Solo circuit description

By Andy Moore

Introduction.

Solo is a single box High quality CD/ DAB-FM tuner and Amplifier solution implementing engineering principles derived from our separates range of products.

Operation building blocks.

Fig 1. Data line control path.

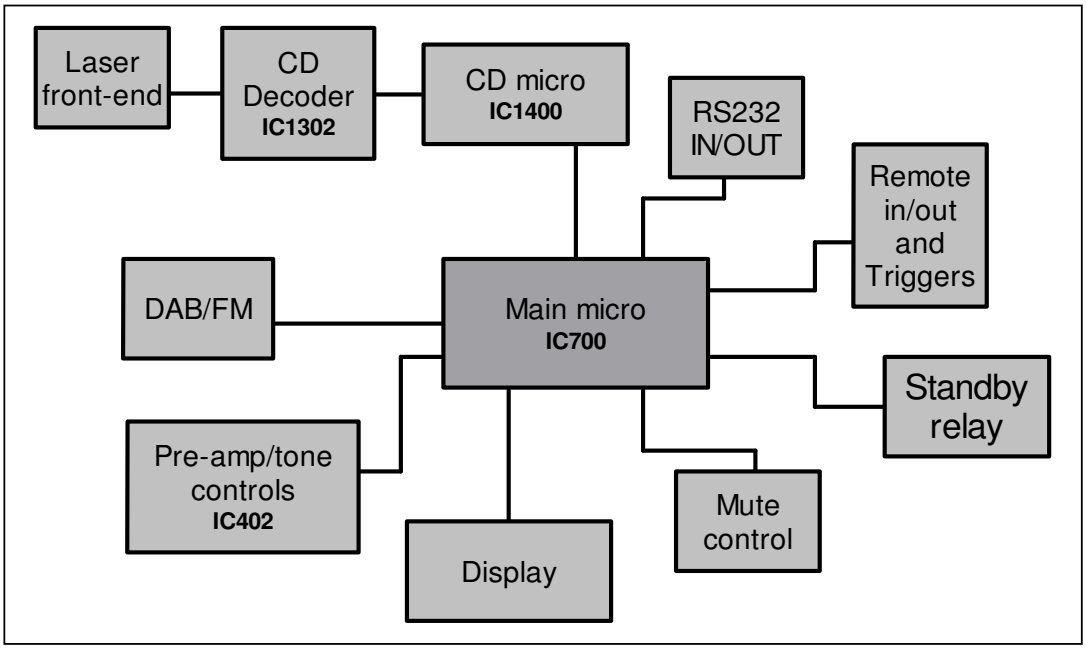
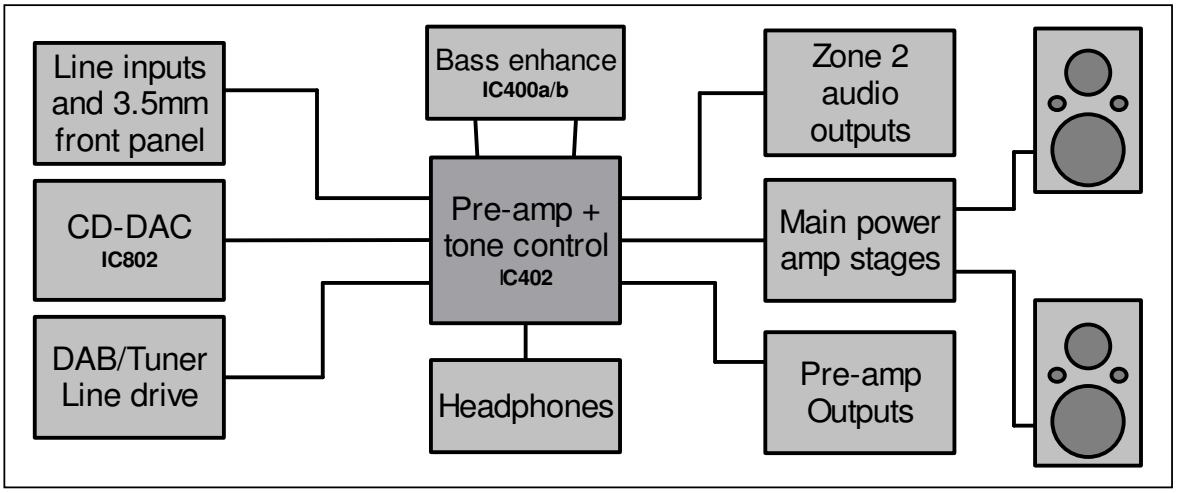


Fig 2. Audio signal path (left to right)



Introduction.

