DENON

Ver. 5

Please refer to the MODIFICATION NOTICE.

SERVICE MANUAL

MODEL	JP	E3	E2	EK	E2A	E1C	E1K	EUT
DRA-F107			✓					
DRA-F107DAB				✓				

AM-FM STEREO RECEIVER

- For purposes of improvement, specifications and design are subject to change without notice.
- Please use this service manual with referring to the operating instructions without fail.
- Some illustrations using in this service manual are slightly different from the actual set.

DENON

D&M Holdings Inc.

S0089-1V05DM/DG1007

SAFETY PRECAUTIONS

The following check should be performed for the continued protection of the customer and service technician.

LEAKAGE CURRENT CHECK

Before returning the unit to the customer, make sure you make either (1) a leakage current check or (2) a line to chassis resistance check. If the leakage current exceeds 0.5 milliamps, or if the resistance from chassis to either side of the power cord is less than 460 kohms, the unit is defective.

CAUTION Please heed the points listed below during servicing and inspection.

◎ Heed the cautions!

Spots requiring particular attention when servicing, such as the cabinet, parts, chassis, etc., have cautions indicated on labels or seals. Be sure to heed these cautions and the cautions indicated in the handling instructions.

◎ Caution concerning electric shock!

(1) An AC voltage is impressed on this set, so touching internal metal parts when the set is energized could cause electric shock. Take care to avoid electric shock, by for example using an isolating transformer and gloves when servicing while the set is energized, unplugging the power cord when replacing parts, etc.

(2) There are high voltage parts inside. Handle with extra care when the set is energized.

◎ Caution concerning disassembly and assembly!

Though great care is taken when manufacturing parts from sheet metal, there may in some rare cases be burrs on the edges of parts which could cause injury if fingers are moved across them. Use gloves to protect your hands.

◎ Only use designated parts!

The set's parts have specific safety properties (fire resistance, voltage resistance, etc.). For replacement parts, be sure to use parts which have the same properties. In particular, for the important safety parts that are marked ⚠ on wiring diagrams and parts lists, be sure to use the designated parts.

◎ Be sure to mount parts and arrange the wires as they were originally!

For safety reasons, some parts use tape, tubes or other insulating materials, and some parts are mounted away from the surface of printed circuit boards. Care is also taken with the positions of the wires inside and clamps are used to keep wires away from heating and high voltage parts, so be sure to set everything back as it was originally.

◎ Inspect for safety after servicing!

Check that all screws, parts and wires removed or disconnected for servicing have been put back in their original positions, inspect that no parts around the area that has been serviced have been negatively affected, conduct an insulation check on the external metal connectors and between the blades of the power plug, and otherwise check that safety is ensured.

(Insulation check procedure)
Unplug the power cord from the power outlet, disconnect the antenna, plugs, etc., and turn the power switch on. Using a 500V insulation resistance tester, check that the insulation resistance between the terminals of the power plug and the externally exposed metal parts (antenna terminal, headphones terminal, microphone terminal, input terminal, etc.) is 1MΩ or greater. If it is less, the set must be inspected and repaired.

CAUTION Concerning important safety parts

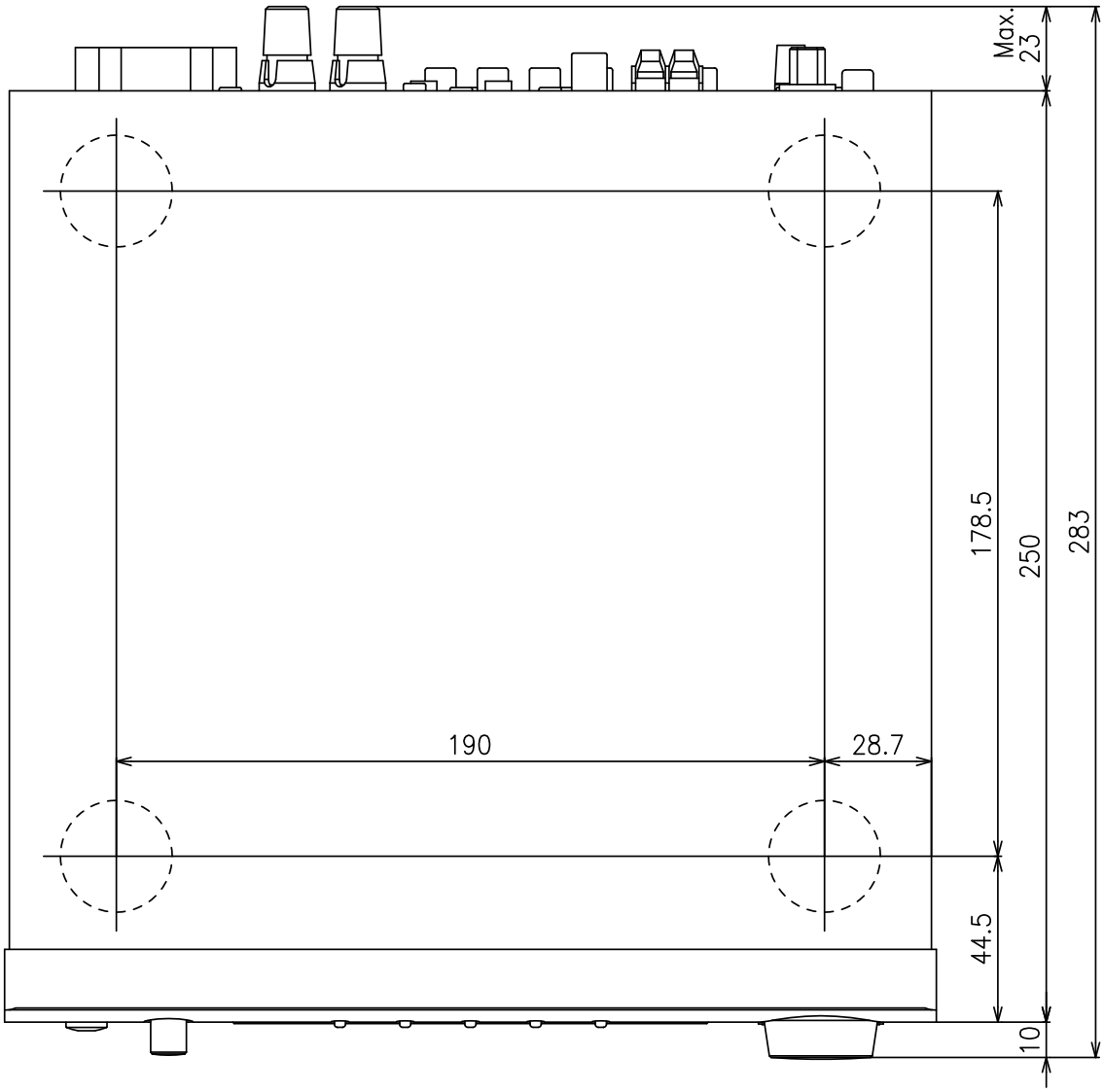
Many of the electric and structural parts used in the set have special safety properties. In most cases these properties are difficult to distinguish by sight, and using replacement parts with higher ratings (rated power and withstand voltage) does not necessarily guarantee that safety performance will be preserved. Parts with safety properties are indicated as shown below on the wiring diagrams and parts lists is this service manual. Be sure to replace them with parts with the designated part number.

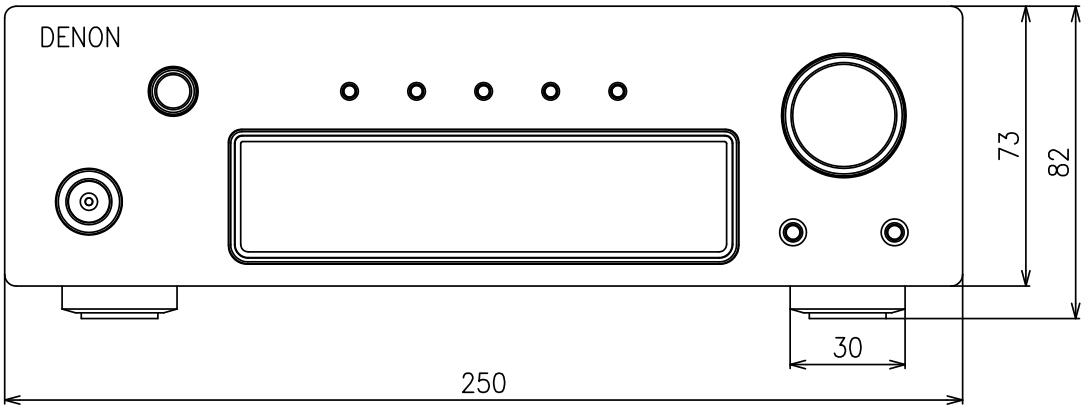
(1) Schematic diagrams ... Indicated by the ⚠ mark.

(2) Parts lists ... Indicated by the ⚠ mark.

Using parts other than the designated parts could result in electric shock, fires or other dangerous situations.

DIMENSION



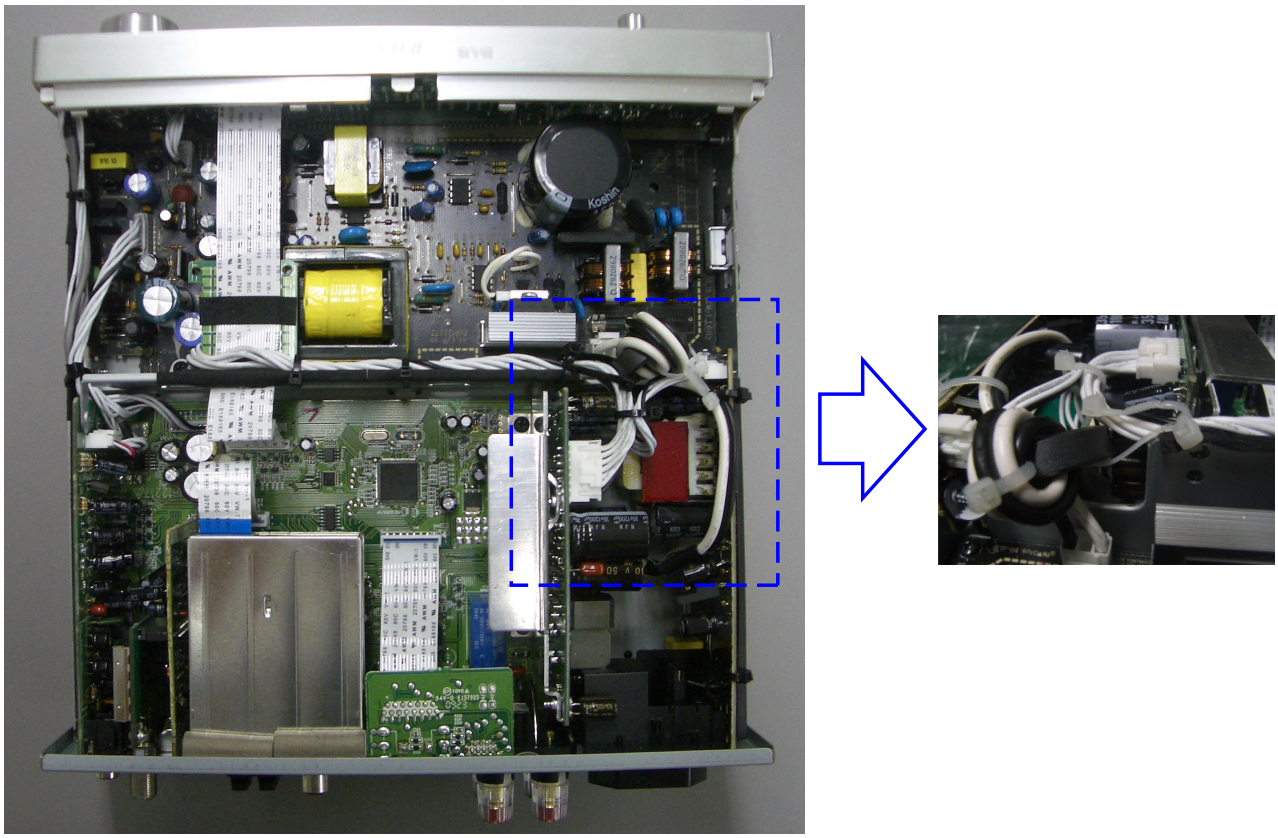


WIRE ARRANGEMENT

If wire bundles are untied or moved to perform adjustment or parts replacement etc.,be sure to rearrange them neatly as they were originally bundled or placed afterward.
Otherwise, incorrect arrangement can be a cause of noise generation.

Wire arrangement viewed from the top

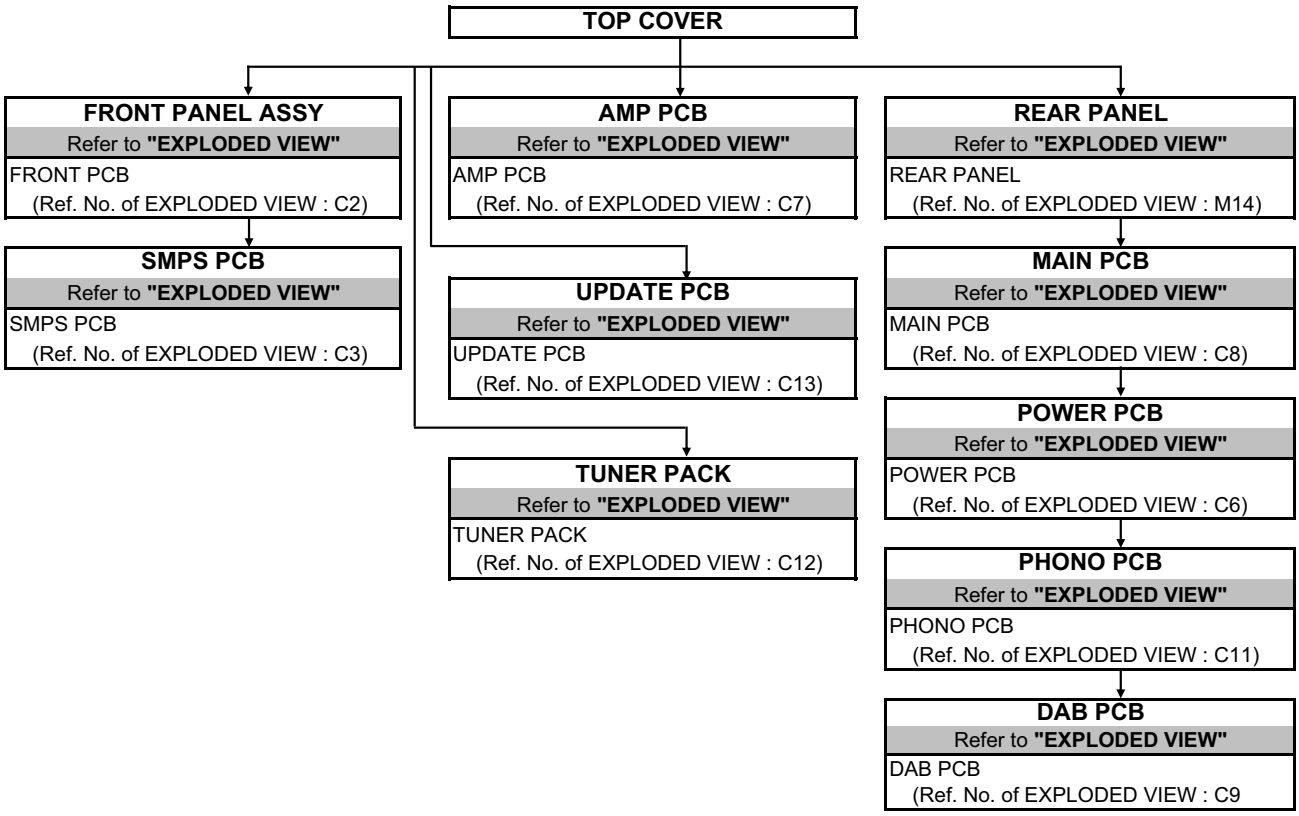
Front Panel side



Back Panel side

DISASSEMBLY

- Disassemble in order of the arrow of the figure of following flow.
- In the case of the re-assembling, assemble it in order of the reverse of the following flow.



Please refer to **"EXPLODED VIEW"** for the disassembly method of each PCB.

CAUTION IN SERVICING

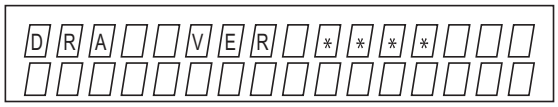
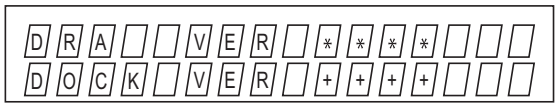
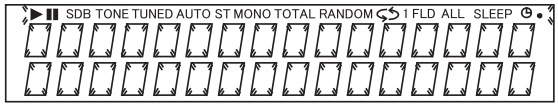
Initializing DRA-F107/DRA-F107DAB

DRA-F107/DRA-F107DAB initialization should be performed when the μcom, and peripheral parts of μcom are replaced.

1. Switch off the unit and remove the AC cord from the wall outlet.
2. Hold the following the ◄ button and the AUTO PRESET button, and plug the AC cord into the outlet. ⚠3

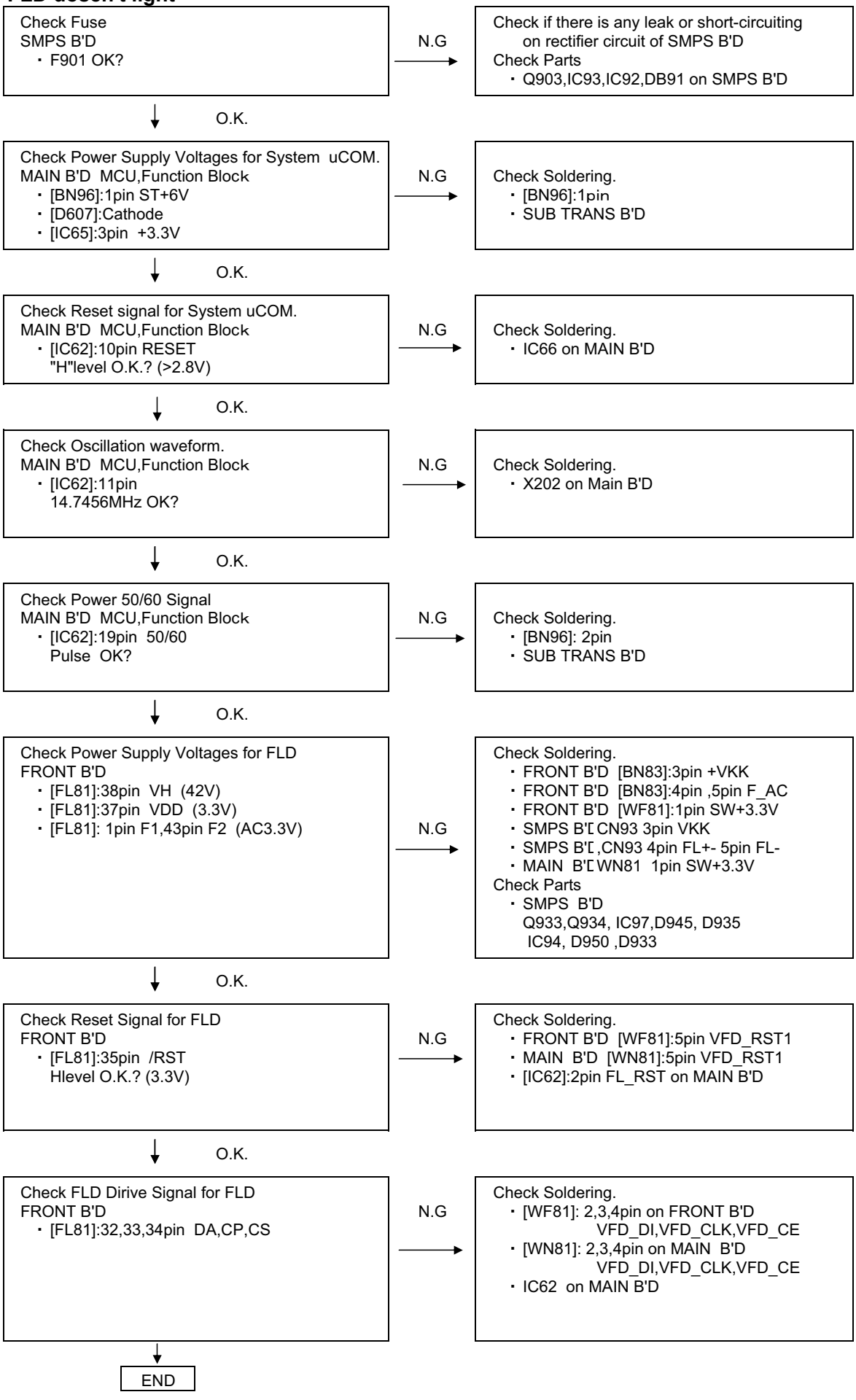
Note: ・All user settings will be lost and this factory setting will be recovered when this initialization mode.
So make sure to m+emorize your setting for restoring after the initialization.

SPECIAL MODECD TEST MODE

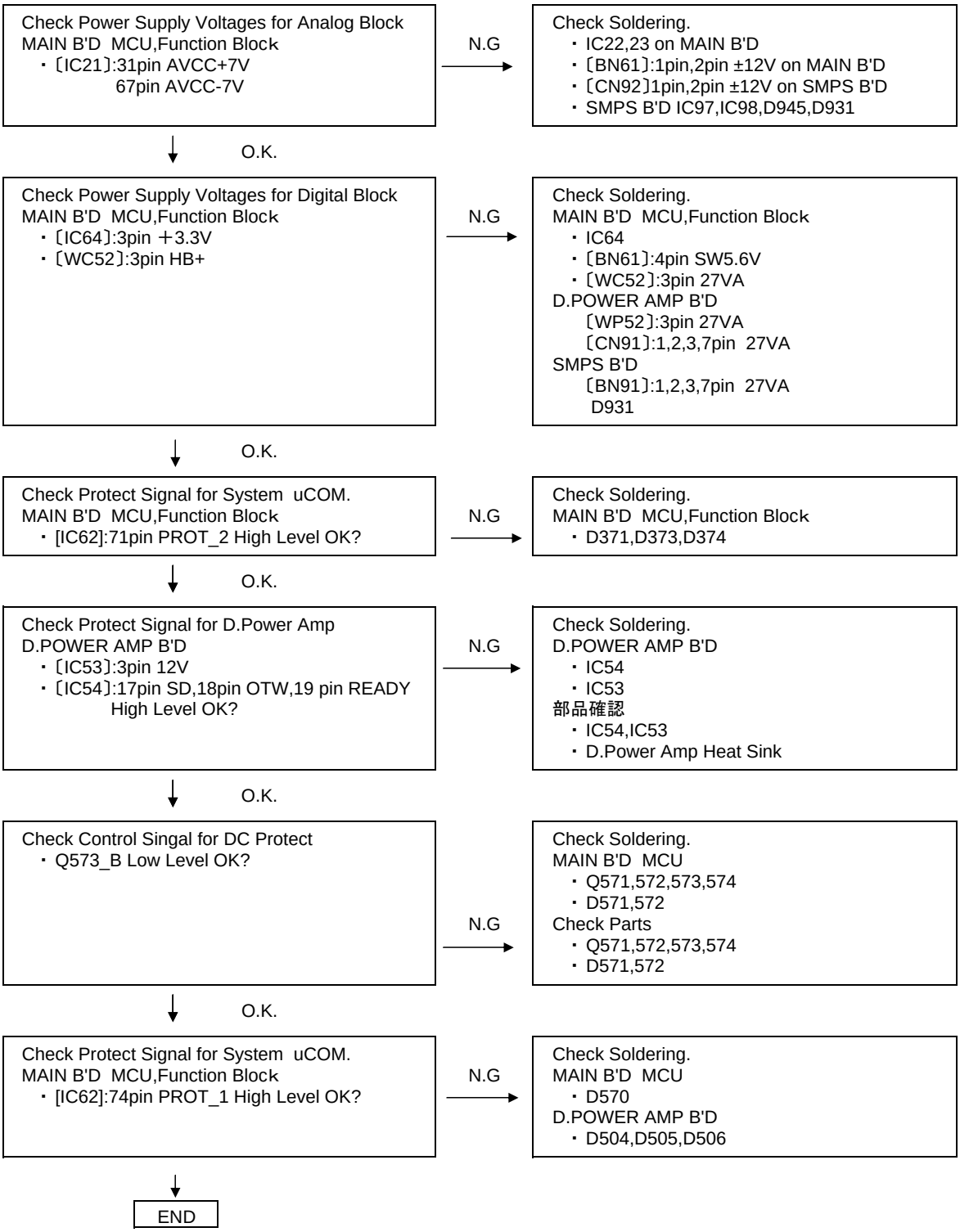
No	Button name	Function	Display
S1	Version No. Display Mode	S1.1 • Plug AC cord into power outlet while pressing the ON/STANDBY button and the SDB/ TONE button same time on Main Unit. • The Version number of MPU is displayed. • MUTING ON • Unplug AC cord to clear this mode.	 ***** : The version number of Main MPU
S1	Version No. Display Mode	S1.2 ※ When the iPod Dock is connected • Plug AC cord into power outlet while pressing the ON/STANDBY button and the SDB/ TONE button same time on Main Unit. • The Version number of MPU is displayed. • MUTING ON • Unplug AC cord to clear this mode.	 ***** : The version number of MPU ++++ : The version number of iPod Dock
S2	VFD checking mode	• Plug AC cord into power outlet while pressing the ON/STANDBY button and the AUTO PRESET button same time on Main Unit. • All segment of FLD is turning on and off every one second . • MUTING ON. • Unplug AC cord to clear this mode.	• All segment turn on and off. 
S3	EEPROM testing Mode	• Plug AC cord into power outlet while pressing the ON/STANDBY button and the TUNER button same time on Main Unit. • ON / STANDBY LED lighted ORANGE (The test is started). • MUTING ON. • When power LED lighted Green, this EEPROM test was OK. • When power LED lighted RED, this EEPROM test was NG. • Unplug AC cord to clear this mode.	
S4	Cold start mode (Initialization)	• Plug AC cord into power outlet while pressing the AUTO PRESET button and the ◄ button same time on Main Unit. • The system is reset. - source : CD/USB - SDB : OFF - BASS : 0 - TREBLE : 0 - BALANCE : CENTER - DIMMER : 100% - VOLUME : 0 - Preset Frequency of TUNER: All 0 - Main Unit ◄/► button: -/+ button for PRESET - CLOCK : 00:00(Flashing) : AM12:00(Flashing)(E3) - TIMER(EVERYDAY/ONCE): Timer Function : CD Timer start time : 0:00 (AM12:00 : E3) Timer stop time : 0:00 (AM12:00 : E3) • The system is reset, and once this is completed the unit is set to the normal mode.	

TROUBLE SHOOTING

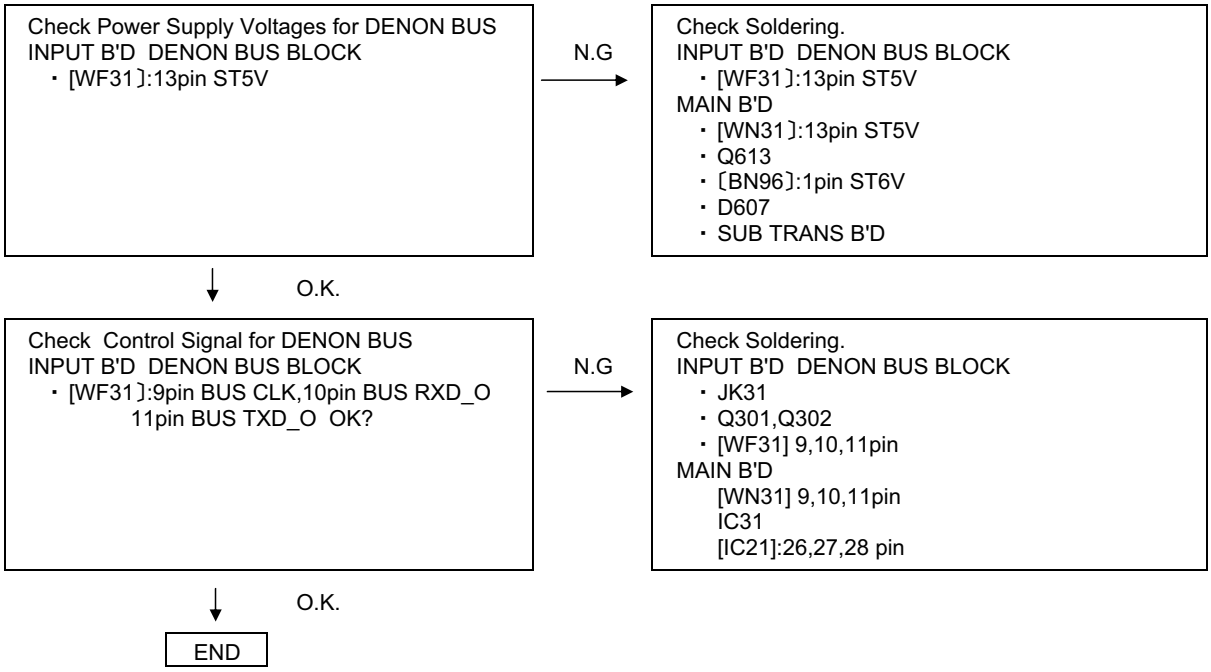
1. FLD dosen't light



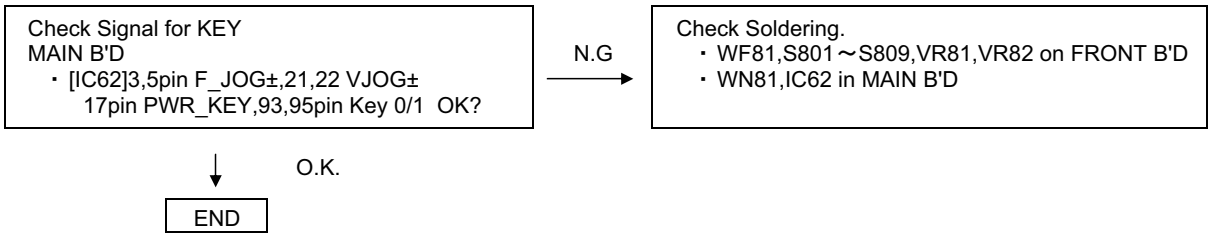
2. POWER OFF with Blinking POWER LED



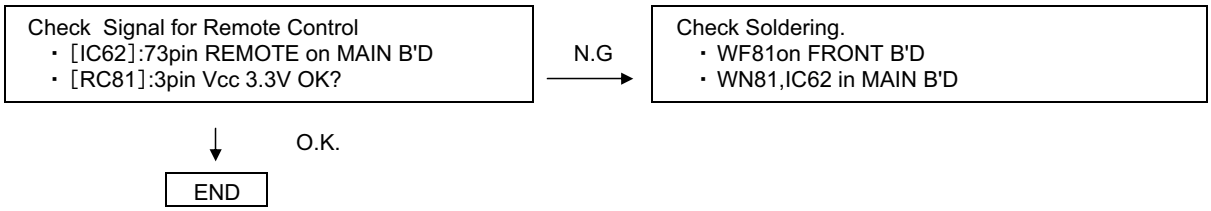
3. System Connector(DENON BUS) don't work



4. The Key Operation don't work

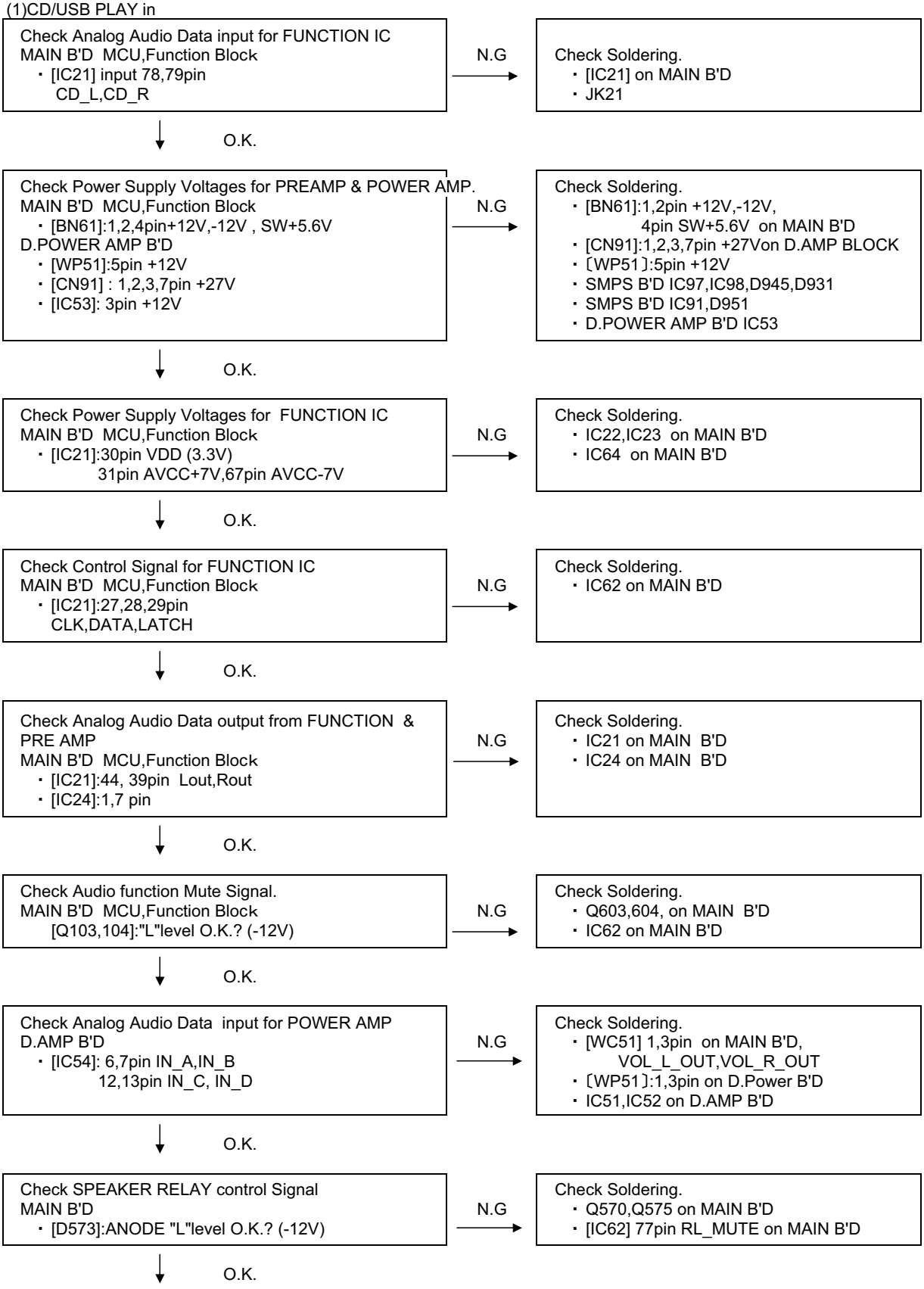


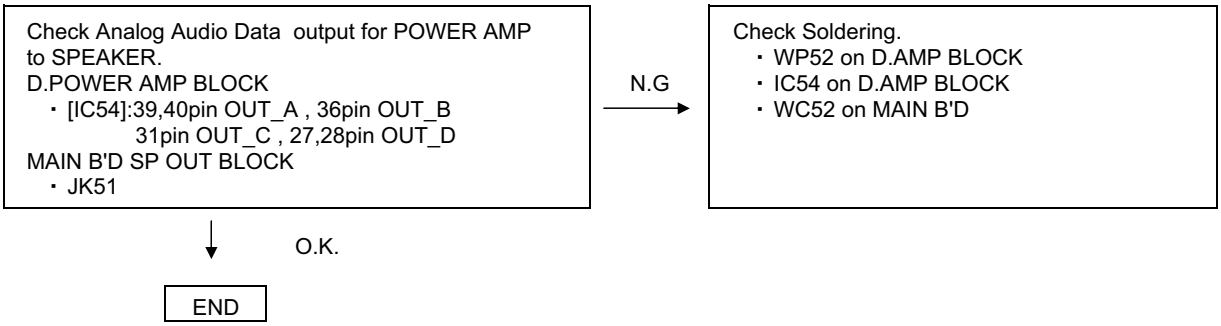
5. The Remote Control Operation don't work



