SOUTHWEST TECHNICAL PRODUCTS CORPORATION

LAMBERT LABS, LTD. ACQUIRED

Southwest Technical Products Corp. is happy to announce the acquisition of Lambert Labs Limited of Westfield, New York. Lambert Labs manufactures several unique instruments of superior quality at prices that cannot be matched by the major instrument manufacturers.

Readers of the popular electronic magazines will remember the pulse generator, low distortion audio oscillator, wide band preamp, etc. that were products of Lambert Labs. Southwest Technical Products will supply these kits and other designs by Mr. Jim Bongiorno of Lambert Labs. The first new kit to be offered will be a "Tone Burst Generator." This design has features not available on any instrument of this type now available. It includes digital control circuits to allow preselection of the exact number of cycles to be included in the tone burst. The generator can switch between two different burst frequencies or deliver a single burst as desired. This instrument should be extremely valuable to anyone doing serious testing of audio equipment.

Mr. Bongiorno is one of the leading designers of audio equipment in this country. He has done consulting work for several major audio manufacturers and was employed by Marrantz before organizing his own company. The "Guest" editorial in this edition contains some of his ideas on current amplifier designs and distortion. He is currently working on several new audio projects that we will begin to offer during the new year. These designs will offer new ideas in audio circuits and will all be advances over current designs.

100% TESTING AND PLUG-IN READOUT

All counters and decoder drivers used in the NX and NUM series counters are 100% tested for proper operation. You can be sure that any intergrated circuits received in these kits will operate properly, provided assembly is done correctly.

Our Nixie Counter series is now being supplied with plug-in type readout tubes and **sockets,** at the same bargain price of $15.00 per decade. This makes it practical for anyone to own digital instruments. Our one board, multidecade Nixie readout system (MNX-1) has also been reduced in price. It is now only $49.50.

The NUM segmented readout kit has been reduced to $13.50, less readout. This kit may be used with the "RCA" Numitron readout tube, the Monsanto MAN-1 light emitting diode readout, or to drive traics for large segmented displays such as are used on scoreboards. The output of the NUM decoder is capable of driving triacs with ratings up to 8 amps on each segment. This is done by simply connecting a 220 Ohm resister between 7447 decoder chip output and the gate terminal of the triac.

Our new Up-Down counter #UNX is now ready. This counter will be described in the Feb. 1971 issue of "Popular Electronics" magazine. Without question this is the most versatile counter available today. Not only will it count both backward and forward, but it can also be connected to count any modulo desired from 2 to 10 It also has parallel data inputs so that a number may be preset into the counter before counting begins. Counting speed is up to 32 MHz.

HOW MANY DIGITS?

One of the most often requested pieces of information here at Southwest Technical Products Corp. is "How do I made a readout system with four (five, six, etc.) numbers, using your circuits?" In a digital readout system all parts of the system should have similar accuracies if the system cost is to be kept within reason. The accuracy that is chosen will determine the number of digits that can be used in the readout before they become meaningless. Thus if we choose to use a 60HZ. line time base to build an economical counter we are limited by the accuracy of the power lines frequency. In most cases this is approximately 0.1%, or three digits. Now we could add another digit to the readout, but the reading on this tube would be meaningless since the time base used to make the reading was only accurate to three places (.1%). Similarly, we could build a voltmeter with four, five or six digits, but if the analog to digital converter was only linear, or accurate to .1%, again we would have a reading with several meaningless numbers due to limitations of the converter circuit.

If your requirement is for a frequency counter only, which will give you a reading accurate to four, or five places; the RPI-1 time base can be used. This time base has a crystal oscilator which can be adjusted to beat with WWV, or other primary standards to give you an accuracy of .001%. As long as the ambient temperature remains fairly constant you can get readings out to five places with such a system. Greater accuracies would require a more accurate (expensive) crystal and an oven to hold it at a constant temperature.

The RPT-1 time base can also be used to build a "Sports Timer" type instrument with either Nixie, or Numitron readout. Construction would be similar to the lamp readout device described in "Popular Electronics" Oct. 1968. Reprints are available.

Write to Southwest Technical Products Corporation, and we will gladly send our free, fully illustrated catalog.

