QEX 48 February 1986 $1

The ARRL Experimenters' Exchange

Of Shooting Stars

Meteor-scatter (MS) propagation gets little attention in the American Amateur Radio press. A recent exception was the article by Clark Green, K1JX, in the January 1986 issue of **QST**. The European Societies have more frequent mention, usually of CW contacts at high speed. These references are to manually operated contacts using conventional modulation modes.

QEX, in August, 1984 announced MS tests planned using packet radio. The tests were timed to take advantage of the Perseids meteor shower. In October, 1984, **QEX** carried an article by Bob Carpenter, W3OTC, of routine 1200-baud contacts between W3OTC in Rockville, MD and WØRPK in Indianola, IA.

Jerry Stover, W5AE, wrote us to ask what's happened since. (Unfortunately, not a lot!) He believes it could well be the most reliable long-haul communications medium that amateurs could use. Before he retired, he was Chairman of Communications Industries, Inc, whose subsidiary, SECODE Electronics built the equipment used for the SNOTEL MS system with over 500 remote sites in ten western states. They ran all sorts of tests between Dallas and Washington, DC--a 1400-mile path and somewhat longer than the typical 1200-mile range usually cited. Jerry writes:

"The neat thing about MS is that it ties in with the packet-radio and computer age of ham radio so very closely. Also, due to the small footprint, QRM would not be a problem if all hams settled on just one or two channels in the 50-MHz band.

"I could envision that MS stations using autostart equipment could be spotted over the country to form a nationwide traffic net that would be there day and night, sunspots or not. With packet techniques they could store and forward automatically to the end station where it would then jump to local 2-m nets for delivery.

"Hams should be able to use 1 kW and 10 dB of antenna gain to handle some long-haul stuff to go VE-VO-OX-TF-GM for the transatlantic.

"The whole key to a nationwide system would be establishment of a standard format, protocol, frequency, etc, and the League is the proper group to do just that."

Well put! As packet radio now stands, up to 8 relays are possible with AX.25 protocol using 1200-baud 2-meter digipeaters in many areas of the country. Most of these areas are connected by HF skywave between WØRLI computer-based message systems that serve as HF-to-VHF gateways. These gateways could have been, and still can be, connected by means of 6-meter MS. A minimum of 12 MS gateways each connected to 2-meter packet-radio nets capable of up to 8 relays apiece could provide reliable store-and-forward service to the entire contiguous 48 states.

So what's stopping us (other than a piggy-bank account, and burnout)? First, there are lots of packet-radio terminal-node controllers (TNCs) around these days. But, 1200 bit/s is too slow for MS; 9600 would be a lot better, but 9600-bit/s modems(compatible with the few existing 6-m radios) are not available. I believe that a 9600-bit/s modem capable of interfacing with something like the ICOM IC-551 and designed to have a bandwidth not to exceed 20 kHz at -26 dB points would be the catalyst to make MS packet a reality. W1AW has everything needed to get on MS with 1 kW except the modem. I'm sure that other stations would be willing to participate in experiments. If you would like to be part of the solution, please drop me a line. On-the-air tests would help us to optimize protocols for the MS environment.

Fortune Cookie

A pleasant surprise awaits you in next month's **QEX**. -- W4RI

Correspondence

Comments on Moonbounce

I saw Rick Wilson's, WØKT, article on "Cheap Moonbounce" in the October 1985 (no. 44) **QEX.** I cannot resist commenting as I do planetary radar for a living. Though the separate arguments have merit, I doubt the proposal as a whole would work.

Cutting down the bandwidth **will** help; I think Orr's 100 Hz is excessive. But, if you are going to narrow the bandwidth, your local oscillator(s) must be stable enough to guarantee that the signal doesn't drift out of the passband. I doubt that you can find an oscillator good enough to give you 0.0625-Hz stability and stay within your budget. I suspect Orr chose 100 Hz as some sort of practical compromise between performance and expense.