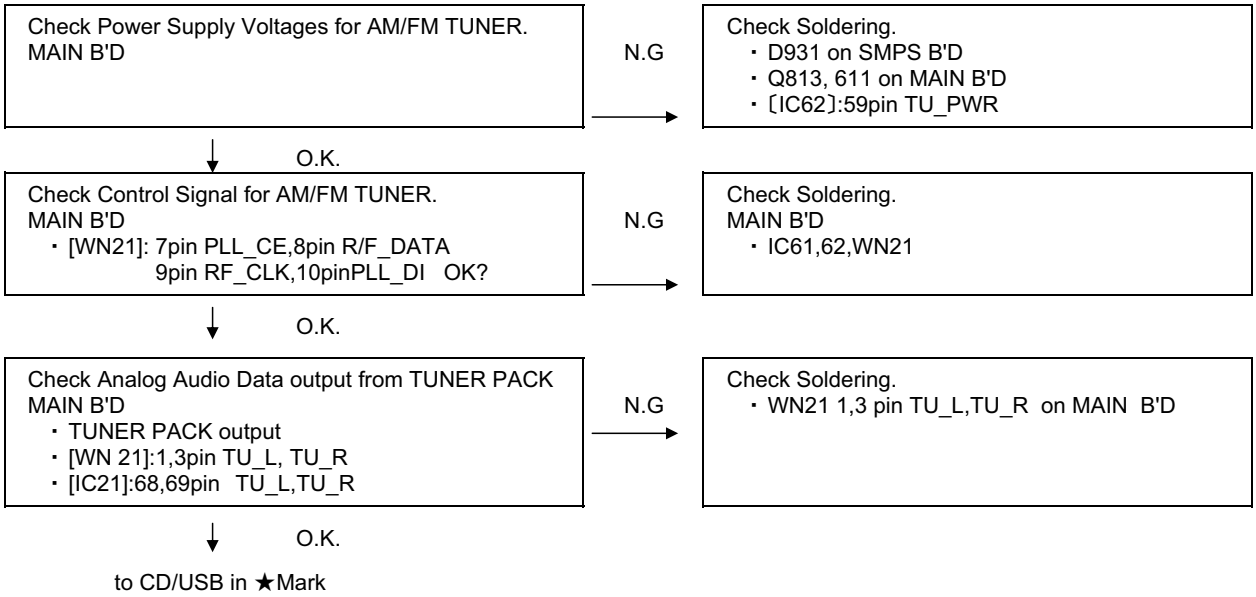
6. No Sound,Noise generated

(1)CD/USB PLAY in

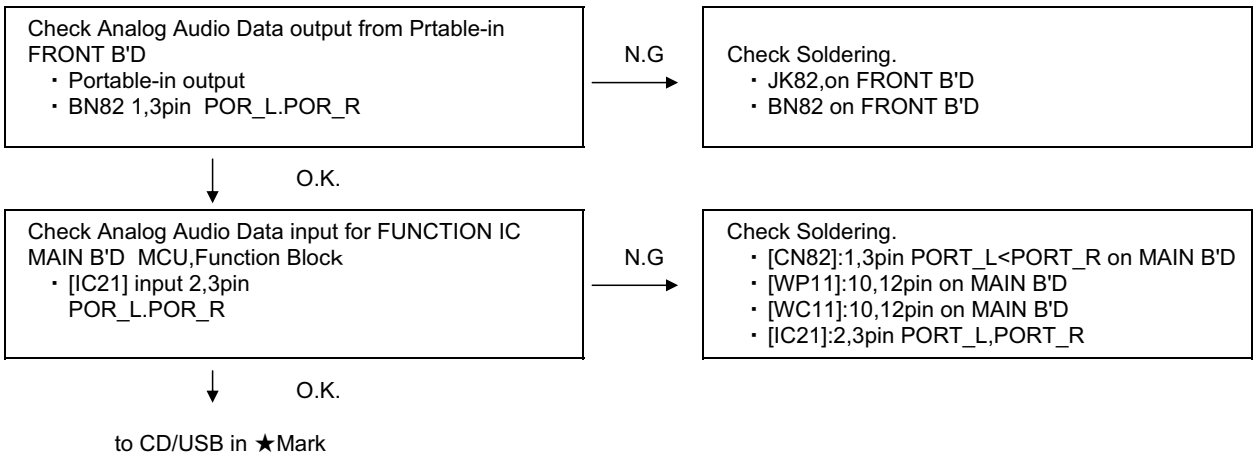




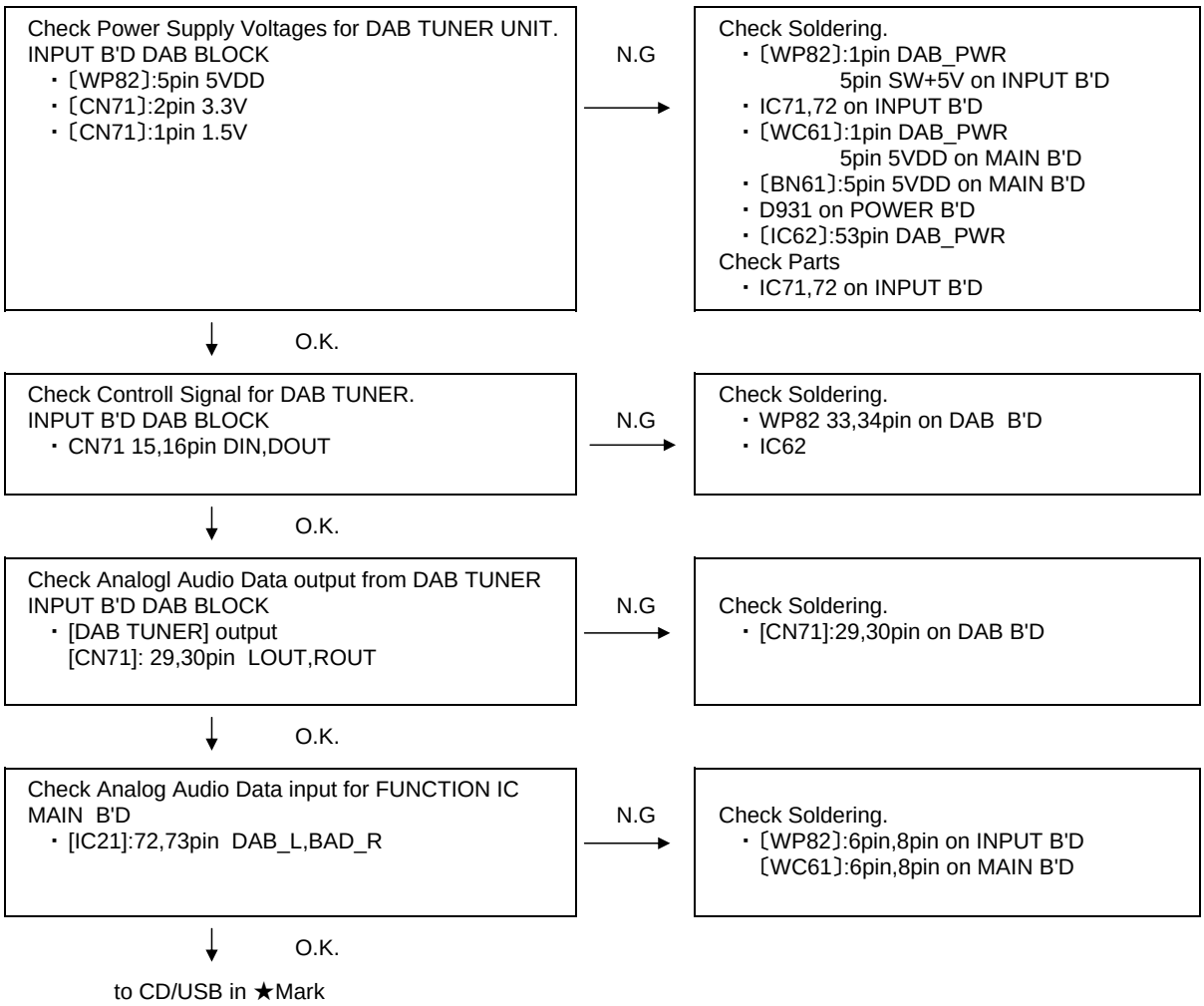
(2) AM/FM TUNER-in



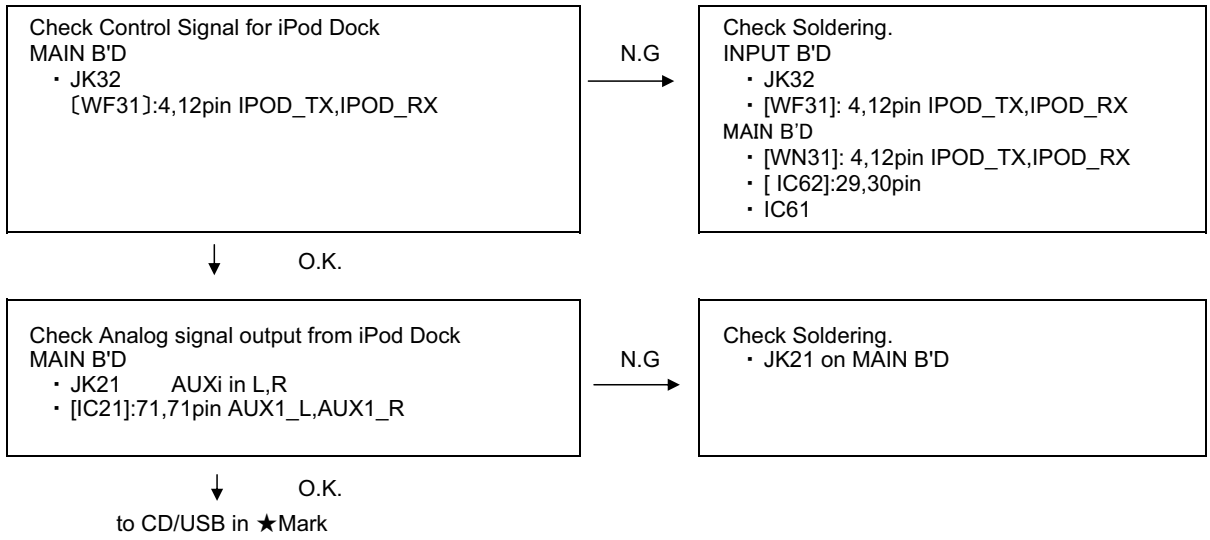
(3) Portable-in(Front-in)



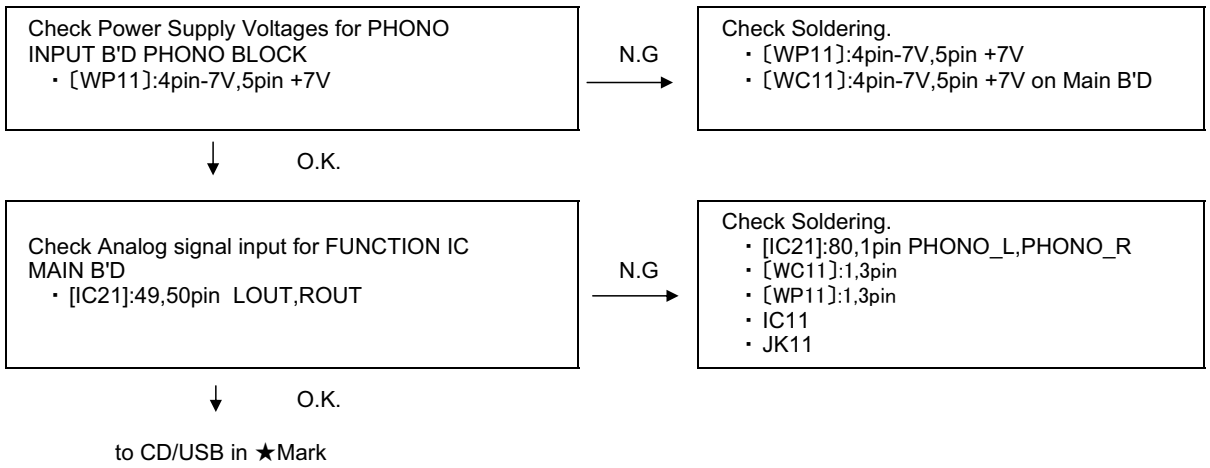
(4) DAB TUNER-in



(5) iPod PLAY

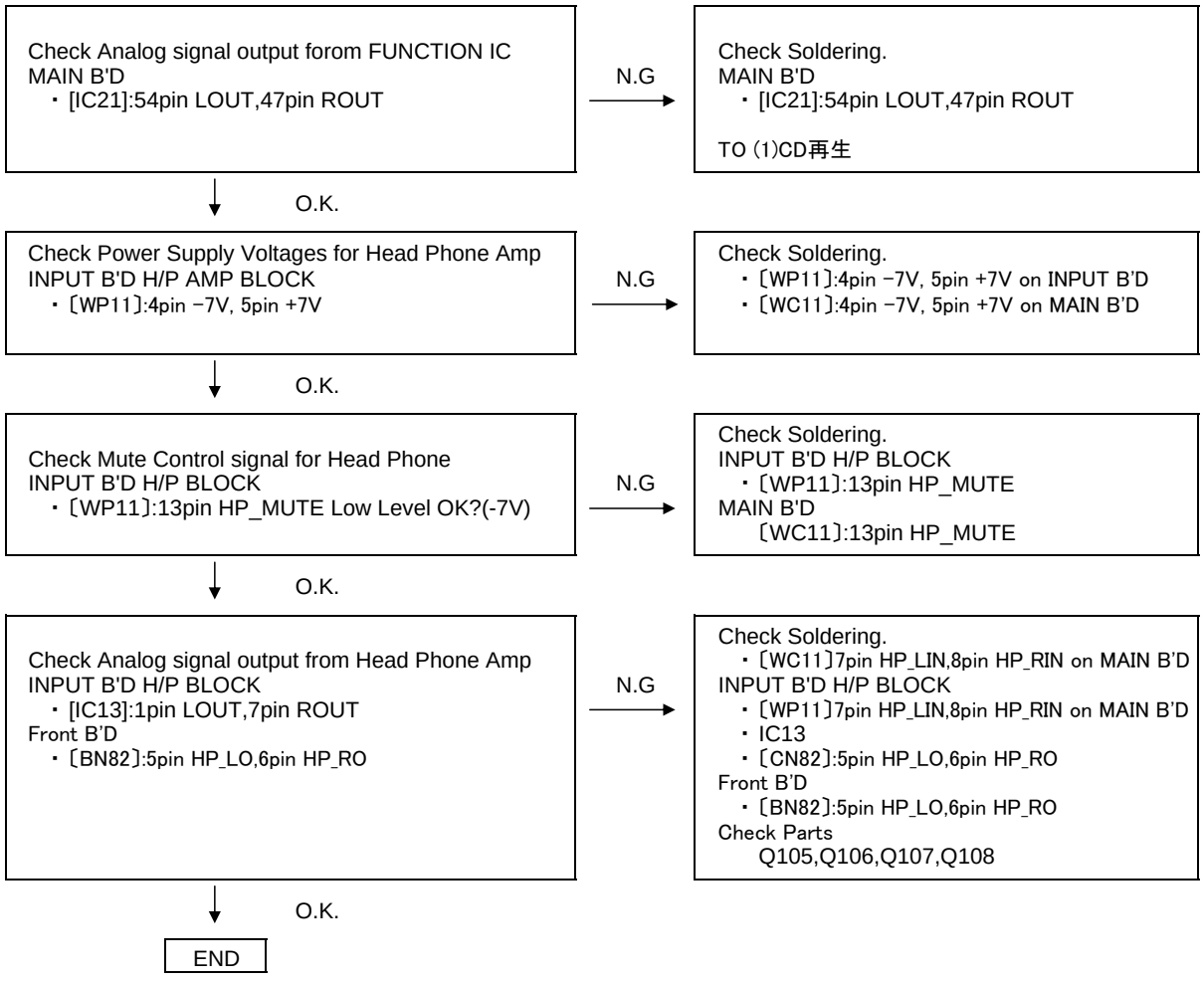


(6) PHONO PLAY



to CD/USB in ★Mark

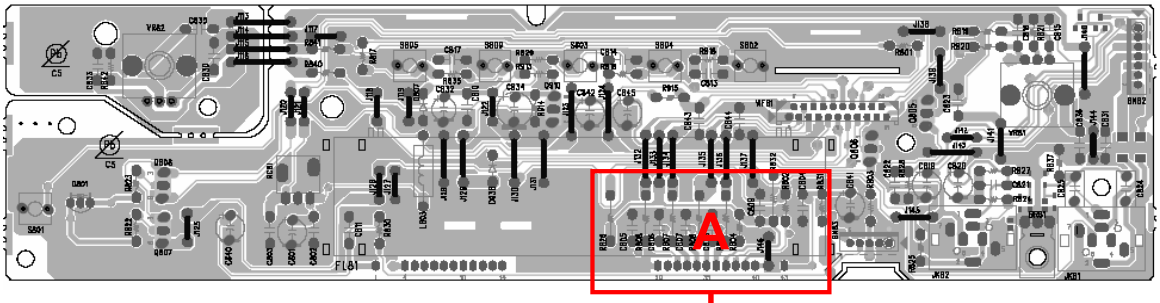
(7) Head Phone OUT



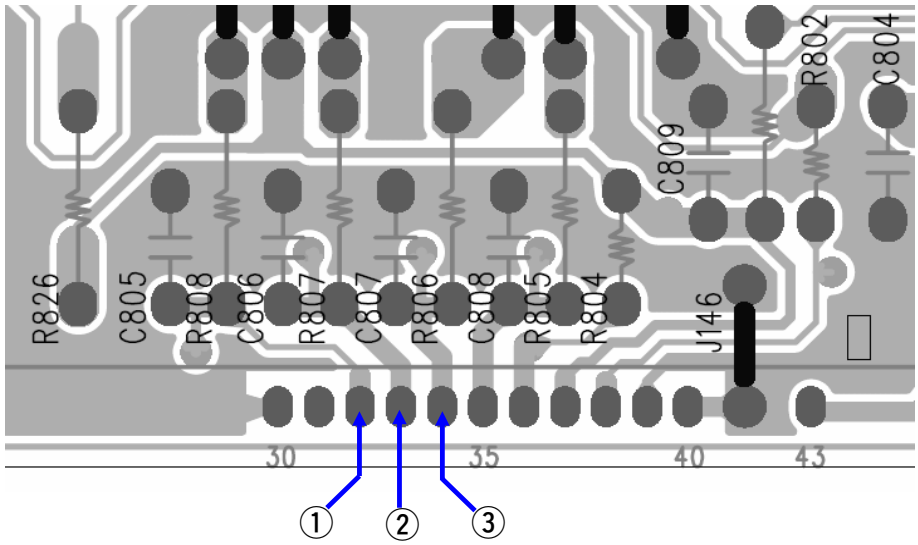
MEASURING POINT AND WAVEFORMS

MEASURING POINT

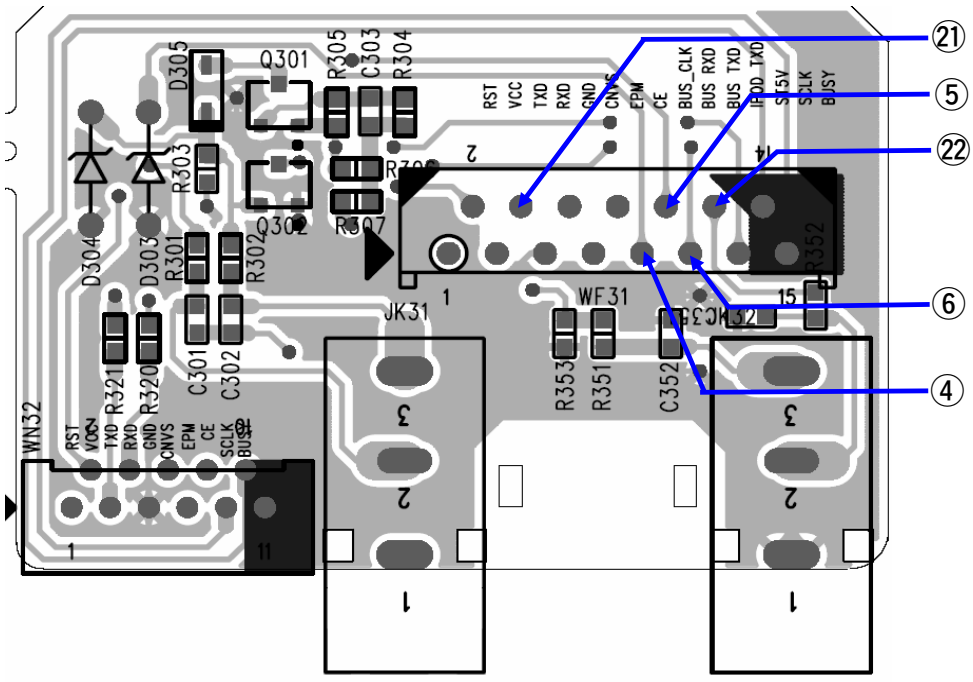
FRONT PCB



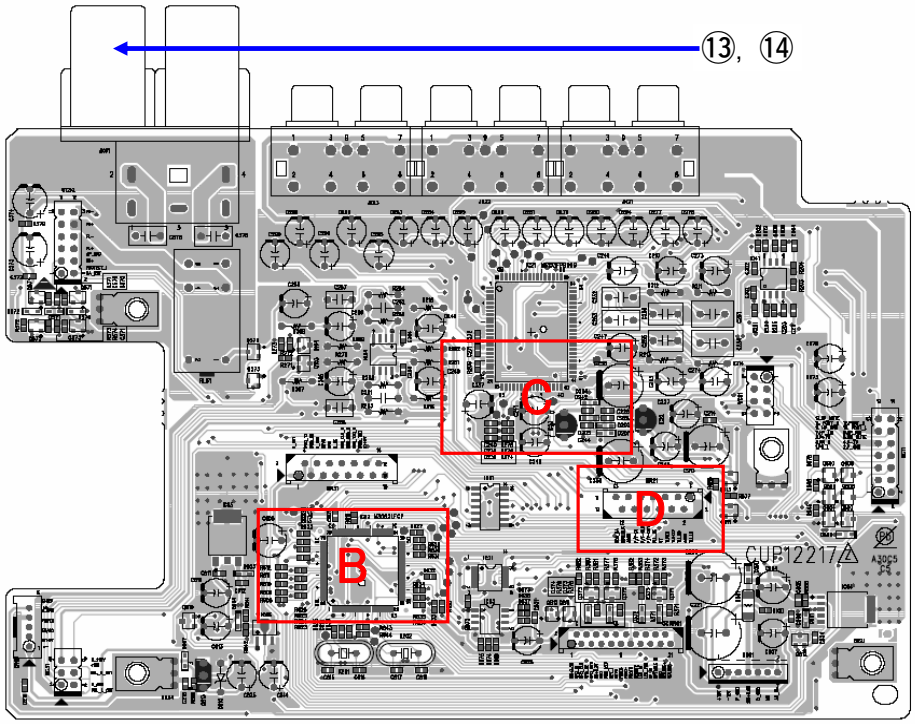
Detail A



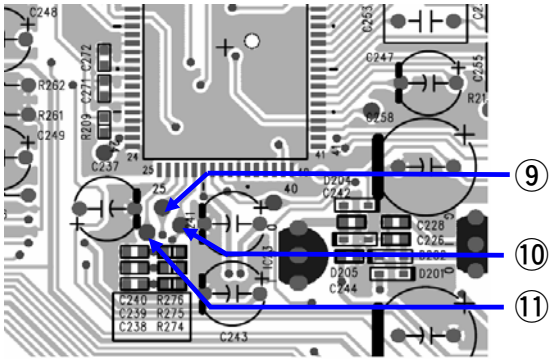
UPDATE PCB



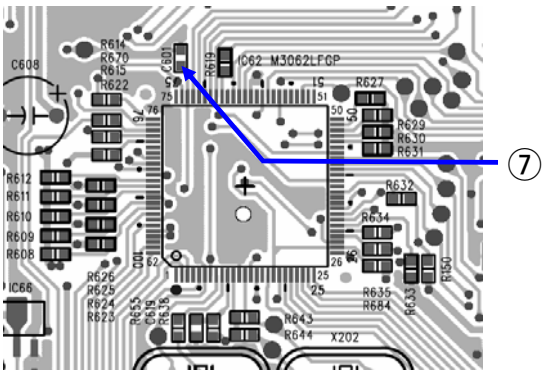
MAIN PCB



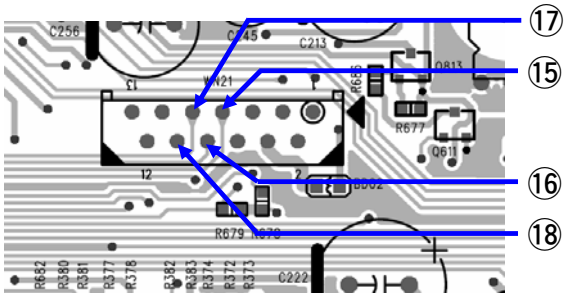
Detail C



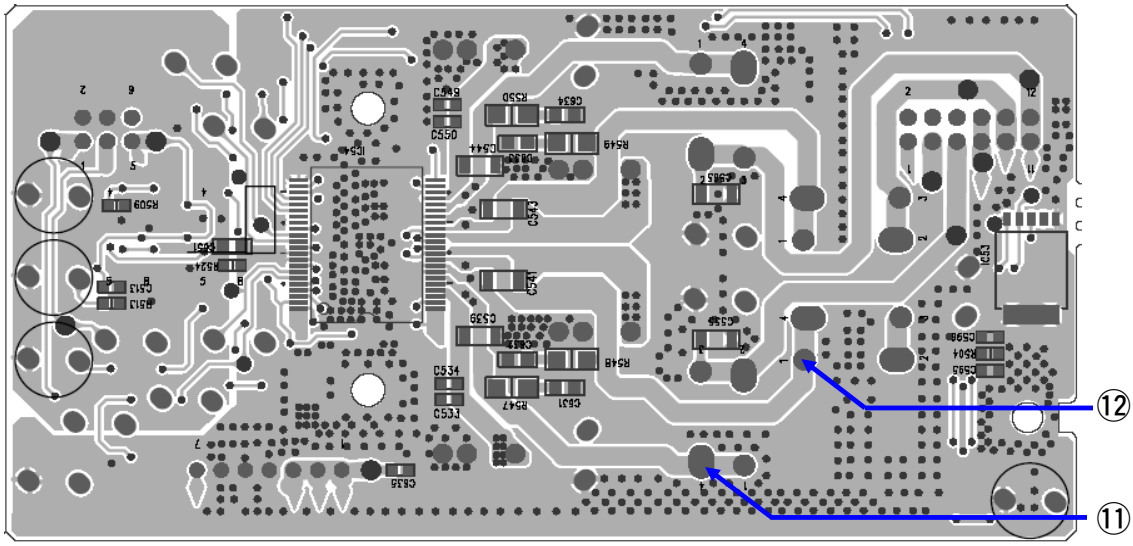
Detail B



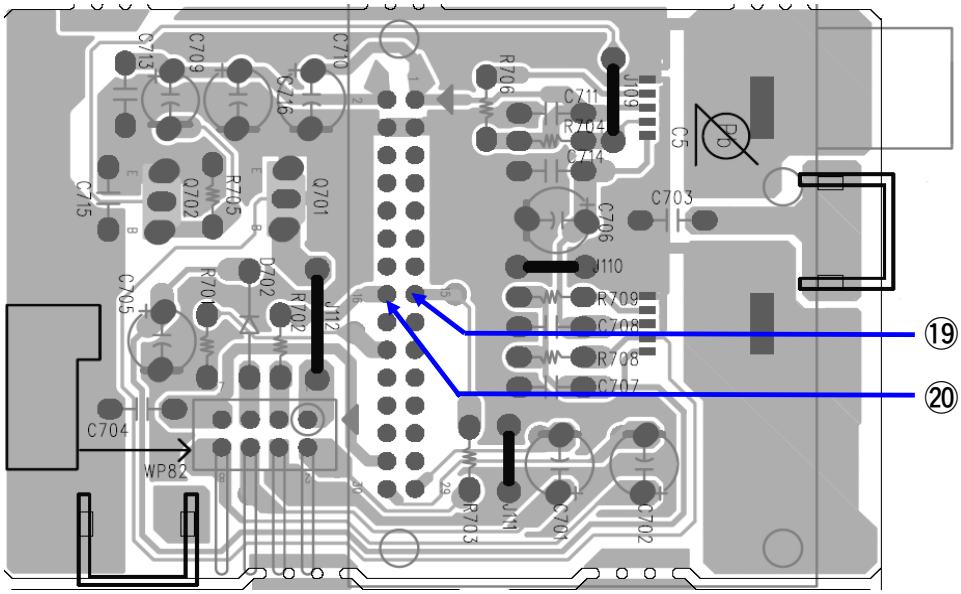
Detail D



POWER AMP



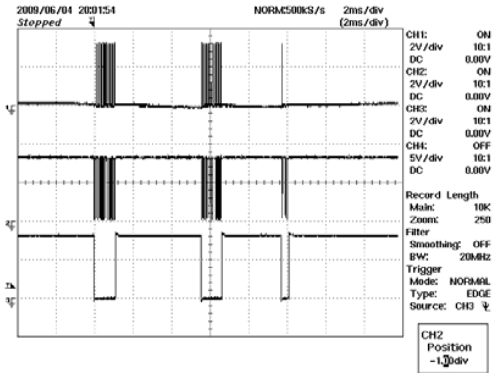
DAB PCB



WAVEFORMS

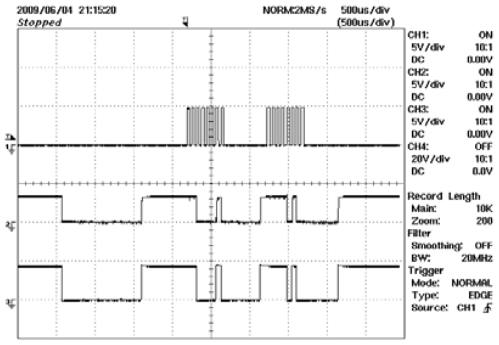
FLD Drive Signal
・Mode:Fanction Select

①FL_DA
②FL_CP
③FL_CS



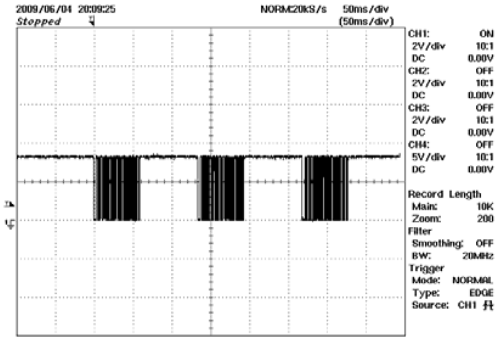
DENON BUS
・Mode:Push Remote Control "CD Play"

④BUS_CLK
⑤BUS_RXD
⑥BUS_TXD



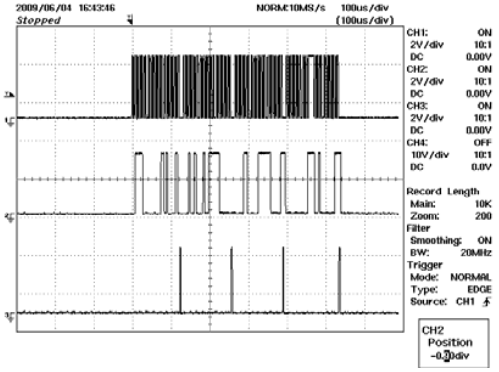
Remote Control
・Mode:Push Remote Control "SOURCE"

⑦REMOTE



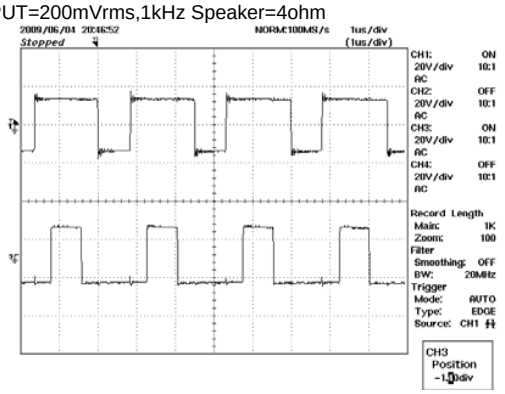
CD/USB INPUT
・Mode:Fanction Select

⑧CLK
⑨DATA
⑩LATCH



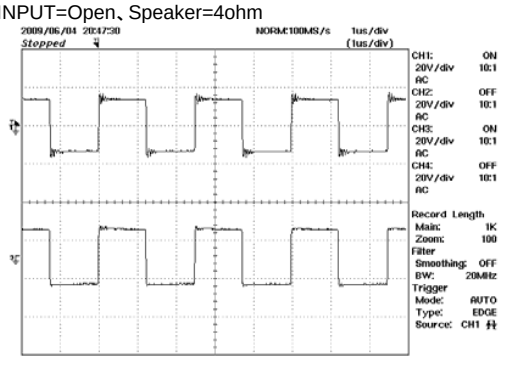
CD/USB Play
・Mode: CD INPUT=200mVrms,1kHz Speaker=4ohm

⑪OUTA
⑫OUTB



・Mode: CD INPUT=Open、Speaker=4ohm

⑪OUTA
⑫OUTB

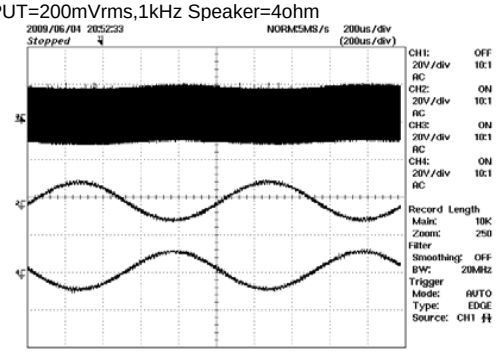


・Mode: CD INPUT=200mVrms,1kHz Speaker=4ohm

⑪OUTA

⑬SPEAKER OUT FL+

⑭SPEAKER OUT FL-

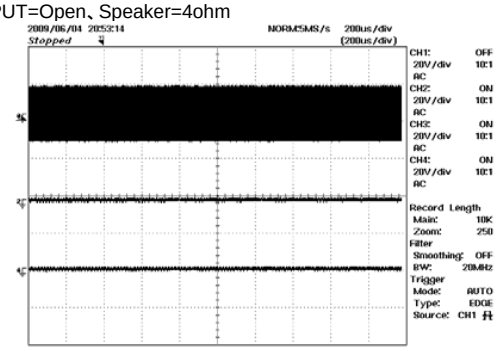


・Mode: CD INPUT=Open、Speaker=4ohm

⑪OUTA

⑬SPEAKER OUT FL+

⑭SPEAKER OUT FL-



AM/FM TUNER INPUT

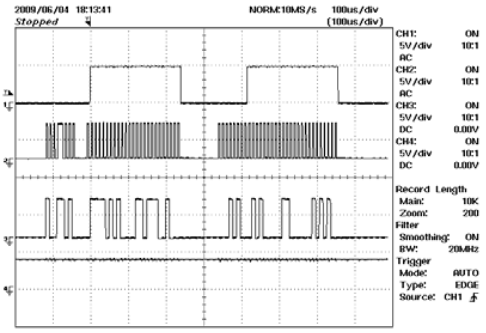
・Mode:Function CD→Tuner FM

⑮PLL_CE

⑯R/F_DATA

⑰R/F_CLK

⑱PLL_DI



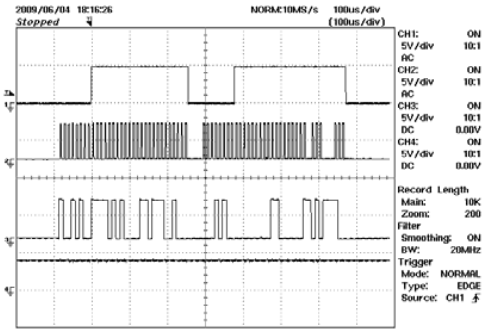
・Mode:Tuner Band FM→AM

⑮PLL_CE

⑯R/F_DATA

⑰R/F_CLK

⑱PLL_DI

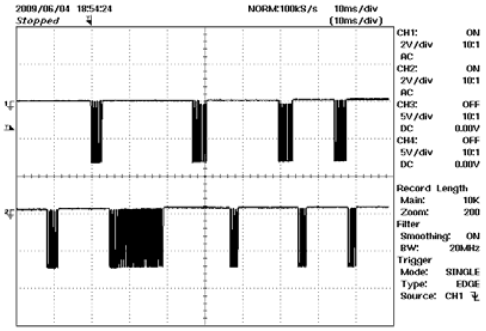


DAB TUNER INPUT

・Mode:Tuner Band AM→DAB

⑲DIN

⑳DOUT

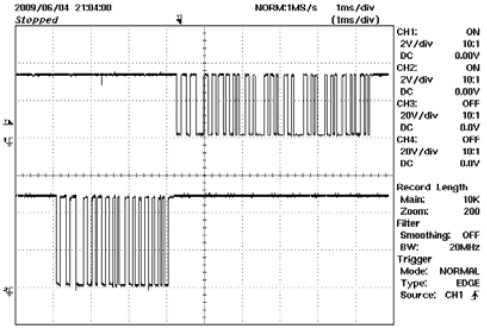


iPod Play

・Mode:iPod Connect

㉑IPOD_TX

㉒IPOD_RX

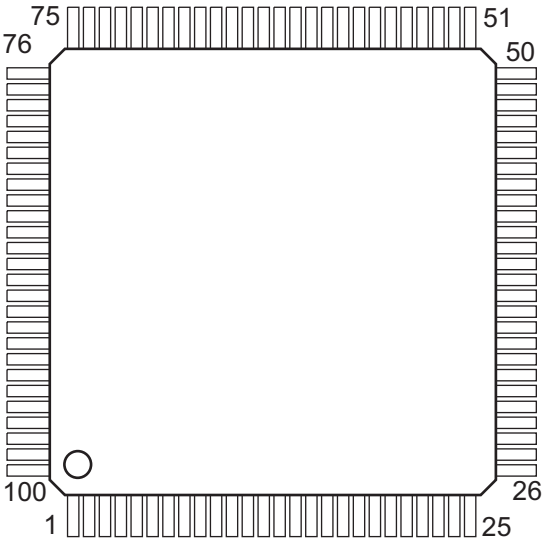


SEMICONDUCTORS

Only major semiconductors are shown, general semiconductors etc. are omitted to list.
The semiconductor which described a detailed drawing in a schematic diagram are omitted to list.

