Build this for your hifi system

An infrared remote control preamplifier

Sit back, relax and enjoy total remote control over your hifi system. With this Infrared Remote Control Preamplifier you can select the program while sitting in your armchair. It's the ultimate labour-saving device for laid-back hifi users.

by JOHN CLARKE

The all-new stereo component to be described here comprises a complete preamplifier in which all functions can be selected and varied by infrared remote control. The preamplifier is designed to complement an existing stereo amplifier or receiver, or it can be used as a control preamplifier in conjunction with a stereo power amplifier in a new system.

When used with existing equipment, it replaces the preamplifier section of an integrated amplifier or receiver and can be connected via the tape monitor loop of the existing unit.

As a preamplifier, the unit has all the expected user features. Inputs are provided for Phono, Tuner, Compact Disc and Auxiliary plus a Tape Monitor loop. These can be selected by pushbuttons on the preamplifier itself or via the remote control.

There are also pushbuttons on the preamplifier for volume, balance, bass and treble control functions and for loudness and mute selection. A Normal control switch returns all settings to a preset position. The bass and treble controls will be flat, while the balance will be centred and the volume fixed to a predetermined level. As before, you can either use the front panel switches on the preamplifier unit or the small remote hand held unit.

The preamplifier itself is housed in a metal case measuring 353 x 231 x 63mm (W x D x H). The remote control module has no less than 21 chrome-plated pushbuttons to select all the above functions and is housed in a case measuring 136 x 70 x 27mm.

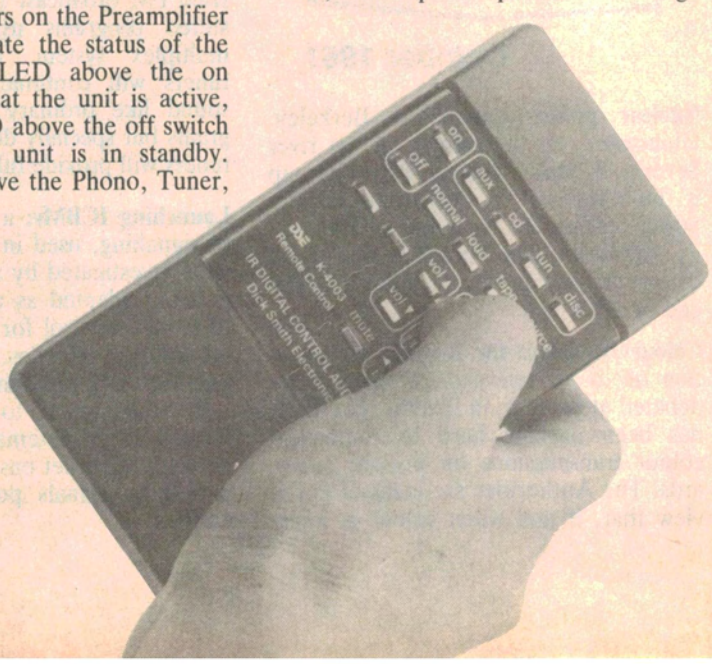
LED annunciators on the Preamplifier are used to indicate the status of the controls. A red LED above the on switch indicates that the unit is active, while a green LED above the off switch indicates that the unit is in standby. Orange LEDs above the Phono, Tuner, CD, Aux, Tape and Source switches indicate which source has been selected.

Similarly, an orange LED above the Loudness switch lights when the loudness function is activated.

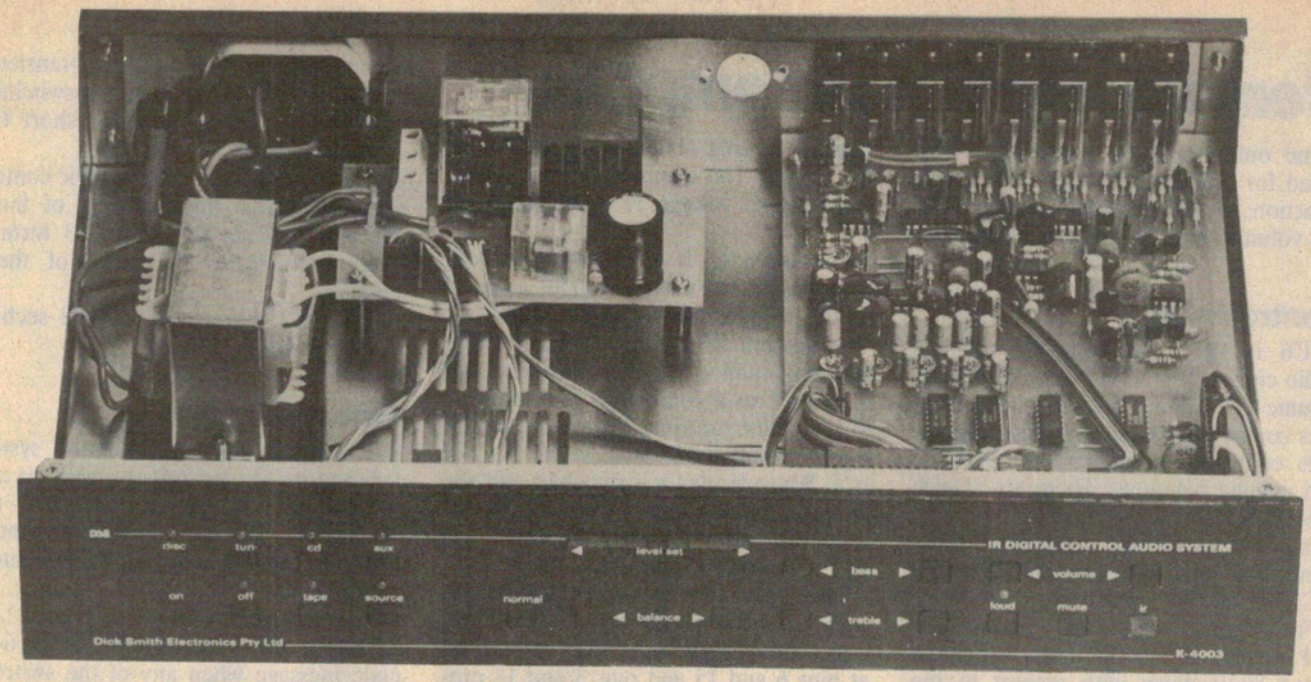
To indicate the status of the remaining functions, a "Level Set" LED bargraph is used. This comprises nine LEDs, eight of which are green and with the centre LED red.