A related point is that you must be able to predict exactly where your received signal will appear if you're going to capture it within the 0.0625-Hz window at 144 MHz. It's going to take a fairly sophisticated computer-driven synthesizer on either your transmitter or receiver (you don't need both) to do this. Your computer will have to predict relative motions of your station(s) and the moon very accurately, then translate that geometry into the appropriate Doppler shifts. That won't be easy with the precision requirements you are imposing.

Thirdly, the signal that comes back will have some bandwidth of its own. Suppose you use A1 with alternating key-up and key-down periods of two seconds each. The transmitted signal already has an inherent bandwidth of something like 0.25 Hz. If you try to receive this with a 0.0625-Hz passband, you'll be throwing away most of the available energy.

When the signal interacts with the moon, it is Doppler broadened. The moon rotates slightly ("librates" is the technical term), even though on-average it keeps the same face toward the earth. Different parts of the moon's surface impart different Doppler shifts to the echo; the total signal that comes back thus appears to be smeared in frequency rather than being a clean sinusoid. This spread is not large at 144 MHz, but it could be important compared with your 0.0625-Hz bandwidth. The actual value depends on many factors.

You are correct in believing that the integrator can improve signal-to-noise ratio, but it only works if you maintain completely stable local oscillator phase over the entire observation period (as per comments above). If you can't do that, the signal will have positive and negative values, just as the noise does, and be washed out with it. Since you cannot control the moon's libration, the longest successful integration you could expect would be a few seconds. You can the combine the results of many integrations, but that improvement in performance is slower.

The noise from the entire 2.1-kHz bandwidth gets folded in with the signal, making your detection process that much more difficult. A physical filter with a bandwidth close to the width of the signal you expect would cut out most of this noise and pay handsome dividends in improving your detection probabilities.

Finally, I don't understand why you want to switch between circular polarizations. Interfering signals will generally have some polarization which is neither linear nor circular — and you won't know what it is. You can fiddle with your balance to eliminate **one** interfering signal, but you will make most of the others worse. Also, Faraday rotation may be different on the signals you transmit with left- and right-circular, which makes recovering the desired signal more difficult if you want simply to add the outputs of two receivers. Clearly you want circular polarization of some type, but I'd pick one or the other and stay with it; I doubt there is much advantage in switching. -- Dick Simpson, W6JTH, ARRL TA, 3326 Kipling St., Palo Alto, CA 94306.

Mr. Wilson's Response

I am pleased by the response I have received concerning my article, "Cheap Moonbounce. I have learned several interesting aspects of weak-signal characteristics and have helped stir up some critical thinking about the possibilities for low-power, small-antenna moonbounce contacts via Amateur Radio. Most informative were two rather lengthy responses from Dick Simpson, W6JTH, and Bob Larkin, W7PUA.

The use of envelope detection, namely the use of the AGC voltage, introduces a quantity of degradation into the system. In order to stay cheap, I advocated this detection method since the ability of two stations to maintain their signals within a 2.1-kHz bandwidth is reasonable, considering the accuracy and stability of the reference oscillators likely to be used in a moderately priced VHF amateur transceiver. Bob pointed me to a discussion of the "signal suppression" phenomenon and enclosed a chart of the expected degradation. [1] The degradation does not greatly affect signals well above the zero-dB signal-to-noise (S/N) level, but affects weak signals near and below that level. My statement that the S/N ratio can be improved by reducing the bandwidth is true proportionally only for strong and weak signals which have been filtered **prior** to detection. Reducing the bandwidth after detection is still helpful, but not as helpful as predetection band-

(Correspondence is continued on p. 9)

TI-99/4A Keyboard Conversion For the TS-1000 Computer

By Eric J. Grabowski, WA8HEB
17020 Snyder Road, Chagrin Falls, OH 44022

With computers performing many Amateur Radio tasks in the shack, it is not surprising to see modification articles on how to run each unit more efficiently. This article is written to assist those who own both a surplus TI-99/4A computer keyboard and a TS-1000 computer. The keyboard can be easily modified for use with a TS-1000 computer. Only 19 jumpers are required and it takes about an hour.

