



# Broadcast News

Volume No. 163, March 1978



**New Bahaman TV Service  
Opens with Royal Fanfare**



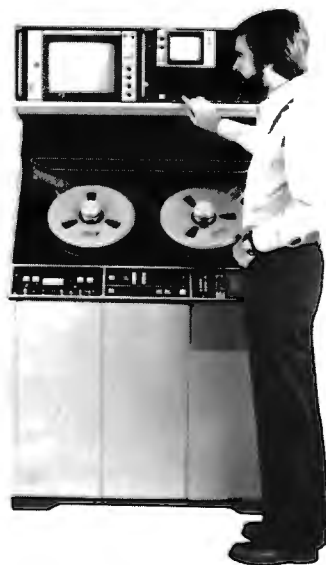
# TR-600A: first and only quad VTR with an editor's heart.

The new TR-600A is great VTR with a dramatic "first": AE-600, an integral on-line Time Code Editing option with built-in microprocessor control. The TR-600A with AE-600 is an editing system capable of operating one record and up to 8 playback TR-600A VTRs, plus three other sources.

## More quad per dollar.

A great basic quad VTR is the best foundation for a good editor. The TR-600A has all-modular electronics. Includes desirable features that cost up to \$20,000 to add to other VTRs. Offers a raft of options, including Super Highband/Pilot Tone for automatic picture correction. All housed in a cabinet that fits in 7 sq. ft. of van or studio floor. All at a surprisingly low price.

For the convincing story of the TR-600A, see your RCA Representative.



# RCA



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**Queen Elizabeth Opens The Bahamas' Own TV Service (cover story)**

A royal salute goes to ZNS-TV, an all-new, all-color TV station that went from on-air to extensive on-location coverage of the Queen's visit in just three months. Herewith is a written and pictorial account of Her Majesty's busy rounds, as well as a description of the facilities.



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**KLAS-TV Opens a New Broadcast Center**

In 1953, TV-8, Las Vegas signed on as Nevada's first television outlet. Another milestone was achieved in 1976 with the opening of a totally new Broadcast Center to handle production as well as broadcast operations. Facility design, equipment and innovations are covered in this article.



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**How TVB Gets the Winning Share of Audience**

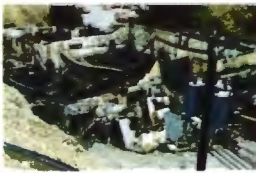
Imaginative use of the latest equipment seems to be a contributing factor keeping this Hong Kong broadcaster on top. This technical exploitation is reflected markedly with the expanding use of the TK-76, in the direction of what TVB calls Total Video.



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**Everything's Changed But the Location for KPLR-TV**

Instead of moving to the suburbs, St. Louis' independent TV-11 opted to stay at its in-town apartment location—while completely revamping its technical facilities. The difficult job was accomplished without losing air time.



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**From Ashes to On-Air in Less Than Two Weeks**

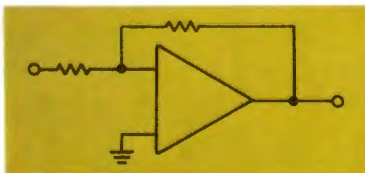
Totally destroyed by fire last September 30, West Virginia station WOAY-TV set an impossible goal—to be back on-air October 10 to broadcast the World Series. Meeting this goal involved a major league effort.



Page 33

**Circularly Polarized TV—The Concept Has Become a Reality**

While circularly polarized TV systems are not yet commonplace, they have progressed quickly from theory and tests to on-air operations. This article provides an overview of CP; its benefits, and available hardware, particularly the RCA antennas developed for circularized operation.



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**Basic Linear Integrated Circuits**

A basic acquaintance with linear integrated circuits is essential for broadcast technicians involved in equipment maintenance. Jack Castleberry of the Technical Training staff writes with that purpose in mind—to provide the required background for understanding the operation of various circuits.

# View Finder

## Argentina Buys \$3.3 Million In TV Systems To Air '78 World Soccer Matches

The 1978 world championship soccer matches in Argentina will be televised using RCA television video tape and film systems.

"Argentina 78 Televisora", the organization responsible for TV coverage and transmission of the matches, placed a \$3.3 million order for equipment which includes sixteen TR-600 quadruplex video tape recorders and six complete TK-28 telecine islands.

Ten TR-600's will be installed at the main TV studio facilities to be established in Buenos Aires, where they will provide editing service for international broadcasters covering the soccer matches. Each of these machines will be equipped with RCA's AE-600 editing system to provide them with sophisticated time code editing capabilities.

Preliminary matches to be held in the cities of Rosario, Cordoba, Mendoza and Mar del Plata will be aired via a TR-600 recorder, located at each stadium. The machines will be equipped with RCA's new SE-1 editing system for simple, fast editing requirements.

Two additional TR-600's located at the Balcarce satellite transmission site, will be used for worldwide TV transmission.

The four soccer stadiums will also be equipped with TK-28 telecine islands to provide film originating capabilities. Two additional telecine units will be installed at the Buenos Aires studios.

At the conclusion of the soccer matches most of the television studio systems will be moved to the Buenos Aires studio to form a new Argentina TV production center.

TWO VIEWS of the New York World Trade Center television broadcast antenna system.

The massive multi-station antenna structure, the largest single stack antenna ever designed by RCA, is now being prepared at the RCA Broadcast Systems antenna facility at Gibbsboro, N. J.

The antenna structure, weighing 362 tons and measuring 351.5 feet, will reach a height of 1,728 feet above street level when mounted on the north tower of the World Trade Center, the highest structure in the city.



## Louisiana ETV Network To Expand Operations With RCA Transmitting System

The Louisiana Educational TV Authority has ordered RCA TV transmitting systems, valued at more than \$1 million, to provide programming to viewers in the state's northwest section.

The 60-kilowatt UHF transmitter, TTU-60 and custom-built antenna system will be installed in Shreveport, La., and will produce approximately 1.7 million watts of effective radiated power on Channel 24, according to Coy Simmons, Director of Engineering for the Authority. The equipment order also includes a new 1,000-foot tower.

"The Shreveport station is the third in our planned statewide network aimed at providing educational TV coverage to all major population centers of the state," Mr. Simmons said.

The Authority's flagship station broadcasts on Channel 27 in Baton Rouge. Viewers in the northeastern part of Louisiana are served by Channel 13 in Monroe.

Louisiana educational TV carries Public Broadcasting System and Southern Educational Communication Association programs, supplementing them

with locally-produced programming of special interest to its viewing audience.

## First Full-Color TV Station In Dominican Republic

The first full-color television broadcast station in the Dominican Republic is scheduled to go on air early this year with RCA television equipment valued at approximately \$2 million.

Tele-Antillas Corp., owner of the new Channel 2 outlet located in Santo Domingo, is supervising installation of the equipment which includes television studio systems, outside broadcast equipment and transmitting systems. The contract also provides for complete installation service by RCA.

The new studio will have three TK-760 television cameras, a complete TK-28 film originating system, three HR-1060 videocassette editing recorder/reproducers, and associated switching, monitoring and control equipment.

An RCA-equipped compact television van will be used for on-the-scene program and commercial production. The van will carry three additional TK-760 cameras and two HR-1060 recorders, as well as switching, audio and intercom equipment.

The new station's transmitting system will consist of an RCA TT-15FL, 15-kilowatt transmitter, and Superturnstile six-bay antenna, mounted on a 200-foot tower.

## WTTV Goes To Circular Polarization

WTTV, an independent VHF station serving Bloomington and Indianapolis, Indiana, is joining the ranks of television stations broadcasting a circularly-polarized TV signal.

The Sarkes Tarzian Inc. station, operating on Channel 4, is installing a new 25-kilowatt transmitter and VHF Fan Vee circularly-polarized antenna from RCA.

The new TT-25FL transmitter replaces the station's lower-power model. The new TFV-7A4 antenna is a seven-layer system designed for tower top mounting. Each layer is composed of two bays, one for the horizontal and one for the vertical components of the circularly-polarized signal.

The new transmitter and antenna combination allows the station to broadcast the circularly-polarized signal at the maximum allowed power for the station's antenna height.

## One-Inch Video Tape Recorders Added To RCA Line

A new line of high quality one-inch helical scan video tape recorders for broadcast and teleproduction applications is now being marketed by RCA Broadcast Systems. Included are the TH-100 compact studio recorder; the TH-50 portable recorder, and accessories such as the TBC-100 digital time base corrector.

The new products will be available in NTSC, PAL and SECAM models.

The one-inch tape products are designed and manufactured by the Sony Corporation and are being marketed by RCA under an agreement with Sony.

Complete product support will be provided by RCA for the tape recorders and accessory equipment, including warranty services, replacement parts, Tech Alert assistance and customer training seminars.

Demonstrations of the recording systems will be conducted by RCA at the NAB Convention, with deliveries commencing soon after the exhibition.



## **Forward Communications Upgrades Five Stations With \$2.5 Million In Equipment**

As part of an ongoing technical improvement program aimed at providing the best service to station viewers, Forward Communications, based in Wausau, Wisconsin, is upgrading the technical facilities of its six group stations with RCA television broadcast equipment valued at \$2.5 million.

The purchase calls for 50-kilowatt transmitters for KOSA-TV, Odessa, Texas, and WTRF-TV, Wheeling, West Virginia, and a UHF TV broadcast antenna for WMTV, Madison, Wisconsin, and WRAU-TV, Peoria, Illinois. Also included are eighteen color cameras.

Each of the four stations plus WSAU-TV, Wausau, the flagship station, and KCAU-TV, Sioux City, will receive two RCA TK-46 studio cameras and one TK-76 electronic news gathering camera.

## **North American Video Installs TR-600 Tape Machines And Editing Systems**

North American Video, a New York City TV commercial and program production facility, is equipping its new studios with RCA video tape recorders and editing systems.

Burton Grodin, President, said three TR-600 quadruplex recorders will be installed in North American Video's studios at Three East 57th Street to handle an increasing teleproduction workload. The new recorders are equipped with RCA's AE-600 time code editing system which provides sophisticated post-production editing capabilities.

## **New RCA TV Transmitting System For CKVR-TV**

CKVR-TV, Barrie, Ontario, Canada, has ordered a complete RCA TV transmitting system, valued at approximately \$400,000.

The new equipment includes a TT-25FL, 25-kilowatt VHF transmitter, which will replace an older RCA model, and a TF6AL Superturnstile antenna, which will replace CKVR-TV's antenna facility which was destroyed accidentally. The station, which broadcasts on Channel 3 in Barrie, plans to place the new equipment in service early this year.

## **\$1 Million Equipment Purchase By Park Broadcasting**

As part of an ongoing program to modernize its technical facilities, Park

Broadcasting Inc., headquartered in Ithaca, N. Y., has ordered RCA color television broadcast systems valued at approximately \$1 million for five of its group stations.

RCA TCR-100 video tape cartridge recorders will be installed at WBMG, Birmingham, WSLS-TV, Roanoke, and WDEF-TV, Chattanooga. Each recorder will be equipped with a Signal Processing Unit which allows the TCR-100 to operate as a stand-alone unit either on line or as an off-line recorder.

WBMG will also install a TR-600A quadruplex video tape recorder, while WSLS-TV will upgrade its studio operation with the addition of two TK-46 TV cameras.

WTVR-TV, Richmond, and WNCT-TV, Greenville, will enhance their electronic news gathering capabilities with the addition of the TK-76 portable camera.

## **CFQC-TV, Saskatoon, To Install New Transmitting System**

CFQC-TV, Saskatoon, Saskatchewan, Canada, has ordered a new RCA television transmitting system, valued at approximately \$500,000.

The RCA TT-35FH, 35-kilowatt VHF transmitter is scheduled for broadcast service this spring, replacing an RCA transmitter which the Channel 8 station has operated since 1954.

The new transmitting system consists of two individual transmitting units, which are combined to provide a maximum of 35-kilowatts of visual power with full transmitter redundancy. The system includes an OPTO Switcher (Optimized Parallel Transmitter Output) which allows the visual and aural outputs of the individual transmitters to be operated in various selected configurations.

## **WVUE-TV, New Orleans Upgrades Studio And Transmitting Plant**

WVUE-TV, New Orleans, La., has ordered RCA transmitting and studio equipment valued at approximately \$900,000 to upgrade its technical facilities.

The Channel 8 station, recently acquired by the Gaylord Broadcasting Co., will install two RCA TT-25FH, 25-kilowatt transmitters, operating in an alternate/main configuration.

WVUE-TV will expand its production and on-air video tape playback capabilities with a second RCA TCR-100 video tape cartridge recorder. Other studio equipment on order includes a TKP-45 portable studio-quality produc-

tion camera, a TK-76 electronic news-gathering unit, and a TFS-121 digital video frame synchronizer which makes possible the smooth intermix of remote and studio signals.

Douglas J. Elleson, WVUE-TV's Vice President and General Manager, said the equipment purchase is part of a continuing program to improve the station's broadcast equipment to provide viewers with the best possible service.

## **Expansion In Sight For LeSea Broadcasting Stations**

LeSea Broadcasting Corp., Indianapolis, Indiana, has ordered \$1 million in RCA TV systems in a major move to upgrade and expand the technical capability of its three television stations.

The order calls for four TR-600 video tape recorders, in addition to four TK-46 studio cameras, a TK-76 portable unit and two complete TK-28 telecine islands.

The equipment will be installed in the studios of WHMB-TV, Indianapolis, flagship of the network; WHFT-TV, Miami, and WHME-TV, the group's newly-acquired outlet in South Bend.

Dr. Lester Sumrall, President of the LeSea Broadcasting Network, said the group's stations will continue to televise family-oriented and religious shows, including prime time gospel programming.

## **KTVT, Ft. Worth/Dallas, Upgrades Facilities**

Ft. Worth/Dallas station KTVT is upgrading and improving its technical facilities with RCA transmitting and film originating equipment.

The independent broadcast station, operated by the Gaylord Broadcasting Co., will install an RCA TT-50FH transmitter and a TK-28B telecine camera.

The transmitter consists of two 25-kilowatt units combined to deliver 50-kW visual output, with full redundancy in the event of a failure in one of the units.

## **Two Venezuelan Stations To Improve Service**

Radio Caracas Television will be upgrading facilities of two of its stations as a result of an order placed with RCA for new broadcast equipment.

The equipment order calls for a TT-25FL 25-kilowatt TV transmitter and related equipment which will replace lower power RCA transmitting equipment at the Venezuelan radio-TV network's Channel 2 outlet in Maracaibo.

YVKS-TV, the network's flagship station in Caracas, will receive a complete TK-28 telecine system.

## TV Formosa, Argentina, To Improve Service With Equipment Order

TV Formosa, serving the Argentina Province of Formosa, will upgrade and expand its broadcast facilities with an order placed with RCA by the Ministry of Public Works and Services for TV transmitting and studio systems.

The station is replacing an existing low power transmitter at the Channel 11 outlet with an RCA TT-17FH 17-kilowatt transmitter, and other associated equipment.

Station program origination capabilities will be enhanced as well with the addition of a TK-28 TV film system and a TR-600 quadruplex video tape recorder.

## Two Week Weather Forecasts Probably In 1980's

World-wide weather forecasts of up to two weeks in advance may lead to tremendous economic savings in the 1980's, say the RCA scientists who develop weather satellites.

Soon a new generation of satellites, called the TIROS-N series, will begin to provide most accurate weather and environmental information ever received from space, enabling forecast-

ers to predict climatic trends accurately up to a week in advance, and eventually to two weeks.

Highly-accurate, extended forecasts could bring enormous economic benefits. Current weather predictions of two days already result in significant savings in the U. S. for agriculture, the transportation industry, retail marketing, the lumber industry, the recreational business and others.

More than 80 nations now have weather satellite stations to take advantage of the global economic benefits of extended forecasting.

Weather and environmental information gathered by the TIROS-N will be processed and distributed at National Environmental Satellite Service Headquarters in Suitland, Md. In addition to weather forecasting, the information will be used for hurricane tracking, storm warnings and in agriculture, commercial fishing, forestry, marine shipping and other industries.

The TIROS-N will include a network of other airborne and ground weather gathering stations. The spacecraft will provide visible and infrared imagery of the earth and its atmosphere and temperature profiles of the atmosphere.

It will collect readings from several

thousand data collection locations on land and at sea and will measure the vertical temperature and moisture distribution in the atmosphere. In addition, the satellite will measure energetic particles for solar research and radiation warning.

For over 17 years RCA-built satellites have helped provide weather data used in this country and abroad for more accurate weather forecasts. During that time, 25 polar-orbiting weather watchers have been lofted into space, sending back to earth more than 3.3 million weather pictures and other vital climatic information.

## Pakistan Television Corp. Adds Studio Equipment

Pakistan Television Corp. currently is installing RCA color television studio equipment valued at nearly \$500,000 to expand its program production capabilities.

Four TK-76 television cameras will enhance the news and documentary program capabilities at Pakistan TV's facilities in Karachi and Rawalpindi. Two TK-46 studio cameras and a TR-600 quadruplex video tape recorder also are being installed for program preparation and origination.

INTEGRATED RADIO ROOM, destined for eventual installation aboard the U. S. Navy's Trident ballistic missile submarine, undergoes final testing at the RCA Government Communications Systems plant in Camden, N. J. The Integrated Radio Room is an advanced communications system that allows for control of shipboard communications from a single console.





**A**s the Canadian Royal Armed Forces jet touched down at Nassau's International airport, all was in readiness for ZNS-TV's coverage of the two-day visit of Her Majesty Queen Elizabeth and her husband Prince Philip. Following the Queen's Silver Jubilee Tour of Canada in late 1977, the Bahamian visit was a historic occasion.

It was the first time a reigning monarch opened a session of The Bahamas Parliament, and officiated at the opening of a TV facility beyond England's shores. And ZNS-TV, The Bahamas' newborn station, provided live and recorded coverage of these ceremonies, as well as many other events in the 31-hour whirlwind tour.

#### **Establishing an Identity**

But for all the importance of the official visit, there was even greater significance from the standpoint of broadcasting.

Among the island nations in the West Indies, local television is in its infancy, and in some cases only in the embryonic stages. The Bahamas' new television service is a landmark for a variety of reasons.

Major stages of development occurred in relatively brief periods of time. Less than two years spanned the first commencement of television negotiations and the station dedication; only three months elapsed from the on-air date to coverage of the royal visit.



# *Royal Visit*

**MARKS NEW HORIZONS FOR**



But what is perhaps most noteworthy is that inception of the new service is a big step towards strengthening all-important national identity. A full range of American TV programs has been beamed in for years from Florida. And although they'll be a part of the programming mix, The Bahamas' own television service introduces a dimension of relevance. For the first time, local programming is available, giving Bahamians an opportunity to see and understand themselves—through their history, their art and their politics.

With ZNS-TV's broadcast of the royal visit, the Bahamians witnessed a distinguishing characteristic of their culture. Even though they gained their independence four years ago, they appreciate their British heritage. Which

is why ZNS-TV was among the most avid queen-watchers.

### Coping with "Royal Time"

Three roving news units, each using a TK-76 camera and HR-1020 portable cassette recorder, along with the station's new compact mobile van, covered almost everything in the royal program. The grand Bahamian welcome and enthusiasm met the royal couple everywhere they went. With so much fun and celebration, as well as pride, patriotism and pageantry, the cameras were never at a loss for unique and interesting pictures.

