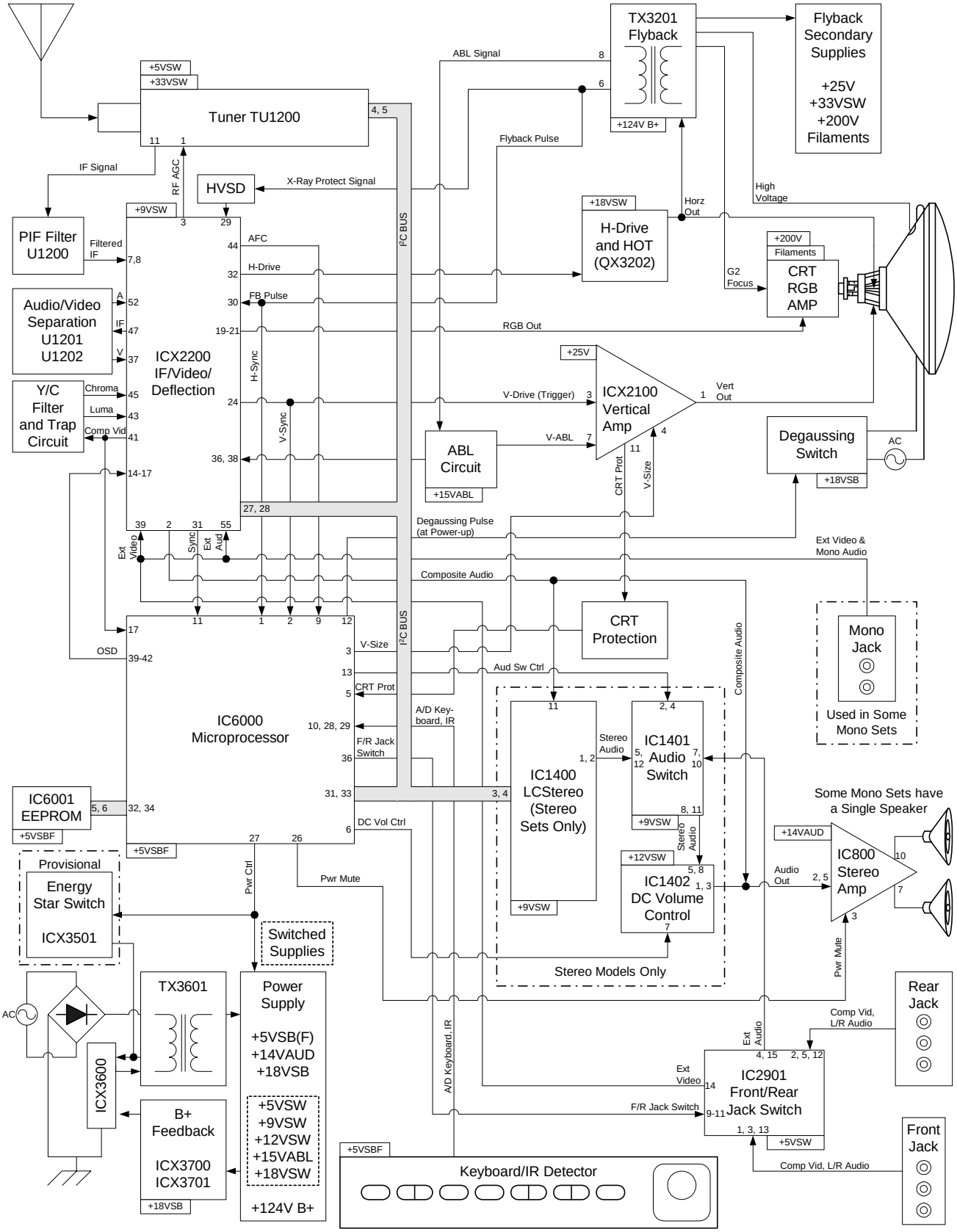
Preface

The C-Line series training material for direct-view televisions continues the departure from recent Zenith training literature styles, which tended to focus on television servicing and customer features. This was somewhat adequate when Zenith televisions had a module-level repair warranty. However, since 1996, when most units below 27 inches went to a component-level service warranty, this emphasis on features and servicing has given way to the need for a better understanding of television circuit theory and function.

The CA and CB chassis training supplement of 1999 provided detailed circuit descriptions and basic troubleshooting flowcharts. C-Line direct-view training material has added discrete component values to the description schematics, where applicable. Due to the fact that more and more of the television electronics are being put into integrated circuits, internal block diagrams of many of the ICs used are supplied. The service menu items are also listed with access and use instructions. These additions notwithstanding, a servicer will still desire to make use of the service manual, particularly for referencing part numbers as well as non-component oriented servicing instructions.

Table of Contents

XO Block Diagram



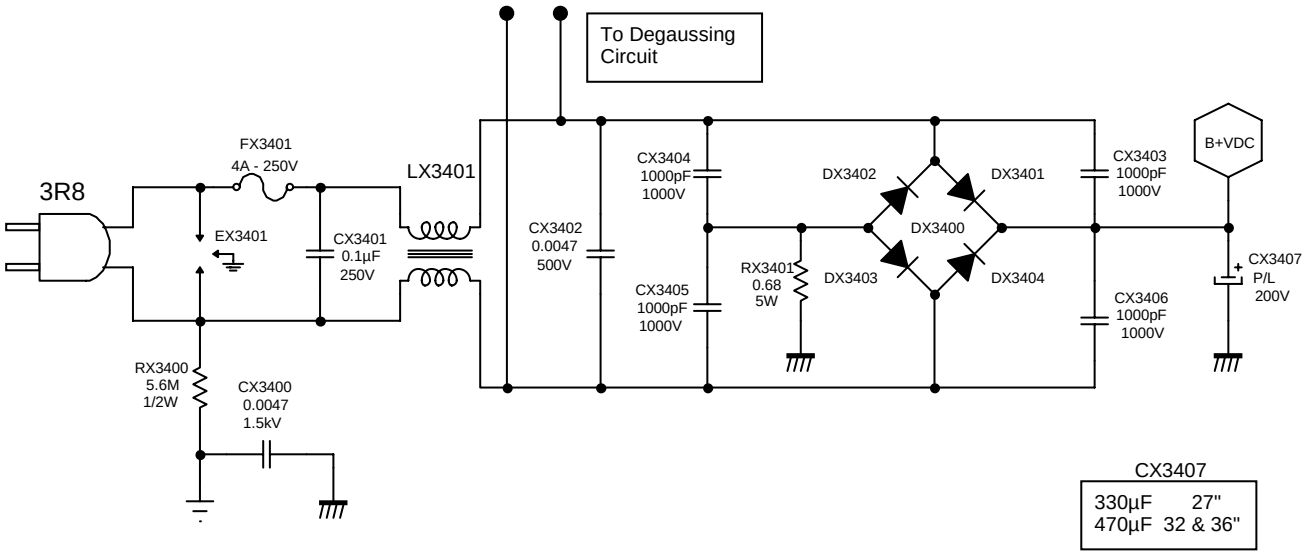
XO CIRCUIT DESCRIPTIONS

Introduction

The XO chassis power circuitry has been developed to support 19" and 20" screen sizes. Its features include a quasi-resonant, flyback type power supply for direct B+ regulation, software controlled degaussing, Energy Star® compliance, and various protection features. Apart from the primary side of the power supply, the XO receiver uses a cold ground.

Primary Side

AC power is supplied through the fuse, FX3401, to the bridge rectifier array, DX3401 through 3404, and capacitor, CX3407. EX3401 gives additional protection for the set. Assuming an AC voltage



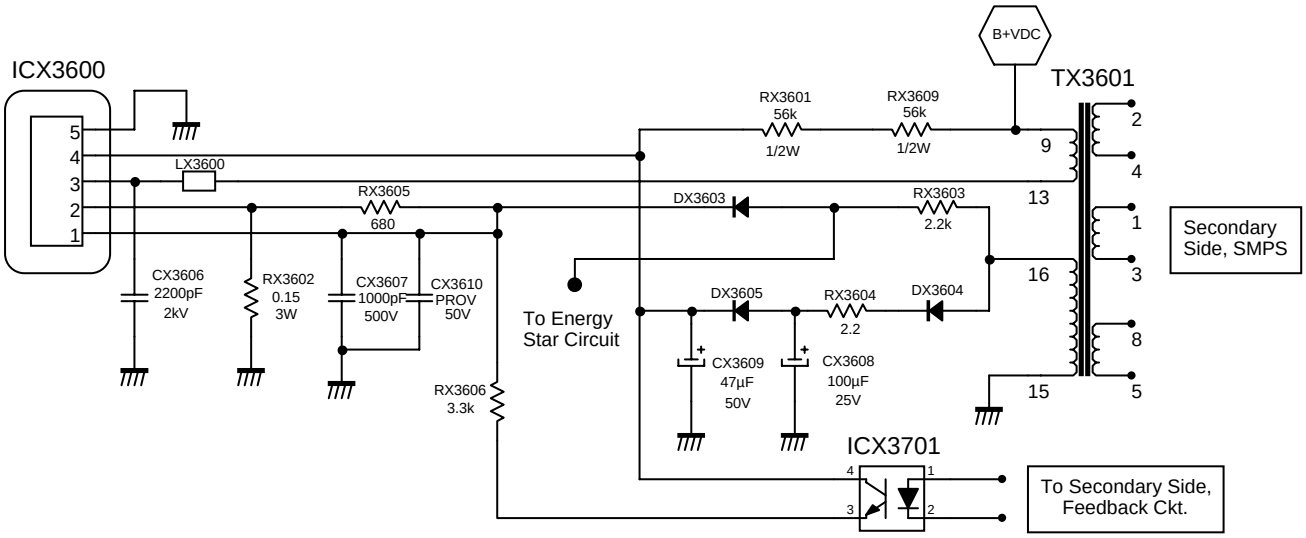
<<Figure 1, Rectifier Circuit>>

range of 90Vrms to 135Vrms, the resulting VDC across CX3407 should be between +127 and +191 volts and is supplied to the regulator, ICX3600. V_{CC} for this IC is fed to pin 4 and is initially derived from the VDC through two resistors, RX3601 and RX3609, which charge capacitor CX3609. V_{CC} should normally be between +16 and +18 volts. If it falls below +11 volts, Under Voltage Lockout is triggered within ICX3600.

When V_{CC} applied to pin 4 of ICX3600 reaches 16 volts, a MOSFET transistor inside the IC begins switching. Initial current draw in the regulator can reach 0.30mA. To reduce the potential for primary capacitance discharge of the MOSFET, which might otherwise result in a false shutdown, a constant-current sink of 1.35mA has been incorporated into the regulator IC. Pin 3 of the regulator supplies drive from the MOSFET to the chopper transformer, TX3601. Once MOSFET switching begins, power generated in TX3601 is half-wave rectified and smoothed by DX3604, DX3605, CX3608, and CX3609 in order to maintain power to pin 4. RX3604 is included in series with this power source to reduce load current variation.

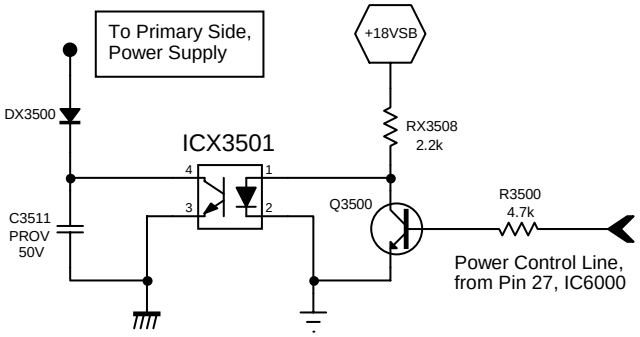
The regulator IC functions in one of two possible ways. In its soft-start mode, it generates a fixed switching pulse with an off time of 50µs. The regulator's normal operation though is known as quasi-resonant mode. For powered-on application in the XO power supply, it should operate in

quasi-resonant mode. It will operate in soft-start when power is first supplied to the regulator, when the XO receiver is in standby (in Energy Star® sets), or when the regulator is overloaded.



<<Figure 2, Main Regulator Circuit>>

While an Energy Star® set is in standby, power is supplied to ICX3501, an optocoupler, which shunts feedback from pin 16 of the chopper away from pin 1 of the regulator. Pin 1 of ICX3600 serves as the control input for regulation. It receives a multi-part signal comprised of the optocoupled voltage error from ICX3701, the drain current ramp from pin 2 and across RX3602, and quasi-resonant feedback from pin 16 of the transformer. In the absence of this feedback, the regulator operates in its soft-start mode. As these signals are fed to pin 1, charge develops on CX3607 and CX3610. The resulting voltage on pin 1 ramps until it exceeds 0.73V at which time an off-time comparator internal to ICX3600 switches off to cancel the oscillator's function and thereby turn off the regulator's MOSFET. An internal capacitor, C_{SS}, sustains a 6.5V potential maintained by the comparator. After the comparator changes state, C_{SS} releases its charge through internal resistor R_{SS} (in parallel with C_{SS}) until its voltage is 3.7V. At this point, the oscillator reactivates, switching on the MOSFET. MOSFET off-time is designed to be 50µs while the regulator is in soft-start mode.

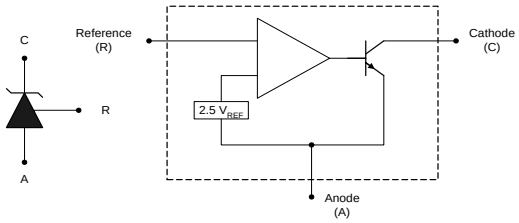


<<Figure 3, Energy Star® Switch>>

Non-Energy Star® models do not normally operate in this mode, even when the set is in standby. Still, the feedback from ICX3701 limits power consumption while the set is not requiring much power.

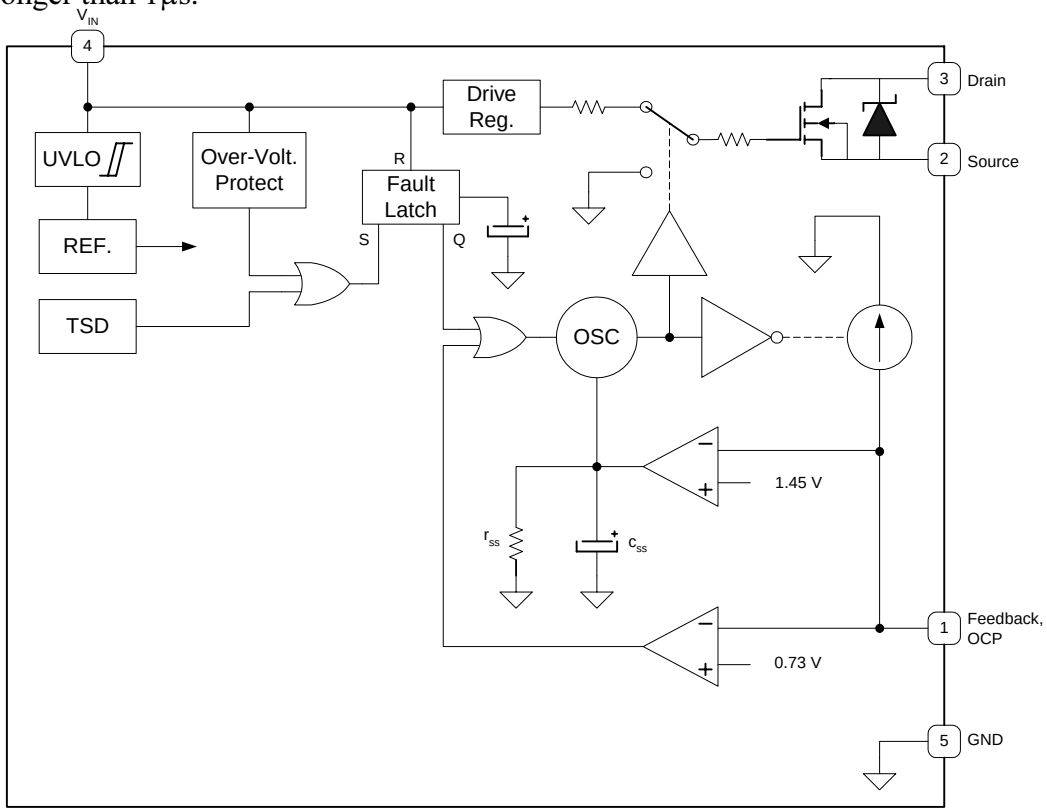
In either standby or fully powered operation, MOSFET on-time is determined by feedback from the programmable shunt regulator, ICX3700, through ICX3701. The reference voltage comes from the

regulated B+ through a voltage divider consisting of RX3700 and RX3701. The shunt regulator operates in direct proportion to its input or reference potential, that is, as reference voltage increases, a corresponding increase in shunted current occurs. The resulting increase in current in ICX3701 yields a higher DC voltage across CX3607, CX3610, and on pin 1 of ICX3600. Consequently a shorter ramp time is necessary for the 0.73V comparator mentioned above to switch off, i.e. there is a shorter on-time in the duty cycle.



<<Figure 4, Programmable Shunt Regulator, ICX3700; Diagram Used with Permission; Copyright, Fairchild Semiconductor, Inc., 2000, All Rights Reserved>>

For Energy Star® sets, when the XO is fully powered, Q3500 switches on and removes current supplied to ICX3501. This eliminates the chopper's feedback shunt, allowing quasi-resonant signal from pin 16 of the TX3601 to reach pin 1 of ICX3600. With the presence of this signal, the regulator operates in its quasi-resonant mode rather than soft-start. In this mode, ICX3600 runs much like it did in soft-start mode except that C_{SS}'s operation in switching the MOSFET is preempted by a second comparator. Using a reference of 1.45V, this comparator senses the potential caused by demagnetization of the chopper transformer and controls the oscillator as C_{SS} did before. In order for the regulator to operate in quasi-resonant mode, pin 1 must see voltage between 2.0V and 5.5V for a duration longer than 1µs.