Normally the display indicates the volume setting as a bargraph. When either the bass, treble, volume or balance up or down switches is pressed, the display automatically indicates the setting of that particular function, in the dot mode. After a setting is made for a particular function, the display automatically returns to bargraph volume indication.

The remaining feature of the front panel is the red window for the infrared diode, which picks up and detects sig-



Most of the front panel controls are duplicated on this compact hand-held controller.



nals from the control module.

At the rear of the preamplifier are eight pairs of RCA sockets for program source connection and a 3-pin mains socket for powering an accompanying amplifier.

Performance

The performance of the preamplifier is detailed in a specification panel accompanying this article. As the figures show, the circuit has a reasonable performance but its main claim to fame is user-convenience, not sheer fidelity.

Circuitry

Circuitry for the IR Remote Control Preamplifier can be broken into two sections. Firstly, there is the audio section which comprises the op amps, the signal switching and gain control circuitry. Secondly, there is the logic and display circuitry and the power supply.

Let us begin by taking a look at the audio circuit. This shows both left and right channels, except for the phono preamplifier which shows the right channel only. Components in the right channel start from one while those in the left channel start from 201, ie, the left-channel equivalent of R1 is R201.

The phono preamplifier is the tried and proven circuit featured in the Playmaster Twin Twenty-Five and other amplifiers published over the last decade or so in EA. It employs two transistors in a differential amplifier configuration, driving an op amp. The purpose of using transistors to drive the op amp is to improve the signal-to-noise ratio as well as the loop gain. This latter feature allows more negative feedback to be applied, thereby reducing distortion.

The 56kΩ resistor used in conjunction with Q1 sets the input impedance of the amplifier at close to 50kΩ while the 47pF capacitor and 1kΩ resistor act as an RF suppression network. These in conjunction with choke L1 help prevent RF breakthrough.

The series 1kΩ resistor and .001μF capacitor between the collectors of Q1 and Q2 ensure stability of the preamplifier at high frequencies.

Five components are used in the equalisation network (560kΩ, 56kΩ, .0012μF, .0056μF and 150pF), and give an RIAA response which is typically within ±1dB of the RIAA curve from 40Hz to 20kHz.

Additional roll-off below 30Hz is provided by the 10μF capacitor and 1kΩ resistor at the base of Q2.

The outputs from the phono preamplifier, tuner, CD and aux inputs are applied to IC2. This IC is a CMOS analog multiplexer/demultiplexer which is configured as a 2-pole 4-way switch. One pole of the switch is used for the left channel and the remaining pole is used for the right channel. Selection of one of the four inputs is determined by the code set on the SA and SB digital inputs at pins 10 and 9.

Note that the tuner, CD and aux inputs to IC2 are protected by voltage dividers. In each case, the 1kΩ series resistor protects the IC input from breakdown if a signal is applied when the unit is off. The 56kΩ resistors determine the input impedance.

Outputs at pin 3 of IC2 for the right channel and pin 13 for the left channel are buffered by high pass filters comprising IC3a and IC3b plus associated resistors and capacitors. These are Sallen and Key configuration with a Butterworth response. They provide a very smooth phase and frequency passband response which is important for audio. The low frequency roll off is at about 7Hz which decreases at 6dB/octave or 20dB/decade.

The filters also perform the function of buffering so that a high impedance load is presented to the IC2 CMOS switches. This minimises distortion since the linearity of these switches is very good under minimal loading.

IC4 is for tape monitor switching. It is a CMOS analog multiplexer/demultiplexer similar to IC2 but its configuration is a 3-pole 2-way switch. Logic inputs for control of the switch are at "a" (pin 11), "b" (pin 10) and "c" (pin 9).

Note that the "a" and "b" control inputs are tied together for stereo operation and are controlled at the ST input. The "c" switch pole is connected to IC6 and this has a separate digital control at SL.

When the "a" and "b" switches are in the Y position, the signal from IC3a and IC3b passes through to the pin 14 and 15 outputs. With the "a" and "b" switches set to the X position, the signals from the Tape In inputs are directed to the pin 14 and 15 outputs for tape monitoring.

IC5a and IC5b are unity-gain buffer amplifiers for the right and left outputs at pin 14 and pin 15 of IC4. The 330kΩ resistor at the non-inverting input to each op amp sets the input impedance.

Output from the gain stage is capactively coupled to IC6. Also at this point are the through Left and through Right

Remote control preamplifier

signal outputs. These outputs are provided for applications when only source selection switching is required without the volume, balance and tone controls.

Controller IC

IC6 is the main controller of the audio circuit. It is a DC-controlled tone, volume and balance control with a loudness compensation feature. Four DC inputs control the bass, treble, balance and volume functions. These are at pins 4, 9, 12 and 14.

In order to control the various functions, it is only necessary to adjust the DC level on the control pins.

For example, when the volume control input is at 0V, the audio volume is about 80dB down with respect to the volume setting at 5V, when the volume is at a maximum of 0dB. The remaining controls have a normal setting of about 2.5V such that the balance is centred and the bass and treble controls are flat.

Note that these inputs are filtered using a two-stage filter comprising a trimpot and 10μF capacitor plus a 47kΩ resistor and 1μF capacitor. The reason for this filtering will become apparent after discussing the control section of the circuit. The trimpots are for adjusting the DC voltage to a maximum of 5V.

For loudness, it is necessary to connect the loudness control input at pin 7 to the volume control input at pin 12. The amount of loudness compensation is a maximum at low volume levels and tapers off to a completely flat response at full volume settings. Loudness switching is accomplished with switch "c" of IC4. When loudness is switched out, the loudness input at pin 7 connects to the reference voltage output at pin 17 to give a flat audio response.

The bass and treble responses are each set by a single capacitor. In this case, the 0.39μF and .01μF capacitors at pins 6 and 15 and pins 3 and 18 provide maximum boost and cut of 15dB at 40Hz and 16kHz respectively.

