ARCAM

DELTA 80 FM/AM TUNER SERVICE MANUAL

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Issue 3 05/07/91 serial nos. 001-

Arcam Drawing No. H04/0007

CONTENTS

CIRCUIT DESCRIPTION

FM front end

This consists of a voltage tuned RF amplifier, a voltage tuned local oscillator and a mixer plus output filter.
The RF amplifier amplifies the desired signal and because it is tuned it reduces unwanted signals - especially the image frequency at 10.7MHz above the LO frequency which would otherwise pass straight through the system. The local oscillator (LO) is tuned to 10.7MHz above the received frequency. The mixer provides the sum and difference frequencies of the RF and LO. The output filter selects the difference frequency (10.7MHz)
The entire front end is housed in a screened metal box and is pre-aligned except for the IF output filter, which has to be tuned to the same frequency as the ceramic filters.

FM IF stage

This is centred around a 3189 IC.

It comprises:

CF1 & CF2 ceramic filters
These filters are tuned to 10.76 MHz and have a band width of 280kHz. They provide the main selectivity of the tuner, blocking adjacent channels and interference. The filters are colour coded to indicate their precise centre frequency. For the Delta 80 tuner they must both be WHITE (i.e. 10.76 MHz) otherwise the digital display will read incorrectly once the tuner is set up. If CF1 and CF2 are of different colours then the bandwidth will be reduced, degrading the distortion and stereo separation performance. R10 provides the correct terminating impedance for the ceramic filter CF2.

The signal enters the 3189 on pin 1, is amplified internally and detected by a quadrature detector. This works as follows: the signal is split two ways internally. One half comes out of pin 8, is phase shifted by 90 degrees by L1 and L9 and re-enters on pin 9. It is compared with the original signal in a phase sensitive detector and any frequency variations are converted into a voltage output, available as the audio output on pin 6. Thus, the frequency modulation present on the 10.7MHz signal appears as the stereo composite signal on pin 6. L1 adjusts the 90 degree phase shift.
Its internal capacitor system is the frequency is adjusted to be the same as the ceramic filters CF1 & CF2.

R13 sets the Q of the system - ie the frequency range over which the phase shift is 90 degrees. Pin 10 is a reference voltage, decoupled by C15. R19 sets the amplitude of the audio output on pin 6.

In addition to amplifying and detecting the 10.7 MHz signal the 3189 provides the following functions:

(i) AFC automatic frequency control. The voltage on pin 7 varies above and below the reference voltage on pin 10 as the frequency into the 3189 varies below and above 10.7 MHz. This is used to adjust the frequency of the front end when the AFC button is pressed in. RV1 & R20 are used to adjust the voltage on pin 7 to be exactly the same as that on pin 10 when the precisely on tune. C18 decouples pin 7. The AFC voltage is also used in the "on tune" indicator.

(ii) Deviation mute. When the input frequency is too far off 10.7MHz the 3189 automatically mutes the output. With R16 = 2k7 this occurs when the signal is approx 100kHz off tune.

(iii) Interstation mute. When there is no signal going into the 3189 the audio output is muted provided pin 5 is connected to pin 12 (via R17,18). The mute switch (which is combined with the mono switch in the Delta) breaks this connection so that the tuner can detect very weak stations if required. C16 and C17 decouple pin 12.

(iv) On channel indicator. When the tuner is "on channel" (- ie within +/-100kHz) pin 12 goes low in voltage. This is used in the Delta as part of the "on tune" indicator.

(v) AGC automatic gain control. The voltage on pin 15 switches from high to low as the signal input to the 3189 increases. The precise point at which it switches is set by the voltage on pin 16 which is connected to the signal strength output on pin 13 (via R11 & R12).
A suitable fraction of the voltage on pin 15 is used to control the gain of the RF amplifier in the front end, to prevent subsequent stages from being overloaded by large aerial signals. The remaining components C8, C9, C10, C11, C12, C13, C14 & R21 provide decoupling for various parts of the 3189 - essential for the best performance and stability of the circuit.

The audio output of the 3189 is filtered by RV2, R3, R23-27, C19, 20, 22 and Q2 which form the "birdie" filter. They prevent any frequencies above 53kHz (ie adjacent channels leaking through) from proceeding to the stereo decoder where they would be decoded and appear as "birdies" on the audio output of the Delta. RV2 tweaks the filter at high frequencies which contain the stereo information and is adjusted for maximum separation between L and R channels. C23 isolates the DC on pin 6.

Note: The 3189 and the front end are only powered up when the Delta is switched to the FM band.

AM section

The AM section is based on a TDA 1072A IC. The aerial is connected to a suitable tapping point on either L3 or L4 (MW or LW) and the signal is tuned by L3 or L4 in combination with one of the varicap diodes contained in D1. This removes the image frequency. The signal is fed to pins 14 & 15 on the TDA 1072A via a secondary winding on L3 or L4. It is amplified in the 1072A and mixed with a local oscillator whose frequency is determined by L5, varicap D1, tracking capacitor C27 and the trimmer capacitors CV3 or CV4 (for MW or LW).

D29, Q1 and their associated components provide temperature compensation for the local oscillator to prevent the frequency display drifting. The IF frequency at 455 kHz comes out of the mixer on pin 1 and is filtered by the ceramic filter CF3. This has an internal tuned circuit to provide additional filtering and to attenuate any spurious responses of the ceramic elements.