1. IC's

M3062LFGPGP (IC62)



M3062LFGPGP Terminal Function

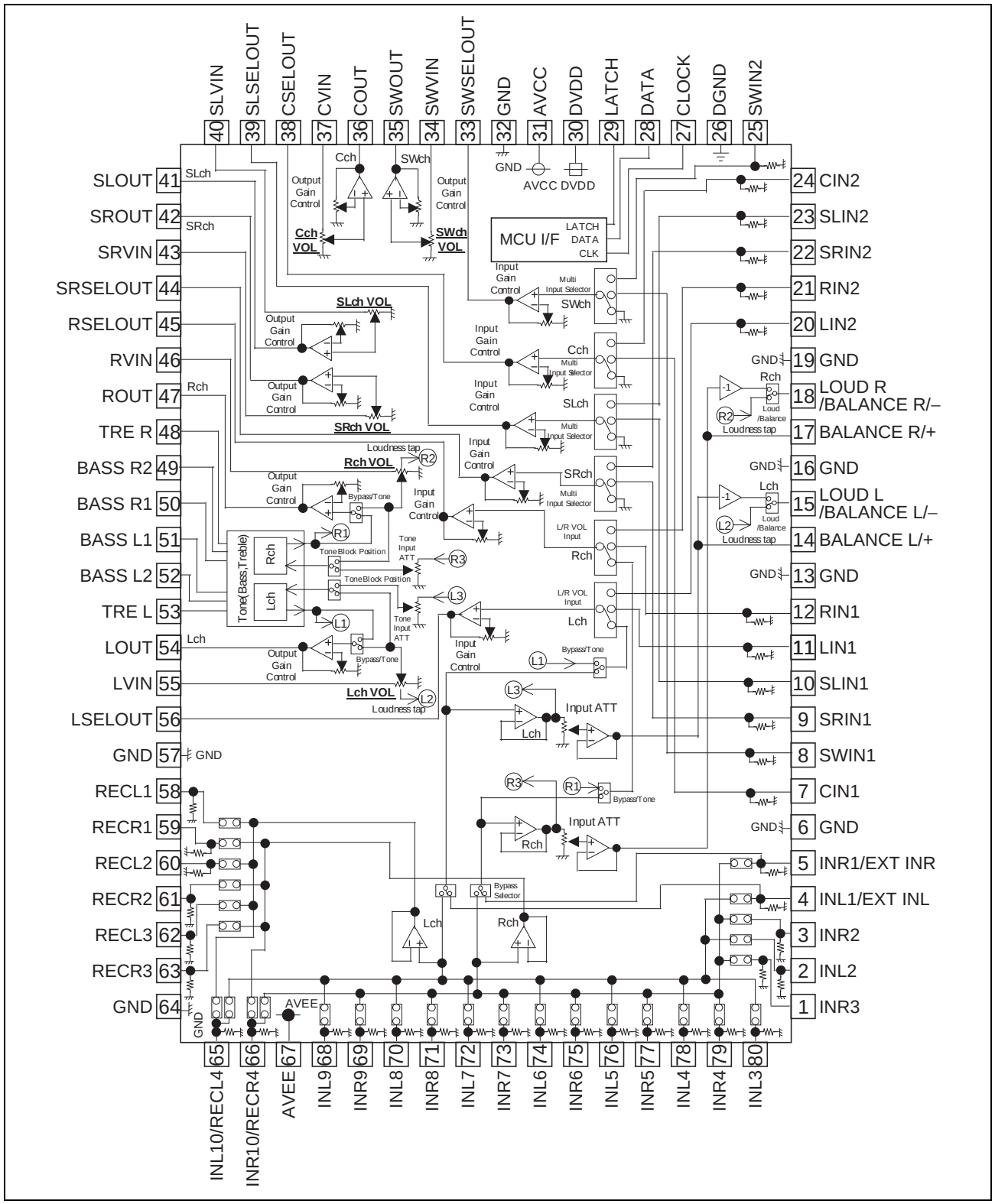
Pin No.	Port Function	Port setting	Port Name	Explaanation	Output of Standby & Default
1	P94	O	[LED_RL]	[STANDBY Red LED output. ON:High]	L
2	P93	O	FL RESET	Reset output to FLD	L
3	TB2IN	I	FUNC_JOGB	FUNCTION encoder Pulse-B input	HI-Z
4	P91	O		Not Used:N.C.	L
5	TB0IN	I	FUNC_JOGA	FUNCTION encoder Pulse-A input	HI-Z
6	BYTE		(VSS)	GND	-
7	CNVSS	I	FLASH CNVss	Select input of Flash rom write mode	HI-Z
8	P87	O		Not Used:N.C.	L
9	P86	O		Not Used:N.C.	L
10	RESET	I	RESET	Reset input	HI-Z
11	XOUT		XTAL(16MHz)	Xtal output	-
12	VSS		(VSS)	GND	-
13	XIN		XTAL(16MHz)	Xtal input	-
14	VCC		(VCC)	Positive power	-
15	NMI	I	(PullUp)	Pull up	HI-Z
16	P84	O		Not Used:N.C.	L
17	INT1	INT	POWER KEY	Power button input (interrupt input)	HI-Z
18	INT0	INT	/DBRXD	DENON BUS Data input (interrupt input)	HI-Z
19	P81	I	50/60	50Hz/60Hz AC Input	HI-Z
20	P80	I	H/P SW	HEAD PHONE insert detect signal input	HI-Z
21	TA3IN	I	VOL JOGB	VOL encoder Pulse-B input	HI-Z
22	TA3OUT	I	VOL JOGA	VOL encoder Pulse-A input	HI-Z
23	P75	O	FLCS	Chip Select output to FLD	L
24	P74	O	LED G	POWER/SANDBY Green LED output. ON:High	L
25	P73	O	LED R	POWER/SANDBY Red LED output. ON:High	L
26	CLK2	O	/DBCLK(DENON BUS)	Serial Clock output for DENON BUS	H
27	RXD2	I	/DBRXD(DENON BUS)	Serial Data input for DENON BUS	HI-Z

Pin No.	Port Function	Port setting	Port Name	Explaanation	Output of Standby & Default
28	TXD2	O	/DBTXD(DENON BUS)	Serial Data output for DENON BUS	H
29	TXD3	SO	IPOD_TX	Serial Data output for IPOD DOCK	L
30	RXD3	SI	IPOD_RX	Serial Data input for IPOD DOCK	HI-Z
31	CLK1	I	(PULLDOWN)	Pull down	L
32	P64	O		Not Used:N.C.	L
33	P63	SO	S1_DIN	Serial Data output to DAB Module	L
34	P62	SI	SI_DOUT	Serial Data input from DAB Module	L
35	P61	O		Not Used:N.C.	L
36	P60	O		Not Used:N.C.	L
37	P57	O.D		Not Used:N.C.	L
38	P56	O		Not Used:N.C.	L
39	P55	I	(FLASH EPM)	Not Used:N.C.	HI-Z
40	P54	SO	E2P CLK	Serial Clock output to EEPROM	L
41	P53	SI	E2P DO	Serial Data input from EEPROM	HI-Z
42	P52	SO	E2P DI	Serial Data output to EEPROM	L
43	P51	O	E2P CS	Chip Enable output to EEPROM	L
44	P50	O	(FLASH CE)	Not Used:N.C.	H
45	P47	O		Not Used:N.C.	L
46	P46	I	PWB check	Pull down	HI-Z
47	P45	I	PWB check	Pull down	HI-Z
48	P44	I	PWB check	Pull down	HI-Z
49	P43	I	PWB check	Pull down	HI-Z
50	P42	O		Not Used:N.C.	L
51	P41	O		Not Used:N.C.	L
52	P40	O		Not Used:N.C.	L
53	P37	O	/FMAM	TUNER Select to DAB or AM/FM . DAB:High AM/FM:Low	L
54	P36	O	TU/PHO	REC.OUTPUT level Select to TU/PHO or Others . TU/PHO:High	L
55	P35	O		Not Used:N.C.	L
56	P34	O		Not Used:N.C.	L
57	P33	O	SW MUTE	MUTE output for SW OUTPUT	H
58	P32	O		Not Used:N.C.	L
59	P31	O	TP.ON/OFF (TPOWER)	AM/FM TUNER Power ON/OFF Switching output	L
60			(VCC)	Positive power	-
61	P30	O		Not Used:N.C.	L
62			(VSS)	GND	-
63	P27	O		Not Used:N.C.	L
64	P26	I	STEREO	"STEREO" indicator input from FM/AM TUNER pack	HI-Z
65	P25	I	TUNED	"TUNED" detect input from FM/AM TUNER pack	HI-Z
66	P24	O	T.MUTE	MUTE output for FM/AM TUNER pack	L
67	P23	O	SANYO CE	Chip Enable output to PLL/RDS IC	L
68	P22	O	SANYO DI	Serial Data input to PLL/RDS IC	L
69	P21	O	SANYO CLK	Serial Clock output to PLL/RDS IC	L
70	P20	I	SANYO DO	Serial Data output to PLL/RDS IC	HI-Z
71	P17	I	PROTECT2	Protect Signal input 2	HI-Z
72	P16	O	/SYR	Reset output to RDS IC	L
73	INT3	INT	REMOTE	Remote Control signal input	HI-Z
74	P14	I	PROTECT1/SP PROTECTION	Protect Signal input 1	HI-Z
75	P13	O	/BUF_EN	Enable signal output fot BUS BUFFER IC	H
76	P12	O	VR MUTE	MUTE output for POWER AMP	H
77	P11	O	RL(RMUTE)	SPEAKER RELAY ON/OFF output	L
78	P10	O	AP.ON/OFF (APOWER)	± 15V POWER ON/OFF Switching output ON:Hight	L
79	P07	O	H/P MUTE	MUTE output for HEAD PHONE output	L
80	P06	O	P.ON/OFF (POWER)	MAIN POWER ON/STANDBY Switching output ON:High	L
81	P05	O		Not Used:N.C.	L

Pin No.	Port Function	Port setting	Port Name	Explaanation	Output of Standby & Default
82	P04	O	[RECOUT MUTE]	[MUTE output for REC.OUTPUT]	L
83	P03	O	M61531_DATA	Serial Data output to M61531	L
84	P02	O	M61531_CLK	Serial Clock output to M61531	L
85	P01	O	M61531_LATCH	Latch output to M61531	L
86	P00	I	PORT.IN_SW	PORTABL INPUT insert detect signal input	HI-Z
87	P107	I		Pull up	HI-Z
88	P106	I	USA	Initial Setting input	HI-Z
89	P105	I	EURO	Initial Setting input	HI-Z
90	P104	I		Pull up	L
91	AN3	AD	FREQ	Initial Setting input	HI-Z
92	AN2	AD	RDS	Initial Setting input	HI-Z
93	AN1	AD	KEY 0	Unit Operation Button input 0	HI-Z
94			(VSS)	GND	-
95	AN0	AD	KEY 1	Unit Operation Button input 1	HI-Z
96	VREF		(VCC)	Positive power	-
97	AVCC		(VCC)	Positive power	-
98	P96	O		Not Used:N.C.	L
99	P97	SO	FLDA	Serial Data output to FLD	L
100	P95	SO	FLCK	Serial Clock output to FLD	L

M61531FP (IC21)

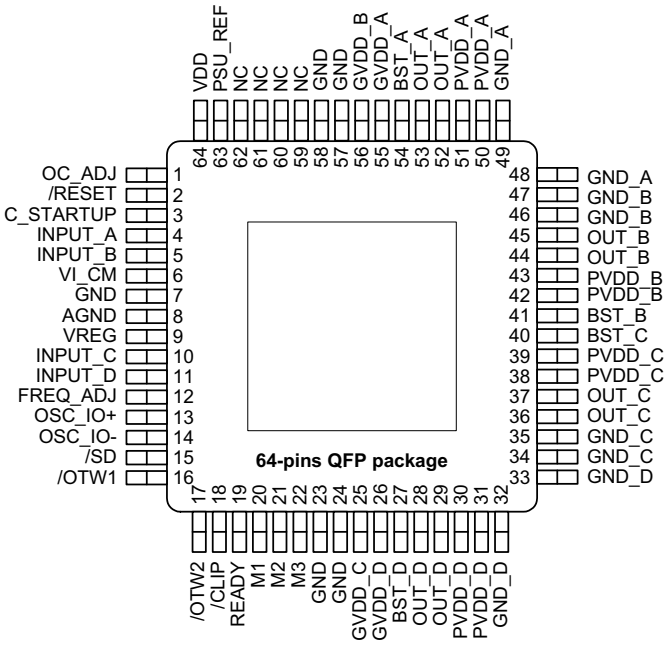
Block Diagram and Pin Configuration (Top View)



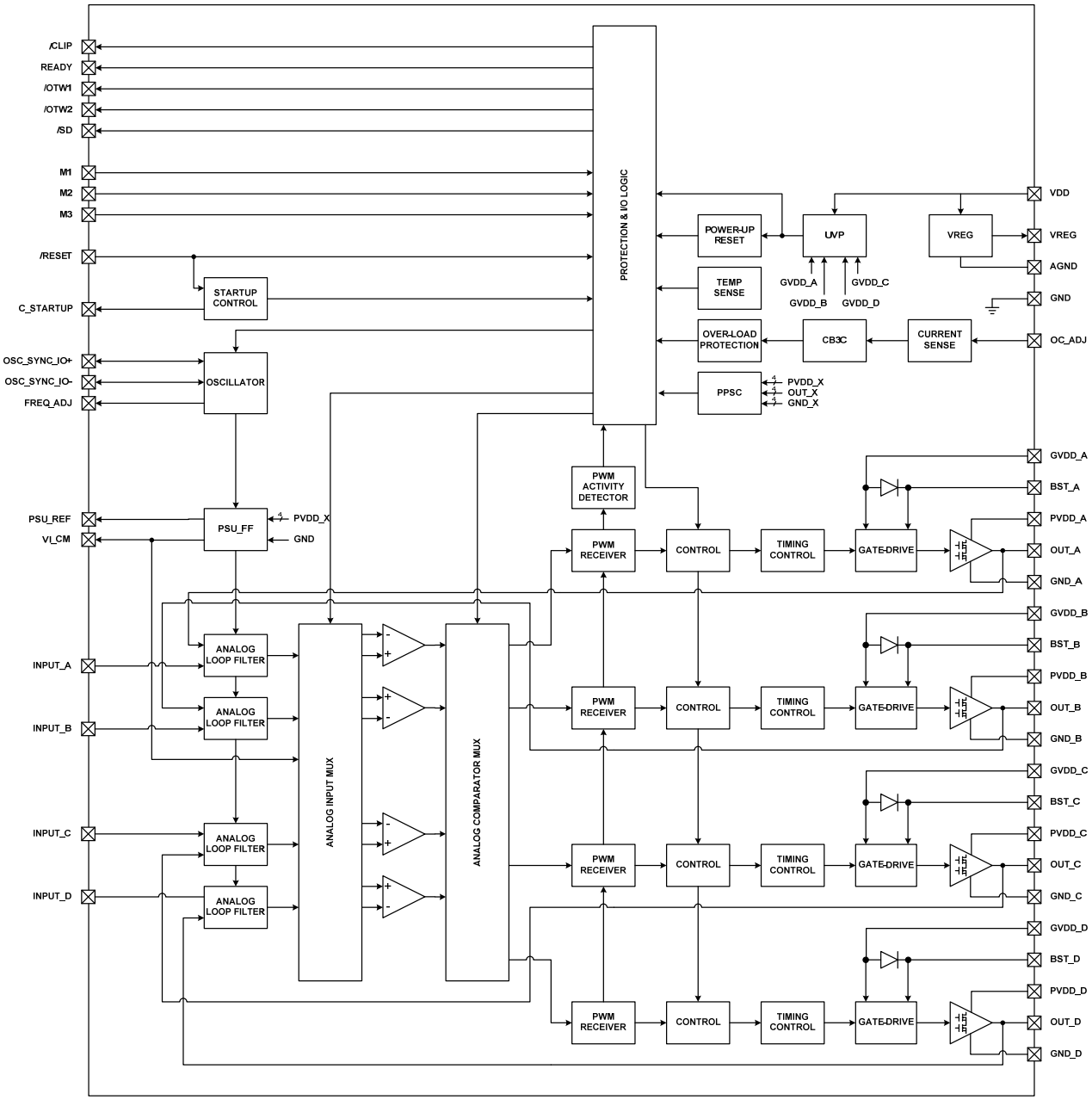
Pin Description

Pin No.	Pin Name	Function
3, 1, 79, 77, 75, 73, 71, 69	INR2, 3, 4, 5, 6, 7, 8, 9	Input pin of R channel (Input Selector)
2, 80, 78, 76, 74, 72, 70, 68	INL2, 3, 4, 5, 6, 7, 8, 9	Input pin of L channel (Input Selector)
4	INL1/EXT INL	Input pin of L channel (Input Selector)/External Input pin(Lch)
5	INR1/EXT INR	Input pin of L channel (Input Selector)/External Input pin(Rch)
6, 13, 16, 19, 32, 57, 64	GND	Analog Ground
7, 24	CIN1/CIN2	Input pin of C channel (2 Input Selector)
8, 25	SWIN1/SWIN2	Input pin of SW channel (2 Input Selector)
9, 22	SRIN1/SRIN2	Input pin of SR channel (2 Input Selector)
10, 23	SLIN1/SLIN2	Input pin of SL channel (2 Input Selector)
11, 20	LIN1/LIN2	Input pin of L channel (2 Input Selector)
12, 21	RIN1/RIN2	Input pin of R channel (2 Input Selector)
14, 17	BALANCE L/+, R/+	Output pin of L/R channel Balance Output(+)
15, 18	LOUD L/BALANCE L/–, LOUD R/BALANCE R/–	Frequency characteristic setting pin of Loudness /Output pin of L/R channel Balance Output(–)
26	DGND	Ground of internal logic circuit
27, 28, 29	CLOCK, DATA, LATCH	Input pin of control clock /data/ trigger
30	DVDD	Power supply to internal logic circuit
31	AVCC	Positive power supply to internal analog circuit
33	SWSELOUT	Output pin of SW channel volume input selector
34	SWVIN	Input pin of SW channel volume
35	SWOUT	Output pin of SW channel
36	COUT	Output pin of C channel
37	CVIN	Input pin of C channel volume
38	CSELOUT	Output pin of C channel volume input selector
39	SLSELOUT	Output pin of SL channel volume input selector
40	SLVIN	Input pin of SL channel volume
41	SLOUT	Output pin of SL channel
42	SROUT	Output pin of SR channel
43	SRVIN	Input pin of SR channel volume
44	SRSELOUT	Output pin of SR channel volume input selector
45	RSELOUT	Output pin of R channel volume input selector
46	RVIN	Input pin of R channel volume
47	ROUT	Output pin of R channel
51, 52, 50, 49	BASS L1, L2/BASS R1, R2	Frequency characteristic setting pin of tone control (BASS)
53, 48	TRE L/TRE R	Frequency characteristic setting pin of tone control (TREBLE)
54	LOUT	Output pin of L channel
55	LVIN	Input pin of L channel volume
56	LSELOUT	Output pin of L channel volume input selector
58, 60, 62/59, 61, 63	REC L1, L2, L3 /REC R1, R2, R3	Output pin of REC (Lch and Rch)
65	INL10/REC L4	Input pin of L channel (Input Selector)/Output pin of REC (Lch)
66	INR10/REC R4	Input pin of R channel (Input Selector)/Output pin of REC (Rch)
67	AVEE	Negative power supply to internal analog circuit

TAS5630DKD (IC54)



TAS5630DKD Block Diagram

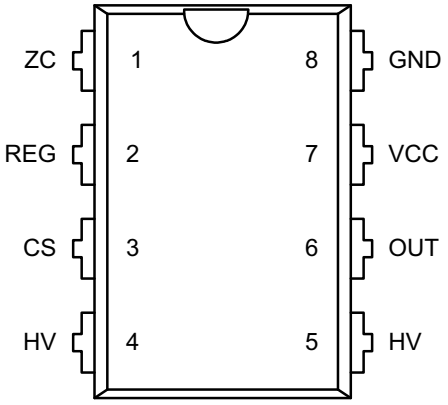


TAS5630DKD Terminal Function

TERMINAL			FUNCTION(1)	DESCRIPTION
NAME	PHD NO.	DKD NO.		
AGND	8	10	P	Analog ground
BST_A	54	43	P	HS bootstrap supply (BST), external 0.033 uF capacitor to OUT_A required.
BST_B	41	34	P	HS bootstrap supply (BST), external 0.033 uF capacitor to OUT_B required.
BST_C	40	33	P	HS bootstrap supply (BST), external 0.033 uF capacitor to OUT_C required.
BST_D	27	24	P	HS bootstrap supply (BST), external 0.033 uF capacitor to OUT_D required.
/CLIP	18	-	O	Clipping warning; open drain; active low
C_STARTUP	3	5	O	Startup ramp requires a charging capacitor of 4.7 nF to AGND in BTL mode.
FREQ_ADJ	12	14	I	PWM frame rate programming pin requires resistor to AGND
GND	7, 23, 24, 57, 58	9	P	Ground
GND_A	48, 49	38	P	Power ground for half-bridge A
GND_B	46, 47	37	P	Power ground for half-bridge B
GND_C	34, 35	30	P	Power ground for half-bridge C
GND_D	32, 33	29	P	Power ground for half-bridge D
GVDD_A	55	-	P	Gate drive voltage supply requires 0.1 uF capacitor to GND_A
GVDD_B	56	-	P	Gate drive voltage supply requires 0.1 uF capacitor to GND_B
GVDD_C	25	-	P	Gate drive voltage supply requires 0.1 uF capacitor to GND_C
GVDD_D	26	-	P	Gate drive voltage supply requires 0.1 uF capacitor to GND_D
GVDD_AB	-	44	P	Gate drive voltage supply requires 0.22 uF capacitor to GND_A/GND_B
GVDD_CD	-	23	P	Gate drive voltage supply requires 0.22 uF capacitor to GND_C/GND_D
INPUT_A	4	6	I	Input signal for half bridge A
INPUT_B	5	7	I	Input signal for half bridge B
INPUT_C	10	12	I	Input signal for half bridge C
INPUT_D	11	13	I	Input signal for half bridge D
M1	20	20	I	Mode selection
M2	21	21	I	Mode selection
M3	22	22	I	Mode selection
NC	59-62	-	-	No connect, pins may be grounded.
OC_ADJ	1	3	O	Analog over current programming pin requires resistor to ground.
OSC_IO+	13	15	I/O	Oscillaotor master/slave output/input.
OSC_IO-	14	16	I/O	Oscillaotor master/slave output/input.
/OTW	-	18	O	Overtemperature warning signal, open drain, active low.
/OTW1	16	-	O	Overtemperature warning signal, open drain, active low.
/OTW2	17	-	O	Overtemperature warning signal, open drain, active low.
OUT_A	52, 53	39, 40	O	Output, half bridge A
OUT_B	44, 45	36	O	Output, half bridge B
OUT_C	36, 37	31	O	Output, half bridge C
OUT_D	28, 29	27, 28	O	Output, half bridge D
PSU_REF	63	1	P	PSU Reference requires close decoupling of 330 pF to AGND
PVDD_A	50, 51	41, 42	P	Power supply input for half bridges A requires close decoupling of 2.2-uF capacitor to GND_A
PVDD_B	42, 43	35	P	Power supply input for half bridges B requires close decoupling of 2.2-uF capacitor to GND_B
PVDD_C	38, 39	32	P	Power supply input for half bridges C requires close decoupling of 2.2-uF capacitor to GND_C
PVDD_D	30, 31	25, 26	P	Power supply input for half bridges D requires close decoupling of 2.2-uF capacitor to GND_D
READY	19	19	O	Normal operation; open drain; active high
/RESET	2	4	I	Device reset Input; active low, requires 47kOhm pull up resistor to VREG.
/SD	15	17	O	Shutdown signal, open drain, active low
VDD	64	2	P	Power supply for internal voltage regulator requires a 10-uF capacitor in parallel with a 0.1-uF capacitor to GND for decoupling.
VI_CM	6	8	O	Analog comparator reference node requires close decoupling of 1 nF to AGND
VREG	9	11	P	Internal regulator supply filter pin requires 0.1-uF capacitor to AGND

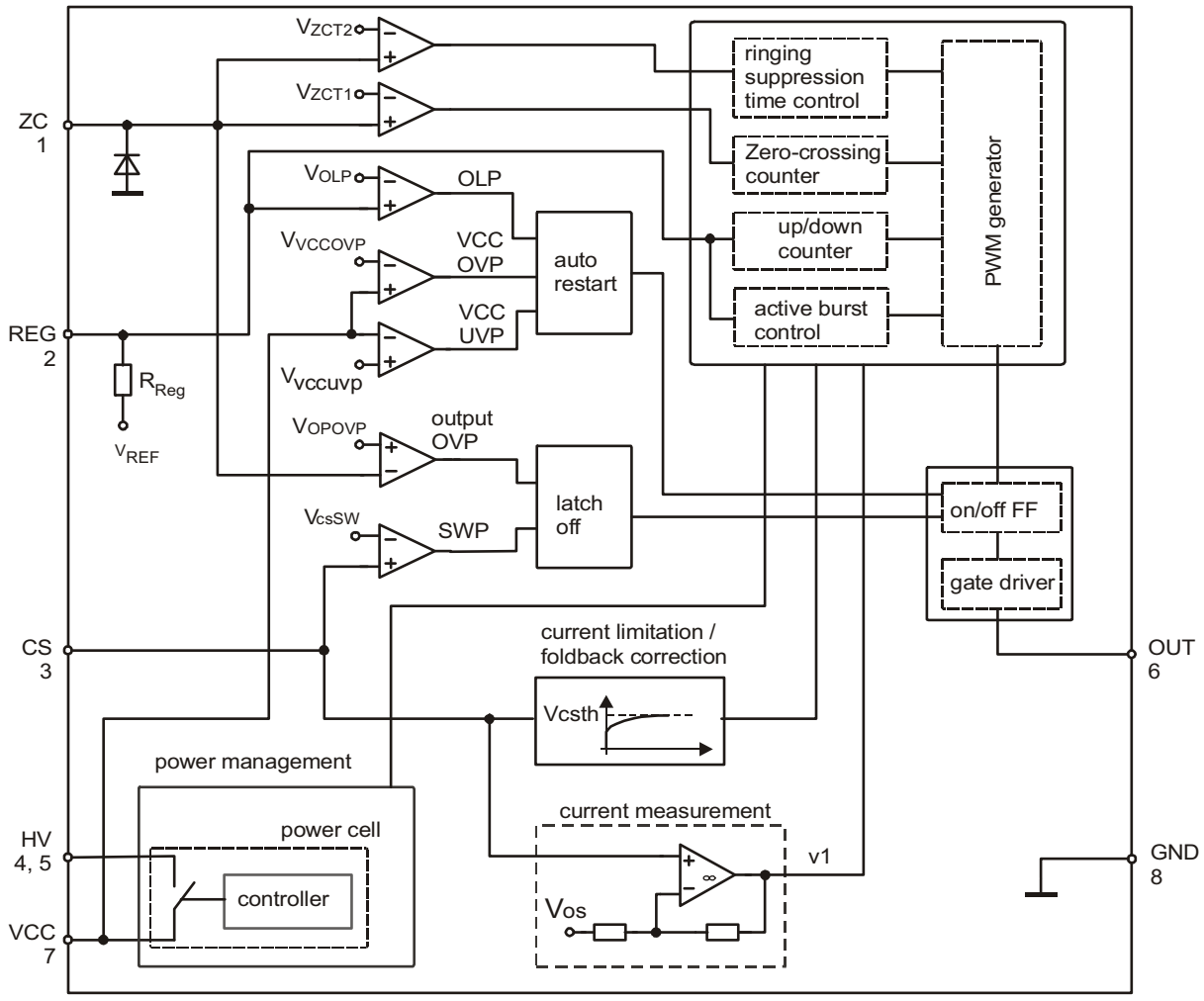
(1) I = input, O = output, P = power

ICE2QS01 (IC93)



Pin	Symbol	Function
1	ZC	Zero Crossing
2	REG	Regulation
3	CS	Primary Current Sensing
4, 5	HV	High Voltage input
6	OUT	gate driver out put
7	VCC	IC supply voltage
8	GND	Common ground

Blockdigram



3 Functional Description

3.1 VCC Pre-Charging and Typical VCC Voltage During Start-up

In the controller ICE2QS01, a power cell is integrated. As shown in Figure 2, the power cell consists of a high voltage device and a controller, whereby the high voltage device is controlled by the controller. The power cell provides a pre-charging of the VCC capacitor till VCC voltage reaches the VCC turned-on threshold V_{VCCon} and the IC begins to operate, while it may keep the VCC voltage at a constant value during burst mode operation when the output voltage is pulled down or the power from the auxiliary winding is not enough, or when the IC is latched off in certain protection mode.

Once the mains input voltage is applied, a rectified voltage shows across the capacitor C_{bus}. The high voltage device provides a current to charge the VCC capacitor C_{vcc}. Before the VCC voltage reaches a certain value, the amplitude of the current through the high voltage device is only determined by its channel resistance and can be as high as several mA. After the VCC voltage is high enough, the controller controls the high voltage device so that a constant current around 1mA is provided to charge the VCC capacitor further, until the VCC voltage exceeds the turned-on threshold V_{VCCon}. As shown as the time phase I in Figure 3, the VCC voltage increase near linearly.

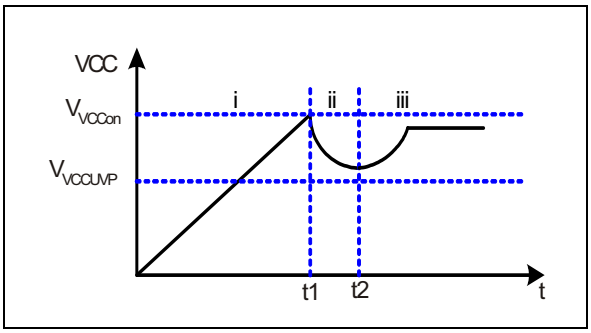


Figure 3 VCC voltage at start up

The time taking for the VCC pre-charging can then be approximately calculated as:

$$t_1 = \frac{V_{VCCon} \cdot C_{vcc}}{I_{VCCcharge2}} \quad [1]$$

where $I_{VCCcharge2}$ is the charging current from the power cell which is 1.05mA, typically.

Exceeds the VCC voltage the turned-on threshold V_{VCCon} of at time t_1, the power cell is switched off, and the IC begins to operate with a soft-start. Due to power consumption of the IC and the fact that still no energy from the auxiliary winding to charge the VCC capacitor before the output voltage is built up, the VCC voltage drops (Phase II). Once the output voltage is high enough, the VCC capacitor receives then energy from the auxiliary winding from the time point t_2 on. The VCC then will reach a constant value depending on output load.

Since there is a VCC undervoltage protection, the capacitance of the VCC capacitor should be selected to be high enough to ensure that enough energy is stored in the VCC capacitor so that the VCC voltage will never touch the VCC under voltage protection threshold V_{VCCUVP} before the output voltage is built up. Therefore, the capacitance should fulfill the following requirement:

$$C_{vcc} \geq \frac{I_{VCCop} \cdot (t_2 - t_1)}{V_{VCCon} - V_{VCCUVP}} \quad [2]$$

with I_{VCCop} the operating current of the controller.

3.2 Soft-start

At the time t_1, the IC begins to operate with a soft-start. By this soft-start the switching stresses for the switch, diode and transformer are minimised. The soft-start implemented in the ICE2QS01 is a digital time-based function. The preset soft-start time is **24ms** with 8 steps. The internal reference for the regulation voltage begins at 1.35V and with an increment of 0.35V for each following step.

3.3 Normal Operation

The PWM section of the IC can be divided into two main portions: PWM controller for normal operation and PWM controller for burst mode operation. The PWM controller for normal operation will be described in the following paragraphs, while the PWM controller for burst mode operation will be discussed in the next section.

The PWM controller for normal operation consists of digital signal processing circuit including an up/down counter, a zero-crossing counter (ZC-counter) and a comparator, and analog circuit including a current measurement unit and a comparator. The switch-on and -off time point is determined by the digital circuit and the analog circuit, respectively. As input information for the switch-on determination, the zero-crossing input signal and the value of the up/down counter are needed, while the feedback signal v_{REG} and the current sensing signal v_{CS} are necessary for the switch-off determination. Details about the operation of the PWM controller in normal operation are illustrated in the following paragraphs.

3.3.1 Switch-on Determination

As mentioned above, the digital signal processing circuit consists of an up/down counter, a zero-crossing counter and a comparator. A ringing suppression time

controller is implemented to avoid mistriggering by the ring after MOSFET is turned off. Functionality of these parts is described as in the following.

3.3.1.1 Up/down Counter

The up/down counter stores the number of zero crossing to be ignored before the main power switch is switched on after demagnetisation of the transformer. This value is a function of the regulation voltage, which contains information about the output power. Generally, a high output power results in a high regulation voltage. According to this information, the value in the up/down counter is changed to a low value in case of high regulation voltage, and to a high value in case of low regulation voltage. In ICE2QS01, the lowest value of the counter is 1 and the highest 7. Following text explains how the up/down counter value changes in responding to the regulation voltage v_{REG}. The regulation voltage v_{REG} is internally compared with three thresholds V_{RL}, V_{RH} and V_{RM}. According to the results, the value in the up/down counter is changed, which is summarised in Table 1 and Figure 4 respectively.

