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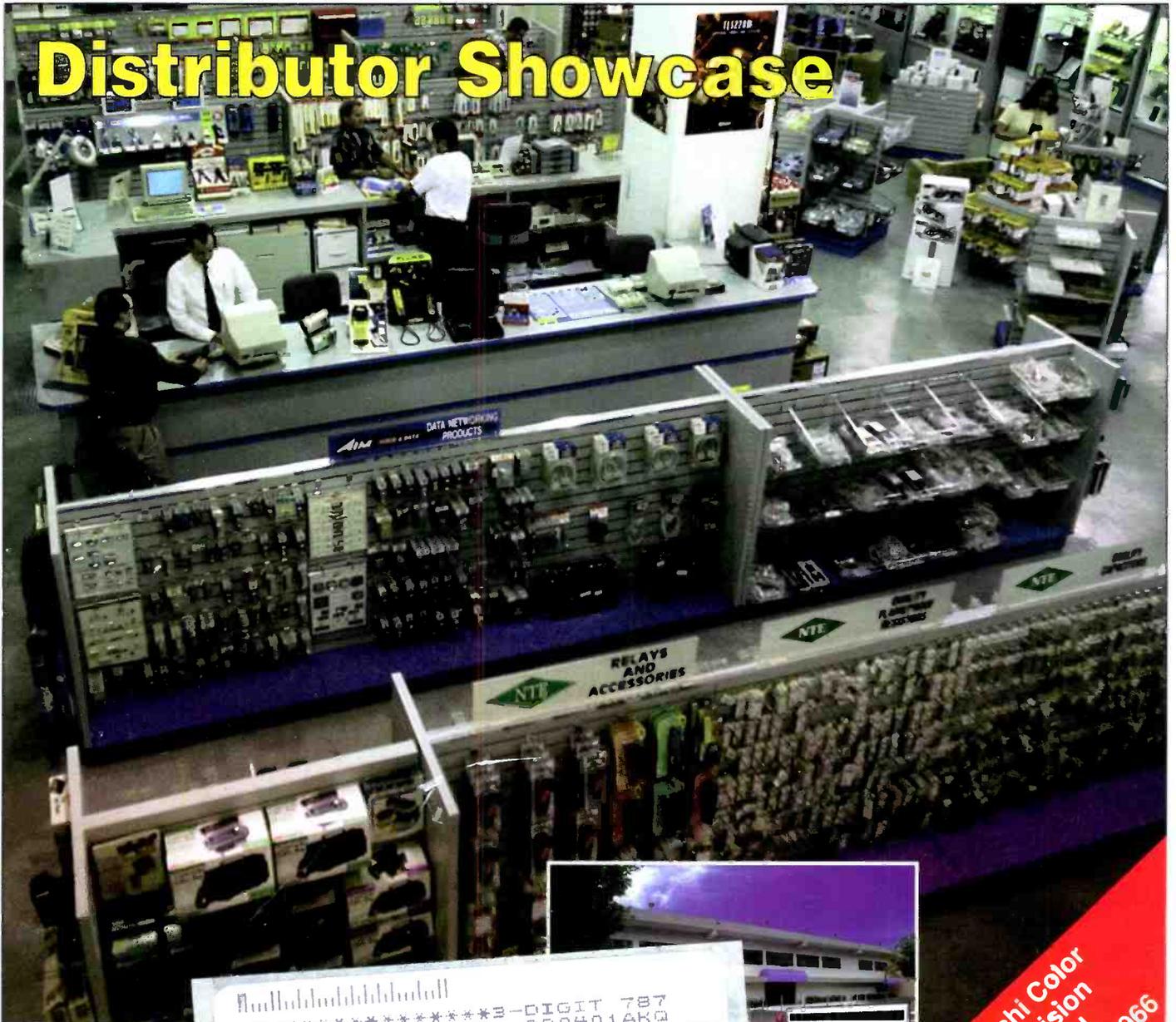
## Servicing & Technology

April 1999

Let's talk about tuners

Service management software

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# ELECTRONIC

Servicing & Technology

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*by Bob Rose*

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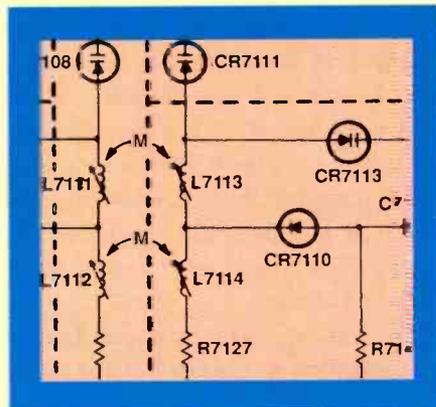
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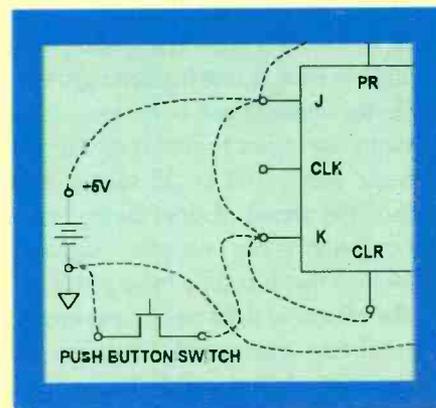
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The quality of service provided by a consumer electronics service center depends to a great extent on the speed and accuracy of the distributor in filling orders for replacement parts. If a service center is to repair a product reliably, in minimum time, it must be able to count on its distributor(s) to be able to provide the replacement parts, quickly and reliably. (Photograph courtesy Herman Electronics.)

# Let there be light

**L**ighting is not one of the subjects that most of us think a lot about. Homes and businesses are generally equipped with some overhead fixtures that we can control with the flip of a switch at the doorway to the room. If that doesn't seem to be adequate, we may buy a few lamps to place here and there to improve the lighting where it's needed. But most people don't have any idea, really, if the light available to us, or other facility, is adequate to perform the tasks required of them.

The more we learn about light, the more important we realize that it is. But light is important not only for seeing; it has a profound effect on biological organisms, a group to which humans belong. As an example, plants, which use photosynthesis to grow, naturally turn toward the sun. This is known as heliotropism.

Here's another example. As I write this, it is March, and the days have become considerably longer than they were in December. The leaf buds on the trees have begun to swell. It will not be long before the trees are bursting forth with leaves. The weather during the winter was warmer than it is now, but the leaves

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***“But there's much more to proper lighting than just adding more overhead lighting, or putting a few tasks on the service bench.”***

---

didn't burst forth then. The longer period of light is what is making them grow.

On the opposite end of the year, in the autumn, the leaves begin to fall. The reason the leaves fall is the shorter days reduce the period of time during which photosynthesis can take place, signaling the leaves that it is time to be going.

The effects of light on humans are still not entirely understood. They are still being studied. But we do know a few things. For one thing, some people

become profoundly depressed during the wintertime when the sun is in short supply. This effect is known as seasonal affective disorder, or SAD. Experimentation has shown that by exposing themselves to very bright light during the dark days of winter, these people can ameliorate, or, in some cases, even totally overcome this problem. More recent experiments suggest that exposure to light helps the human organism to reset its internal clock to keep it correctly synchronized with the rhythms of the passing days.

Moreover, humans are frequently called upon to perform difficult visual tasks. That is certainly true in consumer electronics servicing, where technicians are required to perform visual inspections of faulty products, read complex schematic diagrams, and remove and replace tiny components and intricate subassemblies. In other words, the duties of a technician require a lot of light. And sometimes, depending on the nature of the work, those duties also require magnification. Circuit traces and those tiny components are so small as to be almost invisible without some magnification.

But there's much more to proper lighting than just adding more overhead lighting, or putting a few task lights on the service bench. For one thing, color is important to a service technician. Even though most connections between components these days are via printed circuit board traces, there are some insulated wires in consumer electronics products. Some lighting in use today, such as the very yellow sodium vapor lamps and a few other types of lighting, emits a very limited portion of the visible light spectrum. With such lighting, someone viewing an object may not be able to discern at all what color it is. When it's important to know what color the insulation on a wire should be, lighting such as that is really not appropriate.

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***“Moreover, the type and quality of lighting used in a facility, such as a consumer electronics service center, can affect the mood of the people who work there.”***

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Moreover, the type and quality of lighting used in a facility, such as a consumer electronics service center, can affect the mood of the people who work there. And the mood of the workers can affect their productivity. For example, one very important factor in lighting is to be sure that the ceiling and walls are adequately lighted. If the center of a room is lighted, but the walls are left dark, the overall feeling is one of gloom, or it might even feel threatening.

One other important aspect of lighting is its cost. Most of us rarely think about the amount of the electric bill is represented by the cost of providing lights with electricity, but it's a considerable portion of the bill. Once people become aware how great the cost of electricity for lighting actually is, they're sometimes tempted to cut down on lighting. Given the many important reasons for good lighting, including good morale and productivity, cutting down on lighting may not be such a good idea. There are, however, ways to cut down on the costs of electricity associated with lighting.

Today, lighting manufacturers have come up with a number of products that provide high light output while using much less electricity, as described in an article in this issue. While lighting is only one of the factors that a supervisor in a service center has to consider, it is a more important factor than most of us realize, and should be given due consideration.

*Mike Conrad Penner*

# ELECTRONIC

Servicing & Technology

**Electronic Servicing & Technology** is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

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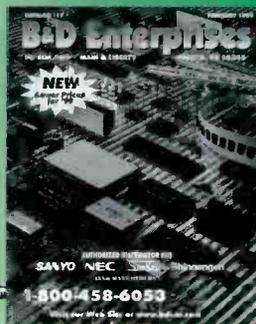
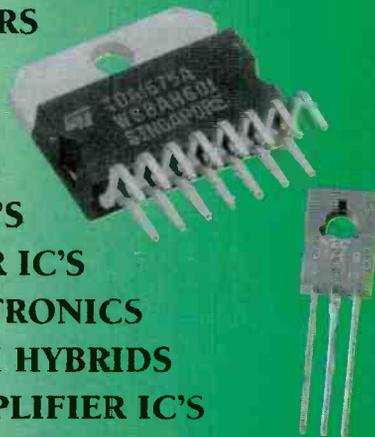
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### **Certified Electronics Associate Exam approved as prerequisite for ISCET associate Certified Electronics Technician Exam**

The International Society of Certified Electronics Technicians (ISCET) officially accepted the Certified Electronics Associate (CEA) exam as one of the qualifications for its own Journeyman Certified Electronics Technician (CET) exam.

To certify technicians on their competency in manufacturing and servicing electronics products, the Consumer Electronics Manufacturers Association (CEMA) launched its national electronics technician certification program, the Certified Electronics Associate (CEA) exam, last September. Those who pass the exam possess the knowledge and abilities to succeed in the highly competitive international electronics marketplace, including the consumer, component, industrial, government, medical, and telecommunications electronic industries.

"This is a landmark step for the CEA program. Before this announcement by ISCET, there were two independent electronics associate technician exams; the CEA and ISCET's CET Associate level exam. Now there are two exams, either of which can lead to the ISCET Journeyman level CET," said Don Hatton, CEMA's vice president of product services. "Both ISCET and CEMA are dedicated to improving technical competency and the electronics industry looks to both our organizations to offer leadership to the electronic service industry. ISCET encourages those technicians with their CEA to set their sights even higher and obtain their Journeyman CET ranking. "ISCET is pleased to be working with CEMA in this industry unifying step," said William S. Warren CET/CSM, chairman of ISCET.

For more information on CEA testing and study guides, contact CEMA's Product Services Department at (703) 907-7670, or fax: (703) 907-7968.

### **CEMA publishes component video standard to link cable boxes and TV receivers**

To help analog television and digital television (DTV) receivers link to cable set-top boxes, the Consumer Electronics Manufacturers Association (CEMA) pub-

lished standard EIA-770. This three-part, component video standard addresses the cable/TV connection for analog broadcasts/NTSC (EIA-770.1), standard definition TV (EIA-770.2), and high definition TV (EIA-770.3). The standard can support analog copy protection technology to safeguard transmission and broadcast of copy protected works.

For the first time, the popular color difference interface technology is standardized for consumer electronics products. Receivers with color difference interfaces do not need to decode a digital signal to utilize the incoming signal.

The Consumer Electronics Manufacturers Association (CEMA) is proceeding with four technical solutions to link cable and other set-top boxes to television receivers: a 1394 interface, the RF remodulator interface, a component video interface, and the National Renewable Security Standard (NRSS) interface. These efforts are designed to ensure that consumers who buy a DTV set in the future will be able to receive digital cable and use their DTV sets with other digital technologies like direct broadcast satellite (DBS), digital versatile disc (DVD) players, digital VCRs, and computers. The four interfaces will provide consumers and manufacturers a myriad of choices for connecting their TV sets to cable systems. With four interfaces, consumers will be able to choose from simple, low-cost connections to high-end, feature-rich models.

Interested parties can order EIA/CEMA standards through Global Engineering Documents, 1-800-854-7179 or <http://global.ihs.com>. CEMA engineering information can be found on CEMA's Website, <http://www.CEMAcity.org>.

### **DTV momentum builds**

Digital Television (DTV) momentum is building, as evidenced by sales of 13,176 units just weeks after the launch of digital broadcasts on November 1, according to Consumer Electronics Manufacturers Association (CEMA) President Gary Shapiro, speaking at a DTV Supersession at the 1999 International Consumer Electronics Show (CES) in January. At CES, consumer electronics manufacturers demonstrated the consumer electronics industry's broad commitment to DTV,

reporting extensive DTV product lines and strong early sales to dealers. The Supersession also featured a panel of speakers from the broadcast and retail industries, and a keynote from Federal Communications Commission (FCC) Commissioner Susan Ness.

"Momentum is building quickly on DTV. All of the major manufacturers have stepped up to provide a variety of products and retailers and consumers are demonstrating real enthusiasm for the technology. This is no longer a chicken and egg debate over products and programming — on the manufacturing side, this technology is hatched and is being served up to consumers all over the country," said Shapiro. He cautioned, however, that the transition will be gradual.

FCC Commissioner Ness spoke with enthusiasm about the successful launch of digital television, applauding the multi-industry effort that has made DTV a reality: "It has taken a collective effort to coordinate the DTV launch," Ness said. "It will continue to take cooperation to win the hearts and pocket books of consumers."

A panel of retailers and broadcast representatives — featuring Tom Campbell of Dow Stereo/Video, Joseph Flaherty of CBS, Stanley Hubbard of USSB, Saul Shapiro of ABC, Terry Shockley of Shockley Communications, and Peter Smith of NBC — reviewed the introduction of digital television and discussed plans for programming.

The manufacturer panel featured Jeffrey Gannon of Zenith, Mark Knox of Samsung Electronics America, Robert Minkhorst of Philips Consumer Electronics North America, Stephen Nickerson of Toshiba America Consumer Products, Inc., Jim Palumbo of Sony Electronics, Inc., Gilbert Ravelette of Thomson Consumer Electronics, Inc., and Frank DeMartin of Sharp Electronics Corp.

When Shapiro asked the manufacturer panelists what percentage of digital sets sold in 1999 would be standard definition vs. high definition, the response was unanimous that at least two thirds of all sets sold would be HDTV sets. When asked how the industry would define success in 1999, manufacturers stressed the importance of educating retailers and consumers to eliminate confusion about DTV. ■

# Let's talk about tuners

by Bob Rose

When I began servicing televisions, tuners were almost as large as a half a loaf of bread; huge mechanical monsters equipped with two vacuum tubes. Servicing these tuners was relatively simple when they were defective: either the tubes (an oscillator and an RF amplifier) were defective and/or the mechanical contacts inside the tuner were dirty and needed a good dose of tuner cleaner.

When transistors became popular and widely used, these mechanical beasts began to shrink in size, some of them becoming about the size of a twelve-ounce soft drink can. Servicing them got a little more difficult. Contacts inside the tuner still needed to be cleaned on a regular basis, but trouble inside the tuner often necessitated replacing it or shipping it to a repair depot to be refurbished. We techs could fix them ourselves, but the job was not only intricate but also time-consuming. Shipping it was the most cost-effective service procedure.

## The electronic tuner

The next step in the evolution of the tuner was the electronic tuner. Early elec-

Rose is an independent consumer electronics business owner and technician.

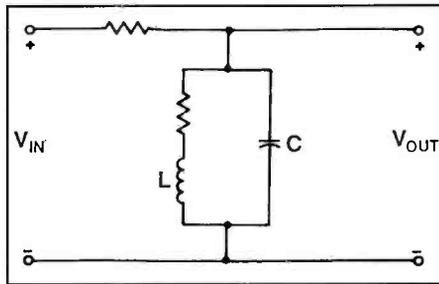


Figure 1. A simple parallel resonant circuit similar to what you find in almost any tuner.

tronic tuners still relied on a certain number of mechanical devices to tune the channels. I remember the early Zenith and RCA televisions. Each had a channel select knob, like its mechanical counterpart, that selected potentiometers used to establish a voltage applied to a varactor diode. The channel select knob gave way to a series of push buttons. If you wanted to view Channel 4, for example, you pushed the switch for Channel 4. However, you still had to set the pot that corresponded to the Channel 4 switch in order to tune Channel 4. There are still lots of those televisions in use. If you work on VCRs, you know that the early VCRs used such a tuner arrangement. If you have been servicing televisions for more than

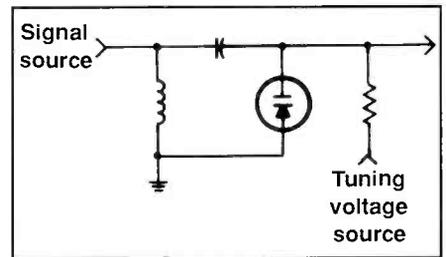


Figure 2. The diode in this circuit is a varactor diode, which acts like a voltage variable capacitor. Increasing the reverse bias across it causes the capacitance to increase, while decreasing the reverse bias causes the capacitance to decrease. This allows the resonant frequency to be raised or lowered electronically.

five or six years, you will also know that this tuning arrangement presented its own servicing challenges.

## Tuners of today

Things are different now. Most of the new tuners are no larger than a small, pocket transistor radio and have absolutely no moving parts because they are totally microprocessor-controlled. The new generation tuners are so small that if the damage is more than minor, the tuner usually has to be replaced. For instance, a lightning strike damaging an area about the size of one of my finger nails destroys

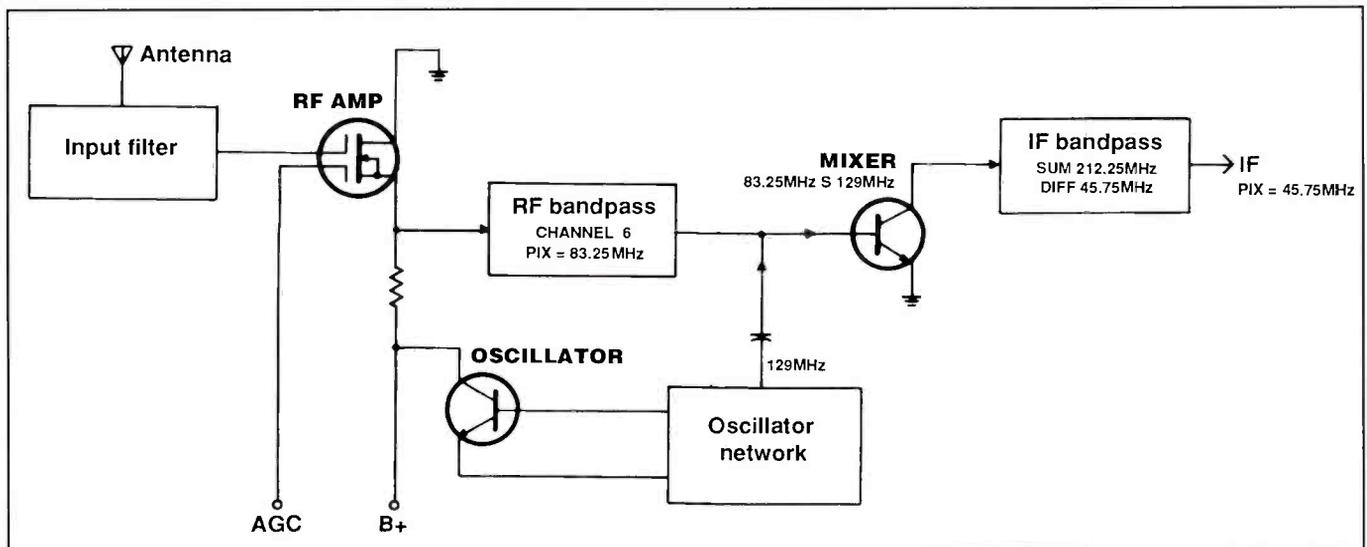


Figure 3. A tuner, any tuner, has certain basic elements, and will be constructed along the design shown here. This theoretical tuner has been instructed to tune Channel 6.

