

harman/kardon
by HARMAN



MAS 101/102/111 **CD**

Music system

Service Manual

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System

| | |
|--------------------------------------|---|
| Power output | 65 watts per channel, 20Hz – 20kHz, THD <0.07%, into 6 ohms, both channels driven |
| Bandwidth | 20Hz – 35kHz, –3dB |
| System frequency response | 20Hz – 20kHz, ±0.5dB |
| Signal-to-noise ratio, A-weighted | 90dB (Analog inputs), 96dB (Digital inputs) |
| Channel separation | ≥65dB |
| Crosstalk between sources | ≥70dB |
| Line-level input sensitivity at 1kHz | 250mV RMS, ±1dB |
| Phono MM input sensitivity at 1kHz | 7.5mV |

Loudspeakers

| | |
|----------------------------|---|
| Low-frequency transducers | Two 130mm honeycomb composite drivers, ported |
| High-frequency transducers | Two 25mm MMD® domes, shielded |
| Nominal impedance | 8 ohms |
| Sensitivity (2.83V/1m) | 85dB |
| Frequency response | 60Hz – 25kHz (–3dB) |
| Crossover frequency | 2200Hz |

FM Tuner Section

| | |
|-----------------------|---|
| Frequency range | 87 – 108.0MHz |
| Usable sensitivity | IHF 1.3µV/13.2dBf |
| Frequency response | 10Hz to 15.3kHz |
| Signal-to-noise ratio | mono/stereo 68/65dB |
| Distortion | mono/stereo 0.15/0.3% |
| Stereo separation | 35dB @ 1kHz, 100% deviation @ 65dBf |
| Selectivity | ±300kHz; 65dBf |
| Image rejection | 80dB |
| IF rejection | 90dB |
| Tuner output level | 1kHz, ±50kHz, Dev 500mV |
| Number of presets | 30 |
| RDS capability | PS (program service), RT (dynamic radio text) |

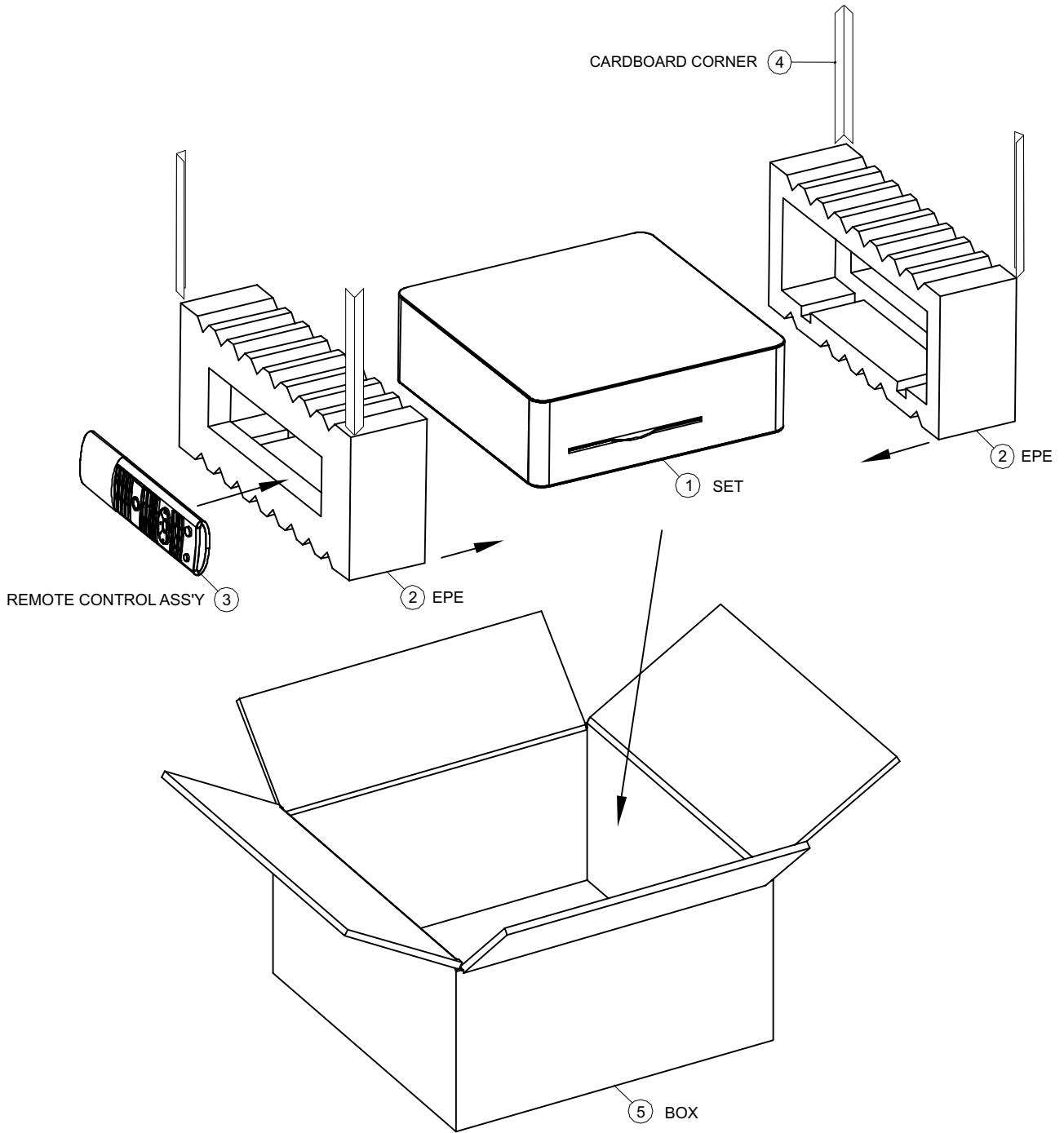
CD Section

| | |
|-----------------------|-----------------------------------|
| Disc compatibility | CD, CD-R, CD-RW, MP3, WMA |
| THD+N (20Hz – 20kHz) | <0.025% |
| Frequency response | 20Hz to 20kHz, 0dB \pm 0.5 |
| Channel separation | \geq 65dB |
| Signal-to-noise ratio | "A"WTG >96dB; 22kHz filter > 94dB |

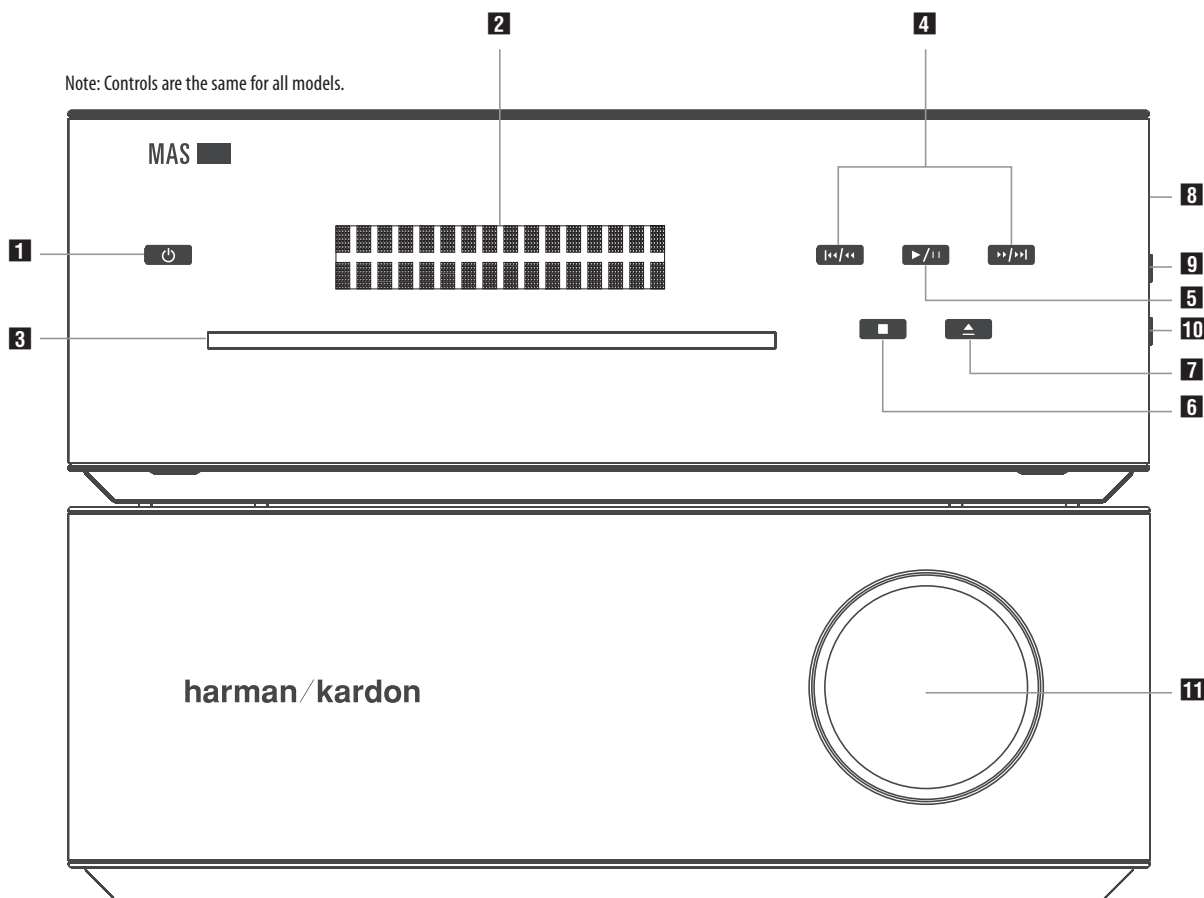
General

| | |
|------------------------|--|
| Power requirement | AC 230V/50Hz (MAS 101/MAS 111); AC 120V/60Hz (MAS 102) |
| Power consumption | <1W full standby (clock not activated); <2W standby (clock activated); 150W maximum (both channels driven) |
| Operating temperature | 0°C to 40°C |
| Dimensions (H x W x D) | Controller: 90mm x 240mm x 240mm (3-9/16" x 9-7/16" x 9-7/16") Amplifier: 90mm x 240mm x 240mm (3-9/16" x 9-7/16" x 9-7/16") Loudspeakers (each, with grille): 272mm x 181mm x 196mm (10-23/32" x 7-1/8" x 7-3/4") |
| Weight | System 13.9kg (30,5lb) Controller 2.0kg (4,4lb) Amplifier 2.8kg (6,3lb) Loudspeakers (each): 4.4kg (9,8lb) |





| NO | DESCRIPTION | PARTS NO. | Q.ty |
|----|---------------------|----------------|------|
| 1 | SET | | 1 |
| 2 | EPE | 8250 503B 0000 | 2 |
| 3 | REMOTE CONTROL ASSY | 3320 0805 0352 | 1 |
| 4 | CARDBOARD CORNER | 8150 5030 0000 | 4 |
| 5 | BOX | 8150 5011 0000 | 1 |

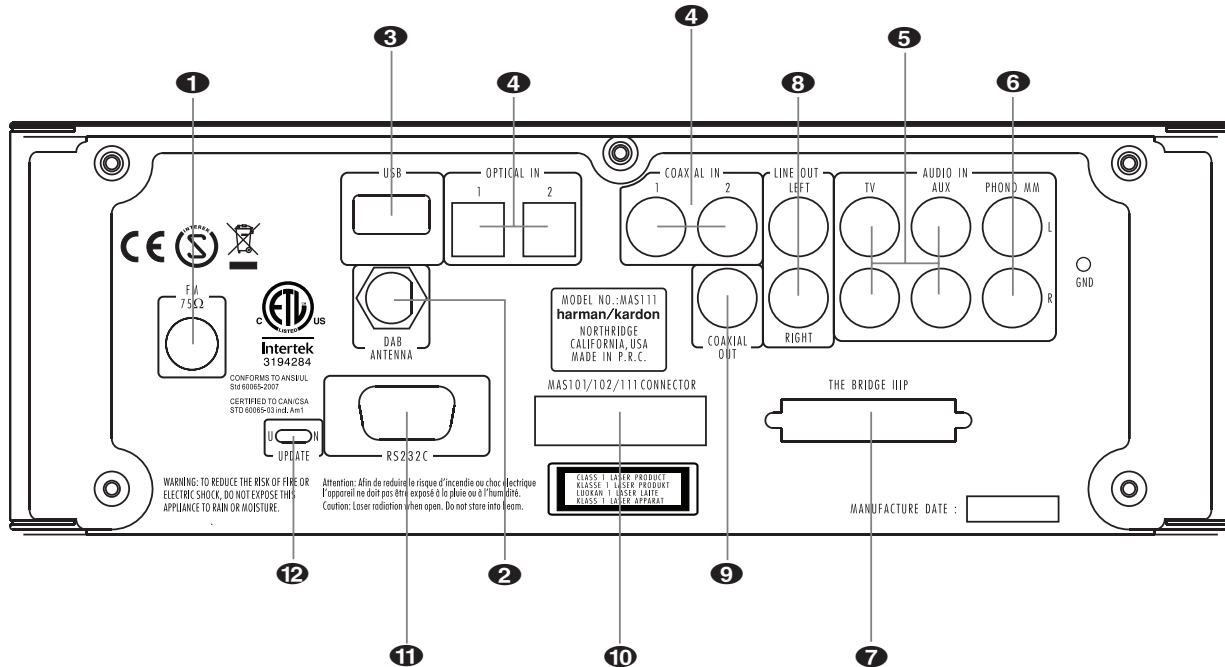


The MAS systems use touch-sensitive controls. To use a control, tap gently on its lit icon.

NOTE: Controls are the same for all models.

- 1 Power:** Turns the MAS system on or places it in Standby mode. To completely power off the unit, unplug the power supply.
- 2 Message Display:** The time and messages are displayed in this two-line text display.
- 3 CD Slot:** Load compatible discs here.
- 4 Skip/Scan Forward/Reverse:** These buttons function differently, depending on the current source:
 - **iPod, CD or USB:** Press and release to skip to the next track. Press the Reverse button twice to skip to the previous track. Press and hold a button to scan forward or reverse within a track.
 - **Radio:** Press and release a button to select the next higher or lower programmed preset station. Press and hold a button to scan to the next available higher or lower station. When you release the button, the tuner continues to scan until it finds a station of acceptably strong signal quality, and then it stops. To stop the scan before a station is found, press the button while the tuner is scanning.
- 5 Play/Pause:** Each tap toggles between the Play and Pause functions.
- 6 Stop:** Fully stops playback.
- 7 Eject:** When a CD is loaded, tap here to eject it.

- 8 USB Port A:** Connect a compatible USB device here to enjoy playback of audio MP3 or WMA files. Although most USB flash and hard-disk drives in the FAT32 file format, as well as many MP3 players, are compatible with the MAS system, due to the wide variety of manufacturers, playback cannot be guaranteed. Do not connect an iPod or iPhone to this port. Do not connect a personal computer or any peripherals to this port.
- 9 Line-In Jack (Line Input):** Connect a stereo 3.5mm male-to-male cable (not included) to the headphone or line-level output on a portable player or other device.
- 10 Headphone Jack:** Outputs a stereo signal for private listening through most headphones that are equipped with a stereo 3.5mm plug.
- 11 Volume Control:** Increases or decreases the volume.



1 FM Antenna Terminal: Connect the included FM antenna wire here.

2 DAB Antenna Terminal (MAS 111 Only): Connect the included DAB antenna wire lead here to enjoy programming from digital DAB, DAB+ or T-DMB-Audio radio stations available in your area.

3 USB Port B: Connect a compatible USB device here to enjoy playback of audio MP3 or WMA files. Although most USB flash and hard-disk drives in the FAT32 file format, as well as many MP3 players, are compatible with the MAS system, due to the wide variety of manufacturers, playback cannot be guaranteed. Do not connect an iPod or iPhone to this port. Do not connect a personal computer or any peripherals to this port.

4 Optical 1/2 and Coaxial 1/2 Digital Audio Inputs: Connect a source device's optical or coaxial digital audio output to the corresponding input. Only the uncompressed PCM format is supported.

5 TV and AUX Analog Audio Inputs: Connect the analog audio outputs of a television or any source device to enjoy playback through the high-performance MAS system.

6 Phono Input: Connect the outputs of a moving-magnet (MM) type turntable to this input. Do not connect any other type of turntable to this input, and do not connect the outputs of an MM-type turntable to any other analog audio inputs on the MAS system without using a phono preamp, available separately from many electronics stores.

7 The Bridge IIIP Input: To enjoy playback of audio materials stored on a compatible iPod (see page 4), connect The Bridge IIIP. Make sure the insert for The Bridge IIIP is installed, and install the appropriate dock adapter for your iPod within the insert, as shown in Figure 1 on page 10.

8 Analog Audio Outputs: Connect these outputs to the analog audio inputs of an audio recorder. When a source connected to the MAS system is playing, the signal will be available at these outputs for recording. **IMPORTANT:** The Analog Audio Outputs will mute when the Mute button on the remote is pressed. See page 9.

9 Coaxial Digital Audio Output: Connect this output to the coaxial digital audio input of a digital audio recorder. When the following sources are playing, the signal will be available at this output for recording: CD, USB Ports A/B, Coaxial 1/2, Optical 1/2. The following sources are not available at this output: FM/DAB, TV, Aux, Phono, The Bridge IIIP.

NOTES:

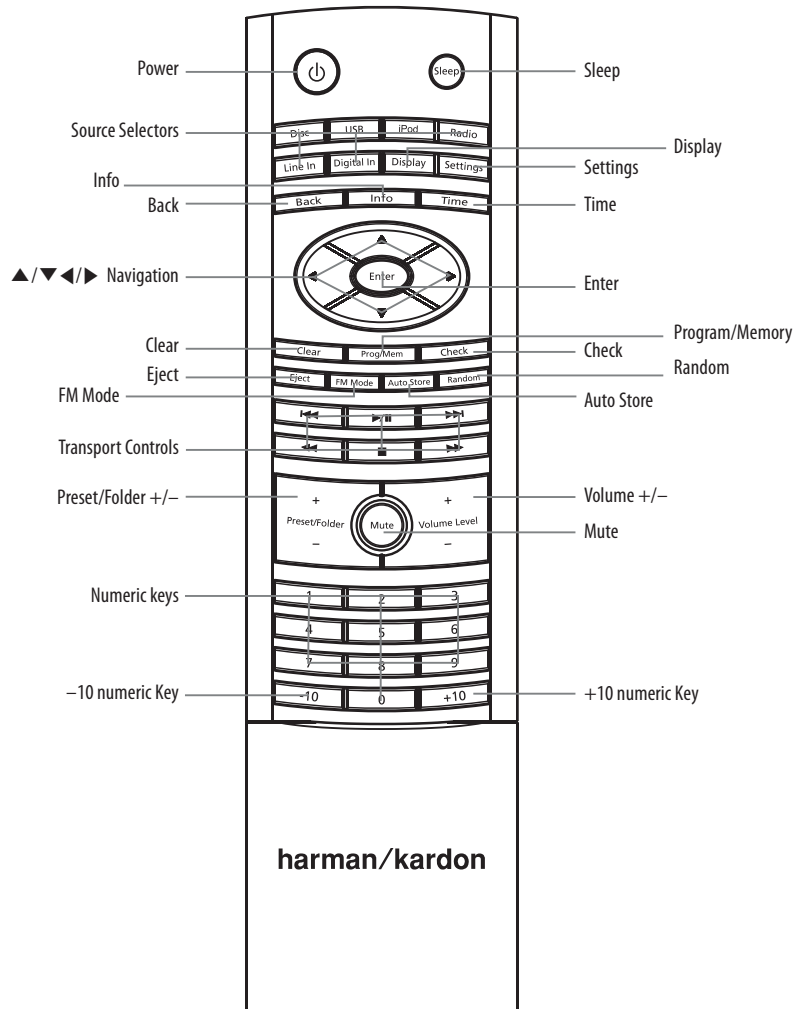
- **The MAS system can convert analog sources to the digital domain, or digital sources to the analog domain for recording.**

- **It is the user's responsibility to comply with all laws pertaining to the copying of audio materials.**

10 Output to Amplifier: Connect the included ribbon cable to this connector and to the corresponding connector on the MAS amplifier. This cable passes audio signals from the controller to the amplifier, and it transfers DC power from the amplifier to the controller. If this cable is ever damaged, do not use it, and contact Harman Kardon for a replacement.

11 RS-232 Serial Port: This port is used only for system upgrades. Do not connect it to any devices unless instructed to do so at the time a system upgrade is released.

12 Update Switch: This switch is used only for system upgrades. Leave it in the "N" position for normal operation unless instructed to switch it to the "U" position to install a system update.



Power: Turns the MAS system on or off. To completely power off the unit, unplug the power supply.

Sleep: Each press increases the time until turn-off, from 10 to 90 minutes, in increments of 10 minutes. The next press after the 90 minutes setting turns off the Sleep function.

Source Selectors: Selects a source input. Each press of the Line In or Digital In button toggles among the available analog (Line Input on right-side panel; TV, AUX or Phono Input on rear panel) or digital audio inputs (Coaxial 1 or 2, Optical 1 or 2), respectively. Press the iPod button to select an iPod docked in The Bridge III.

Display: Adjusts the brightness of the message display. Each time the button is pressed and held for one second, the message display brightness will cycle between full, half and off. When the display is off while the system is turned on, the LEDs inside the Volume knob and behind the front-panel function buttons will remain lit to remind you that the system is still on.

Settings: Accesses menus for Speaker Setup (tone controls), Time Setup (clock), Alarm Setup, System Version and System Reset. See the Operation section for more information.

Back: Returns to previous menu level.

Info: Displays the status of the current source:

- **Radio:** When FM band is in use, each press of the button toggles between the PS (Program Service) and RT (Radio Text) RDS information, if available. When a DAB radio station is playing (MAS 111 only), press this button to access the menu system for the DAB tuner. See pages 13 and 14 for more information.

- **Audio CD:** Displays CD Text information, if available. Each press of the button displays the following items: Song, Artist, Album.

- **USB or Data CD:** Scrolls all ID3 tag information for current source, if available. Each press of the button displays the individual items Song, Artist, Album, File type and Folder, and then goes back to scrolling. If ID3 tags are not available, the file name will appear.

Time: Displays elapsed track time for the current Audio CD (no effect on data CDs or other sources). Each additional press changes the display as follows: remaining track time, elapsed disc time, remaining disc time then back to elapsed track time.

▲/▼◀▶ Navigation buttons: Use the ◀ and ▶ buttons to scroll forward and reverse through the Settings Menus, or through lists of content, and press the Enter button to make selections. Press the Back button to return to the previous menu or content level.

Enter: Selects a menu item, or saves setting changes and returns to the previous menu level.

Clear: Clears the current preset station or a playlist entry.

- **Radio:** To delete the current preset station, press the Clear button while it is playing.
- **Playlist:** While programming a playlist, press the Clear button to delete the track just entered. After the playlist has been saved by pressing the Stop button, press the Clear button to delete the entire playlist. To delete a single track, stop play, press the Check button repeatedly until the desired track appears and press the Clear button. Press the Play or Stop button to exit the Check mode.

Program/Memory: Used to program playlists and radio presets.

- **Radio:** If the current station has not been programmed into a preset, press Program/Memory and press the Enter button to store the station at the current preset number, or use the numeric keys to enter a different preset number. The new preset will overwrite the existing one.
- **USB or CD (Audio or Data):** Press the Program button to begin Program Mode. Add tracks to the playlist by using the Skip/Scan Transport Controls or the numeric keys to select the track, then press the Program button to enter the selection. Add up to 30 files. Press Play to play the playlist, or Stop to save the playlist without playing it. During playback, the order of the track in the playlist will appear on the left, with the disc's track number to the right. See page 14 and 15.

Check: After a playlist has been programmed and play has been stopped, each press of the Check button displays the tracks in the playlist.

Eject: When a CD is loaded, press this button to eject it.

FM Mode: Used with FM radio, each press toggles between Stereo and Monaural playback.

Auto Store: Scans through all frequencies, searching for stations with acceptably strong signal quality, and stores them as presets.

Random: Each press turns Random playback mode (shuffle) on or off. This mode plays the tracks of the current disc or drive in random order.

Transport Controls

Track Skip Up/Down (iPod, CD or USB): Press and release the Next/Previous skip buttons to skip to the next track, or the beginning of the current track. Press the Previous Skip button twice to skip to the previous track.

Scan Forward/Reverse: These buttons function differently, depending on which source has been selected:

- **iPod, CD or USB:** Press and hold a button to scan forward or reverse within a track.
- **Radio:** Press and release a button to tune to the next higher or lower frequency by one increment/decrement. Press and hold a button to scan quickly through the frequencies for next available station. Press the same button again to stop scanning.

Play/Pause: Each tap toggles between the Play and Pause functions.

Stop: Fully stops playback.

Preset/Folder +/-: Selects a preset station or folder on a USB or data CD.

- **Radio:** Each press changes to the next or previous preset station, if any have been programmed.
- **USB or Data CD:** Press once to open the current folder. Each additional press changes to the next or previous folder. After 3 seconds, the first track in the new folder will begin playing.

Mute: Press to temporarily silence the speakers. Press again to restore audio. Muting is also canceled if the MAS system is turned off.

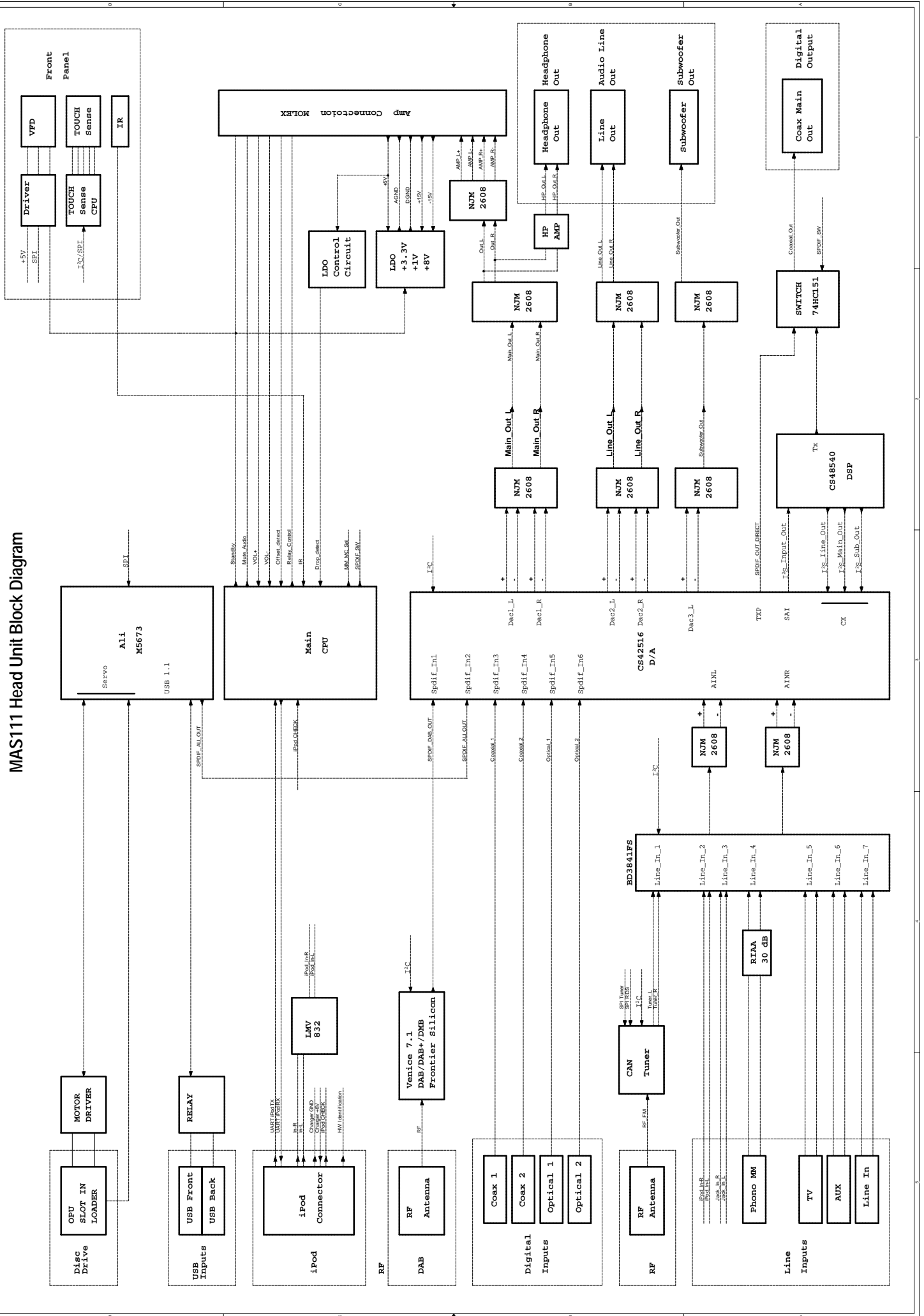
NOTE: Pressing the Mute button also mutes the Analog Audio Outputs. See page 6.

Volume +/-: Increases or decreases the volume. Press and hold to change the volume more quickly.

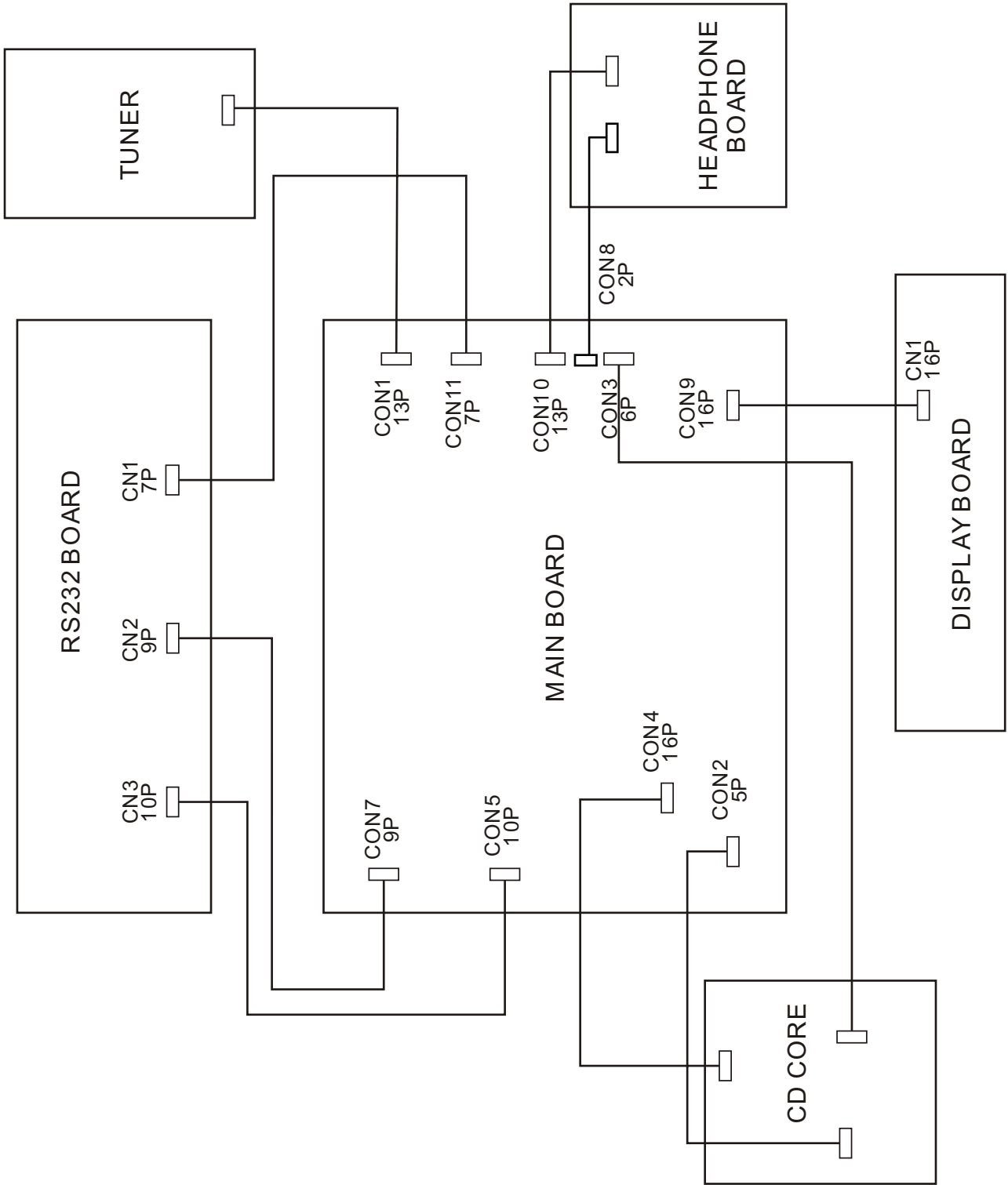
Numeric keys: Used to enter track numbers, radio stations or preset numbers, or while adjusting the clock and alarm times.

-10 and +10 numeric Key: Used with a USB device or CD to quickly advance through a large number of tracks. Each press of these keys changes to the next or previous track in increments of 10.

MAS111 Head Unit Block Diagram



WIRING DIAGRAM



Hex inverter

74HCU04

FEATURES

- Output capability: standard
- I_{CC} category: SSI

GENERAL DESCRIPTION

The 74HCU04 is a high-speed Si-gate CMOS device and is pin compatible with low power Schottky TTL (LSTTL). It is specified in compliance with JEDEC standard no. 7A.

The 74HCU04 is a general purpose hex inverter. Each of the six inverters is a single stage

QUICK REFERENCE DATA

GND = 0 V; $T_{amb} = 25\text{ }^{\circ}\text{C}$; $t_r = t_f = 6\text{ ns}$

| SYMBOL | PARAMETER | CONDITIONS | TYP. | UNIT |
|-------------------|--|--|------|------|
| t_{PHL}/t_{PLH} | propagation delay nA to nY | $C_L = 15\text{ pF}$; $V_{CC} = 5\text{ V}$ | 5 | ns |
| C_I | input capacitance | | 3.5 | pF |
| C_{PD} | power dissipation capacitance per inverter | note 1 | 10 | pF |

Note

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz

f_o = output frequency in MHz

C_L = output load capacitance in pF

V_{CC} = supply voltage in V

$\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs

ORDERING INFORMATION

See *"74HC/HCT/HCU/HCMOS Logic Package Information"*.

FUNCTION TABLE

| INPUT | OUTPUT |
|-------|--------|
| nA | nY |
| L | H |
| H | L |

Note

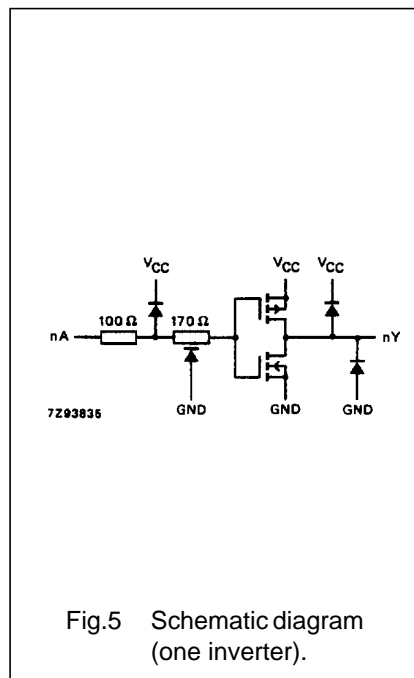
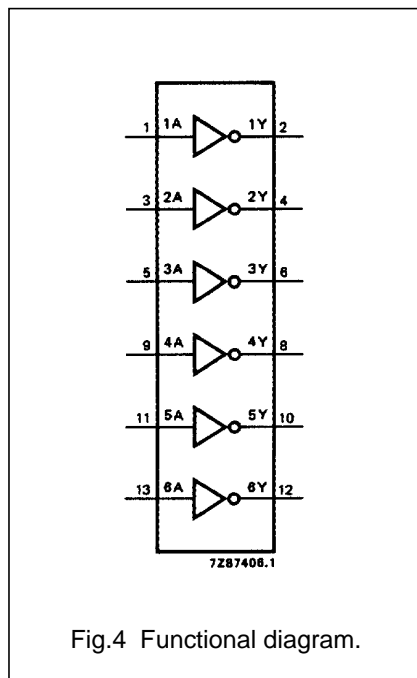
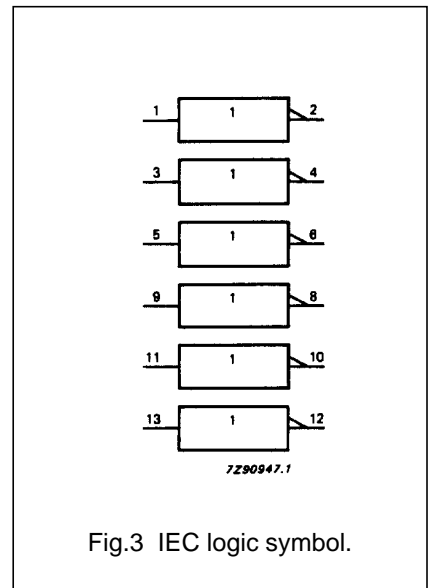
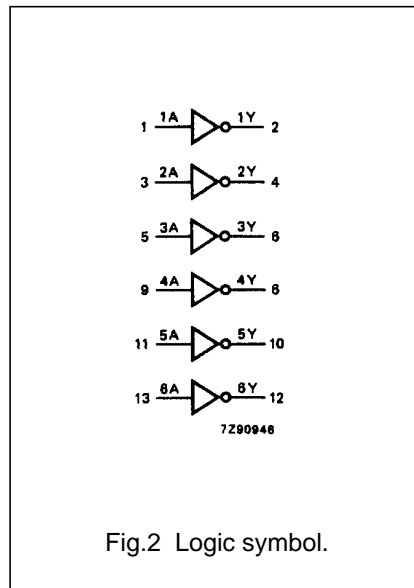
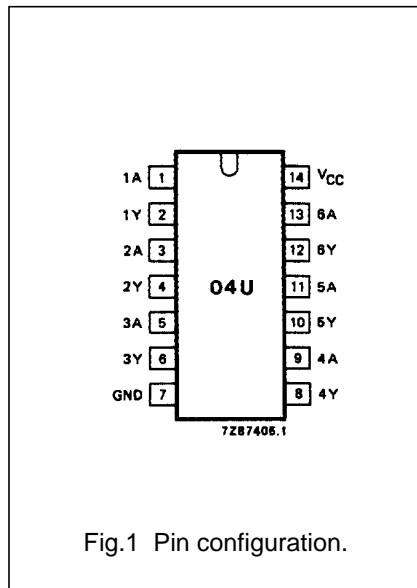
1. H = HIGH voltage level
L = LOW voltage level

Hex inverter

74HCU04

PIN DESCRIPTION

| PIN NO. | SYMBOL | NAME AND FUNCTION |
|--------------------|-----------------|-------------------------|
| 1, 3, 5, 9, 11, 13 | 1A to 6A | data inputs |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y | data outputs |
| 7 | GND | ground (0 V) |
| 14 | V _{CC} | positive supply voltage |



5-channel BTL Driver for DVD player

AM5888S

The AM5888S is a five-channel BTL driver IC for driving the motors and actuators such as used in DVD player and consists of two independent precision voltage regulators with adjustable range from 1.5V to 4 V. It supports a variety of applications. Also, Pb free package is selectable (Please refer to Marking Identification).

● Applications

BTL driver for CD, CD-ROM and DVD.

● Features

- 1) Two channels are voltage-type BTL drivers for actuators of tracking and focus. Two channels are voltage-type BTL driver for sled and spindle motors. It is also built-in one channel bi-direction DC motor driver for tray.
- 2) Wide dynamic range [9.0V (*typ.*) when $V_{cc1}=V_{cc2}=12V$, at $R_L=20\Omega$ load].
- 3) Separating power of V_{cc1} and V_{cc2} is to improve power efficiency by a low supply voltage for tracking, focus, and spindle.
- 4) Level shift circuit built-in.
- 5) Thermal shut down circuit built-in.
- 6) Mute mode built-in.
- 7) **Dual actuator drivers:**
A general purpose input OP provides differential input for signal addition. The output structure is two power OPAMPS in bridge configuration.
- 8) **Sled motor driver:**
A general purpose input OP provides differential input for signal addition. The output structure is one power OPAMP in bridge configuration.
- 9) **Spindle driver:**
Single input linear BTL driver. The output structure are two power OPAMPS in bridge configuration.
- 10) **Tray in-out driver:**
The DC motor driver supports forward/reverse control for tray motor.
- 11) **2 Built-in regulator controllers**
Adjustable range 1.5V ~ 4V

● **Absolute maximum ratings (Ta=25°C)**

| Parameter | Symbol | Limits | Unit |
|--------------------|------------------|---------------|------|
| Supply voltage | Vcc1 Vcc2 | 13.5 | V |
| Power dissipation | P _d | *1.7 | W |
| Operate Temp range | T _{opr} | -35 ~ +85 | °C |
| Storage Temp range | T _{stg} | ** -55 ~ +150 | °C |

*When mounted on a 70mm×70mm×1.6mm glass epoxy board.

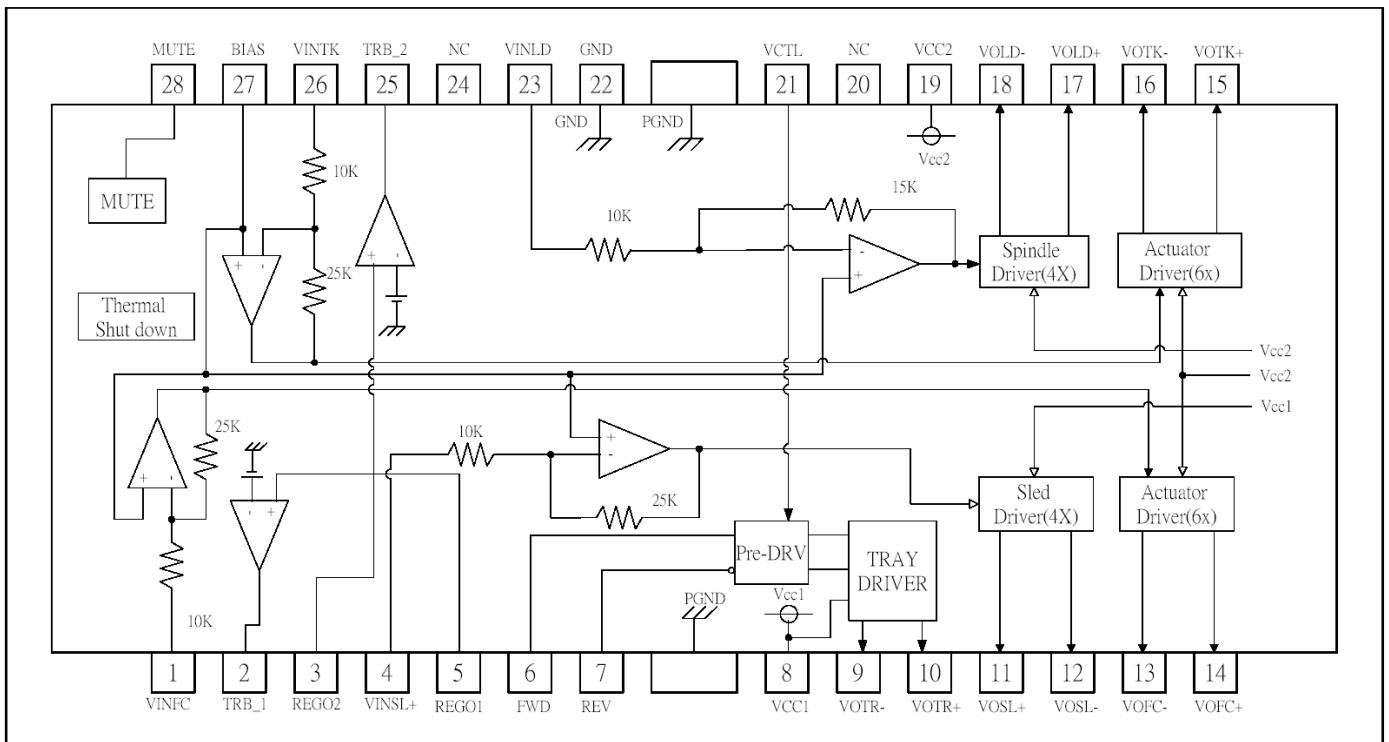
*Reduced by 13.6mW for each increase in T_a of 1°C over 25°C.

