

Pulse Series



Power Ratings

Pulse 4x300	
Into 8 Ohms	170W
Into 4 Ohms	300W
Into 2 Ohms	330W
Pulse 2x650	
Into 8 Ohms	400W
Into 4 Ohms	650W
Into 2 Ohms	850W
Pulse 2x1100	
Into 8 Ohms	700W
Into 4 Ohms	1100W
Into 2 Ohms	1500W

Benefits of the Pulse Series

- Very light weight
- Switched mode power supplies give solid performance at all power levels
- Microprocessor protection system
- Massive heatsinks for cooler operation and higher reliability
- Binding Post or Speakon output connector options
- Optional Remote control via C Audio CONNECT
- Internal crossover card options

Cooler, Lighter, Stronger

The Pulse Series combines state-of-the-art switched mode power supplies to not only reduce amplifier weight by as much as 70% compared to conventional amps, but also to provide solid, consistent performance at all power levels.

Occupying just 2U of rack space, Pulse uses massive heatsinks and front-venting fans to keep the electronics really cool, plus a built-in microprocessor which continually monitors all the protection aspects of Pulse - these factors all dramatically enhance reliability.

Pulse amplifiers will perform for longer periods than conventional amplifiers at high output levels.

The combination of the switched mode PSU and a rugged steel chassis means inherent strength.

Technical Specifications

Power Ratings

	Pulse 4x300	Pulse 2x650	Pulse 2x1100
Measured per channel, both channels driven at 1kHz to no more than 0.1% THD+N			
8 Ohms	170Wrms	400Wrms	700Wrms
4 Ohms	300Wrms	650Wrms	1100Wrms
2 Ohms	330Wrms*	850Wrms*	1500Wrms*

* Note: 2 Ohm spec is at 1% THD

Bridged Mono

16 Ohms	400Wrms	800Wrms	1200Wrms
8 Ohms	600Wrms	1300Wrms	2200Wrms
4 Ohms	660Wrms*	1700Wrms*	3000Wrms*

* Note: 4 Ohm bridged spec is at 1% THD

Input Sensitivity	+1dBu for full output
Input Impedance	20kOhm
Distortion	<0.006% THD, 1kHz, 1dB below clip, 22kHz measurement bandwidth
Frequency Resp.	20Hz to 20kHz, +0/-0.2dB; <2Hz to >120kHz +0/-3dB
Controls	Power switch, bridge mode switching, indented level controls (these may be made tamper-proof)
Indicators	Mains present, Operate, Signal, Bridge, Clip, Overtemperature, Protect, Remote
Protection	Microprocessor supervised: overtemperature, DC on outputs, output stage overload, inrush current surge, mains fail and brownout.
Noise	<-100dB ref full output 20Hz - 20kHz measurement bandwidth
Slew Rate	>50 V/microsecond
Damping Factor	>200 ref 8 Ohm
Output Connectors	4x300 - Binding post or Speakon 2x650, 2x1100 - Binding post and Speakon
Power	115 or 230 volts AC nominal, internally selectable, 2000VA, all channels driven (4x300, 2x650); 3000VA (2x1100)
Dimensions	3.5" (89mm) x 18.2" (460mm) x 19" (483mm) - with rear rack ears depth 19.5", -21", 20" (494, 511, 530mm)
Weight	24lbs (11kg)

Trade Descriptions Act: C Audio have a policy of continued product improvement and accordingly reserve the right to change features and specifications without prior notice.

Pulse P2X1100 circuit description

- 1. switching power supply**
- 2. power amplifiers**
- 3. protection**
- 4. frontpanel & flashing lights**
- 5. PIC and system protection**

1. Switching Power Supply

Mains voltage is inserted via filtered IEC CN3. Earth is connected directly to chassis from the body of CN3. Live passes through fuse F2.

Live and Neutral pass through a further filter consisting of C2 (X2 rated), L1 - a common mode choke - and C15 & 14 (Y2 rated).

Live passes through the soft-start system, TH1, R14 and RLY1. R14 limits the initial current surge caused by the primary reservoir capacitors charging up. TH1 protects R14 if a fault causes excessive dissipation in R14. RLY1 shorts out TH1 and R14 when the PSU is running.

Live and Neutral then pass to bridge rectifier BR2 which, for the 230V setting full-wave rectifies mains, smoothing performed by reservoir capacitors C22,23,44,45,32,33. In the 115V setting, this power supply is configured as a voltage doubler. Thus, the High Tension (+HT) DC generated is approximately equal for 230V mains and 115V mains.

This will result in about 320Vdc between 'LIVE GND' and +HT. 'LIVE GND' is named as such because it is **not** isolated from mains but it is the reference point for the PSU. If you need to stick a scope probe around the primary side with the unit plugged in you must connect mains via an **Isolation Transformer**. Without this, at best you will only trip your RCD breaker, at worst you or your scope may not live to regret it. **Do not forget** that **320Vdc** is still pretty shocking whether it is isolated or not.

R36 and R37 ensure proper voltage sharing of the reservoir capacitors.

Power for the switching controller circuit is provided from two sources.

At start-up, the power comes from R93,113, ZD2, D22 and C75. C75 is charged up to about 47V through D22 from Zener regulator R93,113 and ZD2. The command to start the PSU comes from the PIC (+5V for off, 0V to switch on) via R33. The LED in OPT1 is turned on which turns the transistor on, shorting out pins 5&4. While the transformer windings are cooler than 120°C the thermal cut-out (TX5-B) will be a short circuit. So R166 will be connected to the top of C75 and will form a Zener regulator with ZD9. The output of this zener regulator is buffered by TR49 which then powers the switching controller circuit.

C75 stores enough energy to run the controller for long enough until the second source of power is ready.

The second source of power comes from the transformer on pins 3 and 14. This secondary is voltage doubled by C82, D29,31 and C74 and produces about 48Vdc on VAUX. This is connected via D32 to the top of C75 so the controller circuit can continue running.

VAUX is used to directly power RLY1 to short TH1 and R14 out while the PSU is running.

The circuit comprising R165,R172,ZD10,R178,TR47 and R180 shut down the PSU when the voltage on C75 falls below about 32V. while the voltage on C75 is greater than 32V, TR47 is switched on and pulls pin10 of IC6 down to 0V which 'enables' IC6. When the voltage on C75 falls below 32V, TR47 switches off and pin10 of IC6 is pulled up to 20V through R180, 'disabling' IC6.

R92,8,85,C67,ZD3 and TR23 form a time delayed drive for RLY2. At start-up, RLY2 will be open and R127,145 will be in series with the primary of the transformer. These resistors limit the current surge caused by charging up the secondary reservoir capacitors

C113,114,137,138. About 100ms after a successful start-up, TR23 will energise RLY2, shorting R127,145.

The switching controller circuit is based around IC6, and SG3525 PWM controller. Switching frequency is set by R175 and C199 to about 85kHz. R176 controls the 'dead time' period, setting it to between 500ns and 1µs. Outputs appear at pins11 and 14. These two outputs are complementary, that is when one is high (20V), the other is low (0V). Due to the dead time control, neither outputs are high at the same time but both are low for the 'dead time' period. These outputs are fed through R169,170 to high current buffers TR40,41 and TR42,43. The buffered outputs push-pull drive the primary of Pulse transformer TX4. R160 is a damping resistor used to minimise ringing caused by imperfections in TX4. The transformer has two secondaries, each driving one IGBT in anti-phase. The turns ratio is 1.5:1 (pri:sec) and due to the push-pull connection of the primary, the output of TX4 swings positive to about 15V to turn

the IGBT on, falls to 0V switching the IGBT off during dead time and falls to about -15V whilst the other IGBT is switched on.

IGBTs TR24,29 form a half bridge driver for TX5. D14,23 provide 'flyback' protection for TR24,29. These are not fitted as we are currently using IGBTs with integral 'flyback' diodes. Snubbers R84,C56,R117,C68 damp any ringing which may occur.

The drive for the transformer from the IGBTs is an 85kHz square wave almost hitting '+HT' at the top of it's travel and bottoming out slightly above 'LIVE GND'. This drive is connected to the primary of TX5 at pins 15&16. The other end of the primary at pins 1&2 connects to 'LIVE GND' through the closed RLY2 and C63,64,65.

C63,64,65 perform two important functions.

1. they prevent DC current flowing through TX5 thus preventing early saturation of the core.
2. they form a discontinuous resonant circuit with the leakage and stray inductance of the transformer. This means that the current will not be the same shape as the voltage. It is arranged that, for instance, positive current flow through TR24 will start from 0A, rise and fall in a half-sinusoidal fashion, reach 0A and stop before TR24 is switched off. This means that switching losses in the IGBTs are virtually eliminated because switching occurs whilst 0A of current is flowing.

There are two main secondaries.

1. Pins 10,11,4&5 are the low voltage centre tapped secondary winding. Output of this is full-wave rectified by D49,50,54,55 and smoothed by C126,C132. Further filtering is provided by L2,3 and C120,130 before passing to 15V regulator IC7 and -15V regulator IC8. The +15V and -15V outputs are 'decoupled' by C124,133 close to the regulators to ensure stability. C28 and C29 provide further 'decoupling' close to the option connectors CN11,12. D51 half-wave rectifies the secondary output. This is lightly smoothed by C117 and loaded by R219. This is passed via ZD15,R34,R35 and C25 to the PIC. While the PSU is running, this circuit will produce a digital 'high' at the PIC input. If the PSU stops for any reason, the small value of C117 means that the PIC will receive a digital 'low' well before any of the Power supplies have drooped significantly allowing the PIC time to prevent plops.
2. Pins ... is the main Power centre tapped stacked secondary. This is full-wave rectified by C45,48,53,61,57,60,36,47 and smoothed by C113,137,138,114 to produce HT+, HT- and MT+, MT- so that MT+ is half HT+ and MT- is half HT-. R7,112 roughly equalise the discharge rate when the PSU is stopped.

2. Amplifier

Refer to channel 1

The amplifier consists of a 'Class A' driver and a 'Class AB' rail switched power output stage. The driver provides voltage gain only, the output stage provides current gain only. Audio signal enters the amplifier through DC blocking capacitor C149, then low-pass filter R88 & C51 and onto the base of TR30. R261 provides a low source impedance in case the frontpanel board is disconnected. R89 provides a DC path to ground for the base current of TR30.

The output of the amplifier is fed-back through potential divider R104 and R102 to the base of TR31. C58 decouples the feedback signal at DC so that DC offsets generated by TR30,31 are not amplified at the output. D15,19 protect C58 in the event of a DC fault.

TR30 and TR31 form a Long Tailed Pair to amplify the difference between the input signal and the feedback signal. The gain of the LTP is reduced by R99 and R100 to help prevent oscillations and de-sensitise the performance of the input stage to parametric variations of the two transistors. A bias current of about 2.8mA for this LTP is provided through R98 from current source TR19, R57, D6,7 & R75. In the quiescent state half of this current is driven through each of TR30 and TR31. The collector current of TR30 and TR31 pass through ZD7 and ZD5 and are loaded through D27 and D26 by R137 and R146.

The outputs of TR30 and TR31 are taken from the anodes of D27 and D26 to the bases of another LTP - TR38 and TR37. C70 determines the frequency response to ensure stability. As before, R139 and R140 reduce the gain of this LTP and the bias current is set to about 8mA by R138. The collectors of TR37 and TR38 are loaded with a current mirror - TR20 & TR21 to maximise gain and provide a push-pull output.

Some of this output is fed-back to the base of TR31 through C63 and R103. This defines the open-loop frequency response independently of the output stage characteristics to ensure stability.

Finally, the Vbe multiplier - TR25, R82&83 - provides the output stage with two voltage signals which are identical except they are offset by a voltage varying between about 2.1V (heatsink hot) and 2.4V (heatsink cold). C53 ensures that the two offset signals are identical at AC.

The Current source consisting of TR19, R57, D6,7 and R75 determines the operating point of the whole class A driver. Therefore, one can mute the amplifier by switching this current source off.

The current source is switched off by TR18, R68 and C37. When TR18 is switched on, D6,7 are shorted out through R68 which mutes the current source. C37 is discharged in the process. When TR18 is switched off, C37 charges up through R75 until D6,7 are fully conducting which activates the current source.

TR18 is controlled by TR11, R56, R46, ZD1, R47 and R48.

If the PIC is absent or its +5V supply has failed the 'MUTE1' line will be in a high impedance state, i.e. nothing doing. The 4.7V reference supplied by R46 & ZD1 and emitter resistor R47 set the current through TR11 to about 200µA. This is enough to switch TR18 on and mute the amplifier. This is the default state.

When working, the PIC controls the state of the 'MUTE1' line. To mute the amplifier, the 'MUTE1' line is set to 0V. The current through TR11 is then set to about 4.2mA because R48 is now essentially in parallel with R47. This mutes the amplifier as before.

To activate the amplifier, the 'MUTE1' line is set to +5V. This, through R48, reverse biases the base-emitter junction of TR11. Thus TR11 is switched off as is TR18 so the amplifier becomes active.

Under normal conditions the signals at the bases of TR30 and TR31 will be the same. However, under fault conditions, such as a DC offset at the output, the base voltages will become offset also. For example, in the event of a large DC offset of +50V at the output, a positive DC voltage will appear at the feedback point and hence at the base of TR31. This DC voltage will make D65 conduct protecting C126, so the voltage at TR31 base should be $0.6 + 50V \times R102/(R102+R104)$, about 4V. However, the important issue is that the voltage is **positive**. In the event the voltage is negative this indicates that the feedback divider is faulty. The voltage at TR31 base being positive whilst the base of TR30 is close to 0V will then reverse bias TR31 base-emitter, turning off the transistor. Therefore, no voltage should

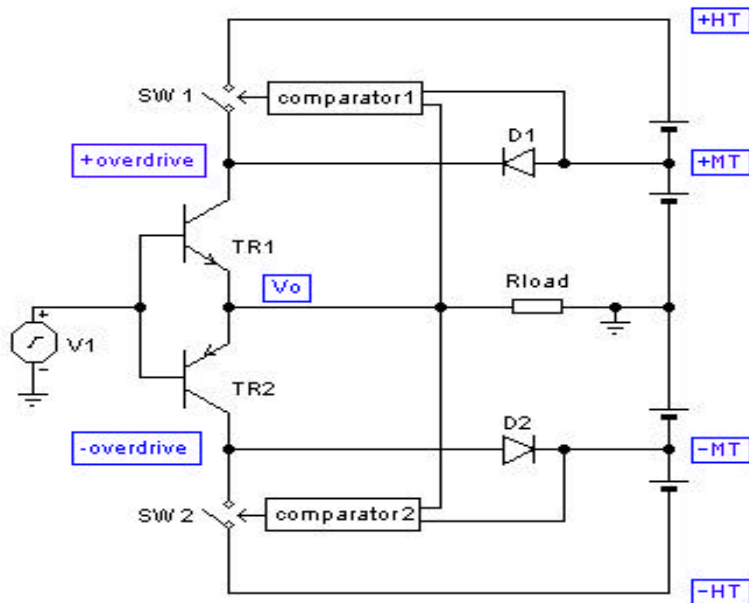
appear across R100 and R146 whilst double the normal voltage will appear across R99 and R137. Should this not be the case, it indicates a fault in the input stage itself.
The same process should now cause TR37 and TR20 & 21 to be off and TR81 to be full on...

Class AB output stage

The input of the Output stage is loaded by C46. This defines the HF input impedance and thus averts very nasty oscillations that are caused by the variable, non-linear and sometimes negative raw input impedance. Resistors R60 and R182 ensure that output offsets are minimised when the amplifier is muted. D5 and D39 stop the Class A driver over-saturating TR12 and TR55. D11 and D40 prevent the output exceeding the power supply rails in the face of 'flyback' pulses from reactive loads.

The output stage consists of a symmetrical Siklai follower - TR12, TR13, R61, TR55, TR56, R181, R81, R80, C52, D13, D17 - generating the high current drive required for the parallel connected symmetrical follower output stage - TR26, TR14, TR34, TR46, R115, R94, R121, R124, TR72, TR59, TR88, TR79, R147, R141, R168, R159. V-I limiting is controlled by D8, D33, TR22, TR44, R96, R95, R116, R119, C60, R129, R149, R164, R163, C81, R64, C48, R128, C77, D10, D25, R212, R214, TR71, R217, R228, TR75.

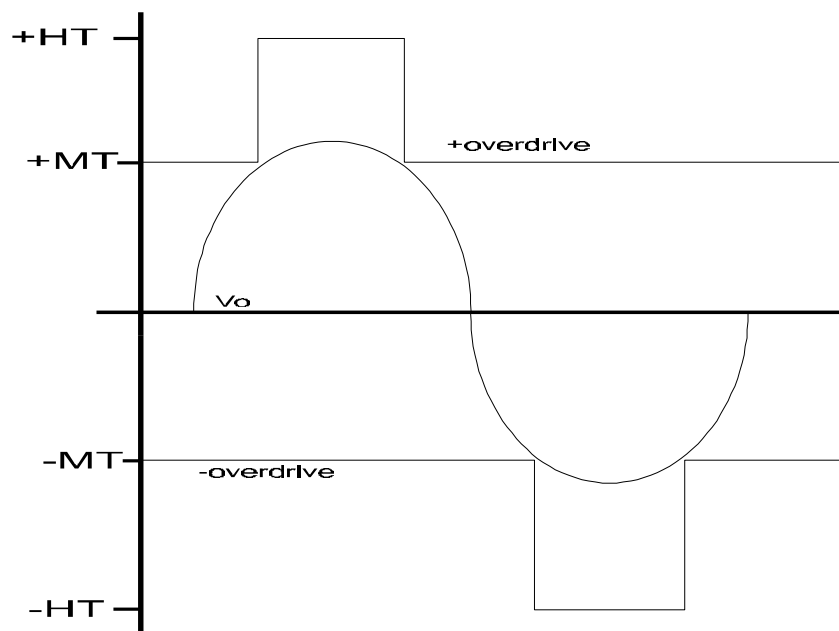
The Pulse 2x1100 amplifier uses a rail switched (class G or commutated) output stage to increase efficiency. This works by effectively rolling two amplifiers into one, switching between them as required.



While V_o is between +MT and -MT, SW1 and SW2 are open and power is drawn from +MT and -MT through D1 and D2.

If V_o gets too close to +MT then comparator1 closes SW1. Power is now drawn directly from +HT and D1 is reverse-biased.

Similarly, if V_o gets too close to -MT then comparator2 closes SW2. Power is now drawn directly from -HT and D2 is reverse-biased.



1. Positive half-cycle

The output voltage is sensed at the top of current sharing resistor R124 to correct for errors caused by the varying voltage drop across current sharing resistors. This is divided down by R221 and R234 and enters pin6 of IC10-B which is used as a comparator. C123 compensates for time delay through the circuit. +MT is divided down by R229 and R230 and enters pin5 of IC10-B. R237 provides hysteresis around the comparator.

Whilst pin6 is lower than pin5, the output of the comparator is at +13.5V on pin7. This switches TR67 on with its collector current set by R216 to about 2.5mA.

When pin6 exceeds pin5, the output of the comparator goes to -13.5 on pin7. This switches TR67 off.

Rail switching is performed by FET1 and FET3 with commutation diode D52. FET1 and FET3 are connected in parallel except for the gates which have separate 'gate stopper' resistors R192, R195. A floating 10V supply for the drive circuit is provided by R199, ZD13 and C112. The drive circuit consists of push-pull buffer TR68,69, pull-up resistor R201 and C110.

When TR67 is on, 2.5mA flows through R201, dropping 12.75V. therefore, TR69 will be off and TR68 will be on, pulling FET1 and FET3 gates low which switches them off. Power for the amplifier thus flows from +MT through D52.

When TR67 is off, R201 pulls the bases of TR68,69 up, which pulls the gates of FET1 and FET3 up and switches them on. Power for the amplifier now flows from +HT through FET1 and FET3. C110 slows the rise and fall times of the +overdrive rail to about 1 μ s.

2. Negative half-cycle

The output voltage is sensed at the bottom of current sharing resistor R159 to correct for errors caused by the varying voltage drop across current sharing resistors. This is divided down by R207 and R248 and enters pin2 of IC10-A. C111 compensates for time delay through the circuit. -MT is divided down by R259 and R256 and enters pin3 of IC10-A. R246 provides hysteresis around the comparator.

Whilst pin2 is higher than pin3, the output of the comparator is at -13.5V on pin1. This switches TR74 on with its collector current set by R225 to about 2.5mA.

When pin2 exceeds pin3, the output of the comparator goes to +13.5 on pin1. This switches TR74 off.

Rail switching is performed by FET5 and FET6 with commutation diode D62. A 10V supply referenced to -HT for the drive circuit is provided by R239, ZD20 and C139.

The drive circuit consists of push-pull buffer TR81,82 pull-up resistor R251, C145 and current mirror TR80,D63,R258,R250.

When TR74 is on, the current mirror reflects 2.5mA through TR80 which pulls down on R251. Therefore, TR82 will be off and TR81 will be on, pulling FET5 and FET6 gates low which switches them off. Power for the amplifier thus flows from -MT through D62.

When TR74 is off, the current mirror reflects this by turning TR80 off. R201 pulls the bases of TR81,82 up, which pulls the gates of FET1 and FET3 up and switches them on. Power for the amplifier now flows from -HT through FET5 and FET6. C145 slows the rise and fall times of the -overdrive rail to about 1 μ s.

3. Protection

Output stage

Output stage protection is accomplished by a three-slope V-I limiting circuit which has limiting characteristics chosen to emulate the Safe operating area of the output stage transistors at their maximum operating temperature.

As the output stage is symmetrical, the positive half only will be described.

The V-I limiting works by controlling TR22: when the base-emitter voltage of TR22 exceeds about 0.65V then TR2 turns on and steals current, via D8, from the input of the output stage and thereby limiting the output. So, V-I limiting is controlled by controlling the base-emitter voltage of TR22.

Each output device has its own current sharing resistor - R115 R94, R121, R124 - the voltage across which is proportional to the current flowing in the output device. These voltages are sampled and summed by R96, R95, R116 and R119. C60 improves stability when V-I limiting is activated.

Thus the amplifier is protected for short circuits because the base-emitter voltage of TR22 reaches 0.65 if the output current is large and the output voltage is less than about 1Vpk. For output voltages exceeding about 1Vpk, D10 conducts connecting R212, R214 & TR71 to sense the output voltage. In this case, as output voltage increases, the base-emitter voltage of TR22 reduces, thus the current limit is increased as the output voltage increases, defining the 2nd slope of the limiting characteristic.

The third slope is controlled by TR71, R214 and the rail switching comparator. If the +overdrive rail is low, then TR71 is switched on and shorts R214, leaving R212 to define the 2nd slope. When the +overdrive is high, TR71 is switched off and the 3rd slope is defined by R214 in series with R212.

C48 and R64 desensitise the current allowing brief peaks of output current which exceed the normal current limited amount to allow proper operation into reactive loads (ie loudspeakers).

Excessive continuous power demand

Continuous maximum sine-wave operation of both channels into the minimum rated load resistor is beyond the capabilities of this product and is treated as a fault condition.

Refer to channel1

Amplifier output current is measured by R159, 124, 183, 191, 177, 179 and IC5-A.

Output current causes a voltage drop across current sharing resistors R124 and R159. If the voltage across both resistors is measured, positive output current will cause the voltage to increase and negative output current will also cause the voltage to increase. This is sensed and attenuated by differential amplifier R183, 191, 177, 179 and IC5-A.

The output at pin1 of IC5-A is the sum of: 1. full-wave rectified replica of the output current; 2. An error signal caused by incomplete common-mode rejection. The error signal is merely attenuated output voltage.

As the desired signal, output current, has been full wave rectified and the undesired signal, output voltage, has not, the undesired signal can be removed without corrupting the desired signal by passing it through an integrator. The raw output current signals from each channel are summed, averaged and inverted by R174, 52, 53, C43 and IC4-A (sheet 4) so that the output at pin1 of IC4-A is a negative DC voltage proportional to the total average output current.

This voltage is compared with a threshold, set by R50 and R51 to about -2.7V, at IC4-B. R55 provides hysteresis. If it is higher than the threshold, pin7 will swing to -13.5V. If it is lower than the threshold then pin7 will swing to +13.5V.

IC4-B pin7 drives transistors TR66, 64, 65 and 63. The collectors of these transistors connect to the collectors of TR67, 86, 74 & 62. When pin7 swings to +13.5V, TR66, 64, 65 & 63 are switched on, the current flow set to 2.5mA by R198 and R197. This forces rail switching off.

IC4-B pin7 is connected to the PIC pin22 through R49.

Bridge imbalance protection.

During normal operation, the bridged output is fully differential mode with little or no common-mode signal component. Activation of the output stage current limiters erratically upsets this state, producing a large common-mode error - imbalance - which can destroy the output stages.

The bridge imbalance detection is performed by R10,12,13, TR3 and R11.

In two channel mode, the 'BRIDGE 1+2' line is pulled up to about +13V. this switches TR3 on through R11. The collector of TR3 is connected to pin 23 of IC1 (PIC). The input of the PIC is internally protected by diodes against inputs above +5V and below 0V. so, in two channel mode, pin23 of IC1 receives no signal.

In bridge mode, the 'BRIDGE 1+2' line is held at 0V which switches TR3 off. Now pin 23 of IC1 can receive a signal. R10, 12 sum the output of each channel, the result appearing across R13 which sets the sensitivity. If the bridge is balanced, the voltage across R13 will be zero. If the bridge is unbalanced then there will be voltage across R13 which is also connected to pin23 of IC1.

When an imbalance is detected the PIC immediately mutes both channels for 4 seconds. Then the channels are re-activated.

DC Protection

Each channels output is connected through R16,R15 to R21 and C16. C16 ensures that only DC is detected.

For no DC fault, R32 pulls pin9 of IC1 towards +5V.

For a positive DC faults, D4 becomes forward biased and turns TR8 on, pulling pin9 of IC1 (PIC) towards 0V.

For a negative DC fault, D3 becomes forward biased which switches TR10 and TR9 on, pulling pin9 of IC1 (PIC) towards 0V.

In the event of a DC fault, the PIC switches the PSU off, waits and then tries again.

C30,31,35,36 prevent the full-wave rectification of PSU noise causing false alarms.

4. Frontpanel and small signal circuits

Refer to channel 1

Audio signal enters the amplifier on CN1, CN5, CN8 or CN10 in balanced form, positive phase - 'hot' - on pin 2 of CN8 and negative phase - 'cold' - on pin 3. The signals on each leg will always be out of phase but will not necessarily equal in amplitude. This signal passes through RF1 and RF2 which shunt RF rubbish to chassis. R1 and R4 prevent thumps due to connection / re-connection. TX1 is an optional audio coupling transformer which is normally not fitted and bypassed by LK2 and LK3. The signal then passes through dc blocking capacitors C3 and C9, through links fitted in the option connectors CN11 and CN12 and on to the frontpanel board via pins 1&2 of CN17.

The balanced signal is converted to single-ended by IC1-A (pins 1,2,3) and R1,2,3,4,52,59 which form a standard differential amplifier. C25 and C26 shunt HF energy to ground. The signal exits pin 1 of IC1-A and is routed to two places, one being the signal led circuit (described later) the other being the level control P1, R5 and analogue switch IC2-A. P1 is a standard linear 10k pot rather than a log taper pot. The level control is given an 'audio' taper (a compromise between log taper and linear taper) by R5 so that the level is attenuated by 10dB at the centre position (rather than 6dB for linear or 20dB for log). The analogue switch is normally closed (pin 1 of IC2 low - 0V) allowing operation of the level control. In remote controlled operation (with the remote option installed) the level control is disabled by pulling pin 1 of IC2 high (+15V) thus opening the switch.

Up to this point channel 1 and channel 2 have identical function. What happens next is determined by the bridge switch (rear panel).

1. bridge mode off

the 'bridge1+2' signal line will be held high by R49 and LD9. Although LD9 will not be illuminated, enough current flows to pull pins 8 & 9 of IC2 high. This opens the switches IC2-C (pins 10 & 11) and IC2-D (pins 6 & 7).

Channel 1 signal enters pin 5 of IC1 which is configured to have a gain of +14.5dB by R17, R15 and continues through R7 to pin 13 of CN1.

Channel 2 signal enters pin 5 of IC3 which is configured to have a gain of +14.5dB by R30, R16 and continues through R14 to pin 15 of CN1.

2. bridge mode on

the 'bridge1+2' signal line will be held low by the rear panel bridge switch. LD9 will be illuminated and pins 8 & 9 of IC2 will be pulled low (0V). This closes the switches IC2-C (pins 10 & 11) and IC2-D (pins 6 & 7).

Channel 1 signal enters pin 5 of IC1 which is configured to have a gain of +14.5dB by R17, R15 and continues through R7 to pin 13 of CN1.

Closure of switch IC2-C connects this signal to pin 6 of IC3 through R29 which, in conjunction with R30, configures IC3-B to be a unity gain inverter (R16 does not affect the signal gain).

Thus, the channel 1 signal is inverted and passed to channel 2 through R14 to pin 15 of CN1. Channel 2 signal is shorted to ground through switch IC2-D.

Signal LED

The signal is coupled from pin 1 of IC1 through C10 and across R35 to IC8 pin 3.

Initial conditions: C15 has 0V across it and LD1 is off. Pins 1, 2 and 3 of IC8 are at 0V.

A signal appears at pin 3 of IC8. It is moving from 0V in a positive direction. Due to the large open-loop gain of IC8, pin 1 will move in a positive direction at a much greater rate. This will forward bias the diode in D1 (which connects pin 1 to the top of C15) and charge up C15.

When enough volts have accumulated on C15, LD1 will conduct, its current limited by R34 and R33. R34 and R33 also form a potential divider applying negative feedback to pin 2 thus setting the sensitivity of the circuit.

The signal at pin3 of IC7 now moves in a negative direction. Therefore pin1 will move negative at a much greater rate and the diode in D1 (which connects pin1 to the top of C15) becomes reverse biased. The other diode in D1 (connecting pin1 to pin2) now conducts preventing saturation of the op-amp. LD1 will continue to glow by discharging C15 until the voltage on C15 falls below that required to turn LD1 on.

Clip LED

The clip detector circuit is on the main board consisting of IC5-B, R87,148,101,153,158 & R173 and C89&93. These are connected to form a differential amplifier which samples the voltage between the base of TR30 and the base of TR31. This voltage is the difference between the input and the divided down output of the amplifier. When the amplifier clips, there is a large difference between the input and the divided down output which is amplified by the differential amplifier. This passes from pin1, through R173 to pin 23 of CN17 and onto the frontpanel board. Here it is full-wave rectified by D5 and D6, smoothed by C17 and the resultant voltage illuminates LD5 through R45.