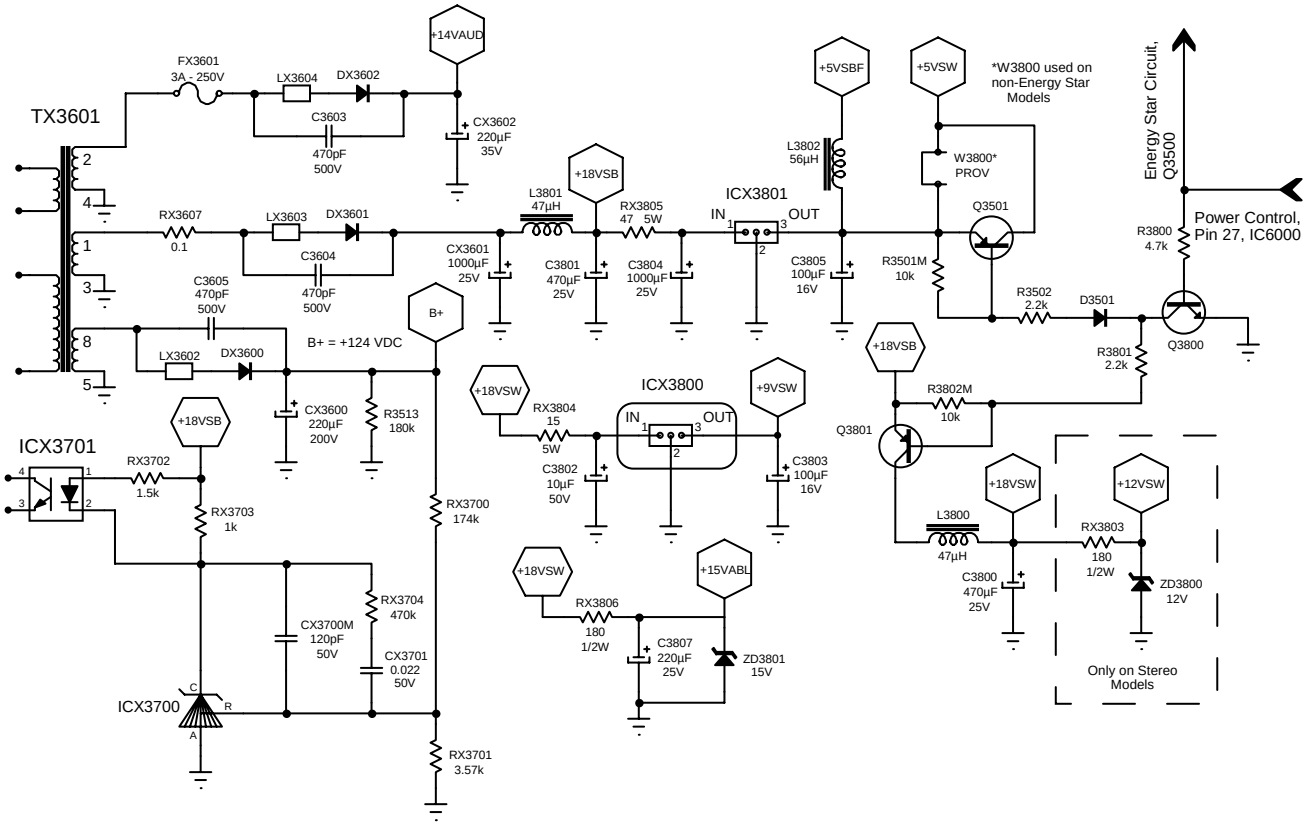
<<Figure 5, Quasi-Resonant B+ Voltage Regulator, ICX3600; Diagram Used with Permission; Copyright, Allegro MicroSystems, Inc., 2000, All Rights Reserved>>

Quasi-resonance makes use of the ringing that occurs in the circuit formed by the chopper transformer and the capacitor CX3606 when current stops flowing through DX3603. (Keep in mind that regulator switching alternates current flow through this diode.) Ringing occurs at a resonant frequency determined by the inductance of the chopper and the capacitance of CX3606. Voltage detected on pin 1 during the first half cycle of the ring causes the MOSFET to switch.

A number of protective functions are built into the regulator IC. Over-current protection (OCP) detected across RX3602 feeds pin 1. Each pulse contributes to the voltage across CX3607 hastening the MOSFET shutoff. The regulator also provides a number of protections that trigger a fault latch. The latch cancels oscillator operations and hence regulated switching. A 10µs noise filter is employed with the latch in order to prevent unnecessary shutdown of the regulator. When the latch is activated, voltage on pin 4 cycles between 10 and 16 volts. To reset the regulator IC, potential on pin 4 must be lowered to 6.5V. Latch triggers include over-voltage protection (OVP) and thermal shutdown (TSD). Thermal shutdown will occur when the internal frame temperature goes over 140°C (284°F). OVP triggers the latch when voltage input to pin 4 of the regulator increases past 22.5V.

Secondary Side

The chopper transformer, TX3601, generates three main output voltages: B+, +18 volts stand-by (VSB), and +14 volts stand-by for the audio amplifier (+14VAud). For XO sets, the B+ is typically +124 volts. B+ of course is used to power the horizontal section of the television including the HOT (horizontal output transistor) and the sweep transformer. A number of tertiary voltages are derived from the sweep section. These will be noted later.



<<Figure 6, Power Supply, Secondary Side>>

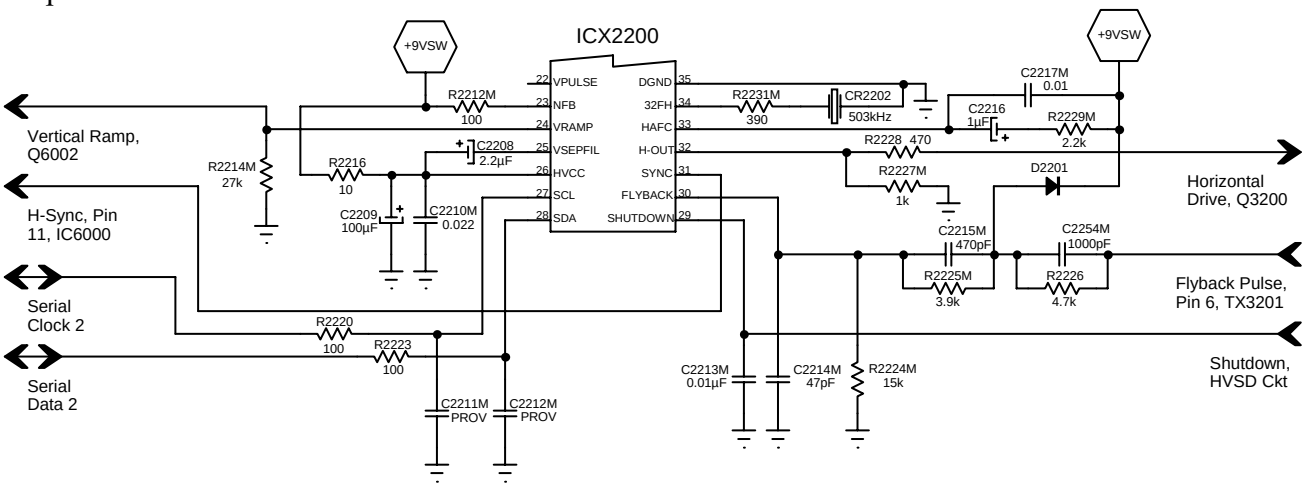
XO CIRCUIT DESCRIPTIONS

The +18VSB line eventually provides power to both the microprocessor (IC6000) and the video processor (ICX2200) using voltage regulators ICX3801 (+5V) and ICX3800 (+9V) respectively. ICX3801 also provides +5 volts to the tuner and to IC2901, a switch IC used in stereo models. Apart from the microprocessor circuit and a DC volume control application, the +5 volt source is switched. Transistors Q3800 and Q3801, and in Energy Star® models, Q3501 are used to activate switched voltages (VSW) when they receive a high DC level from pin 27 of the IC6000. These switched voltages include +18VSW for some of the horizontal circuit, and +15Vabl for the ABL circuitry. Additionally, +9VSW is available for the video/IF IC and the stereo decoder (where used), and +12VSW is provided for IC1402, the DC volume control IC.

Developing Deflection

Deflection signals originate with ICX2200. With the exception of pins 27 and 28, the I2C data lines, pins 22 through 34 are dedicated to the development, adjustment, and transmission of beam deflection control signals. Pin 26, the HV_{CC}, receives +9VSW to power this section of the IC.

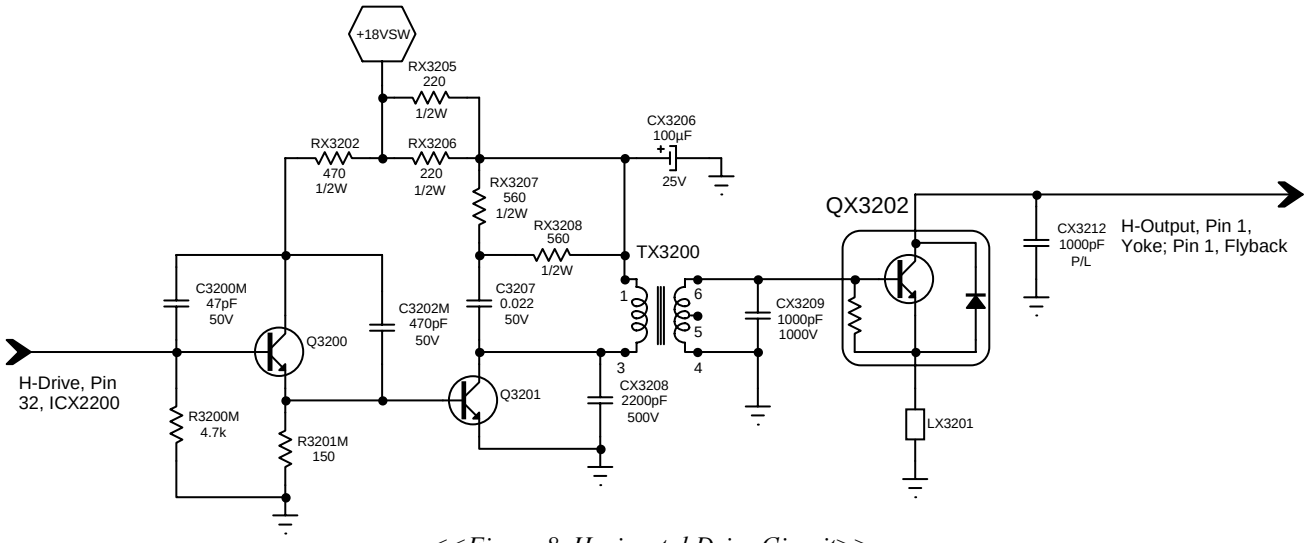
Horizontal synchronization from incoming the luma signal is first separated. A portion of the H-sync goes to pin 11 of IC6000, the microprocessor, from pin 31. The rest of the sync used to generate horizontal drive on pin 32. This drive passes to Q3200 in the horizontal circuitry. Vertical frequency is also derived from the horizontal sync. For the XO chassis, vertical ramp signal is sent through pin 24 to the Q6002. This transistor alters the vertical-ramp signal to function as a trigger pulse. The pulsed vertical signal then travels to the microprocessor as vertical sync and to ICX2100, the vertical amplifier.



<<Figure 7, Deflection Processor Section>>

A couple key inputs should be mentioned here as well. Pin 30 of ICX2200 provides horizontal feedback in the form of a flyback pulse. TX3201, the flyback transformer generates this signal, which helps the deflection processing to make necessary adjustments to the horizontal drive. Incidentally, this same flyback signal also provides the horizontal synchronization needed by IC6000 for generating and locating OSD. Pin 29 is the high-voltage shutdown pin. The actual circuit that generates the shutdown DC level will be described below in the high-voltage circuit description. When the DC on pin 29 reaches approximately 3.5 volts, ICX2200 will clamp the horizontal drive at pin 32, and the XO receiver will need to have IC6000 reset, i.e. AC power removed and reapplied, before the set will power up again.

The horizontal drive (H-drive) circuitry exists to control the drive signal to the Horizontal Output Transistor (HOT). In turn, the HOT drives the horizontal yoke and the horizontal sweep transformer, TX3201. Standard operating frequency for H-drive is 15.734 kHz. As it passes through the driver circuit, H-Drive signal is regulated to provide a proper switching interval that allows the HOT to supply adequate power without self-destructing. H-drive from pin 32 of the Video processor (ICX2200) passes through R2228. The nearly 1.7Vp-p drive signal enters the base of Q3200, which is directly coupled through its emitter to Q3201. Finally, the signal passes from the collector of Q3201 to the Horizontal Output Transformer, TX3200, where voltage-to-current conversion and

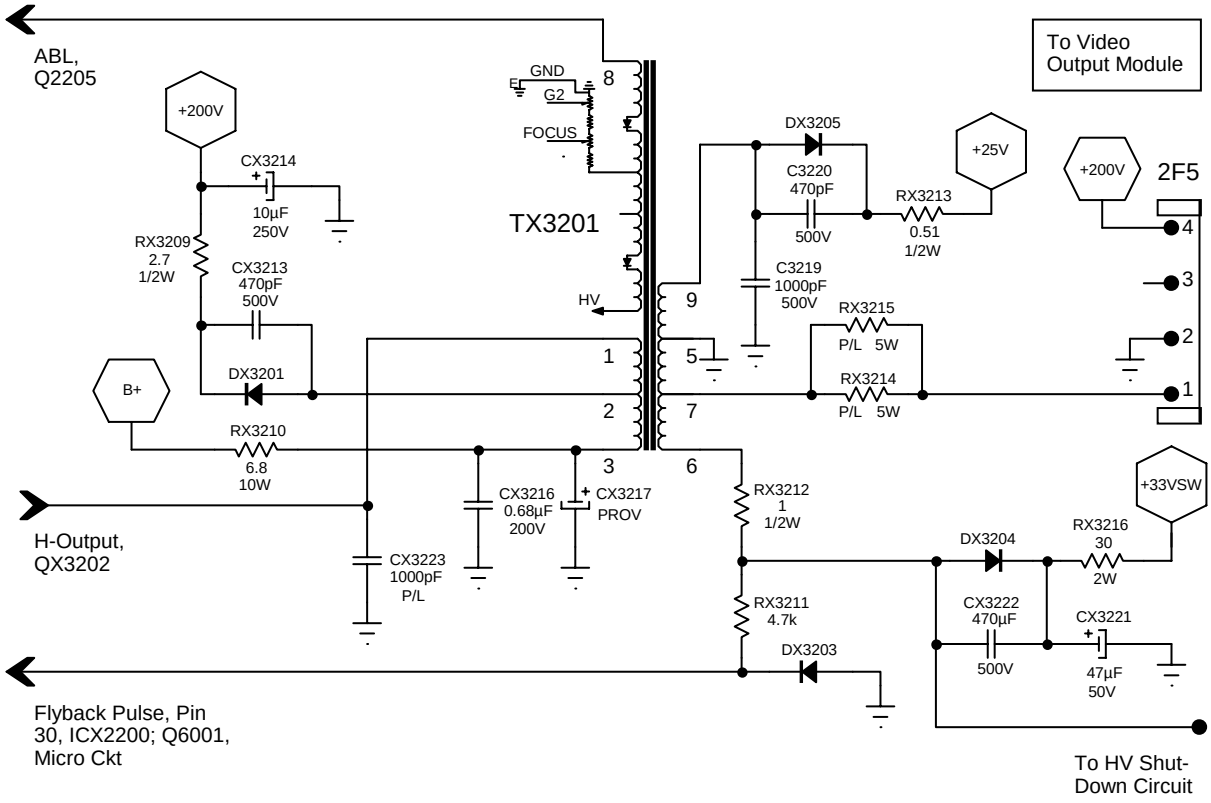


<<Figure 8, Horizontal Drive Circuit>>

proper wave-shaping occurs. After this conversion, the modified H-drive should scope across CX3209 at roughly 5Vp-p. The +18VSW source provides power to the drive amplifier circuit.

Flyback Transformer

From here, the signal switches the HOT (QX3202) to provide a current shunt for the sweep transformer, TX3201 and drive to the horizontal yoke. As the HOT is a high-power transistor, it is not surprising that its output signal exceeds 1kVp-p. This switching signal alternately passes then blocks

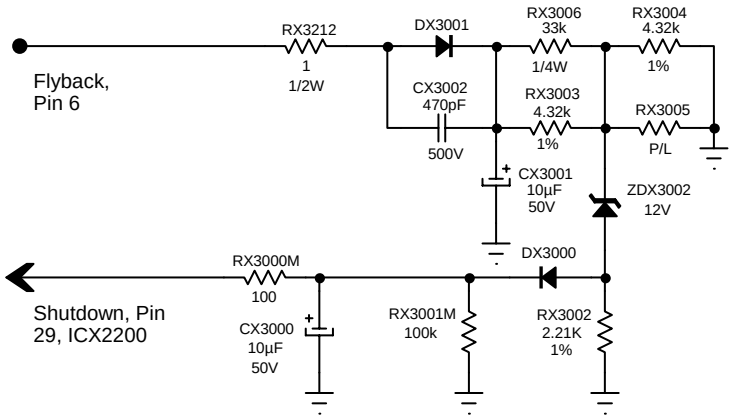


<<Figure 9, Flyback Transformer Circuit>>

the B+ voltage provided through the primary winding of TX3201 to the collector of the HOT. The changing magnetic field in the sweep transformer caused by this action generates the high voltage (HV). This high voltage should normally be between 24 and 27kV depending on load conditions. G2 (screen control) and focus voltages are provided from a portion of the same winding that HV is derived from. As usual, G2 and focus may be adjusted by potentiometers on the sweep transformer. Connections for these adjustments run from the flyback transformer to the CRT socket board apart from other power supplies and signals.

A number of secondary voltages are also provided by the sweep transformer's action. Particularly, +200V source is supplied to the video output circuitry for driving color. In addition, +33V and +25V are supplied, respectively, for a tuner supply and for vertical amplification circuitry. Furthermore, pin 7 of the flyback provides alternating current for the CRT heater. Both heater supply and the +200V are sent to the CRT socket board via connector 2F5.

Another winding from the flyback is used both for high-voltage shutdown, commonly referred to as x-ray protection, and for horizontal feedback. (Refer to the discussion of the flyback pulse above.) Activation of the HV shutdown circuit will occur when it detects a 4 to 6kV increase in the high

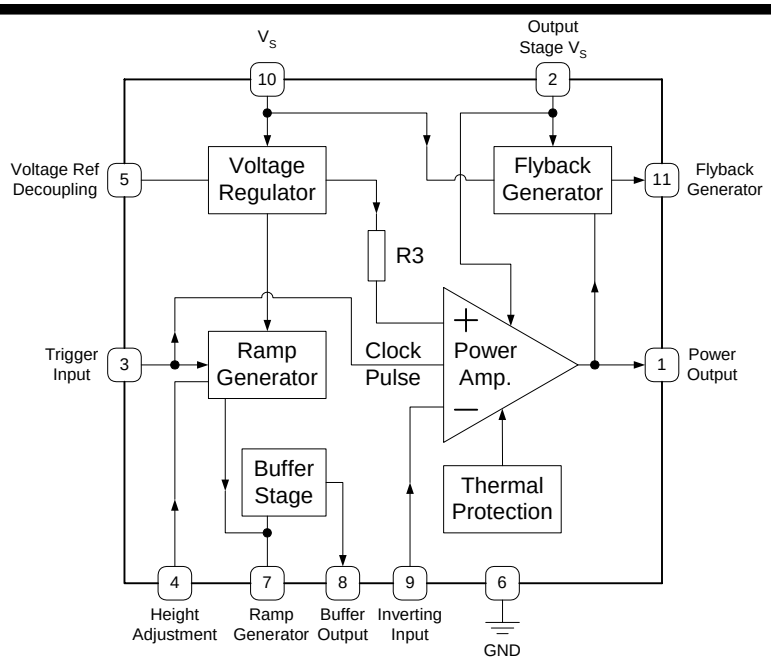


<<Figure 10, High-Voltage Shutdown Circuit>>

voltage. The HV shutdown circuit utilizes a rectified DC voltage across CX3001. This voltage is applied to a zener diode, ZDX3002, through a voltage divider consisting of RX3003, 3004, 3005, and 3006. When this DC voltage becomes high enough, the zener begins to conduct. The resulting voltage can be metered at pin 29 of ICX2200. If the voltage in the shutdown pin is above +3.5 volts, the IC's internal shutdown circuitry will trigger and deactivate all horizontal signal from the IC, thereby shutting off the set. In this case, the microprocessor will have to be reset before the television can be powered on.