Table 1 Operation of the up/down counter

V_{REG}	**up/down counter action**
Always lower than V_{RL}	Count upwards till 7
Once higher than V_{RL}, but always lower than V_{RH}	Stop counting, no value changing
Once higher than V_{RH}, but always lower than V_{RM}	Count downwards till 1
Once higher than V_{RM}	Set up/down counter to 1

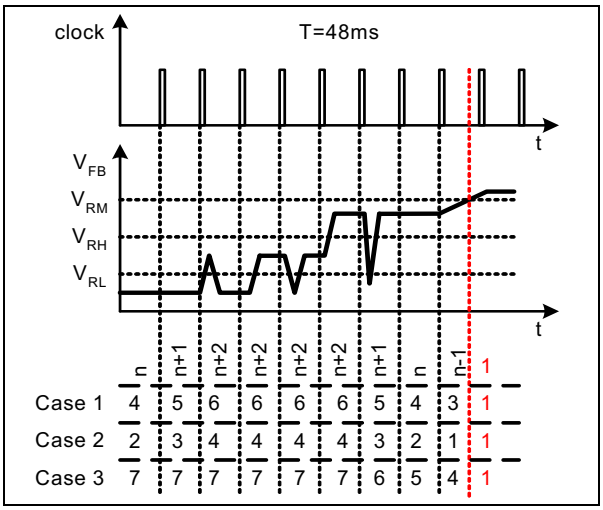


Figure 4 Up/down counter operation

According to the comparison results the up/down counter counts upwards, keeps unchanged or counts downwards. However, the value in up/down counter is limited between 1 and 7. If the counter tends to count beyond this range, the attempt is ignored.

In normal case, the up/down counter can only be changed by one each time at the clock period of 48ms. However, to ensure a fast response to sudden load increase, the counter is set to 1 in the following switching period after the regulation voltage v_{REG} exceeds the threshold V_{RM}.

3.3.1.2 Zero-Crossing Counter and Ringing Suppression Time Controller

In the system, the voltage from the auxiliary winding is applied to the zero-crossing pin through a RC network, which provides a time delay to the voltage from the auxiliary winding. Internally, this pin is connected to a clamping network, a zero-crossing detector, an output overvoltage (OP OVP) detector and a ringing suppression time controller.

During on-state of the power switch a negative voltage applies to the ZC pin. Through the internal clamping network, the voltage at the pin is clamped to certain level. However, it is highly recommended that a fast-recovery diode D_{zc} is added to block the negative voltage when the power switch is on. This is because the device in MOS technology is sensitive to negative voltage.

The voltage at the ZC pin v_{ZC} is compared with the threshold V_{ZCT1}. Once the voltage v_{ZC} crosses the threshold at its falling edge, a pulse is generated which is fed to the zero-crossing counter and the counter value increases by 1.

After MOSFET is turned on, there will be some oscillation on V_{DS}, which will also appear on the voltage on ZC pin. To avoid the MOSFET is turned on mistriggerred by such oscillation, a ringing suppression timer is implemented. The time is dependent on the voltage v_{ZC}. When the voltage v_{ZC} is lower than the threshold V_{ZCT2}, a longer preset time applies, while a shorter time is set when the voltage v_{ZC} is higher than the threshold.

The voltage v_{ZC} is used for the output overvoltage protection, as well. Once the voltage at this pin is higher than the threshold V_{OPOVP} during off-time of the main switch, the IC is latched off after a fixed blanking time.

To achieve the switch-on at voltage valley, the voltage from the auxiliary winding is fed to a time delay network (the RC network consists of D_{zc}, R_{zc1}, R_{zc2} and C_{zc} as shown in typical application circuit) before it is applied to the zero-crossing detector through the ZC pin. The needed time delay to the main oscillation signal Δt should be approximately one fourth of the oscillation period (by transformer primary inductor and drain-source capacitor) minus the propagation delay from the

detected zero-crossing to the switch-on of the main switch t_{delay}, theoretically:

$$\Delta t = \frac{T_{osc}}{4} - t_{delay} \quad [3]$$

This time delay should be matched by adjusting the time constant of the RC network which is calculated as:

$$\tau_{td} = C_{zc} \cdot \frac{R_{zc1} \cdot R_{zc2}}{R_{zc1} + R_{zc2}} \quad [4]$$

3.3.1.3 Switch-on Determination

In the system, turn-on of the power switch depends on the value of the up/down counter, the value of the zero-crossing counter and the voltage at the ZC pin v_{ZC}. Turn-on happens only when the value in the both counters are the same and the voltage at the ZC is lower than the threshold V_{ZCT1}. For comparison of the values from both counters, a digital comparator is used. Once these counters have the same value, the comparator generates a signal which sets the on/off flip-flop, only when the voltage v_{ZC} is lower than the threshold V_{ZCT1}.

Another signal which may trigger the digital comparator is the output of a T_{sMax} clock signal, which limits the maximum off time to avoid the low-frequency operation.

During active burst mode operation, the digital comparator is disabled and no pulse will be generated.

3.3.2 Switch-off Determination

In the converter system, the primary current is sensed by an external shunt resistor, which is connected between low-side terminal of the main power switch and the common ground. The sensed voltage across the shunt resistor v_{CS} is applied to an internal current measurement unit, and its output voltage v_1 is compared with the regulation voltage v_{reg}. Once the voltage v_1 exceeds the voltage v_{REG}, the output flip-flop is reset. As a result, the main power switch is switched off. The relationship between the v_1 and the v_{cs} is described by:

$$v_1 = 3.3 \cdot v_{CS} + 0.7 \quad [5]$$

To avoid mistriggering caused by the voltage spike across the shunt resistor after switch-on of the main power switch, a 330ns leading edge blanking time applies to output of the comparator.

3.3.3 Foldback Point Correction

In addition to the cycle-by-cylce primary current limitation, the IC incorporats a foldback point correction. The current limit on CS pin voltage is now a time dependent one. If the mains input voltage is high, the MOSFET on time will be short and the current limit will be low. In such a way, the maximum output power for the SMPS designed with ICE2QS01 will be nearly constant against the variations of mains input voltage. The current sense voltage limit versus the MOSFET maximum on time is shown in Figure 5.

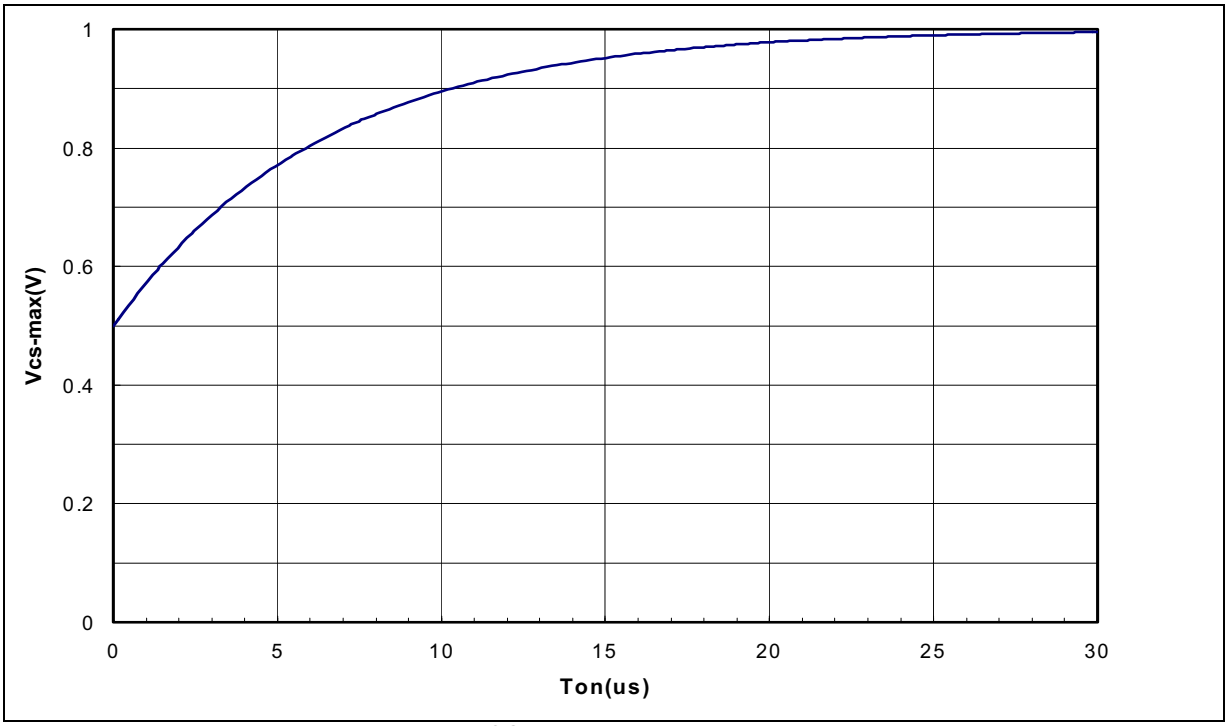


Figure 5 Maximum current limit versus MOSFET maximum on time

3.4 Active Burst Mode Operation

At very low load condition, the IC enters active burst mode operation to minimize the input power. Details about active burst mode operation are explained in the following paragraphs.

3.4.1 Entering Active Burst Mode Operation

For determination of entering active burst mode operation, three conditions apply:

the regulation voltage is lower than the threshold of V_{EB}(1.1V). Accordingly, the peak voltage across the shunt resistor is 0.11V;

the up/down counter has its maximal value of 7; and

a certain blanking time (24ms).

Once all of these conditions are fulfilled, the active burst mode flip-flop is set and the controller enters burst mode operation. This multi-conditional determination for entering active burst mode operation prevents mistriggering of entering active burst mode operation, so that the controller enters active burst mode operation only when the output power is really low during the preset blanking time.

3.4.2 During Active Burst Mode Operation

After entering the Active Burst Mode the regulation voltage rises as V_{OUT} starts to decrease due to the inactive PWM section. One comparator observes the regulation signal if the voltage level V_{BH} (3.6V) is exceeded. In that case the internal circuit is again activated by the internal bias to start with swtiching.

Turn-on of the power MOSFET is triggered by the timer. The PWM generator for burst mode operation composes of a timer with a fixed frequency of 80kHz, typically, and an analog comparator. Turn-off is resulted by comparison of the voltage signal v_1 with an internal threshold, by which the voltage across the shunt resistor V_{csB} is 0.25V, accordingly. A turn-off can also be triggered by the maximal duty ratio controller which sets the maximal duty ratio to 50%. In operation, the output flip-flop will be reset by one of these signals which come first.

If the output load is still low, the regulation signal decreases as the PWM section is operating. When regulation signal reaches the low threshold V_{BL}(3.0V), the internal bias is reset again and the PWM section is disabled until next time regultaion siganl increases beyond the V_{BH} threshold. If working in active burst mode the regulation signal is changing like a saw tooth between 3.0V and 3.6V shown in Figure 6.

3.4.3 Leaving Active Burst Mode

The regulation voltage immediately increases if there is a high load jump. This is observed by one comparator. As the current limit is 25% during active burst mode a certain load is needed so that regulation voltage can exceed V_{LB} (4.5V). After leaving active busrt mode, maximum current can now be provided to stabilize V_O. In addition, the up/down counter will be set to 1 immediately after leaving active burst mode. This is helpful to decrease the output voltage undershoot.

3.4.4 IC Power Supply During Active Burst Mode

During active burst mode operation, the power cell is activated again. Once the power from the auxiliary winding is not high enough to keep the VCC voltage above the preset value of V_{VCCBL}, the power cell keeps the VCC voltage at the preset value V_{VCCBL}. Otherwise, if the VCC voltage is still above this value, no current flows through the power cell though it is activated.

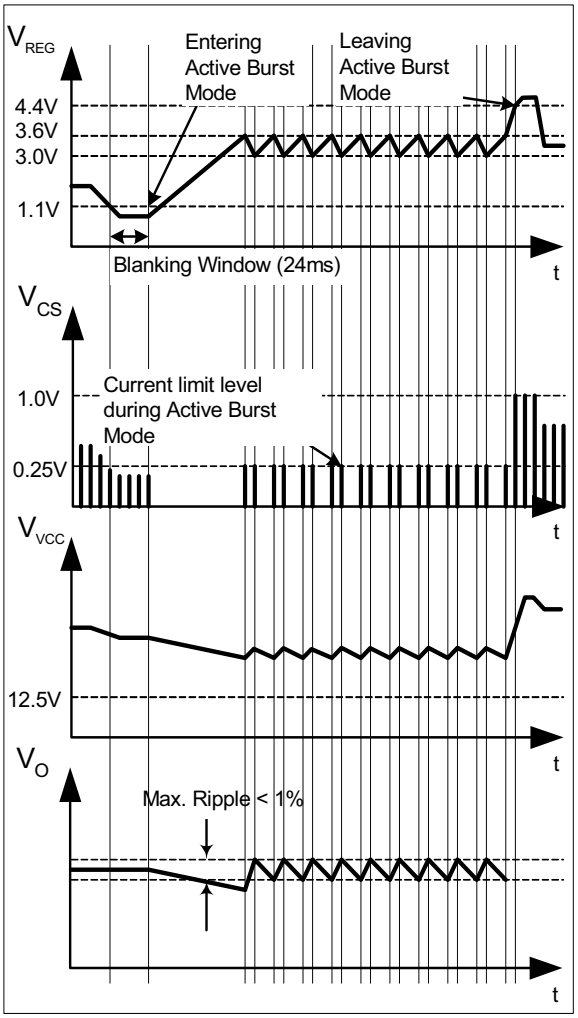


Figure 6 Signals in active burst mode

3.5 Protection Functions

The IC provides full protection functions. The following table summarizes these protection functions.

Table 2 Protection features

VCC Overvoltage	Auto Restart Mode
VCC Undervoltage	Auto Restart Mode
Overload/Open Loop	Auto Restart Mode
Output Overvoltage	Latched Off Mode
Short Winding	Latched Off Mode

During operation, the VCC voltage is continuously monitored. In case of an under- or an over-voltage, the IC is reset and the main power switch is then kept off. After the VCC voltage falls below the threshold V_{VCCUVP}, the power cell is activated. The VCC capacitor is then charged up. Once the voltage exceeds the threshold V_{VCCon}, the IC begins to operate with a new soft-start.

In case of open control loop or output over load, the regulation voltage will be pulled up . After a blanking time of 24ms, the IC enters auto-restart mode. The blanking time here enables the converter to provide a high power in case the increase in V_{REG} is due to a sudden load increase. During off-time of the power switch, the voltage at the zero-crossing pin is monitored for output over-voltage detection. If the voltage is higher than the preset threshold v_{OPOVP}, the IC is latched off after the preset blanking time.

If the voltage at the current sensing pin is higher than the preset threshold v_{csSW} during on-time of the power switch, the IC is latched off. This is short-winding protection.

During latch-off protection mode, the power cell is activated and it keeps the VCC voltage at the level of $V_{VCCBL.}$

4 Electrical Characteristics

Note: All voltages are measured with respect to ground (Pin 8). The voltage levels are valid if other ratings are not violated.

4.1 Absolute Maximum Ratings

Note: Absolute maximum ratings are defined as ratings, which when being exceeded may lead to destruction of the integrated circuit. For the same reason make sure, that any capacitor that will be connected to pin 7 (VCC) is discharged before assembling the application circuit.

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
HV Voltage	V_{HV}	-	500	V	
VCC Supply Voltage	V_{VCC}	-0.3	27	V	
REG Voltage	V_{REG}	-0.3	5.0	V	
ZC Voltage	V_{ZC}	-0.3	5.0	V	
CS Voltage	V_{CS}	-0.3	5.0	V	
OUT Voltage	V_{OUT}	-0.3	27	V	
Junction Temperature	T_j	-40	125	°C	
Storage Temperature	T_S	-55	150	°C	
Thermal Resistance Junction-Ambient	R_{thJA}	-	90	K/W	PG-DIP-8
ESD Capability	V_{ESD}	-	2	kV	Human body model[1)]

1) According to EIA/JESD22-A114-B (discharging a 100pF capacitor through a 1.5kΩ series resistor)

4.2 Operating Range

Note: Within the operating range the IC operates as described in the functional description.

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
VCC Supply Voltage	V_{VCC}	V_{VCCUVP}	V_{VCCOVP}	V	
Junction Temperature	T_{jCon}	-25	125	°C	

4.3 Characteristics

4.3.1 Supply Section

Note: The electrical characteristics involve the spread of values guaranteed within the specified supply voltage and junction temperature range T_J from – 25 °C to 125°C. Typical values represent the median values, which are related to 25°C. If not otherwise stated, a supply voltage of V_{CC} = 18 V is assumed.

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Start-Up Current	$I_{VCCstart}$	-	300	550	µA	V_{VCC} = 21V
VCC Charge Current	$I_{VCCcharge1}$			5.0	mA	V_{VCC} = 0V
	$I_{VCCcharge2}$	0.55	1.05	1.60	mA	V_{VCC} = 1V
	$I_{VCCcharge3}$	-	0.88	-	mA	V_{VCC} = 21V
Leakage Current of Power Cell	$I_{StartLeak}$	-	0.2	50	µA	V_{HV}= 610V at T_j = 100°C
Supply Current in normal operation	I_{VCCop}	-	2.5	3.6	mA	Output low
Supply Current in Auto Restart Mode with Inactive Gate	$I_{VCCrestart}$	-	300	-	µA	
Supply Current in Latch-off Mode	$I_{VCClatch}$	-	300	-	µA	
Supply Current in Burst Mode with Inactive Gate	$I_{VCCburst}$	-	500	950	µA	V_{REG} = 2.5V
Supply Voltage with no power from auxiliary winding in burst mode or in latch-off mode	V_{VCCBL}	-	12.5	-	V	V_{HV} = 100V
VCC Turn-On Threshold	V_{VCCon}	21.2	22.0	22.8	V	
Internal Reference Voltage	V_{REF}	4.8	5.0	5.2	V	measured at pin REG, I_{REG} = 0

4.3.2 PWM Section

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Regulation Pull-Up Resistor	R_{REG}	14	23	33	kΩ	
PWM-OP Gain	A_V	3.18	3.3	-	-	
Offset for Voltage Ramp	V_{OS}	0.63	0.7	-	V	
Soft-Start time	t_{SOFTS}	18	21	38	ms	
Zero crossing threshold voltage	V_{ZCT1}	20	50	110	mV	
Ringing suppression threshold	V_{ZCT2}		0.7		V	
Minimum ringing suppression time	t_{ZCRST1}	2.2	4.2	5.5	µs	$V_{ZC} > V_{ZCT2}$
Maximum ringing suppression time	t_{ZCRST2}	-	42	-	µs	$V_{ZC} < V_{ZCT2}$
Threshold to set Up/Down Counter to one	V_{RM}		3.9		V	
Threshold for downward counting	V_{RH}		3.2		V	
Threshold for upward counting	V_{RL}		2.5		V	
Counter time[1)]	t_{COUNT}		48		ms	
Maximum restart time in normal operation	t_{sMax}	33	42	60	µs	$V_{ZC}<V_{ZCT1}$
Leading Edge Blanking	t_{LEB}	200	330	460	ns	
Peak current limitation in normal operation	V_{csth}	0.95	1.0	1.05	V	
Regulation voltage for entering Burst Mode	V_{EB}		1.1		V	
Regulation voltage for leaving Burst Mode	V_{LB}		4.5		V	
Regulation voltage for burst-on	V_{BH}		3.6		V	
Regulation voltage for burst-off	V_{BL}		3.0		V	
Fixed Switching Frequency in Burst Mode	f_{sB}	64	80	96	kHz	
Max. Duty Cycle in Burst Mode	D_{maxB}		0.5			
Peak Current Limitation in Burst Mode	V_{csB}	0.22	0.25	0.3	V	

1) The parameter is not subject to production test - verified by design/characterization

4.3.3 Protection

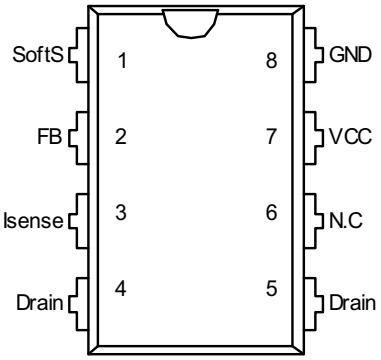
Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
VCC overvoltage threshold	V_{VCCOVP}	24	25.0	26	V	
VCC undervoltage threshold	V_{VCCUVP}	10.3	11.0	11.7	V	
Over Load or Open Loop Detection threshold for OLP protection at REG pin	V_{OLP}		4.5		V	
Over Load or Open Loop Protection Blanking Time	T_{OLP-B}	16	24	35	ms	
Output Overvoltage detection threshold at the ZC pin	V_{OPOVP}		4.5		V	
Threshold for short winding protection	V_{csSW}		1.68		V	

Note: The trend of all the voltage levels in the Control Unit is the same regarding the deviation except V_{VCCOVP}

4.3.4 Gate Driver

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Output voltage at logic low	$V_{GATElow}$		0.7		V	I_{OUT} = 20mA
Output voltage at logic high	$V_{GATEhigh}$		10.0		V	I_{OUT} = -20mA
Output voltage active shut down	$V_{GATEasd}$		1.0		V V	V_{VCC} = 7V I_{OUT} = 20mA
Rise Time	t_{rise}	-	100	-	ns	C_{OUT} = 4.7nF
Fall Time	t_{fall}	-	25	-	ns	C_{OUT} = 4.7nF

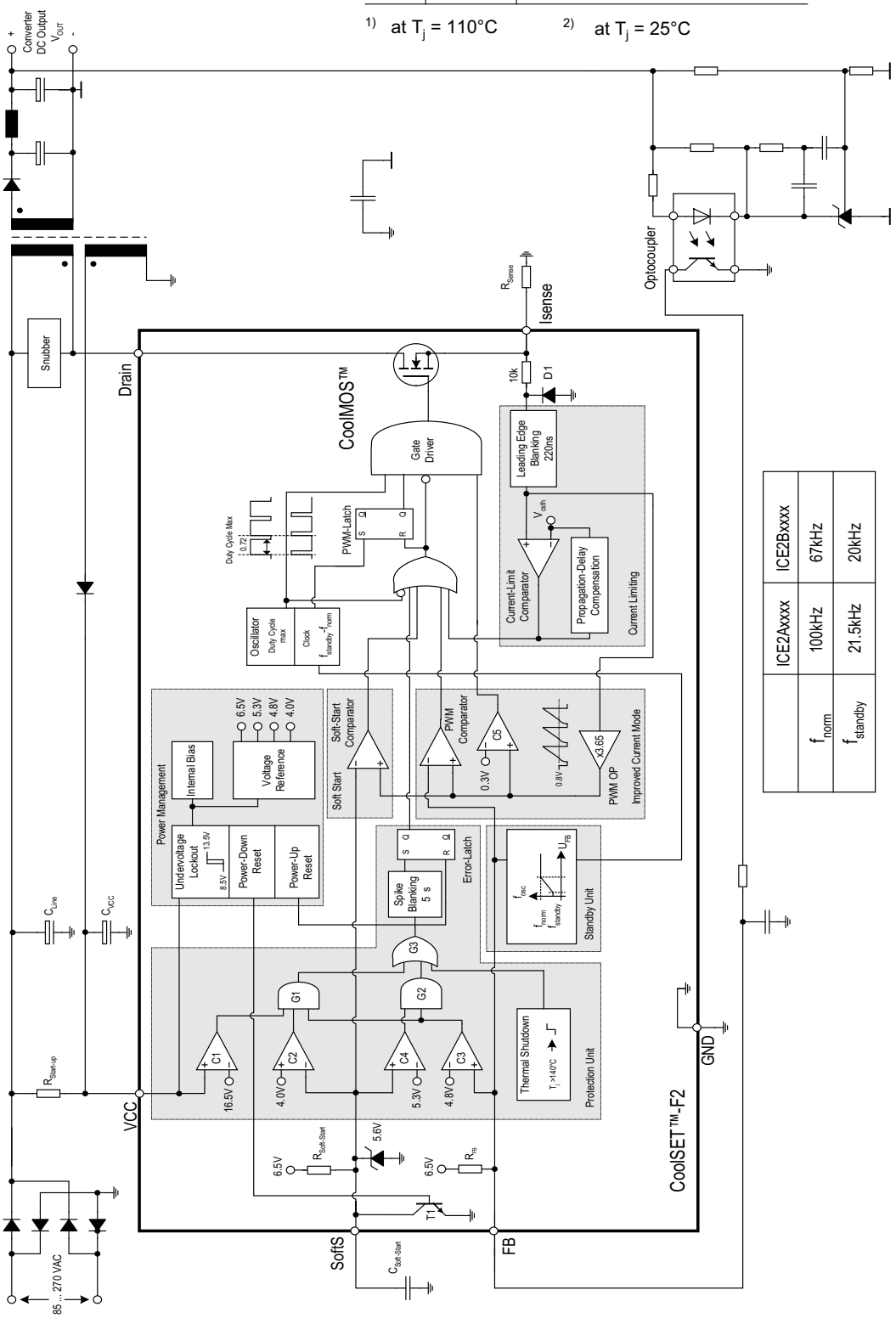
ICE2B265 (IC92)



Pin	Symbol	Function
1	SoftS	Soft-Start
2	FB	Feedback
3	Isense	Controller Current Sense Input, CoolMOS™ Source Output
4	Drain	650V[1]/800V[2] CoolMOS™ Drain
5	Drain	650V[1]/800V[2] CoolMOS™ Drain
6	N.C	Not connected
7	VCC	Controller Supply Voltage
8	GND	Controller Ground

[1] at T_j = 110°C [2] at T_j = 25°C

Blockdiagram



3 Functional Description

3.1 Power Management

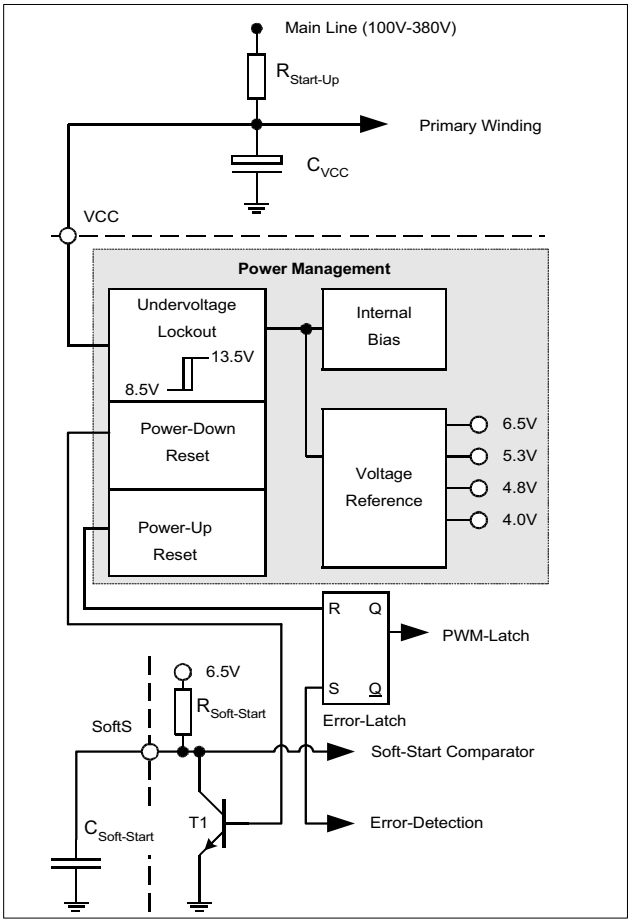


Figure 6 Power Management

The Undervoltage Lockout monitors the external supply voltage V_{VCC}. In case the IC is inactive the current consumption is max. 55µA. When the SMPS is plugged to the main line the current through $R_{Start-up}$ charges the external Capacitor C_{VCC}. When V_{VCC} exceeds the on-threshold V_{CCon}=13.5V the internal bias circuit and the voltage reference are switched on. After that the internal bandgap generates a reference voltage V_{REF}=6.5V to supply the internal circuits. To avoid uncontrolled ringing at switch-on a hysteresis is implemented which means that switch-off is only after active mode when Vcc falls below 8.5V.

In case of switch-on a Power Up Reset is done by resetting the internal error-latch in the protection unit.

When V_{VCC} falls below the off-threshold V_{CCoff}=8.5V the internal reference is switched off and the Power Down reset let T1 discharging the soft-start capacitor $C_{Soft-Start}$ at pin SoftS. Thus it is ensured that at every switch-on the voltage ramp at pin SoftS starts at zero.

3.2 Improved Current Mode

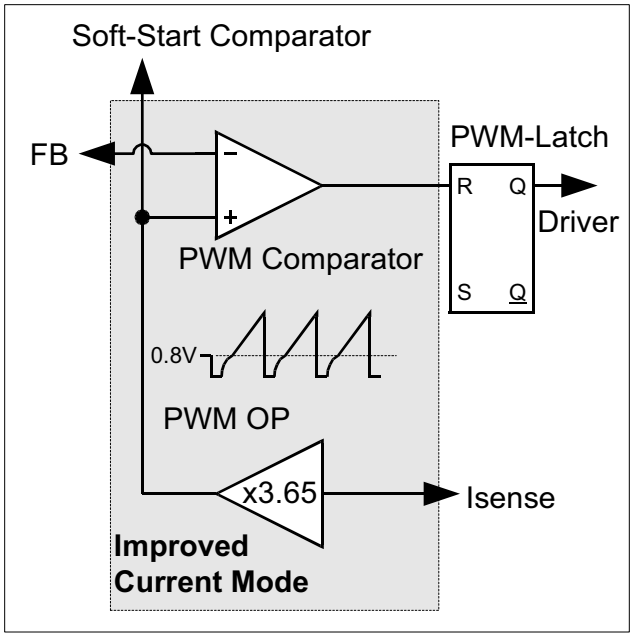


Figure 7 Current Mode

Current Mode means that the duty cycle is controlled by the slope of the primary current. This is done by comparison the FB signal with the amplified current sense signal.

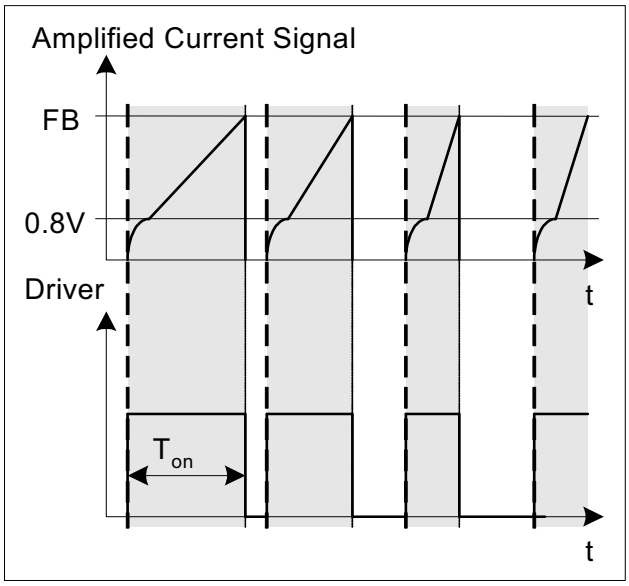


Figure 8 Pulse Width Modulation

In case the amplified current sense signal exceeds the FB signal the on-time T_{on} of the driver is finished by resetting the PWM-Latch (see Figure 8).

The primary current is sensed by the external series resistor R_{Sense} inserted in the source of the integrated CoolMOS™. By means of Current Mode regulation, the

secondary output voltage is insensitive on line variations. Line variation changes the current waveform slope which controls the duty cycle.

The external R_{Sense} allows an individual adjustment of the maximum source current of the integrated CoolMOS™.

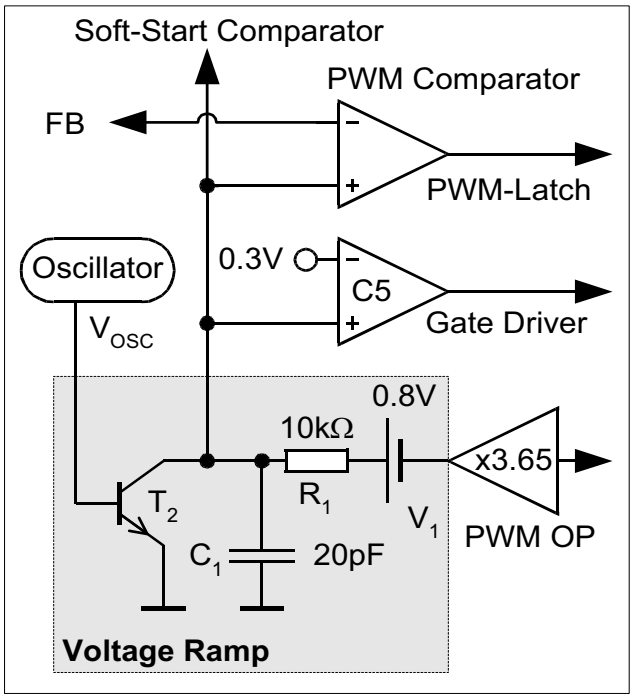


Figure 9 Improved Current Mode

To improve the Current Mode during light load conditions the amplified current ramp of the PWM-OP is superimposed on a voltage ramp, which is built by the switch T_2, the voltage source V_1 and the 1st order low pass filter composed of R_1 and C_1(see Figure 9, Figure 10). Every time the oscillator shuts down for max. duty cycle limitation the switch T2 is closed by V_{OSC}. When the oscillator triggers the Gate Driver T2 is opened so that the voltage ramp can start.

In case of light load the amplified current ramp is to small to ensure a stable regulation. In that case the Voltage Ramp is a well defined signal for the comparison with the FB-signal. The duty cycle is then controlled by the slope of the Voltage Ramp.

By means of the Comparator C5, the Gate Driver is switched-off until the voltage ramp exceeds 0.3V. It allows the duty cycle to be reduced continuously till 0% by decreasing V_{FB} below that threshold.

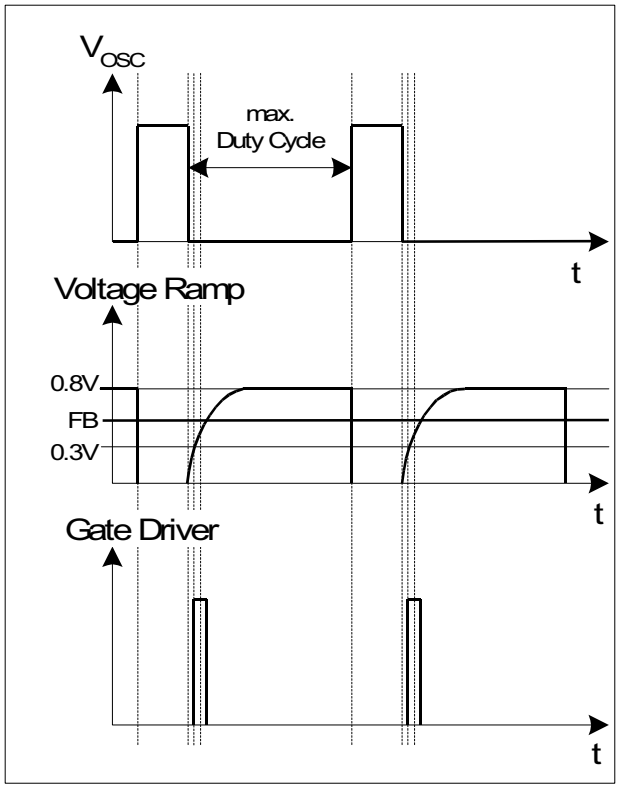


Figure 10 Light Load Conditions

3.2.1 PWM-OP

The input of the PWM-OP is applied over the internal leading edge blanking to the external sense resistor R_{Sense} connected to pin Isense. R_{Sense} converts the source current into a sense voltage. The sense voltage is amplified with a gain of 3.65 by PWM OP. The output of the PWM-OP is connected to the voltage source V1. The voltage ramp with the superimposed amplified current signal is fed into the positive inputs of the PWM-Comparator, C5 and the Soft-Start-Comparator.

3.2.2 PWM-Comparator

The PWM-Comparator compares the sensed current signal of the integrated CoolMOS™ with the feedback signal V_{FB} (see Figure 11). V_{FB} is created by an external optocoupler or external transistor in combination with the internal pull-up resistor R_{FB} and provides the load information of the feedback circuitry. When the amplified current signal of the integrated CoolMOS™ exceeds the signal V_{FB} the PWM-Comparator switches off the Gate Driver.