THE MYTH CONCERNING DISTORTION

by jim bongiorno

In refering to distortion, there is one question that I am asked more often than all others concerning audio. This question is "Why is there still such great concern over the distortion of amplifiers, when the distortion of pickups and loudspeakers is so much worse?" This is not an easy question to answer, but there are many valid reasons for continuing the research into ultra low distortion amplifiers.

Firstly, loudspeakers and pickups are getting surprisingly good in recent years. Also, when considering today's finer loudspeakers, we are almost always dealing with a multiple element system with a complex cross-over network. Since we are therefore limiting the working frequency range of each separate element, we can safely say that very high order distortion products will be greatly subdued (intermodulation). Another of the problems (related to hearing) is the psychological adjustment that the ear makes when you are listening. This adjustment factor is heavily dependent upon the musical awareness of the listener, ie: education hearing range, environment, life style, etc. It is not surprising to find loudspeakers today with distortion factors around 1% or so at normal listening levels. This fact indicates that our amplifiers must surely have orders of magnitude lower distortion factors.

One fault that has been made and continues to be made is the improper interpretations of the results of distortion measurements. In other words are we stating the proper **quantities** of distortion and therefore, are the present subjective results correct? The answer is definitely NO, and I further believe that we need a new set of references in regard to proper measurement techniques and interpretive analysis. In the following examples, it should become very clear that a change in values is needed.

The three major sources of distortion that are found in current transistor amplifiers are asymmetrical distortion, primary cross-over distortion and secondary cross-over distortion. All of these produce distortion products that are primarily outside the audio range and which have a much larger effect on the sound than the normal distortion analyzer indicates. These distortion products must be viewed at the output of an analyzer with a bandwidth of a Megacycle, or more, to appreciate their seriousness. The average reading metering circuit on the analyzer will hardly notice these "burst" of distortion, but a well trained, or even not so well trained ear can detect them rather easily.

Asymmetrical distortion is something that has never been discussed in print before, at least to my knowledge. The sound of this kind of distortion is very gritty and much like intermodulation distortion and like intermodulation, it only requires very small amounts to be objectionable. It can only be observed when displayed in X-Y fashion on an oscilliscope. It looks very much like normal harmonic distortion with the exception that one side or lobe of the pattern usually has a long tail on it. This kind of distortion arises mainly from unbalanced gain stages within the amplifier. It almost never occurs in a balanced bridge (full wave bridge). It is also very common in amplifiers that do not have differentially coupled stages. It will almost certainly be present in an output stage that is not driven by equal current on both positive and negative half cycles. With all of these conditions present, the amplifier has different gains (open loop) between the positive and negative half cycles. Also, the open loop distortion products will almost **never** be proportional. Therefore, the feedback loop doesn't know the difference between the positive or negative half cycle, which results in unequal distortion reduction. Thus we end up with this kind of asymmetrical distortion. Also, some designers say that they don't need to match output transistors. This is definitely a fallacy. Furthermore, not only do the outputs need matching, so do the drivers. There is one factor however, that alleviates this situation a little. All output stages are usually unity gain stages of one sort or another (emitter followers). The designers therefore, put all of the voltage gain (or as much as possible) in the stages preceeding the output stage. Also the open loop gain is made as high and linear as possible. It would however, still be better to match the devices and if the time and equipment (money?) are available, it should be done. But don't be mislead. We are talking about a difference in distortion factors of maybe .02% to .04%. This increase is almost **always** of the asymmetrical type. The cost added to the product for this type of matching and selection could well add up to an additional 50%, as it takes lots of time.

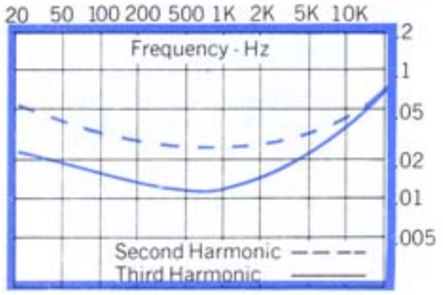
Primary cross-over distortion can be eliminated by operating the output stage class AB and at a high enough idle current so that both transistors are never off at the same time. Idle current must be rather high (over 50 Ma.), unless an active current source driver is used, to insure that no cross-over distortion can occur. This results in considerable heating of the output transistors and compensating diodes must be used to prevent thermal runaway of the output stage. The problem is that these diodes can overcompensate and cause the amplifier to sound bad when it's output transistors are in certain temperature ranges. Perfect tracking is difficult to obtain and if design idle current is on the low side, this distortion can occur. A driver circuit using an active current source, rather than a bootstrap capacitor and split load resistor in the driver, will minimize this type distortion, if it occurs. A compensated current source driving the output transistors will insure that cross-over distortion cannot occur.

