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Third-generation XL-100 XtendedLife chassis

Development of a new family of chassis promises benefits for RCA's XL-100 and ColorTrak television receivers.

Abstract: *The third-generation of XL-100 XtendedLife chassis marks a dramatic departure in packaging concepts. It was planned to be a safer, more reliable, more easily manufactured and serviced chassis to maintain or surpass the high standards of safety and performance set by its predecessors—at a substantial cost reduction.*

The introduction of the model FER450 19" television receiver in February, 1980, was the culmination of a tremendous two-year effort by the Consumer Electronics Division, in the first cooperative design between product design engineering and the new products lab: the CTC-107 family of chassis that will eventually replace all present chassis in the XL-100 line (Fig. 1). A major goal of this development effort was, of course, cost reduction. To maintain profits in such a highly competitive industry requires an ongoing effort to reduce manufacturing costs significantly enough to offset inflation. The real challenge, however, is to improve the final product while reducing its cost. In that light, the following goals were pursued in the development of the CTC-107 family of chassis:

1. Introduce new performance features into the XL-100 line.
2. Incorporate new circuit technology: a one chip chroma/luminance processor and an IF using a SAW filter, combined synchronous detector AFT/AGC IC.
3. Reduce size, weight, and material used in the chassis.
4. Standardize one basic board for all screen sizes and tuning systems.
5. Utilize the latest manufacturing techniques but remain compatible with techniques still in use.
6. Meet requirements for automatic test and alignment.
7. Incorporate more stringent safety and reliability standards.
8. Make improvements in serviceability over previous RCA chassis, which were already highly rated for serviceability.
9. Incorporate a new cost-effective remote system.

Performance improvements

The combination of luminance and chrominance circuitry into one 28-pin IC resulted in major improvements in picture quality. Previously, XL-100 TVs had automatic fleshtone correction, auto-color level adjustment, and the black level clamp. To these features were added: (1) A beam limiter circuit that decreases contrast rather than brightness to limit beam current. Hence, dark details are not lost during bright scenes. (2) A circuit that forces the color level to track with contrast. This virtually eliminates the need for the viewer to adjust the color control once it is set. Also added was an adjustable peaking

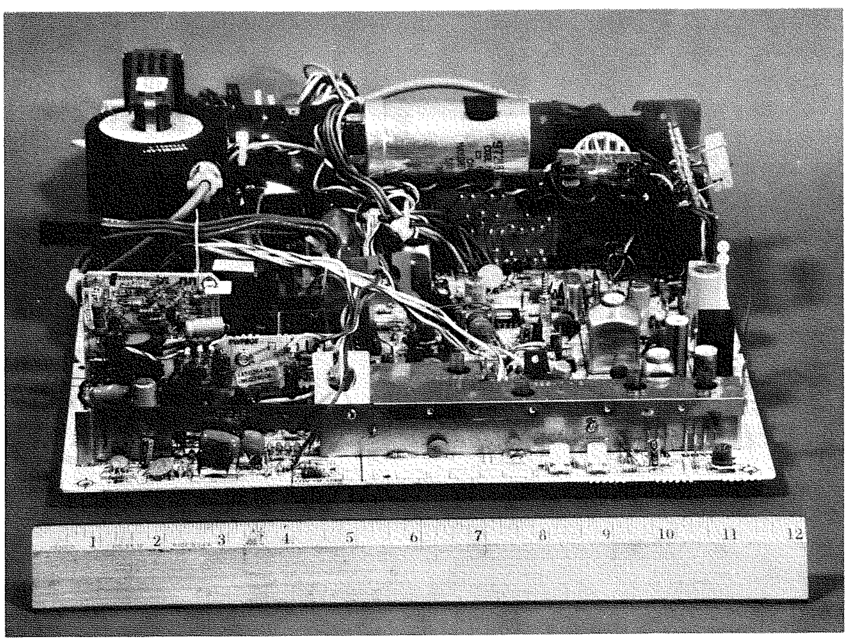

Fig. 1. The CTC108 chassis measures only 9½ x 11¾ inches.

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control that allows for optimal picture sharpness over a wide range of signal strengths. These signal processing features have greatly increased the picture quality in the price-leader models.

Another improvement is a low-power pin-correction circuit that keeps lines straighter around the edges of the screen. In fact, picture geometry in general has improved.