5. System management

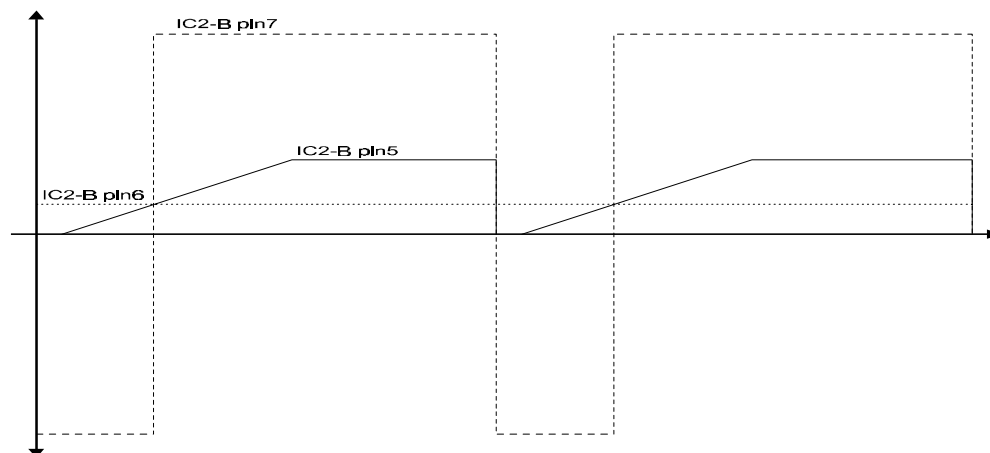
Power for the management system is provided by a conventional transformer-rectifier-capacitor-regulator supply.

TX3 receives mains through F1 and is not affected by the main chassis fuse (F2). The secondary passes through fuse F3 to bridge rectifier BR1. The rectified AC is then smoothed by C11 producing about $25V_{dc}$ for $230V_{ac}$ mains or $12.5V_{dc}$ for $115V_{ac}$ mains.

The regulator circuit used is similar to the internal workings of an LM317. TR1 and TR2 form a darlington pass transistor. R9 provides bias current for D1, a TL431. D1 combines a voltage reference of 2.5V and an amplifier in one package. C6 prevents oscillations. R5 and R6 set the output voltage to 5V - $2.5V \times (1+R5/R6)$.

The brain behind the operations is IC1, a MICROCHIP PIC16C57 microprocessor. This is **not** a re-programmable part. The clock is set to 3.58MHz by XT1, C19, C17 and pins27, 28 of IC1.

Each of the heatsinks has an LM35DZ, IC11 and IC12, attached close to the front of the unit. The voltage at pin2 of each of these gives a measurement of the temperature - $10mV$ per $^{\circ}C$ starting at $0V$ for $0^{\circ}C$. Continuing with channel1, the temperature signal is filtered by R263 and C26 and enters pin3 of IC2-A. this is configured to give a gain of $\times 10.2$ giving $102mV$ per $^{\circ}C$. The output at pin1 of IC2-A is coupled through R42 to pin24 of CN11. It is also coupled through potential divider R38, R39 to pin 6 of IC2-B at which point the signal is $34mV$ per $^{\circ}C$. IC2-B (pins 5, 6, 7), R45, C34, R27 and IC1 pins 6, 7 comprise an analogue to digital converter. At the start of conversion, pin6 of IC1 is set to $0V$ for $1ms$ and discharges C34 through R27. Pin 6 of IC1 is then set to high impedance mode. At this point, pin7 of IC2-B is at $-13.5V$ because pin5 is at a lower voltage than pin6. Now, the voltage on C34 ramps at about $600mV/ms$ because it is being charged by R45. The ramp stops at about $5.5V$, limited by the protection diode on pin6 of IC1. The voltage on C34 is connected to pin5 of IC2-B so that when the ramp voltage exceeds the temperature voltage on pin6, pin7 changes to $+13.5V$. pin7 is connected to pin7 of IC1 through R31. In this way, the IC1 has a measure of time between the start of conversion and when pin7 (IC1) receives a logic 'high' which is proportional to the voltage at pin6 of IC2-B. After $18.32ms$ the conversion cycle starts again.



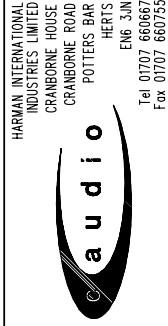
The heatsink temperature measurements are used to control the fan speed and to mute overheating channels.

Take, for instance, channel 1. If the heatsink temperature exceeds $90^{\circ}C$ then channel 1 is muted. Channel 1 will be re-activated when the heatsink temperature falls below $75^{\circ}C$.

The two fans are connected in parallel, the negative wires connected to $-15V$, the positive wires connected through R17 to R18 and the collector of TR6. If the heatsink temperature is less than $55^{\circ}C$ then pin17 of IC1 (PIC) is set to $+5V$. This turns TR5 on which in turn switches TR6 off leaving the fans powered through R18. If the heatsink exceeds $55^{\circ}C$ then pin17 of IC1 is set to $0V$, switching TR5 off and therefore TR6 on so that TR6 shorts R18 out. The fans are returned to slow speed when the heatsink temperature falls below $50^{\circ}C$. TR4 and TR7 are used to completely switch the fans off when a brown-out condition is detected.

DRAWING NUMBER

S-C300AS-05



TITLE: PULSE 4x300 AMPLIFIER

SHEET 1

FILENAME: S-C300AS-05.SCH

DRAWN: BPV

DATE: 12-01-99

CHECKED:

MATERIAL:

FINISH:

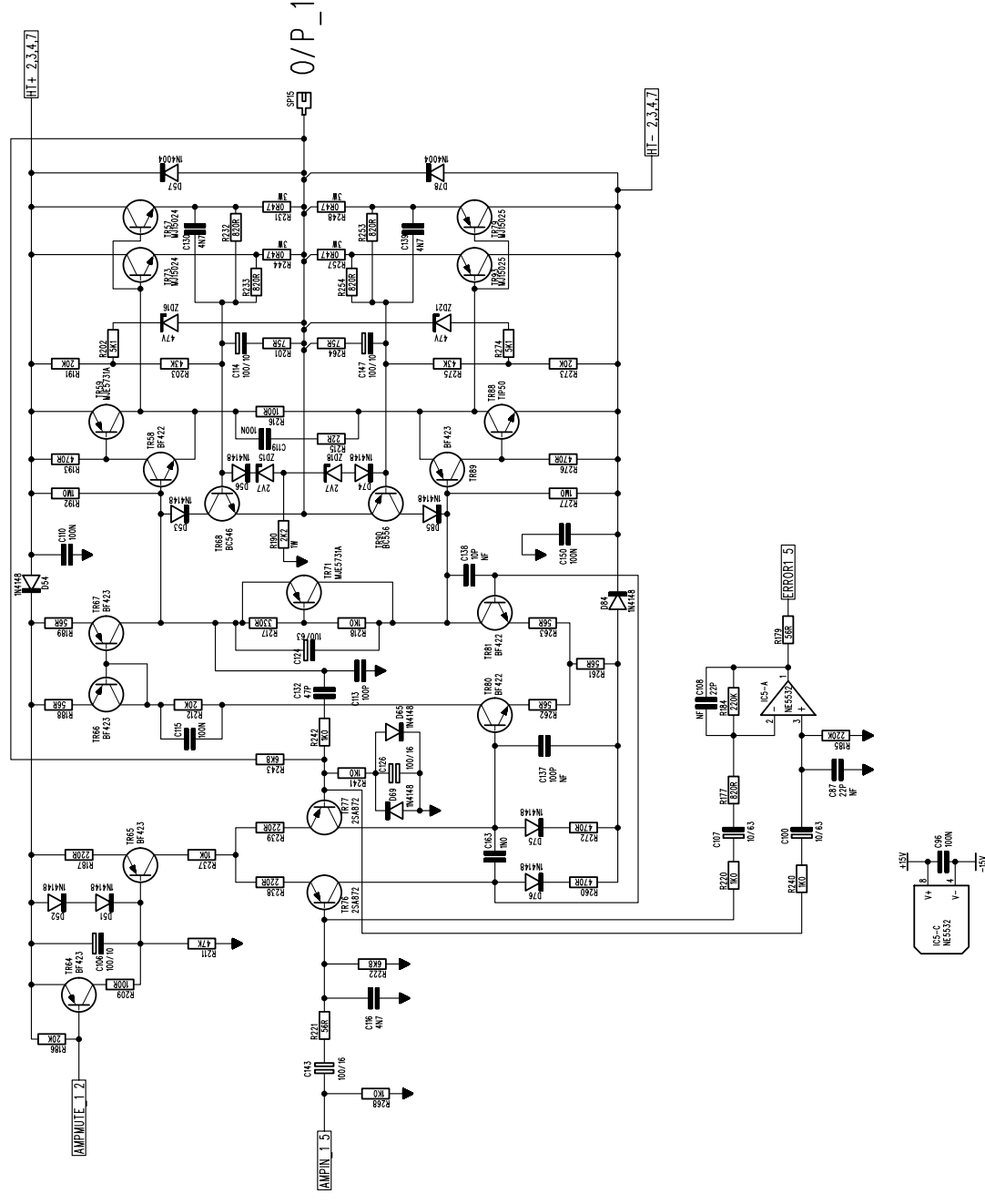
ISSUE COMMENTS:

1. PRODUCTION RELEASE 12-08-98
2. ECN0128 12-01-99
3. ECN0150 19-04-99
4. TX7 CIRCUIT SYMBOL UPDATED
4a. ECN0190 12-07-99
4B. ECN0251 15/11/99
4c. ECN0624 03/12/99
4D. ECN0275 11/01/00
5. ECN0333 05/05/00

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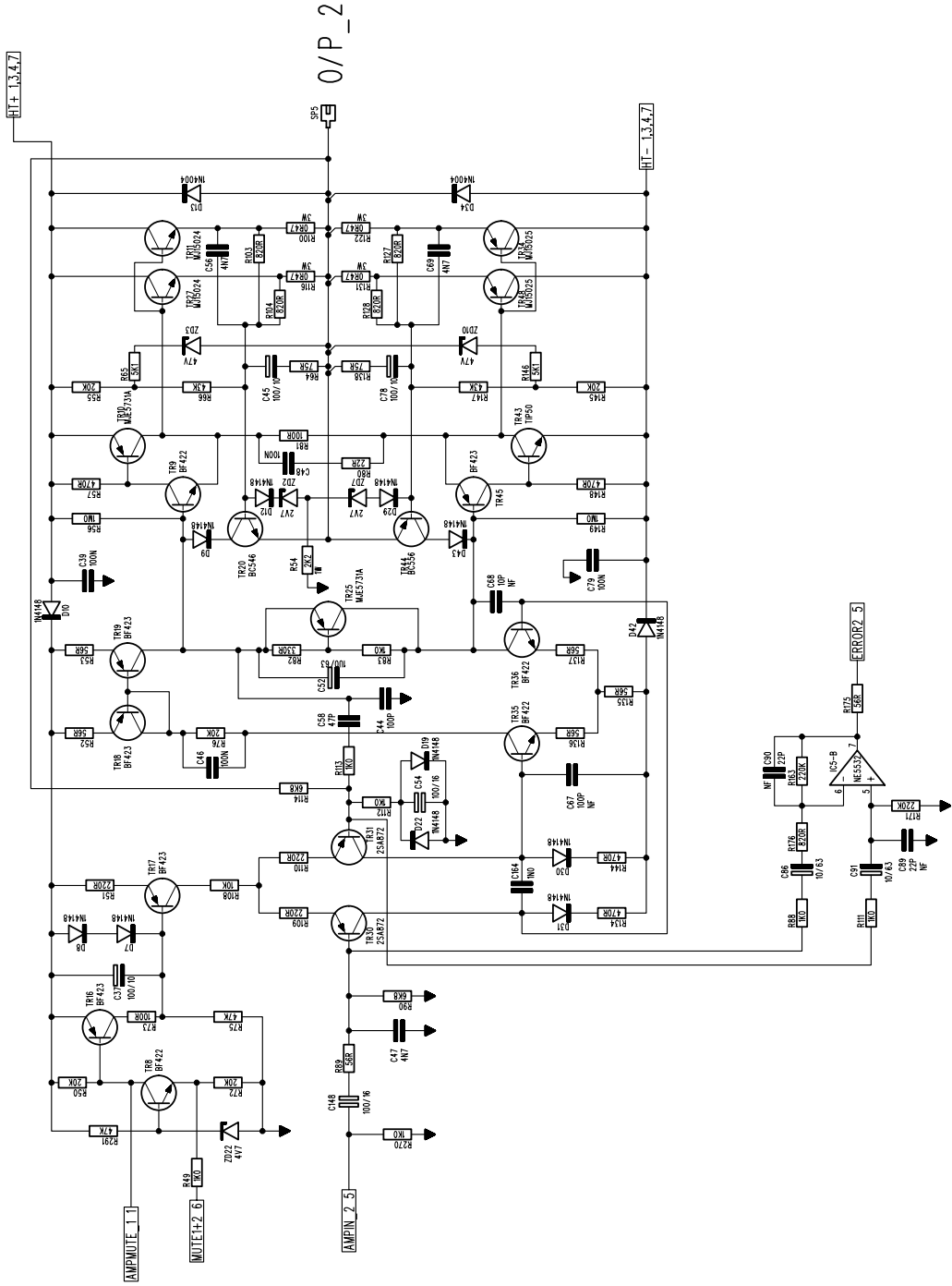
S-C300AS-05



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TITLE:	PULSE 4x300 AMPLIFIER
SHEET 2	
FILENAME:	S-C300AS-05.SCH
DRAWN:	BPV
DATE:	12-01-99
CHECKED:	
MATERIAL:	
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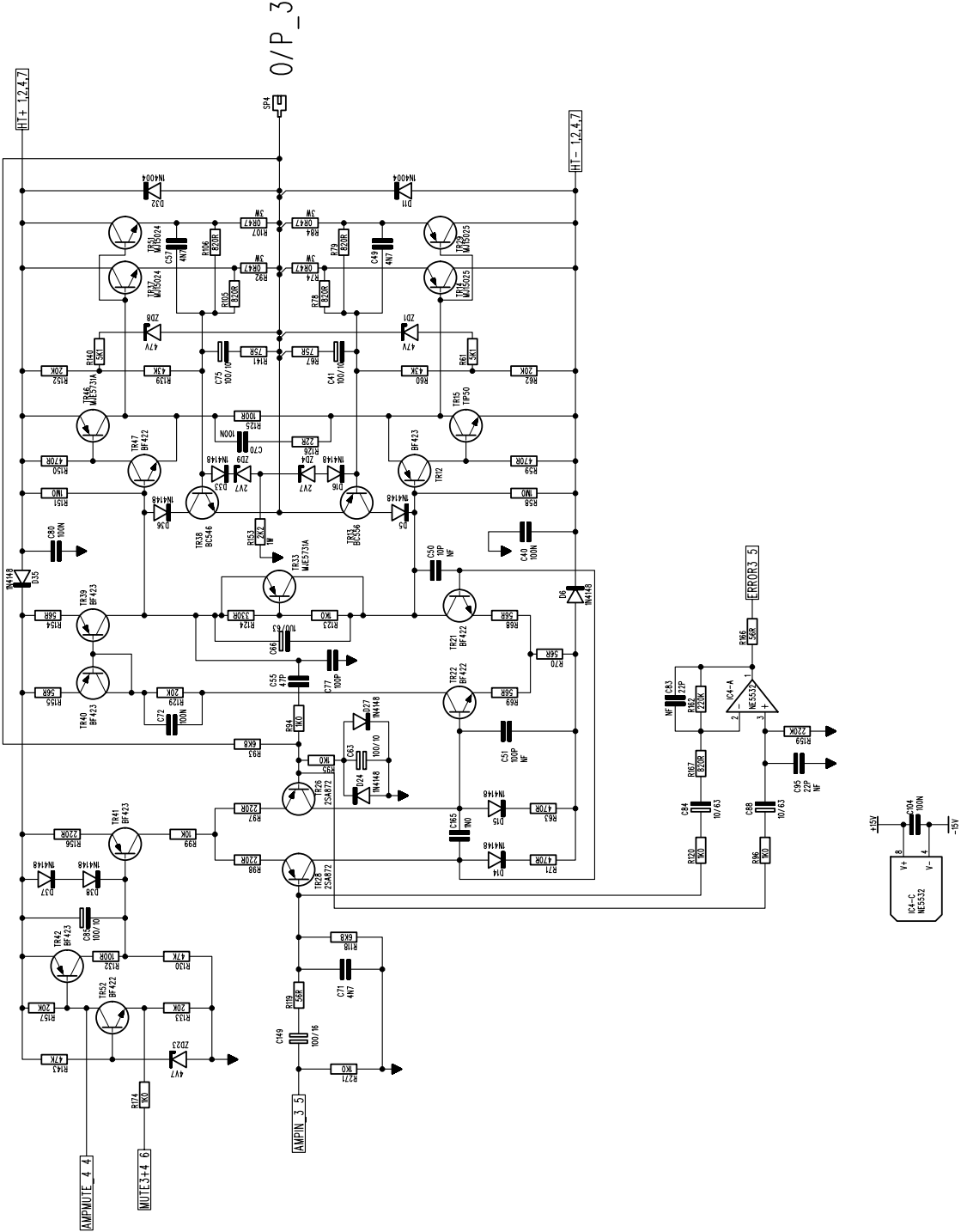
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Fax 01707 660755

TITLE:	PULSE 4x300 AMPLIFIER
SHEET 3	
FILENAME:	S-C300AS-05.SCH
DRAWN:	BPV
DATE:	12-01-99
CHECKED:	

MATERIAL:	
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3. ECN0150 19-04-99
4. TX7 CIRCUIT SYMBOL UPDATED
- 4a. ECN0190 12-07-99
- 4B. ECN0251 15/11/99
- 4c. ECN0624 03/12/99
- 4D. ECN0275 11/01/00
5. ECN0333 05/05/00

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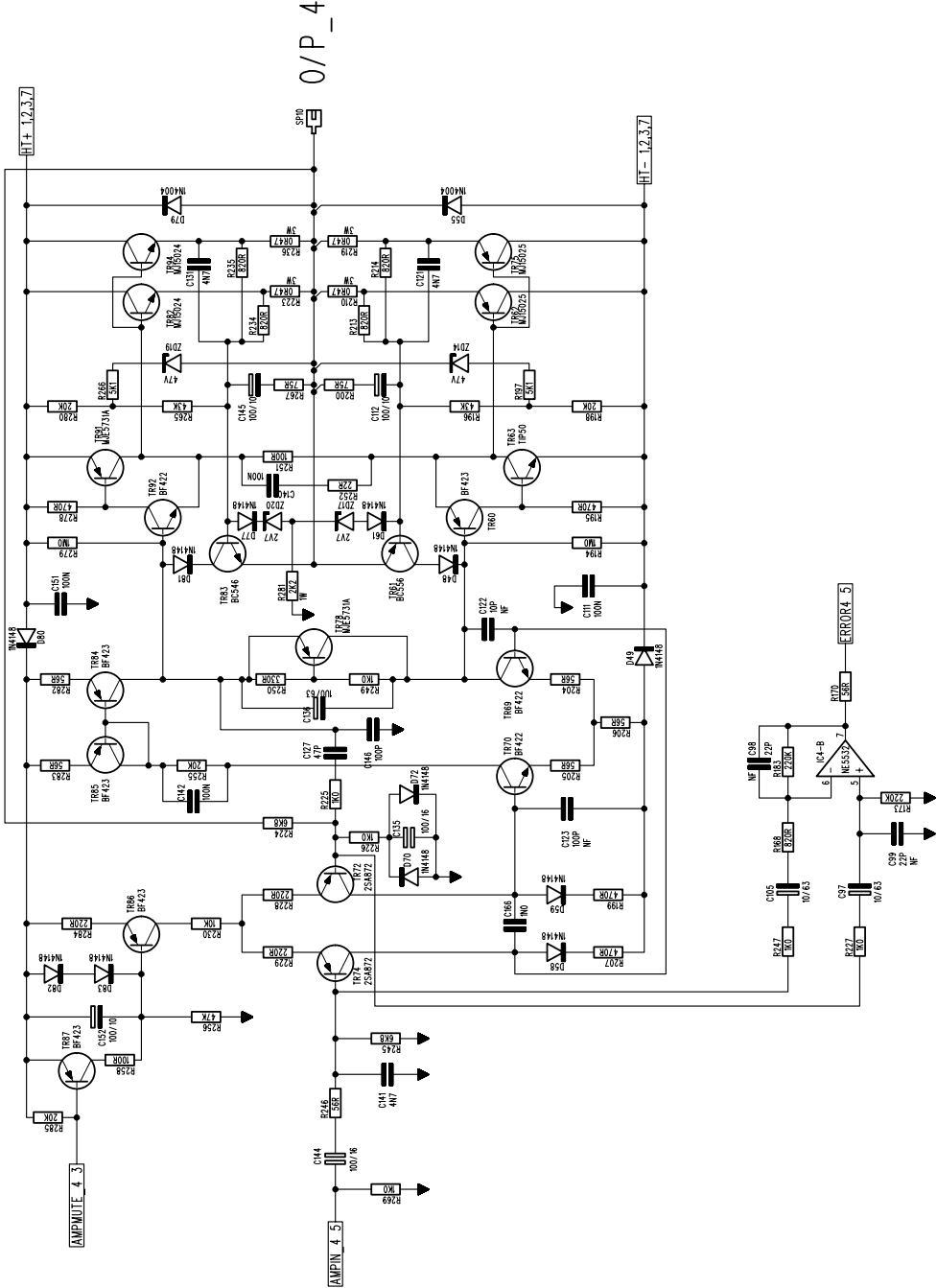
S-C300AS-05



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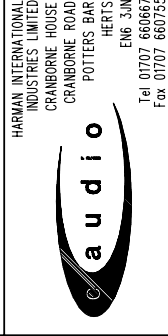
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ISSUE COMMENTS:	1. PRODUCTION RELEASE 12-08-98 2. ECN0128 12-01-99 3. ECN0150 19-04-99 4. TX7 CIRCUIT SYMBOL UPDATED 4a. ECN0190 12-07-99 4B. ECN0251 15/11/99 4c. ECN0624 03/12/99 4D. ECN0275 11/01/00 5. ECN0333 05/05/00
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DRAWING NUMBER

S-C300AS-05



TITLE: PULSE 4x300 AMPLIFIER

SHEET 5

FILENAME: S-C300AS-05.SCH

DRAWN: BPV

DATE: 12-01-99

CHECKED:

MATERIAL:

FINISH:

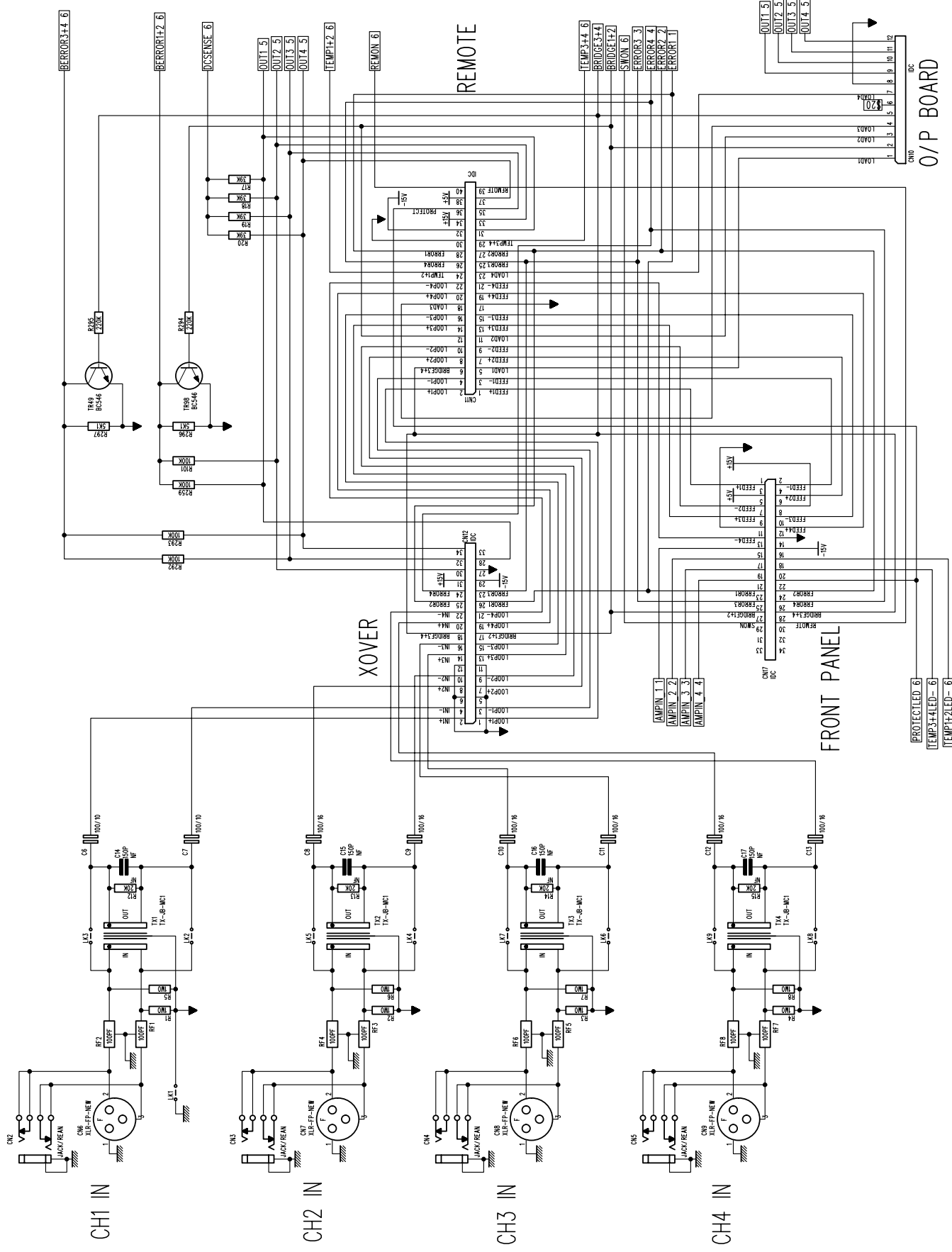
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3. EON0150 19-04-99
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PART NUMBER:

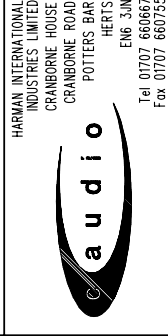
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S-C300AS-05



TITLE: PULSE 4x300 AMPLIFIER

SHEET 6

FILENAME: S-C300AS-05.SCH

DRAWN: BPV

DATE: 12-01-99

CHECKED:

MATERIAL:

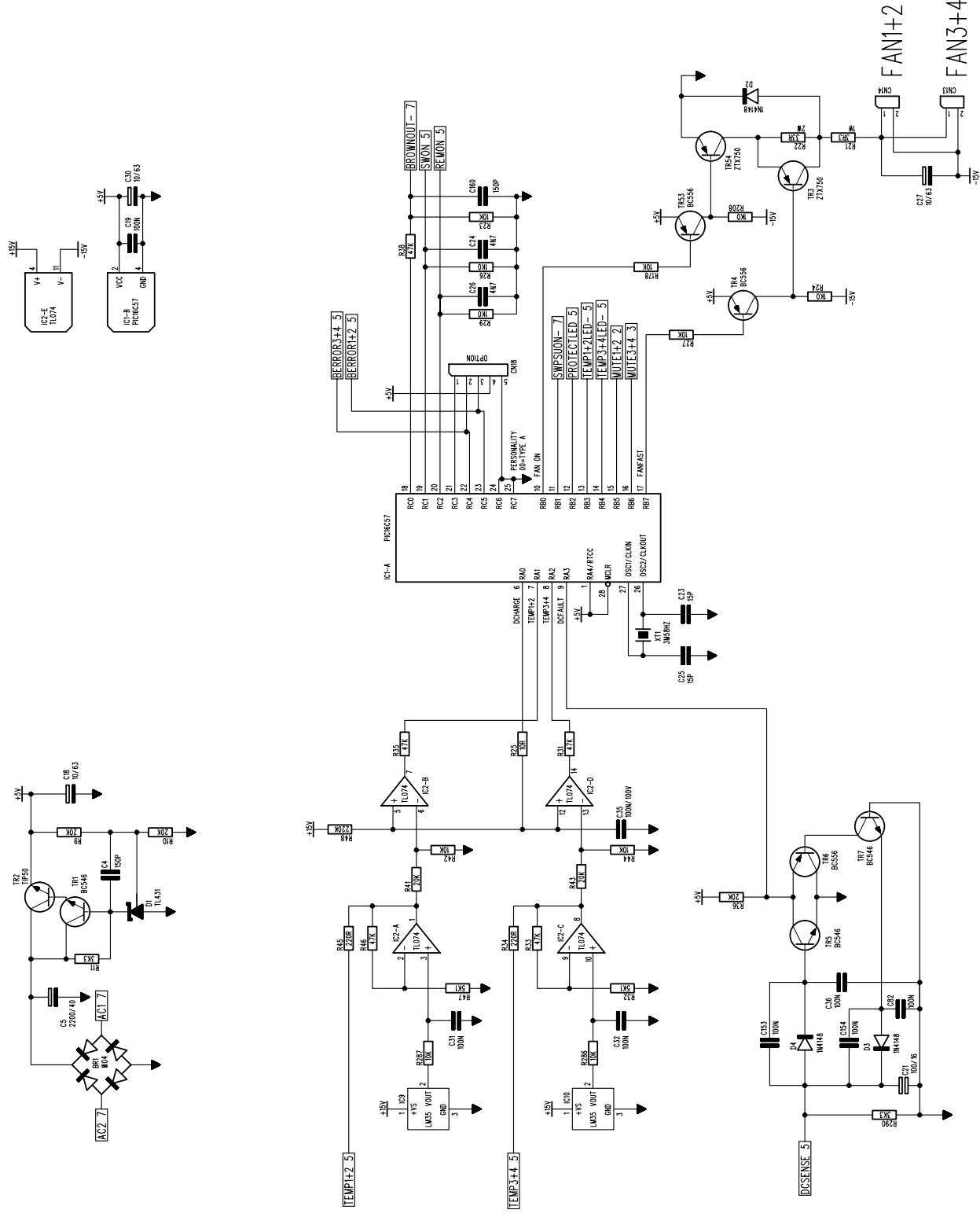
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2. ECN0128 12-01-99
3. ECN0150 19-04-99
4. TX7 CIRCUIT SYMBOL UPDATED
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4c. ECN0624 03/12/99
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5. ECN0333 05/05/00

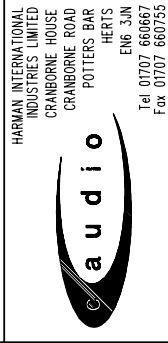
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TITLE: PULSE 4x300 AMPLIFIER

SHEET 7

FILENAME: S-C300AS-05.SCH

DRAWN: BP

DATE: 12-01-99

CHECKED:

MATERIAL:

