OPERATING AND MAINTENANCE INSTRUCTION MANUAL

The "DAVID"

MODEL 715

FM-STEREO PROCESSOR / GENERATOR

INOVONICS
INCORPORATED

- USER'S RECORD -

Model 715 - Serial No.________

Date Purchased ____________

Warranty Card Mailed ________

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FM-STEREO PROCESSOR / GENERATOR

September, 1992

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Section I

INTRODUCTION

MODEL 715 PRODUCT DESCRIPTION

General With the introduction of its Model 715, the "*DAVID,*" Inovonics has reduced the combined functions of stereo audio processing and FM-stereo "multiplex" signal generation to the most basic level.

Simplicity notwithstanding, *DAVID* is a fully professional product with many desired features and with superb specifications. It is equally suited to the most fundamental installations, as it is to the demanding services of "competitive market" broadcasting. The name *DAVID* was suggested by the product's ability to triumph against more formidable (and far more expensive) competitors.

Features Features of Inovonics' *DAVID* include:

- Stereo audio processing includes slow, "gain-riding" AGC, Dynamic Compression, Peak and independent High Frequency Limiting, and a single-knob control for adjusting Program Density.
- Extended-response low-pass filtering with proprietary overshoot compensation to ensure full carrier modulation without need for composite clipping.
- Digital synthesis of pilot and subcarrier for unexcelled performance and freedom from drift and routine adjustment.
- Built-in combining for SCA or RDS subcarriers, including an independent 19kHz, TTL-level Stereo Pilot output for RDS sync.
- Exceedingly easy to install, set-up and use. "Generic" component parts facilitate servicing worldwide.

MODEL 715 TECHNICAL SPECIFICATIONS

Frequency Response (through appropriate deemphasis network):
±1dB, 20Hz - 16kHz; −60dB or better at 19kHz.

Stereo Separation (L/R or R/L):
>60dB, 20Hz - 16kHz.

Distortion:
<0.15% THD in demodulated audio above 200Hz. Distortion below 200Hz is a function of the PROCESSING DENSITY control setting.

Noise:
Better than 80dB below 100% modulation in demodulated audio, 20Hz - 16kHz. 38kHz residual and "digital" noise above 54kHz, −75dB or better.

Crosstalk (M/S or S/M):
−55dB or better "nonlinear" crosstalk at TEST INPUTS (processing bypassed), −45dB or better overall.

(continued)

Stereo Pilot:
19kHz, ±1Hz; injection level adjustable between 6% and 12%, relative to 100% modulation. Pilot distortion <0.5% THD.

Program Inputs:
LINE INPUTS for Left and Right Channel program are active-balanced / bridging, and accept nominal line levels between −15dBu and +15dBu.

Test Inputs:
Unbalanced TEST INPUTS bypass audio processing and preemphasis circuitry for direct signal feed to Stereo Generator section. 0dBu input gives 100% modulation.

SCA / RDS Input:
Unbalanced input accommodates SCA or RDS subcarrier signal levels between −20dBu and 0dBu for nominal 5% - 10% injection.

Preemphasis:
Integral to split-spectrum audio processing circuitry and non-defeatable. May be jumpered for 75μs or 50μs characteristic. TEST INPUTS bypass processing and give a "flat" output.

AGC Amplifier:
Slow (0.5dB/sec.) correction for long-term input level variations; ±10dB capture range displayed by LED indicators.

Compressor/Limiter
Fast-acting peak limiter has secondary "platform" time constant to compress dynamic range with average-value weighting. Independent high frequency limiter conforms to selected preemphasis characteristic. LEDs indicate peak and H.F. limiter action and compressor gain state. DENSITY control alters time constants and platform values.

Signal Clipping:
Program signal clipping is relegated to non-repetitive limiter overshoots 1ms or less in duration. "Safety" clipping of the Composite Output signal is performed prior to Stereo Pilot insertion.

Composite Output:
Single-ended (unbalanced), "zero" (voltage source) impedance. Level is adjustable between −5dBu and +12dBu (0.5 to 3V r.m.s. or 1.2 to 8V p-p).

19kHz Sync Output:
TTL-level symmetrical squarewave, in phase with 19kHz Stereo Pilot component in Composite Output signal.

Digital Synthesis Sampling Rate:
608kHz (16X subcarrier oversampling).

Power Requirement:
105 - 130VAC or 210 - 255VAC, 50/60Hz; 15 watts.

Size and Weight:
1¾"H x 19"W x 7"D (2U); 7 lbs. (shipping).

BLOCK DIAGRAM

A simplified Block Diagram of the *DAVID* is shown on the following page. Generator circuitry is explained in detail under Circuit Descriptions, Section V, which references Schematic Diagrams found in the Appendix, Section VI.

PATENT NOTICE

Low-pass filter overshoot compensation circuitry employed in the Model 715 is protected under U.S. Patent No. 4,737,725.

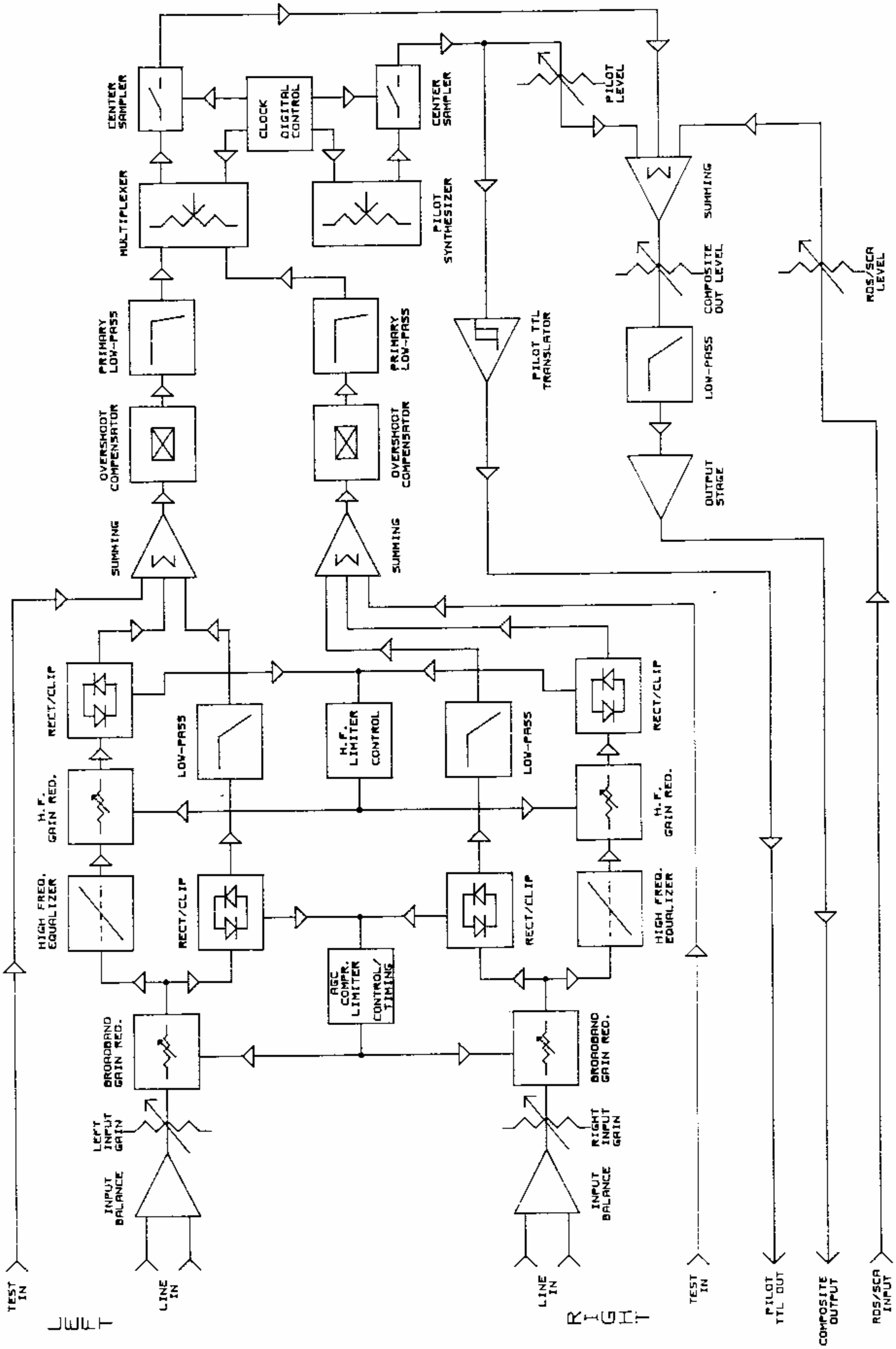


Figure 1 - Block Diagram, Model 715 FM-Stereo Processor/Generator

Section II

INSTALLATION

UNPACKING AND INSPECTION

Immediately upon receipt of the equipment, inspect carefully for shipping damage. If any damage is observed, notify the carrier at once; if not, proceed as outlined below. It is recommended that the original shipping carton and packing materials be saved should future reshipment become necessary. In the event of return for Warranty repair, shipping damage sustained as a result of improper packing for return may *invalidate the Warranty!*

IT IS VERY IMPORTANT that the Warranty Registration Card found at the front of this Manual be completed and returned. Not only does this assure coverage of the equipment under terms of the Warranty, and provide some means of trace in the case of lost or stolen gear, but the user will automatically receive specific SERVICE OR MODIFICATION INSTRUCTIONS should they be issued by the factory.

MOUNTING

Rack Requirement The Inovonics *DAVID* is packaged to mount in a standard 19-inch equpment rack and requires only 1¾ inches (2U) of vertical rack space. Because the *DAVID* has no appreciable weight, only two mounting holes are provided. These holes are positioned in accordance with the current "preferred" EIA specification, but may not align with tapped holes in the mounting rails of some equipment racks manufactured before 1958. *The use of plastic "finishing" washers is recommended to protect the painted finish around the mounting holes.*

Heat Dissipation Consuming less power than the bulb in a refrigerator, heat generated by the *DAVID* is insignificant. The unit is specified for operation within an ambient temperature range of freezing to 120°F / 50°C. Because adjacent, less efficient equipment may radiate substantial heat, be sure that the equipment rack has sufficient ventillation to keep the temperature below the stated maximum.

AC (MAINS) POWER

As-Delivered Unless specifically ordered for export shipment, the *DAVID* is factory-set for operation from 115V, 50/60Hz AC mains. The rear-panel designation next to the fuseholder will confirm both the mains voltage selected and the value of the fuse supplied.

Voltage Selector A mains voltage selector switch is found beneath the top cover of the unit, adjacent to the AC mains connector on the main circuit board. *With mains power disconnected,* slide the red actuator with a small screwdriver so that the proper mains voltage (115 or 230) is visible. You must always install an appropriate fuse, and should mark the rear-panel voltage/fuse designation. It is factory practice to cross out the *inappropriate* marking with an indelible black marking pen. You can remove this strikethrough with solvent to redesignate it.