For any major outside event covered by television, highly mobile cameras with a minimum of associated equipment are essential. But when a Queen visits, this requirement seems even more

critical, as everything happens on precise "royal time".

For example, the Queen's aircraft arrived at Nassau's airport at 3:10 PM—as scheduled. At 3:12 PM—as scheduled—the royal couple disembarked and the Royal Bahamas Police Force Band struck the first note of "God Save the Queen".

After being received by the highest dignitaries present, the Queen ascended a red-carpeted Saluting Base, the Guard gave a royal salute and the band played The Bahamas' national anthem—"March on Bahamaland".

Accompanied by the Officer of the Guard, her Majesty proceeded to inspect the Guard, and receive Senior Officials.



## BAHAMAS TELEVISION

High-energy TK-76 news units roll forth after the Queen's arrival at Nassau airport. All three of the station's TK-76 news units were off repeatedly in such fashion to cover the tight schedule of royal engagements.

### Aggressive Pursuit

Meanwhile, as protocol and Buckingham Palace press regulations dictated up to this point, ZNS-TV's roving news crews were cordoned off with all the news photographers.

It was only when Her Majesty and Prince Philip were escorted to the waiting crowd on the sidelines that the press was free to follow. Amid organized chaos, the TK-76 newsgathering teams were in hot pursuit.

A few minutes later, at 3:37 to be exact, The Queen and Prince Philip were en route to Clifford Park for the official Welcoming Ceremonies commencing at 3:55.

Here again the high mobility of the electronic newsgathering equipment proved advantageous. To arrive before the royal party, the ZNS-TV news crew assigned to Clifford Park had to dash across the airport apron to the station's Land Rover waiting to whisk them away.

Upon arrival, the cameraman took his pre-arranged position on the parade grounds lined with an estimated crowd of 20,000. The TK-76, always ready for a quick start, began shooting the impressive welcoming show almost immediately.

It was a kaleidoscope of color. Aqua, gold and black Bahamian flags fluttered about. Different uniforms and banners of various youth organizations created rows of variegated patterns. And the Royal Bahamas Police Force Band and Guard of Honor accented the visual display with their crisp black-and-white uniforms.

### Putting Spectators Up Close

The camera also captured the royal couple's delight as the ceremonies unfolded before them. The National School of Dance performed. And The Baha-

mas' own carnival, the Junkanoo, with their cowbells and goat-skin drums, added a foot-tapping beat to the eye-catching displays that followed.

Due to the huge size of the crowd at Clifford Park, there were those who could not see the royal couple or the ceremonies. And just about everyone wanted to catch at least a glimpse of Her Majesty for, as one Bahamian explained, seeing a reigning monarch is a privilege you don't have too often.

The TK-76 put anyone who couldn't see in close proximity later that night when the station ran taped highlights of the day's events.

### Covering A Historic Moment

The next day, ZNS-TV took full advantage of the productivity of the TK-76's as well as the compact van for live coverage of the State opening of

Parliament by the Queen. This took place at the Parliament Buildings on Rawson Square in the center of town.

The cameras were well suited to their specific assignments. Outside, three TK-76's covered the royal couple's arrival, and the curbside ceremonies. The van's two TKP-45 portable production cameras were deployed inside the Senate Chamber. Two of the TK-76's were genlocked to the van nearby so all four cameras worked as a system for sequential, live coverage. Switching took place on the van's switcher.

Because there was so much camera activity, directions had to be relayed quickly to all operators. TACTEC portable radios were used to do this, thus permitting close contact among team members without impairing independent use of the cameras.



For the opening of Parliament, curbside ceremonies were covered with three TK-76's, two of which were genlocked to the compact van's two TKP-45's inside the Senate Chamber. All cameras were linked with TACTEC portable radios.



Once the royal couple left the range of the TK-76's close to the street, another near the entrance to Parliament picked them up as they were about to enter still another ceremonious occasion in the Senate Chamber.

Here is where the use of production-type cameras was essential. With ecclesiastical scarlet and dark wood, black robes and white wigs and the Queen's glittering finery, it was a scene of pomp and splendor. But with only 1050 lux illumination allowed, it was a tricky scene to handle.

The TKP's reduced the difficulties considerably with the automatic features for iris and black and white levels, as well as shading controls operated from the cameras' CCU's in the van.

After the opening of Parliament, live coverage ceased and a TK-76 roving

crew took over, taping the couple's return to the Royal Yacht Britannia, anchored at Prince George Wharf.

#### Queen Opens Station

In the afternoon of that same day, the Queen officially opened ZNS-TV, The Bahamas' new \$6.5 million television facilities in the Centreville section of Nassau. Large crowds lined the approach to the complex and clung to the chain-link fence.

The roving ENG crew caught the excitement of the moment as the royal couple stepped out of the open Rolls Royce.

Along with members of the Royal household staff, the Queen and Prince Philip were escorted into the new building for a brief tour of the facilities.

"It's lovely," the Queen said upon en-



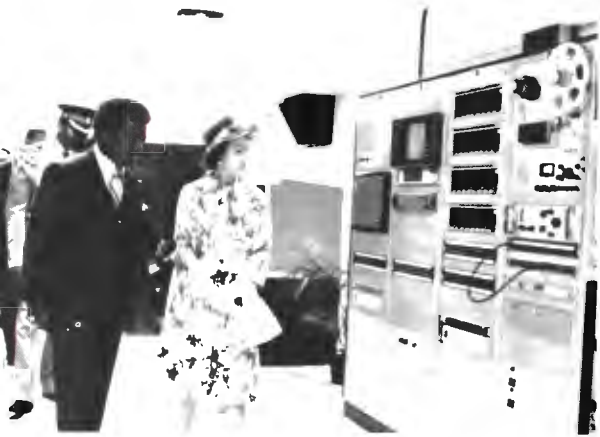
The Royal Bahamas Police Honor Guard performed in front of the Parliament Buildings (top) prior to the arrival of the royal couple (bottom) amidst crowds that gathered in vast numbers along Bay Street.



Following the opening of Parliament, covered live with the TKP's, the Queen and Prince Philip appeared on the balcony of the Senate building to wave and smile at the crowd below.



From the station building's loggia, a nimble TK-76 lenses invited guests' eagerness of anticipation for the Queen's arrival to open the station officially.



Prior to dedication ceremonies outside the station building, the Queen had a brief tour of the new TV facilities. (Above, counterclockwise) Studio A, the main production studio; Master Control room; Telecine area; and Studio A control room. The RCA equipment is valued at approximately \$2.5 million.

tering. Walking through Master Control, she appeared quite interested, and intent on knowing the purpose of equipment whose functions were not immediately apparent.

In TV Studio A, at prior request, the Queen witnessed taping of a local program, "It's Academic", a weekly quiz show in which Bahamian high school students participate.

Once outside the TV studios, the royal party ascended the dais for the dedication ceremony commemorating the official opening.

For this, a TK-76 sat on a tripod amid the invited guests, both of which had no respite from the hot afternoon sun before and during the station dedication.

#### **Thanks, for the Concerted Effort**

In welcoming Her Majesty and the invited guests, Kendal Nottage, Minister of Youth, Sports and Community Affairs, as well as Chairman of the Broadcasting Corporation of The Bahamas,

spoke of the importance of communications in the 700-island Bahamian archipelago. He referred to the new broadcast medium as a means of uniting the Family Islands with New Providence Island, where Nassau and the new TV facility are located.

In his remarks, Mr. Nottage also expressed the Corporation's gratitude for those who assisted in the development and implementation of the facilities.

These included RCA, which supplied and installed the TV systems and initiated technical training; the Caribbean Broadcasting Union, of which the station is a member; WTVS Channel 4, Miami; and the Canadian Broadcasting Corporation and Ryerson Polytechnical Institute which provided formal training in television production.

Then, in a brief ceremony, the Queen pulled a drawstring which opened blue velvet curtains to reveal a plaque dedicating the new station. Following this,

the royal couple prepared for their departure, while a two-person news crew pushed through the crowd.

Only a dockside farewell later that night remained to bring to a close the fast-paced and exhausting schedule set for the official visit.

#### History of RADIO BAHAMAS

It was with justifiable pride that ZNS-TV management considered the challenge to their capabilities for TV coverage of the visit successfully met.

But this success story is even sweeter when one compares this rather sophisticated start-up with the interesting, but meager, beginnings of radio broadcasting in 1936.

At that time, RADIO BAHAMAS began operation as the Broadcast Service of the Telecommunications Department with a studio on Shirley Street in the "Snappy Hat Shop". The station was on the air for only four hours each day, and had a power of 500 watts. Its main purpose was to provide a means of informing people in the Family Islands about weather and shipping, with emphasis on the issuance of hurricane warnings.

Over the years, radio broadcasting grew to include three radio services, both AM and FM: ZNS-1 (Radio Bahamas), ZNS-2 (Radio New Providence) and ZNS-3 (Grand Bahama Service).

#### History of ZNS-TV

Now, The Bahamas has its own color television service. Using the NTSC system, it broadcasts some six hours daily, and slightly longer on weekends.

Although plans call for eventual TV coverage for the entire archipelagic nation, the newly inaugurated service covers mainly New Providence Island, as well as the family islands of Eleuthera, Andros, Exuma and Bimini—about 70% of the population.

The current phase of TV development began when the Broadcasting Corporation of The Bahamas commenced television negotiations at the end of 1975. In January 1976, with the help of the Caribbean Broadcasting Union, the Corporation convened a meeting in Nassau to discuss the basis for the inauguration of television.

After listening to suggestions of different approaches from TV representatives



Backdropped by one of the roving TK-76's at the station dedication, the visitors' book now contains the ultimate in distinguished signatures.

from Bermuda, Jamaica and Surinam, the Bahamas delegation articulated the kind of system it wanted. Then, the delegates formulated a package for the implementation of the desired system, and asked six of the world's top broadcast-equipment manufacturers to bid on the equipment package as a system.

#### A Complete Systems Service

Out of all this came the splendid new ZNS-TV building, and a technical installation with most of the equipment supplied by RCA.

- 3—TK-46 color studio cameras
- 2—TK-28 color film islands, complete with film and slide projectors
- 2—TR-600A quadruplex videotape recorders
- 2—HR-1060 videocassette recorders with editors
- 2—Time Base Correctors (TBC-1000)
- 3—TK-76 portable color cameras
- 4—HR-1020 portable videocassette recorders

1—compact TV van with two TKP-45 portable production cameras, a TR-600A VTR, a video switcher and audio and intercom systems

Towers, antennas, microwave equipment, transmitters, audio equipment, BCS-2000 intercom system and TACTEC portable radios.

The layout of the building addressed the systems approach, based on each piece of equipment's integration into the system as a whole.

#### Priority on Openness

All of this is reflected in a building, 150 x 92 ft overall, with two levels of offices and studios.

Just behind the reception area at one end of the building is the entrance to Studio A, the main studio. Measuring 40 x 60 ft, it provides ample room for operation of the station's three TK-76's, bleacher-style seating for an audience and one or two sets.

Currently, on a daily basis, the studio is used for only one hour of local production, half of which is devoted to the seven o'clock evening news.



#### Access Corridor

Also off the reception area, running the building's length, is a corridor providing access to offices on one side and technical and production areas on the other.

As a point of interest, the office side includes a "community announcement" room, or "electronic mail" system. Bahamians can send personal messages free of charge to family and friends on other islands via radio stations ZNS-1, ZNS 2 and ZNS-3. The main operating facilities for these stations are housed in a separate, but adjacent, building.

#### Multi-Function Room

The corridor also leads to Master Control. It's a generous-sized room (70 x 16 ft) allowing the Master Control operator a clear line of sight to observe and monitor tape, telecine and rack operations.

The control console includes a switcher, remote controls for telecine and tape machines, a BCS-2000 intercom system, a time clock, joystick video controls and CCU's for the three TK-46's. Near the console is a series of

racks containing the TV modulator, distribution amplifiers, microwave link controls, an RT-21 audio tape recorder and switcher control for Studio A.

In an adjoining area in the same room sit two TK-28 film chains. Each is interfaced with two TP-66 16-mm film projectors and a TP-7 35-mm slide projector. One is also fitted with a Super-8 film projector. Everything is remotely controlled to the Master Control console at the other end of the room.

Nearby is the tape area with two TR-600A VTR's used for recording and delayed broadcast. Simple editing is performed with the aid of the recorders' built-in electronic splicers. However, SE-1 editors will be installed shortly for full-scale editing.

Opposite the TR-600's are two HR-1060 videocassette units for dubbing from quad to cassette and vice-versa, as well as playback to air. TBC-1000 Time Base Correctors are employed for the latter.

Next door is Studio B. It is 30 x 40 ft, and will be put into use as the need arises.

Kendal Nottage (right), Minister of Youth, Sports and Community Affairs, as well as Chairman of the Broadcasting Corporation of the Bahamas, and Calsey Johnson, ZNS-TV General Manager, in front of the station's handsome new building.



A 110-ft microwave relay tower rises behind the building. The transmission tower is with the transmitters two miles away.



#### Purpose-Designed Second Level

The second floor has the same corridor-type access, for executive and administrative offices, in addition to studio control rooms. Studio A's, 40 x 16 ft, overlooks the camera studio by means of a large picture window. In this room are a triple re-entry switcher, studio-lighting control and audio consoles.

Close-by, but separated by a viewing room, is Studio B's control room.

#### Complementing the Studios

The compact van's role in the technical facilities is part of the station's plan to eventually help sustain itself by income received from sales of commercial time. This includes a package service whereby the van is utilized for production of commercials for local businesses.

This had already begun with clients such as the Bahamian Lumber Company.

The staff's experiences with the van for the remote broadcasts to date will stand them in good stead for this endeavor.

#### Ingoing and Outgoing Signals

Outside, a 110-ft tall microwave relay

tower rises up directly behind the building, and is the only obvious clue to passersby as to the building's purpose. Painted bright red, this triangular tower holds four horns to receive microwave signals from just about any point on New Providence Island. It also has antennas for the station's TACTEC two-way radio communications.

The transmitting system consists of two 2.5 kW units operating in parallel. Combined with the antenna, they produce 50,000 watts ERP. Both are located at a site approximately two miles away, which is the highest point on the island.

#### More Difficult the Goals, The Sweeter Success

Whether it's producing commercials or programming, or maintaining the quality of its signal, ZNS-TV is ever mindful that continued success will not be easy for a brand-new color broadcaster to achieve.

But this isn't anything new to staff and management. The high ideals, faith and concerted effort that have brought them through so far indicate that they can do it.





## KLAS-TV Moves Into New Television Broadcast Center

From this attractive skylighted lobby/reception area of the KLAS Broadcast Center, visitors are directed to the Administrative or the Operational areas.



KLAS-TV, Las Vegas has the distinction of being the first TV station on-air in Nevada, signing on in 1953.

Since then TV-8 has experienced numerous auspicious events, None of these, however, matches that of July 19, 1976, when KLAS-TV occupied its totally new Broadcast Center. This event capped a plan and a dream nurtured for many years by General Manager, Mark Smith.

During the years of operating from an aging, outmoded broadcast facility, Mark Smith knew that the Las Vegas market needed—and was ready for—a facility capable of handling major television productions. The new TV-8 Television Broadcast Center was designed to accommodate both production and broadcast operations.

“With all of the attractions offered by Las Vegas, especially the availability of major talent and resort surroundings,” Mr. Smith says, “I see it as one of the centers of production in the Southwest.”





Production Manager Tony Bond and General Manager Mark Smith in production studio with TK-46 camera. Production was a key element in planning the new KLAS Broadcast Center.

### Striking Architectural Structure

Framed by a striking architectural structure, the new facility provides spacious, functional and efficient working areas for administration and for operations. The layout groups related functions, and minimizes walled in office spaces. The plant which now comprises 30,000 square feet, anticipates future growth in facility needs. The former plant had only 10,000 square feet—about as much as the studios occupy in the new center.

With its bright white facade, and a front wall of windows, TV-8's Broadcast Center is an inviting showcase. Inside, from the lobby to the operating areas, aesthetics and function are blended beautifully.

From the open, skylighted corner lobby, visitors are directed to either the Administrative wing, or the Operations area via secured glass doors.

### Administrative Area Features "Landscape" Layout

Closest to the lobby/reception area in the Administrative wing is the General Manager's office. Beyond this space, the corridor opens on the Sales, Traffic and Accounting spaces.

Instead of the conventional treatment of providing closed-in offices for key personnel in these areas, TV-8 opted for an open, "landscape" layout featuring free-flowing movable walls, with small, functional interior offices. This layout executed with bright colors and modular furniture provides a cheerful, spacious work environment, in striking contrast to the cramped quarters of the old building. At the same time, the new layout maintained the proximity and ease of communication and contact necessary for coordinating business functions.

Traffic and business functions are handled by a Jefferson Data Computer, which has been a cost-effective investment according to Mr. Smith. The business computer is not now involved in the technical operation, other than generating the log; but there are plans for the future to tie it in to machine control to automate the on-air operation.

### Operations Layout Groups Related Functions

At TV-8, Operations Manager Tom Franklin is responsible for just about all operational functions other than sales, accounting and station manage-



Operations Manager Tom Franklin (left) and Chief Engineer Ken Brookhart share responsibility for implementing technical innovations at TV-8.

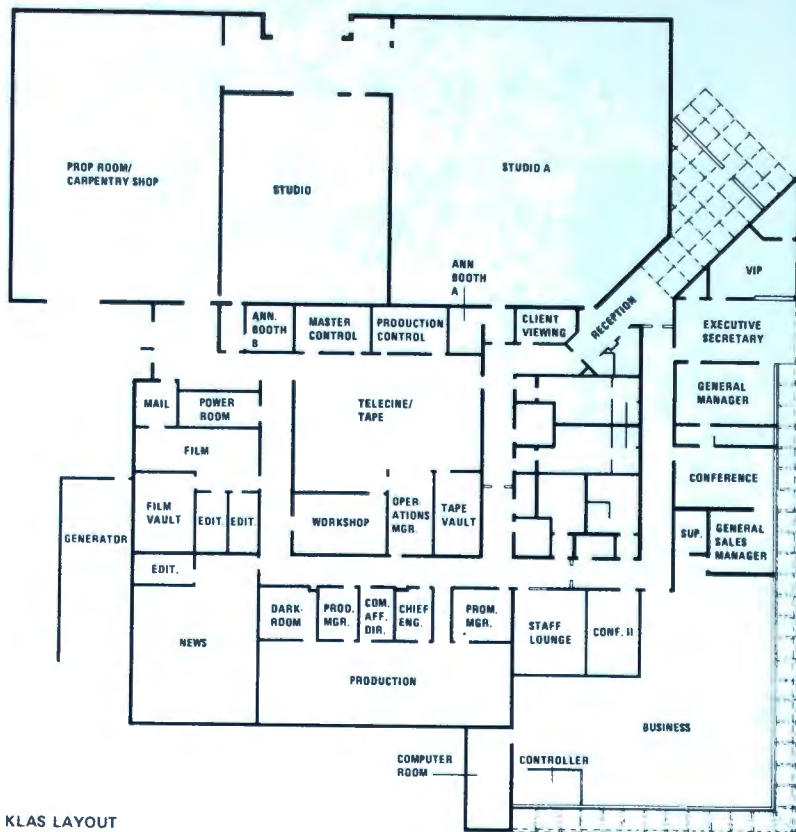
ment—including News, Public Affairs, Production and Engineering.