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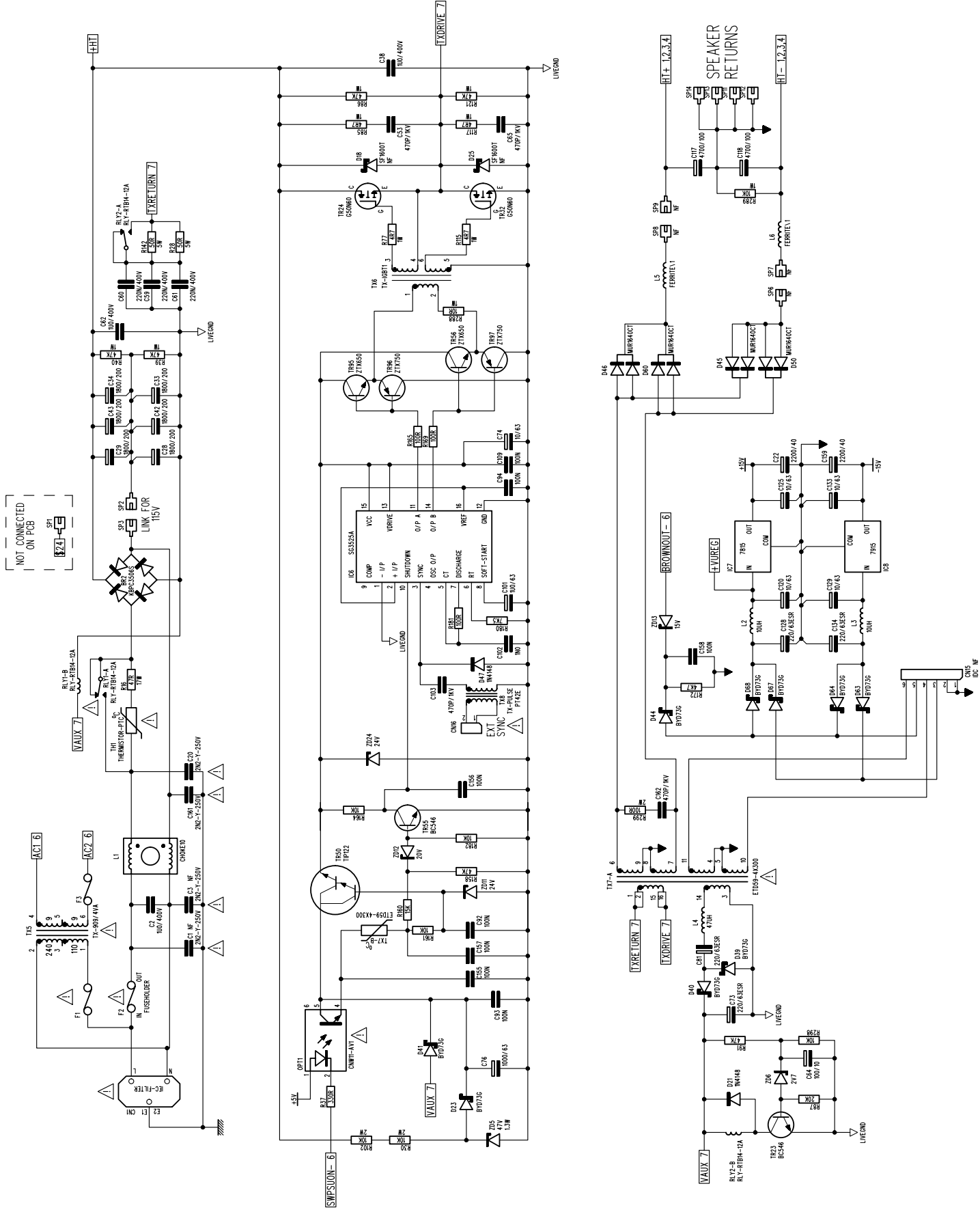
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4. TX7 CIRCUIT SYMBOL UPDATED
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4B. ECN0251 15/11/99
4c. ECN0624 03/12/99
4D. ECN0275 11/01/00
5. ECN0333 05/05/00

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Tel 01707 660667
Fax 01707 660755

TITLE: PULSE 4 x 300
FRONT PANEL

FILENAME:

DRAWN: BPV

DATE: 12-04-99

CHECKED:

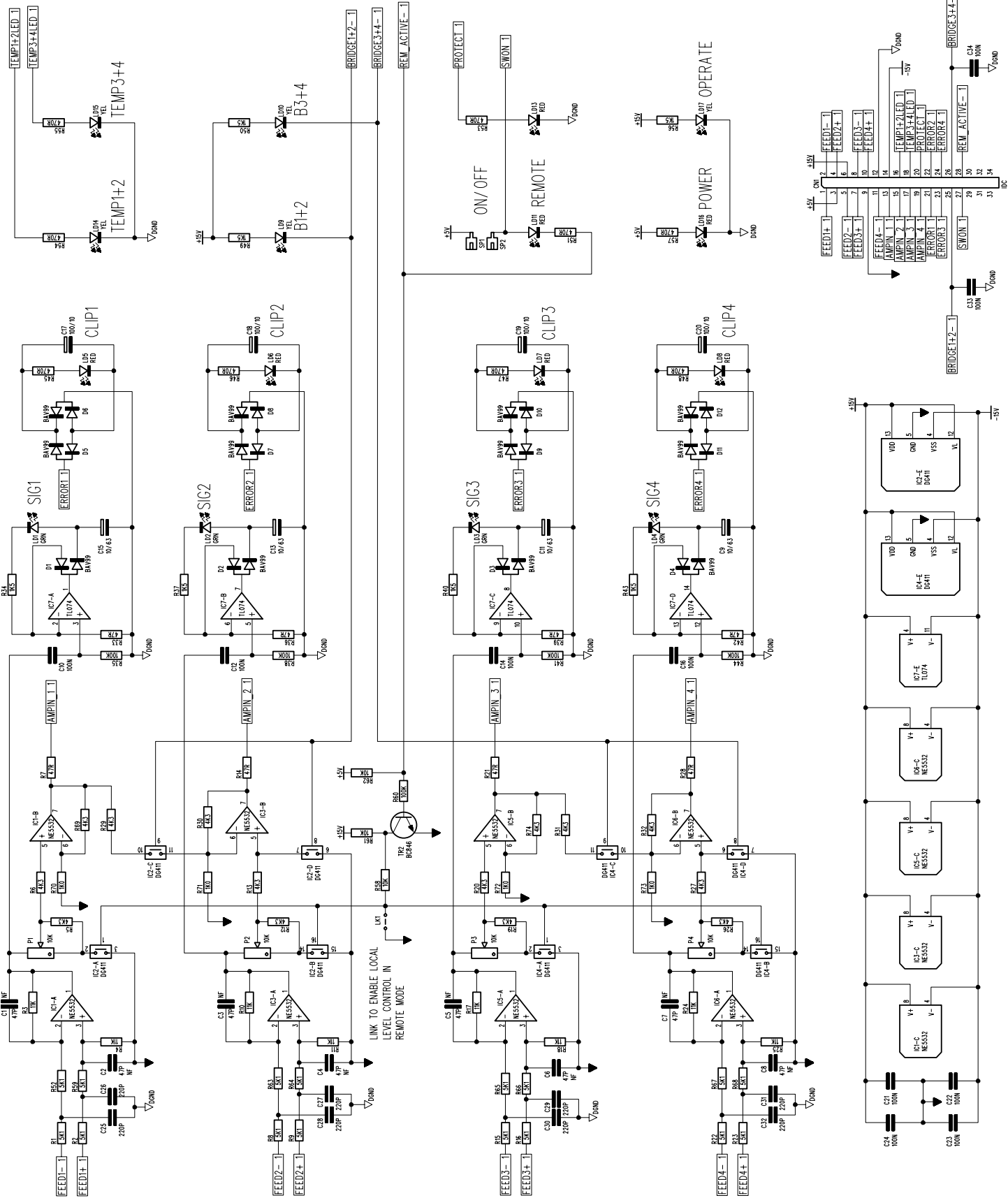
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ISSUE COMMENTS:
1. PRODUCTION RELEASE 12-08-98
2. ECN0128 12-01-99
2a. ECN0186 12-07-99
3. ECN0331 05/05/00


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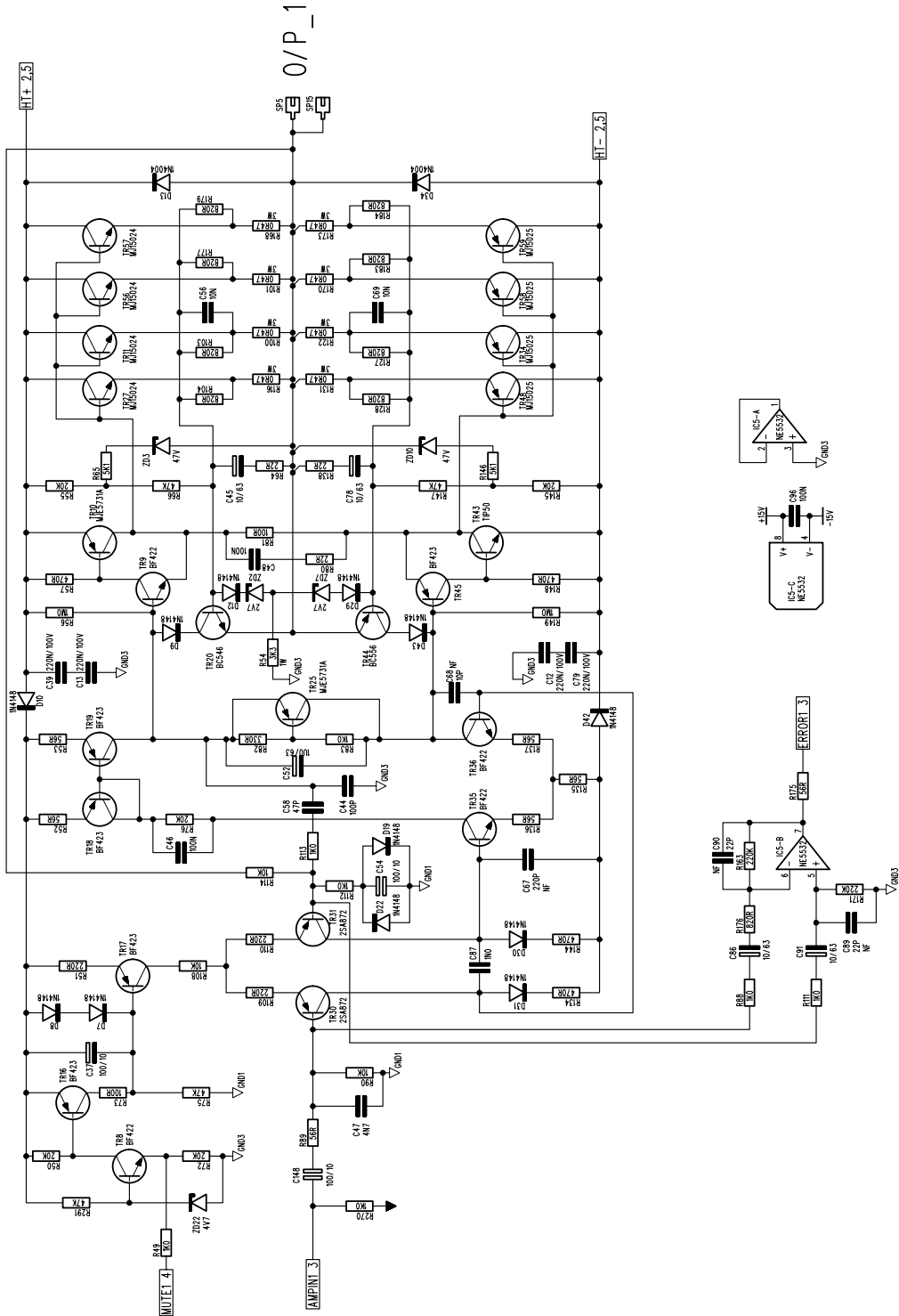
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DATE:	04/01/00
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ISSUE COMMENTS:

1. PRE-PRODUCTION RELEASE 10-05-99
2. PRODUCTION RELEASE 22-06-99
- 2A. ECN203 02/09/99
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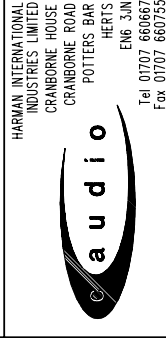
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DRAWING NUMBER

S-C650AS-03



TITLE: PULSE 2x650 AMPLIFIER

SHEET 2

DRAWN: BPV

DATE: 04/01/00

CHECKED:

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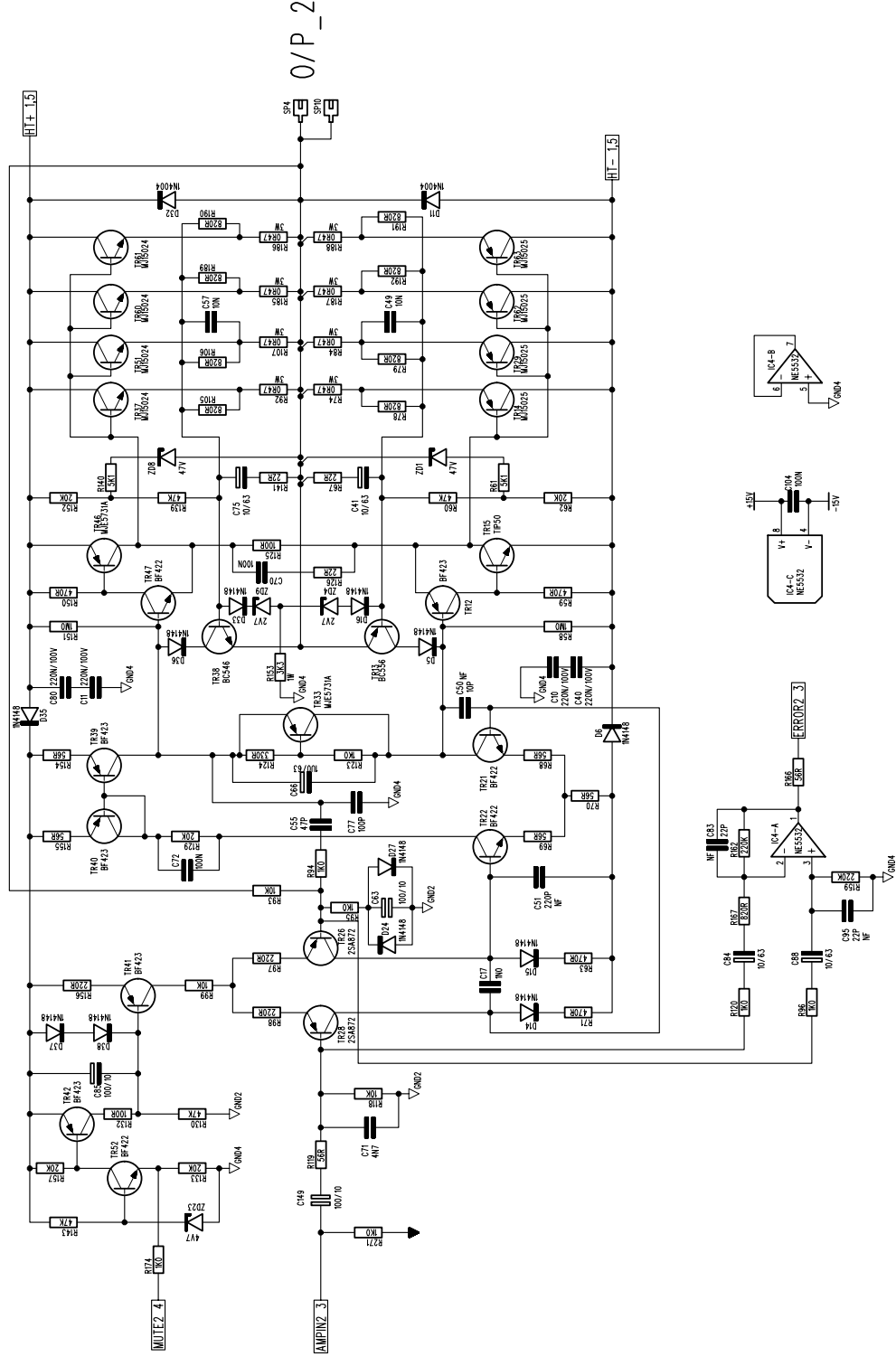
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ISSUE COMMENTS:

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2. PRODUCTION RELEASE 22-06-99
2A. ECN203 02/09/99
2B. ECN251 15/11/99
2C. ECN275 11/01/00
3. ECN0334 05/05/00


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EN6 3JN
Tel 01707 660667
Fax 01707 660755

TITLE: PULSE 2x650 AMPLIFIER

SHEET 3

FILENAME:

DRAWN: BPV

DATE: 04/01/00

CHECKED:

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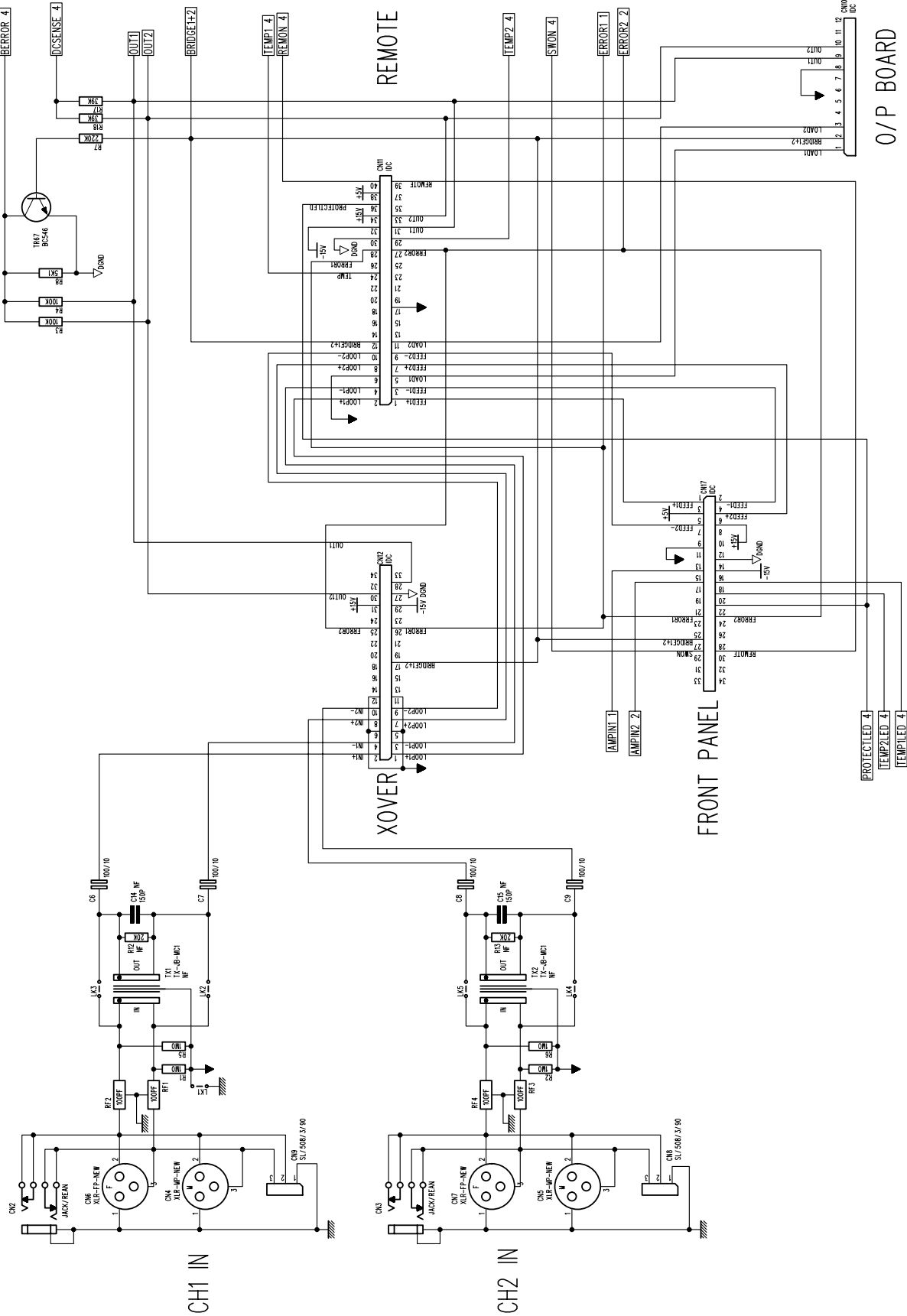
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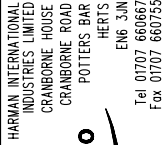
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- 2B. ECN0251 15/11/99
- 2C. ECN0275 11/01/00
3. ECN0334 05/05/00

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TITLE: PULSE 2x650 AMPLIFIER

SHEET 4

FILENAME:

DRAWN:

DATE: 04/01/00

CHECKED:

MATERIAL:

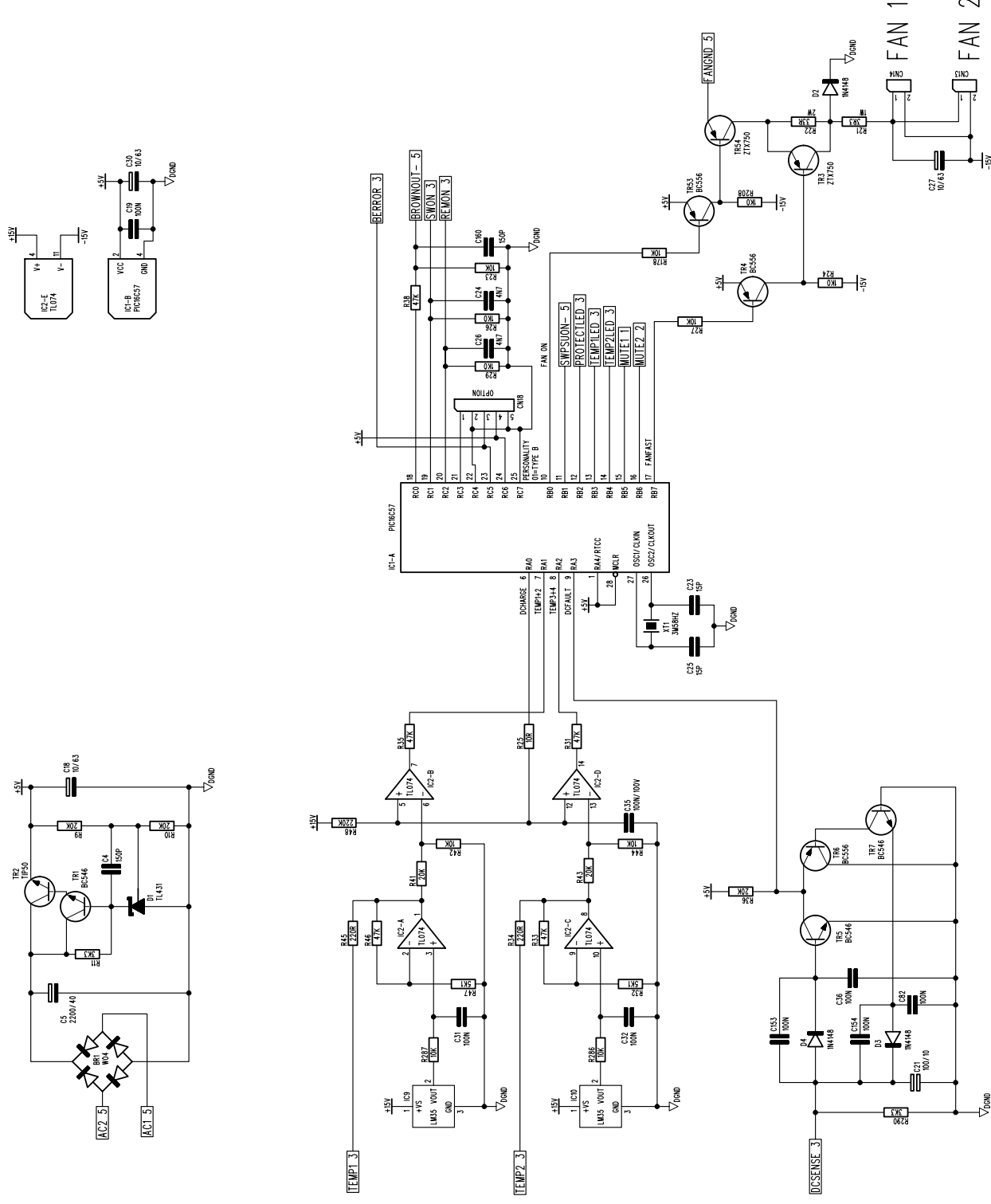
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2A. ECN203 02/09/99
2B. ECN251 15/11/99
2C. ECN275 11/01/00
3. ECN0334 05/05/00

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TITLE: PULSE 2x650 AMPLIFIER

SHEET 5

FILENAME:

DRAWN: BPV

DATE: 04/01/00

CHECKED:

MATERIAL:

FINISH:

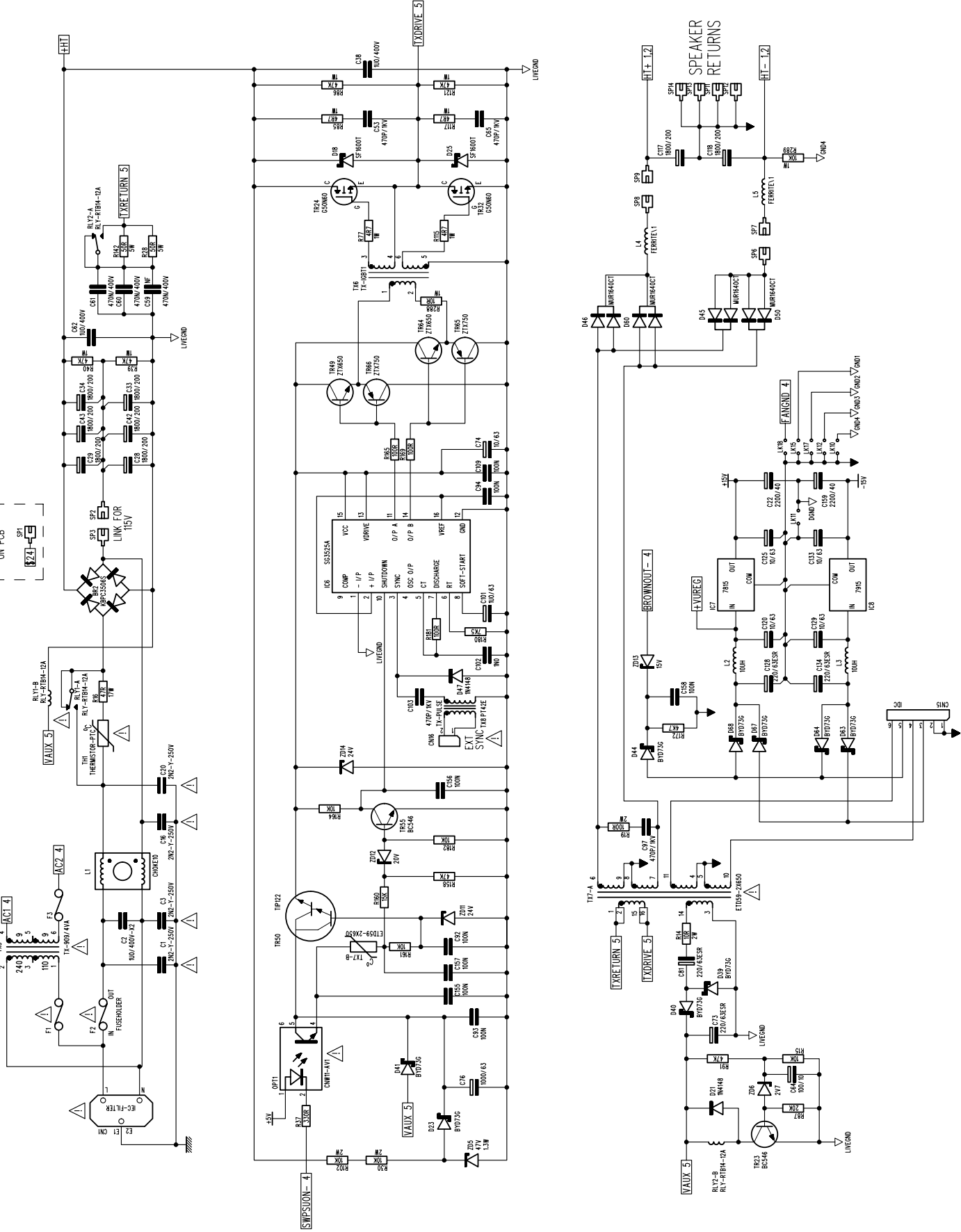
ISSUE COMMENTS:

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2. PRODUCTION RELEASE 22-06-99
- 2A. ECN203 02/09/99
- 2B. ECN0251 15/11/99
- 2C. ECN0275 11/01/00
3. ECN0334 05/05/00

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NOT CONNECTED
ON PCB



DRAWING NUMBER ISSUE

S-C650BS-02B



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CRANBORNE ROAD
POTTERS BAR
HERTS
EN9 3JN
Tel 01707 660667
Fax 01707 660755

TITLE: PULSE 2X650 & 2X1100
SHEET 1 OF 1 FRONT PANEL

FILENAME:

DRAWN: BPV

DATE: 09-02-99

CHECKED:

MATERIAL:

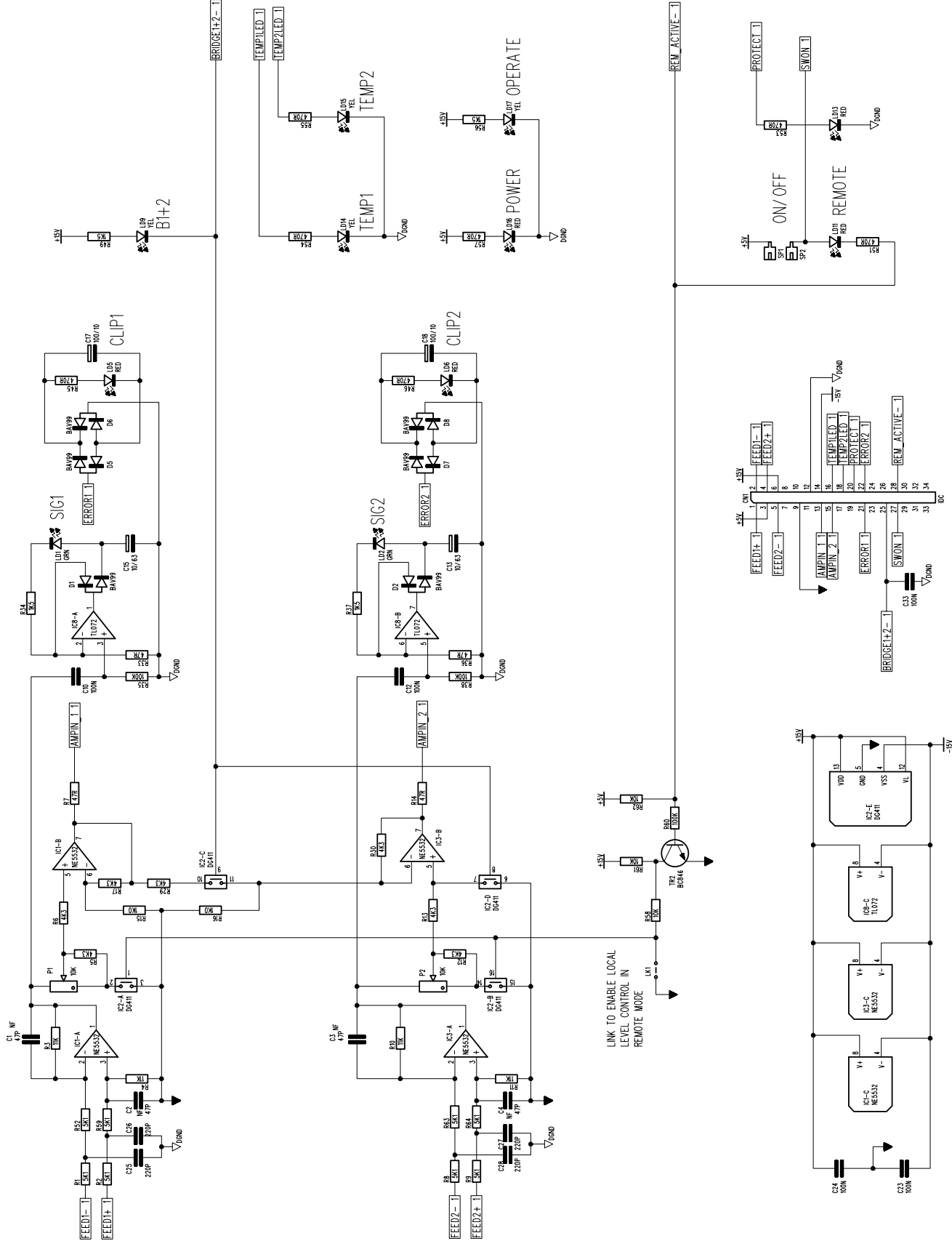
FINISH:

