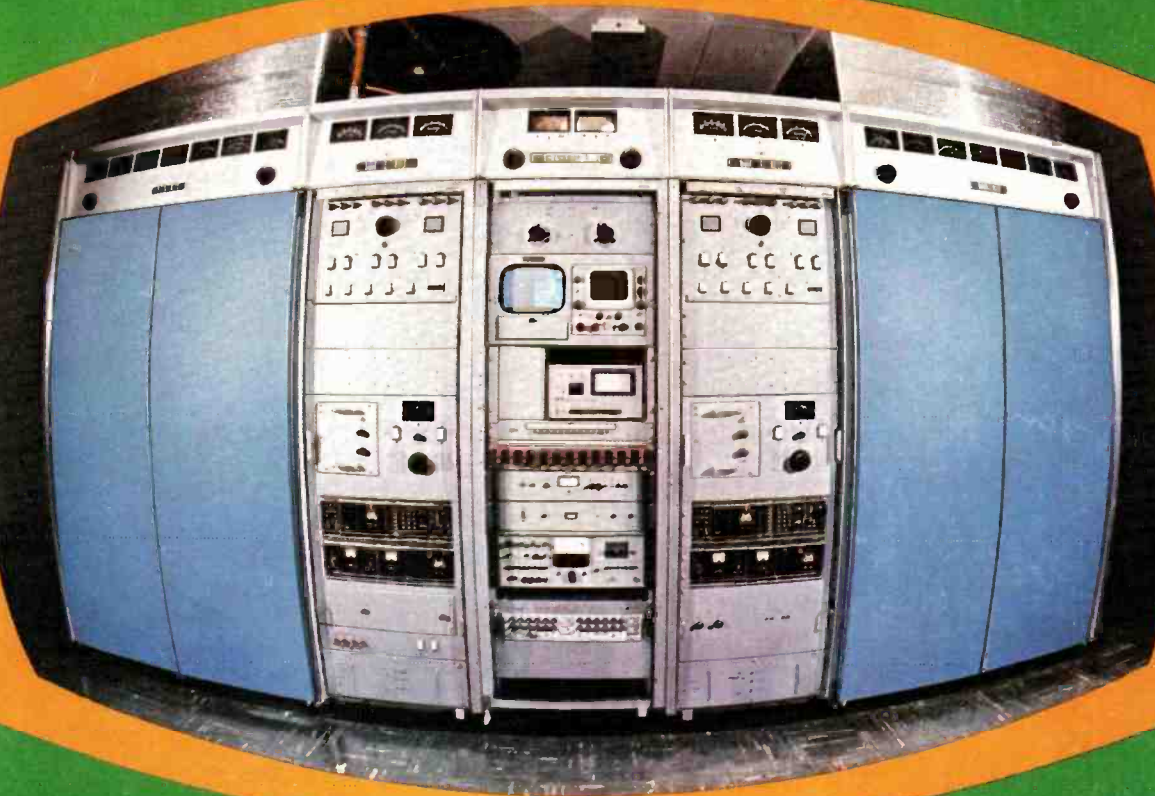


Samson
RCA
Broadcast News

Volume No. 161, June 1977



No Distortion Here!
Unique 50 kW Transmitting System for
WTLV-TV Saturates Jacksonville with a Crisp, Clean Signal

Meet the TK-46 from RCA.

Successor to the world's most successful TV studio cameras.

What's new on the TK-46?

Better signal-to-noise ratio, for one thing. In low light, a new, advanced preamp design improved signal-to-noise ratio by 3 dB—especially useful in multiple-generation tape production.

Also new for the TK-46 is a tiltable viewfinder with an 8" diagonal screen. The cameraman can hold a horizontal view while tilting the camera through a 30° arc.

Simultaneous in- and out-of-band contours with combing and coring are standard on the TK-46.

Feature	Year Introduced	69	70	71	72	73	74	75	76
High Efficiency Prism Optics		•	•	•	•	•	•	•	•
Wide Range Voltage Regulation		•	•	•	•	•	•	•	•
Comb Filter and Coring		•	•	•	•	•	•	•	•
Chromacomp		•	•	•	•	•	•	•	•
Electromechanical Lens Cap		•	•	•	•	•	•	•	•
Small Diameter Mini Cable		•	•	•	•	•	•	•	•
Joystick Remote Control Panel			•	•	•	•	•	•	•
Internal Bias Light	TK-44A			•	•	•	•	•	•
Extended Sensitivity				•	•	•	•	•	•
Scene Contrast Compression				•	•	•	•	•	•
Compact Camera Control Unit				TK-44B	•	•	•	•	•
Simplified Set-Up Controls					•	•	•	•	•
Automatic Color Balance					•	•	•	•	•
Automatic Iris Control					•	•	•	•	•
Automatic Centering Control					•	•	•	•	•
Indoor/Outdoor Switch					•	•	•	•	•
Super Quiet Switch					•	•	•	•	•
Out of Band Aperture Equalization						•	•	•	•
Shared CCU with Portable Camera Head							•	•	•
New State-of-the-Art Preamps							TK-45	•	•
Tilting Viewfinder								•	•
Simplified Control Panel Layout								•	•
Accident-Proof Set-Up Controls								•	•
Simultaneous In/Out of Band Aperture Equalization								•	•
Operations-Oriented Styling								•	•
									TK-46

Chronology of a winner.

The TK-46 is a new camera.

But far from unproved.

It is actually the distillation of years of brilliant camera performance. With features introduced to the industry on the TK-44 and its successors.

Features proved in more than 1,300 of these cameras. Features improved, where possible, for the TK-46. To make it the worthy successor to the world's most successful TV cameras.

Above are 25 reasons why the TK-46 makes superb pictures.



Our chart will show you all the advantages and how long they have been performance proved.

To see what all the TK-46 excitement is about, see your RCA Representative.

RCA



Page 6

WTLV-TV Adds Custom Transmitter and Expands ENG (Cover Story)

For flexibility and redundancy, TV-12, Jacksonville, specified a TT-50FH 50 kW parallel transmitter with custom combining and monitoring facilities. Emphasis on news is reflected in further investments in ENG and studio news operations.



Page 12

TV Helps Bank of America Keep in Touch

This broadcast quality color system produces a diversity of programming for distribution via videocassettes to a network of more than 1100 locations equipped with playback facilities.



Page 16

Videotraining at IBM France

At its Education Center near Paris, IBM operates a full color system which is fully utilized, producing more than 100 video tape courses each year.



Page 18

TKP-45/TK-76 Camera User Reports

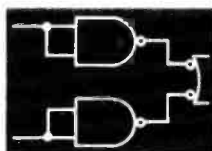
These popular portable cameras are covering the world, handling news, documentaries, commercials, program production. Locations range from the exotic to the prosaic.



Page 22

Two-Way Radio Versatility for the Broadcaster

A close-up report on mobile, portable and area-wide radio communications systems available from RCA for efficient broadcast coordination and on-air news reports.



Page 26

Digital Fundamentals for the Broadcaster

Part II of this series by John Wentworth discusses "families" of logic elements. Content is geared to needs of those concerned with operations and maintenance of equipment rather than designers.

Page 42

Products in the News

Featured products include: TK-760 Color Studio Camera; Three Circularly Polarized TV Antennas; Solid State 5 kW AM Transmitter; Simple Editor for TR-600; new AE-600 Editing System Accessories; UHF Exciter with SAW Filter; and others.

View Finder



A. F. Inglis, President
RCA American Communications, Inc.



N. Vander Dussen, Vice President and
General Manager, RCA Commercial
Communications Systems Division and
J. E. Hill, Vice President and General
Manager, RCA Broadcast Systems.

RCA Executive Changes

Three top management changes at RCA are of particular interest to broadcasters:

Andrew F. Inglis has been elected President of RCA American Communications, Inc.

Neil R. Vander Dussen is Division Vice President and General Manager, RCA Commercial Communications Systems Division, succeeding Mr. Inglis.

J. Edgar Hill has been named Division Vice President and General Manager RCA Broadcast Systems.

Inglis Heads Americom

During his RCA career, Mr. Inglis has been closely identified with broadcast equipment activities. He joined the Company in 1953 as Manager of Studio Equipment Product Planning, and later became manager, TV Systems Engineering. Before becoming a Division chief executive, he served as Division Vice President, Broadcast Systems.

RCA Americom, headquartered in Piscataway, N. J., commenced operation of the RCA domestic satellite communications system (Satcom) in September 1976. Satcom consists of two satellites in orbit, and a growing network of ground stations in major U. S. cities. Since broadcasters are major potential users of the satellite system, Mr. Inglis will continue his close association with the industry.

Vander Dussen Commands CCSD

In his new post, Mr. Vander Dussen is responsible for three major business units: Avionics Systems, which supplied weather radar and other airborne equipment to the aviation industry; Broadcast Systems, which produces studio and transmitting equipment, and Mobile Communications Systems, which markets two-way radio systems to a wide range of users.

After joining RCA in 1957, Mr. Vander Dussen became a broadcast equip-

ment salesman, with a promotion to district manager in 1962. Later he held sales, product and engineering management positions of increasing responsibility in various RCA commercial product activities. He served as Manager, Studio Equipment Engineering and Product Management before being promoted to Division Vice President, RCA Broadcast Systems.

Hill Directs Broadcast Systems

Mr. Hill's career with RCA began in 1935, and includes 30 years of marketing to broadcasters. In 1972, he was appointed Division Vice President, Marketing for RCA Broadcast Systems. For the preceding three years he was Manager, International Sales for the Commercial Communications Systems Division.

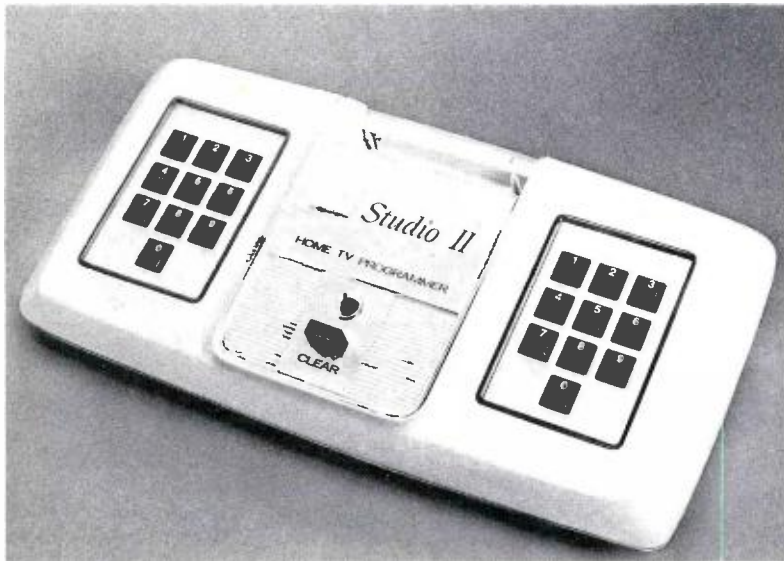
Before transferring to Sales in 1947, Mr. Hill's assignments were in manufacturing and design engineering. He was a broadcast equipment sales representative in New England for seven years when he was promoted to area sales manager, operating from the Camden home office.

Miami Station To Install First RCA CP Lowband Antenna

WPBT-TV, a non-commercial educational outlet in Miami, Fla., will become the first TV station equipped with a new RCA circularly-polarized lowband panel-type broadcast antenna.

The Channel 2 station, operated by the Community TV Foundation of South Florida, Inc., has ordered a six-layer VHF panel antenna, designated the TBK-6A2 (S), for installation this summer.

The antenna, newly designed at RCA's Gibbsboro, N. J. facility, is convertible between horizontally and circularly-polarized transmission signals by a simple electrical field adjustment of the antenna input, without any modifications to the antenna itself.



RCA TV Game And Educational Device

RCA's video game entry now being marketed is the "Studio II", a home TV programmer that has five games built into its control console, with provision for add-on cartridges containing other games and educational programs. The five programs, built into the console, are bowling, freeway (car racing), patterns, doodles, and a competitive math game.

Heart of the RCA programmer is one of the company's new COSMAC microprocessors. This tiny electronic component is often called a "computer-on-a-chip" since it contains over 6,000 transistors and can perform complex calculations in millionths of a second.

"Studio II" consists of a control console which is connected to the antenna terminals of a TV set through a switch, used to select regular TV or to turn on "Studio II". The front panel of the console contains two keyboards for the players, similar to the numbered push buttons on touch-type telephones. With these keyboards, participants feed their decisions into a miniature computer.

RCA's add-on cartridges for the TV programmer utilize semiconductor memories and are inserted into a slot on the console. The initial cartridges are called: TV School House I, Space War and Fun-With-Numbers. TV School House features tests at various educational levels on subjects including social science, math and other subjects. Space War includes two missile target games. Fun-With-Numbers includes three mathematical exercises and puzzles.

"Studio II" concept and logic was de-

veloped at RCA Laboratories at Princeton, N. J. It employs an RCA CDP1802 COSMAC microprocessor and other solid state devices which are produced by the RCA Solid State Division. The home TV programmer was designed by the RCA Distributor and Special Products Division and is being manufactured at the RCA plant in Swannanoa, N. C., where the add-on cartridges are also produced.

New Production Facilities For WDCN-TV, Nashville

In a major upgrading of its studio production and origination facilities, WDCN-TV, Nashville, Tenn., a non-commercial educational station, will install RCA broadcast equipment valued at approximately \$500,000.

The Metropolitan Board of Education, owner of the Channel 8 station, and the Nashville Public Television Council, have ordered color cameras, video tape recorders, and a film originating system for WDCN-TV's recently completed TV studios.

Three TK-46 top-of-the-line color cameras and a TK-28 TV film system are included in the order. Two TR-600 video tape recorders, equipped with RCA's new AE-600 electronic editing system, will enhance the station's video tape recording, editing and playback capabilities.

WDCN-TV broadcasts public service programming ranging from in-school instructional shows, teacher in-service programs and college credit courses to cultural programs on art and drama. The new studio equipment will enable Channel 8 to produce locally more cultural and educational programming of specific interest to its viewers, according to station officials.

TR-600's Picked For Robert Gilmore Teleproduction Center

Robert Gilmore Associates, a TV commercial teleproduction company based in Needham, Mass., has opened new facilities equipped with two top-of-the-line TR-600 quadruplex video tape recorders.

Robert Gilmore, President, said the TR-600's will enable the company to provide highest-quality video tape master recording, post-production editing and dubbing of commercial material.

The new studio, located at the Junction of Rte. 128 and Rte. 1, Needham, also is equipped with the complete switching and audio systems necessary for creative teleproduction work.

"Our new studio will provide a controlled environment for commercial production," Mr. Gilmore said, "and with the TR-600's we'll also be better equipped for post-production processing of commercials shot on location."

Radio TV Bandeirantes, Sao Paulo, Brazil, Continues Expansion Of Broadcast Facilities

As part of an ongoing expansion program of its broadcast facilities, Radio TV Bandeirantes has ordered RCA television transmitting and studio systems valued at more than \$400,000.

The equipment order, placed with RCA, includes a TT-25FH, 25-kilowatt transmitter and associated equipment. The new unit will replace the existing transmitter at the Brazilian broadcaster's Channel 13 outlet in Sao Paulo.

A TKP-45 portable color TV camera, complete with minipack battery and camera control unit which allows the camera to go anywhere as a fully self-contained system, is also included in the order.

Radio TV Bandeirantes, an independent broadcast group, recently purchased RCA TV broadcast equipment valued at approximately \$1 million for its new Channel 7 station in Rio de Janeiro. This installation also included a TT-25FH transmitter, new antenna and transmission line, and a complete microwave transmission system.

Unitel Orders Additional TR-600's For Teleproduction

Unitel Production Services, Inc. is continuing the expansion of teleproduction

capabilities of its New York City TV commercial and program production facility, adding two more TR-600 quadruplex video tape recorders, equipped with super high band and pilot tone for extremely high quality master video tape recordings.

Alex Geisler, Unitel's Executive Vice President, said "the new recorders will be interfaced with our computerized state-of-the-art tape-editing system. A total of seven TR-600's will then be available for production and post production assignments of Unitel."

Dr. V. K. Zworykin, RCA TV Pioneer, Inducted Into National Inventors Hall of Fame

Dr. Vladimir Kosma Zworykin, 87, an RCA scientist who pioneered in the development of television, has been elected to the National Inventors Hall of Fame along with four other famous American inventors. The others are Edwin H. Land (Polaroid camera), and posthumously, Lee de Forest (electronic tubes), George Eastman (Kodak camera), and George Steinmetz (electric power and transmission).

In a telegram congratulating Dr. Zworykin on his election to the National Inventors Hall of Fame, RCA President Edgar H. Griffiths said, "Your contributions to our technology have benefited all mankind."

The holder of more than 120 U. S. patents on developments ranging from television to gunnery controls to electrically controlled missiles and automobiles, Dr. Zworykin has received 27 major awards including the National Medal of Science. This was given to him in 1966 by President Lyndon Johnson "for major contributions to the instruments of science, engineering and television, and for his stimulation of the application of engineering to medicine."

A Russian immigrant, Dr. Zworykin came to the United States soon after World War I. He worked for the Westinghouse Corp. until he joined RCA in 1929 as Director of the Electronic Research Laboratory. In 1947, he was elected Vice President and Technical Consultant for RCA Laboratories.

At RCA Laboratories, Dr. Zworykin was involved in many TV developments, including the iconoscope—a revolutionary TV camera tube that made possible practical picture transmission—and the kinescope or television picture tube.

Dr. Zworykin was the first to predict, many years before it happened, that man's initial view of the backside of

the moon would come through television. And last year he told colleagues that he found the close-up Viking TV pictures of Mars very pleasing and exciting. The pictures fulfilled his dream that television would one day permit man to gaze upon things that otherwise he might never see.

Power-Saving Anode Pulsar For UHF Transmitters Passes On-Air Tests

On-air tests of RCA's new power saving anode pulsar for UHF television transmitters have been conducted by WNJT-TV, New Jersey Public Broadcasting Authority's station in Trenton.

The modulating anode pulsar is a new technique for reducing power consumption of RCA UHF transmitters by applying pulses to the visual klystron amplifier tube. The system was installed last summer as a field modification to Channel 52's RCA TTU-60 transmitter for extended on-air tests under the direction of John T. Wilner, Director of Engineering for the Authority.

Test results to date indicate a beam power saving of 32 kilowatts, or 17.7 percent. Prior to installation of the pulsar, the visual beam power input was 184.3 kW with an output of 60 kW peak of sync power. With the pulsar in operation, the visual beam power input drops to 151.7 kW.

The anode pulsar can be applied to any RCA transmitter equipped with the company's type TTUE-4A solid-state exciter and with "high efficiency" klystrons. Now in production, the pulsar system is offered as an optional accessory on new UHF transmitters or for field installation on existing RCA transmitters.

Three TKP-45 Portable Cameras To WEDW-TV, Bridgeport

WEDW-TV, Bridgeport, Conn., is equipping its new studio facilities at Fairfield University with RCA TKP-45 portable television cameras to provide top-quality local programming in color. Three of the studio-quality portable cameras, as well as a complete TK-28 film originating system, are being installed in the Fairfield studio which will produce programs aimed specifically at that local area, as well as programming to be aired on the state network.

Jack Kean, Vice President for Engineering, said the hand-held cameras will provide mobility and flexibility in local program production. In addition, the TKP-45's will double as studio

cameras when not required in the portable mode.

WEDW-TV is one of four non-commercial TV stations operated by the Connecticut Educational Television Corporation. The others are WEDH-TV, Hartford, WEDN-TV, Norwich, and WEDY-TV, New Haven. The network provides instructional programs for students, training and development services for business and industry, and evening entertainment programs.

New Transmitting Plant For Hershey, Pa. ETV Station

As part of a complete replacement and upgrading of its 12-year-old transmission facilities, WITF-TV, Hershey, Pa., a non-commercial public television station, has ordered RCA transmitting equipment, including a new TTU-60, 60-kilowatt UHF transmitter, transmission line, tower and refurbishing of the station's existing broadcast antenna.

Michael J. Ziegler, the station's Assistant General Manager, said the new equipment will improve the reliability of WITF-TV's service. It also will extend the signal to Berks County, primarily the city of Reading, and greatly improve signal penetration in the station's existing service area, reaching some 562,000 more viewers, Mr. Ziegler noted.

Operating on Channel 33, WITF-TV is licensed to the South Central Educational Broadcasting Council, and provides educational and cultural programming to viewers in that area.

RCA Americom Demonstrates Radio Network Quality Programming Via Satellite

Communications satellite technology now makes possible low cost distribution of press service, radio network and specialty programming to large numbers of radio stations equipped with small dish antennas. This satellite receiving capability eliminates the need for terrestrial communications lines currently used for audio network distribution.

RCA American Communications, Inc., demonstrated this capability recently, using a receive-only earth station on the 15th floor of the New York City headquarters of United Press International.

Currently two domestic satellites (designated RCA Satcom) are operated by RCA Americom. An advantage of satellite technology is its freedom from many interconnections such as switches, amplifiers and other ground equipment that cause noise build-up in the audio signal.



TK-76's VISIT THE WHITE HOUSE.

Four NBC crews equipped with TK-76 cameras spent a long day at 1600 Pennsylvania Avenue early in April, taping the "NBC Reports" special program "A Day with President Carter". The crews followed the President through his work day (17 hours) covering most of the activities on his schedule, including a Cabinet meeting, and a reception and dinner with Egyptian President, Anwar el-Sadat.

of weather conditions up to 300 miles ahead, and also serves as a navigational aid.

Designated PRIMUS-400, the revolutionary new weather radar with color represents a major engineering achievement in adapting color TV technology to the space limitations of aircraft.

First introduced by RCA in 1955, commercial weather radar has been capable of producing only monochromatic pictures to date. Radar permits the pilot to detect storm conditions up to 300 nautical miles ahead of the aircraft and to select a smooth safe course through or around them.

When operating in the mapping mode, the weather radar paints a picture of topographical features which can serve the pilot as a navigational aid.

The new PRIMUS-400, besides its advantage of color, has four times greater resolution than any other digital radar now available, enabling this RCA system to produce weather pictures in finer detail than previously available.

Color pictures produced by the new system will be viewed on a rectangular cathode ray tube which is installed in the instrument panel. The display has a five-inch diagonal screen which is the standard size for aircraft radar installations.

Areas of the heaviest rainfall will appear on the tube in red. The next level of precipitation will appear in yellow, while those areas of the least intensity will be displayed in green.

The PRIMUS-400 system is made up of three basic units—the color indicator, the receiver/transmitter and the antenna—and weighs approximately 37 pounds. The antenna is a flat-plate design which is nearly twice as efficient as the older parabolic "dish" antenna and yields a cleaner weather picture.

The new color system is being produced at RCA Avionics Systems' plant in Van Nuys, California.

The satellite is distance-insensitive and beams down a uniform signal, just like a floodlight, delivering sound or teletype copy to tens, hundreds or thousands of small receive only stations across the country. Small antennas, such as the six-foot dish used in the demonstration, can be installed easily on the ground or rooftops in cities or remote areas.