Modification Instructions

Remove and discard the original ribbon cable supplied with the keyboard. Using a marking pen, label each key on the foil side of the keyboard for reference. Perform the modifications listed in Table 1.

Remove and discard the keyboard connectors on the computer. Then, use the wire list in Table 2 to connect a new ribbon cable from the modified keyboard to the computer.

If any reader has information on where to locate a schematic for the Timex-Sinclair 16-k RAM Module (TS-1016), I would appreciate hearing from you. I will supply a schematic for the TI power supply board or the original TI keyboard for $.25 (photocopy cost) and an s.a.s.e.

TABLE 1
TI-99/4A KEYBOARD MODIFICATIONS FOR
SINCLAIR AND TIMEX COMPUTERS

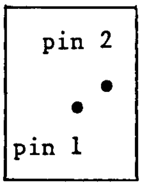
KEY NAME	PIN 1 ISOLATE	PIN 1 JUMP TO	PIN 2 ISOLATE	PIN 2 JUMP TO	REMARKS
=	No	---	No	---	Not Functional.
/	No	---	Yes	---	Not Functional.
ENTER	Yes	L(1)	Yes	P(2)	
;	Yes	---	Yes	---	Not Functional.
SHIFT	Yes	V(1)	Yes	Ø(2)	Near FCTN Key.
,	No	---	Yes	---	Not Functional.
.	No	---	Yes	L(2)	
M	No	---	Yes	K(2)	
N	No	---	Yes	J(2)	
B	Yes	N(1)	Yes	H(2)	
V	No	---	Yes	G(2)	
C	No	Pin 11	Yes	F(2)	
X	No	---	Yes	D(2)	
Z	No	---	Yes	S(2)	
SHIFT	Yes	Z(1)	Yes	A(2)	Near CTRL Key.
FCTN	No	---	No	---	Not Functional.
SPACE	No	M(1)	Yes	Q(2)	Cut Above Jumper.
CTRL	No	---	Yes	---	Not Functional.
ALPHA	Yes	---	No	---	Not Functional.
1	No	---	No	Pin 8	

Notes:
1. Comma and period keycaps swapped so that period resides adjacent to the M-key.
2. Isolate means to cut trace(s) away from switch terminal pad as close to the switch terminal as possible.
3. Jumper To means to install a 30-AWG insulated wire between the pin and destination listed; e.g. L(1) means pin 1 of L-key.
4. Pins 8 and 11 are on the keyboard connector. Pin 1 is closest to the 4-key. After modification, pins 6 and 12 are not used.
5. Keyboard is Stackpole assy. 1039019-1, 76-1151, 86-90-0037.
6. Switch terminals are numbered 1 and 2 for convenience, see figure.
7. Entry "---" means no jumper wire is required.

TABLE 2
TI-99/4A TO TS-1000
KEYBOARD INTERFACE WIRING

KEYBOARD PIN	COMPUTER PIN	REMARKS
1	KB2-5	Near 4-key
2	KB2-3	
3	KB2-4	
4	KB2-7	
5	KB2-8	
6	---	Not Used
7	KB2-1	
8	KB1-Ø	
9	KB1-4	
10	KB2-2	
11	KB2-6	
12	---	Not Used
13	KB1-1	
14	KB1-2	
15	KB1-3	

Notes:
1. Pin 1 on the keyboard connector is near the 4-key.
2. Remove KB1 and KB2 connectors from computer and use short piece of 13-conductor ribbon cable.



Labels given to keyswitch terminals for convenience.

Switch Viewed From Foil Side.

FIGURE 1

Microwave Patent Summaries

By William Conwell, K2PO,
1620 Willamette Center, 121 S.W. Salmon St.,
Portland, OR 97204

Eight short microwave patent summaries are presented here. This compact approach is the best way to expose as diverse a range of patents covering this subject area to the readers of **QEX**.

4,479,100 **Impedance Matching Network Comprising Selectable Capacitance Pads and Selectable Inductance Strips or Pads.** A customizable microwave matching circuit is formed with several microstrip capacitive and inductive elements, each of which may be selectively included or omitted from an L-C-L type "T" network.

