are provided. The short arrows are independent, unattenuated inputs, while the long arrows marked 1, 5, and 9 are wired directly to the corresponding lower inputs for the purpose of attenuating upper matrix switch inputs.

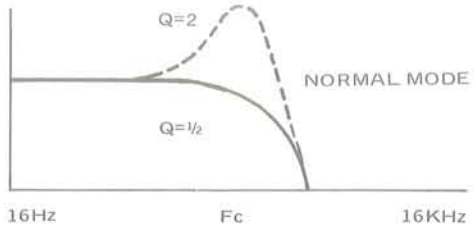
Another feature is keyboard percussion, which allows the filter to generate a wide variety of percussive tones from the keyboard. The keyboard gate and trigger outputs should be connected to the GATE and TRIGGER inputs at the upper right corner of the panel, and the keyboard control voltage applied to any one Fc input. With the KEYBOARD PERCUSSION switch on, striking a key produces a sharp percussive attack followed by a tone which varies from a slightly pitched click resembling a castanet clap (at low Q) to a slowly decaying sine tone at high Q. Upon releasing the key, the tone damps at a rate determined by the FINAL Q knob. The bandpass output gives the most natural percussive quality, although the highpass and lowpass outputs may be used. They give a sharper and a duller attack, respectively.

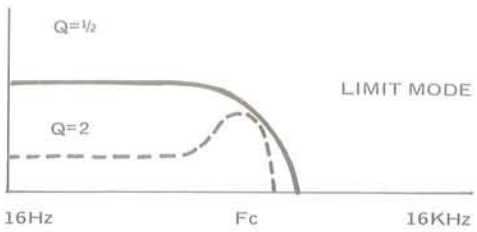


SAMPLE PAGE FROM ELECTRONIC MUSIC MANUAL AVAILABLE SOON FROM TONUS.

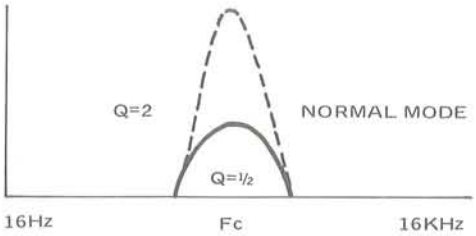
This page: how to set up 'voices' with vibrato. A basic patching operation on the ARP Synthesizer.