**Should not exceed P_d or ASO and T_j=150°C values

● **Guaranteed operating conditions (Ta=25°C)**

| Parameter | Symbol | Limits | Unit |
|----------------------|--------|------------|------|
| Power supply voltage | Vcc1 | 4.3 ~ 13.2 | V |
| | Vcc2 | 4.3 ~ Vcc1 | V |

● **Block diagram**



● Pin description

| PIN No | Pin Name | Function |
|--------|----------|--|
| 1 | VINFC | Input for focus driver |
| 2 | TRB_1 | Connect to external transistor base |
| 3 | REGO2 | Regulator voltage output, connect to external transistor collector |
| 4 | VINSL+ | Input for the sled driver |
| 5 | REGO1 | Regulator voltage output, connect to external transistor collector |
| 6 | FWD | Tray driver forward input |
| 7 | REV | Tray driver reverse input |
| 8 | Vcc1 | Vcc for pre-drive block and power block of sled and tray |
| 9 | VOTR- | Tray driver output (-) |
| 10 | VOTR+ | Tray driver output (+) |
| 11 | VOSL+ | Sled driver output (+) |
| 12 | VOSL- | Sled driver output (-) |
| 13 | VOFC- | Focus driver output (-) |
| 14 | VOFC+ | Focus driver output (+) |
| 15 | VOTK+ | Tracking driver output (+) |
| 16 | VOTK- | Tracking driver output (-) |
| 17 | VOLD+ | Spindle driver output (+) |
| 18 | VOLD- | Spindle driver output (-) |
| 19 | Vcc2 | Vcc for power block of spindle, tracking and focus |
| 20 | NC | No Connection |
| 21 | VCTL | Speed control input of tray driver |
| 22 | GND | Ground |
| 23 | VINLD | Input for spindle driver |
| 24 | NC | No Connection |
| 25 | TRB_2 | Connect to external transistor base |
| 26 | VINTK | Input for tracking driver |
| 27 | BIAS | Input for reference voltage |
| 28 | MUTE | Input for mute control |

Notes) Symbol of + and – (output of drivers) means polarity to input pin.

(For example, if voltage of pin1 is high, pin14 is high.)

Features

- Low-voltage and Standard-voltage Operation
 - 1.8 (V_{CC} = 1.8V to 5.5V)
- Internally Organized 256 x 8 (2K)
- Two-wire Serial Interface
- Schmitt Trigger, Filtered Inputs for Noise Suppression
- Bidirectional Data Transfer Protocol
- 1 MHz (5V), 400 kHz (1.8V, 2.5V, 2.7V) Compatibility
- Write Protect Pin for Hardware Data Protection
- 8-byte Page (2K) Write Modes
- Partial Page Writes Allowed
- Self-timed Write Cycle (5 ms max)
- High-reliability
 - Endurance: 1 Million Write Cycles
 - Data Retention: 100 Years
- 8-lead PDIP, 8-lead JEDEC SOIC, 8-lead Ultra Thin Mini-MAP (MLP 2x3), 5-lead SOT23, 8-lead TSSOP and 8-ball dBGAA2 Packages
- Lead-free/Halogen-free
- Available in Automotive
- Die Sales: Wafer Form, Tape and Reel and Bumped Wafers

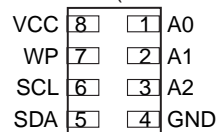
Description

The AT24C02B provides 2048 bits of serial electrically erasable and programmable read-only memory (EEPROM) organized as 256 words of 8 bits each. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential. The AT24C02B is available in space-saving 8-lead PDIP, 8-lead JEDEC SOIC, 8-lead Ultra Thin Mini-MAP (MLP 2x3), 5-lead SOT23, 8-lead TSSOP, and 8-ball dBGAA2 packages and is accessed via a Two-wire serial interface. In addition, the AT24C02B is available in 1.8V (1.8V to 5.5V) version.

Table 0-1. Pin Configuration

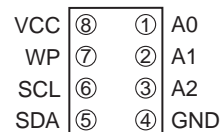
| Pin Name | Function |
|----------|--------------------|
| A0 - A2 | Address Inputs |
| SDA | Serial Data |
| SCL | Serial Clock Input |
| WP | Write Protect |
| GND | Ground |
| VCC | Power Supply |

8-lead Ultra-Thin Mini-MAP (MLP 2x3)



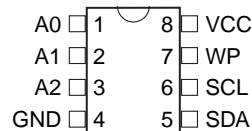
Bottom View

8-ball dBGAA2

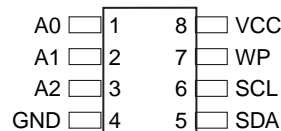


Bottom View

8-lead TSSOP

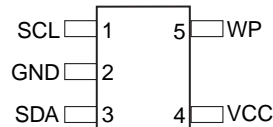


8-lead SOIC

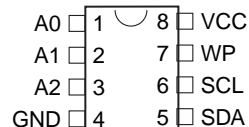


Note: For use of 5-lead SOT23, the software A2, A1, and A0 bits in the device address word must be set to zero to properly communicate.

5-lead SOT23



8-lead PDIP



Two-wire Serial EEPROM

2K (256 x 8)

AT24C02B

5126H-SEEPR-8/07



Structure : Silicon Monolithic Integrated Circuit

Product : 9ch Function Switch

Type : **BD3841FS**

- Feature :
- (1) For 2nd room entertainment.
 - (2) For 2nd source recording.

Absolute Maximum Ratings (Ta=25°C)

| Parameter | Symbol | Limits | Unit |
|-----------------------|--------|-----------|------|
| Power Supply Voltage | Vcc | 15 | V |
| Power Dissipation | Pd | SSOP 950※ | mW |
| Operating Temperature | Topr | -20~+75 | °C |
| Storage Temperature | Tastg | -55~+125 | °C |

※ Over Ta = 25°C, derating at the rate of 9.5mW/°C. When installed on the standard board (size : 70 x70 x 1.6mm).

Operating Voltage Range

| Parameter | Symbol | Limit | Unit |
|---|----------|---------|------|
| Power Supply Voltage (both power sources) | VCC-GND | 5~7.3 | V |
| | VEE-GND | -5~-7.3 | |
| Power Supply Voltage (single power source) | VCC- VEE | 10~14.6 | V |

(It must function normally at Ta = 25°C)

Application example

Note that ROHM cannot provide adequate confirmation of patents.

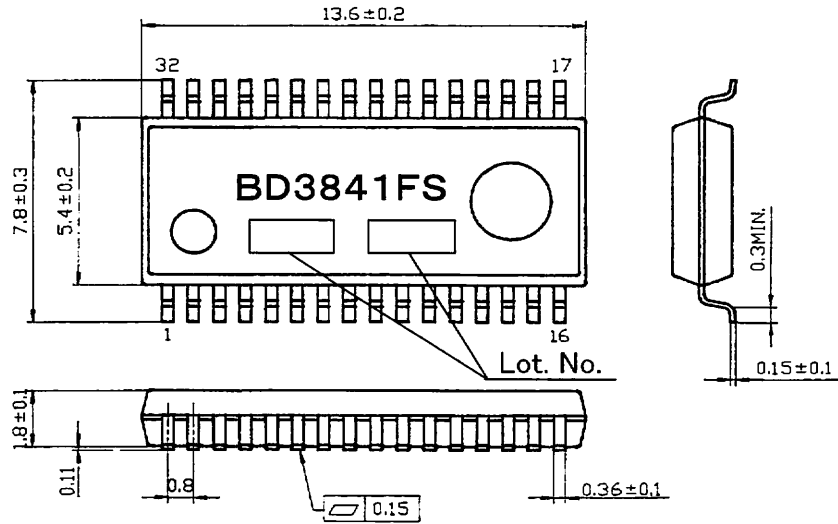
The product described in this specification is designed to be used with ordinary electronic equipment or devices (such as audio-visual equipment, office-automation equipment, communications devices, electrical appliances, and electronic toys). Should you intend to use this product with equipment or devices which require an extremely high level of reliability and the malfunction of which would directly endanger human life (such as medical instruments, transportation equipment, aerospace machinery, nuclear-reactor controllers, fuel controllers and other safety devices), please be sure to consult with our sales representative in advance.

Electrical characteristics

Ta=25°C, VCC=7V, VEE=7V, f=1kHz, Vin=1Vrms, RL=10kΩ, Rg=600Ω, unless otherwise noted.

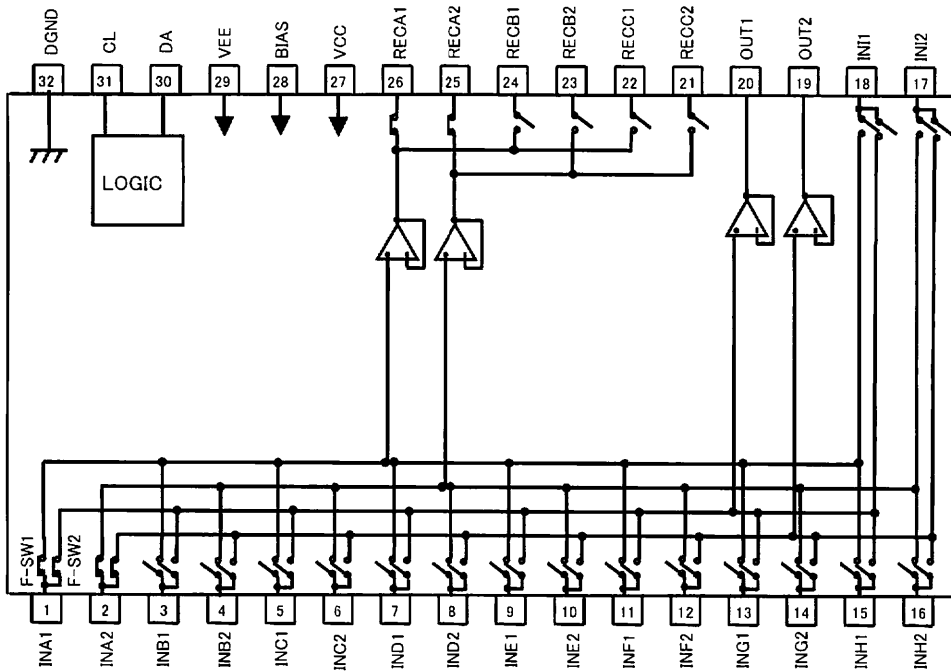
| | Symbol | Parameter | Limit | | | Unit | Conditions |
|------------|--------|---------------------------------------|-------|-------|------|-------|--|
| | | | Min. | Typ. | Max. | | |
| | IQ | Circuit current | — | 3 | 10 | mA | No signal |
| Output | Gv1 | Output voltage gain 1ch | -2 | 0 | 2 | dB | Measure : Pin20 |
| | Gv2 | Output voltage gain 2ch | -2 | 0 | 2 | dB | Measure : Pin19 |
| | THD1 | Total harmonic distortion ratio 1ch | — | 0.004 | 0.05 | % | Measure : Pin20 BW=400~30kHz |
| | THD2 | Total harmonic distortion ratio 2ch | — | 0.004 | 0.05 | % | Measure : Pin19 BW=400~30kHz |
| | Vomax1 | Maximum output voltage 1ch | 3.4 | 4.2 | — | Vrms | Measure : Pin20 THD=1% |
| | Vomax2 | Maximum output voltage 2ch | 3.4 | 4.2 | — | Vrms | Measure : Pin19 THD=1% |
| | Vno1 | Output noise voltage 1ch | — | 1 | 5 | μVrms | Measure : Pin 20 Rg=0Ω, BW=IHF-A |
| | Vno2 | Output noise voltage 2ch | — | 1 | 5 | μVrms | Measure : Pin 19 Rg=0Ω, BW=IHF-A |
| | CTC12 | Cross-talk between channels 1ch→2ch | — | -95 | -80 | dB | Measure : Pin19(OUT2), Rg=0Ω, BW=IHF-A Reference: Pin20(OUT1)=1Vrms |
| | CTC21 | Cross-talk between channels 2ch→1ch | — | -95 | -80 | dB | Measure : Pin20(OUT1), Rg=0Ω, BW=IHF-A Reference: Pin19(OUT2)=1Vrms |
| | CTS1 | Cross-talk between selectors 1ch | — | -95 | -80 | dB | Measure : Pin20 Rg=0Ω, BW=IHF-A |
| | CTS2 | Cross-talk between selectors 2ch | — | -95 | -80 | dB | Measure : Pin19 Rg=0Ω, BW=IHF-A |
| REC output | GVR1 | R voltage gain 1ch | -2 | 0 | 2 | dB | RL=47kΩ, Measure : Pin 22, 24, 26 |
| | GVR2 | R voltage gain 2ch | -2 | 0 | 2 | dB | RL=47kΩ, Measure : Pin 21, 23, 25 |
| | THDR1 | R Total harmonic distortion ratio 1ch | — | 0.01 | 0.09 | % | RL=47kΩ, Measure : Pin 22, 24, 26 BW=400~30kHz |
| | THDR2 | R Total harmonic distortion ratio 2ch | — | 0.01 | 0.09 | % | RL=47kΩ, Measure : Pin 21, 23, 25 BW=400~30kHz |
| | VnoR1 | R output noise voltage 1ch | — | 1 | 5 | μVms | Measure : Pin 22, 24,26 Rg=0Ω, BW=IHF-A |
| | VnoR2 | R output noise voltage 2ch | — | 1 | 5 | μVms | Measure : Pin 21, 23,25 Rg=0Ω, BW=IHF-A |
| | RoutR1 | R output impedance 1ch | — | 50 | 100 | Ω | Measure : Pin 22, 24, 26 |
| | RoutR2 | R output impedance 2ch | — | 50 | 100 | Ω | Measure : Pin 21, 23, 25 |

Outline dimension • Marking dimension



SSOP-A32 (Unit:mm)

Block diagram



* F-SW1:INPUT FUNCTION1
 F-SW2:INPUT FUNCTION2

110 dB, 192 kHz 6-Ch Codec with S/PDIF Receiver

Features

- ◆ Six 24-bit D/A, two 24-bit A/D Converters
- ◆ 110 dB DAC / 114 dB ADC Dynamic Range
- ◆ -100 dB THD+N
- ◆ System Sampling Rates up to 192 kHz
- ◆ S/PDIF Receiver Compatible with EIAJ CP1201 and IEC-60958
- ◆ Recovered S/PDIF Clock or System Clock Selection
- ◆ 8:2 S/PDIF Input MUX
- ◆ ADC High-Pass Filter for DC Offset Calibration
- ◆ Expandable ADC Channels and One-Line Mode Support
- ◆ Digital Output Volume Control with Soft Ramp
- ◆ Digital +/-15 dB Input Gain Adjust for ADC
- ◆ Differential Analog Architecture
- ◆ Supports Logic Levels between 1.8 V and 5 V

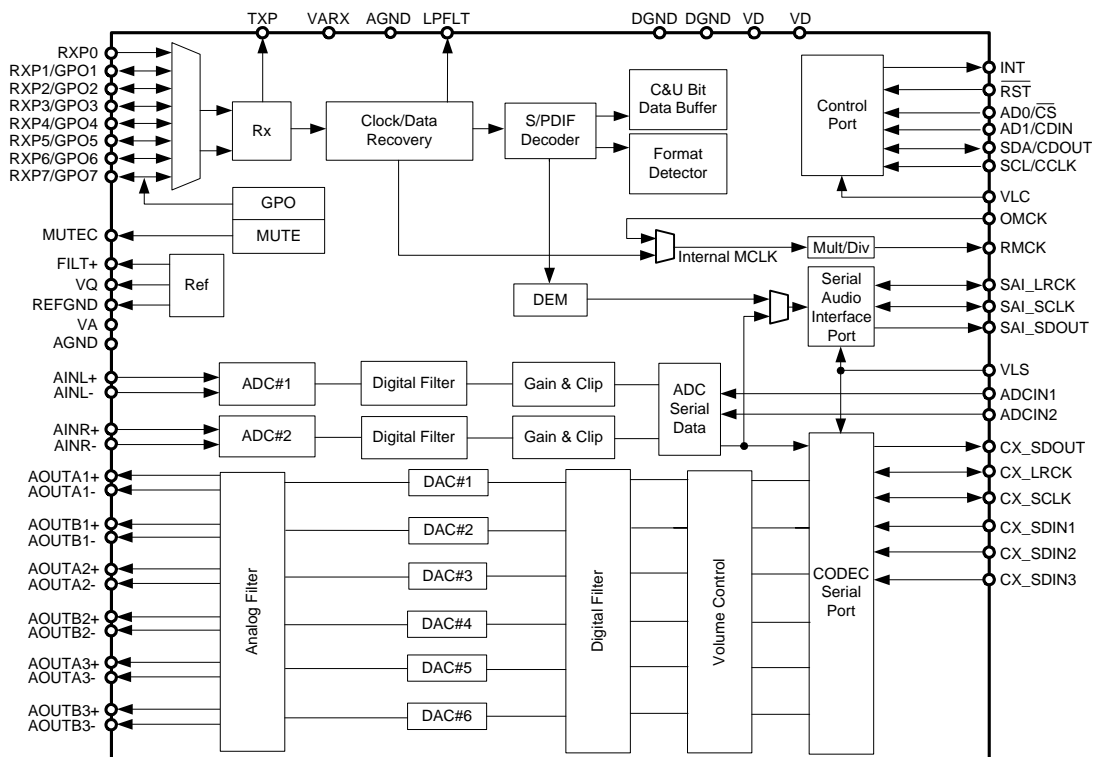
General Description

The CS42516 codec provides two analog-to-digital and six digital-to-analog delta-sigma converters, as well as an integrated S/PDIF receiver.

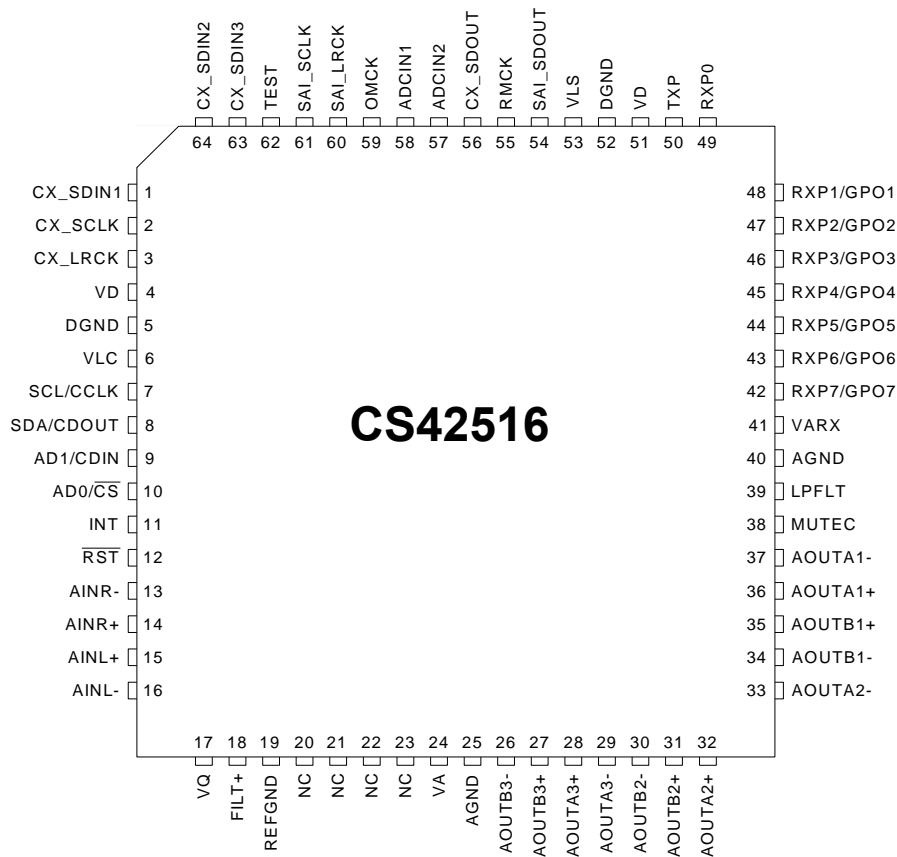
The CS42516 integrated S/PDIF receiver supports up to eight inputs, clock recovery circuitry and format auto-detection. The internal stereo ADC is capable of independent channel gain control for single-ended or differential analog inputs. All six channels of DAC provide digital volume control and differential analog outputs. The general-purpose outputs may be driven high or low, or mapped to a variety of DAC mute controls or ADC overflow indicators.

The CS42516 is ideal for audio systems requiring wide dynamic range, negligible distortion and low noise, such as A/V receivers, DVD receivers, digital speaker and automotive audio systems.

The CS42516 is available in a 64-pin LQFP package in both Commercial (-10° to 70° C) and Automotive (-40° to 85° C) grades. The CDB42518 Customer Demonstration board is also available for device evaluation. Refer to ["Ordering Information" on page 89](#).



2. PIN DESCRIPTIONS

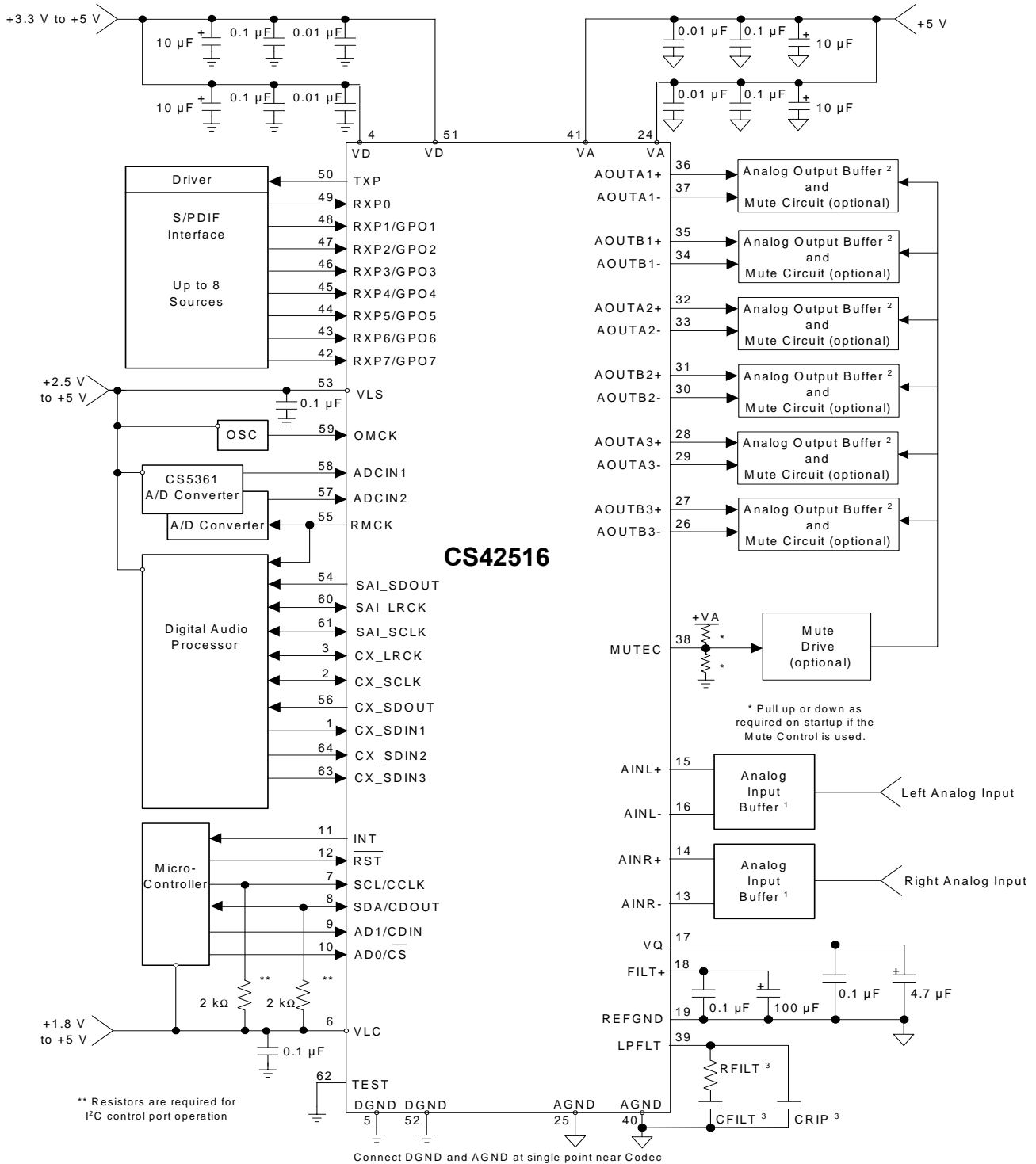


| Pin Name | # | Pin Description |
|-----------------------------|---------|---|
| CX_SDIN1 | 1 | |
| CX_SDIN2 | 64 | Codec Serial Audio Data Input (Input) - Input for two's complement serial audio data. |
| CX_SDIN3 | 63 | |
| CX_SCLK | 2 | CODEC Serial Clock (Input/Output) - Serial clock for the CODEC serial audio interface. |
| CX_LRCK | 3 | CODEC Left Right Clock (Input/Output) - Determines which channel, Left or Right, is currently active on the CODEC serial audio data line. |
| VD | 4 51 | Digital Power (Input) - Positive power supply for the digital section. |
| DGND | 5 52 | Digital Ground (Input) - Ground reference. Should be connected to digital ground. |
| VLC | 6 | Control Port Power (Input) - Determines the required signal level for the control port. |
| SCL/CCLK | 7 | Serial Control Port Clock (Input) - Serial clock for the serial control port. Requires an external pull-up resistor to the logic interface voltage in I ² C mode as shown in the Typical Connection Diagram. |
| SDA/CDOUT | 8 | Serial Control Data (Input/Output) - SDA is a data I/O line in I ² C mode and requires an external pull-up resistor to the logic interface voltage, as shown in the Typical Connection Diagram. CDOUT is the output data line for the control port interface in SPI mode. |
| AD1/CDIN | 9 | Address Bit 1 (I²C)/Serial Control Data (SPI) (Input) - AD1 is a chip address pin in I ² C mode; CDIN is the input data line for the control port interface in SPI mode. |
| AD0/ $\overline{\text{CS}}$ | 10 | Address Bit 0 (I²C)/Control Port Chip Select (SPI) (Input) - AD0 is a chip address pin in I ² C mode; $\overline{\text{CS}}$ is the chip select signal in SPI mode. |

| | | |
|---|--|---|
| INT | 11 | Interrupt (Output) - The CS42516 will generate an interrupt condition as per the Interrupt Mask register. See "Interrupts" on page 40 for more details. |
| $\overline{\text{RST}}$ | 12 | Reset (Input) - The device enters a low power mode and all internal registers are reset to their default settings when low. |
| AINR- AINR+ | 13 14 | Differential Right Channel Analog Input (Input) - Signals are presented differentially to the delta-sigma modulators via the AINR+/- pins. |
| AINL+ AINL- | 15 16 | Differential Left Channel Analog Input (Input) - Signals are presented differentially to the delta-sigma modulators via the AINL+/- pins. |
| VQ | 17 | Quiescent Voltage (Output) - Filter connection for internal quiescent reference voltage. |
| FILT+ | 18 | Positive Voltage Reference (Output) - Positive reference voltage for the internal sampling circuits. |
| REFGND | 19 | Reference Ground (Input) - Ground reference for the internal sampling circuits. |
| | 20 | |
| NC | 21 22 23 | No Connect Pins - Do not make any connection to these pins. |
| AOUTA1 +,- AOUTB1 +,- AOUTA2 +,- AOUTB2 +,- AOUTA3 +,- AOUTB3 +,- | 36,37 35,34 32,33 31,30 28,29 27,26 | Differential Analog Output (Output) - The full-scale differential analog output level is specified in the Analog Characteristics specification table. |
| VA VARX | 24 41 | Analog Power (Input) - Positive power supply for the analog section. |
| AGND | 25 40 | Analog Ground (Input) - Ground reference. Should be connected to analog ground. |
| MUTE $\overline{\text{C}}$ | 38 | Mute Control (Output) - The Mute Control pin outputs high impedance following an initial power-on condition or whenever the PDN bit is set to a '1', forcing the codec into power-down mode. The signal will remain in a high impedance state as long as the part is in power-down mode. The Mute Control pin goes to the selected "active" state during reset, muting, or if the master clock to left/right clock frequency ratio is incorrect. This pin is intended to be used as a control for external mute circuits to prevent the clicks and pops that can occur in any single supply system. The use of external mute circuits are not mandatory but may be desired for designs requiring the absolute minimum in extraneous clicks and pops. |
| LPFLT | 39 | PLL Loop Filter (Output) - An RC network should be connected between this pin and ground. |
| RXP7/GPO7 RXP6/GPO6 RXP5/GPO5 RXP4/GPO4 RXP3/GPO3 RXP2/GPO2 RXP1/GPO1 | 42 43 44 45 46 47 48 | S/PDIF Receiver Input/ General Purpose Output (Input/Output) - Receiver inputs for S/PDIF encoded data. The CS42516 has an internal 8:2 multiplexer to select the active receiver port, according to the Receiver Mode Control 2 register. These pins can also be configured as general purpose output pins, ADC Overflow indicators or Mute Control outputs according to the RXP/General Purpose Pin Control registers. |
| RXP0 | 49 | S/PDIF Receiver Input (Input) - Dedicated receiver input for S/PDIF encoded data. |
| TXP | 50 | S/PDIF Transmitter Output (Output) - S/PDIF encoded data output, mapped directly from one of the receiver inputs as indicated by the Receiver Mode Control 2 register. |
| VLS | 53 | Serial Port Interface Power (Input) - Determines the required signal level for the serial port interfaces. |
| SAI_SDO $\overline{\text{U}}$ T | 54 | Serial Audio Interface Serial Data Output (Output) - Output for two's complement serial audio PCM data from the S/PDIF incoming stream. This pin can also be configured to transmit the output of the internal and external ADCs. |
| RMCK | 55 | Recovered Master Clock (Output) - Recovered master clock output from the External Clock Reference (OMCK, pin 59) or the PLL which is locked to the incoming S/PDIF stream or CX_LRCK. |
| CX_SDO $\overline{\text{U}}$ T | 56 | CODEC Serial Data Output (Output) - Output for two's complement serial audio data from the internal and external ADCs. |

| | | |
|----------|----|---|
| ADCIN1 | 58 | External ADC Serial Input (Input) - The CS42516 provides for up to two external stereo analog to digital converter inputs to provide a maximum of six channels on one serial data output line when the CS42516 is placed in One-Line Mode. |
| ADCIN2 | 57 | |
| OMCK | 59 | External Reference Clock (Input) - External clock reference that must be within the ranges specified in the register " OMCK Frequency (OMCK Freqx) " on page 53. |
| TEST | 62 | Test Pin (Input) - This pin must be connected to DGND. |
| SAI_LRCK | 60 | Serial Audio Interface Left/Right Clock (Input/Output) - Determines which channel, Left or Right, is currently active on the serial audio data line. |
| SAI_SCLK | 61 | Serial Audio Interface Serial Clock (Input/Output) - Serial clock for the Serial Audio Interface. |

3. TYPICAL CONNECTION DIAGRAM



1. See the ADC Input Filter section in the Appendix.
 2. See the DAC Output Filter section in the Appendix.
 3. See the PLL Filter section in the Appendix.

Figure 5. Typical Connection Diagram

FEATURES

- ❑ Cost-effective, High-performance 32-bit DSP
 - 300,000,000 MAC/S (multiply accumulates per second)
 - Dual MAC cycles per clock
 - 72-bit accumulators are the most accurate in the industry
 - 24k x 32 SRAM, 2k blocks - assignable to data or program
 - Internal ROM contains a variety of configurable sound enhancement feature sets
 - 8-channel internal DMA
 - Internal watch-dog DSP lock-up prevention
- ❑ DSP Tool Set w/ Private Keys for Protecting Customer IP
- ❑ Configurable Serial Audio Inputs/Outputs
 - Configurable for all input/output types
 - Maximum 32-bit @ 192 kHz
 - Supports 32-bit audio sample I/O between DSP chips
 - TDM input modes (multiple channels on same line)
 - 192 kHz SPDIF transmitter
 - Multi-channel DSD direct stream digital SACD input
- ❑ Supports Two Different Input Fs Sample Rates
 - Output can be master or slave
 - Dual processing path capability
 - Input supports dual domain slave clocking
 - Hardware assist time sampling for sample rate conversion
- ❑ Integrated Clock Manager/PLL
 - Can operate from external crystal, external oscillator
- ❑ Input Fs Auto Detection
- ❑ Host & Boot via Serial Interface
- ❑ Configurable GPIOs and External Interrupt Input
- ❑ 1.8V Core and a 3.3V I/O that is tolerant to 5V input
- ❑ Low-power Mode
 - “Energy-Star Ready” via low-power mode, 268 μ W in standby

Differentiating from the legacy Cirrus multi-standard, multi-channel decoders, this new CS485xx family is still based on the same high-performance 32-bit fixed point Digital Signal Processor core but instead is equipped with much less memory, tailoring it for more cost-effective applications associated with multi-channel and virtual-channel sound enhancements. Target applications are:

- Digital Televisions
- Multimedia Peripherals
- iPod® Docking Stations
- Automotive Head Units
- Automotive Outboard Amplifiers
- HD-DVD & Blu-ray Disc DVD Receivers
- PC Speakers

There are also a wide variety of licensable DSP codes available today as seen by the following examples:

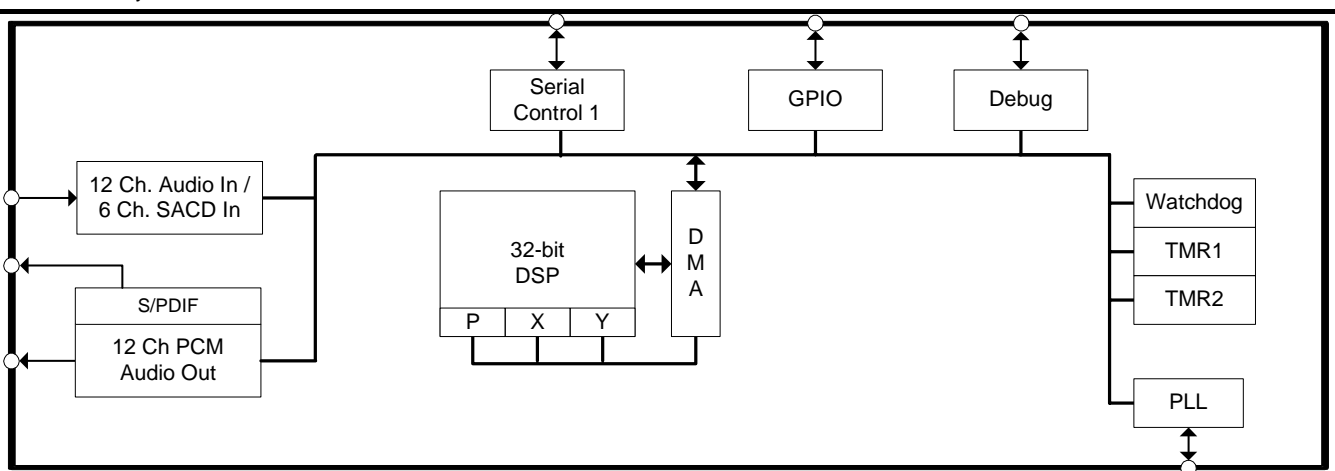


Cirrus also has developed, or is developing their own royalty-free versions of popular features sets like Cirrus Bass Manager, Cirrus Dynamic Volume Leveler, Cirrus Original Multichannel Surround, Cirrus Virtual Speaker & Cirrus 3D-Audio.

The CS485xx family is programmed using the Cirrus proprietary DSP Composer™ GUI development tool. Processing chains may be designed using a drag-and-drop interface to place/utilize functional macro audio DSP primitives. The end result is a software image that is downloaded to the DSP via serial host or serial boot modes.

Ordering Information:

See [page 20](#) for ordering information



8.2 CS48540, 48-pin LQFP Pinout Diagram

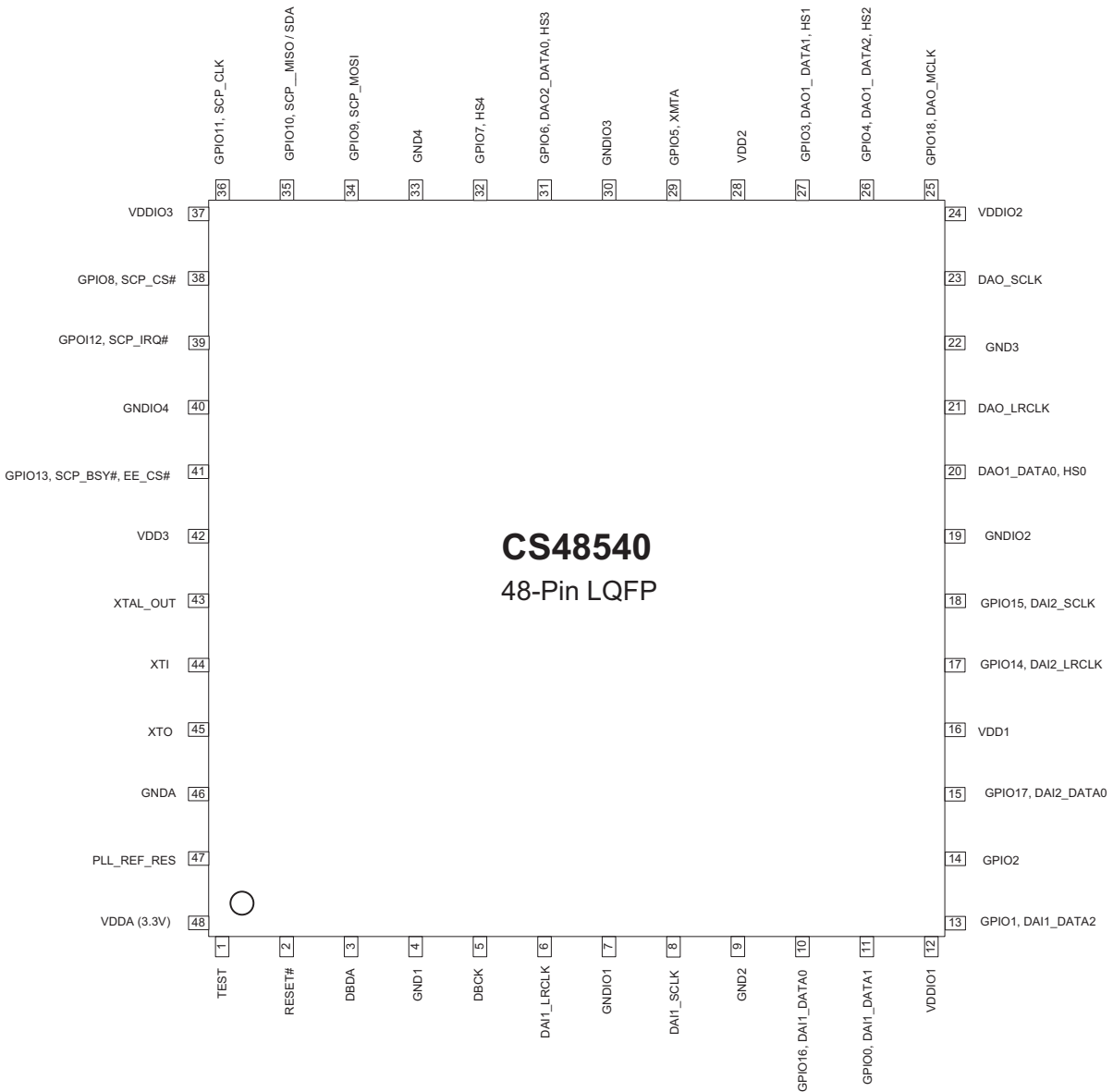


Figure 12. CS48540, 48-Pin LQFP Pinout

FAN1112

1A 1.2V Low Dropout Linear Regulator

Features

- Low dropout voltage
- Load regulation: 0.05% typical
- Trimmed current limit
- On-chip thermal limiting
- Standard SOT-223 and TO-252 packages
- Three-terminal fixed 1.2V

Applications

- Post regulator for switching supplies
- Supply for low-voltage processors

Description

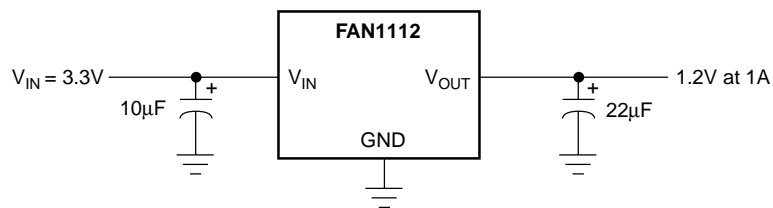
The FAN1112 is a 1.2V low dropout three-terminal regulator with 1A output current capability. The device has been optimized for low voltage where transient response and minimum input voltage are critical.

Current limit is trimmed to ensure specified output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload and ambient temperatures that would create excessive junction temperatures.

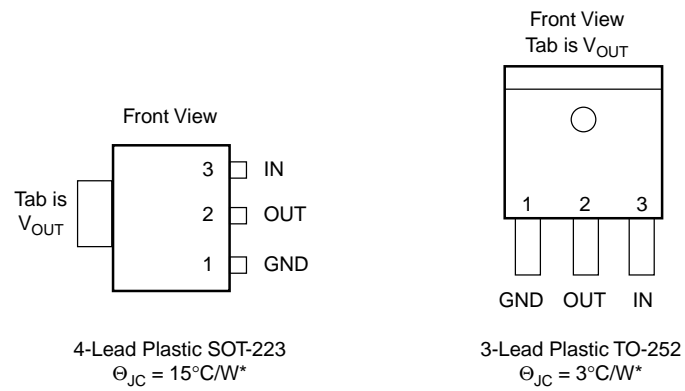
Unlike PNP type regulators where up to 10% of the output current is wasted as quiescent current, the quiescent current of the FAN1112 flows into the load, increasing efficiency.

The FAN1112 regulator is available in the industry-standard SOT-223 and TO-252 (DPAK) power packages.

Typical Application



Pin Assignments



*With package soldered to 0.5 square inch copper area over backside ground plane or internal power plane., Θ_{JA} can vary from 30°C/W to more than 50°C/W . Other mounting techniques may provide better thermal resistance than 30°C/W .