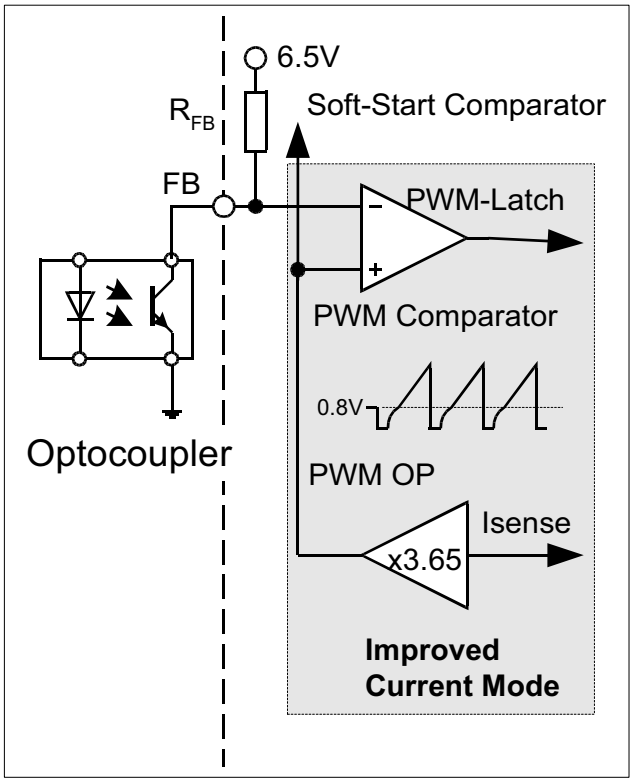


Figure 11 PWM Controlling

3.3 Soft-Start

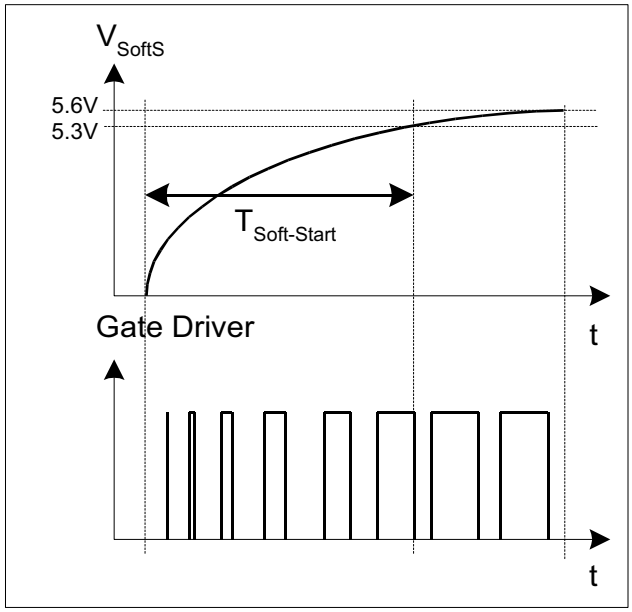


Figure 12 Soft-Start Phase

The Soft-Start is realized by the internal pull-up resistor $R_{Soft\text{-}Start}$ and the external Capacitor $C_{Soft\text{-}Start}$ (see Figure 5). The Soft-Start voltage V_{SoftS} is generated by charging the external capacitor $C_{Soft\text{-}Start}$ by the internal pull-up resistor $R_{Soft\text{-}Start}$. The Soft-Start-Comparator compares the voltage at pin SoftS at the negative input with the ramp signal of the PWM-OP at the positive input. When Soft-Start voltage V_{SoftS} is less than Feedback voltage V_{FB} the Soft-Start-Comparator limits the pulse width by resetting the PWM-Latch (see Figure 12). In addition to Start-Up, Soft-Start is also activated at each restart attempt during Auto Restart. By means of the above mentioned $C_{Soft\text{-}Start}$ the Soft-Start can be defined by the user. The Soft-Start is finished when V_{SoftS} exceeds 5.3V. At that time the Protection Unit is activated by Comparator C4 and senses the FB by Comparator C3 wether the voltage is below 4.8V which means that the voltage on the secondary side of the SMPS is settled. The internal Zener Diode at SoftS has a clamp voltage of 5.6V to prevent the internal circuit from saturation (see Figure 13).

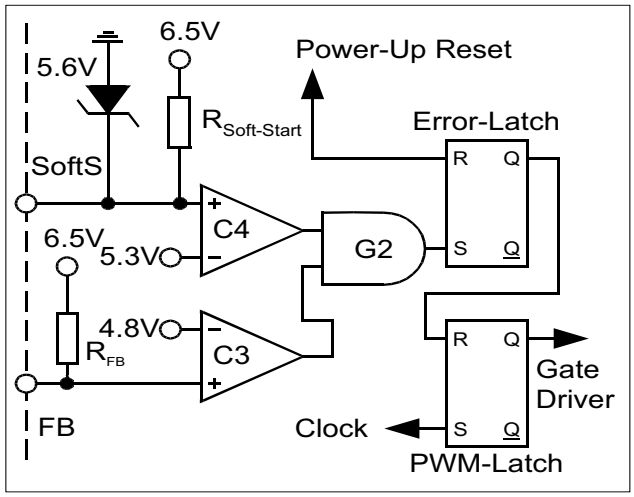


Figure 13 Activation of Protection Unit

The Start-Up time $T_{Start\text{-}Up}$ within the converter output voltage V_{OUT} is settled must be shorter than the Soft-Start Phase $T_{Soft\text{-}Start}$ (see Figure 14).

$$C_{Soft-Start} = \frac{T_{Soft-Start}}{R_{Soft-Start} \times 1.69}$$

By means of Soft-Start there is an effective minimization of current and voltage stresses on the integrated CoolMOS™, the clamp circuit and the output overshoot and prevents saturation of the transformer during Start-Up.

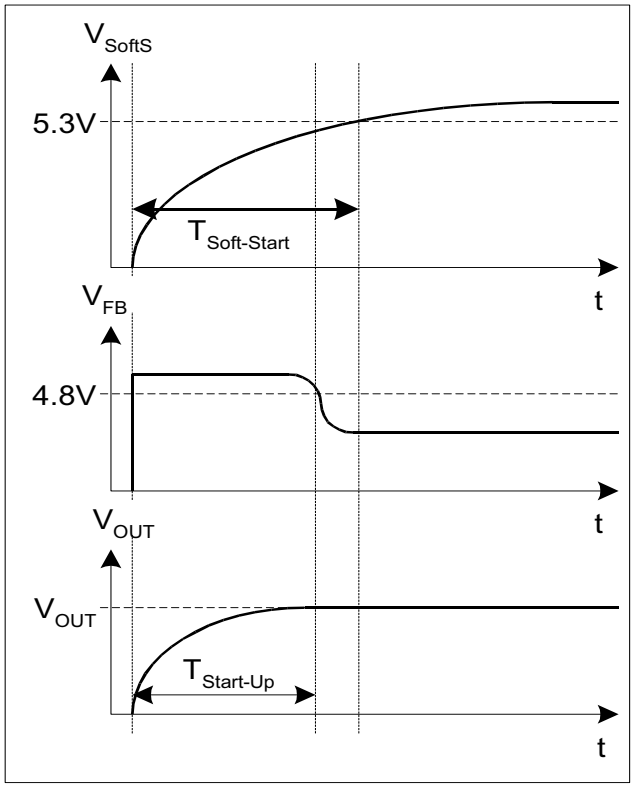


Figure 14 Start Up Phase

3.4 Oscillator and Frequency Reduction

3.4.1 Oscillator

The oscillator generates a frequency f_{switch} = 67kHz/ 100kHz. A resistor, a capacitor and a current source and current sink which determine the frequency are integrated. The charging and discharging current of the implemented oscillator capacitor are internally trimmed, in order to achieve a very accurate switching frequency. The ratio of controlled charge to discharge current is adjusted to reach a max. duty cycle limitation of D_{max}=0.72.

3.4.2 Frequency Reduction

The frequency of the oscillator is depending on the voltage at pin FB. The dependence is shown in Figure 15. This feature allows a power supply to operate at lower frequency at light loads thus lowering the switching losses while maintaining good cross regulation performance and low output ripple. In case of low power the power consumption of the whole SMPS can now be reduced very effective. The minimal reachable frequency is limited to 20kHz/21.5 kHz to avoid audible noise in any case.

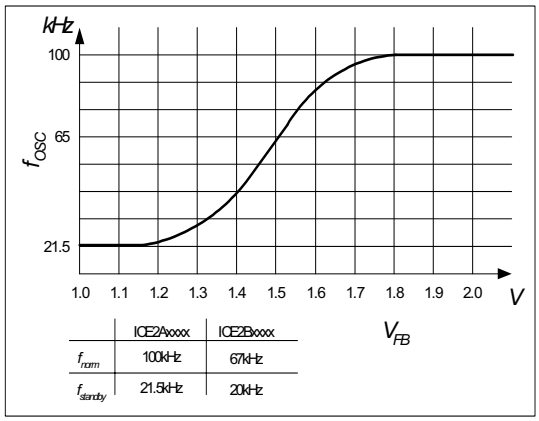


Figure 15 Frequency Dependence

3.5 Current Limiting

There is a cycle by cycle current limiting realized by the Current-Limit Comparator to provide an overcurrent detection. The source current of the integrated CoolMOS™ is sensed via an external sense resistor R_{Sense}. By means of R_{Sense} the source current is transformed to a sense voltage V_{Sense}. When the voltage V_{Sense} exceeds the internal threshold voltage V_{csth} the Current-Limit-Comparator immediately turns off the gate drive. To prevent the Current Limiting from distortions caused by leading edge spikes a Leading Edge Blanking is integrated at the Current Sense. Furthermore a Propagation Delay Compensation is added to support the immediate shut down of the CoolMOS™ in case of overcurrent.

3.5.1 Leading Edge Blanking

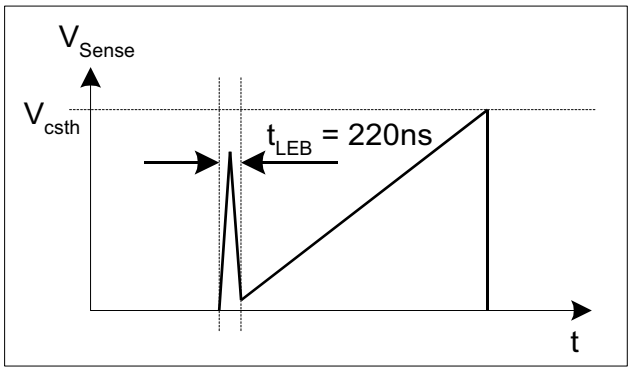


Figure 16 Leading Edge Blanking

Each time when CoolMOS™ is switched on a leading spike is generated due to the primary-side capacitances and secondary-side rectifier reverse recovery time. To avoid a premature termination of the switching pulse this spike is blanked out with a time constant of t_{LEB} = 220ns. During that time the output of

the Current-Limit Comparator cannot switch off the gate drive.

3.5.2 Propagation Delay Compensation

In case of overcurrent detection by I_{Limit} the shut down of CoolMOS™ is delayed due to the propagation delay of the circuit. This delay causes an overshoot of the peak current I_{peak} which depends on the ratio of dI/dt of the peak current (see Figure 17).

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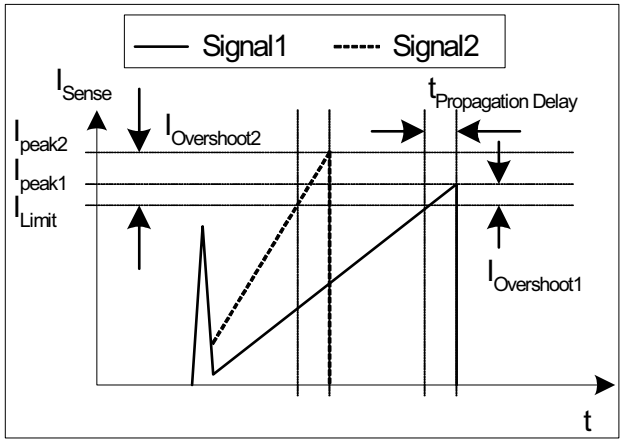


Figure 17 Current Limiting

The overshoot of Signal2 is bigger than of Signal1 due to the steeper rising waveform.

A propagation delay compensation is integrated to bound the overshoot dependent on dI/dt of the rising primary current. That means the propagation delay time between exceeding the current sense threshold V_{csth} and the switch off of CoolMOS™ is compensated over temperature within a range of at least.

$$0 \leq R_{Sense} \times \frac{dI_{peak}}{dt} \leq \frac{dV_{Sense}}{dt}$$

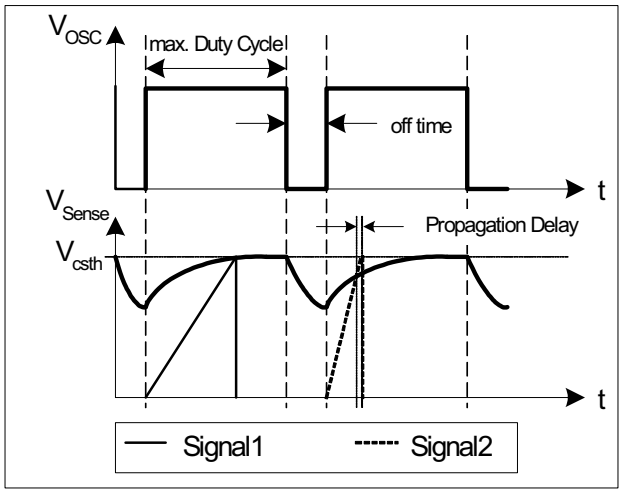


Figure 18 Dynamic Voltage Threshold V_{csth}

The propagation delay compensation is done by means of a dynamic threshold voltage V_{csth} (see Figure 18). In case of a steeper slope the switch off of the driver is earlier to compensate the delay.

E.g. I_{peak} = 0.5A with R_{Sense} = 2. Without propagation delay compensation the current sense threshold is set to a static voltage level V_{csth}=1V. A current ramp of dI/dt = 0.4A/µs, that means dV_{Sense}/dt = 0.8V/µs, and a propagation delay time of i.e. $t_{Propagation\ Delay}$ =180ns leads then to a I_{peak} overshoot of 14.4%. By means of propagation delay compensation the overshoot is only about 2% (see Figure 19).

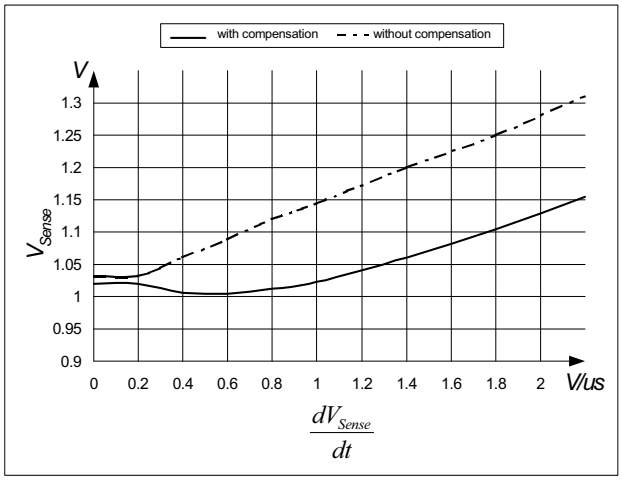


Figure 19 Overcurrent Shutdown

3.6 PWM-Latch

The oscillator clock output applies a set pulse to the PWM-Latch when initiating CoolMOS™ conduction. After setting the PWM-Latch can be reset by the PWM-OP, the Soft-Start-Comparator, the Current-Limit-Comparator, Comparator C3 or the Error-Latch of the Protection Unit. In case of resetting the driver is shut down immediately.

3.7 Driver

The driver-stage drives the gate of the CoolMOS™ and is optimized to minimize EMI and to provide high circuit efficiency. This is done by reducing the switch on slope when reaching the CoolMOS™ threshold. This is achieved by a slope control of the rising edge at the driver's output (see Figure 20) to the CoolMOS™ gate.

Thus the leading switch on spike is minimized. When CoolMOS™ is switched off, the falling shape of the driver is slowed down when reaching 2V to prevent an overshoot below ground. Furthermore the driver circuit is designed to eliminate cross conduction of the output stage. At voltages below the undervoltage lockout threshold V_{VCCoff} the gate drive is active low.

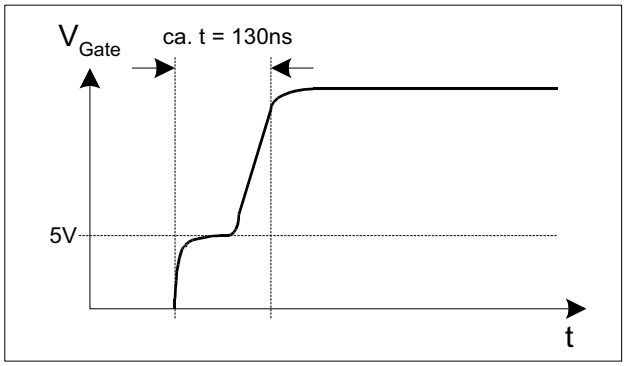


Figure 20 Internal Gate Rising Slope

3.8 Protection Unit (Auto Restart Mode)

An overload, open loop and overvoltage detection is integrated within the Protection Unit. These three failure modes are latched by an Error-Latch. Additional thermal shutdown is latched by the Error-Latch. In case of those failure modes the Error-Latch is set after a blanking time of 5µs and the CoolMOS™ is shut down. That blanking prevents the Error-Latch from distortions caused by spikes during operation mode.

3.8.1 Overload / Open Loop with Normal Load

Figure 21 shows the Auto Restart Mode in case of overload or open loop with normal load. The detection of open loop or overload is provided by the Comparator C3, C4 and the AND-gate G2 (see Figure 22). The detection is activated by C4 when the voltage at pin SoftS exceeds 5.3V. Till this time the IC operates in the Soft-Start Phase. After this phase the comparator C3 can set the Error-Latch in case of open loop or overload which leads the feedback voltage V_{FB} to exceed the threshold of 4.8V. After latching VCC decreases till 8.5V and inactivates the IC. At this time the external Soft-Start capacitor is discharged by the internal transistor T1 due to Power Down Reset. When the IC is inactive V_{VCC} increases till V_{CCon} = 13.5V by charging the Capacitor C_{VCC} by means of the Start-Up Resistor $R_{Start-Up}$. Then the Error-Latch is reset by Power Up Reset and the external Soft-Start capacitor $C_{Soft-Start}$ is charged by the internal pull-up resistor $R_{Soft-Start}$. During the Soft-Start Phase which ends when the voltage at pin SoftS exceeds 5.3V the detection of overload and open loop by C3 and G2 is inactive. In this way the Start Up Phase is not detected as an overload.

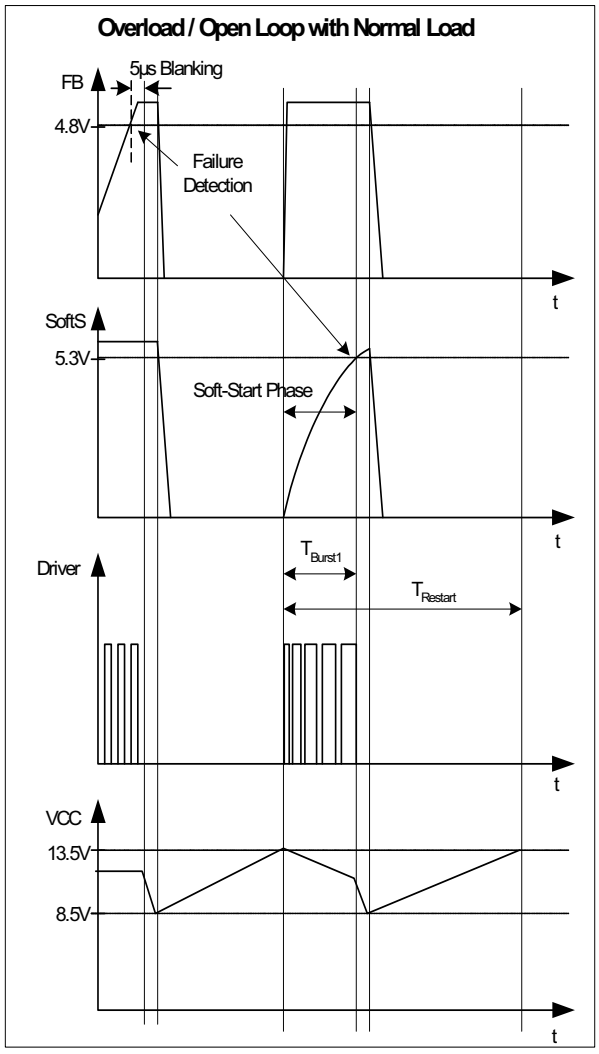


Figure 21 Auto Restart Mode

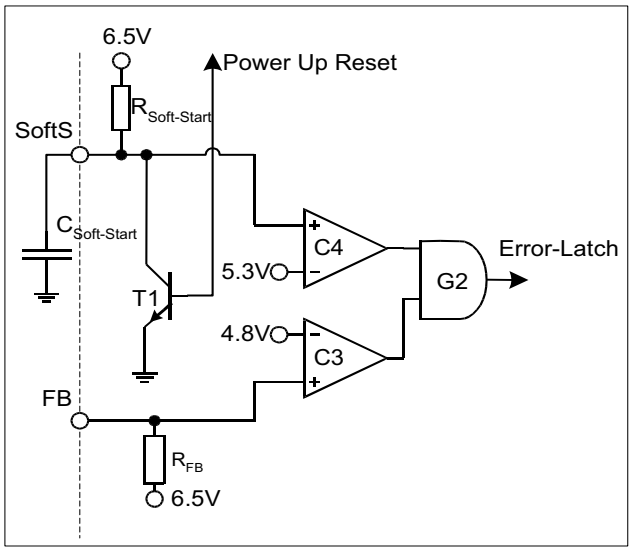


Figure 22 FB-Detection

But the Soft-Start Phase must be finished within the Start Up Phase to force the voltage at pin FB below the failure detection threshold of 4.8V.

3.8.2 Overvoltage due to Open Loop with No Load

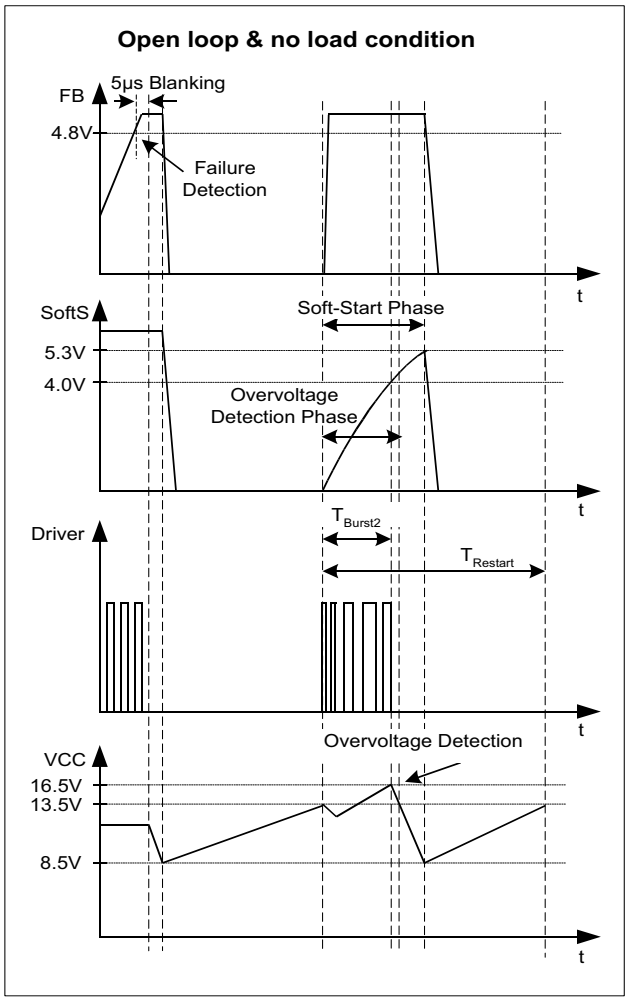


Figure 23 Auto Restart Mode

Figure 23 shows the Auto Restart Mode for open loop and no load condition. In case of this failure mode the converter output voltage increases and also VCC. An additional protection by the comparators C1, C2 and the AND-gate G1 is implemented to consider this failure mode (see Figure 24).The overvoltage detection is provided by Comparator C1 only in the first time during the Soft-Start Phase till the Soft-Start voltage exceeds the threshold of the Comparator C2 at 4.0V and the voltage at pin FB is above 4.8V. When VCC exceeds 16.5V during the overvoltage detection phase C1 can set the Error-Latch and the Burst Phase during Auto Restart Mode is finished earlier. In that case T_{Burst2} is shorter than $T_{Soft\text{-}Start}$. By means of C2 the normal operation mode is prevented from overvoltage detection due to varying of VCC concerning the regulation of the converter output. When the voltage V_{SoftS} is above 4.0V the overvoltage detection by C1 is deactivated.

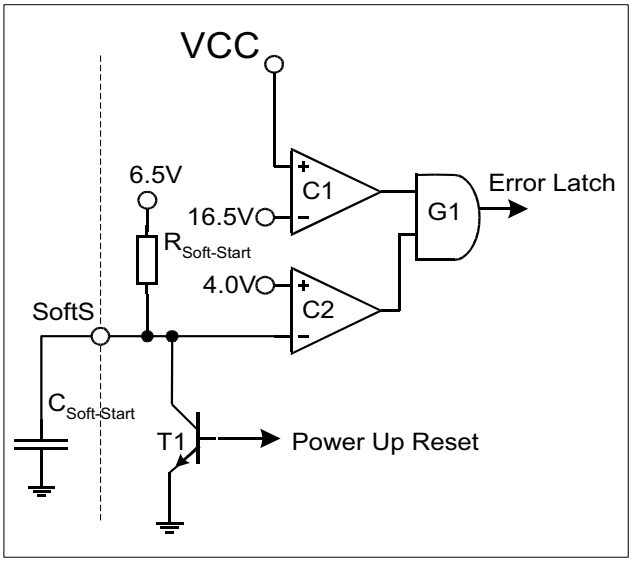


Figure 24 Overvoltage Detection

3.8.3 Thermal Shut Down

Thermal Shut Down is latched by the Error-Latch when junction temperature T_j of the pwm controller is exceeding an internal threshold of 140°C. In that case the IC switches in Auto Restart Mode.

Note: All the values which are mentioned in the functional description are typical. Please refer to Electrical Characteristics for min/max limit values.

4 Electrical Characteristics

4.1 Absolute Maximum Ratings

Note: Absolute maximum ratings are defined as ratings, which when being exceeded may lead to destruction of the integrated circuit. For the same reason make sure, that any capacitor that will be connected to pin 6 (VCC) is discharged before assembling the application circuit.

Parameter		Symbol	Limit Values		Unit	Remarks
			min.	max.		
Drain Source Voltage ICE2A0565/165/265/365/765I/765P2 ICE2B0565/165/265/365/765I/765P2 ICE2A0565G ICE2A0565Z		V_{DS}	-	650	V	T_j = 110°C
Drain Source Voltage ICE2A180Z/280Z/380P2		V_{DS}	-	800	V	T_j = 25°C
Pulsed drain current, t_p limited by T_{jmax}	ICE2A0565/ ICE2B056/ ICE2A0565G/ ICE2A0565Z	I_{D_Puls1}		2.0	A	
	ICE2A165/ ICE2B165	I_{D_Puls2}		3.8	A	
	ICE2A265/ ICE2B265	I_{D_Puls3}		9.8	A	
	ICE2A365/ ICE2B365	I_{D_Puls4}		23.3	A	
	ICE2A180Z	I_{D_Puls5}		4.1	A	
	ICE2A280Z	I_{D_Puls6}		14.8	A	
	ICE2A765P2/ ICE2B765P2/ ICE2A765I/ ICE2B765I	I_{D_Puls7}		19.0	A	
	ICE2A380P2/	I_{D_Puls8}		5.7	A	

Parameter		Symbol	Limit Values		Unit	Remarks
			min.	max.		
Avalanche energy, repetitive t_{AR} limited by max. T_j=150°C[1)]	ICE2A0565	E_{AR1}	-	0.01	mJ	
	ICE2A165	E_{AR2}	-	0.07	mJ	
	ICE2A265	E_{AR3}	-	0.40	mJ	
	ICE2A365	E_{AR4}	-	0.50	mJ	
	ICE2B0565	E_{AR5}	-	0.01	mJ	
	ICE2B165	E_{AR6}	-	0.07	mJ	
	ICE2B265	E_{AR7}	-	0.40	mJ	
	ICE2B365	E_{AR8}	-	0.50	mJ	
	ICE2A0565G	E_{AR9}	-	0.01	mJ	
	ICE2A0565Z	E_{AR10}	-	0.01	mJ	
	ICE2A180Z	E_{AR11}	-	0.07	mJ	
	ICE2A280Z	E_{AR12}	-	0.40	mJ	
	ICE2A765I	E_{AR13}	-	0.50	mJ	
	ICE2B765I	E_{AR14}	-	0.50	mJ	
	ICE2A765P2	E_{AR15}	-	0.50	mJ	
	ICE2B765P2	E_{AR16}	-	0.50	mJ	
	ICE2A380P2	E_{AR17}	-	0.06	mJ	

[1)] Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR}* f$

Parameter		Symbol	Limit Values		Unit	Remarks
			min.	max.		
Avalanche current, repetitive tAR limited by max. T_j=150°C	ICE2A0565	I_{AR1}	-	0.5	A	
	ICE2A165	I_{AR2}	-	1	A	
	ICE2A265	I_{AR3}	-	2	A	
	ICE2A365	I_{AR4}	-	3	A	
	ICE2B0565	I_{AR5}	-	0.5	A	
	ICE2B165	I_{AR6}	-	1	A	
	ICE2B265	I_{AR7}	-	2	A	
	ICE2B365	I_{AR8}	-	3	A	
	ICE2A0565G	I_{AR9}	-	0.5	A	
	ICE2A0565Z	I_{AR10}	-	0.5	A	
	ICE2A180Z	I_{AR11}	-	1	A	
	ICE2A280Z	I_{AR12}	-	2	A	
	ICE2A765I	I_{AR13}	-	7	A	
	ICE2B765I	I_{AR14}	-	7	A	
	ICE2A765P2	I_{AR15}	-	7	A	
	ICE2B765P2	I_{AR16}	-	7	A	
	ICE2A380P2	I_{AR17}	-	2.4	A	
V_{CC} Supply Voltage		V_{CC}	-0.3	22	V	
FB Voltage		V_{FB}	-0.3	6.5	V	
SoftS Voltage		V_{SoftS}	-0.3	6.5	V	
I_{Sense}		I_{Sense}	-0.3	3	V	
Junction Temperature		T_j	-40	150	°C	Controller & CoolMOS™
Storage Temperature		T_S	-50	150	°C	
Thermal Resistance Junction-Ambient		R_{thJA1}	-	90	K/W	PG-DIP-8-6
		R_{thJA2}	-	96	K/W	PG-DIP-7-1
		R_{thJA3}	-	110	K/W	P-DSO-16/12
ESD Robustness[1)]		V_{ESD}	-	2[2)]	kV	Human Body Model

1) Equivalent to discharging a 100pF capacitor through a 1.5 kΩ series resistor

2) 1kV at pin drain of ICE2x0565, ICE2A0565Z and ICE2A0565G

4.2 Thermal Impedance (ICE2X765I and ICE2X765P2)

Parameter		Symbol	Limit Values		Unit	Remarks
			min.	max.		
Thermal Resistance Junction-Ambient	ICE2A765I ICE2B765I ICE2A765P2 ICE2B765P2	R_{thJA4}	-	74	K/W	Free standing with no heat-sink
	ICE2A380P2	R_{thJA5}	-	82	K/W	
Junction-Case	ICE2A765I ICE2B765I ICE2A765P2 ICE2B765P2	R_{thJC1}	-	2.5	K/W	
	ICE2A380P2	R_{thJC2}	-	2.86	K/W	

4.3 Operating Range

Note: Within the operating range the IC operates as described in the functional description.

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
V_{CC} Supply Voltage	V_{CC}	V_{CCoff}	21	V	
Junction Temperature of Controller	T_{JCon}	-25	130	°C	Limited due to thermal shut down of controller
Junction Temperature of CoolMOS™	$T_{JCoolMOS}$	-25	150	°C	

4.4 Characteristics

Note: The electrical characteristics involve the spread of values given within the specified supply voltage and junction temperature range T_J from – 25 °C to 125 °C.Typical values represent the median values, which are related to 25°C. If not otherwise stated, a supply voltage of V_{CC} = 15 V is assumed.