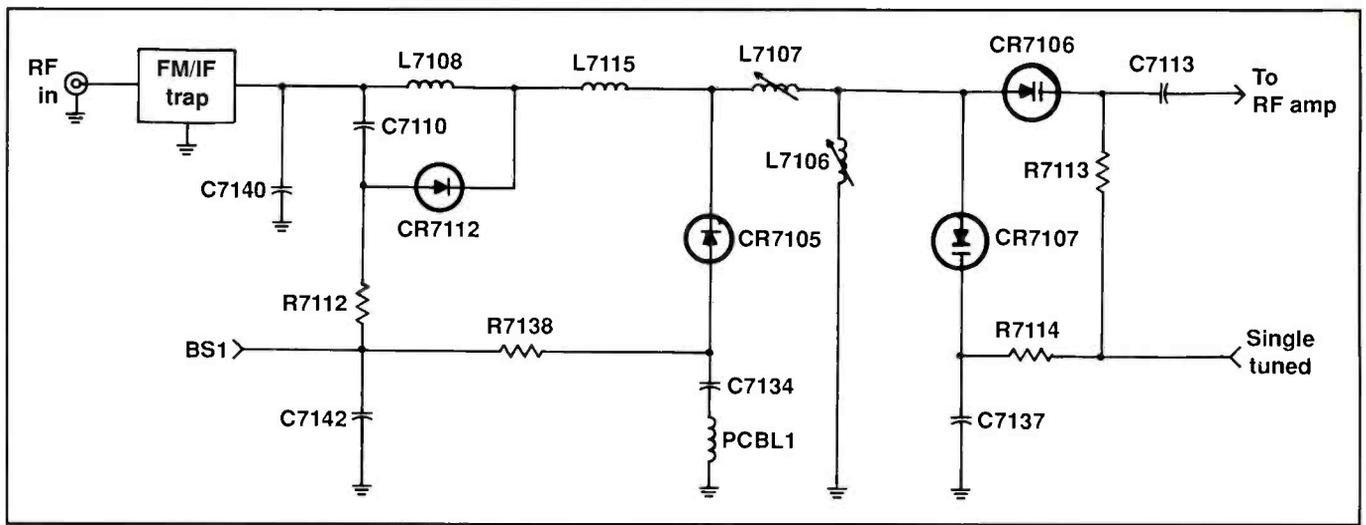


Figure 4. A more-or-less complete tuner.

so many components that nothing short of a miracle can cure it!

Some of the newer tuners are quite expensive. I just priced a tuner for a JVC TV at about \$95.00 (my cost). Some are moderately priced. A tuner for one of the new Sanyo TVs sells for about \$50.00. Others are inexpensive. I have purchased several Zenith tuners for less than \$30.00.

#### Tuner on board

I would be remiss if I didn't mention the most recent step in the evolution of the tuner. Of course, I am referring to Thomson Consumer Electronics' (TCE) development of what it calls "the tuner on board" (TOB), so named because it is built right onto the circuit board, instead being a part that can be replaced. It

debuted in the early 1990s when TCE introduced the CTC175/176/177 chassis and has become standard fare in every Thomson chassis since. I asked my field service engineer if Thomson had plans to revert to the "industry standard" practice instead of the TOB. He said Thomson would continue to utilize TOB technology. For better or for worse, the tuner as an integral part of the motherboard is here to stay, at least for RCA/GE televisions. As of this writing, TCE is the only manufacturer using TOB technology.

Given the cost of tuner replacement versus the cost of new televisions and the fact that TCE uses TOB technology, it behooves us who make a living fixing televisions to learn all we can about tuners. The more we know, the better we

can do our jobs. The better we do our jobs, the better our livelihood gets. So, let's talk about tuners.

#### Inductors, capacitors, resonant circuits, and varactor diodes

The cable system in my hometown is a relatively small outfit. It routes a cable to my house carrying the frequencies of 35 stations. The tuner in my television has the job of selecting the channel I want to see from the 35 possibilities and processing it so I can watch it and only it.

Each "channel" is 6MHz wide and contains audio and video that the tuner must convert to a common intermediate frequency (IF) from which other circuits in the television receiver extract the video and audio information. The tuner accom-

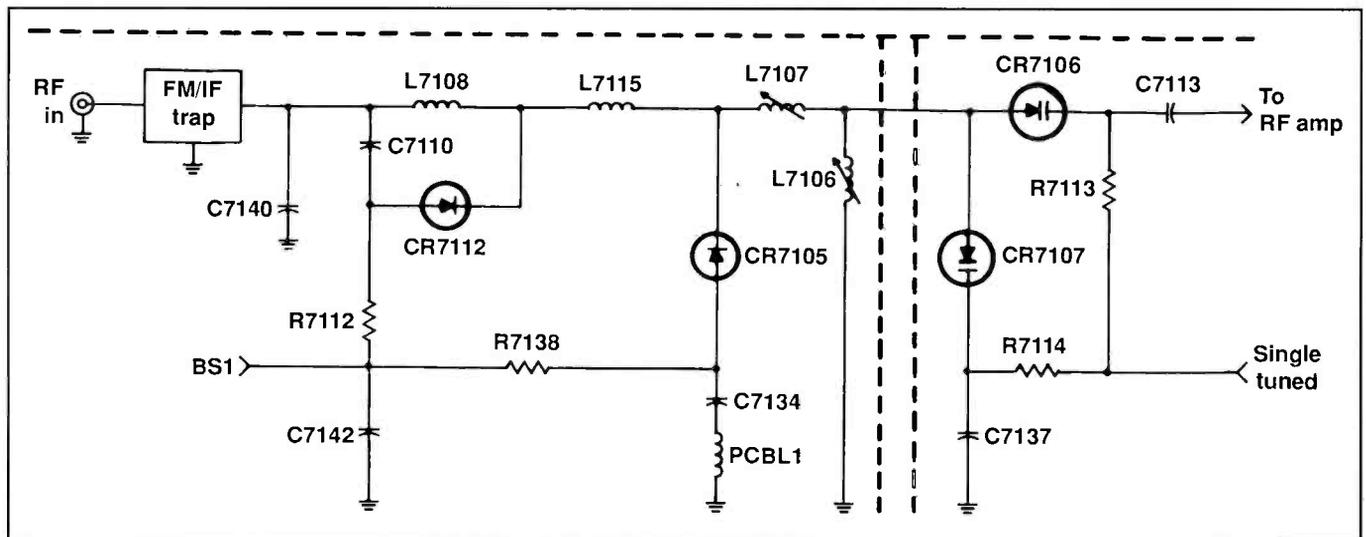


Figure 5. The dashed lines indicate signal flow when the tuner has been asked to tune a channel in the low-band VHF spectrum.

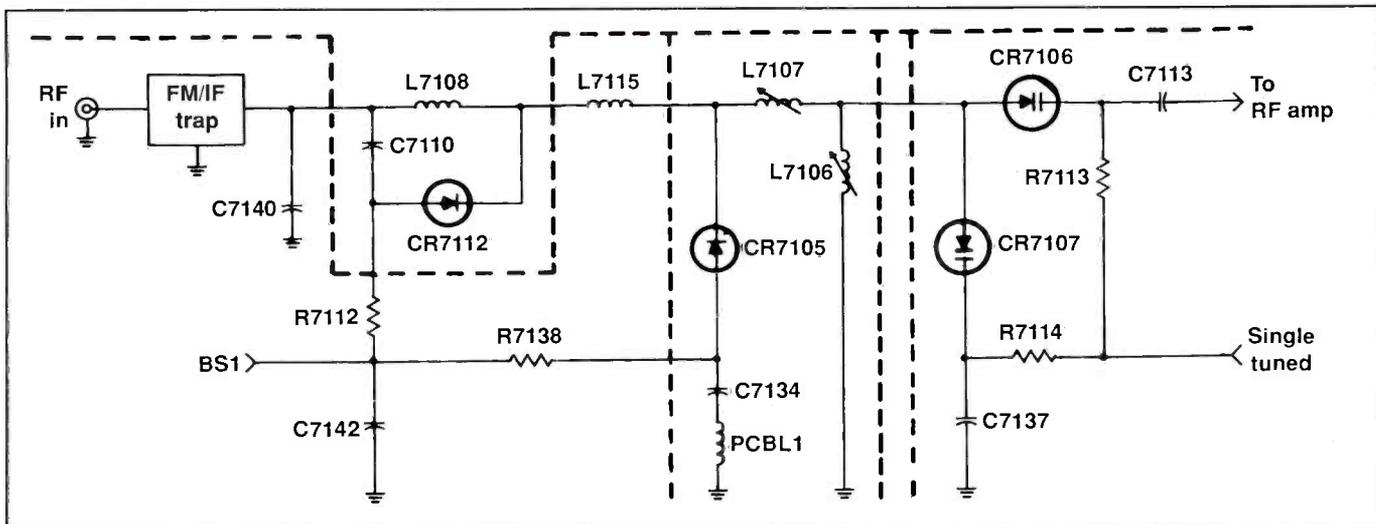


Figure 6. The dashed lines indicate the signal flow when high-band VHF channels are being tuned.

plishes the task by utilizing a series of “tuned circuits.” All television tuners, mechanical and electronic, use these tuned circuits whose resonant frequency determines which channel is tuned. By changing the resonant frequency of the tuned circuit, different RF carriers (channels) can be selected.

Let me explain as simply as possible what I am talking about. A tuned circuit

consists of an inductor and a capacitor configured either in series or parallel. An inductor is just a coil of wire. However, it has the ability to oppose a change in the current flowing through it. Its opposition to current flow is called “inductance” and is measured in henrys (H), millihenrys (mH), and microhenrys (uH). Incidentally, inductance causes voltage to build up before current (“current lags voltage”).

A capacitor is an electrical gizmo composed of parallel conducting plates separated by an insulating (dielectric) material and has the ability to store an electrical charge on its plates. The storage capacity is measured in farads (F), microfarads ( $\mu$ F), and picofarads (pF). Capacitors also affect the circuit into which they are placed by causing the current to build up before the voltage (“current leads voltage”).

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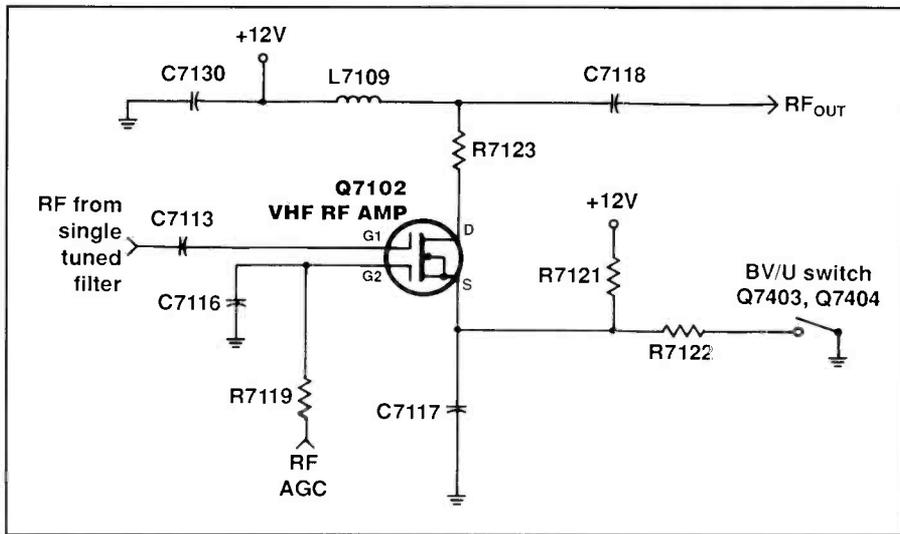
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**Figure 7.** Once the signal has been selected by the tuning filter, it is sent to the rf amplifier. Most rf amplifiers are dual-gate depletion metal-oxide semiconductor field-effect transistors (MOSFET). MOSFETs are voltage-controlled semiconductors that work much like vacuum tubes and have a very high input impedance.

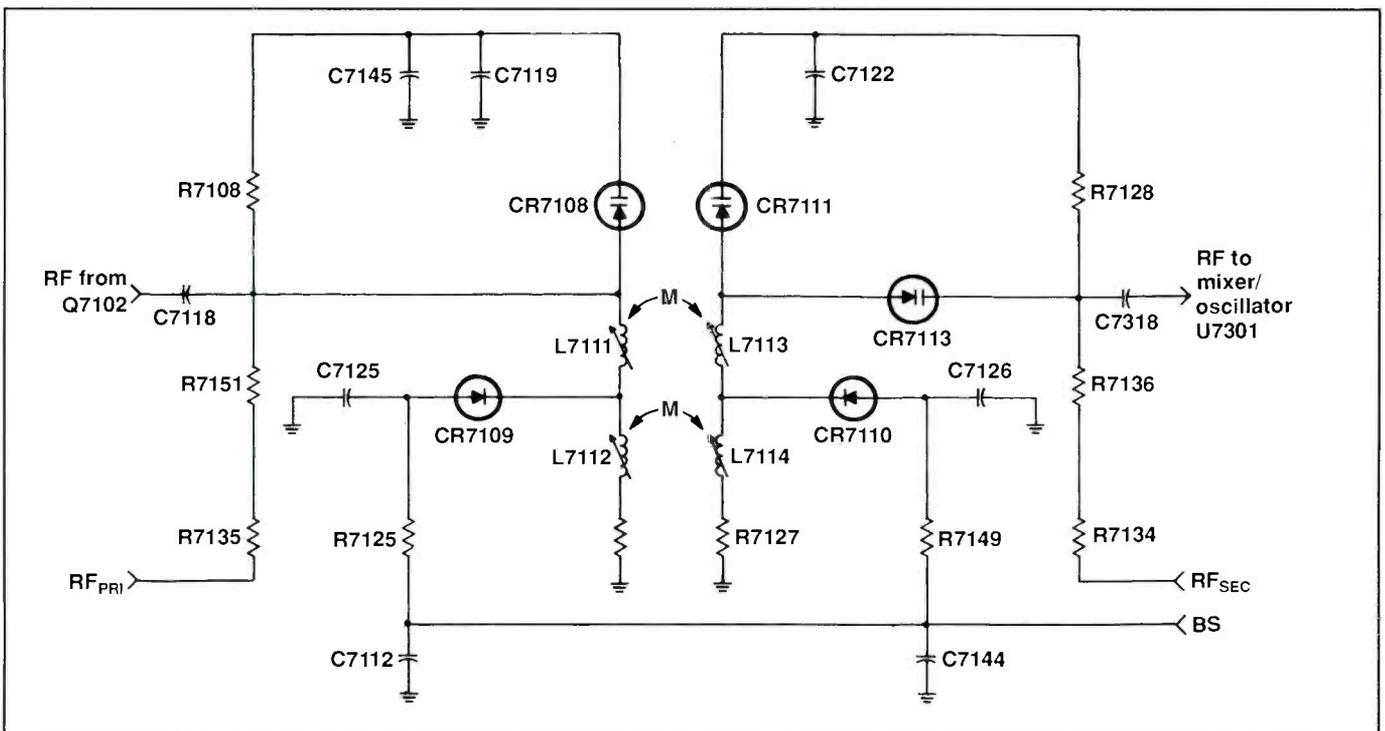
Inductors and capacitors can be connected in series or in parallel. The total inductance of inductors in series is computed the same way as resistors in series, while the total inductance of inductors in parallel is computed like resistors in parallel. However, the total capacitance of capacitors in series is figured like resis-

tors in parallel, while total capacitance of capacitors in parallel is configured like resistors in series.

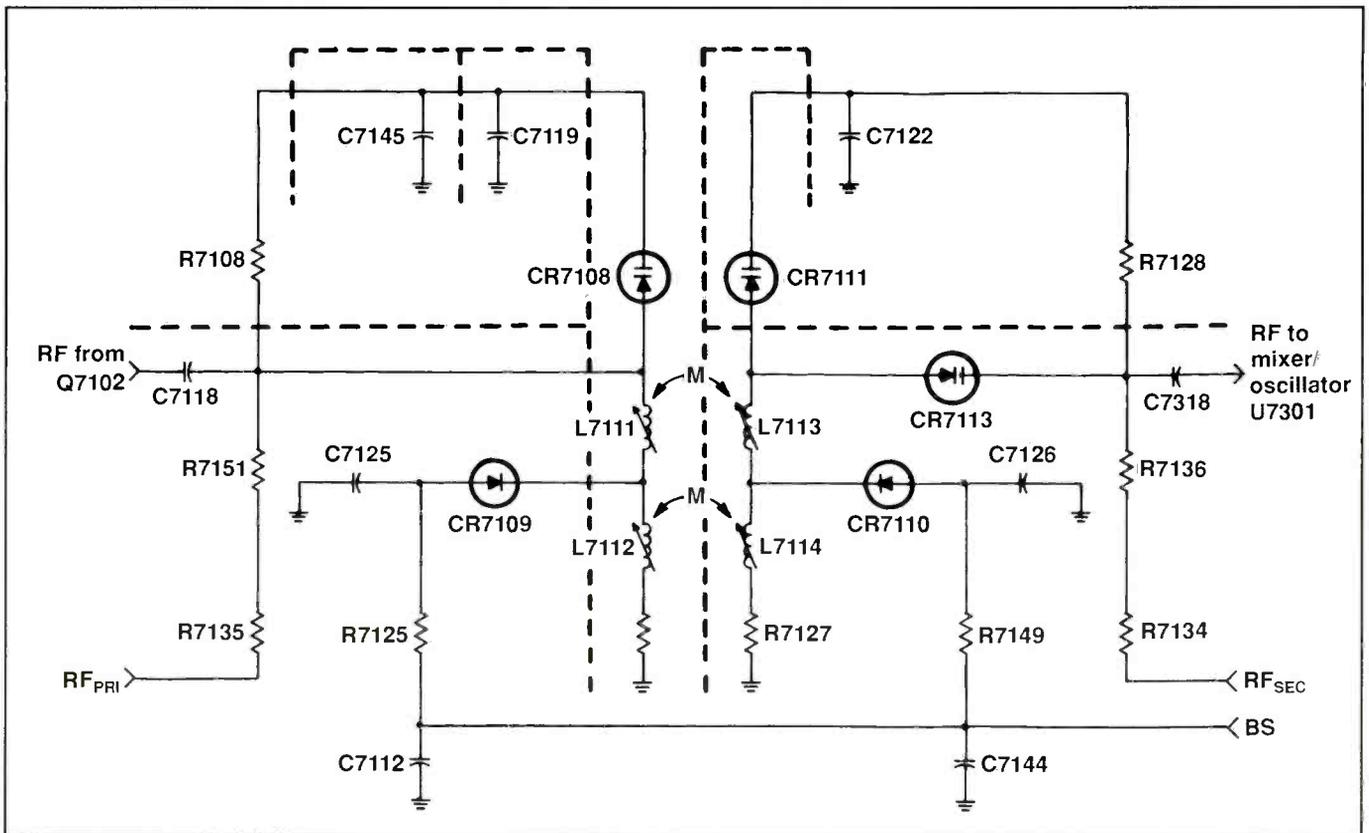
You may be thinking, "Yes, that's just basic electronics." You are correct. It is basic electronics, and these basic concepts are fundamental in understanding and troubleshooting tuner circuits!

Figure 1 is a simple parallel resonant circuit similar to what you find in almost any tuner. *Resonance* is defined as the condition existing in a circuit when the inductive reactance cancels the capacitive reactance or as the condition existing when inductive reactance equals capacitive reactance at the applied frequency. The impedance of the circuit at resonance will be maximum: that means maximum signal voltage will be developed across it. If you decrease the capacitance and/or the inductance, you will raise the resonant frequency, and if you increase the capacitance and/or the inductance, you will lower the resonant frequency.