The filtered signal re-enters the 1072A on pins 3 and 4 where it is detected and appears as an audio signal on pin 6. C34 decouples pin 4, C37 & C38 decouple the power supply and C35 decouples the LO. R36 limits the amplitude of the LO and helps ensure that the oscillator does not oscillate at the self resonant frequency of L5.

R29 provides a dc path for the bias on D1, C26 is an ac short for the RF on D1 and R28 ensures that the diode is not shorted out by the tuning pot.

C39 removes any 455 kHz from the audio output . R38-43, C40-42 and Q5 are a filter to suppress the adjacent channels which would otherwise be heard as whistles. C42 filters out the low bass frequencies and provides DC isolation. R42 & R43 attenuate the audio output so that it sounds at the same volume on MW and LW as it does on FM.

Note: The 1072A is only powered up when the tuner is in MW or LW mode.

Stereo decoder

The audio signal from either the AM section or FM section is fed to the input of the TCA 4500A stereo decoder. The stereo decoder works by detecting the 19 kHz pilot tone in the input signal and locking an internal VCO to this pilot tone. The VCO is used to generate a 38 kHz signal which is now locked to the 38 kHz in the transmitter. This is used to switch the composite signal between L and R outputs - in phase with the switching between L & R in the transmitter - so separation of L and R occurs. In fact the 4500 has a nominal VCO frequency of 228 kHz (set by RV3, R60 and C69,monitoring the 19 kHz on pin 11) which is used to suppress birdies and ARI (Auto Radio Information) as well as to generate the 38 kHz. The VCO can be stopped by taking pin 15 high via R59. This can be done by the mono switch and is automatically done when the FM switch is out. C66,C67 and R57 form a loop filter for the phase locked loop. C68 sets the time constant for the stereo switch level detector. Pin 7 indicates when the VCO is locked to the pilot tone and is used to drive LED D8, the stereo beacon (via R58 to limit current).

C65 provides the correct amount of phase shift for the regenerated 38 kHz to bring it in phase with the 38 kHz in the transmitter.

There are two identical networks on the L and R outputs which work as follows: R62 determines the voltage gain of the decoder. R62 and C71 set the de-emphasis time constant to 50us C71a is used for the alternative time constant of 75us. R61 sets the dc level on pin 4. R65,68,70, C73,76,79, L6 and Q9 form a 19 kHz notch filter to remove the residual pilot tone from the output. This stage is decoupled by C102. C75 blocks DC from the emmitter of Q9. R69 ensures the output does not float high. R67 sets the output impedance and provides a suitable impedance for the mute transistor Q8.

Muting

Q8 and Q11 mute the audio output whenever the tuner is turned on or off, switched between AM and FM or when a preset button is pressed.
R84 and C85 set the length of the mute and are triggered by Q12. Waveband muting is controlled by R83, D11 and part of the FM switch. The preset tuning mute is provided by IC19a,b, R75-82, C81-83 and D9,10. These components detect any changes in the tuning voltage, caused by changing the preset and amplify it sufficiently to switch on Q12. The off-mute circuit R87-90, C84, D13,14 and IC19c monitor the supply voltage, switching on Q12 when it drops below the threshold set by D13. IC19c is an LM324 device which is able to operate at very low voltages. Hence it is able to switch on Q12 even as the supply voltage drops. The on-mute is set directly by the operation of R84 and C85 at initial switch-on.

Digital Frequency Display

The digital display on the Delta 80 tuner is a custom-designed circuit measuring from 0 to 2 MHz in 1 Hz steps. It samples the frequency applied to it fifty times per second.Obviously this counter has the correct range to measure AM frequencies i.e. 150 kHz to 1650 kHz. This input is provided by the local oscillator output of the AM radio chip IC2, buffered and amplified by Q3,4, R30-35 and C28-30. However the local oscillator frequency is offset from the tuned frequency by the IF frequency i.e. +455 kHz. To compensate for this the counter is preset to -455 kHz before each sample.
FM frequencies, 87 to 108 Mhz are too high to be measured directly by the counter. So the output of the FM local oscillator is divided by 100 using prescaler IC3. The output frequency from this is therefore 870 to 1080 kHz. By adding a decimal point the display reads in MHz. IC3 runs on 5V, regulated by R44, C46,47 and Q6 and providing it's own reference voltage. It has differential inputs but is used in single-ended mode. R45 holds the main input to ground to prevent the device responding to random pick-up. R46-48,131, C48,49,104 and Q7 buffer the output of IC3 and convert it from 5V to 12V logic levels, compatible with the frequency counter. C101 rolls off harmonics from IC3 to help eliminate RF interference.

Similarly to AM, the FM frequency input to the counter is offset by the IF frequency i.e.10.7 MHz divided by 100 : +10.7 kHz. Again this is solved by presetting the counter to -10.7 kHz before each sample.

Frequency Counter

As previously stated the frequency counter measures up to 2MHz with 1 Hz resolution and a sampling rate of 50 Hz. In order to obtain high accuracy and minimal drift a highly stable frequency reference is required. The 3.2768 MHz crystal ensures this. It is matched by R49 and C50,51 and buffered to 12V logic levels by IC4e and f. All the logic following this is CMOS 4000 series operating at +12V.

The crystal frequency is divided down to 200 Hz by IC5 and further down to 100 Hz and 50 Hz by IC6. IC4a,c and IC7 provide control logic to the counters IC8-IC12 and latches IC13-IC16. Referring to the circuit diagram and timing diagram, the counter requires three signals to operate.