BE SURE that the mains voltage selector setting and primary fuse value are appropriate for the mains supply before plugging the *DAVID* into the wall socket.

Power Cord The detachable power cord supplied with the *DAVID* is fitted with a North-American-standard male plug. The individual cord conductors are *supposedly* color-coded in accordance with CEE standards:

BROWN = AC "HOT," BLUE = AC NEUTRAL, GRN/YEL = GROUND.

If this turns out *not* to be the case, we offer our apologies (cord vendors vary) and advise that U.S. color coding applies:

BLACK = AC "HOT," WHITE = AC NEUTRAL, GREEN = GROUND.

RADIO FREQUENCY INTERFERENCE (R F I)

Location Though we anticipated the *DAVID* to be operated close to broadcast transmitters, you should exercise care in locating the unit away from *abnormally* high RF fields.

Ground Loops In some installation situations a mains frequency or RF ground loop may be formed between the input or output cable shield grounds and the AC power cord ground. Use of a "ground-lifting" AC adapter should remedy the problem, though the chassis ultimately must be returned to earth ground for safety.

LINE INPUT AND INPUT RANGE SELECTION

The *DAVID* has electronically-balanced (transformerless) Left and Right Channel PROGRAM LINE INPUTS. These are brought out to a screw-terminal barrier strip on the rear panel, and include chassis ground connections for cable shields.

Balanced Inputs A balanced feed to the *DAVID* will use both the "+" and "−" terminals, plus ground, for each channel. Since this is a "bridging" (high impedance) input, no termination is provided for the console output or for other equipment which feeds the *DAVID*. You may place a terminating resistor between the "+" and "−" terminals, should the source require 600-ohm termination.

Unbalanced Inputs Unbalanced inputs use the PROGRAM LINE IN "+" and "GND" (ground) barrier strip terminals. The "−" terminal should also be connected to "GND" when the input is fed from a single-ended source.

Input Gain Range

The *DAVID* can accommodate line-level program inputs with a nominal "Zero-VU" value between −15dBu and +15dBu. This 30dB range is divided into two, more manageable 15dB ranges by internal jumpering.

As shipped, the *DAVID* is jumpered for HIGH level inputs between 0dBu and +15dBu. Most console and STL receiver outputs fall into this range, with +4dBu, +6dBu and +8dBu being typical levels.

Lower levels, between −15dBu and 0dBu, may be encountered when interfacing with "semi-pro" mixers or with lossy studio-transmitter telephone line circuits. The extra gain for the LOW level range is enabled by changing jumpers beneath the top cover.

Gain Jumpers

Just behind the LINE INPUT barrier strip is a jumper pin strip with two "push-on" jumpers. The strip is marked in the circuit board legend with a "HI" and a "LO" for both the Left and the Right Channels. Simply move both jumpers from the "HI" (jumpers apart) to "LO" (jumpers together) as illustrated below in Figure 2.

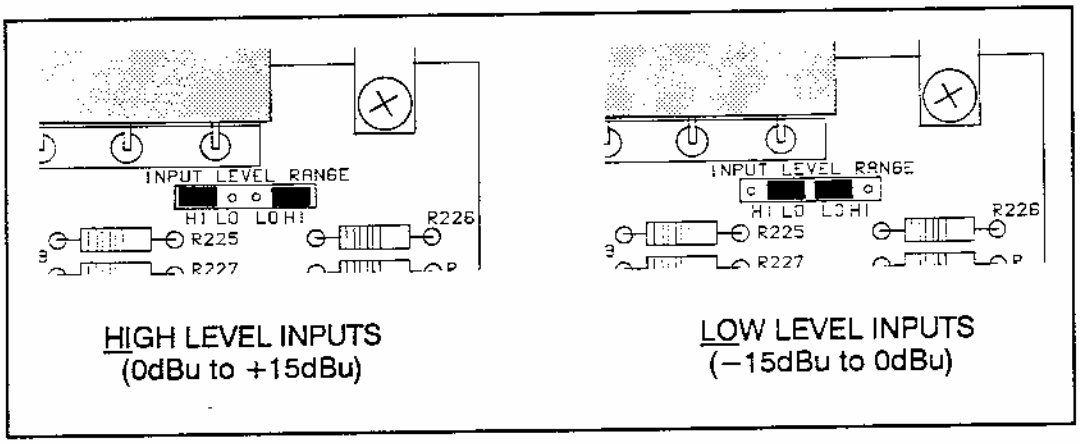


Figure 2 - LINE INPUT Range Selection

PREEMPHASIS SELECTION

Both 75-microsecond (Western Hemisphere and the Orient) and 50-microsecond (Europe and Asia) FM broadcasting preemphasis standards are supported. Preemphasis appropriate to the shipping destination is jumpered at the factory, but this is easily changed if necessary.

Beneath the top cover and about midway between the LINE INPUT barrier strip and the front panel, you will find three jumper pin strips, each with two "push-on" jumpers. These strips are marked with the designations "75uS" (jumpers apart) and "50uS" (jumpers together) in the circuit board artwork. You need only move the jumpers to the appropriate pins to select the desired preemphasis, as illustrated at the top of the next page in Figure 3. Be sure, however, that *all six jumpers* are installed for the same characteristic.

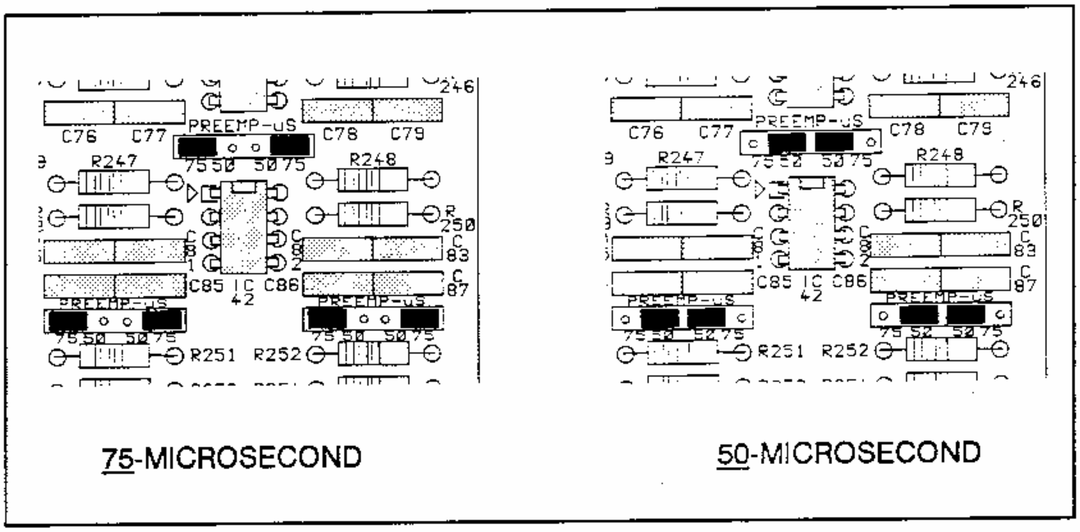


Figure 3 - Preemphasis Jumpering

TEST INPUTS

Two unbalanced, "phono-jack" inputs on the rear panel provide direct access to the input of the Stereo Generator section of the *DAVID*. These inputs, labeled TEST INPUTS, bypass the Audio Processing section entirely. Signals applied here are *not* preemphasized, though they *do* pass through the primary 16kHz low-pass filter and its associated overshoot compensation circuitry.

The TEST INPUTS are *not* program inputs. They are used for alignment, performance verification and troubleshooting of the *DAVID*. A nominal input level of 0dBu yields 100% modulation.

SUBCARRIER INPUT

Internal combining is provided for an RDS or SCA auxiliary subcarrier. The signal is applied via the rear-panel RDS INPUT connector. This is an unbalanced input with a load impedance between 3k-ohms and 10k-ohms, depending on the position of the associated front-panel RDS LEVEL control.

An RDS subcarrier normally accounts for about 5% of the total Composite Output signal, making it about 26dB below peak program modulation. SCA subcarriers normally have a higher injection level of about 10%, or 20dB below program peaks. Subcarrier inputs ranging in level between −20dBu and 0dBu may be fed to the RDS INPUT connector, and can be regulated to the proper injection level by the front-panel RDS LEVEL control.

19KHZ PILOT SYNC OUTPUT

A 5-volt-peak, TTL-level squarewave at the 19kHz Stereo Pilot frequency is available at the rear-panel 19kHZ TTL SYNC OUT connector. This symmetrical squarewave is in phase with the 19kHz Stereo Pilot component in the Conposite Output, and is present even when the front-panel PILOT switch is turned OFF.

COMPOSITE OUTPUT

The *DAVID* has a "voltage source" (zero impedance) COMPOSITE OUTPUT characteristic. This permits quite long runs of coaxial cable between the *DAVID* and the exciter/transmitter.

A Stereo Generator must always be connected to an exciter (or STL) input specifically intended for multiplex stereo. This is a "flat" input, rather than a Monaural Program Input which is preemphasized. (Preemphasis is imparted by the *DAVID* in the processing and stereo generation circuitry.)

Output Ground Loops

Because the *DAVID's* COMPOSITE OUTPUT and the exciter input are both unbalanced, it is best to locate the *DAVID* near the exciter, operating both from a common AC mains circuit. This will help avoid ground loops and mains-related hum in the received signal.

Section III

SETUP AND OPERATION

PANEL CONTROLS AND INDICATORS

A brief description of all front-panel controls and indicators is given here. You are encouraged at least to skim this section to verify that our terminology agrees with your understanding.

PLEASE NOTE: All "set-and-forget" multiturn trim controls require *fifteen to twenty complete rotations* of the adjusting screw to cover their total operating range. Moreover, the end of the range is *not* identified by a "click-click" sound or other audible or tactile indication.

INPUT GAIN

These two trim controls (at the far-right of the front panel) adjust for the range of program levels applied to the Left and Right PROGRAM LINE INPUT barrier strip terminals on the rear panel. The controls have a 15dB range which is extended by the Input Gain Range jumpering option described on Page 8. These controls are adjusted to maintain gain of the AGC circuitry in the center of its operating range, and to correct for imbalance between the Left and the Right program channels.

A G C GAIN

This series of five LED indicators displays the amount of correction in effect for long-term variations in the program input signal. The AGC circuit is Left/Right-correlated; that is, the overall circuit gain is controlled by the *greater* of the Left or Right Channel signals. This prevents stereo image "wandering."

The correction rate of the AGC circuit is intentionally very slow. 10dB of gain correction will take approximately 20 seconds. With a consciencious operator on the console, the indicated AGC GAIN will almost always appear "stuck" at 0dB.

The "safe" operating range of the circuit is within the central three green LEDs. If either the +10dB or −10dB red LED is lighted to full brightness, the program signal is out-of-limits and the reason should be found and corrected.