Absolute Maximum Ratings

| Parameter | Min. | Max. | Unit |
|---------------------------------------|------|--------------|--------------------|
| V_{IN} | | 18 | V |
| $(V_{IN} - V_{OUT}) * I_{OUT}$ | | See Figure 1 | |
| Operating Junction Temperature Range | 0 | 125 | $^{\circ}\text{C}$ |
| Storage Temperature Range | -65 | 150 | $^{\circ}\text{C}$ |
| Lead Temperature (Soldering, 10 sec.) | | 300 | $^{\circ}\text{C}$ |

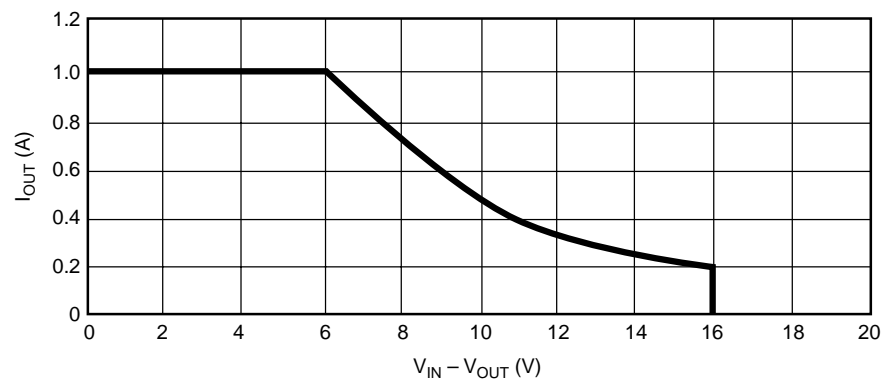


Figure 1. Absolute Maximum Safe Operating Area

HEF4094B

8-stage shift-and-store register

Rev. 08 — 2 April 2010

Product data sheet

1. General description

The HEF4094B is an 8-stage serial shift register. It has a storage latch associated with each stage for strobing data from the serial input to parallel buffered 3-state outputs QP0 to QP7. The parallel outputs may be connected directly to common bus lines. Data is shifted on positive-going clock transitions. The data in each shift register stage is transferred to the storage register when the strobe (STR) input is HIGH. Data in the storage register appears at the outputs whenever the output enable (OE) signal is HIGH.

Two serial outputs (QS1 and QS2) are available for cascading a number of HEF4094B devices. Serial data is available at QS1 on positive-going clock edges to allow high-speed operation in cascaded systems with a fast clock rise time. The same serial data is available at QS2 on the next negative going clock edge. This is used for cascading HEF4094B devices when the clock has a slow rise time.

It operates over a recommended V_{DD} power supply range of 3 V to 15 V referenced to V_{SS} (usually ground). Unused inputs must be connected to V_{DD} , V_{SS} , or another input. It is also suitable for use over the industrial ($-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$) and automotive ($-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$) temperature ranges.

2. Features and benefits

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the automotive temperature range $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information

All types operate from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$.

| Type number | Package | | Version |
|-------------|---------|---|----------|
| | Name | Description | |
| HEF4094BP | DIP16 | plastic dual in-line package; 16 leads (300 mil) | SOT38-4 |
| HEF4094BT | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |
| HEF4094BTS | SSOP16 | plastic shrink small outline package; 16 leads; body width 5.3 mm | SOT338-1 |

4. Functional diagram

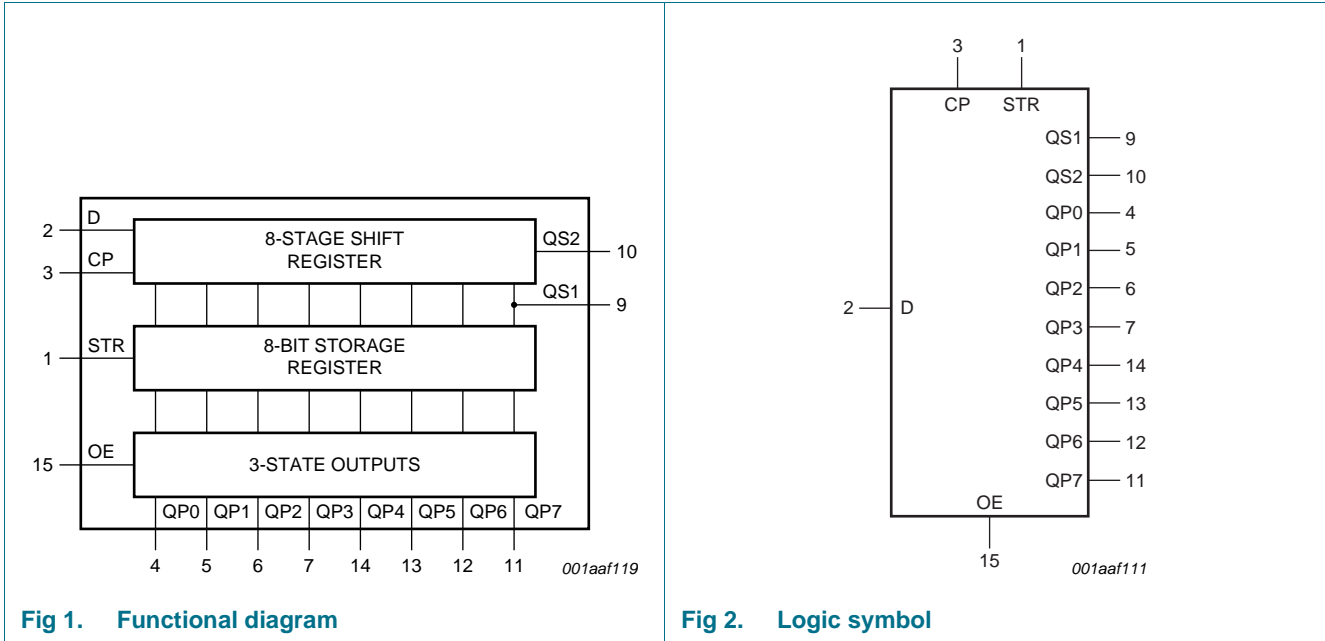


Fig 1. Functional diagram

Fig 2. Logic symbol

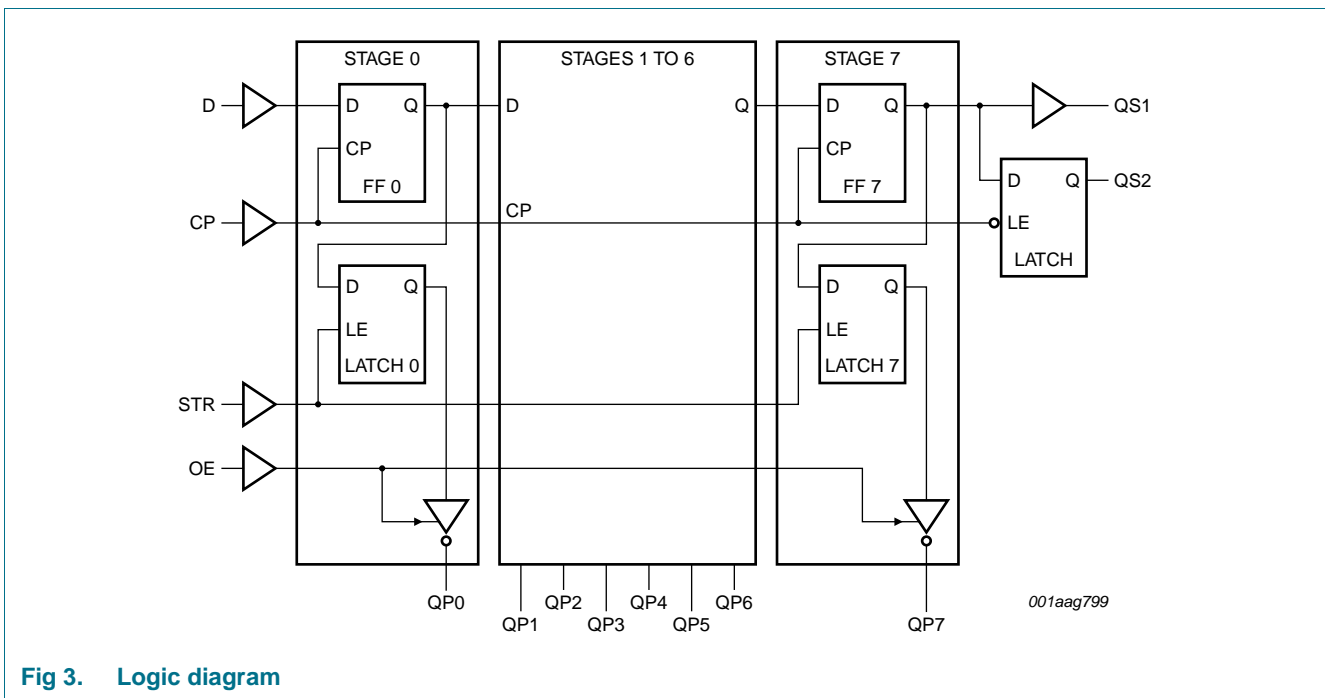
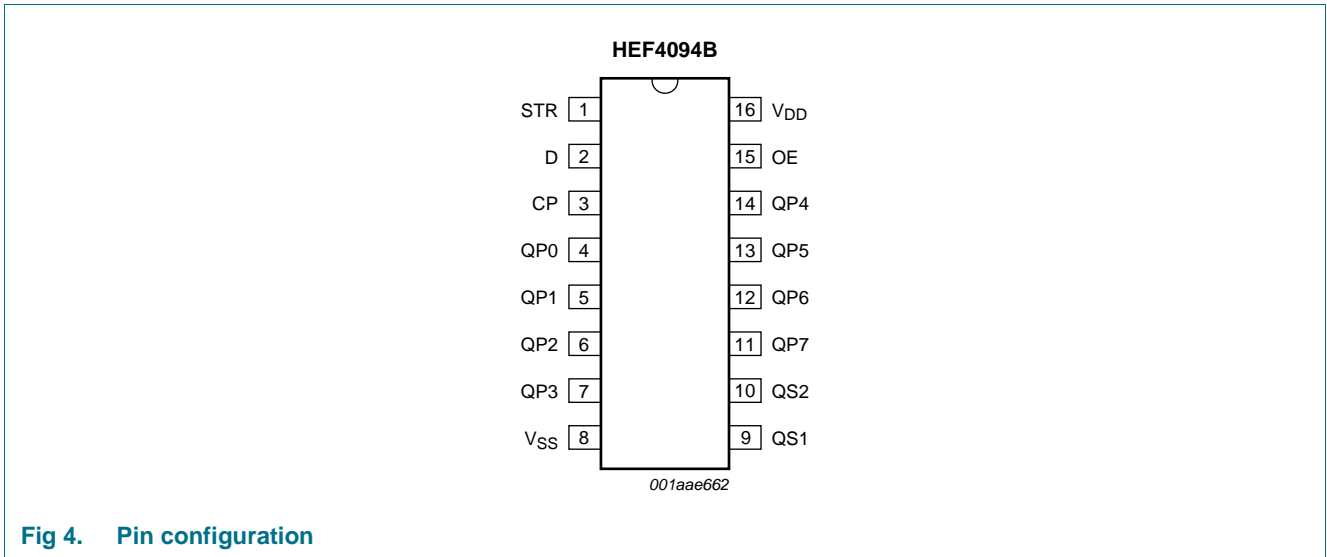


Fig 3. Logic diagram

5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|-----------------|----------------------------|-----------------------|
| STR | 1 | strobe input |
| D | 2 | data input |
| CP | 3 | clock input |
| QP0 to QP7 | 4, 5, 6, 7, 14, 13, 12, 11 | parallel output |
| V _{SS} | 8 | ground supply voltage |
| QS1 | 9 | serial output |
| QS2 | 10 | serial output |
| OE | 15 | output enable input |
| V _{DD} | 16 | supply voltage |

6. Functional description

Table 3. Function table^[1]

| Inputs | | | | Parallel outputs | | Serial outputs | |
|--------|----|-----|---|------------------|---------|----------------|-----|
| CP | OE | STR | D | QP0 | QPn | QS1 | QS2 |
| ↑ | L | X | X | Z | Z | Q6S | NC |
| ↓ | L | X | X | Z | Z | NC | Q7S |
| ↑ | H | L | X | NC | NC | Q6S | NC |
| ↑ | H | H | L | L | QPn - 1 | Q6S | NC |
| ↑ | H | H | H | H | QPn - 1 | Q6S | NC |
| ↓ | H | H | H | NC | NC | NC | Q7S |

- [1] At the positive clock edge, the information in the 7th register stage is transferred to the 8th register stage and the QSn outputs.
 H = HIGH voltage level; L = LOW voltage level; X = don't care;
 ↑ = positive-going transition; ↓ = negative-going transition;
 Z = HIGH-impedance OFF-state; NC = no change;
 Q6S = the data in register stage 6 before the LOW to HIGH clock transition;
 Q7S = the data in register stage 7 before the HIGH to LOW clock transition.

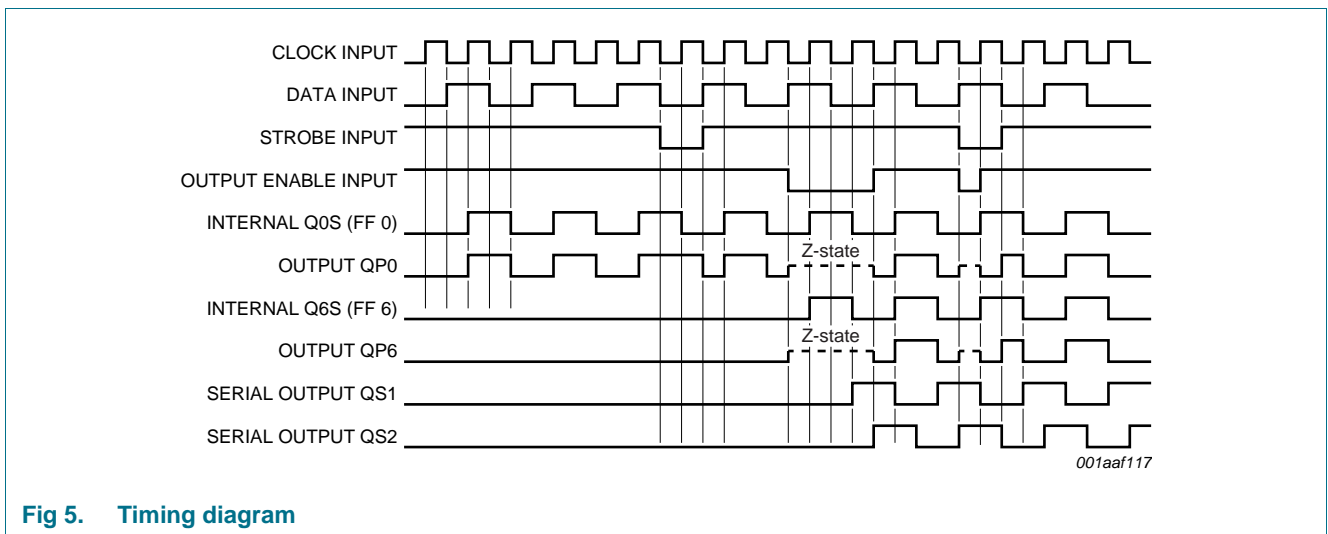


Fig 5. Timing diagram

Features

- Operating voltage: 2.0V~5.5V
- Maximum input serial clock: 500kHz at $V_{DD}=2V$, 2MHz at $V_{DD}=5V$
- Operating current: less than $1\mu A$ at 2V, less than $1.2\mu A$ at 5V
- TTL compatible
 - V_{IH} : $2.0V \sim V_{DD} + 0.3V$ at $V_{DD}=5V$
 - V_{IL} : $-0.3V \sim +0.8V$ at $V_{DD}=5V$
- Two data transmission modes: single-byte, or burst mode
- Serial I/O transmission
- All registers store BCD format
- HT1380: 8-pin DIP package
HT1381: 8-pin SOP package

Applications

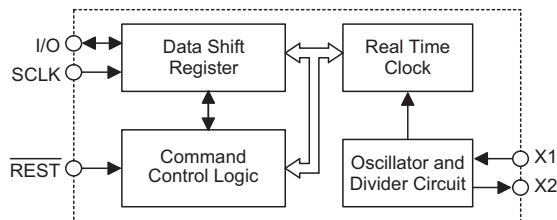
- Microcomputer serial clock
- Clock and Calendar

General Description

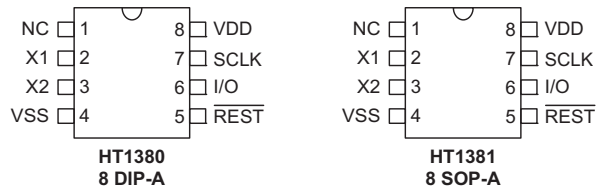
The HT1380/HT1381 is a serial timekeeper IC which provides seconds, minutes, hours, day, date, month and year information. The number of days in each month and leap years are automatically adjusted. The HT1380/HT1381 is designed for low power consumption and can operate in two modes: one is the 12-hour mode with an AM/PM indicator, the other is the 24-hour mode.

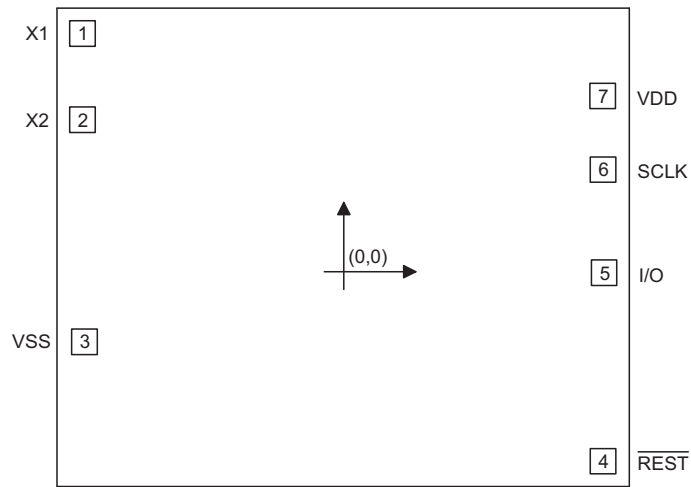
The HT1380/HT1381 has several registers to store the corresponding information with 8-bit data format. A 32768Hz crystal is required to provide the correct timing. In order to minimize the pin number, the HT1380/HT1381 use a serial I/O transmission method to interface with a microprocessor. Only three wires are required: (1) \overline{REST} , (2) SCLK and (3) I/O. Data can be delivered 1 byte at a time or in a burst of up to 8 bytes.

Block Diagram



Pin Assignment



Pad Assignment


Chip size: 2010 × 1920 (μm)²

* The IC substrate should be connected to VSS in the PCB layout artwork.

Pad Coordinates

Unit: μm

| Pad No. | X | Y |
|---------|---------|---------|
| 1 | -851.40 | 775.00 |
| 2 | -851.40 | 494.60 |
| 3 | -844.40 | -203.90 |
| 4 | 845.90 | -618.30 |
| 5 | 848.40 | -4.30 |
| 6 | 845.90 | 332.60 |
| 7 | 844.40 | 572.60 |

Pad Description

| Pad No. | Pad Name | I/O | Internal Connection | Description |
|---------|--------------------------|-----|---------------------|---|
| 1 | X1 | I | CMOS | 32768Hz crystal input pad |
| 2 | X2 | O | CMOS | Oscillator output pad |
| 3 | VSS | — | CMOS | Negative power supply, ground |
| 4 | $\overline{\text{REST}}$ | I | CMOS | Reset pin with serial transmission |
| 5 | I/O | I/O | CMOS | Data input/output pin with serial transmission |
| 6 | SCLK | I | CMOS | Serial clock pulse pin with serial transmission |
| 7 | VDD | — | CMOS | Positive power supply |

LM117/LM317A/LM317 3-Terminal Adjustable Regulator

General Description

The LM117 series of adjustable 3-terminal positive voltage regulators is capable of supplying in excess of 1.5A over a 1.2V to 37V output range. They are exceptionally easy to use and require only two external resistors to set the output voltage. Further, both line and load regulation are better than standard fixed regulators. Also, the LM117 is packaged in standard transistor packages which are easily mounted and handled.

In addition to higher performance than fixed regulators, the LM117 series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe area protection. All overload protection circuitry remains fully functional even if the adjustment terminal is disconnected.

Normally, no capacitors are needed unless the device is situated more than 6 inches from the input filter capacitors in which case an input bypass is needed. An optional output capacitor can be added to improve transient response. The adjustment terminal can be bypassed to achieve very high ripple rejection ratios which are difficult to achieve with standard 3-terminal regulators.

Besides replacing fixed regulators, the LM117 is useful in a wide variety of other applications. Since the regulator is "floating" and sees only the input-to-output differential volt-

age, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded, i.e., avoid short-circuiting the output.

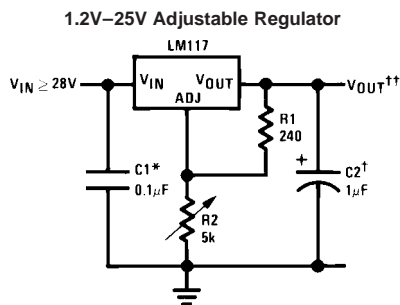
Also, it makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment pin and output, the LM117 can be used as a precision current regulator. Supplies with electronic shutdown can be achieved by clamping the adjustment terminal to ground which programs the output to 1.2V where most loads draw little current.

For applications requiring greater output current, see LM150 series (3A) and LM138 series (5A) data sheets. For the negative complement, see LM137 series data sheet.

Features

- Guaranteed 1% output voltage tolerance (LM317A)
- Guaranteed max. 0.01%/V line regulation (LM317A)
- Guaranteed max. 0.3% load regulation (LM117)
- Guaranteed 1.5A output current
- Adjustable output down to 1.2V
- Current limit constant with temperature
- P+ Product Enhancement tested
- 80 dB ripple rejection
- Output is short-circuit protected

Typical Applications



DS009063-1

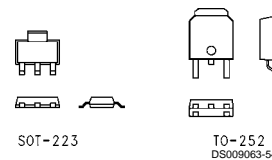
Full output current not available at high input-output voltages
 *Needed if device is more than 6 inches from filter capacitors.
 †Optional — improves transient response. Output capacitors in the range of 1 μF to 1000 μF of aluminum or tantalum electrolytic are commonly used to provide improved output impedance and rejection of transients.

$$\dagger\dagger V_{OUT} = 1.25V \left(1 + \frac{R2}{R1} \right) + I_{ADJ}(R2)$$

LM117 Series Packages

| Part Number Suffix | Package | Design Load Current |
|-----------------------|---------|---------------------------|
| K | TO-3 | 1.5A |
| H | TO-39 | 0.5A |
| T | TO-220 | 1.5A |
| E | LCC | 0.5A |
| S | TO-263 | 1.5A |
| EMP | SOT-223 | 1A |
| MDT | TO-252 | 0.5A |

SOT-223 vs D-Pak (TO-252) Packages



Scale 1:1

LM9022

Vacuum Fluorescent Display Filament Driver

General Description

The LM9022 is a bridged power amplifier capable of delivering typically 2W of continuous average power into a 10Ω filament load when powered by a 5V power supply.

To conserve power in portable applications, the LM9022's micropower shutdown mode ($I_{Q} = 0.6\mu\text{A}$, typ) is activated when V_{DD} is applied to the SHUTDOWN pin.

Additional LM9022 features include thermal shutdown protection, unity-gain stability, and external gain set.

Key Specifications

- I_{DD} during shutdown 0.6μA (typ)
- Thermal Shutdown Protection

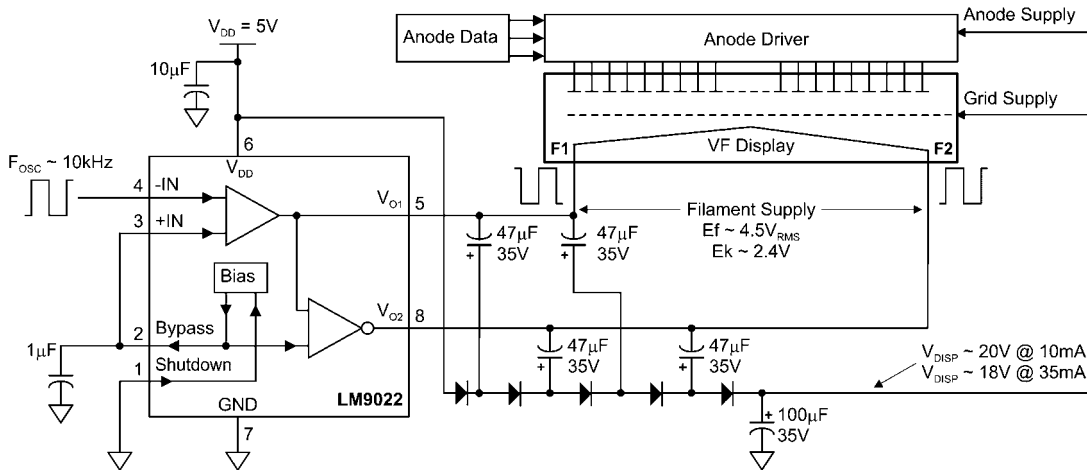
Features

- No transformers required
- SO or DIP packaging

Applications

- VCR/DVD Displays
- RADIO/TUNER Displays

Typical Application $T_A = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$, unless otherwise specified.

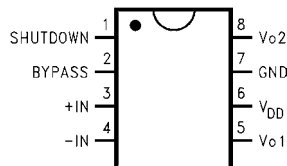


20021501

FIGURE 1. Typical Application Circuit

Connection Diagram

MSOP, Small Outline, and DIP Package



20021502

Top View

Order Number LM9022M or LM9022N
See NS Package Number M08A or N08E

LMV831 Single/ LMV832 Dual/ LMV834 Quad 3.3 MHz Low Power CMOS, EMI Hardened Operational Amplifiers

General Description

National's LMV831, LMV832, and LMV834 are CMOS input, low power op amp IC's, providing a low input bias current, a wide temperature range of -40°C to 125°C and exceptional performance making them robust general purpose parts. Additionally, the LMV831/LMV832/LMV834 are EMI hardened to minimize any interference so they are ideal for EMI sensitive applications.

The unity gain stable LMV831/LMV832/LMV834 feature 3.3 MHz of bandwidth while consuming only 0.24 mA of current per channel. These parts also maintain stability for capacitive loads as large as 200 pF. The LMV831/LMV832/LMV834 provide superior performance and economy in terms of power and space usage.

This family of parts has a maximum input offset voltage of 1 mV, a rail-to-rail output stage and an input common-mode voltage range that includes ground. Over an operating range from 2.7V to 5.5V the LMV831/LMV832/LMV834 provide a PSRR of 93 dB, and a CMRR of 91 dB. The LMV831 is offered in the space saving 5-Pin SC70 package, the LMV832 in the 8-Pin MSOP and the LMV834 is offered in the 14-Pin TSSOP package.

Features

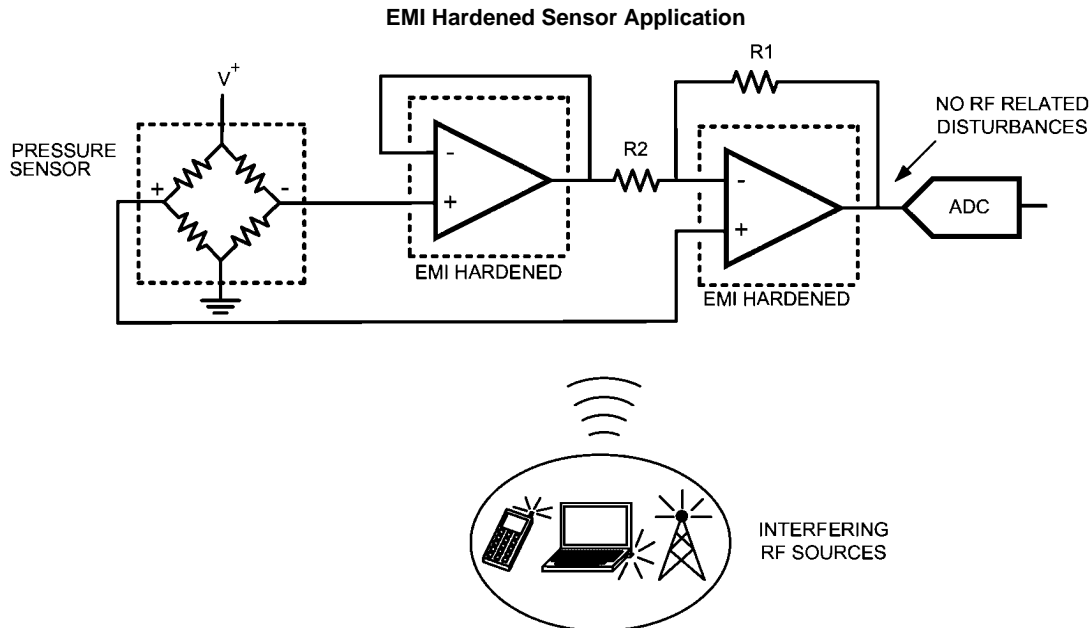
Unless otherwise noted, typical values at $T_A = 25^{\circ}\text{C}$, $V_+ = 3.3\text{V}$

| | |
|---------------------------------------|--|
| ■ Supply voltage | 2.7V to 5.5V |
| ■ Supply current (per channel) | 240 μA |
| ■ Input offset voltage | 1 mV max |
| ■ Input bias current | 0.1 pA |
| ■ GBW | 3.3 MHz |
| ■ EMIRR at 1.8 GHz | 120 dB |
| ■ Input noise voltage at 1 kHz | 12 nV/ $\sqrt{\text{Hz}}$ |
| ■ Slew rate | 2 V/ μs |
| ■ Output voltage swing | Rail-to-Rail |
| ■ Output current drive | 30 mA |
| ■ Operating ambient temperature range | -40°C to 125°C |

Applications

- Photodiode preamp
- Piezoelectric sensors
- Portable/battery-powered electronic equipment
- Filters/buffers
- PDAs/phone accessories

Typical Application



30024101

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

| | |
|--------------------------------------|--------------------------------|
| ESD Tolerance (Note 2) | |
| Human Body Model | 2 kV |
| Charge-Device Model | 1 kV |
| Machine Model | 200V |
| V_{IN} Differential | \pm Supply Voltage |
| Supply Voltage ($V_S = V^+ - V^-$) | 6V |
| Voltage at Input/Output Pins | $V^+ + 0.4V$, $V^- - 0.4V$ |

| | |
|---------------------------------|----------------|
| Storage Temperature Range | -65°C to 150°C |
| Junction Temperature (Note 3) | 150°C |
| Soldering Information | |
| Infrared or Convection (20 sec) | 260°C |

Operating Ratings (Note 1)

| | |
|--|----------------|
| Temperature Range (Note 3) | -40°C to 125°C |
| Supply Voltage ($V_S = V^+ - V^-$) | 2.7V to 5.5V |
| Package Thermal Resistance (θ_{JA} (Note 3)) | |
| 5-Pin SC-70 | 302°C/W |
| 8-Pin MSOP | 217°C/W |
| 14-Pin TSSOP | 135°C/W |

3.3V Electrical Characteristics (Note 4)

Unless otherwise specified, all limits are guaranteed for at $T_A = 25^\circ\text{C}$, $V^+ = 3.3\text{V}$, $V^- = 0\text{V}$, $V_{CM} = V^+/2$, and $R_L = 10\text{ k}\Omega$ to $V^+/2$.

Boldface limits apply at the temperature extremes.

| Symbol | Parameter | Conditions | Min (Note 6) | Typ (Note 5) | Max (Note 6) | Units |
|------------|---|--|-----------------------------|-------------------|--|------------------------------|
| V_{OS} | Input Offset Voltage (Note 9) | | | ± 0.25 | ± 1.00 ± 1.23 | mV |
| TCV_{OS} | Input Offset Voltage Temperature Drift (Notes 9, 10) | | | ± 0.5 | ± 1.5 | $\mu\text{V}/^\circ\text{C}$ |
| | | LMV831, LMV832 | | | | |
| | | LMV834 | | ± 0.5 | ± 1.7 | |
| I_B | Input Bias Current (Note 10) | | | 0.1 | 10 500 | pA |
| I_{OS} | Input Offset Current | | | 1 | | pA |
| CMRR | Common-Mode Rejection Ratio (Note 9) | $0.2\text{V} \leq V_{CM} \leq V^+ - 1.2\text{V}$ | 76 75 | 91 | | dB |
| PSRR | Power Supply Rejection Ratio (Note 9) | $2.7\text{V} \leq V^+ \leq 5.5\text{V}$, $V_{OUT} = 1\text{V}$ | 76 75 | 93 | | dB |
| EMIRR | EMI Rejection Ratio, IN+ and IN- (Note 8) | $V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB _P), $f = 400\text{ MHz}$ | | 80 | | dB |
| | | $V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB _P), $f = 900\text{ MHz}$ | | 90 | | |
| | | $V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB _P), $f = 1800\text{ MHz}$ | | 110 | | |
| | | $V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB _P), $f = 2400\text{ MHz}$ | | 120 | | |
| CMVR | Input Common-Mode Voltage Range | CMRR $\geq 65\text{ dB}$ | -0.1 | | 2.1 | V |
| A_{VOL} | Large Signal Voltage Gain (Note 11) | $R_L = 2\text{ k}\Omega$, $V_{OUT} = 0.15\text{V to } 1.65\text{V}$, $V_{OUT} = 3.15\text{V to } 1.65\text{V}$ | LMV831, LMV832 LMV834 | 102 102 | 121 | dB |
| | | $R_L = 10\text{ k}\Omega$, $V_{OUT} = 0.1\text{V to } 1.65\text{V}$, $V_{OUT} = 3.2\text{V to } 1.65\text{V}$ | LMV831, LMV832 LMV834 | 104 104 | 126 | |
| | | | | 104 103 | 123 | |
| | | | | | | |

| Symbol | Parameter | Conditions | Min (Note 6) | Typ (Note 5) | Max (Note 6) | Units | | |
|-----------|--------------------------------------|--|-------------------|-----------------|-----------------|-----------------------|------------------------|--|
| V_{OUT} | Output Voltage Swing High | $R_L = 2\text{ k}\Omega$ to $V^+/2$ | LMV831, LMV832 | | 29 | 36 43 | mV from either rail | |
| | | | LMV834 | | 31 | 38 44 | | |
| | | $R_L = 10\text{ k}\Omega$ to $V^+/2$ | LMV831, LMV832 | | 6 | 8 9 | | |
| | | | LMV834 | | 7 | 9 10 | | |
| | Output Voltage Swing Low | $R = 2\text{ k}\Omega$ to $V^+/2$ | | | 25 | 34 43 | | |
| | | $R_L = 10\text{ k}\Omega$ to $V^+/2$ | | | 5 | 8 10 | | |
| I_{OUT} | Output Short Circuit Current | Sourcing, $V_{OUT} = V_{CM}$, $V_{IN} = 100\text{ mV}$ | LMV831, LMV832 | 27 22 | 28 | | mA | |
| | | | LMV834 | 24 19 | 28 | | | |
| | | Sinking, $V_{OUT} = V_{CM}$, $V_{IN} = -100\text{ mV}$ | | | 27 21 | 32 | | |
| | | | | | | | | |
| I_S | Supply Current | | LMV831 | | 0.24 | 0.27 0.30 | mA | |
| | | | LMV832 | | 0.46 | 0.51 0.58 | | |
| | | | LMV834 | | 0.90 | 1.00 1.16 | | |
| SR | Slew Rate (Note 7) | $A_V = +1$, $V_{OUT} = 1\text{ V}_{PP}$, 10% to 90% | | 2 | | V/ μ s | | |
| GBW | Gain Bandwidth Product | | | 3.3 | | MHz | | |
| Φ_m | Phase Margin | | | 65 | | deg | | |
| e_n | Input Referred Voltage Noise Density | $f = 1\text{ kHz}$ | | 12 | | $nV/\sqrt{\text{Hz}}$ | | |
| | | $f = 10\text{ kHz}$ | | 10 | | | | |
| i_n | Input Referred Current Noise Density | $f = 1\text{ kHz}$ | | 0.005 | | $pA/\sqrt{\text{Hz}}$ | | |
| R_{OUT} | Closed Loop Output Impedance | $f = 2\text{ MHz}$ | | 500 | | Ω | | |
| C_{IN} | Common-mode Input Capacitance | | | 15 | | pF | | |
| | Differential-mode Input Capacitance | | | 20 | | | | |
| THD+N | Total Harmonic Distortion + Noise | $f = 1\text{ kHz}$, $A_V = 1$, $BW \geq 500\text{ kHz}$ | | 0.02 | | % | | |

5V Electrical Characteristics (Note 4)

Unless otherwise specified, all limits are guaranteed for at $T_A = 25^\circ\text{C}$, $V^+ = 5\text{V}$, $V^- = 0\text{V}$, $V_{CM} = V^+/2$, and $R_L = 10\text{ k}\Omega$ to $V^+/2$.

Boldface limits apply at the temperature extremes.

| Symbol | Parameter | Conditions | Min (Note 6) | Typ (Note 5) | Max (Note 6) | Units |
|------------|---|--|------------------------|-----------------|--|------------------------------|
| V_{OS} | Input Offset Voltage (Note 9) | | | ± 0.25 | ± 1.00 ± 1.23 | mV |
| TCV_{OS} | Input Offset Voltage Temperature Drift (Notes 9, 10) | LMV831, LMV832 | | ± 0.5 | ± 1.5 | $\mu\text{V}/^\circ\text{C}$ |
| | | LMV834 | | ± 0.5 | ± 1.7 | |
| I_B | Input Bias Current (Note 10) | | | 0.1 | 10 500 | pA |
| I_{OS} | Input Offset Current | | | 1 | | pA |
| CMRR | Common-Mode Rejection Ratio (Note 9) | $0\text{V} \leq V_{CM} \leq V^+ - 1.2\text{V}$ | 77 77 | 93 | | dB |

| Symbol | Parameter | Conditions | Min (Note 6) | Typ (Note 5) | Max (Note 6) | Units | |
|-----------|--|---|-------------------|-------------------|---------------------|------------------------|------------------------|
| PSRR | Power Supply Rejection Ratio (Note 9) | $2.7V \leq V_+ \leq 5.5V$, $V_{OUT} = 1V$ | 76 75 | 93 | | dB | |
| EMIRR | EMI Rejection Ratio, IN+ and IN- (Note 8) | $V_{RF_PEAK} = 100 \text{ mV}_P (-20 \text{ dB}_P)$, $f = 400 \text{ MHz}$ | | 80 | | dB | |
| | | $V_{RF_PEAK} = 100 \text{ mV}_P (-20 \text{ dB}_P)$, $f = 900 \text{ MHz}$ | | 90 | | | |
| | | $V_{RF_PEAK} = 100 \text{ mV}_P (-20 \text{ dB}_P)$, $f = 1800 \text{ MHz}$ | | 110 | | | |
| | | $V_{RF_PEAK} = 100 \text{ mV}_P (-20 \text{ dB}_P)$, $f = 2400 \text{ MHz}$ | | 120 | | | |
| CMVR | Input Common-Mode Voltage Range | $CMRR \geq 65 \text{ dB}$ | -0.1 | | 3.8 | V | |
| A_{VOL} | Large Signal Voltage Gain (Note 11) | $R_L = 2 \text{ k}\Omega$, $V_{OUT} = 0.15V \text{ to } 2.5V$, $V_{OUT} = 4.85V \text{ to } 2.5V$ | LMV831, LMV832 | 107 106 | 127 | dB | |
| | | | LMV834 | 104 104 | 127 | | |
| | | $R_L = 10 \text{ k}\Omega$, $V_{OUT} = 0.1V \text{ to } 2.5V$, $V_{OUT} = 4.9V \text{ to } 2.5V$ | LMV831, LMV832 | 107 107 | 130 | | |
| | | | LMV834 | 105 104 | 127 | | |
| V_{OUT} | Output Voltage Swing High | $R_L = 2 \text{ k}\Omega \text{ to } V+/2$ | LMV831, LMV832 | | 32 | 42 49 | mV from either rail |
| | | | LMV834 | | 35 | 45 52 | |
| | | $R_L = 10 \text{ k}\Omega \text{ to } V+/2$ | LMV831, LMV832 | | 6 | 9 10 | |
| | | | LMV834 | | 7 | 10 11 | |
| | Output Voltage Swing Low | $R_L = 2 \text{ k}\Omega \text{ to } V+/2$ | | | 27 | 43 52 | |
| | | $R_L = 10 \text{ k}\Omega \text{ to } V+/2$ | | | 6 | 10 12 | |
| I_{OUT} | Output Short Circuit Current | Sourcing $V_{OUT} = V_{CM}$ $V_{IN} = 100 \text{ mV}$ | LMV831, LMV832 | 59 49 | 66 | mA | |
| | | | LMV834 | 57 45 | 63 | | |
| | | Sinking $V_{OUT} = V_{CM}$ $V_{IN} = -100 \text{ mV}$ | LMV831, LMV832 | 50 41 | 64 | | |
| | | | LMV834 | 53 41 | 63 | | |
| I_S | Supply Current | LMV831 | | 0.25 | 0.27 0.31 | mA | |
| | | LMV832 | | 0.47 | 0.52 0.60 | | |
| | | LMV834 | | 0.92 | 1.02 1.18 | | |
| SR | Slew Rate (Note 7) | $A_V = +1$, $V_{OUT} = 2V_{PP}$, 10% to 90% | | 2 | | V/ μ s | |
| GBW | Gain Bandwidth Product | | | 3.3 | | MHz | |
| Φ_m | Phase Margin | | | 65 | | deg | |
| e_n | Input Referred Voltage Noise | $f = 1 \text{ kHz}$ | | 12 | | nV/ $\sqrt{\text{Hz}}$ | |
| | | $f = 10 \text{ kHz}$ | | 10 | | | |

| Symbol | Parameter | Conditions | Min (Note 6) | Typ (Note 5) | Max (Note 6) | Units |
|------------------|-------------------------------------|--|--------------|--------------|--------------|------------------------------|
| i_n | Input Referred Current Noise | $f = 1 \text{ kHz}$ | | 0.005 | | $\text{pA}/\sqrt{\text{Hz}}$ |
| R_{OUT} | Closed Loop Output Impedance | $f = 2 \text{ MHz}$ | | 500 | | Ω |
| C_{IN} | Common-mode Input Capacitance | | | 14 | | pF |
| | Differential-mode Input Capacitance | | | 20 | | |
| THD+N | Total Harmonic Distortion + Noise | $f = 1 \text{ kHz}, A_V = 1, \text{BW} \geq 500 \text{ kHz}$ | | 0.02 | | % |

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.

Note 2: Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).

Note 3: The maximum power dissipation is a function of $T_{\text{J(MAX)}}$, θ_{JA} , and T_{A} . The maximum allowable power dissipation at any ambient temperature is $P_{\text{D}} = (T_{\text{J(MAX)}} - T_{\text{A}}) / \theta_{\text{JA}}$. All numbers apply for packages soldered directly onto a PC board.

Note 4: Electrical Table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device such that $T_{\text{J}} = T_{\text{A}}$. No guarantee of parametric performance is indicated in the electrical tables under conditions of internal self-heating where $T_{\text{J}} > T_{\text{A}}$.

Note 5: Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

Note 6: Limits are 100% production tested at 25°C. Limits over the operating temperature range are guaranteed through correlations using statistical quality control (SQC) method.

Note 7: Number specified is the slower of positive and negative slew rates.

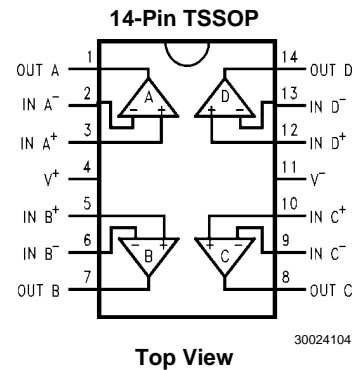
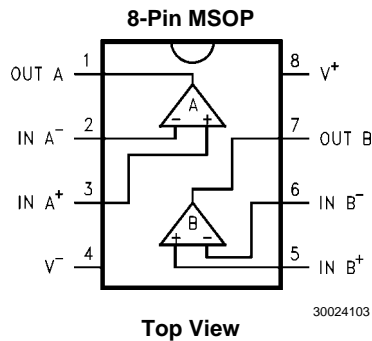
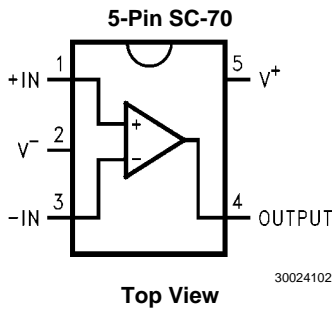
Note 8: The EMI Rejection Ratio is defined as $\text{EMIRR} = 20\log(V_{\text{RF_PEAK}}/\Delta V_{\text{OS}})$.