1) At the start of each sample the counters IC8-IC12 are PRESET to allow for the appropriate IF frequency error. The necessary logic is applied to pins 3,13,12 and 4 of each ic via V+L, V_{cc} FM, V_{cc} AM and 0V. R50,51,132,133 buffer V_{cc} FM and V_{cc} AM.

2) IC7b GATEs in the input frequency to the cascaded BCD (Binary Coded Decimal) counters. This gate stays open for half of the 50Hz sampling period i.e. 10 mS. In this time, the number of pulses counted in are fin/100. In effect this prescales the input frequency range to 0 to 19999 Hz. Since the display can only show up to 1999 the final digit is discarded by IC8. IC9 then counts the LSD (Least Significant Digit), IC10 the LSD+1, IC11 the MSD-1 (MSD=Most Significant Digit), and IC12 the MSD.

3) At the end of this time the LATCH signal transfers the BCD numbers in IC9-12 to the latches IC13-16. the devices convert the BCD to 7-segment format and drive the fluorescent display. When the display reads less than 1000 the MSD is blanked. The latches hold the measured frequency until the next latch signal.
C52,53,55,91,92,93,94,95 provide supply decoupling and C54,89, 97,97,99 serve to slow down rising edges to prevent the risk of RF interference.

Signal Strength Meter

The signal strength outputs of IC1 and IC2 are amplified by IC20a. R103 sets the gain along with R101 for FM and R102 for AM. C88 prevents the meter responding to spurious signals. The required reference voltage is set by RV8 with R104,105 and 106. Q13 provides temperature stability. D28 and R2 serve to increase the reference voltage for AM.

The output of IC20a drives the chain of LEDs via R107-116 and Q14-18. Q19, R117-119 form a constant current source so that the LEDs stay at the same brightness, however many are turned on. The scale of the meter operates so that the LEDs come on at a sensible rate as shown below:-

LED	AMBER	AMBER	GREEN	GREEN	GREEN
APPROX RF INPUT	20uV	50uV	200uV	1mV	2.5mV

On Tune Indicator

IC20b,c form a window detector so that when the AFC voltage is between the limits set by the resistor chain (50 kHz) the red LED will turn off. The reference voltage from pin 10 on the 3189 is fed into the centre of the resistor chain to ensure the "window" is correctly placed. IC20d is fed by the on-channel indicator and turns the green LED on when the system is "on-channel" (100kHz). D22 and D23 form an EXOR gate which is necessary for the logic of the system. D21 and D25 force the LED off in AM mode.
Q20 and Q21 drive the two halves of the bi-colour LED via limiting resistors R127 and R130.

Tuning Voltage System

This is based around a TL431CLP voltage reference (IC21). The voltage at the top of the tuning pot (RV7) is nominally set by R95 and R96 and is fine-tweaked by RV4 and R98. The voltage at the low end of the tuning pot is set by RV6. The track of the tuning pot follows a diode law to match it to the varicap front end.
R97 provides bias current for IC21. C87 decouples IC21.
In addition to all this a voltage derived from the AFC is applied to IC21 to provide the AFC function. IC19d amplifies the difference between the AFC line and the reference line from the 3189 and injects this difference into IC21 via the decoupling network of R93,94 and C86. The gain of the AFC system is set by R92-94.
D15 ensures that the output of IC19d is defined when the Delta is switched to AM.

Power Supply

The mains transfomer may be wired for 220/240 V or 110/120 V operation . The power switch is on the mains side of the transformer and protection is provided by a 250mA fuse. C64 reduces mains-borne interference.
The output of the transformer is rectified by diode bridge D4-7 and smoothed by C58. C59-62 suppress diode switching transients which would otherwise create radio interference. C63 and R55 decouple the 0V line to earth.
The +12V regulated supply is provided by IC17, a three-terminal adjustable regulator. The necessary reference voltage is set by R53,54 and C57. C56 ensures stability and D3 protects the regulator from a short-circuit of the unregulated supply.

D2, driven by R52, gives "power-on" indication. R56 supplies current to the filament of the fluorescent display. C90 and L8 filter the supply to the logic circuitry preventing any interference from there being transmitted onto the other supply rails.

The mains input socket, fuse and switch are **ALWAYS LIVE !!**

DO NOT REMOVE THE INSULATING COVER FROM THE BOTTOM OF THE PCB !

TEST POINTS

TEST POINT	FUNCTION
1	FM local oscillator
2	FM signal strength
3	FM audio
4	AM audio
5	AM local oscillator
6	Tuning voltage
7	19 KHz monitor
8	AM signal strength
9	Signal strength meter reference voltage
10	+12V regulated
11	0V
12	Signal strength meter amplifier output
13	AFC voltage
14	AFC reference voltage
15	Mute

ALIGNMENT OF TUNER

Note: The alignment of the tuner must be carried out in the following order as some of the adjustments are interactive.

Reference voltage

1. AFC out. FM in. Measure the high tuning voltage (left hand tag of tuning pot) and adjust RV4 (P) so the voltage is 8.3 volts. 2. Similarly measure the low tuning voltage (right hand tag of tuning pot) and adjust RV6 (Q) so the voltage is 1.4 volts.

FM IF section and stereo decoder

1. FM in, MONO out, no RF in. Monitor the 19kHz on test point 7 and adjust RV3 (O) so that the frequency is 19kHz +/- 100Hz.