GATE OPEN

AGC and Compressor circuits in the *DAVID* are "gated." This means that during brief pauses in the program, background sounds don't surge-up and cause the "breathing" or "pumping" effects common to elementary processors. The green GATE OPEN indicator will stay lighted during most music programming, but will blink off during speech pauses.

PROCESSING DENSITY

This single knob is the only control which gives you any manual adjustment over the subjective "sound" of the program audio. At the fully counterclockwise position (MIN), the Compression "platform" and the Limiting threshold are essentially at the same point. Under this condition the slow AGC function has greatest control over program dymanics.

As the PROCESSING DENSITY knob is rotated clockwise, two things happen:

1. The Compression "platform" is increasingly separated from the Limiter ceiling value. The farther the PROCESSING DENSITY knob is turned clockwise, the more the program signal is subjected to short-term, fast-release processing.
2. Both the Compression release timing and the Peak Limiting release are made progressively shorter. This increases the average value of the program signal by bringing up low level program components more rapidly.

The program signal will get subjectively "louder" as the PROCESSING DENSITY control is rotated toward (MAX). At the same time, distortion of low frequency signal components will increase due to the "self-modulation" effect. The ultimate setting of this control must be determined by *careful* listening to the effects of processing on typical program material.

COMPRESSOR GAIN

These two LEDs indicate the gain state of the "platform" average-level compression function at any given instant. The red "–" LED lights when the Compressor is *reducing* circuit gain for program material with an already-high average level, the green "+" LED indicates an *increase* in circuit gain to bring up the lower levels. (This latter situation is sometimes mistakenly called "downward expansion," but any action which *reduces* program dynamic range is, by definition, signal *compression*.)

LIMITING — PEAK & HF

The *DAVID's* "split-spectrum" peak control incorporates the usual *Broadband* Peak Limiter to set a ceiling value for program peaks. Specific allowance for "protection" of the preemphasis characteristic is made by a separate and independent *High Frequency* Limiter which follows the selected preemphasis curve. The PEAK (red) LED flashes whenever a broadband peak is reduced, and the HF (green) LED shows any independent reduction of excessive high frequency energy.

FILTER COMP.

Proprietary circuitry integral with the 16kHz low-pass filter inhibits overshoots which would otherwise compromise full modulation of the carrier. Action of this circuit is displayed by the FILTER COMP. (green) LED. It is quite normal for this indicator to flash continuously when "bright" music is broadcast.

LEVEL
RDS / PILOT / OUTPUT

The RDS and PILOT LEVEL adjustments actually set the *injection levels* of any externally-applied RDS or SCA subcarrier and the internally-generated Stereo Pilot. The OUTPUT (COMPOSITE) LEVEL adjustment varies the *overall* Composite Output level of the *DAVID* delivered to the exciter/transmitter or STL. This is a "master" output level control and does *not* affect the relationships (level ratios) between the Stereo Program, Stereo Pilot and RDS/SCA Subcarrier.

PROCESSING
IN / OUT

This switch should be IN (green LED on) for normal operation. With PROCESSING switched OUT (red LED on), gain of the AGC is held at the 0dB resting value, and both Compression and Limiting (Broadband and High Frequency) are defeated. Also with PROCESSING switched OUT, low-pass filter overshoot compensation circuitry is inhibited, as is the "safety" clipper which follows the digital-synthesis stereo generation circuitry.

When PROCESSING is switched OUT, preemphasis is still in effect, though modulation is not controlled in any manner. It is possible under these conditions to modulate the FM carrier to about 200%.

PILOT
ON / OFF

This switch turns ON and OFF the 19kHz Stereo Pilot. It is normally left ON (green LED on), but may be turned OFF (red LED on) for test and alignment. This switch does *not* affect the rear-panel 19kHz TTL SYNC OUT signal which is present at all times.

MODE
STEREO / MONO

Normally left in the STEREO (green LED on) position, this switch may be set to MONO (red LED on) for test and alignment. In MONO the Stereo Pilot is turned off, as indicated by the red LED next to the PILOT switch.

When switched to MONO, the *DAVID* Composite Output will contain the sum of the Left and Right Channel program signals (L+R) only, in addition to any RDS or SCA subcarrier.

POWER
ON / OFF

Intuitive users skilled in the technology of radio broadcasting will find this switch an old friend requiring no introduction. Others may write or call the Technical Support Section of Inovonics for specific instructions on its use.

NORMAL SETUP PROCEDURE

This setup procedure is exceedingly simple. It presupposes a normal installation with the *DAVID* Line Inputs fed directly from the Left and Right Channel outputs of the Audio Console, and a direct connection of the Composite Output to the wideband input of an exciter/transmitter. Variations from these conditions, such as an intermediate STL (microwave link) in either the input or the output path of the *DAVID*, may require considerations not addressed here.

At this point the *DAVID* should be installed in the program chain with power applied, and have all front-panel function switches ON. The PROCESSING DENSITY control should be left at the mid-point (panel marking 5 or 6) during this setup.

INPUT GAIN Calibration

Left (L) and Right (R) INPUT GAIN controls are set individually to center the AGC operating range at the nominal "Zero-VU" program line input level. If the following procedure shows the INPUT GAIN control range to be outside adjustment limits, recheck PC board jumpering for Line Input Range Selection as described on Page 8.

1. To the Left Channel *only*, apply a 1kHz test tone from the console at a level 2.5dB above normal reference level. This is simply a console VU meter indication of +2.5VU.
2. Adjust the Left Channel (L) INPUT GAIN control so that *both* the 0dB *and* the −5dB AGC GAIN indicator LEDs light to *equal brightness*. *NOTE:* The AGC circuit has a very slow response to level changes. Have patience in performing this step of the procedure.
3. Turn off the +2.5VU test signal to the Left Channel and apply it to the Right Channel *only*.
4. Adjust the Right Channel (R) INPUT GAIN control so that *both* the 0dB *and* the −5dB AGC GAIN indicator LEDs light to *equal brightness*.

This completes INPUT GAIN adjustment. The *DAVID* may now be fed from the normal program source. If the above procedure has been performed properly (and with reasonable operator attention to console metering), the AGC RANGE indicators will always remain in the green LED "safe operating" area between -5dB and +5dB.

Output Level Adjustment

Perform this "on-air" under normal transmission conditions, using typical program material and the station Modulation Monitor. An RDS or SCA subcarrier should *not* be connected until Step #6.

NOTE: Please be certain that you understand operation of the Mod-Monitor, and that it is properly calibrated and connected.

1. Put the Mod-Monitor in its "Total Peak Modulation" measurement mode with peak flasher(s) set to 100%.
2. With normal program fed to the *DAVID* (at the level which maintains AGC GAIN in the center of its range), adjust the OUTPUT (COMPOSITE) LEVEL control for a Mod-Monitor indication of *frequent* 100%-modulation peaks.
3. Back-down the OUTPUT (COMPOSITE) LEVEL control slightly, so that the 100% peak flasher(s) light only occasionally.
4. Switch the Modulation Monitor to display injection level of the 19kHz Stereo Pilot.
5. Adjust the *DAVID's* PILOT LEVEL control for a 9% to 10% reading of pilot injection on the Mod-Monitor.
6. *(OPTIONAL)* If an RDS or SCA subcarrier is broadcast, connect it to the *DAVID* at this time. Using the Mod-Monitor or other means to determine auxiliary subcarrier injection level, adjust the RDS LEVEL control for desired injection (normally 5% for RDS, 10% for SCA).
7. Put the Mod-Monitor back into its "Total Peak Modulation" measurement mode with peak flasher(s) set to 100% and, if required, "touch-up" the

OUTPUT (COMPOSITE) LEVEL control so that the 100% peak flasher(s) light only occasionally. *NOTE:* When SCA or RDS subcarriers are broadcast, peak modulation *may* be permitted to exceed 100%. The station (or consulting) engineer should assume responsibility for adjustments which deviate from this procedure, however.

PROCESSING DENSITY CONTROL

Once the OUTPUT (COMPOSITE) LEVEL has been adjusted for proper carrier peak deviation, the only user adjustment over program "loudness" is the PROCESSING DENSITY control.

Though the Audio Processor section of the *DAVID* is simple in concept and execution, it is quite capable holding its own against much more complex audio processing systems. Early in the development of the *DAVID*, we decided *not* to employ excessive program waveform clipping to give a loudness advantage, as this has proven to promote "listener fatigue" and encourage tune-outs.

The PROCESSING DENSITY control simultaneously varies several circuit parameters which affect perceived loudness. You may safely keep this control in the center of its range, or use it judiciously to decrease (counterclockwise) or increase (clockwise) perceived program loudness.

Section IV

CALIBRATION

I. EQUIPMENT REQUIRED

A. Dual-Trace Oscilloscope; 5mV sensitivity, 20MHz bandwidth; with two matched 10:1 probes.

B. Audio Generator; 10Hz - 1MHz, +20dBm output capability with step and vernier output attenuators.

C. AC Voltmeter; "dBm" scaling, −60dB to +20dB measurement range.

D. Frequency Counter; capable of accurate frequency measurement from 1kHz to 2MHz.

E. Spectrum Analyzer; must have good resolution in the 100Hz - 100kHz (FM Composite Baseband) display range.

F. "Precision" FM-Stereo Demodulator; station Modulation Monitor with input for Composite (baseband) signal.

NOTE: In the procedure steps which follow, **BOLDFACE** designations refer to front-panel controls and indicators. CW means clockwise rotation, CCW is counterclockwise ("anticlockwise" in the U.K. and some colonies) rotation.

II. PRESETS, POWER-UP AND CLOCK SET

A. CONTROL PRESETS

1. Set all panel function switches **ON/IN**.
2. Turn all front-panel trimpots fully CCW.
3. Center the **PROCESSING DENSITY** knob (between **5** and **6**).
4. Center all single-turn PC board trimpots.
5. Jumper the Input Gain Range jumper strip for HI level inputs.
6. Connect a temporary (clip-lead) short across R155 (second resistor behind the **COMPRESSOR GAIN** indicator LEDs).

B. POWER SUPPLY CHECK

1. Apply power to the *DAVID*.
2. Check that the positive and negative 9-volt regulated supplies are between 8.5V and 9.5V. You can check these with the 'scope on pins 8 (positive) and 4 (negative) of any 8-pin dual op-amp IC.

C. CLOCK SET

1. Using a low-capacitance 'scope probe connected to the input of the frequency counter, check the clock frequency on pin 11 of IC5.
2. Adjust the trimmer capacitor next to the crystal for a clock frequency of exactly 1,216,000Hz.