The new IF system features both positive and negative noise inverters that provide a clean sync signal to the horizontal and vertical oscillators, improving noise immunity. Vertical interlace has been improved, reducing vertical "jitter" in the picture. Horizontal oscillator stability and pull-in have so improved that the customer horizontal-hold control is unnecessary. Computerized automatic alignment assures consistent peak performance for every set. Even the speaker grills have been redesigned to provide high acoustical transparency. And, further performance improvements are being implemented in a version of this chassis which will be used in some ColorTrak models.

Circuits

Horizontal oscillator and output, as well as the horizontal output bias-regulated B+ supply circuit, are essentially the same as in previous recent RCA designs. An integrated high voltage transformer (IHVT) combines the flyback transformer and high-voltage tripler into one unit. Shutdown circuits provide both overcurrent and overvoltage protection.

The conventional vertical oscillator is coupled to a new vertical output design. This is a totem-pole arrangement, using only one predriver transistor. The bottom output transistor drives the base of the top output transistor through a diode switching arrangement during the first half of vertical scan, then directly drives the vertical yoke windings during the remainder of vertical scan. For retrace there is a resonant circuit that is much simpler than the switched vertical retrace circuit of previous designs. The result is reduced power consumption and the use of only one positive supply: eliminated is the dedicated negative supply used in previous vertical circuits.

In signal processing, a surface acoustic wave (SAW) filter/synchronous detector IF is employed. The SAW filter's input electrodes convert signal voltages to acoustic wave ripples on the surface of the ceramic substrate on which the electrode is deposited. The output electrodes are distorted by these waves and convert them to the processed output voltage. Geometry and spacing of the interdigitated electrodes are adjusted to produce the desired IF input bandpass response, replacing the conventional R-L-C discrete network. A single IC incorporates the amplification, AFT, and AGC functions and uses a filtered sample of the input pix carrier to synchronously detect the input signal. The SAW filter, combined with the one-chip synchronous detector system, affords performance comparable to previous systems, but has 50 fewer components and eight fewer alignments. The nine alignments that remain are simpler peaking or dc adjustments with less interaction.

The audio circuit is the same that has been used in all recent designs. Its heart is SSD's sound-plus-power audio IC. The luminance and chroma circuits have been fused via a new chroma-luma IC, which integrates the luminance channel (including beam limiter, black level clamp, and blanking circuits) with a chroma processor similar to that used previously. Luminance is matrixed with chrominance inside the IC, providing R-G-B outputs into the conventional picture-tube cathode-driver stages. The result is fewer parts and enhanced performance.

Size reduction

The size of the chassis and the material used to build it were reduced in several ways. The new chassis is entirely "hot" or non-line-isolated. Previous RCA chassis had only the regulator and horizontal output circuits "hot", and the rest of the chassis was isolated from the ac line or "cold". "Hot" and "cold" circuits that are physically adjacent required large spacings, wasting much board area. Also, components serving as hot-cold boundaries, such as the horizontal driver transformer, were larger to provide the proper isolation. Thus, going totally "hot", with only one ground system, saved considerable PC board area by permitting tighter copper spacings and smaller components.

The reduced component count, mainly due to the new SAW IF system and one-chip chroma-luma circuit, naturally reduced PC board size. Mounting many ac input-related components off the main board, also reduced its area, since these components are large and require large copper spacings to adjacent circuitry. Most of the regulator control circuit and the bias/drive/vertical height controls were mounted on stand-up PC boards to further reduce the size of the main board.

The amount of sheet metal has been greatly reduced, and that which remains serves many purposes. The SAW IF required far less shielding than previous IF circuits. An arm of this smaller shield is extended across the entire front of the chassis to strengthen the board and prevent warpage during solder. The rear apron, besides providing mechanical strength to the PC board as well as the flyback, also is used to mount the previously mentioned ac line-input components, anchor the stand-up bias/drive control board, mount and heatsink the horizontal output transistor, mount the vertical hold and peaking customer controls, support the service switch lever, and act as a ground plane. Even the two vertical-output transistor and regulator SCR heatsinks were used for other purposes. In fact, there is so little unused space, that it was difficult to find room for all the required labels!

Universal chassis

The CTC-107/108/109 chassis series represents a new level of standardization at Consumer Electronics. It started out at the most basic level—the individual component. The Components Liaison Group studied commonly used components—resistors, capacitors, transistors. They compared their parameters with suppliers' standard or most common component parameters and compiled a list of "preferred" parts that should be specified whenever possible. Thus, if the bulk of components used across the board are from the "preferred" group, savings can result from quantity buying and reduced handling.