2. Connect the RF from the sweep generator to the FM aerial input and connect the sweep output to the X axis input of an oscilloscope. The oscilloscope should be set to display Lissajous figures (X-Y mode) and the Y input should be connected to the sweeper to sweep 96 MHz +/- 0.5 MHz. Tune the Delta to 96 MHz and adjust "A" for maximum and symmetrical response. "A" is the IF coil, identified on the circuit diagram.

3. Set up an RF generator to 96 MHz, frequency modulated by a 1kHz signal to 75kHz deviation. Connect this to the FM aerial input and monitor the audio output on a distortion meter. Adjust L1 (B) to minimise the distortion. It will be necessary to fine tune the frequency of the Delta to get best results. When correctly tuned and adjusted the distortion will be mainly third harmonic with no second harmonic visible on the monitor output of the distortion meter.

4. Press in the AFC button and adjust so that the distortion waveform is the same with the AFC button in as it is with the button out.

5. Change the modulator of the RF generator to a stereo generator. Use the pilot tone ONLY to modulate the RF generator by 7.5kHz deviation (at a 19kHz rate). Use an audio millivoltmeter to monitor the right hand channel audio output and adjust L7 (M) to minimise the output.

6. Repeat 5 for the left hand channel - adjust L6 (N).

7. Set the stereo generator to L ON, R OFF, pilot on, audio frequency 1kHz and adjust modulation level to 75kHz. (ie there will be an output from the tuner on the left channel only.) Monitor the right hand channel on the audio millivoltmeter and adjust RV2 (D) for minimum output.

Signal Strength Meter

1. FM mode. Measure the signal strength reference voltage at TP9. Adjust RV8 (S) until the reading is 1.36 volts +/- 0.02V.

2. Tune the Delta to the signal generator frequency and adjust the RF level from 0 to 10 mV. The LEDs should light up in sequence, the fifth being fully-on at approximately 5 mV emf.

AM Section MW

Connect a 10uH inductor across one of the AM aerial inputs. This can be done by mounting a suitable inductor in a phono plug. The purpose of this inductor is to simulate the AM loop aerial. Connect a sweep generator to the other AM aerial input.
Connect the sweep out to the X axis of an oscilloscope.

Monitor the AM audio output on TP4 (Y axis of scope).

Use the scope to display Lissajous fiqures (X-Y mode).

1. Tune the Delta to the low frequency end of the band. Adjust L5 (E) until the display reads 522 kHz +/- 2 kHz.

2. Tune the Delta to the high end of the band. Adjust CV3 (F) until the display reads 1611 kHz +/- 2 kHz. Go back to step 1 and repeat if necessary.

3. Set RF generator to 550 kHz centre frequency with a +/- 30 kHz sweep. Tune the Delta to 550 kHz. Adjust L3 (H) and CF3 (L) for maximum and symmetrical response on the scope.

4. Tune the generator and Delta to 1600 kHz. Adjust CV1 (I) for maximum and symmetrical response.

5. Go back to 550 kHz and check adjustment of L3 ONLY. Repeat step 4 if L3 is re-adjusted.

AM Section LW

Same equipment set up as for MW.

1. Tune the Delta to the high end of the band. Adjust CV4 (G) until the display reads 149 kHz +/- 2 kHz.

2. Tune the generator and Delta to 160 kHz with a sweep of +/- 30 kHz. Adjust L4 (J) for maximum and symmetrical response.

3. Tune the Delta and generator to 270 kHz. Adjust CV2 (K) for maximum and symmetrical response.

4. Re-tune to 160 kHz and check L4, repeating step 3 if necessary.

SERVICING OPERATIONS

WARNING - the unit **must** be unplugged from the mains when changing the fuse or the modifying for a different voltage as the socket and transformer are at mains potential even with the unit switched off.

Change of mains voltage

To convert from 220/240 v to 110/120 v operation proceed as follows:-

1. Disconnect unit from the mains supply.

2. Remove the top and bottom covers.

3. Remove the mains insulating cover.

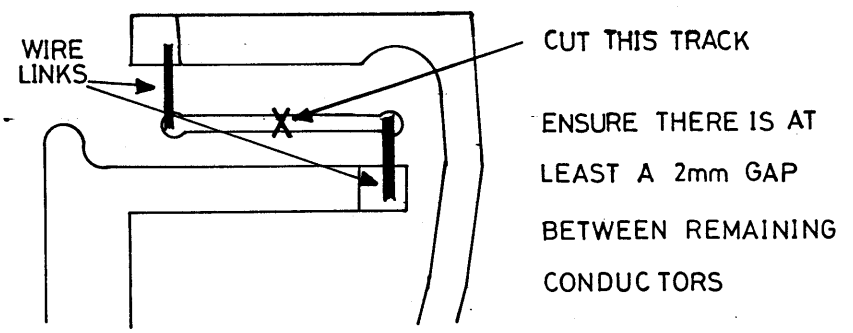
4. Cut through track (marked with an "X" on the solder resist) that links the two primaries of the transformer. Leave a clear gap of at least 2mm between remaining conductors.

5. With some 22swg tinned copper wire solder two links in the positions shown in the diagram below.

6. Replace the mains insulating cover and replace the bottom cover.

N.B. Conversion from 110/120 to 220/240 V is a reversal of this procedure.
The standard transformer connections allow the tuner to operate at 220 to 240 V. When modified as shown below the tuner will work from 110 to 120 V. For 100 V ac mains markets a different mains transformer (A & R part no. 7AJ02B) is required.