Small and economical receive earth stations can be used effectively with the RCA Satellite System to provide an 8 kHz service. This would result in a signal quality improvement over 5 kHz service, which is used for most radio program distribution.

Several radio and/or wire service programs can be transmitted simultaneously using RCA's new audio network distribution service. A single channel or as many as eight different channels may be carried by one satellite transponder.

Transmission can be originated by live performances, tape recordings, teletype or CRT display terminals. Programs can originate at a major RCA earth station or at any location with terrestrial links to one of RCA America's operations centers in key cities.

RCA was the first company to provide domestic satellite communications services to business, government and the media in the United States, and has compiled the longest operating record of any domestic satellite carrier.

Major RCA earth stations, including television and audio facilities are now operating in New York, Philadelphia, Chicago, Los Angeles, San Francisco, Houston and Atlanta.

Nigerian Broadcasting Operates Two RCA Color TV Mobile Units

The Nigerian Broadcasting Corporation is operating two RCA-equipped color TV mobile units, valued at approximately \$2 million. Equipped for complete color program production, the mobile units are assigned to Nigerian state TV centers in Makurdi and Sokoto, to augment TV studio facilities there.

Each of the custom-built mobile vans includes four RCA TK-46 color TV cameras; video tape; switching, audio and monitoring systems. The TK-46 has automatic features designed to keep performance at a uniformly high level in the TV studio, on location, or under low and changing light conditions out of doors.

An RCA two-way radio communications system helps coordinate personnel and operations while the vans are in the field. A self-contained air conditioning and dehumidification system enables the vehicles to operate in varying climates. Power for the television equipment is provided by a trailer-mounted 50 kva electric generator.

RCA Avionics Demonstrates Industry's First Full-Color Weather Radar

The aviation industry's first full-color weather radar system which provides the pilot with weather and ground mapping information was demonstrated recently by RCA Avionics Systems.

The new system will enable pilots to make faster, more accurate evaluations

WTLV-TV

ADDS NEW TRANSMITTER . . . EXPANDS ENG . . .



The moving force behind the on-going capital investment program at WTLV-TV is Gert Schmidt, President and General Manager.

When WTLV-TV, Ch. 12, Jacksonville, went on-air in 1957, its signal was crisp, clean and sharp. The transmitter was an RCA TT-50AH 50 kW system operated at 46 kW visual power to maintain the station's authorized 316 kW ERP.

Today, the TV-12 signal is crisper, cleaner and sharper—and the transmitter is a new customized RCA TT-50FH, 50 kW parallel system.

Mr. Gert Schmidt, President and General Manager, notes that the new transmitting system is one phase of an extensive, on-going capital investment program at WTLV-TV. A second phase, recently completed, includes new technical and studio facilities for the news operation.

Preceding the TT-50FH transmitter purchase, TV-12's studio was upgraded with TK-44B and TK-45A cameras. At the same time, two TK-28 film cameras were added to Telecine, replacing well used TK-26's. With the better color signal output from the studio, the investment in a new generation transmitting plant became even more meaningful.

Redundancy and Flexibility

In planning for the new transmitting system, the TV-12 engineering staff envisioned a system that would provide a maximum of flexibility and protection against lost air time. After evaluating

available product offerings, the TT-50FH custom system was selected. This parallel system provides the desired redundancy and functional flexibility.

In addition, the durable TT-50AH is still licensed as an Alternate-Main transmitter, and is operated for eight hours every Monday morning, providing still more insurance against lost air time. The reliability and trouble-free performance record of this transmitter for 19 years at TV-12 provided a built-in "tilt" toward RCA when a new transmitter purchase was considered.

The new custom TT-50FH system went on-air September 7, 1976, and is delivering a top-quality color signal throughout the TV-12 coverage area.

Custom Parallel Transmitting System

The new transmitting system installation included:

- TT-50FH, 50 kW Parallel Transmitter
- Custom combining and monitoring rack
- OPTO-Switcher
- VSBF, floor-mounted
- Diplexer
- New transmission line to Diplexer

The 12-bay Superturnstile Antenna installed in 1957, and the two transmission line runs up the tower were not replaced at this time.



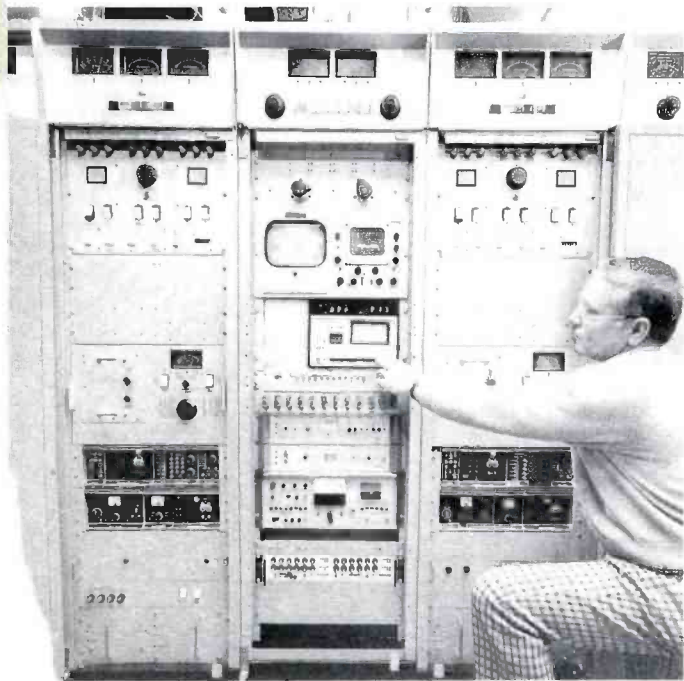
Combining and Monitor Rack

The custom combining and monitoring rack separates the two 25 kW sides of the TT-50FH system, a unique configuration which was specified by WTLV. Positioning the monitor and control facilities between the two transmitter

sides is ideal from an operational and maintenance view. In performing routine maintenance or making tests, the rack in the center is immediately adjacent to the transmitter functions being monitored. The monitoring rack includes the combining panel for the

TT-50FH, and provides control of the combined exciter switches and of the OPTO-Switcher.

Located directly beneath the combining panel at the top of the custom cabinet is the RF monitoring panel. Two coaxial (Bird) switches are mounted in



New TV-12 transmitting system includes OPTO-Switcher for optimum VSWR. Entire system was optimized on site before going on-air.

Custom combining and monitoring rack is positioned between the two 25 kW sides of the TT-50FH Transmitter.

this panel to monitor the various RF points in the system, at various levels in sweeping the transmitter. The output of the coax switches can be fed to either the sideband analyzer or to the demodulator.

The left control has five positions for monitoring:

1. "A" Transmitter IPA
2. "B" Transmitter IPA
3. "A" Transmitter Output
4. "B" Transmitter Output
5. Combined Output

The readings are displayed on a monitor directly below the RF monitoring panel. The right coaxial control switch switches the output of the left control to the Sideband Analyzer or to the Telemet Demodulator (Model 4501) and Synchronous Detector (Model 4504). The difference in readings between the differential phase on the Demodulator and on the Detector is incidental phase. By measuring incidental phase, corrective steps can be taken to eliminate this distortion. Since it is anticipated that home television sets will be equipped with synchronous detectors, more broadcasters, such as WTLV-TV are installing equipment for measuring incidental phase.

Three Water-Cooled Dummy Loads

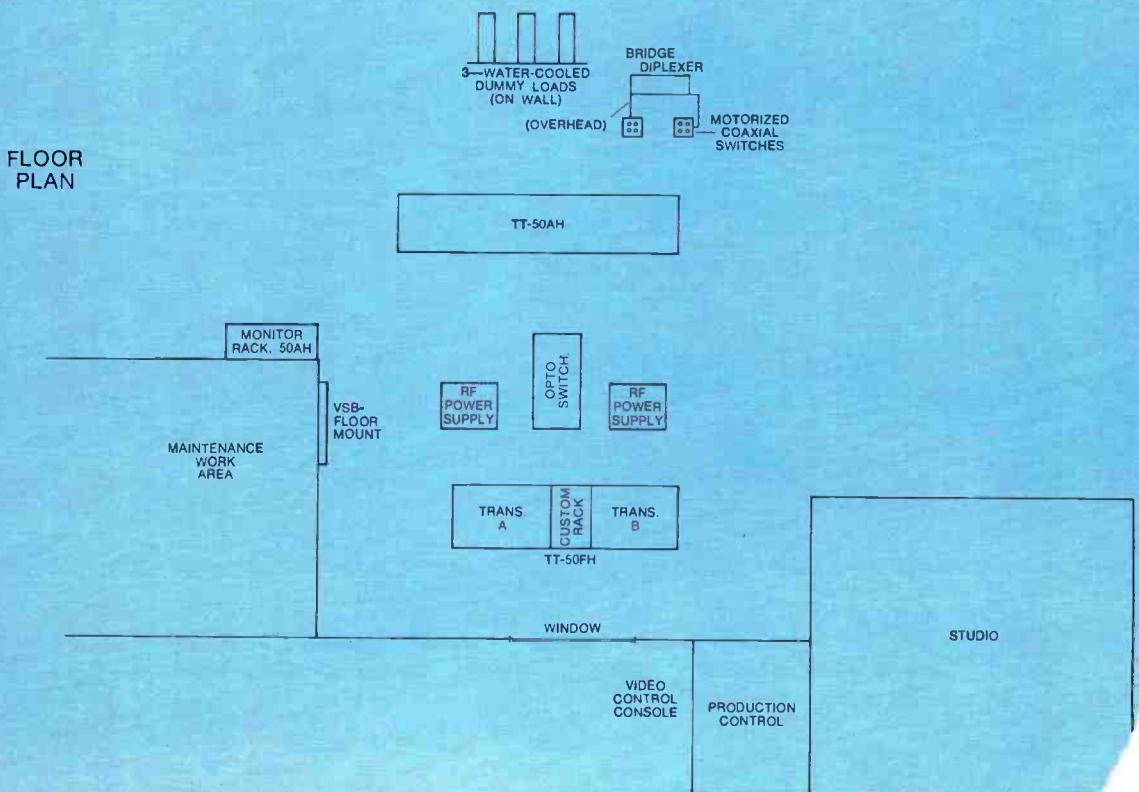
Built into the panel with the coaxial

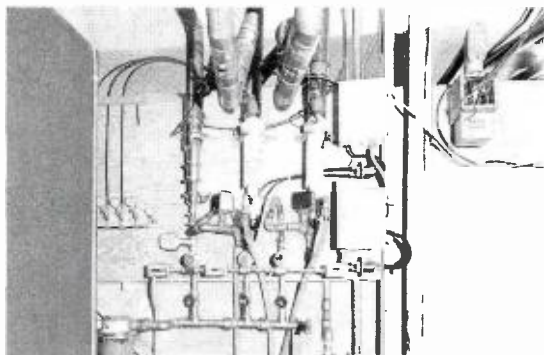
switches are three lights which provide a visual indication of adequate water flow in the dummy loads. The light "on" indicates that water is flowing and a transmitter can be switched to the load. The lights are activated by a pressure and flow solenoid switch at the dummy loads. The system is set up as a fail-safe, so a transmitter cannot be switched into dummy load unless enough water is flowing.

TV-12 uses three water-cooled dummy loads. Two are new 50 kW loads which were installed with the new transmitter system. These handle the visual outputs from the transmitters, and the old 50 kW load takes the aural loads. Aural and visual outputs from the old TT-50AH transmitter and from the TT-50FH OPTO-Switcher are carried to two coaxial motorized transfer switches which are used to switch the output of either transmitter to the diplexer or to dummy load. This arrangement provides complete redundancy and flexibility.

Either transmitter can be switched on air in a matter of 4-6 seconds, and the transmitter not on air is automatically switched into the dummy load.

The diplexer, transmission line and the antenna are the only common points in the transmission system. Both transmitters are separated up to the coaxial

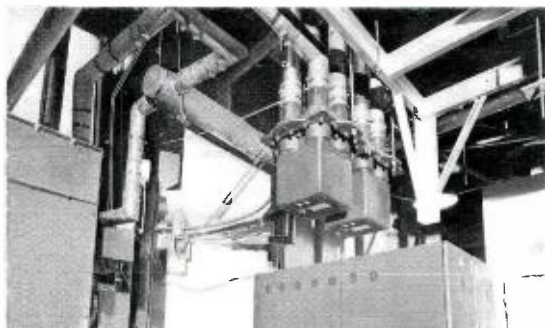




Three water-cooled dummy loads are used in the WTLV-TV system.



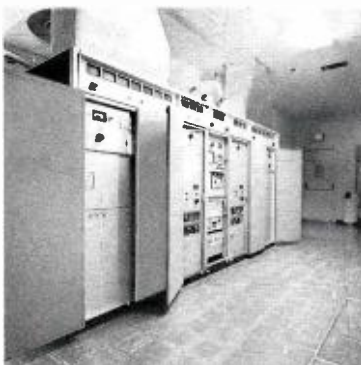
Durable TT-50AH Transmitter, a 19-year veteran is still licensed and goes on-air once a week.



Motorized coaxial switches switch output of either 50 kW transmitter to the diplexer or to dummy load.



Through the picture window, production control operator has a clear view of transmitter control/metering panels.



TT-50FH parallel system provides redundancy and functional flexibility.

switches, including separate monitoring, waveforms, de-mods and frequency monitoring.

The entire TV-12 transmitting system was optimized on site by an RCA field engineer before going on-air.

Smooth Installation and Changeover

At TV-12, the technical facilities are located on the second floor with the administrative offices and studios on the first floor. The transmitter room adjoins the production control area, and the front line cabinets of the TT-50FH are in full view through a large "picture" window. The video operator can visually check the meter readings without leaving the console position.

Installing the new TT-50FH system went smoothly, since the changeover procedures were carefully planned. The old TT-50AH transmitter was performing well and had been completely overhauled in 1972—with contact surfaces re-silverplated and some new contacts added. As a result, the output of the TT-50AH was better than average, and there was no urgency in rushing the installation of the new system.

In fact, the most noticeable change when the new transmitter went on-air was in the differential phase and differential gain according to the TV-12 engineers.

Adding the new transmitter required a minimum of re-arranging, since ample space was available. The TT-50AH remained in its original location, but the console was removed and the monitoring racks re-located, thus providing ample room for moving in the new TT-50FH. Since the old transmitter maintained its normal operation, installation of the new transmitting system went smoothly and without interruption.

On-Air, On-Schedule

The TV-12 game plan of installing and checking out the new transmitting system during the summer came off as scheduled, and the initial air date for the new transmitter was September 7, 1976. And, although it has not been needed for emergencies, the venerable TT-50AH system puts in its eight hours of transmitting time each Monday.



Howard Kelley, News Director is responsible for sustaining the news dominance at TV-12. Expanded ENG facilities include TK-76 cameras, cassette VTR's and three separate editing systems.



Accent On News

As noted previously, the new transmitting plant is just one phase of WTLV-TV's investment in new technical facilities. News is another.

The stepped-up emphasis on the news operation is evident at TV-12. The main studio is dominated by a striking news set similar to that used by Chancellor and Brinkley on the NBC Evening News. The similarity is intentional and provides continuity, since the station carries NBC Evening News and follows it with the local news program. The new TV-12 set includes built-in desk monitors and three separate Chromakey areas. Considering that the Jacksonville market is #65, this investment in a news facility is noteworthy. (As an interesting sidelight, the "old" news set which was replaced was donated to the Navy and will be used at the closed circuit television facility at Guantanamo Bay, Cuba.)

The studio camera complement at TV-12 is a total RCA mix, including three TK-44B's; a TK-45A, and a TK-42.

TK-76 for ENG

The sparkling new set is just one indication of the accent on news. The new ENG facilities is another. The station has been using a TK-76 portable camera for some time and is awaiting de-

Indicative of emphasis on news at TV-12 is this striking new news set.



livery of a second camera. The TK-76 is excellent for both news and for production, according to Howard Kelley, News Director. The second camera will be used primarily for production, but will also be available to the News Department.

“The TK-76 camera is working beautifully. Picture quality is excellent, and we have experienced very few problems with the camera.”

TV-12 started its ENG operation in 1975, and now 80 percent of outside news coverage is aired from tape. Former film crews are handling the ENG function, Mr. Kelley says, and the changeover did not pose a serious problem. “It just takes a while for the film cameraman to adjust to the electronic

medium, and the major adjustment is in routine operating procedures, such as remembering to clean tape heads on the VTR’s.”

ENG Editing Systems

Three separate ENG editing facilities are in operation at WTLV-TV:

- The primary system, with Data-tron computer editor and two 2850 video cassette recorders
- A second system, located in the same room, using a less sophisticated editor, and two other 2850’s
- The third system, in a separate room, is reserved for microwave pickups, which can be broadcast immediately or recorded and edited before airing.

To expedite editing, time code is usually added to the blank video tape before the cassettes are used for field recording.

Careful Planning . . . Good News

Careful planning of the new WTLV-TV transmitting system resulted in a smooth on-schedule changeover. Performance of the new TT-50FH custom parallel system has measured up to expectations, and the TV-12 signal is crisp, clean and sharp.

For the news operation, the same thoughtful planning and investment in technical facilities has resulted in an effective, expanding ENG operation, and a top-rated local news production. □



When not on ENG assignments, the TK-76 cameras at TV-12 are used by the Production Department for producing on-location commercials. Mobility, quick set-up and excellent picture quality make this an ideal use for the TK-76. The cameras and cassette VTR's move fast. In the sequence de-

picted here, the TK-76 handled two "stand-up" commercials, one outdoors and one indoors. The tapes were played back in the client's office and were OK'd for production. The total elapsed time was barely one hour—and the TK-76 was ready to cover an ENG story.



TV HELPS BANK OF AMERICA TO KEEP IN TOUCH

The Bank of America teleproduction system includes a computer editing system with three TR-600 quadruplex tape machines. Responsible for technical operations is Chief Engineer Barry Joseph.

LONG BEFORE the term “corporate communications” became a popular buzzword, the Bank of America was a practitioner of the art. The need for fast, accurate transmission of information was mandated by the continuing growth of branch banking in California, plus expanding domestic and world-wide financial operations.

The bank has been heavily involved in training and communications programs to link its widespread facilities. In 1962, sound filmstrip projectors were installed

in all branches, serving as an effective system for disseminating information and training materials on a standard format.

TV Is Primary Medium Today

Today, television is the primary medium for corporate communications at Bank of America. A broadcast quality color television system installed at corporate headquarters in San Francisco produces program material which is distributed via video cassettes to a network of locations equipped with playback facilities—more than 1,100 in California alone.

Major uses of television are for staff and sales training and for disseminating information on a wide range of policies, procedures and programs.

First-Rate Teleproduction Center

The in-house television facility is not only broadcast quality—it also has full-scale teleproduction capability. The impressive equipment complement includes two TK-45A Studio Cameras; three TR-600 quadruplex VTR's; a color film island; a 16-input, double re-entry switcher; a Datatron computer editing system; a videocassette multiple tape duplicating facility, and a mobile unit equipped with a TPR-10 portable quadruplex VTR.

Responsible for the technical operation and performance of the TV system is Barry Joseph, who was Assistant Chief Engineer at KGUN-TV, Tucson before joining the bank in 1969. At that time, Mr. Joseph recalls, the bank had just finished installing a modest monochrome TV system which was initially used for “role playing” training applications. Other uses soon followed, including supplying some training tapes to 12 key regional offices which were equipped with video tape players.



Videocassette Delivery System

With the introduction and rapid acceptance of the videocassette format, television became a much more viable vehicle, especially for corporate communications. In 1973, an independent research study recommended that television replace filmstrip as the principal medium for bank communications. With videocassettes serving as the delivery system, this study also recommended that the Bank of America monochrome television system be upgraded to a high quality production center capable of producing high quality color tape masters for mass duplication to videocassettes.



Setting up lighting for a studio production. Two TK-45A cameras are installed, one with a portable CCU for handling remotes.

The end product of the B of A's TV system is videocassettes. Some of the dubbing requirement is handled by an internal duplicating facility.

Production Center Layout: Compact and Efficient

The Bank of America production center is a high density facility, packing a maximum of equipment into a limited area. The studio is compact, with a low ceiling, but is efficiently laid out to minimize these limitations. It is the same studio used for the monochrome operation, with Colortran lighting.

Despite its size, the studio can handle two-set productions and has a Chroma-key cyc for added versatility. In fact, the small studio has advantages, according to Production Manager Norman Miller, in that it tests the ingenuity of the production staff. "We have a full two-camera studio, with no compromise in quality," he says. "And we can match our results with those of outside production facilities and not suffer from the comparison."

The two studio cameras are TK-45A's with 10:1 Angenieux lenses. One of the cameras can also be used for remote assignments.

Like the studio, the tape and film area also squeezes a lot of capability into a limited space. In this room are the three TR-600 VTR's; the color film island; 10 videocassette record/playback machines; terminal and distribution racks; audio tape recorder; and a graphics table with two monochrome cameras—plus a workbench and maintenance area.

Production Control/Editing Center

Production Control is located between the studio and the Tape/Film room. It, too, features an efficient layout, fully utilizing available space. The room is on two levels, with the Datatron editing system, production switcher and audio board mounted on a raised platform. Directly in front of the master control



Video control, switching, audio and computer editing facilities are grouped in one area. The Director handles video switching and also is responsible for post production editing.

and editing console are the camera control units and a bank of monitors which display all available program sources. Two large color monitors are for Preview and Program. The rack for one of the TK-45 CCU's is separated from the other monitor and control racks, which permits moving one camera and CCU to the mobile van for handling remotes.

The production switcher is a Grass Valley 1600-3D, 16-input, double re-entry, equipped with downstream keyer, RGB and encoded Chromakeyers. This last feature, Mr. Joseph says, is a frequently used production aid, since it permits adding chroma key material during post-production. "In fact," Norman Miller adds, "our production technique is basically film style, allowing



us to shoot out of sequence while maximizing our use of production and post-production equipment and staff.

A 12-input, 4-channel Ward Beck audio console provides ample flexibility for audio requirements.

For most studio productions, one person handles audio; another video control, and the director does his own video switching. During post-production the director is responsible for the switching and Datatron editing functions.

Three TR-600's Provide Flexibility

The Datatron computer editing system is tied in to the three TR-600 tape machines and to a 4-track reel-to-reel audio tape recorder. One of the TR-600's is designated as "Master Record"; one is "A" playback and the other "B" playback. When needed, however, any machine can be used for Master Record.

Mr. Joseph likes the operational features of the TR-600—the slanted transport deck, easy loading and simple threading. Their technical performance has also been excellent, he adds. The fast lock-up is helpful in editing, and the machines are very stable, requiring a minimal amount of set-up. This is an important consideration when operating with a limited technical staff.

The flexibility of having three TR-600's in the studio plus the TPR-10 portable quad machine in the van means that post-production for one show can be done while another show is being shot.