The layout of the Operations Area, like that for Administration, groups related functions in open spaces. Engineering and Production share an area, while News and Public Affairs occupy separate spaces.

Mr. Franklin came to KLAS early in 1975 as Chief Engineer. At that time, serious planning was underway on the new Television Broadcast Center. The Austin Company had developed architectural plans which were deferred, and the building design was subsequently completed by Archisystems, a subsidiary of Summa Corporation. The overall layout of the new facility was the culmination of years of planning by Mark Smith, with Tom Franklin collaborating in the layout of the technical area.

### Geared For Production

Aside from its functional layout, the technical equipment complement of the TV-8 Broadcast Center is indicative of its capability for handling major pro-



KLAS LAYOUT

ductions and on-air operations simultaneously. There are two fully-equipped telecine islands with TK-28 cameras; three TR-600A quad tape machines equipped with built-in AE-600 Time Code Editing Systems; a TCR-100; Grass Valley 1600 7G Production Switcher; TK-46; TKP-45 and TK-76 color cameras.

In moving to the new facility, budget considerations made it necessary to be selective in making equipment purchases. Emphasis was on getting the best, state-of-art major equipment items first, then upgrading in other areas later. Since production capability was a prime consideration, the TR-600A/AE-600 tape and editing system was included in the initial "buy" package, as were the TK-46 and TKP-45 cameras. Mr. Smith notes that the validity of this approach was confirmed in the first year of operation, when revenues from production tripled those of the old facility.

#### Spacious, Uncrowded Technical Area

The main technical equipment area is open and uncrowded, with ample space between and behind the equipment for ready accessibility. Computer flooring is installed to carry wiring and to provide more efficient air distribution to

the equipment. The room is air-conditioned, kept under positive pressure, and the air is filtered. In effect, it is a "clean room" environment. In addition, smoking is not permitted in this area, which has enhanced equipment performance, Tom Franklin says.

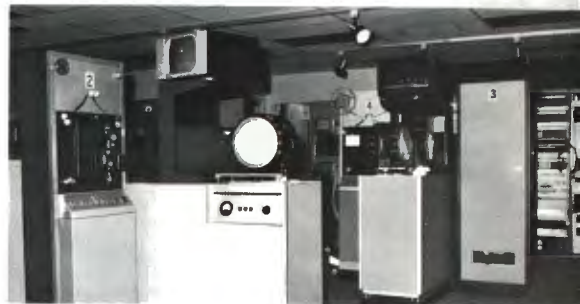
The three TR-600A quad tape machines are positioned side-by-side in a line. Each is equipped with a monitor bridge with a color monitor, and each includes a built-in AE-600 Time Code Editing System. Next to the TR-600's is the TCR-100 "cart" machine which was installed in 1975 at the old facility. It averages 300 plays per day, and keeps the TR-600's free for production.

The two TK-28 telecine islands each include two TP-66 Projectors and a TP-7. The islands are mounted on a steel plate, so the entire system can be moved if necessary without alignment problems.

Near the telecine islands is a row of racks for monitor, control and terminal equipment, including a microwave fault



Quad tape complement at TV-8 includes three TR-600A machines, each equipped with AE-600 Time Code Editing Systems, plus a workhorse TCR-100 "cart" machine.



Computer flooring in technical area facilitates relocation or adding equipment. TK-28 telecine islands are mounted on steel plates to eliminate alignment problems.



Monitor, control and terminal equipment racks. Camera CCU's are to be relocated in a console.

detecting system. (TV-8 operates its own 4-hop microwave system to bring CBS network programs in from Los Angeles.)

Mounted behind the racks is a common control block termination for system controls, including tape and film machines, video and audio switching, and intercom. Terminals are of the quick-connect type. This arrangement simplifies wiring, trouble-shooting, and relocation or addition of equipment.

#### Master Control and Production Control

One wall of the technical area is glassed in and divided into four compartments. The two smaller, outside compartments serve as announce booths. The interior spaces are for Master Control and Production Control.

Master Control is set up so that one man can handle the on-air operation. On weekends, Master Control functions in this mode, with the Master Control operator loading film and tape as well as handling the on-air switching.



Master Control Room.

The Master Control switcher operates on "real time" and is not pre-set. On-air switching is manual, via the "TAKE" bar. All switching is through "Preview" bus and "TAKE" bar. (The "Program" bus was disabled to minimize error.)

In Master Control, to the left of the switcher are joystick controls for the TKP-45, two TK-46's and two TK-28 cameras.

The machine control panel directly at the left of the switcher includes remote panels for the three TR-600's; the two multiplexer outputs; a 3/4-inch VTR, and the TCR-100 remote panel. The 3/4-inch cassettes are used for network delay broadcasts, keeping the TR-600's available for production.

The broadcast schedule ranges from 21 to 24 hours a day, and the transmitter is not shut down. When not broadcasting programs, color bars are transmitted, so the TV-8 control room is manned around the clock.

#### Two Production Studios

The TV-8 Broadcast Center houses two sizable production studios. The main studio is 65 x 68 feet, with a massive lighting system which is believed to be the largest teleproduction lighting system installed outside of Los Angeles.

Each power run for lighting is on a separate circuit (individual conduits) to reduce noise. The board has 18-12 kW dimmers and 12-6 kW dimmers.

The second studio, 40' x 50', is presently used as the permanent news set. News is handled as a three-camera production. The news set is visually striking, well lighted and finished in a combination of yellow and brown. Two chroma key areas on the set are painted yellow which has posed no problems for the cameras, Tom Franklin says. In fact, it has been an improvement

over the standard blue chroma key used formerly, since this tended to put a bluish cast across the walnut-topped news desk.

The production switcher is a Grass Valley 1600-7J which does its job well. Each of the TK-46 and TKP-45 cameras is equipped with Chroma Keyer. This facility is employed frequently in going through the switcher to add effects and integrating live and recorded news and commercials.

Even with equipment limitations, the station can handle two productions simultaneously, along with the on-air operation. This, notes Mark Smith, is the kind of flexibility that is needed to accommodate changing needs.

#### Studio Camera Complement

Two TK-46 studio cameras and a TKP-45 field production camera were installed in July 1976 when the new facilities opened. The TKP-45 is generally used as the third studio camera. It was ordered with the "Mini-max". A shoulder harness and hydraped mounting are also available for the TKP-45. This camera adds versatility for production, since it can be removed from the "mini-max" and used in the studio for high or low shots from any angle to achieve desired effects. It is also frequently used for on-location work, and is also rented to outside producers for local production shoots.

#### Active Tape Operation

The TCR-100 video cartridge system was installed in 1975 in the old facility, and averages 300 plays per day, which keeps the TR-600's free for production. The "cart" machine has registered more than 250,000 plays, and just keeps on rolling.

For TV-8, the spot commercials divide off at 70% local and 30% national. This accounts for the heavy usage of the TCR-100. In addition, the broadcast schedule is often around the clock,



Main production studio is equipped with a sophisticated lighting system. Two productions can be handled simultaneously, along with the on-air operation.



The KLAS-TV "news center 8" set is visually appealing and functional as well. Chroma key areas are painted yellow rather than the conventional blue.



Production Control is a busy operational facility.



Versatile TKP-45 Production Camera with "Minimax" adaptor is used on location and as a third camera for studio productions.

so there is a high proportion of non-network time available for local sponsorship.

The TCR is occasionally used for production—for “Tags”; “Opens” and “Closes”. Sometimes it is used as the fourth tape machine, playing back pre-recorded “carts” on demand. All tape commercials are dubbed to “cart”, but film commercials only if they are scheduled for multiple use.

The TR-600's are used basically for production, which is their priority assignment. The frame-accurate edits made with the AE-600 have made it easier to assemble the news, and to achieve crisper, more professional on-air results.

At TV-8, mastering is done on 2" quad machines. At the same time, a 3/4-inch dub is made, with time code, which can be used for picking off the edit points. Many of the basic commercials are taped and edited on the same day.

Mr. Franklin points out that the tape machines are virtually operating around the clock handling production, programming and dubbing requirements. Downtime is critical, and the TR-600's have been reliable. Other than routine maintenance, adjustments and cleaning, machine maintenance is done “on the fly” according to Mr. Franklin. Head-wheel life has been averaging 1100-1200 hours.

#### Production—16 Hours A Day

“From a production point of view, TV-8 has the ideal set-up.” This admittedly biased opinion is shared by Production Manager, Tony Bond and his active staff.

“The production facilities are centralized and well planned,” Mr. Bond adds. In addition to the inside studio and editing facilities, the Production Department operates a compact mobile unit equipped with a TK-76 Camera and a videocassette VTR. While the

Separate mobile units are used by TV-8 for news and production operations. Each is equipped with a TK-76 camera.



on-location recording is with the 3/4-inch cassette, it is transferred to quad for editing, with time code added.

The TK-76 mobile production van operates with a two-man crew, and is kept busy on-location producing local commercials. The camera performs so well that it is also leased on a regular basis to Trans-American Video for their Las Vegas productions.

Production at TV-8 is a 16-hour a day operation, from 7 A.M. to 11 P.M. The TR-600 tape machines are not turned off. After the daily editing assignments are completed, the machines are used for dubbing. Tony Bond likes the TR-600A/AE-600 editing system for production. The AE-600, he says, is excellent for lip sync: “quick, proficient, easy . . . it's a dream.”

At TV-8, Engineering mans the Master Control position; shades cameras, and backs up the tape operation. Loading and unloading the VTR's and the editing operations involving tape machines are also Engineering functions. Production handles cameras, audio, switching, and lighting.

In adhering to Mark Smith's philosophy, the Production Center is set up to serve the needs of the local community first, then national clients. The station is maintaining a strong effort on local and regional commercials, while attracting national production assignments via performance and testimonials.

#### Programmed For Future Automation

Chief Engineer Ken Brookhart typifies the dynamic, youthful look at KLAS. Only 29 years old, Ken Brookhart is friendly, unassuming and brainy, with a University of Missouri computer background. This computer training has been a valuable asset, with the impact of digital technology in broadcasting.

For example, KLAS purchased an Intel 8080 Microprocessor which is now being programmed by Ken Brookhart and

TK-76 on location is a familiar sight amid the familiar Las Vegas landmarks.



Utilizing computer technology to expand automation at TV-8 is a major project for Chief Engineer Ken Brookhart.

Tom Franklin to perform a variety of automation functions. It will be interfaced with the TV transmitter for an ATS-type operation. It will be tied in with the business automation system for automated machine control. And it is also being interfaced with the AE-600 editing system to extend its capability and to provide additional flexibility.

The in-house 8080 Microprocessor is the same as the one incorporated in the AE-600 Editing System. TV-8's new 8080 system includes two floppy disc memories, each of which can handle up to 500 edit points. It can store a number of edit points and can modify the edits without changing the AE-600 program. The Brookhart system “reads” the status of the AE-600 and the tape machines to verify that the system is ready to perform the requested func-

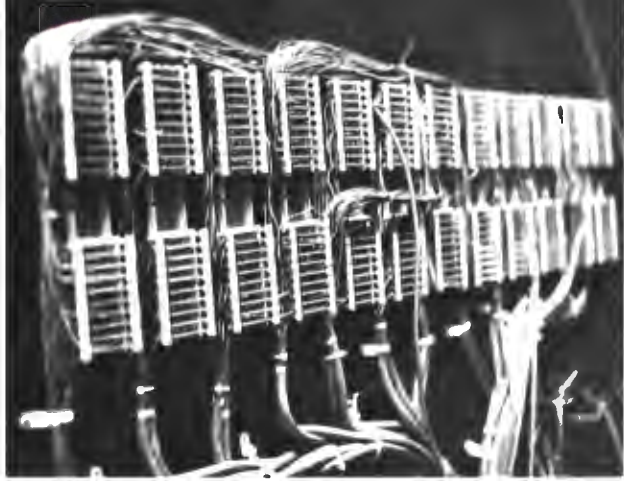


KLAS in-house computer is being programmed to perform a variety of automation functions.

tion. The computer asks questions such as: “Is the machine properly cued?” “Is the tape ready to play?” The computer, for example, asks whether the edit is to be an insert or an add-on. It asks for the desired in and out times. Once all the data is inputted, multiple edits move along swiftly and automatically, with the computer continuously checking to be sure that all elements in the system are functioning properly.

A CRT display with keyboard will be utilized in the editing system. It will function like those used in education

Control signals for tape machines, film chains and remote control panels are routed through a central control block, permitting easy change-out or re-arrangement of equipment.



and training for programmed learning. The purpose is to enable non-technical personnel to handle editing and to feel comfortable with it. The computer "interrogates" the operator to verify that it is performing the requested tasks. If erroneous information is given, or required data is not provided, the computer indicates this and lets the operator make the correction before proceeding.

The computer has 24K ( $\frac{3}{4}$  megabyte) memory, and can be programmed to perform dissolves or cuts along with edits. A three-input mixer will be employed for this function. The production switcher could be accessed for special effects, but this is not planned, since it would limit the use of the switcher.

#### **Coming Later: Automated Machine Control**

The TV-8 computer has 8 parallel ports, 8 bit, and 6 serial ports. The system has excellent versatility and can adapt to varying data inputs, including punched paper tape. In the future, the in-house microprocessor will be used with the Jefferson Data business automation system for automated on-air switching.

Later, the mini-computer will be programmed to operate with the transmitter as an ATS-type system. Ken Brookhart is designing a custom remote control system for the transmitter to function with the computer. Until ATS is authorized by the FCC, the system will involve an operator and a CRT display and keyboard. Instead of automatically correcting for any discrepancies, the computer will request permission of the operator to make the change.

#### **Quick Changeover**

Changing over from the old facility to the new Broadcast Center was accomplished during a three-hour broadcast break between sign-off and sign-on. The combination of pre-planning and a sizable new equipment investment made the change hectic but not traumatic.

One of the TK-28 film islands was in the old building, while the second was installed in the new facility.

The TCR had to be moved, and this was accomplished by dubbing a tape spot reel for the day ahead. The three 2" tape machines were moved first, then the "cart" machine. It was hooked up in place, and played without a hitch.

#### **Central Control Block**

All control signals for the tape machines, film chains and remote control panels are wired to the central block. This makes it easy to change-out or re-arrange the equipment. It provides added system flexibility without disrupting operations. As an example, Ken Brookhart noted that the video switchers initially installed in the system were replaced "on the fly" without losing air time.

In addition to the control block interconnect, the use of computer flooring for carrying the cables adds to flexibility.

The audio and video cables were pre-cut and identified before moving into the new building. Ample cable length was provided to permit relocating the equipment anywhere in the control room area without need for re-cabling. The system is ready now for future expansion, with wiring and DA's already in place for adding more cameras and tape machines.

#### **"Build to the Potential of the Market"**

With all of the resources that Las Vegas offers, TV-8's General Manager, Mark Smith, envisioned not just a new broadcasting plant, but a facility capable of accommodating major production assignments.

"It was quite apparent that we needed a new facility, and if you're going to build one, build it to the potential of the market."

The new KLAS Television Broadcast Center is already tapping the Las Vegas market potential—and anticipating future growth. Mark Smith's plan, dream and philosophy have become a reality. □

The emergency generator used by TV-8 is unusual in that it is a kerosene-powered jet engine instead of the conventional diesel. The engine generates 225 KVA of power, ample to support the technical facilities. Because the engine's pitch is so high, there is less vibration, permitting the station to operate its tape machines while on emergency power.



## HONG KONG

# TVB

Stays on Top  
Technically...

to Help Win its Audience

TK-76 is a major focus among new video techniques emanating from TVB's sophisticated broadcast production center shown in the background.

**W**HEN TVB's Chairman of the Board, Henry W. Lee, was in New York in late 1976, he was urged to take a look at a great new camera NBC news had just begun using. While enthusiastic camera operators extolled the virtues of the TK-76, Lee listened patiently, and then said, "Yes, I know. We've been using ours for nearly three months now."

TVB, or MO 'SIN DIN SEG in Cantonese, has consistently kept abreast of the latest developments in equipment. And that, station management asserts, is what helps keep TVB ahead of its competition.

But that wasn't always the case, which is perhaps the single, greatest reason for TVB's phenomenal and uninterrupted growth.

### Push-Pull for Success

When TVB started operations in 1967, there were no TV sets capable of receiving its signal. The only television then in Hong Kong was cable TV run by the competition.



Henry Wong, TVB's manager of engineering, recalled those first money-losing days when "we first had to convince people to buy television sets that could receive our broadcasts. We did this with good promotion, good programs and a commitment to quality."

In Hong Kong, there's a heavy appetite for the electronic tube, as evidenced by more than 800,000 sets and over 2.5 million viewers in a city of 4.4 million. The latest polls show TVB's capturing an average of more than 80 per cent of the television audience. All 20 top-rated, Chinese-language shows were TVB's, in addition to 19 of the top 20 English-language shows.

The key to the remarkable growth this represents is keeping pace with the changing tastes of its viewers. This, according to TVB, is achieved in large part by taking full advantage of new-technology equipment features, and achieving absolute state-of-the-art every step of the way.

#### Video-Take-Over?

Fast-moving general manager, Kevin Lo, insists there is no master plan at TVB, only an organic organization prepared to adapt quickly to change. Still he sees a clear direction for the future, "total video".

According to Lo, video broadcast of film productions is an expensive, time-wasting hybrid. There are technical advances still to be made, he cautions, before total video is possible for TVB. But, he adds, "We have the confidence to take technical chances and make them work."

With a highly trained engineering and production staff of 380, TVB has the expertise to justify Lo's confidence.

#### TK-76 Enters

The promise of total video came with the delivery of three TK-76's in 1976, the first of the PAL cameras commercially available. They quickly proved themselves on news assignments which caused them to be slammed around the jam-packed streets of Hong Kong. They even weathered typhoons.

Yet, the rugged cameras still produced a high-quality picture, capable of microwave relay from a mountain-top receiver to the station for live broadcast or tape recording for later transmission.

#### Beyond ENG

Once the lightweight cameras proved out so well on the streets, TVB began



TVB's TK-76's are expanding the role of this type of camera beyond ENG applications. Here it is being used to handle teleproduction work for a new dramatic series.

putting them to other uses. First, there were tricky angled shots on TVB's popular variety show "Enjoy Yourself Tonight". Now the TK-76's are being used for regular productions.

TVB's newest dramatic series was planned with the TK-76 specifically in mind. The show "No Man's Land", about life in Hong Kong's squatter slums, had to be authentic. It had to look real, and for TVB that meant it had to be shot outdoors . . . with the TK-76. No film and no other kind of TV camera are used in the production.

With a van for a control room and a collection of shacks for a set, "No Man's Land" is, in Lo's view, the beginning of a better kind of television.

With only one fill light (the sun as primary light) and three lightweight TK-76 cameras, production moves at a fast pace. The setup cuts a normal four days of filming down to three with the TK-76's, and saves two more days in editing.

It also allows the director to concentrate on the actors and the story, and multi-camera positions capture reaction shots simultaneously.

#### A Merger with Film

The location crews are a careful blend of film people and video engineers. TVB prepared its engineers to "speak the language of film" by giving them film training and on-the-set experience. What Kevin Lo wants is not to lose

the virtues of film production, he said, but "to use film technique with video equipment."