Solo is a single box High quality CD/ DAB-FM tuner and Amplifier solution implementing engineering principles derived from our separates range of products.

Analogue supply stages

Mains power arrives at the IEC inlet at location SKT600 and is filtered by X/Y capacitors C617/C618 and C621 in parallel with R623, any failure of these components has probably been caused by an extremely large external voltage surge.

The master mains fuse at location FHLDR600 will be seen as a different value (fuse ratting) within different global markets, see table 1 for fuse value ratings.

Table 1. **Fuse ratings**

Native mains voltage	Fuse value fitted
230v a.c	**T2A 20mm**
115v a.c	**T4A 20mm**
100v a.c	**T5A 20mm**

The master mains switch can be seen at location SW601A/B in normal use the customer will not need to touch this switch, the voltage select switch is found at location SW600 and switches the dual primary's between parallel and series primary terminations.

Please note: the mains voltage select is mounted internally within the Solo underneath the remote interface card and requires the selection of the correct value fuse after a change of voltage.

When switch SW601 is in the "on" position Auxiliary mains transformer TX1 is Live at all times; Transformer TX2 (Main TX) is under the control of the Micro at location IC700 via Relay RLY600a/b (see section on micro control).

Table 2 – Digital/Analogue supplies and key components.

Bridge rectifier	Supplied circuit and type
DBR600	**+12v (D), +8v (D), +3v3 (D), +3v3 (STBY).**
DBR601	**+8v (DAB), +5 (Standby)**
DBR602	**+7v (A), +5v (A)**
DBR603	**-7v (A)**
DBR605	**-35v (A) power amp supply**
DBR606	**+35 (A) power amp supply**

Digital supply stages.

Bridge rectifier **DBR600** is fused by FHLDR602 (T3.15A) and supplies regulators **REG600** and **REG601** these intern provide the +12V(D) and +8V(D) the +8V(D) is further regulated to supply the +3V5(D). This is a **switched** supply.

Bridge rectifier **DBR601** supplies a +8v unregulated rail to the L7805CV regulator at location **REG605** the +5v output forms the +5V(STBY) this supply is constant when the rear panel mains switch is in the ON position and is used to keep the remote circuit powered allowing the Solo to react to remote power up commands from other Zones whilst in standby mode the +5V(STBY) rail also forms the +5V(D) rail and is switched on/off depending on standby status by TR605 under control of the Standby* line OV = off and +3.3v = on when viewed at R600. The unregulated +8V(UNREG) also supplies the +8V(DAB) rail this is switched by the Standby* control line and TR603 and TR606 We should see Standby = +10v and On= 0v at R616

Digital supplies (cont).

The Standby* command logic is supplied by the Micro at location IC700 Pin 7.

The +8V(UNREG) rail also provides the **+3.3V(STBY)** rail via the LM317 regulator at location **REG607** this again is a constant un-switched rail and is used to supply the main micro at location IC700 and all other low level logic around the Micro.

The **A.C sense** for the Micro is taken from the A.C input of Bridge DBR601, the sense is formed by half wave rectifiers D600 and D601, when power is present TR602 is switched and a active high is asserted at Pin 116 of Micro IC700.

Analogue supplies

The low level analogue supplies are derived from **DBR602** and **DBR603** these two bridges are protected by in line secondary fuse rated as 1.6A(T) at locations FS604 and FS605, the + / - 12.5V unregulated outputs of the bridges are regulated by the LM317 at location **REG604** to form the **+7V(A)** rail and LM337 at location **REG606** to form the **–7V(A)** rail, bulk smoothing is implement both prior and after the regulator.