After recording, the tape is run through the TR-600 again, and SMPTE time code data is laid down for editing. At

the same time, a duplicate tape is made on the 3/4-inch videocassette, with time code displayed. This copy is used for "rough edit decisions" which saves time on the quad machines, and also makes it easier to obtain internal approvals prior to final editing and release.

Remote Unit

The mobile unit is an Econoline 350 which is housed in the parking garage of the bank's headquarters. Designed for the bank's particular needs, it is equipped with two 6.5 kW generators, an audio mixer, monitoring facilities, and a TPR-10 Portable Quad VTR. One of the studio TK-45A's and its control rack is moved into the van when needed.

"The TPR-10 is an extremely useful machine," Mr. Joseph confirms. "It does everything we ask of it, and makes possible handling remote productions with studio quality results.

"While on location, we shoot wild footage of stock subjects such as bank exteriors, street scenes, local color. We are building a library of material for production use. It has already saved us from having to take the van out for routine shots."

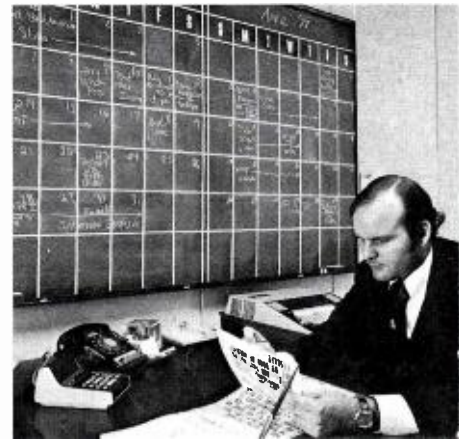
Handling Production Assignments

Most requests for television productions originate with the administrative operations in Bank of America headquarters, with less frequent requests coming from the Regional Offices (B of A has nine regions in California).

Dave Mebane, Vice President, Director of Training, receives the requests and determines whether the Audio-Visual group should be involved in the proposed project. If it is, the assignment is given to Larry Drummond, Assistant Vice President, head of Audio Visual. He assigns a priority, and the AV staff works with the group initiating the request, to determine requirements, budget and scheduling.

With a limited staff, scheduling sometimes becomes a problem, since projects tend to come in bunches. This creates a crunch situation and the priority system is needed to help even out the production load.

In handling a production involving a scripted presentation, meetings are scheduled with bank subject matter specialists, a writer and the AV staff. After the script has been approved, Mr. Drummond determines whether the production should be handled internally or by outside producer.



Reviewing a TV script prior to production is Larry Drummond, Assistant Vice President, head of Audio Visual.

Mr. Drummond notes that the company's philosophy is to get the job done and done well, using internal resources to the fullest. To provide flexibility of operation, the Audio-Visual staff is small and specialized. For the television productions, professional talent as well as bank personnel are utilized.



Mobile unit with TK-45A camera provides flexibility of handling on location assignments, including using outside studio facilities as needed.



TPR-10 Portable Quad VTR is used in the mobile unit.



Classroom training facilities at Bank of America headquarters are equipped with portable television systems on rolling stands. Systems include color TV sets and videocassette players.

Program Distribution

One of the key advantages of the videocassette format, according to Mr. Drummond, is the ability to re-cycle and re-use the cassettes. Program material produced for videocassette distribution falls into three general groupings:

1. Long-term use material—for retention in branch libraries as permanent reference.
2. Special materials sent out for short-term use, with branch copies returned after completion of the program.
3. Timed material, such as ad programs, commercials and similar information materials. These cassettes are also returned to headquarters for re-use.

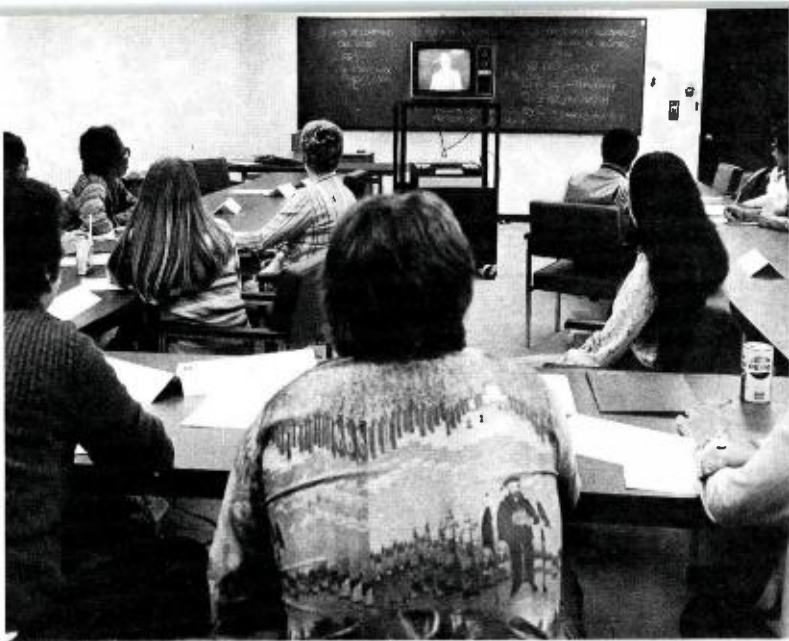
The entire videocassette delivery system is computerized, so the location of all tapes issued can be tracked. This procedure is important in re-cycling the cassettes to maximize tape usage, Mr. Drummond remarks.

Since the video system has been in operation, about 26,000 cassettes have been issued. About 67% of these are for limited use and have been returned for erasing and re-use. The re-cycling stabilizes cost and reduces the tape investment substantially, adds Mr. Drummond.

There are now more than 1,100 videocassette players in Bank of America branches throughout California. Each branch is equipped with a standard system including a rolling stand with a color TV set on top and the videocassette player on a shelf below. Channel 5 or 6 is used for the cassette playback. A number of the Headquarters Training Rooms and other locations are also equipped with the standard videocassette systems. Expansion of the videocassette distribution network beyond California to cover other domestic and world-wide offices is planned.

Diversity of Programming

The television programs produced at Bank of America vary widely, ranging from extemporaneous presentations to tightly scripted shows. The distributed videocassette packages usually include related print support material such as leaders' guidebooks, posters, or handouts. Videocassettes are packaged in special boxes which also contain the print material. A printed label on the package identifies the subject by name, and by a pre-assigned library number.



The printed package label relates to the computer-controlled re-cycling operation. For example, if the cassette is to be returned, the gummed label showing the local branch address is peeled off, uncovering the return mail address to the AV Department at headquarters. The cassettes are distributed via inter-branch mail.

Some productions have been handled as "network delay", where the pre-recorded program is duped to cassettes in limited quantities and sent to selected branches. The tapes are played at each location at a designated time, and a coordinated, pre-scheduled telephone network arrangement permits two-way conversation between the branches and headquarters where the individual responsible for the program content answers questions or elaborates on any part of the tape presentation.

Quick Turn-Around

Among the advantages of television for corporate communications are its immediacy and quick turn-around time. The Annual Founder's Day message exemplifies these advantages. The program was taped in the headquarters studio on Friday; edited Saturday, and sent out for duplication Monday. By Friday, complete videocassette packages were in all Bank of America branches.

The internal videocassette duplicating facility is used for dubbing a limited number of copies of a program. Beyond this, the material is given to a commer-

cial duplicating operation. In either case, the master edited quad tape is not used for duplicating. A dub-master is made for this purpose.

Award-Winning Productions

Post-production is given major emphasis at Bank of America. Computer editing combined with a variety of creative production techniques—inserts; Chromakey; special effects—enhance the professionalism and quality of their productions. The high performance standards have been recognized by fellow professionals—the bank's audio visual section has been awarded two "Emmys" by the Northern California Chapter of the Academy of Television Arts and Sciences.

Performance Breeds Popularity

The professional quality productions have made management more aware of the technical capability of their television center, and of the competence of the AV staff in handling the job. Consequently the TV Center finds itself in demand and booked solid. Quality color TV production combined with a computerized videocassette recycling program have made television a cost-effective medium for Bank of America. □

Videocassette training packages usually include related print support material such as leader's guidebooks and handouts.





Color video is now part of the classroom environment at IBM France's Education Center.

Videotraining Becomes a Colorful Business at IBM France

PARIS

The new tape facility utilizes a TR-600 recorder for masters in the production of training courses eventually dubbed to cassettes.



Commercial television's techniques and production values have been introduced to CCTV operations at IBM France's Education Center just outside of Paris. A two-camera, one-VTR color system, which became operational last September, is the newest of the numerous elements that make up the huge complex.

All aspects of audio-visual training, from origination of courses to classroom delivery, are consolidated in an attractive six-story structure on Avenue Ed Vaillant in Boulogne.

Each year, 45,000 people pass through the Center for instruction on IBM's office products and data-processing machines. About two-thirds consist of customers' employees; the rest, IBM employees such as salesmen, field-support personnel and administrators.

A TR-600 recorder and two TK-45 studio cameras are being used to produce video-taped courses which are transmitted directly to 40 classrooms

throughout the building. Dedicated to DP education, they accommodate classes ranging in size from 12 to 114 people. The small rooms contain only TV monitors; others, everything modern-day a/v instruction requires. This includes lectern, blackboard, 16-mm and 35-mm film and slide projectors as well as color monitors.

TV production at IBM France began in 1968 with monochrome facilities. Ever since, videotraining has become a steadily increasing business. As a manufacturer of sophisticated business machines, the company considers customer training an essential part of the sale. However, with the growing technical sophistication of IBM's products came an evolution in teaching methods.

The conversion to quality color was inevitable. Consumer demand for color TV has some impact on what pupils at the Center expect with videotraining. However, the Television Manager for DP Education gives more relevant reasons.

When asked about selecting broadcast-standard equipment for a CCTV operation, he spoke of the need for quality in effective presentations. "The pedagogy," he said, "is changing." Training media are being called upon to interpret more and more intricate information graphically in a relatively short time. An instructional medium must be versatile enough to adapt easily. He explained how lots of detailed drawings and graphs supported customer-training courses. Faithful TV reproduction of both the trainer's and artist's intent is vital. Furthermore, with computer equipment, color and color coding are key factors.

Mobility of the deluxe-quality studio cameras is another helpful feature when a production job requires "location" shooting—showing the operation or circuitry of the data-processing computers. The cameras, mounted on steerable pedestals, are simply wheeled to the nearby building where the machine rooms are.

But most of the time, the cameras are part of the studio facilities which turn out 120 courses a year with an average length of 30 minutes each. "With 210 working days a year in France," the TV manager added, "this is a good average. But we hope to do better."

"Our current internal production capability," he remarked, "developed and grew over the years. Since elaborate, artistic productions are unnecessary, the video service we provide is well within our capability."

As a TV producer, IBM is working with a relatively small in-house staff.

Production and technical crews have four technicians each. In addition, there are three video producers specializing in DP education. They advise TV lecturers on script writing, and help them prepare their courses. On-camera talent is also sourced in-house. Outside talent and production assistance are hired on an as-needed basis.

The two TK-45 cameras presently make up the video sources. They sit in a 100 square meter studio with acoustically treated walls and ceiling, and a complete 50 kW lighting system, 23 ft from the floor. The studio is also equipped with microphone channels, talkback facilities and provisions for moveable sets. Current expansion plans for the studio include new curtains for the backdrop and the installation of a prop shop.

The floor above is the location of the control room where video from the studio, or the previously mentioned DP machine rooms, are fed through a vision mixing desk. Camera output is then routed for recording on the TR-600 in an adjoining room.

The control room also has a vertical black-and-white camera for titles, which are colored with the help of the video mixer.

The 2-in. quad tape is edited outside, and then used as the master from which 1 in. and $\frac{3}{4}$ in. cassette tapes are dubbed for distribution. This is done in the distribution room where courses can be transmitted over four different closed-circuit systems for 200 monitors throughout the building.

The number of dubbed cassettes varies from one or relatively few for use at the Education Center in Boulogne, to as many as 50 to fill cassette requirements at other IBM facilities.

The company has a complete video distribution network with more than 150 cassette playback units. The system is fed by the Education Center in Boulogne; branch locations in Europe; and IBM's Film and Television Unit at headquarters in White Plains, just outside New York City.

French-language dialogue and/or commentary is added to cassettes sourced elsewhere. They are then re-cycled through IBM's network in France, plus other French-speaking areas such as Switzerland, Belgium, certain African countries and the province of Quebec in Canada.

Although internal and external video distribution is in the $\frac{3}{4}$ in. and 1-in. cassette format, the occurrence of program origination on 2-in. tape is purposeful.

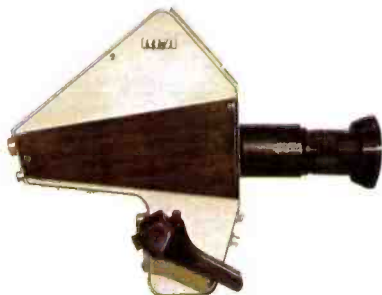
The TV manager has a high opinion of this broadcast standard: "The quad format has international acceptance, allowing duplication and editing almost anywhere. Furthermore, it gives us the technical security necessary for maintaining quality for multiple copies. Transfer with the 1-in. system doesn't give us the same level of assurance."

With the high technical standards broadcast-quality equipment provides, the future and success of IBM's new video system seem assured. □



Camera studio includes two TK-45's allowing production values of broadcast television.

TKP-45



TK-76



USERS ROUNDUP



SMILING IN THE RAIN

The TK-76 demonstrated at NAB its rain-or-shine, indoors-or-outdoors performance capability. This was an easy test, since hundreds of users have put this camera through its paces in a myriad of hostile and friendly environments around the world. Nearly 500 TK-76's are now in use world-wide.

This picture report on the RCA Portables—TK-76 and TKP-45—covers but a handful of camera installations.



ON THE WATERFRONT

At the Unlimited Hydroplane race in Seattle, KING-TV assigned two TK-76's to provide coverage in the pit area of close-ups of cockpits, boat damage and interviews. With the help of an extra sync generator, processor, and 500 feet of 13 conductor cable, the station's technical staff added genlock, intercom and AC power supply to the camera.

RED SQUARE IN MOSCOW

provides an impressive backdrop for a friendly TK-76 camera. This TK-76 is not on tour—it is a part of the equipment complement of Moscow Television.

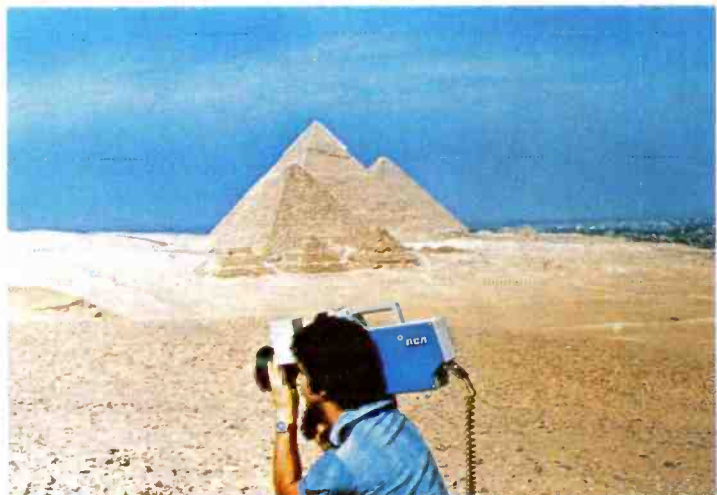


GROUND LEVEL APPROACH

gets the TKP-45 up close during an on-location shoot of a program on aircraft pre-flight operations, a production of Maryland Center for Public Broadcasting. According to David Graham, Director of Engineering, the material recorded using the the TKP-45 would not have been possible with other studio cameras.

FAMILIAR PROFILES OF PYRAMIDS

set the scene for this TK-76 camera on a production assignment. The TK-76 itself is becoming a familiar profile—with about 500 now in use around the world.





**KTLA USES TKP-45
FOR STUDIO AND FIELD CAMERA**

KTLA-TV (Golden West Broadcasting) Los Angeles, is making full use of the versatility designed into the TKP-45 Portable Camera. The camera is used for outdoor field productions such as the Rose Parade and sports events, and for a range of indoor studio productions. KTLA designed a special "gyro" mounting for the TKP-45 (photo) which permits the camera to be swung about to achieve unusual video effects. The camera is used as a shoulder-mount portable; or a tripod mount—and with the Minimax adapter—as a studio camera, with 7-inch viewfinder and zoom lens.



TWO FOR THE NEWS

KUTV, Newswatch 2, Salt Lake City, operates two TK-76 cameras and use them exclusively for news coverage. Reid Carpenter, Director of Engineering reports, "We are well pleased with the operation of the TK-76. It has proved to be very reliable and gives us excellent pictures under a wide variety of operating conditions and light levels."

COLOR IT COLD

WSAU-TV got their TK-76 late in November 1976. On its first remote early in December, the temperature was a mild 5° below zero.

On some later shoots the temperature dropped well below zero, and the TK-76 still performed well, although the lens froze.

How has the TK-76 worked out? Just beautifully, according to Chief Engineer Don Cochart. A second TK-76 has been delivered, and a small remote truck for outside production work is in the planning stage.

The camera is used by both the Production and the News Departments. Camera operators are non-technical personnel who have quickly adapted to the TK-76.

One of the cool assignments handled by the TK-76 was at the World Championship Snowmobile Derby at Eagle River, Wisconsin, in mid-January. The temperature was a brisk -20°, but the TK-76 ignored the cold and did its thing, producing excellent quality color pictures.



**"TK-76 PERFORMS
LIKE A REAL CHAMP"**

Those words are from Sanford Terry, Jr., Technical Operations Manager of WWBT-TV, Richmond, Va. He adds "Our news and technical people are delighted with this very professional piece of television equipment."

One test of the camera's versatility came when an oil tanker rammed a major bridge on the James River near Richmond.

The TK-76 was dispatched to the scene, providing live coverage from the collapsed bridge itself, then transferring to helicopter for live aerial pictures. From the copter, the

TK-76 went aboard a launch to transmit closeup views of rescue and search operations.



When WLUK-TV, Green Bay, took delivery of two TKP-45 portable cameras in 1976, their mobile unit was rolling toward a hectic season of football telecasts, including Green Bay Packer pre-season road games and a series of local high school contests. The cameras "came to play", and were able to handle the rigorous schedule.

In between the football games were a variety of other TV jobs, from producing award-winning on-location TV commercials to televising a weekly syndicated "Bart Starr Show" featuring the popular Packer general manager and head coach.

On Election Day, the cameras were used for 15 remotes from 15 different locations, from 8 A.M. Tuesday to 3 A.M. Wednesday. In addition to election coverage, the TKP-45's were also used to video tape a Bart Starr show from 6:30 to 7 P.M., and were then driven to Appleton, 31 miles south to be on-air live at 8:30 P.M.

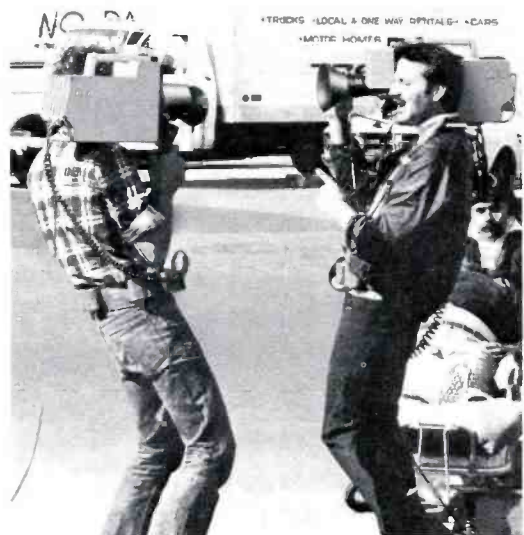
Dale Quick, engineer in charge of the mobile television operation, said the TKP-45's are extremely reliable and very good. Despite the rough roads, tight time schedules and numerous set-ups and pack-ups, the equipment held up extremely well, he notes.

For ENG operations, WLUK has joined the swing to TK-76 portables.



DUELING CAMERAS

Two TK-76 cameras are drawn up for a lens-to-lens duel during shooting of a scene from "The TVTV Show". The pilot program was produced entirely on location using the TK-76. In the show, Billy Murray (right), plays a camera operator for a news crew of WTKO, a fictional TV station.



DIAMOND HEAD AND KING KAMEHAMEHA

are tourist attractions and natural settings for this TK-76 which KITV, Honolulu uses for production. The camera is measuring up to expectations. Jim Mac Dainels, TV-4 Creative Services Director, comments: "We've found the TK-76 to be what it was advertised to be—versatile, durable, with high picture quality and with a minimal amount of maintenance required."



TWO- WAY RADIO VERSATILITY for the Broadcaster



After completing on-location taping assignment, TK-76 cameraman radios home base via TACTEC portable radio. Unit can be belt-mounted and comes equipped with headset/microphone for easy ENG operation.

RUSH A CAMERA crew to the warehouse fire on 32nd Street . . . Zoom in for a close-up of the mayor when he leaves that budget meeting . . . Get an instant news reporter over to the strike scene.”

It's a tough job keeping pace with fast breaking news stories that are occurring in all corners of a coverage area, but it's an essential one. In order to assist in the vital job of remote coverage control and coordination, broadcasters are turning to mobile communications equipment.

RCA provides a complete line of mobile and portable two-way radio equipment, plus a number of system plans designed to achieve wide-area coverage. This combination of versatile equipment and flexible system planning provides the broadcaster with an effective, reliable means to professionally handle remotes.

TACTEC for ENG Coordination and Instant News Reporting

The microelectronic belt-mounted TACTEC portable radio, an advanced design unit that utilizes space age beam-lead integrated circuits, provides the ENG cameraman with a reliable communications link between the van and the station. The unit is battery operated and is available in 1.2 and 4 watt versions in the UHF band, and in 2 and 5 watt models in the VHF band. A complete system has been designed for use with ENG applications and includes a lightweight headset with microphone.

TACTEC can be effectively used by radio newsmen, as well, for on-the-spot reports. Extended coverage over a wide



For greater coverage and communications versatility, TACTEC portable can also be used as a mobile radio with the addition of a vehicular charger and power booster.

area is possible via RCA's VOTEC receiver voting system or the Series 500 repeater system, both of which are described in this article and in the accompanying chart.

"Pocket Mobile" Radio System

The TACTEC portable becomes even more versatile with the addition of a vehicular battery charger and RF power booster. With these system additions, power is increased to 35 watts in UHF and 55 watts VHF for greater communications range and system capability. The system can be operated as a mobile radio with the TACTEC portable inserted in the charger. The radio can be easily removed for portable use, as well.

Portable Dispatching Station

The TACTEC pocket mobile radio system has been packaged in a briefcase to provide broadcasters with a "carry anywhere" satellite base station. It comes complete with a TACTEC portable, charger, RF power booster, speaker, microphone and antenna with ground plane and magnetic mount. It can be assembled for action in seconds for operation from a vehicle battery. With an optional power pack, the briefcase station can be operated from an AC power source. It's an ideal unit for special events since it can be quickly set-up as a temporary command center in a vehicle or in a hotel room.