Producers and directors seem pleased. Said one: "Now I have much better artistic control over the production. I don't have to ask about the lighting on a shot. I can see for myself how it will look on the monitor."

Not even rain mars the outdoor production. "When it rains," said one crewman, "we just shoot that episode as if it were a rainy day. The TK-76 weathers rain, and puts up with it better than the actors and crew."

Lo is gratified with the results, and plans to expand video production to 60 percent of TVB's 23 hours of weekly local programming. The other 40 percent would continue to be locally produced film, at least in the short run. "It is quite possible," Lo said, "one day we will go to all TK-76 production."



Good saturated-color performance is among the TK-46 camera features exploited fully in the studio production of drama and variety entertainment, including the brilliantly costumed Classical Chinese Operas.

#### **TK-46, in the Studio**

TVB's top program, the weekly drama series "Jade Theater", is produced entirely with the TK-46, and TR-600 video recorders. In the latest monthly survey, "Jade Theater" drew an average of 2,175,000 viewers, almost half of Hong Kong's total population.

The show was recently pushed by production overflow into a converted factory without air conditioning, and thus imposed unusually tough environmental conditions on the station's three TK-46's. However, the cameras' heat tolerance brought it through the days of the conversion without major problems.

The cameras' excellent colorimetry also proves itself on "Jade Theater's" brilliant costumes.

#### **TR-600's Save Technician Time**

The other side of the technical expansion story at TVB is with video recording. The station has bought its way almost completely through RCA's developing line of quadruplex VTR's. Starting with the TR-60, the Hong Kong station has added the TR-61, three TR-70's and, most recently, three TR-600's.

Part of the increasing need for more machines lies in the station's bilingual nature. It has a full 22 hours of Chinese-language programming on its "Jade" channel, and about 16 hours of English-language programming on its "Pearl" channel, per day. Foreign programs are dubbed in Chinese on videotape. English-language programs, almost all on film, are transferred to tape, which also keeps TVB's telecine systems—four TK-27's and one TK-28—busy as well.

Increasing demand for local tape production also adds to maximum use of TVB's staff and facilities. Consequently, every trained technician's time becomes increasingly valuable. No time, not even seconds, can be wasted at any point in



The VTR room has kept pace with RCA's developing tape line. Three TR-600's were recently added to meet the growing demand for local tape production.





Because of automatic operating features, TVB regards the TR-600 as a time saver.

the process. And that is one of the reasons TVB relies on the TR-600 recorder.

Lincoln Ning, technical operations engineer in the VTR room, is pleased with the time the TR-600 has saved his crew. The number of automatic features and compensating circuits mean, he said, "you just put the tape on the machine and off it goes, producing a great image."

Quality of video recording is further enhanced by TVB's use of Master Control to monitor studio taping sessions. Master Control, of course, provides On-Air control as well.

#### Editing, TVB Style

Two of TVB's three TR-600's have the AE-600 Time Code Editing system. These two machines are an important link in a self-styled system designed to simulate film editing.

After making a duplicate, the tape is edited "off-line", using an "electronic movieola" connected through a micro-processor and a small computer.

The TVB-designed software automatically records the codes for the edit, and stores them in a computer for the final edit on the TR-600.

"This way," Kevin Lo said, "our editors can sit in a non-engineering atmosphere with basically a single button to punch to make an edit. With this off-line editing we save time, cut down on mistakes and free our editors, often experienced in film, to think only about the story and the picture. Again we're bringing film technique into electronics."

#### High Standards All the Way

From the start, TVB has also sought reliable scheduling. The latest effort involves converting much of its film program to videotape, as tape playback is interfaced with computers programmed with the day's schedule. This runs off automatically. However, a manual override is available when any alteration is needed.

To provide optimum quality in the film-to-tape conversion, TVB usually sees to it that the TK-28 is used, because its ASCET correction circuits maximize the quality of the film right at the transfer point.

The result of all this technical effort is a picture which L. S. Ng, TVB's chief transmission engineer, said is "simply and noticeably better than our competitors'". But transmission into Hong Kong's skyscraper-lined hills requires its own subtleties. Because of an incredibly tight-packed market, no area can be left in transmission "shadow".

So TVB employs 11 re-transmission towers to solve the problem. In addition, since Hong Kong is so small in area, the signal is converted to different frequencies by 11 translators to avoid interference problems.

#### What the People Want

However, as one engineer put it, good picture resolution, brilliant colors and reliable scheduling are not the only factors encouraging viewer loyalty. TVB's soaring popularity also comes from keeping its finger on the pulse of life in Hong Kong.

It has successfully exploited a broad area of programming through the intelligent purchase of top-rated international shows, plus the use of a good mix of locally produced comedy, drama, variety and news coverage.

TVB's perennial favorite, "Enjoy Yourself Tonight" (EYT), is part of the original programming, and is still attracting viewers every night. Often the attractions are local talent developed by TVB right there on the show. But EYT includes more than just entertainment. TVB is proud of its efforts to blend information and public campaigns in with its light entertainment. Spots concerning water safety, traffic jams, and the water shortage have been recently incorporated into the show's format.

The latest change in Hong Kong viewers' ever more sophisticated interests seems to be towards social comedy and

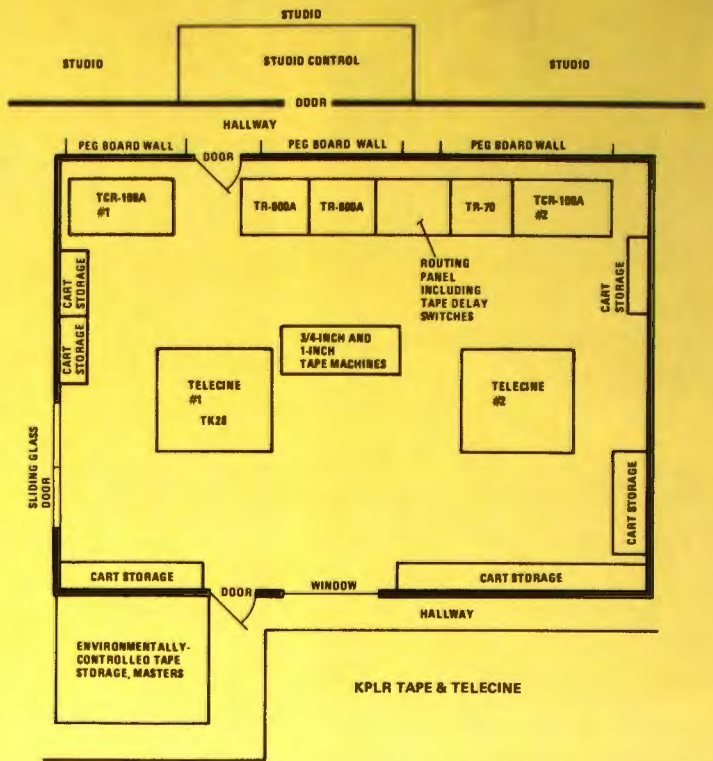


Five telecine systems, including this TK-28 with ASCET, are kept busy transferring English-language film programs to tape.

social realism. The people want programs that show the life and times of Hong Kong with realism and immediacy. TVB means to give their viewers what they want, and RCA cameras and recorders are part of the process. □

ST. LOUIS

at **kplr-TV 11**  
**EVERYTHINGS**  
**CHANGED**  
**BUT THE**  
**LOCATION**



KPLR-TV-staff:  
 Hal Protter, V.P. and General  
 Manager; Larry Marcus,  
 Director of Business affairs;  
 Jim Gonsey, Director of  
 Engineering, and Ted  
 Koplar, V.P., Programming.  
 Not shown in photo: William  
 Crowell, Director of Sales.

**H**AL PROTTER, Vice President and General Manager of KPLR-TV, St. Louis, exemplifies the new breed of broadcast executive. Young. Energetic. Confident. Trained for making the tough decisions that are crucial to successful broadcast operation.

In the three years that Mr. Protter has managed TV-11, there have been drastic and beneficial changes in that independent station's operation, programming; philosophy and performance.

**Technical Facilities Totally Re-Vamped**  
 The technical facilities have undergone a major upgrading, including new studio, control and production equipment; complete system re-wiring a new transmitting plant, and a satellite earth station for bringing in outside news feeds.

All of these changes and more, Mr. Protter proudly notes, were accomplished without disrupting the 20-hour daily broadcast schedule or losing air time.

**Close-Knit Management Staff**  
 The TV-11 upgrading involved people as well as equipment. To make his philosophy of management work, Protter assembled a staff of youthful, dynamic managers to run the station. Only four people report directly to him, and each is expected to function outside his specialty and to be capable of handling the total station management function



Glassed-in rear entrance for TV-11 News operation. In upgrading, KPLR-TV opted to stay at their in-town apartment location by revamping the technical operations and modernizing the total facility.

when necessary. The management team includes:

Edward Koplak, Vice President,  
Programming

Larry Marcus, Director of Business  
Affairs

William Crowell, Director of Sales

Jim Gonsey, Director of Engineering

One of the success stories at KPLR is that of the Director of Engineering, Jim Gonsey. A native of St. Louis, he worked at McDonnell Douglas, then joined the Navy, where he trained in electronics. After leaving the Navy, he moved into broadcasting, with job stints at both TV-30 and TV-11 in St. Louis, and with RCA as an implementation field service engineer. He returned to TV-11 as a maintenance technician, with subsequent promotions to engineering supervisor and then to Chief Engineer. In November 1976 he was appointed to the Engineering Advisory Board of the Association of Independent Television Stations (ITNA).

At TV-11, engineering is responsible for equipment planning, installation and maintenance and for manning technical operations—including camera operators; video control; video tape; audio; lighting. On news shoots or on-location production, the cameraman/VTR operator is supplied by engineering. Master control operations—on-air switching and machine loading are also engineering functions.

#### Rebuild While Maintaining

##### Normal Operations

The revamping of the KPLR technical facilities was a major challenge for Jim Gonsey and his staff. It was accomplished while maintaining normal programming operations and without changing the building location. Confronted with tight space and other location limitations, the logical move for KPLR would have been to spacious new suburban facilities. However, the decision was made to remain in the same building—a solid, urban apartment house.

Aside from the usual difficulties in replacing equipment, one of the really monumental tasks in re-building the technical area was that of changing all cabling. The building was not designed with computer flooring for carrying cables, making the re-wiring operation even more critical.

In re-doing the technical facility, new video, pulse and audio distribution systems were installed. Patch panels were

eliminated, and all switching is handled by routing switchers. One routing switcher is used for all of the VTR's, and each tape machine has a separate proc amp. A 6-in, 1-out switcher is used for audio distribution, and there is a two channel system for in-house monitoring requirements.

#### Technical Performance Goals

KPLR's operating philosophy as an independent broadcaster is to provide viewers with picture quality that is comparable to that of the network stations. Unquestionably, the equipment added over the past three years has vaulted TV-11 into the top level of technical performance. The equipment list alone is impressive, covering just about all areas of the technical operation. Major acquisitions include:

##### Camera:

Two TK-76 Portables with Saticon tubes

Two TK-46 Studio Cameras

TK-28B Film System with Saticons

##### Video Tape:

TCR-100A Cartridge Tape Machine (second system)

TR-70C Quad

Two TR-600 Quad

Two BVH-1000, 1"

Six ¾-inch machines

##### Production:

1600 7G Production Switcher

BC-50 Audio Console

Graphics System

Two TK-46 Studio Cameras are the latest addition to the TV-11 technical complement. Director of Engineering Jim Gonsey (right) checks out one of the new cameras.



#### Transmitter:

TT-50FH, 50 kW Parallel System

#### Satellite Earth Station:

11 Meter steerable Receiving Antenna with two TV-1100, 4 GHz Receivers

#### Video Tape Layout Maximizes Floor Space

The Tape and Telecine layout was planned for convenience in handling production assignments without disrupting air operations. The tape equipment is positioned to back against a wall which is the main hallway from the administrative offices to the technical area. This arrangement permitted TV-11 to use sliding pegboard panels for the hall wall, thus saving space in the Tape/Telecine area, while providing easy access for servicing the machines as well as for air circulation.

Tape machines along the hall wall include the two TCR-100A "cart" systems two TR-600's and a TR-70C quad VTR (which is used for production and as a "master" for one of the TCR-100's). The tape complement also includes both videocassette and 1" VTR's.

#### TK-28B . . . Superb

In the center of the area are two film islands. The newest telecine system is located closest to Master Control, and includes the TK-28B camera equipped with Saticon tubes. According to Jim



Maintenance Supervisor Ray Reome checks TCR-100. To fully utilize available space, the rear of the tape machines are serviced from the outside hallway. Sliding pegboard panels permit easy access.



Waveform monitor below picture monitor simplifies adjustment and maintenance for TK-28. A mirror arrangement permits MC operator to keep TP-66 film reels in view to verify upcoming commercial breaks in film shows.



The two TCR-100 "cart" machines are worked hard. On-air machine averages 400 plays per day.



TV-11 quad tape line-up includes two TR-600's; two TCR-100's and a TR-70. An unusual application for the TR-600's is as a tape delay system for a live phone-in program.

Gonsey, the Saticons provide more stable operation, with increased sensitivity and less lag. The TK-28B, he says, automatically corrects off-color prints and is superb—as it needs to be, since about 80 percent of KPLR's programming at present is on film. The system is also used after sign-off for handling film to tape transfers.

#### 400 "Cart" Plays A Day

The "cart" machines at TV-11 are truly workhorses. The on-air system has been in operation for five years and has logged 330,000 cycles on one deck and 310,000 on the other—over 600,000 operations. The machine is averaging some 1400 cycles a week, per deck. About 400 carts are aired daily by TV-11. Since all spots are dubbed to "cart", the TCR-100 is on-air for about 15-minutes per hour during the broadcast day.

The production TCR-100, an "A" version installed in 1976, has record capability on both decks, and is used for making 30 to 40 dubs a day. For quality control and better air presentation, a VIR signal is put on all "carts". It is also used for production and program assembly, frequently for production of station promos. Some-

times the ITNA network news is recorded on the "cart" for later playback. A TR-70 tape machine is used for the master for this TCR, and also is used for production record and playback operations.

The TCR-100's have been extremely reliable. With the second TCR, discrepancies from the air machine can usually be made good in the same break. The second TCR provides back-up and also permits maintenance to be performed on the other machine during normal hours.

#### TR-600 Tape Delay System

The two TR-600 machines handle both production and programming functions. For a live phone-in program, the TR-600's are operated as a tape delay system, with one machine for record; the other for playback. The take-up and supply reel servo motors are set up so that tape tension is controlled with both machines operating together. The tape runs directly from the record to the playback machine, to provide a built-in seven-second delay.

Ray Reome, Maintenance Supervisor, reports that the TR-600's are operating efficiently, with headwheel life averaging between 1400 and 1500 hours.

The air in the Tape/Telcine area and in the adjoining tape storage space is cooled, cleaned and dehumidified. The KPLR air system for the tape machines is supplied from two compressors in the basement, with a reserve tank for emergency use. The system includes an air chill unit; two air filters for moisture, and one for oil.

#### Film Island Innovations

TV-11 technicians applied their innovative touch to the new TK-28 film island, which is the primary on-air system. It is located just outside the Master Control room, and is positioned so that the MC operator can see the film reels of both TP-66 projectors, providing a clear view of the leader indicating an upcoming break. The reels of one TP-66 are in a direct line-of-sight view of the operator, and a mirror is used with the second TP-66 so the operator can see its film reels.

An "Air" button is installed on the TP-66 projectors to blow compressed air on the film gate, clearing it of dirt and particles. In normal operation, a short burst of air is blown on the gate automatically whenever the projector starts running.

The TP-7 slide projectors are set up



TV-11 Master Control console puts the operator in command. Unique, station-designed push button arrangement at bottom of MC switcher simplifies operations while minimizing errors.



Production Control at TV-11 is a compact, functional layout, with the central TD position flanked by the video switcher (left) and the audio board.

so that the lamp is on only when a slide is aired. This extends lamp life, and protects the slide from burning in. Quartz lamps, identical with those in the TP-66, are used in the TP-7's, giving the same colorimetry for uniform on-air color.

#### Master Control

At KPLR, Master Control is busy, but not hectic. The system is designed to provide clean on-air presentations, with smooth transitions, while minimizing errors and make-goods.

Both tape and film commercials are dubbed to TCR-100 "carts", with slides and audio tape cartridges for bumpers. The system is set up for a two-second pre-roll, and every break starts with a two-second bumper slide which is activated by one pushbutton on the MC console. This "Break With Bumper" button also provides the two-second pre-roll to activate the TCR-100 to play its programmed sequence of carts. The use of the slide/audio announcement cart for breaks has greatly simplified the Master Control operation.

The console layout is extremely functional. The left portion of the console includes the NTSC VITS/VIR units,

audio cartridge tape players, and a battery of preview monitors for video sources. On the right side of the console are the monitor/meter controls for the TT-50FH transmitter, and the studio unit for the BTR-30 remote control system.

The center of the console houses the Master Control switcher, monitors and machine controls for the Telecine systems; the TCR-100's and the VTR's. Unique to this system is a row of push-buttons at the bottom of the console. Designed by the TV-11 technical staff these function buttons put the MC operator in control to simplify normal operations and to minimize panic situations. These most frequently used function controls are:

**Pre-Roll Enable**—used when the 10-second warning light appears on the TCR-100 remote panel, indicating that last event is on. Pushing this button triggers an automatic 2-second pre-roll, after which the next event in sequence comes on.

**Break With Bumper**—This is the most frequently used button in the Master Control operation. It puts on a slide for two-seconds, after which the TCR-100 handles the break events.

**Pre-Roll Cancel**—This button aborts an event called for in error or if a malfunction is noted.

#### Production Control

Production control is compact, but not cramped. It is conveniently located across the hall from Tape/Telecine and looks down on the main studio. Production effectiveness has been enhanced by the addition of a new Grass Valley Type 1600-7G switcher and a BC-50 audio console. Machine controls for the VTR's TCR-100's and one film chain are mounted above the switcher within easy reach of the operator. Small color monitors are used for the video sources, with large color monitors for the PREVIEW and LINE displays.

The audio position is on the right side of the control room and includes a custom BC-50 console; RT-21 tape recorder BQ-50 turntable and two audio cart machines. The #7, 8, 9 and 10 inputs of the BC-50 are used for high level sources, primarily the VTR's. The #8, 9 and 10 inputs are remoted to a small switcher mounted above the BC-50 console. This provides 18 selectable inputs for the BC-50, which is a two-channel system, with two submasters and two equalizers.



TK-76 cameras at KPLR are well utilized, being used for both News and Production assignments, operating with a two-man crew.



In editing suite, Production Manager Bernie Corno reviews commercials produced on location with TK-76 camera and videocassette recorder.



Satellite Earth Station operated by TV-11 is mounted on an adjoining parking garage roof. System uses an 11-meter Steerable Receiving Antenna and provides access to TV newscasts originated by ITNA-affiliated stations. Rack equipment for the Earth Station is conveniently located in the Technical Area near Master Control.

### TK-76's for Production and News

As a part of the production facility upgrading, TV-11 added two TK-76 portable cameras for news and for on-location commercial production. And, in the studio, the most recent camera investment added two TK-46 studio cameras.