The audio output from IC6 is capacitively coupled to gain stages IC7a and IC7b for the right and left channels respectively. The 100kΩ trimpots allow adjustment of output signal level to suit various power amplifier sensitivities.

From there, the audio signals are AC-coupled to the left and right channel output terminals. To prevent transients occurring at the output during switching of power, FETs Q3 and Q4 short the outputs to ground at this time.

The "on" signal from the logic control section controls the switching of these FETs. D1, R32, R33 and C33 form a delay network to the gates of these FETs.

Now let's discuss the control section of the circuit.

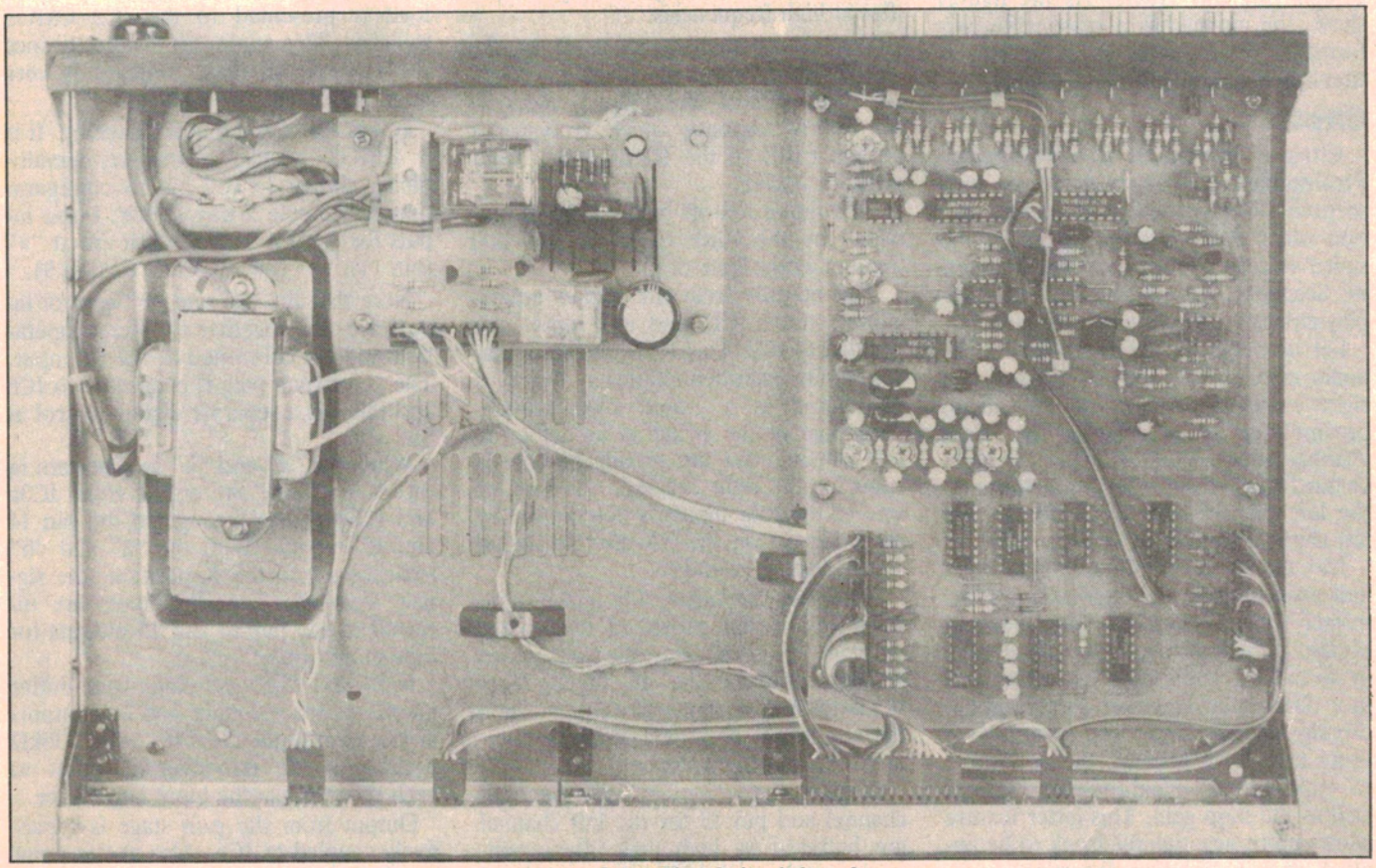
Remote control

The Infrared Remote Control system is based on the Siemens transmitter and receiver set. These were originally designed for TV and radio remote control but they are equally suited for audio control.