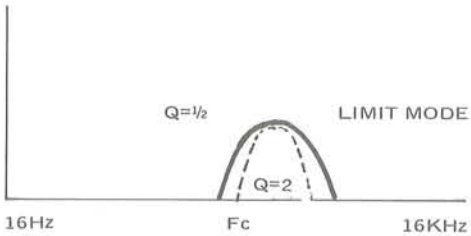
LOWPASS RESPONSE



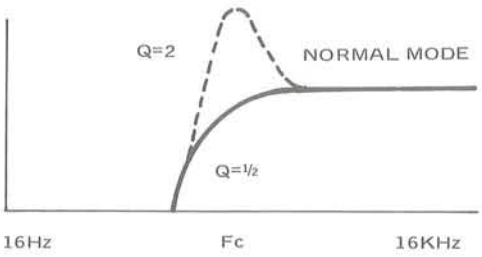


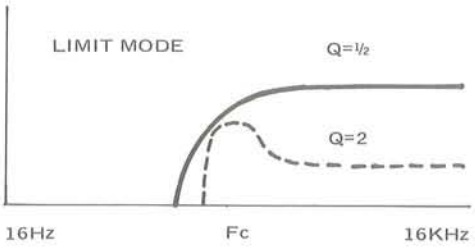
BANDPASS RESPONSE



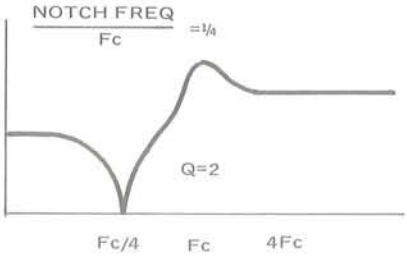


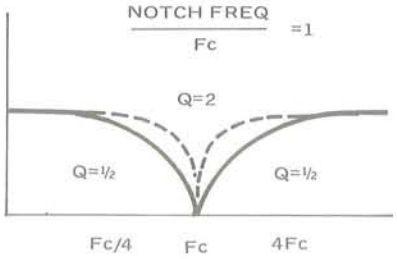
HIGHPASS RESPONSE

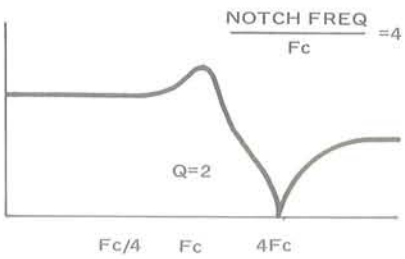




NOTCH RESPONSES







PERCUSSIVE OUTPUT WAVEFORMS



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ELECTRICAL SPECIFICATIONS

CENTER FREQUENCY (Fc):	16 Hz to 16 KHz, voltage controlled.
BANDPASS RESPONSE:	Single pole resonator, 6 db per octave.
RESONANCE (Q):	½ to 512 (0 to 54 db peaking at Fc), voltage controlled.
BANDWIDTH (3 db):	2 octaves to 1/32 semitone.
HIGHPASS AND LOWPASS RESPONSE:	12 db per octave cutoff at Fc, with same resonant peak at Fc as in Bandpass Response.
NOTCH RESPONSE:	Resonant peak at Fc as in Bandpass Response, plus notch at frequency determined by $\frac{\text{NOTCH FREQ}}{\text{Fc}}$ control. With this control at 1, response is flat except for notch at Fc.
NOTCH DEPTH:	> 40 db.
NOTCH WIDTH (3 db):	2 octaves to 1 semitone.
CONTROL INPUT RANGE:	± 10v maximum.
INPUT IMPEDANCE:	50 K ohm minimum.
Fc CONTROL CHARACTERISTIC:	1 octave per volt; at OV, Fc is equal to the frequency knob setting.
Q CONTROL CHARACTERISTIC:	1 volt doubles Q; at OV, Q is equal to resonance (Q) knob setting.
AUDIO INPUT RANGE:	± 10 v maximum.
AUDIO INPUT IMPEDANCE:	50 Kohm minimum.
AUDIO OUTPUT IMPEDANCE:	1 Kohm.
OVERLOAD LIGHT:	Indicates excessive input level.
KEYBOARD PERCUSSION:	Applies pulse from keyboard to filter, which rings according to Q. Upon release of key, tone decays according to Final Q knob setting.
POWER REQUIREMENTS:	± 15 volts @ 60 mA, regulated to ±0.1%. +12 to +15 volts @ 30 mA, lamp supply.

ARP INSTRUMENT DIVISION OF tonus, inc.
45 Kenneth Street / Newton Highlands / Massachusetts 02161 / Telephone (617) 969-0610

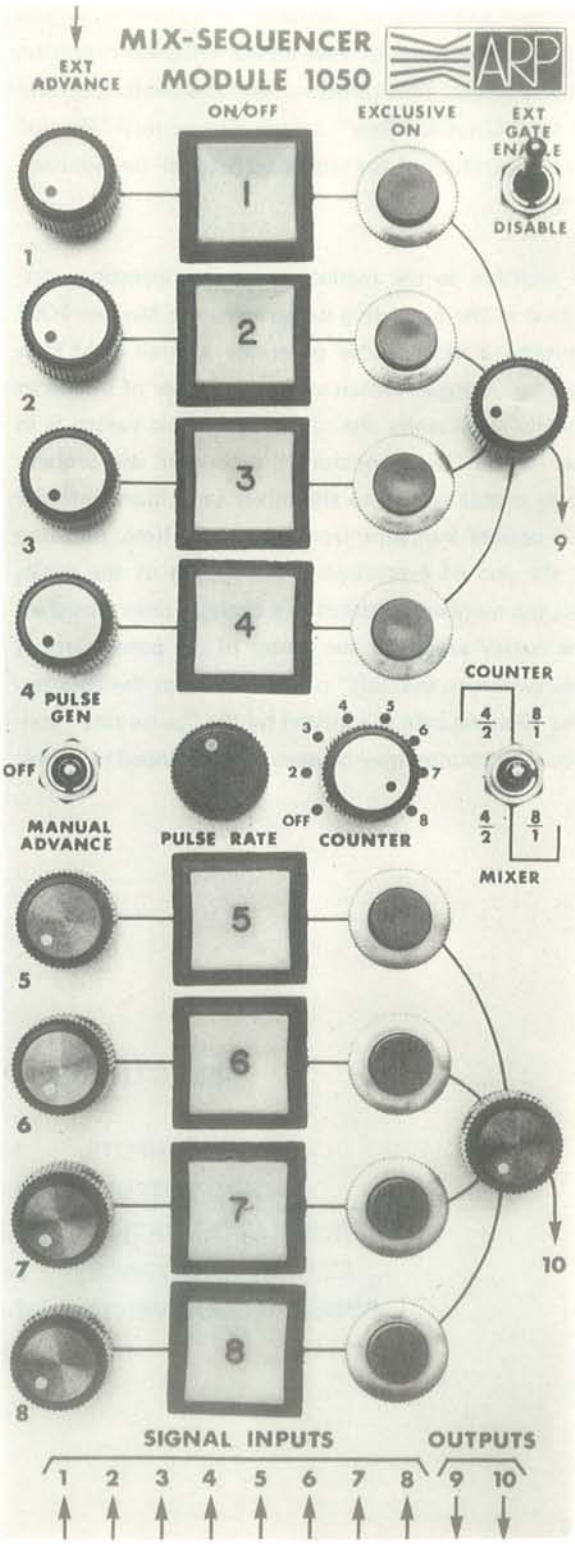
The ARP Module 1050 Sequential Mixer is a multi-functional circuit package designed for use in the ARP Series 2000 Synthesizers. The Module 1050 incorporates sequential switching functions necessary for rapid selection of preset waveforms and signals into a conventional audio mixer format. The Module 1050 contains two four-input mixers with electronically gated inputs, an eight step counter and clock, and associated logic and switching circuitry. Each input has its own attenuator and each output has a master gain control.

The ARP Module 1050 may be used as an eight input mixer with two adjustable outputs or as two separate four input mixers. A toggle switch at the right center of the panel couples the audio circuitry to provide either the 1 x 8 or two 1 x 4 mixer configurations.

A column of illuminated push-buttons indicates which inputs are gated on. The switches are pushed to change the state of an input, push-on/push-off. A column of "Exclusive-on" push-buttons will turn on a particular input while simultaneously turning all others off. This function is particularly useful for quick and convenient selection of preset signals. When the mixer is being used as two four-input mixers, the "Exclusive-on" button affects all eight inputs.

The panel symbols around the "Counter/Mixer" switch indicate how the switching logic (upper symbols) and audio circuitry (lower symbols) are set for the three switch position. In the right position, the audio circuitry is coupled to form one eight-input mixer with two adjustable outputs. The logic is also set so that an "Exclusive-on" button will affect all eight inputs. In the center position, the audio circuitry is again set up as an eight-input mixer.