The new camera complement is especially pleasing to Production Manager Bernie Corno. "We have prided ourselves on providing quality production work. Now, with the TK-46 and TK-76 cameras, our picture quality will be equally outstanding for studio and field productions."

The Production Department at KPLR handles the requirements for News, Public Affairs, commercials, programs and station promos. The TK-76 cameras are scheduled for both news and production assignments. A small van is used for remotes, carrying a TK-76, a 3/4-inch videocassette recorder and audio. In each case a two-man crew is used—a Director and a Cameraman/VTR operator for commercials, and a reporter and Cameraman/VTR operator for news.

"For remotes, our TK-76 mini-camera delivers studio camera quality", Mr. Corno says. "It can operate at low light levels and still produce excellent picture quality."

Jim Gonsey specified Saticon tubes for his TK-76 cameras, and is pleased with the results. "The Saticons provide increased sensitivity and can handle high light levels not possible with lead oxide tubes", he says.

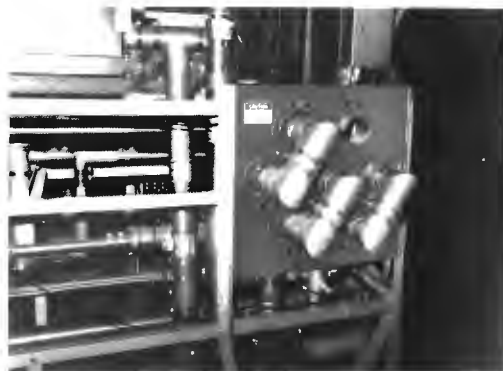
The sample reel of commercials produced with the TK-76 have helped in selling additional production work, particularly with local retailers, Mr. Corno adds.

News Director Bill Thomas credits the TK-76 camera for effecting a dramatic change in the impact of TV-11 news. "Before the TK-76 cameras arrived, we operated without a film news operation, relying on the ITNA network feed for national news, and using slides and graphics for covering local news. With its quality, the TK-76 puts us on par with the local network stations in terms of performance, although we operate with a much more limited staff. At TV-11, the news team covers the stories as well as anchoring the segments on-air."

### Parallel 50 kW Transmitting System

KPLR's TT-50FH 50 kW transmitter is operated as a parallel system, with both sides delivering a total of 23.9 kW of power to achieve maximum of 316 kW. The new system was installed in December 1974, replacing the orig-

Tall Transmitter Supervisor Frank Kresl with TT-50FH parallel transmitter. The 50 kW transmitter, remote-controlled from the studio, operates around the clock, and has logged an excellent performance record.



OPTO-Switcher for TT-50FH transmitter incorporates motorized output switching and coaxial patch panel in a single pre-packaged assembly.



inal TT-25BH. (This latter transmitter is still alive and well, operating in Grand Island, Neb.).

The TT-50FH system has logged more than 25,000 hours and is providing excellent service, operating around the clock. After KPLR's 20-hour broadcast schedule is completed, color bars and station ID are transmitted until sign-on.

#### **Excellent Tube Life**

The transmitter installation was handled by Frank Kresl and the TV-11 technical staff. Then the entire RF output system was optimized on site by RCA service engineer Charlie Wright for optimum VSWR across the channel. An OPTO-Switcher is included in the system to incorporate the motorized output switching and coaxial patch panel in a pre-packaged assembly.

Better than average tube life has been experienced at TV-11, with 15,000 hours on the 8916 and 14,000 hours on the 8890 tubes now installed.

#### **Remote Control and STL Redundancy**

The system is remote-controlled from

the studio via a BTR-30 Remote Control System. Twenty-eight functions are monitored on the system, including the full range of transmitter controls as well as fire and smoke alarms, overload; power level and others.

TV-11 operates two microwave STL systems for redundancy, with provision for automatic switchover in the event of a failure. A second subcarrier was added to the STL, with the first channel being used for program audio, and the second audio channel handling transmitter system telemetry.

Telephone lines are used for normal telemetering functions, with the STL subcarrier providing back-up protection. With the new subcarrier Channel, remote control telemetry is maintained and station personnel still have one hour to get to the transmitter before it shuts itself off.

#### **The KPLR Scorecard:**

**Audience Share Up Dramatically;  
#6 Ranking Among Top 10 Independents**  
Where has the accelerated upgrading of facilities, personnel and operations

brought KPLR? Hal Protter's response indicates that the question has been given thoughtful consideration:

"There are two levels of independent television stations in this country. The first level includes almost all independents. The second is far more exclusive, including such stations as WNEW, New York; WTTG, Washington; KTVU, San Francisco; WGN, Chicago and KTTV, Los Angeles. Each of these operations have been able to upgrade their image to their viewers, and to the advertising community. As a result, they stand head and shoulders above the average independent. KPLR has upgraded itself to that level."

The changes have had a positive effect on station performance. Significantly, the TV-11 share of market in the past two years has jumped from 7 to 16. With this performance, the station has moved into sixth place among the select top 10 group of independent broadcasters in the U. S. □

## **Hal Protter on Operating an Independent TV Station**

"First of all, it does not take a tremendous amount of creativity to run an independent operation. Formulas that good independent stations follow have been established, so what is involved is a matter of adapting the successful formula to the individual market. People, program and promotion comprise the success formula.

#### **Quality Programs and Promotion**

"At KPLR we use counter-programming during prime time, while competing head-to-head with the same programming as the networks on weekends and during early fringe periods. And we do it with comparable quality programming and promotion.

#### **Importance of First-Rate Technical Facilities**

"Excellent technical facilities are even more important for the independent station for the simple reason that virtually all of the programming is local. There is no 'network' button to push when an emergency occurs. Network affiliates can handle maintenance as a routine during the day, while the independent must have the flexibility and the equipment complement to work around technical problems. We rely on film and tape machines for 95% of our programming. Our equipment must be capable of delivering on-air picture quality which compares favorably with the local network offerings. I look forward to the time that 35mm film transfers to 1" tape are offered for feature films and syndicated product, and believe the cost will be competitive with librarying 16mm prints.

#### **Broadcasting in Transition**

"Broadcasting is in a transitional period where many of the technical people who grew up with the industry in the 50's and 60's are now aging, and adjustments must be made to compensate. This is one of the reasons why automation is becoming a vital part of broadcast operations. The need for making error-proof on-air presentations is another. At KPLR, we are using automated equipment such as the TCR-100 "cart" machine to meet this need—and it is making a difference. For example, two years ago, we experienced



KPLR-TV Vice President and General Manager Hal Protter (right) acknowledges the importance of first rate technical facilities in independent station operation. The innovations and new equipment acquisitions of TV-11 support this viewpoint.

100 discrepancies in a given month. This year, for a given month, there were only seven discrepancies.

#### **Innovation Is Self-Preservation**

"To remain viable, independent operations must be ready to respond quickly to changes, particularly those involving technological advances. As a case in point, KPLR was the first broadcaster to apply for and receive a license to operate an earth satellite receiving station, and our earth station is the only one in this country which is in an urban location.

#### **The Fourth Network**

"The fourth network started operations on November 3, 1975 when ten stations began feeding each other news via satellite. This is the ITNA network."

(Mr. Protter is a strong advocate of the Association of Independent Television Stations (ITNA), serving as a member of the Board of Directors and as the Director of the Sales Advisory Committee.)

## WEST VIRGINIA

# FIRE-RAVAGED STATION BACK ON-AIR IN 10 DAYS

decisive management. It also required quick, compassionate response from suppliers and fellow broadcasters.

### Five Transmitters Destroyed

Lost in the fire was the entire WOAY broadcasting facility—TV, AM, FM—burned to the ground. Irreplaceable personal record collections and audio tapes; the station records; film and tape programs and commercials all were reduced to ashes. The entire equipment complement was destroyed, including five transmitters, one of which was a brand new TT-25FL ready for installation and test.

The response to the disaster was swift and positive. RCA had a TT-25FL 25 kW transmitter ready for tuning and test at Meadow Lands for another customer. It was diverted and shipped to WOAY on Sunday, October 2. A BTA-10L, 10 kW AM Transmitter and a BTF-10E, 10 kW FM Transmitter were also sent from Meadow Lands to replace the burned-out units. Another shipment of needed equipment was loaded in RCA, Camden and dispatched to the station. All of this equipment was accumulated and loaded for shipment before an order was signed, on the premise that the station would rebuild.

Robbie Thomas III, General Manager of WOAY wasted little time in deciding. An RCA proposal was reviewed and approved on Saturday, Oct. 1, and the action began at the new installation site. Even before the conclusion of negotiations, it was decided to relocate the WOAY broadcast facilities to an adjoining Sports Arena/Auditorium which was also owned by the Thomas family.



WOAY AM, FM and TV broadcast facilities were totally destroyed in an early morning fire. The TV station was back on-air from an adjacent building in ten days with a completely new transmitting plant.



WOAY employees had the painful and painstaking task of sifting through charred records, aftermath of the fire.

**F**OR 193 ABC network affiliates, televising the first game of the 1977 World Series was an exciting event, with excellent ratings.

For one ABC affiliate—WOAY-TV, Oak Hill, West Virginia—it was a miracle.

Just ten days earlier, September 30, the WOAY broadcast facility—AM, FM and TV—was totally destroyed by fire. Getting the station back on-air in less than two weeks in a new building took super effort, total dedication and





WOAY General Manager Robert Thomas III (right) and new Chief Engineer Jim Martin responded quickly to get the station back in operation.

The first priority was to get on-air with the television operation, to generate network revenue. This happened in just ten days.

#### Transmitters Installed First

RCA Project Implementation personnel were already on-site; made a rough layout and quickly cleared an area for the transmitters. The TV, AM and FM transmitters were moved into the auditorium on Saturday and Sunday and positioned in the selected area which was to be a temporary location. The three transmitters were arranged in a line, resting on top of the existing hardwood floor. Assembly began at once—with many minor and major problems, one of which was a lack of power. With a massive effort, the power company got full power to the building in just five days.

The new TT-25FL transmitter got maximum attention. All new transmission line was required and this had to be cut, fitted and optimized on-site. The transmitter had to be tested and tuned on-location and under trying conditions. While the transmitters were being worked on, the WOAY personnel and contractors were busy ripping up the hardwood floor of the arena, removing the stage, pouring concrete, erecting partitions and preparing for the installation of studio equipment. Sawdust, crates, boxes and debris were everywhere.

#### Breaking In A New Chief

Chief Engineer Jim Martin came from educational station WMUL-TV in Huntington, West Virginia, and was scheduled to start work on TV-4 on October 3. It was an unusual introduction to a new job—confronted with



The major effort was in getting the TV station on-air for the 1977 baseball World Series. Even amid the debris of converting the sports arena into a broadcasting station, the TV transmitting system aired the first game. At left is the makeshift "master control" with the oversize clock.

total destruction and the need to re-build fast, without benefit of advance plans. "All of the manufacturers involved were just great. They recognized our need and responded to the emergency, giving us excellent cooperation and service. Other stations in the area helped out with loans of equipment. Within a week, network lines had been installed by AT&T."

#### "Our Competitors Are Also Our Friends"

Bob Brown, Station Manager of TV-4, was amazed at the reaction to the station being off-air. "People act like they've lost a friend," he said. "WHIS-TV in Bluefield has been tremendous, giving our WOAY news team five minutes a night on their station for Fayette and Raleigh County news coverage. I've been in this business for 30 years and am finding out that our competitors are also our friends. And that's a great feeling."

#### Unrealistic Target Date

Jim Martin is young, energetic and unflappable—and needed all of those attributes to get the WOAY operation back on the air. "The whole process was fantastic—just unbelievable for anyone who has never had the experience. We were hoping to be back on-air with basic radio and TV broadcasts within a month or two—which was a difficult goal.

"Our unrealistic target date for returning on-air with TV was under two weeks. It was October 10, the opening game of the World Series."

The official sign-on came at 5:58 P.M. on October 10, operating at half power (with special permission from the FCC).

"That night," Mr. Martin recalls, "we



RCA Project Management had a key role in re-equipping and re-building the WOAY broadcast facility. RCA Project Manager Herb Oxman arrived on the scene the evening after the fire to assist station management with restoration plans. Logistics, procurement and installation details were also handled by the RCA team assigned to the project. Like Replacement Parts, Emergency Service, Tech Alert and the CRAE shop, Project Management is yet another RCA resource available to support broadcasters in getting on the air quickly and efficiently, on a scheduled or emergency basis.



With smoke still billowing in the background, a new transmitter is unloaded and moved into the sports arena.



WOAY shares its entrance with "TV Lanes" Bowling Alley. The old arena which featured "Sat Nite TV Rasslin" is the new home for the WOAY broadcast operation



Bare walls and bare essentials comprise the first "newsroom" which later became the radio announce booth.



Basic, but functional—the initial TV Master Control. Camera cards were used for station ID's.

were flooded with calls from viewers complimenting us on the excellent pictures they were receiving."

There has been no RF problem with the television transmitter, even though all three transmitters are located close together in the same area. Jim Martin attributes this to the excellent RF shielding of the transmitter and to the groundstrapping of all the transmitters.

#### A Long Way To Go

Getting on-air with network programming was just one major milestone in the reconstruction of WOAY. It was still a long way from a normal—or even basic—broadcasting facility.

The AM-FM studio control room and announce booth were completed quickly and served as the TV "studio" for the first newscast after resuming broadcasting. The 20-foot ceiling created an unusual "boomy" effect on audio, but getting it on was the name of the game.

A new telecine system with TK-28 camera, two TP-66's and a TP-7 were installed and operational in less than a week. This was a key item, Jim Martin says, since it gave TV-4 the flexibility for airing local programs, commercials and ID's.

The video tape machines—two TR-22's—were brought in one day, and were used on air the next day. (A TCR-100 "cart" machine and a TR-70 tape recorder are on order for early 1978 delivery).

Also within the first week of resuming television operations, local commercials were being produced, using ENG cameras and videocassette recorders. The two quad VTR's and the 3/4-inch video-



Addition of a TK-28 telecine island and two TR-22 VTR's moved TV-4 into full local and network programming and commercials.



Radio Station Manager Gene Ellison operates a BC-17, 3-channel audio console for AM-FM simulcasting. WOAY's complete library of tapes and records was lost in the fire, including many irreplaceable 78's and 33's.

cassettes are used for production as well as for on-air operations. A limited spot reel is made up for some tape commercials, but most are aired individually. Film commercials and PSA's are not dubbed to a spot reel, but are aired separately.

#### AM-FM Broadcasting Resume

Once the TV transmitter was on-air, action shifted to the AM and FM transmitting systems. WOAY-AM resumed broadcasts on November 6, and FM was back on air November 14.

By the end of 1977, WOAY was in full operation, with major construction completed, but still with a sizable backlog of projects, especially in the technical area. The next phase is to get back into production. The new studio

—40 x 60 feet—is being readied, with the lighting grid already in place.

#### "Better Than Ever"

Rebuilding an entire TV/AM/FM broadcasting facility in three months time is a challenge few broadcasters face. WOAY General Manager Thomas is rightfully proud of this achievement, particularly of getting the TV operation on in less than two weeks.

"There was no way that we could meet this schedule—but we did. It took a lot of hard work, long hours, cooperation and plain good luck to carry it off, but our WOAY staff made the impossible dream of telecasting the 1977 World Series come true. We passed the test, and our station is better than ever." □



## Circularly Polarized TV is Here!

**T**YPICAL of today's accelerated pace of product development and acceptance, circularly polarized operation for television has moved from concept to reality in a short time frame. From all evidence, it is here to stay.

WPBT, Miami, is on air with a six-section RCA Quatrefoil circularly polarized antenna; XETV is installing an RCA Fan Vee circularly polarized antenna to serve the San Diego area; and new CP antennas for several other TV stations including WTTV, Indianapolis, and WRAL-TV, Raleigh, are being constructed and tested at RCA's Antenna Engineering facility in Gibbsboro, N. J. WLS-TV, Chicago, which began tests in 1974 with an RCA circularly polarized antenna mounted atop the Sears Tower, now transmits CP signals full time.

Stations using CP have reported improved reception by their viewers, and in some locations as high as 65 percent of the homes tested received better pictures—all with no increase in horizontal ERP (source: Interim Engineering Report, Experimental Operation of WLS-TV, Ch. 7, Chicago).

### Dramatically Improved Reception

Circularly polarized operation provides a dramatic improvement in reception, particularly in urban areas where there is a preponderance of rabbit ears, whips, rings and other indoor antennas. For example, one test revealed that three out of four viewers who never reorient their indoor antennas when changing channels get a better picture from a station transmitting a circularly polarized signal (Fig. 1). Just to prove the superiority of CP, the same test demonstrated good urban reception of pictures that were hardly viewable with horizontal polarization. Circular polarization does not enlarge the station's service area; it simply permits more "solid" coverage of the existing audience.

### Rapid Technological Progress

The high degree of interest in circular polarization by TV broadcasters was evidenced in the last two years' NAB conventions where technical papers and new antenna products marked the technological progress in this area.

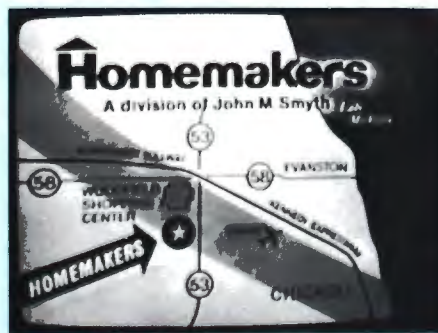
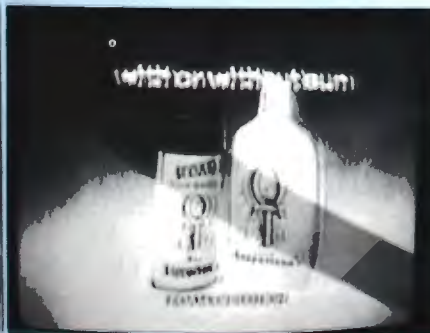


Fig 1 Improved TV Reception with circularly polarized operation. (Interim Engineering Report, Experimental Operation of WLS-TV, Ch. 7, Chicago)

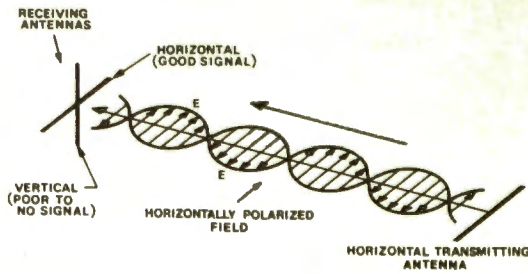


Fig. 2

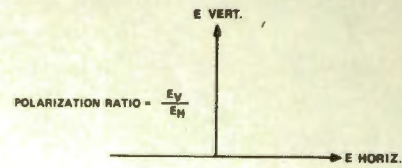


Fig. 3

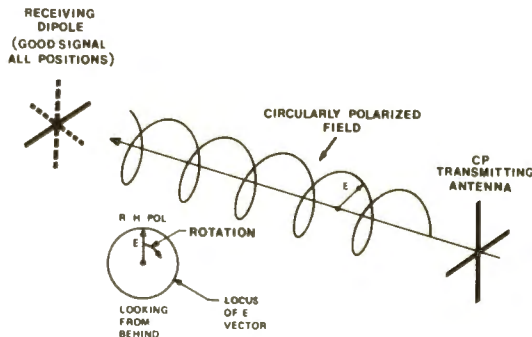


Fig. 4

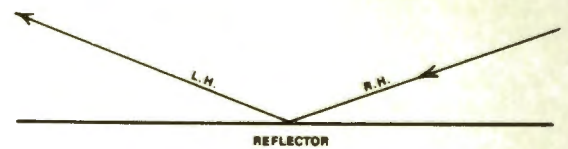


Fig. 5

For many broadcasters weighing the advantage of going to circularly polarized operation, the decision may rest on the response to these two key questions:

How critical is the orientation of receiving antennas in your service area? Are there serious multipath reflections or adjacent channel interference?