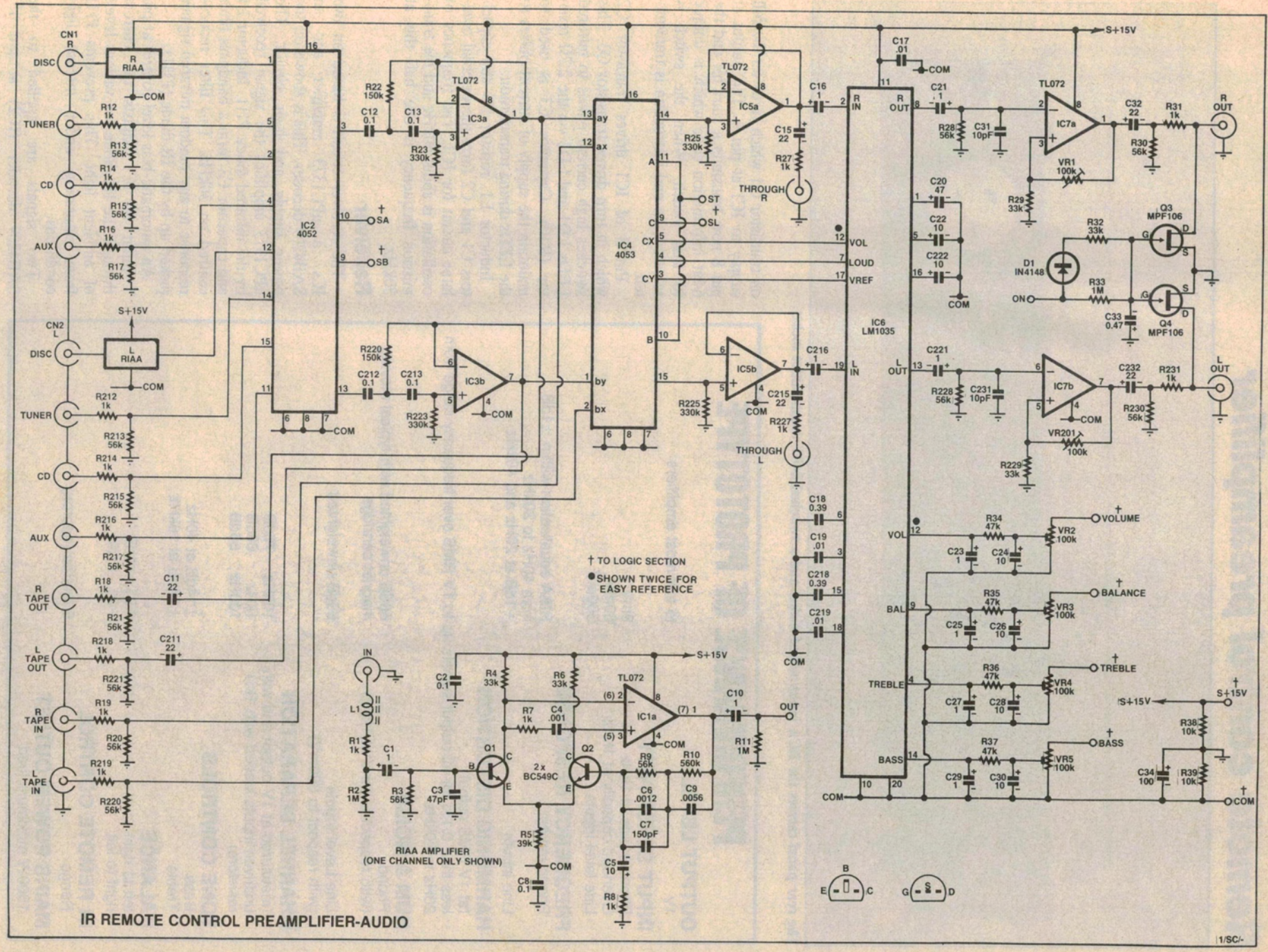
The transmitter circuit uses an SAB3210 IC which produces a 6-bit code message when any of the switches in the keyboard matrix is closed.

Normally only the key scanning function of the IC is operational to minimise the power drain from the IC. But when a switch connects a column to the row, the output at pin 7 goes high to switch

Right: the audio input circuitry is switched by CMOS switches IC2 and IC4 and fed to an LM1035 multi-function controller chip.



The project is easy to build, with all the parts mounted on three printed circuit boards.



IR REMOTE CONTROL PREAMPLIFIER-AUDIO

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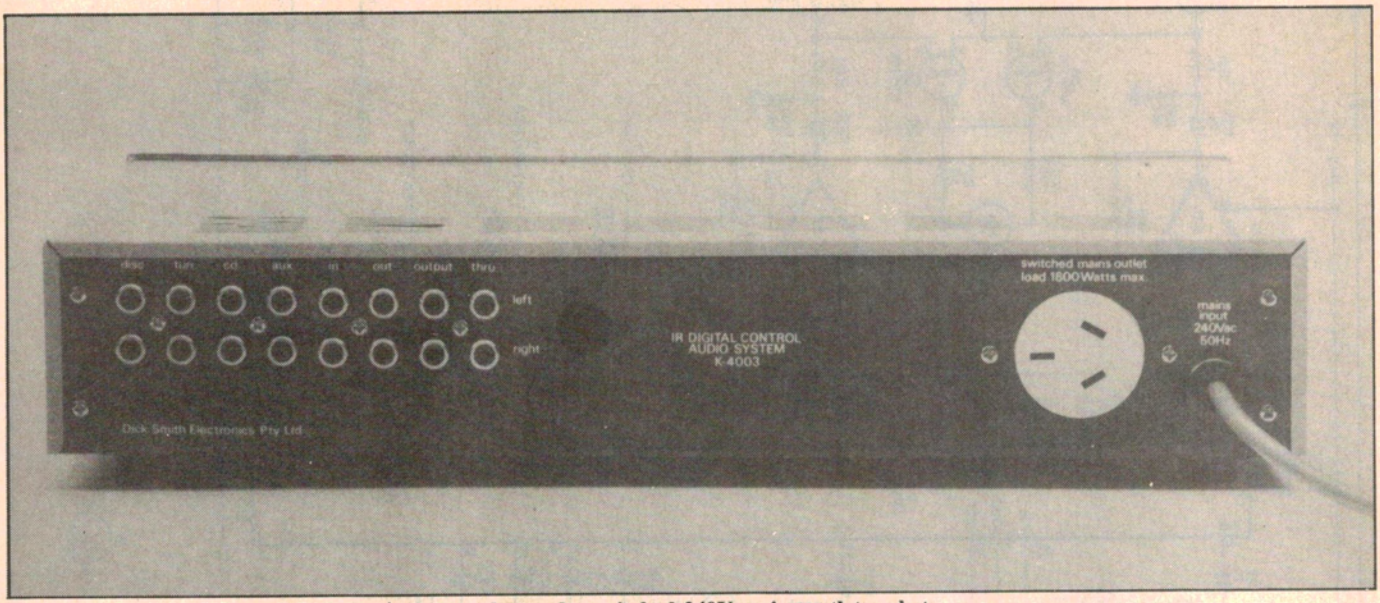


The rear panel carries the RCA input/output socket and a switched 240V mains outlet socket.