4,484,163 **Arrangement for Biasing High-Frequency Components.** Bias voltage is applied from a power supply to a transistor through a tuned microstrip circuit which provides good RF isolation over an octave bandwidth.

4,489,292 **Stub-Type Bandpass Filter.** A bandpass filter is formed using three quarter-wave stubs, the stubs being grounded at one end, open at the other end and fed in-between. This filter configuration provides a broad passband and substantial attenuation at frequencies which are double or treble the passband.

4,490,695 **Wide Band Power Adder-Divider for High-Frequency Circuits and Impedance Transformer Realized on the Basis of the Adder-Divider.** A microstrip power adder-divider is described having a usable bandwidth of several octaves. The circuit can also be configured to act as a two-to-one impedance transformer over similar bandwidths.

4,491,809 **Matching Circuit for a Preamplifier of SHF Band Television Signal Receiver.** A family of microstrip matching circuits is described which matches a receiver preamp to an antenna over a wide passband while providing excellent suppression at the mixer image frequencies.

4,492,939 **Planar, Quadrature Microwave Coupler.** A microstrip coupler device having simple rectangular geometry splits an input signal into equal amplitude quadrature outputs with minimum cross-coupling. Dimension b = 0.46 λ center. Dimension a = b + microstrip width x $\sqrt{2}$.

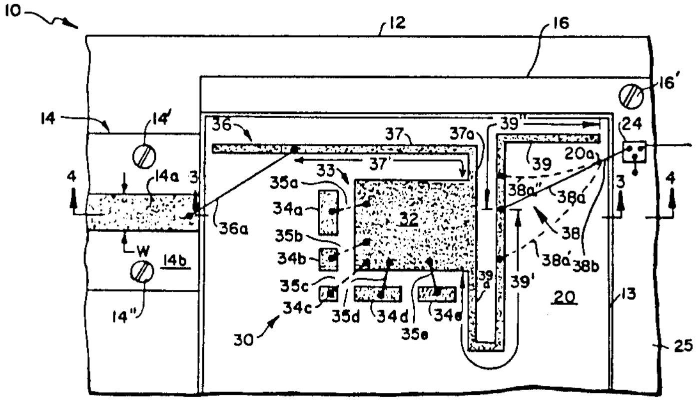
4,492,960 **Switching Mixer.** Two mixer diodes and a 90 degree 3-dB hybrid are combined to form a switching mixer. This mixer permits a single oscillator to function as both the local oscillator and the transmitter in a low-power RF system without the need for duplexing or circulator circuits. The mixer circuit may also be used as a variable attenuator or modulator.

4,494,100 **Planar Inductors.** A planar inductance element is formed by etching a spiral pattern on both sides of a double sided printed circuit board and joining the two spirals at their middles. The arrangement provides greater inductance per unit area than prior art planar inductors and can be modified to allow the inductance to be varied.

Copies of these patents are available from the Commissioner of Patents, United States Patent and Trademark Office, Washington, DC 20231 for $1 each (approximately four week delivery).

Caveat: "Whoever without authority makes, uses or sells any patented invention, within the United States during the term of the patent therefor, infringes the patent." 35 U.S.C. Section 271.

Information on these patented inventions is printed here in accord with **QEX**'s stated purposes of (1) providing a medium for the exchange of ideas and information; (2) documenting advanced technical work in the Amateur Radio field; and (3) supporting efforts to advance the state of the Amateur Radio art. These inventions may not be practiced, without a license from the inventors or assignees, for 17 years. Nonetheless, it is believed that publicity of such advances in the state of the art will broaden the prospective of amateur experimenters and promote future technical advances within the amateur community.