Vertical Amplification

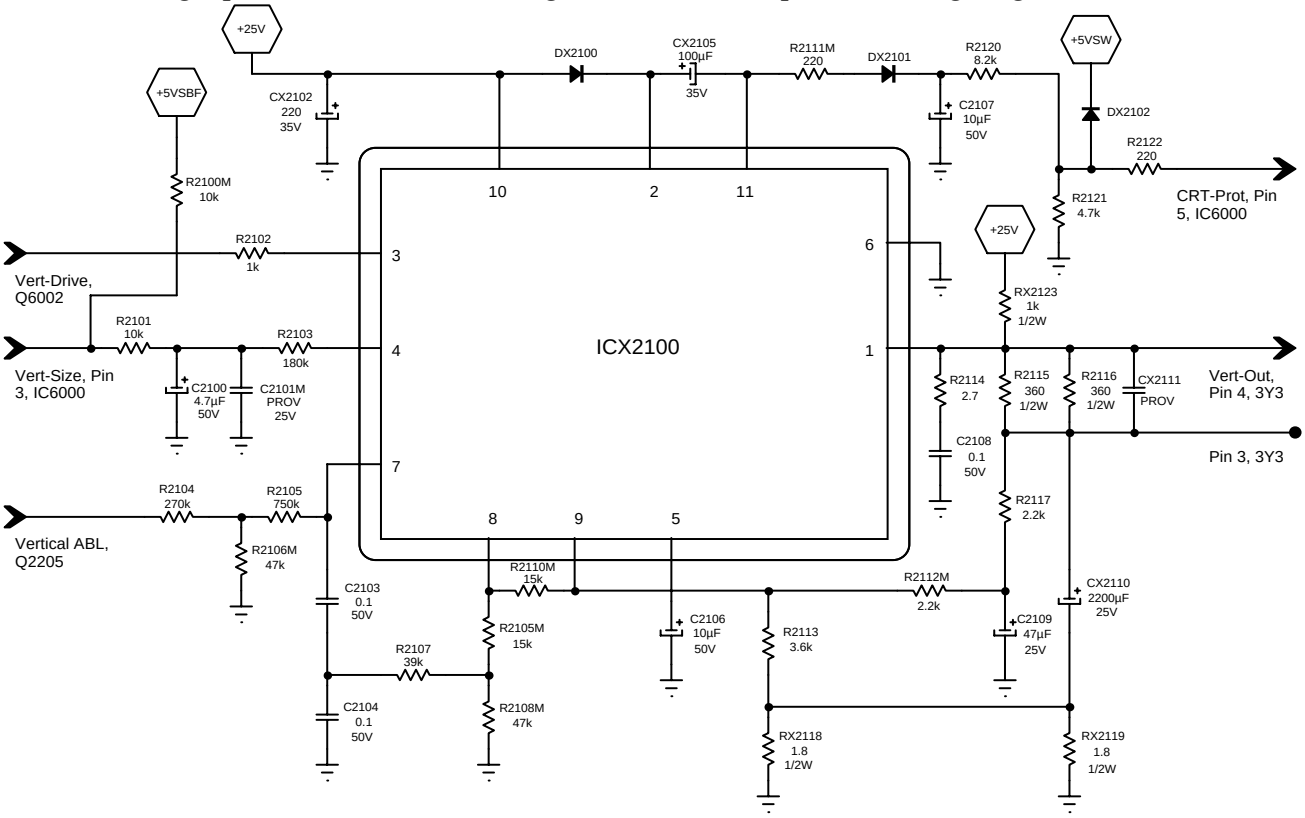
ICX2100 amplifies the incoming vertical drive pulse. This IC contains a power amplifier, a ramp generator, and a flyback generator and is supplied by +25V (from TX3201) to pin 10. The initial vertical drive signal, which should run at 59.94 Hz, is developed from ICX2200 as explained above. This signal is sent from pin 24 of the deflection (jungle) IC to Q6002 where it is inverted and sent as a vertical sync pulse to pin 3 of ICX2100 through R2102. From the collector of Q6002 to ground, the vertical pulse should scope between 4 and 5Vp-p. IC2100 makes use of the vertical sync as a



<<Figure 11, Vertical Amplifier, ICX2100; Diagram Used with Permission; Copyright, STMicroelectronics, Inc., 2000, All Rights Reserved>>

trigger rather than attempting to amplify an external ramp signal. Its internal ramp generator makes doing so possible. Internally generated ramp is less prone to interference that would otherwise adversely effect vertical linearity. The vertical output signal to the yoke comes from pin 1 of the vertical amp.

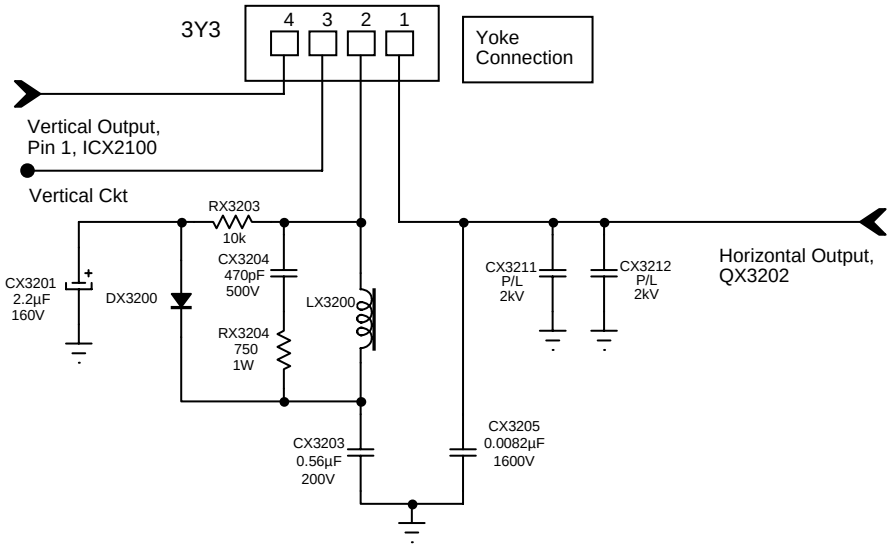
Vertical size is also amplified within ICX2100. IC6000 controls vertical size as directed by its software using a pulse width modulated signal emitted from pin 3. The signal generates a DC



<<Figure 12, Vertical Amp Circuit>>

voltage across C2100. This DC controls vertical height by increasing the slope of the internal ramp. As the width of the pulse changes, a corresponding change occurs in the DC level. In this manner, vertical size may be controlled via the on-screen servicer's menu.

Another signal factors into the development of the internal ramp signal, that being the vertical ABL signal. This waveform is taken from the main ABL (automatic brightness limiter) pulse from pin 8 of TX3201. In unusually bright scenes in the video, high current draw tends to momentarily reduce power to the deflection circuitry. The effect seen by the viewer is a brief drawing in of the borders of the video. The ABL circuitry reduces part of this by clamping some of the video brightness when such an event occurs. However, the vertical ABL pulse allows the vertical amp IC to also compensate for the temporary loss of power. Vertical ABL feeds into pin 7 of the amplifier.



<<Figure 13, Yoke Circuit>>

CRT protection is provided for the XO in circuitry off the vertical amplifier. In case of a damaged ICX2100, this circuit will prevent damage to the CRT by shutting the microprocessor off. In turn, this action shuts down the television receiver. The detector circuit is composed of C2107, DX2101, DX2102, R2111M, R2120, R2121 & R2122. Pin 11, the flyback generator of ICX2100, emits a pulsing waveform typically about 15.25Vp-p. DX2101 rectifies this waveform to a DC voltage across C2107. After passing through the voltage divider network formed by R2120 and R2121, the voltage level can be found on pin 5 of IC6000 and should meter between +3.6 and +5.1 volts. Should the voltage be outside this range, CRT protection will trigger. If the CRT protection circuitry is triggered at power on, the television will turn off in 3 seconds. In case this occurs, it shall be necessary to reset the microprocessor before the television can turn on. Resetting the microprocessor may be accomplished by removing AC to the set for a short time.

Deflection Yoke

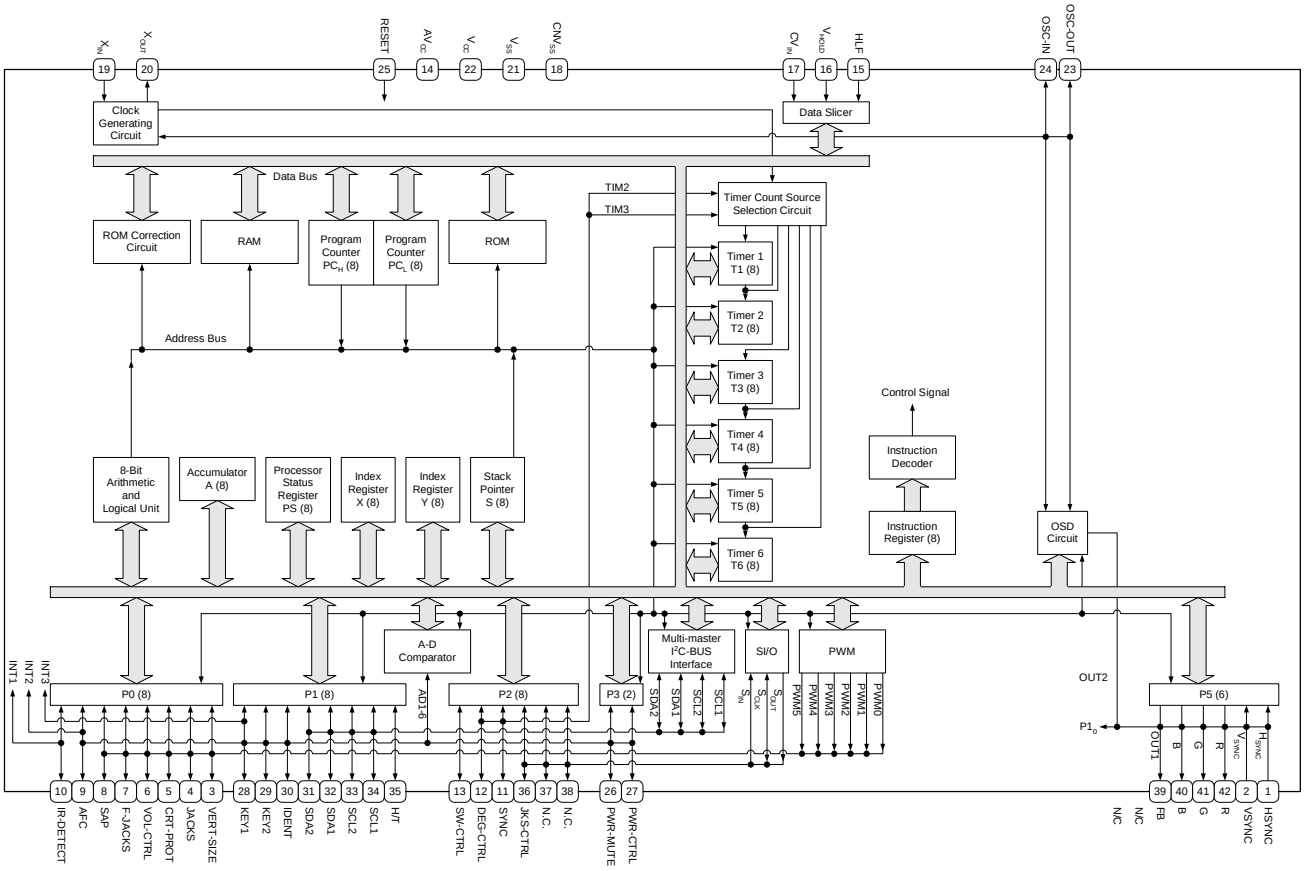
Due to the small television size of the XO models, and because of previous advances in yoke preparation, no width control or pincushion correction is necessary for the horizontal deflection circuits in XO sets. These characteristics are preset in the winding of the yoke. The horizontal output therefore makes use of a simple RLC circuit that responds to the horizontal output from the HOT, QX3202. Both horizontal and vertical deflection signals pass to the yoke by way of connector 3Y3.

XO CIRCUIT DESCRIPTIONS

Microcontroller Circuit Introduction

IC6000, the microcontroller/processor in the XO chassis, provides the means for both the end-user and servicer to communicate with the television receiver. Additionally, the micro communicates control and feedback signals to other devices in the television. Communication occurs in one of three ways. IC6000 can send DC levels for switching other devices. It can also send pulsed waveforms as device control signals or receive pulsed waveforms as feedback and control data. The last way IC6000 can communicate is through its two sets of serial clock and data lines. A set of these lines is commonly known as an I^2C bus. Using this method of communication, IC6000 can both send and receive control information to and from various receiver devices. These devices include the video processor, the audio processor, the tuner, and television memory. Many of the operations performed by the micro remain transparent to the user. IC6000's functions will now be presented.

The microcontroller receives power from the +5VSB supply, which is filtered to become +5VSBF and is supplied to pin 22, the V_{CC} of the micro. Additionally, +5VSBF is fed to pin 14, the AV_{CC}, for the analog functions of the micro. While this is a relatively low voltage supply, the micro consumes considerable power, up to 165mW. While the micro has a tolerance of ±10% on it voltage supply, the +5VSBF source supplies another device with a tighter limit on its tolerance. Pin 21 provides a ground for the chip.



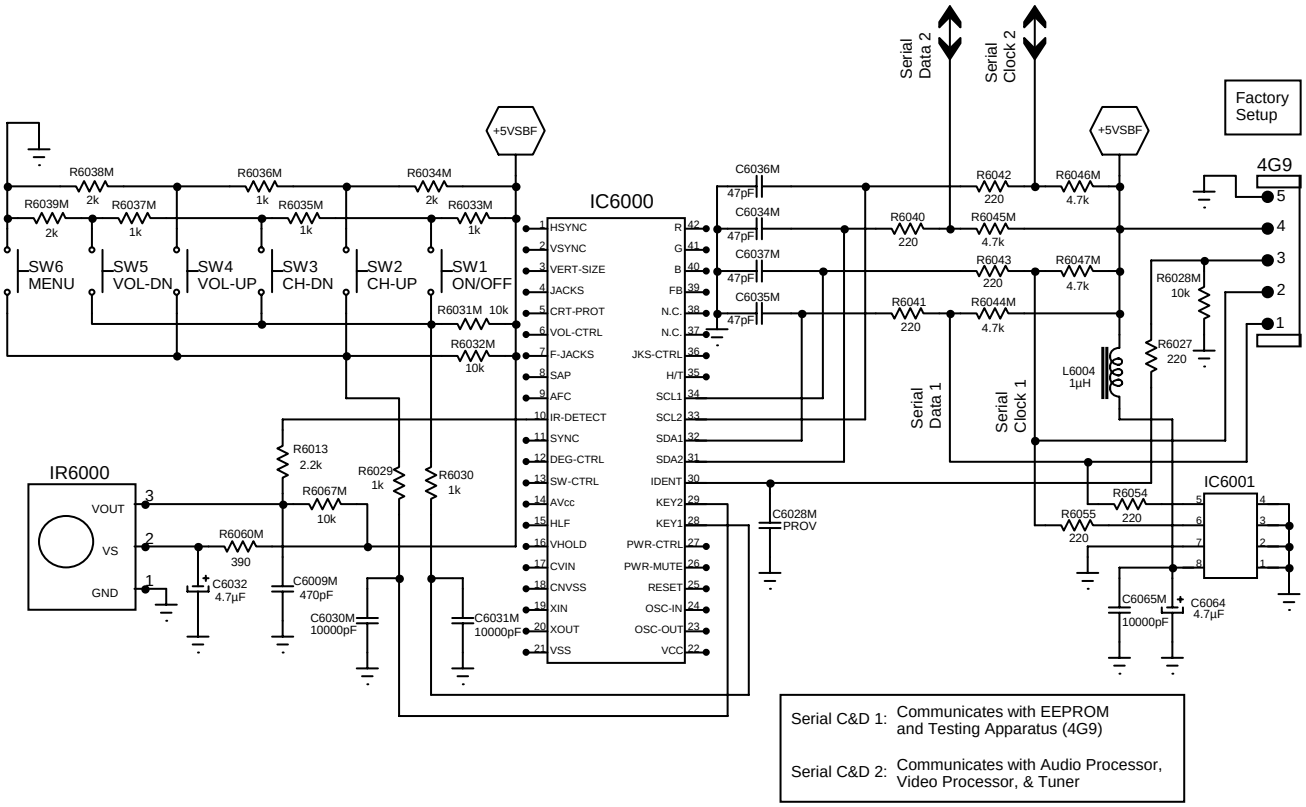
<<Figure 14, Microcontroller, IC6000; Diagram Used with Permission; Copyright, Mitsubishi Electronics America, Inc., 2000, All Rights Reserved>>

Before IC6000 will function, it must be reset. This is accomplished at pin 25 by a signal from IC6002, the reset IC. In order for the micro to reset, pin 25 must have a low voltage signal for at least 2µs. IC6002 provides a low voltage pulse not greater than 0.4VDC to accomplish this.

Under normal conditions, IC6000 will run at an 8MHz clock speed. CRY6001, a quartz crystal, is used in the microprocessor's clock circuit to control the clock generating frequency. It connects to the micro through pins 19 and 20. The processor executes its functions as quickly as 5µs per instruction. A second clock circuit is provided for the on-screen display (OSD). While a ceramic oscillator or a crystal could be used with this clock, it can also run employing an RLC circuit. In either case, the clock inputs for OSD functions feed pins 23 and 24.

Input Devices

The keyboard and the IR detector provide the end-user with the means to communicate with the television microprocessor. In the XO chassis, the keyboard and IR assembly is built directly onto the chassis. The keyboard operates using a split voltage divider ladder and has two corresponding DC inputs to IC6000 at pins 28 and 29. The micro uses two A/D converters to interpret the various DC levels. Such an arrangement reduces the duty load of the micro, which might otherwise have to perform active keyboard scanning. The IR detector demodulates pulses from a 40kHz IR carrier and sends them to pin 10 of the microprocessor. An algorithm then interprets the pulsed signal as the command it represents. Both the keypad and the IR detector rely on a +5VSBF source. It is critical that this source remains within ±4% of +5V in order for the DC levels from the keyboard to be accurately interpreted.