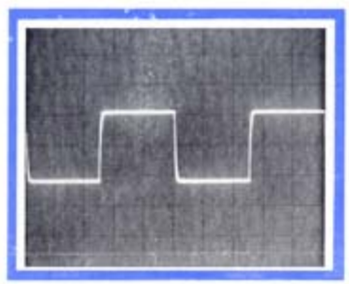
Another type of distortion which is also very unpleasant, and also very rarely mentioned, is secondary cross-over distortion, NOT to be confused with the primary cross-over distortion which is associated with biasing. There is no type of biasing that will alleviate secondary cross-over except pure class A operation. One company has used sensing power diodes in the output stage which effectively lowers this kind of distortion but it does not completely eliminate it. It is also possible to run the drivers only, in class A but this is quite a waste of power and they will also be running at fairly high junction temperatures. A much easier solution is to use 100 Megacycle devices as the drivers instead of the more common single diffused devices that most manufacturers use. This results in an open loop bandwidth which is much, much greater than most amplifiers, and consequently there are not time-delay, stored switching transients in the output stage. Another benefit is the fact that the output transistors can be biased completley off with no idle current—and no ill effects. Of course this results in 100% freedom from any temperature problems associated with the need for biasing.

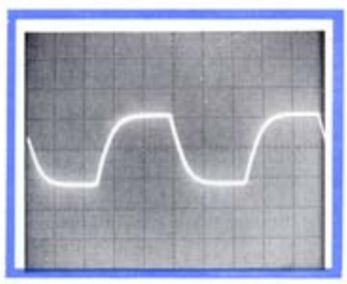
NEW MEDIUM POWER AMPLIFIER

Southwest Technical Products Corporation is happy to announce the latest addition to our line of power amplifier kits. Our answer to your requests for a really "great" amplifier in the 30 to 50 Watt range is now ready — the "PLASTIC TIGER."

Plastic Tiger uses the same basic circuit as is used in our "Universal Tiger," combined with economical complementary silicon plastic output transistors. The result is an amplifier with performance and stability that is outstanding in its power class. Distortion is typically well below 0.1% at listening levels and reaches something in the order of 0.1%, or slightly more, just before clipping. Since distortion levels below .05% are difficult to measure accurately with a total harmonic analyzer, the distortion was measured with a wave analyzer. The results in Figure 1 show a low level of second and third harmonic distortion with no other measurable responses (-75 db limit of instrumentation resolution).







Frequency response is typically 1 to 100,00 Hz @ -1 db points. The circuits rise and fall times are in the order of 2.5 microseconds. There is no ringing present in the output when the amplifier is driven with a high frequency square wave. The oscilloscope photograph shows the amplifier output at 10 KHz which is the usual frequency shown in amplifier literature and at 100 HKHz. The 10 KHz photograph does not prove much except that this a good amplifier with bandwidth considerably greater than 10 KHz. The 100 KHz photograph clearly shows the actual rise and fall

times and the clean well damped response of the amplifier. Note the low amplitude of the small ripples on the top of the square wave. It is not likely that you will see very many amplifier manufacturers publish test data showing square wave response at this frequency. It is quite easy to hide a fast spike on the leading edge of the square wave, or a few cycles of 500 KHz ringing, if you use a frequency of 10KHz and blurr the picture a bit with bad focus, or a touch too much intensity. Of course **we** know that **no one** would do a thing like this. At 100 KHz, the rise time is clearly shown since we are looking at the first 10% of the waveform we saw at 10KHz; any spikes, or ringing cannot be hidden. Of course the fact that many amplifiers would react to a 20 Volt P-P output at 100KHz with a flash, or puff of smoke will also deter the universal acceptance of this particular test.

This kit will be priced the same as the #160 kit it replaces, $18.50 per channel and $55.00 for a two channel kit with chassis and power supply. We do not know of anything that compares with this amplifier at anywhere near this price.