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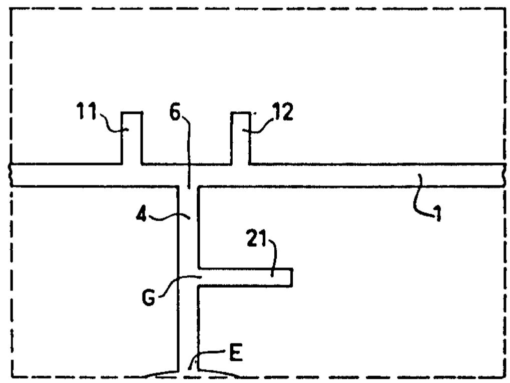

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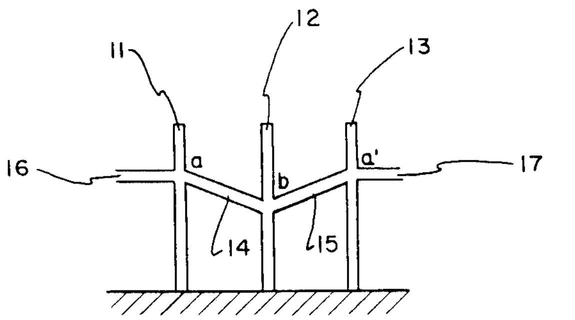

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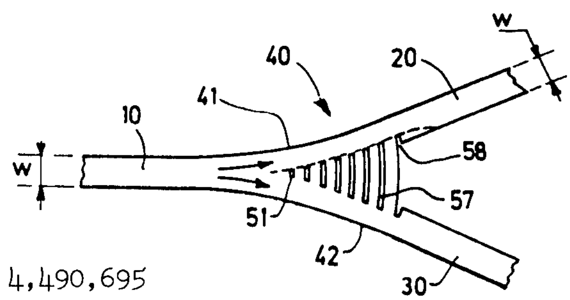

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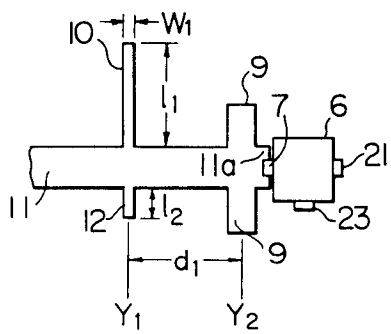

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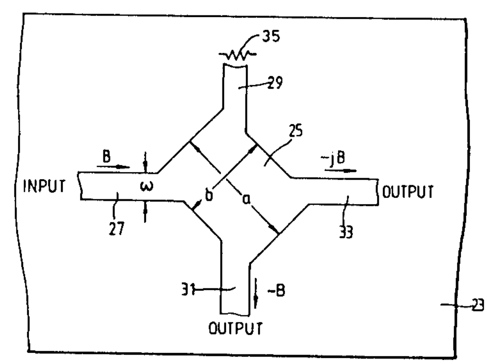

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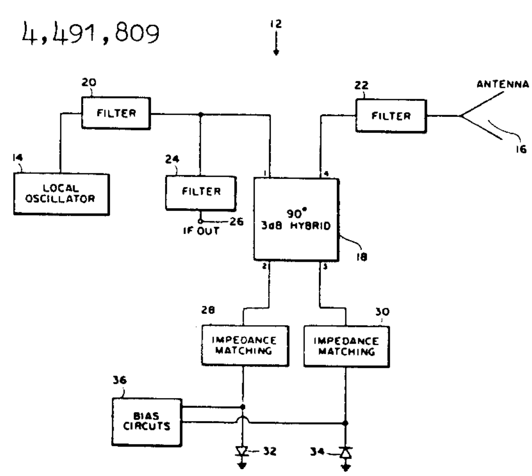

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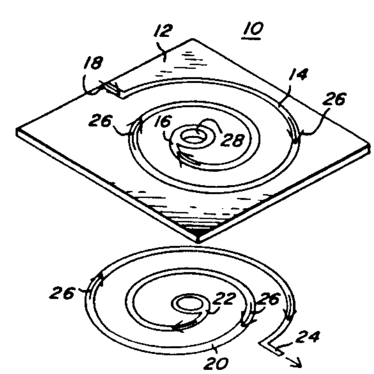

4,494,100

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Computers

Editorials

Miscellaneous

(Continued from p. 2)

width reduction. Post-detection filtering requires much less sophistication, especially where narrow bandwidth and stability are difficult to attain.