<<Figure 15, Microprocessor, EEPROM, & Communication Circuit>>

XO CIRCUIT DESCRIPTIONS

EEPROM

The same +5VSBF that supplies the keyboard and the micro also powers the television's memory chip, the EEPROM (Electronically Erasable Programmable Read Only Memory). In the XO chassis, IC6001 is an 4-kilobit (512 byte) memory storage device. The purpose of using this type of memory is so that servicer adjustments, channel information, and user settings remain stored, even when power is removed from the television. The power supply feeds pin 8. Pins 5 and 6 are serial data and clock lines in that order.

IC6000 Application

Pins 31 through 34 of IC6000 are the I^2C bus sets. In particular, pins 32 and 34 are serial data 1 and serial clock 1 lines respectively. Pins 31 and 38 are the second I^2C set in the same order. Bus 1 communicates with the EEPROM and with the factory setup connection, connector 4G9. If factory test equipment is linked to this connector, pin 30 detects its presence and causes IC6000 to maintain communication with the microprocessor. Bus 2 is responsible for communicating with the stereo audio processor (IC1400), the jungle IC (ICX2200), and the tuner (TU1200).

The remainder of the pins not yet mentioned in this microprocessor circuit section can be generally classified as either DC level or analog waveform inputs and outputs. While other sections may more fully explain the function of these signals, they shall be briefly described below.

Pins 1 and 2 receive horizontal and vertical sync pulses. These are used for the micro to calculate the location of the beam trace on the CRT screen. Once this location is known, RGB (red, green, & blue) signal for the OSD can be sent to the video processor, ICX2200, from pins 40 through 42. Along with the OSD video, pin 39 transmits fast-blanking signals to the video processor so that it can cancel main video output when OSD is to appear. Another output, pin 35, will occasionally be used for sets with half-tone circuits. This is a provisional circuit not found in every set. When used, it de-amplifies the video output signals in an organized fashion so as to generate a transparent, darkened rectangle under the OSD.

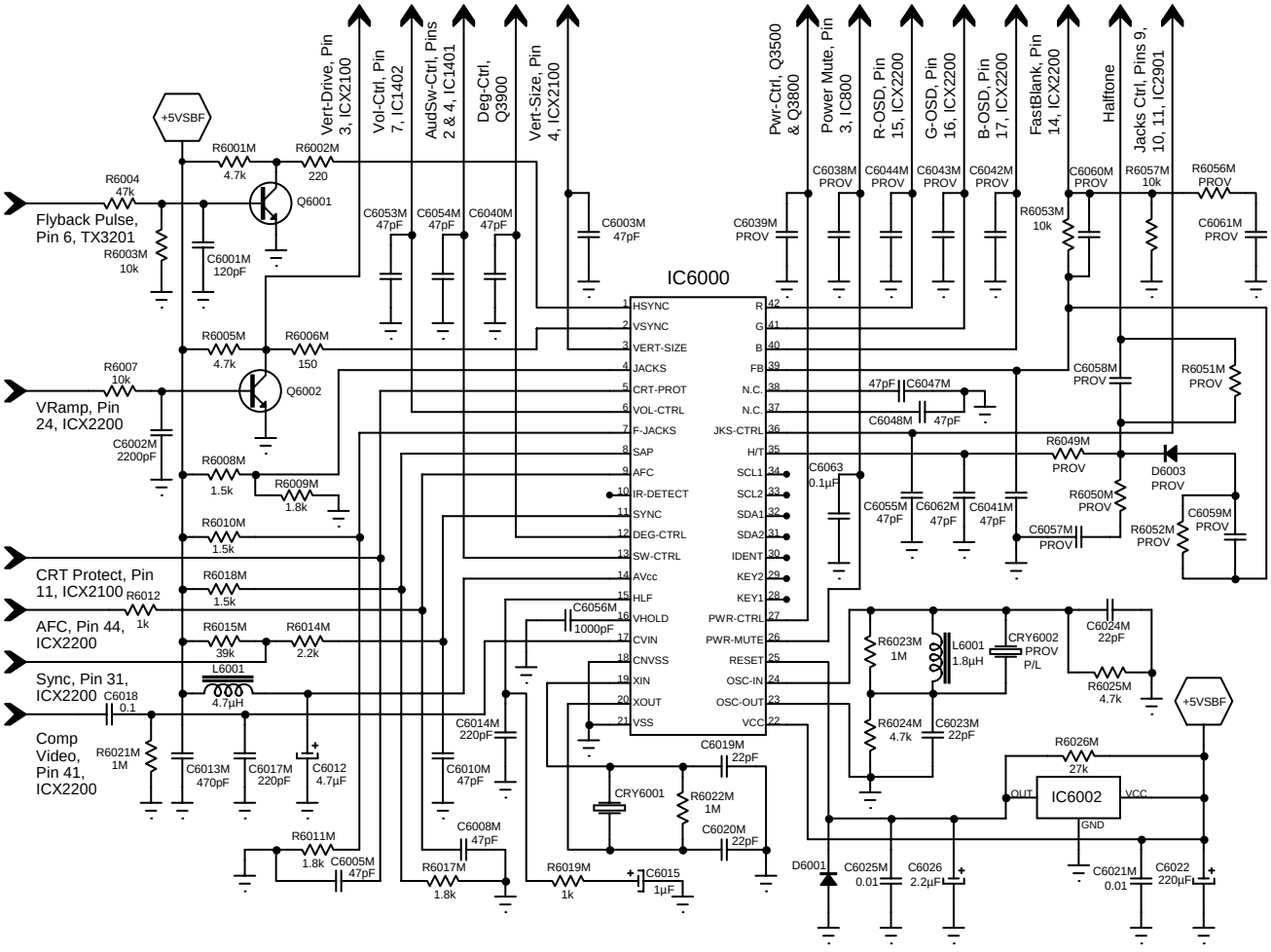
Pin 3 sends control signals that affect the vertical size. The vertical circuit makes use of a pulse-width-modulated (PWM) signal that determines the voltage across a capacitor. That DC voltage in turn is used in the same manner that potentiometers used to be employed in varying vertical size. Size adjustment is then software controlled rather than hardware controlled. Horizontal size is wound into the yoke on the CRT, so there is no pin-out on IC6000 for horizontal size control.

Pin 11 is dedicated to signal detection. This input receives data to let the micro recognize that a bona fide signal has been detected from the IF circuitry. In particular, the sync pin receives the horizontal synchronization separated from the IF signal. Of course this only happens when a valid signal is being tuned. Such detection can be used for auto-programming channels into the television's memory.

Also related to IF is pin 9. The automatic frequency correction (AFC) pin sees a DC voltage from the IF section of ICX2200 that directs the micro to optimize the tuner frequency. When the tuner reaches the ideal frequency, DC on pin 3 should be about +2.5V.

The CV_{IN} input, pin 17, takes composite video signal. IC6000's data slicer extracts from this the closed captioning information, extended data service (XDS), and television rating information. This information is located in the 21st line of the vertical blanking interval in the video IF. Note that when the user chooses to display closed captioning, the captioning will blank when OSD is on the screen. Pins 15 and 16 supplement this subcircuit of the microprocessor. R6019M off pin 15 helps to determine the interval of the timing signal generator circuit of the data slicer. A reference voltage is sustained at pin 16 by C6056M for the same circuit.

DC volume control level is sent from pin 6 of IC6000 to pin 7 of IC1402 as PWM (pulse-width modulated) signal. A rectifier and smoother circuit converts the pulse into a variable DC voltage that dictates the gain of IC1402. This method is used for controlling volume because IC1400, the stereo audio processor, does not provide an internal volume limiter. In mono sets, volume is controlled by microprocessor data transmitted to ICX2200 via I^2C data bus. So that the microprocessor can deter-



<<Figure 16, Control Circuitry>>

mine by which method it should control volume, it polls the SAP pin 8. The resistor divider composed by R6017M and R6018M off this pin is provisional. It is only present if the set has a stereo audio processor. Thus a certain DC level at pin 8 lets the micro know how to control audio. Pin 13 provides a bi-state DC level to determine whether IC1401 will pass internal or external stereo audio to IC800.

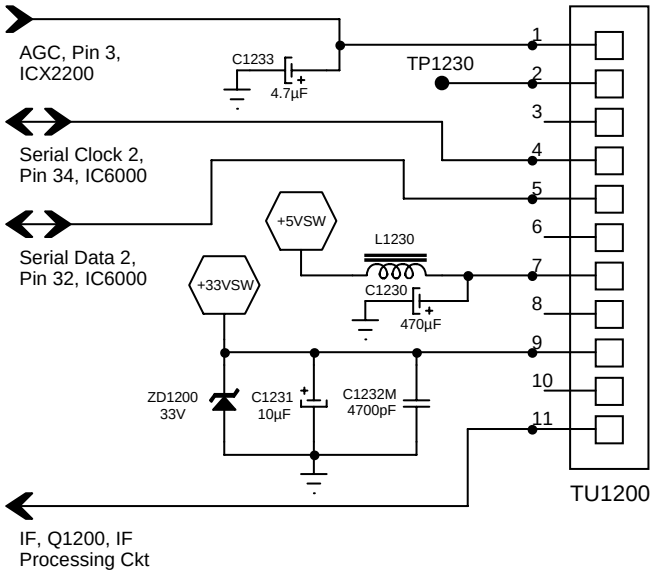
XO CIRCUIT DESCRIPTIONS

The XO uses three possible jackpack arrangements. The most complicated of these arrangements makes use of IC2901, a 6-channel input, 3-channel output switching IC, to support two video/stereo audio jack arrays on both front and rear of the set. Another setup has a video/mono audio array on the back of the set. The lowest feature jackpack has only an RF antenna/cable input jack. Again, a mechanism for determining how the microprocessor should control externally input signals is necessary. Pins 7 and 4 use the same type of provisional voltage divider that pin 8 does if rear and front jackpacks are present. Voltage divider networks on all three pins take +5VSB as their supply. If both front and rear jacks are present on an XO, pin 36 of the microprocessor will be enabled to control IC2901 as a DC level switch.

The remaining four pins are either switching signals or signals which trigger other switches. Pin 27 is a DC level that switches Q3800 to activate the switched power supplies and turn on the television. Pin 12 also switches a DC level at power-up, but the DC level lasts only for about 0.76 seconds at startup. This pin controls the degaussing coil through transistor Q3900. Pin 26 disables the television speakers when the operator selects speaker-mute in the user's menu by sending a high DC level to Q800. Lastly, pin 5 is the CRT protection pin. If the DC level here strays from between +3.6V and +5.1V, the microprocessor will latch the XO receiver in shutdown until AC is removed from and then reapplied to the set. This DC level is dependent on the proper functioning of ICX2100, the vertical amplifier IC.

Tuner

Broadcast, cable, and some peripheral device (such as a VCR) signals enter the television through the varactor tuner, TU1200, via coaxial RF input jack. The tuner can receive 181 channel. Tuner B+ voltage is +5VSW and feeds into pin 7. Pin 9 takes a +33VSW supply generated as a tertiary voltage provided by operation of the sweep transformer, TX3201. This supply is used strictly for tuning purposes.



<<Figure 17, Tuner Circuit>>

TU1200 is controlled by the microprocessor via I^2C data lines to the tuner at pins 4 and 5. Tuning is accomplished by varying the voltage across an internal varactor. The resulting controlled change in the tuner's resonant frequency effectively selects the desired television channel. The microprocessor directs this process based on user input.

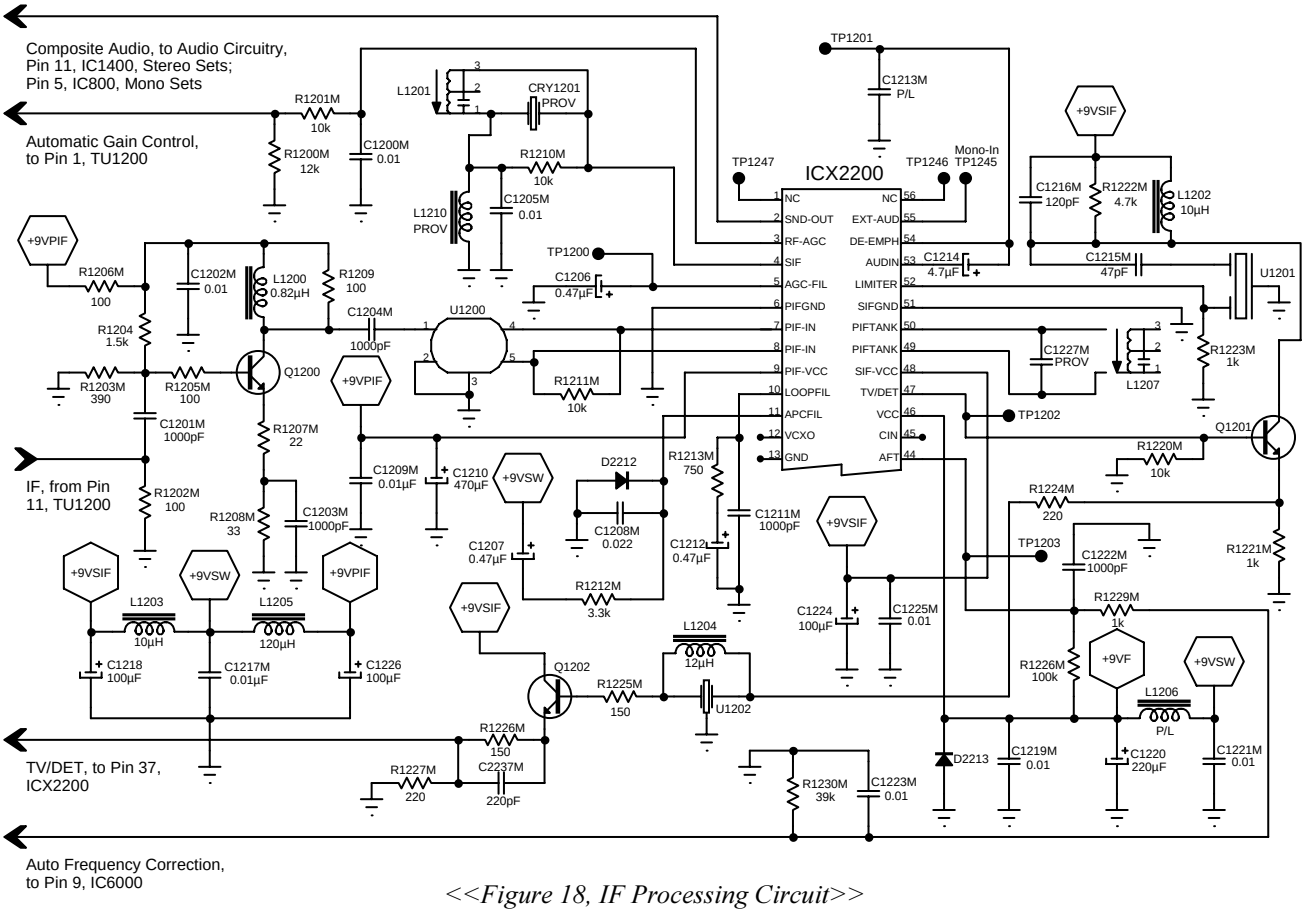
IF Processing

The resultant signal of the tuning process, known as IF (Intermediate Frequency) travels from pin 11 of TU1200 to Q1200 where it is amplified, then filtered by U1200 before it enters the IF processor, ICX2200 at pins 7 and 8. To compensate for a signal strength that is either too strong or too weak, pin 3 of the IF processor feeds back to pin 1of the tuner an AGC (automatic gain control) DC level. This level is typically around +4.3V, but it will vary either to strengthen weak signals or to attenuate signals that would otherwise distort due to their high strength.

ICX2200 is appropriately nicknamed the jungle IC because of its crowded, highly active utility. In addition to processing deflection and video, it also handles the IF demodulation of picture IF (P_{IF}) and sound IF (S_{IF}). +9VP_{IF} is supplied to pin 9, while +9VS_{IF} can be metered at pin 48. Main V_{CC} for the jungle chip, a filtered +9 volt supply, is fed to pin 46.

U1200 is a 43.5MHz P_{IF} SAW (surface acoustic wave) filter that removes the extraneous IF content. The filtered IF enters ICX2200 where it is amplified and sampled for AGC feedback and AFT adjust-

XO CIRCUIT DESCRIPTIONS



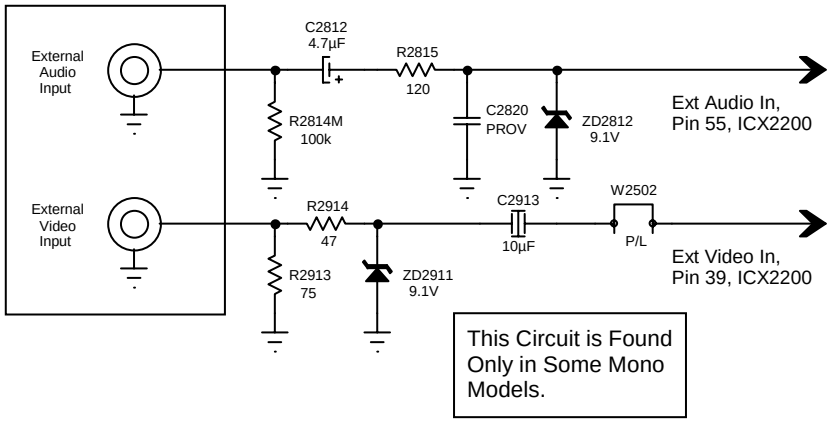
<<Figure 18, IF Processing Circuit>>

ment, then sent from pin 47 to Q1201. The output of this transistor passes to U1201, a 4.5MHz bandpass filter for the audio carrier, and to U1202, a 4.5MHz trap to eliminate audio content from the picture IF. The PIF gets amplified at Q1202 and is sent back into ICX2200 at pin 37. Filtered audio signal is passed to pin 52, the limiter portion of the jungle, out pin 54 where it is de-emphasized, and back into pin 53 where it is attenuated for volume control. The resulting composite audio moves on to the sound circuit from pin 2. Notice that on those sets with a mono-audio input jack, external audio is passed to pin 55. In this case, ICX2200 can be instructed by the micro as to which sound source to select.

Automatic fine tuning (AFT) DC is sent from pin 44 to pin 9 of the microprocessor. The jungle is capable of evaluating the P_{IF} signal quality to determine if the tuner is properly calibrated to the optimum resonant tuning frequency. Optimum voltage communicated to the micro should fall somewhere between +2.25V and +2.5V. When outside of this range, the micro will communicate minor adjustments to the tuner via I^2C lines until the AFC voltage at the micro comes back into range. The range can be adjusted by a servicer who alters the P_{IF} VCO adjustment in the servicer's menu.