As another means of standardization, all screen sizes use common tooling and form factor. The three chassis, CTC-107/108/109, look almost identical—indeed, of the 550 or so components used in the chassis, all but about 20 are common. The entire XL-100 line will eventually be replaced with these chassis: the CTC-107 for the 13-in., CTC-108 for the 17-in. and 19-in., and the CTC-109 for the 25-in. models.

Additionally, each chassis is fitted with all its various tuning systems at the final assembly plant. Previously, a dedicated chassis had to be built for each tuning system at the Taiwan and Juarez feeder plants. Now only the three basic chassis are produced at the feeder plants, and the

Bloomington receiver assembly plant then "plugs on" the appropriate tuning system and customer-control assembly that makes up a particular model (Fig. 2). This greatly reduces shipping, handling, and inventory costs and significantly increases scheduling flexibility.

Manufacture and test

With considerable effort, chassis were made more easily manufacturable. The chassis can be assembled at any of CED's three plants: Taiwan, Juarez, or the Bloomington lines. The chassis requires no pallet, but is itself sent down the production line. Off-line subassembly has been minimized; only the power cord assembly and the stand-up regulator and bias/drive controls cards are assembled separately. All other components, including the rear apron and IF shield, are assembled onto the main PC board on one continuous line. The picture tube socket PC board, which previously was assembled off-line, is physically connected to the main board through solder and test stations and is separated immediately prior to shipping from the feeder plant to the instrument assembly plant.

Most components are auto-insertable; special double sets of copper pads for ceramic disc capacitors allow for easy total hand-insertion also. Computer-generated copper patterns and solder-resist masks and the use of the in-line wave-soldering techniques improve solderability. There is less bridging and fewer touch-ups are necessary.

Chassis testing starts with a light-and-play check that weeds out gross failures. The chassis is then transferred to an automatic-test-equipment (ATE) test station. In less than a minute the chassis is completely aligned and tested. The ATE simulates actual operation under various conditions to check over 100 performance and reliability characteristics. The speed and accuracy of the ATE tester eliminate human error, allow much more consistent alignment and thorough testing than before, and greatly enhance the overall performance level.

TUNING SYSTEM				CHASSIS INTERCONNECT JACKS
ONE-KNOB VARACTOR	CHANNELOCK REMOTE	CHANNELOCK KEYBOARD	MECHANICAL TUNER	
X	*1	X	X	J101 ON/OFF
		X		J102 LAST CHANNEL MEMORY-KEYBOARD
X			X	J103 DIAL LIGHTS
X	*2	X	X	J104 DEGAUSS
	*2			J105 26V SUPPLY
	X			J106 REMOTE ON/OFF
X	X	X	X	J201 SPEAKER
X		X	X	J202 VOLUME
X	X	X	X	J301 I.F. INPUT
KEY	KEY	KEY	KEY	J302 TUNER CONTROL KEY
X				J303 +185V DC SUPPLY
X	X	X	X	J401 YOKE
KEY	KEY	KEY	KEY	J701 CUSTOMER CONTROL *3 BRACKET KEY

Fig. 2. The universal chassis interconnect system. Note J302 and J701 are keyed rows of pins which can accept differently keyed plugs to supply proper control signals to the various tuning systems and customer control arrangements used with the CTC107/108/109 chassis. ***1.** A jumper is plugged across J101 to connect ac line to the rectifier bridge continuously for remote sets. ***2.** A PC board is plugged onto J104 and J105 to provide degaussing on remote sets. ***3.** CTC107 chassis have customer controls mounted on chassis, do not have J701.

Safety and reliability

Safety, of course, is the prime concern in any design and must be built into the chassis. For example, copper was laid out for 3 volts per mil spacing, and two coats of solder resist are used to protect against arc tracking. Power resistors and other components that generate a significant amount of heat are elevated above the board. Redundance of paths carrying high horizontal yoke current provides arc protection should one path fail.

Review and testing by the Product Safety and Reliability Center was an ongoing process. Chassis went through numerous tests, among which were torturous altitude and humidity tests, life tests at elevated temperatures and line voltage, fault tests, salt mist tests, and picture tube arc tests using the Triggered Flashover Generator equipment and techniques developed by G. Forster at the RCA Zurich Labs. All weaknesses or failures discovered were analyzed and corrected.