The second area of interest concerns the necessary and obtainable RF bandwidth, and the subsequent stability required. On this point, both Dick and Bob presented some interesting information on the resultant received signal after a trip to the moon and back. The libration, the wobbling caused by the moon's attempt to rotate in the presence of the earth's gravitational field, causes a short-term time variance in the signals being reflected off it. Also, the signal is not reflected by a single point on the moon, but from a range of locations, whose two-way distances vary. The result is effectively close-in phase noise, or spreading of the signal about a range of frequencies. Bob's conclusion is that the practical minimum bandwidth for a signal reflected off the moon is about one Hertz. My suspicion is that the minimum RF bandwidth is a bit wider.

In addition, the libration problem is the need to accurately predict Doppler shift to maintain a narrow RF bandwidth. This is no big deal; most desktop computers should be able to handle it. The real kicker involves the receiving and transmitting equipment used. My employer, Quintron, purchases ultra-high stability oscillators for use in paging applications at a purchase cost of several hundred dollars each. Typical stability is 0.05 parts per million, about 7 Hz at 144 MHz. An RF-signal accuracy of less than one Hertz at 144 MHz is not "cheap." Just as aggravating is the phase noise of a typical all-mode 2-meter transceiver, which uses a synthesizer with 100-Hz steps. If one imagines an ideal filter with a bandwidth of one Hertz, centered about the transmit frequency of a CW signal, the power loss would easily exceed 3 dB since, at any instantaneous moment in time, the signal would not be close enough to exact to pass unattenuated through the filter. My conclusion was that it would not be feasible to reduce the RF bandwidth to 0.0625 Hz. Dick and Bob's comments have strengthened that conclusion. In the area of RF stability, Dick missed the boat a little in saying that the stability needed is difficult to obtain. All that is necessary with envelope detection, as mentioned above, is the ability to stay within the 2.1-kHz bandwidth. Such accuracy is within the ability of a typical transceiver whose reference has recently been compared with a reference standard. Despite the degradation introduced by post-detection filtering, as pointed out by Bob, I am still advocating this method as being reasonably attainable and "cheap," at least for now. It may require more power or longer bits than I earlier posited, however.

My third point concerns modulating the handedness of circular polarization. An effective modulation system should offer some immunity to ambient noise and interfering signals. My method is to subtract one detection mode from another by comparing the results of listening with both types of handedness. This is superior to attempting to listen to a CW signal and attempting to determine the signal's presence or absence. An FSK detection system would be about as effective. Two filtered detectors would indicate a signal strength, and a comparator would subtract one from the other, voting for the stronger, regardless of the absolute levels at either detector. Modulating the handedness requires two RF relays or two RF diode switches; detecting it requires RF diode switches or two receivers. Sending FSK requires the ability to alter the transmit frequency; detecting it requires changing and comparing frequency or the use of two separate receivers (or IFs). This assumes that the type of FSK employed be no more rigorous in its frequency requirements than handedness modulation, i.e. both frequencies have a 2.1-kHz window.

Those who are cognizant of digital signal-processing methods may have other ideas for computer detection of extremely weak signals. For example, highs and lows could be determined by a change in the modulating frequency of an FM signal. A digital signal processor could be tuned in on a small band of frequencies, looking for such a signature. How about some more ideas that involve ingenuity, rather than ceramic tetrode amplifiers and rotatable jungle gyms?

[1] Middleton, David, **An Introduction to Statistical Communication Theory**, McGraw-Hill, 1960, pp. 553-555. -- Rick Wilson, WØKT, 2221 Maple St., Quincy, IL 62301.

Info Wanted on Building a CW Keyer

I recently purchased an Alpha-Numeric Keyboard made by the Mitsumi Co., for Radio Shack. It has two ICs on the board marked 3E4T - HD 14051BD. I would like to know what these chips are and how they could be used in a CW keyer.

Is there any information or published circuits in Amateur Radio related literature regarding a CW keyer of this sort? Any information in this area would be appreciated as I am interested in building a CW keyer for my transmitter. — Alexander Bogash, W3BVC, P. O. Box 765, Peabody, MA 01960.