PERFORMANCE OF PROTOTYPE

OUTPUT LEVEL
1V — to suit most amplifiers

INPUT SENSITIVITY
Phono inputs at 1kHz — 8mV
Overload capacity at 1kHz — 50mV
Line level inputs — 560mV

FREQUENCY RESPONSE
Phono inputs — RIAA equalisation within ±1dB from 40Hz to 20kHz
Line inputs — −1dB at 20Hz and 40kHz

HARMONIC DISTORTION
(at 1V RMS output)
less than 0.1% for all output signals up to 1V RMS over frequency range from 20Hz to 20kHz

HUM & NOISE
Phono (with respect to 8mV at 1kHz) — 68dB unweighted with typical moving magnet cartridge
Line Level Inputs (with respect to 560mV) — 68dB unweighted

CHANNEL SEPARATION
(measured at 1V output and with undriven inputs loaded with 1kΩ resistors)
10kHz 70dB
1kHz 68dB
100Hz 55dB

TONE CONTROLS
Bass — ±14dB at 40Hz
Treble — ±14dB at 16kHz

BALANCE
left to right — −21, +1dB
right to left — −21, +1dB

IR REMOTE CONTROL
Range — 6 metres (approx)

MAINS POWER OUTLET
1800W maximum load

on transistor Q1 which turns on the full supply to IC1 at pin 6. The output at pin 8 now transmits a start bit and the 6-bit information code which is unique to that switch. When the switch is released, an end instruction is transmitted.

Pin 8 of IC1 drives transistor Q2 which in turn drives transistor Q3. This switches high current pulses to infrared LEDs LD1 and LD2 via the 2.7Ω resistor (R10). Capacitor C3 is used to maintain the supply of current pulses to the LEDs during transmission.

Inductor L1, resistor R6 and capacitors C1 and C2 form the external oscillator circuit for IC1. The frequency of oscillation is about 60kHz and the transmission frequency is one half this at 30kHz.

Receiver

The receiver circuit is based on two ICs: a uPC1373 amplifier and an SAB4209 decoder. This is shown on the power supply and logic circuit. The uPC1373 amplifies the signal received by the infrared diode PH1. Inductor L1 and capacitor C3 form a bandpass filter centred on 30kHz. This filter reduces response to any random infrared signals picked up by the IR diode (PH1).

An automatic bias level control at pin 7 input of IC1 adjusts the current through the IR diode for various levels of ambient light. This prevents PH1 from saturating under intense light conditions.

Two signals are applied to the SAB4209 decoder (IC2) at pin 15.

These are the output of amplifier IC1 and the output of a second SAB3210 transmitter (IC3) which serves the front panel controls on the Preamplifier.

IC3 is connected in a similar manner to the remote control transmitter. To save oscillator components, it takes its clock signal from IC2 (pin 2). The transmitter output is taken from the collector of Q2 which connects to the input of IC2. R5 is a pull-up resistor for the collector of Q2 and output of IC1.

Decoder

When the SAB4209 receiver (IC2) first receives a signal, it checks that the code is valid and then directs this information to the serial output ports at pins 18 and 16 (the DATA and DLEN signals). In addition, it also decodes the signal at the control outputs at pins 4, 5, 6 and 7 for addressing up to 16 functions.

Other outputs available from the SAB4209 are four analog value memories and on/off and program count outputs.

Audio control

The analog memory outputs at pins 10, 12, 13 and 14 of IC2 are used to drive the DC inputs of the LM1035 (IC6 on the audio circuit) for the volume, balance, treble and bass respectively. These outputs are duty-cycle modulated rectangular waves at a 1kHz frequency. In order to obtain a DC voltage from this waveform, the outputs are filtered at IC6. With an equal duty cycle, the filtered DC voltage is at half the supply and as the duty cycle varies so does the average filtered DC voltage.

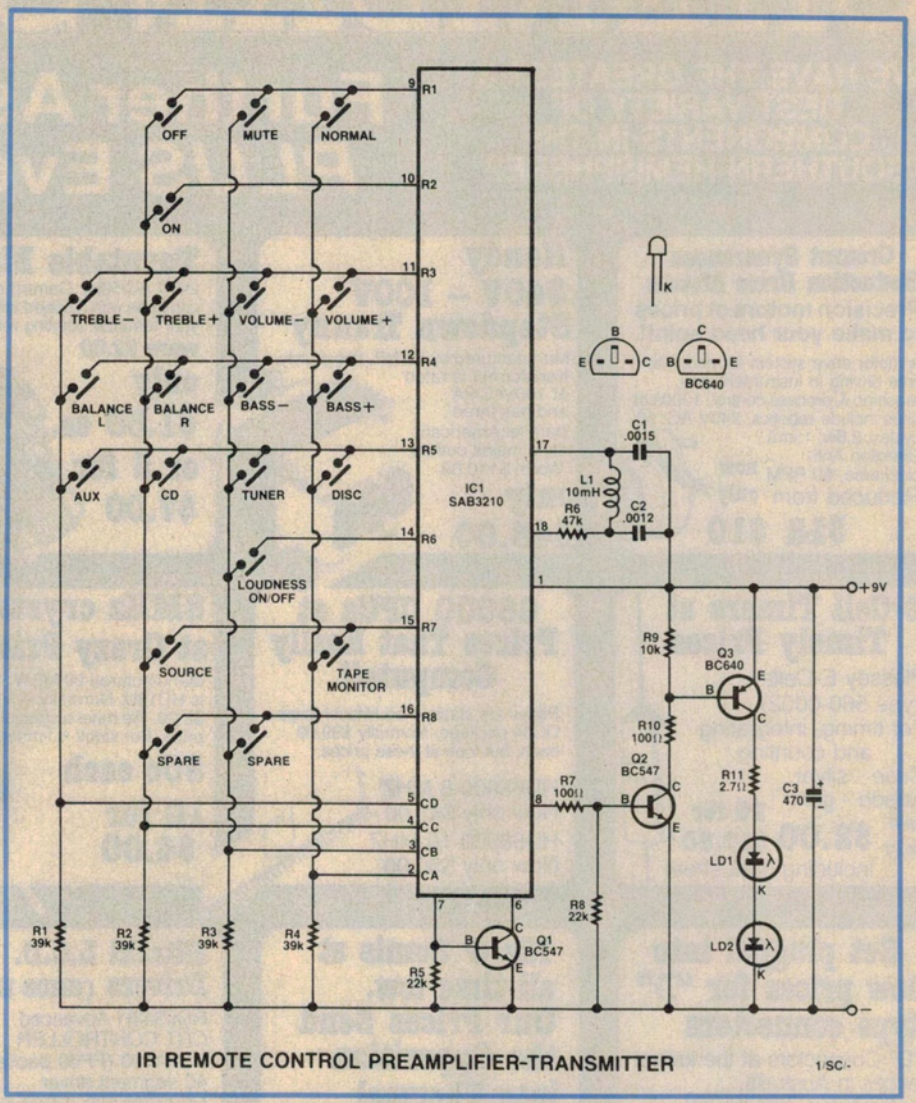
Whenever the Normal function is pressed or the unit is first powered up, the outputs are preset to give 1/3 the supply voltage for the volume and 1/2 the supply for the bass, treble and balance.