III. PROCESSOR FET BALANCE AND PINCHOFF ADJUSTMENT

A. BROADBAND LIMITER ADJUSTMENT

1. Set the **PROCESSING** switch to **OUT** and turn trimpots R190, R191, R257 and R258 fully CCW.
2. Apply a 250Hz, 0dBm oscillator signal to both PROGRAM LINE INPUTS, *in phase* (oscillator "hot" lead to both + terminals, both – terminals and oscillator ground lead to GND).
3. Connect one 'scope probe to the right-hand end of R118, the other to the right-hand end of R119. These resistors are next to the TEST INPUT jacks.
4. Carefully adjusting trimpots R263 and R264, *null* the 250Hz residual signals observed on the 'scope.
5. Set the **PROCESSING** switch to **IN**; reduce the oscillator amplitude to –20dBm.
6. Turn trimpots R257 and R258 fully CW. The **GATE OPEN** LED should light, the **AGC GAIN** indicator go to **+10dB**, and the 1kHz 'scope waveforms increase to about 0.45 volt p-p.
7. *Slowly* back-down R257 and R258 (CCW) until the waveforms *just* begin to drop in amplitude. Leave these trimpots at the *threshold* of their effect on the waveform.

B. HIGH FREQUENCY LIMITER ADJUSTMENT *(must directly follow A, above)*

1. Increase the in-phase, –20dBm oscillator frequency to 15kHz. The **GATE OPEN** indicator should go out and **AGC GAIN** stabilize at **0dB.**
2. Carefully adjusting trimpots R196 and R197, *null* the 15kHz residual signals observed on the 'scope.
3. Turn trimpots R190 and R191 fully CW. The 15kHz waveforms should increase to about 1.2 volts p-p.
4. *Slowly* back-down R190 and R191 (CCW) until the waveforms *just* begin to drop in amplitude. Leave these trimpots at the *threshold* of their effect on the waveform.

IV. LOW-PASS FILTER AND OVERSHOOT COMPENSATION CALIBRATION

A. SETUP

1. Disconnect the test oscillator from the PROGRAM LINE INPUTS and feed it directly to both TEST INPUT jacks. Reset the oscillator frequency to 1kHz, output level to +5dBm.
2. Set the **PROCESSING** switch to **OUT**. Set trimpots R138 and R139 fully CCW.
3. Clip one 'scope probe to the right-hand end of R14, the other to the left-hand end of R21. The waveforms should be about 13V p-p.

B. LOW-PASS FILTER ALIGNMENT

1. Set the oscillator frequency to 19,110Hz and adjust trimpots R86 and R87 for minimum.
2. Set the oscillator frequency to 21,780Hz and adjust trimpots R72 and R73 for minimum.
3. Set the oscillator frequency to 34,570Hz and adjust trimpots R98 and R99 for minimum. If you can't make-out a null at this frequency, just set both trimpots about three-quarters of the way toward full CW.

C. OVERSHOOT COMPENSATION CIRCUIT ADJUSTMENT *(must directly follow B on the previous page)*

1. Reset the oscillator frequency to 1kHz, output level to +10dBm. Turn the **PROCESSING** switch to **IN**. Both traces should show a squarewave of about 8 volts p-p.
2. Set the 'scope vertical attenuator to 0.5V/div, timebase to 50μs/div. With the two 'scope vertical position controls, center the rippled flat top of both waveforms on the graticule centerline as shown in Figure 4.
3. Reset the oscillator frequency to 3220Hz, 'scope timebase to 20μs/div. Adjust trimpots R122 and R123 so that the left-most peak is the same distance *below* the centerline as the right-most peak is *above* it, as shown in Figure 5.
4. Finally, adjust trimpots R138 and R139 to bring both peaks to the *same* level, just a bit below the centerline, as shown in Figure 6.

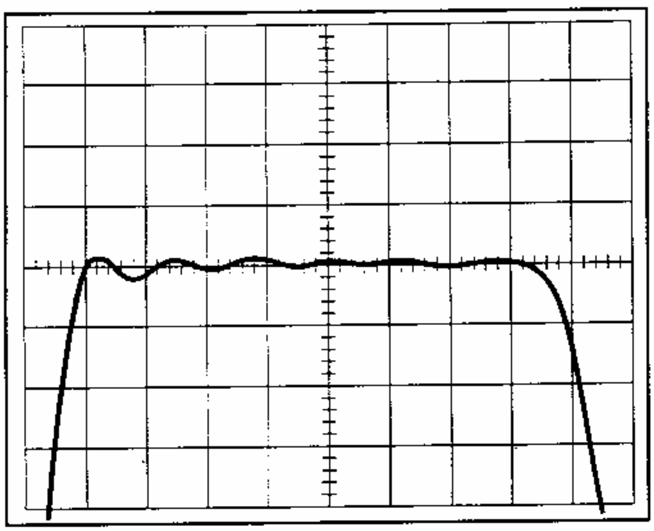


Figure 4 - "Flat-Top" Waveform Centering

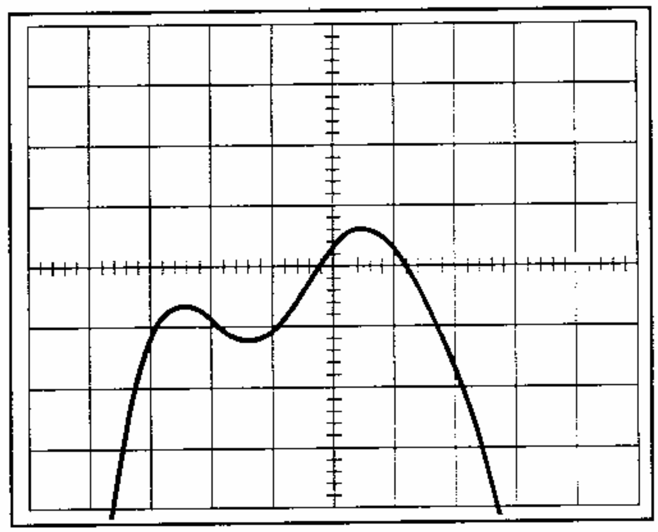


Figure 5 - R122 & R123 Adjustment

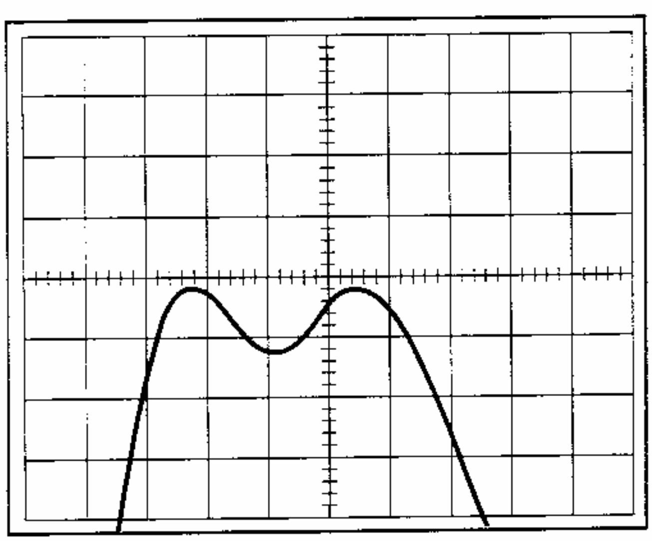


Figure 6 - R138 & R139 Adjustment

V. CROSSTALK AND SEPARATION ADJUSTMENTS

A. LEVEL SET

1. Set the **PROCESSING** switch to **IN**, **MODE** switch to **STEREO**, **PILOT** switch **ON**.

2. Connect the test oscillator to the Left Channel PROGRAM LINE INPUT *only;* oscillator "hot" lead to + terminal, – terminal and oscillator ground lead to GND. Set the oscillator frequency to 1kHz, level to +2.5dBm.

2. Adjust the Left Channel (**L**) **INPUT GAIN** control so that the **0dB** and the **–5dB AGC GAIN** indicator LEDs are lighted equally.

3. Reconnect the test oscillator to the Right Channel PROGRAM LINE INPUT only.

4. Adjust the Right Channel (**R**) **INPUT GAIN** control so that the **0dB** and the **–5dB AGC GAIN** indicator LEDs are lighted equally.

5. Connect the test oscillator signal to both PROGRAM LINE INPUTS, *in phase* (oscillator "hot" lead to both + terminals, both – terminals and oscillator ground lead to GND). Reset the oscillator amplitude to 0dBm. The **AGC GAIN** indicator should rest at **0dB**.

B. CROSSTALK TRIM

1. With the 1kHz oscillator signal feeding both inputs, monitor the COMPOSITE OUTPUT with the Spectrum Analyzer. Set the Spectrum Analyzer sensitivity so that the 19kHz Stereo Pilot is about 20dB below full scale.

2. Adjust the Left Channel (**L**) **INPUT GAIN** control and trimpot R122 alternately for best null of subcarrier sidebands at 37kHz and 39kHz.

3. Increase the test oscillator frequency to 15kHz, level to –20dBm.

4. Adjust trimpots R98 and R190 alternately for best null of subcarrier sidebands at 23kHz and 53kHz.

5. Finally, adjust R11 to null any residual carrier at 38kHz.

C. SEPARATION TRIM

1. Connect the test oscillator to the Left Channel PROGRAM LINE INPUT *only;* oscillator "hot" lead to + terminal, – terminal and oscillator ground lead to GND. Set the oscillator frequency to 1kHz, level to 0dBm.

2. Monitor the COMPOSITE OUTPUT of the *DAVID* with the Mod-Monitor or other "precision" stereo demod.

3. Adjust the *DAVID* **OUTPUT (COMPOSITE) LEVEL** control so that the demodulator reads 0dB, or 100% Left Channel Modulation.

4. Adjust trimpot R35 for best separation (minimum Right Channel signal).

THIS COMPLETES CALIBRATION OF THE *DAVID*. Remove the temporary (clip lead) short across R155. Seal all the circuit board trimpots with a dot of Elmer's® glue (or similar white glue), or typewriter "white-out" correction fluid.

Section V

CIRCUIT DESCRIPTIONS

PARTS LOCATION NOTE

When you turn to the two-sheet Schematic Diagram at the back of this Manual, you will notice that component reference designations do not appear to follow any particular order on the page. We have instead elected to designate the *actual component parts* on the circuit board in a logical left-to-right, top-to bottom sequence. This makes troubleshooting easier, since analysis of the schematic usually precedes suspect component location.

NOTE: Left and Right Channel circuitry throughout the DAVID is identical. Only the Left Channel will be discussed here, as it should not prove too difficult a matter to unravel the complexities of the conservative Right Channel from this description of its liberal companion.

PROGRAM LINE INPUT

IC39A is an "active balancing" stage for Left Channel program audio. It affords rejection for common-mode signals, and includes an input network which may be jumpered for either HI or LO input level ranges as described on Page 8. Gain stage IC40A includes the front-panel Left Channel (L) INPUT GAIN control to give 15dB variable gain adjustment.

BROADBAND AGC / COMPRESSOR / LIMITER

The "Santana" Circuit

Both the broadband Compressor/Limiter and the independent High Frequency Limiter use a balanced J-FET gain control technique. This circuit, originally described by Henry Santana of Hewlett-Packard Corp., is capable of voltage-linear gain reduction at program signal levels considerably higher than those which can be handled by traditional "variolosser" FET attenuator designs.