VEETAC Mobile Radio for Crew Dispatching; On-Air Reports

Recently introduced, the VEETAC mobile two-way radio incorporates much of the same design philosophy that went into TACTEC. It's a radio that

uses advanced state of the art design to achieve the highly effective communications at a realistic price.

Available in both VHF and UHF bands, VEETAC can be used in mobile ENG vans for instant, continuous communications with the station. It can be furnished with up to twelve frequencies so it can be easily integrated with a TACTEC system for contact from the van to an ENG cameraman, from van to van, or from van to station.

Area-Wide Two-Way Radio Coverage

The RCA VOTEC receiver voting system enables broadcasters to have communications with reporters and field crews over a broad area. It's a system that utilizes strategically placed receivers throughout a city or extended metropolitan area. The receivers are connected via wireline or microwave to a central control point at the broadcast station. Transmissions from field personnel are picked up by the nearest receivers and relayed to the station. If two receivers pick up the message, the signals are continually evaluated and the best one is provided the station. VOTEC is equally at home with both TACTEC portables and VEETAC mobiles to provide broadcasters with an effective means of extending communications coverage over a wide area.

Instant News Re-broadcasting with Remote Pick-up Repeater

The Series 500 repeater has been designed for use in the broadcast service to meet FCC Rules and Regulations, Part 74, covering on-air transmissions from base, mobile and portable radios. The system permits broadcasters to

receive "instant news" reports from field personnel for on-air use. It extends communications coverage and, additionally, it automatically monitors the transmit frequency to provide the "lock-out" required to comply with the FCC regulations.

RCA Two-Way Radios Extensively Used by Broadcasters

Over the past few years RCA Mobile Communications Systems has been increasing its activity in the broadcast industry and today over fifty radio and TV stations are using one or more of the systems described. With the current accent on ENG coverage and instant news reporting, more and more stations are turning to two-way radio communications for vital coordination and control links. The equipment and systems discussed in this article can be adapted to meet all requirements of broadcast communications. Regardless of whether you're interested in communications gear for on-air use, mobile dispatching, control or coordination, RCA has the equipment and the planning expertise to meet your needs.

RCA Mobile Communications for Broadcasters

Equipment

Description

Application

TACTEC Portable Radio



Hand-held or belt-worn microelectric portable. Lightweight; VHF or UHF bands; all weather design; nickel-cadmium rechargeable battery operation. Available with up to six frequencies and Quiet Channel to screen out co-channel communications.

For sports, news, specials. Coordination, engineering operations and live remote transmissions.

Pocket Mobile Radio System



TACTEC portable with vehicular battery charger and power booster to provide both mobile and portable communications capability. System increases power to 55 watts at VHF; 35 watts UHF.

For use in van or car for coordination, operations, and live news remotes. Can be used as either mobile or portable

Portable Briefcase Dispatching Station



TACTEC portable radio system in a briefcase. Assembles in seconds; operates from vehicle battery or optional AC power pack. Complete with battery charger, power booster, speaker, microphone, antenna.

For sports, news, specials. Coordination, engineering operations, live remote transmissions. Camera crews for cueing and directing. Quick set-up in vehicle or fixed location for instant transmissions.

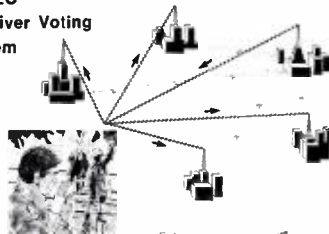
VEETAC Mobile Radio



Advanced design mobile with capability of 1, 2, 4, 8 or 12 channel operation. 35, 110 watts in VHF (132-174 MHz); 25, 65 watts in UHF (450-512 MHz). Positive/negative ground; single conversion receiver with high selectivity, sensitivity, fast squelch. Dust, dirt and moisture resistant.

For use in van or car for coordination, engineering operations and live news remotes.

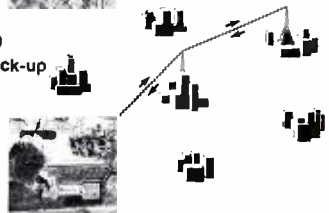
VOTEC Receiver Voting System



Provides extended communications for field personnel. Repeating receivers are strategically placed throughout area. Portable and mobile incoming signals are relayed to station and best signal is provided to studio console.

For live on-scene transmission of news, sports, specials. Also for engineering, coordination and direction.

Series 500 Remote Pick-up Repeater



Specially designed repeater for broadcast service to meet FCC Rules & Regulations, Part 74, covering broadcast transmissions from base, mobile and portable radios. Series 500 is 90 watt local control repeater housed in 67" cabinet. Includes Quiet Channel, safety interlock, duplexer and monitor receiver.

Permits broadcaster to receive reports from field personnel over extended ranges for on-air use. Repeater automatically monitors all transmissions and "locks out" all co-channel communications.

TECHNICAL REVIEW OF AUTOMATIC RELAY OPERATIONS

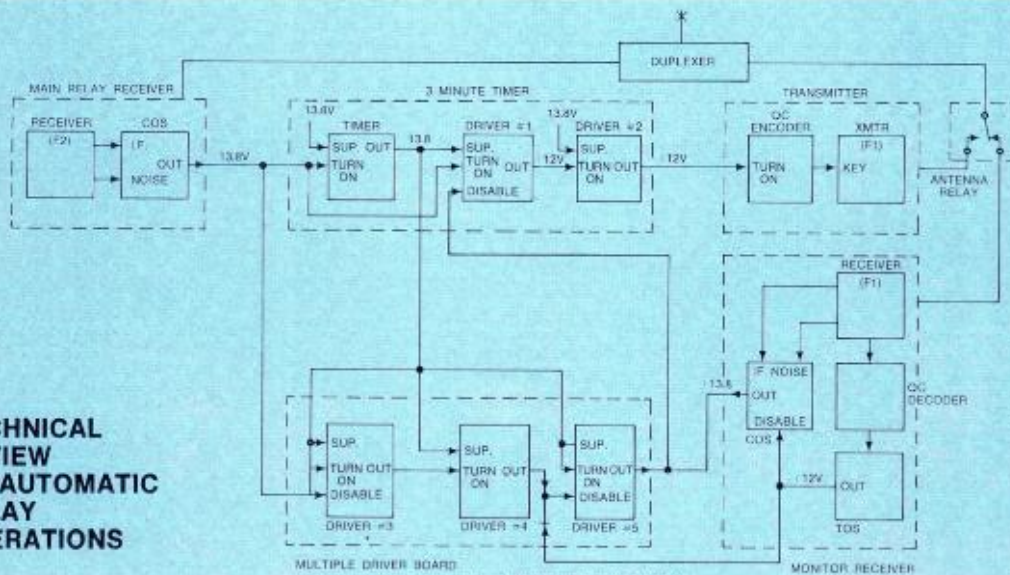


Fig. 1—CONTROL BLOCK DIAGRAM AUTOMATIC RELAY W MONITOR

In order to assist broadcasters in digesting the impact of the FCC rules on automatic relays, here's a brief review of the technical considerations:

The RCA equipment which is provided to meet the requirements for broadcast automatic relay operation includes— (1) a single frequency UHF transmitter with Quiet Channel; (2) a UHF receiver, 5 MHz higher in frequency than the transmitter, used as the relay receiver, and equipped with Quiet Channel; (3) a second UHF receiver on the same frequency as the transmitter, used as a monitor on that frequency, and equipped with Quiet Channel and a tone operated switch; (4) a transmitter control circuit.

The FCC Rules and Regulations on broadcast service automatic mobile relay stations require that the station include a monitor receiver, tuned to the station transmit frequency, and a control circuit which will prevent the relay transmitter from being keyed automatically whenever the monitor receiver receives a signal other than the relay transmitter signal. In addition, the control circuit must also prevent the relay transmitter from being keyed automatically if the monitor receiver has become inoperative. To determine whether or not the monitor has become inoperative, the station includes provisions for automatically testing it each time the transmitter is keyed. If the monitor is operating, the control circuit will allow continuation of the transmitter keying. If the monitor is inoperative, the control circuit will disable the trans-

mitter keying circuit, causing it to shut down.

A block diagram of the automatic relay with monitor and control circuits is shown in Figure 1.

Signals received by the relay receiver will:

- (1) turn on the 3 minute timer
- (2) turn on the transmitter via driver boards 1 & 2
- (3) initiate a transmitter turn-off signal via driver boards 3, 4 & 5. Because of a time delay built into driver board 4, this turn-off signal will disable driver board 1 after approximately 140 milli-seconds.

The monitor receiver will detect, via RF leakage within the cabinet, the presence of the transmitter signal and will:

- (1) Operate the carrier-operated switch (COS) applying a disabling signal to the driver board 1. This will occur approximately 50 milli-seconds after receipt of the signal by the relay receiver, and 100 milli-seconds prior to the disabling signal from driver board 5.
- (2) Operate the Quiet Channel (QC) decoder, and in turn, the tone-operated switch (TOS). The response time of the QC decoder, being inherently slow will delay the TOS output approximately 200 milli-seconds. This output performs two functions:
 - (A) Disables the monitor receiver COS, thereby removing

one disable input to driver board 1.

- (B) Disables driver board 5, thereby removing the second disable input to driver board 1.

A drop-out time delay of approximately 260 milli-seconds built into the driver board 2, enables the transmitter to remain keyed until after the monitor receiver TOS has operated, thereby assuring the uninterrupted keying of the transmitter.

If the monitor receiver is inoperative, no output will be obtained from the TOS and driver board 5 will not be disabled thereby allowing the disabling input to driver board 1 to remain. Driver board 2 will drop out after approximately 400 milli-seconds, shutting down the transmitter.

If a signal of $2\mu\text{v}$ or greater from a source other than the relay transmitter is received by the monitor receiver while the relay transmitter is being keyed, the transmitter will remain keyed on, because of the TOS action, until shut down by the 3 minute timer or removal of received signal in the relay receiver.

However, if the monitor receiver receives a signal $2\mu\text{v}$ or greater from a source other than the relay transmitter when the relay transmitter is not keyed, its COS will operate to disable driver board 1, preventing keying of the transmitter. The TOS and QC decoder will not operate since receipt of the proper QC tone is required. □

DIGITAL FUNDAMENTALS FOR THE BROADCASTER

Part II A Comparison of Logic Families

John W. Wentworth, Manager, RCA Broadcast Technical Training

A. Introduction

In Part I of this series, Broadcast News Vol. 160, we discussed basic logic gates and some of their broadcast applications. Before proceeding to more complex digital circuits, such as flip-flops, registers and counters, we should explore at least briefly some of the electronic circuit concepts embodied in practical versions of the basic gates. Knowing that integrated-circuit logic elements are normally purchased or replaced as complete functional "blocks", some readers may feel that the typical *user* of digital equipment does not really need to know the internal details of a logic circuit, as long as he understands the overall functional behavior. It is this writer's belief, however, that basic understanding of circuit operation can help the user of integrated-circuit devices to approach them with greater intelligence and confidence. It should be emphasized that our objective throughout this series of articles is to provide information that will be helpful to people concerned primarily with the *operation and maintenance* of broadcast equipment; much more technical detail than we plan to present here is needed by engineers concerned with the development and design of new equipment.

Practical logic elements can be constructed with several different types of electronic circuits, giving rise to distinctive "families" of logic elements, commonly identified by initial letters or acronyms, as shown in the following partial list.

DCTL—Direct-Coupled Transistor Logic

RTL—Resistor-Transistor Logic

DTL—Diode-Transistor Logic

TTL or T²L—Transistor-Transistor Logic

CMOS or COS/MOS—Logic elements based on Complementary Symmetry Metal-Oxide-Semiconductor Field-Effect Transistors

ECL or CML—Emitter-Coupled Logic (sometimes called Current Mode Logic)

I²L—Integrated Injection Logic

We shall offer in this paper at least brief explanations of each of the logic families cited in the above list, but we shall concentrate primarily on the three families of greatest interest to the users of current RCA broadcast equipment—DTL, TTL and COS/MOS. DTL devices are used extensively in the TCR-100 Cartridge Video Recorder and in the servo systems of TR-61 and TR-70C Television Tape Recorders. TTL devices are used extensively in the TR-600 Television Tape Recorder, the SP-100A Signal Processing Unit for the TCR-100A, and the TFS-121 Television Frame Synchronizer. COS/MOS devices are used extensively in current camera products, especially the TK-45A, TK-46 and TK-76.

B. Direct-Coupled Transistor Logic (DCTL)

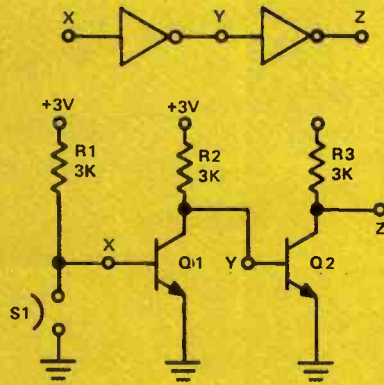
Some of the earliest attempts to produce digital integrated circuits were based on the very simple direct-coupled transistor circuits shown in Fig. 1. The operating principle of DCTL is illustrated by the pair of inverters shown in Fig. 1 (a). If S1 is assumed to be open, the input will be in the HIGH logic state and transistor Q1 will be driven to saturation by bias current supplied through R1. The potential at point X will be nominally 0.7 volts (the drop across the forward-biased emitter junction), and the voltage at point Y will be approximately 0.2 volts (the product of Q1's collector current and saturation resistance). The 0.7-volt voltage drop between base and emitter is effectively offset by an equivalent voltage *rise* between the collector and base, since the collector junction becomes forward-biased when the device is driven into saturation. The 0.2-volt potential at point Y is not enough to turn on transistor Q2, so Q2 remains cut off. The potential at point Z could be as high as +3 volts if the terminal is open-circuited, but would more typically be at 0.7 volts if terminal Z is connected to the input of still another gate in the same logic family.

If switch S1 is closed (taking the input to the logic LOW condition), the ground potential at point X would cut off transistor Q1, leaving point Y at a logic HIGH potential of 0.7 volts and

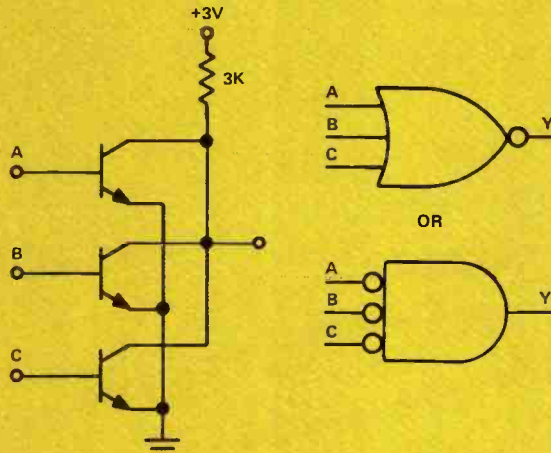
driving Q2 to saturation. The potential at point Z would be approximately 0.2 volts, which would be interpreted as a logic LOW by any following logic element in the same family.

A typical 3-input DCTL NOR gate is shown in Fig. 1 (b). If bias current from a previous stage is supplied through any or all of the input terminals (A, B or C), one or more of the transistors will be saturated and the common output point (Y) will be pulled down to the logic LOW level of +0.2 volts. The only way the potential at point Y can remain HIGH is by holding all three inputs in the LOW state.

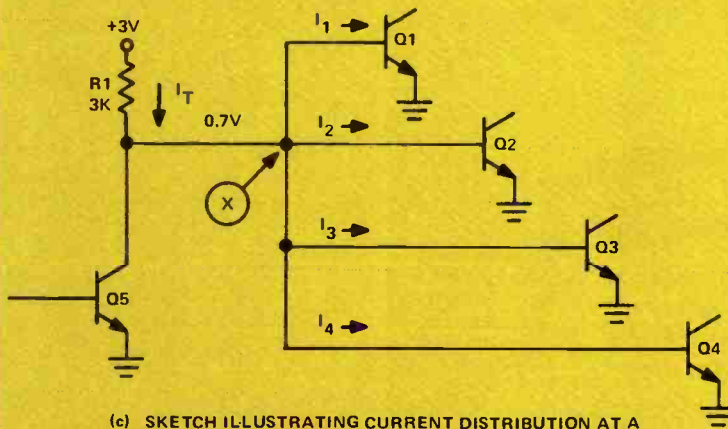
From this brief analysis, it may be seen that the logic LOW and HIGH levels in DCTL are approximately 0.2 volts and 0.7 volts. Because these levels are only about 0.5 volts apart, the *noise immunity* of this logic family is rather poor—small extraneous signals coupled into logic lines could cause faulty operation of the logic elements. A still more serious problem with DCTL results from a phenomenon known as *current hogging*. In practical equipment, it is frequently necessary for the output of a particular gate to be used as the input for many other gates. (The number of gate inputs that may be tied to an output is called the "fan out".) A partial schematic showing a fan out of 4 for a typical DCTL gate is shown in Fig. 1 (c). If transistor Q5 is assumed to be cut off, the potential at point X is held at about 0.7 volts by the base-to-emitter voltages of Q1, Q2, Q3 and Q4 (all in parallel), and the total current drawn through R1 will be $(3 \cdot 0.7)/3K = 0.77$ milliamperes. If transistors Q1 through Q4 are all closely matched and all at the same temperature, the available current will be divided into four equal parts (I_1, I_2, I_3 and I_4), each of which will be more than ample to drive the corresponding transistor into saturation. If any one of the transistors happens to have a slightly lower base-to-emitter offset voltage than the others, however, this transistor will "hog" more than its share of the current. If the mismatch is sufficiently great, there may be insufficient bias current to drive



(a) PAIR OF INVERTERS



(b) 3-INPUT NOR GATE



(c) SKETCH ILLUSTRATING CURRENT DISTRIBUTION AT A FAN-OUT POINT (Q5 ASSUMED TO BE CUT OFF)

Fig. 1. Basic Direct-Coupled Transistor Logic (DCTL) Circuit

some of the transistors at the fan-out point to saturation, and false logic levels will result.

Primarily because of the twin problems of poor noise immunity and current

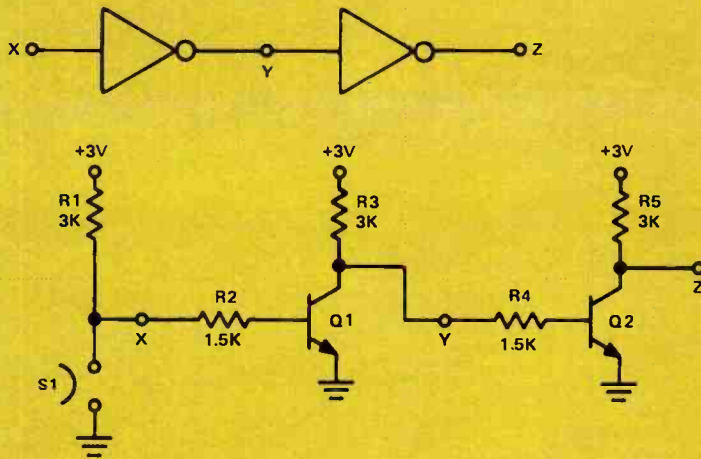
hogging, the DCTL family is now considered obsolete and is not actually available on the commercial market. The chief value in DCTL is as a tutorial point of reference for both the RTL and I^2L logic families.

C. Resistor-Transistor Logic (RTL)

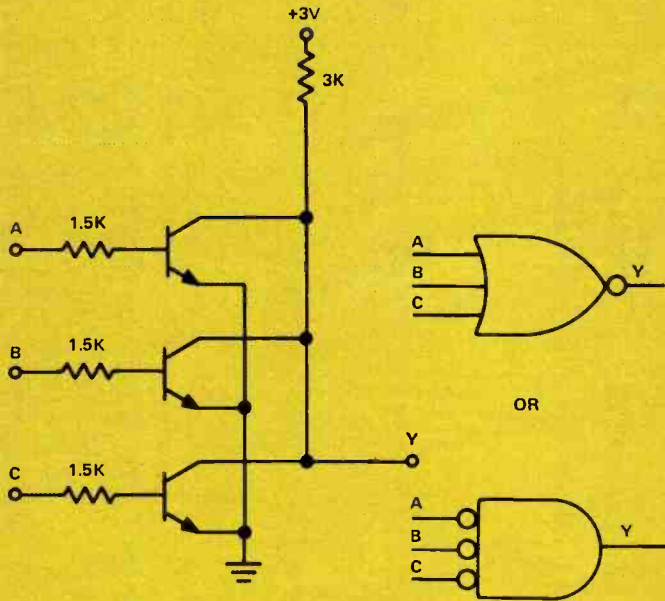
The first logic family to experience widespread commercial exploitation in integrated-circuit form was Resistor-Transistor Logic. As shown in Fig. 2, RTL circuits are very similar to DCTL circuits except that they include resistors in series with base leads to minimize the "current hogging" problem.

The operating principle of RTL circuits may be explored with the simple circuit shown at (a) in Fig. 2. If S1 is assumed to be open (corresponding to a HIGH input), transistor Q1 is biased at saturation by current flowing through R1 and R2. The voltage at the base of Q1 under these conditions would be +0.7 volts, but the voltage at point X would be approximately +1.5 volts. The potential at point Y would be about +0.2 volts, which is too low to provide a turn-on bias for Q2. The potential at Z would therefore be at a logic HIGH with an actual voltage somewhere between +3 volts (if no load is attached) and about +1 volt (if a number of RTL gate inputs are connected to the output point). If switch S1 were closed, the potential at X would be pulled down to zero, Q1 would be cut off, and the potential at point Y would go to the logic HIGH value of about 1.5 volts as bias current for Q2 is drawn through R3 and R4. Under these conditions, Q2 would be saturated and the output voltage at Z would be at the logic LOW value of about 0.2 volts.

The 3-input NOR gate of Fig. 2 (b) is similar to the previously-discussed DCTL gate except for the inclusion of 1.5K resistors in series with each base lead. These resistors help to equalize the distribution of current to several gate inputs that may be connected to a particular output, even when the base-to-emitter offset voltages for the transistors are not perfectly matched. Unfortunately, these series resistors also form small integrators in association with the input capacitances of the transistors, and the low-pass filtering effect of these integrators increases the time required for an RTL gate to respond to a change in logic level. Noise immunity is not much better than for DCTL, although the series resistors help to minimize sensitivity to very narrow noise "spikes". Although RTL devices are still available from several suppliers, they are seldom used in new equipment designs because their performance characteristics are not really competitive with the newer logic families.