Circular polarization would tend to relieve either of these problems, since CP makes receiving antenna orientation less critical. Reduction of ghosting is one of the important benefits of circular polarization. Use of circularly polarized antennas for reception of CP signals may be expected to further reduce noise and adjacent channel interference. Circular polarization also provides an improvement in reception by TV sets operating from defective, improperly installed, or partially disconnected receiving antennas—the incidence of which is higher than one might suspect.

#### Benefits of Circular Polarization

Heretofore, TV transmission was restricted to the use of a horizontally polarized wave, which, of course, was received best on a horizontal antenna. However, as the receiving antenna is

rotated away from the horizontal position, it picks up less and less signal from the horizontally polarized wave, until at the vertical position, no signal is received (Fig. 2). Now, if a vertically polarized wave is added to the transmitted signal (by addition of a vertical transmitting antenna), reception will be good on both horizontal and vertical receiving antennas. Indeed, this is the form of “circular polarization” first used by FM broadcasters to extend their coverage to FM sets with whip antennas on autos and in homes. They simply added vertical transmitting antennas to their horizontal counterparts (Fig. 3). The relative amounts of energy the station put into the vertical and horizontal signals (polarization ratio) varied, after certain FCC restrictions, with coverage area requirements. But here they had the basic elements of a circularly polarized signal. Today, FM antennas employ special radiators developed to produce circularly polarized signals.

In TV, advantage has been taken of what true circular polarization has to offer. Through transmitting antenna design, it has been possible to combine horizontal and vertical radiation components so as to produce a circularly

polarized field that remains almost voltage constant as it rotates around the axis of propagation. The result is a circularly polarized radiated signal (Fig. 4).

#### Constant Signal

This signal has two important properties for improving TV reception: First, an antenna placed in this field can be expected to receive a constant signal regardless of its orientation, thus making it easier to adjust rabbit ears and whip antennas. Secondly, the signal has a right-hand (clockwise) field rotation which is established by the transmitting antenna. This is an important feature because the “sense of rotation” of a circularly polarized receiving antenna must be matched with the sense of rotation of the transmitting antenna to receive the signal; in other words, right-hand polarized transmission will be received by a right-hand (R.H.) polarized receiving antenna, but rejected by a left-hand (L.H.) polarized receiving antenna and vice versa. This, coupled with the fact that a high quality CP signal characteristically reverses its sense of rotation when reflected from a surface (Fig. 5), provides an effective means for discriminating against

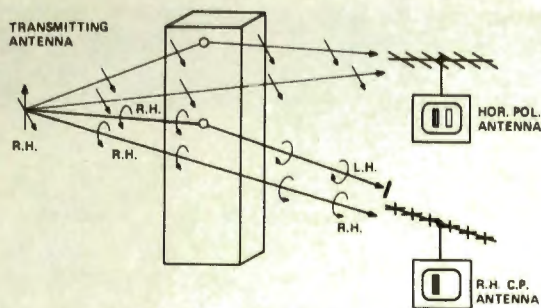


Fig. 6

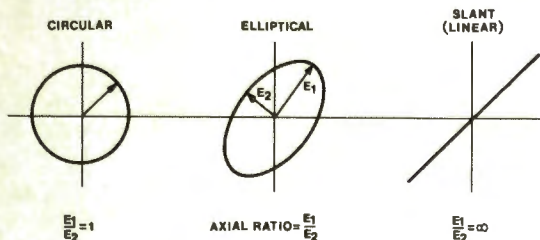


Fig. 7

the reception of ghost signals. The R.H. polarized antenna will receive R.H. polarized direct signal but reject the L.H. ghost signal whose polarity has been reversed by reflection (Fig. 6).

#### Reduced Ghosting and Co-channel Interference

The quality of the circularly polarized wave is described by the ratio of major to minor axes (axial ratio) of the polarized ellipse. The more circular the ellipse (the closer the axial ratio to unity), the more effective the discrimination. A slant polarized wave with infinite axial ratio will provide no ghost reduction capability (Fig. 7). It is interesting to note also that if a circularly polarized receiving antenna is turned 180 degrees, the sense of circular rotation is reversed. In other words, a R.H. polarized receiving antenna is R.H. polarized from the front direction only; from the rear it is L.H. polarized. This simple fact gives circular polarization the potential to reduce adjacent and co-channel interference intercepting the rear of the receiving antenna.

Where ghosts and co-channel interference are not problems, possibly in flat terrain areas, present horizontally polarized receiving antennas will continue to

function well by receiving the horizontal component of the circularly polarized signal. Thus, existing receiving antenna facilities will not be obsoleted. But viewers will certainly benefit most by acquiring circularly polarized receiving antennas.

#### Factors in System Planning

The FCC allows as much effective radiated power in the vertically polarized plane as in the horizontally polarized plane. Therefore, the vertically radiated power could be obtained either by doubling transmitter power, by increasing antenna gain, or by effecting some increase in both. However, any increase in antenna gain (aperture) should be carefully studied, since narrowing of the vertical beam may affect close-in viewers. Other factors such as tower windloading must, of course, be considered.

In the final analysis, "doubling" of the transmitter power to achieve circular polarization may provide the best service. (This was the overwhelming choice of FM broadcasters; for them, circular polarization provided maximum ERP for fringe areas, while picking up additional listeners with whip type vertically polarized antennas.) Close-in, this re-

inforced ERP can be expected to better penetrate difficult urban locations such as large buildings having receivers served only by small indoor antennas. For fringe areas, twice the power should provide higher signal-to-noise ratios for a given distance with the use of circularly polarized receiving antennas.

While the best of present receiving installations employ horizontally polarized antennas, vertically polarized whip and rabbit ears are still plentiful. The circularly polarized transmitting antenna provides proper signals for existing as well as future circularly polarized facilities. The horizontal and vertical patterns, gains, video response and other parameters of the CP transmitting antenna are designed to meet the requirements of all three receiving antenna types.

#### More Considerations

Circularly polarized transmitting antenna performance must be evaluated from the system point of view, taking into consideration not only the transmitting antenna but also the receiving antenna system and the signal that it sees. The radiation patterns produced by the circularly polarized transmitting antenna as well as the gain of both horizontal

and vertical components of the signal need to be known. For effective ghost reduction, axial ratio must be controlled in relation to impedances and other factors to achieve a balanced and cost effective design.

**Available RCA Hardware**

For several years, RCA has been involved in the theoretical approaches to CP as well as in developing the equipment required for circularly polar-

ized transmitting facilities. Now the equipment is here. The required transmitter power levels are available from modern transmitters. Circularly polarized antennas of various types have been developed, tested and placed in service.

Engineers at the RCA Antenna Engineering Center, Gibbsboro, New Jersey, have completed the designs for four circularly polarized TV antennas:

Type	Channel	Application	CP Gain	Horizontal Pattern
TFV, Fan Vee	2-6	Top Mount	6	Omni/Peanut
TCL, Tetra Coil	7-13	Top Mount	16	Omni
TBK, Quatrefoil	2-6	Panel	1-12	Omni/Directional
TBJ, Panel	7-13	Panel	1-18	Omni/Directional

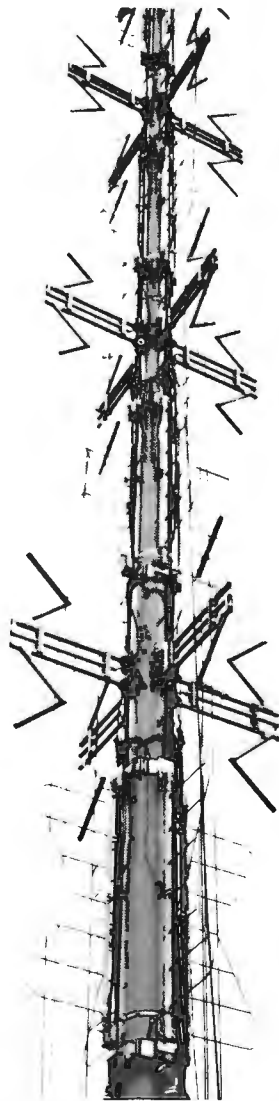


Fig 8 Type TFV, Fan Vee, Top Mount Lowband CP Antenna.



Fig. 9. Type TCL, Tetra Coil, Top Mount Highband CP Antenna.

**Top-Mount Lowband**

The Type TFV Fan Vee (Fig. 8) is a minimum windload design for either directional or omnidirectional service. Each layer employs one bay of the Superturnstile antenna for radiation of the horizontally polarized field and one bay of four double V-shaped dipoles for radiation of the vertically polarized field. A branch type feed system consisting of flexible copper feed lines provides the excellent stability required for low channel operation and minimizes the degradation of performance due to dents or presence of moisture in the feed lines. These feed lines employ a rigid feed point to the radiators, thereby eliminating the use of flexible jumper straps.

**Top-Mount Highband**

The Type TCL Tetra Coil antenna (Fig. 9) combines mechanical simplicity, low windloading and excellent electrical characteristics. A circularly polarized gain of 16 provides an economical means to achieve a 316 kW horizontally polarized ERP with a 50 kW transmitter. The omnidirectional horizontal pattern is circular within  $\pm 1.5$  dB or better for both polarizations; the axial ratio of the antenna is 2.5 dB or better. The antenna consists of four interleaved helices wound about each of the three sections of the support pole. The antenna is illuminated by the traveling wave principle of exciting the elements above the ground plane support pole. Electrical beam tilt is obtained by simple feed system phasing of the three vertical sections.

**Lowband Panel**

The Type TBK Quatrefoil antenna (Fig. 10) is a side-mounted panel with low axial ratio (2 dB) for directional or omnidirectional applications. The three-



Fig. 10. Type TBK, Quatrefoil, Lowband Panel CP Antenna.  
(Photo Credit: G. Chase, WPBT, Miami)



Fig. 11. Type TBJ, Highband Panel CP Antenna

bay design is supplied with a circularly polarized gain of 3. The six-bay antenna provides a circularly polarized gain of 5.8 with approximately ten percent first null fill. The omnidirectional version consists of three panels per layer for mounting on a triangular tower, and offers the broadcaster excellent operating performance. Each panel consists of four ring radiators mounted in front of a rectangular pattern-shaping screen. Custom directional patterns are available.

#### Highband Panel

The Type TBJ Panel antenna (Fig. 11) is a side-mounted circularly polarized antenna for highband channels 7-13. Both omni and directional patterns are available. Each panel consists of two crossed dipoles with one feed point per dipole.

#### Here To Stay

These antenna designs are available now for the broadcaster choosing circularized operation.

Historically, broadcasters have continually upgraded services to their viewers. CP broadcasting offers a promising opportunity for providing improved TV reception without extending the coverage area. Its rapid transition from experiment to accepted on-air transmission indicates that circular polarization for TV has arrived—and is here to stay. □

# BASIC LINEAR INTEGRATED CIRCUITS

Jack Castleberry, RCA Broadcast Systems Technical Training

*NOTE: In preparing for various equipment seminars, the RCA Broadcast Systems Technical Training Staff has developed a comprehensive background of design and application material on circuits and systems. This material is designed to get seminar participants "up-to-speed" quickly, and to make the maintenance and trouble-shooting procedures more effective after the training session has been completed.*

The recent series of articles on "Digital Fundamentals for Broadcasters" by John Wentworth was developed to provide advance preparatory material for seminar participants.

The article included here on "Linear Integrated Circuits" by Jack Castleberry of the Technical Training staff is also directed to the equipment user and the maintenance technician rather than the electronic design engineer.

A basic acquaintance with linear integrated circuits is essential for broadcast technicians involved in equipment maintenance. This article was written with that purpose in mind—to give the technician the background required for understanding the operation of various circuits, and to help him to answer the all-important question: "Is the circuit operating as it should?"

The material is organized on the basis of the usefulness to the technician. First the characteristics of the ideal op-amp, then the basic circuit configurations are presented. Further information concerning how the circuits work and typical applications follow.

## The "Ideal" Op-Amp

The most common Linear Integrated circuit is the operational amplifier (usually abbreviated op-amp). This name was inherited from the tube-type feedback amplifiers which were used to perform mathematical "operations" in analog computers. As a starting point, it is helpful to consider the "ideal" op-amp, since the circuits you encounter can be analyzed with a relatively high degree of accuracy using these "ideal" characteristics.

The accepted symbol for the op-amp

is shown in Fig. 1. Signal flow is from left to right—from the flat vertical side of the triangle to the point as shown. The symbol is usually drawn with the inverting input (a positive going signal at the input results in a negative going signal at the output) at the top and the non-inverting input (a positive going signal at the input results in a positive going signal at the output) at the bottom.

Characteristics of the ideal op-amp may be summarized as follows:

- The voltage gain is infinite—the voltage gain must be high for circuit

performance to be fully determined by circuitry external to the op-amp.

- The input resistance is infinite—if circuit performance is to be independent of the characteristics of the gain block (op-amp) the input resistance must be extremely high to eliminate circuit loading.
- The output resistance is zero—the output impedance must be extremely low to drive any load applied to the unit and to avoid the effects of circuit capacitance on frequency response.
- The bandwidth is infinite—that is,

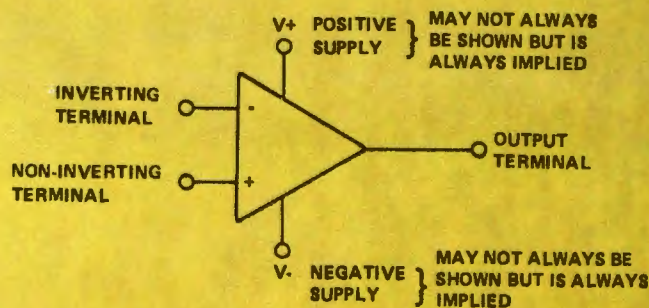


Fig. 1. Symbol for the Operational Amplifier.

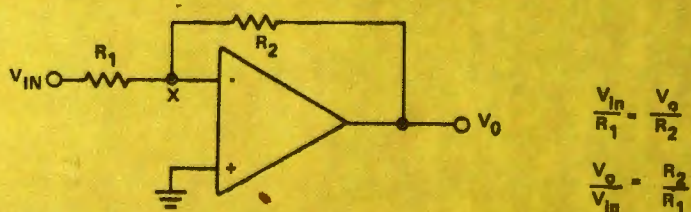


Fig. 2. Schematic of an Op-Amp used as an Inverting Amplifier.

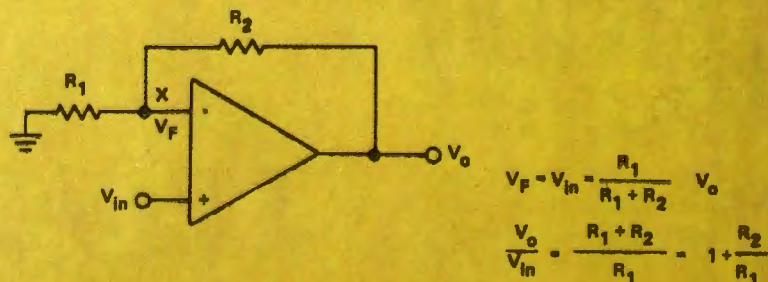


Fig. 3. Schematic of an Op-Amp used as a Non-Inverting Amplifier.



the frequency response of the op-amp will not enter into the design problem over the range of operating frequencies.

- The characteristics of the two signal paths (inverting and non-inverting) through the device are identical— ( $E_{out}=0$  if  $E_{in}=0$ ). If the two inputs are grounded, the voltage at the output terminal will be zero. Further, if identical signals are applied to the two inputs, the signal at the output will be zero.

From these characteristics it can be inferred that:

- The differential input voltage is zero (that is, the two input amplifiers are identical in every respect).
- There is no current flow into either input terminal (this follows from the assumption that the input resistance is infinite).

#### Basic Op-Amp Configurations

The circuitry external to the op-amp determines circuit performance to the extent that performance can be accurately predicted from component parameters (especially if we assume the "ideal op-amp"). Figs. 2 and 3 illustrate op-amps in the inverting and non-inverting configurations respectively.

The schematic for application of the op-amp as an **INVERTING AMPLIFIER** (Fig. 2) shows that the non-inverting input is grounded and that the signal is fed into the inverting input through a resistor ( $R_1$ ). Also, a resistor ( $R_2$ ) is connected between the inverting input end of  $R_1$  and the output terminal. From the characteristics enumerated for the "ideal op-amp", it is seen that the impedance looking into an op-amp input is extremely high and it may be concluded that the current flowing into the inverting input terminal is essentially zero. Taking advantage of this information and Kirchoff's current law (the summation of currents at any point in a circuit must equal zero) it is seen that the signal current through  $R_1$  must be exactly equal and opposite to the current through  $R_2$ ; hence, no signal voltage can be measured at point **X** which, by the way, is the definition of a "virtual ground". From this it follows that the input current  $\frac{V_{in}}{R_1}$  is equal and opposite to the feedback current  $\frac{(-V_o)}{R_2}$ . Noting that the gain

of the stage is equal to the ratio of the output voltage to the input voltage

( $-V_o$ ), manipulation of the factors reveals that the stage gain:  $V_o = R_2 \cdot \frac{V_{in}}{R_1}$ .

Since the "virtual ground" exists at the inverting input terminal, the circuit input resistance is equal to  $R_1$ , and you will not be able to measure a signal voltage at this terminal (don't make the common mistake of throwing away good units because there is zero measurable signal at the inverting input).

The schematic of an OP-AMP used as a **NON-INVERTING AMPLIFIER** and the equations describing its operation are shown in Fig. 3. It is very helpful in understanding OP-AMP circuitry to regard the non-inverting (+) input as a reference which will determine the level that both (+ and -) inputs assume. (For now, take it on faith—the reason for this condition will be apparent from the discussion of what goes on within this "little black box"). Under this assumption, the signal voltage at the inverting input (VF) is equal to the input ( $V_{in}$ ) and is related to the output voltage by the resistive divider network as shown. Manipulation of the equations yields the result that the gain of the stage ( $V_o$ ) =  $1 + \frac{R_2}{R_1}$ . In addition to the fact that the output signal is in phase with the input signal, it should be noted that the input impedance of the amplifier is extremely high as it is determined by the characteristics of the op-amp itself.

Fig. 4 shows the symbol for an OP-AMP with the addition of a gain con-

trol input. Depending upon the external circuitry, this unit will act as an **INVERTING** or **NON-INVERTING** amplifier with the added feature that, over a limited range, the output signal level will be controlled by the current fed into the gain control terminal (**K**).

Fig. 5 is a common schematic representation for the four quadrant multiplier. The multiplier performs an algebraic multiplication  $KXY$  where:

**X** is the difference in the signal voltages present at the **X** inputs.

**Y** is the difference in the signal voltages present at the **Y** inputs.

**K** is a scaling constant which is determined by external circuit parameters.

It should be noted that not only does the output represent the product of the two differential inputs and the control input, but its magnitude is also the vectorial resultant of these factors. It is implicit, therefore, that if one of the factors (**X** or **Y**) goes to zero the output will go to zero.