Mechanical tuners merely switch inductors and capacitors in and out of the circuit as the tuner rotates through its various channel settings. Electronic tuners do the same thing electronically. Take a look at Figure 2. The diode in the circuit is a varactor diode. As you know, a varactor diode acts like a voltage variable capacitor. Increasing the reverse bias across it causes the capacitance to increase, while decreasing the reverse bias causes the capacitance to decrease. This allows the resonant frequency to be raised or lowered electronically.



**Figure 8.** From the rf amplifier, the tuner signal is routed to the rf bandpass network, called the "double-tuned" filter by RCA ("double-tuned primary" and "double-tuned secondary"). This element has a dual function: to perform sharp tuning of the rf signal to obtain greater selectivity and to provide a measure of impedance matching between the rf stage and the later stages in the tuner.



**Figure 9.** When approximately -14.5V is applied to the "Band Switch" line, the tuned circuit of Figure 8 will consist of CR7108, L7111, and L7112. The signal flow is indicated by the dashed line.

### The building blocks of a basic tuner

A tuner, any tuner, has certain basic elements, and will be constructed along the design shown Figure 3. This theoretical tuner has been instructed to tune Channel 6. Since RCA has opted to construct the tuner as an integral unit on the main PCB, I will use the CTC187 chassis as the model for the rest of this discussion. If you want an in-depth discussion of the tuner on the CTC187 chassis, I suggest you consult the CTC177/187 Troubleshooting Guide and Thomson Consumer Electronics Color Television Basic Service Data: CTC187. Both are available through your local RCA parts distributor or from:

Thomson Consumer Electronics  
 Technical Training Department  
 Post Office Box 1976  
 Indianapolis, Indiana 46206.

To a certain extent, a tuner is a tuner is a tuner. Therefore, my comments will apply to just about any tuner you service. There will, of course, be variations based on the manufacturer's design parameters,



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Circle (77) on Reply Card

April 1999 *Electronic Servicing & Technology* 9

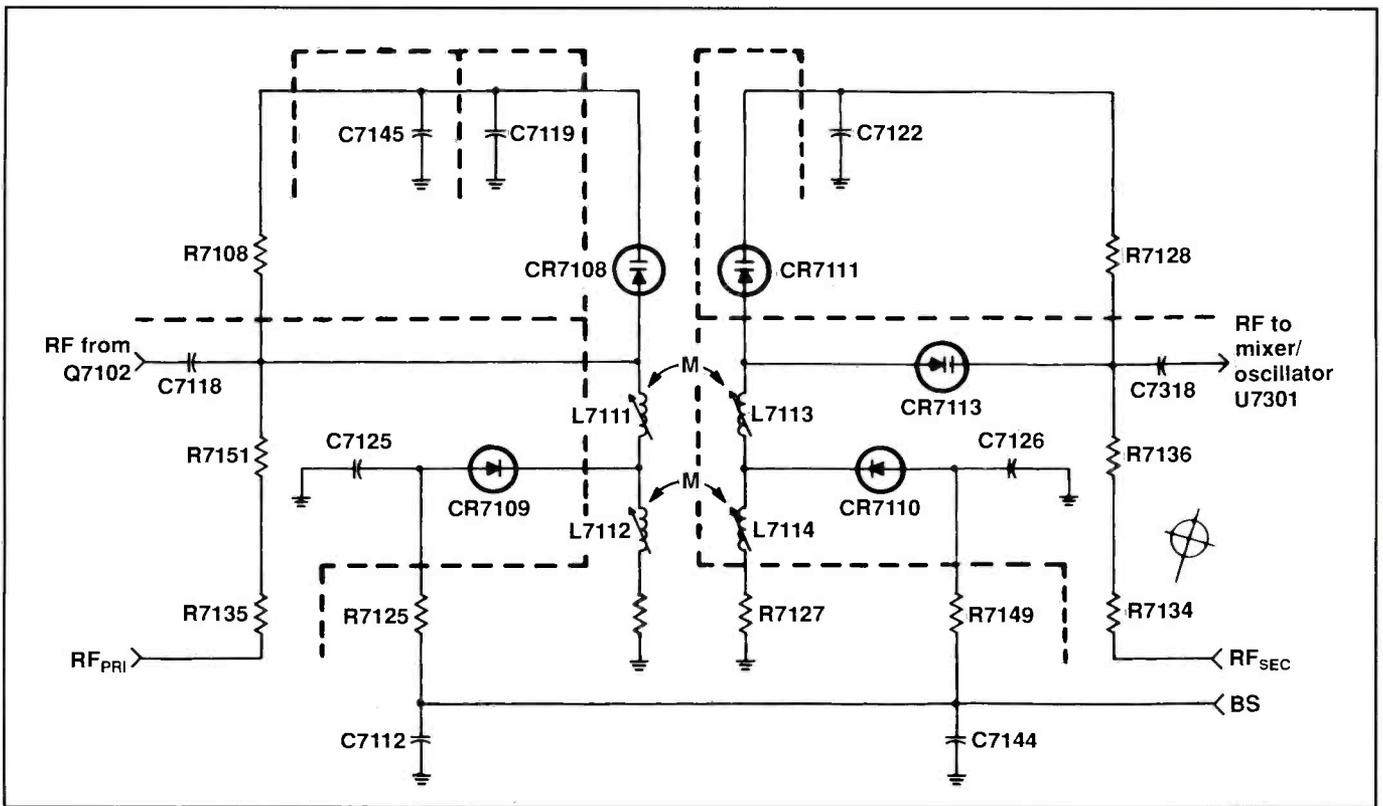


Figure 10. If +11.5V is applied to the band switch line of Figure 8, CR7109 is forward biased, shunting L7112 to ground.

but the variations will not exclude any of the basic elements depicted in Figure 3.

### The input filter

The first "element" in the basic tuner is the input filter. The tuner contains a filter network to eliminate unwanted FM and IF frequencies that may be present. It also contains what the engineers at RCA call "a single tuned filter," that tunes the frequency of the desired channel and inputs the selected frequency to the rf amplifier. The more-or-less complete schematic of a tuner is shown in Figure 4.

Assume the tuner has been asked to tune a channel in the low band VHF spectrum. BS1 (band switch voltage 1) will be about -14.5V, which reverse biases CR7112 and CR7105, causing L7108, L7115, and L7106 to make up the tuned circuit. I have indicated signal flow by the dashed lines in Figure 5. One other voltage is necessary if the circuit is going to work properly, a tuning voltage applied through R7114 and R7113 to varactor diodes CR7107 and CR7106. These diodes tune the resonant circuits with which they are associated. The tuning voltage is derived from the digital alignment parameters stored in the EEPROM and will vary from about 0V (for

Channel 2) to about 5V (for Channel 6).

Suppose the tuner has been asked to tune a high band VHF signal. BS1 will go to about +11.5V. That forward biases CR7112 and CR7105. CR7112 turns on and shunts L7108, removing it from circuit. CR7105 also turns on and connects PCBL1 ("printed circuit board inductor") to the circuit in parallel with L7106. The switching action reduces the total inductance, permitting the higher frequencies to be tuned by CR7106 and CR7107. The dashed lines in Figure 6 indicates the signal flow when high band VHF channels are being tuned. The tuning voltage will now vary from about 0V to about +30V, depending of course on the channel being tuned. Naturally, the voltage will increase as the frequency being tuned increases.

The UHF single-tuned filter works the same way, except there is no "low band" and "high band" to select. One frequency (or channel) follows another in unbroken sequence.

Note: BS1 goes positive (+11.5V) to tune cable Channels 7 through 13 and Channels 18 through 25; and negative (-14.5V) to tune cable Channels 2 through 6 and Channels 14 through 17.

### The radio frequency (rf) amplifier

The next unit in the basic tuner design is the rf amplifier (Figure 7). Most rf amplifiers are dual-gate depletion metal-oxide semiconductor field-effect transistors (MOSFET). MOSFETs are voltage-controlled semiconductors that work much like vacuum tubes and have a very high input impedance. The depletion

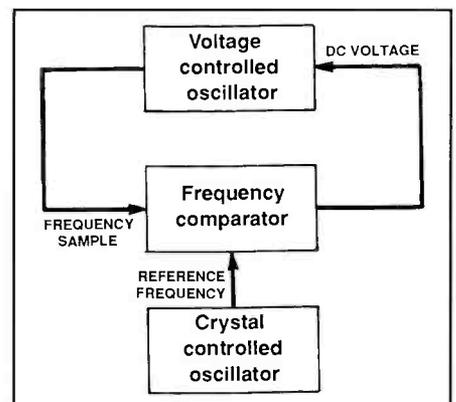


Figure 11. This drawing provides an idea about the make-up of a typical PLL circuit. A voltage-controlled oscillator (VCO) sends a frequency sample to a comparator that compares it to a reference frequency generated by a crystal-controlled oscillator. If the VCO gets off frequency, the comparator sends it an error voltage to correct its output. The VCO therefore stays locked to the crystal oscillator.

TEST CH.	TV CH.	BAND	PIX FREQ	MID FREQ	CHROMA FREQ	SOUND FREQ	LO FREQ
1	2	1	55.25	57	58.83	59.75	101
2	6	1	83.25	85	86.83	87.75	129
3	14	1	121.25	123	124.83	125.75	167
4	17	1	139.25	141	142.83	143.75	185
5	18	2	145.25	147	148.83	149.75	191
6	13	2	211.25	213	214.83	215.75	257
7	34	2	283.25	285	286.83	287.75	329
8	37	2	301.25	303	304.83	305.75	347
9	48	2	367.25	369	370.83	371.75	413
10	50	2	379.25	381	382.83	383.75	425
11	51	3	385.25	387	388.83	389.75	431
12	57	3	421.25	423	424.83	425.75	467
13	63	3	457.25	459	460.83	461.75	503
14	76	3	535.25	537	538.83	539.75	581
15	83	3	577.25	579	580.83	581.75	623
16	93	3	637.25	639	640.83	641.75	683
17	110	3	709.25	711	712.83	713.75	755
18	117	3	751.25	753	754.83	755.75	797
19	125	3	799.25	801	802.83	803.75	845

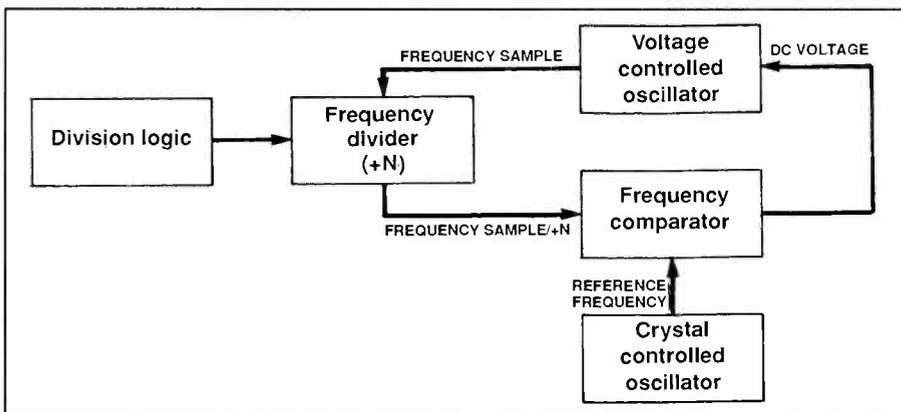
**Table 1.** The tuning voltage produced by the microprocessor comes from data stored in the tuner parameter alignment section of the EEPROM. This information is based on what RCA calls "data channels," of which there are 19, as shown here. The microprocessor uses "linear interpolation" to determine the correct settings for the channels that fall between the data channels.



types are normally "on" without gate bias, as opposed to the enhancement types that require bias to operate. If you apply a negative voltage to the gate (with respect to the source) of a depletion MOSFET, you will reduce or *pinch off* current flow if the negative voltage is sufficiently large. If you apply a positive voltage, you will increase current flow up to a point.

These MOSFETs are dual gate devices.

Both gates affect drain current, another feature making them ideal rf amplifiers. In this role, the rf signal from the tuner input is applied to gate 1, while automatic gain control (AGC) voltage is applied to gate 2. If AGC voltage increases, the rf signal at the drain increases in strength. If AGC voltage decreases, the strength of the rf signal at the drain decreases. Remember this tidbit because it will be important



**Figure 12.** A programmable divider enables the PLL to lock the oscillator to a myriad of frequencies. The microprocessor sends to the programmable divider what is called "division logic." The division logic sets the divide ratio in the frequency divider, permitting the VCO to change frequency. The divided down frequency is then compared to the reference frequency. If it is off frequency, the comparator generates an error voltage that the VCO uses to correct the new frequency.

when you have to troubleshoot one of RCA's TOB units for weak signal output.

You will note the presence of Q7403 and Q7404 indicated by a block labeled "BV/U Switch." These are band-switching transistors which I will discuss later. I will simply note that when a VHF channel is selected the band switch turns on, providing a ground path for the source of the VHF rf amplifier. When a UHF channel is selected, the band switch turns off, removing the ground path for the VHF amplifier turning it off. The UHF amplifier works the same as the VHF amplifier.

### The rf bandpass network

The next element in our basic tuner block diagram is the rf bandpass network (Figure 8), called the "double-tuned" filter by RCA ("double-tuned primary" and "double-tuned secondary"). This element has a dual function:

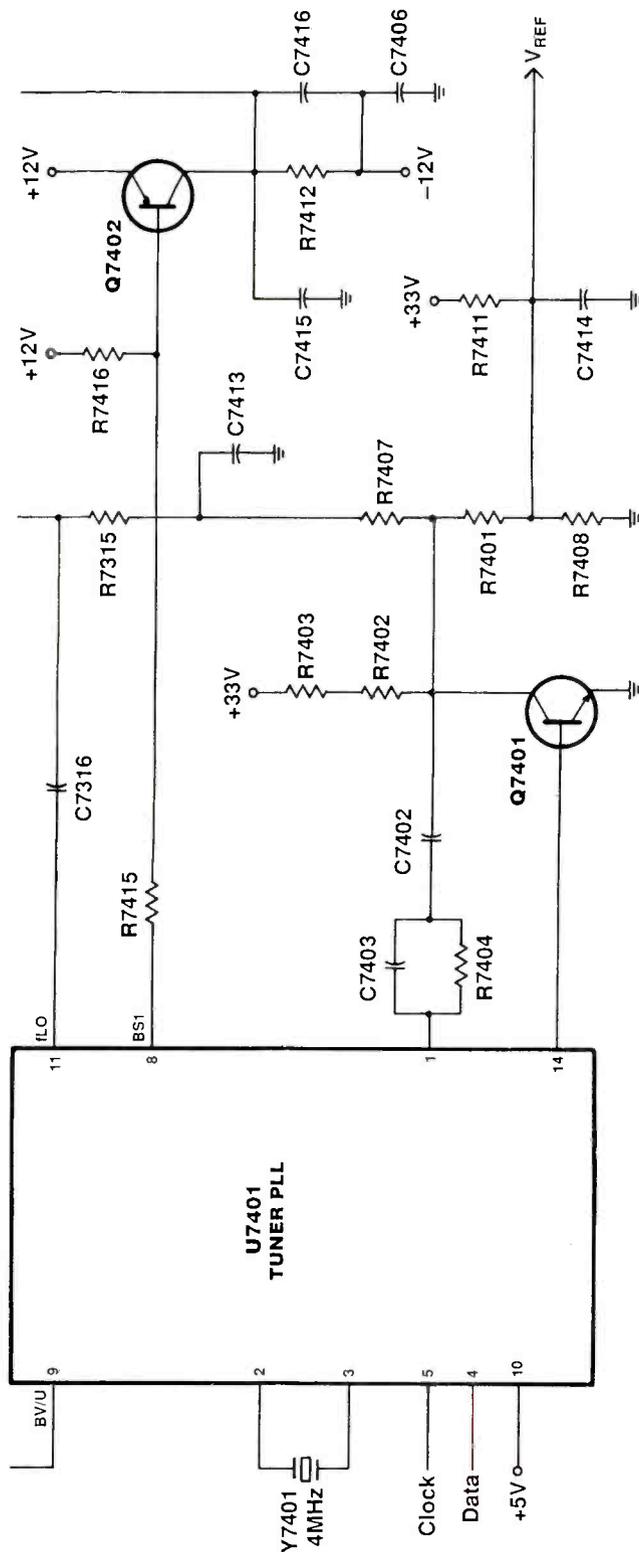
- to perform sharp tuning of the rf signal to obtain greater selectivity and
- to provide a measure of impedance matching between the rf stage and the later stages in the tuner.

The double-tuned primary is tuned by CR7108 via a voltage applied to the "RF Primary" line. The control voltage is developed from the PLL circuit and summed with the digital alignment voltage developed from parameters stored in the EEPROM. When approximately -14.5V is applied to the "Band Switch" line, the tuned circuit will consist of CR7108, L7111, and L7112. The signal flow is indicated by the dashed line in Figure 9. If +11.5V is applied to the band switch line, CR7109 is forward biased, shunting L7112 to ground (Figure 10).

The double-tuned secondary is tuned in a similar manner, this time by a voltage on the "RF Secondary" line and applied to the cathodes of CR7111 and CR7113. Band switching is accomplished by toggling the voltage on the band switch line between -14.5V and +11.5V. When the band switch line has -14.5V on it, L7113 is in series with L7114. When the band switch line goes to +11.5V, CR7110 becomes forward biased, removing L7114 from the circuit by shunting it to ground (Figure 10). The resonant frequency of the tuned circuit is therefore changed (i.e. goes higher).

Note: BS1 is switched positive (+11.5V) for cable Channels 7 through 13





← **Figure 13.** This drawing shows a complete electronic tuner, from the entry points for the UHF and VHF signals to the output for the if signal.

and 18 through 125. It is switched negative (-14.5V) for cable Channels 2 through 6 and 14 through 17.

### The oscillator and mixer

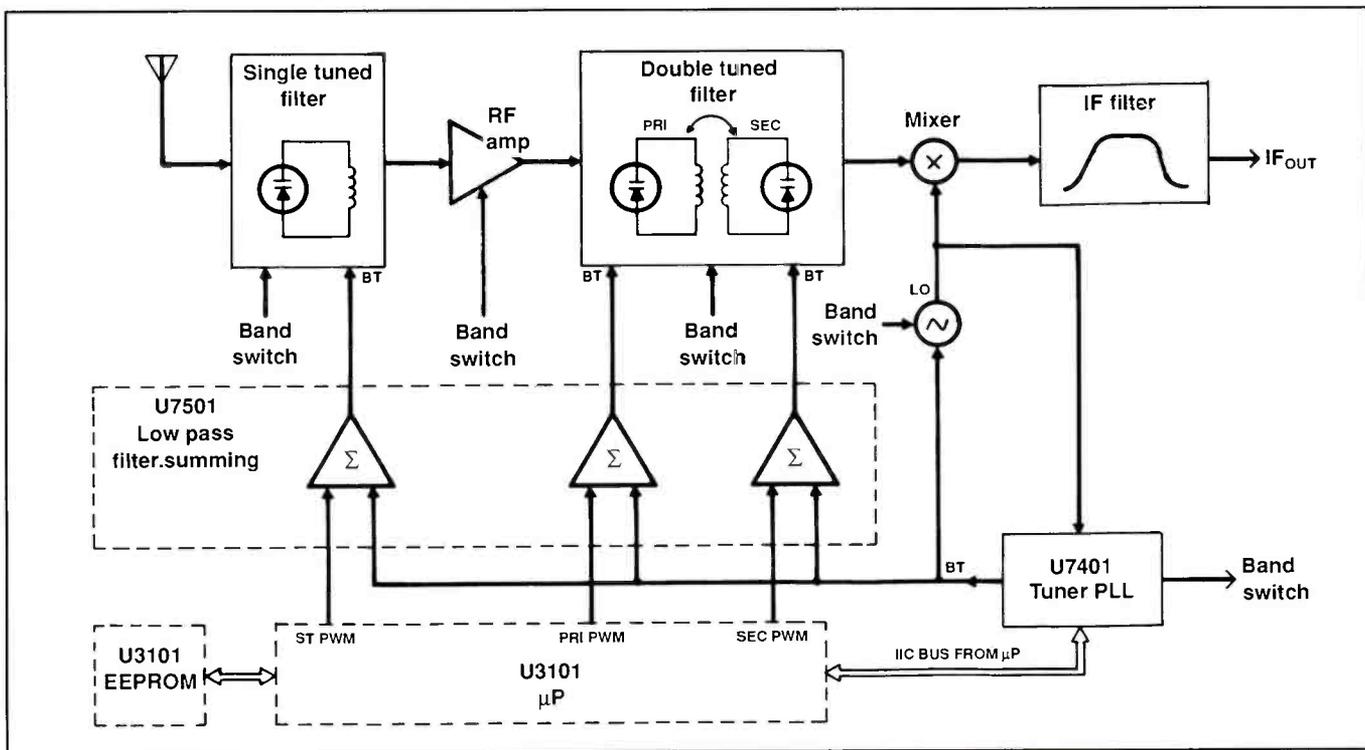
The oscillator and mixer make up the next block in the basic tuner block diagram and are contained within a single IC in the CTC187 chassis: IC7301. The local oscillator (LO) generates a signal that is beat (heterodyned) against the incoming rf signal to produce a 45.75MHz intermediate frequency (if) at the mixer output. The LO output is always tuned to produce a signal that is exactly 45.75MHz above the received signal.