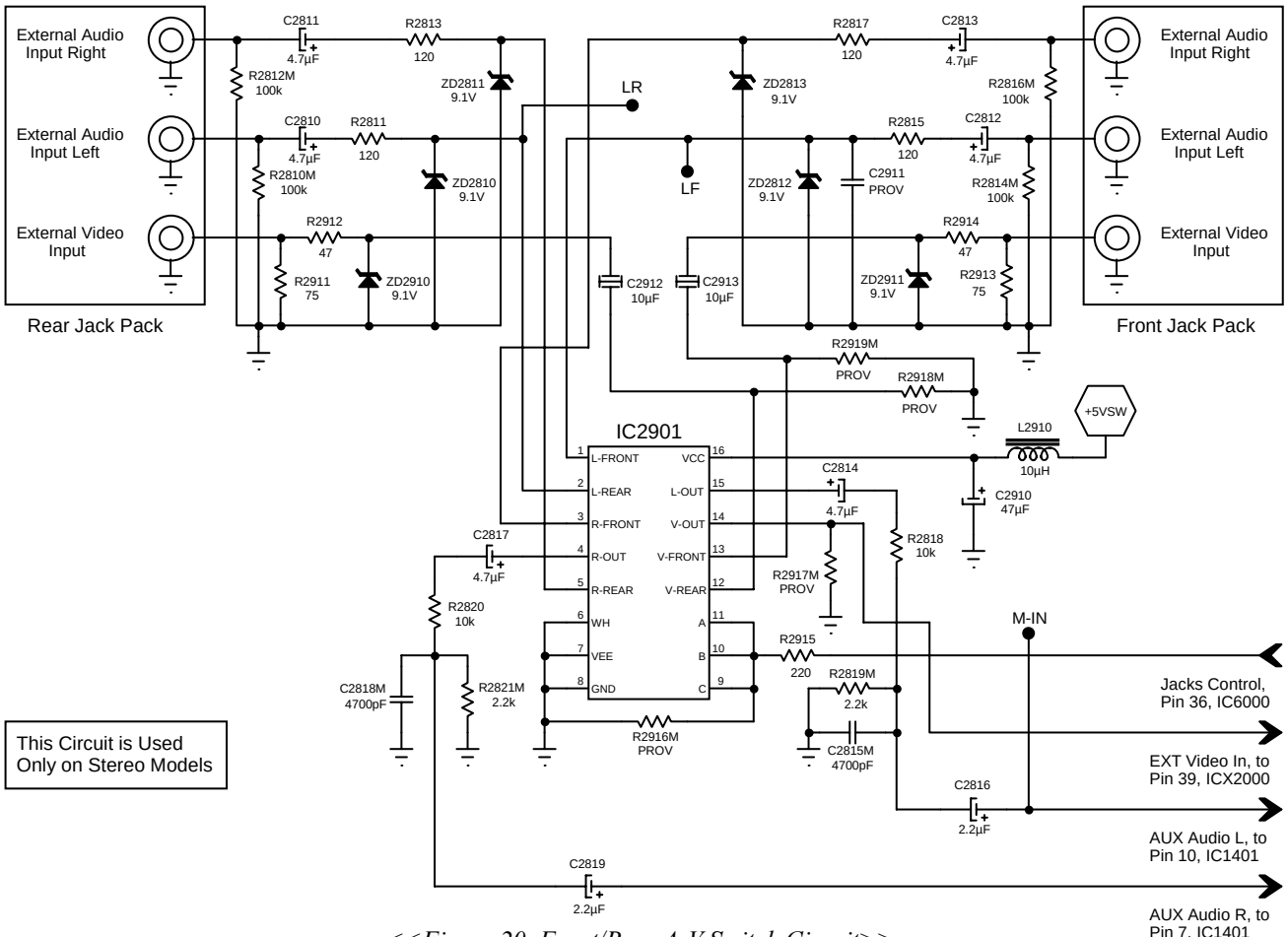
Jack Arrangements

There are basically three possible arrangements for the jacks found in the XO chassis models. The simplest sets contain only an RF coaxial antenna/cable input. For such models, little mention needs to be made as there is essentially no jackpack circuit per se.



<<Figure 19, Mono Jack Arrangement>>

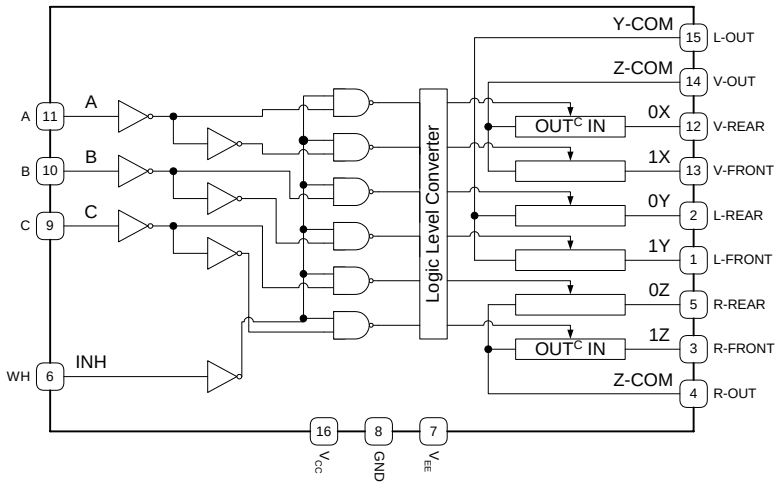
Another arrangement adds an external video and an external mono audio jack to the rear of the set. While this assembly is very rare in most domestic sets, it is briefly described here in the event that a servicer encounters such a set on his bench. Indeed the description will be brief because with only



<<Figure 20, Front/Rear A-V Switch Circuit>>

two auxiliary inputs, both feeding into their respective pins on the jungle IC, the only necessary comment is that these sources are switched internally in ICX2200 depending on commands from the microprocessor, IC6000. A fairly standard composition of Zener diodes, capacitors, and resistors is attached to each line for impedance matching, spike protection, and noise reduction.

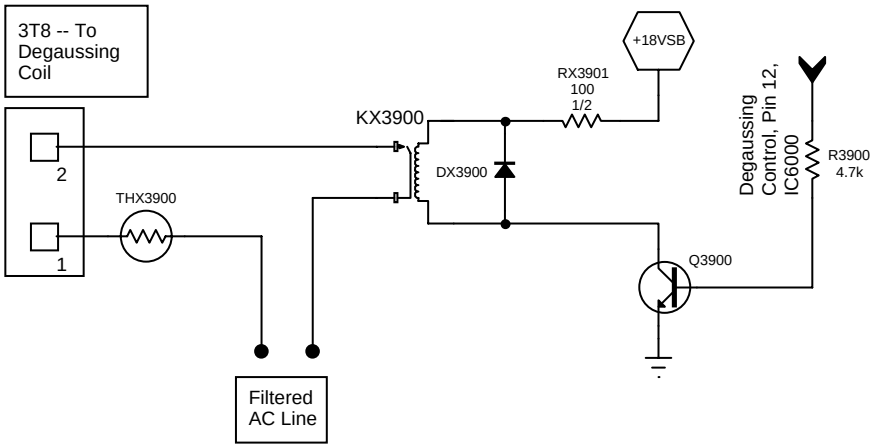
The more common, higher-end jackpack assembly features two identical A/V input arrays, one for the front and one for the rear of the XO receiver. These arrays possess a single composite video input jack and (two) stereo audio input jacks. All six inputs have the necessary filtering equipment, and all feed into IC2901, the front/rear jackpack switch control. This 3-channel output switch is powered by the +5VSW source at pin 16. It is capable of controlling all six of its input channels using bi-state DC levels on pins 9 through 11. However, since only two modes are required for its application in the XO, a single, switched DC level from IC6000 signals all three control pins at once to select whether output will be from the front or the rear jack.



<<Figure 21, A-V Switch, IC2901; Diagram Used with Permission; Copyright, Toshiba America Electronic Components, Inc., 2000, All Rights Reserved>>

Degaussing

In the startup sequence of the XO chassis, arguably the first event that happens with respect to video display is the firing of the degaussing coil. Technically speaking, the degaussing circuit is part of the power supply circuit. However, it really has nothing to do with generating power. Rather it is part of the supply circuit for convenience. The idea behind degaussing is to generate a brief but strong magnetic field around the CRT so that color will be uniformly pure across the display. This event only occurs when the set is first turned on. When power is switched, a 0.75 second DC level biases Q3900 to turn on relay KX3900. This closes the coil's connection to the filtered AC supply. For a brief moment, current floods the coil as thermistor THX3900 heats and creates resistance to limit the current. After the DC level ceases at Q3900, the process is complete and the CRT is ready to accurately scan colors onto the screen.



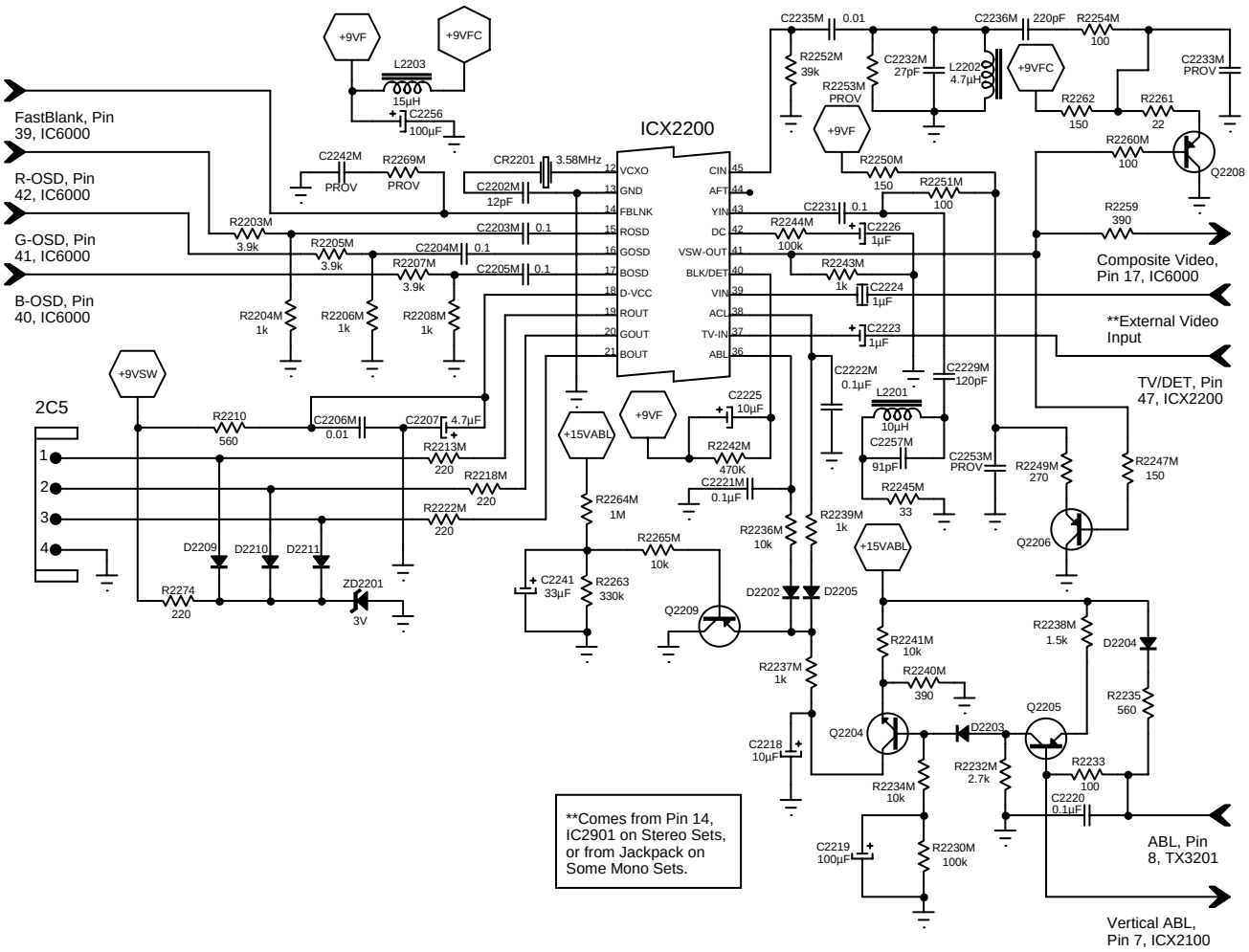
<<Figure 22, Degaussing Circuit>>

Video Processing

Tuner sourced composite video feeds ICX2200 at pin 37. For a discussion of how this is developed, refer to the IF circuit description. Pin 39 provides a channel for an external composite video source. Both feeds are reduced to about 1Vp-p by series resistors in both the picture IF output and the video jack circuit. The serial clock and data bus to ICX2200 communicates which signal is output from pin 41 and therefore viewed on the screen. Actually, the composite video signal at pin 41 is sent simultaneously to filtering sub-circuits in the video section and the microprocessor. CV_{IN} at pin 17 of IC6000 is used for closed captioning development as well as rating and XDS detection.

C2232M, L2202, and R2253M compose a 3.58MHz-centered bandpass filter for the chroma signal that passes to pin 45 (C_{IN}). The chroma signal should be nearly 286mVp-p. Width of the pass-band is roughly 1MHz. Composite video feeds to both this circuit and to the 3.58MHz trap circuit off pin 43, the luma input pin (Y_{IN}). This trap, composed of C2257M, L2201, and R2245M, shunts color signal to ground leaving only picture detail information for the luma section of ICX2200. Its peak-to-peak input level should be 1V.

ICX2200 performs a number of functions in processing video. These include DC restoration, black level stretching, automatic color control, gamma correction, and chroma and luma multiplexing and synthesis for RGB outputs. In this process, RGB for OSD (on-screen display) is merged with the



<<Figure 23, Video Processing Circuitry with ABL Section>>

main video. RGB OSD from the microprocessor feeds pins 15 through 17 of ICX2200. The OSD signals replace main video for the duration that the fastblank pulse is detected at pin 14. The user can alter certain video settings such as brightness, contrast, color level, and sharpness. Commands to accomplish this are communicated from the micro to the video processor via I^2C bus lines.

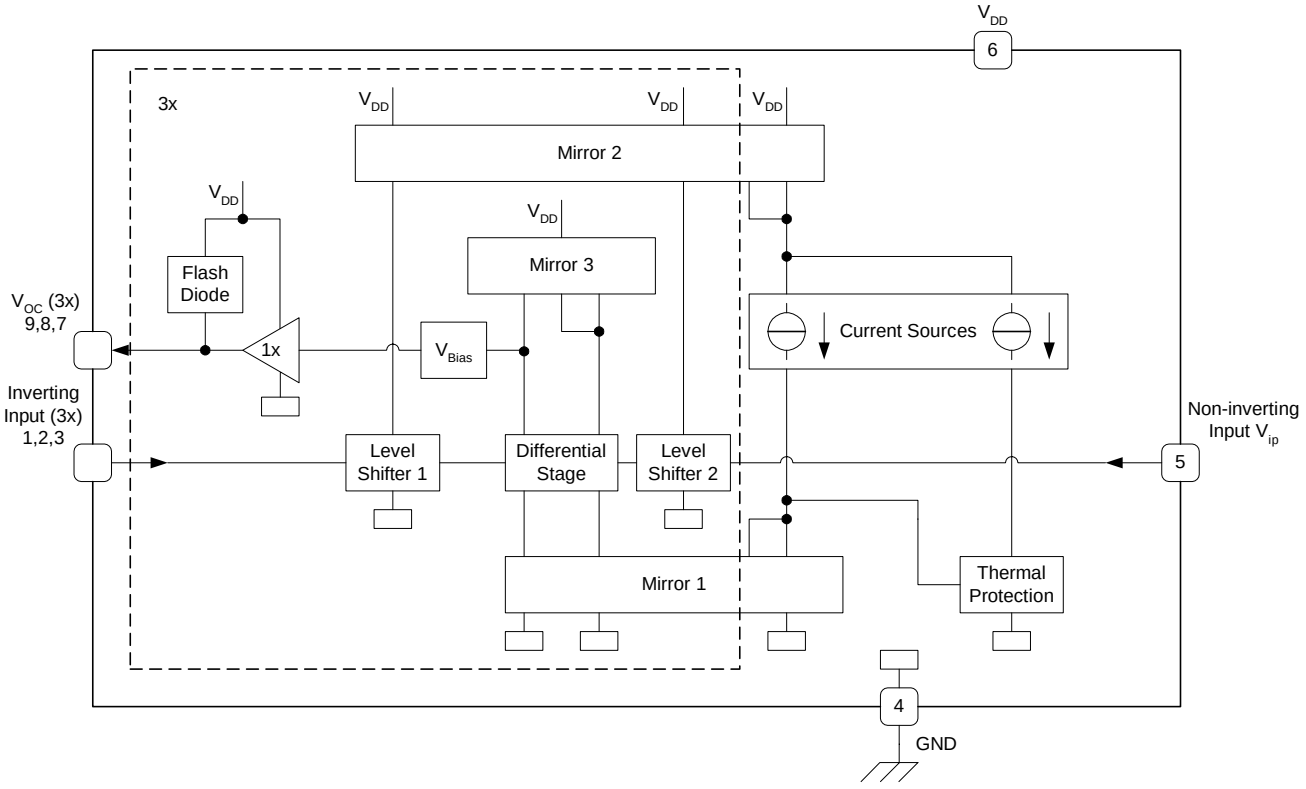
Contrast and brightness settings in particular are also regulated by the ABL (automatic brightness limiter) circuit. This circuit controls the beam current by regulating contrast and brightness output to the RGB pins. To do this, it requires feedback from the high-voltage transformer. The ABL circuit is necessary to keep the video from blooming, especially when the video suddenly changes to from one extreme of luminous intensity to another. For example, when video changes from a dark scene to a very bright scene, the CRT must draw a significantly higher amount of current. Keep in mind that the sweep transformer provides this current, as well as power to run the deflection circuits. If there is a sudden, significant current draw on TX3201, in the absence of ABL, voltage from the sweep transformer is momentarily lowered. This directly affects both the horizontal and the vertical deflection circuitry, in this example, by lowering the amplitude of their respective output. Hence, without limiting beam current draw there will be contraction and expansion of the sweep, also known as blooming

Pin 8 of the sweep transformer provides the current feedback that the ABL circuit interprets and conveys to the video processor through pins 36 and 38. Pin 36 leads to the brightness limiting circuit, while pin 38 leads to the contrast limiter. D2204 and R2235 render the ABL waveform more positive. The waveform then inverts through Q2205 and intensifies through Q2204. If the beam current reaches the ABL threshold, Q2209 will switch on and shunt current away from pins 36 and 38. 19 and 20-inch sets will limit beam current at 1.1mA (±0.05mA). The DC voltage drop detected on both pins 36 and 38 will be interpreted internally by ICX2200 as a signal to limit brightness and contrast. Notice that while both pins have RC circuits off them, the resistance off pin 36, the ABL pin, is significantly higher than that off pin 38, the ACL (automatic contrast limiter). This is the case because contrast limiting must generally react more quickly than brightness limiting.