Logic

Several logic ICs are incorporated into the circuit to enable IC2 to control the source selection, loudness and tape monitor functions.

First, a dual 4-bit shift register (IC8) is used to convert the serial data from the DATA and DLEN outputs of IC2 into parallel data. IC8 is connected as an 8-bit shift register by tying the clock inputs at pins 1 and 9 together and the most significant bit of the first shift register to the data input of the second shift register. Data is sent to the clock input of IC8, while the DLEN signal is sent to the Data input of IC8.

The data output from IC2 is a 7-bit



The transmitter uses an SAB3210 IC to produce a 6-bit code when a key switch is pressed.

serial stream which includes a start bit plus 6-bit data. Once this data is clocked through IC8, the 7-bit code is present on the a, b, c, d, e and f outputs (pins 12, 13, 10, 3, 4 and 5). This extra logic is necessary since the SAB4209 only decodes the a, b, c, and d codes. These only provide 16 functions while 19 functions are required for this circuit.

IC10 is a BCD-to-decimal decoder. It decodes the most significant bits (the f, e, d and c outputs) from IC8. Outputs "4", "6", "5" and "9" are used for this circuit.

These first three outputs of IC10 are applied via AND gates to the clock inputs of flipflops IC12 and IC13. The AND gates are gated via the Program Change (PC) signal of IC2 via IC11b. The "b" output of IC2 is applied to the data inputs of the IC12a and IC13a flipflops. The "a" output of IC2 is applied to the data input of flipflop IC12b.

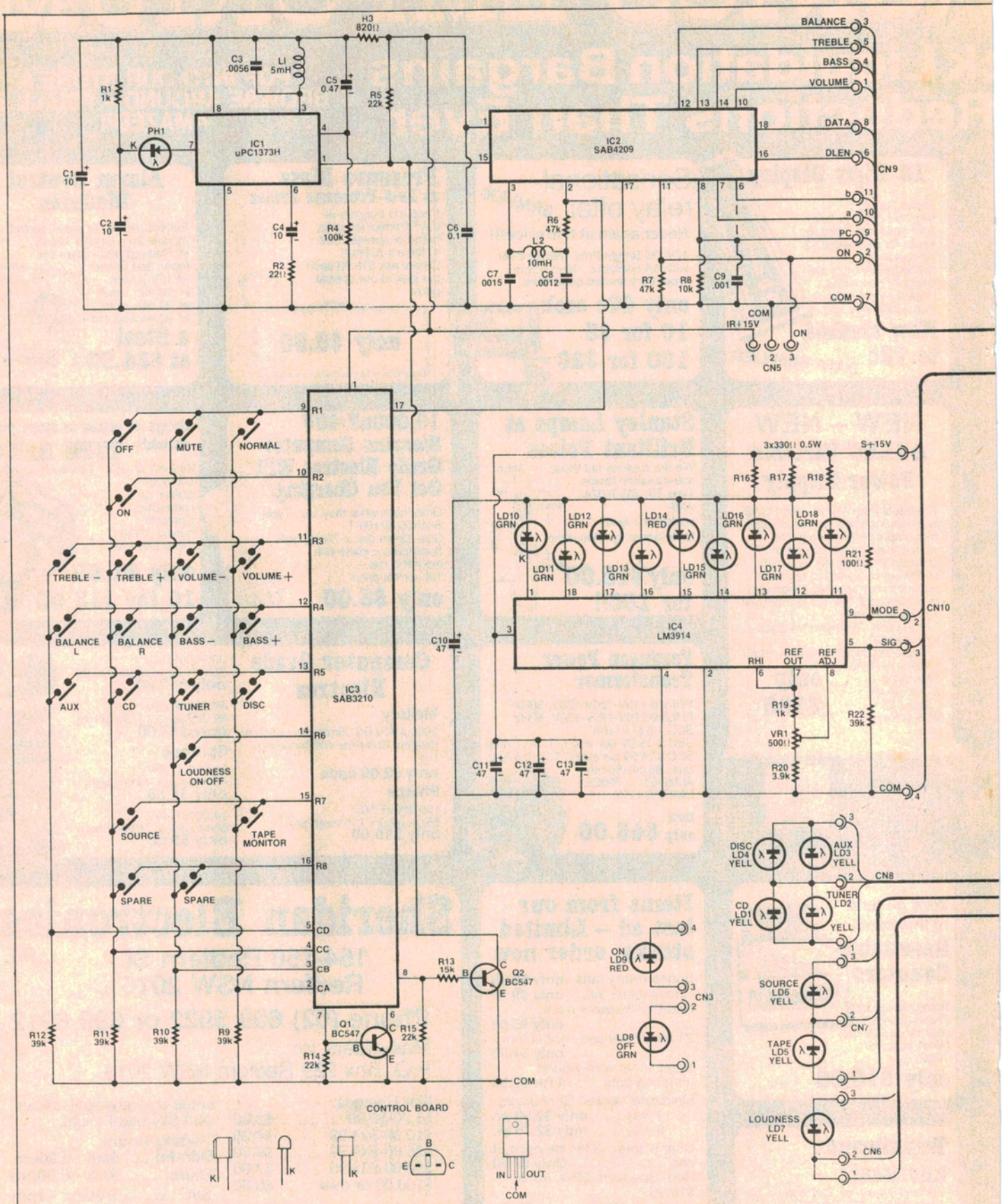
Whenever the PC signal changes, which occurs at each new pressing of the control panel or remote control switches, it clocks the data at the "a" and "b" outputs of IC2 to the Q outputs of IC12a and IC12b. Once clocked, the data at the Q outputs remains latched.