4.4.1 Supply Section

Parameter		Symbol	Limit Values			Unit	Test Condition
			min.	typ.	max.		
Start Up Current		I_{VCC1}	-	27	55	µA	V_{CC}=V_{CCon} -0.1V
Supply Current with Inactive Gate		I_{VCC2}	-	5.0	6.6	mA	V_{SoftS} = 0 I_{FB} = 0
Supply Current with Active Gate	ICE2A0565	I_{VCC3}	-	5.3	6.7	mA	V_{SoftS} = 5V I_{FB} = 0
	ICE2A165	I_{VCC4}	-	6.5	7.8	mA	
	ICE2A265	I_{VCC5}	-	6.7	8.0	mA	
	ICE2A365	I_{VCC6}	-	8.5	9.8	mA	
	ICE2B0565	I_{VCC7}	-	5.2	6.7	mA	
	ICE2B165	I_{VCC8}	-	5.5	7.0	mA	
	ICE2B265	I_{VCC9}	-	6.1	7.3	mA	
	ICE2B365	I_{VCC10}	-	7.1	8.3	mA	
	ICE2A0565G	I_{VCC11}	-	5.3	6.7	mA	
	ICE2A0565Z	I_{VCC12}	-	5.3	6.7	mA	
	ICE2A180Z	I_{VCC13}	-	6.5	7.8	mA	
	ICE2A280Z	I_{VCC14}	-	7.7	9.0	mA	
Supply Current with Active Gate	ICE2A765I	I_{VCC15}	-	8.5	9.8	mA	V_{SoftS} = 5V I_{FB} = 0
	ICE2B765I	I_{VCC16}	-	7.1	8.3	mA	
	ICE2A765P2	I_{VCC17}	-	8.5	9.8	mA	
	ICE2B765P2	I_{VCC18}	-	7.1	8.3	mA	
	ICE2A380P2	I_{VCC19}	-	6.7	8.0	mA	
VCC Turn-On Threshold VCC Turn-Off Threshold VCC Turn-On/Off Hysteresis		V_{CCon} V_{CCoff} V_{CCHY}	13 - 4.5	13.5 8.5 5	14 - 5.5	V V V	

4.4.2 Internal Voltage Reference

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Trimmed Reference Voltage	V_{REF}	6.37	6.50	6.63	V	measured at pin FB

4.4.3 Control Section

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Oscillator Frequency ICE2A0565/165/265/365/765I/765P2 ICE2A0565G/0565Z/180Z/280Z/380P2	f_{OSC1}	93	100	107	kHz	V_{FB} = 4V
Oscillator Frequency ICE2B0565/165/265/365/765I/765P2	f_{OSC3}	62	67	72	kHz	V_{FB} = 4V
Reduced Osc. Frequency ICE2A0565/165/265/365/765I/765P2 ICE2A0565G/0565Z/180Z/280Z/380P2	f_{OSC2}	-	21.5	-	kHz	V_{FB} = 1V
Reduced Osc. Frequency ICE2B0565/165/265/365/765I/765P2	f_{OSC4}	-	20	-	kHz	V_{FB} = 1V
Frequency Ratio f_{osc1}/f_{osc2} ICE2A0565/165/265/365/765I/765P2 ICE2A0565G/0565Z/180Z/280Z/380P2		4.5	4.65	4.9		
Frequency Ratio f_{osc3}/f_{osc4} ICE2B0565/165/265/365/765I/765P2		3.18	3.35	3.53		
Max Duty Cycle	D_{max}	0.67	0.72	0.77		
Min Duty Cycle	D_{min}	0	-	-		V_{FB} < 0.3V
PWM-OP Gain	A_V	3.45	3.65	3.85		
V_{FB} Operating Range Min Level	V_{FBmin}	0.3	-	-	V	
V_{FB} Operating Range Max level	V_{FBmax}	-	-	4.6	V	
Feedback Resistance	R_{FB}	3.0	3.7	4.9	kΩ	
Soft-Start Resistance	$R_{Soft-Start}$	42	50	62	kΩ	

4.4.4 Protection Unit

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Over Load & Open Loop Detection Limit	V_{FB2}	4.65	4.8	4.95	V	V_{SoftS} > 5.5V
Activation Limit of Overload & Open Loop Detection	V_{SoftS1}	5.15	5.3	5.46	V	V_{FB} > 5V
Deactivation Limit of Overvoltage Detection	V_{SoftS2}	3.88	4.0	4.12	V	V_{FB} > 5V V_{CC} > 17.5V
Overvoltage Detection Limit	V_{VCC1}	16	16.5	17.2	V	V_{SoftS} < 3.8V V_{FB} > 5V
Latched Thermal Shutdown	T_{jSD}	130	140	150	°C	[1]
Spike Blanking	t_{Spike}	-	5	-	µs	

[1] The parameter is not subject to production test - verified by design/characterization

4.4.5 Current Limiting

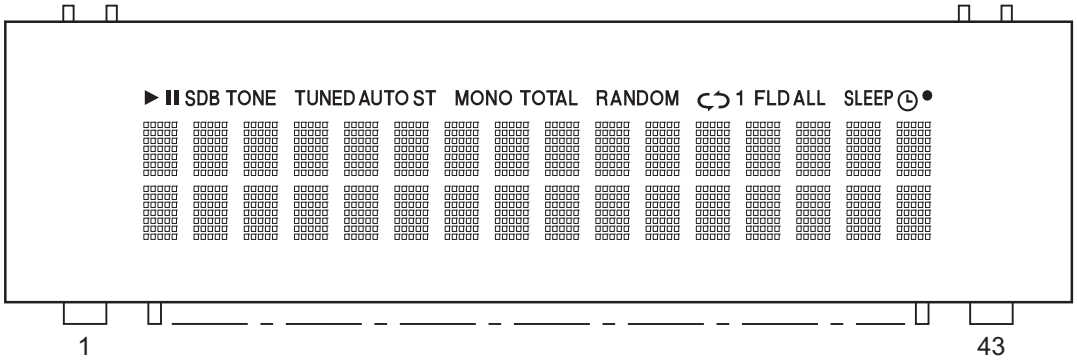
Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Peak Current Limitation (incl. Propagation Delay Time)	V_{csth}	0.95	1.0	1.05	V	dV_{sense} / dt = 0.6V/µs
Leading Edge Blanking	t_{LEB}	-	220	-	ns	

4.4.6 CoolMOS™ Section

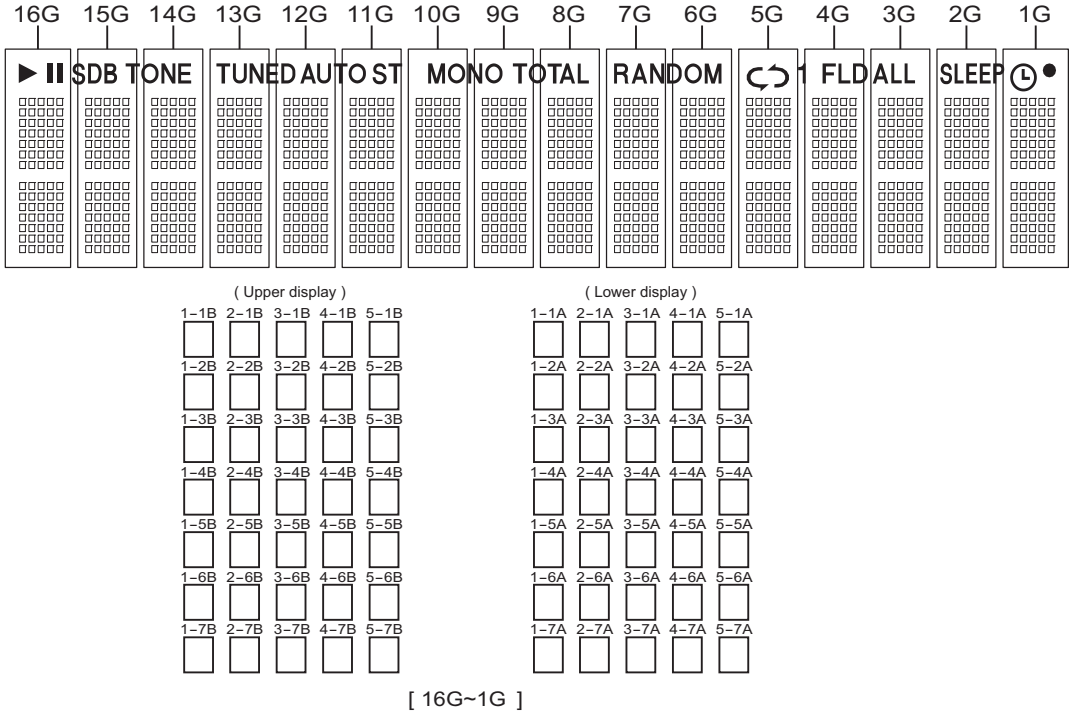
Parameter		Symbol	Limit Values			Unit	Test Condition
			min.	typ.	max.		
Drain Source Breakdown Voltage ICE2A0565/165/265/365/765I/765P2 ICE2B0565/165/265/365/765I/765P2 ICE2A0565G/0565Z		$V_{(BR)DSS}$	600 650	- -	- -	V V	T_j=25°C T_j=110°C
Drain Source Breakdown Voltage ICE2A180Z/280Z/380P2		$V_{(BR)DSS}$	800 870	- -	- -	V V	T_j=25°C T_j=110°C
Drain Source On-Resistance	ICE2A0565	R_{DSon1}	- -	4.7 10.0	5.5 12.5	Ω Ω	T_j=25°C T_j=125°C
	ICE2A165	R_{DSon2}	- -	3 6.6	3.3 7.3	Ω Ω	T_j=25°C T_j=125°C
	ICE2A265	R_{DSon3}	- -	0.9 1.9	1.08 2.28	Ω Ω	T_j=25°C T_j=125°C
	ICE2A365	R_{DSon4}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2B0565	R_{DSon5}	- -	4.7 10.0	5.5 12.5	Ω Ω	T_j=25°C T_j=125°C
	ICE2B165	R_{DSon6}	- -	3 6.6	3.3 7.3	Ω Ω	T_j=25°C T_j=125°C
	ICE2B265	R_{DSon7}	- -	0.9 1.9	1.08 2.28	Ω Ω	T_j=25°C T_j=125°C
	ICE2B365	R_{DSon8}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2A0565G	R_{DSon9}	- -	4.7 10.0	5.5 12.5	Ω Ω	T_j=25°C T_j=125°C
	ICE2A0565Z	R_{DSon10}	- -	4.7 10.0	5.5 12.5	Ω Ω	T_j=25°C T_j=125°C
	ICE2A180Z	R_{DSon11}	- -	3 6.6	3.3 7.3	Ω Ω	T_j=25°C T_j=125°C
	ICE2A280Z	R_{DSon12}	- -	0.8 1.7	1.06 2.04	Ω Ω	T_j=25°C T_j=125°C
	ICE2A765I	R_{DSon13}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2B765I	R_{DSon14}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2A765P2	R_{DSon15}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2B765P2	R_{DSon16}	- -	0.45 0.95	0.54 1.14	Ω Ω	T_j=25°C T_j=125°C
	ICE2A380P2	R_{DSon17}	- -	1.89 4.15	2.27 4.98	Ω Ω	T_j=25°C T_j=125°C

2. FL DISPLAY

16ST85GINK (FL81)



Grid Assignment



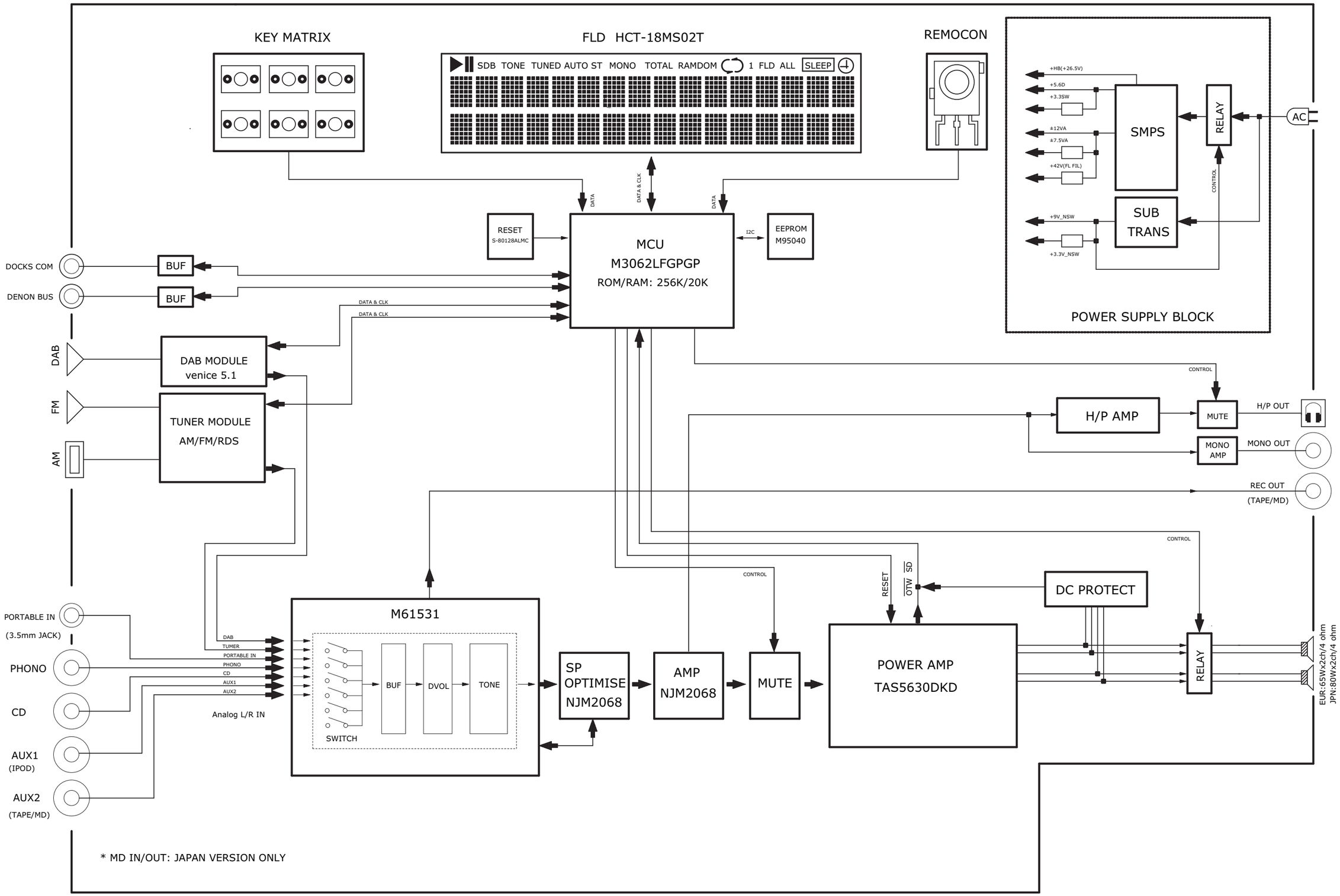
Pin Connection

Pin No.	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29~5	14~4	3	2	1
Connection	F2	NP	NP	LGND	PGND	VH	VDD	OSC	$\overline{RESET}$	$\overline{CS}$	CP	DA	TSA	TSB	NX	NC	NP	NP	F1

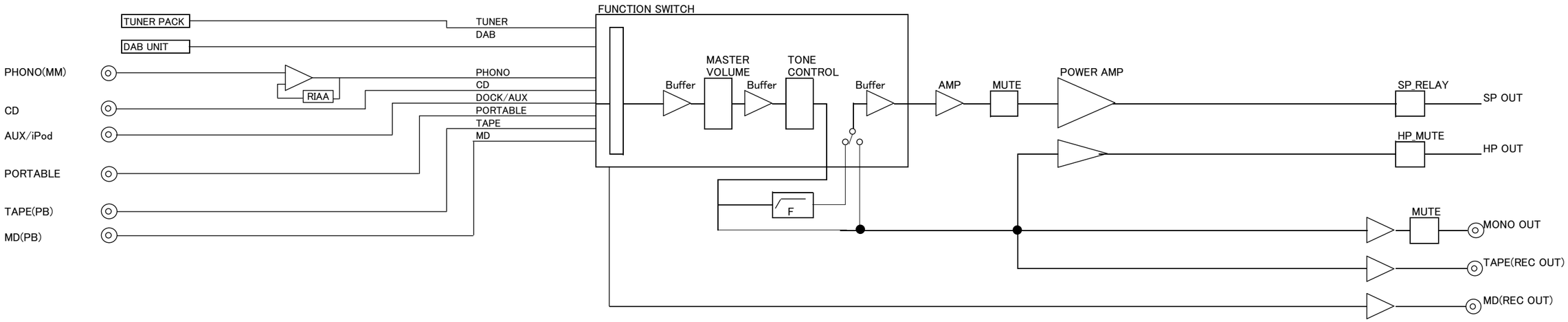
NOTE 1) F1,F2 : Filament
2) NP : No pin
3) NC : No connection
4) NX : No extend pin
5) DL : Datum Line
6) LGND : Logic GND pin
7) PGND : Power GND pin
8) VH : High Voltage Supply pin
9) VDD : Logic Voltage Supply pin
10) CP : Shift Register Clock
11) DA : Serial Data Input
12) TSA,B : Test pin
13) $\overline{CS}$: Chip Select Input pin
14) $\overline{RESET}$: Reset Input
15) OSC : Pin for self-oscillation

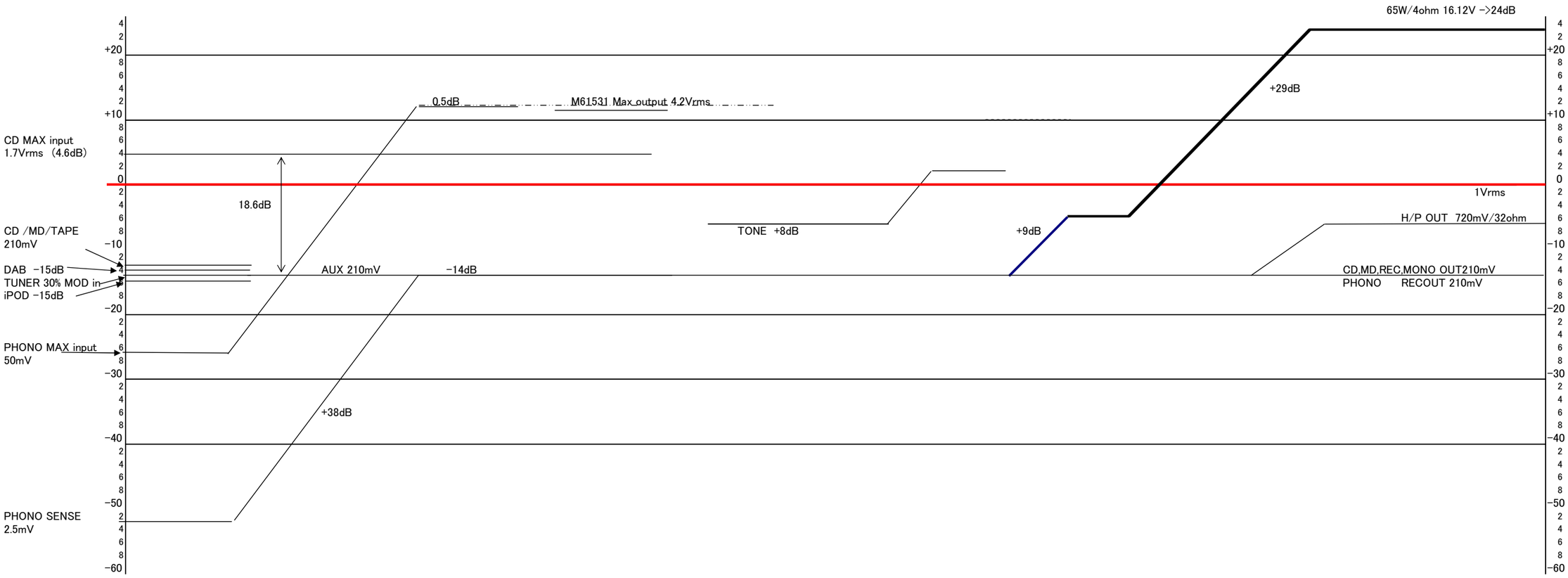
---MEMO---

BLOCK DIAGRAM



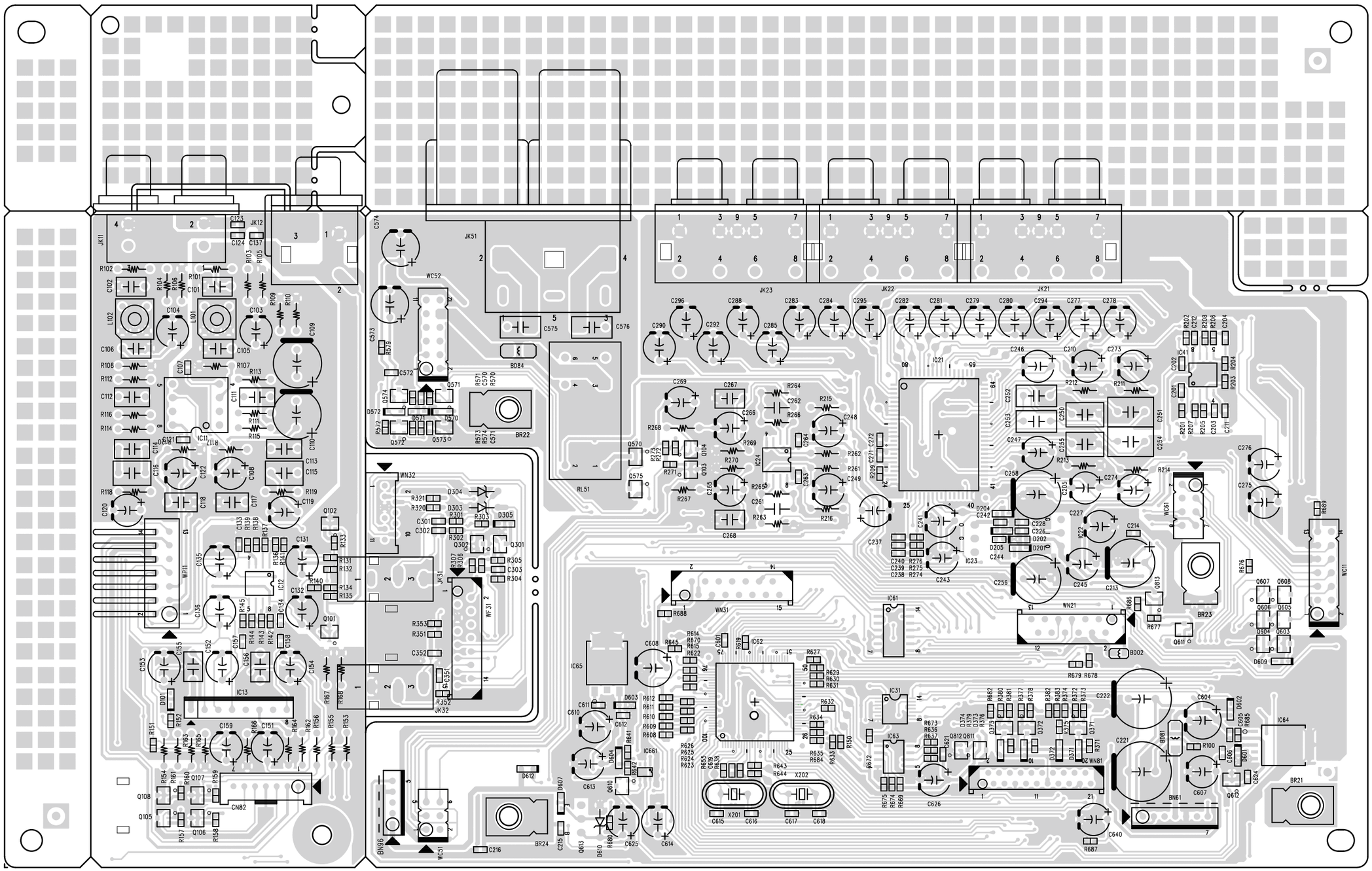
LEVEL DIAGRAM





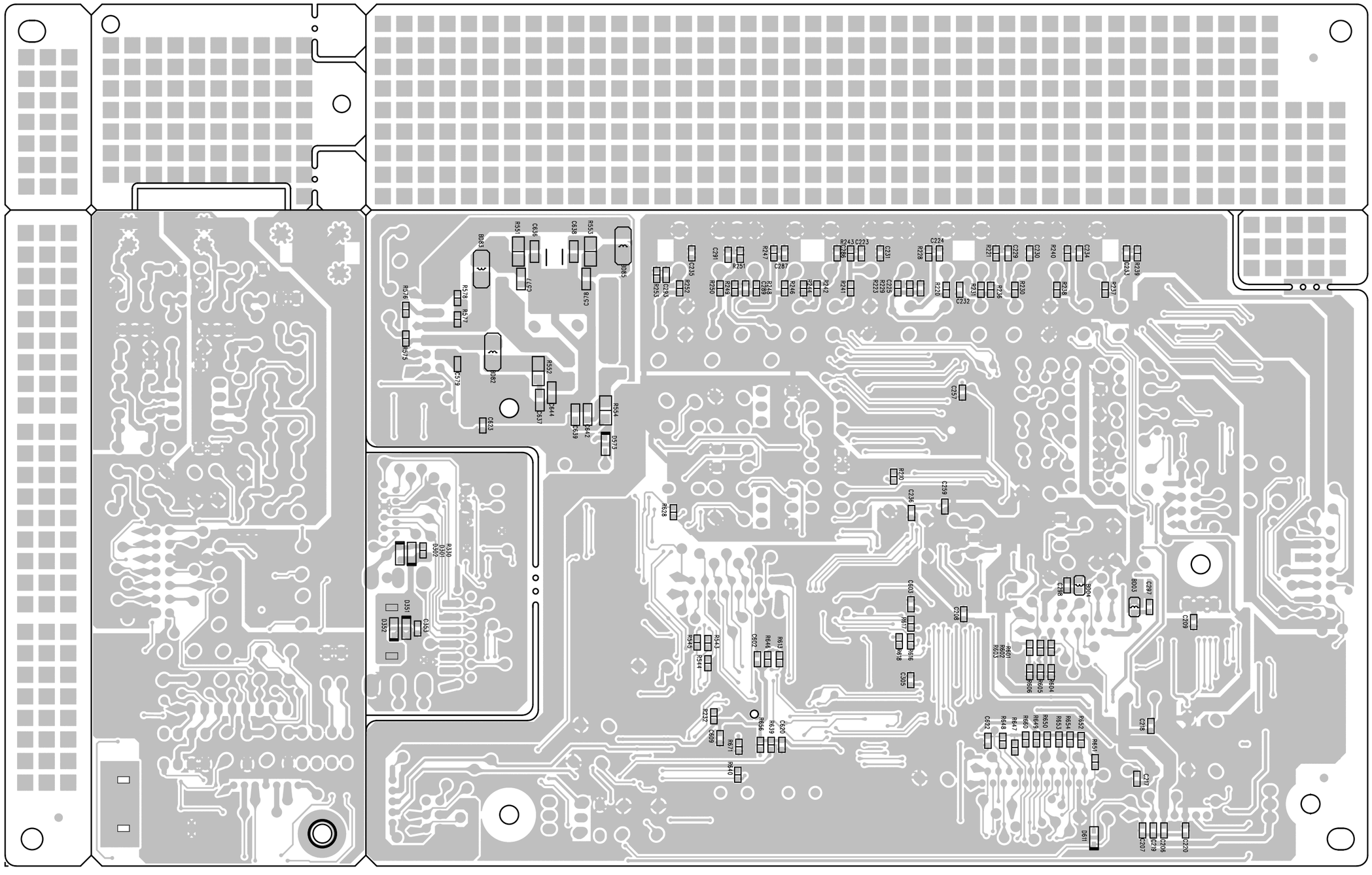
PRINTED WIRING BOARDS

MAIN PCB ASS'Y (1/2)



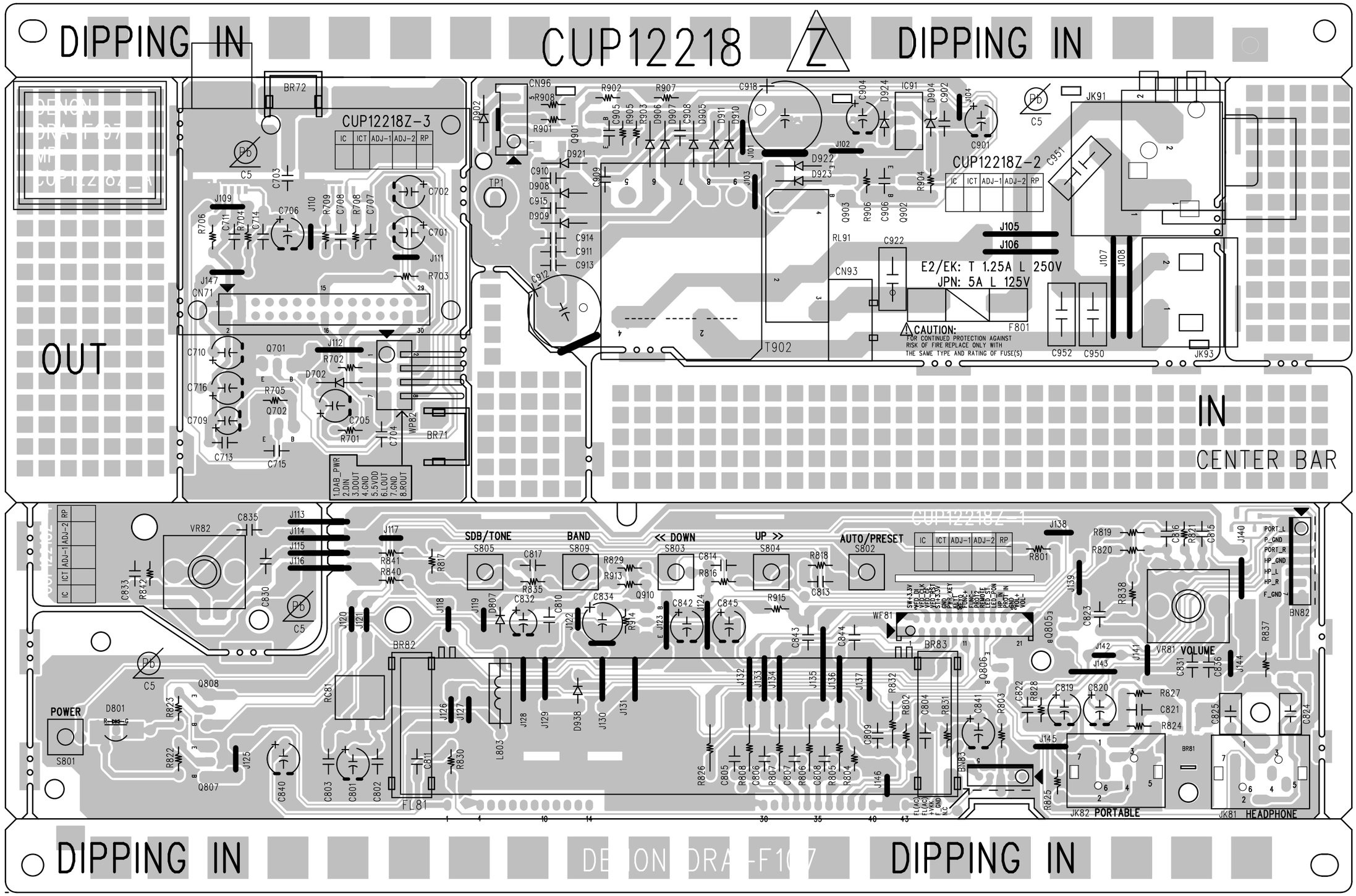
COMPONENT SIDE

MAIN PCB ASS'Y (2/2)



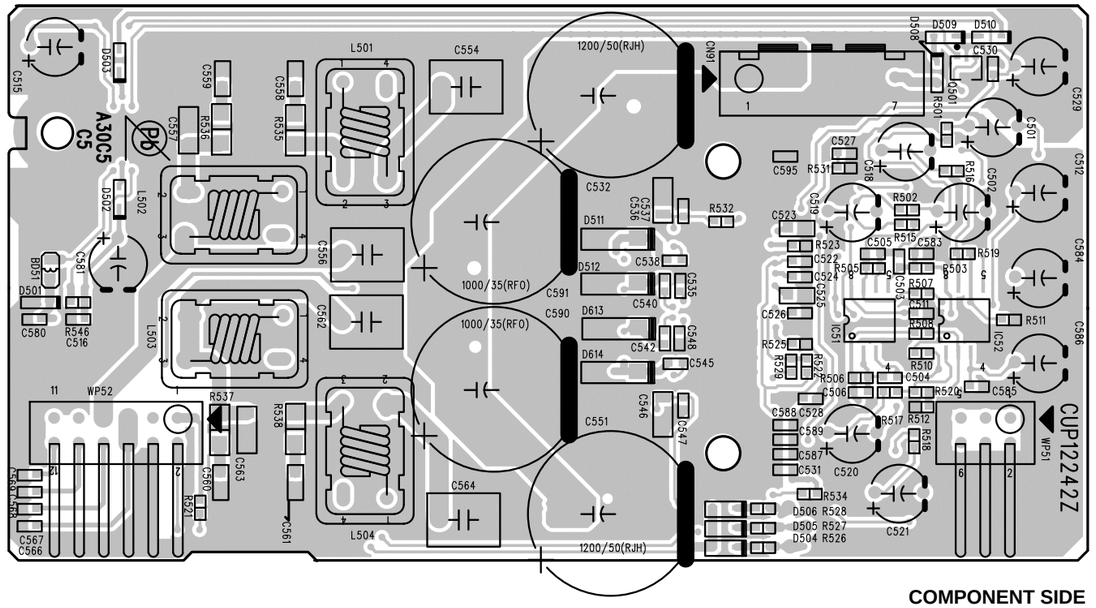
FOIL SIDE

FRONT PCB ASS'Y

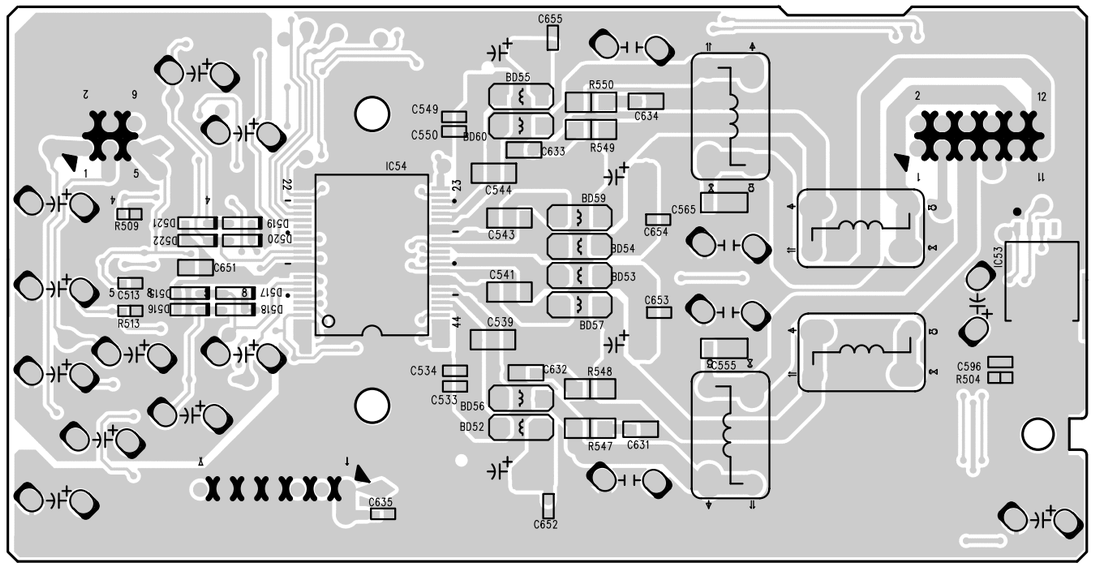


COMPONENT SIDE

AMP PCB ASS'Y



COMPONENT SIDE



FOIL SIDE

SMPS PCB ASS'Y

COMPONENT SIDE

NOTE FOR PARTS LIST

1. Parts for which "nsp" is indicated on this table cannot be supplied.
2. When ordering of part, clearly indicate "1" and "I" (i) to avoid mis-supplying.
3. Ordering part without stating its part number can not be supplied.
4. Part indicated with the mark "★" is not illustrated in the exploded view.
5. Not including General-purpose Carbon Film Resistor in the P.W.Board parts list. (Refer to the Schematic Diagram for those parts.)
6. Not including General-purpose Carbon Chip Resistor in the P.W.Board parts list. (Refer to the Schematic Diagram for those parts.)

WARNING:
Parts marked with this symbol ⚠ have critical characteristics.
Use ONLY replacement parts recommended by the manufacturer.

● Resistors

Ex.: RN (Type) | 14K (Shape and performance) | 2E (Power) | 182 (Resistance) | G (Allowable error) | FR (Others)

Type	Power	Allowable error	Others
RD : Carbon	2B : 1/8 W	F : ±1%	P : Pulse-resistant type
RC : Composition	2E : 1/4 W	G : ±2%	NL : Low noise type
RS : Metal oxide film	2H : 1/2 W	J : ±5%	NB : Non-burning type
RW: winding	3A : 1 W	K : ±10%	FR : Fuse-resistor
RN : Metal film	3D : 2 W	M : ±20%	F : Lead wire forming
RK : Metal mixture	3F : 3 W		
	3H : 5 W		

＊ Resistance

1 8 2 ⇨ 1800ohm=1.8kohm
- 2: Indicates number of zeros after effective number.
- 18: 2-digit effective number.

1 R 2 ⇨ 1.2ohm
- 2: 1-digit effective number.
- 1R: 2-digit effective number, decimal point indicated by R.

: Units: ohm

● Capacitors

Ex.: CE (Type) | 04W (Shape and performance) | 1H (Dielectric strength) | 3R2 (Capacity) | M (Allowable error) | BP (Others)

Type	Dielectric strength	Allowable error	Others
CE : Aluminum foil electrolytic	0J : 6.3 V	F : ±1%	HS : High stability type
CA : Aluminium solid electrolytic	1A : 10 V	G : ±2%	BP : Non-polar type
CS : Tantalum electrolytic	1C : 16 V	J : ±5%	HR : Ripple-resistant type
CQ : Film	1E : 25 V	K : ±10%	DL : For change and discharge
CK : Ceramic	1V : 35 V	M : ±20%	HF : For assuring high requency
CC : Ceramic	1H : 50 V	Z : +80%	U : UL part
CP : Oil	2A : 100 V	: - 20%	C : CSA part
CM: Mica	2B : 125 V	P : +100%	W : UL-CSA part
CF : Metallized	2C : 160 V	C : ±0.25pF	F : Lead wire forming
CH : Metallized	2D : 200 V	D : ±0.5pF	
	2E : 250 V	= : Others	
	2H : 500 V		
	2J : 630 V		

＊ Capacity (electrolyte only)

2 2 2 ⇨ 2200 μF
- 2: Indicates number of zeros after effective number.
- 22: 2-digit effective number.

・Units: μF.

2 R 2 ⇨ 2.2 μF
- 2: 1-digit effective number.
- 2R: 2-digit effective number, decimal point indicated by R

・Units: μF.

＊ Capacity (except electrolyte)

2 2 2 ⇨ 2200pF=0.0022 μF
- 2: Indicates number of zeros after efective number. (More than 2)
- 22: 2-digit effective number.

・Units:pF

2 2 1 ⇨ 220pF
- 1: Indicates number of zeros after effective numver. (0 or 1)
- 22: 2-digit effective number.

・Units:pF

・ When the dielectric strength is indicated in AC,"AC" is included after the dieelectric strength value.