The **+/- 7V** rails supply all Op-amps in the analogue domain.

The **+5V(A)** Analogue rail is taken from **DBR602** and is current limited by the 1watt 10ohm resistor at location R626 before being regulated to +5 by the LM317 at location **REG602** bulk smoothing is supplied by C632

The **high level** analogue supplies form the power supply to the high quality **LM3886T** chip output drivers, the are derived from the dual bridge networks at locations **DBR604** and **DBR605** this are surround by “Snubber Capacitors” for improved power supply noise rejection each phase of the supply is smoothed **2 x 3’300uf** Capacitors damped with sound quality enhancing Sorbo-rings.

Analogue input stage Sheet 4 of 11

All inputs are filtered and by in series resistors and high quality Wima capacitors down to analogue ground before being A.C coupled to the 6 channel volume/8 input selector chip at location IC402.

The pre-amp stage is partially obscured by the tuner module fitted to inside the Solo this can be removed for fault finding with the pre-amp and the Solo will remain fully operational.

The **BD3811K1** input/selector/tone control chip at location **IC402** forms the heart of the pre-amp stage and is under control of the master micro via 2 wire serial the BD3811k1 can be looked at as a single chip pre-amp solution with a external discrete **Bass Sub-enhance** circuit implemented to alter the Bass Q of small bookshelf speakers.
We implement the BD3811 in a rather novel way as already mentioned the chip is a 6 channel volume control under software control this allows us to use various in/output ports to and from chip signal routing, in the instance of the **Bass Enhance** function we route the left and right signals from the main left and main right outputs (pins 19 and 17) via a high pass filter with a Q of 85Hz, below 50Hz the filters based around I.C 400a/b provide a roll off slope (-10dB @ 30Hz), both the left and right channels are then fed back into IC402 on input ports IN1Mix and IN2Mix (pins 22 and 24) any bass enhancements (lift) are made to the left and right channels internally allowing for up to +4.5 of lift at 85Hz.

The remaining tone control adjustments (Bass and Treble) are made within the BD3811.

The BD3811 also performs the Volume control adjustment/output switching/tape out switching for Zone 1 and Zone 2.

Please see: Fig One – Quick Pin guide for IC402

Bass Q = 234Hz +/- 7dB
Treble Q = 22.5KHz +/- 12dB
Bass Enhance Q= 85 – 100Hz +/- 4.5dB

Fig One – quick BD3811 pin guide.

Key – (a) Audio - (d) Data

Pin No.	Description
3	TV in Left (a)
4	TV in Right (a)
5	CD in Left (a)
6	CD in Right (a)
9	Alarm input (a)
10	Alarm input (a)
11	Aux front in Left (a)
12	Aux front in Right (a)
17	Output to Bass enhance Left (a)
18	Audio output to audio in at Pin 31 (a)
19	Output to Bass enhance Right (a)
20	Audio output to audio in at Pin 34 (a)
22	Return from Bass enhance Left (a)
24	Return from Bass enhance Right (a)
31	Audio from Pin 18 (a)
34	Audio from Pin 20 (a)
35	Headphone audio output Right (a)
36	Headphone audio output Left (a)
37	Zone 2 Audio output Left (a)
38	Zone 2 Audio output Right (a)
39	
40	Tuner gain o/p left – under software control. (a) when tuner selected only
42	
43	Tuner gain o/p Right – under software control. (a) when tuner selected
46	Data Input from micro at IC700 (d)
47	Clock input from micro at IC700 (d)
48	Mute Input from micro at IC700 (d)
50	
52	VCC = +7v(A)
55	Main o/p to pre-out Left and P.Amp (a)
56	External tone control configuration.
57	Main o/p to pre-out Right and P.Amp (a)
58	External tone control configuration.
59	External tone control configuration
60	External tone control configuration.
61	External tone control configuration.
62	External tone control configuration.
63	External tone control configuration.
64	External tone control configuration.