Note 9: The typical value is calculated by applying absolute value transform to the distribution, then taking the statistical average of the resulting distribution.

Note 10: This parameter is guaranteed by design and/or characterization and is not tested in production.

Note 11: The specified limits represent the lower of the measured values for each output range condition.

Connection Diagrams



Ordering Information

| Package | Part Number | Package Marking | Transport Media | NSC Drawing |
|--------------|-------------|-----------------|--------------------------|-------------|
| 5-Pin SC-70 | LMV831MG | AFA | 1k Units Tape and Reel | MAA05A |
| | LMV831MGE | | 250 Units Tape and Reel | |
| | LMV831MGX | | 3k Units Tape and Reel | |
| 8-Pin MSOP | LMV832MM | AU5A | 1k Units Tape and Reel | MUA08A |
| | LMV832MME | | 250 Units Tape and Reel | |
| | LMV832MMX | | 3.5k Units Tape and Reel | |
| 14-Pin TSSOP | LMV834MT | LMV834MT | 94 Units/Rail | MTC14 |
| | LMV834MTX | | 2.5k Units Tape and Reel | |

1. Features

Ali's M5673 provides cost-effective solutions for playback audio from disc, SD/MMC/MS flash card and USB mass storage device. It built-in audio 24-bit Digital Signal Processor. With state-of-the-art technology and cost-effective integration in mind, M5673 is developed to provide many leading features in a system-on-chip solution, including CD RF PreAmp, CD Servo controller, EDC/ECC error detection and correction, full-speed USB1.1 host controller, SD/MMC/MS memory card interface, high-performance caching micro-controller with user-configurable I/Os, high-performance mixed-mode audio macros, etc.

CD Servo

- Integrated RF Amp, Servo control, CD-DSP and CD-ROM decoder.
- Support CD/CD-R/CD-RW physical format disc.
- Support CDDA, CD-ROM(mode 1, mode2 form 1)logical format playback.
- Support up to 4X speed optical pickup unit.
- Embedded SRAM for ECC buffer, no need extra external DRAM.

USB1.1 Controller

- on-chip USB transceiver compliant with USB Specification revision 1.1 Full-Speed(FS)
- Support full-speed USB1.1 host mode for USB disc.
- Built-in Configurable Four USB Endpoint FIFOs.
 - Endpoint 0: 64-byte FIFO support for Control transfer.
 - Endpoint A: 64-byte double-buffered bulk-In transfer.
 - Endpoint B: 64-byte double-buffered bulk-Out transfer.
 - Endpoint C: 8-byte interrupt transfer.
- Support USB wakeup/suspend.
- support DMA operation for bulk transfer.

Data Storage Controller

- Support flash cards including Secure-Digital (SD) and Multi-Media Card (MMC), Memory Stick (MS), MS-Pro, etc.
- Support DMA operation.

High performance Micro-controller

- High-performance 8-bit 56MHz micro-controller with 8051 compatible instruction set.
- Built-in 8KBytes 2-way i-cache SRAM.
- Support up to 256 KBytes external Serial-Flash.
- Maximum 32K-bytes internal program SRAM for system FW upgrade when audio DSP is disabled.

Audio DSP

- High-performance 24-bit digital Signal Processor.
- Support MPEG1 Layer 1/Layer 2/Layer 3 decode.
- Support MPEG2/2.5 Layer 3 decode.
- Support WMA full class decode.
- Support ADPCM 4 bit mode encode/decode.

Integrated Audio Codec

- Built-in high-performance stereo A/D and D/A converters.
- Support Line In/FM in inputs.
- Microphone input with boost.
- Built-in Bass filter and PGA gain controller.

Integrated Linear Regulator

- Built-in 3.3V to 1.8V regulator for M5673 core power .
- Programmable 1.8V power ranges: 1.6V~1.9V.

General feature

- Programmable GPIOs for Buttons and LED control.
- Build-in 3 ADC for key detection or other application.

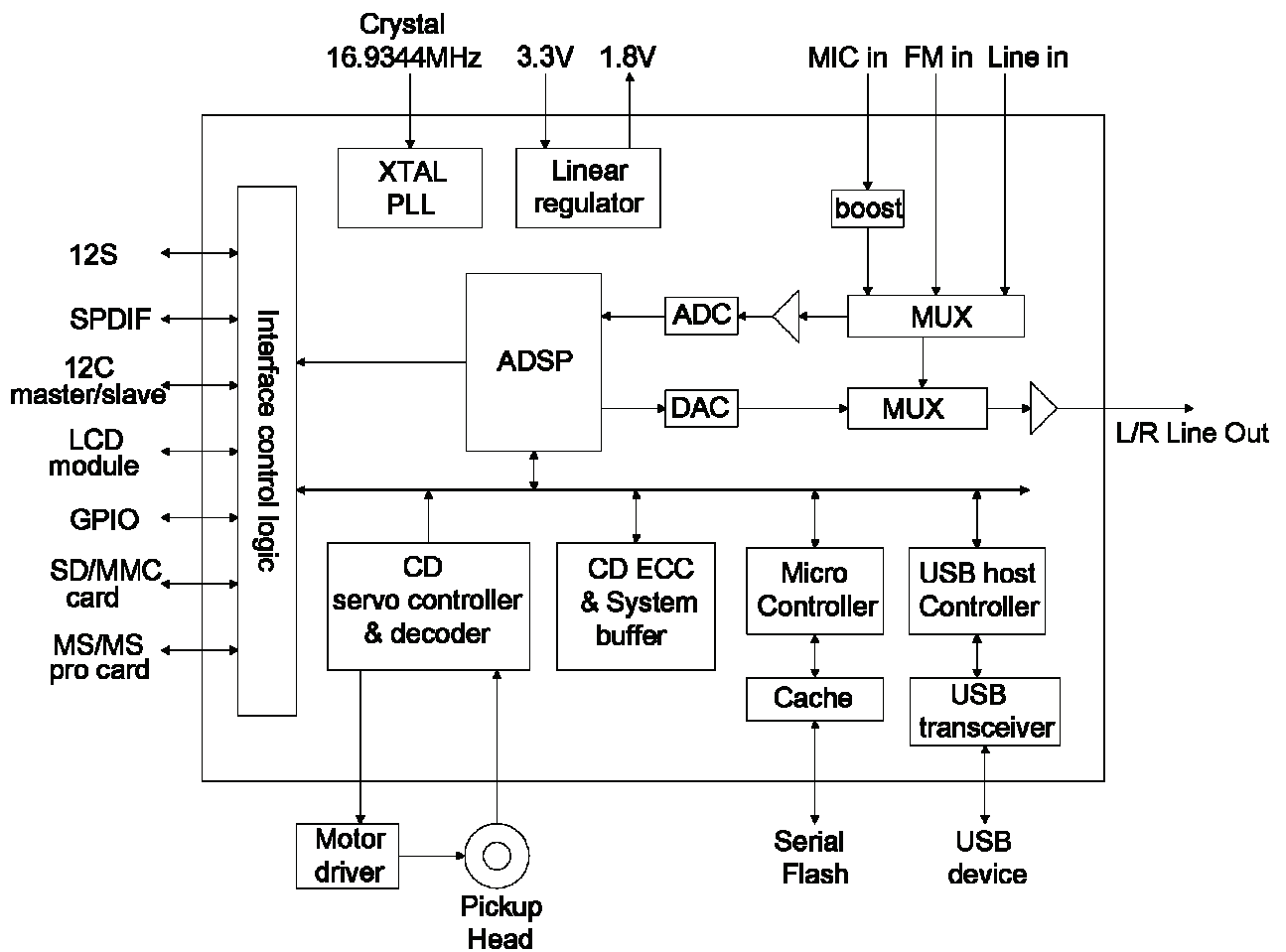
www.ali.com.tw

specifications subject to change without notice

M5673 Data Sheet V1.0

Preliminary Confidential Proprietary

3. Block Diagram



4. Pin Configuration

Table 4-4. Pins Listed in Numeric Order

| Pin | Signal | Pin | Signal | Pin | Signal | Pin | Signal |
|-----|------------|-----|---------------------|-----|-----------------------|-----|-------------------------|
| 1 | LDO | 33 | LINEOUTL | 65 | GPIOD1/ 12CM-DAT | 97 | GPIOH5/LCDRS |
| 2 | TP1 | 34 | BICAPR | 66 | GPIOD2/ 12S-SCLK | 98 | GPIOH6/LCDCSJ |
| 3 | TP2 | 35 | BOCAPR | 67 | GPIOD3/ 12S-REFCLK | 99 | PRSTB |
| 4 | MC | 36 | LINEOUTR | 68 | GPIOD4/ 12S-D0 | 100 | GPIOH7/LCDRDJ |
| 5 | MB | 37 | AVSS33-AUD | 69 | GPIOD5/ 12S-D1 | 101 | GPIO10/LCDWRJ |
| 6 | MD | 38 | AVSS33-AUD | 70 | GPIOD6/ 12S-WCLK | 102 | GPIOI1/PWMO/ LCD-ALE |
| 7 | MA | 39 | FMINR | 71 | GPIOD7/SPDIF | 103 | GPIOI2/IRC |
| 8 | AVDD33-2 | 40 | LINEINR | 72 | GPIOE0 | 104 | GPIOI3/PWM1 |
| 9 | HAVC | 41 | MICIN | 73 | GPIOE1 | 105 | GPIOI4/PWM2 |
| 10 | V12 | 42 | FMINL | 74 | GPIOE2 | 106 | GPIOI5 |
| 11 | AVSS33-2 | 43 | LINEINL | 75 | GPIOE3 | 107 | GPIOI6 |
| 12 | TELP | 44 | MICBIAS | 76 | GPIOE4/SDD0 | 108 | GPIOI7/ 12CS-CLK |
| 13 | MPXOUT1 | 45 | V08L | 77 | GPIOE5/SDD1 | 109 | GPIOJ0/ 12CS-DAT |
| 14 | MPXOUT2 | 46 | V15L | 78 | GPIOE6/SDD2 | 110 | GPIOJ1 |
| 15 | MPXOUT3 | 47 | V08R | 79 | GPIOE7/SDD3 | 111 | GPIOJ2 |
| 16 | COSP | 48 | V15R | 80 | GPIOF0/SDCMD | 112 | GND-PAD |
| 17 | COSN | 49 | VREF | 81 | GPIOF1/SD-CLK | 113 | VDD-PAD |
| 18 | AVDD33-3 | 50 | SFGP | 82 | GPIOF2 | 114 | GND-CORE |
| 19 | VTB | 51 | SFGN | 83 | GPIOF3 | 115 | VDD-CORE |
| 20 | VTP | 52 | DM | 84 | GND-PAD | 116 | AVDD-D33 |
| 21 | AVSS33-3 | 53 | DP | 85 | VDD-PAD | 117 | BTN-ADIN1 |
| 22 | AVSS33-LDO | 54 | VDD-CORE | 86 | GPIOG2 | 118 | BTN-ADIN2 |
| 23 | AVDD33-LDO | 55 | GND-CORE | 87 | GPIOG3 | 119 | BTN-ADIN3 |
| 24 | AVDD18-LDO | 56 | GND-PAD | 88 | GPIOG4 | 120 | VREF16 |
| 25 | AVDD33-CKG | 57 | VDD-PAD | 89 | GPIOG5/LCDDDB0 | 121 | FMO |
| 26 | XTAL1 | 58 | GPIOB6/SFDO | 90 | GPIOG6/LCDDDB1 | 122 | AVD33-1 |
| 27 | XTALO | 59 | GPIOB7/SFDI | 91 | GPIOG7/LCDDDB2 | 123 | DMO |
| 28 | AVSS33-CKG | 60 | GPIOC0/SFCSB | 92 | GPIOH0/LCDDDB3 | 124 | AVSS33-1 |
| 29 | AVDD18-1 | 61 | GPIOC1/SFCK | 93 | GPIOH1/LCDDDB4 | 125 | GPWM |
| 30 | AVSS18-1 | 62 | GPIOC2/URTX | 94 | GPIOH2/LCDDDB5 | 126 | FOO |
| 31 | BICAPL | 63 | GPIOC3/URRX | 95 | GPIOH3/LCDDDB6 | 127 | TRO |
| 32 | BOCAPL | 64 | GPIOD0/ 12CM-CLK | 96 | GPIOH4/LCDDDB7 | 128 | MDI |

5. Pin Description

Table 5-2. Pin Description

| Pin(s) No. | Signal | Attribute | Description |
|------------|------------|-----------|--|
| 1 | LDO | O/A | Laser Driver Output of APC |
| 2 | TP1 | I/A | 3 Beam Satellite PD Positive Input |
| 3 | TP2 | I/A | 3 Beam Satellite PD Negative Input |
| 4 | MC | I/A | Input of main Beam Signal (C) |
| 5 | MB | I/A | Input of main Beam Signal (B) |
| 6 | MD | I/A | Input of main Beam Signal (D) |
| 7 | MA | I/A | Input of main Beam Signal (A) |
| 8 | AVDD33-2 | P | Servo Analog Power |
| 9 | HAVC | O/A | Voltage Reference (programmable) |
| 10 | V12 | O/A | Voltage Reference (1.2V) |
| 11 | AVSS33-2 | G | Servo Analog Ground |
| 12 | TELP | O/A | Low Pass Filter Capacitor Connecting for TEZC Detection |
| 13 | MPXOUT1 | O/A | Multiplexer output 1 for Analog Signal Monitoring |
| 14 | MPXOUT2 | O/A | Multiplexer output 2 for Analog Signal Monitoring |
| 15 | MPXOUT3 | O/A | Multiplexer output 3 for Analog Signal Monitoring |
| 16 | COSP | O/A | External Capacitor Connection of offset Cancellation Loop for VGA in EQRF Block (Positive) |
| 17 | COSN | O/A | External Capacitor Connection of offset Cancellation Loop for VGA in EQRF Block (Negative) |
| 18 | AVDD33-3 | P | PRML ADC Power |
| 19 | VTB | B/O | PRML ADC Voltage Control, connect to Capacitor |
| 20 | VTP | B/O | PRML ADC Voltage Control, connect to Capacitor |
| 21 | AVSS33-3 | G | PRML ADC Ground |
| 22 | AVSS33-LDO | G | LDO Ground |
| 23 | AVDD33-LDO | P | LDO 3.3V input |
| 24 | AVDD18-LDO | O/A | LDO 1.8V output |
| 25 | AVDD33-CKG | P | Clock Generator Power |
| 26 | XTAL1 | I/A | External XTAL (I), 16.9344MHz |
| 27 | XTALO | O/A | External XTAL (O), 16.9344MHz |
| 28 | AVSS33-CKG | G | Clock Generator Ground |
| 29 | AVDD18-1 | P | Analog Power for PLL |
| 30 | AVSS18-1 | G | Analog Ground for PLL |
| 31 | BICAPL | I/A | Left channel Bass capacitor in |
| 32 | BOCAPL | O/A | Left channel Bass capacitor out |
| 33 | LINEOUTL | O/A | Left Channel Audio out |
| 34 | BICAPR | I/A | Right channel Bass capacitor in |
| 35 | BOCAPR | O/A | Right channel Bass capacitor out |
| 36 | LINEOUTR | O/A | Right channel Audio out |
| 37 | AVSS33-AUD | G | VSS of ADC/DAC |
| 38 | AVDD33-AUD | P | VDD of ADC/DAC |
| 39 | FMINR | I/A | Right channel ADC FM in |
| 40 | LINEINR | I/A | Right channel ADC line in |
| 41 | MICIN | I/A | ADC MIC in |
| 42 | FMINL | I/A | Left channel ADC FM in |
| 43 | LINEINL | I/A | Left channel ADC line in |
| 44 | MICBIAS | I/A | MIC DC bias |
| 45 | V08L | O/A | Left channel VCM reference |
| 46 | V15L | O/A | Left channel voltage reference |
| 47 | V08R | O/A | Right channel VCM reference |
| 48 | V15R | O/A | Right channel voltage reference |
| 49 | VREF | O/A | Internal resistor string provide Vref |
| 50 | SFGP | I/A | DISC stop pos input/GPIO |
| 51 | SFGN | I/A | DISC stop neg input/GPIO |
| 52 | DM | | USB D- |
| 53 | DP | | USB D+ |
| 54 | VDD-CORE | P | Digital Core power |
| 55 | GND-CORE | G | Digital Core Ground |
| 56 | GND-PAD | G | Digital PAD Ground |

| Pin(s) No. | Signal | Attribute | Description |
|------------|---------------------|-----------|---|
| 57 | VDD-PAD | P | Digital PAD power |
| 58 | GPIOB6/SFDO | B / D | GPIOB6/Seriel flash data input |
| 59 | GPIOB7/SFDI | B / D | GPIOB7/Seriel flash data output |
| 60 | GPIOC0/SFCSB | B / D | GPIOC0/Seriel flash csj |
| 61 | GPIOC1/SFSCK | B / D | GPIOC1/Seriel flash clk |
| 62 | GPIOC2/URTX | B / D | GPIOC2/RS-232 TX |
| 63 | GPIOC3/URRX | B / D | GPIOC3/RS-232 RX |
| 64 | GPIOD0/12CM-CLK | B / D | GPIOD0/12C clk output (M5673 is master) |
| 65 | GPIOD1/12CM-DAT | B / D | GPIOD1/12C data (M5673 is master) |
| 66 | GPIOD2/12S-SCLK | B / D | GPIOD2/12S bit clk output |
| 67 | GPIOD3/12S-REFCLK | B / D | GPIOD3/12S system(reference) clk output |
| 68 | GPIOD4/12S-D0 | B / D | GPIOD4/12S data output |
| 69 | GPIOD5/12S-D1 | B / D | GPIOD5/12S data input |
| 70 | GPIOD6/12S-WCLK | B / D | GPIOD6/12S word clk(LRCK) output |
| 71 | GPIOD7/SPDIF | B / D | GPIOD7/SPDIF output |
| 72 | GPIOE0 | B / D | GPIOE0 |
| 73 | GPIOE1 | B / D | GPIOE1 |
| 74 | GPIOE2 | B / D | GPIOE2 |
| 75 | GPIOE3 | B / D | GPIOE3 |
| 76 | GPIOE4/SDD0 | B / D | GPIOE4/SD Card data0 |
| 77 | GPIOE5/SDD1 | B / D | GPIOE5/SD Card data1 |
| 78 | GPIOE6/SDD2 | B / D | GPIOE6/SD Card data2 |
| 79 | GPIOE7/SDD3 | B / D | GPIOE7/SD Card data3 |
| 80 | GPIOF0/SDCMD | B / D | GPIOE0/SD Card command |
| 81 | GPIOF1/SD-CLK | B / D | GPIOE1/SD Card clk |
| 82 | GPIOF2 | B / D | GPIOF2 |
| 83 | GPIOF3 | B / D | GPIOF3 |
| 84 | GND-PAD | G | Digital PAD Ground |
| 85 | VDD-PAD | P | Digital PAD power |
| 86 | GPIOG2 | B / D | GPIOG2 |
| 87 | GPIOG3 | B / D | GPIOG3 |
| 88 | GPIOG4 | B / D | GPIOG4 |
| 89 | GPIOG5/LCDDDB0 | B / D | GPIOG5/LCD data0 |
| 90 | GPIOG6/LCDDDB1 | B / D | GPIOG6/LCD data1 |
| 91 | GPIOG7/LCDDDB2 | B / D | GPIOG7/LCD data2 |
| 92 | GPIOH0/LCDDDB3 | B / D | GPIOH0/LCD data3 |
| 93 | GPIOH1/LCDDDB4 | B / D | GPIOH1/LCD data4 |
| 94 | GPIOH2/LCDDDB5 | B / D | GPIOH2/LCD data5 |
| 95 | GPIOH3/LCDDDB6 | B / D | GPIOH3/LCD data6 |
| 96 | GPIOH4/LCDDDB7 | B / D | GPIOH4/LCD data7 |
| 97 | GPIOH5/LCDRS | B / D | GPIOH5/LCD status/command |
| 98 | GPIOH6/LCDCSJ | B / D | GPIOH6/LCD CSJ |
| 99 | PRSTB | B / D | Chip reset, low active |
| 100 | GPIOH7/LCDRDJ | B / D | GPIOH7/LCD read control signal |
| 101 | GPIO10/LCDWRJ | B / D | GPIO10/LCD write control signal |
| 102 | GPIO11/PWMO/LCD-ALE | B / D | GPIO11/PWMO output /LCD ALE signal when address /data share bus |
| 103 | GPIO12/IRC | B / D | GPIO12/remote controller received |
| 104 | GPIOI3/PWM1 | B / D | GPIOI3/PWM1 output |
| 105 | GPIOI4/PWM2 | B / D | GPIOI4/PWM2 output |
| 106 | GPIOI5 | B / D | GPIOI5 |
| 107 | GPIOI6 | B / D | GPIOI6 |
| 108 | GPIOI7/12CS-CLK | B / D | GPIOI7/12C clk when M5673 is slave |
| 109 | GPIOJ0/12CS-DAT | B / D | GPIOJ0/12C data when M5673 slave |
| 110 | GPIOJ1 | B / D | GPIOJ1 |
| 111 | GPIOJ2 | B / D | GPIOJ2 |
| 112 | GND-PAD | G | Digital PAD Ground |
| 113 | VDD-PAD | P | Digital PAD power |
| 114 | GND-CORE | G | Digital Core ground |
| 115 | VDD-CORE | P | Digital Core power |
| 116 | AVDD-D33 | P | 3.3V for digital circuit in a analog. |

| Pin(s) No. | Signal | Attribute | Description |
|------------|-----------|-----------|---|
| 117 | BTN-ADIN1 | I/A | Bottom check input, connect to servo ADC |
| 118 | BTN-ADIN2 | I/A | Bottom check input, connect to servo ADC |
| 119 | BTN-ADIN3 | I/A | Bottom check input, connect to servo ADC |
| 120 | VREF16 | O/A | SERVO DAC common mode voltage |
| 121 | FMO | O/A | Focus servo output, 3 level PWM output |
| 122 | AVD33-1 | P | Servo Analog Power |
| 123 | DMO | O/A | Disk motor control output. 3 level PWM output |
| 124 | AVSS33-1 | G | Servo Analog Ground |
| 125 | GPWM | O/A | General purpose 3 level PWM output |
| 126 | FOO | O/A | Focus servo output. 3 level PWM output |
| 127 | TRO | O/A | Tracking servo output. 3 level PWM output |
| 128 | MDI | I/A | Laser Power Monitor Input For APC |

The definitions of the signal attributes:

D: Digital

I: Input

O: Output

B: Bi-direction

P: Power

G: Ground

A: Analog Pad

6. DC Characteristics

Absolute Maximum Rating

Power Supply(Vcc).....-0.3V to 3.6V

Input Voltage.....-0.3V to VCC+0.3V

Output Voltage-0.3V to VCC+0.3V

Storage Temperature-55°C to 150°C

Comments

Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to this device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied, and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 6-1. DC Electrical Characteristics(Operation Condition Vcc=3.0V~3.6V, Tj=0°C~70°C)

| PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|---|--|---------|------|---------|------------------|
| Input low voltage | CMOS | - | - | 0.3*Vcc | V |
| Input High Voltage | CMOS | 0.7*Vcc | - | - | V |
| Schmitt trigger negative going threshold voltage | CMOS | - | 1.20 | - | V |
| Schmitt trigger positive going threshold voltage | CMOS | - | 2.10 | - | V |
| Output low voltage | I _{OL} =4mA | - | - | 0.4 | V |
| Output high voltage | I _{OH} =4mA | 2.4 | - | - | V |
| Input Pull-up resistance | V _{IL} =0V or V _{IH} =V _{CC} | - | 75 | - | KΩ |
| Input Leakage current | No pull-up | -1 | - | 1 | uA |
| | | -1 | - | 1 | mA |
| Input capacity | | - | 10 | - | pF |
| Audio Codec Characteristics | | | | | |
| VddA (Codec) | | 3.0 | 3.3 | 3.6 | V |
| Full Scale Input Voltage | Gain=0 and Boost=0 | | | 1 | Vp-p |
| Signal-to-noise Ratio of all Line Inputs | Note 1 | 86 | | | |
| Signal-to-noise Ratio of Microphone | Note 1 | 45 | | | dB |
| Total Harmonic Distortion of all Line Inputs/Microphone | Note 2 | 0.03 | | | % |
| Total Harmonic Distortion of Microphone | | 0.55 | | | |
| Line inputs/Microphone PGA gain | | -20 | | 14.8 | dB |
| Microphone Boost Gain | | 0 | | 20 | dB |
| Headphone Full Scale output Voltage | VddHP=1.8V | | 0.74 | | V _{rms} |
| Headphone PGA gain | | -57 | | 6 | dB |
| Total Harmonic Distortion of DAC to Headphone | Note 4 | 0.018 | | | dB |
| Dynamic Range of DAC | Note 5 | 85 | | | dB |
| In band ripple (0~20kHz) | | | -1 | | dB |
| Inter-channel isolation | | 90 | | | dB |

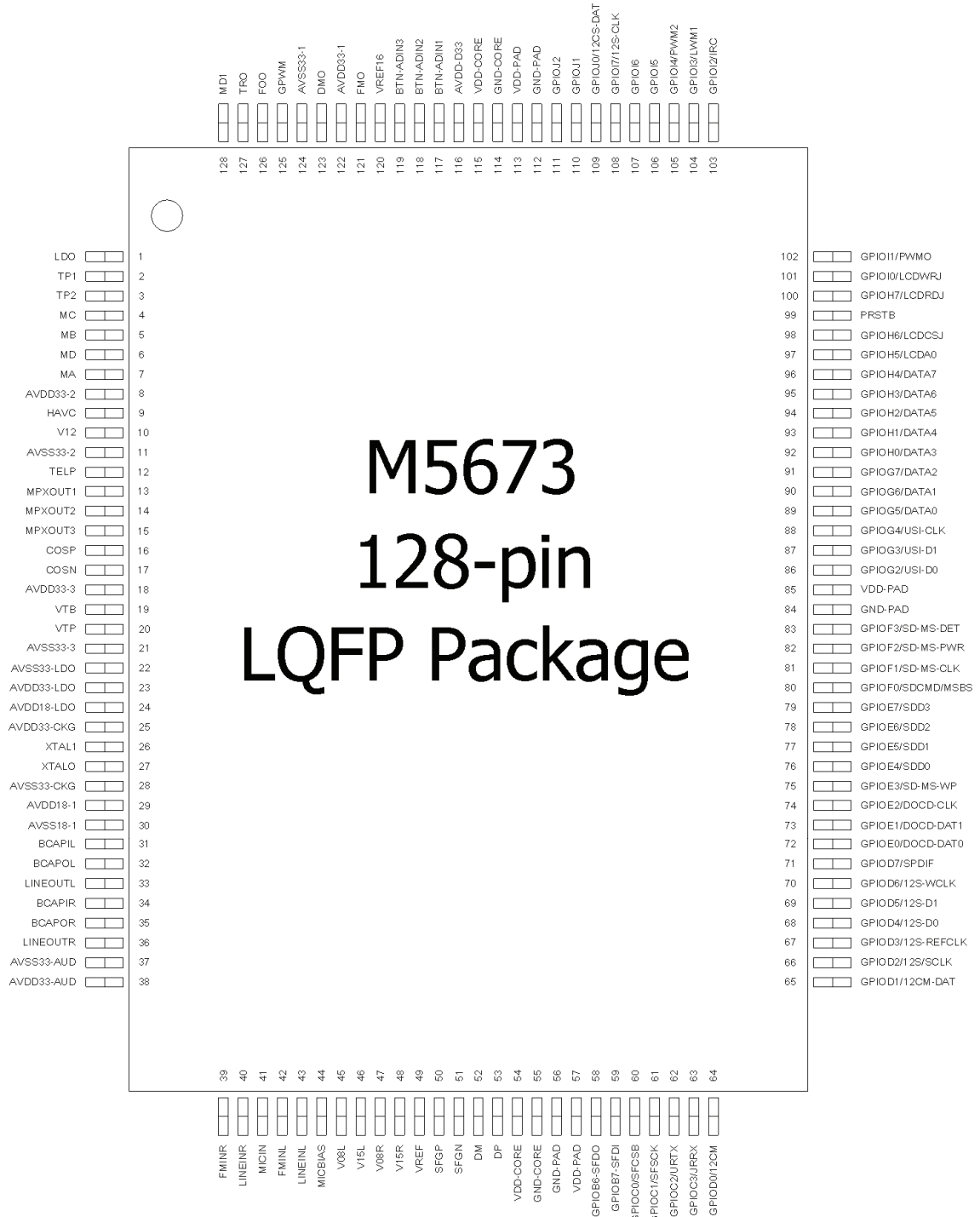
Note 1: -60dB @ 1kHz input is applied to LINEIN/FMIV. The SNR result is obtained at the output of ADC with A-weighting filter (20Hz~20kHz).

Note 2: 0dB @ 1kHz input is applied to LINEIN/FMIV. The SNR result is obtained at the output of ADC with A-weighting filter (20Hz~20kHz).

Note 4: 0dB @ 1kHz sigma-delta bit-stream is applied to DAC. The THD result is obtained at the output of Line out with A-weighting filter (20Hz~20kHz).

Note 5: -60dB @ 1kHz sigma-delta bit-stream is applied to DAC. The SNR result is obtained at the output of Line out with A-weighting filter (20Hz~20kHz).

7. Package Information



1. Introduction

MosArt's Touch Sensor Solution is divided into 2 series:

MA81/83/85P0x MCU series: It is a general purpose MCU with powerful functions (Ex. touch sensor, serial interfaceetc.).

The MA81P0x has 6 models and it has SPI, ADC, LCD driver ...etc.

The MA83P0x has 9 models and it has SPI, UART, I2C ... etc.

The MA85P0x has 3 models and it has SPI, UART, I2C ... etc.

The difference between MA81P0x, MA83P0x and MA85P0x refer to 1.1 The Features of MA81/83/85P0x Series.

MA81xxx series: This series had been built in the touch sensor and application firmware (a communication interface with a simple protocol).

The MA81xxx series can be used as a slave and can be controlled by a master through a communication interface.

The touch sensor can be used as human-machine-interface like key pads, scrolling bar ...etc

| | MA83P05 | MA83P06 | MA83P07 | MA83P08 | MA83P09 | MA83P10 | MA83P11 | MA83P12 | MA83P13 |
|--|---|---|--|-----------------------------|---|---|---|--|---|
| Core CPU | 65C02 CMOS 8-bit core CPU compatible | | | | | | | | |
| Instruction set | 166 bytes | | | | | | | | |
| Instruction execution time | 1μs @ 2MHz (2 clocks / instruction) | | | | | | | | |
| OTP ROM capacity | 8K bytes | | | | | | | | |
| RAM capacity | 256 bytes | | | | | | | | |
| Low-speed oscillation circuit | 32.768KHz (X'tal) | N/A | 32.768KHz (X'tal) | N/A | N/A | N/A | N/A | N/A | N/A |
| High-speed oscillation circuit | 2 kind of clock source which can be selected by software: 1. On-chip RC oscillator (4.5MHz ~ 310KHz) 2. RC oscillation circuit (Max. 16MHz) (there is no RC oscillation circuit in MA83P08) | | | | | | | | |
| I/O ports | 12 bits (Max.) P13, P17 P20 | 10 bits (Max.) P13, P17 P20 | 20 bits (Max.) P13, P17 P20 ~ P22 P30 ~ P34 P40 ~ P47 P50 ~ P51 | 2 bits (Max.) P30, P31 | 7 bits (Max.) P13 P20 P30, P31, P34 P50 ~ P51 | 7 bits (Max.) P13 P20 P30, P31, P34 P50 ~ P51 | 4 bits (Max.) P20 P30, P31, P34 | 8 bits (Max.) P13, P17 P20 P30, P31, P34 P50 ~ P51 | 14 bits (Max.) P13, P17 P20 P30, P31, P34 P40 ~ P47 |
| Input mode: with or w/o pull-up | | | | | | | | | |
| Output mode: N-channel open drain or Complementary | | | | | | | | | |
| Wake-up pins | P17, P20 | P17, P20 | P17, P20~P22 | N/A | P20 | P20 | P20 | P17, P20 | P17, P20 |
| Watchdog timer | Built-in | | | | | | | | |
| Clock timer | 8-bit | | | | | | | | |
| Programmable timer | 8 bits x1 and 16 bits x1 (can be cascaded to form a 24-bit timer) | | | | | | | | |
| Serial peripheral interface | SPI master / slave mode, I2C slave mode, UART | | | I2C slave mode | | | | SPI master / slave mode, I2C slave mode, UART | |
| Pulse width modulation | 8-bit * 1 | | | N/A | 8-bit * 1 | 8-bit * 1 | N/A | 8-bit * 1 | 8-bit * 1 |
| Power on / down reset | Built-in | | | | | | | | |
| Touch sensor channel | Built-in | | | | | | | | |
| LCD driver | 12 channels | N/A | N/A | 2 channels | 7 channels | 7 channels | 6 channels | 6 channels | 8 channels |
| Analog to digital converter (12 bits ADC) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| External interrupt (It is divided by group) | 4 pins Group 1: K20, K21 Group 2: K10 Group 3: K00 | 4 pins Group 1: K20, K21 Group 2: K10 Group 3: K00 | 8 pins Group 1: K20 ~ K23 Group 2: K10 Group 3: K00 ~ K02 | 2 pins Group 1: K20, K21 | 3 pins Group 1: K20, K21 Group 2: ~ Group 3: K00 | 3 pins Group 1: K20, K21 Group 2: ~ Group 3: K00 | 3 pins Group 1: K20, K21 Group 2: ~ Group 3: K00 | 4 pins Group 1: K20, K21 Group 2: K10 Group 3: K00 | 4 pins Group 1: K20, K21 Group 2: K10 Group 3: K00 |
| Internal interrupt | Programmable timer 0 interrupt Programmable timer 1 interrupt SPI interrupt (There is no SPI interrupt in MA83P08) PWM interrupt (There is no PWM interrupt in MA83P08, MA83P11) Clock timer interrupt UART interrupt (There is no UART interrupt in MA83P08) Touch sensor interrupt I2C interrupt | | | | | | | | |
| Current consumption | Chip current consumption (@ 3.3V) During SLEEP mode : (OSC1 off, OSC3 off, power on/down reset on): 10uA During IDLE mode : (OSC1 off, RC-OSC3 @ 1MHz): 100uA During operation : (OSC1 on, OSC3 off, LCD off): 50uA (OSC1 off, RC-OSC3 @ 2MHz, LCD off): 850uA (OSC1 off, X'tal-OSC3 @ 2MHz, LCD off): 1200uA | | | | | | | | |
| Power supply voltage | 2.2V ~ 3.6V | | | | | | | | |
| Operating temperature range | -40°C ~ 85°C | | | | | | | | |
| Package | QFN32 | SSOP28L | QFN40 | SOP8 | QFN20 | SSOP20 | SSOP16 | SSOP20 | SSOP28 |

2. Selection Table

2.1 MA81/83/85P0x Series Selection Table

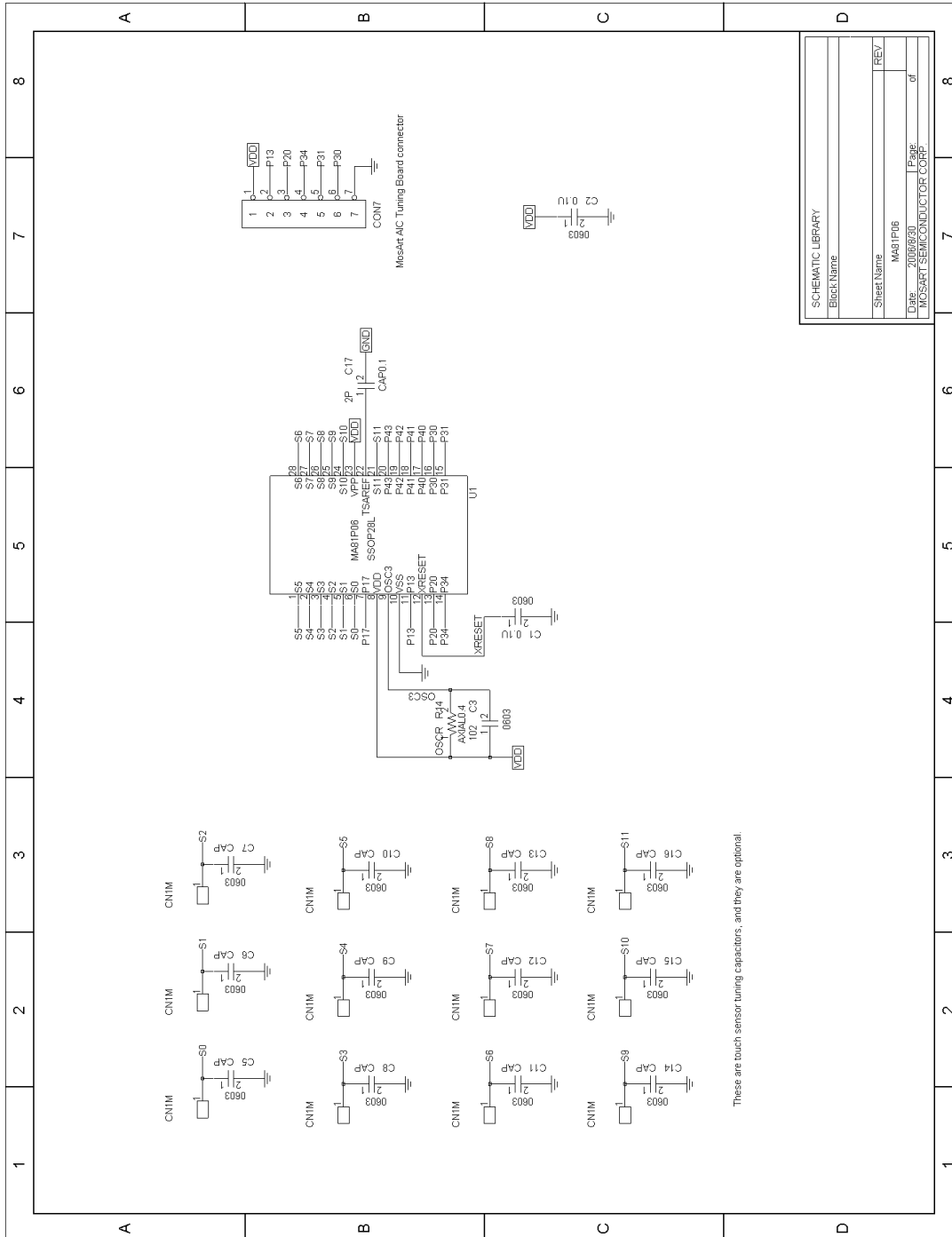
| Order-Number | Package | Memory | | Clock Sources | | | IO (max) | Timer | | | SPI | I2C | UART/PWM | Touch Sensor | LCD | 12bit ADC | | SVD | Wake-up | Interrupt | |
|--------------|---------|---------|------|---------------|---|-----------|----------|-------|---------|----------|-----|-----|----------|--------------|------|-----------|---------|-----|---------|-----------|------|
| | | OTP ROM | SRAM | High-speed | | Low-speed | | CT | PT 8bit | PT 16bit | | | | | | WD | Int. ch | | | Ext. ch | Int. |
| MA81P01 | LQFP100 | 8KB | 512B | V | V | V | 60 | | | | V | 1 | 1 | V | 1 | | | - | 1 | | |
| MA81P02 | LQFP64 | 8KB | 512B | V | V | V | 36 | V | 1 | 1 | V | 1 | - | 1 | 16x4 | 1 | 3 | V | 3 | 8 | 5 |
| MA81P03 | LQFP48 | 8KB | 512B | V | V | V | 26 | V | 1 | 1 | V | 1 | - | 1 | - | - | 4 | V | 5 | 8 | 8 |
| MA81P05 | QFN32 | 4KB | 256B | V | V | V | 12 | V | 1 | 1 | V | 1 | - | 1 | - | - | - | V | 2 | 7 | 4 |
| MA81P06 | SSOP28L | 4KB | 256B | V | V | - | 10 | V | 1 | 1 | V | 1 | - | 1 | - | - | - | V | 2 | 7 | 4 |
| MA81P07 | QFN40 | 4KB | 256B | V | V | V | 20 | V | 1 | 1 | V | 1 | - | 1 | - | - | - | V | 4 | 7 | 8 |
| MA83P05 | QFN32 | 8KB | 256B | V | V | V | 12 | V | 1 | 1 | V | 1 | V | 1 | - | - | - | - | 2 | 8 | 4 |
| MA83P06 | SSOP28L | 8KB | 256B | V | V | - | 10 | V | 1 | 1 | V | 1 | V | 1 | - | - | - | - | 2 | 8 | 4 |
| MA83P07 | QFN40 | 8KB | 256B | V | V | V | 20 | V | 1 | 1 | V | 1 | V | 1 | - | - | - | - | 4 | 8 | 8 |
| MA83P08 | SOP8 | 8KB | 256B | V | - | - | 2 | V | 1 | 1 | V | - | V | - | - | - | - | - | - | 5 | 2 |
| MA83P09 | QFN20 | 8KB | 256B | V | V | - | 7 | V | 1 | 1 | V | 1 | V | V | - | - | - | - | 1 | 8 | 3 |
| MA83P10 | SSOP20 | 8KB | 256B | V | V | - | 7 | V | 1 | 1 | V | 1 | V | V | - | - | - | - | 1 | 8 | 3 |
| MA83P11 | SSOP16 | 8KB | 256B | V | V | - | 4 | V | 1 | 1 | V | 1 | V | V | - | - | - | - | 1 | 7 | 3 |
| MA83P12 | SSOP20 | 8KB | 256B | V | V | - | 8 | V | 1 | 1 | V | 1 | V | V | - | - | - | - | 2 | 8 | 4 |
| MA83P13 | SSOP28L | 8KB | 256B | V | V | - | 14 | V | 1 | 1 | V | 1 | V | V | - | - | - | - | 2 | 8 | 4 |
| MA85P01 | LQFP64 | 8KB | 256B | V | V | V | 16 | V | 1 | 1 | V | 1 | V | V | - | - | - | V | 2 | 12 | 10 |
| MA85P02 | LQFP48 | 8KB | 256B | V | V | - | 16 | V | 1 | 1 | V | 1 | V | V | - | - | - | V | 2 | 12 | 10 |
| MA85P03 | QFN40 | 8KB | 256B | V | V | - | 8 | V | 1 | 1 | V | 1 | V | V | - | - | - | V | 2 | 12 | 2 |

3.1.8 MA83P06 (SSOP 28L-209 MIL)

3.1.8.1 MA83P06 Pin Assignment

| Pin Name | Pin No | In/Out | Pin Description |
|----------|--------|--------|---|
| S5 | 1 | I | Touch sensor pad 5 |
| S4 | 2 | I | Touch sensor pad 4 |
| S3 | 3 | I | Touch sensor pad 3 |
| S2 | 4 | I | Touch sensor pad 2 |
| S1 | 5 | I | Touch sensor pad 1 |
| S0 | 6 | I | Touch sensor pad 0 |
| P17/K10 | 7 | I/O | I/O port (with pull-up resistor and wake-up/system-reset function), and input port (K10) |
| VDD | 8 | P | Power (+) supply pin |
| OSC3 | 9 | I | External resistor connecting pin for RC-ring oscillator type |
| VSS | 10 | P | Power (-) supply pin |
| P13 | 11 | I/O | I/O port (with pull-up resistor) When PWM is used, P13 can be used as PWM output pin (PWM) |
| XRESET | 12 | I | Initial reset input pin, low active (with pull-up resistor) |
| P20/K00 | 13 | I/O | I/O port (with pull-up resistor and wake-up/system-reset function) and input port (K00) When UART is used, P20 can be used as UART Rx pin |
| P34 | 14 | I/O | I/O port (with pull-up resistor) When SPI is used, P34 can be used as SPI data serial input "SDI" When UART is used, P34 can be used as UART Tx pin |
| P31/K21 | 15 | I/O | I/O port (with pull-up resistor) and input port (K21) When SPI is used, P31 can be used as SPI data serial output "SDO". When I2C is used, P31 can be used as I2C data "SDA". |
| P30/K20 | 16 | I/O | I/O port (with pull-up resistor) and input port (K20) When SPI is used, P30 can be used as serial clock "SCK". When I2C is used, P30 can be used as I2C clock "SCL" |
| P40 | 17 | I/O | I/O ports (with pull-up resistor) |
| P41 | 18 | I/O | I/O ports (with pull-up resistor) |
| P42 | 19 | I/O | I/O ports (with pull-up resistor) |
| P43 | 20 | I/O | I/O ports (with pull-up resistor) |
| S11 | 21 | I | Touch sensor pad 11 |
| TSAREF | 22 | I | Reference pin for touch sensor |
| VPP | 23 | P | Power (+) supply pin for OTP ROM: in programming mode: operates at 6.5V; In normal mode: be connected to VDD |
| S10 | 24 | I | Touch sensor pad 10 |
| S9 | 25 | I | Touch sensor pad 9 |
| S8 | 26 | I | Touch sensor pad 8 |
| S7 | 27 | I | Touch sensor pad 7 |
| S6 | 28 | I | Touch sensor pad 6 |

3.1.8.2 MA83P06 Application Circuit



| | |
|--------------------|-----------|
| SCHEMATIC LIBRARY: | |
| Block Name | |
| Sheet Name | MA83P06 |
| Date | 2006/6/30 |
| Page | 1 |
| of | 1 |
| REV | |

These are touch sensor tuning capacitors, and they are optional.