Diagram showing wiring details for voltage change 240 to 120 V

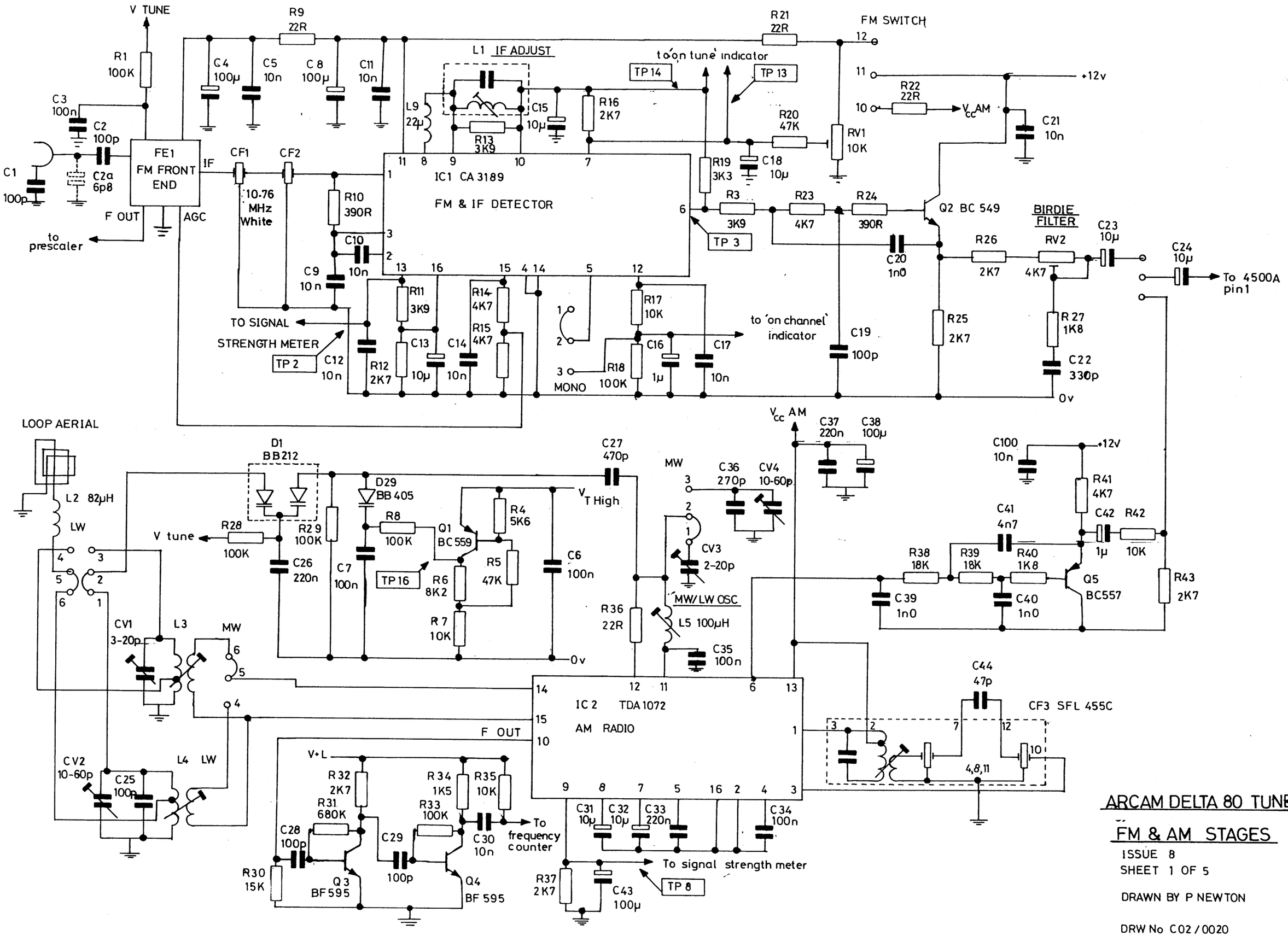


Change of de-emphasis

To change from 50us to 75us de-emphasis insert 2n2 capacitors in positions C71a and C72a. These are available from A&R, part no. 2D222.
To convert from 75us to 50us de-emphasis remove capacitors C71a and C72a.

CIRCUIT DIAGRAMS

No.	Title of Circuit
1	FM & AM Stages
2	Stereo Decoder & Mute Circuit
3	Presets, Signal Strength Meter & On Tune Indicator
4	Display Drive & Decoding
5	Power Supply