Suppose the tuner has been set to receive Channel 6. The incoming video portion of the rf signal will be at 83.25MHz. The local oscillator will produce a signal with a frequency of 129MHz. When the two are mixed (beat or heterodyned), the results will be the sum of the two (212.25MHz) and the difference between the two (45.75MHz). The if bandpass extracts the desired signal, 45.75 MHz, while it rejects the other signal frequencies.

As you know, the LO frequency must change over a wide range to do its job. Modern electronic tuners, including the TOB, use a frequency synthesizer to control the LO. A frequency synthesizer consists of a phase lock loop (PLL) and a programmable divider. Figure 11 will give you an idea about the make-up of a typical PLL circuit.

A voltage-controlled oscillator (VCO) sends a frequency sample to a comparator that compares it to a reference frequency generated by a crystal-controlled oscillator. If the VCO gets off frequency, the comparator sends it an error voltage to correct its output. The VCO therefore stays locked to the crystal oscillator.

A programmable divider enables the PLL to lock the oscillator to a myriad of frequencies (Figure 12). The micro-processor sends to the programmable divider what is called "division logic." The division logic sets the divide ratio in the frequency divider, permitting the VCO to change frequency. The divided down frequency is then compared to the reference frequency. If it is off frequency, the com-



**Figure 14.** The tuner on board used by Thomson Consumer Electronics television sets differs from a conventional electronic tuner. Perhaps the best way to get at the difference and to understand the technology is to discuss the place and function of U7501, an integrated circuit called “a summing amplifier.”

parator generates an error voltage that the VCO uses to correct the new frequency.

Take a few moments to study Figure 13. U7301 contains the oscillator, the mixer, and first if amplifier. U7401 is the tuner PLL. It receives information from the system microprocessor via the I-squared-C bus that it decodes and uses to set up the tuning voltages for the different RF stages and the local oscillator.

Pin 8 outputs the Band Switch/Select 1 voltages we have already noted. It selects VHF low/VHF high bands for the incoming rf signal, as well as for the local oscillator. When pin 8 goes high, Q7402 turns off, permitting its emitter to be pulled low by the -12V supply. This action reverse biases CR7303, preventing it from affecting the VHF oscillator tank circuit. When pin 8 goes low, Q7402 turns on, putting +12V on its emitter. The positive voltage forward biases CR7303, shunting L7305 and C7323 out of the circuit by switching C7315 in parallel. The switching action changes the LO tank circuit from VHF low to VHF high. In other words, when pin 8 of U7401 goes low, the resonant frequency of the LO tank circuit rises, permitting it to generate the frequencies necessary to decode high band VHF rf signals.

Now you know how the LO switches

bands. How does it change frequency within a particular band? The PLL (U7401) generates a LO tuning voltage at pins 1 and 14. It actually outputs a series of pulses that are low-pass filtered and used to sink current through Q7401 to lower the tuning voltage at its collector. As Q7401 conducts less, the +33V pull-up supply pulls the tuning voltage higher. The tuning voltage is split and sent to two places. The first is via R7401 and R7408, where it is divided to form the “V<sub>REF</sub>” signal. The V<sub>REF</sub> signal is routed to the interface circuitry, where it is summed with the digital alignment offset voltages and used to tune the single tuned and double tuned primary and secondary circuits. The second route for the tuning voltage is to the varactor diodes in the LO VHF and UHF tank circuits. It is this voltage which causes the frequency of the LO to vary.

### The if bandpass

The last block in the diagram is the if bandpass. Look again at Figure 13, paying attention the components tied to pins 3 and 5. The inductor and capacitors form a circuit that permits the if frequency (45.75MHz) to pass, while blocking other signals that are always present at the mixer output. The if signal is amplified

and output at pin 1. It passes through a second if filter (L7302, C7306, and R7317) before it is further amplified by Q7601 and passed on to the receiver’s demodulating circuits inside U1001.

### Digital alignment

As I have hinted, the tuner on board differs from a conventional electronic tuner. Perhaps the best way to get at the difference and to understand the technology is to discuss the place and function of U7501 (Figure 14), an integrated circuit called “a summing amplifier.”

Every tuner has circuits similar to RCA’s single tuned and double tuned filters. The difference is the typical tuned circuits are tuned by the same voltage that tunes the local oscillator. One voltage tunes everything, in other words. Traditional electronic tuners are often called “track tuners” because every tuned circuit, as well as the local oscillator, tracks the same voltage. You know from experience that the typical tuner produces varying results. That is, some channels come in sharp and clear, while other channels do not; the results of all circuits tracking one voltage. RCA attempted to improve overall tuner performance by optimizing the tuning voltage applied to

the tuned circuits. One voltage controls the LO, while other voltages (three of them!) control the single tuned, double tuned primary, and double tuned secondary circuits.

The question becomes, "How did they do that?" Remember the tuning voltage developed at pins 1 and 14 of U7401? It is sent to two places, one of which is to U7501 as  $V_{REF}$ . This voltage is added to another developed by the microprocessor. The two voltages, the tuning voltage from the tuner PLL and the voltage developed by the microprocessor, are summed inside U7501 and sent to each of the three tuned circuits, permitting them to be tuned in a way that optimizes the signal for each channel the TV receives. Actually, the microprocessor does not "output a voltage." It does output a pulse width modulated signal that is low pass filtered and summed with the  $V_{REF}$ .

The voltage produced by the microprocessor comes from data stored in the tuner parameter alignment section of the EEPROM. This information is based on what RCA calls "data channels," of which there are nineteen (Table 1). The microprocessor uses "linear interpolation" to determine the correct settings for the channels that fall between the data channels. Using data channels and linear interpolation instead of all the channels the TV receives greatly reduces the number of alignments and saves valuable space in the EEPROM. Each data channel, as you know from experience, is aligned via the service menu using the procedure outlined in the service data.

### A summary of the tuning process

I can summarize the tuning process like this. When the viewer selects a channel, U3101 sends clock and data information to U7401 telling it what band and frequency to synthesize. The output of pins 1 and 14 sets the tuning voltage for the LO and  $V_{REF}$  tuning voltage sent to U7501, while pin 9 tells the oscillator/mixer which oscillator to use (VHF or UHF). The local oscillator responds by producing the necessary frequency to tune the requested channel. BS1 voltage from U7401 tells the filters which band to tune. At the same time, the  $V_{REF}$  is summed with the D/A voltages from U3101 and sent to the tuned filters to tune the desired channel. The result is the viewer gets to see and hear the channel he/she has selected. ■

# Test Your Electronics Knowledge

by Sam Wilson

- What is the RMS value of a 10V peak-to-peak sine wave?
  - 1.4V
  - 3.5+V
  - 5V
  - 7.07V
- In order to lower the resonant frequency of a series LC circuit,
  - increase the inductance value.
  - lower the inductance value.
- The differentiating circuit in a television receiver is a:
  - high-pass filter.
  - low-pass filter.
- In order to increase the capacitance or a capacitor, you would move the plates
  - closer together.
  - farther apart.
- Power transformer cores are laminated in order to
  - reduce cost.
  - reduce copper loss.
  - reduce eddy current loss.
  - reduce hysteresis loss.
- Write the Boolean expression using A, B,  $\bar{A}$  and  $\bar{B}$  for the circuit shown in Figure 1.
- In a series RC circuit connected across an ac source, the
  - voltage leads the current.
  - current leads the voltage.
- In an ideal circuit, the power factor is:
  - one.
  - zero.
- Which of the following will be hotter?
  - 500Ω resistor with a dc voltage of 10V across it.
  - 500Ω resistor with a sine-wave voltage with a peak voltage of 10V across it.
- The frame frequency of a black and white television is about \_\_\_\_\_ Hz.

Bonus Question: What is the value of the following determinant?

$$\begin{vmatrix} 23.6 & -42.8 \\ 19.4 & 13.6 \end{vmatrix} =$$

Wilson is the electronics theory consultant for ES&T.

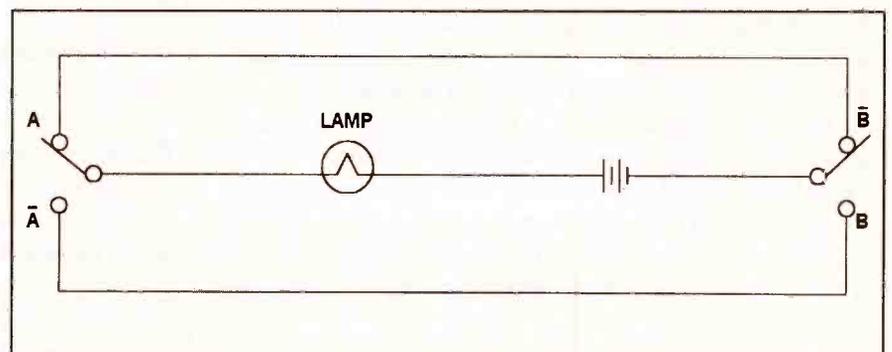


Figure 1. Write the Boolean expression for this circuit.

# Other ideas for improving a consumer electronics service business

by Gerry McCann and the members of NESDA



The ideas published here were generated by members of the National Electronics Service Dealers Association (NESDA) during a "Best Ideas Contest." We publish them in the hope that they may help other service centers, and perhaps inspire them to come up with their own ideas to improve their businesses.

1. Give away packs of microwave popcorn as an ad for your business. The contributor passed around a sample and showed he had labeled the popcorn pack "Enjoy your snack this evening on us. Thank you for choosing Merrow Electronic Servicing as your Service Center." Feedback of thankful comments and excellent acceptance at a very low cost of about 25 cents per item. This idea received the most votes of the session.

2. When you come across a printed circuit board covered with goo, use a piece of an aspirin on the solder joint and heat it with a solder gun to clean the board. This item can sometimes be found around service areas. Yes, it was mentioned that smaller resin mess may only require a baby aspirin to clean it up.

3. Offer a special telephone discount of \$10.00 for telephone price shoppers, those who price shop by phone. Ask them to mention the discount when they bring their unit in. Use a tracking number to increase caller awareness of this attraction.

4. Build your own low-cost, in the service center, second-story power lift system. Uses a winch in the girder on the second floor, with cart, using offset wheels and a platform to keep large TV and PTV units level. The need here was to safely make the second story available for large-product short-term storage at a reasonable cost of about \$650.00 to construct.

Gene Doba of Bammel TV in Houston brought a miniature prototype and a set of pictures to show the concept. This idea received the second most votes as "best" of the session.

5. Use a 2 part form as a front counter accessory check list. Show client name, tag #, and a list of most possible accessories with "Y" and "N" indications which can be circled. Have lines

for other accessories and condition of the unit. Include a disclaimer for accessories not visible, like tapes, CDs, etc. Client signs and receives a copy — other copy stays with unit.

6. Maximize your tax deductions. There are special rules where the charitable deduction the corporation is allowed is the inventory's cost, plus a fraction of its appreciated value. Use for inventory or schematics donated to specific authorized organizations. Investigate IRC Section 501(c)(3).

7. Use stickers for info on computer repairs. State hard drive type, cylinder sectors size, etc. Sticker can also be used on diskettes showing unit was virus-free when unit left the service center, date, and tech ID can be shown.

8. Use a brochure with a check list to be used in home service calls. Show a map of the service center locations, the brands serviced, and a history of the company. Add a coupon for the next service needed. Leave two at each call, asking that a neighbor be given the second coupon

9. Small inexpensive toys, such as small cars, are handed out to the kids who come into the service center. This way when something needs repairing, the children bring in the parents. The children will vocally remind the parents of the toy long after the visit. This servicer also repairs the battery-operated child-sized motorized cars.

10. Give a median estimate on all products at the front counter. Get this amount pre-approved. Call estimate if repair runs over that amount.

11. Use some type of code on your counter invoice to indicate if the client left the remote: Suggestion: WR = With Remote NR = No Remote.

12. Work with your local BBB to create and have them print a Electronic Service Brochure for consumers. Use the BBB copies and tag with your own label. Hand out when units are brought in. This tells clients what to expect, and promotes your service center as believing in fair business practices. Larry Parnell of Houston describes the experience of remaining active with BBB relations. This idea received the third most votes of the session.

13. Collect a technical diagnostic fee on each incoming service product.

McCann is owner of an independent consumer electronics service business.

14. If you have a sales and service dealership, allow a percentage of the minimum diagnostic fee to be applied to the purchase of a new unit if the set brought in is not repaired.

15. Collect a minimum diagnostic fee and get a pre-estimate approved. Use the history of other similar products — symptom/cures and promise the owner to be notified if the actual repair exceeds the pre-estimate amount.

16. With each outgoing repaired audio tape recorder, video tape recorder, and camcorder product include a sample tape of information recorded on the product. Label it as a final Quality-Control tape done after repair completion and request it be saved for the length of the repair warrant, then used as a blank. Include only good-quality tape in this program.

17. Use a quality-control tape as outgoing advertising. Show pictures of your service center on the tape.

18. Retirement program ideas were mentioned as a way to keep technicians. Money market funds are available through stock brokers. Can be set up with 5% of salary, no federal taxes. There are limitations on participation percentages, matching funds and changes but a retirement is now worth investigating, even for small business.

19. Use video head cleaning tapes at the front counter on all call backs. They cure a high percentage of common dirt-related problems and 90% of the time the client will then purchase the cleaner tape.

20. Advise all clients that units will require maintenance. Suggest that every household should budget for some electronics equipment repairs. Suggest clients use a piggy bank at the TV set or stereo for spare change and use this money when repairs are needed. This sets a standard of what to expect.

21. Supply the above piggy bank. Advertise on the side of the bank.

22. Remind personnel to speak slowly and distinctly when answering the phone. Many times the client can't understand the name of the company they are calling, or who they are speaking too. Clearly pronounce the company name, a greeting, and your own name. A professional call taker then owns the conversation.

23. Leave advertising pens and business cards at local video stores for their clients to take home. If the video store customer becomes a servicer client, send the video store a rebate check at the end of the month, depending on volume. Track by special coupons or specially code numbered pens.

24. Mail a sign-off letter to clients who don't pick up their units. This frees up space on your shelves. The client can elect to sign it off to you for disposal or come pick it up. This approach allows for a sense of urgency to move the unit away from your storage.

25. Avoid the perception of any kind discrimination on minimum diagnostic charges collected at the front counter. Collect from everyone alike. Be very careful of waivers. Clients don't always hear what you say to them, but listen carefully to what you say to everyone else at the counter.

26. Communicate with employees by setting up team breakfasts.

27. Meet at an area restaurant. Employees get to talk to owner and each other. Rotate departments.

As an incentive to meet production, set up a team lunch for those departments, or technicians, that meet production quotas.

28. Have cardboard sleeves with your store's advertising printed to return CDs or CD-Roms that had been stuck in audio and computer drives.

29. Use sealing tape over at least one of the cabinet screws after wrapping up each repair. It will keep others out of your repair work or make intrusion obvious until the repair warranty is over. Security tags are commercially available like those used on rental videotapes that show "Void if removed" when tampered.

30. Wrap up each outgoing repaired unit in a bag or protection container. If a plastic bag is used, they should be stamped with the "small child" warning.

These ideas were generated by members of NESDA, the National Electronic Service Dealers Association, during a session called the NPSC '96 Best Idea Contest. This session took place during the NESDA National Professional Service Conference, in August, 1996. We thank NESDA for giving permission to reprint them here. For more information about NESDA, call or write: NESDA, 2708 W. Berry, Fort Worth, TX 76109-2356, 817-921-9061. ■



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Circle (78) on Reply Card

The whole is greater than the sum of its parts, or so it is said. That statement is certainly true when it comes to a consumer electronics product: a TV, VCR, or a stereo system, for example. It's interesting to consider. If you place all the parts that make up one of those products in a heap, it's just a jumble of pieces. Connect them correctly and apply the correct type of power, and it becomes a functioning marvel of modern technology.

Conversely, if one of the components of such a whole no longer functions, the product no longer functions, and it reverts to the useless heap that it was before it was assembled. When that happens, assuming that it's not too old, or too cheap, the owner usually wants to find someone who can determine which part or parts are faulty, find replacements for them, and restore the product to wholeness and functionality.

Once that someone, the service center, has isolated the components that have caused the fault and ordered a replacement, then it becomes the responsibility of the distributor to supply the part.

Naturally, the owner of the faulty product hopes that the service center can get the product back to him quickly, so that he can put it back in operation in his home. And, of course, the service manager wants to get the product repaired quickly so that he can return the product to its owner quickly, so that he can be paid for the work. If the service center has chosen the correct distributor, they may be able to get the replacement components quickly and quickly get the product back to the owner. On the other hand, if the distributor has to back order the component, it may be weeks before the transaction is completed.

That's why it's important to do a little research before selecting a distributor. Some distributors are more efficient, more conscientious than others. Some distributors are authorized for certain brands and have a much better likelihood of having those parts than do some other distributors.

That's why **ES&T** presents this "Distributor Showcase" once a year. In the showcase, we give each distributor who advertises in this issue an additional amount of space equivalent to the size of their ad in which to tell readers more about their business than is possible with an ad. We hope that reading these showcase entries helps readers make a more informed decision in choosing a distributor. The fol-

lowing text gives some suggestions on making this decision.

### Consider these variables

When choosing a distributor, consider some of the factors listed below. Some apply only to the local distributor, and some apply only to mail order, but it would be a good idea to keep them in mind any time you're thinking about doing business with a new firm. These items are not listed in any particular order, for the simple reason that their order of priority or importance depends upon your particular wants and needs. Put them in order of importance for yourself.

- Do the distributor's facilities and/or literature give the impression of competence and order?
- Do prices seem reasonable and in line with what other companies charge?
- Are most items in stock, or does the distributor have to back order many of them?
- Does the distributor offer a broad line of products, or will you have to find other sources of supply for many of your needs?
- Does the distributor specialize in any particular kinds of products that you typically order?
- What kind of payment options does the distributor offer: Open order account, credit card, COD, check, etc.?
- How soon after receipt of an order does the distributor ship?
- Does the distributor add a shipping surcharge, or a handling charge?
- Does the company list a toll-free telephone number?
- Are such ordering options as fax, and telex available? Do they have a website where you can look up products and order what you need?
- What is the distributor's return policy?
- Are all of the distributor's policies well-documented, or do you have to guess at them? Or do they seem to differ depending on his whim?
- What kind of warranty, if any, does the distributor offer?
- Does the distributor publish a catalog? If so, is it clear and easy to understand?
- Is there a minimum order amount? If so, is it reasonable?
- What kind of shipping options are available: mail, UPS, Federal Express, etc.?
- What kind of special services, such as assembling cables, etc., does he offer?
- What research services does the dis-

tributor offer to help you to find the part you need?

### Some important questions to ask

Some of these questions may not seem important, but from what we have learned from some of our readers, they may be very important. For example, we learned from one of our readers that one mail order company that he dealt with made a regular practice of charging unnecessarily high shipping charges on the products he sells.

Another practice that some distributors indulge in is to hold shipment of products for some time after the purchaser's check has cleared. This gives the distributor a nice little interest-free loan between the time the check clears and the time he decides to ship the merchandise. This is not necessary. Some companies ship the product immediately after receiving an order.

One other thing to keep in mind is that some distributors charge a restocking fee even when they were responsible for shipping the incorrect product in the first place.