ISSUE COMMENTS:

- 1. PRE-PRODUCTION RELEASE 10-05-99
- 2. PRODUCTION RELEASE 22-06-99
- 2A. EGN204 02/09/99
- 2B. EGN0330 05/05/00


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S-C1100AS-03



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Tel 01707 660667
Fax 01707 660755

TITLE: PULSE 2x1100

SHEET 1

FILENAME: S-C1100AS-03.SCH

DRAWN: BPV

DATE: 8/11/1999

CHECKED:

MATERIAL:

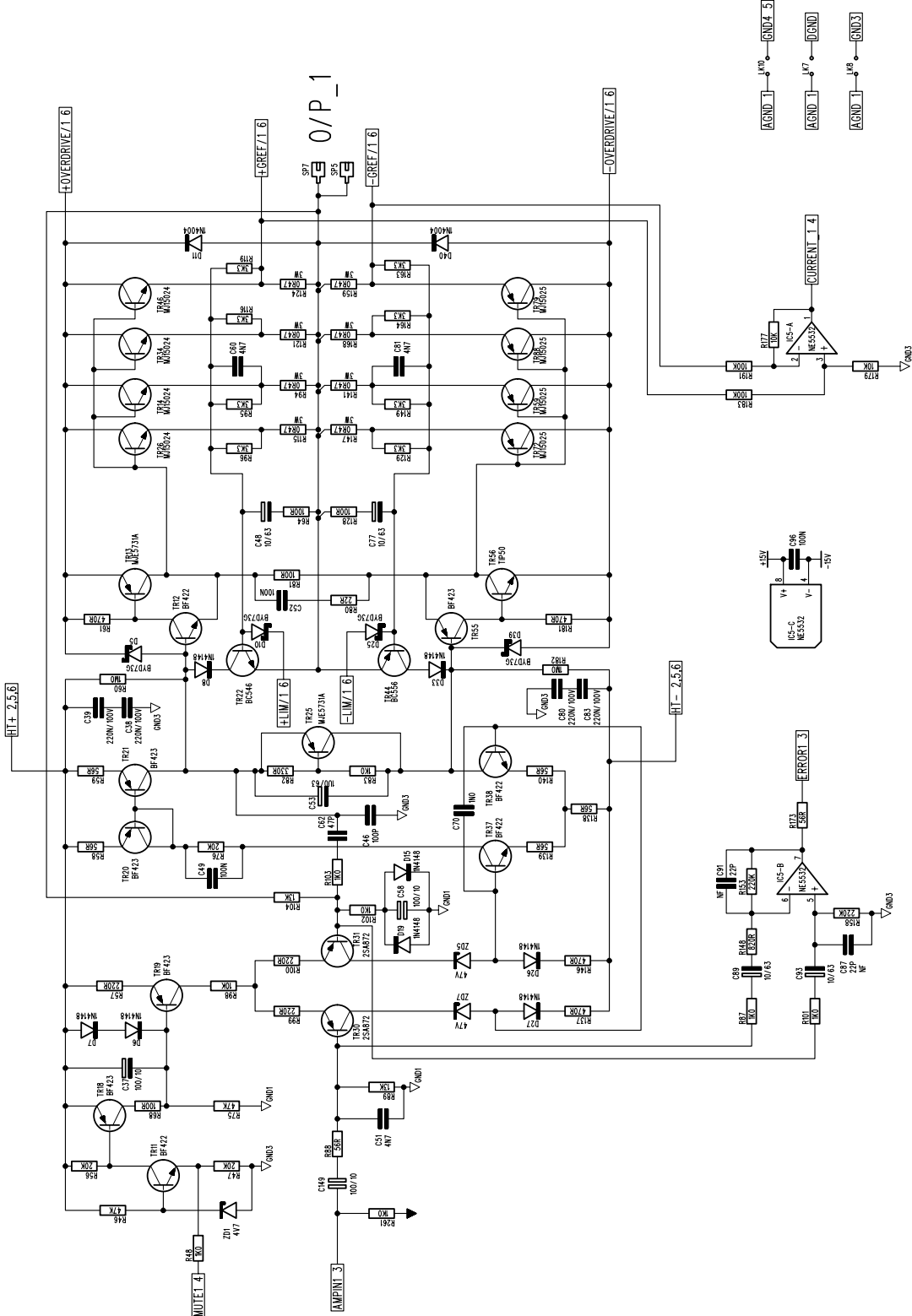
FINISH:

ISSUE COMMENTS:

1. PROTOTYPE
2. PRE-PRODUCTION ISSUE
- 2A. EGN0231 TX5 SYMBOL CORRECTED
- 2B. EGN0251 15/11/99
- 2C. EGN0275 11/01/00
- 2D. EGN0305 02/03/00
3. EGN0335 05/05/00


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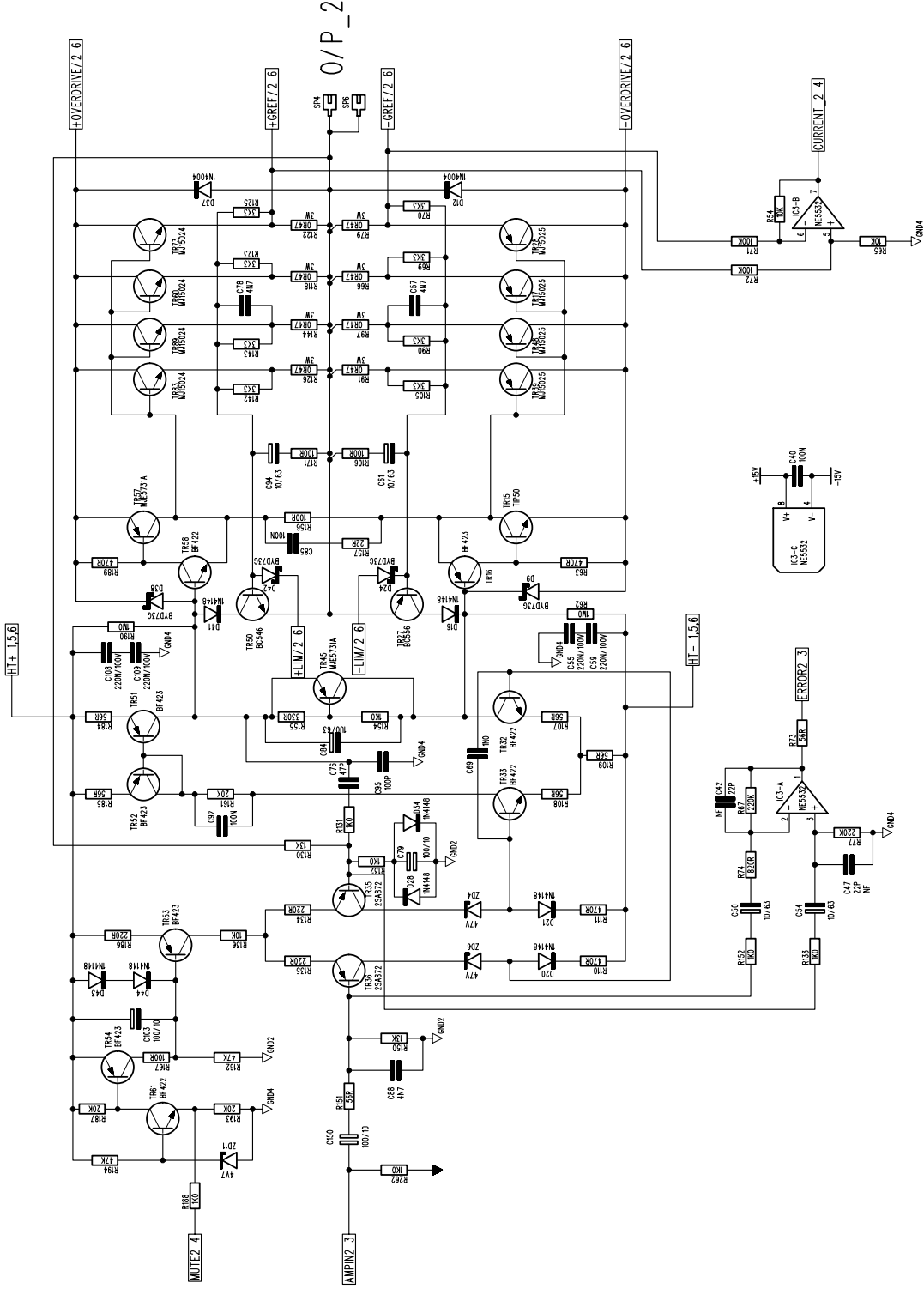
S-C1100AS-03



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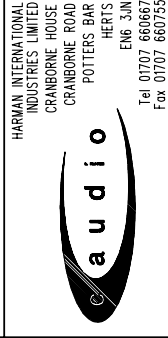
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DRAWING NUMBER

S-C1100AS-03



TITLE: PULSE 2x1100

SHEET 4

FILENAME: S-C1100AS-03.SCH

DRAWN: BPV

DATE: 8/11/1999

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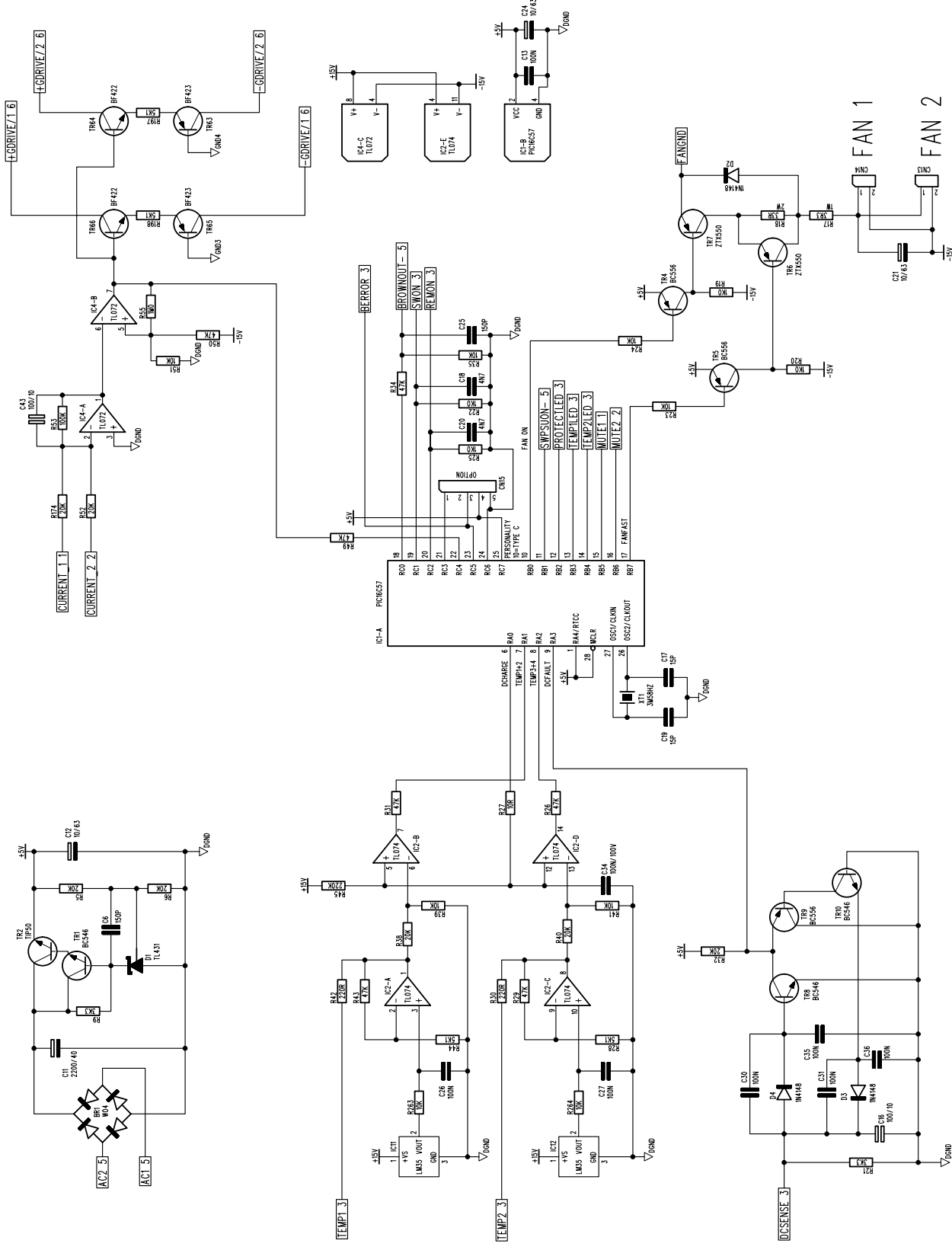
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2. PRE-PRODUCTION ISSUE
2A. ECN0231 TX5 SYMBOL CORRECTED
2B. ECN0251 15/11/99
2C. ECN0275 11/01/00
2D. ECN0305 02/03/00
3. ECN0335 05/05/00

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S-C1100AS-03

audio

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Tel 01707 660667
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TITLE: PULSE 2x1100

SHEET 5

FILENAME: S-C1100AS-03.SCH

DRAWN: BPV

DATE: 8/11/1999

CHECKED:

MATERIAL:

FINISH:

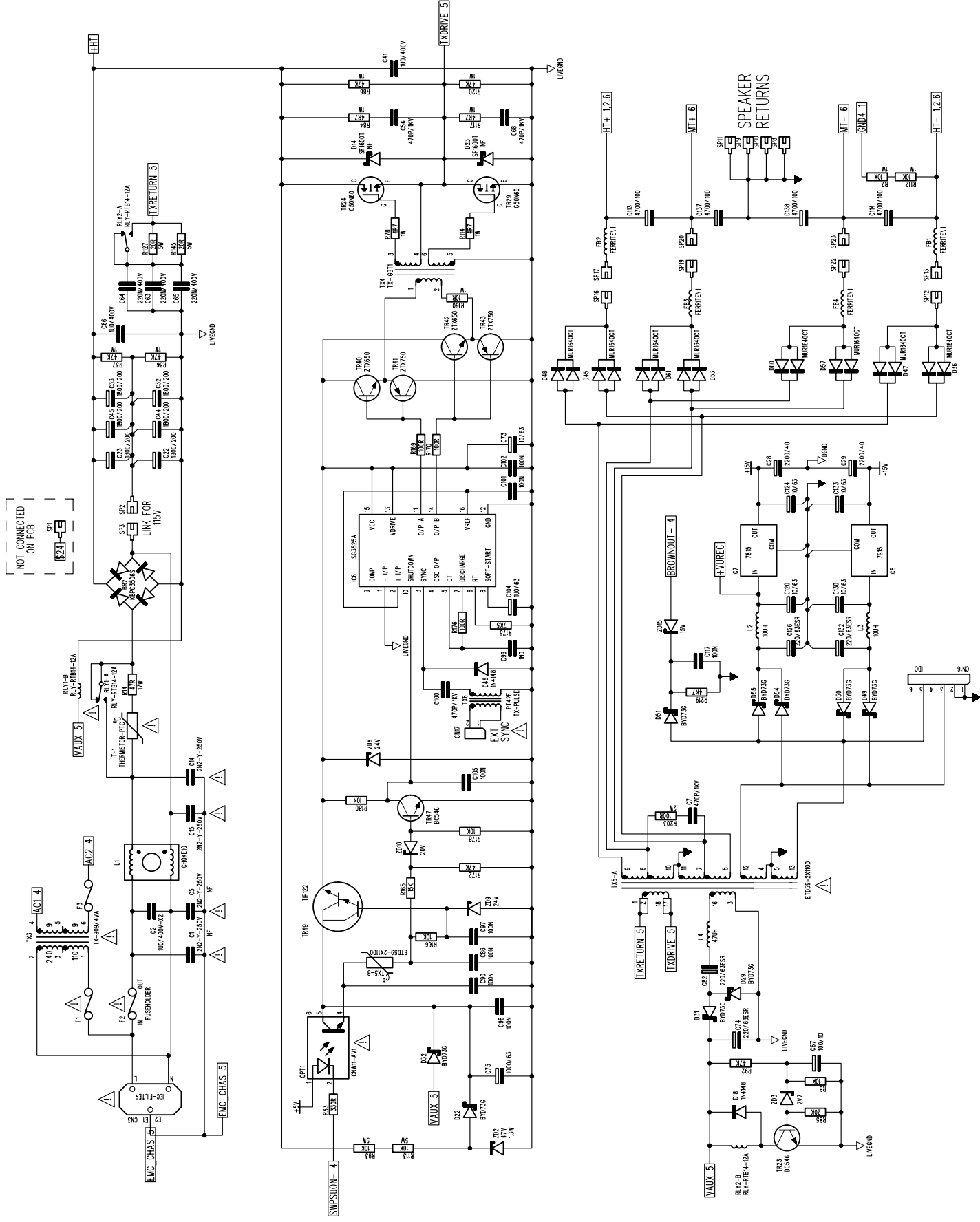
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DRAWING NUMBER

ISSUE

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Tel 01707 660667
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TITLE: PULSE 2x100

SHEET 6

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DRAWN: BPV

DATE: 8/11/1999

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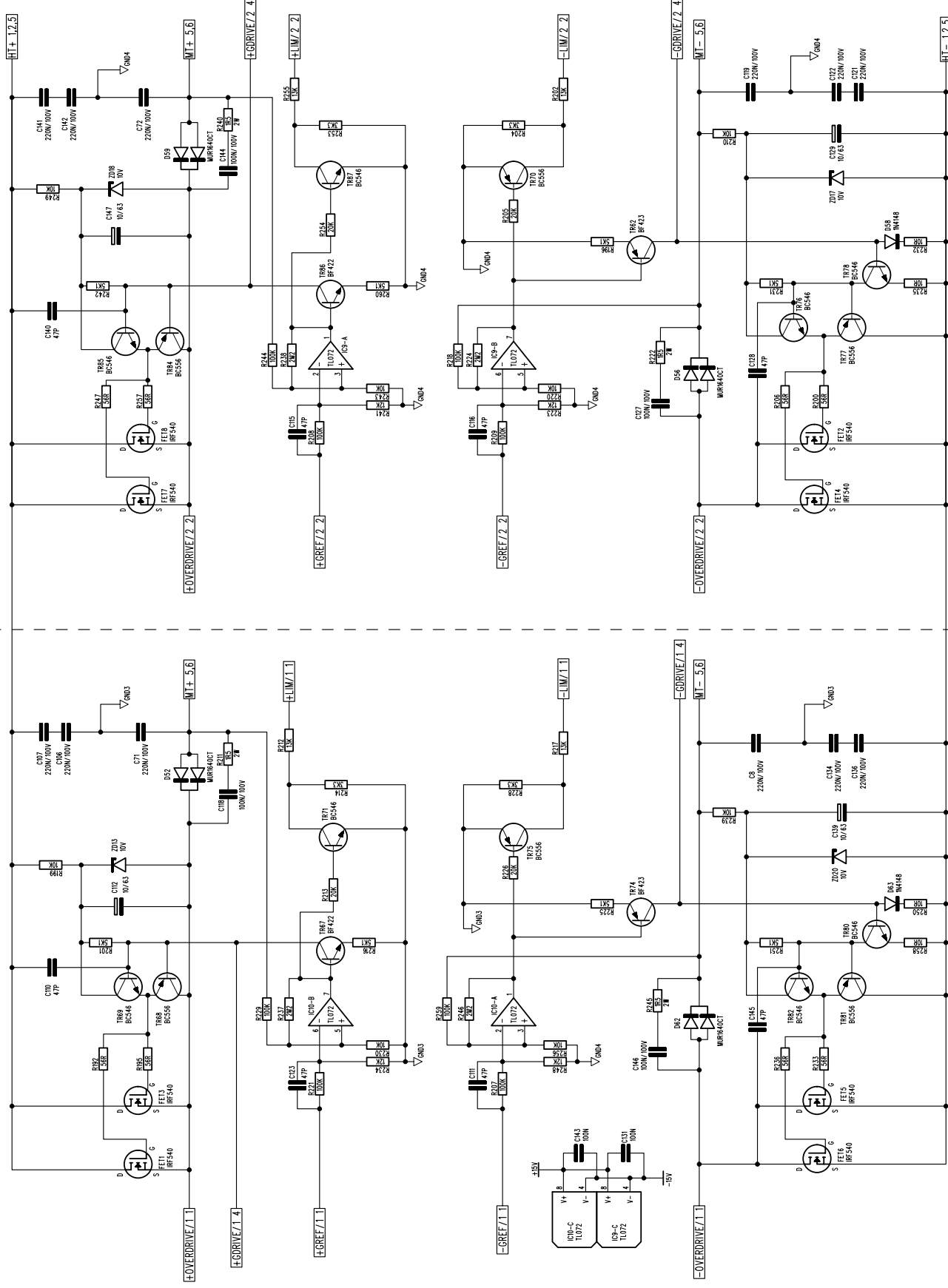
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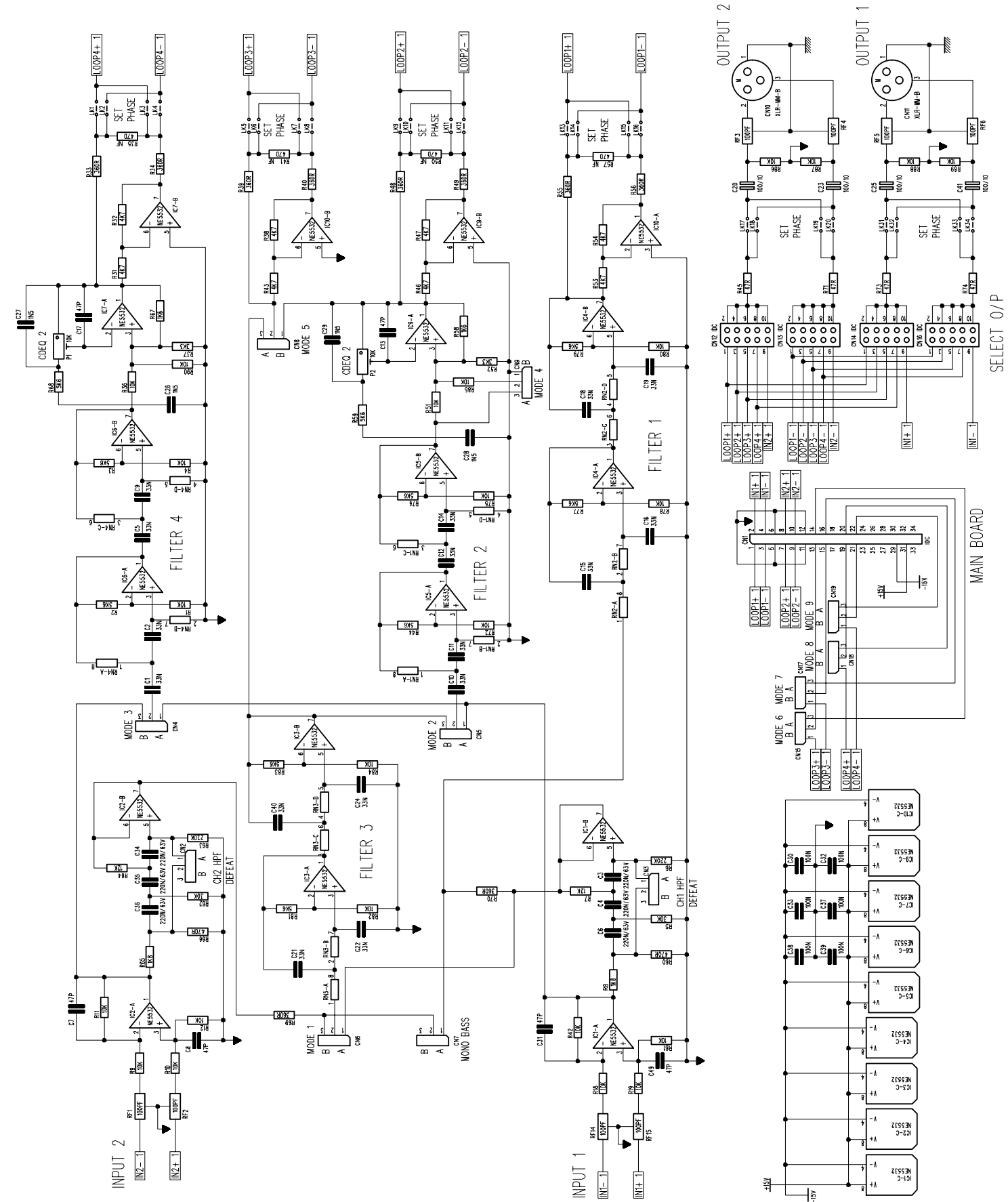
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Crown Pulse Series Service Documentation

The information furnished in this manual does not include all of the details of design, production, or variations of the equipment. Nor does it cover every possible situation which may arise during installation, operation or maintenance. If you need special assistance beyond the scope of this manual, please contact the Crown Technical Support Group.

1718 W. Mishawaka Road Elkhart IN 46517
Phone: (800) 342-6939 / (219) 294-8200
FAX: (219) 294-8301

CAUTION

TO PREVENT ELECTRIC SHOCK DO NOT REMOVE TOP OR BOTTOM COVERS. NO USER SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL. DISCONNECT POWER CORD BEFORE REMOVING REAR INPUT MODULE TO ACCESS GAIN SWITCH.

AVIS

À PRÉVENIR LE CHOC ÉLECTRIQUE N'ENLEVEZ PAS LES COUVERTURES. RIEN DES PARTIES UTILES À L'INTÉRIEUR. DÉBRANCHER LA BORNE AVANT D'OUVRIER LA MODULE EN ARRIÈRE.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE!



The lightning bolt triangle is used to alert the user to the risk of electric shock.



The exclamation point triangle is used to alert the user to important operating or maintenance instructions.

Cautions and Warnings



Exclamation Mark Symbol:

This symbol is used to alert the user to make special note of important operating or maintenance instructions.



Lightning Bolt Symbol:

This symbol is used to alert the user to the presence of dangerous voltages and the possible risk of electric shock.



DANGER: The outputs of the amplifier can produce LETHAL energy levels! Be very careful when making connections. Do not attempt to change output wiring until the amplifier has been off at least 10 seconds.



WARNING: This unit is capable of producing high sound pressure levels. Continued exposure to high sound pressure levels can cause permanent hearing impairment or loss. User caution is advised and ear protection is recommended when using at high levels.



WARNING: Do not expose this unit to rain or moisture.



WARNING: Only properly trained and qualified technicians should attempt to service this unit. There are no user serviceable parts inside.



WARNING: When performing service checks with the power off, discharge the main power supplies fully before taking any measurements or touching any electrical components. A 300-ohm 10-W resistor is recommended for this. Hold the resistor with pliers, as the resistor may become extremely hot.



CAUTION: Under load, with a sine wave signal at full power into both channels, the amplifier may draw in excess of 30 amperes from the AC service mains.



CAUTION: When performing tests, do not connect any load to the amplifier until instructed to do so. There is no danger to the amplifier in operating without any load (open outputs).



WARNING: Do not change the position of the mode switches when the amplifier is turned on. If the position of these switches is changed while the amplifier is powered, transients may damage your speakers.



WARNING: Heatsinks are not at ground potential. Simultaneously touching either heatsink and ground, or both heatsinks will cause electrical shock.



CAUTION: Eye protection should be worn at all times when protective covers are removed and the amplifier is plugged in.



CAUTION: When performing tests that require a load, the load must be resistive and must be capable of handling 1000 W (per channel).



CAUTION: Disconnect the power cord before installing or removing any cover or panel.



CAUTION: Electrostatic discharge will destroy certain components in the amplifier. Technicians must have approved ESD protection. Proper grounding straps and test equipment are required.

Circuit Theory, Pulse Series

Introduction

This section is intended to assist maintenance and service of the Pulse family of amplifiers. Component references detailed are for channel 1. Operation of channel 2, 3, and 4 is identical except where explicitly noted.

Switch mode power supply

Mains power is brought in through a small, filtered IEC inlet; the purpose of this filter is to attenuate any high frequency noise produced by the SMPS, conducting back down the mains inlet.

The chassis fuse protects the system in the event of failure or severe abuse by the user.

A second, large, common mode inductor and two small Y capacitors, provide attenuation of relatively low frequency (100kHz – 1MHz) noise, conducting back down the mains.

An inrush limiting power resistor (R16), is used to prevent mains current inrush. The resistor is protected by a PTC thermistor (TH1) and once the SMPS is running, a relay (RLY1) closes over, shorting out the resistor and PTC and allowing normal operation. The bridge rectifier (BR2) is used with a bank of 6 1800uF/200V capacitors (C28, C29, C33, C34, C42 & C43), to produce 320V DC.

The SMPS control electronics is powered by the output of the SMPS; therefore in order to start the SMPS, a boot supply is used. The boot supply comprises of R30 and R102 (10K/2W), C76 (1000uF/63) and ZD5 (47V). C76 is charged up to 47V via R102 and R30 from the 320V rail, this then powers the control electronics until SMPS operation has started and can keep itself running. It takes approximately 4 seconds to charge C67 and the SMPS cannot be switched on until this capacitor has been fully charged. The purpose of the SMPS control electronics is to provide 85kHz switching waveforms to a pair of power IGBTs (TR24 and TR32) the micro-controller turns on the control electronics through an opto-coupler (OPT1).

When told to start by the microprocessor, all secondary supplies of the SMPS are off, and both soft start relays are open. Immediately after being told to start, the IGBT's are producing a power square wave, which is applied to the power transformer, initially through two 50R/5W resistors (R28, R142). The function of these resistors is to limit the start up current through the IGBT's. Approximately 50mS after start up, the secondary rails are present and the SMPS is powering its own control electronics, at this point the input soft start relay RLY1 will close. Approximately 100mS after RLY1 closes the relay (RLY2), across R28, and R142 will close and at this point the SMPS is fully up and running.

All secondary voltages are produced by rectification of the square wave from the IGBT's.

The power amplifier consists of a fairly conventional Class A driver stage driving a Class AB bipolar output stage. Each stage will be dealt with individually.

Input Stage

Class A Driver

The input signal returned from the level control is fed via DC blocking capacitor C143 and R221. DC bias current for the Class A input stage is supplied via R222, while 4n7 capacitor C116 prevents any extreme high frequency input signals from reaching the power amplifier and also provides a low source impedance at high frequencies to ensure frequency stability.

The first stage of the class A driver consists of TR76 and TR77 configured as a long tailed pair differential amplifier. Emitter resistors R238 and R239 de-sensitize the performance of the input stage to parametric variations of the two input transistors. The quiescent current for the input stage is delivered by current source TR65. Diodes D51 and D52 provide a reference voltage of approximately 1.2V, which is applied to the base of TR65. Approximately half of this (0.6V) will then appear across R187 (220R), which then sets the current, sourced from TR65 collector at approximately 2.7mA. In the quiescent state half of this current is driven through TR76 and TR77. Hence the voltage dropped across emitter resistors R238 and R239 will be approximately equal at 75mV.