Reliability, too, was considered. A more expensive but durable glass-laminate material is used for PC boards instead of convential phenolic material. Wide-narrow junctions in the copper pattern were tapered wherever possible to prevent hairline cracks. Components were derated to operate at less than their maximum ratings, even under worst case conditions, so they run cooler and last longer.

A major problem overcome was the mounting on the PC board of such a heavy component as the flyback transformer. In drop tests, boards broke because of the momentum of this massive component. In the new design, the flyback is mechanically supported by the rear apron (Fig. 3). The PC board slides into loose fitting rails in the cabinet and is also supported by the rear apron, which is anchored by two screws driven through the back cover. Thus, the PC board does not support the flyback at all, and drop testing has been very successful.

Serviceability

Many steps were taken to improve serviceability. The chassis layout chart inside the cabinet contains more information. Service test points are clearly identified on the PC board "roadmap," and alignment points are labeled. The board is marked and labeled according to circuit function, such as IF and sound, for quick location of problems (Fig. 4). Other labels provide additional servicing information.

The chassis slides out of the cabinet rails and tips up on its side so the bottom of the board is accessible. Since all auxiliary subassemblies plug-on, the chassis can be completely removed from the cabinet without tools and taken into the shop, if necessary. The SAW IF system is easier to align than previous circuits, another servicing plus.

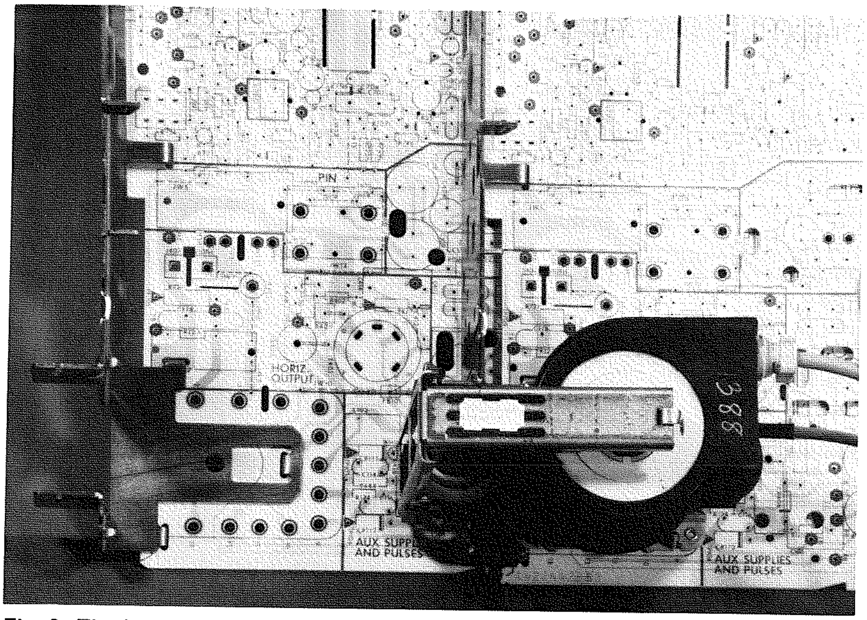

Fig. 3. The flyback transformer is electrically connected to PC board but, as can be seen in the view with flyback removed at left, it is mechanically supported by the rear apron.