Pre-amp and Zone 2 Mute

Both the Pre-amp and Zone 2 mute stages are under direct control from the Micro a location IC700 the control lines can be see on the Base of transistor TR4010 (pre) and TR4011 (Z2) the voltage will be seen as follows

Mute =

Un mute =

If loud clicks are heard at power up/down the above control lines should be checked.

Engineering hint #1

For ease of fault finding full access to the main board of Solo is available by removing the CD interface board and DAB/FM board, Solo will remain operational from the external inputs whilst configured in this fashion.

Microcontroller IC700 and associated circuits.

The micro controller at location **IC700** is pre-programmed the with custom Arcam software and forms the heart of the Solo and is tasked with interfacing with the outside world via the front panel keyboard and remote sensor, it will also receive and act on RC5 signals received from the 3.5mm inputs for Zone 1 and Zone 2

The micro controller is driven from a constant **+3.3V (STBY)** supply as such at anytime we have mains present and the rear panel power switch in the on position we should see a 3.3v supply to the micro.

Resets

We should witness the operation of the system reset at location **IC702** this will be seen as a constant high 3.3v when mains is present, intern the Micro supplies a system reset to all other devices requiring reset the is via the digital transistor at location **TR701** we should see a constant +3.3v logic high at the collector of this device when the Solo is not in Standby.

Clock

X700 supplies the main clock for the micro we should be able to see a **24.576MHz** clock on the capacitor at location **C728** (linked to XTAL of IC700).

Memory retention.

The E-Eprom at location **IC703A** is used to store information on the last operational status for Solo.

Headphone Sense.

The **3.5mm** Headphone output socket has an **integral switched contact** allowing us the monitor the presence of headphones and as such mute the main o/p stages.

Our monitor point can be seen on **R1000** of the main board (within the proximity of IC700) when headphones are inserted we will measure **3.3V** D.C when the headphones are removed we should measure 0v this is worth mentioning as **past experience** has shown that a number of headphone sockets have been damaged by customer abuse rendering the audio outputs muted with no obvious sign of damage.

Pre amp output and Zone 2 output mute.

Under power down conditions or if a **3.5mm** jack is inserted into the headphone socket the Pre-amp output will mute the pre-amp mute control line can be seen a on the base of **TR4010** in normal operation we should see 0v and when mute is asserted we will see 3.3v, the Zone 2 mute works in a similar fashion but will not mute when the headphone socket is inserted the measurement point will be the base of

Pre amp chip IC402 mute line

The Pre-amp chip is under control of a master mute from the main micro this is seen on the resistor at location **R7000** will should see that during normal operation the control line is **Low (0V)** and when the Solo is muting the Pre-amp chip the signal will be seen **High (3.3V)**.

Protection modes.

A.C Present – Flagged as a 3v3 D.C high-level control line from TR602 within the Power supply circuit

Time keeping.

The micro requires an external clock/date control device this is provided by the time keeping chip at location IC704.

IC704 has a trickle charge facility provided by the 0.1F capacitor at location C732 and this supply is used to maintain clocks setting in the event of the unit spending time without a mains under these circumstances IC704 will sense that the VCC2 has dropped below the circa +3v supply rail offered by VCC1 (memory cap).

IC704 requires an external clock for accurate time keeping, this is offered by the **32.768KHz** crystal at location **X701.**

IC704 interfaces with the main micro via a 3-wire interface and we should see active data on Pin 6 RTC DA the toggle at the front of the DA chain should be seen to move at one second intervals.

Service mode.

Access the Service mode as follows.

Put unit into standby mode then press and hold **Mute + Volume up + Volume down**
Use the **Source +/-** buttons to navigate between set-up options and the **Track forward** and **Back buttons** to change the selected option.

The Solo will allow you access to the following menu options.

F.M De-emphasis – Changes the De-emphasis characteristics from 50uS (Europe) and 75uS(USA).

Region – Adjusts the A.M step ratio for units fitted with the Analogue tuner option.