Overall voltage feedback of the amplifier is derived through R243 and R241. R242 and C20 provide local feedback around the Class A section only to define the dominant pole of the amplifier. C126 connected in series with R241 gives 100% DC feedback to minimize any DC offset at the output. The resultant feedback signal is applied to the base of TR77.

The collector currents of TR76 and TR77 are fed via D76 and D75 to R260 and R272 respectively. Hence, in the quiescent state, R260 and R272 should each exhibit a voltage drop of 1.35V or so.

Under normal conditions the signals at the bases of TR76 and TR77 will be identical. However, under fault conditions, such as a DC offset at the output, the base voltages will become offset also. For example, in the event of a large DC offset of +50V at the output, a positive DC voltage will appear at the feedback point and hence at the base of TR77. Although this would, in theory, be the full +50V, owing to C126 being rated at only 16V, the voltage will, in practice, be somewhat lower. However, the important issue is that the voltage is positive. In the event the voltage is negative this indicates that the feedback network is faulty (most likely R243 itself). The voltage at TR77 base being positive whilst the base of TR76 is close to 0V will then reverse bias TR77 base-emitter hence turning off the transistor. Hence, no voltage should appear across R239 and R272 while double the normal voltage will appear across R238 and R260 (150mV and 1.3V respectively). Should this not be the case, it indicates a fault in the input stage itself.

The output of the input long-tailed-pair (i.e. the voltages at the anodes of D76 and D75) are fed to a second long-tailed-pair TR80 and TR81. The bias current for this stage, is set by resistor R261 thus; D76 drops approximately the same voltage as the base-emitter junction of TR80. The same can be said of D75, and the base-emitter junction of TR80. This sets a current of about 5.75mA, split between TR80 and TR81. C137 and C138 provide a little Miller Feedback around TR80 and TR81 respectively. These capacitors can be important to the stability of the amplifier but do not define the dominant pole. It should also be noted that either of these capacitors becoming "leaky" (difficult to measure in circuit) will result in a DC offset at the output. The collector of TR81 drives the output stage in conjunction with the collector of TR67 while the collector of TR80 drives current mirror TR66/TR67 via R212. In the quiescent state R212 will show a voltage drop of around 52V, and the current mirror emitter resistors R188 R189 and will show equal voltage drops of 145mV. Hence, for the same +50V DC offset, described earlier, one would expect no voltage drop across any of R212, R188 or R189, indicating that the feedback is attempting to correct the fault. Likewise, for a negative DC offset one would expect these voltages to be twice their usual value. If this is not the case then the second stage (TR80-TR67) is at fault. The collectors of TR81 and TR67 are joined to form the output of the class A driver by the Vbe multiplier - R128, R127 and TR71 (mounted on the heatsink) bypassed at AC by C124 - which sets the output stage bias. The bias voltage across the Vbe multiplier should range between 2.4V (heatsink warm) and 2.5V (heatsink cold). Bias voltages outside this range indicate a fault with the Vbe multiplier and/or a fault in the second long-tailed pair (TR80 - TR81, R261, R212, R188, R189). For example, too small a bias voltage could be caused by: R261 being high, R189 being high, R127 being low, TR71 being faulty etc. Too high a bias voltage is rare, and would, most likely, be caused by a faulty transistor or resistor in the Vbe multiplier circuit.

C132 is very important for ensuring HF Stability. A faulty capacitor in this position will usually cause excess distortion and in the case of anything less than 100pF can reveal a very spiky instability.

Output Stage

The output stage consists of a symmetrical Siklai follower - TR89-TR59, R189, R29A, R35A, R56A and C21A - generating the high current drive required for the parallel connected symmetrical follower output stage TR57, TR73, TR79, and TR93, R231, R244, R248, R257. V-I limiting is controlled by TR90, TR68B, R36A-R43A, C1A, C2A, R212, R25A-R27A, R30A, R33A, R55A, D7A-D9A, D11A, ZD76-ZD6A. As the output stage is symmetrical, the positive half only will be described (Q13A-Q16A, R44A-R47A, C2A, TR68A, R36A-R39A, R25A, R26A, R30A, R55A, D8A, D11A, ZD76, ZD5A).

Output stage protection is accomplished by a three-slope V-I limiting circuit which has limiting characteristics chosen to emulate the Safe operating area of the output stage transistors at their maximum operating temperature.

The V-I limiting works by controlling TR68A: when the base-emitter voltage of TR68A exceeds about 0.65V then TR68A turns on and steals current, via D8A, from the input of the output stage and thereby limiting the output. So, V-I limiting is controlled by controlling the base-emitter voltage of TR68A.

Each output device has its own current sharing resistor - R44A-R47A - the voltage across which is proportional to the current flowing in the output device. These voltages are sampled and summed by R36A-R39A. C2A ensures stability when V-I limiting is activated.

The voltage across the output devices is sampled by R25A and R26A (R30A and ZD5A limit the voltage range to reduce off-load distortion) and this, summed with the output current derived signals from R36A-R39A, controls TR68A for output voltages

less than about 3Vpk. Thus the amplifier is protected for short circuits because the base-emitter voltage of TR68A increases when output current increases and when voltage across the output devices increases.

For output voltages exceeding about 3Vpk, ZD76 conducts connecting R55A to sense the output voltage. In this case, as output voltage increases, the base-emitter voltage of TR68A reduces, thus the current limit is increased as the output voltage increases, defining the third slope of the limiting characteristic.

“Peak” LED circuit

The “peak” LED (LED1A) is driven in series with the Limiter LED (LED2A) from the output of the amplifier via D13A with its threshold controlled by ZD7A and R58A. With no signal present, ZD7A and R58A generate a reference voltage at the anode of ZD7A, which is 18V below the +HT supply rail. All the current flowing through R58A comes from ZD7A. To turn the LED's on, the amplifier is required to produce an output voltage approximately 5V above the reference, at which point ZD7A is no longer in breakdown and the current flowing through R58A comes from the output stage via D13A, LED1A and LED2A. Thus the “peak” LED threshold and the “Clip Limiter” threshold vary with the +HT voltage and thus the output loading conditions.

Protection System

The protection system is based around IC1, a TL074 quad op-amp. The temperature of the heatsink is monitored by TH1, an LM35DZ temperature sensor integrated circuit producing 10mV / °C. The temperature signal is then multiplied by 10 by one op-amp (pins 8,9,10) & R16,R17. The output (pin 8) is fed directly to pins 6 & 13 serving as a temperature dependent (0.1V / °C) reference for two comparator circuits - one (pins 5, 6, 7) controls the relays and the other (pins 12, 13, 14) controls the fan speed.

The Fan can run at two speeds, the changeover happening at about 55 °C. R9 and ZD2 produce a reference voltage of 9.1V at the cathode of ZD2. This is divided by R18 & R19 to give about 5.5V at pin 12, the non-inverting input, which is compared with the temperature signal at pin13, the inverting input.

1. Temperature signal is less than 5.5V: the output of the op-amp will be high (+24V), turning Q1 off and therefore Q2 off. The fan speed is controlled by R21 which forces approximately half speed.
2. Temperature signal is more than 5.5V: the output of the op-amp will be low (-5.6V), turning Q1 on and therefore Q2 on. R21 is now effectively shorted out by Q2 and the fan runs at full speed.

At turn-on C16 will charge through R9 and R10 towards the 9.1V reference (ZD2). The voltage is fed to the non-inverting input (pin 5) of op-amp at pins 5, 6, 7 configured as a comparator with hysteresis (D9 and R11). The reference for the comparator is set by the temperature reference which is about 2.5V at room temperature (25 °C). When the voltage across C16 exceeds the temperature reference, the op-amp output will swing high (+24V) and turn Q3 on via current limiting resistor R13. When Q3 is on, it pulls current through the coils of RLY1 (soft-start) and RLY1A, RLY1B on the output board. This also means that the collector of Q3 will swing low (close to 0V) effectively shorting out R15 and LED2 to turn LED2 (Protect, Yellow) off.

Output Connections

The output of the amplifier is connected to Zobel Network R12A/C8A. This network presents a defined load impedance to the output stage at high frequencies to ensure stability. Either of R12A or C8A being faulty will result in the amplifier oscillating at high frequency, which may also be evidenced by mains "hum" and/or distortion at the output. This signal is fed via output choke L1A which isolates any load capacitance from the amplifier feedback to ensure stability. The output is then fed through output relay RLY1A and on to the rear panel output connectors.

Pulse Checkout Procedures

- [1 Dissassembly for Service](#)
- [2 Checkout Procedures](#)
- [3 Post Testing Procedure](#)

Observe all [Cautions and Warnings](#) when servicing this amplifier.

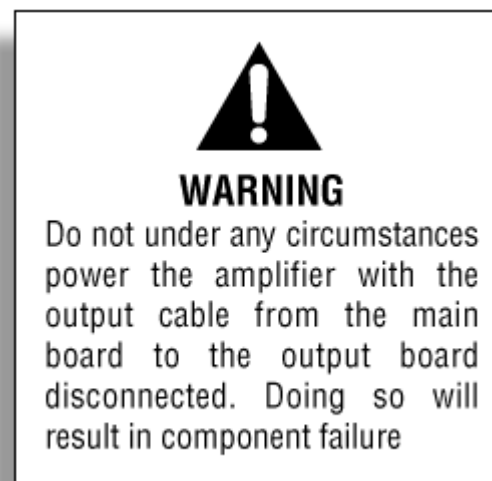
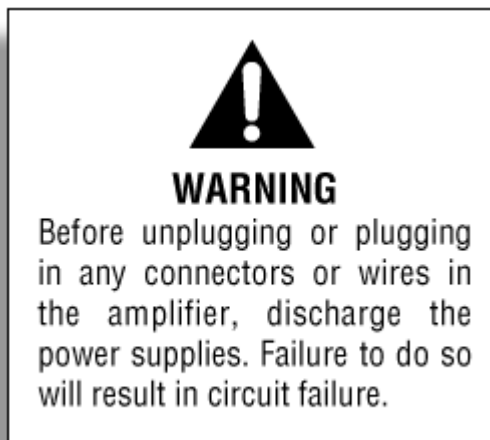
1 Dissassembly for Service

1.1 Main Module Removal

1. Remove the top cover by removing the two side, two back, and four top screws. Lift up slightly on the rear of the cover, and then pull it toward the back of the amplifier.
2. Remove the eight screws that hold the input connectors to the chassis.
3. Remove the four screws that hold the output jacks to the back panel.
4. Remove the four screws that hold the circuit board down to the chassis.
5. Remove nut from green and yellow striped ground wire connected to back panel.
6. Remove the two screws that hold the IEC filter to the back panel.

Remove all eight screws from underneath the chassis. Grip the front silver handle and gently pull forwards about ½ inch (be careful; it is a tight fit), and then lift up and away from the chassis.

After removing the PCB from the chassis, discharge the power supply capacitors. For C75 use a 1k/5W resistor. For the bulk reservoir capacitors, use a 10k/5W resistor.



2 Troubleshooting

2.1 Non-Powered Checks

1. Perform a cursory check of all major items in the power supply i.e. IGBT's.
2. Locate the flyback diodes D114, D115, D214, and D215 on the main modules and check for indications of a short. If a short is indicated, this means that an output device or driver transistor in parallel with that diode is shorted, usually not the diode itself. If an output device is found to be defective, emitter resistors should also be checked. If no output device is found defective, perform a quick check of driver, pre-driver, and bias transistors.
3. Check driver and pre-driver transistors for shorts or opens. If a fault is found, do an in-circuit static check of all semiconductors on the main board. If no output device and nothing upstream is found defective, move to power-on checks.

Otherwise continue.

4. If a failure has occurred anywhere in the output stages, check the bias servo transistor. Any failure associated with bias transistors may result in repeat failure of the affected channel even if all other defective components have been found and replaced.

5. If a failure is found in any LVAs, checks should continue up to the voltage translator stage.

2.2 Powered Checks



WARNING: Use extreme caution when making internal adjustments when the unit is powered.

1. Apply AC mains. The PIC microprocessor will perform a self-test, during which time the Fault LED and both Temp LEDs will flash. After the self-test, the AC-present LED will remain on.

2. Switch on the amplifier using the front panel switch. If the protect light is on and not flashing, this indicates a DC offset fault on one of the channels. Remove AC mains. Disconnect the output board from the main board at the header strip on the rear. Apply AC mains, switch the unit on, and measure for a DC offset at the output connector for each channel (WRT amplifier ground).

3. If the protect light is flashing, check the chassis fuse on the rear of the unit. If this is OK, you will make a few simple measurements with a DVM set to Ohms range:

4. Remove AC mains.

5. Discharge the power supply capacitors. For C75 use a 1k/5W resistor. For the bulk reservoir capacitors, use a 10k/5W resistor.

6. Check the soft-start resistors, located between the transformer and the left heat sink. These two ceramic resistors will be broken if the power supply is OK and there is a fault in one of the channels.

7. Measure the resistance between the following points. There should not be any short circuits or low-resistance readings.

- Case of the output devices to the heat sink.
- Case of the output devices to the output connector tag.
- Across the outer legs of the driver transistors (BF422, BF423) on each channel.

If you have a short or low resistance at any of these points, you have located the faulty channel. If these tests do not reveal the fault, then the fault is most likely in the power supply. The following procedure should help to locate it.

1. Be sure AC mains is removed.

2. Separate the power supply unit and amplifier stages by breaking the links (shown in green on Diagram 1). These are down the front part of the PCB (underside) by the capacitors nearest the connections for the four black wires, shown in blue in Diagram 1.

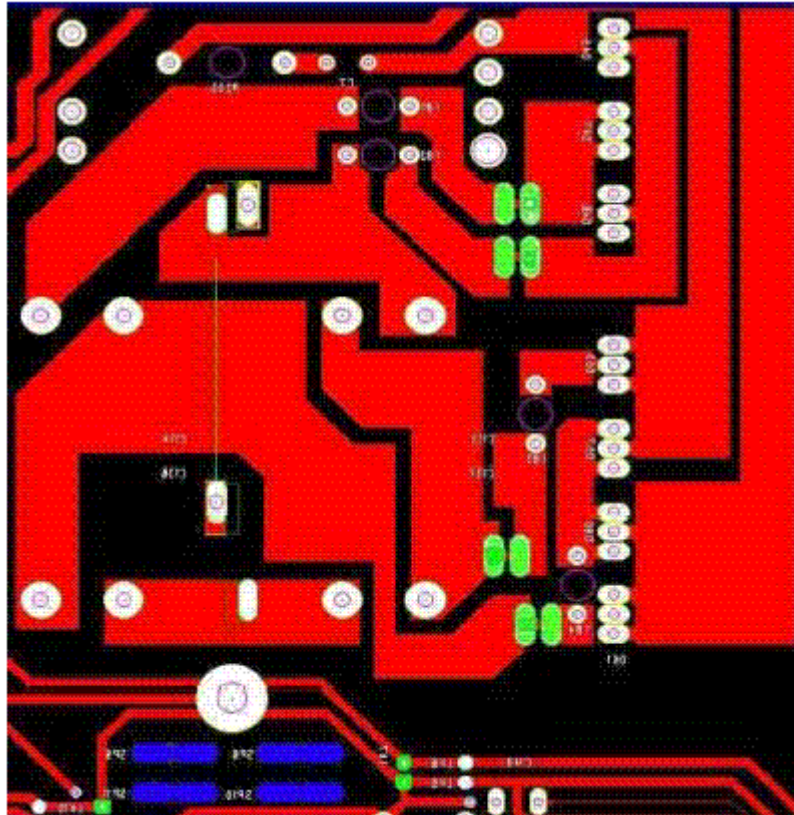
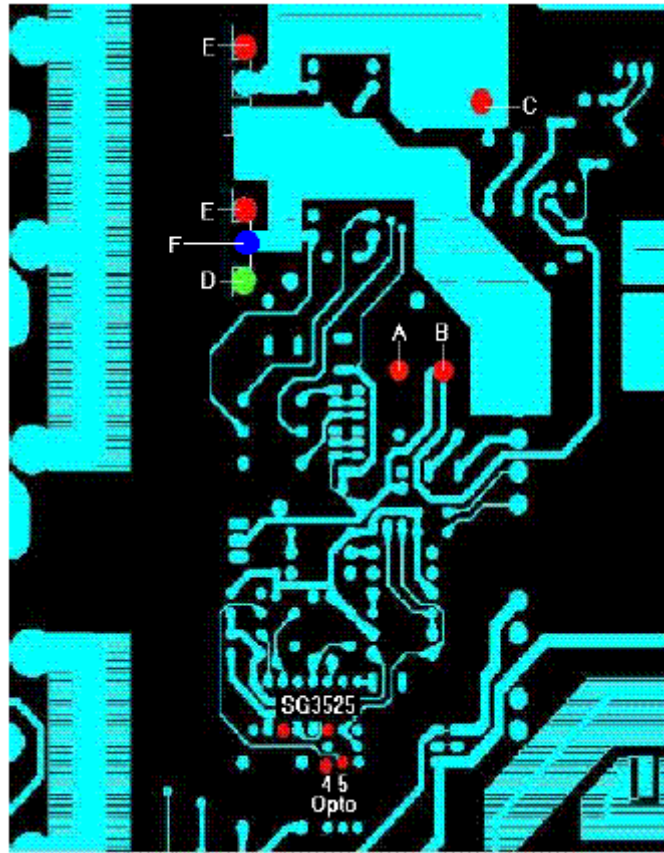


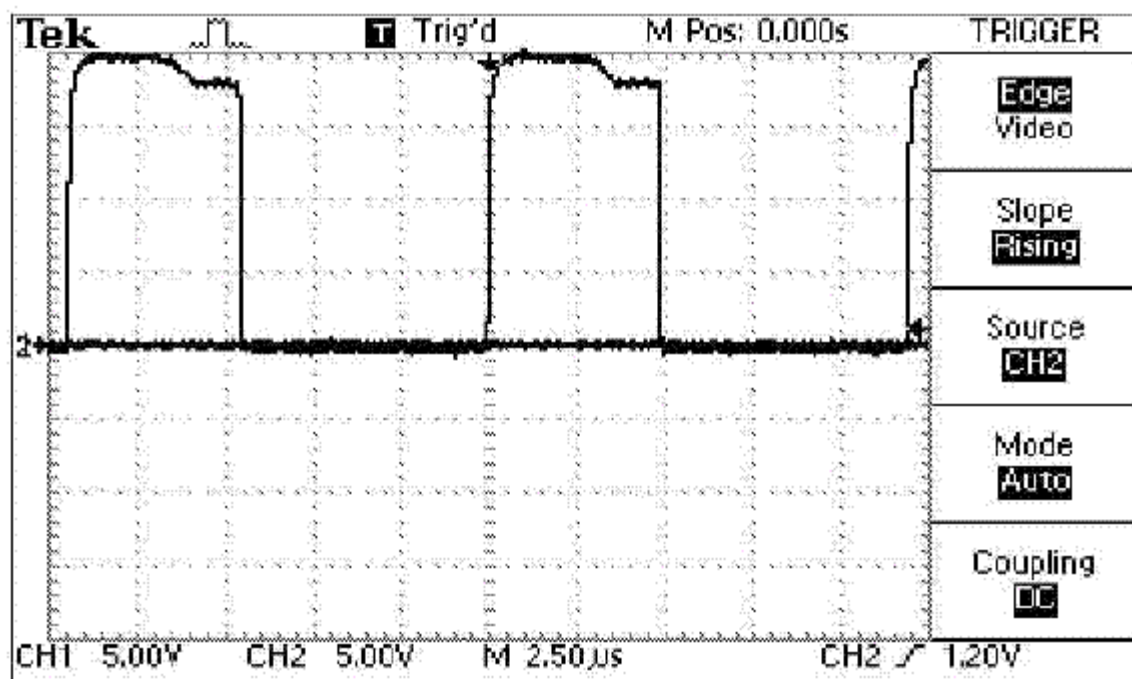
Diagram 1. View from solder side of PCB.

3. Use a 60V DC bench supply (current limited). Connect it across C75 with +60V to point B and Gnd to point A (see Diagram 2). Fit a switch (switched off) across pins 4 and 5 of OPTO1 (be very careful, as a spark here will kill it).

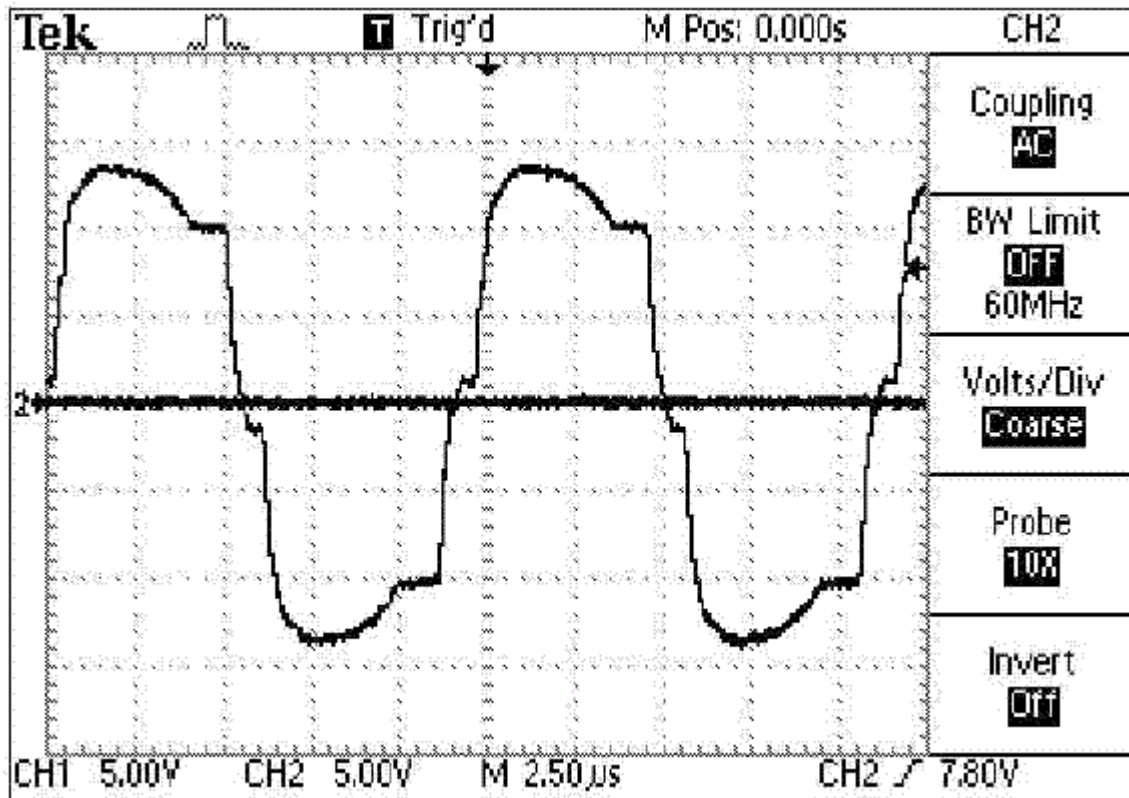


Diagram

4. With your scope Gnd referenced to point D or A, switch on the DC supply. Wait a second and then switch the opto. The current should go up to about 110 mA. If it goes rather high you have a fault.
5. Using the oscilloscope, check pins 11 and 14 of the SG3525. This should give a square wave output similar to that shown below:

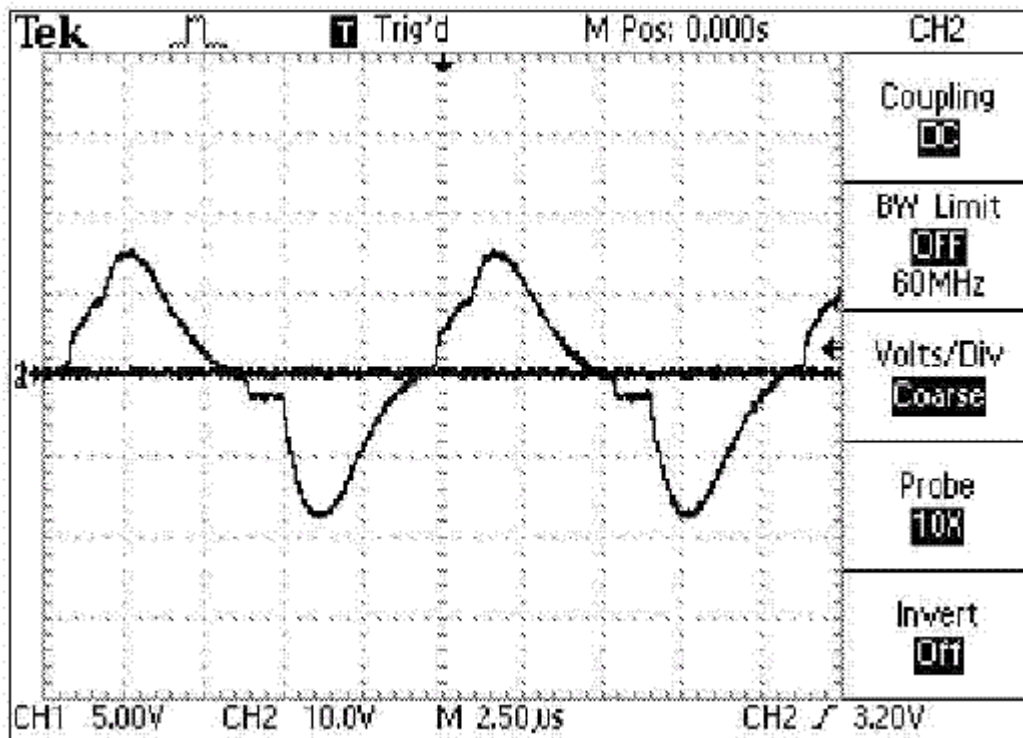


6. Move the probe to monitor the waveform at the IGBT's marked E on Diagram 2. You should see a switching waveform similar to that shown below.

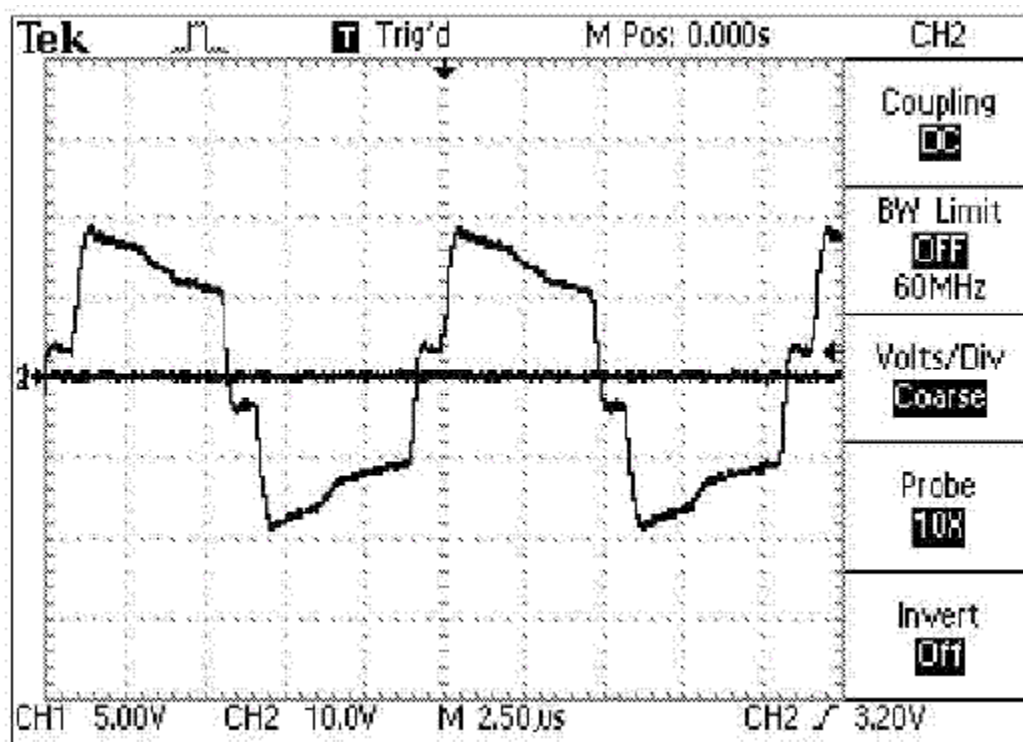


7. Some examples of incorrect waveforms are shown below, along with the likely area of failure.

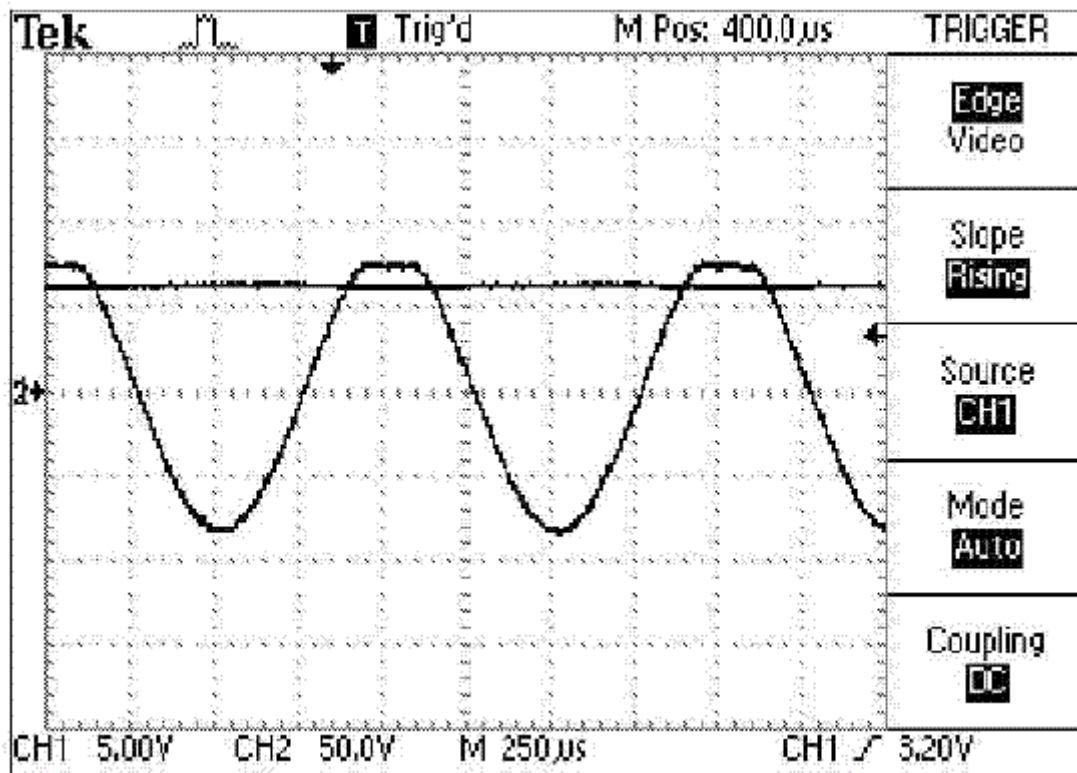
The waveform below is commonly caused by faulty ZTX650-ZTX750 transistors in the power supply.