In his original disclosure, Mr. Santana used two matched FETs; a *control* FET between the inverting input of an op-amp gain stage and ground, and a matching "*dummy*" FET from the non-inverting input to ground. This second FET is always biased "on" and is presented with the same input signal through an identical input resistor. The "dummy" FET compensates for channel nonlinearities and temperature characteristics of the control FET to provide low distortion voltage-variable resistor performance.

Broadband G/R Stage

IC43A is the Santana gain stage. Q28 is the control FET, Q29 the "dummy" FET. R257 matches the pinchoff voltage of Q28 to the "full-gain" gain-reduction voltage value (about -8VDC) from the rectifier and time constant circuits.

Full-Wave Rectifier

Transistors Q17 and Q18 perform a dual function. The emitters are tied to a stiff bipolar DC source (approx. ±0.5V) which, when added to the V_{be} of the transistors, represents the peak value of a 0dBu signal (approx. 1.1V). Thus when the output of IC43A reaches 0dBu, it is clipped at that level concurrently with the two transistors driven into conduction. Q19 and Q20, essentially in parallel with Q17 and Q18, perform a similar function for the Right Channel. This is an analog "OR" function; the louder of the two channels will determine gain control for both.

Q22 is a unity-gain inverting stage for negative-going program peaks caught by Q18 and Q20. Positive-going peaks from Q17 and Q19, and the inverted negative peaks from Q22, feed DC gain stage Q21. Peak-derived current from Q21 charges C59 through R150, the R/C time constant determining Peak Limiting attack time. Release timing is a rather complex function, but adjustable constant-current source Q8 serves as a primary discharge path for C59. DC gain-reduction voltage is buffered by IC34C and fed through CR24 to the two FET pinchoff trimpots, R257 and R258.

AGC Timing and Compression Platform

Peak-derived G/R voltage from buffer stage IC34C is very slowly integrated to an average value by R155 and C57. This average value is fed through CR23 and R152 to "catch" the discharge of C59, holding the Peak Limiter release point at a "platform" G/R value. This platform represents the slow AGC gain-reduction action, and the level difference between it and the average value of peak reduction is the working range of program dynamic *compression*.

Indicators

R153 and C57 perform a faster integration equivalent to average-level program compression. IC33B compares this with instantaneous peak reduction, lighting the PEAK LIMITING indicator for the time period that peak reduction exceeds the value of average level compression.

The fast-integrated voltage is similarly compared with the slow-integrated AGC voltage by IC34B. The + and − COMPRESSOR GAIN indicators display the equivalent compressor gain state; that is, whether the average value of the program is being brought up (+) or pulled down (−).

AGC GAIN is displayed by a series of LEDs driven by quad comparator IC38. Comparator section gains and crossover points have been programmed so that one LED fades to the next, facilitating interpolation of intermediate values.

PROCESSING DENSITY Control

Unlike a simple *logarithmic* R/C discharge characteristic, current source Q8 provides *straight-line* discharge for C59. This has some merit in itself, insofar as Limiter release is concerned, for the *initial* period of limiter release is not disproportionately fast compared with the overall time for return to full circuit gain. This means that for a given, "tolerable" percentage of self-modulation distortion at low frequencies, a faster release time is realized, increasing program density (loudness).

The *DAVID* benefits from a second advantage of the current-source technique utilized here. When the PROCESSING DENSITY control is turned clockwise, increasing current through Q8, the voltage drop across R152 similarly increases, expanding the "platform" value and raising the overall amount of average level compression.

AGC Gating

Leveled Left and Right Channel audio signals are combined by IC37B. The L+R resultant is rectified by CR25 and CR26 at the input of comparator IC37A.

When no audio is present, or when Q27 is turned off by switching the PROCESSING switch to OUT, the output of IC37A sits at the positive supply rail. This voltage is divided by R203 and R205 to a value representing 10dB of broadband gain reduction. This "jams" the AGC integrator, IC34A, to a resting point of 0dB AGC GAIN.

L+R audio above −25dBu causes the IC37A output to toggle negative. This lights the GATE OPEN indicator and back-biases CR27, permitting the AGC to work over its entire range. Whenever leveled L+R audio falls below −25dBu, AGC action is inhibited and gain is slowly returned to the resting (0dB) value.

BAND-SPLITTING AND PREEMPHASIS

Low-Pass Filter

Leveled Left Channel program audio is fed to IC42A, a second-order (12dB/octave) low-pass filter stage which is jumpered to accommodate either the 75μs or the 50μs preemphasis function. The turnover frequency of this filter *approximately* corresponds to the +3dB point on the selected preemphasis curve. The rolloff is, of course, twice as steep.

An advantage of the steep rolloff is greater attenuation of higher-order distortion products generated by the clipping action of Q17 and Q18. Considerably more clipping may be tolerated, and more program density realized, when clipping harmonics are low-passed in this manner.

H.F. EQ

Leveled audio is also routed to IC41A, a first-order (+6dB/octave) equalizer. This stage also is jumpered for either the 75μs or the 50μs curve, with the unity-gain frequency offset slightly from the expected value. When this signal is later combined with low-passed program from IC42A, gain and phase responses are such that the sum follows the intended preemphasis curve.

HIGH FREQUENCY LIMITER

IC36B is a Santana gain-control stage very similar to the one described earlier. There is no "platform" associated with the High Frequency Limiter, however, and DC control circuitry is correspondingly less complex.

Whereas the Broadband Limiter has more of a full-time "gain-riding" function to provide a leveled output, the subsequent High Frequency Limiter is called on to reduce only the additional high frequency energy aggravated by the preemphasis characteristic. Because this stage levels only the equalized high frequencies, attack and release time constants can be made considerably faster without the same concern for self-modulation audible artifacts.

Q4 lights the HF LIMITING indicator whenever the High Frequency Limiter is active.

Combining / TEST INPUTS

The low-passed broadband program signal and the equalized and independently-limited preemphasis component are combined in IC35B. This summing stage also accepts inputs from the rear-panel TEST INPUT jacks which bypass the Processing Section of the *DAVID* completely.

FILTER OVERSHOOT COMPENSATOR

Source of Overshoot

Any low-pass filter will exhibit a certain amount of "overshoot" and "ringing" at its output when presented with complex (program) input waveforms. Generally, the sharper the cutoff the more pronounced the effect. Rather than a reflection on filter design, overshoots are attributable in large part to the expected and desired elimination of higher-order input signal components which, themselves, help define the signal amplitude boundaries. A 7-pole "elliptic" filter, like the one used in the *DAVID*, can overshoot 3dB or more – 1.5 times the level of an amplitude-limited program input.

Unlike other systems of overshoot control which permit the primary low-pass filter to overshoot, then isolate and re-introduce the overshoots back into the signal path to cancel themselves, *DAVID* circuitry conditions the amplitude-limited program signal *ahead* of the filter so that there is little or no tendency to generate overshoots in the first place.

Input Clipper

CR15 and CR16 comprise a "hard" clipper at the compensator input, and are biased to a point which represents 100% modulation. Since the program is already limited to this same value in the Audio Processing section, the diodes rarely clip legitimate program waveshapes.

Phase-Lag and Recombining

IC9A is a phase-*lag* circuit which time-displaces the fast leading and trailing edges of steep waveforms. This means that the primary characteristic of a program waveform which would normally *excite* filter overshoots is instead added to the waveform *amplitude*. CR18 and CR20, also biased to the 100%-modulation reference, "strip" these displaced-and-added components from the program signal. They are subsequently recovered by IC31A, which derives the difference between the "stripper" input and output. These components, containing much of the program harmonic (high frequency) content, are recombined with the "stripped" program signal *in opposite phase*. This 180-degree displacement of certain program overtones is not discernable to the listener, but is quite effective in inhibiting filter overshoots.

DC Bias

DC bias is derived from the power supply with a divider string consisting of resistors R165 - R172. The level representing 100% modulation for the Overshoot Compensator is taken from the "top" of the divider, and a level equivalent to the peak value of 0dBu for biasing the Peak and High Frequency Limiter rectifier transistors is taken from the "bottom." Two normally-on FET switches, Q15 and Q16, are turned off when the PROCESSING switch is set to OUT. This sends all DC bias points to higher values and inhibits signal processing.

LOW-PASS FILTER

The 7-pole, elliptic-function (Cauer) low-pass filter is an active version of the classic L/C designs worked-out in Germany during the late 1940s – probably with a slide rule! The particular active configuration used here is frequently called the "FDNR" because each of the legs to ground simulates a Frequency-Dependent Negative Resistance. With reference back to the classic L/C design, resistors in series with the signal replace series inductors, and each of the active circuits to ground replaces an inductor/capacitor series-resonant element.

For an in-depth discussion of this and other filter circuits useful to the broadcast engineer/tinkerer, the reader is directed to the "cookbook" used for the *DAVID* design, the *Electronic Filter Design Handbook* written by Arthur B. Williams and published by McGraw-Hill. In this book the "FDNR" is called a "GIC," or *Generalized Impedance Converter*. Whatever.

IC21B buffers the output of the low-pass filter and provides gain to make up filter insertion loss. The signal level at the output of IC21B corresponding to 100% modulation of the Left Channel is about 8V p-p.

PILOT AND SUBCARRIER GENERATION

Clock IC5A is the crystal-controlled oscillator running at 1.216MHz. Timing for the digital synthesis of the 19kHz Stereo Pilot and 38kHz difference subcarrier is based on this master clock. The clock is buffered by IC5D and divided to the 608kHz sampling frequency by IC3A.

Pilot Generation IC9 is an up/down BCD counter clocked at the 608kHz sampling frequency. 1-of-10 decoder IC12, OR gate IC7C, and binary divider IC4A work together to keep IC9 continually counting from zero to 8, then back down to zero. Counting logic is decoded by a 1-of-9 de-multiplexer, IC13 and IC15C, which samples a sine-weighted resistor string, R24-R31. This generates one-*half* a sinewave for each counting cycle. IC4B reverses DC polarity applied to the top of the resistor string for every-*other* up/down count, forming the complete 19kHz Stereo Pilot sinewave comprising 32 discrete steps. R11 introduces an offset to compensate for any difference between the two power supplies, nulling the second harmonic component (38kHz). The segmented Stereo Pilot signal is buffered by IC16A.

Center-Sampling IC15D is controlled directly by the 1.216MHz clock, turning on for one-half of one clock period precisely at the *center* of each stepped Stereo Pilot waveform sample. This charges C15 to the sample voltage value, which is held by buffer stage IC16B until the next center-sample. Center-sampling eliminates integration of switching noise concurrent with leading and trailing edges of the waveform steps.

TTL Pilot Output Comparator IC17 translates the buffered Stereo Pilot waveform into a symmetrical 19kHz squarewave, in phase with the Pilot component in the composite output of the *DAVID*. This is a 5-volt p-p, TTL-compatible output for synchronizing 57kHz RDS generators to reduce audible interference with the stereo program.