Bits

Cynwyn Offers Two New Programs for the Radio Shack Computer

HF Antenna Design is the latest offering from Cynwyn for Amateur Radio enthusiasts and the Radio Shack Model I/III/IV. The program makes the necessary calculations for the dipole, Yagi, and quad, for frequencies of 1.8 to 30 MHz, and displays them in an easy-to-read tabular format. **HF Antenna Design** requires 16-k RAM, and is available only on cassette from Cynwyn, 4791 Broadway, Suite 2F, New York, NY 10034, tel (212) 567-8493. Cost is $14.95 plus $2 shipping.

The Log runs on a 16-k or 32-k ECB Color Computer (Radio Shack) and is available in cassette or RS-DOS versions. The program tests for memory and configures itself to use the maximum available memory. **The Log** provides fields for entering data such as call sign, QTH, date, remarks, and allows the operator to make a printout of his logbook. Up to 13,600 contacts can be stored per diskette. Price from Cynwyn is $19.95 for cassette and $24.95 for diskette, plus $2 for shipping. The call sign of the user is required when ordering.

New Spectrophotometer Has Unmatched Levels of Precision and Reliability

HunterLab of Reston, VA, recently introduced the UltraScan™, an advanced spectrophotometer for color and appearance analysis. UltraScan features a sphere optical sensor with the highest reflectance sphere coating available today. New software allows the user to obtain reflectance and transmittance measurements that achieve precision and realiability.

The UltraScan is interfaced to an IBM® PC, XT , with standard color display, for accurate and rapid data processing. The system allows the user to compare related samples on a spectral curve plot or color difference graph, and provides storage for both standard and sample data. It performs measurements in 22 color scales and indices under nine separate illuminants, and is available with a wide range of options to meet specific requirements in a variety of industries.

For additional information, contact Hunter Associates Laboratory, Inc., 11495 Sunset Hills Rd., Reston, VA 22090, tel. (703) 471-6870, ext. 278.

ASM — Book and Software Catalog

Metals Handbook, Powder Metallurgy, and an IBM program called **Metal Selector.** What do these three have in common? They are each listed in the American Society for Metals book and software catalog. Whether you work with a certain phase of processing metals, or from the basics of metallurgy, one of the many handbooks or computer programming applications may be the one for you.

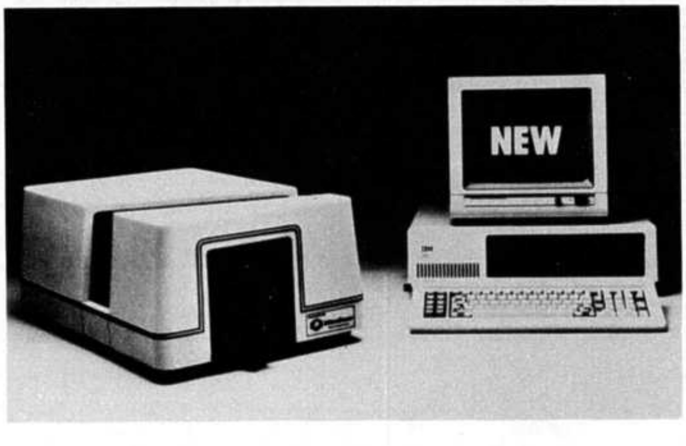
If you are interested in receiving your own catalog, contact the American Society for Metals, Book Order Department, Metals Park, OH 44073. There are over 100 publications and approximately 40 software packages to choose from.

Designer's Toroid Kit

Pulse Engineering, a subsidiary of Varian Associates, is a major manufacturer of a broad range of magnetic devices that include delay lines, pulse transformers, high-frequency power magnetics and EMI line filters. One of their newer features is an 845 Designer's Toroid Inductor Kit.

This kit provides electronic design engineers a selection of 19 different low-cost toroids, which are featured in the **Inductors** product catalog no. 845. Powdered iron inductors are typically used in power supply and filtering applications. Inductance values range from 20 µH to 450 µH. Current ranges are from 2-A dc to 10-A dc.