(a) PAIR OF INVERTERS



(b) TYPICAL 3-INPUT NOR GATE

Fig. 2. Basic Resistor-Transistor Logic (RTL) Circuits

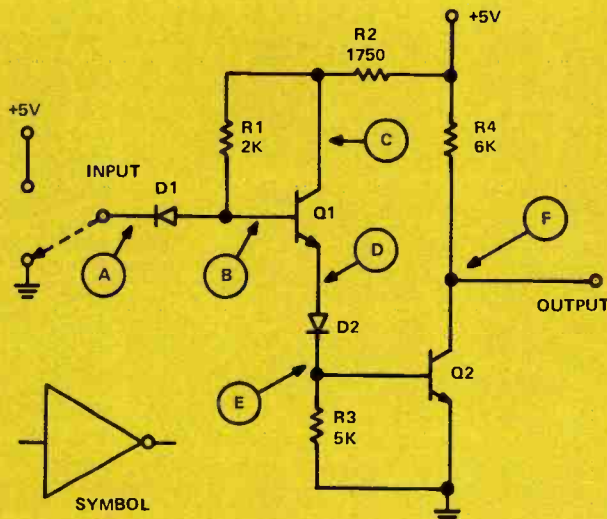


Fig. 3. Basic DTL Inverter

D. Diode-Transistor Logic (DTL)

Prototype versions of DTL gates were presented for tutorial purposes in the first article of this series. An actual circuit for a typical DTL inverter is shown in Fig. 3. (A Type 936 integrated circuit consists of six inverters based on this schematic diagram.)

Since this circuit is intended for use in a zero-to-plus-five voltage domain, the circuit performance may be evaluated by assuming that the input is switched to either ground or to +5 volts. If we assume that the input (point A) is grounded, the input diode is forward biased by current flowing through R1 and R2, and the voltage at point (B) is at approximately +0.7 volts. This is too low a voltage to turn on the string of three semiconductor junctions consisting of the emitter junction of Q1, diode D2 and the emitter junction of Q2; therefore Q2 is cut off, and the voltage at point (F) is very close to +5 volts, since no significant current flows through R4. (Even if one or more DTL gate inputs are connected to the output, they will not draw significant current when in the HIGH logic state.) The intermediate voltages at points (D) and (E) would be at approximately 0.47 and 0.23 volts, respectively.

If the input for the circuit in Fig. 3 is switched to +5 volts (or a logic HIGH condition), diode D1 is effectively switched off since there can be no forward bias for it. Forward bias current will now flow, however, through R2, R1, the emitter of Q1, diode D2 and the emitter of Q2, driving Q2 to saturation and taking the voltage at (F) to about 0.2 volts (or the logic LOW state). The voltages at (E), (D) and (B) will be about +0.7, 1.4 and 2.1 volts, respectively. Note that diode D1 is held cut off by a reverse bias of almost 3 volts. Q1 functions as an emitter follower, providing a low-impedance source of bias current for the output transistor, Q2. Some of the output current from Q1 is lost, of course, through resistor R3, but this resistor provides thermal stability for Q2 by maintaining a moderately low base impedance even when diode D2 is cut off. Thermal stability for Q1 is provided by returning its base bias resistor (R1) to its own collector; the voltage drop across R2 generates negative feedback to stabilize the operating point for Q1. Some DTL devices use a 2K pull-up resistor at R4 instead of the 6K value shown in Fig. 3; such devices can handle greater currents at the output terminal, thus permitting greater "fan out".

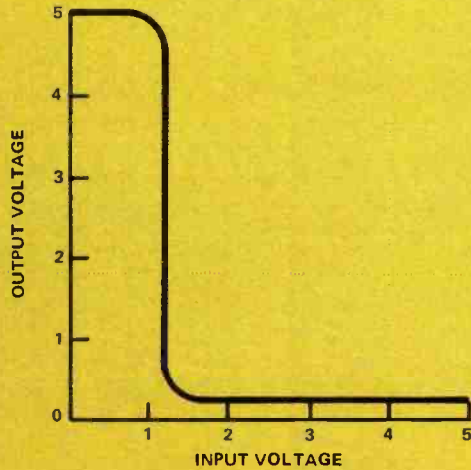


Fig. 4. Typical Transfer Characteristic for a DTL Inverter

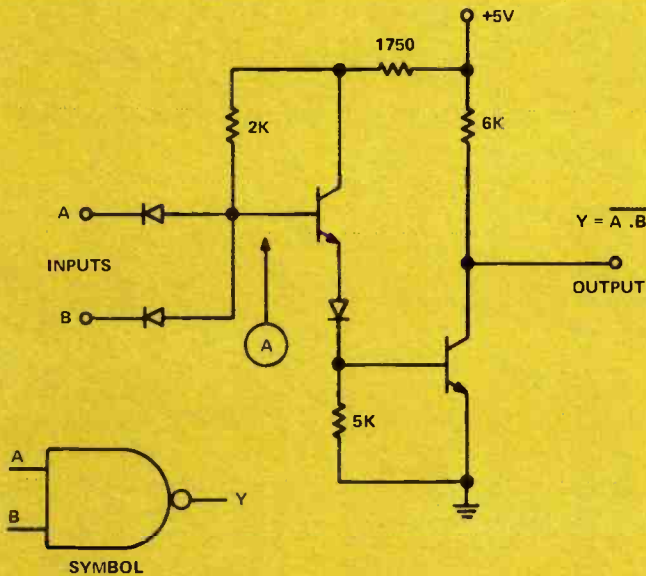


Fig. 5. DTL 2-Input NAND Gate (1/4 of Type 946)

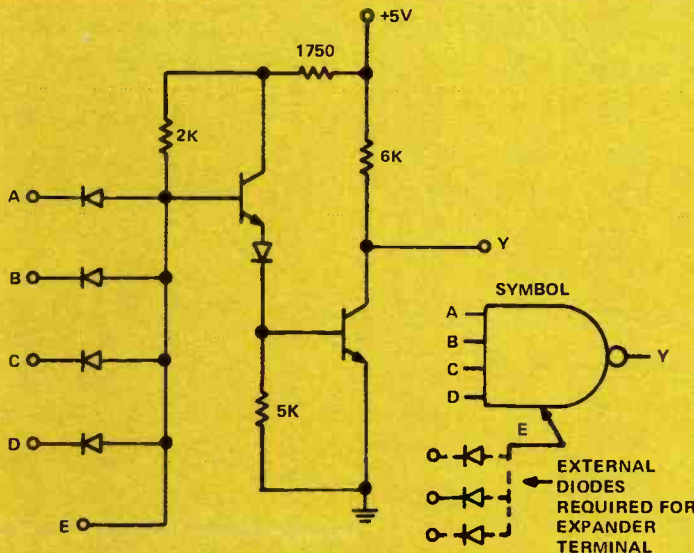


Fig. 6. 4-Input DTL NAND Gate with Expander Terminal

A typical transfer characteristic for a DTL inverter is shown in Fig. 4. If the input terminal is held at or near ground potential, the output voltage will be at the HIGH level of nominally 5 volts. When the input voltage rises to about 1.2 volts, however, the voltage at internal point (B) in Fig. 3 rises to about 1.8 volts, and this is high enough to turn on the combination of Q1, D2 and Q2, causing the output voltage to fall to about 0.2 volts. (The output voltage remains slightly above ground potential because of the saturation resistance of Q2.) The voltage swing at the output terminal between the HIGH and LOW logic states will decrease as a function of the current drawn from the terminal in the HIGH state and the current passing into the terminal in the LOW state. The precise location of the switching threshold along the input voltage axis varies slightly between different units and is somewhat temperature sensitive.

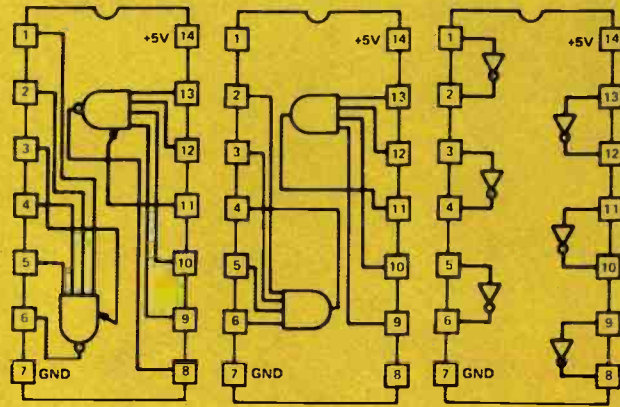
The DTL inverter of Fig. 3 may be converted to a 2-input NAND gate by the simple addition of another input diode, as shown in Fig. 5. The voltage at point (A) in this circuit can be pulled down to about 0.7 volts if either A or B goes to the LOW state. In effect, the two input diodes in association with their bias resistors form an AND gate, and the two transistors form an inverter. Two more inputs are provided by the DTL circuit shown in Fig. 6, which also shows an *expander* terminal. This expander terminal provides access to the appropriate circuit point for the attachment of external diodes for still more inputs.

Approximately 90% of all the logic sections of the RCA TCR-100 Cartridge Video Recorder consist of the six DTL types identified in Fig. 7. Types 930 and 944 have the same pin-out diagram, but 944 is designated as a pair of "power gates", capable of handling approximately three times as much current at the output terminals as Type 930. The "dual expanders" identified as Type 933 consist only of arrays of diodes, interconnected in a manner suitable for connection to the expander terminals of either Type 930 or Type 944. With the exception of Types 933 and 944, all of the DTL devices shown in Fig. 7 are based on the circuit of Figures 3, 5 and 6. At the time of this writing, interchangeable DTL devices are made by at least six different manufacturers, although the type numbers are not identical in all cases. (Most semiconductor man-

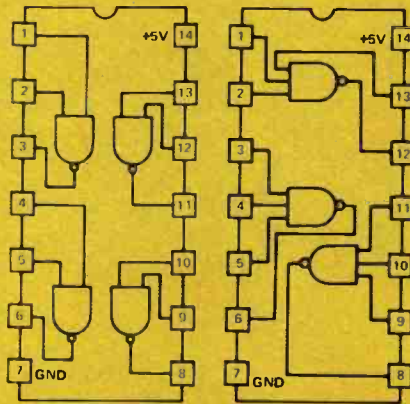
ufacturers provide "interchangeability guides" in their published catalogs to show how their type numbers relate to those of competing companies.)

In brief summary, the "ground rules" for utilizing the DTL devices employed in RCA broadcast equipment are as follows:

1. Noise-free input voltages below 1 volt will be reliably interpreted as logic LOW's.
2. Noise-free input voltages above 2 volts will be reliably interpreted as logic HIGH's.
3. Steady-state voltages in the range of 1 to 2 volts should be avoided, since the actual switching thresholds are in this region.
4. Unused inputs for DTL devices may be permitted to float, in which case they will function as logic HIGH's.
5. The fan-out specification (that is, the number of inputs that may be tied to a given gate output) is inter-related with the noise immunity characteristic, and noise immunity is also a function of temperature. For a fan-out of 4 and a temperature range between 0°C and 60°C, the noise margin may be as great as 1 volt. The noise margin decreases to about 0.6 volts for a fan-out of 12 and a temperature range of -20°C to +100°C.
6. The output of any gate may be shorted to ground without damage to the gate output or to the following gate inputs. (In effect, the external short circuit simply substitutes for the saturated switching transistor—currents drawn from the power supply are essentially the same as those observed when the gate goes LOW in the course of normal operations.) This characteristic of DTL gates makes possible a simple "grounded clip lead" approach to set-up procedures and logic trouble-shooting in equipment like the TCR-100.
7. The propagation delays through DTL gates with 6K pull-up resistors are typically in the range of 20 to 40 nanoseconds when the load capacitance is no greater than 15 picofarads per gate output; the delay goes up to the range of 35 to 55 nanoseconds if the load capacitance is increased by 50 picofarads. The increase in delay with capacitance is less rapid for "power drivers" or for DTL gates using 2K pull-up resistors instead of 6K resistors.



930, 944 DUAL 4-INPUT NAND GATES WITH EXPANDERS
933 DUAL EXPANDERS
936 HEX INVERTERS



946 QUAD 2-INPUT NAND GATES
962 TRIPLE 3-INPUT NAND GATES

Fig. 7. Basic DTL Gates Used Most Extensively in RCA TCR-100's, TR-70's and TR-61's

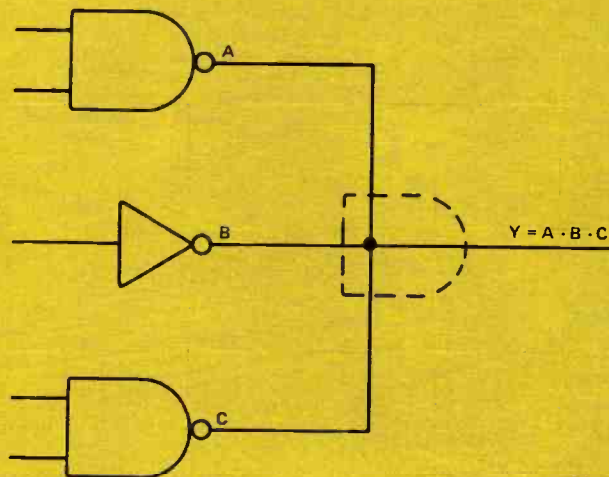


Fig. 8. "Wired AND" Gate Created by Joining the Output Terminals of DTL Gates

8. As shown in Fig. 8, a phantom AND gate (known as a "wired AND") is created at the junction point when the outputs of two or more DTL gates are connected together. The common point can be HIGH only if all gates tied together are HIGH; a LOW level at any of the gate outputs will pull the common point LOW. (In negative logic, the same connection point would function as an OR gate, and some instruction books follow an unfortunate custom in referring to DTL phantom gates as "wired OR's", even though the rest of the equipment is presented as positive logic.) Such "wired AND" gates can be advantageous in two ways—they are very inexpensive, and they introduce no significant propagation delay.

One noteworthy characteristic of DTL gates is that they have very different output impedance values for the LOW and HIGH logic states. When a gate output is LOW, its output impedance is essentially the saturation resistance of a transistor (typically less than 100 ohms), but when the gate output is HIGH the impedance is either 6K or 2K (depending upon the gate type). This dual impedance can be both a problem and an opportunity. If there is significant capacitance loading on an output line, the propagation delay associated with *rising* edges can be significantly greater than for *falling* edges because of the very different time constants involved. In some applications, this characteristic may be troublesome, but in other applications (including the TCR-100), the deliberate use of capacitors on the lines between DTL gates can provide useful delays in the passage of logic signals. The principle involved is illustrated by Fig. 9; inverters are shown in the figure, but any type of DTL gate could be used. The delay capacitor has very little effect on falling edges at the point where it is inserted, but *rising* edges take on the characteristic shape of RC exponential curves. Because it takes time for such a slowly-rising edge to reach the switching threshold of the following stage, the "squared-off" pulse at the output of the next stage will have a delay in the edge corresponding to the rising edge at the capacitor. As a "rule of thumb", the delay amounts to approximately 0.8 milliseconds per microfarad, assuming the use of DTL gates with 6K pull-up resistors.

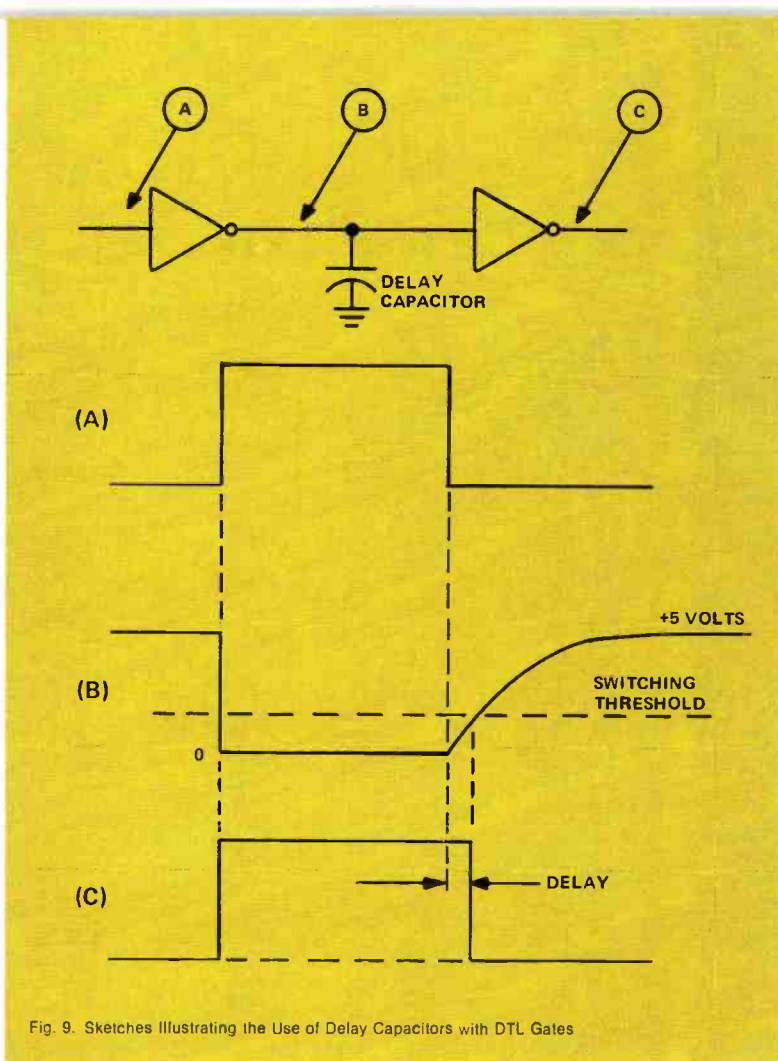


Fig. 9. Sketches Illustrating the Use of Delay Capacitors with DTL Gates

From a commercial point of view, DTL appears to have reached its full maturity. A reasonable array of well-standardized gates and flip-flops are available from several sources, but very little advanced development of new devices and larger scales of integration is being based on DTL technology. It is unlikely, therefore, that any major new items of broadcast equipment will be based primarily on DTL devices, although individual DTL gates may continue to be used where their special characteristics turn out to be advantageous. Fortunately, DTL devices are basically compatible with most TTL devices.

E. Transistor-Transistor Logic (TTL)

At the time of this writing, the most popular and most highly-developed logic family is clearly Transistor-Transistor Logic or TTL. In addition to basic gates and flip-flops for general-purpose use, TTL packages are now readily available in both medium-scale and large-scale integrated-circuit logic arrays tailored to specific applications. (Most manufacturers define small-scale integration (SSI) as 1 to 12 gates

per package, medium-scale integration (MSI) as 13 to 100 gates, and large-scale (LSI) as arrays of more than 100 gates on a single package.) In spite of excellent success with DTL in TCR-100, TR-70C and TR-61 equipment, RCA design engineers switched to TTL for the TR-600 primarily to take advantage of the wide range of MSI and LSI packages available in TTL technology.

With respect to circuit concepts, TTL inverters and gates are quite similar to DTL devices, except that special transistors are used instead of diode gating elements at the inputs. Many (but not all) TTL devices use so-called "totem pole" output stages instead of the simple saturated transistor switches found in most DTL devices.

A basic TTL inverter circuit, specifically that used in the Type 7404 hex inverter, is shown in Fig. 10. Q1 is the special input transistor which substitutes for a pair of diodes in the corresponding DTL circuit. Q1 is used in an unusual way, in that its collector junction (as well as its emitter junction) may become forward-biased un-

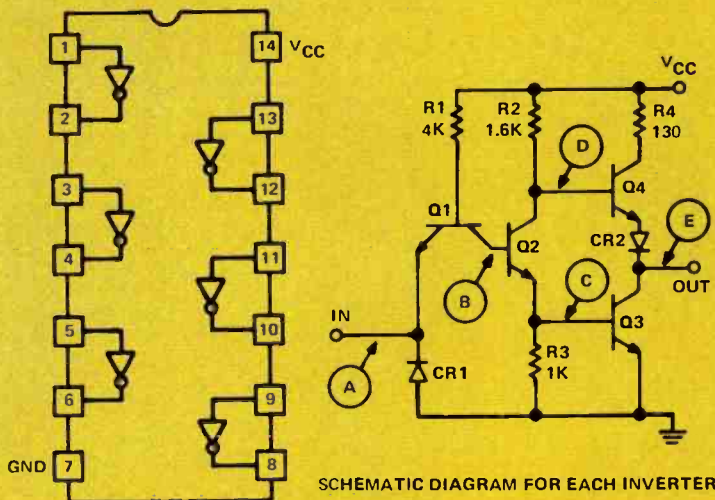


Fig. 10. Type 7404 Hex Inverters (TTL)

der many operating conditions. Diode CR1 serves only as a protection device for the input, limiting negative-going excursions to -0.7 volts.

As an aid in interpreting the circuit of Fig. 10, let us assume that the input terminal is held at ground potential. Under these circumstances, the emitter junction of Q1 is forward-biased through R1, and the base of Q1 is at a potential of about 0.7 volts. This potential is too low to turn on the series combination of the collector junction of Q1, the emitter junction of Q2 and the emitter junction of Q3; the actual voltages at points (B) and (C) will be approximately 0.47 volts and 0.23 volts. It follows, therefore, that tran-

sistor Q3 is cut off and the output voltage at (E) will be at the HIGH logic state. The output stage is of the "totem-pole" type, however, so the output voltage will not be pulled all the way up to +5 volts as it would be in a simple DTL output stage. Instead, the voltage is pulled up to the HIGH state by the flow of emitter current through Q4 and CR2. If the output is connected to the input of one or more similar TTL devices (the usual case), there will be no steady current flow during the logic High state, but current will have to flow momentarily to charge the interstage capacitance to its new value. When the current flow ceases, the voltage at (E) will be approximately 3.8 volts—somewhat lower than V_{CC} (as-

sumed to be +5 volts) because of the diode drops across the emitter junction of Q4 and across CR2. If a resistive load is connected to the output terminal so as to draw a small current even in the logic HIGH state, the output voltage would be a little less than +3.8 volts, since the flow of bias current through R2 would cause the voltage at (D) to drop below +5 volts.

If the input voltage is pulled up far enough to reverse-bias the emitter junction of Q1, the collector junction of Q1 becomes forward-biased by the flow of current through R1, the collector junction of Q1, and the emitter junctions of both Q2 and Q3. Both Q2 and Q3 become saturated, and the output terminal is pulled down to about 0.2 volts. (If the output terminal is connected to the input terminals of one or more other TTL devices, the bias currents required to hold the inputs in the LOW state will be drawn *into* the output terminal and through Q3.) When Q2 is saturated, the voltage difference between (D) and (E) is insufficient to turn on the combination of the emitter junction of Q4 and CR2; hence Q4 and CR2 are cut off.

The transfer characteristic of a typical TTL inverter is shown in Fig. 11. As pointed out in the preceding analysis, the output terminal will be at a logic HIGH value of nominally +3.8 volts when the input is held at or near ground potential. There is no change in the output level until the input rises to about 0.65 volts (point X in Fig. 11), at which time the potential at point (b) in the circuit of Fig. 10 reaches the value which permits Q2 to start conducting. As Q2 starts conducting, it functions as a conventional common-emitter amplifier with a gain of -1.6 , established by the ratio of R2 to R3. The voltage at the output terminal (e) moves downward in response to the downward movement at point (d), following a slope of -1.6 between the points labeled X and Y in Fig. 11. When the input voltage rises to about 1.2 volts, Q3 begins to conduct and its low base-to-emitter resistance shunts R3 and greatly increases the gain of Q2. The output voltage therefore falls rapidly from Y to Z on Fig. 11 as Q4 is cut off and Q3 is driven into saturation. The final value of voltage at Z is a function of how much current is drawn into the output terminal, which is in turn a function of the fan out (or the number of gate inputs connected to the output terminal).