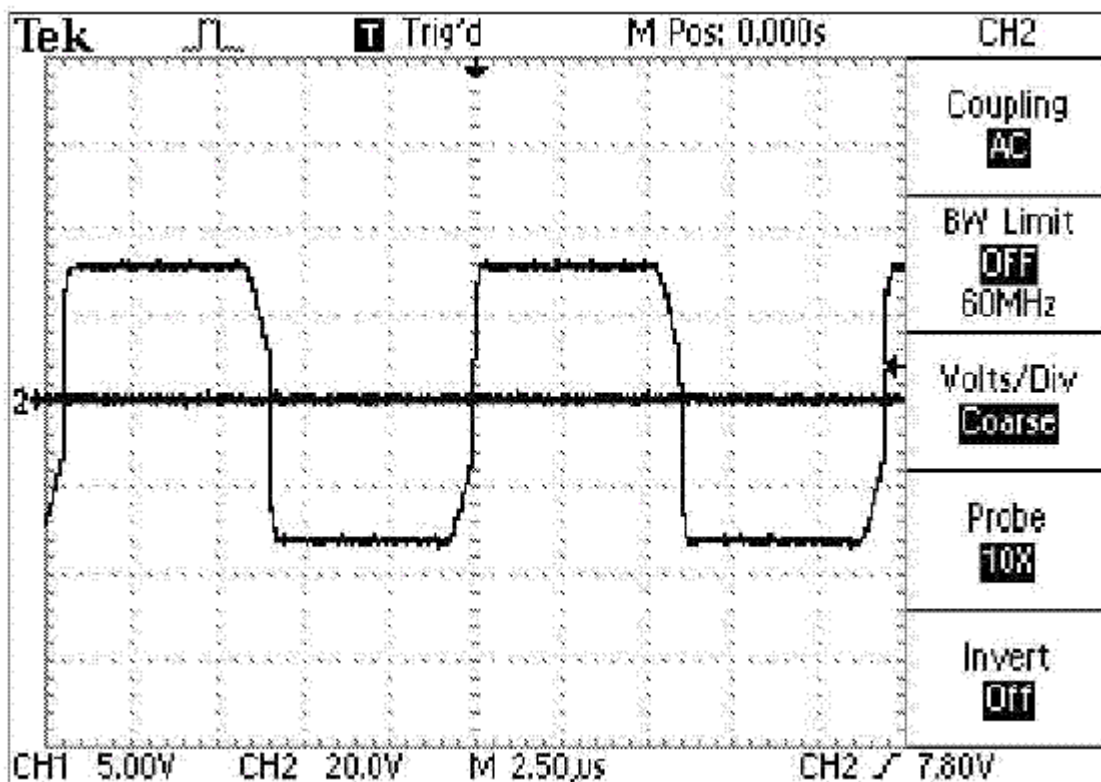
The waveform below is commonly caused by a faulty PWM transformer TX4.



The waveform below is typical of an overdrive fault (2x1100 version only). This may be caused by a faulty IRF540 or in the BC546-BC556-BF422 transistors in the FET drive section. Or it may be a result of breakdown in the BF422 transistors in the driver stage (refer to [Tech Note #165](#).)



8. All being well, connect another jumper wire from the +60V rail to the PCB point marked C on Diagram 2. Check the waveform from the output of the IGBT. To do this, monitor the middle pin of the IGBT marked F on Diagram 2. You should have a waveform similar to that shown below.



9. Move the oscilloscope's Gnd reference to the normal ground point of the amplifier; i.e., the four black wires (shown blue in Diagram 1). When you turn on the DC power supply, the current should have risen to about 150 mA. You should see square-

wave outputs from the transformer at the points shown in green on Diagram 3.

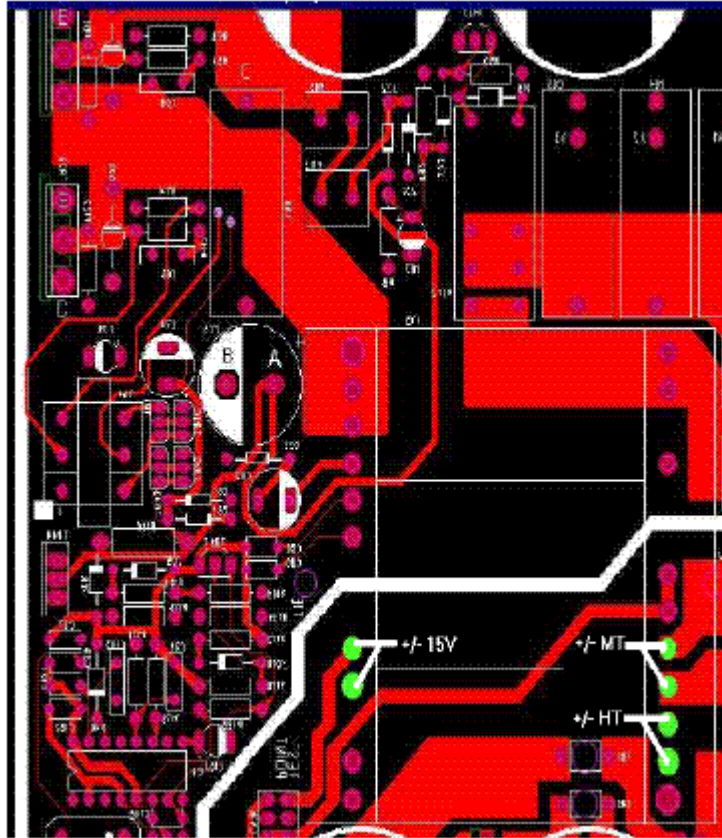
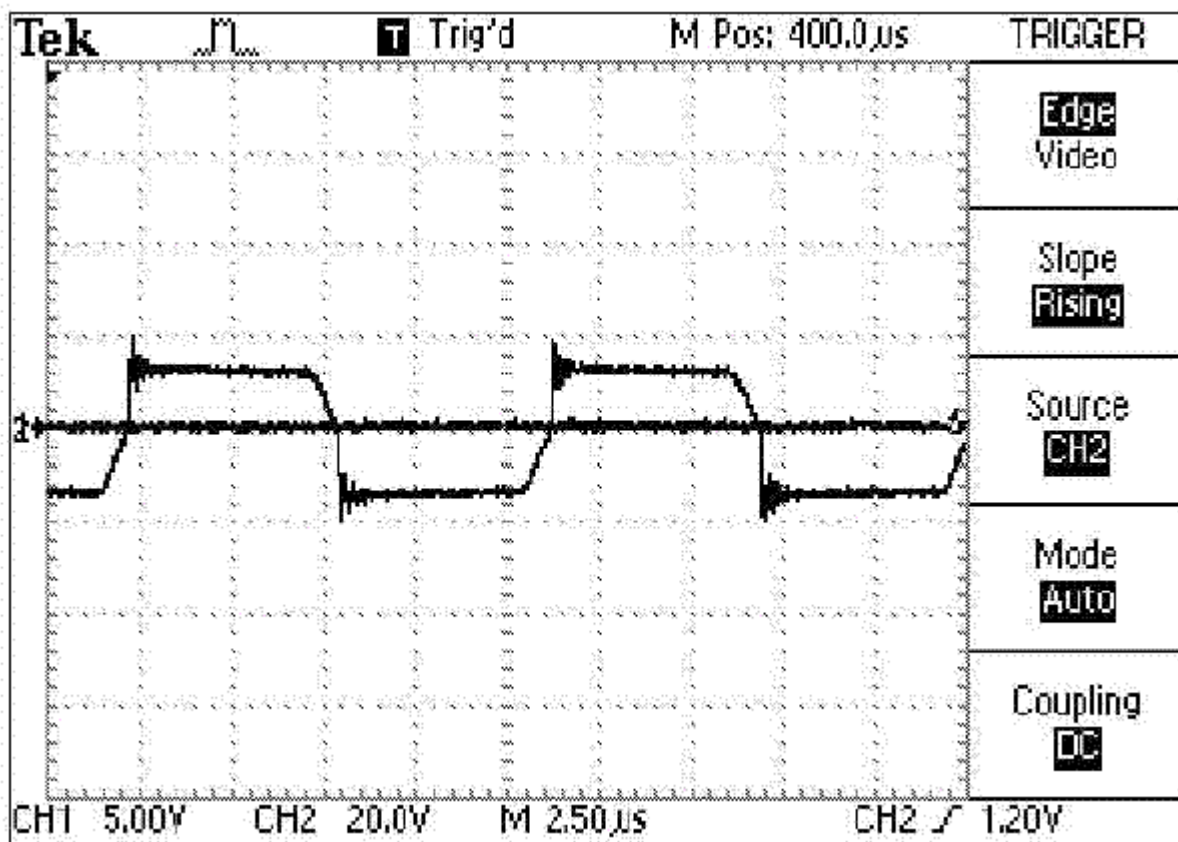
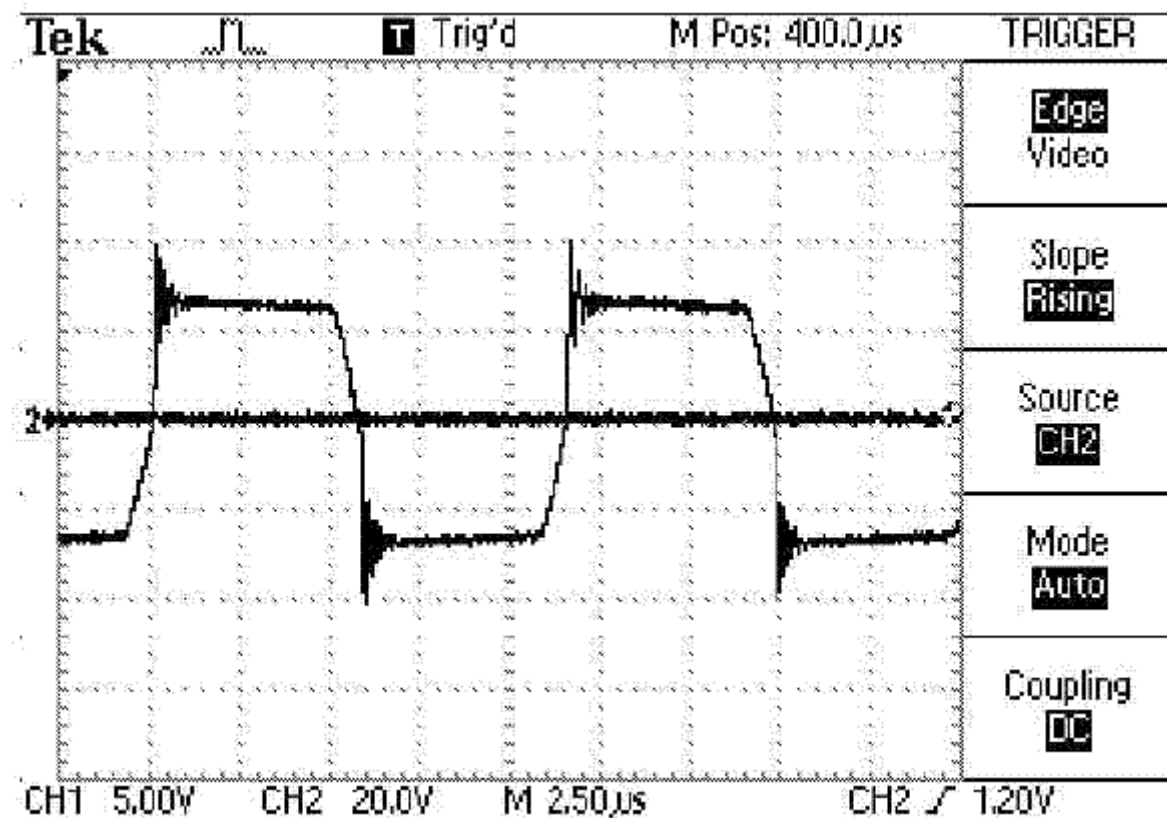


Diagram 3. View from solder side of PCB.

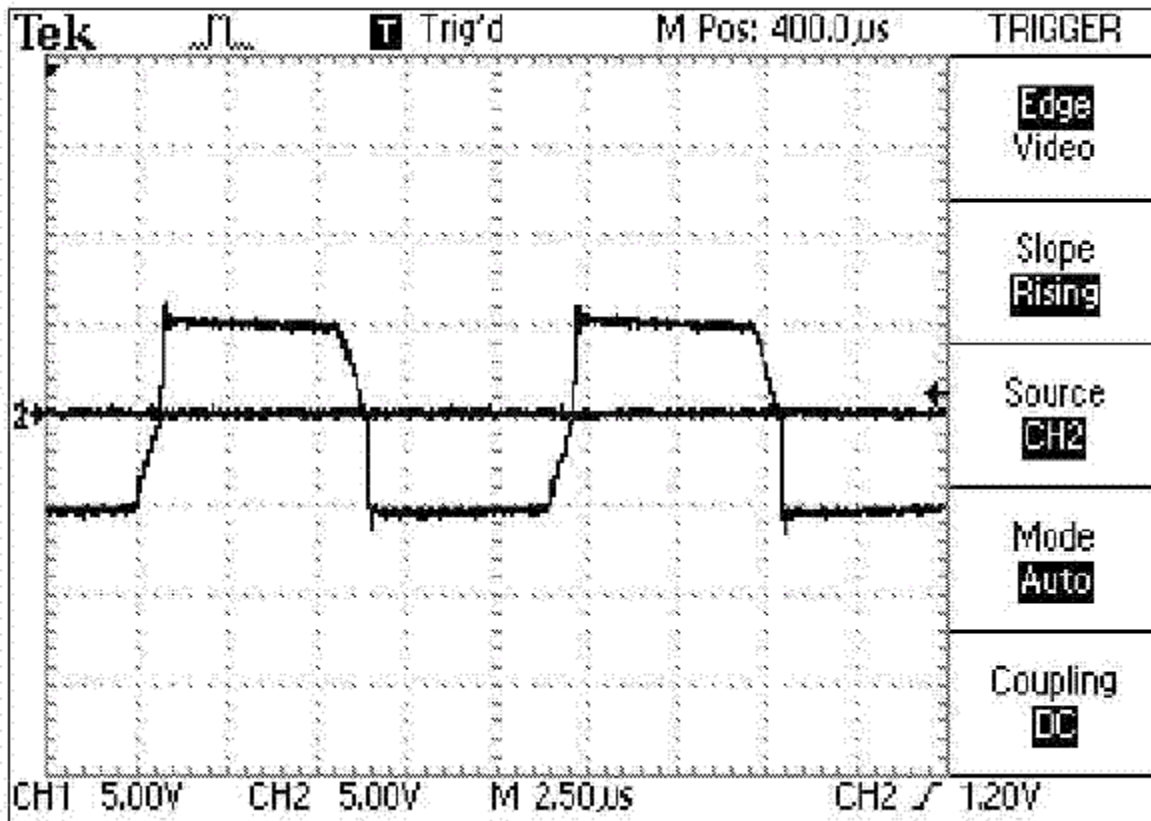
10. The waveforms should be similar to those shown below.
For \pm MT:



For \pm HT:



For \pm 15V (Note: the gain on the V/Div has been increased to give a better view):



You have now determined that the power supply is running and that there are DC supplies being generated. You should now check the power supply using a mains supply input.

1. Remove all the connections used for the DC bench supply test. Be sure to remove the switch on the opto isolator -- if it's left in position and switched on, the power supply will not power up.
2. At this stage you WILL NEED a MAINS isolation transformer. Note: This is not the same as
3. Plug the mains isolation transformer into the mains AC supply.
4. From the output of this transformer, connect the AC power cord to the amplifier.



WARNING: Using a Variac or noise isolation transformer instead of a MAINS isolation transformer could lead to injury or death.

5. The unit should go through its normal start-up procedure. Once it has stopped flashing, move the Operate switch to the ON position. The amplifier's power supply should start up after approximately 2 seconds.
6. If the protection light flashes, disconnect the AC power cord and check the chassis fuse and replace if necessary.
7. Also check the soft-start resistors (the flat thick-film 20-ohm resistors alongside the main transformer). If the resistors are open circuit, use a temporary resistor during this phase, as changing the soft-start resistors is difficult and the resistors are fragile. See Diagram 4 for details of the temporary resistor.

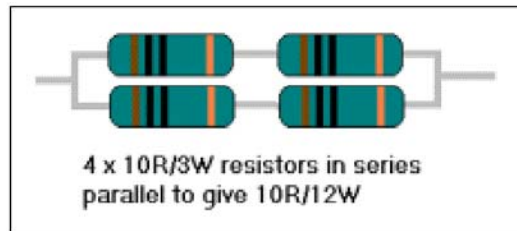
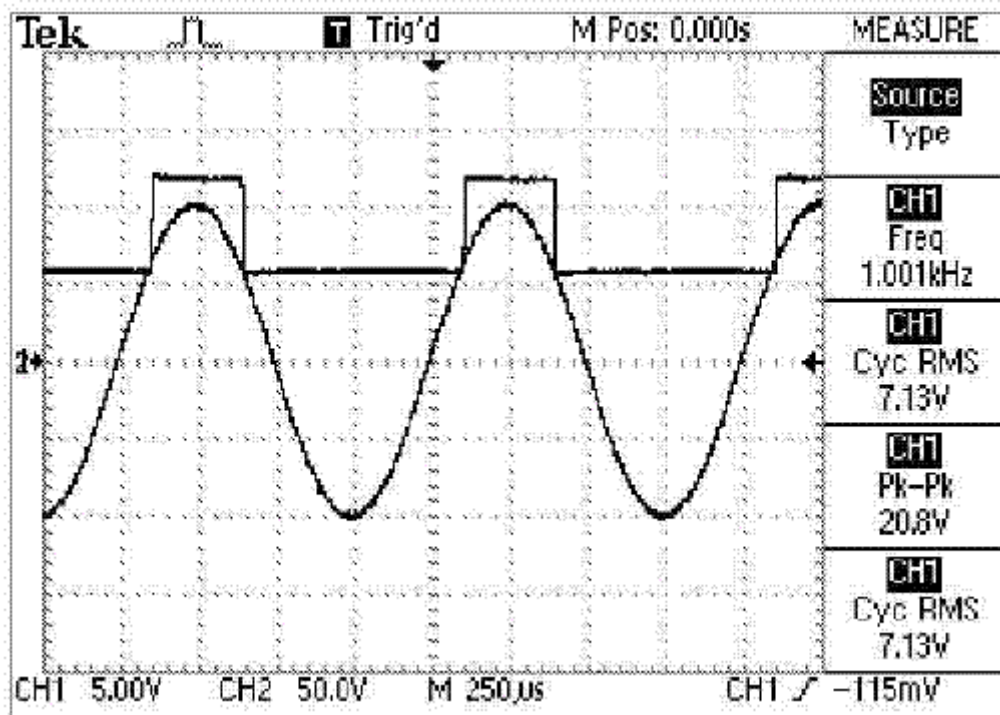
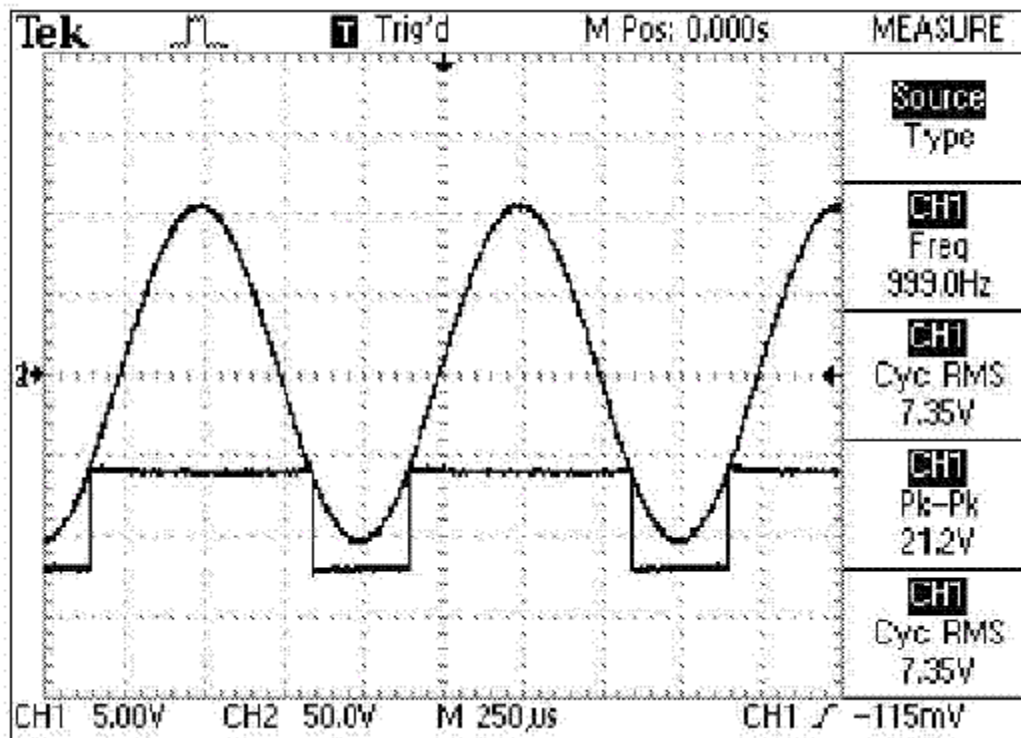


Diagram 4. Temporary resistor.

8. Replace the power cord and try the power supply again. It should start. You can measure the DC supply rails at the link points.
9. Switch off the unit and bridge the isolating links between the PSU and amplifier stages with solder. Switch on the unit.
10. If the unit goes into protect mode, there is another fault in one or more channels. If the unit powers up correctly, inject a 1 kHz 1.5 dBu signal into Channel 1. Monitor the output (off load) for a clean sine wave.
11. Then use the second channel of the oscilloscope to monitor the case of the MJ15024 device. As you increase the output from the amplifier, you should see a waveform similar to that shown below.



12. Move the second channel monitor to the case of the MJ15025 devices. Check that the waveform is similar to that shown below.



Now put the amplifier boards back into the chassis. Fit the minimum of screws to ensure good earthing. If there are any further problems, it is very frustrating to have to undo all the fixing screws again.

The screw fixings we suggest are

- The two chassis earth points.
- One of each heat sink to chassis screw.
- One silver PCB to chassis screw.
- Two output panel screws.

This will allow you to run the amplifier and perform the quick test. You will use a large input signal and overdrive each channel for a while, then short the output and again overdrive each channel for a while.

1. Load the output to 4 ohms.
 2. Turn the level control to maximum.
 3. Inject a +5 dBu, 100Hz sine wave signal into each channel's input and check for heavily clipped output. Run for 30 seconds.
 4. After 30 seconds, short circuit the output for a further 30 seconds.
 5. Remove the short circuit and reduce the signal to +1.5 dBu (+1 dBu for the 4x300). You should see a clean, unclipped output at the correct level shown below.
- **4x300** 300W
 - **2x650** 650W
 - **2x1100** 1100W

3 Checkout/Adjustment Procedures

The following instructions outline an orderly checkout and troubleshooting procedure. The purpose and arrangement of this procedure is to ensure proper operation after a repair has been completed. Before beginning these power-on tests, perform

the checks listed in Section 2. These checks will minimize the possibility of receiving a nasty surprise when turning on the amplifier.

3.1 Initial Conditions

The start of each step assumes all switches are pre-set to the following positions:

- Mode Switch: Normal position.
- Level Controls: Both up (clockwise) fully.

3.2 Test Procedure



CAUTION: If you are attempting to check or measure VI limiting, output power, or any other test which would require the amplifier to produce large amounts of heat, the main module should be securely mounted inside the chassis. If the module must be removed from the chassis, the test should be of very short duration.



WARNING: Do not connect any load to the Pulse power amplifier during these tests until specifically instructed to do so.

3.2.1 Turn-on Delay No Signal

No Load

Apply mains and check for the following:

Mains LED is on and red. Protect LED (red) and both temp. LEDS (yellow) flash together 5 times and then go off.

Switch on and observe the following:

After 2 seconds the operate LED is on and yellow. Fans are on at full speed. After another 2 seconds clip LEDS flash and fans slow to idle.

3.2.2 DC Output Offset No Signal

No Load

With the input level controls turned fully clockwise, the DC offset for both channels should be less than ± 100 millivolts. A large DC offset usually indicates a failure in the output stage, though such an offset should have shut down the amplifier on a DC/LFI signal.

3.2.3 Quiescent Power No Signal

No Load

While there is no published specification on quiescent power, it should be checked. A power draw with the fan operating slowly will normally be less than 120 W ($< 800\text{mA}$). If quiescent power greatly exceeds expectation, then turn the amplifier off immediately and search for power supply or output failure. If quiescent draw exceeds expectation by a “small” amount, check bias immediately.

3.2.4 Sensitivity (Gain) 1-kHz Sine Wave

No Load

Check that both level controls are full clockwise. Insert a 0.1V 1-kHz sine wave and measure 14.9V – 16.5V at the output of each channel for the 2x1100, 11.7V – 13V at the output of each channel for the 2x650, 8V – 8.8V at the output of each channel for the 4x300 .

3.2.5 Bridge Mono 1-kHz Sine Wave

No Load

Note: Always turn power to the amplifier off prior to changing the position of the Mode Switch. With the dual/mono switch in the bridge mono position, insert a 0.45Vrms 1-kHz signal into channel one input. There should be signal present on both channel outputs, equal in amplitude, with channel two 180 degrees out of polarity from channel one (see Fig. 2.3). Channel one input level control should control the output level for both channels. Return the amplifier to stereo operation.

Figure 2.3 Bridge-Mono Waveform

3.2.6 10-kHz Square Wave 10-kHz Sq. Wave

Slew Rate Test 8-ohm Load

With an 8-ohm load on each channel, insert a 10-kHz square wave and adjust amplitude to produce an output 10V below clipping. Observe a 50V/ μ S (or higher) slew rate. The output waveform should be stable with no ringing or over-shoot.



WARNING: Many of the following checks are done by connecting a resistive load to the output of the amplifier. Use caution and follow check-out procedures carefully to ensure correct results. These tests require a resistive load capable of over 2000 W continuous into as low as 2 ohms.



WARNING: The Pulse-Series is capable of drawing 10 Amperes of current from 230VAC mains when loaded to 2 ohms per channel and with both channels driven by a 1 kHz sine wave.

Note: For the remaining tests, the main module should be placed back into the chassis if at all possible. Otherwise, the heatsinks will become very warm, causing the amplifier to thermally protect itself. It is also possible under high-power bench testing to blow the fuse.

3.2.7 1-kHz Power + THD 1-kHz Sine Wave

Various Loads

Note: Operation with a sine wave into a low-impedance load will cause the fuse to blow after 5 to 10 seconds.

AC Mains of 230 VAC, 50-Hz

- **8-Ohm Load:** Minimum voltage is 56.6 Vrms (400W) with <0.1% THD for the 2x650, 74.8 Vrms (700W) with <0.1% THD for the 2x1100, and 36.9 Vrms (170W) with <0.1% THD for the 4x300.
- **4-Ohm Load:** Minimum voltage is 51.0 Vrms (650W) with <0.1% THD for the 2x650, 66.3 Vrms (1100W) with <0.1% THD for the 2x1100, and 34.6 Vrms (300W) with <0.1% THD for the 4x300.
- **2-Ohm Load:** Minimum voltage is 41.2 Vrms (850W) with <1.0% THD for the 2x650, 54.8 Vrms (1500W) with <1.0% THD for the 2x1100, and 25.7 Vrms (330W) with <1.0% THD for the 4x300.

3.2.8 Noise No Signal

No Load

Make sure the level controls are fully clockwise. Terminate the input with a 600-ohm load. Using a 20 to 20,000-Hz bandpass filter, measure the noise on the output of the channel under test. Noise is measured relative to power output at 8 ohms: 56.6 Vrms (400W) for the 2x650, 74.8 Vrms (700W) for the 2x1100, and 36.9 Vrms (170W) for the 4x300 and should be at least 100-dB down from these numbers.

3.3 Post Testing Procedure

At the completion of testing, set all switches per customer request. If none are specified by the customer, the following are standard factory settings for original shipment:

- Mode Switch: Normal position.
- Level Controls: Both down (counter-clockwise) fully.
- Front panel switch: OFF position.

4 P.A.T. Check

There is also a requirement to perform a P.A.T (Portable Appliance Test) check on the product prior to return to customer. This must be carried out by a P.A.T. certified engineer.