Subcarrier Generation The L−R "difference" component of the stereo composite signal is digitally synthesized in much the same manner as the Stereo Pilot; that is, by sinewave segmentation. The subcarrier, however, is generated by sinusoidal *commutation* between the Left and the Right stereo program channels.

Up/down counter IC6 is clocked at the 608kHz sampling frequency, decoded by IC11, and, with gating provided by IC7C and IC3B, counts continuously from zero to 8, then back to zero. A pulse from IC8D presets the counter to zero (Right Channel) when the Stereo Pilot is at the proper phase relationship, ensuring positive synchronization between Pilot and subcarrier.

IC10 and IC15B decode the count, sequentially sampling each tap of the resistor divider, R14-R21, which bridges the Left and Right program signals. The effective "wiper" of this commutator is buffered by IC14A, center-sampled by IC15A, and held between samples by C13 and buffer IC14B. The stereo multiplex signal thus consists of 16 discrete, sinusoidally-weighted steps.

COMBINING AND OUTPUT FILTER CIRCUITRY

Combining Amplifier The Stereo Pilot and subcarrier are combined by current-summing stage IC18A. Q3 may be turned on with the panel-mounted PILOT switch to kill the Stereo Pilot completely, and insertion level is adjusted with PILOT LEVEL control, R51. RDS LEVEL control, R65, similarly adjusts the insertion level of an auxiliary subcarrier applied at the rear-panel connector.

Output Low-Pass Filter IC18B, IC19B and IC20 comprise a fifth-order, elliptic-function low-pass filter for the composite output signal. Though elliptic filters are notorious for poor group delay performance, the first null in this filter is at the sampling frequency of 608kHz, and the phase response in the 10Hz - 100kHz passband is flat-as-a-pancake. DC gain of the filter is adjusted with R35, set for optimum 1kHz stereo separation.

Output Stage IC19A provides an low-impedance output with a virtual "voltage-source" characteristic. With the discrete-transistor buffering, the Composite Output is capable of driving long coax lines or other complex loads without any instability.

POWER SUPPLY

All *DAVID* circuitry operates from a bipolar 9-volt power supply. The two supplies are regulated by linear "three-terminal" IC voltage regulators, IC1 and IC2. The power transformer has dual primaries which may be switched in parallel or in series for 115V or 230V mains, respectively.

Section VI

APPENDIX

The following Section of this Manual contains Parts Lists for the Inovonics *DAVID,* Schematic Diagrams of all electronic circuitry, and an explanation of Inovonics' Warranty Policy.

PARTS LIST

EXPLANATION OF PARTS LISTINGS

This section contains listings of component parts used in the Inovonics *DAVID* FM-Stereo Processor / Generator. These are listed either *en-masse,* or by schematic component reference designation and may, or may not, specify a particular manufacturer. When no manufacturer is called-out, the term "open mfgr." advises that any manufacturer's product is acceptable.

If a particular component is *not listed at all*, this means that we do not consider it a typical replacement item. Should you need to order an unlisted part, call, write or FAX the factory with a brief description, and we'll do our best to figure out what you're talking about.

PARTS LISTING

Unless specifically noted by component reference designation below, **capacitors** are specified as follows:

a: **Under 100pF** are "dipped mica" type, DM-15 (or CM-05 military series) size designation; "P" value is picofarads, ±5%, 200VDC. Manufacturer open.

b: **100pF to 0.47µF** are of the metalized mylar or polyester variety; whole number "P" values are picofarads, decimal values are microfarads, ±5%, 50VDC or better. The style used in the *DAVID* is the "minibox" package with lead spacing of 0.2 inch. **Preferred mfgr.:** WIMA, MKS-2 or FKC-2 series. **Alternates:** CSF-Thompson IRD series or Roederstein KT-1808 or KT-1817 series.

C1,2	Capacitor, Ceramic Disc "Safety," .0047µF, 440VAC; Murata/Erie DE7150 F 472M VA1-KC
C3,4	Capacitor, Electrolytic, axial leads, 470µF, 35VDC; (open mfgr.)
C5,6,9,12,14, 21,27,28,51, 52,55,63,64	Capacitor, High-Reliability Electrolytic, radial leads, 2.2µF, 50V; Illinois Capacitor 225 RMR 050M (preferred)
C10	Capacitor, Variable, 5-50pF; Mouser 24AA024
C25,26,61, 62,88,89	Capacitor, Electrolytic, radial leads, 100µF, 25V; (open mfgr.)
C30,35,58	Capacitor, Electrolytic, radial leads, 4.7µF, 25V; (open mfgr.)
C31,34,36-49	Capacitor, "High-Q," .0033µF, 2.5%, 100VDC; WIMA FKC-2 (Polycarbonate) preferred, any equivalent *must* have identical characteristics.
C32,33,65,66	Capacitor, Electrolytic, radial leads, 22µF, 25V; (open mfgr.)
C56,59	Capacitor, Electrolytic, radial leads, 1.0µF, 50V; (open mfgr.)
C57,90,91	Capacitor, Electrolytic, radial leads, 47µF, 25V; (open mfgr.)
CR1-6	Diode, Silicon Rectifier; (open mfgr.) 1N4005
CR7-11,14-27	Diode, Silicon Signal; (open mfgr.) 1N4151 or equiv.
CR12,13	Diode, Schottky; Hewlett-Packard 1N5711
F1	Fuseholder, PC-mount; Littlefuse 345-101-010 with 345-101-020 Cap for ¼-inch fuses, or 345-121-020 Cap for 5mm fuses. (Fuse is normal "fast-blow" in value specified on rear panel for mains supply.)
FB1	Ferrite Bead; Amidon 73-801

I1,3,5	LED Indicator, Diffused Pastel Red, T-1 package; Stanley MVR 3878S
I2,4,6	LED Indicator, Diffused Pastel Green, T-1 package; Stanley MPG 3878S
I7,11,12,14-16	LED Indicator, Diffused Pastel Green, T1¾ package; Stanley MPG 5774X
I8-10,13,17	LED Indicator, Diffused Pastel Red, T1¾ package; Stanley MVR 5744X
IC1	Integrated Cct.; (open mfgr.) LM337-T
IC2	Integrated Cct.; (open mfgr.) LM317-T
IC3,4	Integrated Cct.; (open mfgr.) CMOS 4013B
IC5	Integrated Cct.; (open mfgr.) CMOS 4011B
IC6,9	Integrated Cct.; (open mfgr.) CMOS 4029B
IC7	Integrated Cct.; (open mfgr.) CMOS 4071B
IC8	Integrated Cct.; (open mfgr.) CMOS 4081B
IC10,13	Integrated Cct.; (open mfgr.) CMOS 4051B
IC11,12	Integrated Cct.; (open mfgr.) CMOS 4028B
IC14,16,18,19,20	Integrated Cct.; Motorola MC34082P
IC15	Integrated Cct.; (open mfgr.) CMOS 4066B
IC17	Integrated Cct.; (open mfgr.) LM311N
IC21-32,35, 37,39-42	Integrated Cct.; (open mfgr.) LM353N
IC33,34,38	Integrated Cct.; (open mfgr.) LM324N
IC36,43	Integrated Cct.; Raytheon RC4558NB
J1	AC Mains Connector, PC-mount; Switchcraft EAC303
J2,3	"Phono Jack" Connector, PC-mount; Mouser 15PJ097
J4	Barrier Strip, 6-Terminal, PC-mount; Magnum A-204206NL-R-50
Q1	Transistor, PNP; Motorola MJE350
Q2	Transistor, NPN; Motorola MJE340
Q3,15,16,27	Transistor, FET; (open mfgr.) J108
Q4,6-9,11,14,17,19	Transistor, NPN; (open mfgr.) 2N3904
Q5,10,12,13, 18,20,21	Transistor, PNP; (open mfgr.) 2N3906
Q23-26,28-31	Transistor, FET, (actually 4 sets of matched pairs); *SPECIAL - Inovonics Part No. 1222* (Selected pair of 2N3819s)

Unless specifically noted by component reference designation below, **resistors** are specified as follows:

a: **Fixed resistors** with no tolerance specified are ¼-watt, 5%, carbon-film. With 1% tolerance specified, ¼-watt, 1% metal-film. Values are in ohms; K signifies kilohms, M signifies megohms. Manufacturer open.

b: **Multi-Turn Trimming Potentiometers** (front-panel adjustable) are Beckman 89PR series or equivalent "cermet" type.

c: **Single-Turn Trimmers** (circuit board) are Beckman 91AR series.

R159	Resistor, Variable, 10K; Piher 15PTNB10KA with Fig. 3 Spindle; Selco S111-004/BLK Knob with C111/RED Cap.
S1	Switch, SPST Slide, Power; CW Industries GF-323-0000
S2	Switch, DPDT Slide, Voltage Selector; C&K V202-12-MS-02-QA
S3-5	Switch, DPDT PC-mount Slide; CW Industries GI-152-0001
T1	Power Transformer, PC-mount; Signal LP20-300 or direct cross-ref.
Y1	Crystal, 1216kHz; *SPECIAL - Inovonics Part No. 1242*