ARCAM DELTA 80 TUNER

FM & AM STAGES

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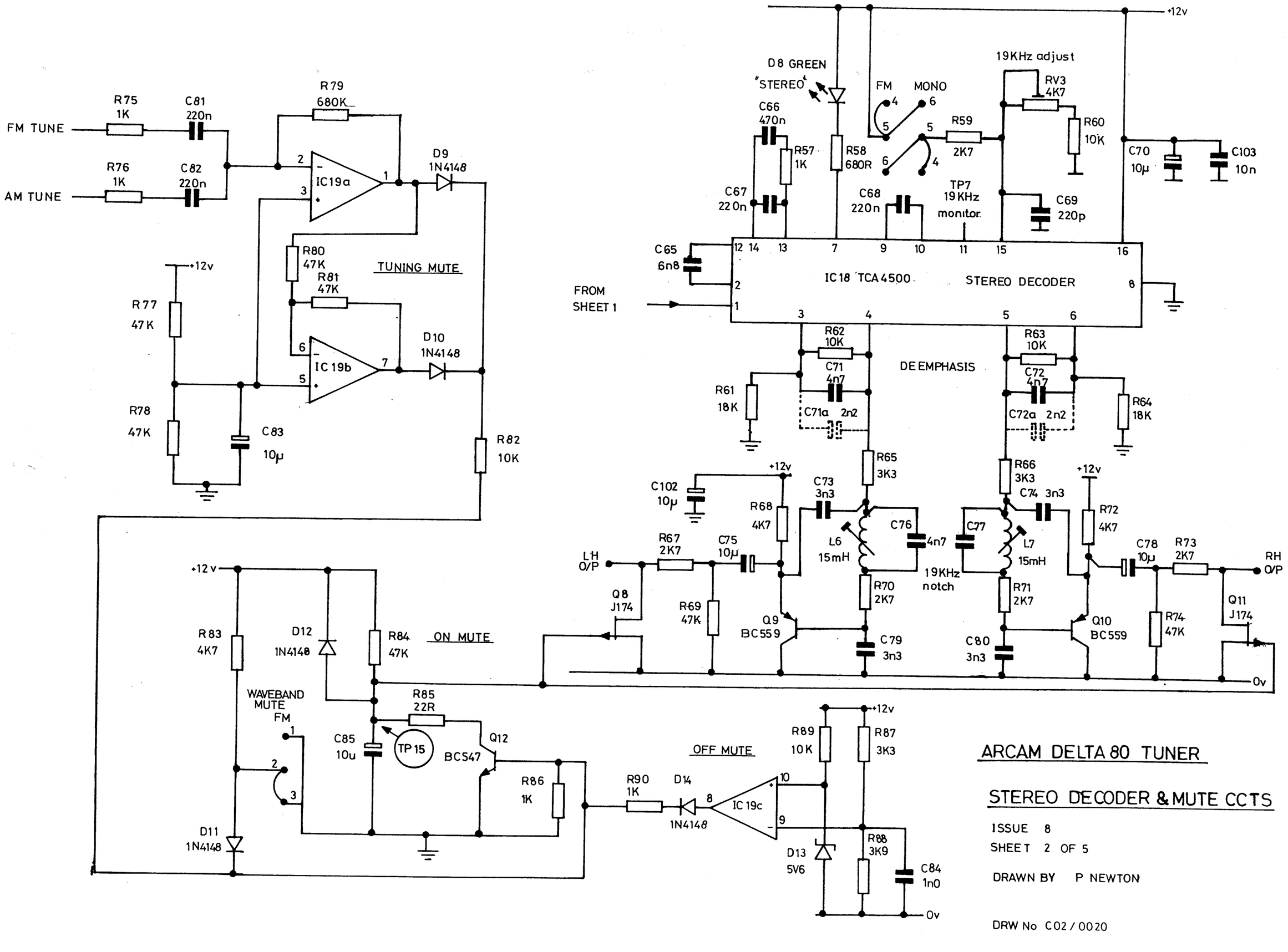
SHEET 1 OF 5