### This showcase may help

The purpose of this distributors' showcase is to provide the distributors who advertise in it with additional space to give readers information about their companies. We hope you'll take this opportunity to learn a little more about these companies so that you'll have a better idea of their capabilities and practices.

### Let the buyer beware

Most replacement parts distributors are hard-working, well-organized, ethical companies, who will make every effort to help you obtain the correct replacement for a faulty component. Some are less ethical in their practices. It's not always easy to locate the good ones and avoid the ones that will give you problems.

When you're considering ordering products from a new distributor, it might be wise to start out with a small order and see what kind of treatment you get. If the service is good, you might gradually increase the size of your order and gradually build up a close working relationship.

If the service you receive is not what you'd like, try someone else. It's your business that will suffer if you don't get what you order when you need it, or if you're hit with exorbitant freight charges that you have to pass along to your customer. ■

## Thomson Consumer Electronics

Thomson Consumer Electronics believes that you should have a choice. We realize that you rely on our genuine replacement parts not only during the required warranty period, but also when you want the highest level of quality and performance available. We also realize that not every estimate you give can be converted to a repair using original parts. That's our difference, we give you the choice!

### Original Parts

RCA and GE genuine replacement parts provide today's service professional with the reliability they need when completing in-warranty repairs. And they are delivered to you by parts distributors who provide an outstanding level of service. In fact, our most recent survey of the service industry continues to show that three out of four servicers believe that no other manufacturer provided a consistently better parts fulfillment system than the Thomson Consumers Electronics' parts distributors.

Thomson Premier Distributors can fill your warranty parts orders either off their shelves on all in-stock products, or by placing a Direct Drop Shipment (DDS) order via computer directly into the TCE national parts depot. Either way, you receive the part you need to complete the repair quickly and you get the highest possible fill rate for warranty parts to service RCA, GE, and ProScan products. This computer link also allows the Premier Distributor access to all the information needed to provide you with the high level of service you require in today's fast paced business.

### SK Series Universal Parts

You know that lower estimates

equal more repairs and more business for you. To help you turn more of those COD estimates into repairs, Thomson continues to broaden its line of SK Series Universal Products. These quality parts let you reduce the repair estimate by lowering your replacement cost, and that's good news for you!

SK Series Universal Products cover a wide range of high wear, high usage parts. Whether you need video heads, flyback transformers, video replacement parts, belts, tires, pinch rollers, laser pickups, RF modulators, exact semiconductors, servicer aids, repair kits, capacitors, resistors and more, you can look for SK Series 1st!

### TCE Literature

Thomson also provides a number of publications which makes finding the right part for the repair even easier. Our latest "SK Series Product Guide" (Catalog #401) is a quick reference tool to the SK Series Universal Product line. Photographs, text and graphic illustrations all help guide you to the right stock number very quickly and easily.

In addition to TCE's service data, the "Television Components Quick Reference Guide" contains key part numbers for recent RCA, GE, and ProScan chassis. It's ideal for the technician on the road. It folds to fit in your pocket. The Quick Reference Guide also contains a section dedicated to the EPROM's associated with chassis CTC169 through CTC189.

And there is of course, our well known and widely accepted "OEM Remote Control" book. This book is printed once a year and no one that

repairs TCE products should be without one!

These publications are available from your Authorized Thomson Parts Distributor. For the "SK Series Product Guide" order publication 1J1226, for the "Quick Reference Guide" order publication 1J9548, and for the "Remote Control" book order 1F5790.

### Accessories and Components Business

The Thomson Consumer Electronics, Accessories and Components Business provides service from a 358,000 square foot facility located in Deptford, New Jersey. All business functions — customer service, sales and marketing, quality assurance, product analysis, administrative departments and warehousing operate under one roof. Some parts are stocked in satellite warehouse facilities in El Paso, TX and Indianapolis, IN.

A full line of RCA brand Consumer Electronics Accessories is marketed from this facility as well. The business is managed by Jack Nick, Vice President. Thomson Consumer Electronics corporate headquarters is in Indianapolis.

### One Call Is All You Need To Make

Whether you need original RCA and GE parts or SK Series products, your Thomson distributor is your one stop source. A single call to a Thomson Distributor gives you the choice you deserve, making your business more profitable. To locate a nearby Thomson Authorized Distributor, simply call (800) 336-1900 today.

## Panasonic Services Company

20421 84th Avenue South

Kent, Washington 98032

Phone: 800-833-9626

Fax: 800-237-9080

For over 35 years, the Panasonic, Quasar, and Technics brand names have appeared throughout American homes and industries. In that time, our company's commitment to total customer satisfaction has manifested itself in many ways. Our approach to post sales support has evolved to include programs that encompass qualitative human resource training, as well as ones that stress the development of automated processes that allow us to offer timely, accurate solution to our users' service needs.

The engine behind PACS's ability to ensure timely repairs is our ability to deliver parts, accessories, and service literature to our network of factory service centers, independent servicers, and dealers in a timely manner. We are now seeing the results of over a decade of continued investment in the modernization of our facilities. The primary point of support for all replacement parts and service literature is the National Parts Center in Kent, Washington. From here and with further support from sales & marketing staff and field staff throughout our U.S. regions, we handle a wide variety of inquiries and fill just about any request made of us.

### Customer Contact

Generally, the first line of customer support is provided by our Customer Service Department located in Kent, WA. This office handles a wide variety of customer calls ranging from simple parts orders to research requests on unique model numbers. Currently, the Customer Service Department handles over 3,200 calls per day taking orders, supplying estimated shipping time, return authorizations, processing credits, and special orders. Also the Customer Service Department receives over 1,000 faxes daily. In addition, we offer retail customers toll-free phone and fax numbers and on line ordering through the Internet. Our customers can order literature, parts or any of our comprehensive line of accessories.

In order to further improve our level of customer service we have made significant

investments in phone management systems in order to improve our efficiency. Data gathered from these systems graphically depict work load volume, peak times, and average call length on a daily basis, and give management a true picture of where additional improvements are needed.

Our staff includes representatives that reach out to the field as well. Regional Parts & Accessory Representatives call on distributors, independent servicers, dealers, and even to consumers to assess their needs. With a comprehensive portfolio of sales programs and promotional items, they are able to offer profitable opportunities to small and large businesses alike. Along the way they are able to keep in touch with ever changing needs of all, and make the necessary recommendations to our market development personnel.

Our commitment does not stop with our internal efforts. We also maintain a network of over 40 authorized independent parts and accessory distributors who are well positioned to support our wide range of customers in various markets throughout the country.

### Parts and Service Literature Distribution

Once we've established what our customer needs, we have to get it to them. That's the job of over 125 employees that staff our parts and service literature warehouse in Kent. The building is a quarter mile long, and encompasses 228,000 square feet, which houses over 110,000 line items and 2.8 millions pieces.

The warehouse day begins at 6:00 a.m. There are over 2,000 parts orders being processed at any given time. In order to manage such an overwhelming task, procedures have been created that allow us to meet our goal of having all orders shipped within 24 hours. By the end of the day, the facility will have shipped approximately 2,700 parts and literature orders, which consist of over 7,000 line items, and over 35,000 pieces!

Through the use of bar coding, and a RF

(radio frequency) based receiving system, we are able to reduce the turn around time for receiving and stocking, making goods available to the customer even sooner.

We have recently completed our investment in the modernization of our warehouse operations. This includes the expanded use of RF and bar codes throughout the facility, conveyors, carousels and a new software system. Designed to create a paperless environment, this comprehensive, state-of-the-art installation enables us to provide faster, error free service to our customers as well as positioning Matsushita for the next decade.

Finally, in our effort to be earth friendly, the warehouse has been a leaders in the effort to recycle. It all started four years ago when we began to use biodegradable packing material. Today, we have a comprehensive program to recycle all paper, cardboard, aluminum cans and pallets. We make an effort to purchase recycled product when it is available. In recognition of our efforts, we were designated a "Distinguished Business in the Green" by King County.

### The Future

We have recently expanded our customers ability to have on-line access with Panasonic Services in the form of an Internet parts inquiry and ordering system. Our new order system is easy to use and provides up to the minute detail on parts availability, orders, credits, returns and order history.

Internally, with systems that our customers don't directly see, we move further into the information age. Not only do our purchasing agents continue to employ CD-ROM information systems, we are now on-line with our factories in Japan for inquiry purposes, a capability we plan to expand to selected aspects of our market. The use of bar coding will continue to expand.

Our goal for the future is customer satisfaction, not just for our direct customer, but anyone who comes in contact with Panasonic, Technics, or Quasar.

# Matsushita Original Replacement Parts and Accessories

**A Guarantee of Quality**

Nothing less than total satisfaction is expected by today's customers. The only way to live up to this standard is by using Matsushita Original Replacement Parts and Accessories. The source of this quality is Panasonic Services Company and your Authorized Replacement Parts Distributor. Consult the list below, or call **1-800-545-2672** for the location nearest you.

## CALIFORNIA

Andrews Electronics (C/V/M/A) \* 25158 Avenue Stanford, Santa Clarita 91355 \* 800-289-0300 \* FAX 800-289-0301  
AVAC Corp. (V) \* 3746 Bradway Dr., Sacramento 95827 \* 916-361-7491 \* FAX 916-361-5480  
Blakeman Wholesale (V) \* 1800 E. Walnut St., Fullerton. 92631 \* 714-680-6800 \* FAX 714-680-8700  
Cass Electronics (C/V/M/A) \* 801 Seventh Ave., Oakland 94606 \* 510-839-2493 or 800-974-5775 (outside 510) \* FAX 510-465-5927  
E and K Parts, Inc. (C/V/M/A) \* 2115 Westwood Blvd., Los Angeles 90025 \* 800-331-8263 or 310-475-6848 \* FAX 800-826-0890 or 310-474-0846  
Pacific Coast Parts (C/V/M/A) \* 15024 Staff Court, Gardena 90248 \* 800-421-5080 \* FAX 800-782-5747  
Star For Parts (V) \* 10727 Commerce Way, Suite B, Fontana. 92335 \* 909-428-1404 \* FAX 909-428-3213

## COLORADO

Star For Parts (V) \* 2350 Arapahoe St., Denver 80205 \* 303-296-2117 \* FAX 303-296-2120

## CONNECTICUT

Signal Electronics Supply, Inc. (C/M/A) \* 589 New Park Ave., West Hartford 06110 \* 860-233-8551 \* FAX 860-233-8554

## FLORIDA

Herman Electronics (C/V/M/A) \* 7350 N.W. 35th Terrace, Miami 33122 \* 800-938-4376 \* FAX 800-938-4377  
Layco, Inc. (C/V/M/A) \* 501 S. Main St., Crestview 32536 \* 850-682-0321 \* FAX 850-682-8820  
Vance Baldwin (C/M/A) \* 2701 W. McNab Road, Pompano Beach, 33069 \* 800-432-8542 \* 954-969-1811 \* FAX 954-969-0226 \* 800-552-1431  
Vance Baldwin (C/M/A) \* 1801 N.E. 2nd Ave., Miami 33132 \* 305-379-4794 \* FAX 305-373-8855  
Vance Baldwin (C/V/M/A) \* 1007 N. Himes Ave., Tampa 33607 \* 800-299-1007 \* FAX 813-870-1088

## GEORGIA

Buckeye Vacuum Cleaner (V) \* 2870 Plant Atkinson Rd., Smyrna 30080 \* 404-351-7300 \* FAX 404-351-7307  
Wholesale Industrial (C/M/A) \* 5925 Peachtree Corners East, Norcross 30071 \* 770-447-8436 \* FAX 770-447-1078

## ILLINOIS

B-B & W, Inc. (C/V/M) \* 2137 S. Euclid Ave., Berwyn 60402 \* 708-749-1710 \* FAX 708-749-0325  
Hesco, Inc. (V) \* 6633 N. Milwaukee Ave., Niles 60714 \* 847-647-6700 \* FAX 847-647-0534  
Joseph Electronics, Inc. (C/M/A) \* 8830 N. Milwaukee Ave., Niles 60714 \* 847-297-4208 \* FAX 847-297-6923  
Union Electronic Dist. (C/V/M/A) \* 311 E. Coming Rd., Beecher, IL 60401 \* 800-648-6657 or 708-946-9500 \* FAX 800-43-UNION or 708-946-9200

## INDIANA

Electronic Service Parts (C/V/M) \* 2901 E. Washington St., Indianapolis 46201 \* 317-269-1527 \* FAX 800-899-1220

## MARYLAND

Tritronics, Inc. (C/V/M/A) \* 1306 Continental Dr., Abingdon 21009-2334 \* 800-638-3328 \* FAX 800-888-FAXD

## MASSACHUSETTS

Tee Vee Supply Co. (C/V/M/A) \* 407 R Mystic Ave., Unit 14, Medford 02155 \* 781-395-9440 \* FAX 781-391-8020

## MICHIGAN

Allied National (V) \* 13270 Capital Avenue, Oak Park 48237 \* 800-999-8099 \* FAX 800-730-5696  
G. M. Popkey Co. (C/V/M/A) \* 5000 W. Greenbrooke Dr. S.E., Grand Rapids 49512 \* 800-444-3920 or 616-698-2390 \* FAX 616-698-0794  
Remcor Electronics (C/V/M/A) \* 10670 W. Nine Mile Rd., Oak Park 48237 \* 248-541-5666 \* FAX 248-398-1016

## MINNESOTA

Almo Distributing (V) \* 8600 109th Ave. N., Champlin 55316 \* 800-252-2566 \* FAX 612-421-8640  
AVAC Corp. (V) \* 666 University Ave., St. Paul 55104 \* 612-222-0763 \* FAX 612-224-2674  
Ness Electronics, Inc. (C/V/M/A) \* 441 Stinson Blvd. N.E., Minneapolis 55413 \* 612-623-9505 \* FAX 612-623-9540

## MISSOURI

Cititronix, Inc. (C/V/M/A) \* 1641 Dielman Rd., St. Louis 63132 \* 800-846-2484 or 314-427-3420 \* FAX 314-427-3360  
Tacony Corp. (V) \* 1760 Gilsinn Lane, Fenton 63026 \* 314-349-3000 \* FAX 314-349-2333

## NEW JERSEY

Panson Electronics, (C/V/M/A) \* I-80 and New Maple Ave, PO Box 2003, Pine Brook 07058 \* 800-846-2484 or 973-244-2400 \* FAX 800-332-3922

## NEW YORK

Dale Electronics (C/V/M/A) \* 7 E. 20th St., New York City 10003 \* 212-475-1124 \* FAX 212-475-1963  
Jayso Electronics Corp., (C/V/M/A) \* 3210 White Plains Road, Bronx 10467 \* In NY 713-798-1050 - Outside NY 800-426-4422 \* FAX 718-655-1196  
Radio Equipment Corp. (C/A) \* 196 Vulcan St., Buffalo 14207 \* 716-874-2690 \* FAX 716-874-2698  
Standard Electronics (C/V/M/A) \* 215 John Glenn Dr., Amherst 14228 \* 800-333-1519 OR 716-691-3371 \* FAX 800-338-1241  
Star For Parts (V) \* 250 Rabro Drive E., Hauppauge 11788-0255 \* 800-525-6046 \* FAX 516-348-7160

## OHIO

Carmen's Vacuum (V) 85 South Hamilton Rd., Columbus, OH 43213 \* 614-864-0190 \* (F) 614-864-0193  
Electric Sweeper Co./ESSCO (V) \* 7800 Hub Parkway, Valley View 44125-5711 \* 800-321-2664 \* FAX 216-524-4142  
Fox International, Inc. (C/V/M/A) \* 23600 Aurora Rd., Bedford Heights 44146 \* 440-439-8500 \* FAX 800-445-7991  
MCM Electronics (C/V/M/A) \* 650 Congress Park Dr., Centerville 45459-4072 \* 800-543-4330 or 937-434-0031 \* FAX 937-434-6959

## OKLAHOMA

Huey's, (V) \* 6005 N.W. 2nd, Oklahoma City 73127 \* 800-654-6622 \* FAX 405-495-3812

## OREGON

Diversified Parts (C/V/M/A) \* 2114 S.E. 9th Ave., Portland 97214-4615 \* 800-338-6342 \* FAX 800-962-0602  
Northwest Wholesale (V) \* 426 N.E. Davis St., Portland 97232 \* 800-234-8227 or 503-232-7114 \* FAX 503-232-7115

## PENNSYLVANIA

Steel City Vacuum Co., Inc. (V) \* 919 Penn Ave., Pittsburgh 15221 \* 800-822-1199 or 412-731-0300 \* FAX 412-731-3205

## TENNESSEE

Shields Electronics Supply, Inc. (C/V/M/A) \* 4722 Middlebrook Pike, Knoxville 37921 \* 423-588-2421 \* FAX 423-588-3431

## TEXAS

Electrotox, Inc. (C/V/M/A) \* 2300 Richmond Ave., Houston 77098-3299 \* 713-526-3456 \* FAX 713-639-6400  
Electrotox, Inc. (C/V/M/A) \* 1200 W. Hildebrand, San Antonio 78201 \* 210-735-9271 \* FAX 210-737-2642  
Fox International (C/V/M) \* 752 S. Sherman, Richardson 75081 \* 800-321-6993 or 214-439-8500 \* FAX 800-445-7991  
Genvac (V) 1560 A Industrial Drive, Missouri City 77489 \* 800-229-8227 \* FAX 281-261-6383  
VCP International, Inc. (V) \* 2285 Merritt Dr., Garland 75040 \* 972-271-7474 \* FAX 972-278-5981

(C) Consumer Electronic Parts (V) Vacuum Parts (M) Major Appliance Parts (A) Accessories

## Panasonic Services Company

20421 84th Avenue South, Kent, Washington 98032

**Panasonic**®

**Technics**

**Quasar**®

## PTS

**5233 South Highway 37  
Bloomington, IN 47402  
Phone: 800-844-7871  
Fax: 800-844-3291  
E-mail: pts@ptscorp.com  
Website: www.ptscorp.com**

For over thirty years, PTS has been providing quality service to the electronic service industry. PTS is the nation's largest source for all major brands of television replacement tuners and mainboards. Television tuners and mainboards are in stock for immediate shipment. Brands such as Zenith, RCA and Philips are available at significant savings when compared to manufacturer direct replacements. PTS employs over 400 technical and support staff with branches in California and Colorado.

### Satellite Receivers

In addition to television tuners and mainboards, PTS offers 24-hour in-house turnaround time, subject to parts availability, on major brands of satellite receivers. Most major makes and models are currently serviced for \$49.95 plus parts.

DBS and C-Band receivers are serviced at corporate headquarters in Bloomington, IN.

### Free Shipping

Television tuners purchased from PTS are shipped with **FREE** overnight delivery to most destinations. Over 40 different brands are available with a 90% fill rate. Order today and have it delivered tomorrow.

### Thousands In-Stock

PTS maintains an extensive inventory on most major brands of television replacement tuners and mainboards. Thousands of tuners and mainboards are readily available. If the item is not currently in stock, PTS has a service support system to rebuild your non-working tuner or mainboard. PTS also offers express service on Hitachi, Sony,

and Mitsubishi mainboards. Call for service availability on recently introduced models.

### Our Objectives

PTS has been supporting the independent service dealer, retailers, and independent manufacturers since 1967. If you're a one-man operation, multiple location service center, or a manufacturer, PTS can help with service solutions. PTS will help increase profits utilizing four primary objectives: **REDUCE PARTS INVENTORY.** There is no need to stock expensive, unnecessary parts for repair when you rely on PTS for replacement tuners and mainboards. **PROVIDE FASTER SERVICE.** You'll minimize having to wait for backordered parts, schematic, or technical information. In most cases, we'll process your order long before you could have obtained special ordered parts or schematics. **MINIMIZE LABOR COST.** Knowing that PTS provides an excellent source for repair assistance, your technicians will no longer have to agonize over "dog" units which results in a high labor cost per unit. Your output per man-hour and workflow will improve dramatically. **INCREASE PROFITS.** By relying on PTS for replacement tuners and mainboards, you could realize savings up to 60% when compared to manufacturer replacements. PTS tuners and mainboards carry a 6 month limited warranty from date of purchase. "When you want the right part, the right service, right away" — **CALL PTS.** ■

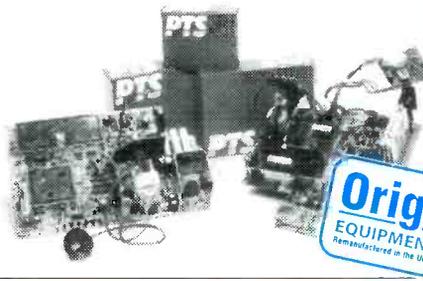
# PTS Electronics

The Nation's Largest Source  
for TV Tuners and Mainboards

*When you want the right part, the right service, right away.*

## TV Mainboards

Zenith • RCA • Philips in stock  
Service available for Hitachi,  
Mitsubishi, and more!!