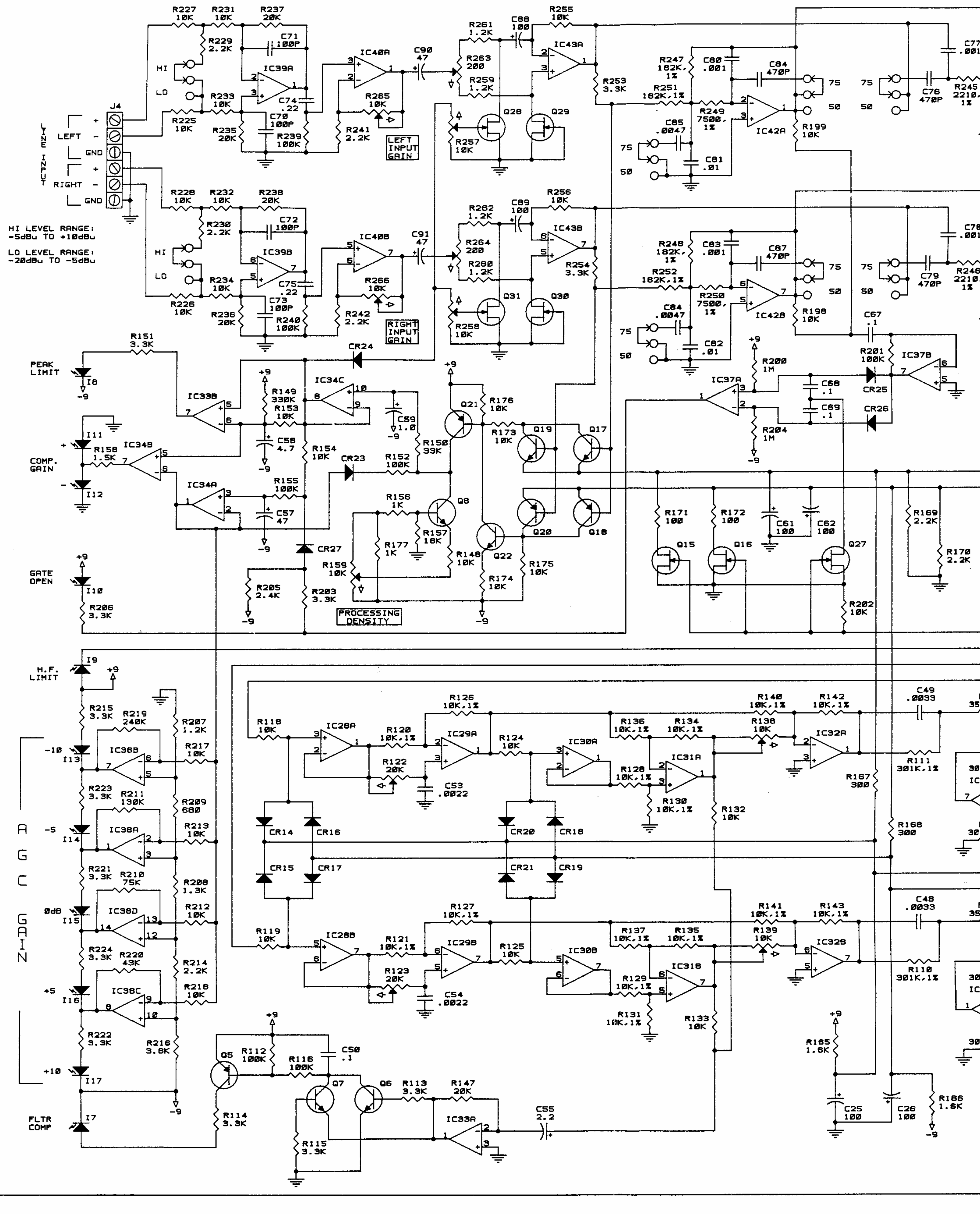
MAIL-ORDER COMPONENT SUPPLIERS

The following electronic component distributors have proven to be reputable suppliers of both large and small quantities of parts. Any semiconductor, IC, capacitor, resistor or connector used in the *DAVID* is available from one or more of these firms. Each supplier publishes a full-line catalog, available free of charge.

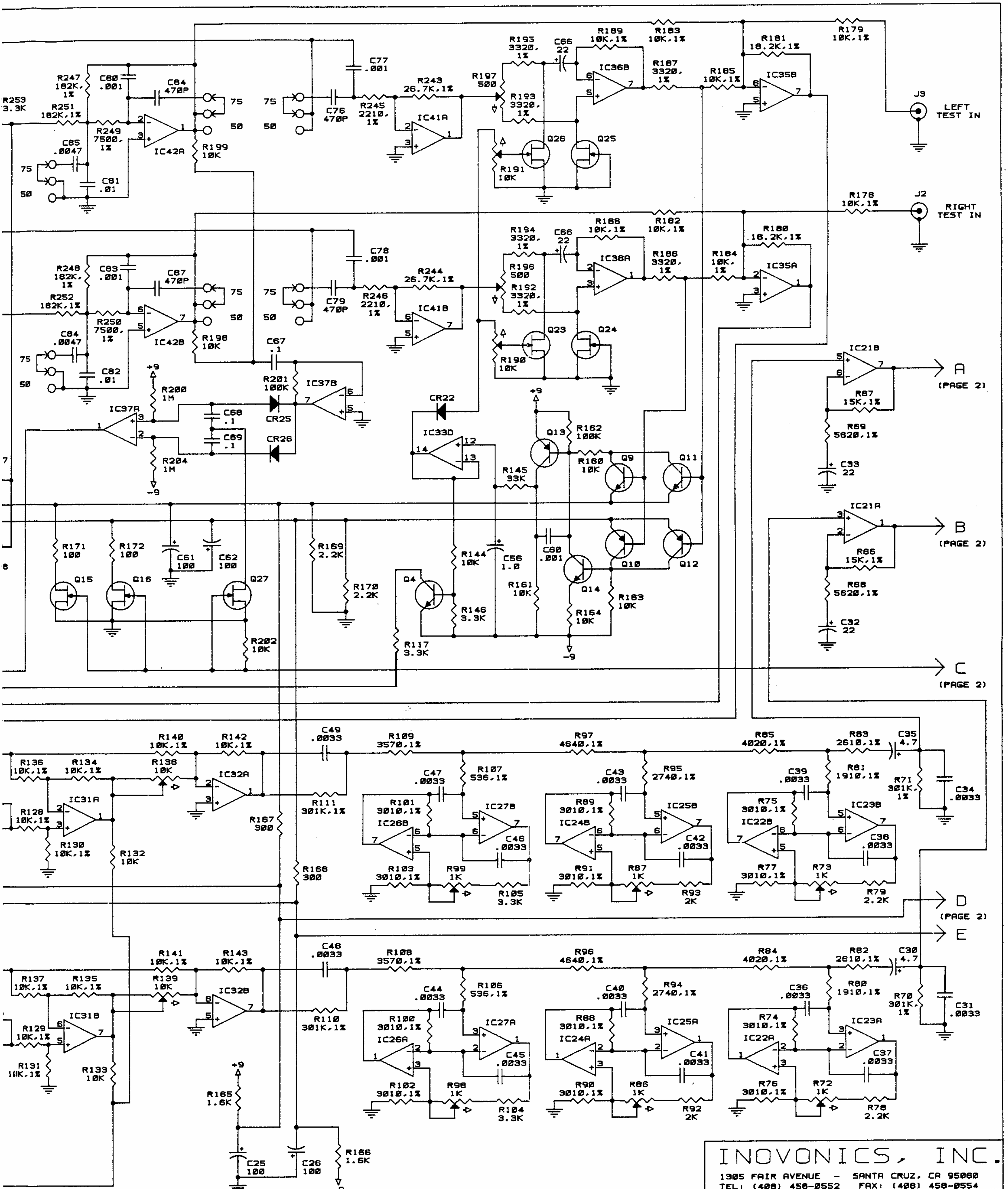
Mouser Electronics - Call: 1-800-34-MOUSER

Digi-Key Corporation - Call: 1-800-DIGI-KEY

ACTIVE (div. of Future Electronics - Call: 1-800-677-8899



J4
LINE INPUT
LEFT
RIGHT
GND
HI
LO
HI LEVEL RANGE: -5dBu TO +10dBu
LO LEVEL RANGE: -20dBu TO -5dBu
R227 10K
R231 10K
R237 20K
R229 2.2K
C71 100P
IC39A
R233 10K
R225 10K
R235 20K
C70 100P
C74 .22
R239 100K
IC40A
C90 47
R265 10K
R241 2.2K
LEFT INPUT GAIN
R228 10K
R232 10K
R238 20K
R230 2.2K
C72 100P
IC39B
R234 10K
R226 10K
R236 20K
C73 100P
C75 .22
R240 100K
IC40B
C91 47
R266 10K
R242 2.2K
RIGHT INPUT GAIN
R261 1.2K
C88 100
R255 10K
IC43A
R263 200
R259 1.2K
R257 10K
Q28
Q29
R253 3.3K
R262 1.2K
C89 100
R256 10K
IC43B
R264 200
R260 1.2K
R258 10K
Q31
Q30
R254 3.3K
R247 182K, 1%
C80 .001
C84 470P
R251 182K, 1%
R249 7500, 1%
IC42A
C85 .0047
C81 .01
R199 10K
75
50
C76 470P
R245 2210, 1%
C77 .001
R248 182K, 1%
C83 .001
C87 470P
R252 182K, 1%
R250 7500, 1%
IC42B
C84 .0047
C82 .01
R198 10K
C79 470P
R246 2210, 1%
C78 .001
C67 .1
R201 100K
IC37B
CR25
CR26
IC37A
R200 1M
R204 1M
C68 .1
C69 .1
PEAK LIMIT
I8
R151 3.3K
IC33B
CR24
IC34C
R149 330K
R153 10K
C59 1.0
R150 33K
C58 4.7
R154 10K
COMP. GAIN
I11
I12
R158 1.5K
IC34B
IC34A
CR23
R152 100K
R155 100K
C57 47
R156 1K
Q8
R177 1K
R157 10K
CR27
R159 10K
R205 2.4K
R203 3.3K
PROCESSING DENSITY
R148 10K
Q22
R174 10K
R175 10K
Q21
R176 10K
R173 10K
Q19
Q17
Q20
Q18
R171 100
R172 100
C61 100
C62 100
Q15
Q16
Q27
R169 2.2K
R170 2.2K
R202 10K
GATE OPEN
I10
R206 3.3K
H.F. LIMIT
I9
R215 3.3K
R219 240K
R207 1.2K
IC38B
R217 10K
-10
I13
R223 3.3K
R211 130K
R209 680
-5
I14
IC38A
R213 10K
R221 3.3K
R210 75K
R208 1.3K
0dB
I15
IC38D
R212 10K
R224 3.3K
R220 43K
R214 2.2K
+5
I16
IC38C
R218 10K
R222 3.3K
R216 3.6K
+10
I17
AGC GAIN
FLTR COMP
I7
R118 10K
IC28A
R126 10K, 1%
R120 10K, 1%
IC29A
R122 20K
C53 .0022
R124 10K
IC30A
R136 10K, 1%
R134 10K, 1%
R128 10K, 1%
IC31A
R130 10K, 1%
R132 10K
R140 10K, 1%
R142 10K, 1%
R138 10K
IC32A
R167 300
R111 301K, 1%
C49 .0033
R168 300
CR14
CR16
CR20
CR18
CR15
CR17
CR21
CR19
R119 10K
IC28B
R127 10K, 1%
R121 10K, 1%
IC29B
R123 20K
C54 .0022
R125 10K
IC30B
R137 10K, 1%
R135 10K, 1%
R129 10K, 1%
IC31B
R131 10K, 1%
R133 10K
R141 10K, 1%
R143 10K, 1%
R139 10K
IC32B
R110 301K, 1%
C48 .0033
Q5
R112 100K
R116 100K
C50 .1
R114 3.3K
Q7
Q6
R113 3.3K
R147 20K
IC33A
C55 2.2
R115 3.3K
R165 1.6K
C25 100
C26 100
R166 1.6K



INOVONICS, INC.