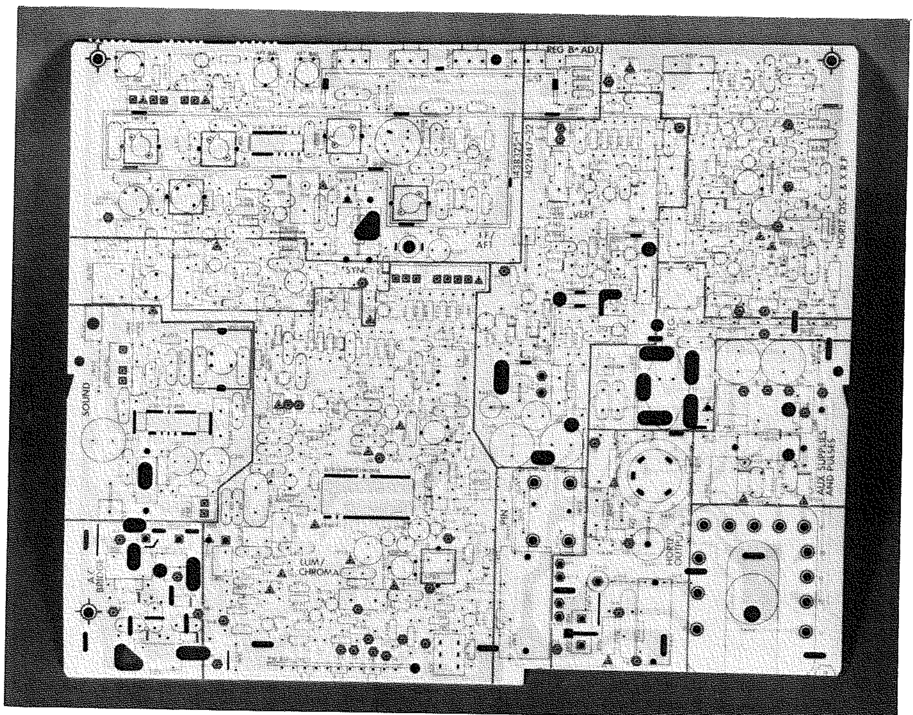

Fig. 4. The top of the bare board is replete with assembly and service information.

Remote system

The one-board approach was also applied to the remote system. The preamp and control modules were combined into one board, and the sheet metal frame stripped away (Fig. 5a). The remote board slides into rails molded into the cabinet. The remote board cables are all plug-in so that no special chassis is needed for remote.

A new scheme for controlling on/off function eliminated the step-down transformer and rectifier circuit (which powered the remote board in the "off" mode) and the relay, which provided the on-off function in previous designs. The main power supply bridge is now left on continuously, and its +150 V dc output supplies power to the remote board through a simple dropping resistor arrangement. A transistor switch in the remote board turns the receiver on and off. The switch enables and disables the regulator control oscillator, which turns on or off the B+ to the horizontal output stage. Since all other supplies are derived from auxiliary windings in the flyback, removing the input pulse to the flyback effectively turns the set off (Fig. 5b).

Only one problem remained: normally, when ac is turned on, current passes through the field-neutralizing coil surrounding the picture tube until the thermistor in series with the coil heats up and opens the circuit, thus degaussing the picture tube. If the ac line is always connected to the rectifier bridge and a dc voltage turned on and off further upstream, auto-degaussing becomes a problem. The desire to maintain a common chassis for all tuning systems caused more complications.

The problem was solved by using a small PC board that plugged onto four bead-chain terminals on the main board; two terminals which the degauss coil cable plugged onto on non-remote sets and two terminals that picked up the set's 26 V dc supply and ground. The 26-V supply actuated a relay in series with one side of the degauss coil (the degauss cable now plugging to the small board). When the chassis was turned off, the 26-V supply dropped out, opened the relay, and disconnected ac from the degaussing coil. This allowed the thermistor to cool and permitted degaussing when the set was again turned on.

The relay handled degaussing current and was considerably smaller and less costly than the relay that had to handle total set current in the old system. This proved to be very cost-effective, especially so since production schedules call for an