Video Amplification

RGB output from pins 19 through 21 passes to the CRT socket board through the 2C5 connector. On most sets, diodes D2209, 2210, and 2211 serve to clamp RGB output. ZD2201, a 3V zener diode maintains a constant clamping threshold for the video. However, if a set has the provisional half-tone circuit, a different array of diodes, D2206 through 2208, feed to Q2210. This transistor triggers based on the half-tone level from pin 35 of IC6000. This means of clamping generates a darkened, transparent, rectangular area surrounding OSD.

In most previous Zenith model direct-view sets, color is amplified by using a two or three-stage transistor amplification system. This year's models employ a single, 9-pin, RGB color amplifier IC to accomplish the same function. This metal oxide semiconductor (MOS) IC can take a supply of up to +250VDC on pin 6, and provide cathode outputs (VOC, pins 7 through 9) at a peak-to-peak level



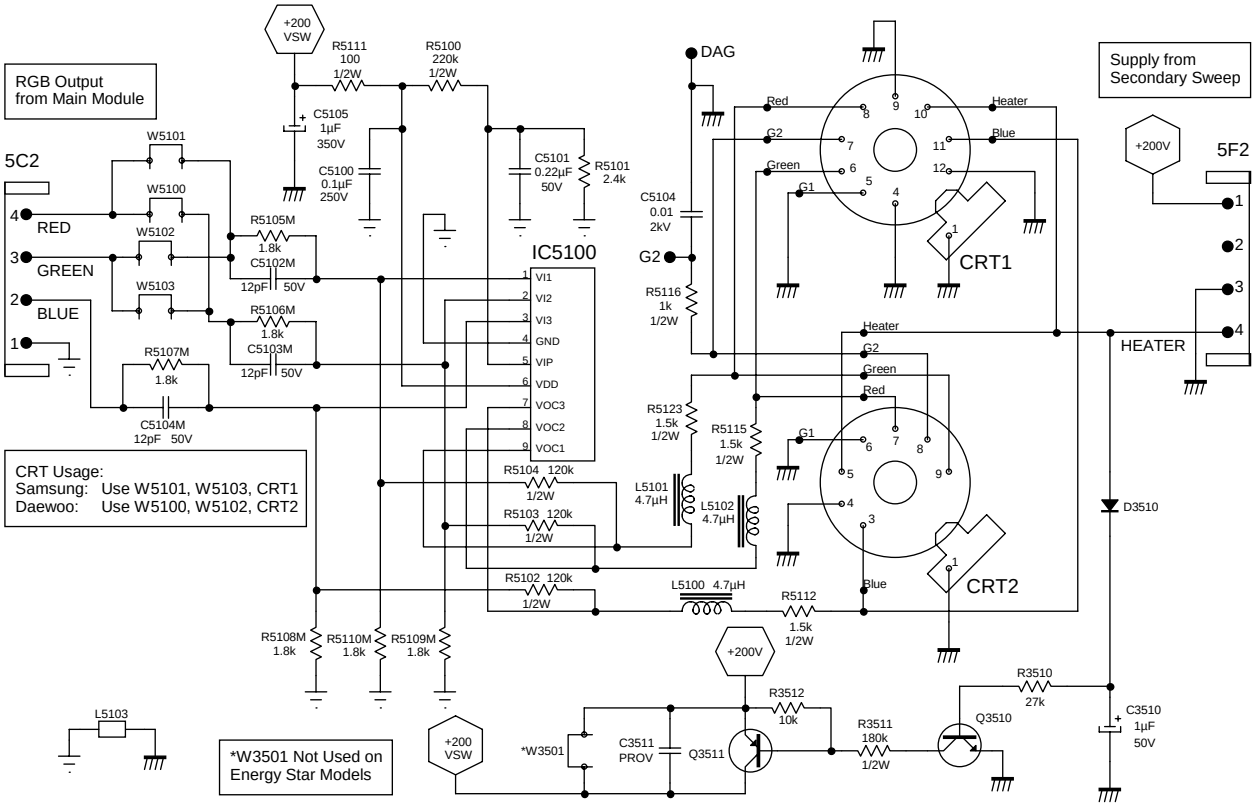
<<Figure 24, Triple Video Amplifier, IC5100; Diagram Used with Permission; Copyright, Philips Semiconductors, Inc., 2000, All Rights Reserved>>

within 10 volts of the supply depending on how the amplifier gain is set up. Other features include a 7.5MHz typical bandwith, internal thermal protection, and internal protection against peak currents in the output. The chip outputs have a 1600V/µs slew rate. The thermal protection will decrease the slew rate by 10% if the IC reaches 130°C (266°F) and by 30% if the IC reaches 145°C (293°F). In case of a high resistance flash, cathode outputs can sustain a maximum peak current of 5 Amps with a charge of 50µC (micro Coulombs). For low resistance flashes, the IC will allow peak currents of 10 Amps with a 100nC (nano Coulomb) charge. In either case, the supply voltage must be within ±15volts of a typical +195V_{DD} when the peak currents occur.

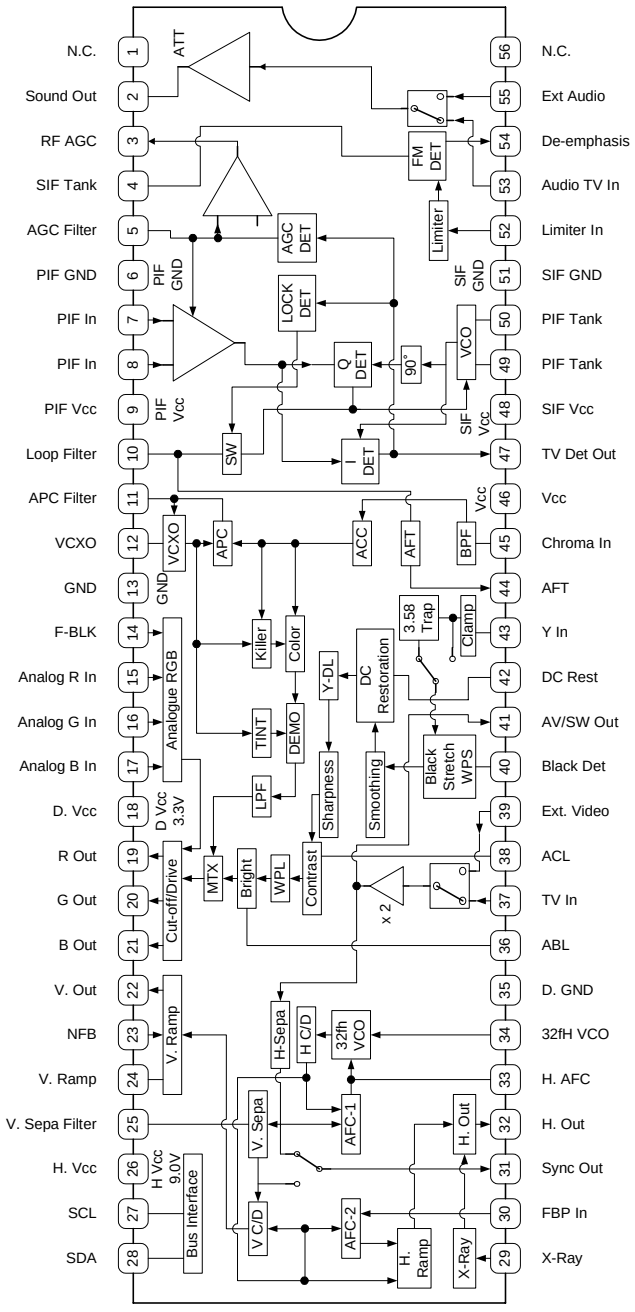
As this IC is used in the XO chassis, VDD is comes from the +200VSW. (R5111 is provisional.) The IC typically draws 9.25mA of current. Gain for each channel is established at almost 52 using 120k-ohm resistors that feed back a sample of the outputs to the inputs. Cathode outputs can be scoped at 140Vp-p. Pin 4 is the IC ground, while pin 5 is the non-inverting DC input for all three internal amplifiers. The voltage on this pin should be about +2.2 volts. Inverting input is supplied to pins 1 through 3 and can have a maximum level of 12 volts. However, in the XO chassis the color signal inputs will not normally exceed 4.5Vp-p and will be reduced somewhat by the voltage divider circuits on each input channel.

Notice that the CRT board can be set up for one of two possible CRT sockets. The CRT1 socket is used in sets that have a Samsung CRT. CRT2 is present for Orion/Daewoo tubes. The jumper array composed of W5100 through 5103 is available for reversing the red and green color inputs, depending on which tube is used.

Also be aware of the +200V switching circuit on the socket board. This is used in Energy Starâ models to switch off the +200VSW when not in use.



<<Figure 25, CRT Amplifier Board Circuit>>

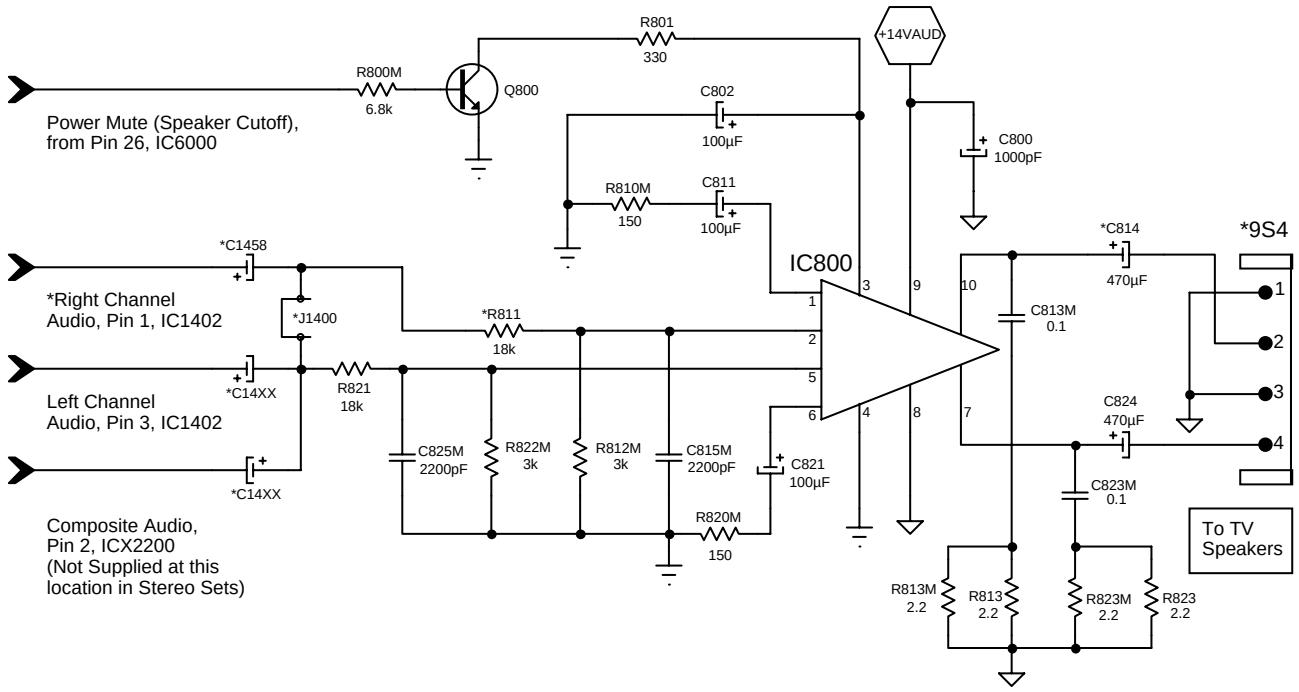


<<Figure 26, IF/Deflection/Video Processor, ICX2200; Diagram Used by Permission; Copyright, Toshiba America Electronic Components, Inc., 2000, All Rights Reserved>>

XO CIRCUIT DESCRIPTIONS

Audio Amplification

As is the case with the jackpack arrangement, there are a number of configurations for the audio circuitry. All make use of IC800, the two-channel, 3.5-watt audio amplifier that drives the television speakers. Although it was designed for stereo sound, this amplifier can just as easily intensify monophonic audio passed into one or both of its inputs. In fact, there are a couple models in the XO class of sets which have two speakers but do not have stereo audio. For either case, IC800 amplifies processed audio. In sets where there is only one speaker, a different speaker connection, 9M4 rather than 9S4, is used. In that situation, there is only one active output (pin 7). With two-speaker mono models, a jumper, J1400, links both left and right channel inputs together. In this manner, they both receive the composite audio signal coming from ICX2200. For both single and dual-speaker mono modes, ICX2200 controls the audio volume based on control input from the user.



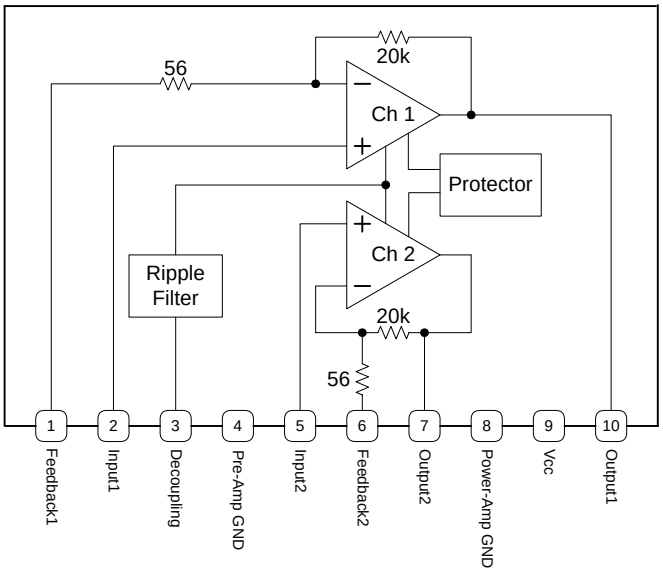
Refer to *Starred Items
on the Schematic

	Mono - 1 Speaker	Mono - 2 Speaker	Stereo
Right Channel Audio			Present
C1458			Present 1µF
J1400		Present	
C14XX	C1422 4.7 µF	C1422 4.7µF	C1460 1µF
R811		Present	Present
C814		Present	Present
9S4		Present	Present
9M4	Present		

<<Figure 27, Audio Amplifier Circuit>>

Normal gain of IC800 is 50dB. However, in order to drive the 8-ohm speakers at a maximum of 1.5 watts per channel, audio input to pins 2 and 5 must be limited. Therefore, the 490mVrms (max) input is voltage divided to produce a 50mVrms signal at pins 2 and 5. Also, the gain of the IC is limited to 42dB on each channel by the RC combination of C811 and R810M on pin 1 and C821 and

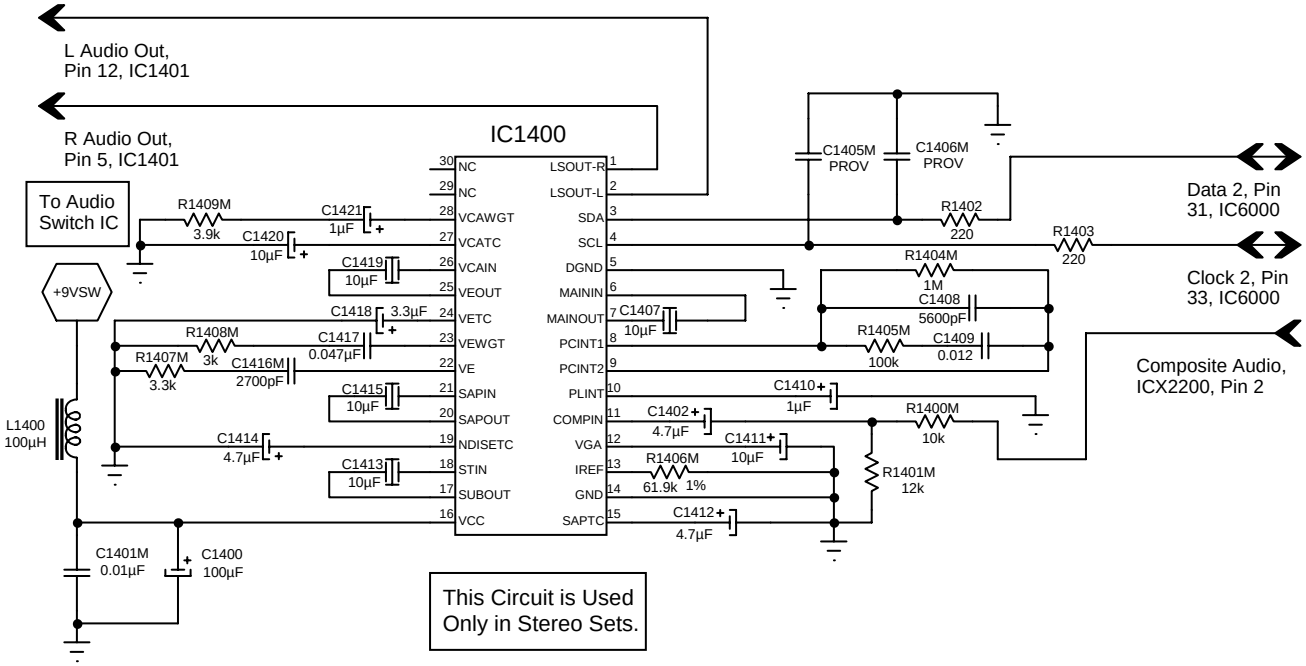
R820M on pin 6. The amplifier runs on +14VAud supplied to pin 9. Pin 4 and pin 8 provide ground and speaker ground respectively. Speaker mute is accomplished by grounding pin 3. This will happen when an operator selects speaker cutoff from the audio menu. The mute line also acts momentarily when the user switches IF channels so that popping and noise associated with channel switching is eliminated. A DC level from pin 26 of the micro switches Q800 to accomplish this. Cut frequency of the amplifier is determined by C825M (left channel and in mono sets) and C815M to be approximately 14kHz.