The 845 Designer's Toroid Inductor Kit sells for $20 from Pulse Engineering Magnetics Division, P. O. Box 12235, San Diego, CA 92112, tel. (619) 268-2400.



HunterLab's UltraScan™ spectrophotometer diffuse/8° integrating sphere sensor (left), interfaces with IBM® PC XT (right).

Miniature Manual Line Includes Square Pushbuttons and Indicators

The Micro Switch Miniature Manual Line (MML), now offers tiny (0.390 x 0.390 inches) square pushbuttons and indicators. Their size allows them to fit into small spaces, and their uniform housing depth of 17mm allows for quick and easy installation (they can be cleaned both before and after wave soldering).

Consumers are offered a choice of full-face incandescent or LED lighting, or unlighted versions, and hot stamp legending is also available. A variety of mounting options are also offered, such as horizontal and vertical strip mounting and support frames to provide additional mounting strength for stand-alone pushbuttons.

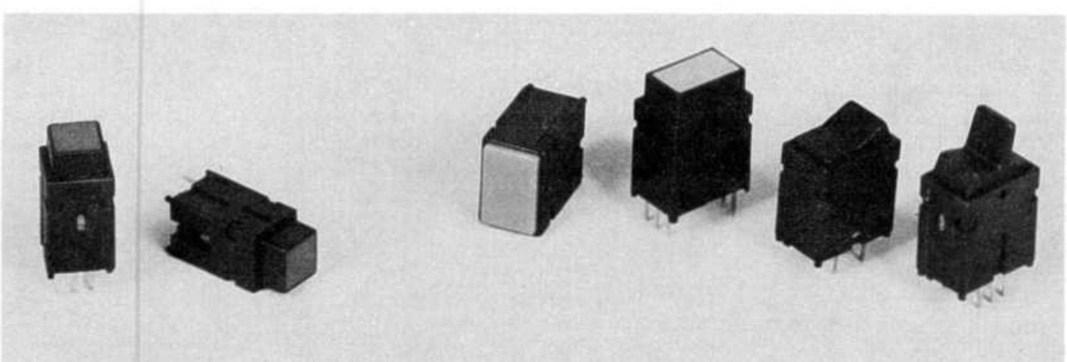
The square MML units offer electronic, one- or two-pole switching circuitry with gold or silver contacts. Ratings range from one to six amps, and all MML units are designed to meet UL, CSA, and other international standards. For more information on MML miniature manual controls, write MICRO SWITCH, a Honeywell Division, 11 West Spring St., Freeport, IL 61032, tel. (815) 235-6600.

Cericor's Future in HP's Hands

Cericor, Inc., of Salt Lake City, UT, is presently being considered for new ownership. Back in September 1985, Hewlett-Packard Co. announced it had signed a letter of intent to purchase all of the assets of Cericor, a company which develops advanced computer-aided-engineering (CAE) software tools.

Prior to this date, the two companies reached an agreement to integrate Cericor's CDA 5000 software packages into HP's logic-design products for CAE application. Cericor, Inc. will become an entity in the recently formed electronic computer-aided engineering/computer-aided design (CAE/CAD) business unit of the Design Systems Group.

Cericor was founded in 1983 to develop software for the CAE/CAD/computer-aided manufacturing industries. The company's current product uses newly developed software techniques, including artificial intelligence, to provide an integrated solution to the development, manufacture and field support of digital-electronic products. HP is an international manufacturer of measurement and computation products and systems used in many fields worldwide.



Square pushbuttons and indicators (left) have been added to the MML series of miniature manual controls from Micro Switch. The line offers a complete selection, including rockers and paddles, with a choice of unlighted or incandescent or LED versions, all with a total depth of only 17mm.

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The purposes of QEX are to:

1) provide a medium for the exchange of ideas and information between Amateur Radio experimenters,

2) document advanced technical work in the Amateur Radio field, and

3) support efforts to advance the state of the Amateur Radio art.

Subscriptions are available to ARRL members and non-members at the rates shown on the QEX Subscription Order Card inside this issue.

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