The following are the settings required:

- Earth Bond 25A @ 6VRMS Pass $\leq 0.1\Omega$ Typical 0.08Ω
- Insulation 500V DC Pass $> 9.9M\Omega$
- Flash Test N/A (Unit will fail this test due to filtered IEC which will indicate a breakdown)
- Load Test Unit will power up for 8 seconds

- Operation Test Pass < 3KVA
- Leakage Test Pass < 3 mA

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Pulse 2x650 Parts List

Part Number	Description	Qty	Designator(s)
AE0047	MF 1W RES 5% 4R7 PRO1	4	R85, R117, R77, R115
AE0100	MF 1W RES 5% 10R PRO1	5	R288, R1, R4, R3, R5
AE10002	RES 47K0 5% 1W MF PRO1 XA01-	4	R86, R121, R39, R40
AE10010	RES 3R3 5% 1W MF PRO1 XA01-	1	R21
AE10012	RES 10K 5% 1W MF PRO1 XA01-	1	R289
AE10015	MF 2W RES 5% 10R PRO2 AE100	1	
AE10018	MF RES 2W 5% 33R PRO2 AE100	1	R22
AE10022	RES 3K3 5% 1W MF PRO1 XA01-	2	R54, R153
AE10027	100R 2W MF RESISTOR PRO2	1	R19
AE2100	MF 2W RES 5% 10R PRO2	1	R14
AG10007	RES W/W 0R47 3W CA-RE	16	R116, R100, R101, R168, R131, R122, R170, R173, R92, R107, R185, R186, R74, R84, R187, R188
AJ10002	RES 50R 5W THICK FILM XA01-	2	R142, R28
AJ10003	RES 10K 5% 5W VERT XA01-	2	R30, R102
AM10001	RES 47R 5% 17W XA02-	1	R16
AP1301	MF 0.25W RES 1% 10R BL	1	R25
AP1309	MF 0.25W RES 1% 22R BL	6	R80, R126, R64, R138, R141, R67
AP1319	MF 0.25W RES 1% 56R BL	14	R89, R175, R136, R137, R135, R52, R53, R119, R166, R69, R68, R70, R154, R155
AP1325	MF 0.25W RES 1% 100R BL	7	R132, R125, R73, R81, R181, R185, R169
AP1333	MF 0.25W RES 1% 220R BL	8	R51, R109, R110, R156, R98, R97, R45, R34
AP1337	AF 0.25W RES 1% 330R BL	3	R82, R124, R37
AP1341	MF 0.25W RES 1% 470R BL	8	R134, R144, R57, R148, R71, R63, R150, R59
AP1347	MF 0.25W RES 1% 820R BL	18	R176, R104, R103, R177, R179, R128, R127, R183, R184, R167, R105, R106, R189, R190, R78, R79, R192, R191
AP1349	AP 0.25W RES 1% 1K BL	18	R49, R270, R88, R111, R112, R113, R83, R174, R271, R120, R96, R95, R94, R123, R24, R208, R26, R29
AP1361	MF 0.25W RES 1% 3K3 BL	2	R11, R290
AP1365	MF 0.25W RES 1% 4K7 BL	1	R172

AP1366	MF 0.25W RES 1% 5K1 BL	7	R65, R146, R140, R61, R8, R47, R32
AP1370	MF 0.25W RES 1% 7K5 BL	1	R180
AP1373	MF 0.25W RES 1% 10K BL	17	R90, R108, R114, R118, R99, R93, R287, R286, R42, R44, R23, R27, R178, R161, R182, R164, R15
AP1377	MF 0.25W RES 1% 15K BL	1	R160
AP1380	MF 0.25W RES 1% 20K BL	16	R50, R72, R76, R145, R55, R157, R133, R129, R152, R62, R9, R10, R41, R43, R36, R87
AP1387	MF 0.25W RES 1% 39K BL	2	R17, R18
AP1389	MF 0.25W RES 1% 47K BL	15	R291, R75, R66, R147, R143, R130, R139, R60, R46, R33, R35, R31, R38, R158, R91
AP1397	MF 0.25W RES 1% 100K BL	2	R3, R4
AP1405	MF 0.25W RES 1% 220K BL	6	R163, R171, R159, R162, R7, R48
AP1421	MF 0.25W RES 1% 1M BL	8	R56, R149, R151, R58, R1, R5, R2, R6
AS0102R-0805F	SM0805 RES 1K 1% 0.1W T200	2	R15, R16
AS0103R-0805F	SM0805 RES 10K 1% 0.1W T200	3	R58, R61, R62
AS0104R-0805F	SM0805 RES 100K 1% 0.1W T200	3	R60, R38, R35
AS0113R-0805F	SM0805 RES 11K 1% 0.1W T200	4	R4, R11, R3, R10
AS0152R-0805F	SM0805 RES 1K5 1% 0.1W T200	4	R34, R37, R56, R49
AS0432R-0805F	SM0805 RES 4K3 1% 0.1W T200	7	R5, R12, R6, R13, R30, R17, R29
AS0470R-0805F	SM0805 RES 47R 1% 0.1W T200	4	R7, R14, R33, R36
AS0471R-0805F	SM0805 RES 470R 1% 0.1W T200	7	R45, R46, R54, R57, R53, R51, R55
AS0512R-0805F	SM0805 RES 5K1 1% 0.1W T200	8	R1, R2, R52, R59, R8, R9, R63, R64
BA0001	DIODE 1N4148	29	D7, D8, D30, D31, D19, D22, D10, D42, D43, D29, D12, D37, D38, D14, D15, D24, D27, D6, D35, D5, D36, D16, D33, D9, D4, D2, D3, D47, D21
BA0025	DIODE FAST 400V 1.7A BYD73G	9	D23, D41, D39, D40, D44, D68, D67, D64, D63
BA10004	DIODE IN4004 CA-DB	4	D11, D32, D13, D34
BB0116	ZENER DIODE 1.3W 47V	1	ZD5
BB10001	ZENER DIODE 20V 400MW XD03-	1	ZD12
BB10002	ZENER DIODE 500MW 2V7 CA-DB	5	ZD2, ZD7, ZD9, ZD4, ZD6
BB10005	ZENER DIODE 500MV 15V CA-DB	1	ZD13
BB10007	ZENER DIODE 500MW 4.7V5% CA-DB	2	ZD22, ZD23
BB10011	ZENER DIODE 500MW 47V CA-DB	4	ZD3, ZD10, ZD1, ZD8

BB10022	ZENER DIODE 500MW 24VOLT 1	2	ZD11, ZD14
BC0217	DIODE BRIDGE 1.5A 400V W04	1	BR1
BC10003	RECTIFIER MUR1640CT XD04-	4	D46, D60, D45, D50
BC10004	BRIDGE REC 35A 600V	1	BR2
BD0364	BF422 NPN TRANS	8	TR8, TR35, TR36, TR9, TR52, TR21, TR22, TR47
BD0365	BF423 PNP TRANS	10	TR16, TR17, TR18, TR19, TR45, TR42, TR41, TR39, TR40, TR12
BD0373	MJ15024 NPN POWER TRANS TO3 @	8	TR27, TR11, TR56, TR57, TR37, TR51, TR60, TR61
BD0374	MJ15025 PNP POWER TRANS TO3 @	8	TR48, TR34, TR58, TR59, TR14, TR29, TR62, TR63
BD0394R	TRANSISTOR BC546BT NPN TAPED	8	TR20, TR38, TR67, TR1, TR5, TR7, TR55, TR23
BD0395R	TRANSISTOR BC556BT PNP TAPED	5	TR44, TR13, TR6, TR4, TR53
BD0396	OPTO TRANSISTOR CNW11-AV1	1	OPT1
BD10011	2SA872 TRANSISTOR TO220 CA-TF	4	TR30, TR31, TR26, TR28
BD10014	MJE5731A TRANSISTOR CA-TF	4	TR25, TR33, TR46, TR10
BD10020	TIP50 CA-TF	3	TR43, TR15, TR2
BD10026	TRANS TIP122 TO220 XE01-	1	TR50
BD10032	IGBT SGL50N60RUF-D TO264 XF07-	2	TR24, TR32
BD10042	ZTX651 NPN TRANSISTOR	2	TR49, TR64
BD10043	ZTX751 PNP TRANSISTOR	4	TR3, TR54, TR66, TR65
BE0403	TL074CN QUAD OP AMP	1	IC2
BE0417	V.REG 7915 -15V 1A	1	IC8
BE0428	NE5532P/NJM5532D DUAL OP AMP @	2	IC5, IC4
BE0503	TL431 SHUNT REGULATOR	1	D1
BE10012	LM35-DZ (SRX) IC CA-TF	2	IC9, IC10
BE10030	V.REG 7815 +15V 1A	1	IC7
BK10008	IC MICROC PIC16C57-04P XG04-	1	IC1
BS0005R-SOT23	BAV99 SM DIODE	6	D1, D2, D5, D6, D7, D8
BS0506R-SOT23	NPN TRANS BC846B	1	TR2
BS10043	ANALOG SW.DG411 QUAD SM	1	IC2
BS7001R-SO8	TL072CD SM DUAL OP AMP #	1	IC8
BS7009R-SO8	NE5532 SM DUAL OP AMP #	2	IC1, IC3
BZ10000	(A) PWM CONT SG3525AN XF04-	1	IC6
BZ10002	!THERMISTOR MAIN VOLTAGE CA-DB	1	TH1
CA0026	M/LAYER CAP .1UF 63V	17	C31, C32, C153, C154, C36, C82, C19, C93, C155, C157, C92, C156, C94, C109, C158,

C46, C48

CA0027	M/LAYER CRMC CAP 10N 100V	4	C2, C3, C4, C5
CA0030	M/LAYER CRMC CAP 50V 4N7	2	C24, C26
CA0038R	C/CAP 0.2" TAPED 100V 15PF	2	C23, C25
CA0041R	C/CAP 0.2" TAPED 100V 47PF	2	C58, C55
CA0044R	C/CAP 0.2" TAPED 100V 100PF	2	C44, C77
CA0045R	C/CAP 0.2" TAPED 100V 150PF	2	C4, C160
CA10023	C/CAP 1000V 470PF XC03-	4	C103, C53, C65, C97
CC0238	MICRO-BOX 5MM 5% 63V 1N	3	C87, C17, C102
CC0242	MICRO-BOX 5MM 5% 63V 4N7	2	C47, C71
CC0244	MICRO-BOX 5MM 5% 63V 10N	4	C56, C69, C57, C49
CC0246	MICRO-BOX 5MM 5% 63V 22N	2	C1, C6
CC0250	MICRO-BOX 5MM 5% 100V 100N	5	C35, C96, C72, C104, C70
CC0251	MICRO-BOX 5MM 5% 100V 220N	8	C39, C13, C12, C79, C80, C11, C10, C40
CC0288	POLYPROPYLENE 2200PF 250VAC (C	2	C16, C20
CC10077	POLY-CAP 400V 1U XC09-	2	C38, C62
CC10078	POLY-CAP 400V 470N XC09-	2	C60, C61
CE0403	VERT ELEC 0.2" TPD 100UF 10V SK	5	C37, C85, C64, C17, C18
CE0445	VERT ELEC 1UF 63V SKP	3	C52, C66, C101
CE0462	VERT ELEC 10UF/63V 5X11MMSKP	18	C86, C91, C45, C78, C84, C88, C75, C41, C18, C27, C30, C74, C120, C129, C125, C133, C13, C15
CE10003	ELEC/LYTIC RAD 200V 1800	8	C28, C29, C42, C43, C33, C34, C117, C118
CE10004	ELEC/LYTIC RAD 40V 2200 XC06-	3	C5, C22, C159
CE10005	ELEC/LYTIC RAD 63V 1000 XC06-	1	C76
CE10009	NON-POL 10V 100UF JAMIC	9	C148, C54, C149, C63, C6, C7, C8, C9, C21
CE10033	ELEC/L 63V 220UF 105 C XC06-	4	C73, C81, C128, C134
CS1221R-1206J	CAP CRMC 220PF 5% 50V NP0	4	C25, C26, C27, C28
CS7104R-1206K	CAP CRMC 100NF 10% 50V X7R	5	C10, C12, C23, C24, C33
CX10000	!CAP 275V 1UF X2 XC09-	1	C2
D-C300A-01	POT 16MM 10K LIN RD1610 A0X-P	2	P1, P2
DG10010	SWITCH ROUND SPST XK04-	1	
DJ10006	SWITCH SLIDE DPDT 30A NO LE	1	SW1
DZ10012	RELAY SPCO 16A 48V XK06-	2	RLY1, RLY2

FA10002	40W IDC CONN SIDE EJECT XL04-	1	
FA10003	34W IDC CONN SIDE EJECT XL04-	1	
FF0728	28WY DIL IC SKT DUAL WIPE TIN	1	
FF10003	PC JUMPER XL02-	8	
FF10019	BINDING POST ASSY 4MM XL05-	1	
FF10022	SPADE TAB VERT PC 0.125C	2	
FF10030	4 POLE SKT - SPEAKON CA-CO	2	CN1, CN2
FF10046	2W 0.1 ST&F/L CONN HDR CA-CO	3	CN13, CN14, CN16
FF10055	SKT 1X12 SIDE ENTRY X	1	
FF10063	CONN. 34W BOX GOLD XL04-	1	
FF10073	HEADER 2X17 R/A XL04-	1	
FF10079	TERMINAL BLOCK - 3 WAY XL04-	2	CN8, CN9
FF10080	PLUG 3 WAY FREE KLIPPON XL04-	2	
FF10083	5 WAY PIN HDR.LATCH TYPE XL04-	1	
FF10085	HEADER 1x12 THU VERT XL04-	1	
FG10006	PCB FASTON	11	
FH0760	REAN SLIMJACK S203-84G	2	CN2, CN3
FJ10005	!IEC FILTERED 10AMP CONN XL02-	1	CN1
FJ8019	!LEAD 10A USE FJ8016:17:18	1	
FK0986	XLR CON FML R/A CHAS PIN MTL	2	CN6, CN7
FK0987	XLR CON ML R/A CHAS PIN MTL	2	CN4, CN5
HB10042	TRANS 240V/11-0-11V 4VA	1	TX5
HB10045	TRANSFORMER PT42E XP01-	1	TX8
HC0021	FERRITE BEAD AX 5X3.5MM TAPED	2	L4, L5
HC0028	INDUCTOR 10UH TOKO R621LY-100K	2	L2, L3
H-C300A-01	TRANSFORMER FET DRIVER W	1	TX6
H-C300B-01	CHOKE COM MODE E251	1	L1
H-C300E-01	CHOKE PULSE OUTPUT	2	L1, L2
H-C650A-01	TRANSFORMER.SMPS P2X650	1	TX7
J-C300A-01	LIGHTPIPES 8+1 - PULSE WAS J	1	
J-C300B-01	LIGHTPIPE LARGE - PULSE WAS J	1	
JS0004	LED RED SML-010UT	5	LD5, LD6, LD16, LD13, LD11
JS0005	LED YEL SML-010YT	4	LD9, LD14, LD15, LD17
JS0006	LED GRN SML-010PT	2	LD1, LD2
KA0267	SIF LIVE 4/8 POT KNOB GREY	2	
KZ10000	POT COVER - PULSE XV02-	2	
LA0008	7/0.2 RED WIRE	0.16	

LA0041	16/0.2 GREEN/YELLW WIRE	0.12
LA0051	1/0.6 SINGLE STRAND WIRE PINK	0.05
L-B100A-02	EARTH WIRE MAINS TO CHASS	1
L-C300A-02	WIREFORM ASSY.FAN-80MM X 12V	2
L-C300B-03	WIRING LOOM - PULSE WAS -	1
L-C300C-02	WIRING LOOM-PULSE F\PANEL	2
L-C300E-01	INDUCTOR WIRE DETAIL	1
LF0572	H20 NEOPRENE SLEEVES	3
LF0573	H30 X 20 BLACK SLEEVE	2
LF0596	CABLE TIE 8.0 NARROW	7
M-C250A-01	250 & 650 SOFTWARE	1
NA0084	M3X6MM PAN POZI BLK SCREW	4
NA0384	M2.5X6MM PAN POZ BLK TAPTITE	8
NA0392	SCREW PLAS NO8X3/8" BLK	2
NA0397	M3X6 FLANGE SCREW BLK POZI	10
NA0424	NO.8X5/8" PAN POZI BLK Y CUT	4
NA10002	M3.6 PAN POZI TAPTITE ZN XW02-	4
NA10015	M3X16 PAN POZI SCR BZP CA-FI	32
NA10042	M3X16 SCREW BZP HEX CA-FI	2
NA10045	M4X6 PAN POZI SCR BLK CA-FI	4
NA10047	M3X10MM P/P ZINC CA-FI	1
NA10050	M5X20 TORX TAPTITE BK XW05-	4
NA10051	M5X16 TORX TAPTITE BLK XW05-	8
NB0113	M3 NYLON INSERT NUT	1
NB0122	M3 PLAIN NUT	6
NB10005	M3.5 NUT FULL BZP CA-FI	32
NB10014	NUT HALF M4 XW13-	4
N-B966B-01	ADHESIVE STRIP 10X10 966 WAS N	11
NC0221	M3 S/PROOF WASHER	6
NC0249	M4 PLAIN STEEL WASHER ZNC CLR	32
NC0256	M3 PLAIN WASHER	3
NC10018	WASHER-PLAS 9.5X4.75X0.5 XW07-	8
NC10022	M4 SPRING WASHER STL.BZP	32
ND10004	PILLAR METAL M3X10MM XW10-	2
ND10025	SPACER F/PANEL - PULSE XW10-	4
ND10027	SPACER NYLON FAN SCREW XW10-	4
ND10040	SPACER-NYLON 6.35X3.56X6.35LG.	4

NE0408	M3 SOLDER TAG	1
NZ10000	ADHESVIE BCK MIN SUPPORT CA-EL	2
P-C1100D-01	SPRING CLIP P-C11	1
P-C300A-02	INSULATOR HEATSINK - 250 XV01-	2
P-C300B-03	INSULATOR BASE TRAY-PULSE	1
P-C300E-01	FRONT PANEL THERM.INSUL.	2
P-C300F-01	HEATSINK-CUT & PUNCH	2
P-C300J-03	LID AMPLIFIER - PULSE	1
P-C300M-01	SPACER FAN (CUT) - PULSE	2
P-C300N-01	FAN SPACER FOAM - PULSE	2
P-C650A-01	SPACER - BINDING POST	1
P-C650Z-01	BADGE - PULSE 2X650	1
P-CR1100C-02	1100 SUB FRONT PANEL	1
P-CR300C-01	BADGE - CROWN	1
P-CR300I-02	FRONT PNL PUNCHED- CROWN	1
P-CR650B-01	650 BASETRAY	1
R-C650A-04-AF	650 PULSE MAIN PCB ASSY. R-650	1
R-C650B-02-AF	650 FRONT PANEL PCB ASSY R-650	1
R-C650B-02-SC	650 FRONT PANEL PCB -SC R-650	1
R-C650B-02-SM	650 FRONT PANEL PCB-SM R-650	1
R-CR650C-01-AF	CROWN 650 REAR PANEL PCB ASSY.	1
S-C650A-04	PCB MAIN BOARD P2X650 W	1
S-C650B-02	PCB FRONT PANEL BRD.P2X650	1
S-CR650C-01	PCB CROWN OUTPUT BRD.P2X650	1
TA10022	CARTON CUSTOM PACK (WAS	1
TZ10001	GRIP BAG A4 XT01-	1
TZ10002	GRIP BAG SMALL 4 X 8IN XT01-	1
TZ10004	POLYBAG -26X24X250 GAUGE CA-MI	1
ZA0395-01	FCC LABEL SELF ADH 70X15	1
ZA10004	STICKER - SAFETY EARTH XT03-	1
ZA10020	LABEL SHOCK & MOISTURE XT03-	1
ZA10027	LABEL UL STD.6500 55X25 XT03-	1
ZA10039	FOAM SEALING STRIP XT05-	1.25
ZA10081	LABEL CARTON-CROWN PULSE	1
ZC0240	REG KOOL-PAD,SELF ADH 105SP900	4
ZC10014	HEATSINK TO220 CLIP ON CA-HA	1
ZC10018	CLIP HEATSINK TO-247 XW13-	15

ZC10029	TO3 INSULATING WASHER	16	
ZC10030	TO3 PLASTIC COVER	2	
ZD0332	FUSEHOLDER 10A 250V PCB MNT	1	
ZD0334	20MM S/ENC PCB MNGT FUSEHOLDER	2	
ZD10000	FUSE 20MM T200MA XM01-	1	
ZD10002	FUSE 20MM T500MA XM01-	1	
ZD10014	!FUSE 6.3 AMP S/D SLOW T CA-EL	1	
ZE10007	CER RESONATOR 3.58MHZ XI01-	1	XT1
ZM10092-01	MANUAL CROWN P2X650 V1.0	1	
ZZ2893R	FILTER 100PF RFI TAPED	4	RF1, RF2, RF3, RF4

Pulse 2x1100 Parts List

Part Number	Description	Qty	Designator(s)
AE0047	MF 1W RES 5% 4R7 PRO1	4	R84, R117, R78, R114
AE0100	MF 1W RES 5% 10R PRO1	5	R160, R1, R4, R3, R5
AE10002	RES 47K0 5% 1W MF PRO1 XA01-	8	R46, R194, R75, R162, R36, R37, R86, R120
AE10010	RES 3R3 5% 1W MF PRO1 XA01-	1	R17
AE10012	RES 10K 5% 1W MF PRO1 XA01-	2	R7, R112
AE10018	MF RES 2W 5% 33R PRO2 AE100	1	R18
AE10019	RES 1R5 5% 2W MF PR02 XA01-	4	R245, R222, R211, R240
AE10027	100R 2W MF RESISTOR PRO2	1	R203
AG10007	RES W/W 0R47 3W CA-RE	16	R115, R94, R121, R124, R147, R141, R168, R159, R126, R144, R118, R122, R91, R97, R66, R79
AJ10003	RES 10K 5% 5W VERT XA01-	2	R93, R113
AJ10004	RES.20R 5W THICK FILM	2	R127, R145
AM10001	RES 47R 5% 17W XA02-	1	R14
AP1301	MF 0.25W RES 1% 10R BL	5	R27, R258, R235
AP1309	MF 0.25W RES 1% 22R BL	2	R80, R157
AP1319	MF 0.25W RES 1% 56R BL	22	R88, R151, R173, R139, R140, R58, R59, R73, R107, R108, R184, R185, R192, R195, R236, R233, R247, R257, R200, R206, R250, R232
AP1325	MF 0.25W RES 1% 100R BL	13	R68, R138, R81, R64, R128, R167, R109, R106, R171, R156, R176, R169, R170
AP1333	MF 0.25W RES 1% 220R BL	8	R57, R99, R100, R186, R134, R135, R30, R42
AP1337	AF 0.25W RES 1% 330R BL	3	R82, R155, R33
AP1341	MF 0.25W RES 1% 470R BL	8	R137, R146, R181, R61, R110, R111, R63, R189
AP1347	MF 0.25W RES 1% 820R BL	2	R148, R74
AP1349	AP 0.25W RES 1% 1K BL	18	R48, R261, R188, R262, R87, R101, R102, R103, R83, R133, R152, R131, R132, R154, R25, R22, R19, R20
AP1361	MF 0.25W RES 1% 3K3 BL	23	R96, R95, R116, R119, R129, R149, R164, R163, R142, R143, R123, R125, R105, R90, R69, R70, R9, R21, R214, R228, R204, R253, R13

AP1365	MF 0.25W RES 1% 4K7 BL	1	R219
AP1366	MF 0.25W RES 1% 5K1 BL	12	R28, R44, R198, R197, R251, R201, R242, R260, R216, R225, R196, R231
AP1370	MF 0.25W RES 1% 7K5 BL	1	R175
AP1373	MF 0.25W RES 1% 10K BL	27	R98, R177, R179, R136, R54, R65, R263, R39, R264, R41, R51, R35, R23, R24, R199, R230, R256, R239, R210, R220, R243, R249, R166, R178, R180, R8
AP1375	MF 0.25W RES 1% 12K BL	4	R234, R248, R241, R223
AP1376	MF 0.25W RES 1% 13K BL	8	R89, R150, R104, R130, R212, R217, R255, R202
AP1377	MF 0.25W RES 1% 15K BL	1	R165
AP1380	MF 0.25W RES 1% 20K BL	18	R47, R56, R193, R187, R76, R161, R5, R6, R38, R40, R52, R174, R213, R226, R254, R205, R32, R85
AP1387	MF 0.25W RES 1% 39K BL	2	R15, R16
AP1389	MF 0.25W RES 1% 47K BL	9	R29, R43, R26, R31, R49, R50, R34, R172, R92
AP1397	MF 0.25W RES 1% 100K BL	15	R183, R191, R72, R71, R10, R12, R53, R259, R229, R221, R207, R208, R209, R218, R244
AP1405	MF 0.25W RES 1% 220K BL	6	R153, R67, R158, R77, R11, R45
AP1421	MF 0.25W RES 1% 1M BL	9	R60, R182, R62, R190, R1, R4, R2, R3, R55
AP1429	MF 0.25W RES 1% 2M2 BL	4	R237, R246, R224, R238
AS0102R-0805F	SM0805 RES 1K 1% 0.1W T200	2	R15, R16
AS0103R-0805F	SM0805 RES 10K 1% 0.1W T200	3	R58, R61, R62
AS0104R-0805F	SM0805 RES 100K 1% 0.1W T200	3	R60, R38, R35
AS0113R-0805F	SM0805 RES 11K 1% 0.1W T200	4	R4, R11, R3, R10
AS0152R-0805F	SM0805 RES 1K5 1% 0.1W T200	4	R34, R37, R56, R49
AS0432R-0805F	SM0805 RES 4K3 1% 0.1W T200	7	R5, R12, R6, R13, R30, R17, R29
AS0470R-0805F	SM0805 RES 47R 1% 0.1W T200	4	R7, R14, R33, R36
AS0471R-0805F	SM0805 RES 470R 1% 0.1W T200	7	R45, R46, R54, R57, R53, R51, R55
AS0512R-0805F	SM0805 RES 5K1 1% 0.1W T200	8	R1, R2, R52, R59, R8, R9, R63, R64
BA0001	DIODE 1N4148	23	D6, D7, D27, D26, D15, D19, D8, D33, D43, D44, D20, D21, D28, D34, D16, D41, D4, D3, D2, D63, D58, D46, D18

BA0025	DIODE FAST 400V 1.7A BYD73G	17	D5, D39, D10, D25, D9, D38, D24, D42, D22, D32, D31, D29, D51, D55, D54, D50, D49
BA10004	DIODE IN4004 CA-DB	4	D40, D11, D37, D12
BA10006	ZENER DIODE 500MW 10V CA-DB	4	ZD13, ZD18, ZD20, ZD17
BA10008	DIODE SF1600 1A FAST XD01-	2	D14, D23
BB0116	ZENER DIODE 1.3W 47V	1	ZD2
BB10001	ZENER DIODE 20V 400MW XD03-	1	ZD10
BB10002	ZENER DIODE 500MW 2V7 CA-DB	1	ZD3
BB10005	ZENER DIODE 500MV 15V CA-DB	1	ZD15
BB10007	ZENER DIODE 500MW 4.7V5% CA-DB	2	ZD1, ZD11
BB10011	ZENER DIODE 500MW 47V CA-DB	4	ZD5, ZD7, ZD4, ZD6
BB10022	ZENER DIODE 500MW 24VOLT 1	2	ZD9, ZD8
BC0217	DIODE BRIDGE 1.5A 400V W04	1	BR1
BC10003	RECTIFIER MUR1640CT XD04-	12	D52, D62, D59, D56, D48, D45, D61, D53, D60, D57, D47, D36
BC10004	BRIDGE REC 35A 600V	1	BR2
BD0364	BF422 NPN TRANS	12	TR11, TR37, TR38, TR12, TR61, TR32, TR33, TR58, TR64, TR66, TR67, TR86
BD0365	BF423 PNP TRANS	14	TR18, TR19, TR20, TR21, TR55, TR54, TR53, TR51, TR52, TR16, TR63, TR65, TR74, TR62
BD0373	MJ15024 NPN POWER TRANS TO3 @	8	TR26, TR14, TR34, TR46, TR83, TR89, TR60, TR73
BD0374	MJ15025 PNP POWER TRANS TO3 @	8	TR72, TR59, TR88, TR79, TR39, TR48, TR17, TR28
BD0394R	TRANSISTOR BC546BT NPN TAPED	16	TR22, TR50, TR3, TR1, TR8, TR10, TR69, TR71, TR80, TR82, TR85, TR87, TR76, TR78, TR47, TR23
BD0395R	TRANSISTOR BC556BT PNP TAPED	11	TR44, TR27, TR4, TR5, TR9, TR68, TR75, TR81, TR84, TR70, TR77
BD0396	OPTO TRANSISTOR CNW11-AV1	1	OPT1
BD10003	TRANS ZTX550T/A XE01-	2	TR6, TR7
BD10011	2SA872 TRANSISTOR TO220 CA-TF	4	TR30, TR31, TR35, TR36
BD10014	MJE5731A TRANSISTOR CA-TF	4	TR13, TR25, TR57, TR45
BD10020	TIP50 CA-TF	3	TR56, TR15, TR2
BD10026	TRANS TIP122 TO220 XE01-	1	TR49
BD10032	IGBT SGL50N60RUF-D TO264 XF07-	2	TR24, TR29
BD10035	(A) MOSFET IRF 540 XE05-	8	FET1, FET3, FET5, FET6,

			FET7, FET8, FET2, FET4
BD10042	ZTX651 NPN TRANSISTOR	2	TR40, TR42
BD10043	ZTX751 PNP TRANSISTOR	2	TR41, TR43
BE0403	TL074CN QUAD OP AMP	1	IC2
BE0413	JRC DUAL OP AMP 072BDE	3	IC9, IC10, IC4
BE0417	V.REG 7915 -15V 1A	1	IC8
BE0428	NE5532P/NJM5532D DUAL OP AMP @	2	IC3, IC5
BE0503	TL431 SHUNT REGULATOR	1	D1
BE10012	LM35-DZ (SRX) IC CA-TF	2	IC11, IC12
BE10030	V.REG 7815 +15V 1A	1	IC7
BK10008	IC MICROC PIC16C57-04P XG04-	1	IC1
BS0005R-SOT23	BAV99 SM DIODE	6	D1, D2, D5, D6, D7, D8
BS0506R-SOT23	NPN TRANS BC846B	1	TR2
BS10043	ANALOG SW.DG411 QUAD SM	1	IC2
BS7001R-SO8	TL072CD SM DUAL OP AMP #	1	IC8
BS7009R-SO8	NE5532 SM DUAL OP AMP #	2	IC1, IC3
BZ10000	(A) PWM CONT SG3525AN XF04-	1	IC6
BZ10002	!THERMISTOR MAIN VOLTAGE CA-DB	1	TH1
CA0026	M/LAYER CAP .1UF 63V	18	C98, C90, C86, C86, C97, C105, C101, C102, C117, C144, C13, C36, C26, C27, C30, C31, C35
CA0027	M/LAYER CRMC CAP 10N 100V	4	C2, C3, C4, C5
CA0030	M/LAYER CRMC CAP 50V 4N7	2	C18, C20
CA0038R	C/CAP 0.2"TAPE 100V 15PF	2	C17, C19
CA0041R	C/CAP 0.2"TAPE 100V 47PF	10	C62, C76, C110, C123, C111, C145, C140, C115, C116, C128
CA0044R	C/CAP 0.2"TAPE 100V 100PF	2	C46, C95
CA0045R	C/CAP 0.2"TAPE 100V 150PF	2	C6, C25
CA10023	C/CAP 1000V 470PF XC03-	4	C100, C56, C41, C68, C7
CC0238	MICRO-BOX 5MM 5% 63V 1N	3	C70, C69, C99
CC0242	MICRO-BOX 5MM 5% 63V 4N7	14	C51, C148, C151, C125, C135, C60, C81, C88, C154, C155, C152, C153, C57, C78
CC0246	MICRO-BOX 5MM 5% 63V 22N	2	C1, C6
CC0250	MICRO-BOX 5MM 5% 100V 100N	10	C49, C52, C96, C92, C85, C40, C34, C118, C146, C127
CC0251	MICRO-BOX 5MM 5% 100V 220N	20	C38, C39, C80, C83, C108, C109, C55, C59, C107, C106, C71, C134, C136, C8, C141, C142, C72, C119, C122,

C121

CC0288	POLYPROPYLENE 2200PF 250VAC (C	4	C14, C15
CC10076	CAP POLYPROP 220N 400V 5%XC09-	3	C63, C64, C65
CC10077	POLY-CAP 400V 1U XC09-	2	C2, C66
CE0403	VERT ELEC 0.2"TPD 100UF 10V SK	5	C37, C103, C67
CE0416	VERT ELEC 0.2"TPD 2.2UF/50 SSP	4	C48, C77, C94, C61
CE0445	VERT ELEC 1UF 63V SKP	3	C53, C84, C104
CE0462	VERT ELEC 10UF/63V 5X11MMSKP	18	C89, C93, C12, C24, C21, C112, C139, C129, C147, C73, C120, C124, C130, C133
CE0467	VERT ELEC 4700/100V LPW	4	C113, C137, C138, C114
CE10003	ELEC/LYTIC RAD 200V 1800	6	C22, C23, C44, C45, C32, C33
CE10004	ELEC/LYTIC RAD 40V 2200 XC06-	3	C11, C28, C29
CE10005	ELEC/LYTIC RAD 63V 1000 XC06-	1	C75
CE10009	NON-POL 10V 100UF JAMIC	10	C149, C150, C58, C79, C3, C9, C4, C10, C16, C43
CE10033	ELEC/L 63V 220UF 105 C XC06-	4	C74, C82, C126, C132
CS1221R-1206J	CAP CRMC 220PF 5% 50V NP0	4	C25, C26, C27, C28
CS7104R-1206K	CAP CRMC 100NF 10% 50V X7R	5	C10, C12, C23, C24, C33
CX10000	!CAP 275V 1UF X2 XC09-	1	C2
D-C300A-01	POT 16MM 10K LIN RD1610 A0X-P	2	P1, P2
DG10010	SWITCH ROUND SPST XK04-	1	SW1
DZ10012	RELAY SPCO 16A 48V XK06-	2	RLY1, RLY2
FA10002	40W IDC CONN SIDE EJECT XL04-	1	
FA10003	34W IDC CONN SIDE EJECT XL04-	1	
FF0728	28WY DIL IC SKT DUAL WIPE TIN	1	
FF10003	PC JUMPER XL02-	8	
FF10019	BINDING POST ASSY 4MM XL05-	1	
FF10022	SPADE TAB VERT PC 0.125C	2	
FF10030	4 POLE SKT - SPEAKON CA-CO	2	CN1, CN2
FF10046	2W 0.1 ST&F/L CONN HDR CA-CO	3	CN13, CN14, CN17
FF10055	SKT 1X12 SIDE ENTRY X	1	
FF10063	CONN. 34W BOX GOLD XL04-	1	
FF10073	HEADER 2X17 R/A XL04-	1	
FF10079	TERMINAL BLOCK - 3 WAY XL04-	2	CN1, CN2