<<Figure 28,Audio Amplifier, IC800; Diagram Used with Permission; Copyright, Sanyo Semiconductor Corp., 2000, All Rights Reserved>>

Stereo Processing

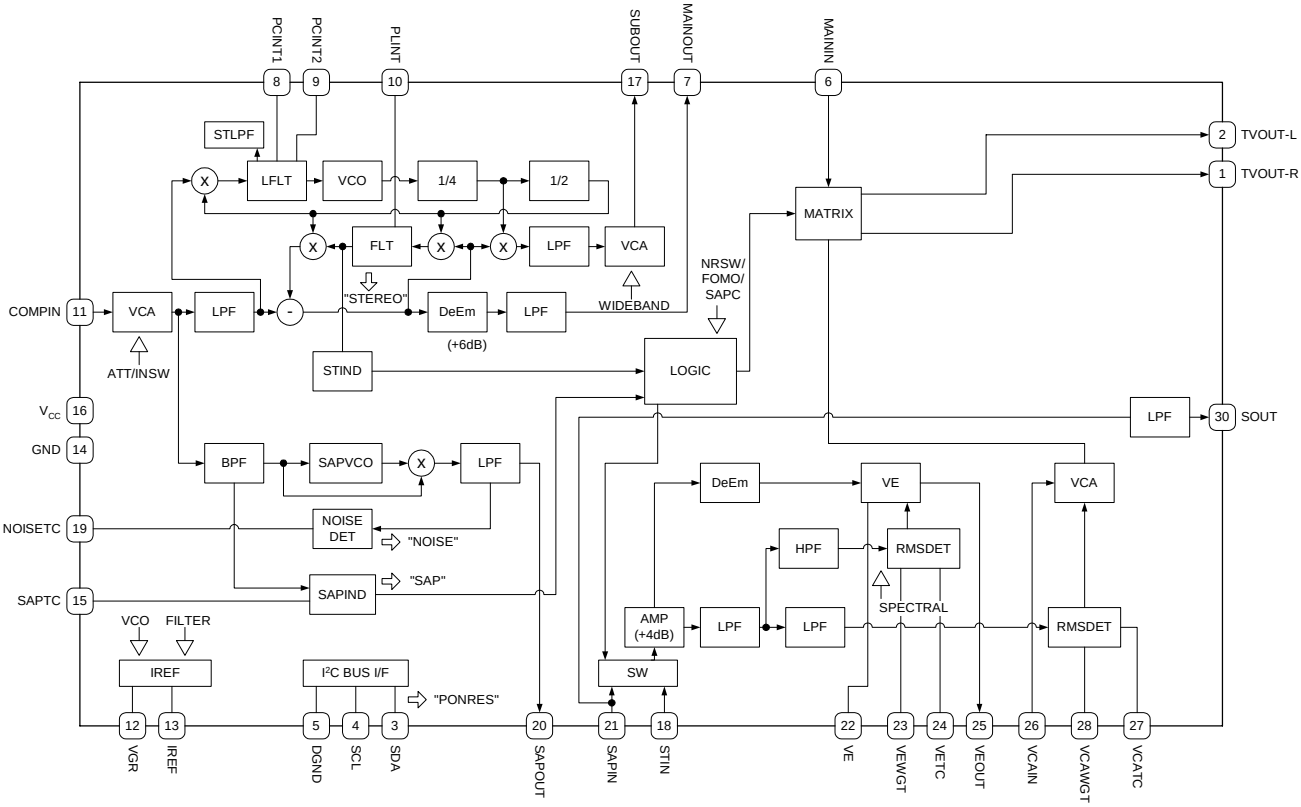
Often, Zenith television stereo receivers have a single IC that is capable of processing both internally generated audio IF and externally supplied stereo audio signals. The XO is an exception to this



<<Figure 29, Stereo Processing Circuit>>

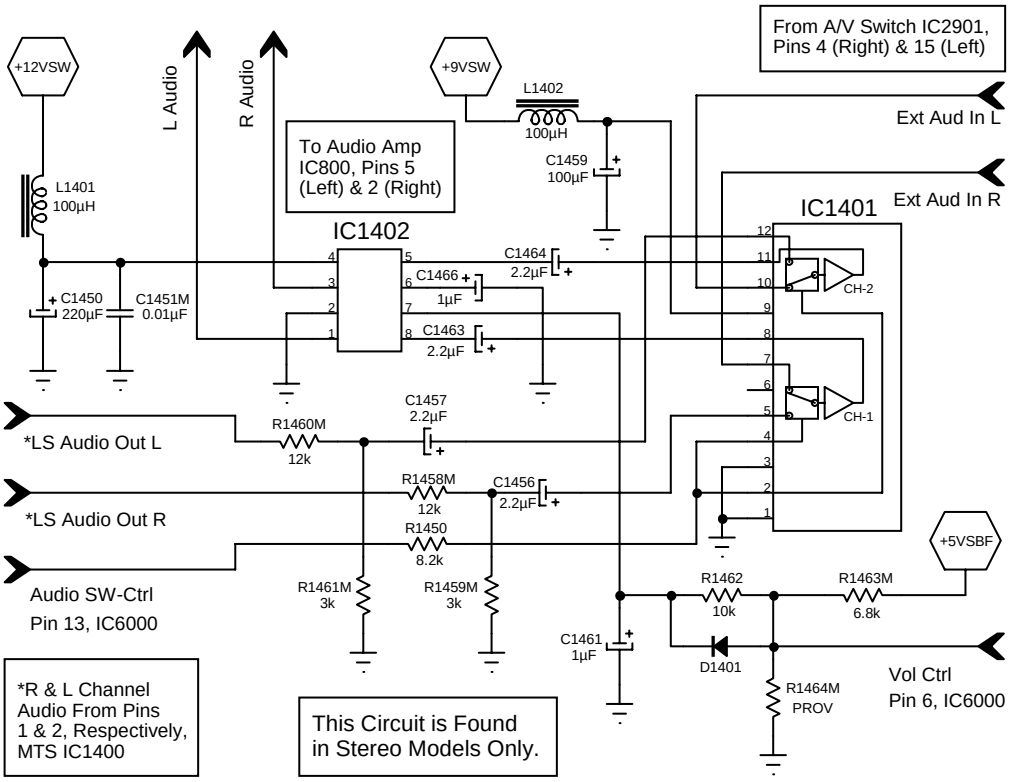
generality. It makes use of three ICs: IC1400 serves as a stereo audio processor for incoming composite audio from the jungle IC. IC1401 switches between internal and auxiliary audio on command from the microprocessor. Lastly, IC1402 serves as the DC volume control amplifier.

IC1400's composite audio input is at pin 11. This signal should be about 245mVrms. Typical audio output from ICX2200 is 490mVrms, so the signal must be voltage divided to be at an acceptable input level. (The exception to this is when ICX2200 controls volume, as it does in mono sets. In that case, signal should vary between 0 and 490mVrms.) The stereo processor chip itself takes command signals from the I^2C bus. It not only can separate composite signals into their respective channels, but it can also detect and demodulate SAP (second audio programming). A forced mono mode is also provided. Note though that these adjustments cannot apply to the external audio, as auxiliary sources do not pass through the stereo IC. Pin 16 of IC1400 is the V_{CC} of the stereo processor, and takes the +9VSW as its supply. Pin 14 provides the ground. Left and right audio outputs come from pins 2 and 1, respectively, at a level of 490mVrms.



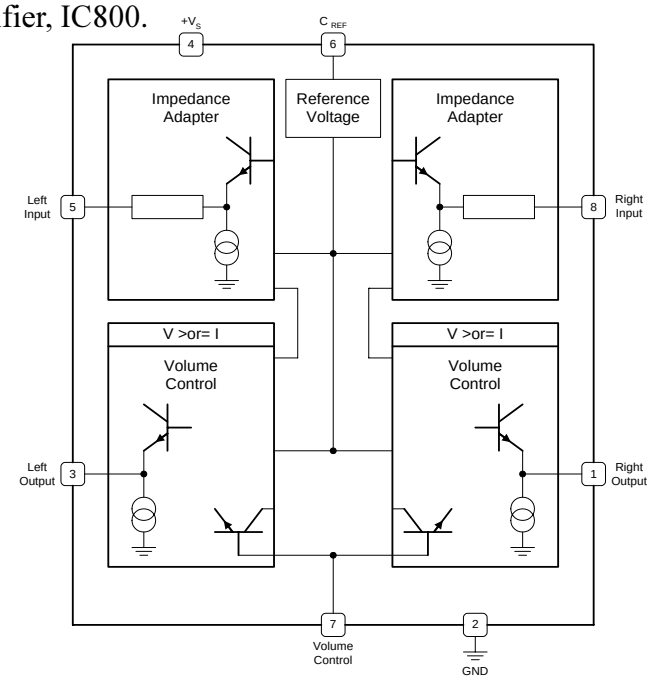
<<Figure 30, Stereo Processor, IC1400; Diagram Used by Permission; Copyright, Sony Electronics, Inc., 2000, All Rights Reserved>>

The internal/external audio switch package, IC1401, is also powered by the +9VSW source at pin 9. Pins 1 and 3 serve to ground the IC. Left channel audio from both internal and external sources feed correspondingly into pins 12 and 10. Right channel input passes in a similar manner to pins 5 and 7. Left and right outputs from this switch come from pins 11 and 8, respectively, and pass into pins 5 and 8 of the DC volume control, IC1402. The switch is controlled by a bi-state DC level from pin 13 of the microprocessor. This current source is tied to both pin 2 and pin 4 in order to control both channels simultaneously.



<<Figure 31, Audio Source Selection and Volume Control>>

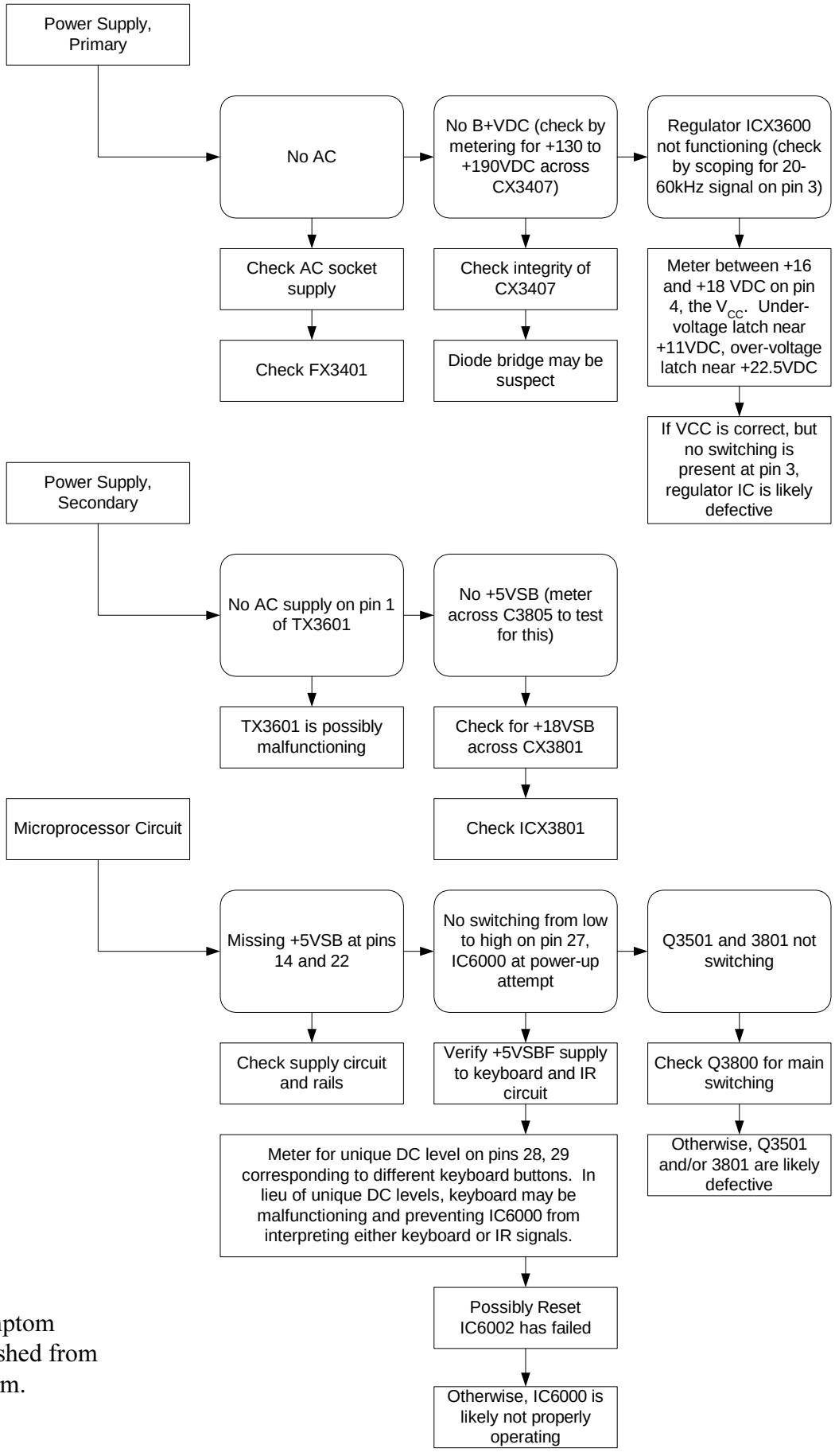
Finally, in the last stage of the audio development specifically utilizing the stereo circuitry, audio signal is intensified (or minimized) by IC1402. It does so according to the DC level on pin 7. This level is derived from a pulse-width modulated signal emanating from pin 6 of the microprocessor. C1461, R1462, and D1401 serve to smooth the signal into a voltage that will range between +0.5 and +5VDC. The DC volume IC is powered at pin 4 by the +12VSW source and yields a maximum gain of 12dB. Pin 2 serves as the IC's ground. Pin 1 and 3 output the adjusted left and right audio signals to the audio speaker amplifier, IC800.



<<Figure 32, DC Volume Control, IC1402; Diagram Used by Permission; Copyright, STMicroelectronics, Inc., 2000, All Rights Reserved>>

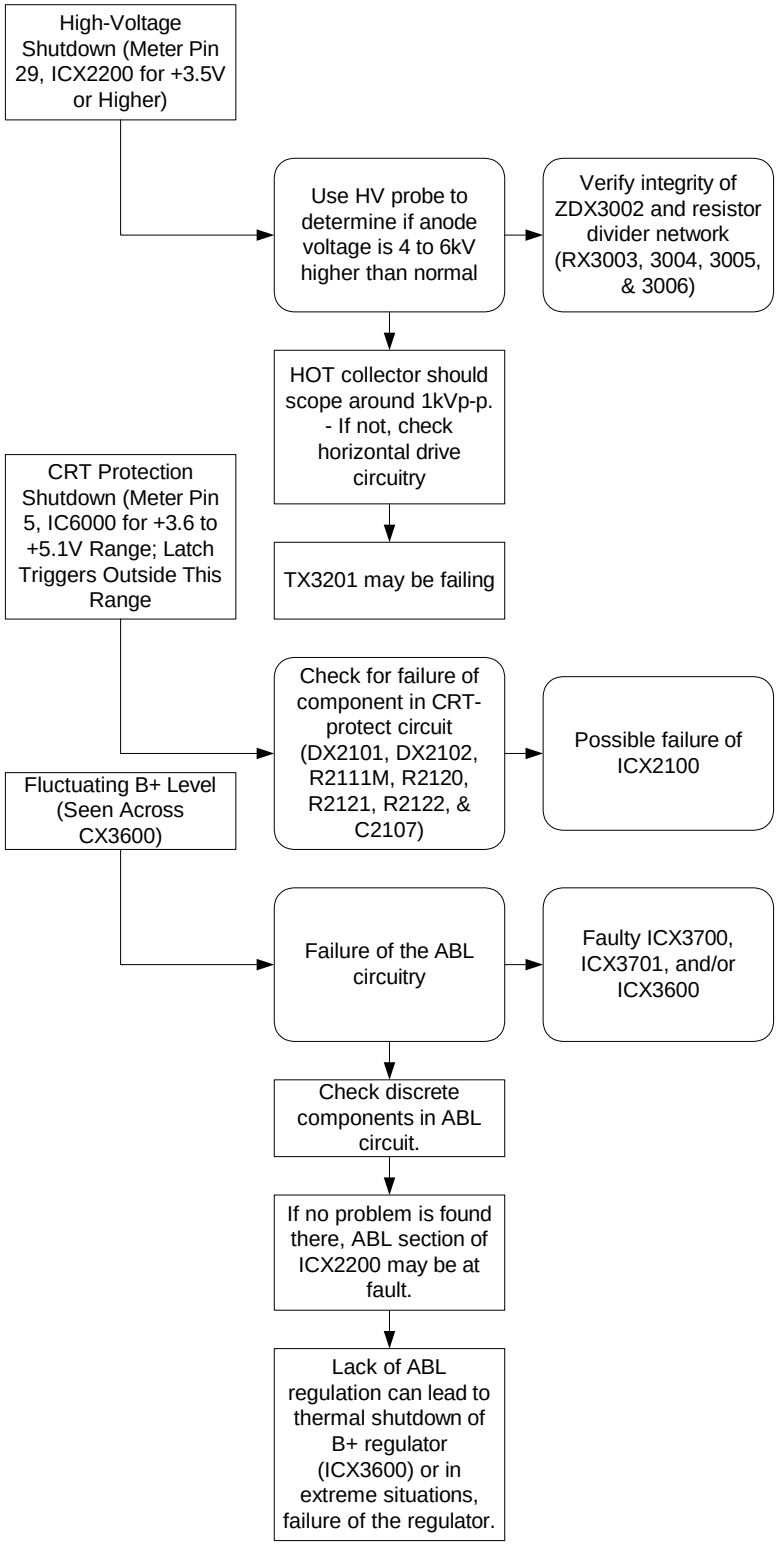
XO CIRCUIT TROUBLESHOOTING

1. No Power Up*



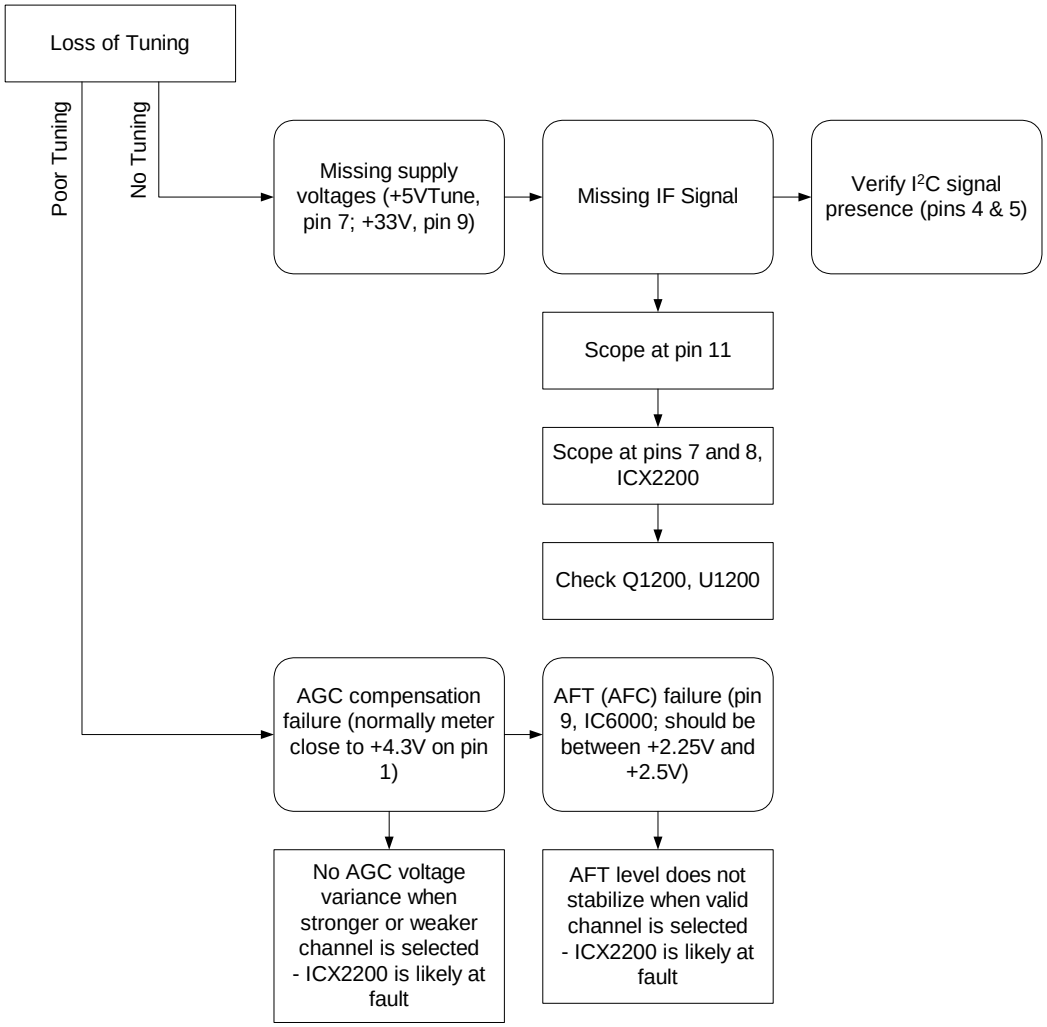
*No Power Up symptom should be distinguished from Shut-Down symptom.