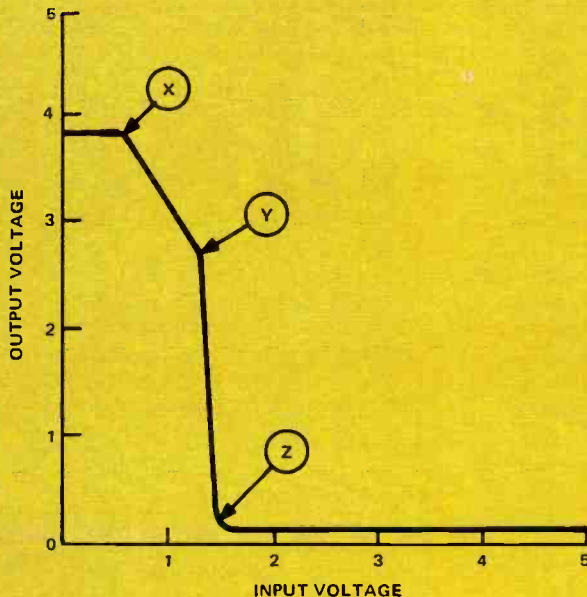


Fig. 11. Typical Transfer Characteristic for a TTL Inverter

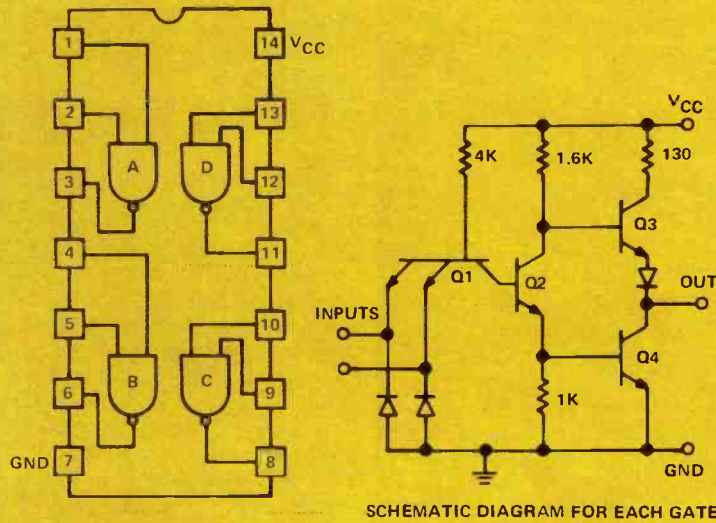


Fig. 12. Type 7400 Quad 2-Input Positive NAND Gate

Conversion of the TTL inverter into a NAND gate is accomplished simply by providing an additional emitter for Q1 (the input transistor) as shown in Fig. 12. Each input is also protected against excessive negative voltages by a separate protection diode. Still more inputs can be provided by the addition of still more emitters to Q1.

Some of the advantages of the TTL configuration are not at all self-evident from the schematic diagram. A multi-emitter transistor can actually be fabricated in appreciably less area on a silicon wafer than a comparable array of conventional diodes, thus increasing the yield from manufacturing processes and also reducing the wiring capacitances (which helps to improve the switching speed). The special input

transistor with its collector operated under forward-bias conditions also serves as a low-impedance driving point for the base of Q2, which speeds up the process of switching Q2 to the "off" state. The "totem pole" output stage provides active pull-up as well as pull-down of the logic levels at the output terminal, so the effective switching speed of the output stage is also improved relative to the usual DTL configuration.

The most popular TTL devices are available from many different manufacturers in two basic series—the 5400 series and the 7400 series. The two series have the same pin-out diagrams and many of the same basic specifications, but performance characteristics are guaranteed over wider environmen-

tal extremes for the military-grade 5400-series devices as compared to the industrial-grade 7400-series devices. In brief summary, 5400-series devices are guaranteed over a temperature range of -55°C to $+125^{\circ}\text{C}$ and over a supply voltage range of 4.5 to 5.5 volts, while the 7400-series devices are guaranteed only over the temperature range of 0°C to $+70^{\circ}\text{C}$ and over a supply voltage range of 4.75 to 5.25 volts. In both cases, performance specifications are guaranteed for a fan-out of 10 within any given branch of the logic family. Many manufacturers of 5400 and 7400-series devices also sell supplementary lines of proprietary TTL devices, some of which may not be interchangeable with the products of any other manufacturer.

Fig. 13 shows a two-input NOR gate implemented with TTL (Type 7402). Note that two transistors in parallel are used for the intermediate driver stage. A logic HIGH on either input terminal will cause the lower part of the output stage to become saturated, taking the output terminal to a logic LOW condition.

The Type 7408 two-input positive AND gate is shown in Fig. 14. The basic NAND gate of Fig. 12 is converted to an AND gate by the addition of an internal inverter stage between the multi-emitter input stage and the normal driving stage for the totem-pole output.

Some of the "ground rules" for selecting and utilizing TTL devices are as follows:

1. Within the appropriate temperature, supply-voltage and fan-out limits, the output voltage corresponding to a logic HIGH (V_{OH}) is guaranteed to be not less than 2.4 volts, and the output voltage corresponding to a logic LOW (V_{OL}) is guaranteed to be not greater than 0.4 volts.
2. Also within the appropriate temperature, supply-voltage and fan-out limits, the input voltage that will be reliably interpreted as a logic HIGH (V_{IH}) may be as low as 2.0 volts and the input voltage that will be reliably interpreted as a logic LOW (V_{IL}) may be as high as 0.8 volts.
3. Comparing statements 1 and 2 reveals that dc noise margins for standard TTL devices are 0.4 volts for both the high or low conditions. That is, extraneous signals with levels up to 0.4 volts may be super-

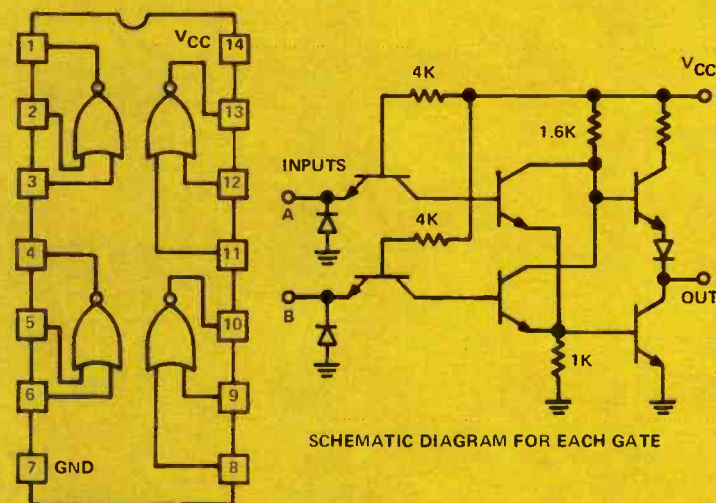


Fig. 13. Type 7402 Quad 2-Input Positive NOR gate

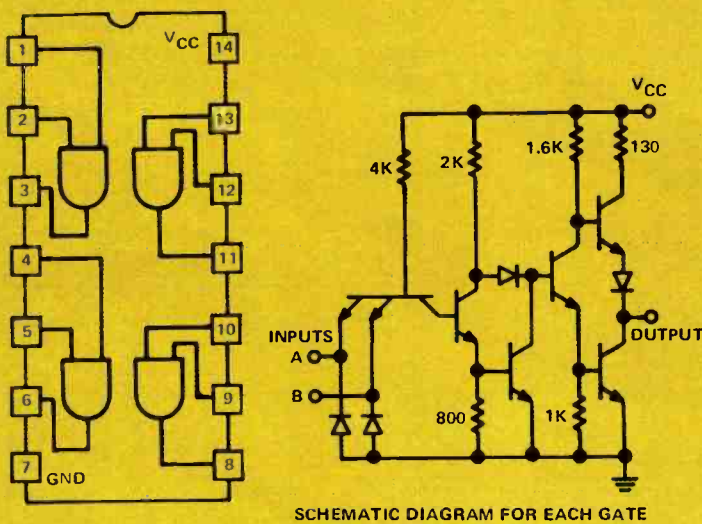


Fig. 14. Type 7408 Quad 2-Input Positive AND Gate

- imposed on normal logic levels without causing false triggering.
- TTL gates tend to generate somewhat more noise than DTL gates because there are brief periods during transitions when transistors Q2, Q3 and Q4 (in Fig. 10) are all "on" simultaneously, causing brief "spikes" of current to be drawn from the power supply. Because of this current spiking effect, it is common practice to place decoupling capacitors (usually of 0.01 to 0.1 ufd) at intervals of every four or five packages along the power supply busses interconnecting groups of TTL gates.
 - In principle, the output terminals of TTL gates with totem-pole output stages may be shorted to ground without damaging the gates, but this practice is not recommended because the gates are placed under abnormal stress. The chief function of resistor R4 in the basic circuit of Fig. 10 is to limit the short-circuit current to a safe value, but when the output is shorted the current drawn from the power supply is substantially greater than normal and the temperature within the package will rise above normal levels.
 - Unused inputs for TTL gates should not be allowed to "float", but should be connected either to other inputs of the same gate (which has the disadvantage of increasing the loading on the line driving the combined input) or through pull-up resistors (of about 5K) to +5 volts.

Some devices in the 5400 and 7400 series are specified as having "open collector" outputs, as in the case of Type 7401 shown in Fig. 15. Omission of the usual totem-pole output makes the output stages of such units similar to those used in DTL gates (except

that an external pull-up resistor is required). The chief advantage of open-collector output gates is that several gate outputs may be tied together in a "wired AND" configuration. If the phrase "high voltage" also appears on the specification sheet for a TTL device with open-collector outputs, it means that the output stage has been designed to switch load currents drawn from external loads that are connected to sources at higher voltage than the +5 volts specified for most TTL circuits. Some such devices are rated at +15 volts, while others can handle up to +30 volts. These high-voltage devices serve as interface units for driving external equipment, such as lamps, relays or small solenoids.

F. Major Categories of TTL Devices

TTL products in the 5400 and 7400 series are further subdivided into five categories, designated by certain letters incorporated into their type numbers, as indicated by the following table. Propagation delay is used in the table as an indicator of switching speed (to which it is inversely related). Propagation delay is defined as the time lapse between the 50% points of a level change at the input and the corresponding level change at the output.

Series Designation	Category	Typical Propagation Delay per Gate (Approximate)	Typical Power Dissipation per Gate
5400/7400	Basic	9 ns	5 mw
54H00/74H00	High-Speed	6 ns	12 mw
54L00/74L00	Low-Power	33 ns	0.55 mw
54S00/74S00	Schottky-Clamped	3 ns	12 mw
54LS00/74LS00	Schottky-Clamped, Low Power	9 ns	1 mw

NOTE: Devices in the 54C00 or 74C00 series are not in the TTL family, but are CMOS devices using the same pin-out diagrams as functionally equivalent members of the TTL family.

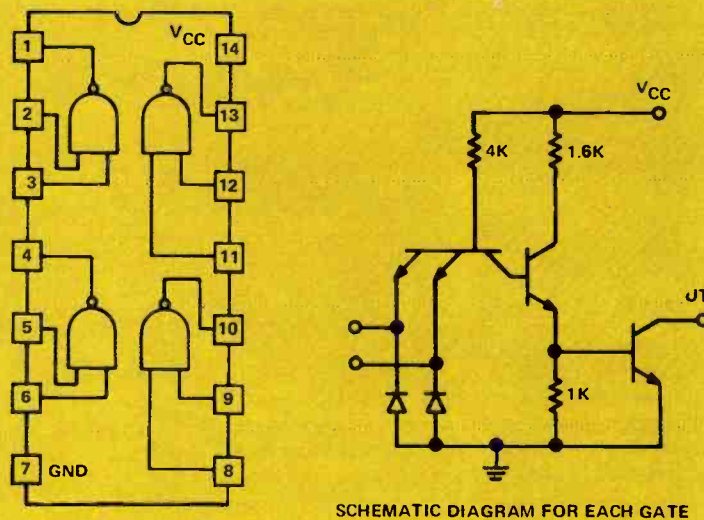


Fig. 15. 7401 Quad 2-Input Positive NAND Gate, Open-Collector Outputs

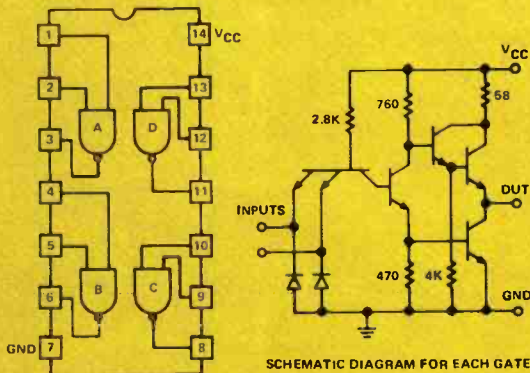


Fig. 16. Type 74H00 Quad 2-Input Positive NAND Gate, High-Speed Version

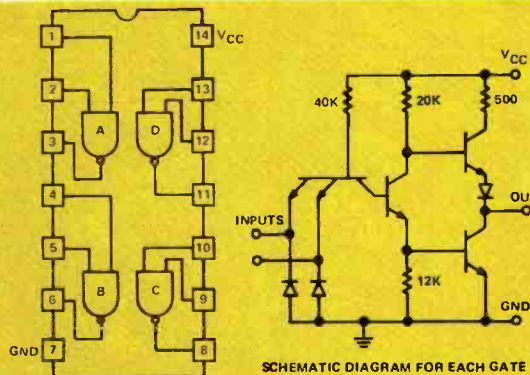


Fig. 17. Type 74L00 Quad 2-Input Positive NAND Gate, Low-Power Version

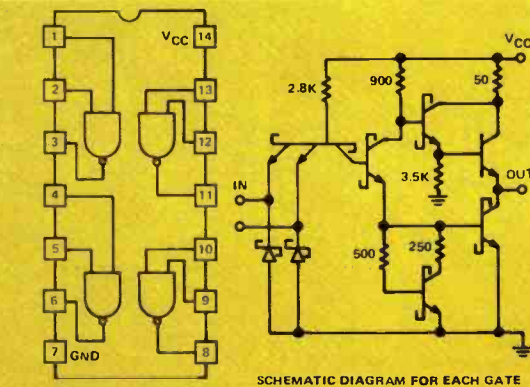


Fig. 18. Type 74S00 Quad 2-Input Positive NAND Gate Schottky-Clamped Version of 7400

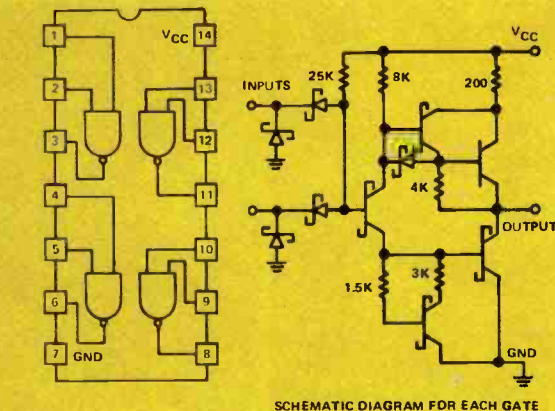


Fig. 19. Type 74LS00 Quad 2-Input Positive NAND Gate Low-Power, Schottky-Clamped Version of 7400

The key differences among the TTL categories can be explored briefly with the aid of Figures 16 through 19 in comparison with Fig. 12. In each case, we shall examine a two-input NAND gate as a representative example of each category.

As shown in Fig. 16, the *High-Speed* versions of TTL gates achieve their higher switching speeds (at the price of substantially higher power dissipation) by the simple expedient of decreasing the values of all resistors in the circuit by approximately a factor of two. For given values of stray and junction capacitance, this strategy lowers the time constants. Note also that an emitter follower is added to lower the driving impedance for the upper half of the totem-pole output stage.

The *Low-Power* version of the same gate, shown in Fig. 17, is based on a circuit that has been revised in exactly the opposite direction. In this case, all resistors have been *increased* in value by a factor of approximately 10 relative to the basic version. This revision reduces the power consumption by a factor of nearly 10, but also increases the propagation delays because of the longer time constants.

The fastest TTL gates employ Schottky diodes (also known as "hot carrier" diodes) in parallel with conventional semiconductor junctions. As shown in Fig. 18, the Schottky-clamped gates use resistor values generally similar to those used for High-Speed TTL gates, but they also use special transistors and diodes. The stylized "S" incorporated in the transistor symbols indicates that a Schottky diode has been connected across each collector junction.

A Schottky or "hot carrier" diode is based on a metal-to-semiconductor junction that exhibits the property of one-way current flow but without the use of minority charge carriers as in ordinary p-n junctions. When a p-n junction is driven into saturation, many hole-electron pairs are broken apart to form the many charge carriers that provide the high forward conductivity. Such a p-n junction cannot be switched "off" rapidly, however, because it takes time for the minority carriers (electrons in p-type material, holes in n-type material) to recombine with majority carriers, thus restoring a "depletion zone" barrier. A "hot carrier" diode does not have this problem; the application of a reverse-bias electric field will almost immediately withdraw the charge carriers from the depletion zone. A further

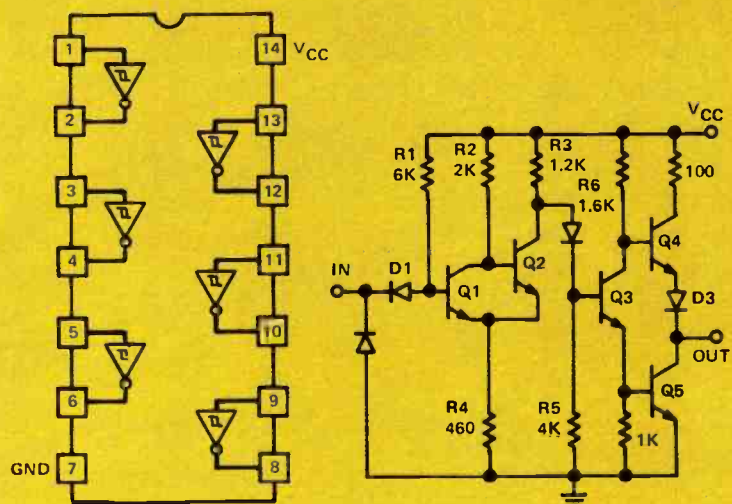
characteristic of Schottky diodes is that their offset voltage drop is only about $\frac{1}{2}$ that of conventional silicon p-n junctions. A Schottky diode connected across a conventional p-n junction (and polarized in the same direction) will therefore conduct at a lower voltage than the p-n junction and will clamp the voltage difference across the junction to a value too low to permit conventional saturation in the p-n junction. The overall result is a substantial decrease in switching times for Schottky-clamped TTL gates. Power dissipation is about the same as for High-Speed gates.

Low-Power, Schottky-Clamped TTL gates based on the circuit shown in Fig. 19 represent a balanced use of two techniques to achieve certain advantages. Power dissipation is reduced by a factor of about five relative to the basic TTL gates through the use of moderately large resistors, but switching speed is maintained at values generally comparable to the basic gates through the use of Schottky-diode clamps. One could argue that the circuit of Fig. 19 has actually been converted back to DTL, since the distinctive multi-emitter transistor that characterizes most TTL circuits has been replaced by multiple Schottky-clamped diodes.

G. Schmitt-Trigger TTL Devices

Still another variation for the basic TTL circuit is the Schmitt-Trigger inverter shown in Fig. 20. Because *hysteresis* in the form of separation of the high-going and low-going switching threshold levels is a distinctive characteristic of Schmitt triggers, the symbol for a Schmitt-trigger inverter is distinguished from that of a conventional inverter by the inclusion of a small picture of a hysteresis loop.

The Schmitt-trigger action is obtained through the use of Q1 and Q2 in Fig. 20; these transistors are interconnected as a positive-feedback pair that provides two stable operating conditions and a fast "flipping" action between them (as in a multivibrator or flip-flop). If the input terminal is LOW, the base of Q1 is held too low to allow Q1 to conduct, but Q2 is saturated by the flow of current through R2. The voltage at the collector of Q2 is pulled low enough that the series combination of D2, Q3 and Q5 cannot be turned on, but Q4 and D3 can be biased "on" through R6 to pull the output terminal to the HIGH logic state. The flow of Q2's emitter current through R4 holds the emitter voltage at Q1 to a sufficiently high value that the input voltage must rise to about 1.7 volts before the



SCHEMATIC DIAGRAM FOR EACH INVERTER

Fig. 20. Type 7414 Hex Schmitt-Trigger Inverters

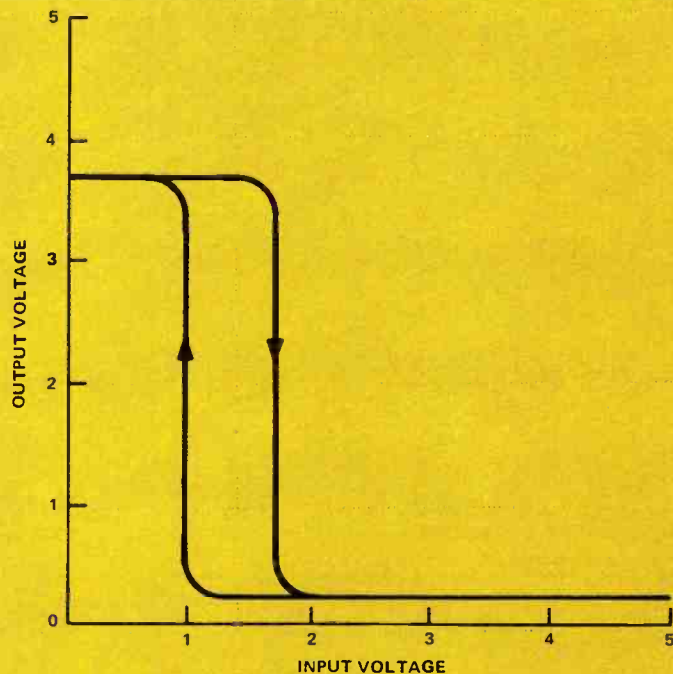


Fig. 21. Typical Transfer Characteristic for a Schmitt-Trigger TTL Inverter

output terminal is permitted to "flip" from the HIGH to the LOW state, as indicated in Fig. 21. Once Q1 is driven into conduction, the base voltage for Q2 drops rapidly (aided by the positive feedback from the emitter of Q2 to the emitter of Q1), and when Q1 reaches saturation Q2 becomes cut off. Bias current then flows through R3 to turn on the series combination of D2, Q3 and Q5; Q5 is driven to saturation and pulls the output terminal to a logic

LOW level. Meanwhile, the voltage across R4 (at the emitter of Q1) has fallen to a lower value than that which prevailed while the input was LOW because the saturation current through Q1 is less than the previous saturation current through Q2. (Note that R2 is somewhat larger than R3.) As a result, the output will not switch back to the HIGH state until the input voltage drops below about 0.9 volts, as shown by the rising part of the transfer char-

acteristic in Fig. 21. Separation of the low-going and high-going switching thresholds is determined primarily by the relative values of resistors R2 and R3.