The Future of Analog IC Technology™

PRELIMINARY SPECIFICATIONS SUBJECT TO CHANGE – INTERNAL USE ONLY

MP1423

3A, 23V, 385KHz
Step-Down Converter

DESCRIPTION

The MP1423 is a step-down regulator with a built in internal Power MOSFET. It achieves 3A continuous output current over a wide input supply range with excellent load and line regulation.

Current mode operation provides fast transient response and eases loop stabilization.

Fault condition protection includes cycle-by-cycle current limiting and thermal shutdown. Adjustable soft-start reduces the stress on the input source at turn-on. In shutdown mode the regulator draws 20µA of supply current.

The MP1423 requires a minimum number of readily available external components to complete a 3A step-down DC to DC converter solution.

EVALUATION BOARD REFERENCE

| Board Number | Dimensions |
|--------------|------------|
| TBD | TBD |

FEATURES

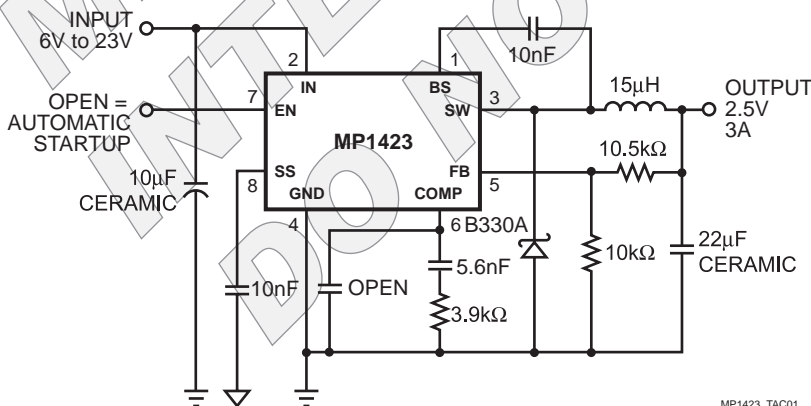
- 3A Output Current
- Programmable Soft-Start
- 100mΩ Internal Power MOSFET Switch
- Stable with Low ESR Output Ceramic Capacitors
- Up to 95% Efficiency
- 20µA Shutdown Mode
- Fixed 385KHz frequency
- Thermal Shutdown
- Cycle-by-Cycle Over Current Protection
- Wide 6V to 23V Operating Input Range
- Output is Adjustable From 1.22V to 21V
- Under Voltage Lockout

APPLICATIONS

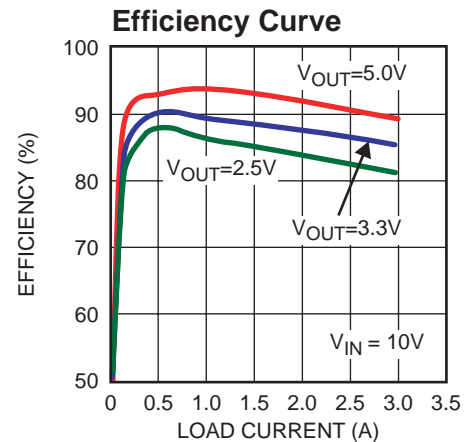
- Distributed Power Systems
- Battery Chargers
- Pre-Regulator for Linear Regulators

"MPS" and "The Future of Analog IC Technology" are Trademarks of Monolithic Power Systems, Inc.

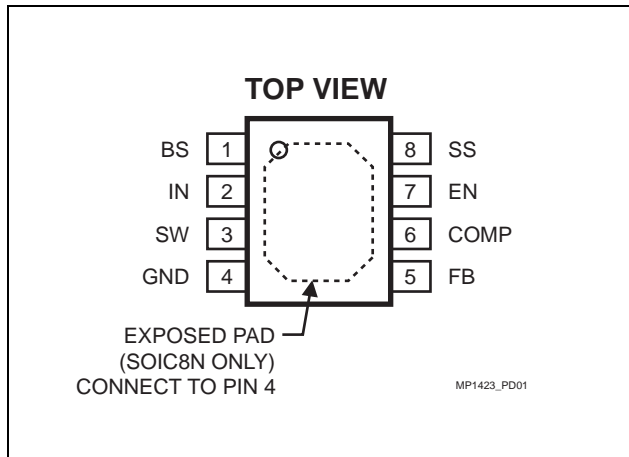
TYPICAL APPLICATION



MP1423_TAC01



MP1423_EC01

PACKAGE REFERENCE


| Part Number* | Package | Temp |
|--------------|---------|----------------|
| MP1423DN | SOIC8N | -40°C to +85°C |
| MP1423DP | PDIP8 | -40°C to +85°C |

* For Tape & Reel, add suffix -Z (eg. MP1423DN-Z)
 For Lead Free, add suffix -LF (eg. MP1423DN-LF-Z)

ABSOLUTE MAXIMUM RATINGS ⁽¹⁾

| | |
|---------------------------------|----------------------------------|
| Supply Voltage V_{IN} | -0.3V to +28V |
| Switch Voltage V_{SW} | -1V to $V_{IN} + 0.3V$ |
| Bootstrap Voltage V_{BS} | $V_{SW} - 0.3V$ to $V_{SW} + 6V$ |
| All Other Pins..... | -0.3V to 6V |
| Junction Temperature..... | 150°C |
| Lead Temperature..... | 260°C |
| Storage Temperature..... | -65°C to 150°C |

Recommended Operating Conditions ⁽²⁾

| | |
|------------------------------|----------------|
| Input Voltage V_{IN} | 6V to 23V |
| Ambient Operating Temp..... | -40°C to +85°C |

Thermal Resistance ⁽³⁾

| | θ_{JA} | θ_{JC} | |
|-------------|---------------|---------------|------|
| SOIC8N..... | 50 | 10 | °C/W |
| PDIP8..... | 95 | 55 | °C/W |

Notes:

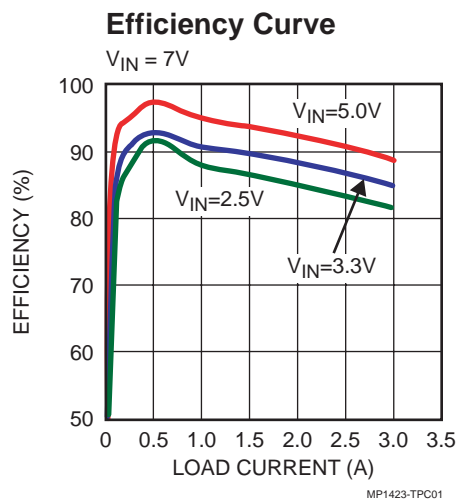
- Exceeding these ratings may damage the device.
- The device is not guaranteed to function outside of its operating conditions.
- Measured on approximately 1" square of 1 oz copper.

ELECTRICAL CHARACTERISTICS

$V_{IN} = 12V$, $T_A = +25^\circ C$, unless otherwise noted.

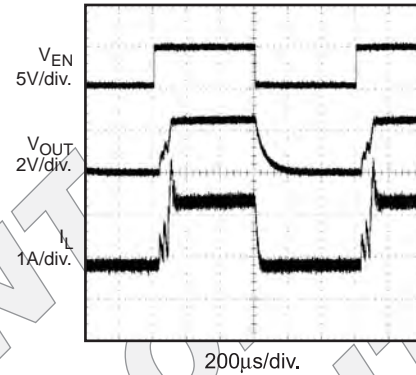
| Parameters | Symbol | Condition | Min | Typ | Max | Units |
|--|---------------|---------------------------------|-------|-------|-------|-----------|
| Shutdown Supply Current | | $V_{EN} = 0V$ | | 20 | 30 | μA |
| Supply current | | $V_{EN} = 2.8V, V_{FB} = 1.4V$ | | 1.0 | 1.2 | mA |
| Feedback Voltage | V_{FB} | $6V \leq V_{IN} \leq 23V$ | 1.194 | 1.222 | 1.250 | V |
| Error Amplifier Voltage Gain | A_{VEA} | | | 400 | | V/V |
| Error Amplifier Transconductance | G_{EA} | $\Delta I_{COMP} = \pm 10\mu A$ | 500 | 800 | 1120 | $\mu A/V$ |
| High Side Switch On Resistance | $R_{DS(ON)1}$ | | | 0.1 | | Ω |
| Low Side Switch On Resistance | $R_{DS(ON)2}$ | | | 10 | | Ω |
| High Side Switch Leakage Current | | $V_{EN} = 0V, V_{SW} = 0V$ | | 0 | 10 | μA |
| Current Limit | | | 4.0 | 4.9 | 6.0 | A |
| Current Sense to COMP Transconductance | G_{CS} | | | 3.8 | | A/V |
| Oscillation Frequency | f_s | | 335 | 385 | 435 | KHz |
| Short Circuit Oscillation Frequency | D_{MAX} | $V_{FB} = 0V$ | 25 | 40 | 55 | KHz |
| Maximum Duty Cycle | | $V_{FB} = 1.0V$ | | 90 | | % |
| Minimum Duty Cycle | | $V_{FB} = 1.5V$ | | | 0 | % |
| EN Threshold Voltage | | | 0.9 | 1.2 | 1.5 | V |
| Enable Pull Up Current | | $V_{EN} = 0V$ | 1.1 | 1.8 | 2.5 | μA |
| Under Voltage Lockout Threshold | | V_{IN} Rising | 2.37 | 2.54 | 2.71 | V |
| Under Voltage Lockout Threshold Hysteresis | | | | 210 | | mV |
| Soft Start Period | | $C_{SS} = 0.1\mu F$ | | 10 | | ms |
| Thermal Shutdown | | | | 160 | | °C |

TYPICAL PERFORMANCE CHARACTERISTICS



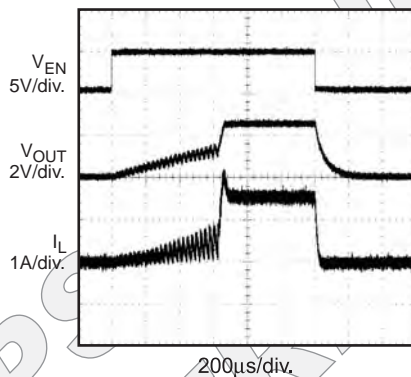
Soft-Start

C_{SS} Open, $V_{IN} = 10V$, $V_{OUT} = 3.3V$,
 1.5A Resistive Load



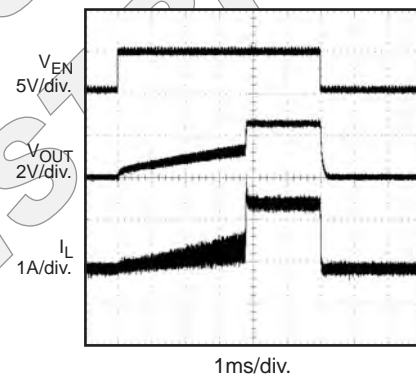
Soft-Start

$C_{SS} = 0.01\mu F$, $V_{IN} = 10V$, $V_{OUT} = 3.3V$,
 1.5A Resistive Load



Soft-Start

$C_{SS} = 0.1\mu F$, $V_{IN} = 10V$, $V_{OUT} = 3.3V$,
 1.5A Resistive Load



PIN FUNCTIONS

| Pin # | Name | Description |
|-------|------|---|
| 1 | BS | High-Side Gate Drive Bootstrap Input. BS supplies the drive for the high-side N-Channel MOSFET switch. Connect a 4.7nF or greater capacitor from SW to BS to power the high side switch. |
| 2 | IN | Power Input. IN supplies the power to the IC, as well as the step-down converter switches. Drive IN with a 6V to 23V power source. Bypass IN to GND with a suitably large capacitor to eliminate noise on the input to the IC. See <i>Input Capacitor</i> |
| 3 | SW | Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load. Note that a capacitor is required from SW to BS to power the high-side switch. |
| 4 | GND | Ground. (Note: For the SOIC8N package, connect the exposed pad on backside to Pin 4). |
| 5 | FB | Feedback Input. FB senses the output voltage to regulate said voltage. Drive FB with a resistive voltage divider from the output voltage. The feedback threshold is 1.222V. See <i>Setting the Output Voltage</i> |

PIN FUNCTIONS *(continued)*

| Pin # | Name | Description |
|-------|------|---|
| 6 | COMP | Compensation Node. COMP is used to compensate the regulation control loop. Connect a series RC network from COMP to GND to compensate the regulation control loop. In some cases, an additional capacitor from COMP to GND is required. See <i>Compensation</i> |
| 7 | EN | Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, low to turn it off. For automatic startup, leave EN unconnected. |
| 8 | SS | Soft Start Control Input. SS controls the soft start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1 μ F capacitor sets the soft-start period to 10ms. To disable the soft-start feature, leave SS unconnected. |

OPERATION

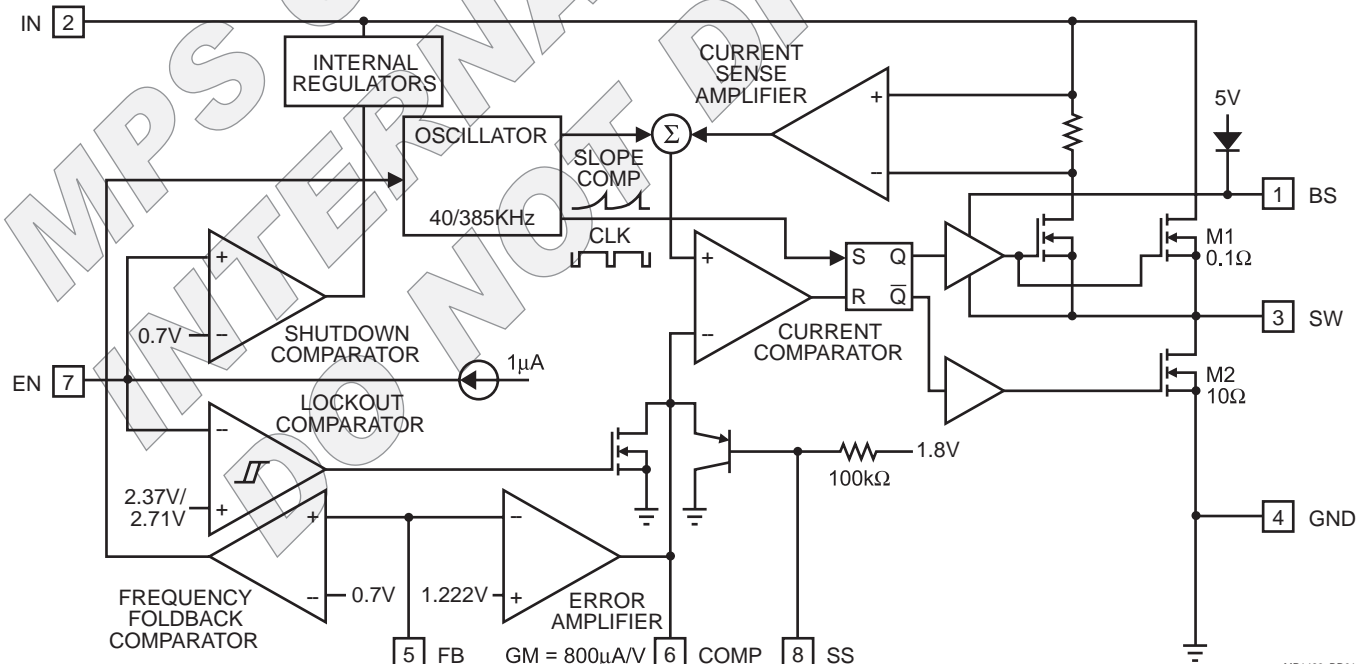
The MP1423 is a current-mode step-down regulator. It regulates input voltages from 6V to 23V down to an output voltage as low as 1.222V, and is able to supply up to 3A of load current.

The MP1423 uses current-mode control to regulate the output voltage. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal error amplifier. The output current of the transconductance error amplifier is presented at COMP where a network compensates the regulation control system.

The voltage at COMP is compared to the switch current measured internally to control the output voltage.

The converter uses an internal N-Channel MOSFET switch to step-down the input voltage to the regulated output voltage. Since the MOSFET requires a gate voltage greater than the input voltage, a boost capacitor connected between SW and BS drives the gate. The capacitor is internally charged while SW is low.

An internal 10 Ω switch from SW to GND is used to insure that SW is pulled to GND when SW is low to fully charge the BS capacitor.


Figure 1—Functional Block Diagram

MP1423_BD01

LOW-NOISE DUAL OPERATIONAL AMPLIFIER

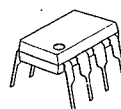
■ GENERAL DESCRIPTION

The NJM2068 is a high performance, low noise dual operational amplifier. This amplifier features popular pin-out, superior noise performance, and superior total harmonic distortion. This amplifier also features guaranteed noise performance with substantially higher gain-bandwidth product and slew rate which far exceeds that of the 4558 type amplifier. The specially designed low noise input transistors allow the NJM2068 to be used in very low noise signal processing applications such as audio preamplifiers and servo error amplifier.

■ FEATURES

- Operating Voltage (±4V ~ ±18V)
- Low Total Harmonic Distortion (0.001% typ.)
- Low Noise Voltage (FLAT+JISA, 0.56 μV typ.)
- High Slew Rate (6V/μs typ.)
- Unity Gain Bandwidth (27MHz @f=10kHz)
- Package Outline DIP8, DMP8, SIP8, SSOP8
- Bipolar Technology

■ PACKAGE OUTLINE



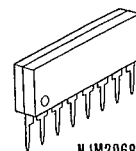
NJM2068D



NJM2068M

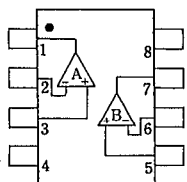


NJM2068V

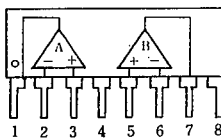


NJM2068L

■ PIN CONFIGURATION



NJM2068D
NJM2068M
NJM2068V

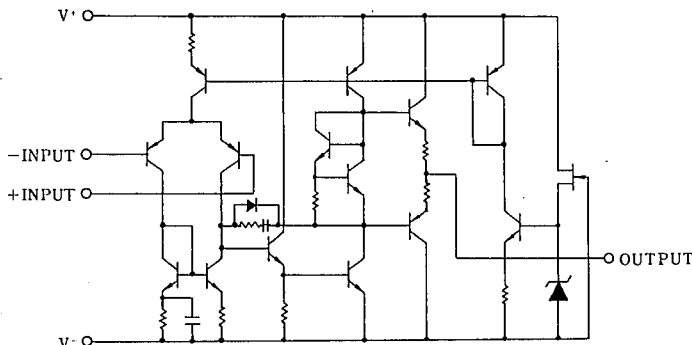


NJM2068L

PIN FUNCTION

1. A OUTPUT
2. A-INPUT
3. A+INPUT
4. V-
5. B+INPUT
6. B-INPUT
7. B OUTPUT
8. V+

■ EQUIVALENT CIRCUIT (1/2 Shown)



DUAL OPERATIONAL AMPLIFIER

■ GENERAL DESCRIPTION

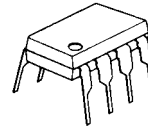
NJM4580 is the dual operational amplifier, specially designed for improving the tone control, which is most suitable for the audio application.

Featuring noiseless, higher gain bandwidth, high output current and low distortion ratio, and it is most suitable not only for acoustic electronic parts of audio pre-amp and active filter, but also for the industrial measurement tools. It is also suitable for the head phone amp at higher output current, and further more, it can be applied for the handy type set operational amplifier of general purpose in application of low voltage single supply type which is properly biased of the low voltage source.

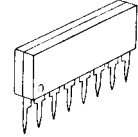
■ FEATURES

- Operating Voltage ($\pm 2V \sim \pm 18V$)
- Low Input Noise Voltage ($0.8\mu V_{rms}$ typ.)
- Wide Gain Bandwidth Product ($15MHz$ typ.)
- Low Distortion (0.0005% typ.)
- Slew Rate ($5V/\mu s$ typ.)
- Package Outline DIP8, SIP8, EMP8, SSOP8, DMP8
- Bipolar Technology

■ PACKAGE OUTLINE



NJM4580D



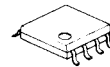
NJM4580L



NJM4580E

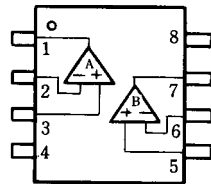


NJM4580V

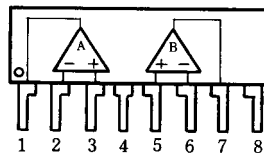


NJM4580M

■ PIN CONFIGURATION



NJM4580D, NJM4580E
NJM4580M, NJM4580V

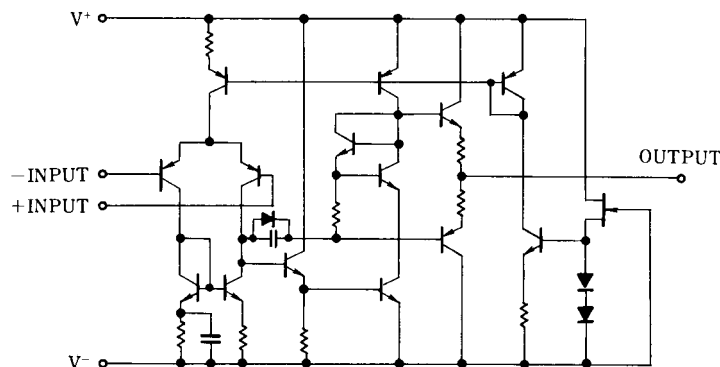


NJM4580L

PIN FUNCTION

- 1. A OUTPUT
- 2. A -INPUT
- 3. A +INPUT
- 4. V⁻
- 5. B +INPUT
- 6. B -INPUT
- 7. B OUTPUT
- 8. V⁺

■ EQUIVALENT CIRCUIT (1/2 Shown)





Product List

SM59128C25, 25MHz 128KB internal flash MCU
SM59128C40, 40MHz 128KB internal flash MCU

Description

The SM59128 series product is an 8-bit single chip microcontroller embedded with 128KB on-chip flash with In-System Programming (ISP) capability and 1024 bytes RAM. It is a derivative of the 8052 microcontroller family. In addition, SM59128 has IIC interface which is compatible with standard VESA DDC/CI and built in 4-channel SPWM. User can access on-chip expanded RAM by its 'bank mapping direct addressing mode' scheme. With its hardware features and powerful instruction sets, it's straight forward to make it a versatile and cost effective controller for those applications which demand up to 32 I/O pins for PDIP package or up to 36 I/O pins for PLCC or QFP package, or applications which need up to 64K bytes flash memory for program and/or for data. To program the on-chip flash memory, commercial writers are available by parallel programming method. On the other hand, the on-chip flash memory can be programmed through either parallel or serial interface with its ISP feature.

Ordering Information

yymm
SM59128ihhkL

yy: year, ww: month
v: version identifier { , A, B,... }
i: process identifier {L=3.0V~3.6V,C=4.5V~ 5.5V}
hh: working clock in MHz {25, 40}
k: package type postfix {as below table}
L: PB Free identifier
{No text is Non-PB Free , " P" is PB Free }

Table with 4 columns: Postfix, Package, Pin / Pad Configuration, Dimension. Rows include P (40L PDIP), J (44L PLCC), and Q (44L QFP).

Features

- Working Voltage: 4.5V to 5.5 V
General 8052 family compatible
12 clocks per machine cycle
128K bytes on-chip flash with In-System Programming (ISP) capability
IIC (Two wire serial bus) interface compliant with VESA DDC 2B/2Bi/2B+ standard
On-chip 1024 bytes RAM
Three 16-bit Timers/Counters
One Watch Dog Timer
Four 8-bit I/O ports for PDIP package
Four 8-bit I/O ports + one 4-bit I/O ports for PLCC or QFP package
Full duplex serial channel
Bit operation instruction
Temperature range of Industrial level
8-bit Unsigned Division
8-bit Unsigned Multiply
BCD arithmetic
Direct Addressing
Indirect Addressing
Nested Interrupt
Two priority level interrupt
A serial I/O port
Power-Saving mode: Idle mode and Power-down mode
Code protection function
Low EMI (inhibit ALE)
Reset with address \$0000 blank initiate ISP service program
Configurable ISP service program space with N*512 bytes (N=0 to 8) size
4-channel SPWM function

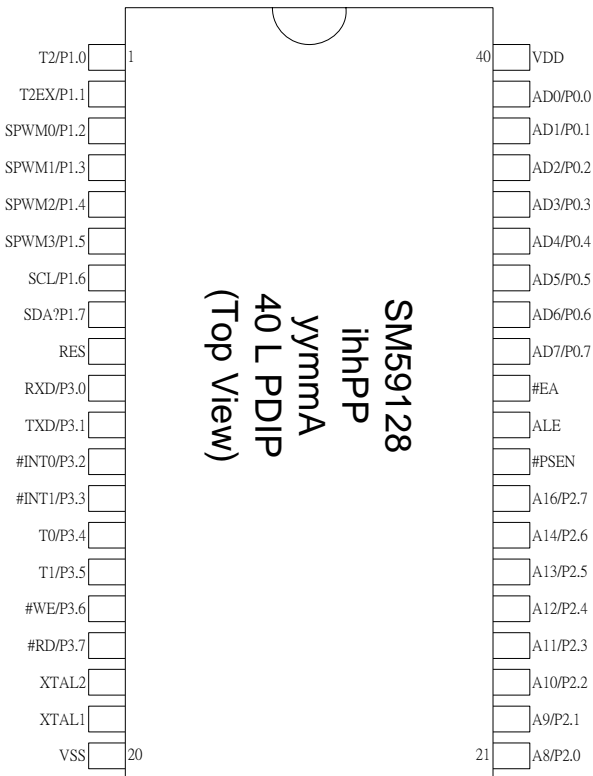
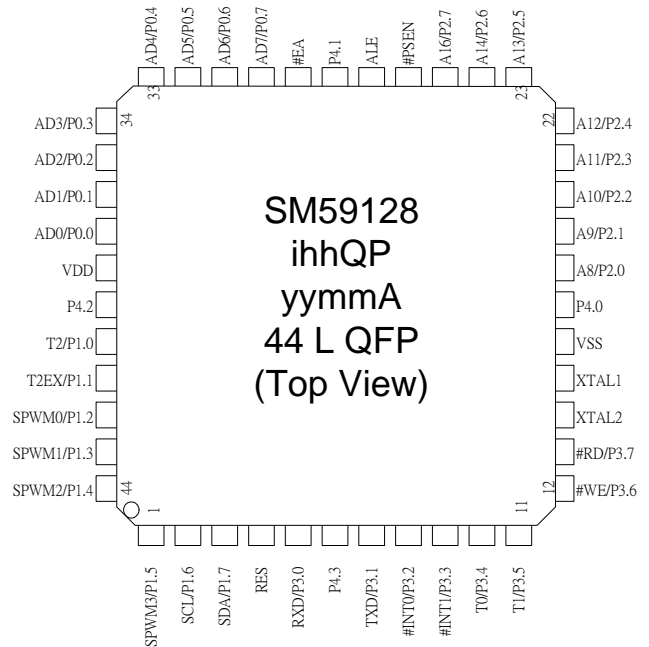
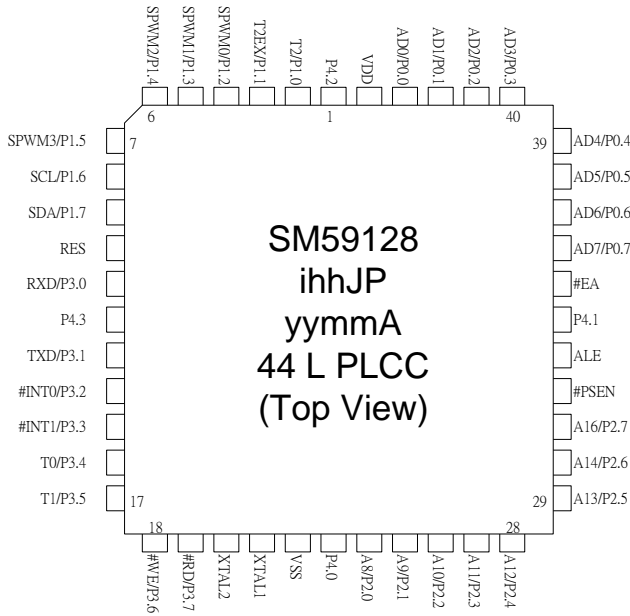
Taiwan
6F, No.10-2 Li- Hsin 1st Road ,
Science-based Industrial Park,
Hsinchu, Taiwan 30078

TEL: 886-3-567-1820
886-3-567-1880
FAX: 886-3-567-1891
886-3-567-1894

Specifications subject to change without notice contact your sales representatives for the most recent information.



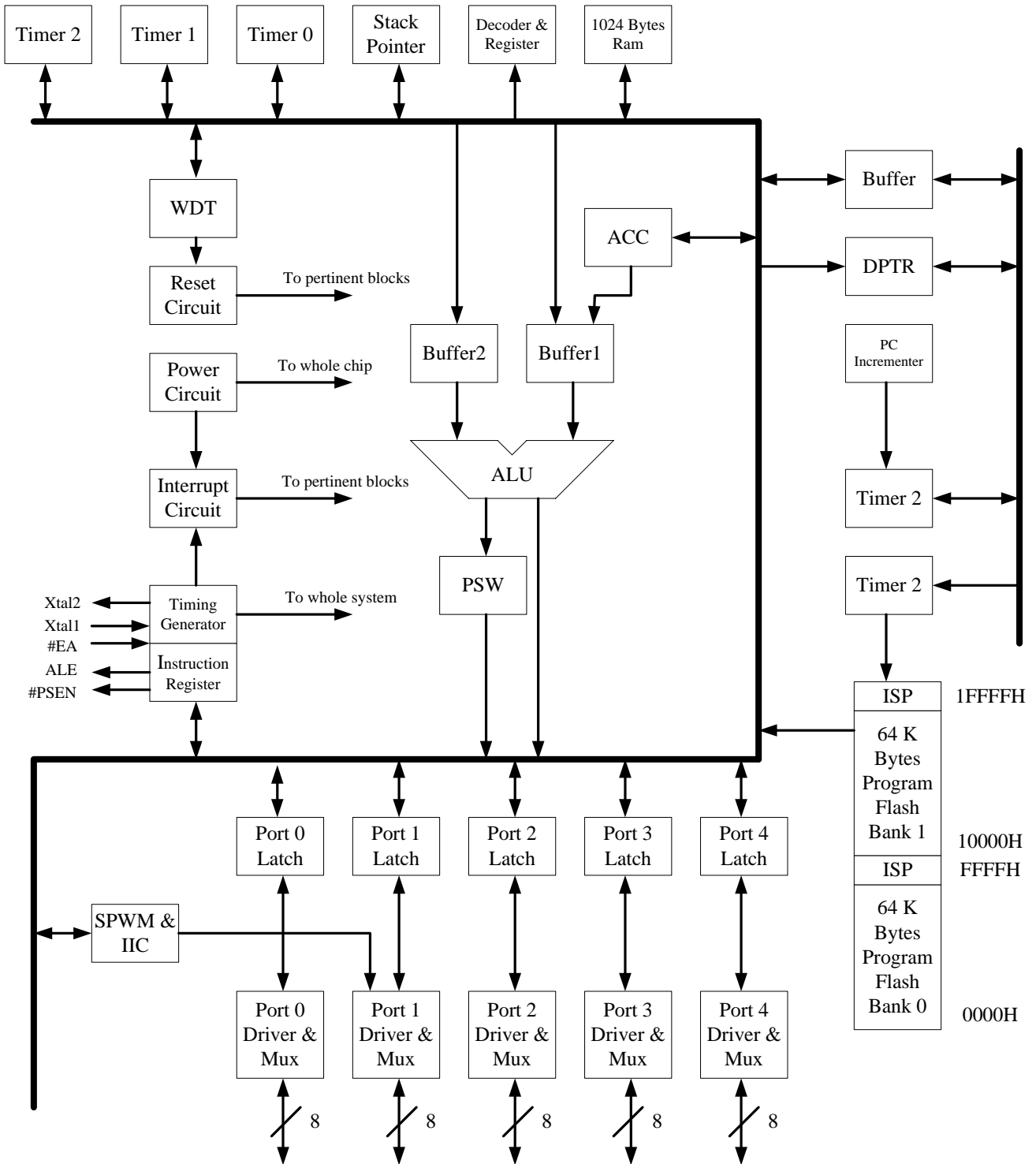
Pin Configuration



Specifications subject to change without notice contact your sales representatives for the most recent information.



Block Diagram



Specifications subject to change without notice contact your sales representatives for the most recent information.



Pin Description

| 40L PDIP Pin# | 44L QFP Pin# | 44L PLCC Pin# | Symbol | Active | I/O | Names |
|---------------|--------------|---------------|------------|--------|-----|---|
| 1 | 40 | 2 | P1.0/T2 | | i/o | bit 0 of port 1 & timer 2 clock out |
| 2 | 41 | 3 | P1.1/T2EX | | i/o | bit 1 of port 1 & timer 2 control |
| 3 | 42 | 4 | P1.2 | | i/o | bit 2 of port 1 |
| 4 | 43 | 5 | P1.3/SPWM0 | | i/o | bit 3 of port 1 & SPWM channel 0 |
| 5 | 44 | 6 | P1.4/SPWM1 | | i/o | bit 4 of port 1 & SPWM channel 1 |
| 6 | 1 | 7 | P1.5/SPWM2 | | i/o | bit 5 of port 1 & SPWM channel 2 |
| 7 | 2 | 8 | P1.6/SCL | | i/o | bit 6 of port 1 & IIC Bus Clock |
| 8 | 3 | 9 | P1.7/SDA | | i/o | bit 7 of port 1 & IIC Bus Data |
| 9 | 4 | 10 | RES | H | i | Reset |
| 10 | 5 | 11 | P3.0/RXD | | i/o | bit 0 of port 3 & Receiver data |
| 11 | 7 | 13 | P3.1/TXD | | i/o | bit 1 of port 3 & Transmit data |
| 12 | 8 | 14 | P3.2/#INT0 | L/- | i/o | bit 2 of port 3 & low true interrupt 0 |
| 13 | 9 | 15 | P3.3/#INT1 | L/- | i/o | bit 3 of port 3 & low true interrupt 1 |
| 14 | 10 | 16 | P3.4/T0 | | i/o | bit 4 of port 3 & Timer 0 |
| 15 | 11 | 17 | P3.5/T1 | | i/o | bit 5 of port 3 & Timer 1 |
| 16 | 12 | 18 | P3.6/#WR | | i/o | bit 6 of port 3 & ext. memory write |
| 17 | 13 | 19 | P3.7/#RD | | i/o | bit 7 of port 3 & ext. memory Read |
| 18 | 14 | 20 | XTAL2 | | o | Crystal out |
| 19 | 15 | 21 | XTAL1 | | i | Crystal in |
| 20 | 16 | 22 | VSS | | | Sink Voltage, Ground |
| 21 | 18 | 24 | P2.0/A8 | | i/o | bit 0 of port 2 & bit 8 of ext. memory address |
| 22 | 19 | 25 | P2.1/A9 | | i/o | bit 1 of port 2 & bit 9 of ext. memory address |
| 23 | 20 | 26 | P2.2/A10 | | i/o | bit 2 of port 2 & bit 10 of ext. memory address |
| 24 | 21 | 27 | P2.3/A11 | | i/o | bit 3 of port 2 & bit 11 of ext. memory address |
| 25 | 22 | 28 | P2.4/A12 | | i/o | bit 4 of port 2 & bit 12 of ext. memory address |
| 26 | 23 | 29 | P2.5/A13 | | i/o | bit 5 of port 2 & bit 13 of ext. memory address |
| 27 | 24 | 30 | P2.6/A14 | | i/o | bit 6 of port 2 & bit 14 of ext. memory address |
| 28 | 25 | 31 | P2.7/A15 | | i/o | bit 7 of port 2 & bit 15 of ext. memory address |
| 29 | 26 | 32 | #PSEN | | o | program storage enable |
| 30 | 27 | 33 | ALE | | o | address latch enable |
| 31 | 29 | 35 | #EA | L | I | external access |
| 32 | 30 | 36 | P0.7/AD7 | | i/o | bit 7 of port 0 & data/address bit 7 of ext. memory |
| 33 | 31 | 37 | P0.6/AD6 | | i/o | bit 6 of port 0 & data/address bit 6 of ext. memory |
| 34 | 32 | 38 | P0.5/AD5 | | i/o | bit 5 of port 0 & data/address bit 5 of ext. memory |
| 35 | 33 | 39 | P0.4/AD4 | | i/o | bit 4 of port 0 & data/address bit 4 of ext. memory |
| 36 | 34 | 40 | P0.3/AD3 | | i/o | bit 3 of port 0 & data/address bit 3 of ext. memory |
| 37 | 35 | 41 | P0.2/AD2 | | i/o | bit 2 of port 0 & data/address bit 2 of ext. memory |
| 38 | 36 | 42 | P0.1/AD1 | | i/o | bit 1 of port 0 & data/address bit 1 of ext. memory |
| 39 | 37 | 43 | P0.0/AD0 | | i/o | bit 0 of port 0 & data/address bit 0 of ext. memory |
| 40 | 38 | 44 | VDD | | | Drive Voltage, +5 Vcc |
| | 17 | 23 | P4.0 | | i/o | bit 0 of Port 4 |
| | 28 | 34 | P4.1 | | i/o | bit 1 of Port 4 |
| | 39 | 1 | P4.2 | | i/o | bit 2 of Port 4 |
| | 6 | 12 | P4.3 | | i/o | bit 3 of port 4 |

Specifications subject to change without notice contact your sales representatives for the most recent information.

2 Mbit SPI Serial Flash

SST25VF020



Data Sheet

FEATURES:

- **Single 2.7-3.6V Read and Write Operations**
- **Serial Interface Architecture**
 - SPI Compatible: Mode 0 and Mode 3
- **20 MHz Max Clock Frequency**
- **Superior Reliability**
 - Endurance: 100,000 Cycles (typical)
 - Greater than 100 years Data Retention
- **Low Power Consumption:**
 - Active Read Current: 7 mA (typical)
 - Standby Current: 8 μ A (typical)
- **Flexible Erase Capability**
 - Uniform 4 KByte sectors
 - Uniform 32 KByte overlay blocks
- **Fast Erase and Byte-Program:**
 - Chip-Erase Time: 70 ms (typical)
 - Sector- or Block-Erase Time: 18 ms (typical)
 - Byte-Program Time: 14 μ s (typical)
- **Auto Address Increment (AAI) Programming**
 - Decrease total chip programming time over Byte-Program operations
- **End-of-Write Detection**
 - Software Status
- **Hold Pin (HOLD#)**
 - Suspends a serial sequence to the memory without deselecting the device
- **Write Protection (WP#)**
 - Enables/Disables the Lock-Down function of the status register
- **Software Write Protection**
 - Write protection through Block-Protection bits in status register
- **Temperature Range**
 - Commercial: 0°C to +70°C
 - Industrial: -40°C to +85°C
 - Extended: -20°C to +85°C
- **Packages Available**
 - 8-lead SOIC 150 mil body width
 - 8-contact WSON (5mm x 6mm)
- **All non-Pb (lead-free) devices are RoHS compliant**

PRODUCT DESCRIPTION

The SST serial flash family features a four-wire, SPI-compatible interface that allows for a low pin-count package occupying less board space and ultimately lowering total system costs. SST25VF020 SPI serial flash memories are manufactured with SST's proprietary, high performance CMOS SuperFlash Technology. The split-gate cell design and thick-oxide tunneling injector attain better reliability and manufacturability compared with alternate approaches.

The SST25VF020 device significantly improves performance, while lowering power consumption. The total energy consumed is a function of the applied voltage, cur-

rent, and time of application. Since for any given voltage range, the SuperFlash technology uses less current to program and has a shorter erase time, the total energy consumed during any Erase or Program operation is less than alternative flash memory technologies. The SST25VF020 device operates with a single 2.7-3.6V power supply.

The SST25VF020 device is offered in an 8-lead SOIC 150 mil body width (SA) package, and in an 8-contact WSON package. See Figure 2 for the pin assignments.