DRAWN BY P NEWTON

DRW No C02/0020



ARCAM DELTA 80 TUNER

STEREO DECODER & MUTE CCTS

ISSUE 8

SHEET 2 OF 5

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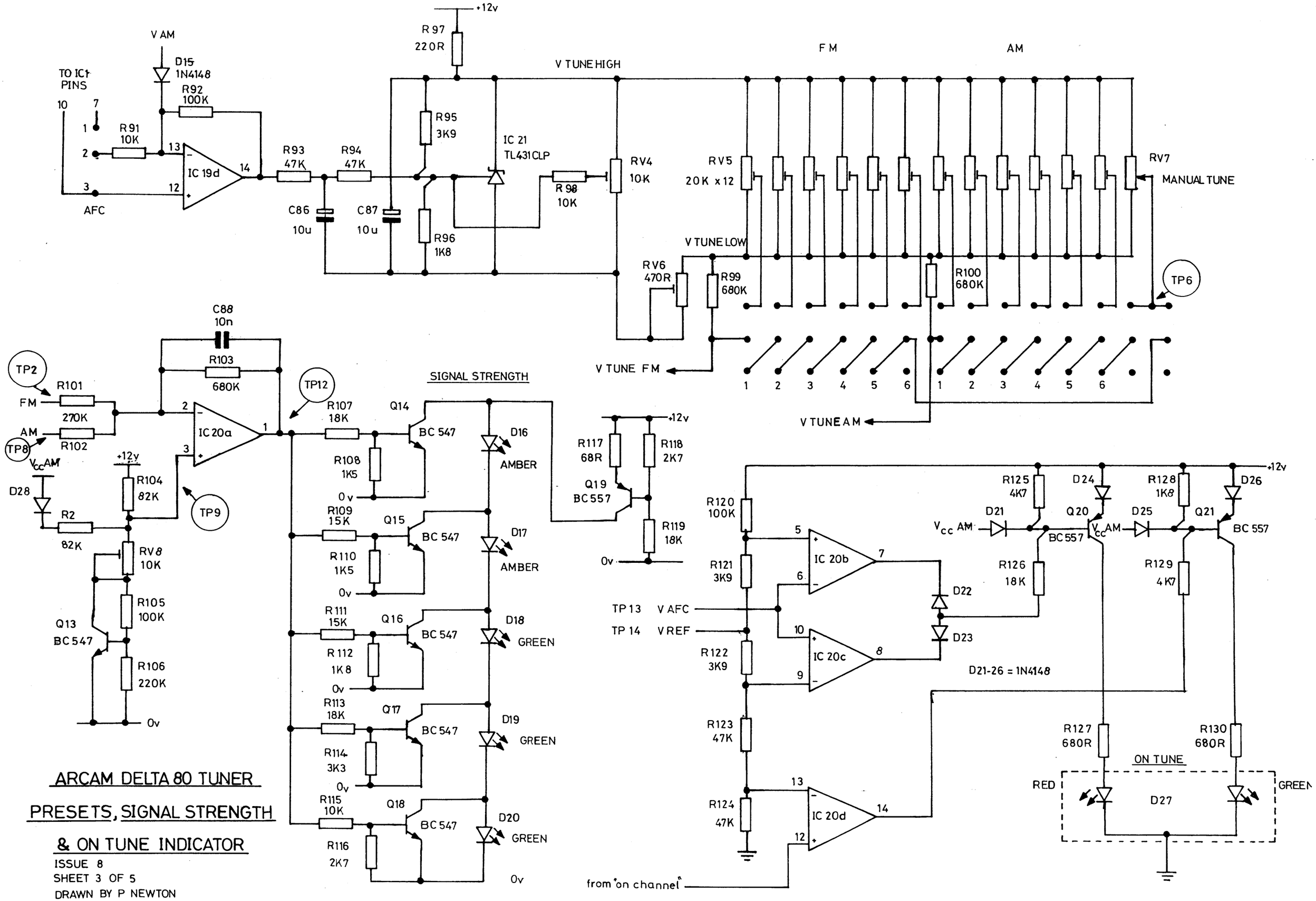
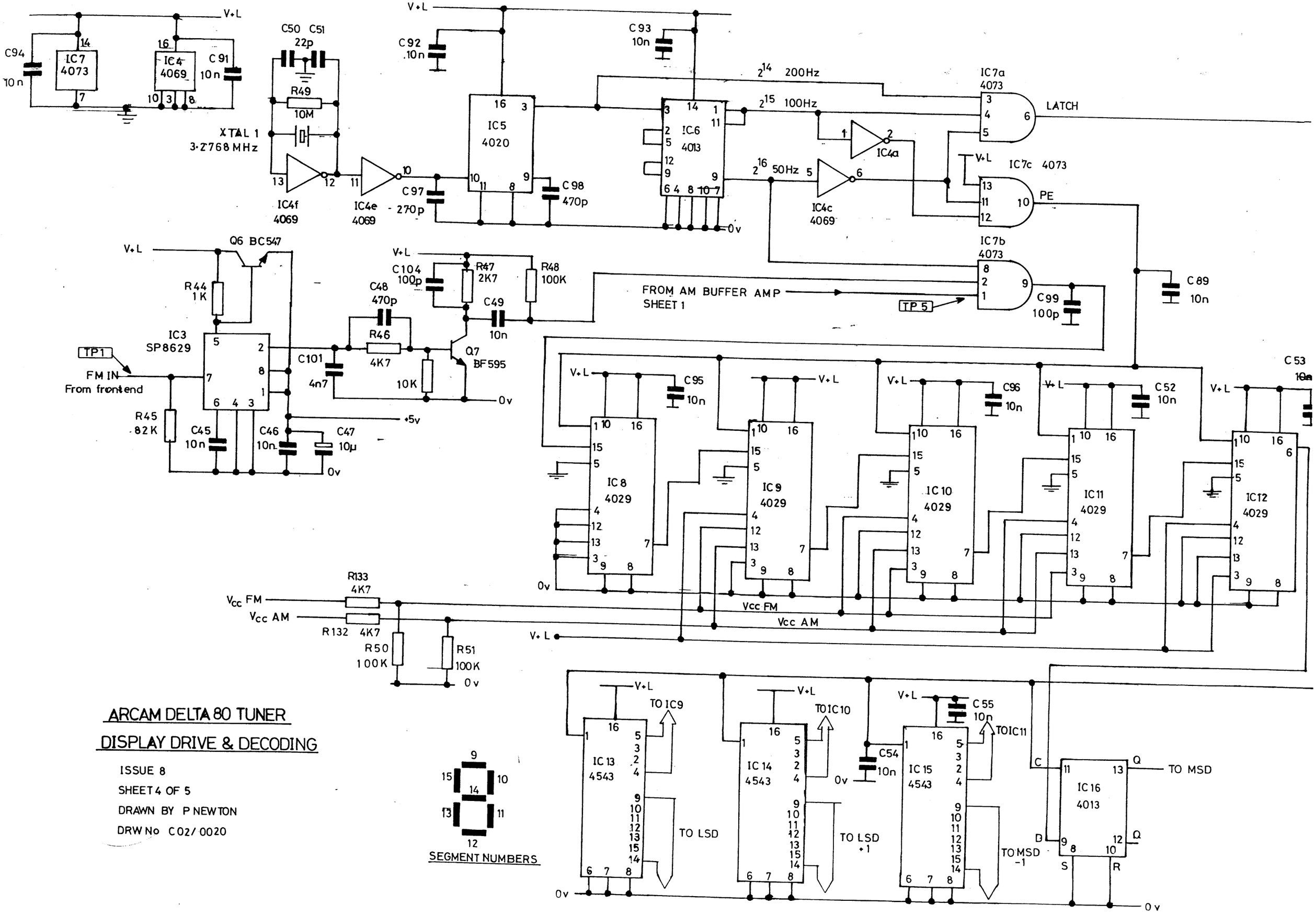