PARTS LIST OF P.W.B. UNIT

* Parts for which "nsp" is indicated on this table cannot be supplied.
* The parts listed below are for maintenance only, might differ from the parts used in the unit in appearances or dimensions.

Note: The symbols in the column "Remarks" indicate the following destinations.
E2 : Europe model EK : U.K. model

MAIN PCB ASS'Y

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
SEMICONDUCTORS GROUP							
	IC11	00D2630609002	OP AMP IC		HVINJM2068DD		
	IC12	00D9430007108	OP AMP IC		HVINJM2068MDTE1		
	IC13	00D9430059800	HEADPHONE IC		HVINJM4556AL		*
	IC21	00D2631245009	6H VOLUME IC (10 INPUT, PLASTIC 80P QFP)		CVIM61531FPR60G		
	IC22	00D9430005702	REGULATOR IC (-8V)		HVIKA79L08AZT		
	IC23	00D9430005605	REGULATOR IC (+8V)		HVIKA78L08AZT		
	IC24	00D9430007108	OP AMP IC		HVINJM2068MDTE1		
	IC31	234010016508S	HEX INVERTER IC		HVITC74VHCT04AFT		
	IC41	00D9430007108	OP AMP IC		HVINJM2068MDTE1		
	IC61	943239007750S	HEX INVERTER IC		HVI74LVC04ADT		
	IC62	943243010810D	I.C U-COM (M3062LFGPGP Renesas)		CVIANAM1497AT		⚠5
	IC63	943249006970S	I.C EEPROM (4K,SO8-8P)		CVIM95040-WMN6TP		
	IC64	943239007760S	REGULATOR IC (3.3V, DPAK-5)		CVIKIA78R033F		
	IC65	00D2622977946	REGULATOR IC (3.3V SMD Type)		BVIBA33BC0FP		
	IC66	943239007240M	RESET IC 2.8V (50ms,C-MOS,SOT23-5P)		CVIS80128ALMCJANT2		
	Q101-108	00D9430072502	CHIP TR		HVTKTC2875B		
	Q301	00D9430058908	CHIP TR		HVTKTA1504SYRTK		
	Q302	00D9630121606	CHIP TR		HVTKRC107S		
	Q371-373	00D9630121606	CHIP TR		HVTKRC107S		
	Q570	00D9630121606	CHIP TR		HVTKRC107S		
	Q571,572	00D9430058908	CHIP TR		HVTKTA1504SYRTK		
	Q573,574	00D2730464901	CHIP TR		HVTKTC3875SYRTK		
	Q575	00D9430038009	CHIP TR		HVTKRA102S		
	Q603	00D9430038009	CHIP TR		HVTKRA102S		
	Q604	00D9630121606	CHIP TR		HVTKRC107S		
	Q605	00D9430038009	CHIP TR		HVTKRA102S		
	Q606-607	00D9630121606	CHIP TR		HVTKRC107S		
	Q608	00D9430038009	CHIP TR		HVTKRA102S		
	Q610	00D2690184907	CHIP TR		HVTKRA102S		
	Q611	00D9630121606	CHIP TR		HVTKRC107S		
	Q613	00D9430072609	T.R		HVTKTC3199YT		
	Q811	00D9430038009	CHIP TR		HVTKRA102S		
	Q812	00D9630121606	CHIP TR		HVTKRC107S		
	Q813	00D9430058908	CHIP TR		HVTKTA1504SYRTK		
	D101	00D2760717903	CHIP DIODE		HVD1SS355T		
	D201,202	00D2760717903	CHIP DIODE		HVD1SS355T		
	D204,205	00D2760717903	CHIP DIODE		HVD1SS355T		
	D301,302	00D2760717903	CHIP DIODE		HVD1SS355T		
	D303,304	90M-HD302150R	ZENER DIODE		HVDMTZJ6.8BT		
	D305	00D2760717903	CHIP DIODE		HVD1SS355T		
	D351,352	00D2760717903	CHIP DIODE		HVD1SS355T		
	D371-374	00D2760717903	CHIP DIODE		HVD1SS355T		
	D570-573	00D2760717903	CHIP DIODE		HVD1SS355T		
	D601-604	00D2760717903	CHIP DIODE		HVD1SS355T		
	D607	00D2760717903	CHIP DIODE		HVD1SS355T		
	D609	00D2760717903	CHIP DIODE		HVD1SS355T		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New	
	D610	00D9430087607	ZENER DIODE		HVDMTZJ6.2BT			
	D611-612	00D2760717903	CHIP DIODE		HVD1SS355T			
RESISTORS GROUP								
	R551-554		RES , CHIP 1/4W		CRJ14CJ3R3T			
	R535-538	nsp	METAL(OXIDE)FILM RES 5%		KRG1SANJ4R7RT			
	R626	nsp	CHIP RES		CRJ10DJ103T			
	R610	nsp	CHIP RES		CRJ10DJ103T			
	R609	nsp	CHIP RES	EK	CRJ10DJ103T			
	R624	nsp	CHIP RES	E2	CRJ10DJ103T			
	R608	nsp	CHIP RES		CRJ10DJ103T			
CAPACITORS GROUP								
	C101,102	nsp	CERAMIC CAP		CCKT1H101KB			
	C103,104	nsp	ELECT CAP		CCEA1HKS100T			
	C105,106	nsp	CERAMIC CAP		CCKT1H101KB			
	C107	nsp	CHIP CAP		CCUS1H103KC			
	C108	nsp	ELECT CAP		CCEA1HH220T			
	C109,110	nsp	ELECT CAP		CCEA1AKS221T			
	C111-112	nsp	CAP , METALLIZED FILM (6800pF/100V)		CCME2A682JXT			
	C113-114	nsp	MYLAR CAP		HCQI1H682JZT			
	C115,116	nsp	METALLIZED FILM CAP (100V/0.018UF, J)		CCME2A183JXT		*	
	C117,118	nsp	MYLAR CAP		HCQI1H392JZT			
	C119,120	nsp	ELECT CAP		CCEA1HH100T			
	C121	nsp	CHIP CAP		CCUS1H103KC			
	C122	nsp	ELECT CAP		CCEA1HH220T			
	C123,124	nsp	CHIP CAP		CCUS1H104KC			
	C131	nsp	ELECT CAP		CCEA1HH1R0T			
	C132	nsp	ELECT CAP		CCEA1HH4R7T			
	C133,134	nsp	CHIP CAP		CCUS1H103KC			
	C135,136	nsp	ELECT CAP		CCEA1HH4R7T			
	C137	nsp	CHIP CAP		CCUS1H104KC			
	C151,152	nsp	ELECT CAP		CCEA1HH100T			
	C153,154	nsp	ELECT CAP		CCEA1CH101T			
	C155,156	nsp	CERAMIC CAP		CCKT1H101KB			
	C157,158	nsp	CHIP CAP		CCUS1H103KC			
	C159	nsp	ELECT CAP		CCEA1HH1R0T			
	C201-204	nsp	CHIP CAP		CCUS1H104KC			
	C205	00D2544692901	ELECT CAP (10uF/63V RFO)		CCEA1JRFO100T			△2
	C206,207	nsp	CHIP CAP		CCUS1H104KC			
	C208	nsp	CHIP CAP		CCUS1H102KC			
	C209	nsp	CHIP CAP		CCUS1H104KC			
	C210	00D2544692901	ELECT CAP (10uF/63V RFO)		CCEA1JRFO100T			△2
	C211,212	nsp	CHIP CAP		CCUS1H103KC			
	C213	00D2544694912	ELECT CAP (220uF/25V, RFO)		CCEA1ERFO221T			△2
	C214	nsp	CHIP CAP		CCUS1H104KC			
	C215	nsp	CHIP CAP		CCUS1H102KC			
	C216-220	nsp	CHIP CAP		CCUS1H104KC			
	C221,222	00D2544694912	ELECT CAP (1000uF/25V, RFO, 12.5X20)		CCEA1ERFO102E			
	C223-225	nsp	CHIP CAP		CCUS1H181JA			
	C226	nsp	CHIP CAP		CCUS1H103KC			
	C227	nsp	ELECT CAP		CCEA1CH470T			
	C228	nsp	CHIP CAP		CCUS1H104KC			
	C229	nsp	CHIP CAP		CCUS1H181JA			
	C230,231	nsp	CHIP CAP		CCUS1H104KC			
	C232-234	nsp	CHIP CAP		CCUS1H181JA			

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	C235	nsp	CHIP CAP		CCUS1H104KC		
	C236	nsp	CHIP CAP		CCUS1H103KC		
	C237	00D2544693939	ELECT CAP(100uF/50V RFO)		CCEA1HRFO101T		2
	C238-240	nsp	CHIP CAP		CCUS1H101JA		
	C241	00D2544693900	ELECT CAP (ELNA, RFO, 50V/22UF)		CCEA1HRFO220T		
	C242	nsp	CHIP CAP		CCUS1H103KC		
	C243	00D2544693926	ELECT CAP (47uF/50V RFO)		CCEA1HRFO470T		
	C244	nsp	CHIP CAP		CCUS1H104KC		
	C245	00D2544693900	ELECT CAP (ELNA, RFO, 50V/22UF)		CCEA1HRFO220T		
	C246-249	nsp	ELECT CAP		CCEA1HH4R7T		
	C250	nsp	MYLAR CAP		HCQI1H223JZT		
	C251	nsp	METALLIZED FILM CAP		CCME2A473JXT		
	C252,253	nsp	METALLIZED FLIM CAP (100V/0.22UF)		CCME2A224JXT		
	C254	nsp	METALLIZED FILM CAP		CCME2A473JXT		
	C255	nsp	MYLAR CAP		HCQI1H223JZT		
	C256	943134006940S	ELECT CAP(47uF/50V ROA)		CCEA1HROA470T		*
	C257	nsp	CHIP CAP		CCUS1H104KC		
	C258	943134006940S	ELECT CAP(47uF/50V ROA)		CCEA1HROA470T		*
	C259	nsp	CHIP CAP		CCUS1H104KC		
	C261,262	nsp	CERAMIC CAP (100PF/50V)		CCBS1H101KBT		
	C263,264	nsp	CHIP CAP		CCUS1H103KC		
	C265,266	00D2544693900	ELECT CAP (ELNA, RFO, 50V/22UF)		CCEA1HRFO220T		
	C267,268	nsp	METALLIZED FILM CAP (1000pF APSV)		CCMP2A102JN09T		*
	C269	nsp	ELECT CAP		CCEA1HH1R0T		
	C271,272	nsp	CHIP CAP		CCUS1H473KC		
	C273,274	nsp	ELECT CAP		CCEA1HH4R7T		
	C275-284	nsp	ELECT CAP		CCEA1HH100T		
	C286	nsp	CHIP CAP		CCUS1H181JA		
	C297,298	nsp	CHIP CAP		CCUS1H104KC		
	C301,302	nsp	CHIP CAP		CCUS1H470JA		
	C303	nsp	CHIP CAP		CCUS1H102KC		
	C305	nsp	CHIP CAP		CCUS1H104KC		
	C351,352	nsp	CHIP CAP		CCUS1H181JA		
	C353	nsp	CHIP CAP		CCUS1H104KC		
	C570-572	nsp	CHIP CAP		CCUS1H102KC		
	C573,574	nsp	ElECT CAP (220uF/25V, RFO)		CCEA1ERFO221T		
	C575,576	943139001280S	METALLIZED FILM CAP		CCME2A103JXT		
	C577,578	nsp	CHIP CAP		CCUS1H104KC		
	C601	nsp	CHIP CAP		CCUS1H101JA		
	C602,603	nsp	CHIP CAP		CCUS1H104KC		
	C604	nsp	ELECT CAP		CCEA1AH471T		
	C605,606	nsp	CHIP CAP		CCUS1H104KC		
	C607	00D2544693939	ELECT CAP(100uF/50V RFO)		CCEA1HRFO101T		2
	C608	nsp	ELECT CAP		CCEA1AH471T		
	C609	nsp	CHIP CAP		CCUS1H104KC		
	C610	nsp	ELECT CAP		CCEA1CH101T		
	C611,612	nsp	CHIP CAP		CCUS1H104KC		
	C613	nsp	ELECT CAP		CCEA1CH101T		
	C614	nsp	ELECT CAP		CCEA1HH1R0T		
	C617	nsp	CHIP CAP (15PF/50V)		CCUS1H150JA		
	C618	nsp	CHIP CAP		CCUS1H270JA		
	C619	nsp	CHIP CAP		CCUS1H103KC		
	C620-623	nsp	CHIP CAP		CCUS1H104KC		
	C625,626	nsp	ELECT CAP		CCEA1HH100T		
	C636-639	nsp	CHIP CAP (2012 SIZE)		CCUC2A103KC		
	C642,644	nsp	CHIP CAP		CCUS1H104KC		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	C640	nsp	CHIP CAP		CCEA1CH470T		
OTHERS PARTS GROUP							
	BD81	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		
	BD02-04	nsp	CHIP FERRITE BEAD(220ohm, 2012)		CLZ9R006Z		
	BD82-85	nsp	CHIP FERRITE BEAD(220ohm, 2012)		CLZ9R006Z		
	BN61	nsp	7P WIRE ASS'Y(120mm, 2.0mm)		CWB1C90712047		
	BR21-24	nsp	EARTH PLATE		HJT1A025		
	CN82	nsp	LOCKING TYPE , STRAIGHT WAFER , 2MM		CJP07GI236ZW		
	CN96	nsp	LOCKING TYPE , STRAIGHT WAFER , 2mm		CJP05GI236ZW		
	JK11	nsp	JACK, RCA(2P, RCA-215-13, W/R, NO PLATE)		CJJ4N089Z		
	JK12	nsp	BOARD JACK		CJJ4M046Z		
	JK21,22	nsp	BOARD JACK		CJJ4P048Z		
	JK31,32	nsp	STEREO JACK		CJJ2D008Z		
	JK51	943643007770S	4P SPK TERMINAL (RD/BK, RD/BK, 94V-O)		CJJ5P031Z		*
	L101,102	00D9430193601	TOROIDAL COIL		CLU9S004Z		*
	RL51	00D9430060608	RELAY		HSL4A004ZU		
	WC11	nsp	FEMALE HEADER (14P,2.54mm) , STRAIGHT TYPE		CJP14GA221ZB		
	WC51	nsp	FEMALE HEADER (6P,2.54mm) , STRAIGHT TYPE		CJP06GA221ZB		
	WC52	nsp	FEMALE HEADER (12P,2.54mm) , STRAIGHT TYPE		CJP12GA221ZB		
	WC61	nsp	FEMALE HEADER (08P,2.54mm) , STRAIGHT TYPE		CJP08GA221ZB		
	WF31	nsp	WAFER , CARD CABLE		CJP15GA115ZY		
	WN21	nsp	WAFER , CARD CABLE		CJP13GA115ZY		
	WN31	nsp	WAFER , CARD CABLE		CJP15GA115ZY		
	WN32	nsp	WAFER		CJP09GA117ZY		
	WN81	nsp	WAFER		CJP21GA117ZY		
	WP11	nsp	PIN HEADER(14PIN, 2.54mm, ANGLE)		CJP14GB142ZB		
	X202	943141007780S	X-TAL , HC-49/S (14.7456MHz 18pF)		COX14745E180C		*

FRONT PCB ASS'Y

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
SEMICONDUCTORS GROUP							
	IC71	943239007760S	REGULATOR IC (3.3V, DPAK-5)	EK	CVIKIA78R033F		
	IC72	943239008020S	REGULATOR IC (ADJ, DPAK-5)	EK	CVIKIA78R000F		
	IC91	00D2631100018	REGULATOR IC +6V		HVIKIA7806API		
	Q701	00D9430004305	TR	EK	HVTKRC107MT		
	Q805,806	00D9430004305	TR		HVTKRC107MT		
	Q807,808	00D9430154200	TR		HVTKRA102MT		
	Q809,810	00D9630121606	CHIP TR		HVTKRC107S		
	Q901	00D9430072609	TR		HVTKTC3199YT		
	Q903	00D9430072609	TR		HVTKTC3199YT		
	Q910	00D9430004305	TR		HVTKRC107MT		
	D702	00D9430182502	RECT DIODE	EK	CVD1N4003ST		
	D801	00D9430106203	2COLOR LED		HVDSPR39MVW3		
	D802-805	00D2760717903	CHIP DIODE		HVD1SS355T		
	D902	00D9430182502	RECT DIODE		CVD1N4003ST		
	D905-911	00D9430041902	SCHOTTKY DIODE		HVD1N5819T		
	D921-923	00D9430182502	RECT DIODE		CVD1N4003ST		
	D924	00D9430086404	DIODE		HVD1SS133MT		
	D938	00D9430086404	DIODE		HVD1SS133MT		
RESISTORS GROUP							
	VR81	943667007540S	ENCODER VOLUME		CSR2A052Z		*
	VR82	943667007550S	ENCODER , FUNCTION (16MM, 24PULSES)		CSR2A051Z		*
CAPACITORS GROUP							
	C701,702	nsp	ELECT CAP	EK	CCEA1HKS4R7T		
	C703	nsp	CERAMIC CAP	EK	CCBS1H104ZFT		
	C703	nsp	COPPER WIRE		C3A206		
	C704	nsp	CERAMIC CAP	EK	CCBS1H104ZFT		
	C704	nsp	COPPER WIRE		C3A206		
	C705	nsp	ELECT CAP	EK	CCEA0JH471T		
	C706	nsp	ELECT CAP	EK	CCEA0JKS470T		
	C707,708	nsp	CERAMIC CAP	EK	CCBS1H103ZFT		
	C710	nsp	ELECT CAP	EK	CCEA0JKS470T		
	C711	nsp	CERAMIC CAP	EK	CCBS1H104ZFT		
	C713,714	nsp	CERAMIC CAP	EK	CCBS1H104ZFT		
	C715	nsp	CERAMIC CAP	EK	CCBS1H104ZFT		
	C715	nsp	COPPER WIRE	E2	C3A206		
	C716	nsp	ELECT CAP	EK	CCEA1AH221T		
	C801	nsp	ELECT CAP		CCEA1CKS101T		
	C802	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C803	nsp	CERAMIC CAP (47PF/50V)		CCBS1H470JT		
	C804	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C805-807	nsp	CERAMIC CAP (100PF/50V)		CCBS1H101KBT		
	C808-810	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C811	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C813,814	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C815,816	nsp	CERAMIC CAP (1000PF/50V)		CCBS1H102KBT		
	C817	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C819,820	nsp	ELECT CAP		CCEA1HKS4R7T		
	C821,822	nsp	CERAMIC CAP (470PF/50V)		CCBS1H471KBT		
	C823	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C824,825	943139001280S	METALLIZED FILM CAP		CCME2A103JXT		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	C826,827	nsp	CHIP CAP		CCUS1H104KC		
	C830	nsp	CERAMIC CAP (1000PF/50V)		CCBS1H102KBT		
	C831	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C832	nsp	ELECT CAP		CCEA1HKS1R0T		
	C833	nsp	CERAMIC CAP (1000PF/50V)		CCBS1H102KBT		
	C834	nsp	ELECT CAP		CCEA1CKS101T		
	C835,836	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C843,844	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C846	nsp	CHIP CAP		CCUS1H104KC		
	C901	00D2544693939	ELECT CAP(100uF/50V RFO)		CCEA1HRFO101T		
	C902,903	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C904	00D2544693939	ELECT CAP(100uF/50V RFO)		CCEA1HRFO101T		
	C905	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C907-911	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C912	nsp	ELECT CAP		CCEA1EH222E		
	C913-915	nsp	CERAMIC CAP		CCBS1H103ZFT		
	C916,917	nsp	CERAMIC CAP		CCBS1H104ZFT		
	C918	nsp	ELECT CAP		CCEA1EH222E		
⚠	C922	00D9430024408	CERAMIC CAP (X1/Y2/SC)		KCKDKS472ME		
⚠	C952	90M-OF100550R	CAP , X2		CCQF2E104KZC		
OTHERS PARTS GROUP							
	BN82	nsp	7P SHIELD WIRE ASS'Y(180mm, 2.0mm)		CWB1B90718047001		
	BN83	nsp	5P WIRE ASS'Y(100mm, 2.0mm)		CWB1C90510047		
	BR71		BRACKET , PCB		CMD1A629		
	BR72		BRACKET , PCB		CMD1A569		
	BR81	nsp	EARTH PALTE		HJT1A025		
	BR82,83	nsp	FLT BRACKET		CMD1A468		
	CN71	nsp	2.54mm 30PIN WAFER	EK	CJP30GA221ZB		
	CN93	nsp	WAFER		CJP02GA89ZY		
	FL81	00D3938086009	V.F.D , DCD-510AE (16ST85GINK)		CFL16ST85GINK		
⚠	F801	nsp	FUSE HOLDER		KJCFC5S		
⚠	F801	00D9430207208	FUSE 1.25AL/250V		KBA2C1250TLEY		*
	JK81,82	00D9430105204	HEADPHONE JACK (SILVER)		HJJ2D003Y		
	JK91	00D9430199206	AC OUTLET (EUR/1P)		KJJ7A022Z		*
	JK93	00D2033905015	AC INLET (250V/2.5A PCB MOUNT TYPE)		CJJ8A012Z		
	L803	nsp	CORE BEAD		KLZ9H001Z		
	L801,802	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		
	L903	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		
	RC81	00D9430194706	REMOCON SENSOR		CRVKSM603TH2E		
	RL91	00D9430194900	POWER RELAY		CSL1E002ZE		
	S801-805	00D9430004402	TACT SW		CST1A012ZT		
	S809	00D9430004402	TACT SW		CST1A012ZT		
⚠	T902	943101007910D	SUB TRANS 6V (EUR) DCD710AE2/E1C		CLT5I015ZE		*
	WF81	nsp	WAFER		CJP21GA117ZY		
	WP82	nsp	PIN HEADER (08P, 2.54mm) , ANGLE TYPE		CJP08GB142ZB		

SMPS PCB ASS'Y

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
SEMICONDUCTORS GROUP							
	IC91	943231007650S	VOL-REGULATOR IC (15V TO-220IS-4)		CVIKIA7815AP		*
	IC92	943235003200S	COOLSET IC		CVIICE2B265		*
	IC93	943235003210S	PWM CONTROLLER IC (PG-DIP-8)		CVIICE2QS01		*
	IC94	943231007660S	REGULATOR IC (24V, TO-92L)		CVIL78L24AB		*
	IC96	90M-HC300770R	REGULATOR IC		HVIKIA431BAT		
	IC97	00D9430206908	REGULATOR IC (12V OUTPUT LOW DROP)		HVIKIA78R12PI		
	IC98	00D9430183909	REGULATOR IC		HVIKIA7912PI		
	IC99	90M-HC300770R	REGULATOR IC		HVIKIA431BAT		
	PC91,92	00D9430038601	PHOTO COUPLER		HVIPC17L1CB		
	Q933,934	943219007680S	T.R (TO-126, EPITAXIAL PLANAR NPN)		CVTKTD1691Y		
	Q903	943229007670S	F.E.T , SPW20N60C3 (N-CH, P-TO247, POWER,INFINEO		CVTSPW20N60C3		*
	Q931	00D9430107804	T.R		HVTKRC102MT		
	Q935	943213003350S	SWITCHING TR		CVTKTN2222A		*
	D902	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D904-908	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D911	00D9430182609	DIODE		HVD1SS133MT		
	D912	90M-HD302310R	ZENER DIODE		HVDMTZJ27BT		
	D913	00D9430195909	ZENER DIODE		HVDMTZJ16BT		
	D914,915	00D9430087102	ZENER DIODE		HVDMTZJ20BT		
	D920-924	00D9430182609	DIODE		HVD1SS133MT		
	D931	90M-HD201950R	SCHOTTKY DIODE (60V/1A)		HVD11EQ06T		*
	D933	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D935	00D9430087500	ZENER DIODE		HVDMTZJ5.6BT		
	D936	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D938	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D939	00D9430182609	DIODE		HVD1SS133MT		
	D940,941	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D944,945	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D946	00D9430182609	DIODE		HVD1SS133MT		
	D950	943202007690S	ZENER DIODE (ROHM,18V)		HVDMTZJ18BT		
	D951	943203003140S	SCHOTTKY DIODE (20A, 200V)		CVDFCH20A20		*
⚠	DB91	943203003170S	BRIDGE DIODE		HVDGBJ606		*
RESISTORS GROUP							
	R910	nsp	WIRE WOUND RES (1W/0.5ohm)		CRW1PJR50V		
	R911	nsp	METAL OXIDE FILM RES		KRG2SANJ683H		
	R920,921	nsp	WIRE WOUND RES		CRW1PJR15V		
	R928	nsp	METAL OXIDE FILM RES		KRG2SANJ683H		
	R968	nsp	METAL OXIDE FILM RES		CRG1ANJ100R		
	R970	nsp	METAL OXIDE FILM RES (2W, 2.2K)		CRG2SANJ222RT		
	R991	nsp	METAL FILM RES (1/2W , 1M OHM)		KROS1TJ105V		
	R995	nsp	METAL OXIDE FILM RES (2W, 75ohm)		CRG2SANJ750RT		
CAPACITORS GROUP							
	C901	943134007790S	ELECT CAP (K3J, 450V/390UF, 105, 35X50)		CCET450VK3J391AK		*
	C902	nsp	COPPER WIRE		C3A206		
	C903	00MOF15223541	APSV223J0.022uF (TF) 100VPP		CCMPA223JN09T		④
	C904	nsp	COPPER WIRE		C3A206		
	C905	nsp	MONO CAP (50V.102)		CCUMT1H102KB		

SMPS PCB ASS'Y

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
SEMICONDUCTORS GROUP							
	IC91	943231007650S	VOL-REGULATOR IC (15V TO-220IS-4)		CVIKIA7815AP		*
	IC92	943235003200S	COOLSET IC		CVIICE2B265		*
	IC93	943235003210S	PWM CONTROLLER IC (PG-DIP-8)		CVIICE2QS01		*
	IC94	943231007660S	REGULATOR IC (24V, TO-92L)		CVIL78L24AB		*
	IC96	90M-HC300770R	REGULATOR IC		HVIKIA431BAT		
	IC97	00D9430206908	REGULATOR IC (12V OUTPUT LOW DROP)		HVIKIA78R12PI		
	IC98	00D9430183909	REGULATOR IC		HVIKIA7912PI		
	IC99	90M-HC300770R	REGULATOR IC		HVIKIA431BAT		
	PC91,92	00D9430038601	PHOTO COUPLER		HVIPC17L1CB		
	Q933,934	943219007680S	T.R (TO-126, EPITAXIAL PLANAR NPN)		CVTKTD1691Y		
	Q903	943229007670S	F.E.T , SPW20N60C3 (N-CH, P-TO247, POWER,INFINEO		CVTSPW20N60C3		*
	Q931	00D9430107804	T.R		HVTKRC102MT		
	Q935	943213003350S	SWITCHING TR		CVTKTN2222A		*
	D902	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D904-908	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D911	00D9430182609	DIODE		HVD1SS133MT		
	D912	90M-HD302310R	ZENER DIODE		HVDMTZJ27BT		
	D913	00D9430195909	ZENER DIODE		HVDMTZJ16BT		
	D914,915	00D9430087102	ZENER DIODE		HVDMTZJ20BT		
	D920-924	00D9430182609	DIODE		HVD1SS133MT		
	D931	90M-HD201950R	SCHOTTKY DIODE (60V/1A)		HVD11EQ06T		*
	D933	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D935	00D9430087500	ZENER DIODE		HVDMTZJ5.6BT		
	D936	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D938	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D939	00D9430182609	DIODE		HVD1SS133MT		
	D940,941	00D9430040709	SCHOTTKY DIODE		HVDUF4007T		*
	D944,945	00D9430040806	SCHOTTKY DIODE		HVDUF4004T		*
	D946	00D9430182609	DIODE		HVD1SS133MT		
	D950	943202007690S	ZENER DIODE (ROHM,18V)		HVDMTZJ18BT		
	D951	943203003140S	SCHOTTKY DIODE (20A, 200V)		CVDFCH20A20		*
⚠	DB91	943203003170S	BRIDGE DIODE		HVDGBJ606		*
RESISTORS GROUP							
	R910	nsp	WIRE WOUND RES (1W/0.5ohm)		CRW1PJR50V		
	R911	nsp	METAL OXIDE FILM RES		KRG2SANJ683H		
	R920,921	nsp	WIRE WOUND RES		CRW1PJR15V		
	R928	nsp	METAL OXIDE FILM RES		KRG2SANJ683H		
	R968	nsp	METAL OXIDE FILM RES		CRG1ANJ100R		
	R970	nsp	METAL OXIDE FILM RES (2W, 2.2K)		CRG2SANJ222RT		
	R991	nsp	METAL FILM RES (1/2W , 1M OHM)		KROS1TJ105V		
	R995	nsp	METAL OXIDE FILM RES (2W, 75ohm)		CRG2SANJ750RT		
CAPACITORS GROUP							
	C901	943134007790S	ELECT CAP (K3J, 450V/390UF, 105, 35X50)		CCET450VK3J391AK		*
	C902	nsp	COPPER WIRE		C3A206		
	C903	nsp	MYLAR CAP (0.022uF/100V)		CCQI2A223JZT		
	C904	nsp	COPPER WIRE		C3A206		
	C905	nsp	MONO CAP (50V.102)		CCUMT1H102KB		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	C906	nsp	MONO CAP		CCUMT1H104KB		
	C907	nsp	ELECT CAP		CCEA1HH220TS		
	C908	nsp	MONO CAP (4700pF/100V)		CCUMT2A472KC		
	C909	nsp	MONO CAP (0.47uF/50V)		CCUMT1H474KC		
	C910	nsp	CERAMIC CAP		CCKT3A222KBL		
	C911	nsp	MONO CAP (50V.102)		CCUMT1H102KB		
	C912	nsp	MONO CAP (2200pF/100V)		CCUMT2A222KC		
	C913	nsp	MLCC CAP (100PF/50V)		CCUMT1H101KC		
	C914	nsp	CERAMIC CAP (220PF/1KV)		CCKT3A221KB		
	C915	nsp	ELECT CAP		CCEA1HH220TS		
	C916	nsp	MONO CAP (470PF/50V)		CCUMT1H471KC		
	C917	nsp	CERAMIC CAP		CCKT3A222KBL		
	C918,919	nsp	MONO CAP		CCUMT1H104KB		
	C921,926	nsp	MONO CAP		CCUMT1H104KB		
	C922	943134003030S	ELECT CAP (KRM, 100V/1UF, 105C, 5X11)		CCEA2AH1R0TS		*
	C923,924	nsp	MONO CAP		CCUMT1H104KB		
	C925	nsp	CERAMIC CAP		CCKT3A102KBL		
	C931	nsp	ELECT CAP (1000uF/10V, 10X16, KLH)		CCEA1AKLH102EKS		*
	C932	nsp	ELECT CAP		CCEA1HH1R0TS		
	C933	nsp	ELECT CAP (10V/2200UF, 105C, 10X20)		CCEA1AH222ES		
	C935	nsp	ELECT CAP		CCEA1JH470TS		
	C935	nsp	ELECT CAP (47uF/63V, 8X12, KLH)		CCEA1JKLH470TKS		
	C936	00D2544692930	ELECT CAP(47uF/63V RFO)				
	C940	nsp	ELECT CAP (100uF/16V, 6.3X11, KLH)		CCEA1CKLH101TKS		
	C948	nsp	ELECT CAP (100uF/25V, 6.3X11, KLH)		CCEA1EKLH101TKS		
	C949	943134008030S	ELECT CAP(56uF/25V RJH)				*
	C950	943134006960S	ELECT CAP (470uF/35V RJH)				*
	C951	943134008040S	ELECT CAP(220uF/25V RJH)				*
	C960	nsp	ELECT CAP		CCEA1HH1R0TS		
	C962	nsp	CAP , CHIP(3216 SIZE)		CCUP2A104KC		
	C965	nsp	CERAMIC CAP		CCKT3A102KBL		
	C967	nsp	ELECT CAP (2200uF/35V, 16X31.5, KLH)		CCEA1VKLH222EKS		
	C968	nsp	ELECT CAP		CCEA1HH102ES		
	C969-972	nsp	MONO CAP		CCUMT1H104KB		
	C974,975	nsp	COPPER WIRE		C3A206		
	C976-980	nsp	MONO CAP		CCUMT1H104KB		
	C985	00D2544692930	ELECT CAP(47uF/63V RFO)				
	C987,988	nsp	MONO CAP		CCUMT1H104KB		
OTHERS PARTS GROUP							
	BN91	nsp	7P WIRE ASS'Y(220mm, 2.0mm)		CWB1E90722058		
	CN90	nsp	WAFER		KJP02KA060ZY		
	CN91	nsp	LOCKING TYPE , STRAIGHT WAFER, 2.5MM		CJP07GI237ZW		
	CN92	nsp	LOCKING TYPE , STRAIGHT WAFER , 2MM		CJP07GI236ZW		
	CN93	nsp	LOCKING TYPE , STRAIGHT WAFER , 2.5MM		CJP05GI237ZW		
⚠	CX91	nsp	POLYPROPYLENE FILM CAP		CCQF2E224KZE		
⚠	CX92	nsp	POLYPROPYLENE FILM CAP		HCQF2E104KZE		
⚠	CY91,92	nsp	CERAMIC CAP (400V Y-CAP)		CCKDHS102ME		
⚠	CY94	nsp	CERAMIC CAP (400V Y-CAP)		CCKDHS222ME		
	FH91,92	nsp	FUSE HOLDER		KJCFC5S		
⚠	F901	943652008050S	FUSE (215 Series, 250V,3.15A)		KBA2C3150TLHEY		*

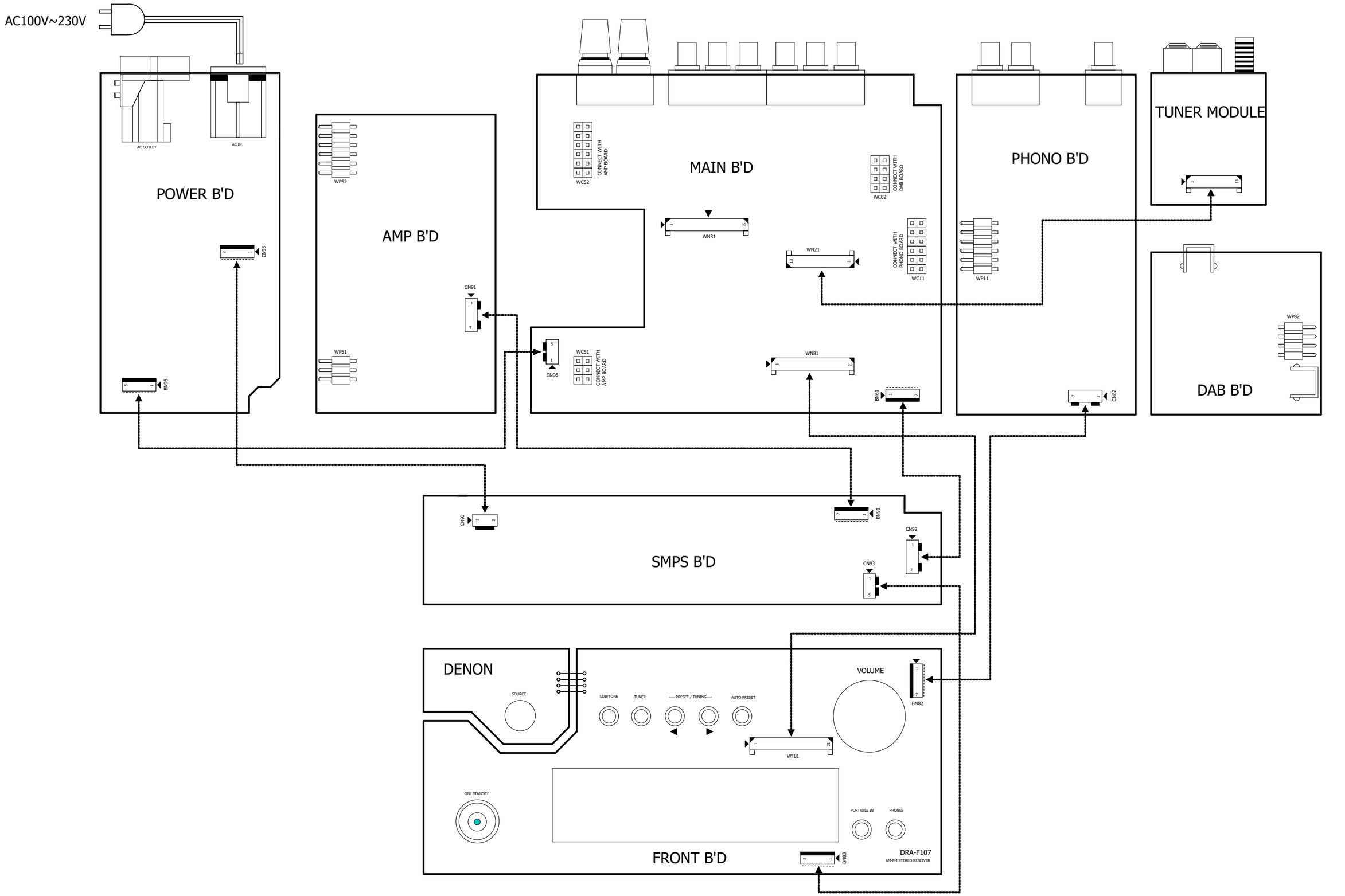
	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
⚠	LF91,92	943111007730S	LINE FILTER (22mH, RING-615)		CLZ9Z113Z		
	L921	943111003310S	CHOKE COIL (20uH)		CLZ9Z074Z		*
	L922	943111007720S	CHOKE COIL (220uH)		CLZ9Z112Z		*
	L928	943111003330S	CHOKE COIL (7UH)		CLZ9Z090Z		*
	TF91	943102007610D	SWITCHING TRANS EE1312 V-TYPE		CLT9Z053ZE		*
	TF92	943102007620D	SWITCHING TRANS EE2525W V-TPYE		CLT9Z054ZE		*
	TF93	943102007630D	SWITCHING TRANS EER4042 H-TYPE		CLT9Z055ZE		*
	TH91	00D9430035206	THERMISTOR NTC (10MM PITCH)		KRT5D15MSFC		
	TS91	943252007740S	THERMAL PROTECTOR (100'C, 70mm)		CRTST22100070W		*
⚠	VT91	943251003480S	VARISTOR		CRVSVC471D14A		
	BD90-99	nsp	CHIP FERRITE BEAD(60ohm, 4516)	CLZ9Z014Z			*