The Q outputs of IC12a and IC12b connect to the SA and SB control inputs of IC2 in the audio circuit. This selects the phono, tuner, CD and auxiliary input sources.

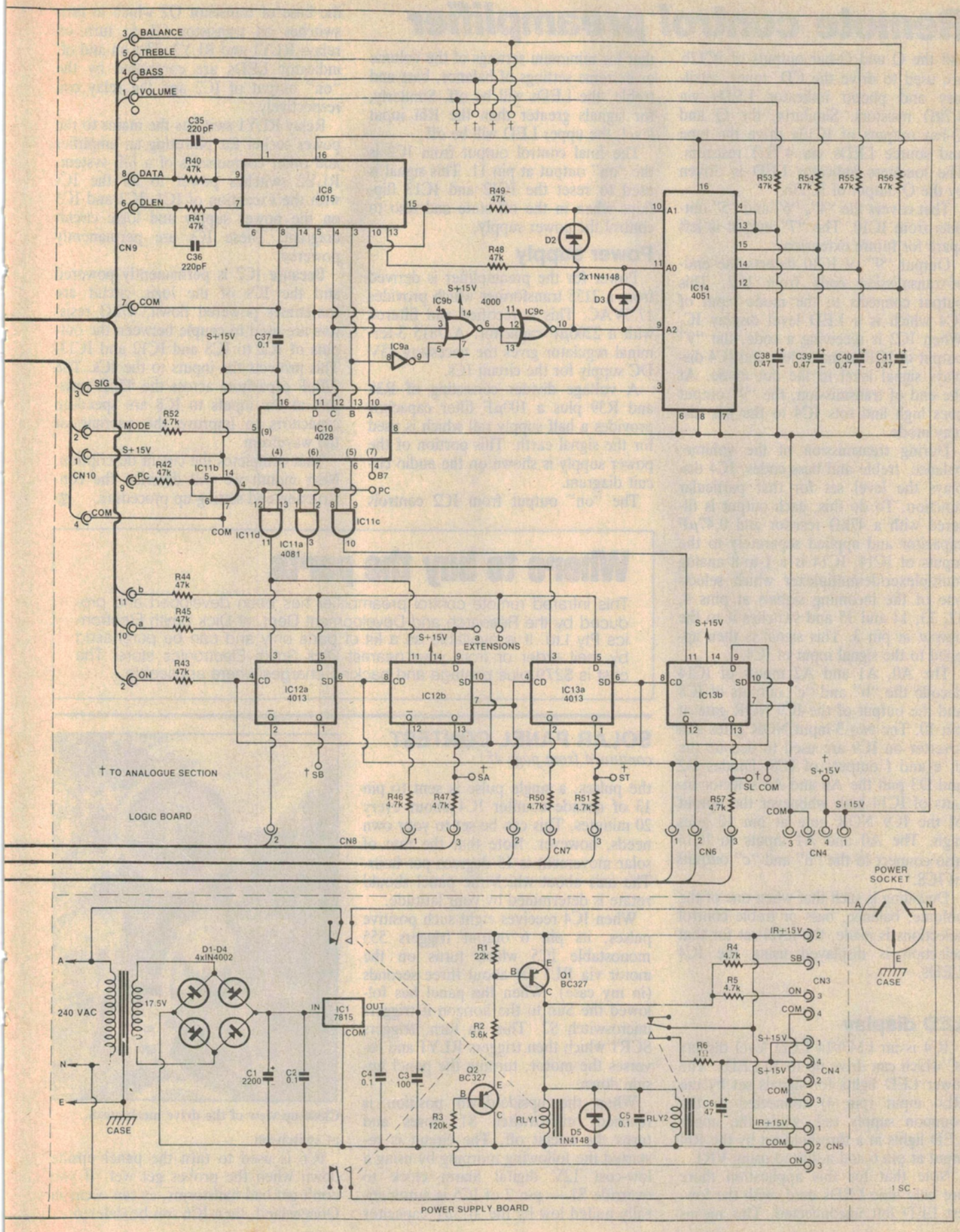
Similarly, the Q output of IC13a connects to the ST input of IC4 in the audio circuit. This controls selection of source or tape monitoring.

IC13b is connected as a flipflop with the Q-bar output connected to the data input. At each clock signal, the Q output changes state to control the SL input of IC4 on the audio circuit. This selects and deselects the loudness mode.

Note that the Q-bar output of IC12a



IR REMOTE CONTROL PREAMPLIFIER-POWER SUPPLY & LOGIC


BALANCE
TREBLE
BASS
VOLUME
DATA
DLEN
CN9
COM
SIG
MODE
S+15V
CN10
PC
COM
ON
C35 220pF
R40 47k
R41 47k
C36 220pF
IC8 4015
R49 47k
R48 47k
D2
2x1N4148
D3
IC14 4051
R53 47k
R54 47k
R55 47k
R56 47k
C38 0.47
C39 0.47
C40 0.47
C41 0.47
IC9b
IC9a
IC9c
4000
C37 0.1
R52 4.7k
IC10 4028
R42 47k
IC11b
B7
PC
COM
IC11d
IC11a 4081
IC11c
R44 47k
R45 47k
R43 47k
EXTENSIONS
IC12a 4013
IC12b
IC13a 4013
IC13b
† TO ANALOGUE SECTION
† SB
+ SA
+ ST
† SL COM
S+15V
COM
LOGIC BOARD
R46 4.7k
R47 4.7k
R50 4.7k
R51 4.7k
R57 4.7k
CN8
CN7
CN6
CN4
POWER SOCKET
A
N
E
CASE
D1-D4 4xIN4002
240 VAC
17.5V
IC1 7815
IN
OUT
COM
C1 2200
C2 0.1
C4 0.1
C3 100
R1 22k
Q1 BC327
R2 5.6k
Q2 BC327
R3 120k
RLY1
D5 1N4148
C5 0.1
RLY2
C6 47
R4 4.7k
R5 4.7k
R6 1k
IR+15V
SB
ON
COM
S+15V
CN3
CN4
CN5
POWER SUPPLY BOARD

Remote control preamplifier

and the Q and Q-bar outputs of IC12b are used to drive the CD, tuner, auxiliary and phono indicator LEDs via 4.7kΩ resistors. Similarly, the Q and Q-bar outputs of IC13a drive the tape and source LEDs via 4.7kΩ resistors. The loudness indicator LED is driven by the Q output of IC13b.