ARCAM DELTA 80 TUNER

PRESETS, SIGNAL STRENGTH & ON TUNE INDICATOR

ISSUE 8
SHEET 3 OF 5
DRAWN BY P NEWTON

DRW No C02/0020


V+L
C94
10n
IC7
4073
IC4
4069
C91
10n
C50 C51
22p
R49
10M
XTAL 1
3·2768 MHz
IC4f
4069
IC4e
4069
C92
10n
C93
10n
IC5
4020
C97
270p
C98
470p
IC6
4013
0v
2^14 200Hz
2^15 100Hz
2^16 50Hz
IC4a
IC4c
4069
IC7a
4073
LATCH
IC7c 4073
PE
IC7b
4073
FROM AM BUFFER AMP
SHEET 1
TP 5
C99
100p
C89
10n
Q6 BC547
R44
1K
IC3
SP8629
TP1
FM IN
From frontend
R45
82K
C45
10n
C46
10n
C47
10µ
C104
100p
R47
2K7
R48
100K
C48
470p
C49
10n
R46
4K7
10K
Q7
BF595
C101
4n7
+5v
C95
10n
C96
10n
C52
10n
C53
IC8
4029
IC9
4029
IC10
4029
IC11
4029
IC12
4029
R133
4K7
Vcc FM
Vcc AM
R132 4K7
R50
100K
R51
100K
V+L
Vcc FM
Vcc AM
TO IC9
TO IC10
TO IC11
C55
10n
C54
10n
IC13
4543
IC14
4543
IC15
4543
TO LSD
TO LSD
+1
TO MSD
-1
IC16
4013
TO MSD
S
R
ARCAM DELTA 80 TUNER
DISPLAY DRIVE & DECODING
ISSUE 8
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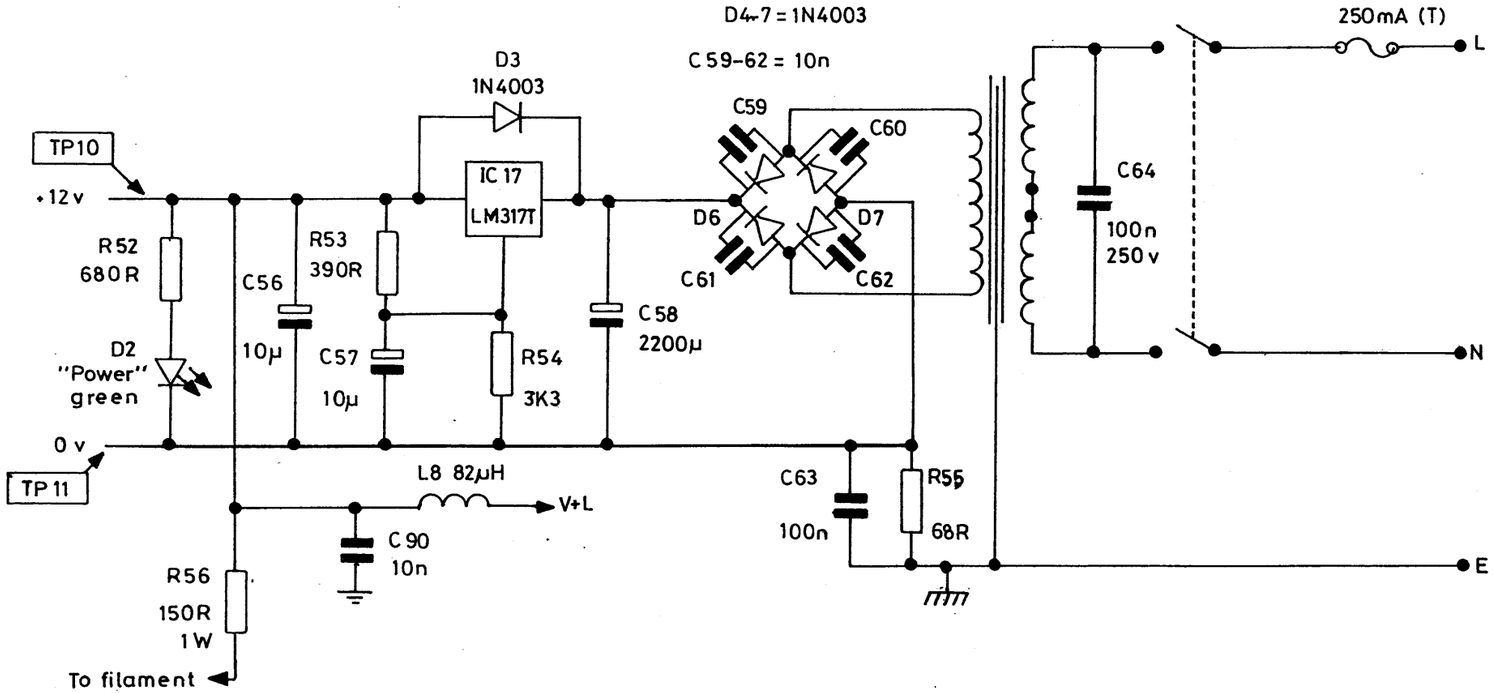
DRAWN BY P NEWTON
DRW No C02/0020
SEGMENT NUMBERS



ARCAM DELTA 80 TUNER

POWER SUPPLY

ISSUE 8

SHEET 5 OF 5

DRAWN BY P NEWTON

DRW No C02 / 0020