With the "Counter/Mixer" switch in the left position, both the audio circuitry and the logic circuitry are arranged as if the module were two separate four-input



ACTUAL SIZE

mixers. "Exclusive-on" switches will affect either the upper or lower set of four inputs without interaction between sets. This position, and the center position of the "Counter/Mixer" switch also permits "Parallel step" operation of the sequencer, as shall be discussed below.

In addition to the manual switching operations described in the preceding paragraphs, the Module 1050 contains a clock pulse generator and an eight step counter. A toggle switch at the left center of the panel enables or disables the clock. When this switch is in the "Pulse Gen" position, the counter will sequentially enable inputs to the mixer (and illuminate the appropriate indicator lamps) one at a time, resetting at the end of every cycle. The length of the cycle, i.e., the number of counts in a cycle, is determined by the rotary switch at the center of the panel. Setting this switch to the "off" position disables the counter. The stepping rate is adjusted by the "pulse rate" control. The counter may be manually advanced by either the front panel toggle switch or an External Advance pulse.

The "parallel step" operation mentioned earlier permits the upper and lower sets of four inputs to be sequenced in tandem. In other words, the counter would actuate inputs in pairs: (1,5), (2,6), (3,7), (4,8).

The outputs of the counter or the front panel push-buttons can actuate a mixer input. Inputs can be held on by setting the appropriate push-buttons even though the counter may be operating.

A cable connector on the rear panel of the Module 1050 permits the inputs of the mixer to be enabled from an external control. For instance, the Module 1050 may be slaved from sequencers and other preset modules. The panel "Ext. Gate Enable" switch permits the user to disengage any external control of the Module 1050 without disconnecting cables.

ELECTRICAL SPECIFICATIONS

AUDIO INPUTS:	±10 volts @ 50 Kohms.
AUDIO OUTPUTS:	±10 volts @ 1 Kohm.
INPUT ATTENUATION:	100 dB min.
EXTERNAL ADVANCE:	Sensitivity 1.3 volts @ 100 Kohms.
POWER REQUIREMENTS:	±15 volts @ 60 ma, regulated to ±0.1%.
	+12 volts to +15 volts @ 170 ma, unregulated.

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All ARP Keyboards have 61 notes. The following models are standard with the 2000 series synthesizers:

- 3001 Simple one-voice standard 5 octave keyboard.
- 3002 Two-voice 5 octave keyboard.
- 3112 One single-voice black octave, and a four octave two-voice white section.
- 3212 Two single-voice black octaves, and a three octave two-voice section.
- 3221 Two octave two-voice black section, and a three octave single-voice white section.

In the cases of the 3112, 3212, and 3221, the two sections of the keyboard are completely independent.

The keyboard model number is suffixed by a letter and a number. The following code applies to the suffix:

- U2 Upper keyboard for a 2002 synthesizer
- U3 Upper keyboard for a 2003 synthesizer
- L2 Lower keyboard for a 2002 synthesizer
- L3 Lower keyboard for a 2003 synthesizer.

The following code applies to the first four digits of the model number:

1) 3 means "keyboard"
2) number of black octaves
3) number of black voices
4) number of white voices.

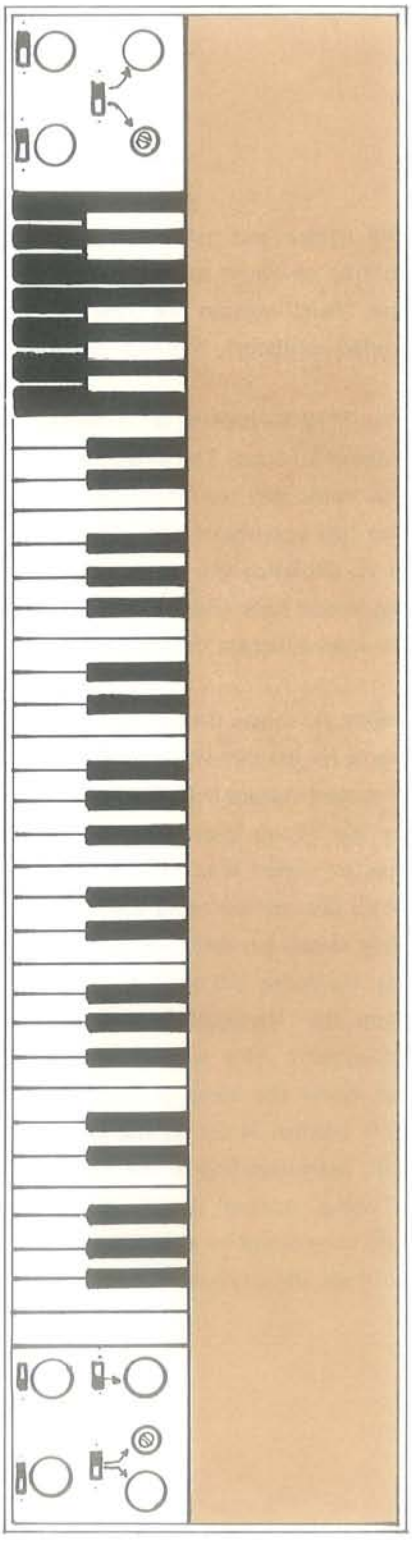
For instance, a keyboard model 3112U2 would have one single-voice black octave, a two voice white section, and would fit a 2002 Synthesizer as the sole keyboard or as the upper of two keyboards.

Both the one and two voice sections have the following output voltages:

1) Trigger—a short transient 10 volt pulse, which occurs whenever a key is depressed.
2) Gate—a switched 10volt signal indicating that a key is depressed.
3) Output—a control voltage whose amplitude is related to lowest key being depressed.