**Original**  
EQUIPMENT PARTS  
Remanufactured in the United States by PTS

## Television Tuners

**FREE OVERNIGHT DELIVERY!\***  
Over 40 Major Brands in stock



\*Call for details

## Satellite Receivers

DBS and C-Band  
Most makes and models



**24**  
HOUR  
TURNAROUND

Over 20,000 customers rely on PTS for professional service. For over three decades PTS has been one of the largest independent repair facilities in the country. The professionals choice!

**email** | pts@ptscorp.com  
**website** | www.ptscorp.com

**Indiana** | Bloomington  
Corporate Headquarters  
Toll Free 800-844-7871  
Fax 800-844-3291

**Colorado** | Arvada  
Toll Free 800-331-3219  
Fax 303-422-5268

**Expanded Customer Service Hours**

## Sencore, Inc.

**3200 Sencore Drive  
Sioux Falls, SD 57107**

**Phone: 800-736-2673**

**Fax: 605-339-0317**

**Website: [www.sencore.com](http://www.sencore.com)**

For nearly 50 years, Sencore Electronics has been dedicated to one goal — making our customers more successful in electronic servicing. Today, Sencore is a leading manufacturer of electronic test equipment because we listen to our customers needs and design instruments that help them achieve success. Sencore is committed to its customers success with an exclusive product line and the absolute best support in the industry. Our obligation and support are just beginning when a customer says “yes” to Sencore equipment.

Sencore was started in 1951, in downtown Chicago, Illinois by R.H. (“Herb”) Bowden. As the business grew, Sencore moved west to Sioux Falls, South Dakota in 1971, attracted by the area’s superb quality of life. The now second generation business remains in Sioux Falls where Sencore is proud to be actively involved in community events and charities. Sencore’s second generation, represented by co-owners Al and brother Doug Bowden, is committed to adapting to the technical challenges necessary to take Sencore into the 21<sup>st</sup> century.

Sencore’s highly-trained employees continually design new equipment based on advances in the electronics industry. With each new product, the company deals with complex issues of marketability, design feasibility and manufacturability and brings these together in the shortest time possible. Sencore designs and manufactures test instruments that provide the highest quality and reliability in the entire service industry.

Every Sencore instrument is engineered to provide our customers with exclusive tests and capabilities that will make testing and troubleshooting easier and more efficient. When customers invest in Sencore instruments, they also receive the best after-the-sale support available in the industry. During the past 48 plus years, Sencore has remained dedicated to one goal — making our customers more successful. And since our success depends on our customers success,

we’re working even harder to be the premier test equipment company in the industry.

The future looks exciting at Sencore. As technology advances from the broadcast studio to your living room TV receiver, Sencore is preparing itself for new challenges and forming global alliances to stay on top of the industry. We’re a forward looking engineering/manufacturing/marketing firm with an eye on the future.

With the ushering of Digital Television, Sencore is proud of our alliance with Adherent Technologies in serving North America with MPEG, DTV, and other excellent digital products. These offerings are providing cutting-edge answers for the broadcasting industry in this exciting technical revolution. On November 1, 1999, the top 10 television networks will be going digital with the use of Sencore technology! For the past 5 years, Sencore has been instrumental in educating and providing the right tools to the manufacturers and broadcasters responsible for compressing video signals. They rely on Sencore to be their “digital” resource for all the changes and regulations they need to meet. Sencore provides digital solutions that support: Studios, Networks, Local TV Stations, Cable Companies, Retailers, Consumers, and ultimately Servicers!

Sencore TechDisc is a new multimedia service and training tool designed to increase the productivity of the people who use, support, and service products. TechDisc lets the customer package technical knowledge, procedures, and expertise and make it available to their end users, field engineers, customer service representatives, and technical trainers. High resolution photographs and audio clips, full motion video, and animated graphics can capture details, illustrate concepts, and demonstrate procedures quickly and comprehensively.

Users will become proficient on customer products faster. . . field engineers will service more effectively. . . support representatives will deliver the right answer more

quickly when they use the TechDisc Interactive Manuals.

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TechDisc specifically provides the following products:

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Additionally, Sencore TechDisc offers. . .  
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Sencore’s Contract Manufacturing is an important area for growth, as numerous firms have recognized Sencore’s high quality capabilities and rely on the firm to build their electronic-related products.

Our state-of-the-art facilities give us the capabilities needed to provide our customers with fast, quality service. Who knows where the future will take us next. We do know one thing, Sencore will be at the forefront of new technology with products and alliances to insure we remain on top of our industry.

See you in the future! ■

## Herman Electronics

7350 Herman Way

Miami, FL 33122

Phone: 800-938-4376

Fax: 800-938-4377

Herman Electronics is a diverse and multi-faceted full-line distributor of everything in electronics, committed to offering only the best in original replacement parts and everything in service accessories including tools, test equipment, cable, connectors, semiconductors, chemicals, and most importantly, customer service to their customers. In business for over 40 years, Herman Electronics has clearly established itself as one of the leaders in the industry by providing only quality products and superb customer service to all facets of the electronics industry.

The heartbeat of the company lies in the OEM parts department. While serving the industry for over 3 decades, Herman has many of the major OEM parts lines enabling them to provide more efficient and cost effective service to you, their valued customer. Herman Electronics is one of the largest original replacement parts and acces-

sory distributors in the country and is factory authorized for SONY, PANASONIC, THOMSON-Premier (RCA-GE-PROSCAN), SAMSUNG, QUASAR, ONKYO, TECHNICS, TOSHIBA, HITACHI, (Elite Distributor), DAEWOO, and KENWOOD. Stocking one the largest and most comprehensive parts inventories in the country enables the company to fill over 80% of their orders from inventory and guarantees SAME DAY shipment of all in-stock orders placed before 5:30 P.M. (EST).

In addition, Herman Electronics is the source for everything in service accessories, distributing only name brand products. If you need it, Herman has it. Tools, test equipment, soldering equipment, chemicals, power products, technician aids, cable connectors, and accessories from all of the industry leading manufacturers including Fluke, Sencore, Hakko, Chemtronics, Belden, Xcelite, B&K, Weller, TrippLite, and many more.

Herman Electronics provides a variety of customer support services as a result of their commitment to customer service excellence. They have several professional customer service representative to serve all your needs from 8:30 A.M. to 6:00 P.M. (EST) Monday through Friday. The company prides itself on being accommodating to its customers in order to provide complete customer satisfaction, says Jeffrey

A. Wolf, President and son of one of the company's founders. "It is our job to EXCEED customers' expectations by taking that extra step in providing the highest level of professional, personalized service. As the year 2000 rapidly approaches, it is our commitment and dedication to maintain a standard of excellence in customer service, while at the same time continue to develop innovative ideas and fresh approached in order to meet and exceed the demands that lie ahead." And the company is doing just that.

Herman Electronics is preparing to launch their new internet based, live interactive website. The new Herman site will provide Herman customers with direct access to OEM parts, pricing and availability, ETA information, order status, and more. This new system will make ordering and inquiring faster and more efficient for Herman customers. In addition, Herman is introducing their Cyber Warehouse. This will provide the entire industry with access to every product they distribute and the ability to order directly from their site. Herman Electronics expects to launch this new site by 5/1/99.

If you haven't given Herman Electronics a try, please do so today. Call to request a copy of their new catalog or simply visit them on the World-Wide-Web at hermanelectronics.com. Herman Electronics... Leading the Way. ■



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Our sales staff is technically trained. To service the OEM customers, we have to be. We have the largest library of semiconductor manuals in the market available to support our sales. Hundreds of part cross references are in our database. We back what we say. When we offer a cross, we know it's right and can send you the specifications to prove it. Feel free to talk to our Engineering/Technical Support office at 814-757-8300.

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As a factory authorized distributor, we only sell original quality manufactured parts. NO

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Phone: 317-298-5400

Fax: 317-298-5604

Over 40 years ago, Howard W. Sams was the first company to recognize that the increasing popularity of home entertainment electronics meant a corresponding demand for reliable service documentation. This insight gave birth to the first PHOTOFACT® which presented concise technical information to help service technicians repair specific makes and models of radios. Televisions were soon added to the product line, followed by computer equipment and then VCRs.

Today, Howard W. Sams is the nation's largest provider of after-market service data for televisions and VCRs in the form of PHOTOFACT® and VCRfacts® through subscription services, distribu-

tors, and direct order. Some 95% of after-market repair companies use Howard W. Sams technical data. The addition of Branded PHOTOFACT® Sets combining of technical documentation grouped by manufacturer makes ordering easy.

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At [www.hwsams.com](http://www.hwsams.com), guests are treated to complete titles summaries for Prompt® books, as well as an entirely searchable version of the Annual Index. On-line response forms are provided to request free copies of the Annual Index and Prompt® Publications Book Catalog.

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Fax: 800-RNJ-FAX1 (765-3291)

Since its inception in 1981 as a full line discount distributor of electronic parts and test equipment, RNJ Electronics has committed to supply the electronics industry with state of the art products and accessories. RNJ Electronics now distributes original TV & VCR parts from Sony, RCA, Panasonic, JVC, Sharp Hitachi and Test Equipment from B&K Precision, Global Specialties, Fluke, and Emco all at very competitive prices, making RNJ your one stop source for all of your parts and test equipment needs.

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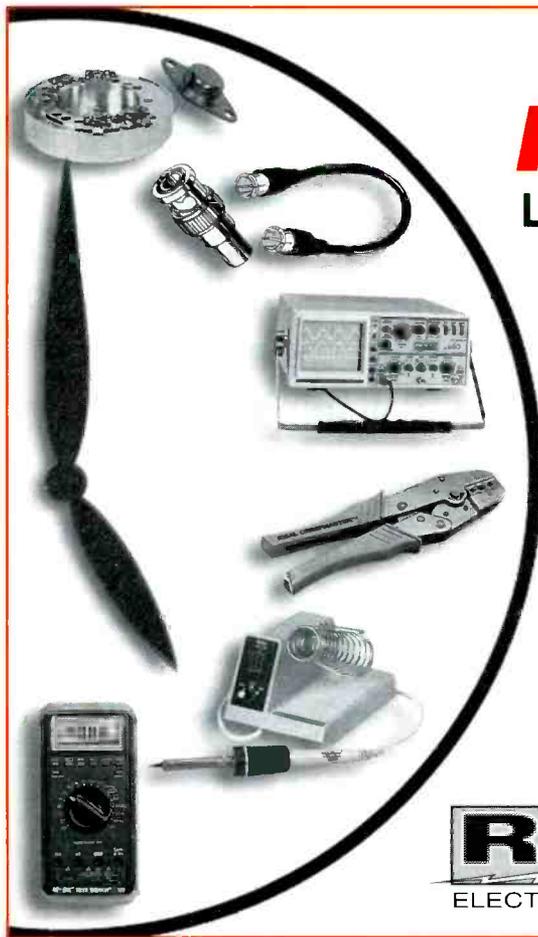
The company is also a master distributor in an industry experiencing tremendous growth: the security industry, stocking prod-

ucts such as cameras (regular & covert), monitors, switchers/quads/multiplexers, lenses, mounts/housing/pan & tilts/domes, wire & connectors, Cat 5 products and much more from companies such as Sony, Panasonic, Provideo, Philips, Robot, Computar, Tamron, Pelco and many more.

In addition to the above products, the company also carries in its semi-annual 160 page catalog items such as Panasonic cable converters, audio video & antenna accessories, universal remotes, camcorder batteries, semi-conductors, mobile carts, tools & soldering equipment, educational kits and much more.

As you can see RNJ Electronics prides itself on its ability to stay current with the ever changing needs of its customers. Customer service is a top priority for the company. The sales department and technical staff provide friendly & courteous service at all times. All orders are processed in a timely manner with shipping via UPS ground, red, blue, orange FedEx, or air parcel domestically and internationally. Volume discounts are available for large orders. OEM quotes and bids are welcomed.

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## Tritronics, Inc.

1952 NW 93<sup>rd</sup> Avenue

Miami, FL 33122

Phone: 800-638-3328 • 800-365-8030

Fax: 800-888-FAXD • 800-999-FAXD

Tritronics Inc., a family owned and operated business, is now open twenty-four hours a day with the introduction of our interactive website, [www.tritronicsinc.com](http://www.tritronicsinc.com). Our open account customers can access our model and parts database, place orders, check the status of their account, and e-mail us whenever it is convenient for them.

Servicers can search for pricing and availability by model number or part number. Our extensive research files and pricing information are updated continuously to provide the best information on over 25 brand names. Why not make Tritronics your one stop center for all your electronics parts and accessories needs?

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VISA, Mastercard, and Discover to save on COD fees. Call us with a list of your backorders and we will check one of the largest inventories in the industry. Tritronics averages an overall 85% fill rate on initial shipments. Our newest catalog will be mailed to over 30,000 service centers in late spring. Keep an eye out for your copy, which will include cross-references for popular replacement parts, such as mechanical parts, semiconductors, optical pick-ups, and more cost savings ideas.

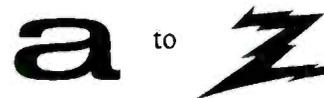
Tritronics has a fully-staffed research department that is knowledgeable. This department has a full range of service manuals, microfiche, and CD-Rom available to assist our customers with parts identification. They can be reached directly at (410) 676-7300, from 8:30 a.m. to 5:00 p.m. EST Monday to Friday.

Tritronics, Inc. has a branch located in Miami at 1952 NW 93<sup>rd</sup> Avenue. The branch manager, Doug Maris, has recently created a counter area with about 1,500 square feet of tools, service aids, accessories, antenna/DSS supplies, and parts. If you are in the area, stop by for a visit. The branch is located within minutes of Miami's International Airport.

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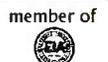
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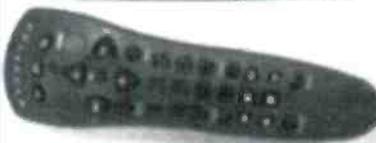
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CyberTech is designed exclusively to help Electronic and Appliance Service Centers and Technical Professionals manage information more efficiently and profitably. CyberTech is developed base on exposure from large to small size Service Center facilities. Many of the problems areas associated in running repair organizations concerning technical efficiency, training, systemic organization of service process including information retention and Electronic Claim Processing are the key revolving issues that lead to the development of CyberTech for Windows.

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Mr. Eric Elley - Manager of B&B TV (Hightstown, NJ) - "The remote access feature is convenient! We now can create invoices and process customer's credit cards. What a time saver!"

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# LG Precision

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Phone: 562-404-0101

Fax: 562-921-6227

e-mail: lgpa@pdc.net

Website: www.oscilloscope.com



**LG Precision**

LG Precision was founded in Korea in 1976. Since its establishment, LG Precision has grown significantly in the Test and Measurement market-place.

It has expanded with a wide selection of Analog and Digital Storage Oscilloscopes, Frequency Counters, DC Power Supplies, Digital Multimeters (Handheld and Bench-Top), Function Generators, and Audio Oscillator.

In 1998, LG Precision made significant upgrades in its products line, such as launching high performance 2.7GHz Spectrum Analyzer and portable digital 100MHz Oscilloscope. The SA-7270 is a high performance and state-of-the-art designed spectrum analyzer providing 2.7GHz wideband range, a bright large-scale LCD screen, convenient menu operation, memory function, etc. The OS-310M is a 100MHz Digital Oscilloscope with built-in Digital Voltmeter. It is designed for field service and bench operations as well.

The new triple output DC power supply GP-4303TP and the 5MHz Functions Generator with built-in frequency counter FG-7005C have recently joined LG Precision's products line.

LG Precision runs its U.S. office to provide effective customer service in U.S. and Canadian market places. It is conveniently located in Cerritos, California and carries sufficient inventory and technical support for immediate response to customer requirement. LG Precision provides detailed information about the products on the internet. Welcome to visit the website at <www.oscilloscope.com> and conveniently download specifications and pictures. ■



**Other Products**



**OS-310M**



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## Andrews Electronics

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Santa Clarita, CA 91355

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Andrews Electronics is housed in 50,000 square feet of warehousing and office space. Miles of shelving are arranged for immediate identification and easy accessibility for over 250,000 different parts that we carry.

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CT-98 is an extraordinary tool in assisting technicians with electrolytic capacitor repairs. When using CT-98, technicians no longer need to waste time unsoldering the capacitor to test its value. Simply touch the leads to the legs of the component and the value of the capacitor will be read on the analog scale. Thus, the technician can efficiently and accurately determine if the component is defective. This is a True In-Circuit Capacitor Tester. Ordinary ESR meters only see effective impedance. CT-98 discriminates between capacitor, resistor, and inductors. CT-98 has a built-in short/test indica-

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Technicians using CT-98 now have the

potential of substantially increasing productivity by cutting down on time loss on troubleshooting for failed capacitors. CT-98 is being used on many types of electronic repairs such as : TV, VCR, AUDIO, COMPUTER MONITOR, LASERDISC and CAMCORDERS, however, it can be used on any type of equipment that has electrolytic failure. CT-98 comes with an internal rechargeable battery, test leads, and a 90-day warranty. ■

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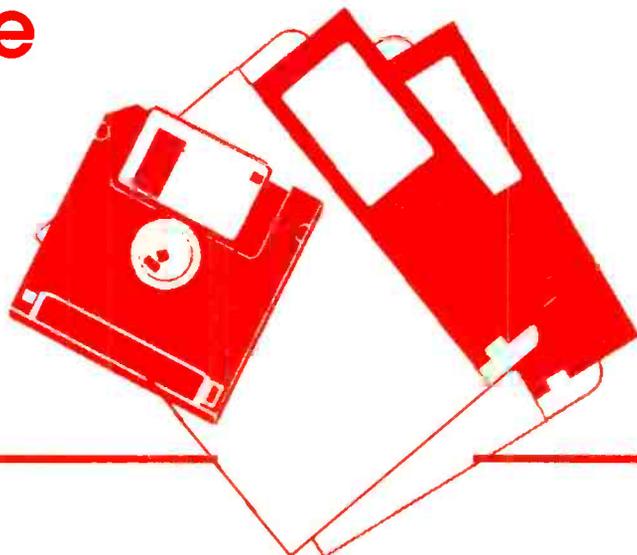
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Circle (80) on Reply Card

# Gaining profits and respectability through service management software

by John A. Ross



The electronics service business has become intensely competitive for several reasons. Discount houses offer products, such as televisions, VCRs, stereos, and personal computers, at cut-rate prices. With the emergence of lower-cost products, customers may choose to purchase new items rather than having older products repaired. The emergence of larger service depots has taken business away from independent service centers. As a result, the pressures on independent service centers have pushed those businesses into servicing a greater variety of products, while attempting to hold net costs, service fees, and operating expenses to a realistic level.

All this continues to heighten competition and increase innovation. One method for coping with the competition; opening new markets; and increasing innovation lies within the use of available software products. As mentioned in two previous articles, the application of service management software and resources found on the World Wide Web can boost the efficiency and effectiveness of your service business. This article provides an overview of service center management software.

## Knowing your customer

Huge numbers of books and articles exist that extol the virtues of customer

service. In many ways, customer service involves a large amount of preparation and the recognition of the individuality of your customer's needs. Service management software can provide this advantage through the listing of detailed customer records; the addition of history notes to those records; and the logging of telephone conversations between you and your customer.

Given this type of information, service center owners have a better opportunity to match products and services with particular customer needs. In addition, different types of available software also allow the service center manager to compile statistics about customer preferences; the number of specific types of parts used; and the types of repairs completed by technicians. Service management software provides the benefit of allowing access to this information through a single keystroke or click of the mouse. With these statistics in hand, the staff of a service center or the owner of a service business will remain better prepared.

## Purchasing service center management software

As with all software, service center management software can vary in terms of usefulness and cost. The usefulness of the software depends on your particular needs and on your management style. Before purchasing service center man-

agement software, carefully review all the features and the ease of operation given by the product. Generally, the least expensive service center management software packages carry a retail cost of a few hundred dollars. Packages that offer more features can have prices that exceed several thousand dollars.