That covers the "4", "6" and "5" outputs from IC10. The "7" output is left spare for future extension.

Output "9" of IC10 detects the end-of-transmission code from IC2. This output connects to the mode input of IC4 which is a LED level display IC. When IC2 is receiving a code, the "9" output of IC10 remains low and IC4 displays signal level in the dot mode. At the end of transmission, the "9" output goes high and sets IC4 to the bar display mode.

During transmission of the volume, balance, treble and bass codes, IC4 displays the level set for that particular function. To do this, each output is filtered with a 47kΩ resistor and 0.47μF capacitor and applied separately to the inputs of IC14. IC14 is a 1-to-8 analog multiplexer/demultiplexer which selects one of the incoming signals at pins 4, 12, 13, 14 and 15 and switches it to the output at pin 3. This signal is then applied to the signal input of IC4.

The A0, A1 and A2 inputs of IC14 decode the "b" and "c" outputs of IC8 and the output of the IC9 NOR gate at pin 10. The two 3-input NOR gates and inverter on IC9 are used to decode the d, e and f outputs of IC8. Diodes D2 and D3 pull the A0 and A1 selector inputs of IC14 high whenever the output of the IC9 NOR gate at pin 10 goes high. The A0 and A1 inputs to IC14 also connect to the "b" and "c" outputs of IC8.

Decoding is such that when one of the volume, balance, bass or treble control selections is made, the level set for that selection is displayed using the IC4 LEDs.

LED display

IC4 is an LM3914 LED level display IC which can drive up to 10 LEDs. The lower LED lights for signals set by the RLo input (pin 4) connected to the common supply rail, while the upper LED lights at a threshold set by the Rhi input at pin 6 and adjusted using VR1.

Note that for this application there are only nine LEDs used, with the lowest LED left unconnected. This means that for minimum settings of the volume or extreme settings of balance, bass and treble, the LEDs will be off. Similarly, for signals greater than the Rhi input level, the upper LED will be off.

The final control output from IC2 is the "on" output at pin 11. This signal is used to reset the IC12 and IC13 flip-flops when in the off state and also to control the power supply.

Power supply

Power for the preamplifier is derived from a 2155 transformer which provides 17.5VAC. This is rectified and filtered with a 2200μF capacitor. A 7815 3-terminal regulator gives the necessary 15V DC supply for the circuit ICs.

A voltage divider consisting of R38 and R39 plus a 100μF filter capacitor provides a half supply rail which is used for the signal earth. This portion of the power supply is shown on the audio circuit diagram.

The "on" output from IC2 controls the base of transistor Q2 which in turn switches on transistor Q1 to turn on relays RLY1 and RLY2. The on and off indicator LEDs are controlled by the "on" output of IC2 and the relay coil respectively.

Relay RLY1 switches the mains to the power socket for powering an amplifier and other components of a hifi system. RLY2 switches power to all the ICs with the exception of IC1, IC2 and IC3 on the power supply and logic circuit diagram. These ICs are permanently powered.

Because IC2 is permanently powered and the ICs of the logic circuit are sometimes powered down, 47kΩ resistors are used to couple between the outputs of IC2 to IC8 and IC12 and IC13. This protects the inputs to the ICs. The 220pF capacitors across the 47kΩ resistors at the inputs to IC8 are speed-up capacitors to improve the risetime of the waveform.

That completes the circuit description. Next month we will describe the construction and setting up procedure.

Where to buy the parts

This infrared remote control preamplifier has been developed and produced by the Research and Development Dept. at Dick Smith Electronics Pty Ltd. It is available as a kit of parts only and can be purchased by mail order or from your nearest Dick Smith Electronics store. The cost is $279 plus postage and packing charges where applicable.

SOLAR PANEL CONTEST

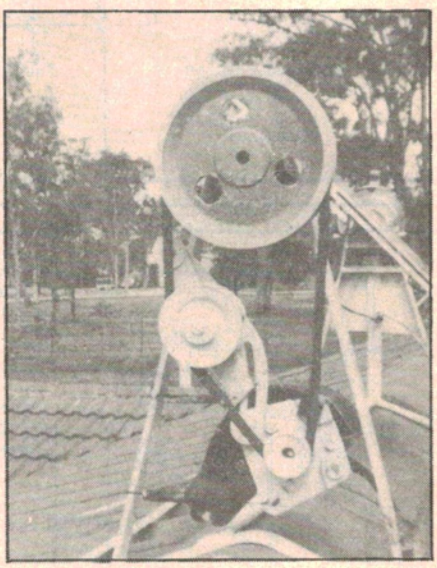
continued from page 45

the pulses, a single pulse is sent to pin 13 of decade counter IC4 about every 20 minutes. This can be set to your own needs, however. Note that the rate of solar movement is 15 degrees per hour. The axis about which the panel should rotate is determined by your latitude.

When IC4 receives eight such positive pulses, its pin 6 output triggers 555 monostable IC5 which turns on the motor via RL1 for about three seconds (in my case). When the panel has followed the Sun to the horizon it triggers microswitch S2. This, in turn, triggers SCR1 which then triggers RLY1 and reverses the motor, turning the panel upside down.

When the upside-down position is reached, microswitch S1 closes and turns the circuit off. The circuit is restarted the following morning by using a low-cost 12V digital alarm clock to override S1 — pin 2 of IC5 is automatically pulled low by the .015μF capacitor at switch on.

IC6 is used to turn the panel upside down when the probes get wet. If you don't get bad hailstorms, as can occur in Queensland, then IC6 can be deleted.



Close-up view of the drive mechanism.