The two-voice keyboard sections have an additional output:

4) Aux—an additional control voltage proportional to the interval between the lowest and highest key depressed if two or more keys are depressed simultaneously.



1/6 SIZE

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The trigger and gate voltages are typically used to control envelope generators. The "Output" voltage and "Aux" voltage are used to control voltage controlled oscillators, filters, and amplifiers.

The 3112 Keyboard, for example, is capable of controlling 3 voices. The single black octave can control one voice and the upper white octaves can control two (the uppermost note is derived by summing within an oscillator the output voltage corresponding to the lowest note and the aux voltage corresponding to the lowest-highest note interval).

Figure A. shows the control panel and schematic diagrams for the two-voice keyboard section. The change of output voltage between adjacent notes is controlled by the "Tone interval" knobs. This "Tone interval" may be varied from roughly 48 notes per volt to 6 notes per volt by using the "Variable" knob with the slide switch beneath that knob as shown in the drawing. Reversing the position of the slide switch disconnects the "Variable" knob and connects the "fixed" adjustment. This is a screwdriver adjustment which can cause the same effect as the "Variable" knob. This control is set at the factory for 12 notes per volt, corresponding to the equal tempered scale. The "Tuning" control permits the keyboard output voltage to be raised by about ½ volt. Normally the lowest note on the keyboard produces zero output voltage. This would be the case if the "Tuning" knob were rotated fully counterclockwise or if the "Tuning" knob were deactivated by using the slide switch beneath it.

The portamento control is used to cause the output voltage to slide from one point to another. Advancing this control will increase the time constant for the slide.

The "Aux Output" control permits adjustment of "Aux" voltage output. Normally this control is adjusted so that the "Aux" voltage is zero when only one note is depressed. When tuning two oscillators to the two-voice keyboard, one oscillator is normally connected only to the "Out" voltage while the other is connected to both the "Out" voltage and the "Aux" voltage. With the slide switch under the "Aux output adjust" knob in the off position, the oscillators are tuned to the same frequency. With the slide switch in the "on" position, the "Aux output adjust" control is tuned so that the oscillators are again at the same frequency. One oscillator will now follow the lowest note played while the other will follow the highest note played.

Figure B. shows drawings for a single voice keyboard control panel. All the previous operations are the same for this keyboard except that there is no "Aux" voltage output and associated controls.

All ARP Keyboards have 61 notes. The following models are standard with the 2000 series synthesizers:

- 3001 Simple one-voice standard 5 octave keyboard.
- 3002 Two-voice 5 octave keyboard.
- 3112 One single-voice black octave, and a four octave two-voice white section.
- 3212 Two single-voice black octaves, and a three octave two-voice section.
- 3221 Two octave two-voice black section, and a three octave single-voice white section.

In the cases of the 3112, 3212, and 3221, the two sections of the keyboard are completely independent.

The keyboard model number is suffixed by a letter and a number. The following code applies to the suffix:

- U2 Upper keyboard for a 2002 synthesizer
- U3 Upper keyboard for a 2003 synthesizer
- L2 Lower keyboard for a 2002 synthesizer
- L3 Lower keyboard for a 2003 synthesizer.

The following code applies to the first four digits of the model number:

1) 3 means "keyboard"
2) number of black octaves
3) number of black voices
4) number of white voices.

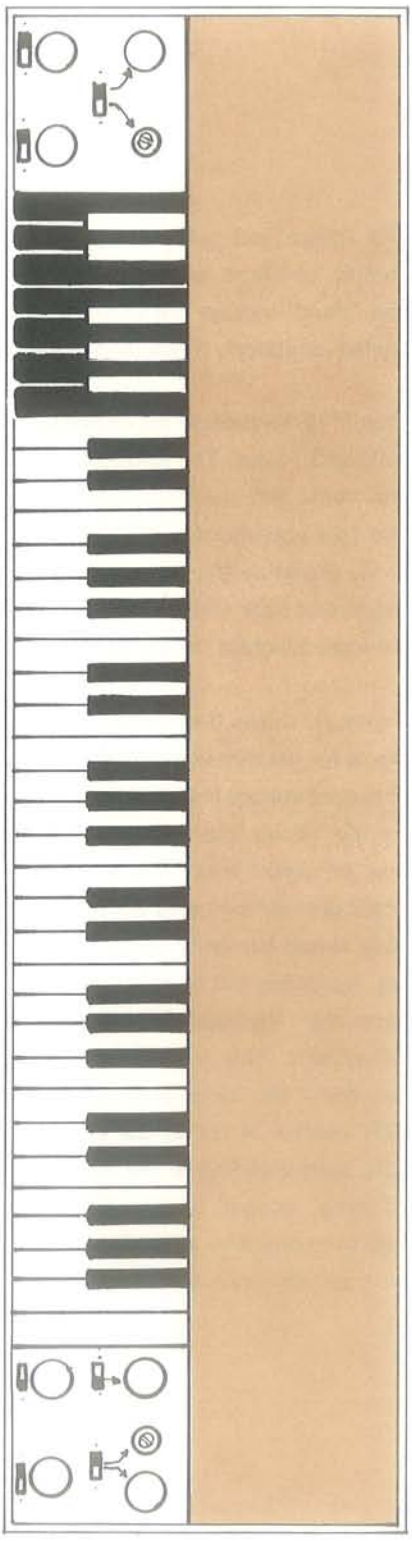
For instance, a keyboard model 3112U2 would have one single-voice black octave, a two voice white section, and would fit a 2002 Synthesizer as the sole keyboard or as the upper of two keyboards.

Both the one and two voice sections have the following output voltages:

1) Trigger—a short transient 10 volt pulse, which occurs whenever a key is depressed.
2) Gate—a switched 10volt signal indicating that a key is depressed.
3) Output—a control voltage whose amplitude is related to lowest key being depressed.