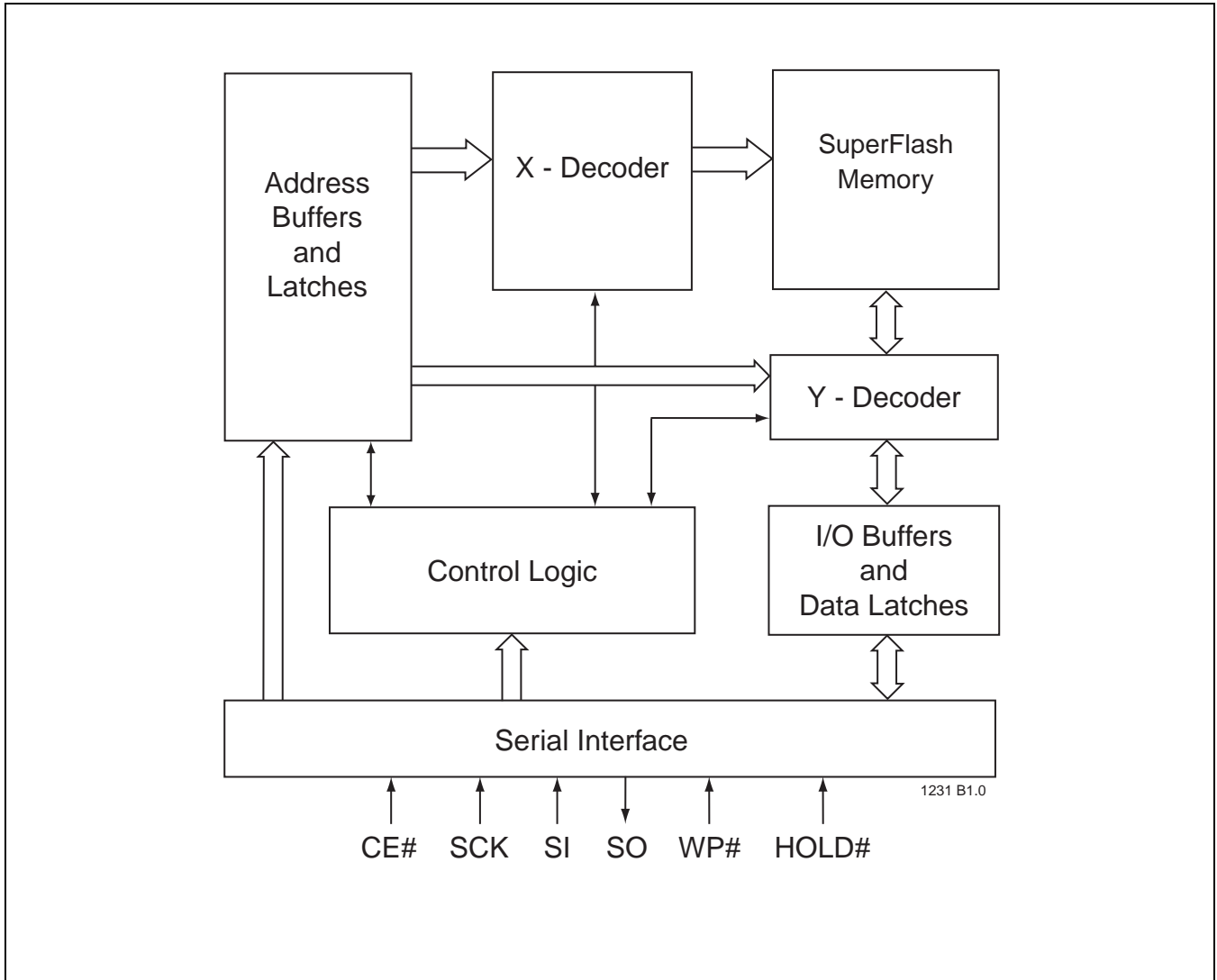


FIGURE 1: Functional Block Diagram

PIN DESCRIPTION

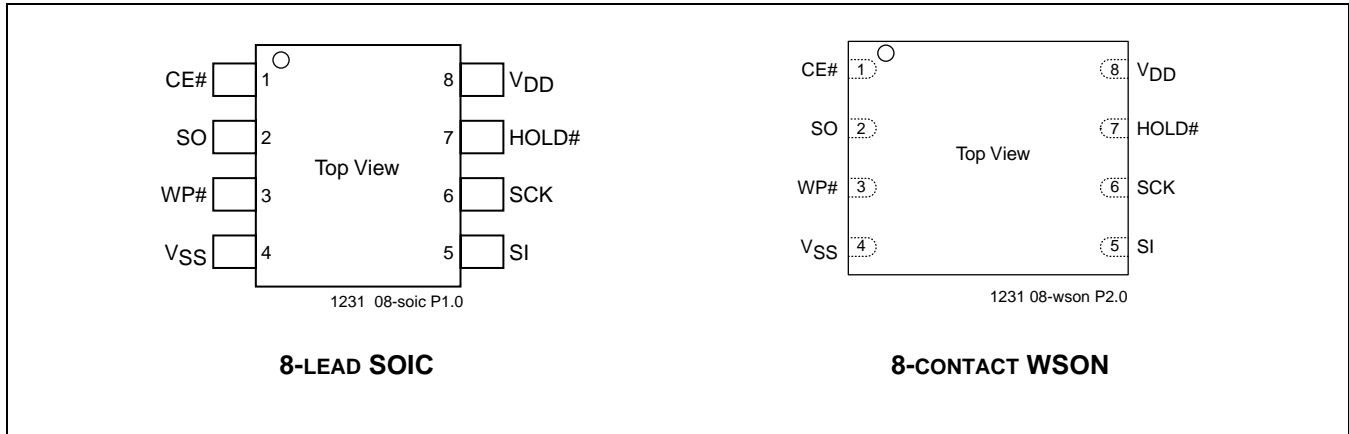


FIGURE 2: Pin Assignments

TABLE 1: Pin Description

| Symbol | Pin Name | Functions |
|-----------------|--------------------|--|
| SCK | Serial Clock | To provide the timing of the serial interface. Commands, addresses, or input data are latched on the rising edge of the clock input, while output data is shifted out on the falling edge of the clock input. |
| SI | Serial Data Input | To transfer commands, addresses, or data serially into the device. Inputs are latched on the rising edge of the serial clock. |
| SO | Serial Data Output | To transfer data serially out of the device. Data is shifted out on the falling edge of the serial clock. |
| CE# | Chip Enable | The device is enabled by a high to low transition on CE#. CE# must remain low for the duration of any command sequence. |
| WP# | Write Protect | The Write Protect (WP#) pin is used to enable/disable BPL bit in the status register. |
| HOLD# | Hold | To temporarily stop serial communication with SPI flash memory without resetting the device. |
| V _{DD} | Power Supply | To provide power supply (2.7-3.6V). |
| V _{SS} | Ground | |

T1.0 1231

TOSHIBA TRANSISTOR SILICON PNP EPITAXIAL TYPE (PCT PROCESS)

2SA950

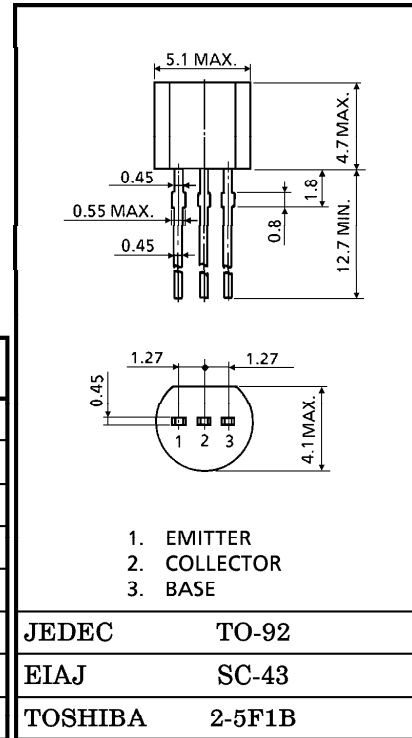
AUDIO POWER AMPLIFIER APPLICATIONS

Unit in mm

- High h_{FE} : $h_{FE} = 100 \sim 320$
- 1W Output Applications
- Complementary to 2SC2120

MAXIMUM RATINGS ($T_a = 25^\circ\text{C}$)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-----------------------------|-----------|-----------|------------------|
| Collector-Base Voltage | V_{CB0} | -35 | V |
| Collector-Emitter Voltage | V_{CEO} | -30 | V |
| Emitter-Base Voltage | V_{EBO} | -5 | V |
| Collector Current | I_C | -800 | mA |
| Base Current | I_B | -160 | mA |
| Collector Power Dissipation | P_C | 600 | mW |
| Junction Temperature | T_j | 150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -55 ~ 150 | $^\circ\text{C}$ |



Weight : 0.21g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ\text{C}$)

| CHARACTERISTIC | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--------------------------------------|--------------------|---|------|------|------|---------------|
| Collector Cut-off Current | I_{CBO} | $V_{CB} = -35\text{V}, I_E = 0$ | — | — | -0.1 | μA |
| Emitter Cut-off Current | I_{EBO} | $V_{EB} = -5\text{V}, I_C = 0$ | — | — | -0.1 | μA |
| Collector-Emitter Breakdown Voltage | $V_{(BR)CEO}$ | $I_C = -10\text{mA}, I_B = 0$ | -30 | — | — | V |
| DC Current Gain | $h_{FE(1)}$ (Note) | $V_{CE} = -1\text{V}, I_C = -100\text{mA}$ | 100 | — | 320 | |
| | $h_{FE(2)}$ | $V_{CE} = -1\text{V}, I_C = -700\text{mA}$ | 35 | — | — | |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = -500\text{mA}, I_B = -20\text{mA}$ | — | — | -0.7 | V |
| Base-Emitter Voltage | V_{BE} | $V_{CE} = -1\text{V}, I_C = -10\text{mA}$ | -0.5 | — | -0.8 | V |
| Transition Frequency | f_T | $V_{CE} = -5\text{V}, I_C = -10\text{mA}$ | — | 120 | — | MHz |
| Collector Output Capacitance | C_{ob} | $V_{CB} = -10\text{V}, I_E = 0,$ $f = 1\text{MHz}$ | — | 19 | — | pF |

Note : $h_{FE(1)}$ Classification O : 100~200、Y : 160~320

961001EAA2

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- The information contained herein is subject to change without notice.

TOSHIBA Transistor Silicon PNP Epitaxial Type (PCT process)

2SA1162

Audio Frequency General Purpose Amplifier Applications

- High voltage and high current: $V_{CE0} = -50\text{ V}$, $I_C = -150\text{ mA}$ (max)
- Excellent h_{FE} linearity: $h_{FE}(I_C = -0.1\text{ mA})/h_{FE}(I_C = -2\text{ mA}) = 0.95$ (typ.)
- High h_{FE} : $h_{FE} = 70\sim 400$
- Low noise: $NF = 1\text{ dB}$ (typ.), 10 dB (max)
- Complementary to 2SC2712
- Small package

Absolute Maximum Ratings ($T_a = 25^\circ\text{C}$)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------|-----------|---------|------------------|
| Collector-base voltage | V_{CB0} | -50 | V |
| Collector-emitter voltage | V_{CE0} | -50 | V |
| Emitter-base voltage | V_{EB0} | -5 | V |
| Collector current | I_C | -150 | mA |
| Base current | I_B | -30 | mA |
| Collector power dissipation | P_C | 150 | mW |
| Junction temperature | T_j | 125 | $^\circ\text{C}$ |
| Storage temperature range | T_{stg} | -55~125 | $^\circ\text{C}$ |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

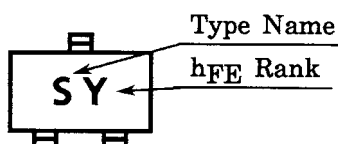
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Electrical Characteristics ($T_a = 25^\circ\text{C}$)

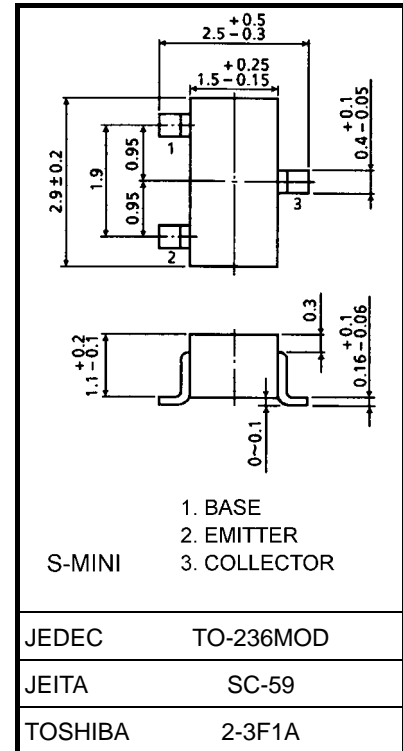
| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------------|--------------------|--|-----|------|------|---------------|
| Collector cut-off current | I_{CBO} | $V_{CB} = -50\text{ V}$, $I_E = 0$ | — | — | -0.1 | μA |
| Emitter cut-off current | I_{EBO} | $V_{EB} = -5\text{ V}$, $I_C = 0$ | — | — | -0.1 | μA |
| DC current gain | h_{FE} (Note) | $V_{CE} = -6\text{ V}$, $I_C = -2\text{ mA}$ | 70 | — | 400 | |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C = -100\text{ mA}$, $I_B = -10\text{ mA}$ | — | -0.1 | -0.3 | V |
| Transition frequency | f_T | $V_{CE} = -10\text{ V}$, $I_C = -1\text{ mA}$ | 80 | — | — | MHz |
| Collector output capacitance | C_{ob} | $V_{CB} = -10\text{ V}$, $I_E = 0$, $f = 1\text{ MHz}$ | — | 4 | 7 | pF |
| Noise figure | NF | $V_{CE} = -6\text{ V}$, $I_C = -0.1\text{ mA}$, $f = 1\text{ kHz}$, $R_g = 10\text{ k}\Omega$, | — | 1.0 | 10 | dB |

Note: h_{FE} classification O (O): 70~140, Y (Y): 120~240, GR (G): 200~400, () marking symbol

Marking



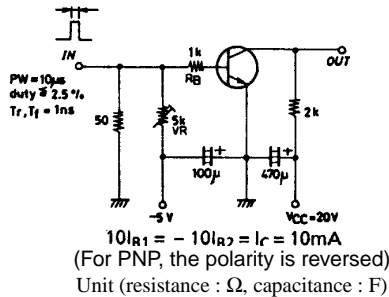
Unit: mm



Weight: 0.012 g (typ.)

2SA1331/2SC3361**SANYO****High-Speed Switching Applications****Features**

- Fast switching speed.
- High breakdown voltage.
- Small-sized package permitting the 2SA1331/2SC3361-applied sets to be made small and slim.

Switching Time Test Circuit

() : 2SA1331

Specifications**Absolute Maximum Ratings at Ta = 25°C**

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------------|-----------|------------|-------------|------|
| Collector-to-Base Voltage | V_{CBO} | | (-)60 | V |
| Collector-to-Emitter Voltage | V_{CEO} | | (-)50 | V |
| Emitter-to-Base Voltage | V_{EBO} | | (-)5 | V |
| Collector Current | I_C | | (-)150 | mA |
| Collector Current (Pulse) | I_{CP} | | (-)400 | mA |
| Base Current | I_B | | (-)40 | mA |
| Collector Dissipation | P_C | | 150 | mW |
| Junction Temperature | T_J | | 125 | °C |
| Storage Temperature | T_{stg} | | -55 to +125 | °C |

Electrical Characteristics at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | | Unit | |
|---|---------------|--------------------------------|---------|--------------|--------|-----|
| | | | min | typ | | max |
| Collector Cutoff Current | I_{CBO} | $V_{CB} = (-)40V, I_E = 0$ | | | (-)0.1 | µA |
| Emitter Cutoff Current | I_{EBO} | $V_{EB} = (-)4V, I_C = 0$ | | | (-)0.1 | µA |
| DC Current Gain | h_{FE} | $V_{CE} = (-)6V, I_C = (-)1mA$ | 90* | | 400* | |
| Gain-Bandwidth Product | f_T | $V_{CE} = (-)6V, I_C = (-)1mA$ | | 100 | | MHz |
| Common Base Output Capacitance | C_{ob} | $V_{CB} = (-)6V, f = 1MHz$ | | (3.5) 2.7 | | pF |
| Collector-to-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = (-)10mA, I_B = (-)1mA$ | | (-)0.1 | (-)0.4 | V |
| Base-to-Emitter Saturation Voltage | $V_{BE(sat)}$ | $I_C = (-)10mA, I_B = (-)1mA$ | | (-)0.75 | (-)1.1 | V |
| Collector-to-Base Breakdown Voltage | $V_{(BR)CBO}$ | $I_C = (-)10µA, I_E = 0$ | | (-)60 | | V |
| Collector-to-Emitter Breakdown Voltage | $V_{(BR)CEO}$ | $I_C = (-)1mA, R_{BE} = ∞$ | | (-)50 | | V |
| Emitter-to-Base Breakdown Voltage | $V_{(BR)EBO}$ | $I_E = (-)10µA, I_C = 0$ | | (-)5 | | V |
| Delay Time | t_d | See specified Test Circuit | | 40 | | ns |
| Rise Time | t_r | See specified Test Circuit | | (120) 80 | | ns |
| Storage Time | t_{stg} | See specified Test Circuit | | (190) 230 | | ns |
| Fall Time | t_f | See specified Test Circuit | | (200) 160 | | ns |

* : The 2SA1331/2SC3361 are classified by 1mA h_{FE} as follows :

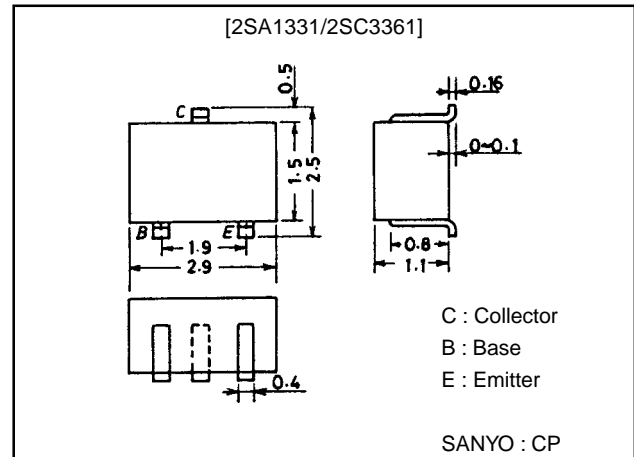
| | | | | | | | | |
|----|---|-----|-----|---|-----|-----|---|-----|
| 90 | 4 | 180 | 135 | 5 | 270 | 200 | 6 | 400 |
|----|---|-----|-----|---|-----|-----|---|-----|

Marking 2SA1331 : O, 2SC3361 : S

 h_{FE} rank : 4, 5, 6**Package Dimensions**

unit:mm

2018A

**SANYO Electric Co.,Ltd. Semiconductor Business Headquarters**

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

TOSHIBA TRANSISTOR SILOCON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC2120

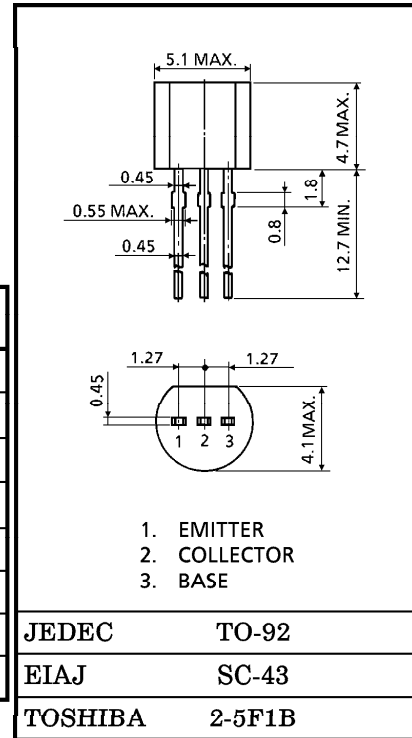
AUDIO POWER AMPLIFIER APPLICATIONS

Unit in mm

- High h_{FE} : $h_{FE(1)} = 100 \sim 320$
- 1 Watts Amplifier Applications.
- Complementary to 2SA950

MAXIMUM RATINGS ($T_a = 25^\circ\text{C}$)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-----------------------------|-----------|----------------|------------------|
| Collector-Base Voltage | V_{CBO} | 35 | V |
| Collector-Emitter Voltage | V_{CEO} | 30 | V |
| Emitter-Base Voltage | V_{EBO} | 5 | V |
| Collector Current | I_C | 800 | mA |
| Base Current | I_B | 160 | mA |
| Collector Power Dissipation | P_C | 600 | mW |
| Junction Temperature | T_j | 150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | $-55 \sim 150$ | $^\circ\text{C}$ |



Weight : 0.21g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ\text{C}$)

| CHARACTERISTIC | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|-------------------------------------|--------------------|--|------|------|------|---------------|
| Collector Cut-off Current | I_{CBO} | $V_{CB} = 35\text{V}, I_E = 0$ | — | — | 0.1 | μA |
| Emitter Cut-off Current | I_{EBO} | $V_{EB} = 5\text{V}, I_C = 0$ | — | — | 0.1 | μA |
| Collector-Emitter Breakdown Voltage | $V_{(BR)CEO}$ | $I_C = 10\text{mA}, I_B = 0$ | 30 | — | — | V |
| DC Current Gain | $h_{FE(1)}$ (Note) | $V_{CE} = 1\text{V}, I_C = 100\text{mA}$ | 100 | — | 320 | |
| | $h_{FE(2)}$ | $V_{CE} = 1\text{V}, I_C = 700\text{mA}$ | 35 | — | — | |
| Collector-Emitter Breakdown Voltage | $V_{CE(sat)}$ | $I_C = 500\text{mA}, I_B = 20\text{mA}$ | — | — | 0.5 | V |
| Base-Emitter Voltage | V_{BE} | $V_{CE} = 1\text{V}, I_C = 10\text{mA}$ | 0.5 | — | 0.8 | V |
| Transition Frequency | f_T | $V_{CE} = 5\text{V}, I_C = 10\text{mA}$ | — | 120 | — | MHz |
| Collector Output Capacitance | C_{ob} | $V_{CB} = 10\text{V}, I_E = 0,$ $f = 1\text{MHz}$ | — | 13 | — | pF |

Note : $h_{FE(1)}$ Classification O : 100~200, Y : 160~3200

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TOSHIBA TRANSISTOR SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC2712

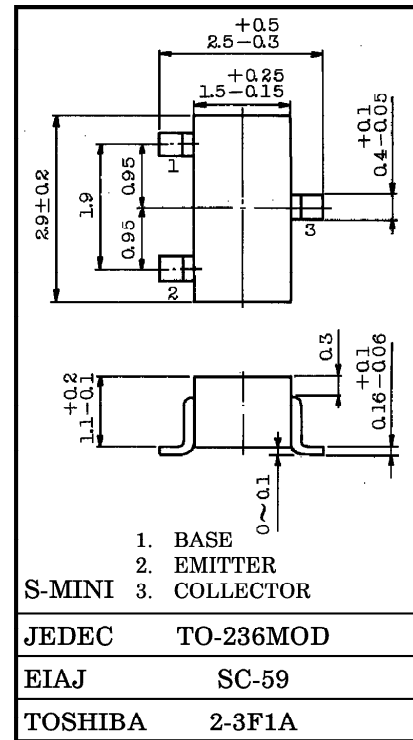
AUDIO FREQUENCY GENERAL PURPOSE AMPLIFIER APPLICATIONS.

Unit in mm

- High Voltage and High Current
: $V_{CE0}=50V, I_C=150mA$ (Max.)
- Excellent h_{FE} Linearity
: $h_{FE}(I_C=0.1mA) / h_{FE}(I_C=2mA) = 0.95$ (Typ.)
- High h_{FE} : $h_{FE}=70\sim700$
- Low Noise : $NF=1dB$ (Typ.), $10dB$ (Max.)
- Complementary to 2SA1162
- Small Package

MAXIMUM RATINGS ($T_a = 25^\circ C$)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-----------------------------|-----------|---------|------------|
| Collector-Base Voltage | V_{CB0} | 60 | V |
| Collector-Emitter Voltage | V_{CE0} | 50 | V |
| Emitter-Base Voltage | V_{EBO} | 5 | V |
| Collector Current | I_C | 150 | mA |
| Base Current | I_B | 30 | mA |
| Collector Power Dissipation | P_C | 150 | mW |
| Junction Temperature | T_j | 125 | $^\circ C$ |
| Storage Temperature Range | T_{stg} | -55~125 | $^\circ C$ |



Weight : 0.012g

ELECTRICAL CHARACTERISTICS ($T_a = 25^\circ C$)

| CHARACTERISTIC | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|--------------------------------------|-----------------------|---|------|------|------|---------|
| Collector Cut-off Current | I_{CBO} | $V_{CB}=60V, I_E=0$ | — | — | 0.1 | μA |
| Emitter Cut-off Current | I_{EBO} | $V_{EB}=5V, I_C=0$ | — | — | 0.1 | μA |
| DC Current Gain | $h_{FE}(\text{Note})$ | $V_{CE}=6V, I_C=2mA$ | 70 | — | 700 | |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C=100mA, I_B=10mA$ | — | 0.1 | 0.25 | V |
| Transition Frequency | f_T | $V_{CE}=10V, I_C=1mA$ | 80 | — | — | MHz |
| Collector Output Capacitance | C_{ob} | $V_{CB}=10V, I_E=0, f=1MHz$ | — | 2.0 | 3.5 | pF |
| Noise Figure | NF | $V_{CE}=6V, I_C=0.1mA, f=1kHz, R_g=10k\Omega$ | — | 1.0 | 10 | dB |

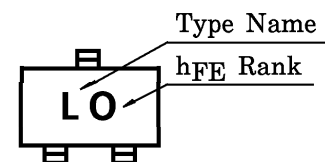
Note : h_{FE} Classification

O (O) : 70~140, Y (Y) : 120~240, GR (G) : 200~400,

BL (L) : 350~700

() Marking Symbol

MARKING



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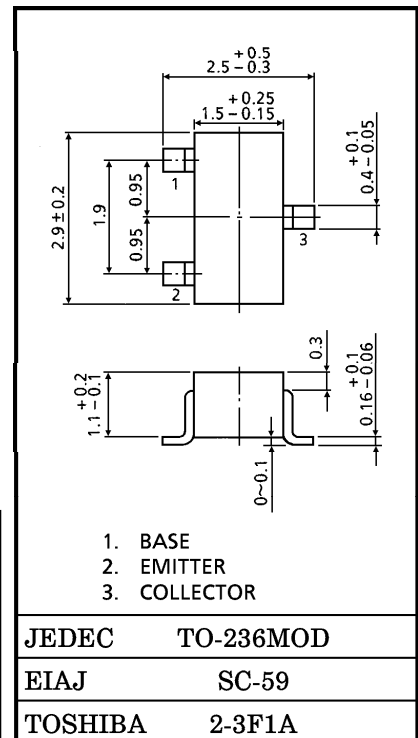
TOSHIBA TRANSISTOR SILICON NPN EPITAXIAL TYPE (PCT PROCESS)

2SC3326

FOR MUTING AND SWITCHING APPLICATIONS

Unit in mm

- High Emitter-Base Voltage : $V_{EBO} = 25V$ (Min.)
- High Reverse h_{FE} : Reverse $h_{FE} = 150$ (Typ.)
($V_{CE} = -2V, I_C = -4mA$)
- Low On Resistance : $R_{ON} = 1\Omega$ (Typ.) ($I_B = 5mA$)
- High DC Current Gain : $h_{FE} = 200 \sim 1200$
- Small Package

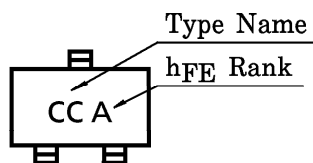


Weight : 0.012g

MAXIMUM RATINGS ($T_a = 25^\circ C$)

| CHARACTERISTIC | SYMBOL | RATING | UNIT |
|-----------------------------|-----------|---------|------------|
| Collector-Base Voltage | V_{CBO} | 50 | V |
| Collector-Emitter Voltage | V_{CEO} | 20 | V |
| Emitter-Base Voltage | V_{EBO} | 25 | V |
| Collector Current | I_C | 300 | mA |
| Base Current | I_B | 60 | mA |
| Collector Power Dissipation | P_C | 150 | mW |
| Junction Temperature | T_j | 125 | $^\circ C$ |
| Storage Temperature Range | T_{stg} | -55~125 | $^\circ C$ |

MARKING



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FEATURES

- Three Terminal Adjustable or Fixed Voltages*
1.5V, 1.8V, 2.5V, 2.85V, 3.3V and 5.0V
- Output Current of 800mA
- Operates Down to 1V Dropout
- Line Regulation: 0.2% Max.
- Load Regulation: 0.4% Max.
- SOT-223 and TO-252 package available

APPLICATIONS

- High Efficiency Linear Regulators
- Post Regulators for Switching Supplies
- 5V to 3.3V Linear Regulator
- Battery Chargers
- Active SCSI Terminators
- Power Management for Notebook
- Battery Powered Instrumentation

GENERAL DESCRIPTION

The AMS1117 series of adjustable and fixed voltage regulators are designed to provide 800mA output current and to operate down to 1V input-to-output differential. The dropout voltage of the device is guaranteed maximum 1.3V at maximum output current, decreasing at lower load currents.

On-chip trimming adjusts the reference voltage to 1%. Current limit is also trimmed, minimizing the stress under overload conditions on both the regulator and power source circuitry.

The AMS1117 devices are pin compatible with other three-terminal SCSI regulators and are offered in the low profile surface mount SOT-223 package and in the TO-252 (DPAK) plastic package.

ORDERING INFORMATION:

| PACKAGE TYPE | | OPERATING JUNCTION TEMPERATURE RANGE |
|----------------|--------------|---|
| TO-252 | SOT-223 | |
| AMS1117CD | AMS1117 | 0 to 125° C |
| AMS1117CD-1.5 | AMS1117-1.5 | 0 to 125° C |
| AMS1117CD-1.8 | AMS1117-1.8 | 0 to 125° C |
| AMS1117CD-2.5 | AMS1117-2.5 | 0 to 125° C |
| AMS1117CD-2.85 | AMS1117-2.85 | 0 to 125° C |
| AMS1117CD-3.3 | AMS1117-3.3 | 0 to 125° C |
| AMS1117CD-5.0 | AMS1117-5.0 | 0 to 125° C |

*For additional available fixed voltages contact factory.

PIN CONNECTIONS

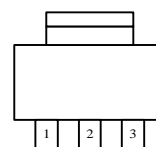
FIXED VERSION

- 1- Ground
- 2- V_{OUT}
- 3- V_{IN}

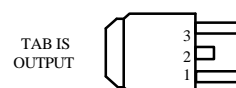
ADJUSTABLE VERSION

- 1- Adjust
- 2- V_{OUT}
- 3- V_{IN}

SOT-223 Top View



TO-252 FRONT VIEW



ABSOLUTE MAXIMUM RATINGS (Note 1)

| | |
|--------------------------------|--------------------|
| Power Dissipation | Internally limited |
| Input Voltage | 15V |
| Operating Junction Temperature | |
| Control Section | 0°C to 125°C |
| Power Transistor | 0°C to 150°C |
| Storage temperature | - 65°C to +150°C |

Soldering information

| | |
|---|------------------------------------|
| Lead Temperature (10 sec) | 300°C |
| Thermal Resistance | |
| TO-252 package | $\phi_{JA} = 80^\circ\text{C/W}$ |
| SOT-223 package | $\phi_{JA} = 90^\circ\text{C/W}^*$ |
| * With package soldering to copper area over backside ground plane or internal power plane ϕ_{JA} can vary from 46°C/W to >90°C/W depending on mounting technique and the size of the copper area. | |

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at $I_{OUT} = 0$ mA, and $T_J = +25^\circ\text{C}$ unless otherwise specified.

| Parameter | Device | Conditions | Min | Typ | Max | Units |
|---------------------------------|--------------|---|--------------|--------------|--------------|-------|
| | | | | | | |
| Reference Voltage (Note 2) | AMS1117 | $I_{OUT} = 10$ mA $10\text{mA} \leq I_{OUT} \leq 800\text{mA}$, $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 12\text{V}$ | 1.238 | 1.250 | 1.262 | V |
| | | | 1.225 | 1.250 | 1.270 | V |
| Output Voltage (Note 2) | AMS1117-1.5 | $0 \leq I_{OUT} \leq 800\text{mA}$, $3.0\text{V} \leq V_{IN} \leq 12\text{V}$ | 1.485 | 1.500 | 1.515 | V |
| | | | 1.476 | 1.500 | 1.524 | V |
| | AMS1117-1.8 | $0 \leq I_{OUT} \leq 800\text{mA}$, $3.3\text{V} \leq V_{IN} \leq 12\text{V}$ | 1.782 | 1.800 | 1.818 | V |
| | | | 1.773 | 1.800 | 1.827 | V |
| | AMS1117-2.5 | $0 \leq I_{OUT} \leq 800\text{mA}$, $4.0\text{V} \leq V_{IN} \leq 12\text{V}$ | 2.475 | 2.500 | 2.525 | V |
| | | | 2.460 | 2.500 | 2.560 | V |
| | AMS1117-2.85 | $0 \leq I_{OUT} \leq 800\text{mA}$, $4.35\text{V} \leq V_{IN} \leq 12\text{V}$ | 2.82 | 2.850 | 2.88 | V |
| | | | 2.79 | 2.850 | 2.91 | V |
| | AMS1117-3.3 | $0 \leq I_{OUT} \leq 800\text{mA}$, $4.75\text{V} \leq V_{IN} \leq 12\text{V}$ | 3.267 | 3.300 | 3.333 | V |
| | | | 3.235 | 3.300 | 3.365 | V |
| | AMS1117-5.0 | $0 \leq I_{OUT} \leq 800\text{mA}$, $6.5\text{V} \leq V_{IN} \leq 12\text{V}$ | 4.950 | 5.000 | 5.050 | V |
| | | | 4.900 | 5.000 | 5.100 | V |
| Line Regulation | AMS1117 | $I_{LOAD} = 10$ mA, $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 12\text{V}$ | | 0.015 | 0.2 | % |
| | | | | 0.035 | 0.2 | % |
| | AMS1117-1.5 | $3.0\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.3 | 5 | mV |
| | | | | 0.6 | 6 | mV |
| | AMS1117-1.8 | $3.3\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.3 | 5 | mV |
| | | | | 0.6 | 6 | mV |
| | AMS1117-2.5 | $4.0\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.3 | 6 | mV |
| | | | | 0.6 | 6 | mV |
| | AMS1117-2.85 | $4.35\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.3 | 6 | mV |
| | | | | 0.6 | 6 | mV |
| | AMS1117-3.3 | $4.75\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.5 | 10 | mV |
| | | | | 1.0 | 10 | mV |
| | AMS1117-5.0 | $6.5\text{V} \leq V_{IN} \leq 12\text{V}$ | | 0.5 | 10 | mV |
| | | | | 1.0 | 10 | mV |
| Load Regulation (Notes 2, 3) | AMS1117 | $(V_{IN} - V_{OUT}) = 3\text{V}$, $10\text{mA} \leq I_{OUT} \leq 800\text{mA}$ | | 0.1 | 0.3 | % |
| | | | | 0.2 | 0.4 | % |
| | AMS1117-1.5 | $V_{IN} = 5\text{V}$, $0 \leq I_{OUT} \leq 800\text{mA}$ | | 3 | 10 | mV |
| | | | | 6 | 20 | mV |
| | AMS1117-1.8 | $V_{IN} = 5\text{V}$, $0 \leq I_{OUT} \leq 800\text{mA}$ | | 3 | 10 | mV |
| | | | | 6 | 20 | mV |
| | AMS1117-2.5 | $V_{IN} = 5\text{V}$, $0 \leq I_{OUT} \leq 800\text{mA}$ | | 3 | 12 | mV |
| | | | | 6 | 20 | mV |

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at $I_{OUT} = 0$ mA, and $T_J = +25^\circ\text{C}$ unless otherwise specified.

| Parameter | Device | Conditions | Min | Typ | Max | Units |
|---|---------------------------------------|---|------------|----------------------|-----------------|--------------------------------|
| Load Regulation (Notes 2, 3) | AMS1117-2.85 | $V_{IN} = 5\text{V}, 0 \leq I_{OUT} \leq 800\text{mA}$ | | 3 6 | 12 20 | mV mV |
| | AMS1117-3.3 | $V_{IN} = 5\text{V}, 0 \leq I_{OUT} \leq 800\text{mA}$ | | 3 7 | 15 25 | mV mV |
| | AMS1117-5.0 | $V_{IN} = 8\text{V}, 0 \leq I_{OUT} \leq 800\text{mA}$ | | 5 10 | 20 35 | mV mV |
| Dropout Voltage ($V_{IN} - V_{OUT}$) | AMS1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0 | $\Delta V_{OUT}, \Delta V_{REF} = 1\%, I_{OUT} = 800\text{mA}$ (Note 4) | | 1.1 | 1.3 | V |
| Current Limit | AMS1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0 | $(V_{IN} - V_{OUT}) = 5\text{V}$ | 900 | 1,100 | 1,500 | mA |
| Minimum Load Current | AMS1117 | $(V_{IN} - V_{OUT}) = 12\text{V}$ (Note 5) | | 5 | 10 | mA |
| Quiescent Current | AMS1117-1.5/-1.8/-2.5/-2.85/-3.3/-5.0 | $V_{IN} \leq 12\text{V}$ | | 5 | 10 | mA |
| Ripple Rejection | AMS1117 | $f = 120\text{Hz}, C_{OUT} = 22\mu\text{F}$ Tantalum, $I_{OUT} = 800\text{mA}$, $(V_{IN} - V_{OUT}) = 3\text{V}, C_{ADJ} = 10\mu\text{F}$ | 60 | 75 | | dB |
| | AMS1117-1.5/-1.8/-2.5/-2.85 | $f = 120\text{Hz}, C_{OUT} = 22\mu\text{F}$ Tantalum, $I_{OUT} = 800\text{mA}$, $V_{IN} = 6\text{V}$ | 60 | 72 | | dB |
| | AMS1117-3.3 | $f = 120\text{Hz}, C_{OUT} = 22\mu\text{F}$ Tantalum, $I_{OUT} = 800\text{mA}$ $V_{IN} = 6.3\text{V}$ | 60 | 72 | | dB |
| | AMS1117-5.0 | $f = 120\text{Hz}, C_{OUT} = 22\mu\text{F}$ Tantalum, $I_{OUT} = 800\text{mA}$ $V_{IN} = 8\text{V}$ | 60 | 68 | | dB |
| Thermal Regulation | AMS1117 | $T_A = 25^\circ\text{C}, 30\text{ms}$ pulse | | 0.008 | 0.04 | %W |
| Adjust Pin Current | AMS1117 | $10\text{mA} \leq I_{OUT} \leq 800\text{mA}, 1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 12\text{V}$ | | 55 | 120 | μA μA |
| Adjust Pin Current Change | AMS1117 | $10\text{mA} \leq I_{OUT} \leq 800\text{mA}, 1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 12\text{V}$ | | 0.2 | 5 | μA |
| Temperature Stability | | | | 0.5 | | % |
| Long Term Stability | | $T_A = 125^\circ\text{C}, 1000\text{Hrs}$ | | 0.3 | 1 | % |
| RMS Output Noise (% of V_{OUT}) | | $T_A = 25^\circ\text{C}, 10\text{Hz} \leq f \leq 10\text{kHz}$ | | 0.003 | | % |
| Thermal Resistance Junction-to-Case | | | | | 15 | $^\circ\text{C}/\text{W}$ |

Parameters identified with **boldface type** apply over the full operating temperature range.

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed.

Note 2: Line and Load regulation are guaranteed up to the maximum power dissipation of 1.2 W. Power dissipation is determined by the input/output differential and the output current. Guaranteed maximum power dissipation will not be available over the full input/output range.

Note 3: See thermal regulation specifications for changes in output voltage due to heating effects. Line and load regulation are measured at a constant junction temperature by low duty cycle pulse testing. Load regulation is measured at the output lead $\sim 1/8''$ from the package.

Note 4: Dropout voltage is specified over the full output current range of the device.

Note 5: Minimum load current is defined as the minimum output current required to maintain regulation. When $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 12\text{V}$ the device is guaranteed to regulate if the output current is greater than 10mA.

APPLICATION HINTS

The AMS1117 series of adjustable and fixed regulators are easy to use and are protected against short circuit and thermal overloads. Thermal protection circuitry will shut-down the regulator should the junction temperature exceed 165°C at the sense point.

Pin compatible with older three terminal adjustable regulators, these devices offer the advantage of a lower dropout voltage, more precise reference tolerance and improved reference stability with temperature.

Stability

The circuit design used in the AMS1117 series requires the use of an output capacitor as part of the device frequency compensation. The addition of 22µF solid tantalum on the output will ensure stability for all operating conditions.

When the adjustment terminal is bypassed with a capacitor to improve the ripple rejection, the requirement for an output capacitor increases. The value of 22µF tantalum covers all cases of bypassing the adjustment terminal. Without bypassing the adjustment terminal smaller capacitors can be used with equally good results.

To ensure good transient response with heavy load current changes capacitor values on the order of 100µF are used in the output of many regulators. To further improve stability and transient response of these devices larger values of output capacitor can be used.

Protection Diodes

Unlike older regulators, the AMS1117 family does not need any protection diodes between the adjustment pin and the output and from the output to the input to prevent over-stressing the die. Internal resistors are limiting the internal current paths on the AMS1117 adjustment pin, therefore even with capacitors on the adjustment pin no protection diode is needed to ensure device safety under short-circuit conditions.

Diodes between the input and output are not usually needed. Microsecond surge currents of 50A to 100A can be handled by the internal diode between the input and output pins of the device. In normal operations it is difficult to get those values of surge currents even with the use of large output capacitances. If high value output capacitors are used, such as 1000µF to 5000µF and the input pin is instantaneously shorted to ground, damage can occur. A diode from output to input is recommended, when a crowbar circuit at the input of the AMS1117 is used (Figure 1).

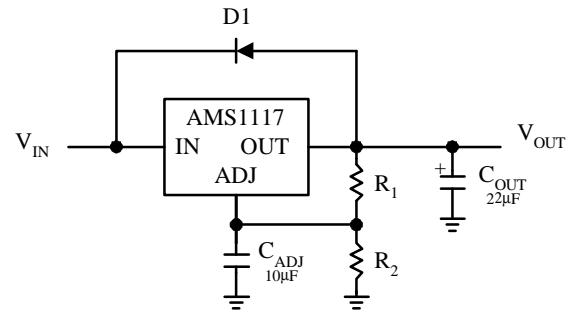


Figure 1.

Output Voltage

The AMS1117 series develops a 1.25V reference voltage between the output and the adjust terminal. Placing a resistor between these two terminals causes a constant current to flow through R1 and down through R2 to set the overall output voltage. This current is normally the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant it represents a small error and it can usually be ignored.

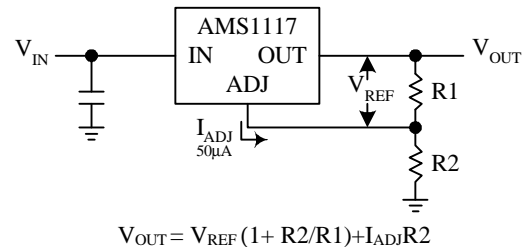


Figure 2. Basic Adjustable Regulator

Load Regulation

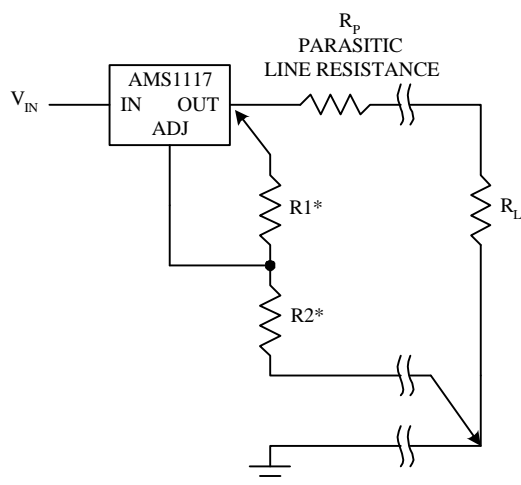
True remote load sensing it is not possible to provide, because the AMS1117 is a three terminal device. The resistance of the wire connecting the regulator to the load will limit the load regulation. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load.

The best load regulation is obtained when the top of the resistor divider R1 is connected directly to the case not to the load. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_P \times \left(\frac{R_2 + R_1}{R_1} \right), \quad R_P = \text{Parasitic Line Resistance}$$

APPLICATION HINTS

Connected as shown, R_p is not multiplied by the divider ratio



*CONNECT R1 TO CASE
CONNECT R2 TO LOAD

Figure 3. Connections for Best Load Regulation

In the case of fixed voltage devices the top of R1 is connected Kelvin internally, and the ground pin can be used for negative side sensing.