Full reset of settings – Resets Solo to the factory preset defaults for all set-up options, please note: once selected this is **non-reversible.**

Software Version – Seen as **V1.4** etc.

CD Playback stages.

The CD playback stages of the Solo are almost identical to those found within the existing **Diva CD73** again we will see a fairly familiar CD front end pick chip and Sony CD decoder partnered with a BTL driver for control of the Optic and Spindle/sledge drive.

Front end and laser control

Conventional CD fault finding practise can be followed within this stage of the Solo a few points of interest follow with regards to fault finding.

The laser control circuit is driven from the +3.5V D.C supply the supply to the laser diode is derived from the 3.5v rail under the control of the laser diode on/off toggle from pin 1 of IC1301 via switching transistor TR1301 we can measure the laser - current drawn by the diode at this point by measuring the voltage drop across R1336 this should directly relate to the label on the KSS-213CM these will seen as

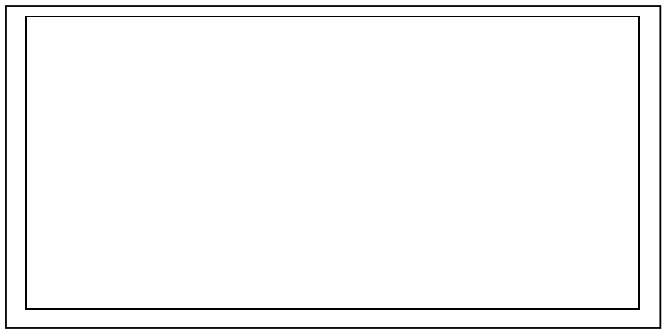
KSS213-CL
30241
df**420**

The 3rd text line down reads **df420** this indicates that the optic was set to **42.0mA** and we should see a voltage drop of **420mV** across **R1336** +/- the 5% tolerance of the resistor.

We can observe the operation of the **Focus Control** circuit on **Pin 13** of **IC1303 (FCS-)**, with no disc loaded open and close the tray, the player will initiate it's focal search during the time we should see a **170 kHz** saw tooth wave that should transverse through the 0V **(DGND)** as the Laser lens moves up and down.

The **6 signals** direct from the photodiodes from within the laser head can be seen entering the **IC1301** on pins **6 – 11** these feed the chips internal summing amplifier, we can see the combined **R.F output** as **RFDC** on resistor. The signal at this point should look very much like the diagram below **(eye pattern)** when the scope is set to .2uS/Div and should measure around 400mV pk-pk

Fig two - HF eye-pattern.



Please note: The RF output will obviously differ from disc to disc use the Philips SBC 444 playability disc if possible.

We can see the **FE error (FE)** output signal on **R1313**, this will appear as a high frequency R.F stream of **200mV pk-pk**, any excessive bounce may indicate a damaged or worn/borderline optic. The Focus is correct when **(A+D) – (B+C) = 0.**

The **Tracking error (TE)** signal can be seen as a High frequency R.F stream of on **R1345** we should expect to see **150-200mV pk-pk** during normal operation, under tracking error conditions the R.F will rise up to **300-600mV** dependent on the severity of the error. The Tracking error will be derived as **E –F = 0**.

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Engineering Hint #2

Due to the bandwidth of the Photodiodes within the Laser optic, we can use a standard IR remote control as a quick Photodiode test if we aim the output of the remote control directly into the laser lens we can expect to see the RC5 stream pass through the photodiodes allowing us to ascertain that the Diodes are operational. The monitor points will be Pins 6 – 11 of IC1301 this method can be used to diagnose the majority of laser related failures.

CD Decoder Chip

The **CXD3017Q** micro at location **IC1302** performs the majority of the Data processing and control tasks within the CD stage of the Solo, the micro receives the **RFDC, RFAC** along with the **EF, TE, SE** flags these signals are fed into the Servo DSP and the **PWM** modulator from this point the mechanism control signals leave the micro and travel to the BTL driver at location IC1303 as the **SFDR, SPDR, TFDR, TRDR, SFDR, SFD** PWM lines, the turntable motor control line leaves the micro as **MDP** and is filtered and referenced to **VC** to form a single **SPDR** line.