#### What is Inside the "Black Box"?

It is a rare technician or engineer who could be satisfied to stop with the essential, minimal level of understanding of Linear Integrated Circuits presented in the preceding paragraphs. Most of us have a curiosity which forces continued study of a device until we can say, "I understand how it works". This section is written to satisfy that desire.

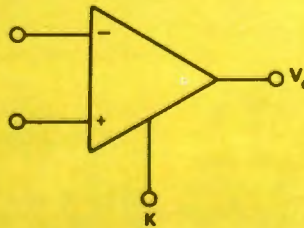


Fig. 4. Symbol for Op-Amp showing Gain Control Connection (K).

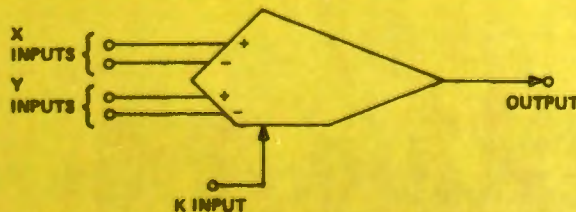


Fig. 5. Symbol for Multiplier.

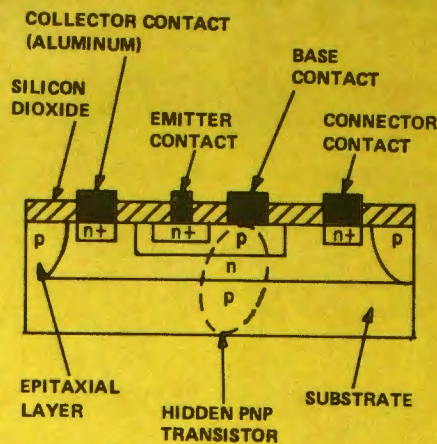


Fig. 6. Cross Section of a Typical Monolithic NPN Transistor.

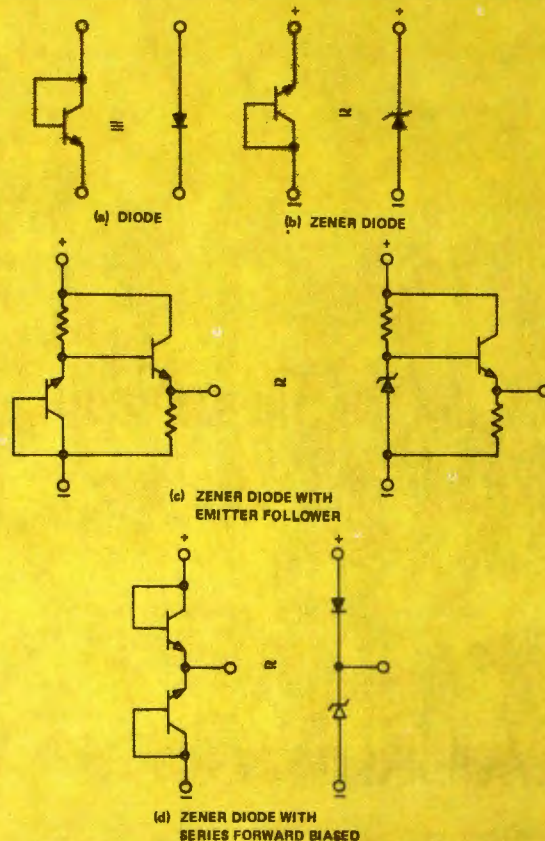


Fig. 7. Schematics showing how various circuit functions can be derived from the Transistor.

Semiconductor devices have been used since the beginning of electronics. The Galena Crystal and the Coherer were widely used, and even a solid state amplifier was demonstrated in the 1930's. These devices were not particularly reliable, and since we did not really understand what made them work, they could not be reliably or consistently reproduced; hence, they were discarded in favor of the vacuum tube which we could understand fairly well, and could reproduce with reasonable accuracy. The performance of the point contact transistor announced by Bell Laboratories in 1946 was not that great compared to the Galena Crystal with a Cat Whisker (if you could find one that

would amplify). But, the fact that they understood the physics of the device, and the fabrication processes well enough to replicate the device was nothing less than a marvelous accomplishment.

#### Circuit Elements

Before particular Linear Integrated Circuits are covered, a review of the characteristics of the various commonly used circuit elements will be presented as such a discussion may prove helpful to some readers.

The basic circuit element of the monolithic integrated circuit is the transistor. The cross section of a typical NPN

transistor (Fig. 6) shows how the various areas are doped with impurities to form the elements of the transistor. Selective photo etching, diffusion and plating processes are employed to form the elements. Closer examination reveals that there is a hidden PNP transistor between the collector junction and the substrate. In normal operation, these hidden elements are reverse biased and, as long as the manufacturers' instructions are followed, will not cause problems.

Although it is possible to form a diode by omitting one of the elements of a transistor, they are usually made by shorting the transistor base to its collector as shown in Fig. 7(a). It should be noted that, conventionally, the end result is shown on the schematic—not how the element is fabricated.

If a transistor such as the 2N3904 is connected as shown in Fig. 7(b), a Zener diode regulating at 6.2 volts results. The range of application of this voltage reference is limited by the internal impedance of the device (60 to 100 ohms) but the impedance can be greatly lowered by incorporating an emitter follower as shown in Fig. 7(c). There is still a problem with the device, as the Zener voltage varies with temperature. This problem can be resolved by fabricating a forward biased diode in series with the Zener diode as shown in Fig. 7(d). Since the thermal characteristics of a forward biased diode are the inverse of the characteristics of the Zener diode, the effects of temperature variations are nullified and a thermally stable voltage reference of 7.7 volts results.

Each of the metal pads used to contact the elements of a transistor forms a capacitor with the active material of the transistor as a dielectric and the substrate as the other plate of the capacitor. With the dimensions and dielectric material used, the capacitance is approximately 0.07 pf per square mil of area. Cost and other consideration limit "on chip" capacitors to about 10 pf.

Resistors can be fabricated by changing the material used to "dope" a particular area however, the effect of a resistor may also be realized by biasing a transistor so that its "ON" resistance approximates the circuit requirements.

The relatively large bulk of an inductor renders it impractical to include these components in monolithic units. The need for this circuit function is usually resolved by using external components

or special circuits to realize the effect of an inductor.

For convenience in analyzing the various op-amp configurations, a chart (Fig. 8) outlining the approximate parameters of transistor amplifiers, is included. The chart is self-explanatory except for the arrows appearing at the input and output of the amplifier. These are included to indicate the direction of the change in output voltage expected when the input voltage is made more positive. The other symbol which should be clarified is  $h_{fe}$ . This appears in manufacturer's specifications as the "small signal forward current transfer ratio in the common emitter configuration." For modern transistors such as those in the op-amps to be discussed and discrete components such as the 2N3904 and 2N3906 a typical value of  $h_{fe}$  is 100.

As the technology of making transistors progressed from making individual devices to fabricating many units simultaneously on a slice of Silicon or Germanium, the pressure to place more of the circuit elements on a single chip increased. The early attempts to fabricate a complete functional element on a chip were successful for digital components which required only ON or OFF states but were limited in application as analog signal amplifiers. This limitation resulted from the inability to closely control the parameters of devices such as transistors or resistors ( $\pm 5\%$  was required while  $\pm 30\%$  was practical) making up the integrated circuit. This impasse was resolved by the use of the differential amplifier which depends upon the ratio of values rather than absolute values for its operation as the amplifying element.

Examination of the schematic for the Basic Differential Amplifier (Fig. 9a) reveals two transistor amplifiers sharing a common emitter resistor. If we assume that the two halves are very nearly identical, the circuit can be redrawn as in Fig. 9(b) with a single transistor and an emitter resistor of  $2R_e$ . Applying Kirchoff's voltage law to the base emitter loop, the quiescent emitter current ( $I_{EQ}$ ) can be determined to be:

$$I_{EQ} = \frac{V_{ee} - 0.7}{2R_e + \frac{R_b}{h_{fe}}}$$

Since the base current is only a small percentage of the emitter current, we can assume that the quiescent collector current ( $I_{CO}$ ) is equal to  $I_{EQ}$ . It follows that the emitter resistor limits the collector current and, for a given supply

CIRCUIT CONFIGURATION	SCHEMATIC	VOLTAGE GAIN	CURRENT GAIN	INPUT R	EQUATION FOR $R_i$	OUTPUT R	EQUATION FOR $R_o$
COMMON EMITTER		200	47	1700	-	$R_L$	$R_L = R_o$
COMMON BASE		2.00	0.98	30	-	$1.0 \times 10^8$	-
COMMON COLLECTOR		1	48	$5 \times 10^8$	$R_b/h_{fe}$	22	$\frac{R_L}{h_{fe}}$

SIGNAL GROUND -  
= (NOT NECESSARILY DC GROUND)  
(CONDITIONS:  $I_E = 2 \text{ ma}$ ;  $R_L = 10^3 \Omega$ )

Fig. 8. Approximate Parameters of Transistor Amplifiers.

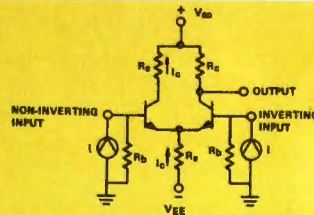


Fig. 9a. Schematic of the Basic Differential Amplifier.



Fig. 9b.

voltage, thereby limits the voltage swing at the output. This poses a dilemma since a very large value of emitter resistor (approximately one megohm) is required to minimize any loss of signal in the emitter circuit and, if a reasonable signal current such as two milliamperes is required, then the supply voltage (neglecting the drop across the collector resistor which will be small compared to the drop across one megohm) will be 2000 volts. The other choice would be a relatively low value of emitter resistor, a reasonable power supply voltage and relatively poor coupling between the two halves of the differential pair.

This dilemma was resolved through the substitution of a current source for the emitter resistor as shown in Fig. 10. It can be shown that with a supply voltage larger than that required to overcome the forward voltage drops between emitter and collector, the cur-

rent through a transistor is determined by the bias applied to the base. Since the total flow of current through the current source is independent of the remainder of the circuit, the effect on the signal at the common emitter junction of the differential pair is that of an infinite resistance. It will be noted that the infinite impedance in the emitter circuit has been realized at the cost of the very low voltage drop across a forward biased transistor.

Several things about this primitive amplifier should be noted:

- Balance is determined by how nearly identical the two halves of the differential can be made—not by the exact values of the parameters. (Balance between the halves of an integrated differential amplifier follows from the fact that all the components are in very close physical proximity and have been simultaneously subjected to the same chemical processes.)

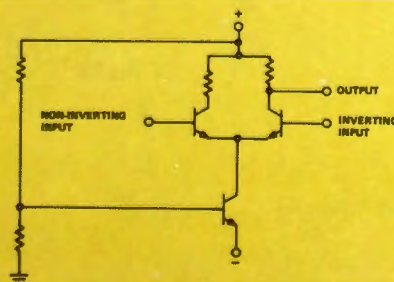


Fig. 10. Differential Amplifier with Current Source.

- Maximum peak-to-peak voltage swing at the output and voltage gain of the device is determined, primarily, by the value of the load resistor and the current supplied by the constant current source.
- The efficiency of coupling between the emitters is very high because little signal loss is caused by the nearly infinite impedance of the current source.

It should be noted that there are two common measures of the balance between the two halves of a differential amplifier:

- **DC OFFSET**—If the two inputs are shorted together and grounded does the output voltage remain constant? Presently available units exhibit DC offsets of a few millivolts.
- **COMMON MODE REJECTION RATION (CMRR)**—With identical signals fed to the two inputs, the ratio of the input voltage to the output voltage is the CMRR. A perfectly balanced unit would have zero output; however, readily available units exhibit CMRR's of 90 dB.

A useful application of the differential amplifier, which may not be obvious from the preceding discussion, is as a limiter or voltage comparator. At normal temperatures (25° C) the output voltage will limit sharply for input voltage swings greater than ±100 millivolts.

#### Typical Op-Amps

A logical next step in exploring "what is in the little black box" is a look at typical op-amps. This section will present several which are currently in use.

#### CA-3000 Integrated Circuit DC Amplifier

The CA-3000 integrated circuit DC amplifier, Fig. 11, is representative of the first available monolithic integrated circuits. The values given for resistors are representative and are useful only for understanding the circuit. (Absolute values may vary ±30% but, since the ratio of values and not the absolute value determine circuit performance, the performance of most units fall within a ±3% range). This amplifier is very similar to the previously discussed basic differential amplifier.

The designation of the inverting and non-inverting inputs is purely arbitrary as the circuit is symmetrical. If pin #1 is designated as the non-inverting input, then pin #8 is the output. A positive-going signal applied to pin #1 causes more current to flow in the cascaded amplifier on the left and, since the current available from the common constant source is fixed, the output (pin #8) goes more positive. If pin #6 goes more positive, current through R2 increases and the output (pin #8) becomes less positive hence, the signal is inverted.

Several features of this device should be noted:

- Degeneration resistors (R4 and R5) have been included in the lines feeding the differential pair from the constant current source. These serve to minimize the effect of any imbalance in the characteristics of the output transistors and tend to linearize the transconductance characteristic of the amplifier at the expense of the absolute value of transconductance.

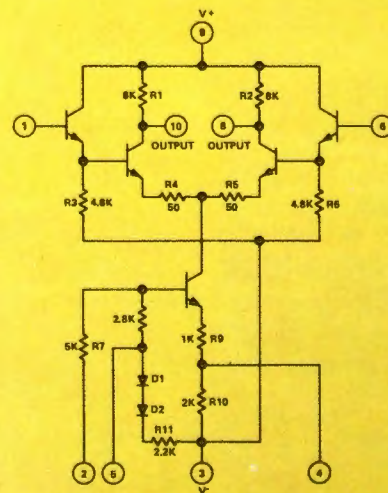
- It is not practical to calculate the input impedance of an operational amplifier such as the CA3000 because the interaction of the various elements is quite complex. Instead, the manufacturer usually publishes a curve of input impedance versus temperature for a given frequency. For example, the CA3000 has an input impedance of 195K ohms at 25° C at a frequency of 1Khz.
- The current gain will be high as a result of the cascading of the pairs of transistors approximately:  $B_1 - B_2 = (100) \times (100) = 10^4$
- A temperature-compensating voltage reference (D1, D2) is included in the base of the constant current source to minimize the effects of temperature over the operating temperature range.
- Provision is made to control the total current through the device, and therefore the gain, in two ways—first, one of two current limiting resistors in the emitter of the constant current source can be shorted out via pin #4. Secondly, the voltage at the base of the constant current transistor can be varied via pin #2; hence, the total current and gain can be varied.
- The output impedance is relatively high—approximately the 8K ohms of the collector resistors.

#### CA-3001 Integrated Circuit Video Amplifier

Examination of the schematic of the CA-3001 integrated circuit schematic (Fig. 12) reveals that, while it is quite similar to the CA-3000, there are important differences.

- The collector resistors for the differential pair are much smaller than those in the CA-3000 (1K VS 8K) thus reducing by a factor of 8 the effects of the unavoidable on chip circuit capacitances.
- The output is connected via an emitter follower rather than directly to the collector of one of the differential amplifiers which has the important effect of lowering the output impedance, thereby minimizing the effects of external circuit capacitance on the frequency response of the amplifier. If we assume an hfe of 100 for the output transistor, the output impedance ( $R_b$ ) will be  $\frac{1000}{hfe}$  or 10 ohms.

This compares very favorably with the output impedance of 8K ohms for the CA3000.



ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE SPECIFIED

Fig. 11. CA3000 Integrated-Circuit DC Amplifier.

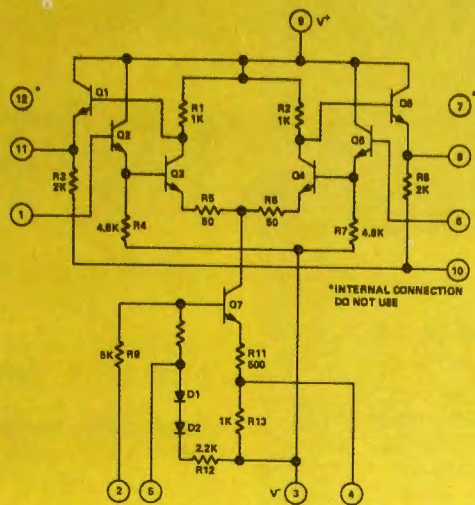


Fig. 12. CA3001 Integrated-Circuit Video Amplifier.

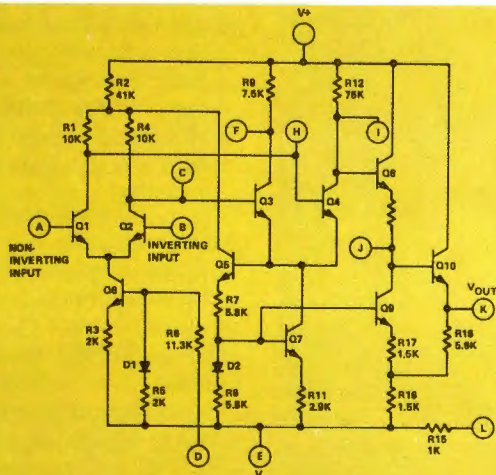


Fig. 13. Schematic Diagram of the CA3008 Family of Op-Amps.

### CA-3008 Family of Low Power Op-Amps

This family includes type:

- |         |         |
|---------|---------|
| CA-3008 | CA-3029 |
| CA-3010 | CA-3030 |
| CA-3015 | CA-3037 |
| CA-3016 | CA-3038 |

These devices all have the circuit configuration shown in Fig. 13, but vary in details of packaging, power supply ratings and performance.

The operational amplifier consists of two differential amplifiers and a single-ended output circuit in cascade. Most of the circuit gain is realized from the cascaded differential amplifiers. Since the second differential pair is driven push-pull, the signal at the emitter junction of Q3 and Q4 will be zero when the first differential amplifier stage and the base-emitter circuits are matched and there is no common mode input. Any voltage resulting from a common mode error signal appearing at the emitter of Q3 and Q4 is applied to the base of Q5 which shares a collector load resistor (R2) with Q1 and Q2. The signal developed across R2

as a result of Q5's collector current is in proper phase to reduce the common mode error. The emitter circuit of transistor Q5 also reflects a portion of the same error signal into the constant-current-source transistor Q7 in the second differential amplifier stage so that the effects of the error signal is further reduced.

Transistor Q5 also develops feedback signals to compensate for dc common mode effects produced by variations in supply voltages. For example, a decrease in the dc voltage from the positive supply results in a decrease in the voltage at the emitters of transistors Q3 and Q4. This negative going change in voltage is reflected by the emitter circuit of Q5 to the bases of transistors Q7 and Q9 and less current then flows through these transistors. The decrease in the collector current of Q7 results in a reduction of the current through transistors Q3 and Q4 and the collector voltages of these transistors tend to increase. The compensating effect of Q5 could be further detailed; however,

greater detail would only reinforce the argument that Q5 does yield a degree of immunity from power supply variations.