Thermal Considerations

The AMS1117 series have internal power and thermal limiting circuitry designed to protect the device under overload conditions. However maximum junction temperature ratings of 125°C should not be exceeded under continuous normal load conditions. Careful consideration must be given to all sources of thermal resistance from junction to ambient. For the surface mount package SOT-223 additional heat sources mounted near the device must be considered. The heat dissipation capability of the PC board and its copper traces is used as a heat sink for the device. The thermal resistance from the junction to the tab for the AMS1117 is 15°C/W. Thermal resistance from tab to ambient can be as low as 30°C/W.

Table 1.

| COPPER AREA | | BOARD AREA | THERMAL RESISTANCE (JUNCTION-TO-AMBIENT) |
|-------------|-------------|-------------|---|
| TOP SIDE* | BACK SIDE | | |
| 2500 Sq. mm | 2500 Sq. mm | 2500 Sq. mm | 45°C/W |
| 1000 Sq. mm | 2500 Sq. mm | 2500 Sq. mm | 45°C/W |
| 225 Sq. mm | 2500 Sq. mm | 2500 Sq. mm | 53°C/W |
| 100 Sq. mm | 2500 Sq. mm | 2500 Sq. mm | 59°C/W |
| 1000 Sq. mm | 1000 Sq. mm | 1000 Sq. mm | 52°C/W |
| 1000 Sq. mm | 0 | 1000 Sq. mm | 55°C/W |

* Tab of device attached to topside copper.

The total thermal resistance from junction to ambient can be as low as 45°C/W. This requires a reasonable sized PC board with at least on layer of copper to spread the heat across the board and couple it into the surrounding air.

Experiments have shown that the heat spreading copper layer does not need to be electrically connected to the tab of the device. The PC material can be very effective at transmitting heat between the pad area, attached to the pad of the device, and a ground plane layer either inside or on the opposite side of the board. Although the actual thermal resistance of the PC material is high, the Length/Area ratio of the thermal resistance between layers is small. The data in Table 1, was taken using 1/16" FR-4 board with 1 oz. copper foil, and it can be used as a rough guideline for estimating thermal resistance.

For each application the thermal resistance will be affected by thermal interactions with other components on the board. To determine the actual value some experimentation will be necessary.

The power dissipation of the AMS1117 is equal to:

$$P_D = (V_{IN} - V_{OUT})(I_{OUT})$$

Maximum junction temperature will be equal to:

$$T_J = T_{A(MAX)} + P_D(\text{Thermal Resistance (junction-to-ambient)})$$

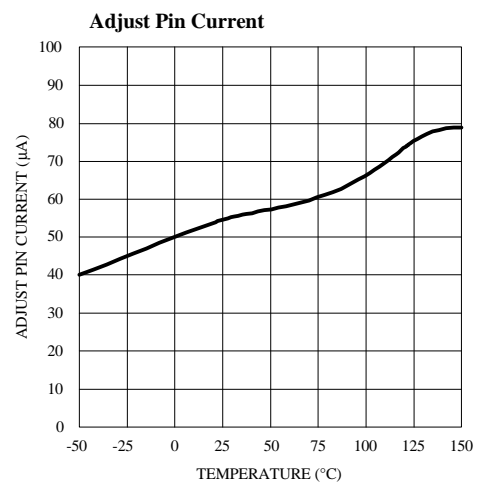
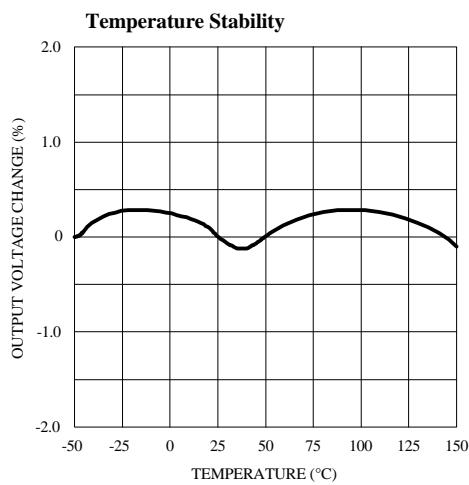
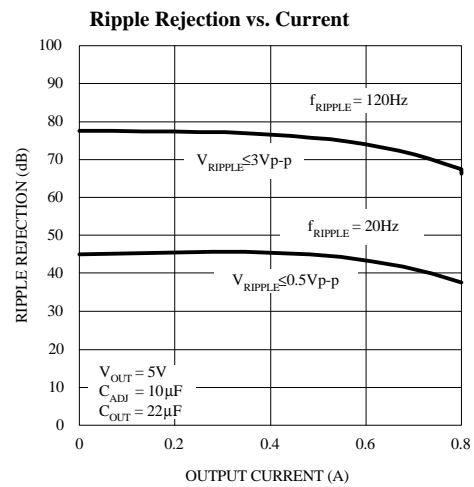
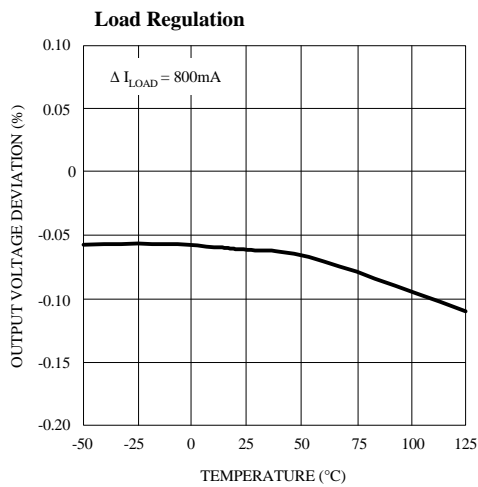
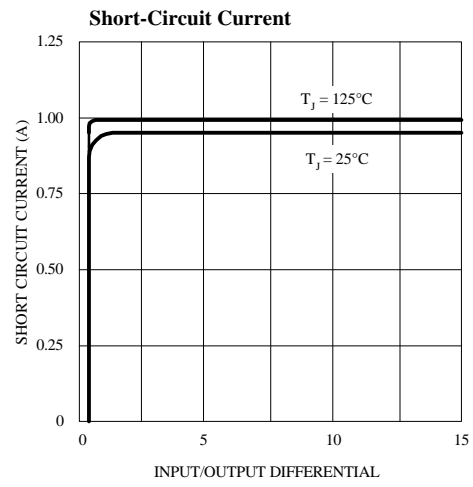
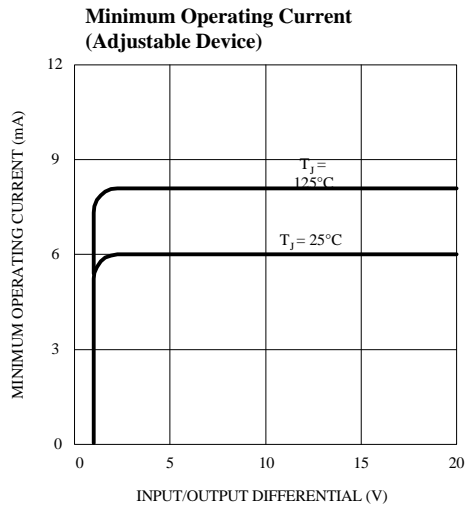
Maximum junction temperature must not exceed 125°C.

Ripple Rejection

The ripple rejection values are measured with the adjustment pin bypassed. The impedance of the adjust pin capacitor at the ripple frequency should be less than the value of R1 (normally 100Ω to 200Ω) for a proper bypassing and ripple rejection approaching the values shown. The size of the required adjust pin capacitor is a function of the input ripple frequency. If R1=100Ω at 120Hz the adjust pin capacitor should be >13μF. At 10kHz only 0.16μF is needed.

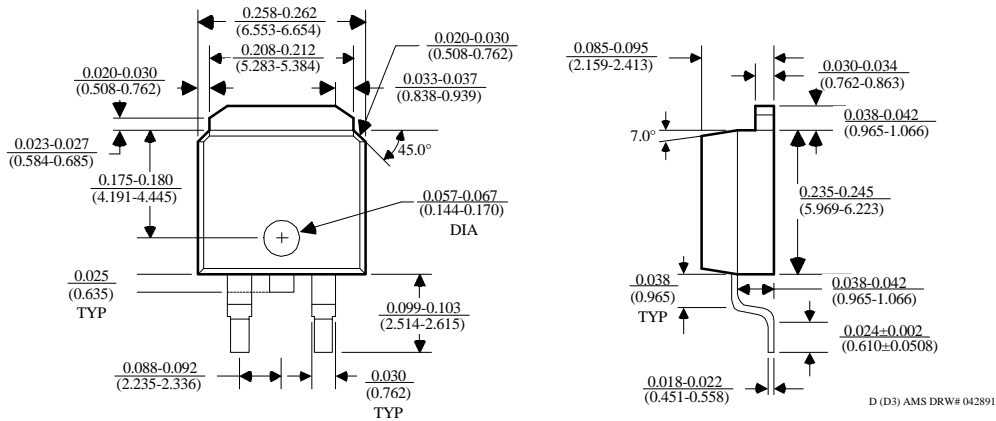
The ripple rejection will be a function of output voltage, in circuits without an adjust pin bypass capacitor. The output ripple will increase directly as a ratio of the output voltage to the reference voltage (V_{OUT} / V_{REF}).

TYPICAL PERFORMANCE CHARACTERISTICS

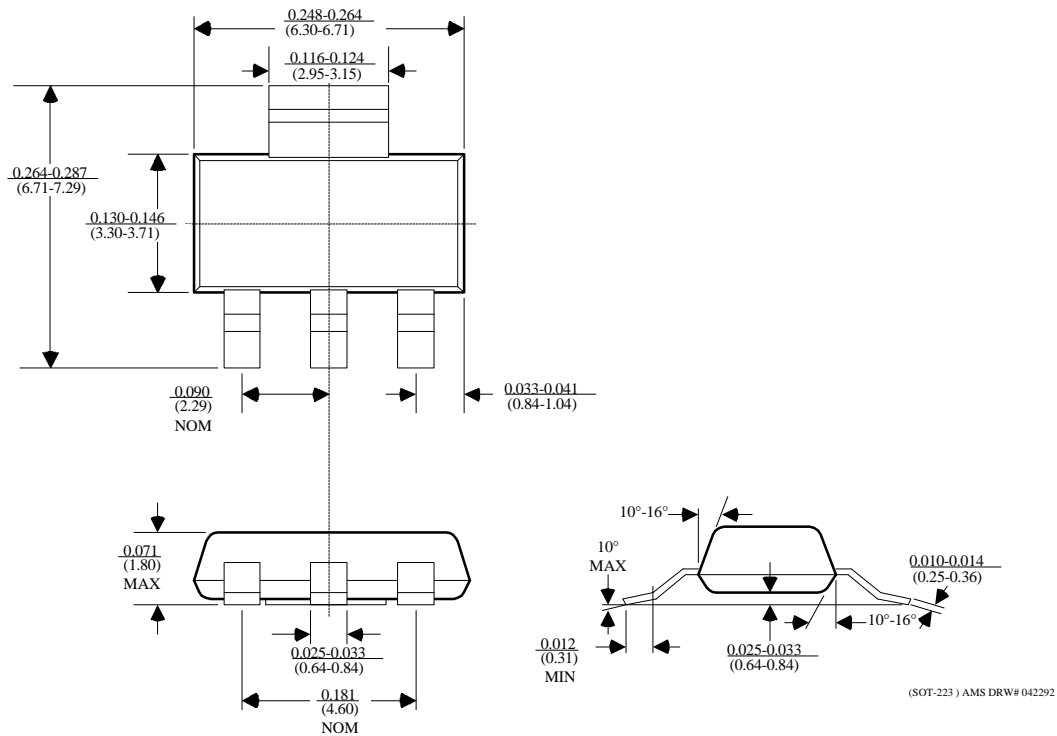


PACKAGE DIMENSIONS inches (millimeters) unless otherwise noted.

TO-252 PLASTIC PACKAGE (D)

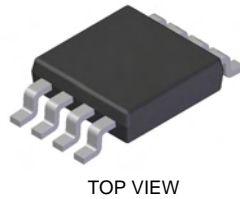


3 LEAD SOT-223 PLASTIC PACKAGE

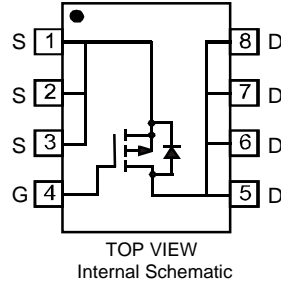


Features

- Low On-Resistance
 - 14mΩ @ $V_{GS} = -10V$
 - 25mΩ @ $V_{GS} = -4.5V$
- Low Gate Threshold Voltage
- Low Input Capacitance
- Fast Switching Speed
- Low Input/Output Leakage
- **Lead Free By Design/RoHS Compliant (Note 2)**
- **"Green" Device (Note 4)**
- **Qualified to AEC-Q101 Standards for High Reliability**



SOP-8L



Mechanical Data

- Case: SOP-8L
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020D
- Terminals Connections: See Diagram
- Terminals: Finish - Matte Tin annealed over Copper lead frame. Solderable per MIL-STD-202, Method 208
- Marking Information: See Page 3
- Ordering Information: See Page 3
- Weight: 0.072g (approximate)

Maximum Ratings @ $T_A = 25^\circ C$ unless otherwise specified

| Characteristic | Symbol | Value | Units | |
|-------------------------------|--------------|--------------------|-------|---|
| Drain-Source Voltage | V_{DSS} | -30 | V | |
| Gate-Source Voltage | V_{GSS} | ± 20 | V | |
| Drain Current (Note 1) | Steady State | $T_A = 25^\circ C$ | -12 | A |
| | | $T_A = 70^\circ C$ | -6 | A |
| Pulsed Drain Current (Note 3) | I_{DM} | -40 | A | |

Thermal Characteristics

| Characteristic | Symbol | Value | Unit |
|---|-----------------|-------------|--------------|
| Total Power Dissipation (Note 1) | P_D | 2.5 | W |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 50 | $^\circ C/W$ |
| Operating and Storage Temperature Range | T_J, T_{STG} | -55 to +150 | $^\circ C$ |

Electrical Characteristics @ $T_A = 25^\circ C$ unless otherwise specified

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|-------------------------------------|--------------|------|------|-----------|-----------|--|
| OFF CHARACTERISTICS (Note 5) | | | | | | |
| Drain-Source Breakdown Voltage | BV_{DSS} | -30 | — | — | V | $V_{GS} = 0V, I_D = -250\mu A$ |
| Zero Gate Voltage Drain Current | I_{DSS} | — | — | -1 | μA | $V_{DS} = -30V, V_{GS} = 0V$ |
| Gate-Source Leakage | I_{GSS} | — | — | ± 100 | nA | $V_{GS} = \pm 20V, V_{DS} = 0V$ |
| ON CHARACTERISTICS (Note 5) | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | -1 | — | -2 | V | $V_{DS} = V_{GS}, I_D = -250\mu A$ |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | — | 11.6 | 14 | $m\Omega$ | $V_{GS} = -10V, I_D = -8A$ |
| | | — | 18.6 | 25 | $m\Omega$ | $V_{GS} = -4.5V, I_D = -5A$ |
| Forward Transconductance | g_{fs} | — | 12 | — | S | $V_{DS} = -10V, I_D = -12A$ |
| Diode Forward Voltage (Note 5) | V_{SD} | -0.5 | — | -1.1 | V | $V_{GS} = 0V, I_S = -2A$ |
| DYNAMIC CHARACTERISTICS | | | | | | |
| Input Capacitance | C_{iss} | — | 1655 | — | pF | $V_{DS} = -20V, V_{GS} = 0V$ $f = 1.0MHz$ |
| Output Capacitance | C_{oss} | — | 286 | — | pF | |
| Reverse Transfer Capacitance | C_{rss} | — | 240 | — | pF | |

- Notes:
1. Device mounted on 2 oz. Copper pads on FR-4 PCB with $R_{\theta JA} = 50^\circ C/W$.
 2. No purposefully added lead.
 3. Pulse width $\leq 10\mu s$, Duty Cycle $\leq 1\%$.
 4. Diodes Inc.'s "Green" policy can be found on our website at http://www.diodes.com/products/lead_free/index.php.
 5. Short duration pulse test used to minimize self-heating effect.

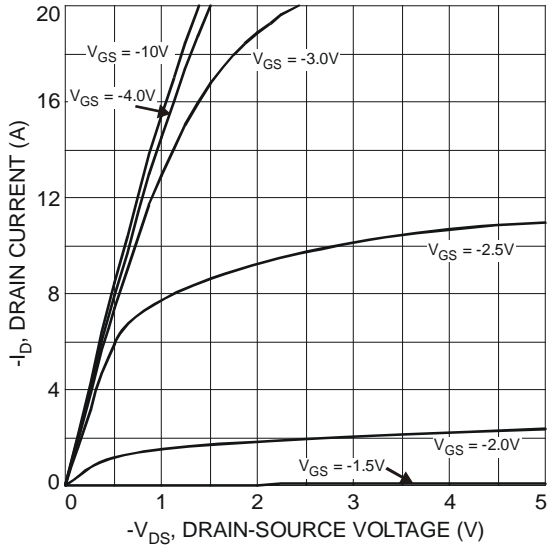


Fig. 1 Typical Output Characteristic

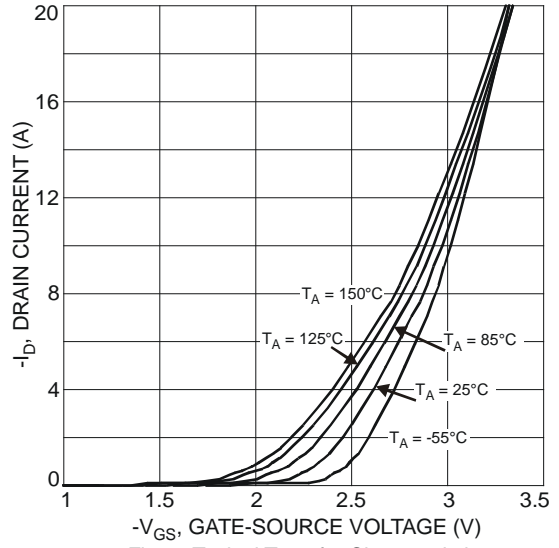


Fig. 2 Typical Transfer Characteristic

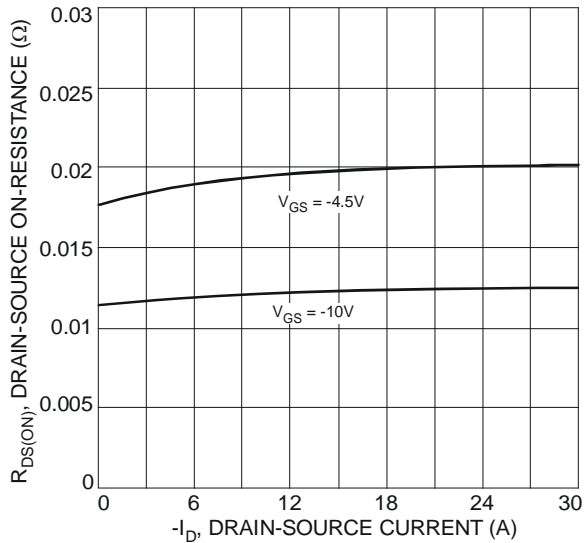


Fig. 3 Typical On-Resistance vs. Drain Current and Gate Voltage

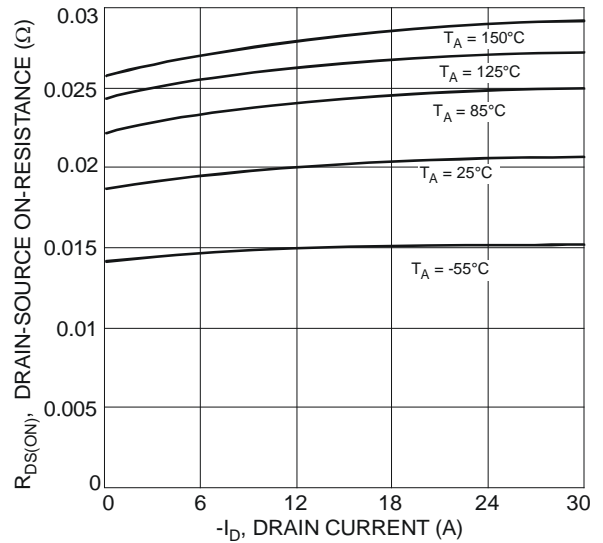


Fig. 4 Typical On-Resistance vs. Drain Current and Temperature

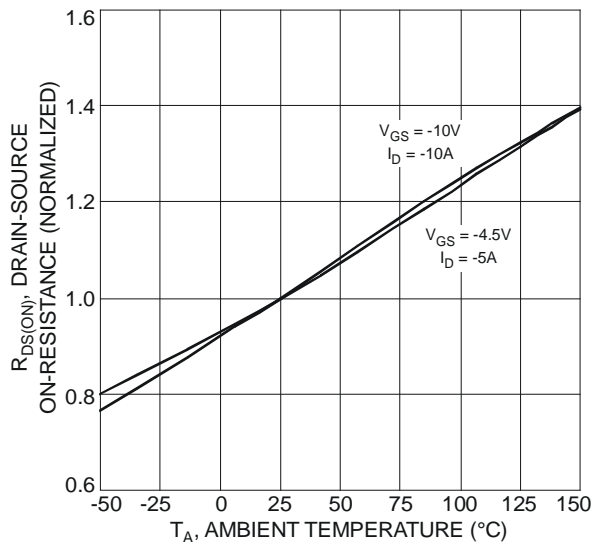


Fig. 5 Normalized On-Resistance vs. Ambient Temperature

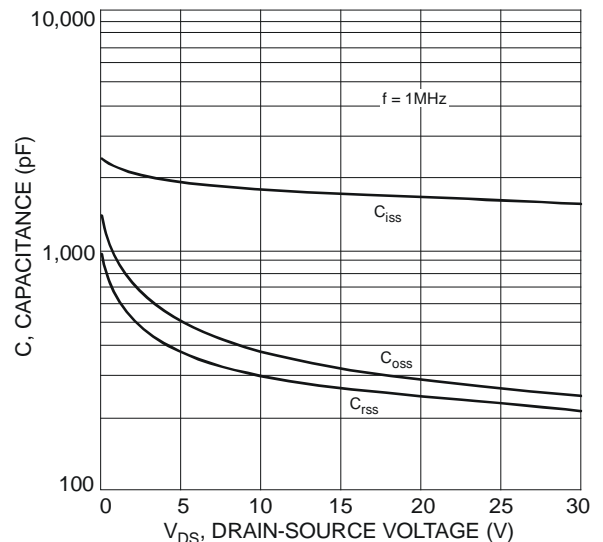


Fig. 6 Typical Total Capacitance

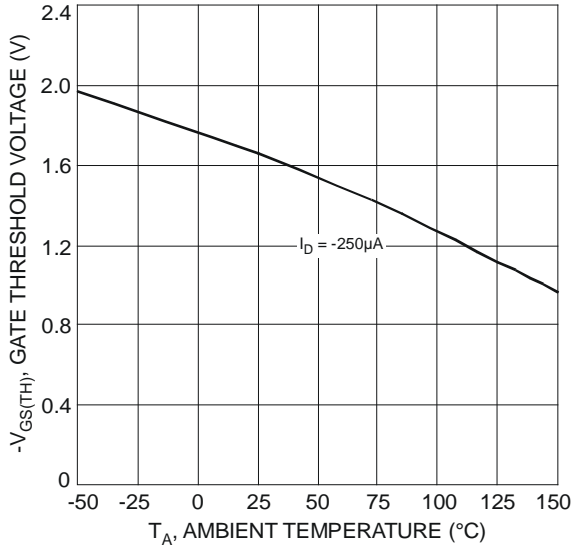


Fig. 7 Gate Threshold Variation vs. Ambient Temperature

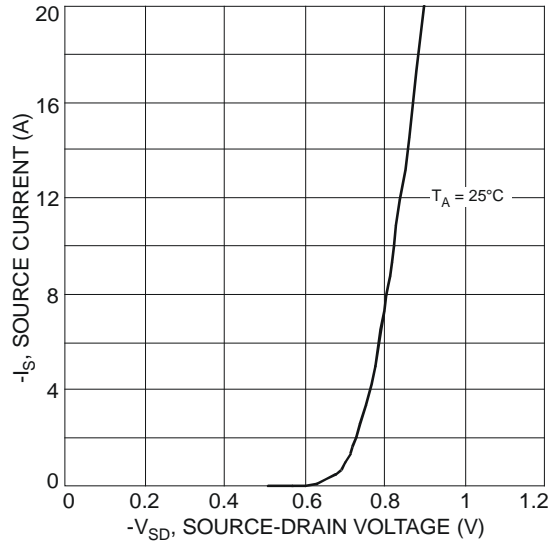


Fig. 8 Diode Forward Voltage vs. Current

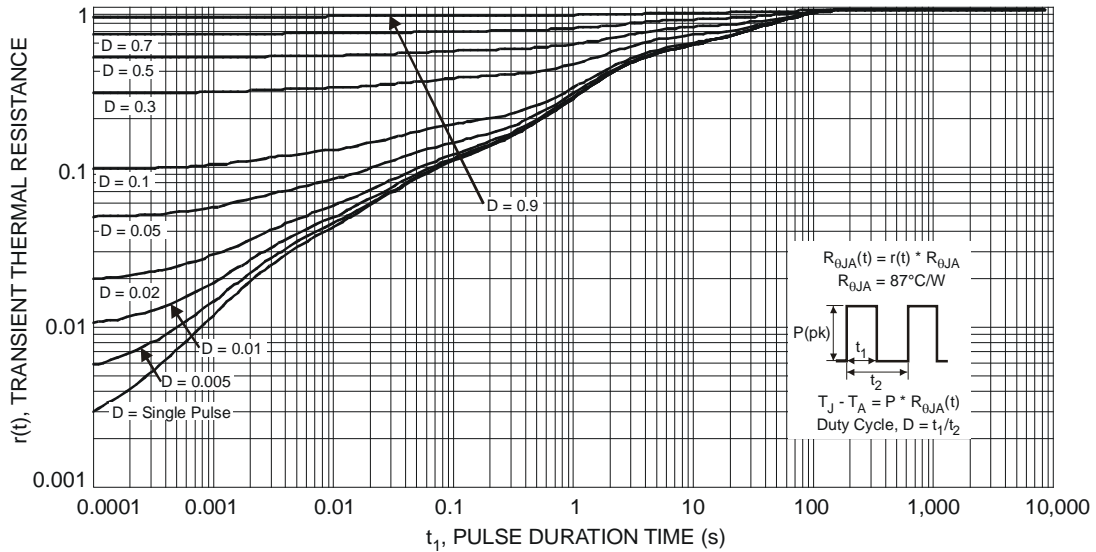


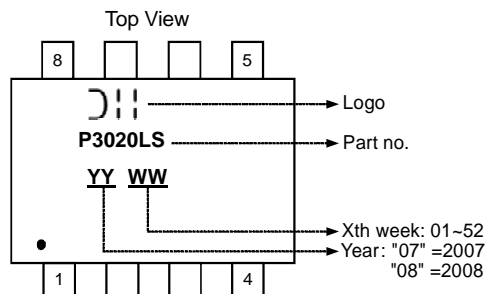
Fig. 9 Transient Thermal Response

Ordering Information (Note 6)

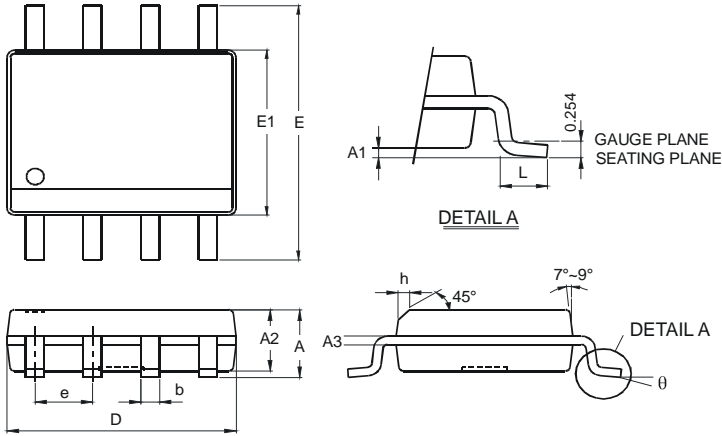
| Part Number | Case | Packaging |
|---------------|--------|------------------|
| DMP3020LSS-13 | SOP-8L | 2500/Tape & Reel |

Notes: 6. For packaging details, go to our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

Marking Information

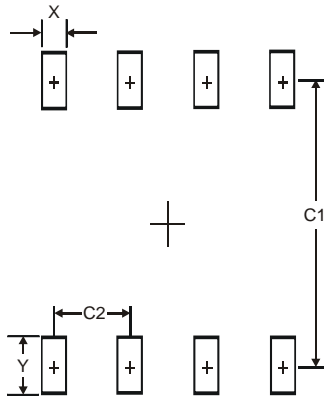


Package Outline Dimensions



| SOP-8L | | |
|-----------------------------|-----------|------|
| Dim | Min | Max |
| A | — | 1.75 |
| A1 | 0.08 | 0.25 |
| A2 | 1.30 | 1.50 |
| A3 | 0.20 Typ. | |
| b | 0.3 | 0.5 |
| D | 4.80 | 5.30 |
| E | 5.79 | 6.20 |
| E1 | 3.70 | 4.10 |
| e | 1.27 Typ. | |
| h | — | 0.35 |
| L | 0.38 | 1.27 |
| θ | 0° | 8° |
| All Dimensions in mm | | |

Suggested Pad Layout



| Dimensions | Value (in mm) |
|------------|---------------|
| X | 0.60 |
| Y | 1.55 |
| C1 | 5.4 |
| C2 | 1.27 |

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S8050LT1 TRANSISTOR (NPN)

FEATURES

Power dissipation

P_{CM} : 0.3 W ($T_{amb}=25^{\circ}C$)

Collector current

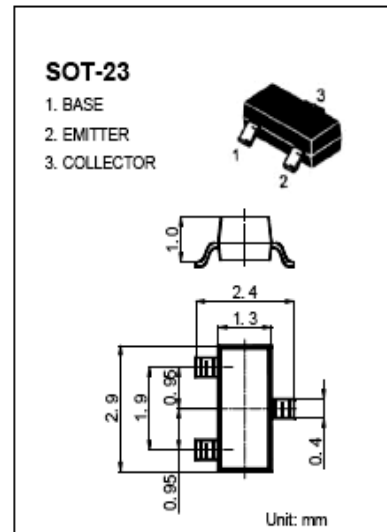
I_{CM} : 0.5 A

Collector-base voltage

$V_{(BR)CBO}$: 40 V

Operating and storage junction temperature range

T_J, T_{stg} : $-55^{\circ}C$ to $+150^{\circ}C$



ELECTRICAL CHARACTERISTICS ($T_{amb}=25^{\circ}C$ unless otherwise specified)

| Parameter | Symbol | Test conditions | MIN | TYP | MAX | UNIT |
|--------------------------------------|---------------|------------------------------------|-----|-----|-----|---------|
| Collector-base breakdown voltage | $V_{(BR)CBO}$ | $I_C=100\mu A, I_E=0$ | 40 | | | V |
| Collector-emitter breakdown voltage | $V_{(BR)CEO}$ | $I_C=1mA, I_B=0$ | 25 | | | V |
| Emitter-base breakdown voltage | $V_{(BR)EBO}$ | $I_E=100\mu A, I_C=0$ | 5 | | | V |
| Collector cut-off current | I_{CBO} | $V_{CB}=40V, I_E=0$ | | | 0.1 | μA |
| Collector cut-off current | I_{CEO} | $V_{CB}=20V, I_E=0$ | | | 0.1 | μA |
| Emitter cut-off current | I_{EBO} | $V_{EB}=5V, I_C=0$ | | | 0.1 | μA |
| DC current gain | $h_{FE(1)}$ | $V_{CE}=1V, I_C=50mA$ | 120 | | 350 | |
| | $h_{FE(2)}$ | $V_{CE}=1V, I_C=500mA$ | 50 | | | |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C=500mA, I_B=50mA$ | | | 0.6 | V |
| Base-emitter saturation voltage | $V_{BE(sat)}$ | $I_C=500mA, I_B=50mA$ | | | 1.2 | V |
| Transition frequency | f_T | $V_{CE}=6V, I_C=20mA$ $f=30MHz$ | 150 | | | MHz |

CLASSIFICATION OF $h_{FE(1)}$

| Rank | L | H |
|-------|---------|---------|
| Range | 120-200 | 200-350 |

S8550LT1 TRANSISTOR (PNP)

FEATURES

Power dissipation

$$P_{CM}: 0.3 \text{ W (Tamb=25}^\circ\text{C)}$$

Collector current

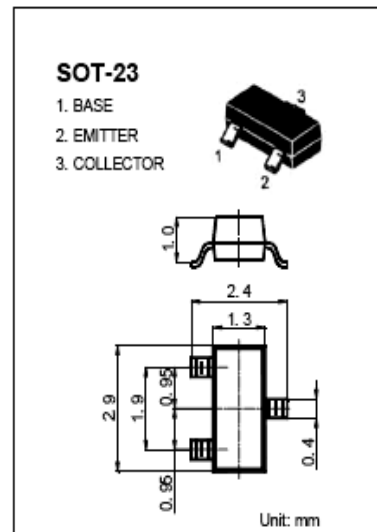
$$I_{CM}: -0.5 \text{ A}$$

Collector-base voltage

$$V_{(BR)CBO}: -40 \text{ V}$$

Operating and storage junction temperature range

$$T_J, T_{stg}: -55^\circ\text{C to } +150^\circ\text{C}$$



ELECTRICAL CHARACTERISTICS (Tamb=25°C unless otherwise specified)

| Parameter | Symbol | Test conditions | MIN | MAX | UNIT |
|--------------------------------------|---------------|---|-----|------|---------------|
| Collector-base breakdown voltage | $V_{(BR)CBO}$ | $I_C = -100\mu\text{A}, I_E = 0$ | -40 | | V |
| Collector-emitter breakdown voltage | $V_{(BR)CEO}$ | $I_C = -1\text{mA}, I_B = 0$ | -25 | | V |
| Emitter-base breakdown voltage | $V_{(BR)EBO}$ | $I_E = -100\mu\text{A}, I_C = 0$ | -5 | | V |
| Collector cut-off current | I_{CBO} | $V_{CB} = -40\text{V}, I_E = 0$ | | -0.1 | μA |
| Collector cut-off current | I_{CEO} | $V_{CE} = -20\text{V}, I_B = 0$ | | -0.1 | μA |
| Emitter cut-off current | I_{EBO} | $V_{EB} = -3\text{V}, I_C = 0$ | | -0.1 | μA |
| DC current gain | $h_{FE(1)}$ | $V_{CE} = -1\text{V}, I_C = -50\text{mA}$ | 120 | 350 | |
| | $h_{FE(2)}$ | $V_{CE} = -1\text{V}, I_C = -500\text{mA}$ | 50 | | |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C = -500 \text{mA}, I_B = -50\text{mA}$ | | -0.6 | V |
| Base-emitter saturation voltage | $V_{BE(sat)}$ | $I_C = -500 \text{mA}, I_B = -50\text{mA}$ | | -1.2 | V |
| Transition frequency | f_T | $V_{CE} = -6\text{V}, I_C = -20\text{mA}$ $f = 30\text{MHz}$ | 150 | | MHz |

CLASSIFICATION OF $h_{FE(1)}$

| Rank | L | H |
|-------|---------|---------|
| Range | 120-200 | 200-350 |

SS8550

2W Output Amplifier of Portable Radios in Class B Push-pull Operation.

- Complimentary to SS8050
- Collector Current: $I_C=1.5A$
- Collector Power Dissipation: $P_C=2W$ ($T_C=25^\circ C$)



TO-92
1. Emitter 2. Base 3. Collector

PNP Epitaxial Silicon Transistor

Absolute Maximum Ratings $T_a=25^\circ C$ unless otherwise noted

| Symbol | Parameter | Ratings | Units |
|-----------|-----------------------------|-----------|------------|
| V_{CBO} | Collector-Base Voltage | -40 | V |
| V_{CEO} | Collector-Emitter Voltage | -25 | V |
| V_{EBO} | Emitter-Base Voltage | -6 | V |
| I_C | Collector Current | -1.5 | A |
| P_C | Collector Power Dissipation | 1 | W |
| T_J | Junction Temperature | 150 | $^\circ C$ |
| T_{STG} | Storage Temperature | -65 ~ 150 | $^\circ C$ |

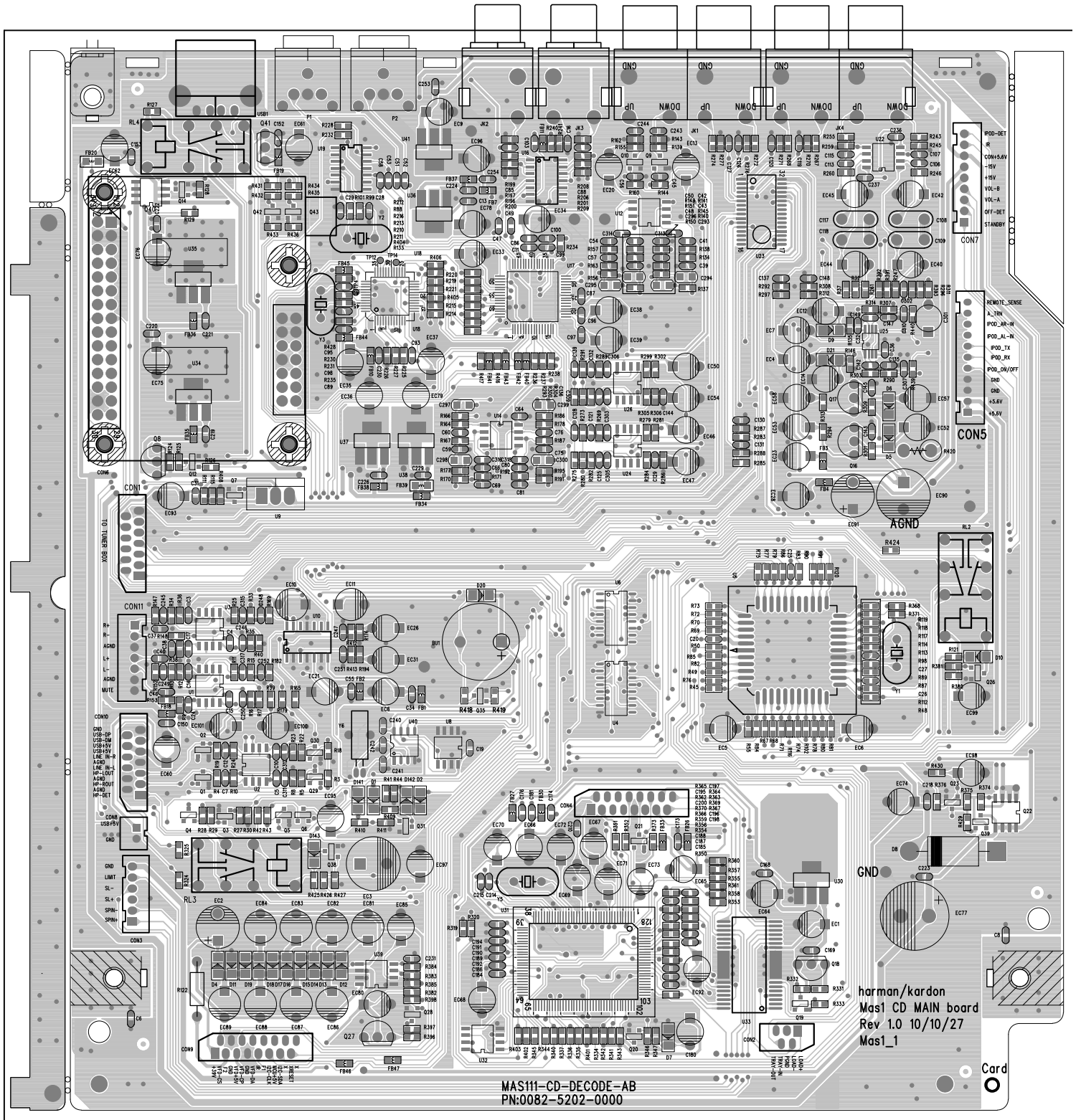
Electrical Characteristics $T_a=25^\circ C$ unless otherwise noted

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Units |
|---------------|--------------------------------------|--|------|-------|------|-------|
| BV_{CBO} | Collector-Base Breakdown Voltage | $I_C = -100\mu A, I_E = 0$ | -40 | | | V |
| BV_{CEO} | Collector-Emitter Breakdown Voltage | $I_C = -2mA, I_B = 0$ | -25 | | | V |
| BV_{EBO} | Emitter-Base Breakdown Voltage | $I_E = -100\mu A, I_C = 0$ | -6 | | | V |
| I_{CBO} | Collector Cut-off Current | $V_{CB} = -35V, I_E = 0$ | | | -100 | nA |
| I_{EBO} | Emitter Cut-off Current | $V_{EB} = -6V, I_C = 0$ | | | -100 | nA |
| h_{FE1} | DC Current Gain | $V_{CE} = -1V, I_C = -5mA$ | 45 | 170 | | |
| h_{FE2} | | $V_{CE} = -1V, I_C = -100mA$ | 85 | 160 | 300 | |
| h_{FE3} | | $V_{CE} = -1V, I_C = -800mA$ | 40 | 80 | | |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage | $I_C = -800mA, I_B = -80mA$ | | -0.28 | -0.5 | V |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage | $I_C = -800mA, I_B = -80mA$ | | -0.98 | -1.2 | V |
| $V_{BE(on)}$ | Base-Emitter on Voltage | $V_{CE} = -1V, I_C = -10mA$ | | -0.66 | -1.0 | V |
| C_{ob} | Output Capacitance | $V_{CB} = -10V, I_E = 0$ $f = 1MHz$ | | 15 | | pF |
| f_T | Current Gain Bandwidth Product | $V_{CE} = -10V, I_C = -50mA$ | 100 | 200 | | MHz |

h_{FE} Classification

| Classification | B | C | D |
|----------------|----------|-----------|-----------|
| h_{FE2} | 85 ~ 160 | 120 ~ 200 | 160 ~ 300 |