2. Shut-down

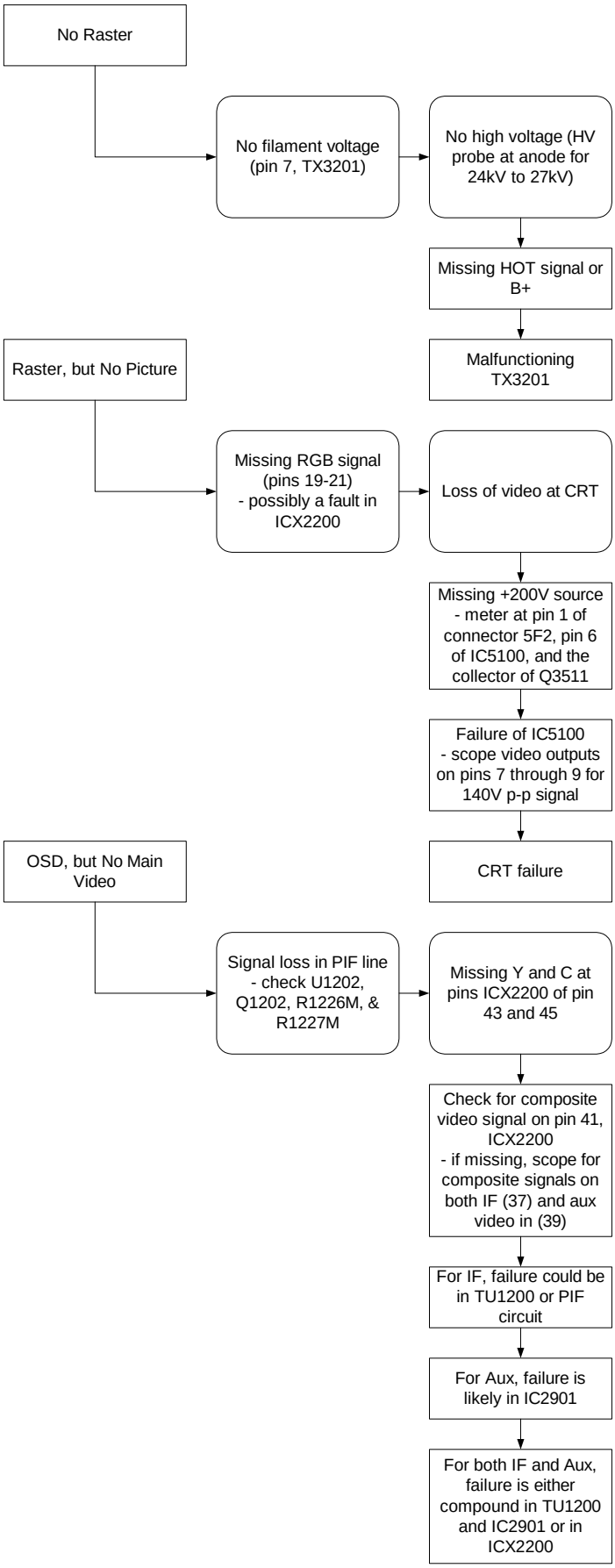

High-Voltage Shutdown (Meter Pin 29, ICX2200 for +3.5V or Higher)
Use HV probe to determine if anode voltage is 4 to 6kV higher than normal
Verify integrity of ZDX3002 and resistor divider network (RX3003, 3004, 3005, & 3006)
HOT collector should scope around 1kVp-p. - If not, check horizontal drive circuitry
TX3201 may be failing
CRT Protection Shutdown (Meter Pin 5, IC6000 for +3.6 to +5.1V Range; Latch Triggers Outside This Range
Check for failure of component in CRT-protect circuit (DX2101, DX2102, R2111M, R2120, R2121, R2122, & C2107)
Possible failure of ICX2100
Fluctuating B+ Level (Seen Across CX3600)
Failure of the ABL circuitry
Faulty ICX3700, ICX3701, and/or ICX3600
Check discrete components in ABL circuit.
If no problem is found there, ABL section of ICX2200 may be at fault.
Lack of ABL regulation can lead to thermal shutdown of B+ regulator (ICX3600) or in extreme situations, failure of the regulator.

XO CIRCUIT TROUBLESHOOTING

3. Poor or No Tuning

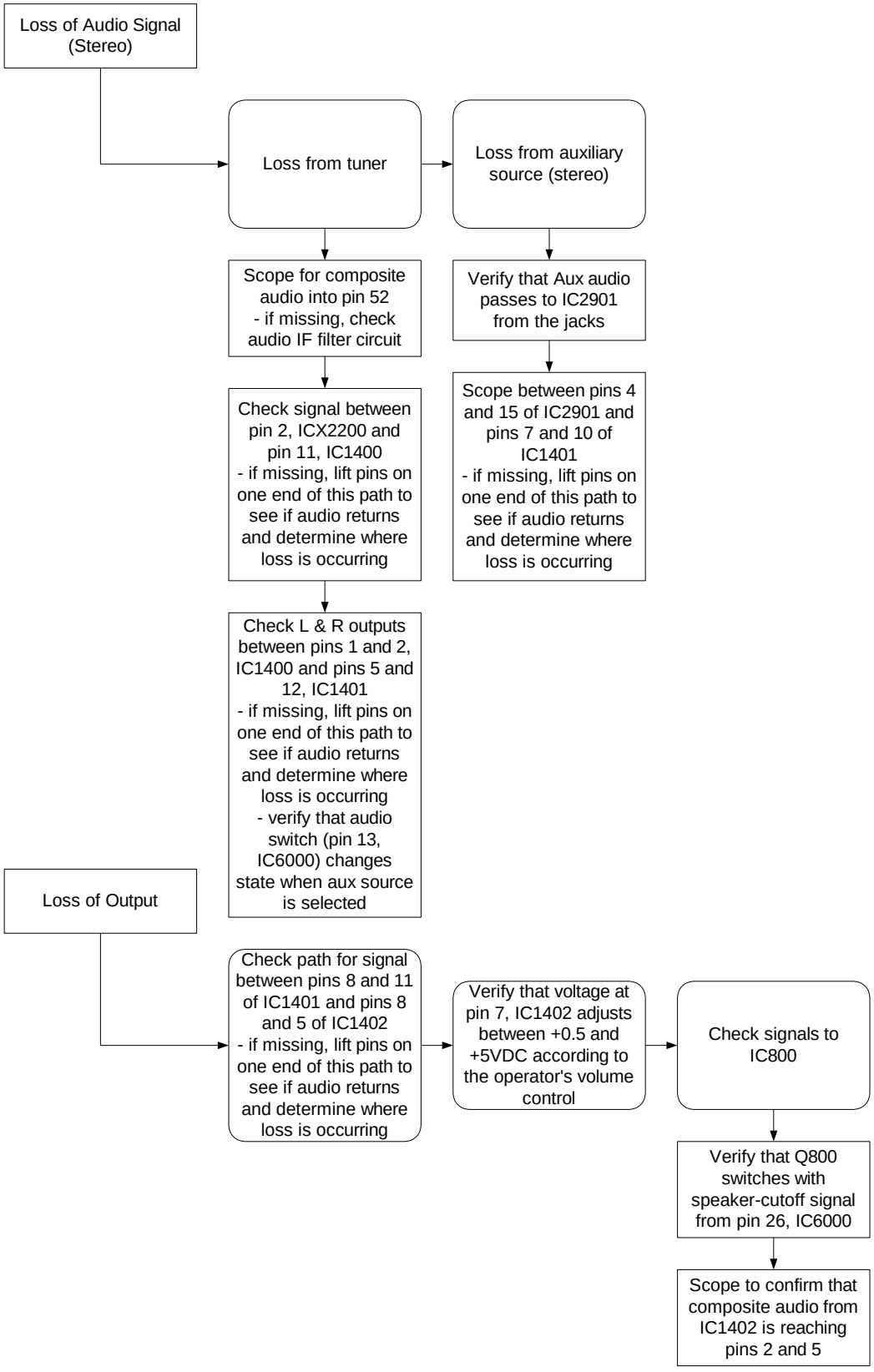


4. No Video


No Raster
No filament voltage (pin 7, TX3201)
No high voltage (HV probe at anode for 24kV to 27kV)
Missing HOT signal or B+
Malfunctioning TX3201
Raster, but No Picture
Missing RGB signal (pins 19-21) - possibly a fault in ICX2200
Loss of video at CRT
Missing +200V source - meter at pin 1 of connector 5F2, pin 6 of IC5100, and the collector of Q3511
Failure of IC5100 - scope video outputs on pins 7 through 9 for 140V p-p signal
CRT failure
OSD, but No Main Video
Signal loss in PIF line - check U1202, Q1202, R1226M, & R1227M
Missing Y and C at pins ICX2200 of pin 43 and 45
Check for composite video signal on pin 41, ICX2200 - if missing, scope for composite signals on both IF (37) and aux video in (39)
For IF, failure could be in TU1200 or PIF circuit
For Aux, failure is likely in IC2901
For both IF and Aux, failure is either compound in TU1200 and IC2901 or in ICX2200

XO CIRCUIT TROUBLESHOOTING

5. No Audio



Using the Service Menu

The factory service menu used on the XO chassis is quite similar to most others found in recent model, direct view Zenith televisions. Adjustments not intended for the user can be altered by the ASC using this menu.

A brief description of the menu items will be listed below. However, a number of characteristics about the factory menu should first be noted.

Entering the factory menu on the XO may be accomplished either by remote or by the front keyboard. To access the service menu by remote, press and hold the MENU key until the on-screen menu times out and is replaced by the channel/time display. Then release the MENU key and press in sequence the 9, 8, 7, and 6 keys followed by ENTER. Servicers that use the keyboard to enter the service menu will encounter either 6-button or 10-button keyboards. On 6-button keyboards, press and hold the MENU button until the channel/time display appears, just as it does using the remote method. The release the MENU button and press simultaneously the VOLUME UP and CHANNEL DOWN buttons. For the 10-button keyboard, use the MENU button just as with the 6-button keyboard, but then concurrently push the ADJUST RIGHT and CHANNEL UP buttons.

When using the remote, five keys allow control over the factory menu. The UP and DOWN arrows select which menu item to adjust. LEFT and RIGHT arrows decrease or increase the setting. Pressing ENTER will exit the menu. These are analogous to the SELECT, ADJUST LEFT/RIGHT, and ENTER buttons on the 10-button keyboard, and the CHANNEL UP/DOWN, VOLUME UP/DOWN, and MENU buttons on the 6-button keyboard.

Upon entering the service menu, the operator will notice one of two conditions. If item 00 of the menu, F MODE, is set to 0, the default, then the set is in normal mode. In this case, the operator will see three horizontal bars containing text information. The top bar will display from left to right IC6000's part number, the software revision, and the font revision. The middle bar has in the same order a factory menu item number, brief text description, and the item's setting. The bottom bar shows the date the software was installed on the chassis and a binary display showing the status of the test equipment communication. If the user presses the up or down arrow keys (or the selection button on the keyboard), he will cycle through items 00 through 06 while in normal mode. New television sets are shipped in this mode.

The second condition the servicer may encounter is a set in factory mode (item 00 F MODE set to 1). Servicers that order IC6000 as an individual part should be aware that it defaults to factory mode when it is installed. In the XO, this mode will allow the operator to view all 31 (00-30) of the service adjustments in the service menu. There is a simple way to identify a set that is in factory mode, apart from entering the factory menu: in the customer menus that do not use bar graph displays, a double-dash symbol will appear to indicate that factory mode is activated. Additionally, custom video preferences set in the user's menu are inhibited when F MODE is set to 1. This is done for factory setup purposes. Another possibility occurs when the receiver will not power down either by keyboard or remote. This may indicate that factory mode is on, but there is the chance that menu item 06, the AC ON setting, is turned on (set to 1), so this factor by itself is not conclusive

proof that the set is in factory mode.

There are three simple ways to turn off the factory mode. The first and most obvious is to enter the menu and set F MODE to 0. The second way is to run the automatic channel program feature in the user's menu. Lastly, the factory mode can be turned off by using the clock set option also found in the user's menu.

One more note: entering the factory menu will automatically deactivate any parental control that has been set. This is particularly useful if a user has forgotten the access code and wants full television service restored.

Service Menu Items

The following is a summary of items found in the factory service menu. Note that for toggled items, 0 represents the OFF setting while 1 is ON unless otherwise stated.

01 PICT PREF: Stores customer video menu adjustments including Contrast, Brightness, Color, and Tint in the non-volatile memory of the EEPROM. Setting is for either customer's adjustments (0) or preset adjustments (1).

02-03 VERT AND HORZ POS: Adjusts vertical and horizontal position of on-screen display.

04 FEATURE LEVEL: Used by the factory to determine available features for the set. Set to 0 for private label and 1 or 2 for Zenith. Note that this can only change the level if pins 3 and 4 of the 4G9 connector on the main module are shorted. Do so carefully as shorting the wrong pins can potentially damage the module. Also be sure to remove the jumper between these pins after the level has been changed.

05 BAND: Setting for tuner band. Usually determined by the microcontroller when the auto program is run.

0 – Broadcast fixed	4 – Broadcast afc
1 – CATV afc	5 – CATV fixed
2 – HRC afc	6 – HRC fixed
3 – ICC afc	7 – ICC fixed

06 AC ON: Causes the set to power up or down depending exclusively on the presence or absence of AC power.

07-08 BAND PASS & TRAP 3.58: Toggles the RF bandpass filter and the chroma trap on or off.

09-10 RF & AUX SUB BRT: Sets the adjustment range for customer screen brightness control while video utilizes the tuner and auxiliary sources respectively.

11 MAX CONTRAST: Sets adjustment range for customer contrast control.

12-13 VERT& HORZ SIZE: Vertical and horizontal screen size adjustments.

14-15 VERT & HORZ PHASE: Shifts the picture vertically and horizontally.

16 A LVL: Composite audio level adjustment for tuner source.

17 RF AGC: RF automatic gain control. To adjust, tune the weakest available channel and adjust for a picture free of interference.

18 HORZ AFC: Toggles between a fast or slow response for horizontal frequency control.

19 WHITE COMPRESS: Toggles white compression. For this item, 1 is disabled and 0 is enabled.

20 60 Hz SW: Determines the synchronization method used by the receiver. 0 is for normal mode. 1 is for H, V sync fixed.

21 PIF VCO: Adjusts the picture IF voltage controlled oscillator.

22-26 R,G, & B CUT; G & B GAIN: Color tracking adjustments.

27 6 KEYS: Notifies the microcontroller of which keyboard interpreter to use. 0 is for a 10-button keyboard while 1 is for the 6-button keyboard.

28 AUDIO ATT: Adjusts audio attenuation.

29-30 AUDIO SPECTRAL & WIDEBAND: Stereo separation adjustment for normal and low frequency.

XO SERVICE ADJUSTMENTS

XO MODEL FACTORY MENU SETTINGS							
ITEM	RANGE	C19A02D/F LGC20A02DM	C19A02D8/F8 LGC20A02DM8	C19A21D/F LGC20A20DM	C19A21D8/F8	LGC20A21DM	LDG20A21M8
00 F MODE	0-1	0	0	0	0	0	0
01 PICT PREF	0-1	1	1	1	1	1	1
02 V POS	0-24	13	13	13	13	13	13
03 H POS	0-20	6	6	6	6	6	6
04 LEVEL	0-1	1	1	1	1	1	1
05 BAND	0-7	0	0	0	0	0	0
06 AC ON	0-1	0	0	0	0	0	0
07 BAND PASS	0-1	1	1	1	1	1	1
08 3.58 TRAP	0-1	0	0	0	0	0	0
09 RF BRT	0-63	30	30	30	30	30	30
10 AUX BRT	0-63	30	30	30	30	30	30
11 MAX CON	0-63	63	63	63	63	63	63
12 VSIZE	0-254	154	102	154	102	154	102
13 HSIZE	0-254	154	102	154	102	154	102
14 V PHASE	0-7	0	2	0	2	0	2
15 H PHASE	0-31	18	18	18	18	18	18
16 A LVL	0-63	46	46	46	46	46	46
17 RF AGC	0-63	31	31	31	31	31	31
18 HORZ AFC	0-1	1	1	1	1	1	1
19 WHCOMP	0-1	1	1	1	1	1	1
20 60HZSW	0-2	2	2	2	2	2	2
21 PIF VCO	1-127	31	31	31	31	31	31
22 R CUT	0-254	0	0	0	0	0	0
23 G CUT	0-254	0	0	0	0	0	0
24 B CUT	0-254	0	0	0	0	0	0
25 G GAIN	0-254	90	90	90	90	90	90
26 B GAIN	0-254	90	90	90	90	90	90
27 6 KEYS	0-1	1	1	1	1	1	1
28 A ATT	0-15	9	9	9	9	9	9
29 A SPECTRAL	0-63	31	31	31	31	31	31
30 WBAND	0-63	31	31	31	31	31	31