FF10080	PLUG 3 WAY FREE KLIPPON XL04-	2	
FF10083	5 WAY PIN HDR.LATCH TYPE XL04-	1	
FF10085	HEADER 1x12 THU VERT XL04-	1	
FG10006	PCB FASTON	11	
FH0760	REAN SLIMJACK S203-84G	2	CN4, CN5
FJ10005	!IEC FILTERED 10AMP CONN XL02-	1	CN3
FJ8019	!LEAD 10A USE FJ8016:17:18	1	
FK0986	XLR CON FML R/A CHAS PIN MTL	2	CN7, CN8
FK0987	XLR CON ML R/A CHAS PIN MTL	2	CN9, CN10
HB10042	TRANS 240V/11-0-11V 4VA	1	TX3
HB10045	TRANSFORMER PT42E XP01-	1	TX6
HC0021	FERRITE BEAD AX 5X3.5MM TAPED	4	FB1, FB2, FB3, FB4
HC0028	INDUCTOR 10UH TOKO R621LY-100K	2	L2, L3
HC10012	INDUCTOR 47UH RADIAL	1	L4
H-C1100A-01	TRANSFORMER-MAINS P2X1100	1	TX5
H-C300A-01	TRANSFORMER FET DRIVER W	1	TX4
H-C300B-01	CHOKE COM MODE E251	1	L1
H-C300E-01	CHOKE PULSE OUTPUT	2	L1, L2
J-C300A-01	LIGHTPIPES 8+1 - PULSE WAS J	1	
J-C300B-01	LIGHTPIPE LARGE - PULSE WAS J	1	
JS0004	LED RED SML-010UT	5	LD5, LD6, LD16, LD13, LD11
JS0005	LED YEL SML-010YT	4	LD9, LD14, LD15, LD17
JS0006	LED GRN SML-010PT	2	LD1, LD2
KA0267	SIF LIVE 4/8 POT KNOB GREY	2	
KZ10000	POT COVER - PULSE XV02-	2	
LA0008	7/0.2 RED WIRE	0.16	
LA0041	16/0.2 GREEN/YELLW WIRE	0.12	
LA0051	1/0.6 SINGLE STRAND WIRE PINK	0.05	
L-B100A-02	EARTH WIRE MAINS TO CHASS	1	
L-C300A-02	WIREFORM ASSY.FAN-80MM X 12V	2	
L-C300B-03	WIRING LOOM - PULSE WAS -	1	
L-C300C-02	WIRING LOOM-PULSE F/PANEL	2	
L-C300E-01	INDUCTOR WIRE DETAIL	1	
LF0572	H20 NEOPRENE SLEEVES	3	
LF0573	H30 X 20 BLACK SLEEVE	2	
LF0596	CABLE TIE 8.0 NARROW	7	
M-C250A-01	250 & 650 SOFTWARE	1	

NA0084	M3X6MM PAN POZI BLK SCREW	4
NA0384	M2.5X6MM PAN POZ BLK TAPTITE	8
NA0392	SCREW PLAS NO8X3/8" BLK	2
NA0397	M3X6 FLANGE SCREW BLK POZI	10
NA0424	NO.8X5/8" PAN POZI BLK Y CUT	4
NA10002	M3.6 PAN POZI TAPTITE ZN XW02-	4
NA10015	M3X16 PAN POZI SCR BZP CA-FI	32
NA10042	M3X16 SCREW BZP HEX CA-FI	2
NA10045	M4X6 PAN POZI SCR BLK CA-FI	4
NA10047	M3X10MM P/P ZINC CA-FI	1
NA10050	M5X20 TORX TAPTITE BK XW05-	4
NA10051	M5X16 TORX TAPTITE BLK XW05-	8
NB0113	M3 NYLON INSERT NUT	1
NB0122	M3 PLAIN NUT	6
NB10005	M3.5 NUT FULL BZP CA-FI	32
NB10014	NUT HALF M4 XW13-	4
N-B966B-01	ADHESIVE STRIP 10X10 966 WAS N	11
NC0221	M3 S/PROOF WASHER	6
NC0256	M3 PLAIN WASHER	3
NC10018	WASHER-PLAS 9.5X4.75X0.5 XW07-	8
NC10022	M4 SPRING WASHER STL.BZP	32
ND10004	PILLAR METAL M3X10MM XW10-	2
ND10025	SPACER F/PANEL - PULSE XW10-	4
ND10027	SPACER NYLON FAN SCREW XW10-	4
ND10040	SPACER-NYLON 6.35X3.56X6.35LG.	4
NE0408	M3 SOLDER TAG	1
NZ10000	ADHESVIE BCK MIN SUPPORT CA-EL	2
P-C1100B-01	INSULATOR-CAPACITORS	1
P-C1100D-01	SPRING CLIP P-C11	1
P-C1100E-01	BADGE - PULSE 2X1100	1
P-C300A-02	INSULATOR HEATSINK - 250 XV01-	2
P-C300B-03	INSULATOR BASE TRAY-PULSE	1
P-C300E-01	FRONT PANEL THERM.INSUL.	2
P-C300F-01	HEATSINK-CUT & PUNCH	2
P-C300J-03	LID AMPLIFIER - PULSE	1
P-C300M-01	SPACER FAN (CUT) - PULSE	2
P-C300N-01	FAN SPACER FOAM - PULSE	2

P-C650A-01	SPACER - BINDING POST	1	
P-CR1100A-01	P2X1000 BASE TRAY	1	
P-CR1100C-02	1100 SUB FRONT PANEL	1	
P-CR300C-01	BADGE - CROWN	1	
P-CR300I-02	FRONT PNL PUNCHED- CROWN	1	
R-C1100A-05-AF	1100 PULSE MAIN PCB ASSY	1	
R-C650B-02-AF	650 FRONT PANEL PCB ASSY R-650	1	
R-C650B-02-SC	650 FRONT PANEL PCB -SC R-650	1	
R-C650B-02-SM	650 FRONT PANEL PCB-SM R-650	1	
R-CR650C-01-AF	CROWN 650 REAR PANEL PCB ASSY.	1	
S-C1100A-05	PCB MAIN BOARD - P2X1100	1	
S-C650B-02	PCB FRONT PANEL BRD.P2X650	1	
S-CR650C-01	PCB CROWN OUTPUT BRD.P2X650	1	
TA10022	CARTON CUSTOM PACK (WAS	1	
TZ10001	GRIP BAG A4 XT01-	1	
TZ10002	GRIP BAG SMALL 4 X 8IN XT01-	1	
TZ10004	POLYBAG -26X24X250 GAUGE CA-MI	1	
ZA0395-01	FCC LABEL SELF ADH 70X15	1	
ZA10004	STICKER - SAFETY EARTH XT03-	1	
ZA10020	LABEL SHOCK & MOISTURE XT03-	1	
ZA10027	LABEL UL STD.6500 55X25 XT03-	1	
ZA10039	FOAM SEALING STRIP XT05-	1.25	
ZA10081	LABEL CARTON-CROWN PULSE	1	
ZC0240	REG KOOL-PAD,SELF ADH 105SP900	5	
ZC10014	HEATSINK TO220 CLIP ON CA-HA	1	
ZC10018	CLIP HEATSINK TO-247 XW13-	31	
ZC10029	TO3 INSULATING WASHER	16	
ZC10030	TO3 PLASTIC COVER	2	
ZD0332	FUSEHOLDER 10A 250V PCB MNT	1	
ZD0334	20MM S/ENC PCB MNGT FUSEHOLDER	2	
ZD10000	FUSE 20MM T200MA XM01-	1	
ZD10002	FUSE 20MM T500MA XM01-	1	
ZD10014	!FUSE 6.3 AMP S/D SLOW T CA-EL	1	
ZE10007	CER RESONATOR 3.58MHZ XI01-	1	XT1
ZM10090-01	MANUAL CROWN P2X1100 V1.0	1	
ZZ2893R	FILTER 100PF RFI TAPED	4	RF1, RF2, RF3, RF4

Pulse 4x300 Parts List

Part Number	Description	Qty	Designator(s)
AE0047	MF 1W RES 5% 4R7 PRO1	4	R77, R115, R117, R85
AE0100	MF 1W RES 5% 10R PRO1	9	R288
AE10002	RES 47K0 5% 1W MF PRO1 XA01-	4	R39, R40, R86, R121
AE10010	RES 3R3 5% 1W MF PRO1 XA01-	1	R21
AE10012	RES 10K 5% 1W MF PRO1 XA01-	1	R289
AE10018	MF RES 2W 5% 33R PRO2 AE100	1	R22
AE10027	100R 2W MF RESISTOR PRO2	1	R299
AE10030	RES.2K2 5% 1W PRO1 TYPE	4	R190, R54, R153, R281
AG10007	RES W/W 0R47 3W CA-RE	16	R257, R244, R248, R231, R131, R122, R116, R100, R74, R84, R92, R107, R219, R210, R223, R236
AJ10002	RES 50R 5W THICK FILM XA01-	2	R28, R142
AJ10003	RES 10K 5% 5W VERT XA01-	2	R30, R102
AM10001	RES 47R 5% 17W XA02-	1	R16
AP1301	MF 0.25W RES 1% 10R BL	1	R25
AP1309	MF 0.25W RES 1% 22R BL	4	R215, R80, R216, R252
AP1319	MF 0.25W RES 1% 56R BL	28	R221, R261, R262, R263, R179, R188, R189, R89, R52, R53, R135, R136, R137, R175, R119, R166, R68, R69, R70, R154, R155, R246, R170, R283, R282, R205, R204, R206
AP1322	MF 0.25W RES 1% 75R BL	8	R201, R264, R64, R138, R67, R141, R200, R267
AP1325	MF 0.25W RES 1% 100R BL	11	R216, R73, R81, R132, R209, R125, R258, R251, R181, R165, R169
AP1333	MF 0.25W RES 1% 220R BL	14	R187, R51, R109, R110, R238, R239, R156, R97, R98, R284, R228, R229, R34, R45
AP1337	AF 0.25W RES 1% 330R BL	5	R217, R82, R124, R250, R37
AP1341	MF 0.25W RES 1% 470R BL	16	R260, R272, R276, R134, R144, R57, R148, R63, R71, R59, R150, R199, R207, R195, R278
AP1347	MF 0.25W RES 1% 820R BL	20	R253, R254, R177, R232, R233, R104, R128, R103,

			R127, R176, R78, R79, R105, R106, R168, R213, R214, R234, R235, R176
AP1349	AP 0.25W RES 1% 1K BL	30	R268, R241, R242, R220, R240, R218, R49, R270, R112, R113, R83, R88, R111, R174, R271, R94, R95, R96, R120, R123, R269, R225, R226, R227, R247, R249, R24, R208
AP1361	MF 0.25W RES 1% 3K3 BL	2	R11, R290
AP1365	MF 0.25W RES 1% 4K7 BL	1	R172
AP1366	MF 0.25W RES 1% 5K1 BL	12	R274, R202, R65, R146, R61, R140, R197, R266, R296, R297, R32, R47
AP1369	MF 0.25W RES 1% 6K8 BL	8	R222, R90, R114, R243, R118, R93, R245, R224
AP1370	MF 0.25W RES 1% 7K5 BL	1	R180
AP1373	MF 0.25W RES 1% 10K BL	15	R137, R108, R99, R230, R286, R287, R44, R42, R23, R26, R29, R27, R178, R161, R164, R182, R298
AP1377	MF 0.25W RES 1% 15K BL	1	R160
AP1380	MF 0.25W RES 1% 20K BL	24	R186, R273, R212, R191, R50, R72, R76, R55, R145, R157, R133, R219, R62, R152, R265, R255, R198, R280, R12, R13, R14, R15, R9, R10, R43, R41, R36, R87
AP1387	MF 0.25W RES 1% 39K BL	4	R17, R18, R19, R20
AP1388	MF 0.25W RES 1% 43K BL	8	R275, R203, R66, R147, R60, R139, R196, R265
AP1389	MF 0.25W RES 1% 47K BL	13	R211, R291, R75, R143, R130, R256, R33, R46, R31, R35, R38, R158, R91
AP1397	MF 0.25W RES 1% 100K BL	4	R292, R293, R259, R101
AP1405	MF 0.25W RES 1% 220K BL	11	R184, R185, R163, R171, R159, R162, R173, R183, R294, R295, R48
AP1421	MF 0.25W RES 1% 1M BL	16	R277, R192, R56, R149, R58, R151, R194, R279, R1, R2, R3, R4, R5, R6, R7, R8
AS0102R-0805F	SM0805 RES 1K 1% 0.1W T200	4	R70, R71, R72, R73
AS0103R-0805F	SM0805 RES 10K 1% 0.1W T200	2	R58, R62

AS0104R-0805F	SM0805 RES 100K 1% 0.1W T200	5	R35, R38, R41, R44, R60
AS0113R-0805F	SM0805 RES 11K 1% 0.1W T200	8	R3, R4, R10, R11, R17, R18, R24, R25
AS0152R-0805F	SM0805 RES 1K5 1% 0.1W T200	7	R34, R37, R40, R43, R49, R50, R56
AS0432R-0805F	SM0805 RES 4K3 1% 0.1W T200	14	R5, R6, R29, R12, R13, R30, R19, R20, R31, R26, R27, R32, R69, R74
AS0470R-0805F	SM0805 RES 47R 1% 0.1W T200	8	R7, R14, R21, R28, R33, R36, R39, R42
AS0471R-0805F	SM0805 RES 470R 1% 0.1W T200	9	R45, R46, R47, R48, R54, R55, R51, R53, R57
AS0512R-0805F	SM0805 RES 5K1 1% 0.1W T200	16	R1, R2, R8, R9, R15, R16, R22, R23, R52, R59, R63, R64, R65, R66, R67, R68
AS1103R-1206F	SM1206-RES 10K 1% 1/8W T200	1	R61
BA0001	DIODE 1N4148	53	D51, D52, D69, D65, D75, D76, D84, D85, D74, D53, D54, D56, D7, D8, D19, D22, D10, D30, D31, D42, D9, D43, D12, D29, D37, D38, D24, D27, D14, D15, D6, D35, D5, D36, D33, D16, D82, D83, D58, D59, D70, D72, D49, D80, D48, D81, D61, D77, D3, D4, D2, D47, D21
BA0025	DIODE FAST 400V 1.7A BYD73G	9	D23, D41, D39, D40, D44, D68, D67, D64, D63
BA10004	DIODE IN4004 CA-DB	8	D78, D57, D13, D34, D11, D32, D55, D79
BB0116	ZENER DIODE 1.3W 47V	1	ZD5
BB10001	ZENER DIODE 20V 400MW XD03-	1	ZD12
BB10002	ZENER DIODE 500MW 2V7 CA-DB	9	ZD18, ZD15, ZD2, ZD7, ZD4, ZD9, ZD17, ZD20, ZD6
BB10005	ZENER DIODE 500MV 15V CA-DB	1	ZD13
BB10007	ZENER DIODE 500MW 4.7V5% CA-DB	2	ZD22, ZD23
BB10011	ZENER DIODE 500MW 47V CA-DB	8	ZD21, ZD16, ZD3, ZD10, ZD1, ZD8, ZD14, ZD19
BB10022	ZENER DIODE 500MW 24VOLT 1	2	ZD11, ZD24
BC0217	DIODE BRIDGE 1.5A 400V W04	1	BR1
BC10003	RECTIFIER MUR1640CT XD04-	4	D45, D46, D50, D60
BC10004	BRIDGE REC 35A 600V	1	BR2
BD0364	BF422 NPN TRANS	14	TR80, TR81, TR58, TR8, TR35, TR36, TR9, TR52, TR22, TR21, TR47, TR69,

TR70, TR92

BD0365	BF423 PNP TRANS	20	TR64, TR65, TR16, TR17, TR18, TR19, TR42, TR41, TR40, TR39, TR12, TR87, TR86, TR84, TR85, TR60, TR89, TR66, TR67, TR45
BD0373	MJ15024 NPN POWER TRANS TO3 @	8	TR73, TR57, TR27, TR11, TR37, TR51, TR82, TR94
BD0374	MJ15025 PNP POWER TRANS TO3 @	8	TR79, TR93, TR34, TR48, TR14, TR29, TR62, TR75
BD0394R	TRANSISTOR BC546BT NPN TAPED	11	TR68, TR20, TR38, TR83, TR98, TR49, TR1, TR5, TR7, TR55, TR23
BD0395R	TRANSISTOR BC556BT PNP TAPED	7	TR90, TR44, TR13, TR61, TR6, TR4, TR53
BD0396	OPTO TRANSISTOR CNW11-AV1	1	OPT1
BD10011	2SA872 TRANSISTOR TO220 CA-TF	8	TR76, TR77, TR30, TR31, TR26, TR28, TR74, TR72
BD10014	MJE5731A TRANSISTOR CA-TF	8	TR71, TR59, TR25, TR10, TR33, TR46, TR78, TR91
BD10020	TIP50 CA-TF	5	TR88, TR43, TR15, TR63, TR2
BD10026	TRANS TIP122 TO220 XE01-	1	TR50
BD10032	IGBT SGL50N60RUF-D-TO264 XF07-	2	TR24, TR32
BD10042	ZTX651 NPN TRANSISTOR	2	TR56, TR95
BD10043	ZTX751 PNP TRANSISTOR	4	TR3, TR54, TR96, TR97
BE0403	TL074CN QUAD OP AMP	1	IC2
BE0417	V.REG 7915 -15V 1A	1	IC8
BE0428	NE5532P/NJM5532D DUAL OP AMP @	2	IC5, IC4
BE0503	TL431 SHUNT REGULATOR	1	D1
BE10012	LM35-DZ (SRX) IC CA-TF	2	IC9, IC10
BE10030	V.REG 7815 +15V 1A	1	IC7
BK10008	IC MICROC PIC16C57-04P XG04-	1	IC1
BS0005R-SOT23	BAV99 SM DIODE	12	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12
BS0506R-SOT23	NPN TRANS BC846B	1	TR2
BS10043	ANALOG SW.DG411 QUAD SM	2	IC2, IC4
BS7002	TL074A SM QUAD OP-AMP #	1	IC7
BS7009R-SO8	NE5532 SM DUAL OP AMP #	4	IC1, IC3, IC5, IC6

BZ10000	(A) PWM CONT SG3525AN XF04-	1	IC6
BZ10002	!THERMISTOR MAIN VOLTAGE CA-DB	1	TH1
CA0026	M/LAYER CAP .1UF 63V	17	C150, C110, C46, C39, C79, C72, C40, C80, C104, C115, C119, C48, C96, C70, C142, C111, C151, C140, C31, C32, C153, C154, C82, C19, C93, C155, C157, C92, C156, C94, C109, C158
CA0027	M/LAYER CRMC CAP 10N 100V	8	C139, C130, C56, C69, C71, C49, C57, C141, C121, C131
CA0030	M/LAYER CRMC CAP 50V 4N7	2	C116, C47, C24, C26
CA0038R	C/CAP 0.2"TAPED 100V 15PF	2	C23, C25
CA0041R	C/CAP 0.2"TAPED 100V 47PF	4	C132, C58, C55, C127
CA0044R	C/CAP 0.2"TAPED 100V 100PF	4	
CA0045R	C/CAP 0.2"TAPED 100V 150PF	2	C14, C15, C16, C17, C4, C160
CA10023	C/CAP 1000V 470PF XC03-	4	C103, C53, C65, C162
CC0238	MICRO-BOX 5MM 5% 63V 1N	5	C163, C164, C165, C166, C102
CC0242	MICRO-BOX 5MM 5% 63V 4N7	4	C116, C47, C24, C26
CC0244	MICRO-BOX 5MM 5% 63V 10N	8	C2, C3, C4, C5, C8, C9, C10, C11
CC0246	MICRO-BOX 5MM 5% 63V 22N	4	C1, C6, C7, C12
CC0250	MICRO-BOX 5MM 5% 100V 100N	17	C106, C147, C114, C37, C45, C78, C85, C41, C75, C152, C112, C145, C64, C17, C18, C19, C20
CC0288	POLYPROPYLENE 2200PF 250VAC (C	2	C1, C3, C161, C20
CC10077	POLY-CAP 400V 1U XC09-	2	C62, C38
CC10078	POLY-CAP 400V 470N XC09-	1	C61
CE0403	VERT ELEC 0.2"TPD 100UF 10V SK	13	
CE0445	VERT ELEC 1UF 63V SKP	5	C124, C52, C66, C136, C101
CE0446	VERT ELEC 100UF 25V SKP	4	C17, C18, C19, C20
CE0462	VERT ELEC 10UF/63V 5X11MMSKP	20	C100, C107, C86, C91, C84, C88, C97, C105, C18, C30, C27, C74, C120, C129, C125, C133, C9, C11, C13, C15
CE0467	VERT ELEC 4700/100V LPW	2	C117, C118
CE10003	ELEC/LYTIC RAD 200V 1800	6	C28, C29, C42, C43, C33, C34

CE10004	ELEC/LYTIC RAD 40V 2200 XC06-	3	C5, C22, C159
CE10005	ELEC/LYTIC RAD 63V 1000 XC06-	1	C76
CE10009	NON-POL 10V 100UF JAMIC	17	C143, C126, C144, C135, C149, C63, C148, C54, C6, C7, C8, C9, C10, C11, C12, C13, C21
CE10033	ELEC/L 63V 220UF 105 C XC06-	4	C73, C81, C128, C134
CS1221R-1206J	CAP CRMC 220PF 5% 50V NP0	8	C25, C26, C27, C28, C29, C30, C31, C32
CS7104R-0805K	CAP CRMC 100NF 10% 50V X7R	4	C10, C12, C14, C16
CS7104R-1206K	CAP CRMC 100NF 10% 50V X7R	6	C21, C22, C23, C24, C33, C34
CX10000	!CAP 275V 1UF X2 XC09-	1	C2
CZ10001	100N 630V POLYP.CAP.22.5 MM PT	2	
D-C300A-01	POT 16MM 10K LIN RD1610 A0X-P	4	P1, P2, P3, P4
DG10010	SWITCH ROUND SPST XK04-	1	
DJ10006	SWITCH SLIDE DPDT 30A NO LE	2	SW1, SW2
DZ10012	RELAY SPCO 16A 48V XK06-	2	RLY1, RLY2
FA10002	40W IDC CONN SIDE EJECT XL04-	1	CN11
FA10003	34W IDC CONN SIDE EJECT XL04-	1	
FF0728	28WY DIL IC SKT DUAL WIPE TIN	1	
FF10003	PC JUMPER XL02-	16	
FF10022	SPADE TAB VERT PC 0.125C	2	
FF10030	4 POLE SKT - SPEAKON CA-CO	4	CN1, CN2, CN3, CN4
FF10046	2W 0.1 ST&F/L CONN HDR CA-CO	3	
FF10055	SKT 1X12 SIDE ENTRY X	1	CN10
FF10063	CONN. 34W BOX GOLD XL04-	1	
FF10073	HEADER 2X17 R/A XL04-	1	CN17
FF10083	5 WAY PIN HDR.LATCH TYPE XL04-	1	
FF10085	HEADER 1x12 THU VERT XL04-	1	
FG10006	PCB FASTON	11	
FH0760	REAN SLIMJACK S203-84G	4	CN2, CN3, CN4, CN5
FJ10005	!IEC FILTERED 10AMP CONN XL02-	1	CN1
FJ8019	!LEAD 10A USE FJ8016:17:18	1	
FK0986	XLR CON FML R/A CHAS PIN MTL	4	CN6, CN7, CN8, CN9
HB10042	TRANS 240V/11-0-11V 4VA	1	TX5
HB10045	TRANSFORMER PT42E XP01-	1	TX8

HC0021	FERRITE BEAD AX 5X3.5MM TAPED	2	L5, L6
HC0028	INDUCTOR 10UH TOKO R621LY-100K	2	L2, L3
HC10012	INDUCTOR 47UH RADIAL	1	L4
H-C300A-01	TRANSFORMER FET DRIVER W	1	TX6
H-C300B-01	CHOKE COM MODE E251	1	L1
H-C300C-01	TRANSFORMER SMPS P4X300	1	TX-7
H-C300E-01	CHOKE PULSE OUTPUT	4	L1, L2, L3, L4
J-C300A-01	LIGHTPIPES 8+1 - PULSE WAS J	1	
J-C300B-01	LIGHTPIPE LARGE - PULSE WAS J	1	
JS0004	LED RED SML-010UT	7	LD5, LD6, LD7, LD8, LD11, LD13, LD16
JS0005	LED YEL SML-010YT	5	LD14, LD15, LD9, LD10, LD17
JS0006	LED GRN SML-010PT	4	LD1, LD2, LD3, LD4
KA0267	SIF LIVE 4/8 POT KNOB GREY	4	
KZ10000	POT COVER - PULSE XV02-	4	
LA0008	7/0.2 RED WIRE	0.16	
LA0041	16/0.2 GREEN/YELLW WIRE	0.48	
LA0051	1/0.6 SINGLE STRAND WIRE PINK	0.22	
L-B100A-02	EARTH WIRE MAINS TO CHASS	4	
L-C300A-02	WIREFORM ASSY.FAN-80MM X 12V	2	
L-C300B-03	WIRING LOOM - PULSE WAS -	1	
L-C300C-02	WIRING LOOM-PULSE F\ PANEL	2	
L-C300E-01	INDUCTOR WIRE DETAIL	4	
LF0572	H20 NEOPRENE SLEEVES	6	
LF0573	H30 X 20 BLACK SLEEVE	2	
LF0596	CABLE TIE 8.0 NARROW	7	
M-C250A-01	250 & 650 SOFTWARE	1	
NA0084	M3X6MM PAN POZI BLK SCREW	4	
NA0384	M2.5X6MM PAN POZ BLK TAPTITE	8	
NA0392	SCREW PLAS NO8X3/8" BLK	2	
NA0397	M3X6 FLANGE SCREW BLK POZI	10	
NA0424	NO.8X5/8" PAN POZI BLK Y CUT	4	
NA10002	M3.6 PAN POZI TAPTITE ZN XW02-	4	
NA10015	M3X16 PAN POZI SCR BZP CA-FI	32	

NA10042	M3X16 SCREW BZP HEX CA-FI	2
NA10045	M4X6 PAN POZI SCR BLK CA-FI	4
NA10047	M3X10MM P/P ZINC CA-FI	1
NA10050	M5X20 TORX TAPTITE BK XW05-	4
NA10051	M5X16 TORX TAPTITE BLK XW05-	8
NB0113	M3 NYLON INSERT NUT	1
NB0122	M3 PLAIN NUT	6
NB10005	M3.5 NUT FULL BZP CA-FI	32
NB10014	NUT HALF M4 XW13-	4
N-B966B-01	ADHESIVE STRIP 10X10 966 WAS N	16
NC0221	M3 S/PROOF WASHER	6
NC0249	M4 PLAIN STEEL WASHER ZNC CLR	32
NC0256	M3 PLAIN WASHER	3
NC10007	M3.5 WASHER PLAIN BZP CA-FI	8
NC10018	WASHER-PLAS 9.5X4.75X0.5 XW07-	8
NC10022	M4 SPRING WASHER STL.BZP	32
ND10004	PILLAR METAL M3X10MM XW10-	2
ND10025	SPACER F/PANEL - PULSE XW10-	4
ND10027	SPACER NYLON FAN SCREW XW10-	4
ND10040	SPACER-NYLON 6.35X3.56X6.35LG.	4
NE0408	M3 SOLDER TAG	4
NF10005	RIVET 3.2X11 BLACK CA-FI	8
NZ10000	ADHESVIE BCK MIN SUPPORT CA-EL	2
P-C1100D-01	SPRING CLIP P-C11	1
P-C300A-02	INSULATOR HEATSINK - 250 XV01-	2
P-C300B-03	INSULATOR BASE TRAY-PULSE	1
P-C300D-01	BADGE - PULSE 4X300	1
P-C300E-01	FRONT PANEL THERM.INSUL.	2
P-C300F-01	HEATSINK-CUT & PUNCH	2
P-C300J-03	LID AMPLIFIER - PULSE	1
P-C300M-01	SPACER FAN (CUT) - PULSE	2
P-C300N-01	FAN SPACER FOAM - PULSE	2
P-CR300C-01	BADGE - CROWN	1

P-CR300G-01	BASE TRAY 4 CHAN - PULSE	1	
P-CR300H-02	SUB PANEL 4 CHAN - PULSE	1	
P-CR300I-02	FRONT PNL PUNCHED- CROWN	1	
P-CR300L-01	PANEL SPEAKON - PULSE	1	
R-C300A-06-PF	MAIN PCB ASSY.P4X300	1	
R-C300B-03-AF	FRONT PANEL PCB ASSY	1	
R-C300B-03-SM	FRONT PANEL PCB SM	1	
R-CR300C-01-AF	CROWN SPEAKON PCB C300 ASSY.	1	
R-CR300D-01-AF	CROWN BINDING POST PCB ASSY.	1	
S-C300A-06	PCB C300 MAIN BOARD	1	
S-C300B-03	PCB C300 FRONT PANEL	1	
S-CR300C-01	PCB C300 CROWN SPEAKON BOARD.	1	
TA10022	CARTON CUSTOM PACK (WAS	1	
TZ10001	GRIP BAG A4 XT01-	1	
TZ10002	GRIP BAG SMALL 4 X 8IN XT01-	1	
TZ10004	POLYBAG -26X24X250 GAUGE CA-MI	1	
ZA0395-01	FCC LABEL SELF ADH 70X15	1	
ZA10004	STICKER - SAFETY EARTH XT03-	1	
ZA10020	LABEL SHOCK & MOISTURE XT03-	1	
ZA10027	LABEL UL STD.6500 55X25 XT03-	1	
ZA10039	FOAM SEALING STRIP XT05-	1.25	
ZA10081	LABEL CARTON-CROWN PULSE	1	
ZC0240	REG KOOL-PAD,SELF ADH 105SP900	6	
ZC10014	HEATSINK TO220 CLIP ON CA-HA	1	
ZC10018	CLIP HEATSINK TO-247 XW13-	21	
ZC10029	TO3 INSULATING WASHER	16	
ZC10030	TO3 PLASTIC COVER	2	
ZD0332	FUSEHOLDER 10A 250V PCB MNT	1	
ZD0334	20MM S/ENC PCB MNGT FUSEHOLDER	2	
ZD10000	FUSE 20MM T200MA XM01-	1	
ZD10002	FUSE 20MM T500MA XM01-	1	
ZD10014	!FUSE 6.3 AMP S/D SLOW T CA-EL	1	
ZE10007	CER RESONATOR 3.58MHZ XI01-	1	XT1

ZM10091-01	MANUAL CROWN P4X300 V1.0	1	
ZZ2893R	FILTER 100PF RFI TAPED	8	RF1, RF2, RF3, RF4, RF5, RF6, RF7, RF8