The presence of the **+3.6V(D)** rails is crucial to the operation of micros own internal PWM.

The micro initiates a programmed **disc load procedure** when the tray is closed, the procedure should be seen as follows.

Do not look directly into the laser beam.

- **Tray close**
- **Spin turntable motor**
- **Light laser**
- **Attempt focal alignment**
- **Read Table Of Contents (TOC)**

If the player fails to read the disc check.

- **Movement of the laser lens**
- **+5v(D) supply**
- **+3.6v(D) supply**
- **+8v supply**
- **Operation of tray micro switches**
- **Laser current (over R1336)**
- **Focus control**

The **CXD3017Q** contains a **CPU interface**; this port sends and receives Data packages from the front panel CPU at location IC1400.

The active communication ports can be seen as **DATA, XLAT, CLOK, SYSM,** and **XRST** the output ports are **SQSO** (CD Text), **SENS** and **SCOR**. We should see active data streams on **SENS**, **DATA**, and **SQCK** at all times when a disc is playing.

Clock Generation CD Decoder and DAC

The clock for the CD Decoder **CXD3017Q** and the **WM8740** DAC are derived from the same crystal although separately buffered.

The **16.9344MHz** crystal at location **X1300** drive trough transistor TR1330 and enter the Buffer at location **IC1304** on pin 3 and leaves the first buffer stage on pin 6 before being driven back into the chip to form to parallel buffers that leave from pin 12(CD MCK) and pin 10(DSP CLK).

Solo will remain operation under a clock failure although the CD playback will not be operational.

DAC and Audio stages.

The DAC and audio stages are partially obscured by the CD interface card although we can remove the two mounting screws and the two screw holding the rear panel RS232 socket and rest the card over the Main toroid transformer allowing us to play a test disc and trace the audio path.

The **WM8740 DAC** is driven from both the 3V5(D) rail for its core voltage and the +5V(A) for it's audio output stages.

The critical data lines can be seen at the below DAC input pins.

- **LRCLK – Pin 1**
- **ADATA – Pin 2**
- **BCLK – Pin 3**
- **CD MLK – Pin 5**

The Audio outputs from the **DAC** can been seen via a x10 probe R822 and R823 (L) and R824 and R827 (R) the DAC has a differential output stage and as such the signals will have a +/- offset respectively.

The differential audio is summed by the **Op-amp** at location **IC800 (a/b)** before leaving the chip on Pin 1 (L) and Pin 7 (R) from this point we run directly to the CD input ports of the Preamp chip as described on pages 2 and 3.

Digital outputs.

The Solo offers a **SPDIF** digital output feed for both **DAB** and **CD** selected sources IC803A allows us to switch the necessary SPDIF to the output and track the Audio selected by the customer, IC803A is under control of Pin 45 of the micro at location IC700.

Power Amp stages.

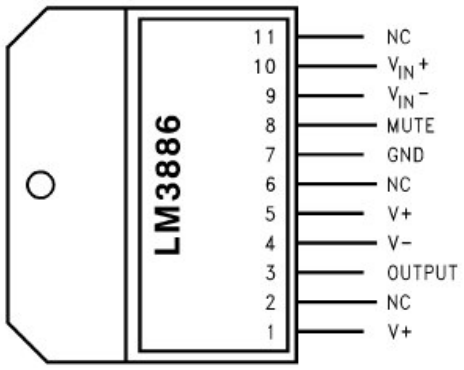
The power amp stage of the solo is based around a pair of exceptionally high quality National **LM3886** chip amplifiers these form a complete power amp on a single piece of silicon with very few ancillary components the topology is quasi – AB type please see below diagram for pin identification.

The Power chip has proven to be very robust during product testing but the protection modes of the package are worth highlighting.

Under power protection – The LM3886 shuts down under low power supply rail voltage conditions.

Over Voltage Protection – The LM3886 will self-limit under over-voltage/current conditions the max current swing is set to a limit of circa 12A.