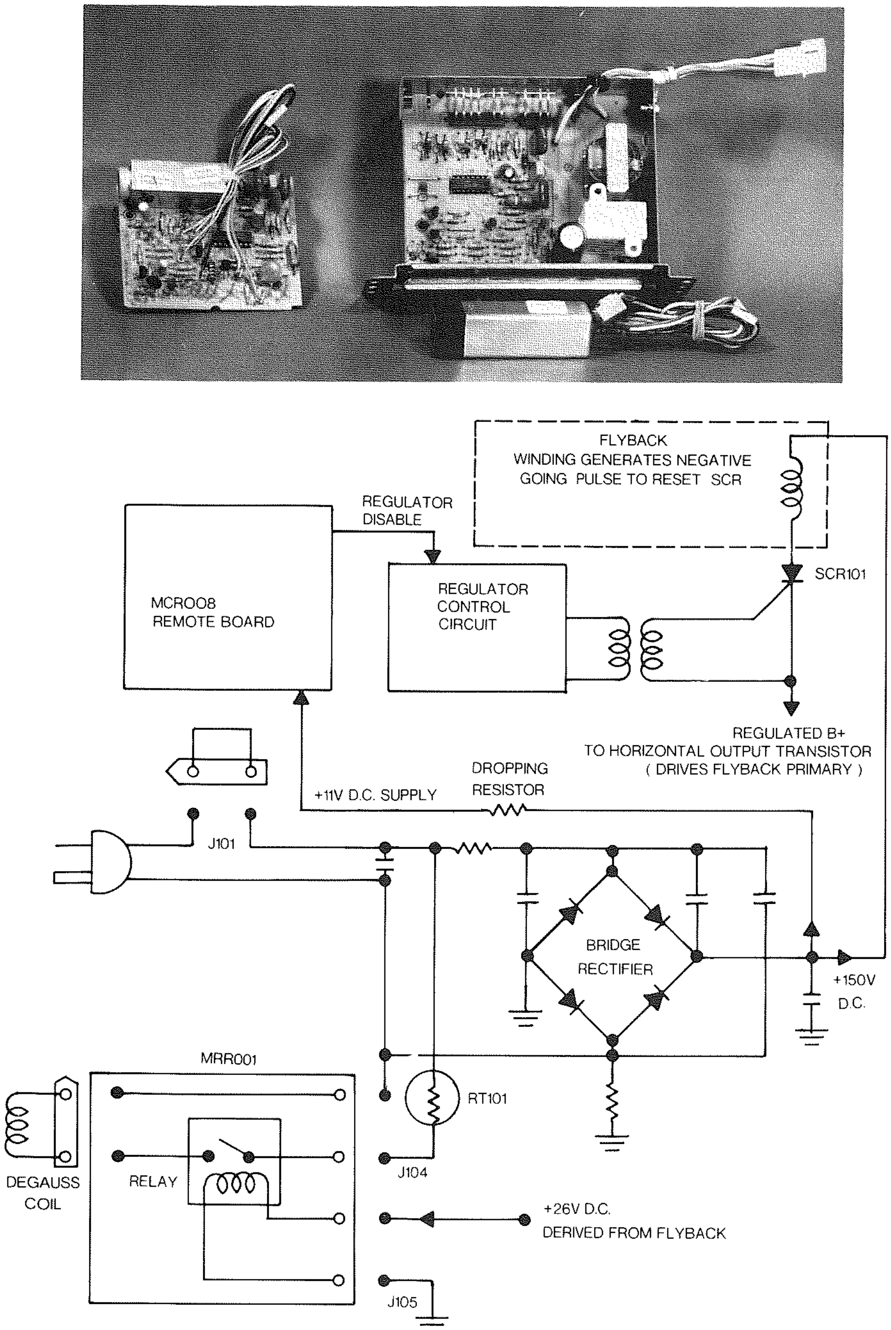

Fig. 5. Top: Size comparison of unitized MCR008 remote board (left) with the two units it replaces. Bottom: Cost effective remote turn-on circuit: ac bridge is on continuously; remote board turns regulated B+ on/off; degaussing is achieved using relay on MRR001 module.

increasing percentage of remote sets to keep up with consumer demand.

Conclusion

The CTC-107/108/109 chassis has dramatically reduced weight and material. With its excellent performance, it also has the most cost-effective design in RCA's history. The cabinets designed to house these chassis are also smaller. The CTC-108 instrument with ChanneLock keyboard tuning system has broken the 50 pound barrier for 19-inch receivers—weighs only 48 pounds. The 13-inch CTC-107 receiver is over 25 percent smaller. Of course console cabinets housing the CTC-109 chassis continue to follow conventional furniture designs.

Safety, reliability, and serviceability were of prime importance in the development of this chassis. New circuitry, notably the SAW filter IF and one chip chroma-luma system have joined time-proven circuits to boost performance while cutting size. And, a new cost-effective remote system provides an advantage in this growing market.

As for the future, plans are already underway to upgrade performance further in this extremely flexible chassis for use in some ColorTrak models.

And a deflection LSI has been designed to integrate the vertical and horizontal oscillators and regulator functions, allowing further improvements in upcoming chassis. So, it is with pride that we announce RCA's small color chassis design has a big future ahead of it!

Acknowledgment

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John Nicholson joined RCA Consumer Electronics as a Resident Engineer in Bloomington, Ind., upon graduation from Purdue University in 1976. His responsibilities included follow-up of design-related factory problems for the CTC85/86/89/90 chassis and later for the CTC93 chassis. He transferred to the Indianapolis Project Engineering Group in 1978, where he took on his present assignment as systems design engineer for the CTC107/108/109 chassis.

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