Schmitt-trigger TTL devices are useful in applications where significant noise is present or where slowly-changing voltages are to be converted to pulse-type signals. The hysteresis effect (i.e., separation of the switching thresholds) prevents erratic and repetitive triggering when a signal "hovers" in the vicinity of a switching threshold either because of poor rise time or superimposed noise. The integrated Schmitt-trigger circuit (Q1, Q2 and the related resistors in the circuit of Fig. 20) can be incorporated in almost any kind of TTL gate. For a multiple-input NAND gate, diode D1 would be replaced by the usual multi-emitter transistor with a short circuit across its collector junction. Schmitt triggers are particularly popular at the inputs of monostable multivibrators.

H. TTL Tri-State Devices

In many types of modern digital equipment (including most micro-computer systems based on microprocessors), extensive use is made of "party line" data or address busses that may be controlled by any one of many devices all permanently connected to the same bus lines. Such systems require the use of *tri-state devices* whose outputs may assume any of three states: logic LOW, logic HIGH and FLOATING. In the last-mentioned state, the device may remain physically connected to a line, but it is not determining the voltage on the line.

A basic tri-state inverter implemented in Transistor-Transistor Logic is shown in Fig. 22. This circuit will function as a conventional TTL inverter only when the ENABLE input line is HIGH. If the ENABLE input goes LOW, both Q4 and Q5 are cut off and the output terminal simply "floats", free to assume whatever logic state some other device connected to the same line assigns to it. Tri-state inverters or non-inverting buffers are frequently incorporated as output stages in larger-scale TTL devices, such as latches (arrays of flip-flops), shift registers and microprocessors.

I. COS/MOS Logic Elements

COS/MOS (or CMOS) logic elements are based on complementary-symmetry pairs of field-effect transistors of metal-oxide-semiconductor construction, and operate on electronic principles quite different from those used in DTL and

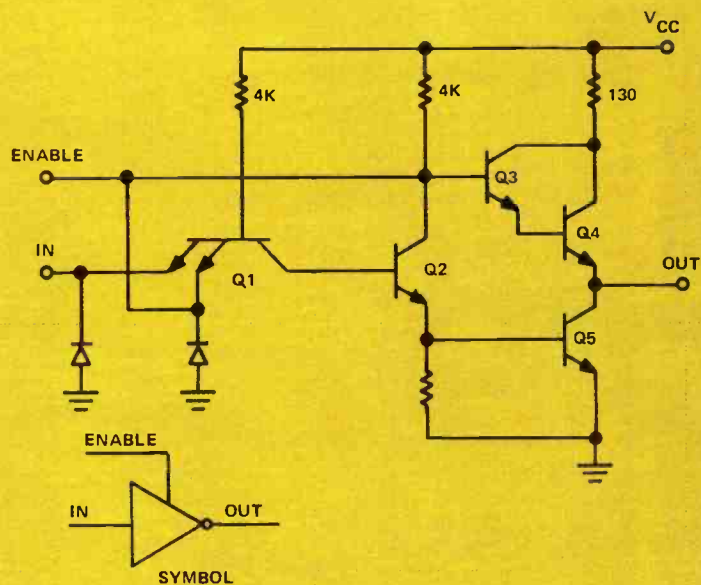


Fig. 22. Basic TTL Tri-State Inverter

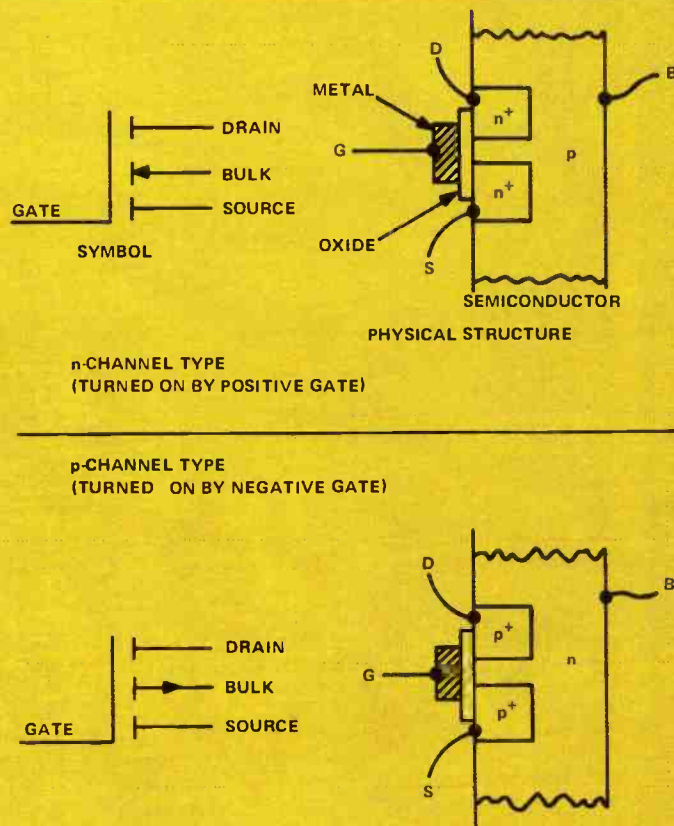


Fig. 23. COS/MOS Field-Effect Transistors

TTL gates. In essence, COS/MOS gates are voltage-operated, while DTL and TTL gates are current-operated.

The two types of enhancement-mode field-effect transistors used for COS/MOS circuits are shown in Fig. 23. In the n-channel type, two pockets of heav-

ily-doped n-type material are placed in a "well" of lightly-doped p-type material to form the source and drain electrodes. A metal gate electrode is deposited over the region between the drain and source electrodes, but is insulated from them by a thin layer of oxide. If the gate is at the same poten-

tial as the bulk of the material, there can be no conduction between the drain and source electrodes because at least one of the p-n barriers will be reverse-biased. If the gate becomes positive with respect to the bulk, however, enough free electrons can be drawn from the bulk of the material toward the gate to convert the region immediately below the gate from p-type to n-type material; relatively easy conduction between drain and source then becomes possible.

In COS/MOS circuits, each n-channel transistor is paired with a p-channel transistor, also shown in Fig. 23. In the p-channel devices, the drain and source electrodes consist of pockets of heavily-doped p-type material embedded in wells of lightly-doped n-type material. As in the n-channel devices, the gate consist of metal deposited over an insulating oxide in the region between the source and drain electrodes. When the gate is made negative with respect to the bulk, enough minority carriers (holes) can be drawn into the region immediately below the gate to support conduction between the drain and source electrodes.

The gate electrode of an MOS transistor is quite different from the base of a conventional bipolar or junction transistor in that no current is required for its operation. Because of the oxide insulation under the gate electrode, no charge carriers actually flow between the gate and the bulk of the device. Unfortunately, the switching speed for MOS transistors is relatively slow because they depend for their control action on the use of minority charge carriers, which require time to recombine with majority carriers when the electric fields which formed them are removed. The intrinsically high impedances associated with MOS transistors also tend to produce rather long time constants in association with the inevitable capacitances associated with the transistors and the interconnecting wires or leads.

The basic circuit for a COS/MOS inverter is shown in Fig. 24. If the input terminal is LOW, the lower transistor is cut off (because there is no electric field between its gate and the bulk), but the upper transistor is in a conducting state and pulls the output terminal up to +5 volts. If the input is HIGH, the upper transistor is cut off, but the lower transistor is now conductive and pulls the output down to ground potential. The total absence of resistors in this circuit is significant in two ways:

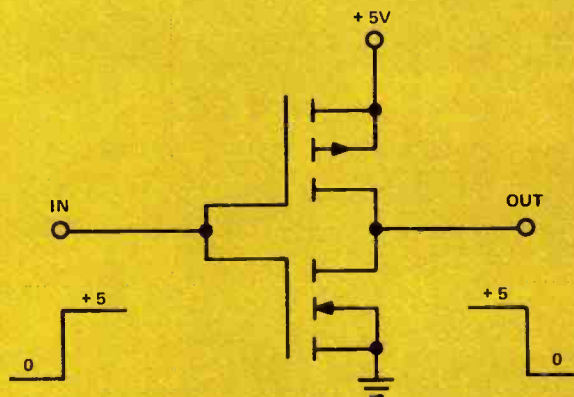


Fig. 24. COS/MOS Inverter

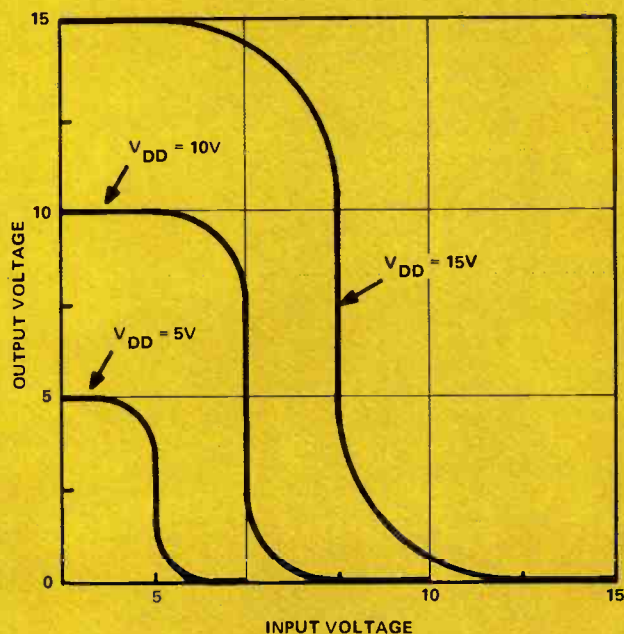


Fig. 25. Typical Transfer-Characteristics for COS/MOS Inverters

(a) the circuit dissipates no power on a steady-state basis, assuming that the output terminal is connected only to the input terminals of other COS/MOS gates, and (b) manufacturing costs can be kept down when resistors are eliminated, because resistors generally require larger areas on IC silicon wafers than do transistors and diodes. (In IC processing, the larger the area required for a device the smaller is the yield from each processing "batch".) In COS/MOS circuits, the primary loss of energy (power dissipation) occurs only during actual switching periods as small amounts of electric charge are moved around to establish new voltage relationships on the relatively small intrinsic capacitors consisting of the

electrodes and the metal paths which interconnect them.

One advantage of COS/MOS technology is that devices can be operated over a wide range of supply voltages, ranging from 3 volts to 15 volts for "A series" devices and from 3 volts to 20 volts for "B series" devices. The higher voltages provide greater switching speed and greater noise immunity. Transfer characteristics for a typical COS/MOS inverter with supply voltages of 5V, 10V and 15V are shown in Fig. 25. Because the COS/MOS inverter is a symmetrical field-effect circuit (not involving conventional p-n junctions for switching purposes), the switching threshold voltage changes with the supply voltage, and is typically

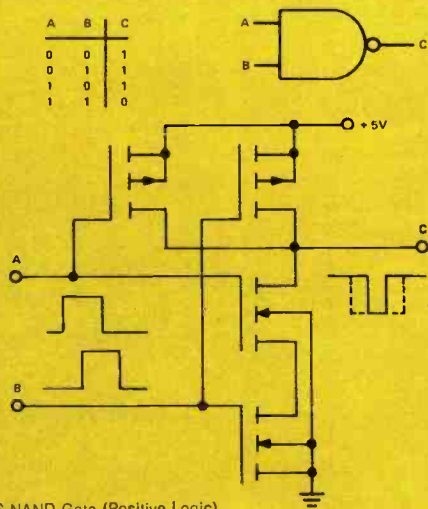


Fig. 26. COS/MOS NAND Gate (Positive Logic)

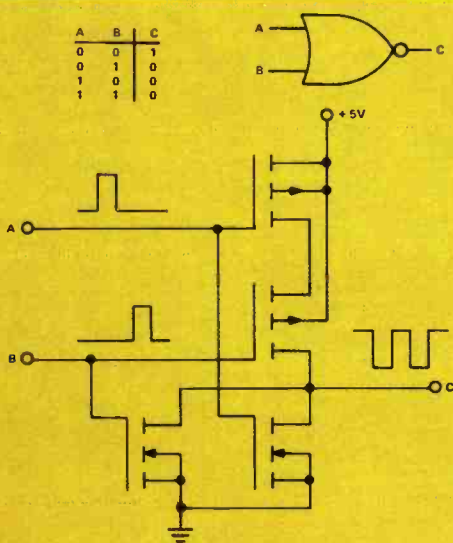


Fig. 27. COS/MOS NOR Gate (Positive Logic)

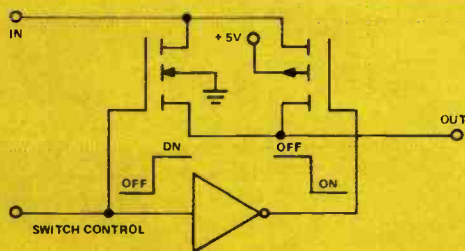


Fig. 28. COS/MOS-Transmission Gate

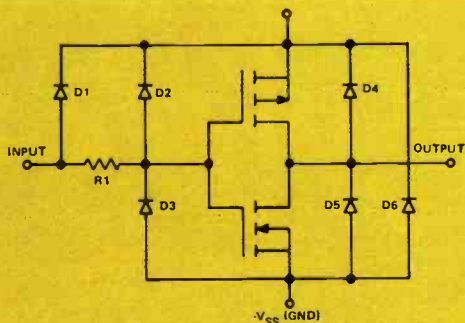


Fig. 29. Typical COS/MOS Inverter Circuit with Protection Diodes

within 10% of the mid-point of the supply-voltage range. The HIGH and LOW voltages at the output terminal come very close to the actual voltages of the ground (V_{SS}) and power supply (V_{DD}) terminals; the maximum tolerance for the voltage differences is usually cited as 0.05 volts.

The basic circuit for a two-input COS/MOS NAND gate is shown in Fig. 26. This circuit consists of two p-channel transistors in parallel between the output terminal and the positive supply terminal and two n-channel transistors in series between the output terminal and ground. If either of the input terminals is LOW, the series connection to ground is broken and one or the other of the upper transistors pulls the output terminal to the HIGH state. The only way the output can go LOW is to have both input terminals HIGH—this will turn on both series transistors and turn off the two parallel transistors. The same concept can be extended to any reasonable number of inputs by adding more transistors to the series and parallel groups.

The basic circuit for a two-input COS/MOS NOR gate, shown in Fig. 27, is essentially an inverted version of the NAND gate circuit. In this case, the parallel-connected transistors (of the n-channel type) are between the output terminal and ground, while the series-connected transistors (of the p-channel type) are between the output terminal and the positive supply terminal. The output will remain HIGH only if a LOW condition prevails on both inputs; a HIGH on either or both inputs will cause the output to go LOW. As in the case of the NAND gate, the circuit can be extended to more inputs by adding more transistors to the series and parallel groups.

The COS/MOS functional equivalent to the TTL tri-state buffer is the *Transmission Gate* shown in Fig. 28. In this circuit, a conventional COS/MOS inverter (as previously described) is used to control a complementary pair of transistors which are connected in parallel between an input terminal and an output terminal. If the switch control line is LOW, both transistors are cut off and the output terminal is in a "floating" condition. When the switch control line goes HIGH, both transistors conduct and the output terminal assumes the same potential as the input terminal. Two interesting properties of this circuit are: (1) it is bi-directional, in the sense that the input and output

terminals may be interchanged and signals sent through in either direction, and (2) the signals transmitted through the gate when it is in the ON condition need not necessarily be *digital* signals —*analog* signals may be handled as long as their voltage range stays within the V_{SS} and V_{DD} limits for the COS/MOS devices. (Each of the transistors in the complementary pair becomes a poor conductor as the input/output voltage approaches one of the power-supply limits, but the other transistor in the pair would be conducting strongly at this time.) Groups of transmission gates may share a common input or output terminal to form *multiplexers* or *commutators* capable of connecting a given line to any of several different inputs or outputs.

A few additional characteristics of COS/MOS devices and “ground rules” for handling them are summarized in the following list.

1. RCA is one of the leading suppliers of COS/MOS devices, and identifies its product by type numbers in a CD4000 series. Several other manufacturers provide interchangeable products, in many cases using the same 4000-series type numbers but with different letter prefixes.
2. In comparison with TTL gates, functionally-equivalent COS/MOS gates are typically somewhat slower in switching speed but use very much less power (sometimes by a factor as large as 1000). COS/MOS technology is particularly well suited for battery-operated equipment and for adverse noise environments (especially when higher supply voltages can be used).
3. The switching speed of COS/MOS devices is affected both by the supply voltage used and by the load capacitance. Typical performance for individual gates with 15 picofarad loading is summarized in the following table. Transition time refers to the time required for a rising or falling waveform to move between 10% and 90% limits, while *propagation delay* refers to the delay between the 50% point of a logic level change at an input and the 50% point of the corresponding level change at the output.

V_{DD} (Supply Voltage):	5V	10V	15V
Typical Transition Time:	65 ns	35 ns	22 ns

Typical Propagation Delay:	35 ns	25 ns	17 ns
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4. The power dissipation of COS/MOS gates connected to other COS/MOS gates is essentially proportional to the frequency at which logic changes occur, since the gates draw almost no power when they are in a steady-state condition but require momentary flows of current as they switch. Typical dissipation factors for gates with 15-pf capacitance loading are as follows:

V_{DD} (Supply Voltage):	5V	10V	15V
Power per gate @ 1 KHz	0.8 uW	4 uW	10 uW
Power per gate @ 1 MHz	0.8 mW	4 mW	10 mW

5. All COS/MOS gate inputs should be terminated; unused inputs must be tied to either $+V_{DD}$ or V_{SS} (usually grounded), depending upon logic requirements. When a gate input is connected through a plug-in connector that might become disconnected while power is on, it is good practice to connect a shunt resistor (usually of about 22K) between the input terminal and either V_{DD} or V_{SS} .
6. Input voltages must remain within the range established by V_{DD} and V_{SS} , and it is important that signal voltages not remain present when the supply voltage is removed.
7. When an MOS transistor is in the ON state, its resistance is typically of the order of 2K. This is trivial in comparison with the input impedance of COS/MOS gates (which is many megohms), but the intrinsic resistance limits the ability of a COS/MOS gate to drive a current-operated load. Special buffers and drivers are included in the CD4000 series to permit interfacing COS/MOS devices to other logic families or to special loads (such as light-emitting diodes).
8. Non-complementary MOS devices are seldom used for small-scale, general-purpose logic elements, but both p-MOS and n-MOS devices are used separately in many LSI applications, such as semiconductor memories for microcomputer systems.
9. The thin oxide insulation under COS/MOS gate inputs is vulner-

able to damage from static-electricity discharges, particularly when the device is being handled in isolation before it is mounted in place on a circuit board. COS/MOS devices are usually shipped with their terminals all shorted together either through a conductive foam or by means of a metal foil wrapper. These protective shorts should be kept in place until just before installation, and installation is best performed on a grounded metal working surface and with a grounded soldering iron. (In many factories assembling COS/MOS equipment, operators wear grounded metallic wrist bands to further reduce static hazards.) Once COS/MOS devices are mounted in place and connected to appropriate busses, they are rather well protected by built-in diodes incorporated in the integrated-circuit structure at both inputs and outputs. Fig. 29 shows a typical COS/MOS inverter with its protection diodes, along with the basic circuit shown in Fig. 24. Some of these diodes are inherent in the manufacturing process—that is, they are related to the techniques used to isolate each transistor from its neighbors on the same silicon chip. The small resistor in series with the gate input is helpful for protection but does not significantly affect the circuit performance; its value is typically between 200 and 2000 ohms, while the gate impedance with which it is in series is many megohms.

J. Emitter-Coupled Logic (ECL)

Emitter-Coupled Logic has not been widely used in broadcast equipment up to the time of this writing, but it may become more important in the high-speed logic circuits that will be required in future equipment handling video-bandwidth signals that have been converted to digital form. The special features of ECL are high switching speed (roughly comparable to Schottky-clamped TTL) and relative freedom from noise “spiking” problems.

A typical ECL NOR gate is shown in Fig. 30. The heart of this circuit is a differential amplifier, consisting of Q2 and the parallel combination of Q3 and Q4. None of these transistors are permitted to go into saturation, and the coupling provided by the common emitter resistor (R3) assures that the total current drawn from the power supply will be essentially constant. As noted

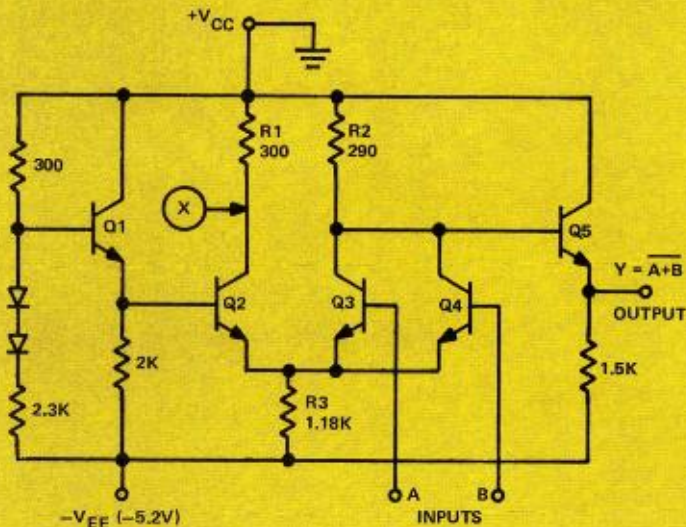


Fig. 30. Typical ECL NOR Gate (Positive Logic)

on the diagram, the circuit is commonly operated with the $+V_{CC}$ terminal grounded and the $-V_{EE}$ terminal at -5.2 volts.

If the bias on the base of either Q3 or Q4 is higher than that on the base of Q2, the available current will pass through R2, and the drop across R2 will take the output terminal (through emitter follower Q5) to the logic LOW level of -1.6 volts. If the bases of Q3 and Q4 are both at lower levels than the bias on the base of Q2, the available current will be switched to R1, eliminating the voltage drop across R2 and taking the voltage at the output terminal to the logic HIGH level of -0.75 volts (essentially one diode drop below the grounded $+V_{CC}$ terminal. Q1 is a low impedance, temperature-stabilized voltage source designed to maintain a bias of -1.175 V on the base of Q2 (half-way between the LOW and HIGH logic levels for this family). An OR output could be derived from this same gate by connecting another emitter follower to point X in the diagram.

The high switching speed of ECL gates results from the fact that the transistors do not go into saturation, and the freedom from noise generation results from the fact that there is no significant change in supply current as the gate switches from one logic state to the other. (This logic family is sometimes called Current-Mode Logic or CML.) Typical ECL gates in small-scale-integration packages have a propagation delay of about 4 nanoseconds and power dissipation of about 35 milliwatts. (Some LSI devices based on ECL tech-

nology have achieved switching times of well under 1 nanosecond.) Because the gates have high input impedance and low output impedance, a fan-out of up to 25 is acceptable. Use of a supply voltage range different from the usual 0 to $+5$ range makes it awkward to use this family in association with other logic devices.