Ensuring that you are making a wise purchase becomes easier through the use of demonstration programs. Most companies that produce service management solutions offer demos either through regular outlets, mail order, or the World Wide Web. Although demo packages have limitations, the use of the demo will allow you to make a decision concerning the purchase of the full package.

Along with obtaining a demo program, also check the software specifications to ensure compatibility with your computer system. For example, the software may work only with Windows 95 rather than Windows NT or the Macintosh operating system. Other software may work only as a stand-alone package rather than in a networked environment, or vice versa. If the software relies on a structured query language, or SQL, database, it may require additional system memory. In turn, check the specifications for the type of display card required. Many software applications work only with a given number of colors and a specified video resolution. Finally, verify whether the reporting function of the software requires an addi-

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tional spreadsheet package, such as Lotus or Excel, or if the software is compatible with common spreadsheet packages.

### Attractive features to consider

The category "service center management" software establishes that the software has the task of assisting us with the management of our service centers. To do this, the software offers standard features such as:

- Tracking and Scheduling;
- Inventory Management;
- Invoicing;
- Codes and Tables; and
- Forms and Reports.

Each of these features releases you and your staff from the routine operations of a business and allows good time management to surface.

Dedicated service center management packages offer tracking and scheduling in several ways. Primarily, this feature creates a job ticket and stores information related to the particular service call. The tracking and scheduling function should allow both management and technical staff to easily handle the initial phone call that leads to the actual servicing of the customer's product.

To do this, the software should provide easily-read entry screens that allow the quick entry of customer's name, phone number, and address, as well as a job number, product type, product model and serial numbers, the job status, and a schedule for the repair. In addition, the software should include a memo field that allows the listing of any information that may make the service call less difficult.

With these basic features, the software program gives all the service center staff instant access to job status information; a history of the repair that links the service call to a product model and serial number; and schedule of the repair. By listing the combination of address, product type, product model number, and product serial number, the software allows the service center manager to assign the service call to the most-capable technician.

Independent service center owners can take advantage of those features by setting up service call schedules according to areas and availability of required parts.

The reference to "required parts" also brings us to another feature provided by most service center management soft-

ware packages. An inventory management program indicates individual parts movement by month or day; cross-references the OEM part to valid replacements; shows current prices; quantities in stock; and a re-order report.

As with the tracking and scheduling portion of the program, the inventory management portion allows any member of your service team to gain essential information about the parts required to complete a particular task. The inventory management software also provides the fiscal benefits of ensuring adequate inventories without accumulating large numbers of slow-moving parts. These fiscal benefits multiply if the service team uses the information provided by the software to purchase parts before such time as a critical need arises.

### Generating reports

Because most service center management packages offer integrated functions, each of the features that we have discussed combines within full-reporting functions. User-defined codes and parts pricing tables allow your service team to customize the software so that its capabilities match the needs of your operation. A user-defined code establishes "hot keys" for possible code entries and allows a technician to see codes for unit types, brands, manufacturers, and jobs.

The reporting function takes advantage of the information entered into the system by technicians and the user-defined codes through the generation of information in specified formats. Because information is entered only one time, technicians spend less time with paperwork and more time with the actual repair. Most software applications allow the user to choose different types of forms.

Along with creating invoices, the software can also generate accounting payable and receivable records for the entire operation. Other types of forms and reports include management reports that show daily-work-in-progress and a listing of work completed but not picked up. Technician reports can show the productivity of individual technicians, as well as job tracking and scheduling. Many applications also include reports that provide added detail about warranty and service literature or product call-backs, as well as any industry upgrades.

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## ES&T Calendar

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National Professional Service  
Convention  
August 2–7, 1999  
(Trade Show August 4 and 5)  
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PCS '99  
September 22–24, 1999  
New Orleans, LA  
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## Test Your Electronics Knowledge

### Answers to Test

(from page 15)

1. B — If the p-p voltage is 10V, the  $V_{MAX}$  is 5V. The rms value is  $5 \times 0.707$  volts.
2. A
3. B
4. A
5. C
6.  $A\bar{B} + A\bar{B} = L$
7. B
8. A
9. A
10. 30Hz

Answer to the Bonus Question:  
 $320.96 - (-830.32) = 1151.28$

Invoices generated through the reporting function automatically show the customer name, address, and phone number. In addition, the added features of the service center management software also establish an invoice that lists the number of contacts made with the customer; the extent and time of those contacts; amount and types of parts used for the repair; a detailed listing of the job history; and current pricing information. The amount of information made available through the software can eliminate many discrepancies and prevent disputes from arising.

### Other available features

Many more expensive service center management applications contain features that may provide additional benefits for larger service centers and repair depots. Call center applications allow service center staff to automate troubleshooting, call queuing, parts management, and return/repair authorizations. To accomplish these tasks, the call center application tracks customer histories, while opening requests that align with the customer needs. More specifically, the software allows technicians to identify and define steps for the service delivery process and build a template that includes expected labor and parts usage. The software also permits management to match a list of technicians to the service call through task delegation functions.

Workflow management options within the software allow a company to select business rules and policies to fit particular tasks. In part, these rules establish criteria for notifying technicians through pagers, e-mail, or a screen message. In addition, the software defines obligations regarding time commitments. That is, the software reminds technicians 60 and 30 minutes before a scheduled job and ten minutes after this time has passed. This feature combines with event management rules, where the software creates a log that shows when the technician has arrived at the job location and the number of calls required to complete the task.

Many of the same service center management software packages also contain contract and warranty management software. Contract software establishes timetables so that a service center will renew customer service contracts on a regular, timely basis. As a result, the ser-

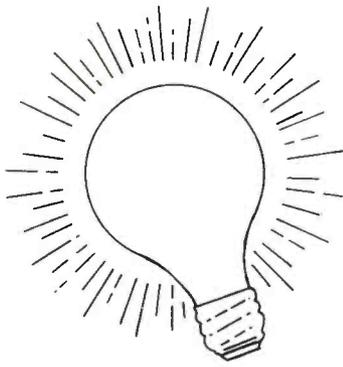
vice center benefits from having the contract in place and not losing revenue. The customer benefits through the preventive maintenance and extended coverage provided by the contract. This portion of the software links warranty service information with the task and scheduling software. When a technician services an in-warranty product, the software marks the job invoice as "in-warranty" and provides the technician with details of the warranty contract specifications.

### Important things to remember

The software described in this article provides the mechanism for creating good management practices. All the features within the software add reliability and can allow a service center to automate a large number of business functions. Taking full advantage of those features requires a thorough understanding of common business practices and familiarity with the software. Even after the purchase and installation of the software, both you and your staff may require additional training.

Most important, though, good management practices begin with you and your staff. Software cannot provide the essential interpersonal communications or the leadership needed for a business to succeed. Rather than relying on software for communications between you and your staff, maintain regular visits and formal meetings with all personnel. Whether your decision-making involves the purchase of software and equipment or human resources issues, always consider the impact of that decision on the people who make up your staff, as well as the bottom line. All too often, a decision made with good intentions but without the knowledge of the staff will have a negative rather than a positive impact.

This last statement becomes especially important as you contemplate the purchase of service center management software. Installing the software and implementing the functions given through the package requires consistent communication between you and your staff, along with a solid plan. Consistent communication will lead to the type of acceptance needed as everyone moves away from old habits. A solid plan of action confirms that the decision to purchase the software is sound and that the transition will be smooth. ■



# Energy-efficient lighting; a good idea

by the ES&T Staff

**M**ost of us don't spend a lot of time thinking about lighting. That's not surprising, given the fact that most of us have a lot of other things to do. That's really unfortunate, however, since lighting can have a profound effect on our moods, and even on how we do our jobs. Moreover, with all of the advances in lighting technology in the past several years, lighting devices have been made considerably more efficient. That means that if a service center is still using those old fixtures and lamps, they could be throwing money away. But if a service center is spending more than they should be on lighting, that means that they're also wasting one of our most precious natural resources: fossil fuel.

As many readers may already know, the Environmental Protection Agency (EPA) has a program through which it encourages manufacturers to produce and sell products that conserve energy. For example, many computer monitors are "Green," so-called not because of the color of the screen, but because their energy consumption habits tend to help keep the earth green. That is, when green monitors haven't been in use for a while, they enter a standby mode during which they consume considerably less electrical power than when they are in full-operating mode. As soon as the user touches the keyboard or the mouse, the monitor immediately changes back to the operational mode.

This green program applies to many other areas of electric power consumption, including lighting. Companies that adhere, or try to adhere, to these programs can not only help to safeguard the environment, but can also save some money on the bottom line.

The following paragraphs apply most

directly to larger corporations, but if it's good for the bottom lines of large corporations, a service center that follows a similar program can realize some benefits.

## **Some general thoughts on saving energy through lighting**

The following exposition is based on information that was presented on the Dazor Lighting Website at <http://www.dazor.com>.

Green Lights is an innovative program sponsored by the EPA which encourages U.S. corporations to install energy-efficient lighting technologies. Using these technologies, energy consumption can be dramatically reduced, while delivering the same or better quality lighting. Green Lights is a non-regulatory program. Corporations voluntarily become a Green Lights "Partner" by agreeing to upgrade with energy-efficient lighting wherever it is profitable, while maintaining or improving lighting quality.

Green Lights will produce multiple national benefits by addressing critical issues of energy-efficiency, pollution prevention, and economic competitiveness. Corporations which make the commitment to Green Lights will profit by lowering their electricity bills, improving lighting quality, and increasing worker productivity. They will also reduce the air pollution caused by electricity generation, which includes carbon dioxide, sulfur dioxide, and nitrogen oxides.

## **The benefits of energy-efficient lighting**

Lighting accounts for 20 to 25 percent of the electricity used annually in the United States. Lighting for industry, stores, offices, and warehouses represents from 80 to 90 percent of total light-

ing electricity use.

If energy-efficient lighting was used everywhere it was profitable, the electricity required for lighting would be cut by 50 percent and aggregate national electricity demand would be reduced by 10 percent. Energy savings would exceed \$12 billion a year and air pollution would be decreased by five percent. This would be equivalent to taking 15 million cars off the road, resulting in less smog, acid rain, and a slowing of global climate change. By the year 2000, EPA's target is to increase the Green Lights program to 6,000 participants for a total annual energy savings of 30.5 billion kilowatt-hours. The estimated annual impact of fulfilling this is a 7.5 million metric ton reduction in green house emissions, which is equal to taking over one million cars off U.S. highways or planting over two million acres of trees.

## **The Green Lights process**

When a corporation joins the Green Lights program, it signs a Memorandum of Understanding with the EPA. This agreement commits the corporation to survey all of its facilities and install new lighting systems that maximize energy savings to the extent that they are profitable and do not compromise lighting quality. In other words, if it costs money, or has an adverse effect on the company's operations, they won't do it.

There are no technology prescriptions. The corporation agrees to complete these upgrades within five years and to document the improvements it makes. After the company joins the Green Lights program, it commits to using the most current building energy guidelines when new facilities are constructed.

Typically, a corporation will imple-

ment the Green Lights process through four phases:

1. *Survey*: Green Lights corporations will survey their facilities to determine where lighting can be upgraded.

2. *Options analysis*: The corporation will identify the most favorable upgrades for each area covered by the survey.

3. *Trial installation*: Green Lights recommends a trial installation of the new technology and a gathering of feedback from employees.

4. *Final upgrade*: After Green Lights corporations make the final installation of new technologies, they will begin to realize large savings on electricity bills, significant pollution prevention, and public recognition of environmental leadership.

### **Task lighting: a simple and practical component of an energy-efficient lighting system**

The process of upgrading a facility or facilities to an energy-efficient lighting system involves the evaluation of many potential options. As described above, the procedure involves surveying, options analysis, and trial installation before the final full-scale upgrade.

One component of the final energy-efficient lighting system that is often overlooked is the use of task lighting. "Task Lighting" is any localized light source in a person's work area directed on some activity or "Task" (e.g., an adjustable-arm desk lamp).

Use of task lighting can significantly reduce overall lighting demands by effectively putting the light where it is needed — on the individual's desk. Instead of attempting to generate all the light needed on the desktop from overhead fixtures, a system that uses task lighting can achieve desired lighting output at the work surface level more efficiently and with less power consumption.

Task lighting improves the quality of light by putting the user in control of the direction and intensity of the light on his/her work area. This flexibility is crucial to compensate for differences in vision between people. Older people need substantially more light to see than younger people. The visual capabilities of individuals of the same age can vary greatly.

By raising, lowering, and tilting an adjustable-arm task light, the user determines how much light is needed, and the

best angle required to avoid direct glare and reflections. A task light permits an individual to compensate for fluctuations within one's own visual acuity from time-to-time, as well as variations throughout the day caused by changes in daylight.

In addition to reduced power consumption as compared to a system that relies totally on overhead lighting, task lights are easy to install and maintain. Task lights are available in several mounting options that are quick to install in a variety of locations. Advantages are gained in ease of lamp replacement and cleaning.

### **EPA's Green Lights support program**

EPA commits to help Green Lights participants with technical support projects which benefit Green Lights Partners, help strengthen the infrastructure of the energy-efficient lighting industry, and lower the barriers to energy-efficient lighting.

A computerized decision support system developed by the EPA will allow Green Lights Corporations to rapidly survey the lighting systems in their facilities, assess their retrofit options, and select the best energy-efficient lighting upgrades. The decision support software produces reports suitable for use by facility managers at all levels in the company.

EPA has established a national lighting product information program in conjunction with utilities and other organizations. This program will provide brand-name information so that purchasers will be able to choose products with confidence. In addition, it will allow innovative products to be rapidly qualified, removing a significant barrier for new technologies.

As part of the support program, EPA has developed a project to identify and enhance financing resources for energy-efficient lighting. Green Lights Partners will be given rosters of financing sources such as utility programs, energy service companies, government grants and low-interest loans, banks, and leasing companies. A computerized database of all utility financing programs for lighting is available.

For further information, contact:  
Green Lights U.S. Environmental Protection Agency  
401 M St., SW, Washington, DC 20460.  
Green Lights Hotline:  
Toll Free: (888)782-7937  
FAX:(202)775-6680

24-Hour Faxback information:  
(202)233-9659  
<http://www.epa.gov/greenlights.html>

### **More details on the cost of light**

General Electric Lighting has some good information on their Website at <http://www.ge.com/lighting/>. Here's what they have to say.

Many facility owners and managers think cost of light means the purchase price of the lamps themselves. In reality, the lamp purchase represents only a small fraction of the overall cost of light. Power usage is the biggest expense.

Regardless of the application, upgrading lighting with high technology lamps can save thousands of dollars each year in electricity.

For example, one typical calculation of the actual cost of lighting over a period of time shows that the cost of the light bulbs is about 8% of the total cost. The labor to change the bulbs, clean the fixtures, and provide other maintenance over the life of the system is about 17% of the total cost. The electricity to light the lamps over the life of the system is a whopping 75% of the total cost. There's no question then, that anything that can be done to reduce the power consumption of the lighting will result in significant savings.

In one retail store, older F40 Cool White T12 fluorescent lamps were replaced with new T8 with Starcoat lamps and electronic ballasts. The calculations showed that a 50-store retail chain would save approximately 2.7 million dollars in energy costs over the life of the lamps. Pretty significant.

Of course, the average consumer electronics service center won't realize savings anywhere near that magnitude. Still, a buck's a buck.

According to the most recent issue of the "Overview," a quarterly newsletter for the residents of Overland Park, Kansas (that's where the **ES&T** editorial office is), a great way to save energy and money is to simply replace the three most often used incandescent light bulbs in the house with compact fluorescent light bulbs. This would save more than \$30.00 over the lifetime of the bulb. Imagine what something as simple as that might do in a larger service center. And you'll have to change bulbs a lot less often. ■

# PHOTOFACTS

## DAEWOO

DTQ-29S1FCN.....4114

## FISHER

FVH-T657.....(sim to) VCR-308  
 FVH-T677.....(sim to) VCR-308  
 G5H-6532U0.....4104  
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## SHARP

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# Technology: Flat transformers?

by the ES&T Staff

*This article is based on information provided by BTC Power Electronics.*

In a development that promises to revolutionize the production of low voltage, high-current power supplies, BTC Power Electronics has announced their new line of IMT-series high-density dc/dc converters. While industry standard “brick”-type dc/dc power converters are already available on the market, what is capturing the attention of the power supply industry is the “engine” being used to drive the IMT series — *flat transformer technology*.

For over 60 years, conventional transformer design has been based on the principle of multiple windings on a single core. While this technology served its purpose for low-frequency applications, plummeting voltage ratings and high-frequency requirements of today’s sophisticated microprocessors have exposed severe design limitations — which actually threaten to bring the power supply industry to a standstill.

“The design limitations of the conventional transformer center on poor heat dissipation due to bulky windings, high leakage inductance, and poor high frequency characteristics,” explains James Lau, president of Flat Transformer Technology Corp. “An even more imposing problem when considering high power density is the ‘hot spot’ caused by the build-up of windings. As a result, the transformer remains the largest, hottest, and noisiest component in the power converter.”

## Voltages driven by semiconductor technology

Rapid advances in semiconductor design and fabrication have driven prime voltages down to 3.3V, 2.5V, and 2V. By some estimates, voltage levels could drop as low as 1V by the year 2000. As voltage levels drop, the CPU power require-



ments are expected to increase significantly. For most microprocessor-based equipment, this means that low voltage and high current will be required power supply characteristics.

According to K. Kit Sum, a power systems consultant based in Modesto, California, the power supply industry has largely ignored the need for high output currents — until now.

“When people talk about power density, they just talk about power and forget about high current density,” says Sum. “With the BTC converter, you not only get high power density but high current density in an industry-standard package size.”

Available in the industry size standard brick (4.6 x 2.4 x 0.5-inch) and half-brick sizes (2.28 x 2.4 x 0.5-inch), the IMT-series dc/dc converters from BTC are less expensive and extremely reliable. BTC currently has 24 models at 200W in standard brick size (0.5 x 2.4 x 4.6-inch) and plans on expanding their line into the 400W range in March, with 600W and 960W versions available by year’s end.

The power limits of the flat transformer technology for the standard brick size is calculated at 1200W.

## Applications

The primary applications for such products include distributed power systems, industrial applications that require regulated dc power, telecommunications applications, and custom power supply companies that use dc/dc converters as building blocks.

“Using a superior technology lowers the price of the converter, extends the life of the product, and allows the design engineer to build products with a competitive advantage, which in turn increases market share,” says Sum.

Although such new technology is now available, Sum believes that engineers are often pushed so hard to meet deadlines and produce products quickly that they often take the easiest route — choosing power supplies they are already familiar with instead of investigating new technologies which may be superior. Sum

warns that such conservatism could have an impact on the bottom line.

"By investigating new technologies, such as flat transformer technology, application engineers might find that they wind up with a lower price power converter with an extended life cycle that could provide a competitive advantage in the marketplace," says Sum.

### **Flat transformers: Dividing the workload**

The unique technology driving BTC's low-cost, high-performance, and high-reliability converters can be summarized simply; whereas conventional technology utilizes a single core with multiple windings to achieve a voltage step-down ratio, flat transformer technology uses multiple cores with a single winding.

These cores are packaged in a modular block with built-in, single-turn secondary windings using simple stamped and formed parts. The entire network of elements behaves as a single transformer, resulting in a low-profile, high-density transformer with distributed thermal properties not found in conventional transformer design. These properties essentially solve the problem of transferring heat away from the transformer, which is the key to higher current output.

"The flat transformer eliminates many of the problems associated with conventional transformers. With this new technology, a single primary turn is possible," says Lau. "The flat transformer has the advantage of using a number of smaller windings, each carrying a smaller current, rather than one large winding which carries the entire current."

Unlike conventional transformers, flat transformers have excellent high-frequency characteristics. This is due, in part, to the reduction of the number of windings surrounding the core and the corresponding decrease of trapped heat.

"Because of the small size of the cores and excellent heat dissipation, flat transformers can be tightly packaged with associated semiconductors and inductors and direct solder-bonded to the baseplate, yielding very high power densities," says Lau. "That's what we've done with the BTC converter."