If the output were taken at pin 1, most of the stage gain would be realized but the operating point of the output signal would be offset with respect to ground. Emitter follower Q8 shifts the DC level down from that present at the collector of Q4 to that present at the collector of Q9—the constant current source for the base of Q10. The level is further shifted by Q10 so that the output is at nominally ground potential (assuming equal and opposite supply voltages).

A small voltage gain (approximately 1.5) is realized in the output stage by bootstrapping the Q10 emitter current to an intermediate point on the emitter resistor of Q9. Although this gain is only a small percentage of the total, it is significant because it markedly increases the voltage swing at the output.

If a higher current drive is required, then pin L can be connected to pin K—shunting the Q10 emitter resistors.

### CA-3140 BIMOS Operational Amplifier

Solid state technology has now progressed to the point where it is possible to include both metal oxide (MOS) and bi-polar semiconductors on a single chip. Very simply, this means that is is now possible to combine the very high input impedance of FET input stages with the high current and low impedance of a bipolar output stage.

The CA-3140 is the first of what will undoubtedly be a very large family of such devices. Input resistance is in the order of  $10^{12}$  ohms with an input offset current of 0.1 pa, a large signal voltage gain of 100 dB and the ability to source 10 ma at the output makes it certain that devices in this family will be found in many applications in the future.

It will be noted from the block diagram (Fig. 14a) that the CA-3140 is made up of four functional units. The differential input stage has a gain of approximately 10X and includes provision for nulling any offset caused by imbalance of the circuit elements. The second stage provides most of the gain (10,000X) and has provision for strobing the signal (if pin #8 is connected to pin #4 the signal output drops to zero). The output stage has unity gain with relatively low output impedance. The bias circuit and regulator renders the amplifier relatively immune to variations in the temperature and power supply voltages. The bias circuit also

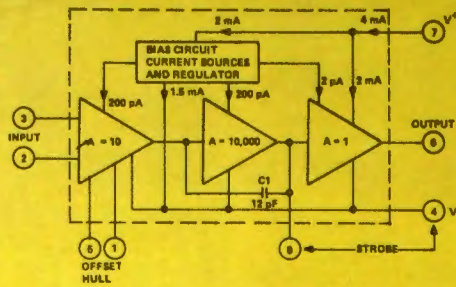


Fig. 14a. Block Diagram of CA3140 Series.

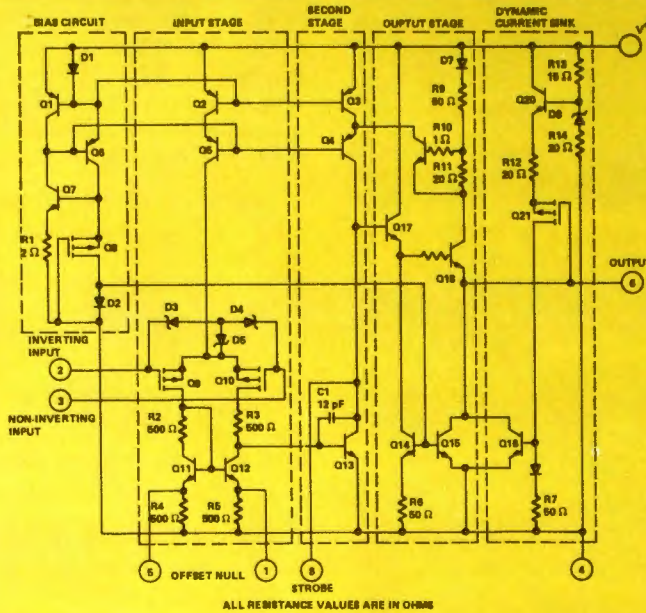


Fig. 14b. CA3140 BIMOS Operational Amplifier.

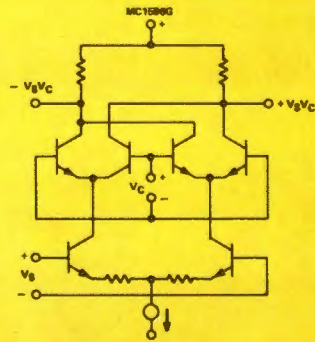


Fig. 15a. Simplified Schematic of Balanced Modulator Demodulator Circuit.

supplies the reference voltages for the several constant current sources on the chip.

Examination of the CA-3140 schematic (Fig. 14b) shows that the input stage is a differential pair of PMOS FET's (Q9 and Q10). These transistors work into a current mirror pair of bi-polar transistors (Q11 and Q12) which, with resistors R2 through R5, function as the load for Q9 and Q10. The mirror pair transistors also function as a differential to single-ended convertor to provide base current drive to the second stage bi-polar transistor (Q13). Cascade connected bi-polar transistors

Q2 and Q5 are the constant-current source for the input stage.

Most of the voltage gain in the CA-3140 is provided by the second amplifier stage—consisting of bi-polar transistor Q13 and its cascade connected load resistance provided by transistors Q3 and Q4. On chip phase compensation, sufficient for a majority of the applications, is provided by C1. Terminal #8 can be used as a strobe by connecting it to the negative supply.

The CA-3140 employs a broadband output stage that can sink loads to the negative supply to complement the capability of the PMO's input stage when

operating near the negative rail. Q17 and Q18 act as emitter followers with Q14 and Q15 serving as current sources for the stages. Q19 measures the voltage drop across R11 and provides short circuit protection by diverting current from Q4 when the threshold is exceeded.

**Balanced Modulator**

In addition to performing the amplitude modulation function (multiplication of two signals), the balanced modulator goes a step further and effectively cancels both the carrier and the modulating signal—leaving only the product signals. The operation of this very versatile device can be described as follows:

- The transconductance of a transistor (gm-collector current for a given signal voltage applied to the base) is a function of the emitter current.
- If a signal voltage is applied to the base of a transistor and current representing a second signal is caused to flow in the emitter of that transistor, the collector current will represent the product of the two signals (it should be noted that the product current will be a non-linear function of the two signals; however, this non-linearity is tolerable in many applications such as balanced modulators).
- With the above background, refer to Fig. 15a and note that this circuit is a practical implementation of the concepts described. If the two halves of the circuit are identical (which, with external balancing potentiometers is a valid assumption) then the Carrier and Signal frequencies will be cancelled and only the products of these two signals (upper and lower sidebands and harmonics thereof in the case of amplitude modulation) will be present at the output.
- If the amplitude of the carrier waveform is large compared to the saturation and cut off levels of the transistors, then the carrier waveform causes the two sections to switch on alternate half cycles as shown in Fig. 15b and 15c.

Now, assuming a high amplitude Carrier waveform and a linear Signal waveform, the result will be a modulation envelope as shown in Fig. 16. The effect of the square wave modulation (switching signal) is an infinite series of odd harmonics; hence, a filter must be used to select the desired signal.

- Comparison of the simplified diagram of the Balanced Modulator (Fig. 15a) used to explain the operation of the unit and the schematic

of the Balanced Modulator (Fig. 17) reveals that the former has a single common current source with balancing resistors in the emitters of the upper differential pairs and the latter has two current sources with provision for connecting a single "Gain Adjusting" resistor between the emitters of the differential pair. In view of the fact that a current source appears to the differential pair as an infinite impedance, the current source will not enter into the calculation of the balancing impedance between the two emitters. Therefore, if instead of a single current source and a pair of balancing resistors, two current sources (each supplying one-half the current supplied by the single current source) and a single balancing resistor equal in value to the sum of the two original resistors is used, we will have equivalent circuits.

#### Linear Four Quadrant Multiplier

Examination of the schematic of the Motorola MC1595 Linear Multiplier (Fig. 18) reveals many similarities with the previously discussed MC1596 Balanced Modulator; however, the differences are extremely important and are as follows:

- The "X" differential pair supplies the emitter currents of the two summing differential pairs. It will be remembered that the transconductance ( $g_m$ ) of the output transistors is determined by the emitter current.
- The "Y" differential pair supplies the base voltage to the bases of the summing differential pairs. Note the diodes in series with each of the "Y" amplifiers. These diodes precondition the "Y" signals so that the current in the collectors of each of the summing transistors is a linear product of its base voltage and emitter current.
- The "X" and "Y" differential pairs are fed by current sources having the base connection brought out. The base voltage controls the current supplied by the source and, therefore, the magnitude of the signal developed by the "X" or "Y" differential pair. Usually, only the "X" or the "Y" current source is controlled. The output currents then will be  $\pm K$  (factor determined by the externally controlled current source)  $XY$ .
- Tracing signals through the multiplier reveals that a signal  $KXY$  is present on pin #14 and  $-KXY$  is

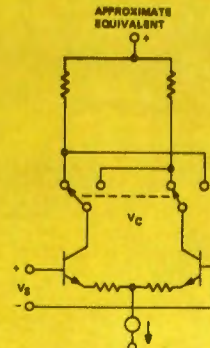


Fig. 15b. Further Simplified Schematic of Balanced Modulator showing the Switching Equivalent Circuit.

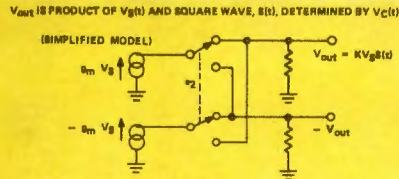


Fig. 15c. Further Simplification of Switching Circuit.

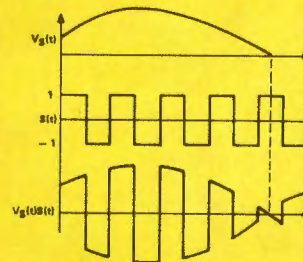


Fig. 16. IC Balanced Modulator Operation.

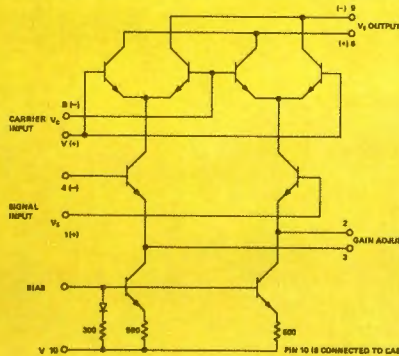


Fig. 17. MC-596G Balanced Modulator Schematic.

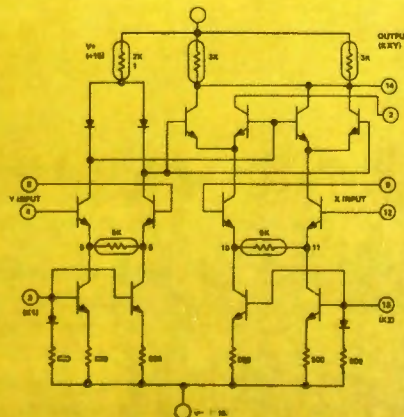


Fig. 18. Four-Quadrant IC Multiplier (slightly simplified version of MC 15956 or MC 1495L—Circled Resistors are external to IC Package, and tailored to the application)

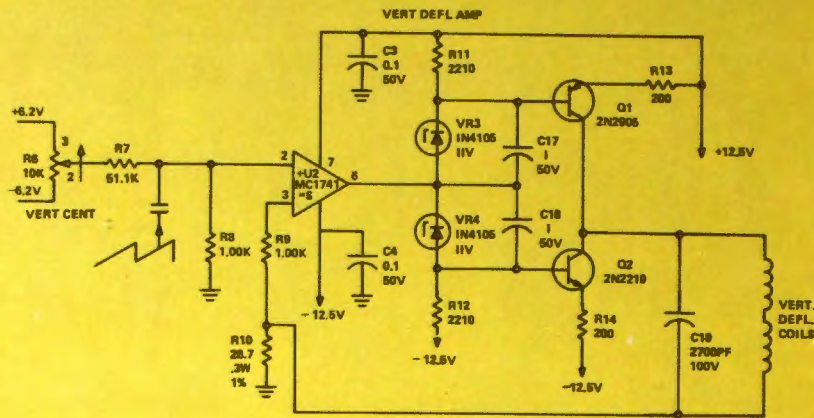


Fig. 19. Non-Inverting Amplifier in the TKP-45 Vertical Deflection Circuit.

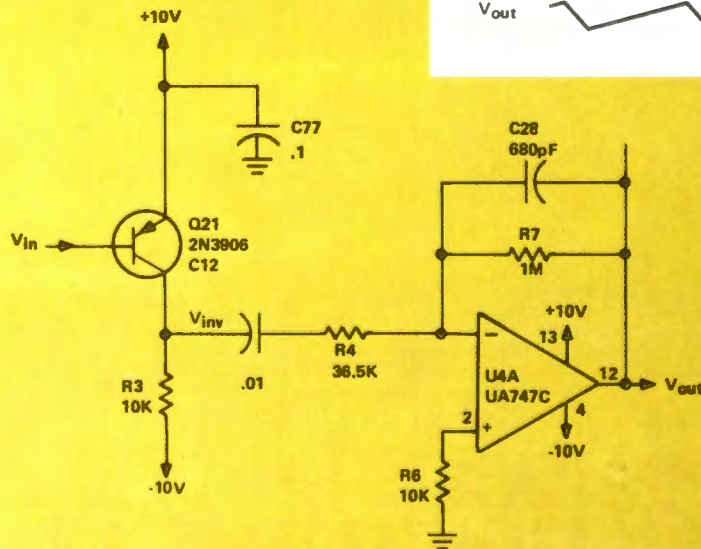
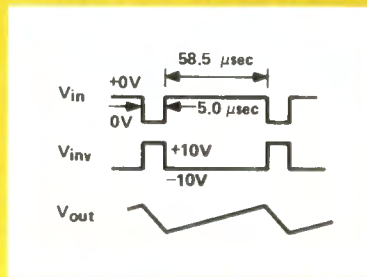


Fig. 20. Inverting Amplifier used as a Sawtooth Generator.

present on pin #2. Further, it is seen that the outputs are a vector multiplication of the input signals and can assume any value including zero.

#### Applications

Further understanding of Linear Integrated circuits results from examining how they are applied to system prob-

lems. The following paragraphs present applications from RCA Broadcast Television equipments.

#### Non-Inverting Amplifier

An application of the non-inverting op-amp as a vertical deflection amplifier in the TKP-45 camera is shown in Fig. 19. The deflection sawtooth of voltage in capacity coupled to the non-

inverting input and a DC centering voltage is directly coupled to this input. The composite input voltage is amplified in U2 and is applied to the power amplifier (Q1 and Q2) which brings the power up to a level suitable for driving the vertical deflecting coils.

The deflection of an electron beam is proportional to the current through the deflecting coils and at a 60 Hz field rate the deflecting current is very nearly a linear function of the voltage applied to the coils; hence, the required waveform of current can be maintained by tailoring the input wave shape to suit the electron optics of the deflection assembly pick up tube and feeding back a voltage obtained by placing a small current sampling resistor (R10) in series with coils. This system minimizes the effects of temperature on raster height as any change of temperature causes a change in coil resistance and a proportional change in the feedback voltage.

#### Integrator

The Integrator shown in Fig. 20, is used to generate a sawtooth of voltage having the same duration as the controlling waveforms. The input waveform ( $V_{in}$ ) is the horizontal drive pulse in the TKP-45 Minipack camera. The input logic level signal is amplified and inverted by Q21 resulting in a signal ( $V_{inv}$ ) which swings between plus 10 volts and minus 10 volts. The inverted waveform is AC coupled into the inverting input of the op-amp (U4A) which acts as a low impedance constant current source charging C28. The output waveform ( $V_{out}$ ) reflects the charge and discharge of capacitor C28. It will be remembered that AC coupling shifts the DC axis of a waveform so that there are equal areas positive and negative areas under the curve; hence, the effective amplitude of the drive pulse causes a constant output current which discharges the capacitor (C28) exactly the same amount as it was charged between pulses. Feedback resistor is included to assure DC stability of the circuit.

It is worth noting that while the integral of a pulsed wave form as shown is a sawtooth of voltage, the integral of the sawtooth of voltage is a parabola.



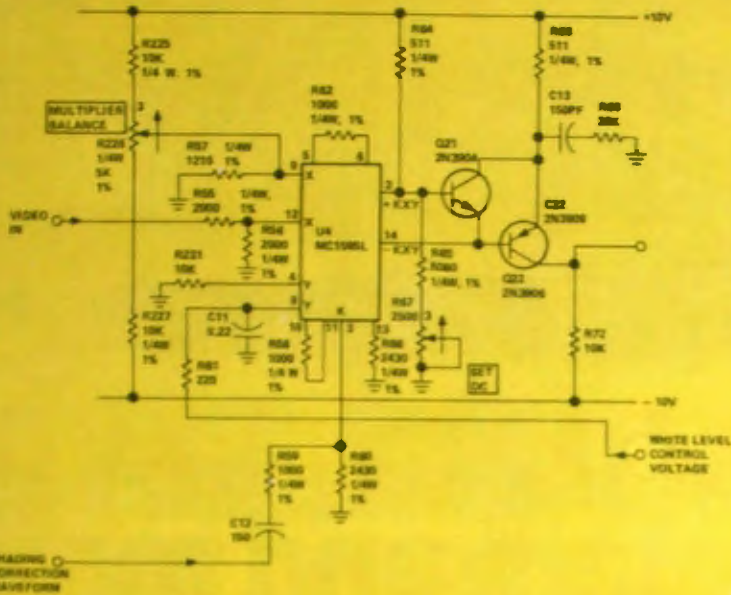


Fig. 21. Four Quadrant Multiplier used as a Shading Modulator.

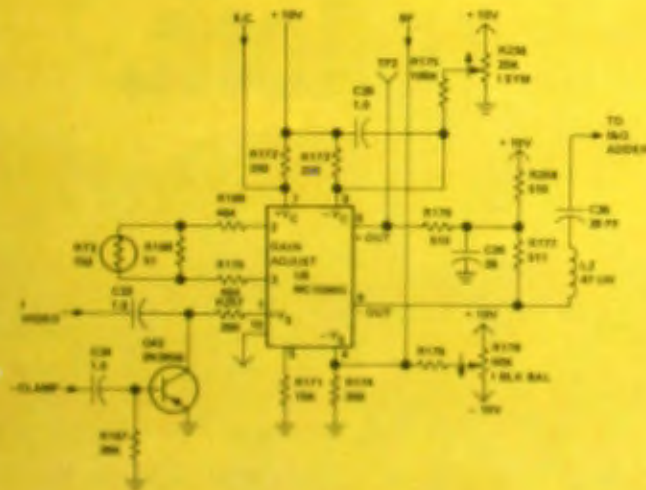


Fig. 22. "T" Balanced Modulator

### Shading Modulator

The Four Quadrant Multiplier makes an excellent Shading Modulator as shown in Fig. 21. The video to be processed is fed into the X input (pin = 12) and DC balance is established by adjustment of the Multiplier Balance Control (R225). The Shading correction signal is AC coupled into the K input (pin = 3) and the White Level Control Voltage is fed into the Y inputs (pin = 8). The output at pin = 2 is KXY and at pin = 14 is KXY. The outputs are combined by Q1 and Q2 with the DC level set by R67.

### Balanced Modulator

Fig. 22 is the schematic of the T Balanced Modulator using the TKP-45 Multiplier. The Shading correction signal is AC coupled into the K input (pin = 3) and the White Level Control Voltage is fed into the Y inputs (pin = 8). The output at pin = 2 is KXY and at pin = 14 is KXY. The outputs are combined by Q1 and Q2 with the DC level set by R67.

The circuit is designed to process video signals and provide shading correction.

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