K. Integrated Injection Logic (I²L)

One of the newest and fastest-growing segments of the integrated-circuit industry is that concerned with integrated injection logic. This logic family does not lend itself particularly well to the manufacture of individual gates or small-scale groups of gates, but it offers some significant advantages in large-scale integration. Essentially, I²L represents a return to the basic principles of Direct-Coupled Transistor Logic (DCTL) as presented in Section B of this article, but with two important differences: (a) collector load resistors are replaced by pnp-transistor current sources, and (b) multi-collector transistors are used to assure equitable distribution of currents to the multiple inputs connected to a given gate output.

It is virtually impossible to explain the unique properties of I²L circuits with schematic diagrams alone, since most of the advantages of this family result from the use of new (and simple) physical structures and layouts within the context of large-scale integrated circuits. The physical design of integrated circuits is somewhat beyond the scope of this introductory paper, and is of very limited interest to most broadcast equipment users. In the case

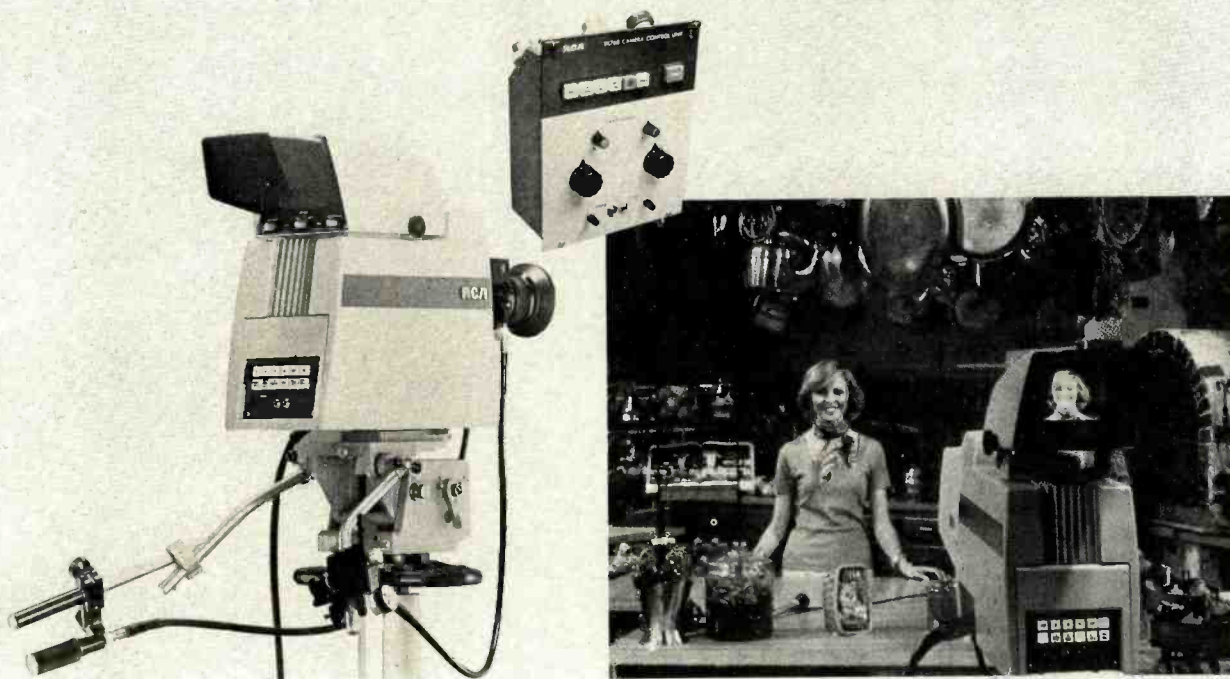
of I²L, even the basic physical "cell" used in constructing the circuits is not a logic element in the conventional sense so much as it is a junction point between interconnected logic elements. In essence, a single pnp transistor with a single, large-area emitter but many collector electrodes is used as a common current injector for all the logic elements in a large-scale array. The total current used is conveniently adjustable over a large range by means of a simple external resistor. If a relatively large total current is used, the performance characteristics approach those of conventional TTL gates in terms of power dissipation and switching speeds. If the current is greatly reduced, the performance becomes comparable to COS/MOS circuits, again in terms of power consumption and switching speeds. In terms of packing density, I²L circuits are among the most compact ever devised.

Suggested References for Further Study

1. *Designing with TTL Integrated Circuits*, by the IC Applications Staff of Texas Instruments, Incorporated, McGraw-Hill Book Company, 1971.
2. *RCA COS/MOS Integrated Circuits Manual*, Technical Publication CMS-271, RCA Solid State Division, Somerville, N.J. 08876, 1972.

□

Products IN THE News



TK-760 Camera Combines Quality, Economy, Versatility

The TK-760 is a new compact, high-quality color television camera for studio and field use. A feature attraction at the 1977 NAB Convention, this camera offers the high degree of stability needed in a portable camera, and the flexible control system necessary to operate in the studio or on location.

It can be operated as a completely self-contained camera without a separate camera control unit, with AC power fed directly to the camera through a power cord, and video output carried by a coaxial cable.

The compact design of the camera makes it easily transportable to the field for on-location applications, with rapid set-up on site. It weighs only 45 pounds complete with lens, and measures 8 inches by 22 inches by 19 inches. A five-inch diagonal tilting viewfinder provides easy viewing for the camera operator.

The camera is weather-proofed and gasket-sealed for operation under a wide range of environmental conditions, and is shielded against radio frequency interference.

The TK-760's electronics are based on RCA's highly successful TK-76 portable camera, sharing with the TK-76 such features as prism optics, rugged "T" frame construction, shock-mounted optical system, bias light, automatic iris, and automatic white balance.

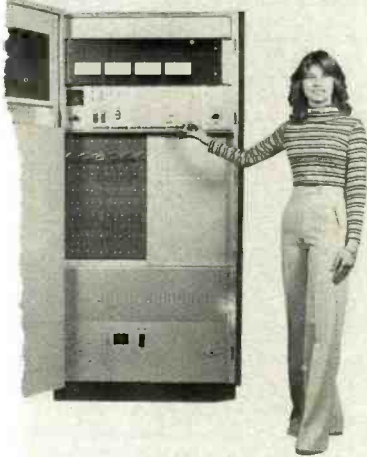
The TK-760, however, is designed for the more stringent needs of studio and field programming, and includes the control functions and other features necessary in teleproduction work, particularly for handling remotes.

Automatic cable equalization assures full response signals by adjusting for variations in cable lengths and in cable characteristics. No adjustments to the camera are necessary when different cables are used in a studio, or when changing cables for various field assignments.

When remote control is desired for artistic purposes in a multi-camera set-up or for other applications, a separate camera control unit is used. The compact unit, connected to the camera head through a small 45 conductor camera cable, provides for control of iris, black level, and R & B white balance. Push button switches are provided for bars, auto white balance, tally call, high sensitivity, auto iris, and power. A two-way interphone is also provided in the CCU. A chroma keyer accessory, which becomes an integral part of the camera when installed, is available as an option.

The TK-760 uses a new $\frac{3}{8}$ -inch pickup tube, the improved RCA SATICON, which provides uniform sensitivity and clearer, sharper pictures. The camera will operate on NTSC, PAL-B, PAL-M and SECAM television standards.

All Solid-State Five kW AM Broadcast Transmitter



BTA-5SS designates a new 5 kilowatt AM transmitter introduced by RCA, the first completely solid state system available at this power level.

The new design transmitter uses transistor arrays in place of the vacuum tubes of earlier generation units. As a result, the transmitter operates with reduced power consumption, with inherent reliability and minimum maintenance requirements.

The unit features pulse width modulation and a synthesized exciter which uses a single temperature-compensated crystal oscillator (TCXO). The transmitter, consisting of a single 38-inch wide cabinet, will be tuned and tested on the user's frequency (535-1620 kHz) and shipped ready for operation.

The wide-band modulation concept of the BTA-5SS will permit the same

bright, full audio response that RCA's Ampliphase line of AM transmitters is noted for.

The wide-band capability also makes the transmitter "transparent" to the desired effects of modern audio processing systems used in contemporary AM radio, and looks forward to AM stereo applications.

A unique feature of the BTA-5SS is a complete LED status/overload indicator system. In the event of a malfunction, light-emitting diodes indicate the exact subsystem at fault.

The transmitter design provides for remote control of operating functions and parameters as standard equipment, and also incorporates provisions for monitoring and control options necessary for full automatic operation and automatic transmitter systems.



Quatrefoil CP Antenna

New Circularly Polarized TV Antennas

In response to broadcast industry requirements, three new VHF Circularly Polarized antennas have been developed by the RCA Antenna Engineering staff at Gibbsboro, N. J. These new antennas are: Tetra Coil; Quatrefoil, and Fan Vee.

Tetra Coil, Type TCL, is a top-mounted design for highband VHF channels 7-13 which combines excellent electrical

characteristics, mechanical simplicity and minimum windloading. Vertical pattern beam tilt and null fill are supplied as standard to provide a more uniform signal.

The Tetra Coil antenna is made up of four interleaved radiating elements wound about each of the three sections of the support pole. Illumination of the antenna is achieved by the traveling wave principal of exciting the radiating elements above the ground plane support pole. Electrical beam tilt is achieved by simple feed system phasing of the three vertical sections.

Quatrefoil, Type TBK, is a side-mounted panel type CP antenna for lowband VHF channels 2-6. The antenna is convertible between horizontally and circularly polarized transmission signals by a simple electrical field adjustment of the antenna input, without any modifications to the antenna itself.

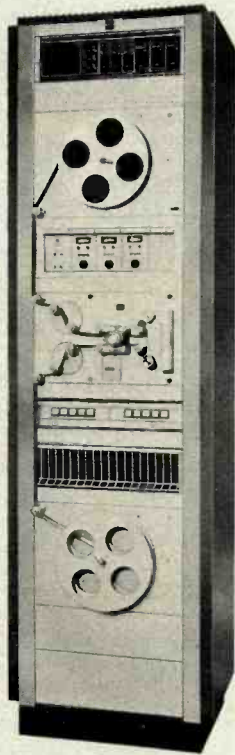
The Quatrefoil antenna is comprised of three panel radiators per layer side mounted on a triangular tower. Each panel consists of four concentric ring radiators located in front of a rectangular pattern shaping screen.

The first Quatrefoil antenna, a six-layer, Type TBK-6A2, is being installed this summer by WPTB-TV, Miami, Florida.

Fan Vee, Type TFV, designates a top-mounted CP antenna for lowband VHF Channels 2-6. Four-bay and six-bay versions are standard. The four-bay Fan Vee contains approximately the same wind loading as that of the six bay RCA horizontally polarized Superturnstile antenna for which it is intended as a replacement with a minimum of tower rework.

The antenna layers each consist of two bays, one for the horizontal component, and one for the vertical component. These layers are properly phased to produce the circularly polarized signal. Each layer is made up of a re-designed horizontal "batwing" radiator which provides optimum match across each channel, and a V-shaped dipole for radiation of the vertically polarized field. A branch type feed system feeds all radiating elements which nominally equal line lengths, providing excellent pattern stability.

Station XETV, Tijuana, Mexico is installing the first Fan Vee circularly polarized antenna.



New Series Of Magnetic Recorders And Reproducers

The PM-86SL is a new magnetic recorder/reproducer system designed to interface with both film and tape machines to meet the demanding post-production needs of motion picture and teleproduction operations.

The new units feature a servo-controlled film transport mechanism designed to apply smooth continuous drive motion to the film.

A built-in electronic interlock facility permits the PM-86SL to run precisely synchronized with a variety of machines—another sprocketed sound recorder, a projector, a video tape machine, or a capstan-drive sound recorder. The unit can be locked to non-sprocketed equipment using SMPTE,

EBU and other time code data, with appropriate interface.

The interlock system automatically counts, stores in a "count memory", and corrects position error during start-up and film-run errors caused by a splice or other mechanical disturbance.

The PM-86SL can be locked to an incoming power line (50 or 60 cycles), and will operate at 24 or 25 frames per second. For telecine operation, the system can be locked or referenced to TV vertical sync for high-quality sound in television production.

The PM-86SL can be equipped for 16mm or 35mm sound recording. Interchangeable sprockets and plug-in head assemblies permit changing from one film size to the other quickly and easily.



BC-50 Audio Console Planning Guide

The BC-50 Audio Console is a quality audio control system that can be custom-planned and assembled from a wide range of solid state input, output and switching modules.

A new booklet, Form 3J5924-1, is available as an aid to "do-it-yourself" planners. It provides detailed information on the system and includes instructions to help a user custom-design a console to his individual requirements. The booklet describes each of the modules and submodules that are combined to form a monaural or stereo audio system, and includes functional diagrams. Copies are available from RCA Broadcast Systems offices.

BC-50 Audio Consoles are also offered as custom-assembled systems, shipped ready for installation.

New UHF Exciter Incorporates Surface Acoustic Wave Filter

The new TTUE-44 UHF Exciter announced at NAB incorporates a Surface Acoustic Wave (SAW) Filter to accomplish low level vestigial sideband filtering.

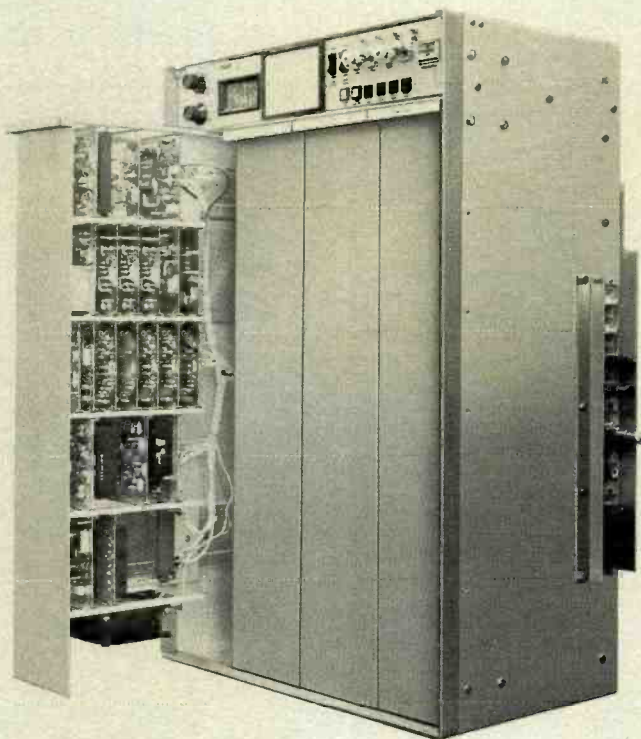
As a result of this technological advance, improved UHF transmitter system performance can be attained particularly in flatness of amplitude frequency response throughout the video passband.

By using the SAW filter, an untuned passive device, excellent sideband response can be maintained for long time

periods. Envelope delay characteristics of the SAW filter require no large delay corrections at band edge. Necessary corrections are accomplished externally at video frequencies by the TTS-2 video delay equalizer.

Linearity correction is provided at IF after sideband filtering. This assures optimum system linearity at the output of the klystron transmitters being driven by the exciter. Separate incidental phase modulation correction is provided for sync and video regions.

The TTUE-44 Exciter-Modulator will be available for inclusion in new RCA UHF Transmitters.



New AV Training Packages

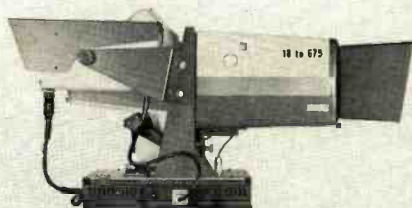
Six separate Audio-Visual Training Packages are now available from RCA Broadcast Systems. The packages were developed to help users achieve and maintain peak equipment performance.

Four packages cover RCA color cameras, including TK-44B; TK-45A; TK-76 and TK-28. Presented in these packages are updated set-up procedures, including waveforms, closeup view of controls and detailed methods for peaking the camera chain to full performance capability.

The two additional training packages are on the TCR-100 Cartridge Video Tape Recorder—one for orientation and one for detailed mechanical maintenance procedures.

Slides and audio cassette narrations provide detailed, step-by-step instructions for set-up, test and maintenance of specific RCA equipment. The audio-visual packages are convenient reference sources, suitable for individual or group use, for initial instruction, or as "refreshers".

Response to the AV training packages has confirmed the need for the program. The initial order for TK-44B packages was sold out and had to be reordered, and a number of testimonials have been received attesting to the effectiveness of the training material.



Minimax Adapter For TKP-45

The Minimax Adapter permits use of large zoom lenses with the TKP-45 Portable, extending its versatility as a studio production camera.

The full size lenses provide uncompromised optical quality, longer zoom ranges and the inclusion of sophisticated range extension devices. With the large zoom lens and a 7-inch viewfinder, the TKP-45 Minimax gives the operator the feel of a full sized studio type camera. For field use, the camera disassembles into easily transportable units, and it is no longer necessary to carry a heavy camera into the field.

The Minimax uses standard TV-81 mini cable (MI-557831 series) to accommodate the power requirements of the

large lens and the high resolution 7-inch viewfinder. Interface is provided in the Minimax Adapter to feed the camera head, lens and viewfinder. Only a single cable from the adapter is connected to the TKP-45 Camera Head, making it a very simple matter to install or remove the head. Lens and viewfinder may be left intact and interconnected when the camera head is removed.

AC power is required to operate the zoom lens iris, tally light and the viewfinder.

The TKP-45 mated with the Minimax Adapter is a versatile camera system suitable for virtually every production situation, providing an opportunity for maximum equipment utilization.



Picture Compression And Freeze Options For Video Synchronizer

The TFS-121 Digital Video Frame Synchronizer designed and manufactured by RCA, automatically locks to station sync all non-synchronous signals such as remote pickups or network and satellite feeds, without disrupting live shows in progress or program production and taping operations at the station.

State of the art digital sampling and storage techniques are used to achieve superior video performance in differential gain, differential phase, signal-to-noise frequency response. The higher rate of picture signal sampling achieved—4 x subcarrier frequency—produces a high quality picture when converted back to an analog signal.

A new picture compressor option available with the TFS-121 allows a full TV picture to be compressed to 1/4 size and positioned in a selected portion of the TV screen. Pushbuttons provide selection of any of four quadrant positions, and a joystick control permits positioning of the compressed picture

into any desired part of a full-size picture.

In addition, any pre-selected position on the screen for the compressed picture can be programmed by the operator. A pushbutton control automatically moves the insert to that position when desired.

As another effect, the compressed picture can be moved off the raster in any direction and back on from the same or different direction. The full picture, without masking or compression, also can be moved off and on in the same manner.

A second option for the TFS-121, the still picture mode of operation, enables a single picture to be retained on the screen for as long as desired.

The still picture can be made to disappear and be replaced by black after a specific time interval—or immediately. An unusual effect can also be obtained by pulsing the freeze mode, manually or electronically. The result is an attention-getting stroboscopic action effect, one of many possible with this option.



Simple Editor For TR-600A

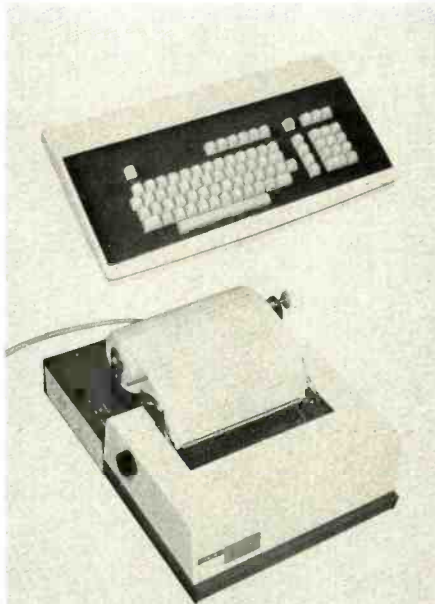
A new simplified editing device, the SE-1, provides previewable editing capability for the TR-600A quadruplex video tape recorder.

Economical and easy to install, the new system is ideal for many local editing requirements such as commercial "tags", station promos, ID's, sports highlights, art-card, animations, and others.

The state-of-the-art electronics for the new system, which include a micro-processor and programmable read-only memories, are contained in modules mounted inside the TR-600A. The operational controls are mounted on the main control panel.

The SE-1 system counts control track pulses on the video tape to provide both in and out edit point selection. Three preview modes are included: in and out, in-only, and out only.

Other features include automatic rescue, variable pre-roll times, programmable relay closure, an out-transfer mode, and a record safety interlock. Edit points may be shifted over a range of ± 99 frames in single frame increments. The editing device also can record cue marks at the in and out points for future re-editing requirements.



Keyboard And Teleprinter For AE-600

These two accessories available for AE-600 Editing Systems are used in conjunction with the External Monitor Display.

The **AE-600 Keyboard** is used to enter notations for display on the picture monitor connected to the Monitor Display. Notations might include:

Date	Edit Number
Time of Day	Tape Reel Number
Client Number	Act Number
Commercial Title	Scene Number
Editor's Name	Type of Transition

The Keyboard also is used to activate the AE-600 Teleprinter.

The **AE-600 Teleprinter** gives a hard copy printout of all information displayed on the external video monitor. Features include:

- Impact 5 x 7 Dot Matrix Printing
- 8½" Standard Paper; 80 Character Line Length
- 30 Characters Per Second
- Compact—12½" W x 17½" D x 5" H

The Teleprinter is serviced by RCA Service Company.

Diagnostic Module For AE-600 Editing System Maintenance

A diagnostic "self-test" module is now available for AE-600 Editing systems. The module is an operational/troubleshooting aid used for confirming proper system operation or to identify specific system faults.

The diagnostic module, MI-593587, systematically tests all possible operating functions of the system from either a local or a remote AE-600 control panel. Each diagnostic test step is manually sequenced by the operator from the control panel keyboard, with resulting status indication displayed on the panel.

Besides checking the IC components, the diagnostic module a) generates all operational system commands and checks return status signals, b) checks all control panel switches, status lights and numeric displays, c) verifies interface signal status, and (d) checks operational features of the AE-600 options such as the time code generator, video character generator, monitor display interface module, and the external monitor display assembly.

The diagnostic module is supplied complete with an operating/troubleshooting instruction manual.



TK-76: rain-checked at NAB.

Our NAB "rain shower" demonstration doused the TK-76 44 times. No other TV camera went through any test like it.

Viewers saw the TK-76 come right out of its case and go on-line from cold start to crisp picture in just five seconds.

And they watched the great pictures this portable delivered with only 20 foot-candles of light.

These are just a few of the high-performance features of the lightweight self-contained, highly automatic TK-76. It's no surprise that more than 400 are already in use.

If you missed seeing the TK-76 swinging in the rain at NAB, check with your RCA Representative.

Call him today.

The RCA logo is displayed in a bold, orange, sans-serif font. The letters are thick and blocky, with a slight shadow effect behind them.

The Dependables