The BTC converter operates with 4 flat transformer cores, each required to handle only 1/4 of the load. By dividing the

workload among the cores, as well as ancillary components such as rectifiers, heat sinks, and MOSFETs, lower current rated and lower cost components can be used. The reduced stress and improved heat dissipation due to current sharing increases reliability and extends the life of the converter.

"For example, in our 50A dc/dc converters, we use four ferrite transformer cores and four rectifiers. By sharing the current, each core and its associated rectifier is only required to handle a fourth of the load — or 12.5A each," explains Lau. "Although this allows us to use smaller and less expensive rectifiers, we've chosen to increase the reliability of the product by using a rectifier rated at 40A, so each rectifier is only required to operate at less than a third of its rated current."

One of the system's advantages, explains Lau, is that if one of the four cores were to fail, the transformer could still operate at 75 percent of its rating. With conventional transformer technology, a single point of failure equals complete failure.

### **Thermal issues: If you can't take the heat**

According to Lau, the power supply industry has not put enough emphasis on the thermal issues surrounding the transformer. Baseplate temperature ratings and internal thermal gradient usually dictate the maximum heat the converter can handle before internal components are subject to stress and begin to fail. Because industry standard brick converters are still the effect of "hot" conventional transformers, most carry lower base plate temperature rating and do not specify the internal temperature rise. However, design engineers often overlook this factor when choosing a converter.

Dan Jitaru, president of engineering firm Rompower, agrees: "The thermal issues surrounding the transformer are the limiting factor when discussing power density. If the internal temperature is higher, the maximum power capability will be lower," says Jitaru. "You must be able to extract the heat because internal components have temperature limits."

Because of flat transformer's excellent heat dissipation, the IMT-series of converters offers the lowest internal temperature gradient in the industry.

"For a given base plate temperature, the temperature of the internal components will be higher," says Jitaru. "Because flat transformer technology has excellent thermal transfer to the base plate, the temperature rise inside the converter will be lower than that of a competitor's product with the same base plate rating."

Flat transformers used in the converter limit the temperature rise inside the unit to less than 10°C above the base plate temperature, compared to an average rise of 20°C to 40°C in the industry. This allows BTC converters to operate at a higher base plate temperature rating.

"We can extend the operating base plate temperature to 105°C and still limit the hottest point inside the converter to under 115°C, well below the component's temperature safety limits [estimated at 135°C]," explains Lau.

According to Lau, every 10°C reduction in internal temperature doubles the Mean Time Between Failure (MTBF) of the product.

"Conventional transformers require extensive cooling and large heat sinks to keep the temperature down," claims Lau. "If less cooling is required, you can keep the overall temperature of the system higher without damaging components."

To further optimize heat transfer away from the transformer, flat transformers utilize many paralleled single turn secondary windings that are automatically bonded to the inside surfaces of the ferrite cores during the manufacturing process. These cores are surface mounted directly to the base plate for maximum heat dissipation. Furthermore, the large surface-to-volume ratio of the multiple ferrite cores assists in heat transfer, eliminating the hot spot so common in conventional transformer technology.

### **Low leakage inductance: Reduced noise effects at low voltages**

Because of the numerous turns in a conventional step down transformer, noise effects caused by leakage inductance are exaggerated at high frequencies. These problems increase as current levels rise.

Since leakage inductance can be calculated as the square of the number of turns, high leakage inductance is the direct result of the numerous primary turns in conventional transformers. Although this problem is partially solved by the use of

interleaved windings, the windings are difficult to insulate.

"Because the leakage inductance associated with a transformer is proportional to the square of the number of turns, it is desirable to have a single turn primary winding," continued Lau. "If you reduce the number of turns, then the leakage inductance is reduced by the square of the turn. When leakage inductance is low, it is possible to operate high-frequency, high-density dc/dc converters using a simplified topology."

Due to excellent couplings between windings and the absence of multiple turns, flat transformer technology boasts a leakage inductance 2000 times lower than conventional transformers. Low leakage inductance also reduces stress on MOSFET switches, effectively extending the life of these components.

#### Lower costs: The true benefit

Perhaps the greatest impact of the new technology will be the price of transformers and power converters in the future. Lau

estimates that with the new technology, the price of brick type dc/dc converters will drop dramatically, allowing design and systems engineers to specify low-profile power converters more frequently.

To illustrate his point, Lau observes that the cost of the new 200W IMT-series is roughly equivalent to 100W converters currently on the market. He attributes the low price to the reduction of ancillary components, the ability to use components with lower power ratings, the use of simpler circuit topology made possible by the performance of the flat transformer, as well as the manufacturing capabilities of BTC. The 400W and 600W power converters due in early 1999 are expected to reflect similar cost advantages.

"The reason why many companies are not using low profile, brick dc/dc converters is cost," says Lau. "Instead, they use more bulky traditional ones because they are cheaper. Our goal is to offer more affordable converters so our customers can use them for a variety of applications."

Aaron Levy of Technology Dynamics, who purchased the BTC converter to handle difficult second and third outputs, explains that application engineers are most interested in size, reliability, and price. If there is no sacrifice in basic performance, price is the dominant factor.

"To the application engineer, what's important is the size of the converter and the ability to fit it in the budget for the product," explains Levy. "We elected to use the BTC converter because it costs almost half of what other companies are charging. To me, that was a critical issue because power converter modules are often expensive, which cuts into our profit margin. BTC's price for the 200W line was very appealing, and as quantity goes up, the price drops even lower."

"The performance of the module was on par with other manufacturer's products and the sacrifice in features was very minimal," continued Levy.

To take advantage of the lower price and increased reliability, BTC offers the IMT series converters in industry standard packaging, which allows pin-to-pin compatibility with other products.

So, if one of these days you encounter a device that should look like a transformer, in a product, but it doesn't look like a transformer, maybe it's a flat transformer. ■

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#### Tools catalog

Jensen Tools has just released a completely redesigned and expanded, 308-page full-color catalog. This comprehensive reference guide features the company's branded products, including 50 pages of original tool kits, a brand new line of handheld multimeters, and an extensive selection of hand tools. Over 5,000 total products from all major manufacturers are available, including test equipment, computer and LAN, wire and cable, telecom, power tools, soldering, storage and handling work stations, lighting and optical, shop supplies, and communications products.

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#### Instrumentation catalog

Triplet introduces its newly acquired line of instrumentation in its new "LFE/

api by Triplet" catalog. This new 16-page full-color catalog features optical, solid-state, locking-coil and magnetic-contact meter-relay controllers, plus analog panel meters, including models with removable scales, edgewise meters, and ruggedized-sealed meters. The new catalog also features programmable digital panel meters.

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### Pipe mountable earth station antenna

Andrew Corporation has introduced a 3.7-meter pipe mountable earth station antenna. The new antenna can be securely mounted onto a customer supplied 6-inch (6.5-in O.D.) nominal pipe instead of a pedestal.

The new design eliminates the equipment enclosure, enabling the antenna to be installed in areas where space is limited. If required, outdoor RF equipment can be attached easily to the antenna's mounting frame in close proximity to the antenna feed system.

The antenna is available with C-, X-, Ku-, and K-band feed systems. Intelsat and Eutelsat type approvals have been applied for and are pending.

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### Dual display multimeter

Tenma Test Equipment, introduces the new Model 72-6558 Professional Dual Display True RMS Multimeter. Features of the meter include dual 5-1/2 backlit



LCD display with analog bargraph; simultaneous measurement of two different parameters of the same signal; selectable count resolution of 200,000, 20,000, and 2,000; measurement of ac and dc voltage, and current, resistance, frequency, capacitance, and temperature; true rms ac and ac+dc measurement; and 1000V maximum dc measurement with 1 $\mu$ V resolution and 0.01% accuracy. The unit also includes an RS-232 interface and can be used in IEEE systems with optional IEEE-488 GPIB interface.

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### Hand-held computer monitor pattern generator

*B&K Precision announces the Model 1275 Hand-Held Computer Monitor Pattern Generator*

The unit provides the basic test and alignment patterns necessary for internal or external monitor adjustment. The device enables the user to conduct fundamental operational tests using crosshatch or dot pattern, color bars, and raster patterns in red, green, blue, black, and white.

Packaged in a compact 1.5" x 3.8" x 5.7", light-weight, hand-held enclosure, the product can be used to test CGA, EGA, VGA, SVGA, and MAC monitors with a wide range of resolutions including 640 x 480, 800 x 600, 1064 x 768, and 1280 x 1024. It works with both interlaced and progressive monitors and provides color bars, crosshatch, dots, and color rasters.

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### Heavy-duty DMM

Wavetek introduces the HD115B, a heavy-duty meter. The meter is designed to withstand continuous and long-lasting use in the most demanding field environments. It is resistant to damage from water, dust, chemicals, dropping and voltage transients, and spikes. The new unit features oversized character display and a new patented ergonomic shape.

A Safety Tester feature quickly checks for live circuits and indicates the presence of common power supply voltages with a series of LEDs. This feature does not use the meter's internal battery, so live voltage levels can always be detected, even if the meter's battery is dead.

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### Computer technician tool kit

Techni-Tool's 54-piece Computer Technician Tool Kit stores computer servicing instruments in an organized case. One side of the Brown Cordura II case holds tools in 34 handy pockets. The other side features a pen holder, document portfolio, and legal pad holder for jotting notes and holding important papers.

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### PC-based oscilloscopes

The Single-Channel PCI-443 and Dual-Channel PCI-444 Digital Oscilloscopes feature 12-bit resolution, 50MSPS realtime sample rate on each channel, 20MHz bandwidth, and an advanced triggering system. The oscilloscopes occupy one expansion slot of a PC and include BenchTop users interface software and the BenchCom suite of third-party drivers, DLLs, and example programs.

This product by *PC Instruments* has an input circuit with ten vertical voltage ranges (2mv/div to 2 V/div), a temperature-compensated offset control that is independent of the vertical range, ac/dc coupling,  $\pm 200V$  of input protection (whether the computer is turned on or off), and an input impedance of 1M $\Omega$  and 15pF. And, two channels can be combined to create a 12-bit, 100MSPS single-channel oscilloscope. Differential inputs are also available.

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# What Do You Know About Electronics?

by J. A. Sam Wilson

Here is something we haven't done in a long time. I have written questions based upon articles from previous issues of **ES&T**. Are you reading your issues of **ES&T** magazines?

1. What is the meaning of SCSI in computer systems?
2. What is the meaning of PCI in computers?
3.  $2 + 3 \times 7 + 4 - 14 + 2 = ?$
4. In which repair job would you expect to find a stirrer fan?
5. What is the meaning of DVD?

6. Regarding a "dead set" RCA CTC 185 chassis, which section is at the head of the list of systems that cause a dead set?

7. You want to calculate the decrease in resistance of a resistor ( $\Delta R$ ). You know the beginning resistance ( $R_1$ ) [ $28.8\Omega$ ]. You know the temperature coefficient ( $\alpha$ ) [ $-0.00025$ ] and the temperature rise in  $^{\circ}\text{C}$  ( $\Delta t$ ) [ $25^{\circ}$ ] from the initial temperature of  $25^{\circ}$ .

Using the equation:

$$\Delta R = 28.8\Omega \times (-0.00025)/^{\circ}\text{C} \times 25^{\circ}$$

$$\Delta R = ?$$

8. A magnetron is a:
- A. form of magnetic amplifier.
  - B. device that measures the strength of the earth's magnetic field.
  - C. diode.
  - D. None of these answers are correct.
9. When the computer is first turned on, an internal POST test is performed. POST stands for \_\_\_\_\_.

10. If the system locks up and does not respond to the keyboard, try to reboot by pressing the CTRL-ALT-DEL keys:

Wilson is the electronics theory consultant for **ES&T**.

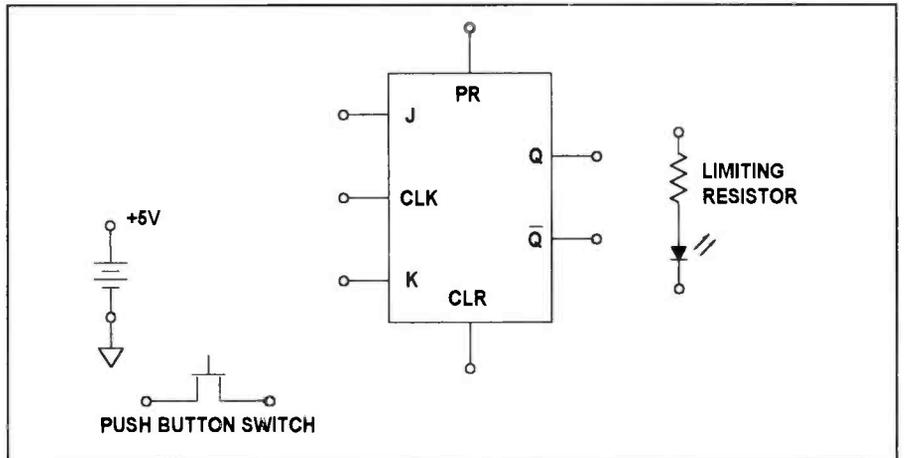


Figure 1

- A. simultaneously.
  - B. one-at-a-time.
- (Answers on following page)

## Newton and Einstein

Einstein once said that Newton was the most brilliant man that ever lived. He also said that if Newton had the same information he had, he would have reached the same conclusions.

You should know that Einstein was a very friendly person. Newton, on the other hand, was not very friendly.

Here is the equation Einstein gave the

world and forced a revision of physical laws and effects:  $e = mc^2$ . (The amount of energy in a body is equal to the mass of a body times the square of the velocity of light.) The velocity of light is about 300,000,000 meters per second, or, about 186,000 miles per second.

Newton's laws that revised scientists' thinking was given in three laws. Compare those laws with Einstein's  $e = mc^2$ .

**First law — The Law of Inertia** — A body at rest tends to remain at rest, and a body in motion tends to continue to move along a straight line unless acted upon by an unbalanced force.

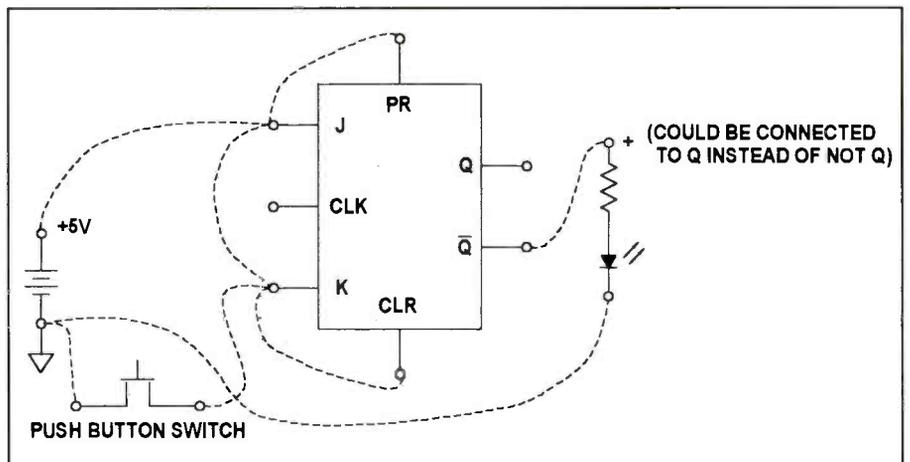


Figure 2

**Second law — The Law of Acceleration** — An unbalanced force, acting on a body, causes a body to accelerate in the direction of the unbalanced force, and the acceleration is directly proportional to the unbalanced force and inversely proportional to the mass of the body.

**Third law — The Law of Balanced Forces** — For every action there is an equal and opposite reaction.

I read in a magazine article that there

## ANSWERS TO QUESTIONS:

1. Small Computer Systems Interface — "Understand SCSI: The small computer systems interface" by Philip M. Zorian, January 1999, page 4.

2. Personal Computer Interface. (Same reference as #1)

3. In mathematics, multiplication and division take precedence over addition and subtraction. So, the problem becomes  $2 + 21 + 4 - 7 - 12$ . TYEK, J.A. Sam Wilson, December 1998, page 21.

4. In a microwave oven. "Microwave oven repair basics" by John Ross, November 1998.

5. "Digital Versatile Disk," in WDYKAE? by John Schmid, student at Florida Institute of Technology, Extended Graduate Studies, Orlando Graduate Center, November 1998.

6. The power supply — "Servicing a 'dead set' RCA CTC 185 chassis" by Bob Rose, October 1998, page 24.

$$7. \Delta R = 28.8\Omega \times (-0.00025)/^{\circ}\text{C} \times 25^{\circ} = -0.18\Omega$$

The resistance of the carbon-composition resistor at  $50^{\circ}\text{C}$  is:

$$28.8\Omega - 0.18\Omega = 28.62\Omega.$$

WDYKAE? October 1998, page 52.

8. C — TYEK, September 1998, page 26.

9. Power On Self Test — "How to start a computer repair job," by Victor Meeldijk, July 1998.

10. A — TYEK, July 1998.

are only a few people in the world who really understand Newton and Einstein's laws. I don't believe that anyone beyond the eighth grade would have any trouble understanding those laws. The real problem was to get people to believe them.

I had a little problem understanding Newton's third law. It seemed to say that when you push on a tree, it has to push back at you or the tree would fall over. Is that what you interpreted it to mean? Think about it!

### Design question

Here is an interesting design problem. Work it out and check your answer at the end of the article.

Connect the components of Figure 1 so that the LED will come on with one push of the switch and go off with the next push of the switch. The power supply connection for operating the integrated circuit need not be shown.

### More stuff found on the Internet

As I have pointed out before, we have been checking the chitchat on the Internet. Here is the latest news flash from Circuit City Online.

Manufacturers plan to introduce add-on boxes to allow conventional TV sets to receive and show digital broadcasts. Of course, you won't see broadcasts in a wide-screen format and you may not see all of the resolution that *may* be broadcast, but you will be able to watch your set beyond the year 2006 and you can add your converter set anytime beyond that.

### A quick comparison between NTSC and HDTV

NTSC — 525 scanning lines and 450 active lines

HDTV — 1125 scanning lines and 947 active lines

An important factor in the greater detail in the HDTV picture is that there are almost twice as many active lines making up the picture.

### The elusive negative sign

Here's an interesting experiment for you to try. Photocopy Figure 9, page 50 in the December 1999 *ES&T*. Don't enlarge it. Very carefully cut out a negative sign. Your cutout should show only the black (-).

Have someone hide that tiny cutout in the living room of your home. See how long it takes to find it.

Result? Now you know how easy it is to lose a negative sign. In Figure 9 of that article, the answer should have been  $-2/3A$ . That negative sign was lost. It was fine on my manuscript but it traveled a lot of miles to your copy of the magazine.

Now that the lost negative sign has been fully explained, we can go on.

### The end of Cramer's Rule for determinant solutions

In the previous issue, we reviewed the use of determinants for basic network solutions. We reviewed a circuit with two equations and two unknowns, and a circuit with three equations and three unknowns.

That is as far as you can go using Cramer's Rule. So, if you have to solve for current in a circuit with four equations and four unknowns, you have to go to another type of solution. (Sometimes, the more complicated circuit can be reduced to three equations and three unknowns).

### Connecting the flip-flop of Figure 1

In order to have the LED shown in Figure 1 go on with one push of the switch and off with the next push of the switch, wire it as shown in Figure 2. ■

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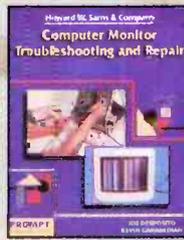
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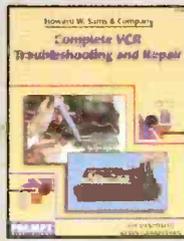
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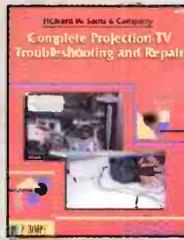
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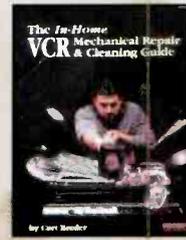
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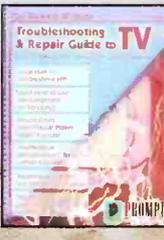
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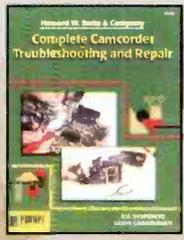
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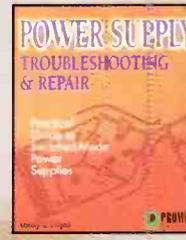
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