SONOLITE-COLOR ORGAN

Lamp Dimmer or Speed Control
X 147C Kit—Sonolite Color Organ (2 lbs) $11.00
147—Assembled Color Organ (2 lbs.) $16.50

PSYCHEDELIA COLOR ORGAN

QX—3 channel Filter and power control kit (3 lbs.) $42.45
QA—Complete Assembled Kit (4 lbs.) $59.95
QD—Assembled—plastic covered black display—7 lamp system not wired (size of unit requires shipping by bus or express collect) $26.50

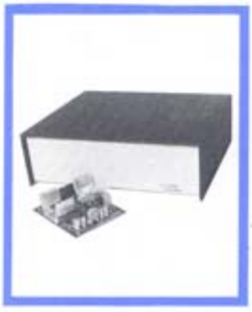
REVERB ADAPTOR

139-C Complete kit including board, springs, and chassis $18.75
139 Board Only $2.00
1V-C Reverb springs only 16½" long (2 lbs.) $10.00

ULTRASONIC INTRUSION ALARM

Simply aim at area to be protected; set sensitivity. 12 volts—also for car or boats. Internal power supplies to 1 Amp to any 12 volt alarm.

UA-1 Ultrasonic Alarm Kit (4 lbs.) $37.25



LIL TIGER

140-CX—Lil Tiger Amplifier (6 oz.) $11.10
P-140—Power Supply and Chassis (6 lbs.) $15.00
Complete Stereo Amp. Kit (2 ea - 140-CX & P-140) (7 lbs.) $37.00

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UT-M—Single Channel Kit (14 lbs.) $60.00
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X-149C Psychedelic Strobe Kit (2 lbs.) $17.50
X-149A Assembled Psychedelic Strobe (2 lbs.) $29.95

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- Verify designs quickly
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DLM Complete kit as shown (5 lbs.) $29.95
RTL Cookbook by Don Lancaster (1 lb.) $5.50

FET PREAMP

156 Complete kit without power supply (5 lbs.) $44.50

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MMM Complete Amplifier, less cabinet with reverb and both preamps. (13 lbs.) $90.00
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NUMITRON READOUT DECADE COUNTER

NUM-1 Kit including circuit board, socket, and two integrated circuits (8 oz.) $13.50

DR-2010 "RCA-Numitron" readout (0-9 with decimal) $5.95

DR-2020 "RCA-Numitron" readout (+ or - and number 1) $3.95

MAIN FRAME

170 Power Supply & Cabinet (3 lbs.) $19.55

MNX-1 Multi-Decade® Nixie® Readout (1 lb.) $49.50

DIGITAL VOLT-OHMMETER

- Measures up to 2,000 volts
- 10 Meg OHM Input impedance
- Better than .5% accuracy
- Dual-slope conversion

VM-1 Voltmeter plug-in (2 lbs) $29.95

NIXIE® READOUT

Decade Counting Unit

NX—Decade Counter: Std. type, or NX-6 Modulo-Six (specify type) (5 oz.) $15.00

UNX—Decade Counter Up Down, storage type (7 oz.) $25.00

COUNTER FREQUENCY

- Measures frequency directly
- 1,000 Hz to 20 MHz full scale ranges
- .01% Accuracy-Line time base

FC-2 Frequency Counter Plug-in-kit (2 lbs.) $34.95

TIME PERIOD PLUG-IN

This instrument consists of a precision oscillator, divider circuits, and a controlled gate. Its six ranges accurately measure any time interval (plus or minus ten microseconds)

TM-2 Time period plug-in (2½ lbs) $38.75

MULTI-DECADE NIXIE© READOUT

- 3½ decades—one circuit board
- TTL circuits 10 MHz toggle rate
- Overflow indicator circuit

MNX-1 Multi-Decade® Nixie® Readout (1 lb.) $49.50

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1430—Short Proof Power Supply (8 lbs.) $39.50

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We are proud to offer this excellent series of simple, inexpensive integrated circuit projects. All of these projects make use of integrated circuits and printed circuit type construction. The finished projects are useful as demonstrators of digital circuit operation, or test equipment. All are packaged in a combination of brushed gold and wood grain cabinets.

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172 **Shift Register** (2 lbs.) $9.75

173 **100 KHz Frequency Standard** (2 lbs.) $10.85

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