AMP PCB ASS'Y

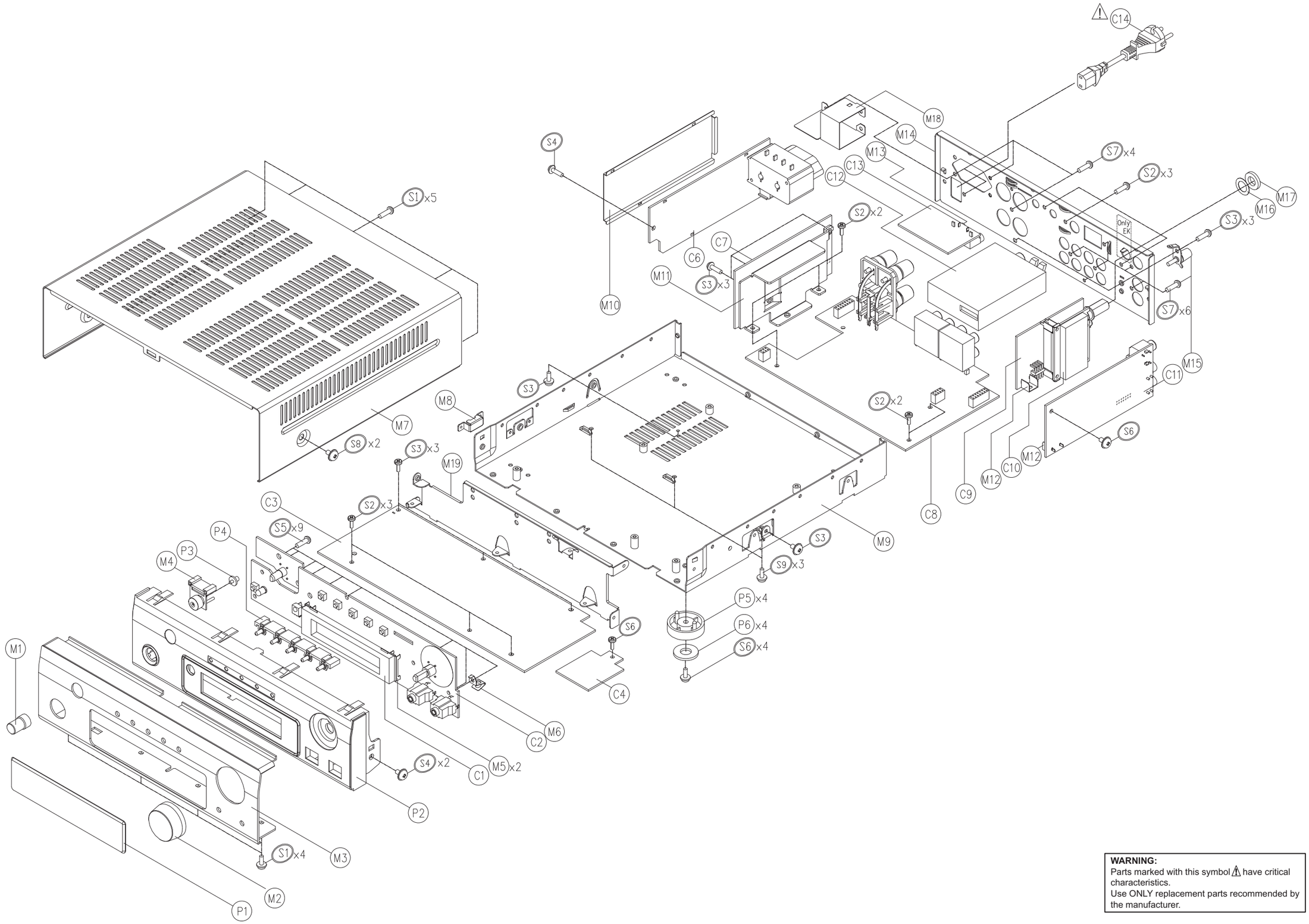
	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
SEMICONDUCTORS GROUP							
	IC51,52	00MHC10102090	OP AMP IC		HVINJM2068MDT		
	IC53	943231007700S	REGULATOR IC (12V, DPAK-5)		CVIKIA78R12F		
	IC54	943235007710S	CLASS-D DIGITAL AMP IC (300W, DKD-44P)		CVITAS5630DKD		
	D501-506	00D2760717903	CHIP DIODE		HVD1SS355T		
	D508-510	00D2760717903	CHIP DIODE		HVD1SS355T		
	D515-522	00D2760717903	CHIP DIODE		HVD1SS355T		
CAPACITORS GROUP							
	C501,502	nsp	ELECT CAP		CCEA1HH100T		
	C503-506	nsp	CHIP CAP		CCUS1H101JA		
	C511	nsp	CHIP CAP		CCUS1H104KC		
	C512	00D9430185402	ELECT CAP (ELNA RFO 100uF/25V)		CCEA1ERFO101T		
	C513	nsp	CHIP CAP		CCUS1H104KC		
	C515	00D2544693939	ELEC CAP ELNA RFO SERIES 100uF/50V		CCEA1HRFO101T		
	C516	nsp	CHIP CAP		CCUS1H104KC		
	C518-521	00D2544693900	ELECT CAP (ELNA, RFO, 50V/22UF)		CCEA1HRFO220T		
	C522	nsp	CHIP CAP		CCUS1H331JA		
	C523	nsp	CHIP CAP (25V/4.7uF, 2125 SIZE)		CCUC1E475KC		
	C524	nsp	CHIP CAP		CCUS1H472KC		
	C525	nsp	CHIP CAP (25V/4.7uF, 2125 SIZE)		CCUC1E475KC		
	C526,527	nsp	CHIP CAP		CCUS1H104KC		
	C528	nsp	CHIP CAP		CCUS1H102KC		
	C529	00D2544694912	ElECT CAP (220uF/25V, RFO)		CCEA1ERFO221T		
	C530	nsp	CHIP CAP		CCUS1H102KC		
	C531	nsp	CHIP CAP		CCUS1H104KC		
	C532	943134007870S	ELECT CAP (1800uF/35V, ELNA, RJF, 16X25)		CCEA1VRJF182E		*
	C533	nsp	CHIP CAP		CCUS1H102KC		
	C534	nsp	CHIP CAP		CCUS1H103KC		
	C535	nsp	CHIP CAP		CCUS1H104KC		
	C536	nsp	CHIP CAP (50V/4.7uF, 3216 SIZE)		CCUP1H475KC		
	C537	nsp	CHIP CAP		CCUS1H102KC		
	C538	nsp	CHIP CAP		CCUS1H333KC		
	C539	nsp	CHIP CAP (50V/4.7uF, 3216 SIZE)		CCUP1H475KC		
	C540	nsp	CHIP CAP		CCUS1H333KC		
	C541	nsp	CHIP CAP (50V/4.7uF, 3216 SIZE)		CCUP1H475KC		
	C542	nsp	CHIP CAP		CCUS1H333KC		
	C543,544	nsp	CHIP CAP (50V/4.7uF, 3216 SIZE)		CCUP1H475KC		
	C545	nsp	CHIP CAP		CCUS1H333KC		
	C546	nsp	CHIP CAP (50V/4.7uF, 3216 SIZE)		CCUP1H475KC		
	C547	nsp	CHIP CAP		CCUS1H102KC		
	C548	nsp	CHIP CAP		CCUS1H104KC		
	C549	nsp	CHIP CAP		CCUS1H103KC		
	C550	nsp	CHIP CAP		CCUS1H102KC		
	C551	943134007870S	ELECT CAP (1800uF/35V, ELNA, RJF, 16X25)		CCEA1VRJF182E		*
	C554	nsp	POLYESTER CAP (100V/0.47uF, Panasonic ECQV Type)		CCME2A474JO14		*
	C556	nsp	POLYESTER CAP (100V/0.47uF, Panasonic ECQV Type)		CCME2A474JO14		*
	C558-561	nsp	CHIP CAP (2012 SIZE)		CCUC2A103KC		
	C562	nsp	POLYESTER CAP (100V/0.47uF, Panasonic ECQV Type)		CCME2A474JO14		*
	C564	nsp	POLYESTER CAP (100V/0.47uF, Panasonic ECQV Type)		CCME2A474JO14		*
	C566-569	nsp	CHIP CAP		CCUS1H102KC		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	C580	nsp	CHIP CAP		CCUS1H104KC		
	C581	00D2544693900	ELECT CAP (ELNA, RFO, 50V/22UF)		CCEA1HRFO220T		
	C584	00D2544694912	ElECT CAP (220uF/25V, RFO)		CCEA1ERFO221T		
	C583	nsp	CHIP CAP		CCUS1H101JA		
	C585	nsp	CHIP CAP		CCUS1H101JA		
	C586	00D2544694912	ElECT CAP (220uF/25V, RFO)		CCEA1ERFO221T		
	C587	nsp	CHIP CAP		CCUS1H102KC		
	C588	nsp	CHIP CAP		CCUS1H103KC		
	C589	nsp	CHIP CAP		CCUS1H104KC		
	C590,591	943134006960S	ELECT CAP (1000uF/50V, ELNA, RFO)				*
	C595	nsp	CHIP CAP		CCUS1H104KC		
	C596	nsp	CHIP CAP		CCUS1H102KC		
	C631-634	nsp	CHIP CAP (330pF/100V,2012 SIZE)		CCUC2A331JA		
	C635	nsp	CHIP CAP		CCUS1H104KC		
	C651-655	nsp	CAP CAP 0.1UF/50V/2012		CCUC1H104KC		
OTHERS PARTS GROUP							
	BD51	nsp	CHIP FERRITE BEAD(220ohm, 2012)		CLZ9R006Z		
	BD52-57	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		*
	BD59	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		*
	BD60	nsp	CHIP FERRITE BEAD(60ohm, 4516)		CLZ9Z014Z		*
	CN91	nsp	LOCKING TYPE , STRAIGHT WAFER, 2.5MM		CJP07GI237ZW		
	L501-504	00MLC11034420	POWER INDUCTOR COIL		CLZ9Z111Z		
	WP51	nsp	PIN HEADER(6P, 2.54mm)		CJP06GB142ZB		
	WP52	nsp	PIN HEADER(12PIN, 2.54mm, ANGLE)		CJP12GB142ZB		

WIRING DIAGRAM



EXPLODED VIEW



WARNING:
Parts marked with this symbol ⚠ have critical characteristics.
Use ONLY replacement parts recommended by the manufacturer.

PARTS LIST OF EXPLODED VIEW

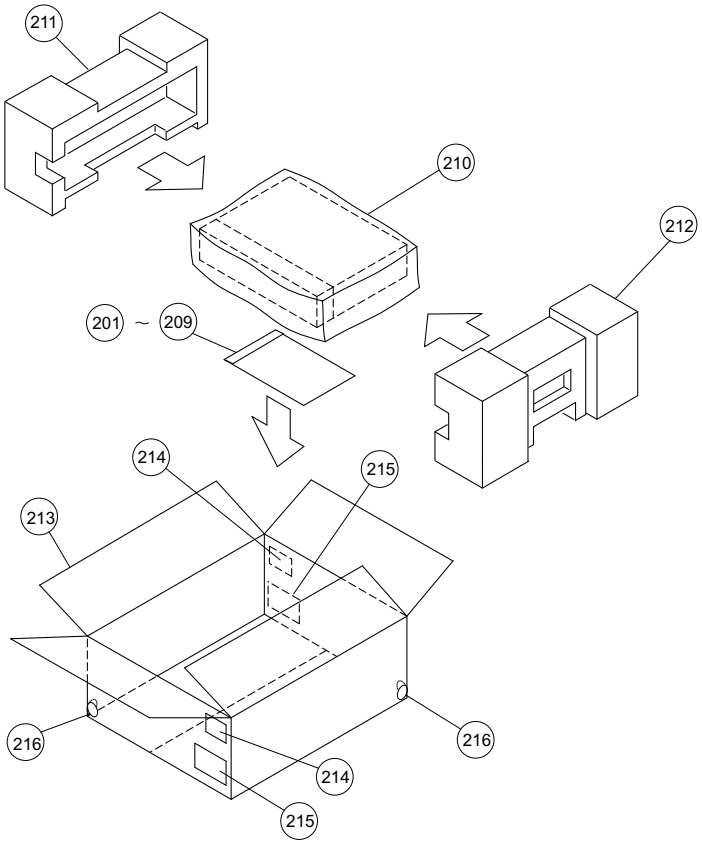
* Parts for which "nsp" is indicated on this table cannot be supplied.
* P.W.B. ASS'Y for which "nsp" is indicated on this table cannot be supplied. When repairing the P.W.B. ASS'Y, check the board parts table and order replacement parts.
* The parts listed below are for maintenance only, might differ from the parts used in the unit in appearances or dimensions.

Note: The symbols in the column "Remarks" indicate the following destinations.
E2 : Europe model EK : U.K. model
BK : Black model SP : Premium Silver model

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New	
	C2A	nsp	FRONT PCB ASS'Y	E2	CIP12218B	1	*	
	C2A	nsp	FRONT PCB ASS'Y	EK	CIP12218C	1	*	
	C2	-	FRONT PCB					
	C6	-	POWER PCB					
	C9	-	DAB PCB	EK				
	C8A	nsp	MAIN PCB ASS'Y	E2	CIP12217B	1	*	
	C8A	nsp	MAIN PCB ASS'Y	EK	CIP12217C	1	*	
	C4	-	SUB PCB					
	C8	-	MAIN PCB					
	C11	-	PHONO PCB					
	C13	-	UPDATE PCB					
	C3	nsp	SMPS PCB ASS'Y		CIP12227B	1	*	
	C7	nsp	AMP PCB ASS'Y		CIP12242B	1	*	
	P1	943416007600D	WINDOW		CGU1A440Y	1	*	
	P2	943443006530D	INNER PANEL	BK	CGW1A484B28	1	*	
	P2	943443006540D	INNER PANEL	SP	CGW1A484RGG45	1	*	
	P3	943481000370D	LENS		CGL1A230A14	1		
	P4	943412006550D	5P KNOB	BK	CBT1A1115MBC57	1	*	
	P4	943412007590D	5P KNOB	SP	CBT1A11157MBC22	1	*	
	P5	00D9430094506	FOOT		CKL1A189	4		
	P6	943471006570D	CUSHION		CHG1A285	4		
	M1	00D1120884228	KNOB(F) ASSY	BK	CGK00D1120884228D	1	*	
	M1	00D1120884215	KNOB(F) ASSY	SP	CGK00D1120884215D	1		
	M2	00D1120980119	VOLUME KNOB ASSY	BK	CGK00D1120980119D	1	*	
	M2	00D1120980106	VOLUME KNOB ASSY	SP	CGK00D1120980106D	1		
	M3	943402006580D	FRONT PANEL (AL)	BK E2	CKM1A217ZC45	1	*	
	M3	943402006590D	FRONT PANEL (AL)	SP E2	CKM1A217ZC62	1	*	
	M3	943402007920D	FRONT PANEL (AL)	BK EK	CKM1A217YC45	1	*	
	M3	943402007930D	FRONT PANEL (AL)	SP EK	CKM1A217YC62	1	*	
	M4	943412006440D	POWER KNOB ASSY	BK	CBY1A049ZA	1	*	
	M4	943412006450D	POWER KNOB ASSY	SP	CBY1A049YA	1	*	
	M5	nsp	FIP BRACKET		CMD1A468	2	*	
	M6	nsp	EARTH PLATE		CMC1A371	1	*	
	M7	943403006630D	TOP CABINET	BK	CKC1A198B49	1	*	2
	M7	943403006640D	TOP CABINET	SP	CKC1A198G60	1	*	2
	M8	nsp	SCREW COVER		CMD1A495	1	*	
	M9	nsp	MAIN CHASSIS		CUA1A300	1	*	
	M10	nsp	PC COVER		CMX1A268	1	*	
	M11	nsp	HEAT SINK		CMY1A331	1	*	
	M12	nsp	PCB BRACKET		CMD1A629	2		
	M13	nsp	PCB BRACKET		CMD1A569	2		
	M14	943406007940D	REAR PANEL	EK	CKF1A406Z	1	*	
	M14	943406006650D	REAR PANEL	E2	CKF2A406Z	1	*	
	M15	nsp	GROUND TERMINAL		KMA1A006	1		

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New
	M16	nsp	WASHER	EK	CNW1A052	1	
	M17	nsp	DAB NUT	EK	CNE1A009	1	
	M18	nsp	PC INSULATOR		CMX1A274	1	*
	M19	nsp	BRACKET SHIELD		CMD1A723	1	*
	C1	943172007420D	FIP		CFL16ST85GINK	1	
	C10	943183007950S	DAB	EK	CNVF2025-1V328A	1	
	C12	00D9430055202	TUNER PACK		CNVMV114MA1-19(E2/EK)	1	
⚠	C14	943611007960S	AC CORD	E2	CJAZB108ZV(E2)	1	
⚠	C14	943611000210S	AC CORD	EK	CJA2E106ZV(EK)	1	
SCREWS							
	S1	nsp	SCREW	BK	CTBD3+8JFZR	9	
	S1	nsp	SCREW	SP	CTBD3+8JFN	9	
	S2	nsp	SCREW		CTB3+6FFZR	10	
	S3	nsp	SCREW		CTB3+8JFZR	11	
	S4	nsp	SCREW		CTS3+8JR	3	
	S5	nsp	SCREW		CTB3+10JR	9	
	S6	nsp	SCREW		CTW3+8JR	6	
	S7	nsp	SCREW	SP	CTB3+10JFZR	10	
	S7	nsp	SCREW	BK	CTB3+10JFZR	9	
	S8	nsp	SCREW	BK	CTWD4+6FFZR	2	
	S8	nsp	SCREW	SP	CTWD4+6FFN	2	
	S9	nsp	SCREW		CTB3+6JR	2	

PACKING VIEW



PARTS LIST OF PACKING & ACCESSORIES

＊ Parts for which "nsp" is indicated on this table cannot be supplied.

＊ The parts listed below are for maintenance only, might differ from the parts used in the unit in appearances or dimensions.

Note: The symbols in the column "Remarks" indicate the following destinations.

E2 : Europe model EK : U.K. model

BK : Black model SP : Premium Silver model

	Ref. No.	Part No.	Part Name	Remarks		Q'ty	New	
	201	nsp	POLY BAG		CPB1A190Z	1	*	
	202	943541007970D	INST MANUAL(E2/EK)		CQX1A1464Z	1	*	2
	203	nsp	S.S.LIST(EX)		-	1		
	204	nsp	BATTERY (SIZE 'AAA')		-	1		
	205	943307007900D	REMOCON(RC1127)		CARTDRAF107BK	1	*	
	206	00D9430113500	ANT.AM LOOP		CSA1A020Z	1	*	
	207	00D9430113403	FM 1 POLE ANT.		CSA1A018Z	1	*	
	208	943429007990S	ANT.DAB T	EK	CSA1A036Z	1	*	
	209	943611000190S	CORD POWER E2	E2	CJA2B108ZV	1	*	
	209	943611000210S	CORD POWER EK	EK	CJA2E106ZV	1	*	
	210	943535007470D	POLY BAG		CPB1A184Z	1	*	2
	211	943533007480D	SNOW PAD		CPS1A852	1	*	
	212	943533007490D	SNOW PAD		CPS1A853	1	*	
	213	943531008000D	OUT CARTON BOX	E2	CPG1A898X	1	*	
	213	943531008010D	OUT CARTON BOX	EK	CPG1A898W	1	*	
	214	nsp	POS LABEL	SPE2	CQB1A943Z	2	*	
	214	nsp	POS LABEL	BKE2	CQB1A943Y	2	*	
	214	nsp	POS LABEL	SPEK	CQB1A943X	2	*	
	214	nsp	POS LABEL	BKEK	CQB1A943W	2	*	
	215	nsp	CONTROL LABEL	SPE2	CQB1A627	2	*	
	215	nsp	CONTROL LABEL	BKE2	CQB1A627	2	*	
	215	nsp	CONTROL LABEL	SPEK	CQB1A627	2	*	
	215	nsp	CONTROL LABEL	BKEK	CQB1A627	2	*	
	216	nsp	COLOR LABEL	SP	CQB1A882Z	1	*	

NOTE FOR SCHEMATIC DIAGRAM

WARNING:

Parts marked with this symbol ⚠ have critical characteristics.
Use ONLY replacement parts recommended by the manufacturer.

CAUTION:

Before returning the unit to the customer, make sure you make either (1) a leakage current check or (2) a line to chassis resistance check. If the leakage current exceeds 0.5 milliamps, or if the resistance from chassis to either side of the power cord is less than 460 kohms, the unit is defective.

WARNING:

DO NOT return the unit to the customer until the problem is located and corrected.

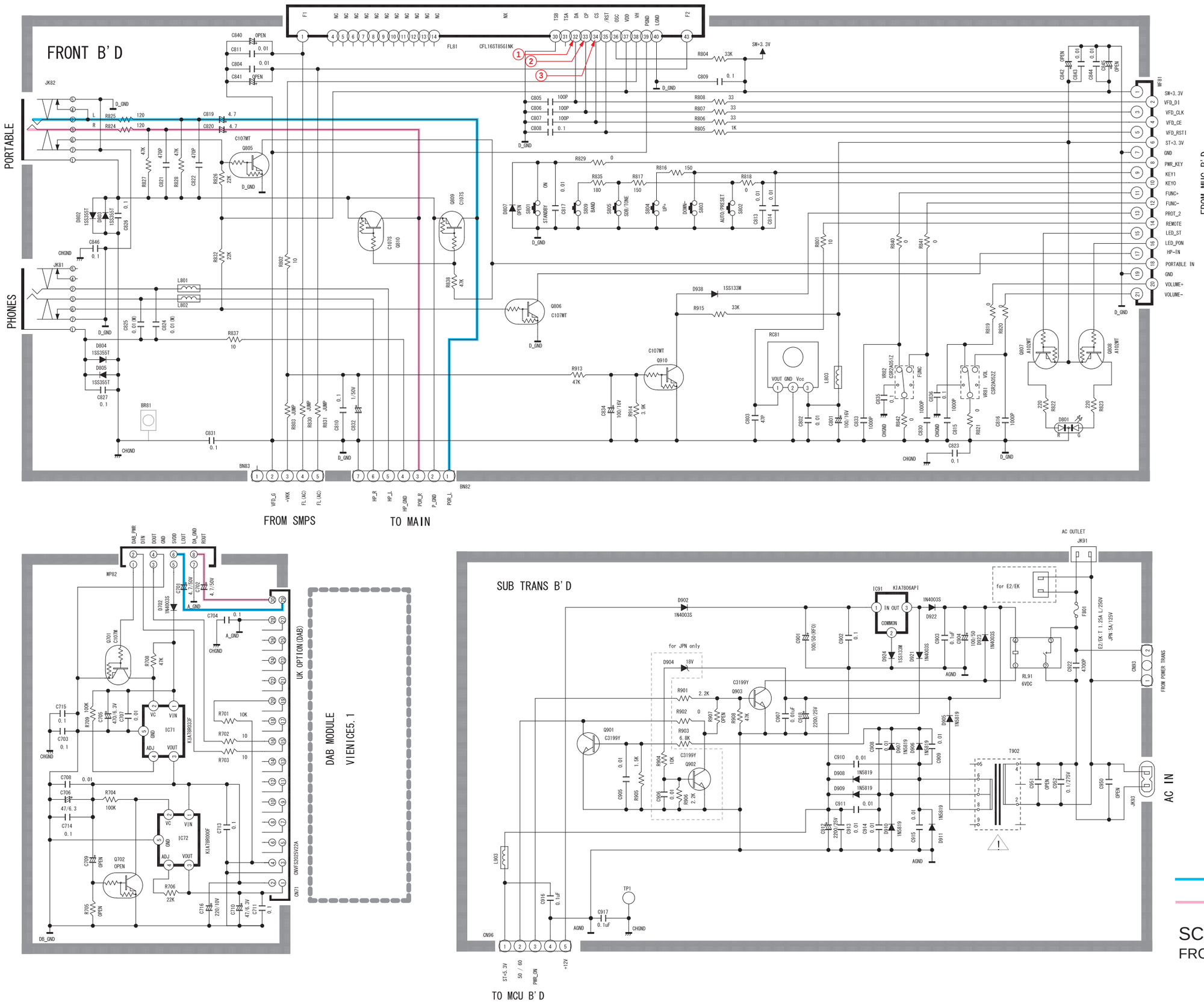
NOTICE:

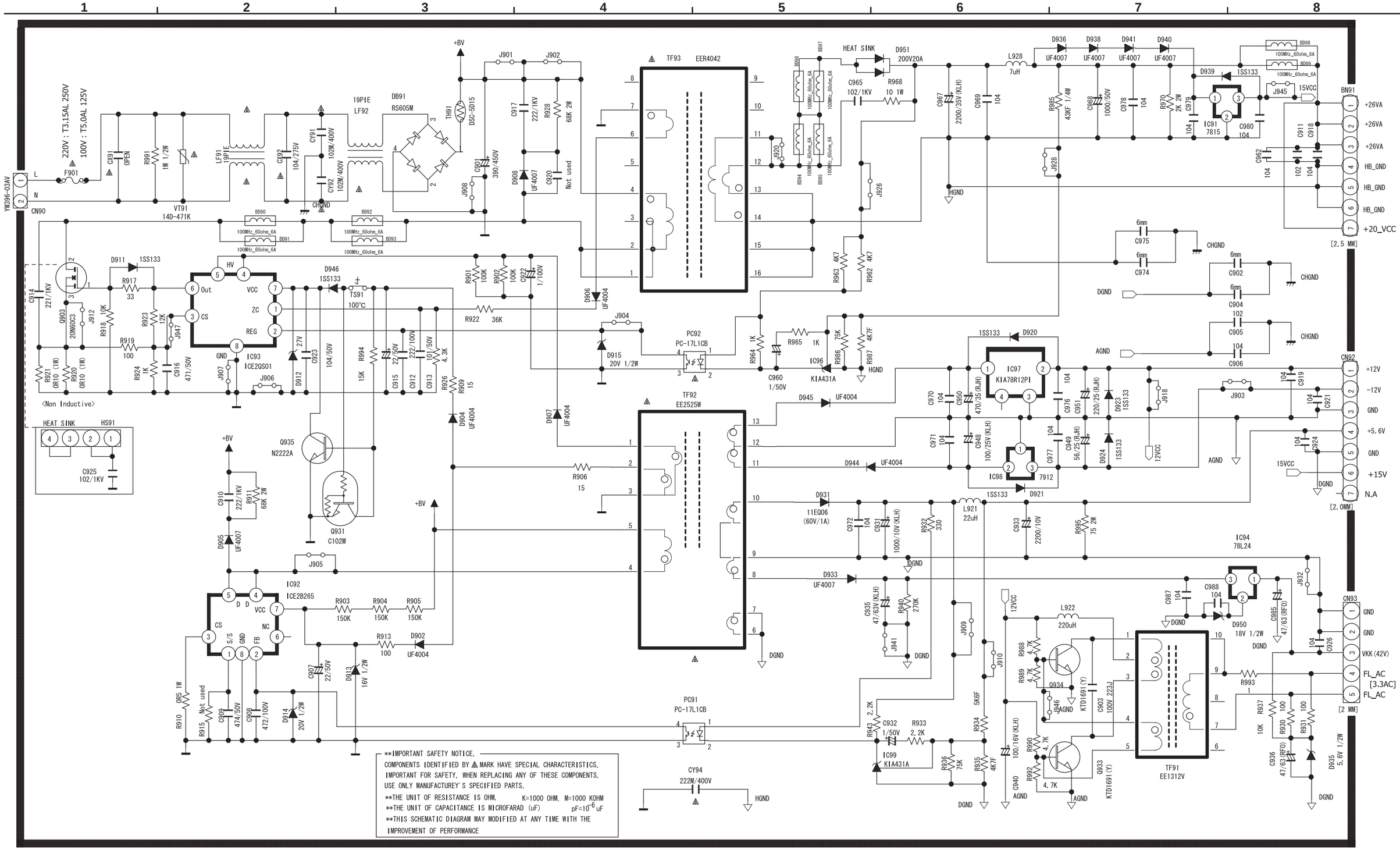
ALL RESISTANCE VALUES IN OHM. k=1,000 OHM
M=1,000,000 OHM
ALL CAPACITANCE VALUES IN MICRO FARAD.
P=MICRO-MICRO FARAD
EACH VOLTAGE AND CURRENT ARE MEASURED AT NO SIGNAL INPUT CONDITION.
CIRCUIT AND PARTS ARE SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

SCHEMATIC DIAGRAMS (1/4)

MAIN UNIT

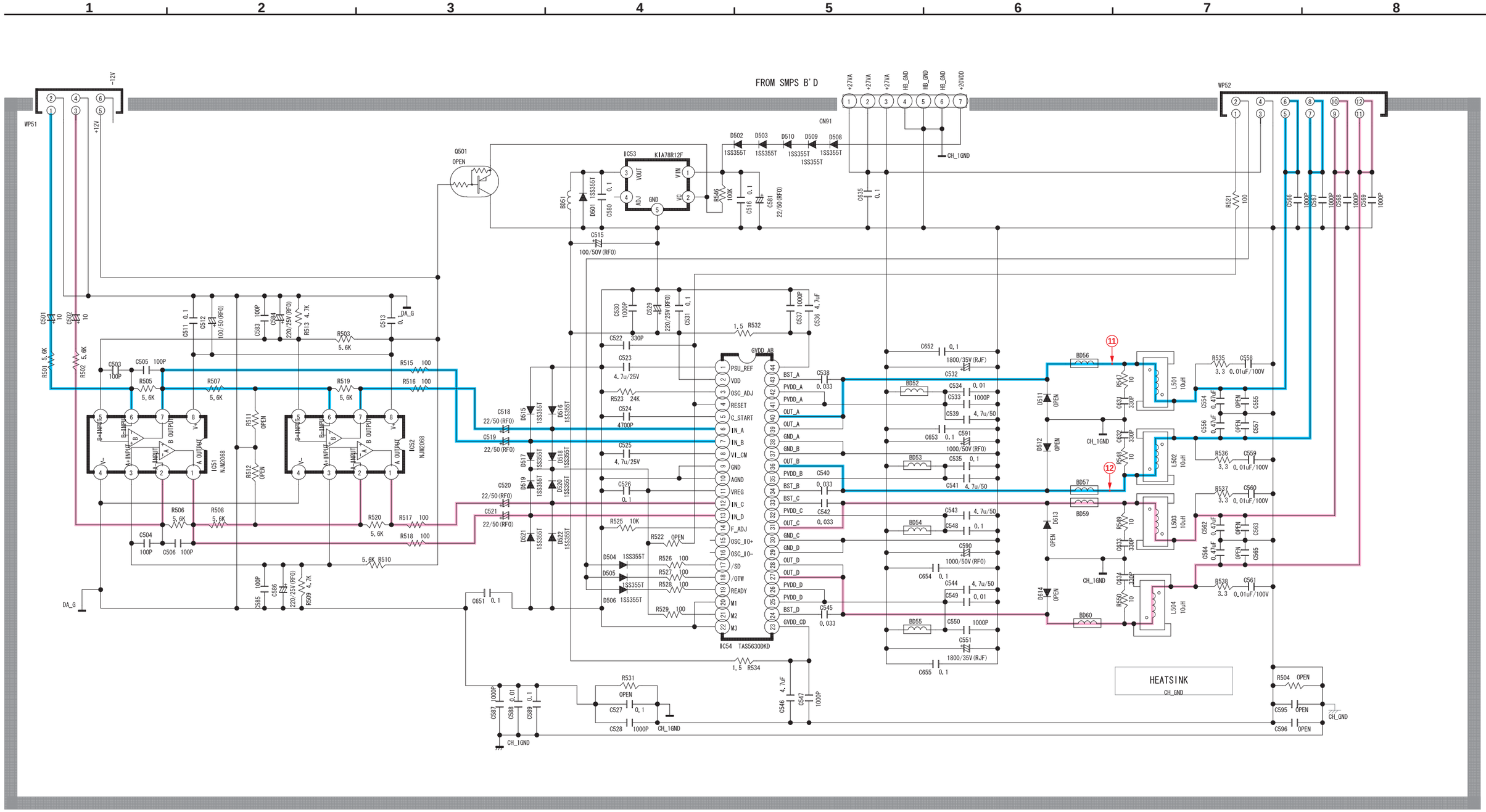
⚠2 DRA-F107/DRA-F107DAB


FRONT B'D
PORTABLE
PHONES
JK82
JK81
FL81
CFL16ST856INK
WF81
FROM MUC B'D
SW+3.3V
VFD_DI
VFD_CLK
VFD_CE
VFD_RSTI
ST+3.3V
GND
PWR_KEY
KEY1
KEYO
FUNC+
FUNC-
PROT_2
REMOTE
LED_ST
LED_PON
HP-IN
PORTABLE IN
GND
VOLUME+
VOLUME-
BN83
BN82
FROM SMPS
TO MAIN
VFD_S
+VKK
FL(AC)
FL(AC)
HP_R
HP_L
HP_GND
POR_R
P_GND
POR_L
WP82
DAB_PWR
DIN
DOUT
GND
5VDD
LOUT
DA_GND
ROUT
DAB MODULE
VIENICE5.1
UK OPTION(DAB)
CN71
CNVFS202SV2ZA
DB_GND
SUB TRANS B'D
AC OUTLET
JK91
AC IN
JK93
FROM POWER TRANS
CN93
TO MCU B'D
CN96
S7+5.3V
50 / 60
PWR_ON
+12V
for JPN only
for E2/EK
Lch SIGNAL LINE
Rch SIGNAL LINE
SCHEMATIC DIAGRAMS (2/4)
FRONT UNIT
DRA-F107/DRA-F107DAB



SCHEMATIC DIAGRAMS (3/4)

SMPS UNIT



Lch SIGNAL LINE

Rch SIGNAL LINE

SCHEMATIC DIAGRAMS (4/4)

AMP UNIT

DRA-F107/DRA-F107DAB