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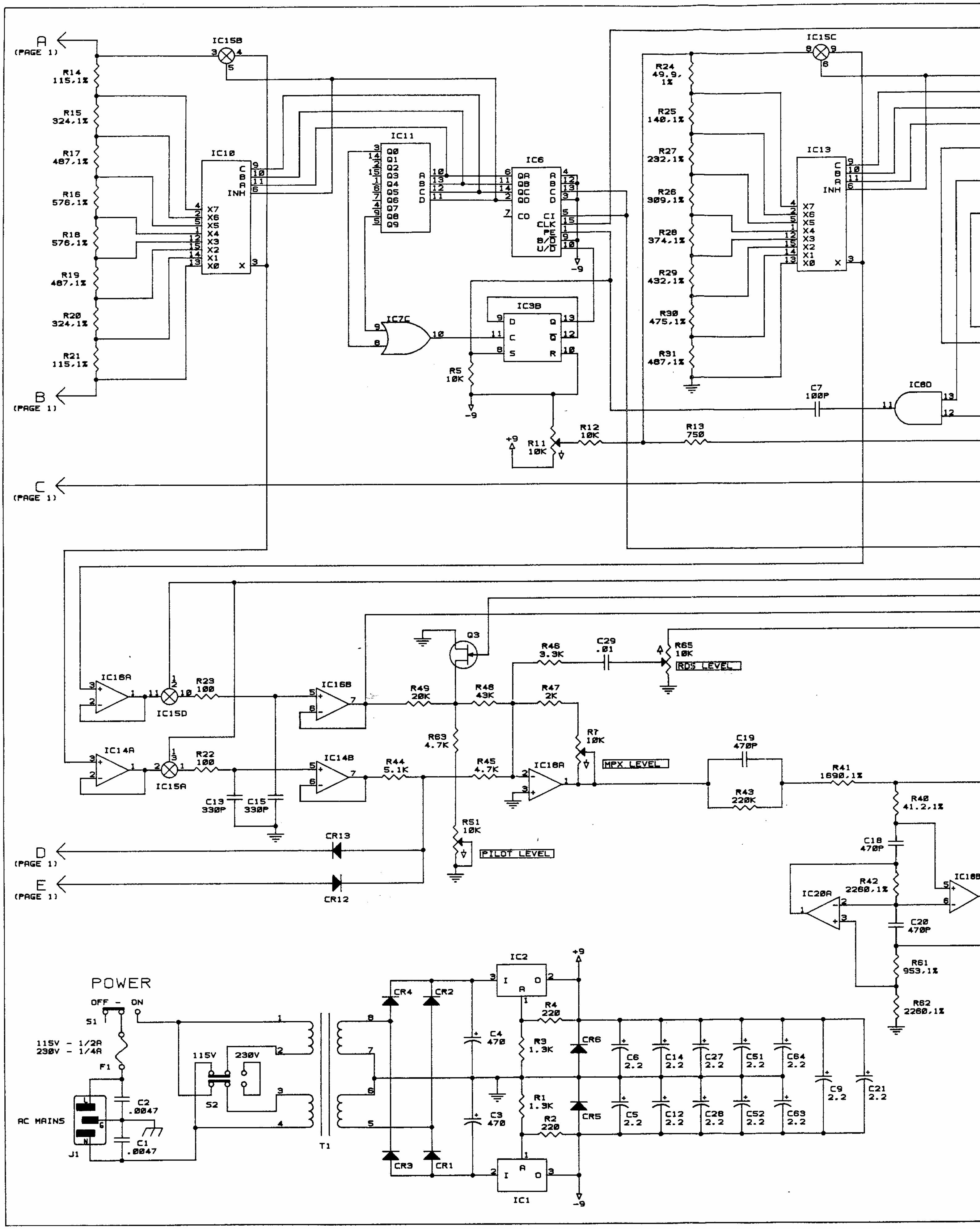
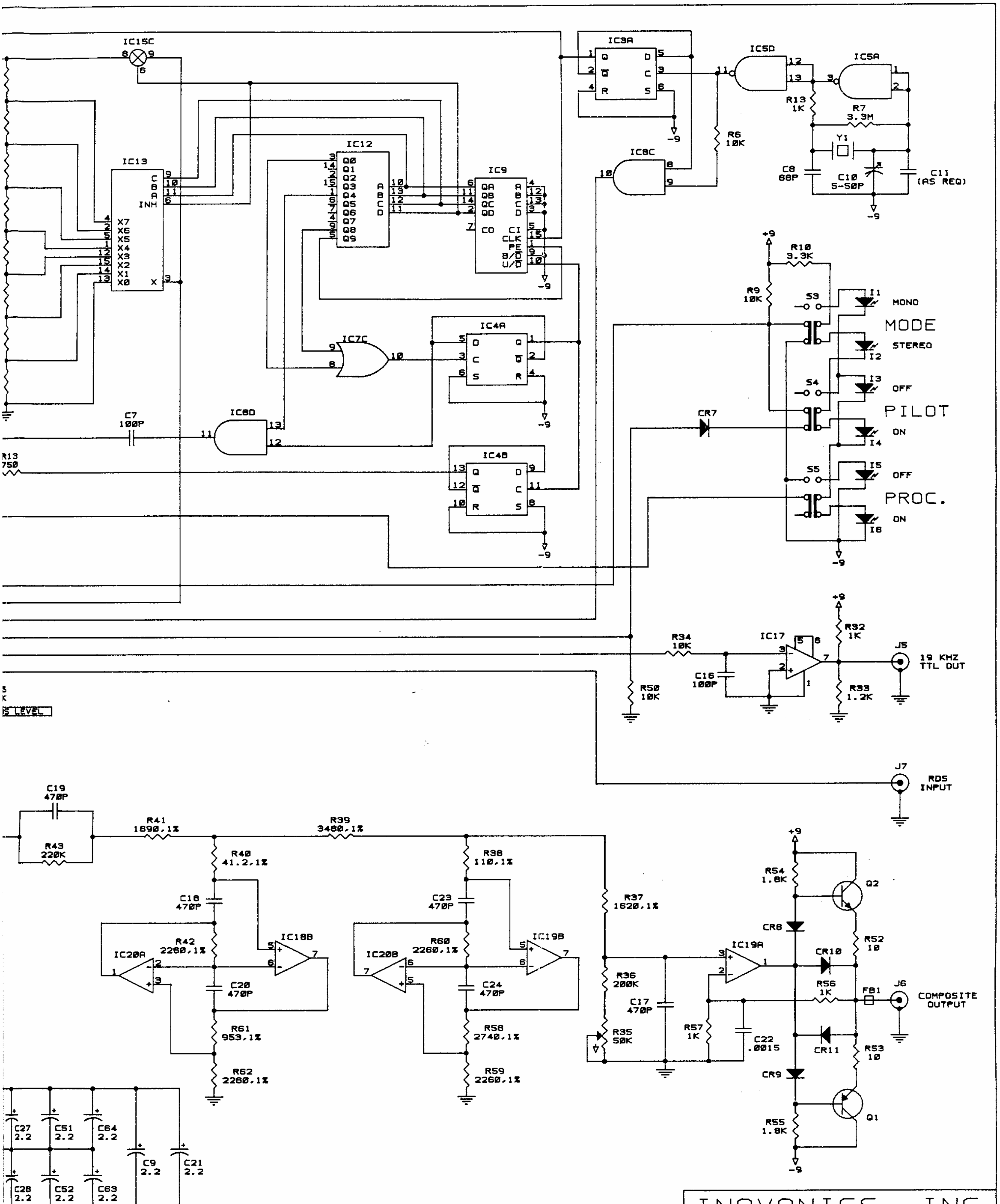
SCHEMATIC, MODEL 715 "DAVID" FM STEREO GEN.

Size	Document Number	REV
C	192200	A

Date: September 25, 1992 Sheet 1 of 2



A (PAGE 1)
B (PAGE 1)
C (PAGE 1)
D (PAGE 1)
E (PAGE 1)
R14 115,1%
R15 324,1%
R17 487,1%
R16 576,1%
R18 576,1%
R19 487,1%
R20 324,1%
R21 115,1%
IC15B
IC10
IC11
IC6
IC7C
IC3B
R5 10K
R11 10K
R12 10K
R13 750
IC15C
R24 49.9, 1%
R25 140,1%
R27 232,1%
R26 309,1%
R28 374,1%
R29 432,1%
R30 475,1%
R31 487,1%
IC13
C7 100P
IC8D
IC16A
IC15D
R23 100
IC16B
IC14A
IC15A
R22 100
IC14B
C13 330P
C15 330P
Q3
R46 3.3K
C29 .01
R65 10K
RDS LEVEL
R49 20K
R48 43K
R47 2K
R63 4.7K
R7 10K
MPX LEVEL
R44 5.1K
R45 4.7K
IC18A
C19 470P
R43 220K
R41 1690,1%
R40 41.2,1%
RS1 10K
PILOT LEVEL
CR13
CR12
C18 470P
R42 2260,1%
IC20A
IC18B
C20 470P
R61 953,1%
R62 2260,1%
POWER
OFF - ON
S1
115V - 1/2A
230V - 1/4A
F1
AC MAINS
J1
C2 .0047
C1 .0047
115V
230V
S2
T1
CR4
CR2
CR3
CR1
C4 470
C3 470
IC2
IC1
R4 220
R3 1.3K
R1 1.3K
R2 220
CR6
CR5
C6 2.2
C14 2.2
C27 2.2
C51 2.2
C64 2.2
C5 2.2
C12 2.2
C28 2.2
C52 2.2
C63 2.2
C9 2.2
C21 2.2
+9
-9



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SCHEMATIC, MODEL 715 "DAVID" FM STEREO GEN.		
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Date: September 25, 1992	Sheet 2 of 2	

INOVONICS WARRANTY

I **TERMS OF SALE:** Inovonics products are sold with an understanding of "full satisfaction"; that is, full credit or refund will be issued for products sold as new if returned to the point of purchase within 30 days following shipment, provided that they are returned in "as-shipped" condition.

II **CONDITIONS OF WARRANTY:** The following terms apply unless amended *in writing* by Inovonics, Inc.

A. Warranty Registration Card supplied with product *must* be completed and returned to the factory within 10 days of delivery.

B. Warranty applies only to products sold "as new." It is extended only to the original end-user and may not be transferred or assigned.

C. Warranty does not apply to damage caused by misuse, abuse or accident. Warranty is voided by unauthorized attempts at repair or modification, or if the serial identification has been removed or altered.

III **TERMS OF WARRANTY:** Inovonics, Inc. products are warranted to be free from defects in materials and workmanship.

A. Any discrepancies noted within 90 days of the date of delivery will be repaired free of charge, or the equipment will be replaced at the option of Inovonics.

B. Additionally, parts for repairs required between 90 days and one year from the date of delivery will be supplied free of charge. Labor for *factory* installation of such parts will be billed at the prevailing "shop rate."

IV **RETURN OF GOODS FOR FACTORY REPAIR:**

A. Equipment *will not be accepted* for Warranty or other repair without a Return Authorization (RA) number issued by Inovonics prior to its return. An RA number may be obtained by calling the factory, and should be prominently displayed on the outside of the shipping carton.

B. Equipment must be shipped *prepaid* to Inovonics. Shipping charges will be reimbursed for valid Warranty claims. Damage sustained as a result of improper packing for return to the factory is *not* covered under terms of the Warranty, and may occasion additional charges.