Thermal Protection – The LM3886 has an internal thermal monitor circuit that will shut the device down at a max die temperature of **165°C** and reactivate when the package has cooled to **155°C**.



Full data sheet available from.

http://www.national.com/pf/LM/LM3886.html

Engineering Hint #3

Should the output package ever need replacing it will also be necessary to replace the Thermally bonding Sil-pad and it is imperative that any remnants of the original Sil-pad are removed from the Heatsink surface.

Display Board

The Solo display board has a very low component count and is powered by the **+3V3(STBY)** and **+5V(STBY)**. The board consists of a Itron display filament and a keyboard matrix with resistor ladder we can also see the IR pickup all display drive information travel from the main CPU via the Flexi foil link at location CON114.

The **Headphone output** and **3.5mm (in)** are attached to the front panel but are on a separate wafer from the display card Analogue audio travels out to the Headphone output from the pre-amp chip, and left right stereo travel from the 3.5mm input to the Pre-amp chip we can also see the Headphone status line.

Remote interface board

The remote interface card sends and receives **36KhZ** modulated **RC5** remote control signals SKT201 accepts **Zone 1** remote control information, the signal is passed by a zener diode at location **DZ200** to prevent any excessively high voltage levels from damaging the subsequent stages the signal is de-modulated by the circuit based around **IC200a/b** before becoming the Z1_RM_IN data line this is directly connected to the main micro at location **IC700** (Pin 120).

The **Zone 2** remote control input topology mirror the Zone 1 circuit but is based around **IC201 a/b**.

Before the RC5 input signals are demodulated a line is tapped off from the Z1FP_RM_OUT (front panel reciever) / Zone 1 remote and Zone 2 remote these are mixed by the digital transistors at locations TR200, TR201, TR209 before being driven to the **Remote output** 3.5mm jack by **TR202**.

DAB/FM and FM/AM stages

The Tuner modules implemented within the Solo carry no serviceable parts aside from the +5v-regulated supply based around the **L7805** regulator at location **REG900**.

We should expect to see Digital **SPDIF** audio leave the card on **R908** and **Analogue** audio Left and Right will be seen on Pins 4 and 2 this is easier to pick at the input of the line drive stage on the main board at the input pins 3 and 4 of **IC900a/b** we should see audio exit the op-amp on pins 1 and 7 respectively and from this point we run the pre-amp chips input MUX.

Technical Specification.

Pre-amplifier

Inputs

Maximum input level	2.5Vrms
Input impedance	47Kohm
Signal/noise ratio	105dB

Line outputs

Maximum output level	2.5Vrms
Output impedance	500ohm

Optical output (TOSLINK)

Sample rate	44.1kHz (CD) 48kHz (DAB)
Otherwise muted	(no A to D)

Power-amplifier

Cont power output, per channel 80kHz band

2 CH, 4ohm, 1kHz	0.013%THD+n
2 CH, 4 ohm, 80% max, 1kHz	0.011%THD+n

CD playback

Frequency response

20Hz-20kHz	+/- 0.5dB

DAB Receiver (where fitted)

Characteristics

DAC	AKM 96kHz 24-bit Delta-Sigma
RF tuning range	174-240MHz (Band III) 1452-1490MHz (L Band)
Sensitivity (typical)	-98dBm VHF EN50248
Input Impedance	50ohm
Audio data rate (max)	224kbits/s MPEG layer II, protection level 2
Max number of stored services	128

FM Receiver

Characteristics

RF tuning range	87.5 – 108MHz
Sensitivity (typ)	2uV
Signal/noise ratio (at 200mV)	58dB
Distortion (THD at 200mV)	0.5%

AM Receiver (where fitted)

Characteristics

RF tuning range	522-1611kHz
Sig to Noise ratio at 200mV	40dB
Distortion (THD at 30% mod)	1.5%

General

Supply voltage	100V, 115V or 230V	
Power consumption	Standby	3.2W
	Typical	50W
	Max	400W

Engineering support is available for all Arcam recognized service departments and distributors from

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