The two-voice keyboard sections have an additional output:

4) Aux—an additional control voltage proportional to the interval between the lowest and highest key depressed if two or more keys are depressed simultaneously.



1/6 SIZE

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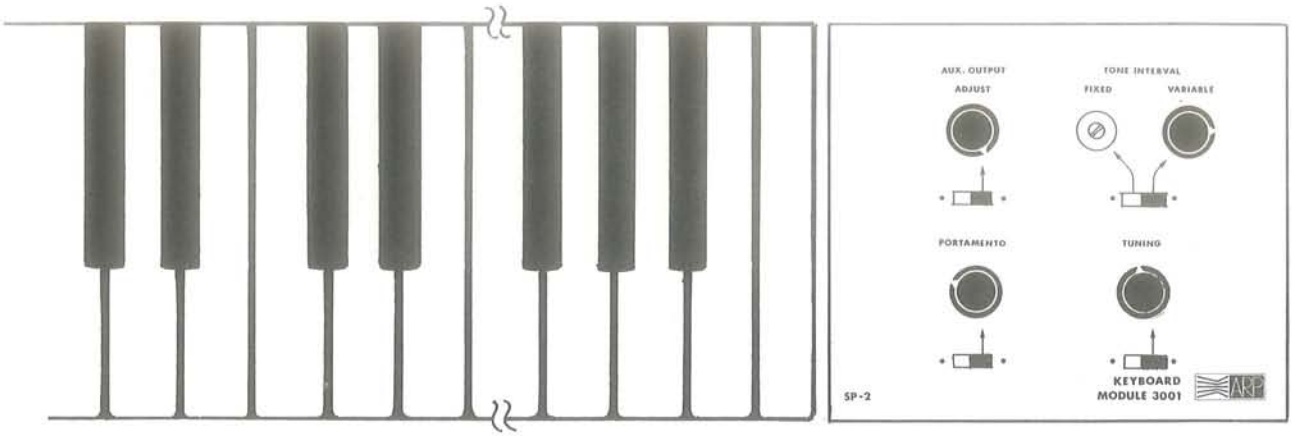
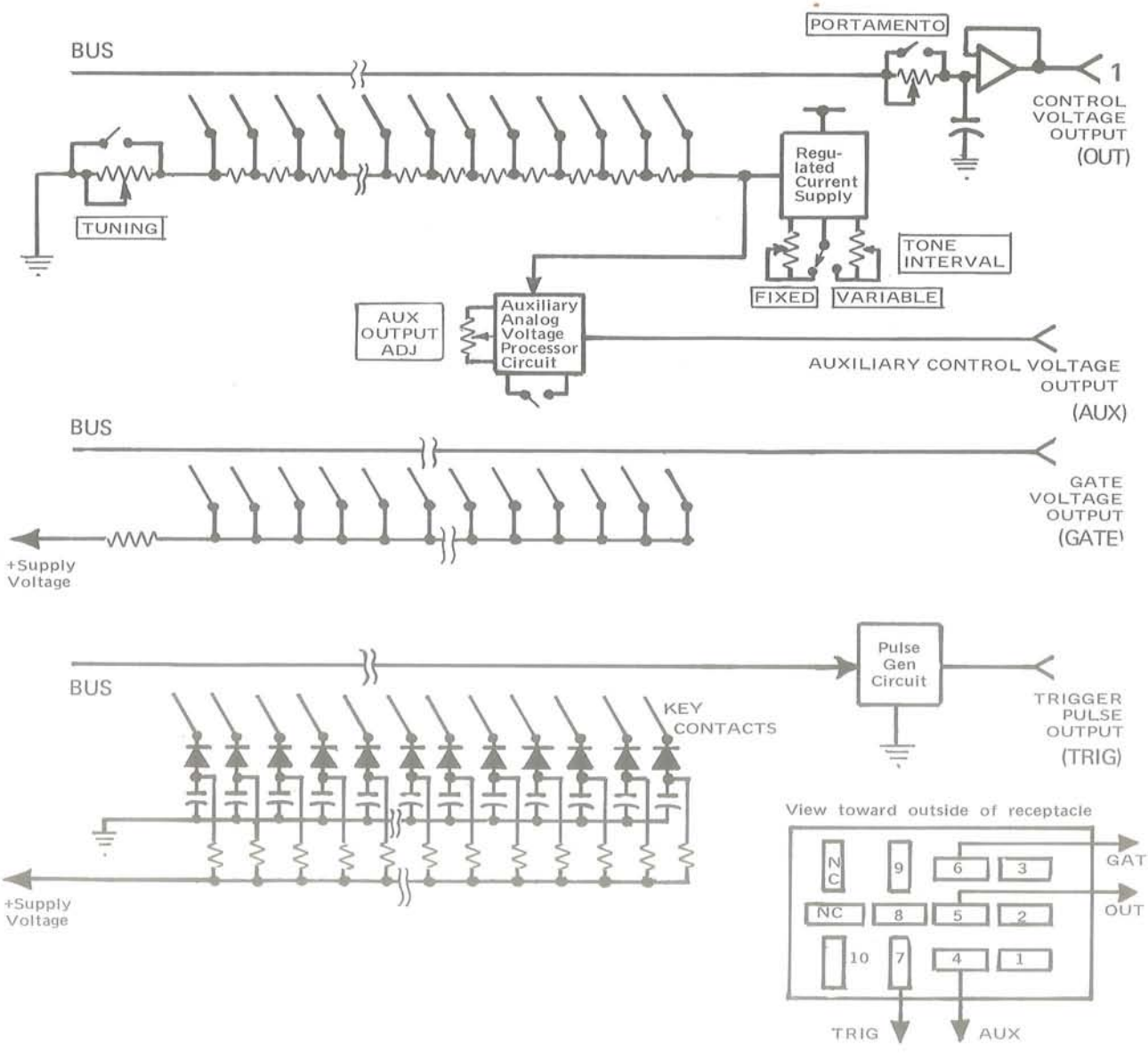
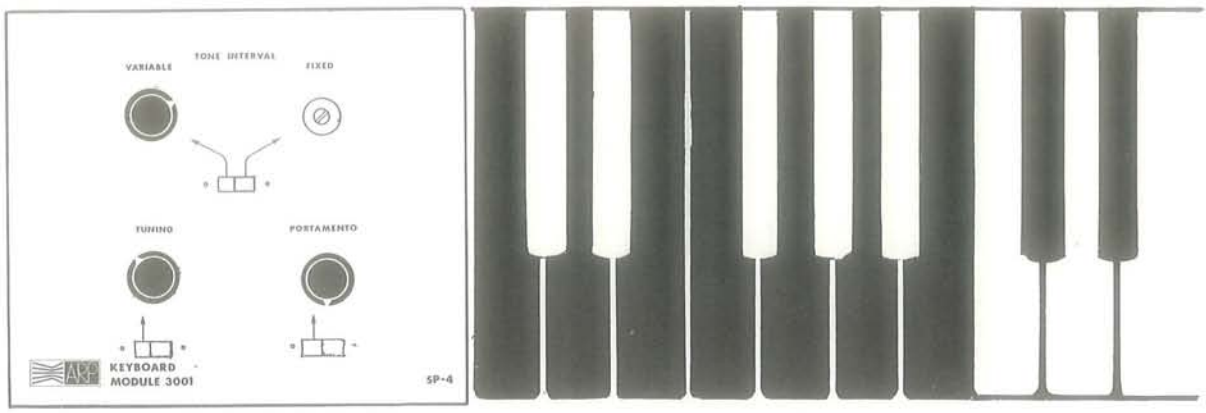
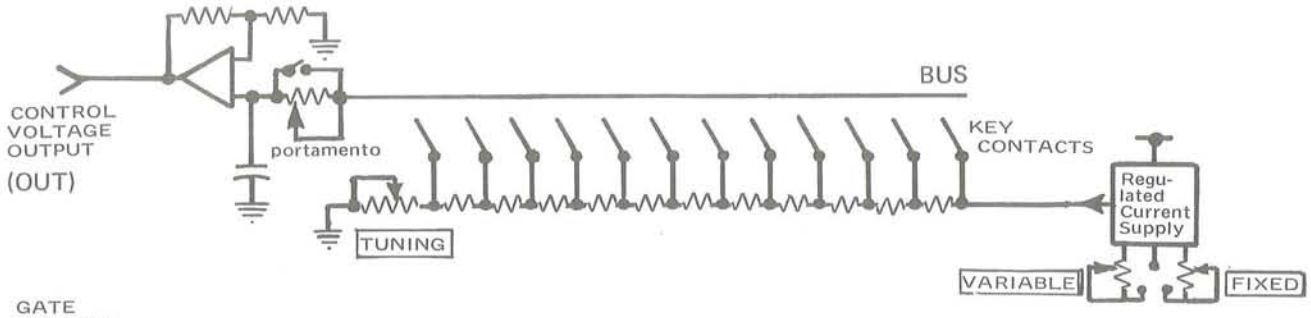
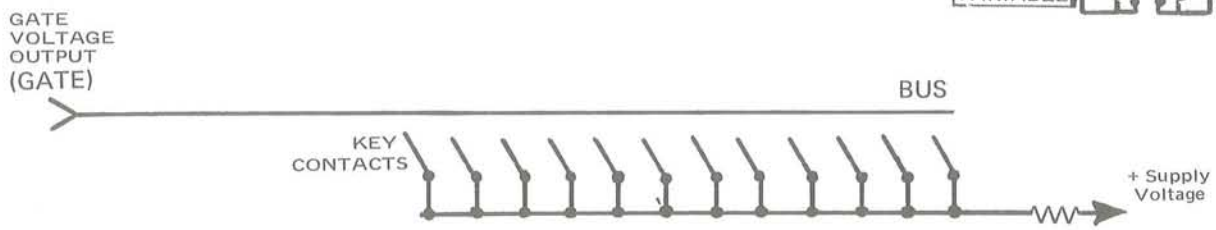
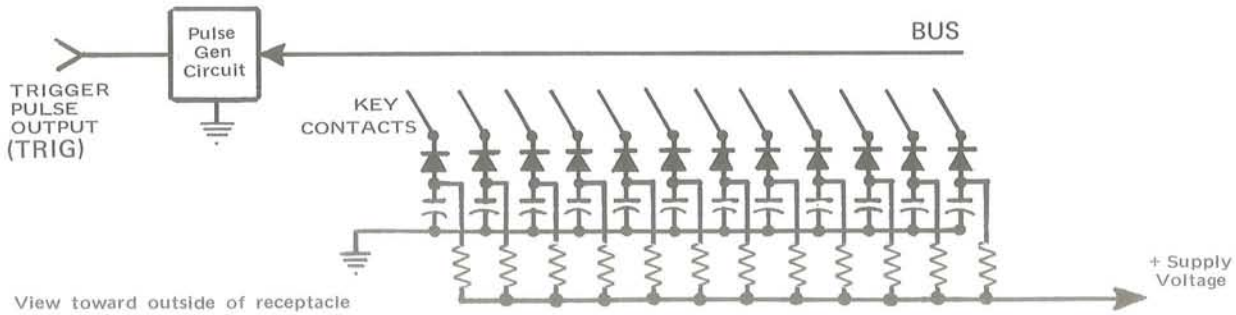

AUX. OUTPUT
ADJUST
TONE INTERVAL
FIXED
VARIABLE
PORTAMENTO
TUNING
SP-2
KEYBOARD
MODULE 3001

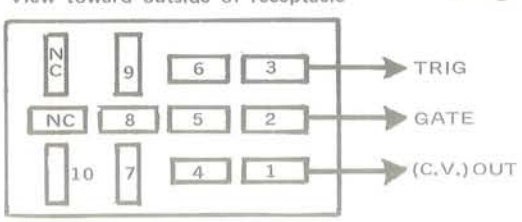

BUS
PORTAMENTO
1
CONTROL VOLTAGE OUTPUT
(OUT)
TUNING
Regulated Current Supply
TONE INTERVAL
FIXED
VARIABLE
AUX OUTPUT ADJ
Auxiliary Analog Voltage Processor Circuit
AUXILIARY CONTROL VOLTAGE OUTPUT
(AUX)
BUS
GATE VOLTAGE OUTPUT
(GATE)
+Supply Voltage
BUS
Pulse Gen Circuit
KEY CONTACTS
TRIGGER PULSE OUTPUT
(TRIG)
+Supply Voltage
View toward outside of receptacle
NC
9
6
3
GATE
NC
8
5
2
OUT
10
7
4
1
TRIG
AUX

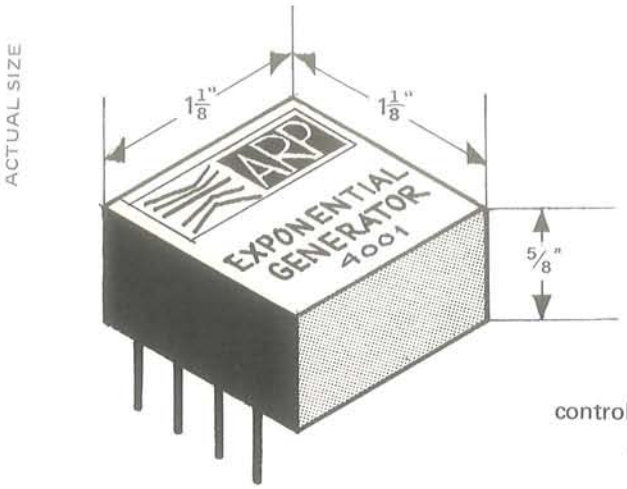

TONE INTERVAL
VARIABLE
FIXED
TUNING
PORTAMENTO
KEYBOARD
MODULE 3001
SP-4


CONTROL
VOLTAGE
OUTPUT
(OUT)
portamento
BUS
KEY
CONTACTS
TUNING
Regu-
lated
Current
Supply
VARIABLE
FIXED


GATE
VOLTAGE
OUTPUT
(GATE)
BUS
KEY
CONTACTS
+ Supply
Voltage

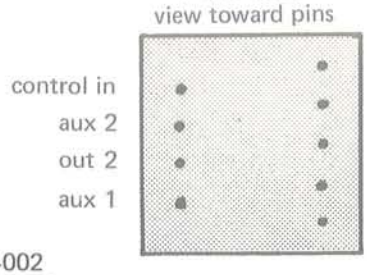

Pulse
Gen
Circuit
TRIGGER
PULSE
OUTPUT
(TRIG)
BUS
KEY
CONTACTS
+ Supply
Voltage


View toward outside of receptacle
NC
9
6
3
TRIG
NC
8
5
2
GATE
10
7
4
1
(C.V.) OUT

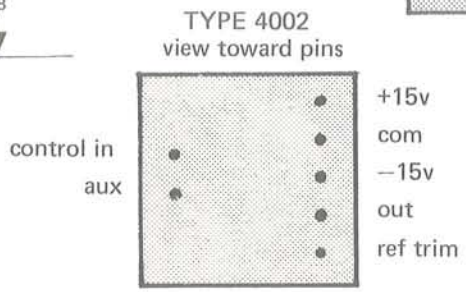


pins are .040" diameter on 0.1" grid

TYPE 4001
view toward pins



TYPE 4002
view toward pins



Types 4001 and 4002 are encapsulated modular electronic assemblies designed to produce output current signals exponentially related to an input control signal voltage.

Type 4001 is a dual output, 'N' type exponential current generator, which provides two individual negative polarity current outputs controlled by a single voltage input. The two outputs are designed to track each other over a range of at least ten octaves of current (three decades). Auxiliary control input terminals are provided to permit either or both of the two output currents to be gated off or to permit the two output currents to be adjusted to an exact balance.

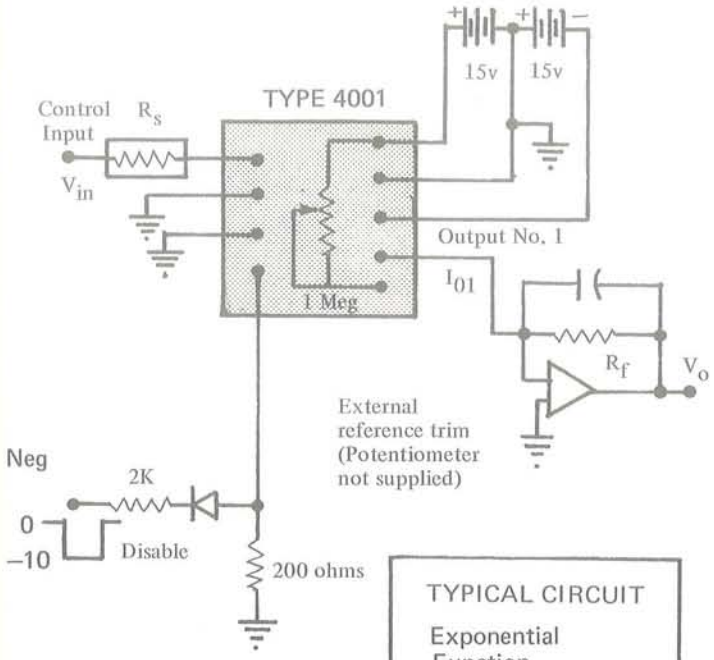
Type 4002 is a single output, 'P' type exponential current generator, which provides a single positive polarity current output current controlled by a voltage input. An auxiliary control input terminal permits the output current to be gated off, if desired.

Both of the above module types are designed to operate from a dual regulated power supply of +15 volts and −15 volts. Each module is provided with a reference trim terminal to permit the user to adjust the output current value obtained for zero control input voltage to an exact value. The exponential slope (octaves per volt or decades per volt of control voltage is also adjustable by the user by selecting an external resistor (not supplied) in series with the control input. The outputs of either of these modules are constant currents over a limited range of about 50 millivolts with respect to ground. For best results, the output current signals should be connected to a low impedance load, such as the summing input of an operational amplifier with feedback applied.

Typical characteristics and applications are shown on the reverse side of this sheet.

Type	1–9 (Base)	10–99 (−10%)	100–499 (−15%)	500–999 (−20%)	1000 (−25%)
4001(N)	$30	$27	$25.50	$24	$22.50
4002(P)	30	27	25.50	24	22.50
VCA-1N	25	22.50	21.25	20	18.75
VCA-3N	35	31.50	29.75	28	26.25
VCA-2P	35	31.50	29.75	28	26.25
VCA-2N	35	31.50	29.75	28	26.25
VCA-3P	35	31.50	29.75	28	26.25
VCA-1P	25	22.50	21.25	20	18.75

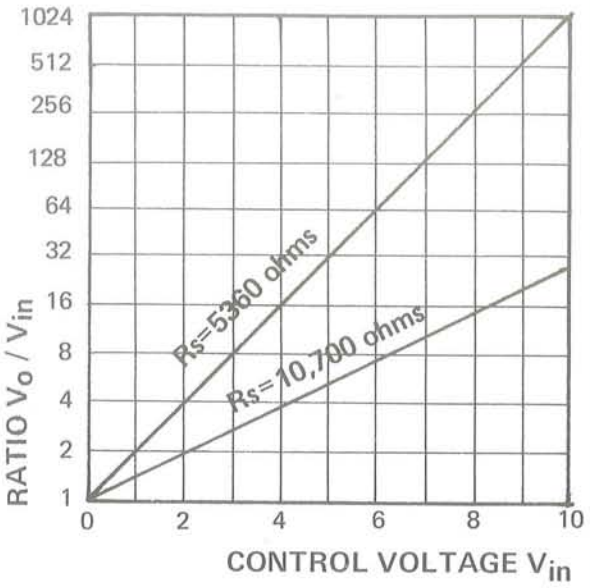
Replaces Preliminary Data Sheet of May 21, 1970

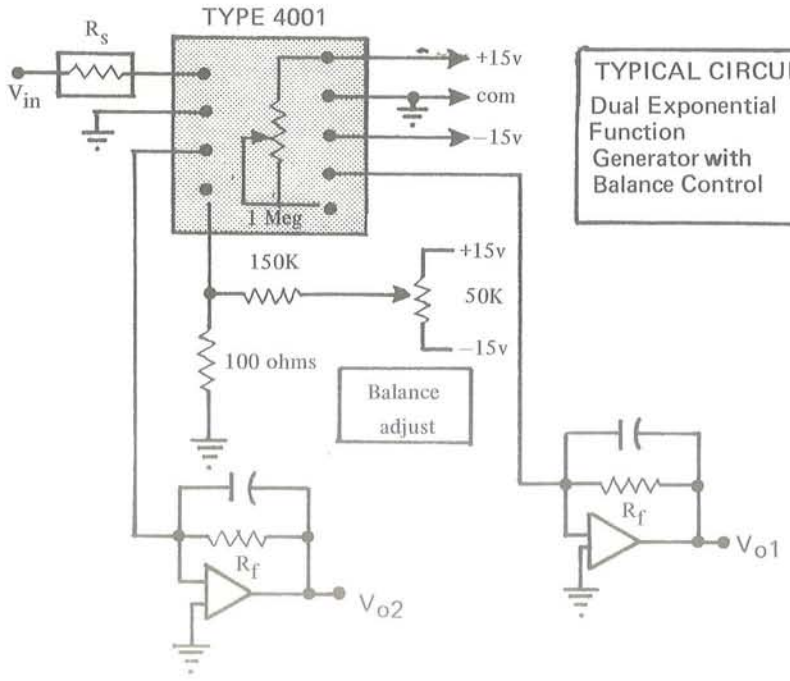


TYPICAL CIRCUIT
Exponential Function Generator

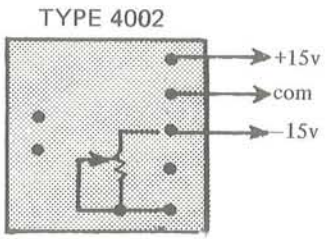
NOTE: Output No. 2 should be grounded if not used.

TYPICAL CHARACTERISTICS AND APPLICATIONS





TYPICAL CIRCUIT
Dual Exponential Function Generator with Balance Control



NOTE: For the 4002 module, the external reference trim potentiometer should be connected as shown.

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