CD MAIN PCB 1/2

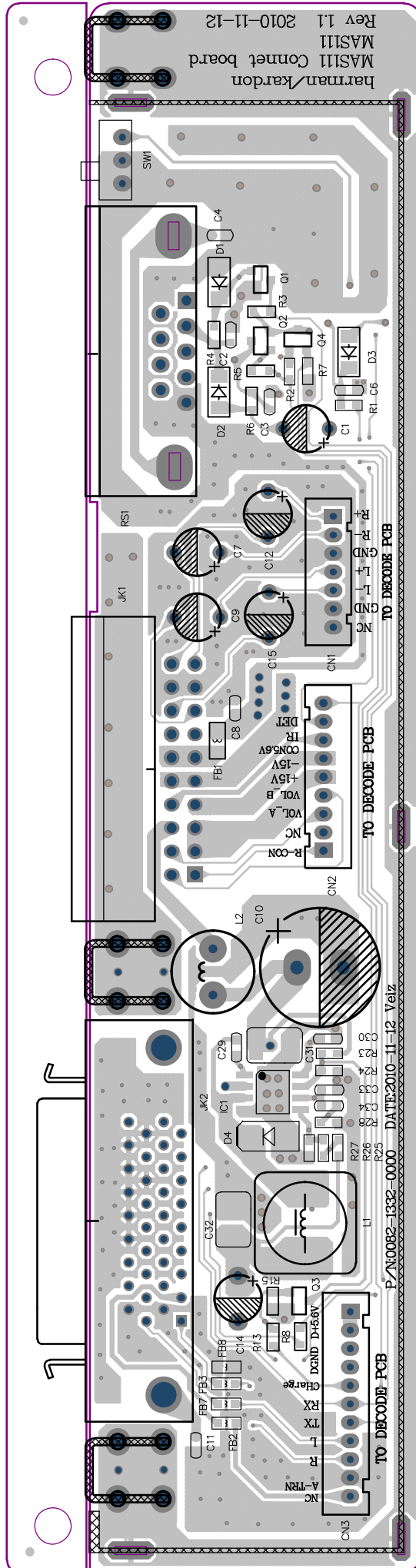


MAS111-CD-DECODE-AB
PN:0082-5202-0000

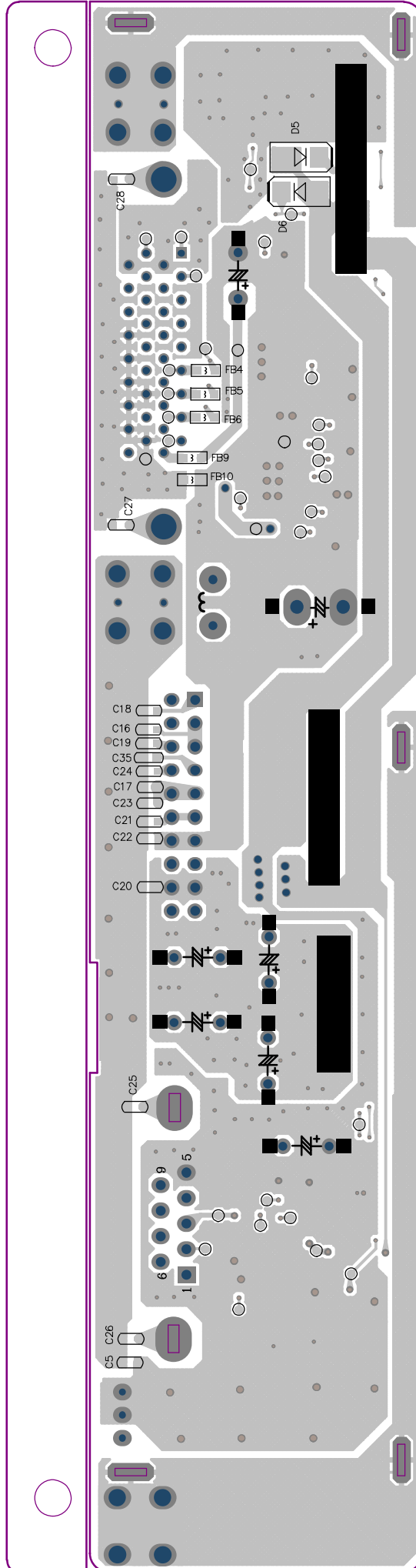
harman/kardon
Mas1 CD MAIN board
Rev 1.0 10/10/27
Mas1_1

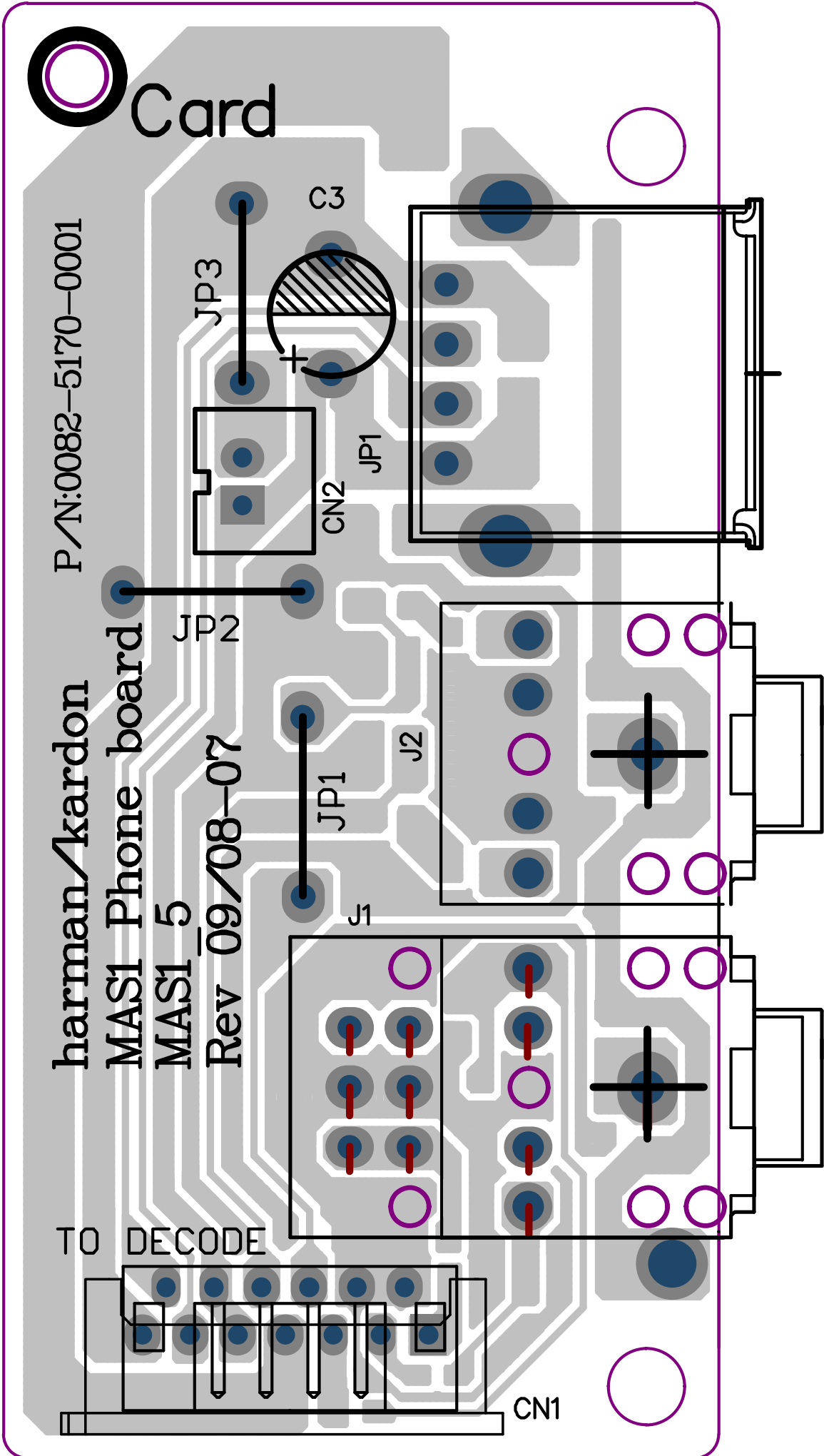
Card

RS232 PCB 1/2

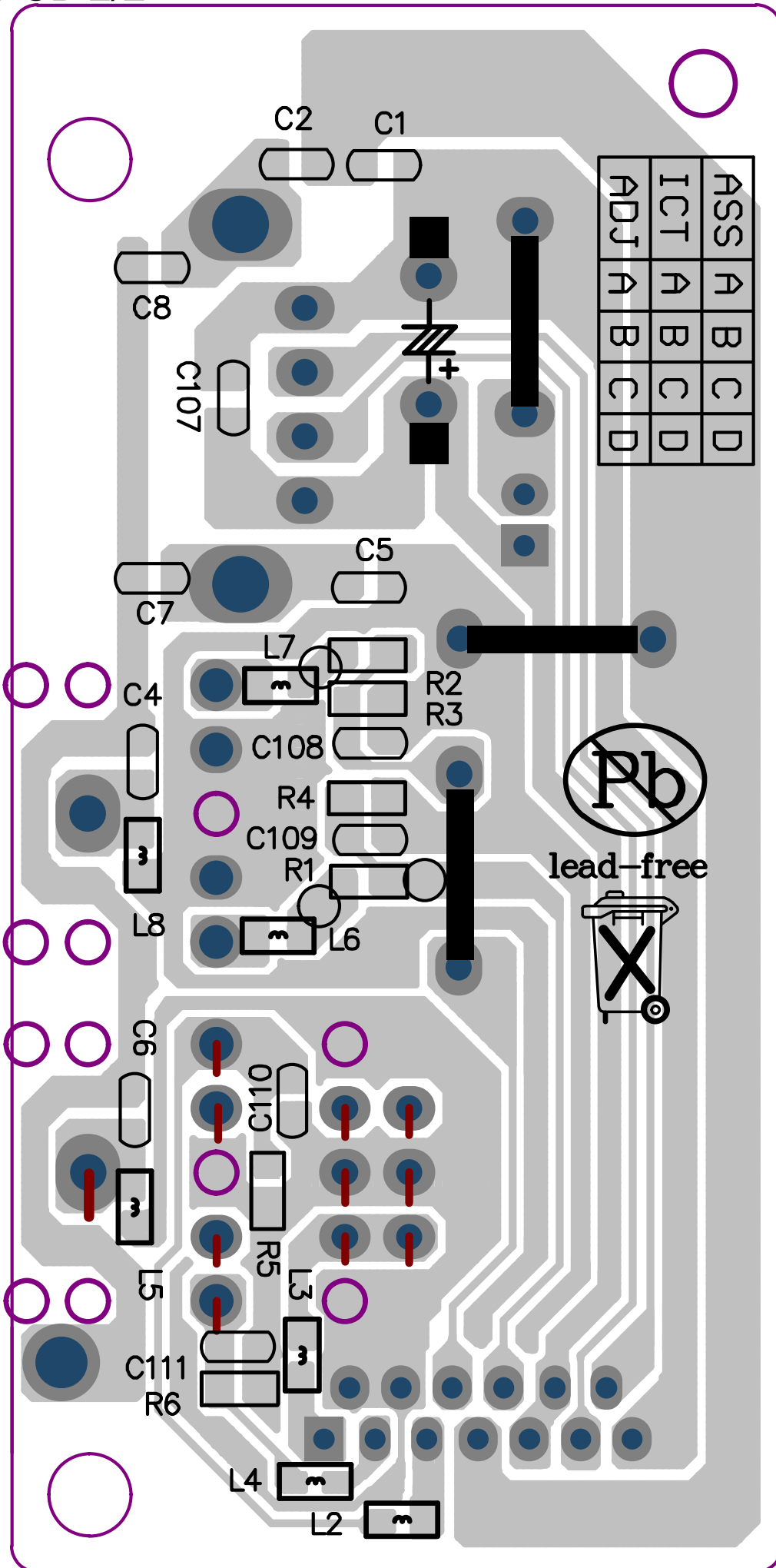


RS232 PCB 2/2

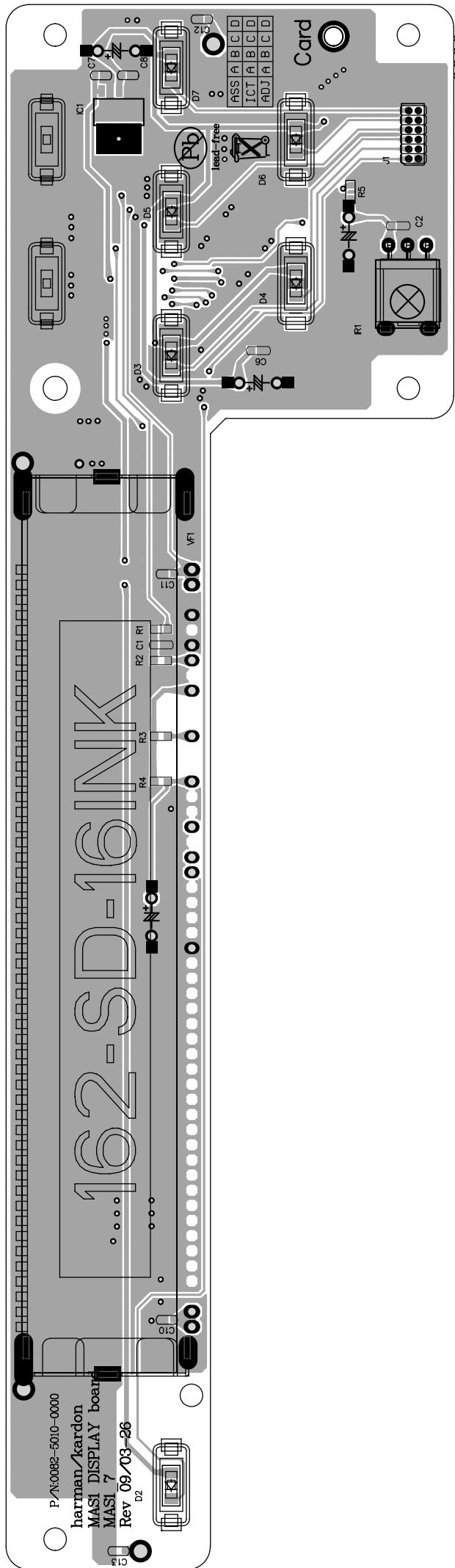




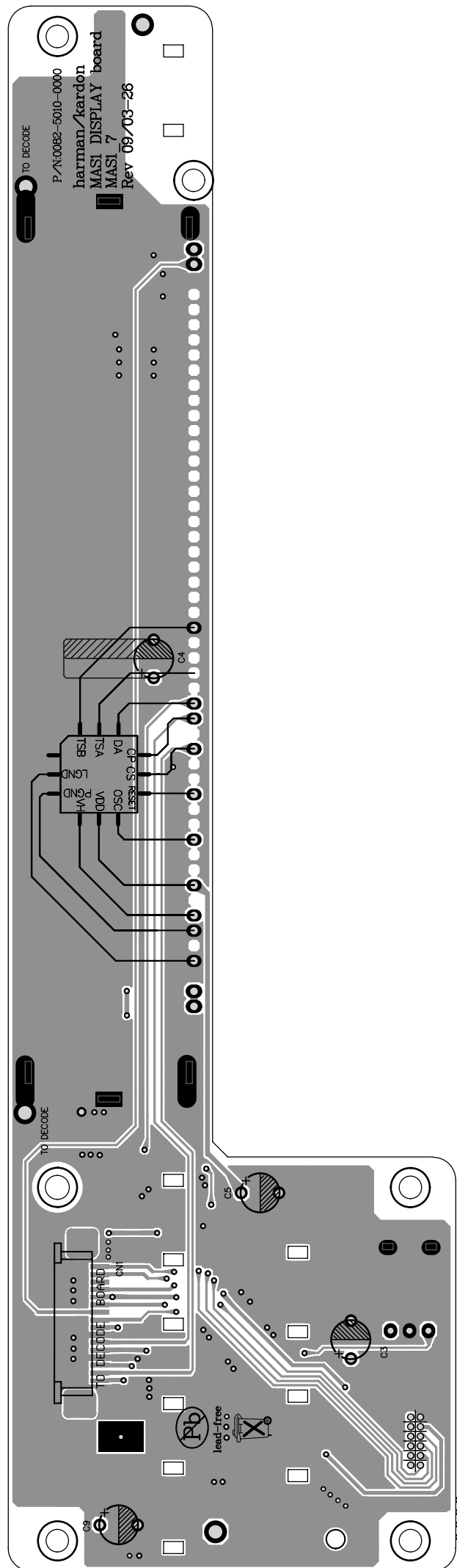
PHONE PCB 2/2



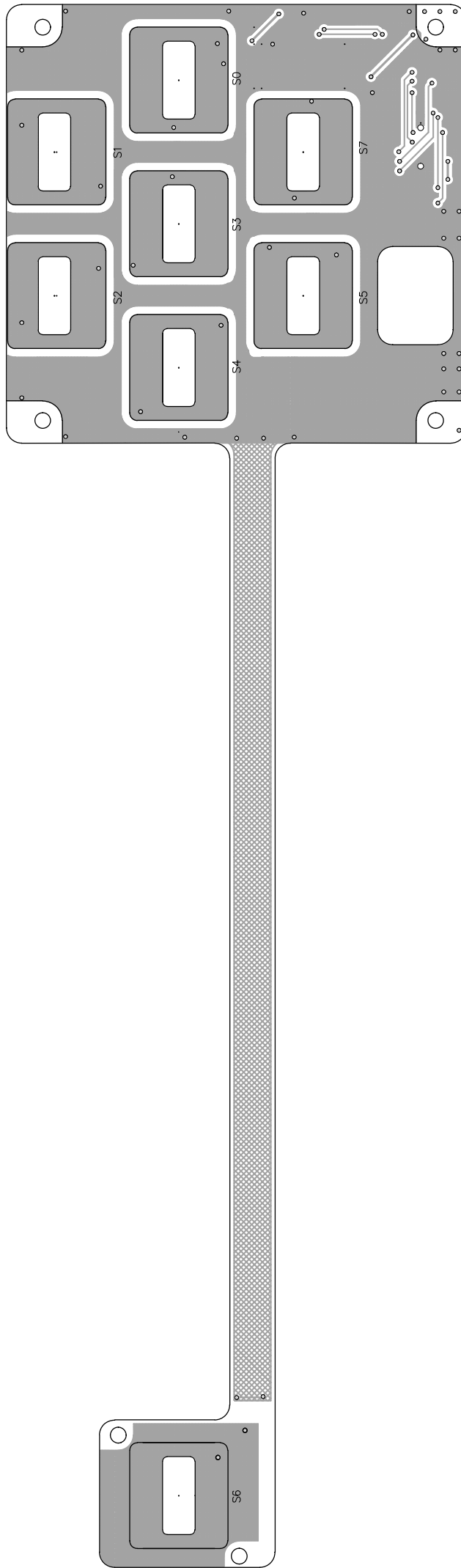
DISPLAY PCB(1/2)



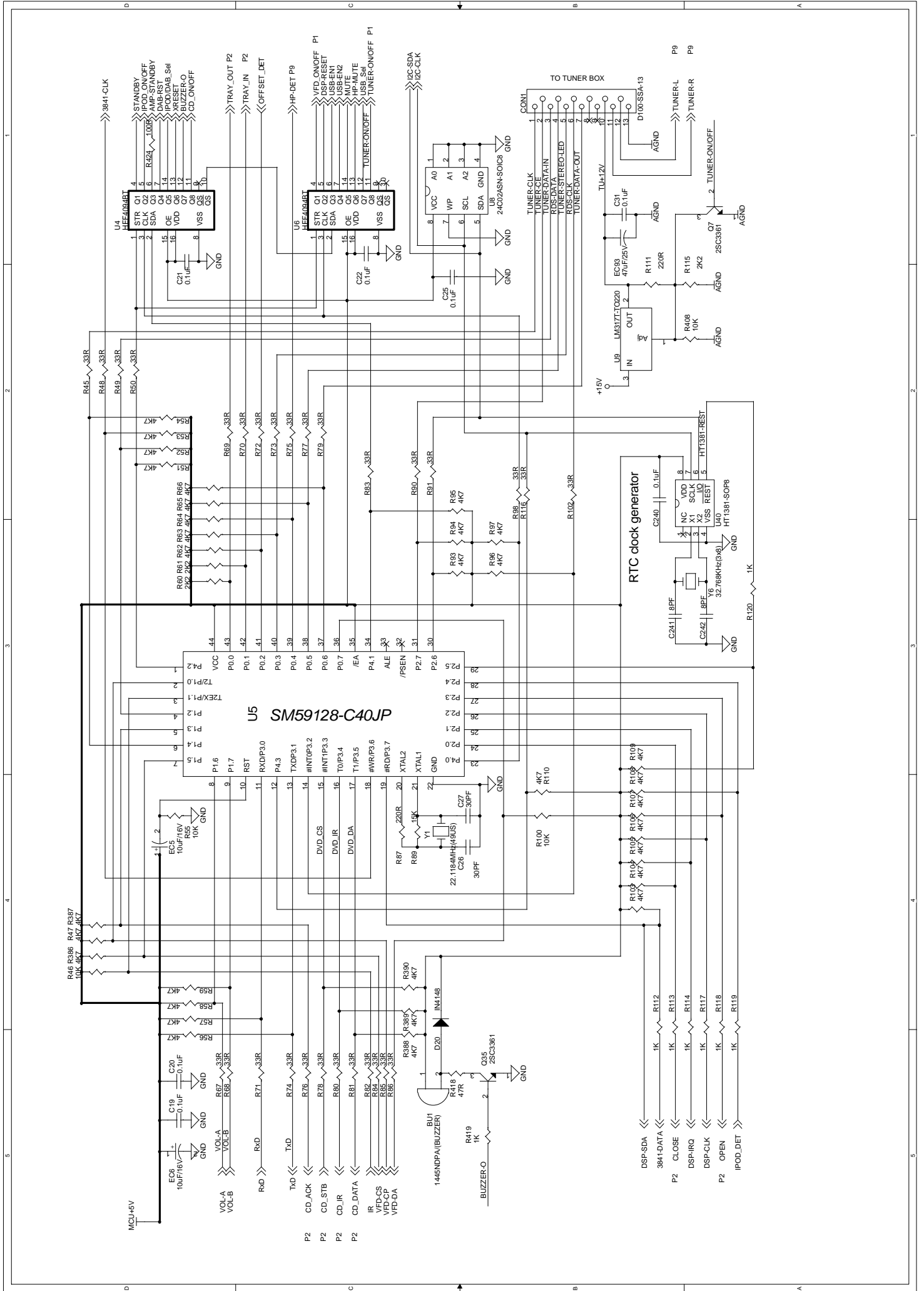
DISPLAY PCB(2/2)



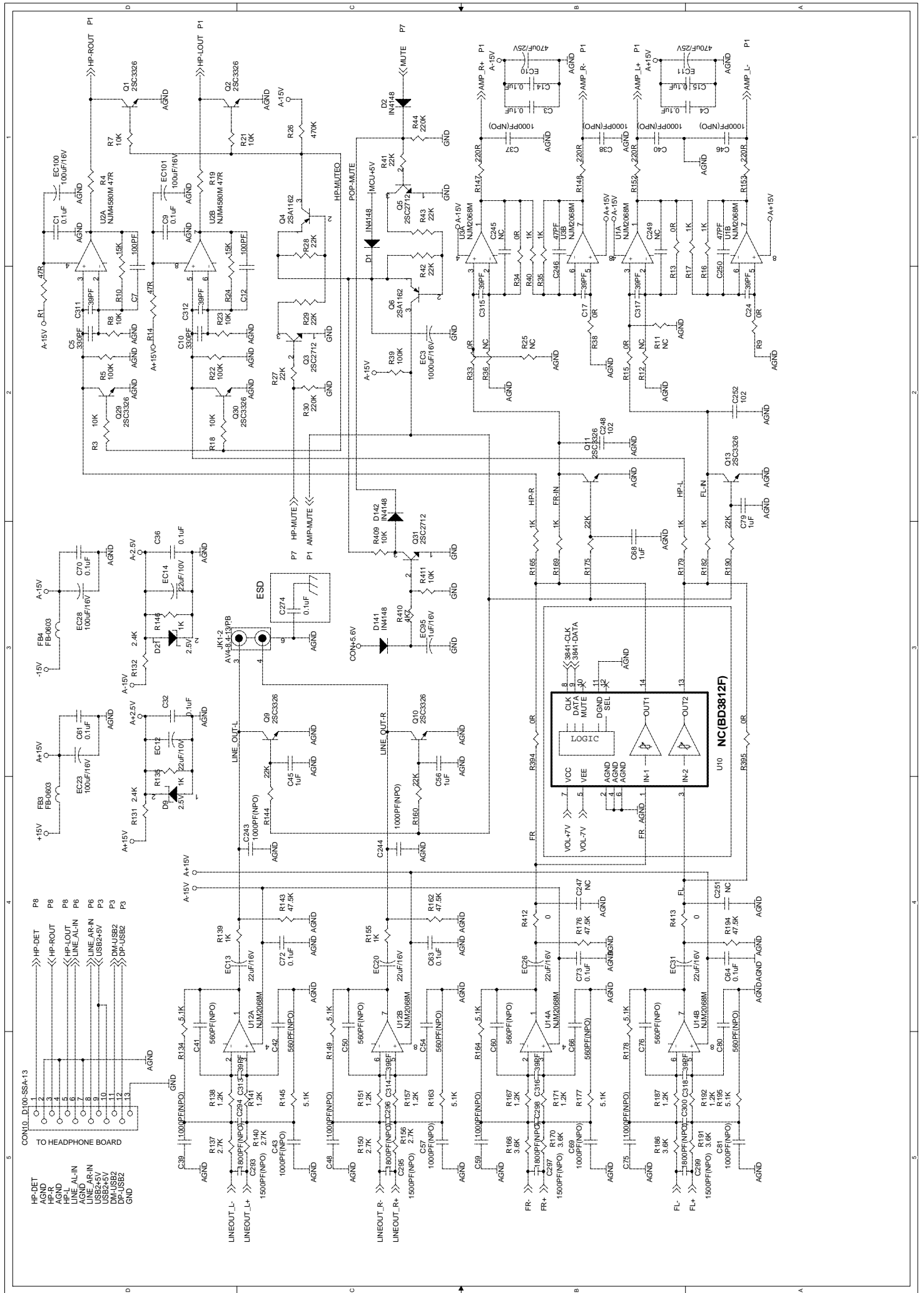
TOUCH PCB(1/2)



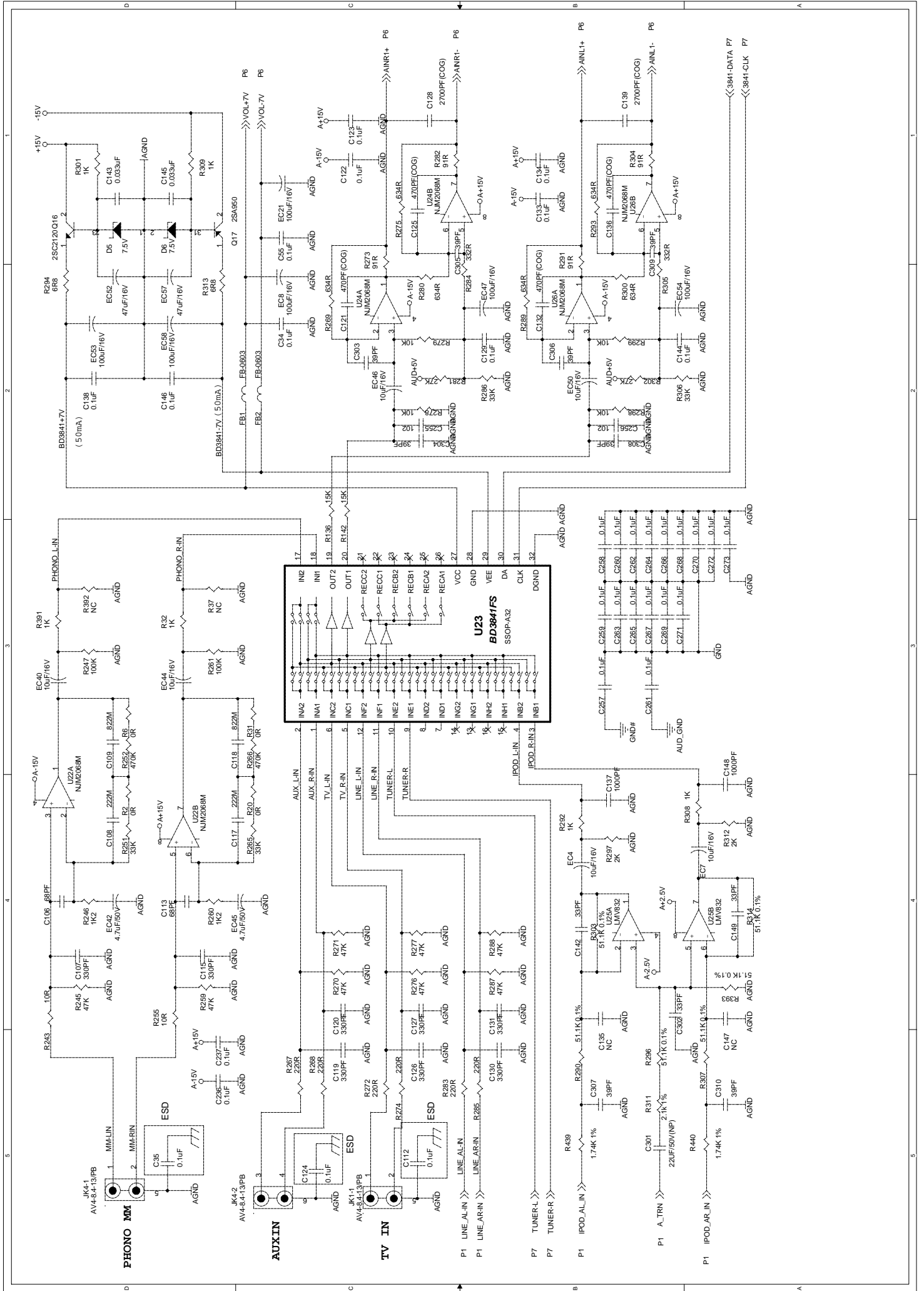
CD MAIN SCH 1/7



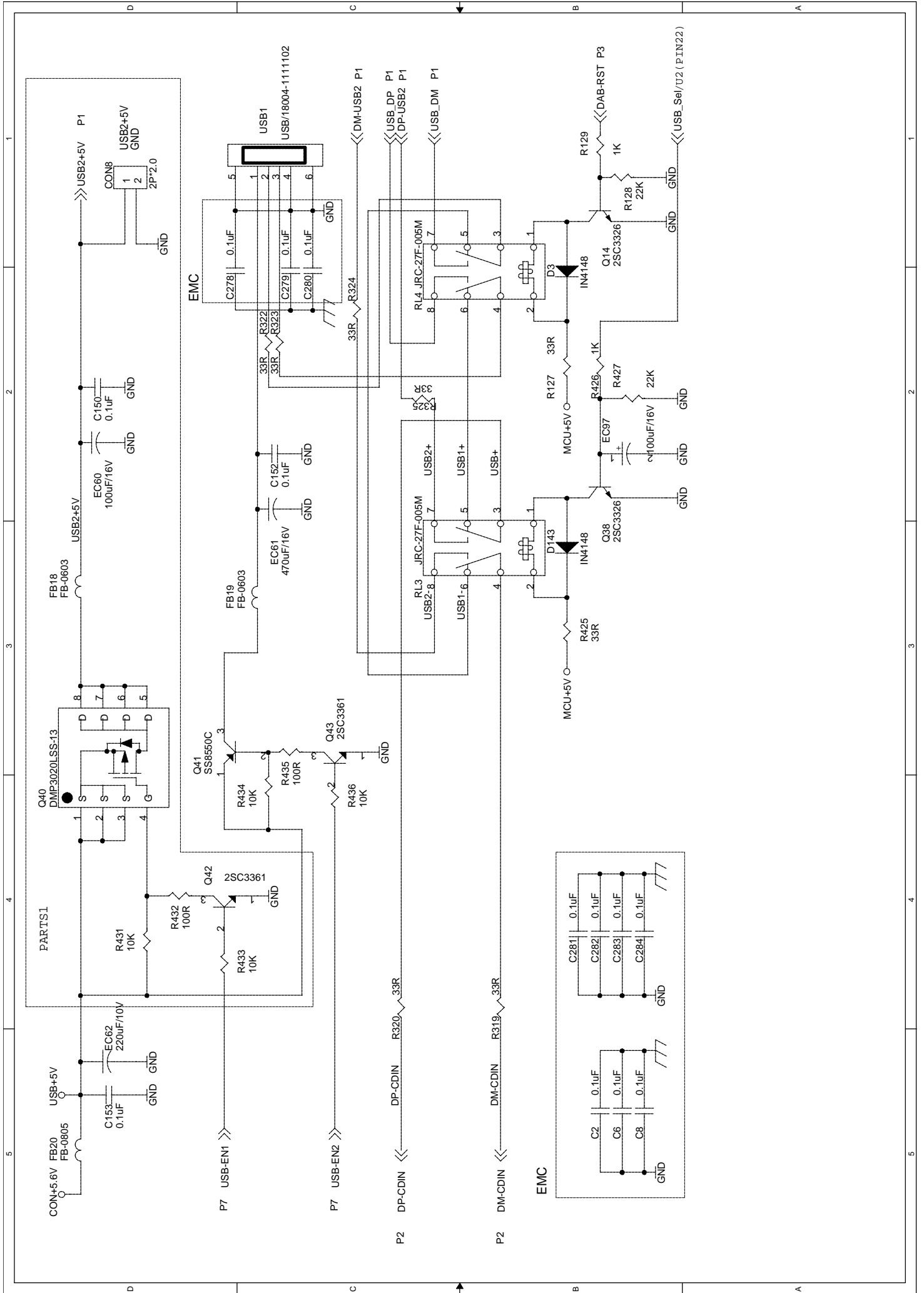
CD MAIN SCH 2/7



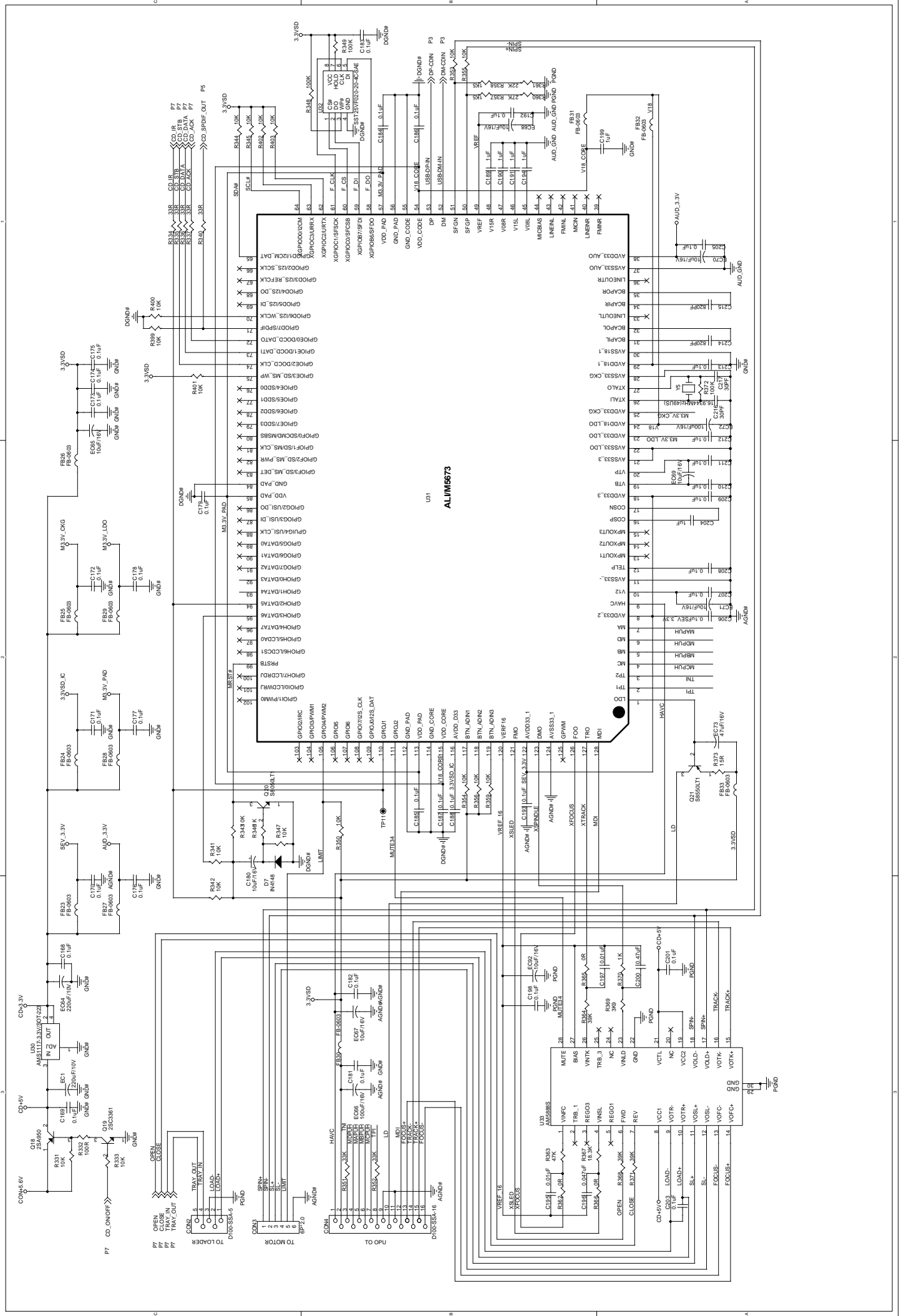
CD MAIN SCH 4/7



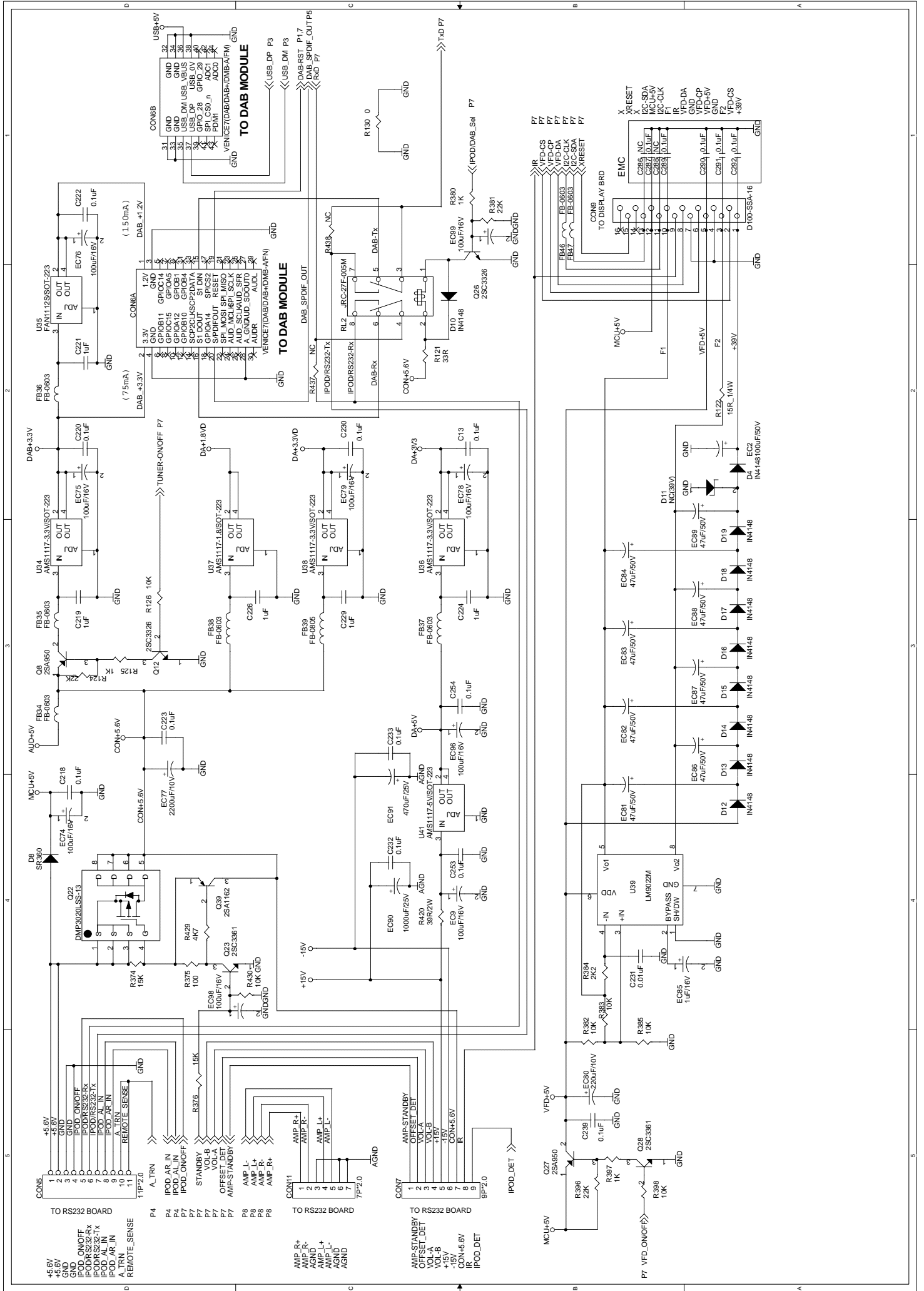
CD MAIN SCH 5/7



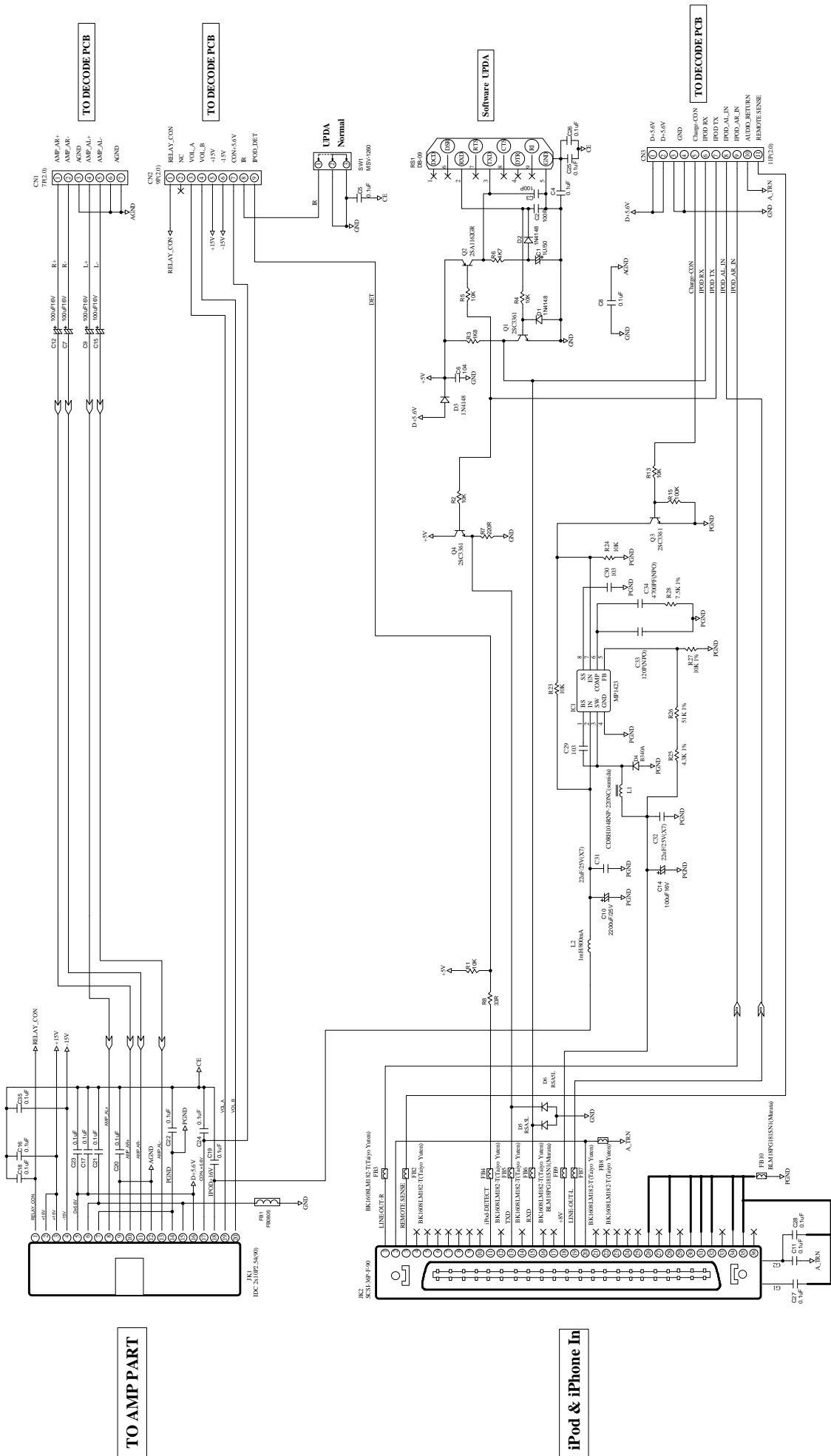
CD MAIN SCH 6/7



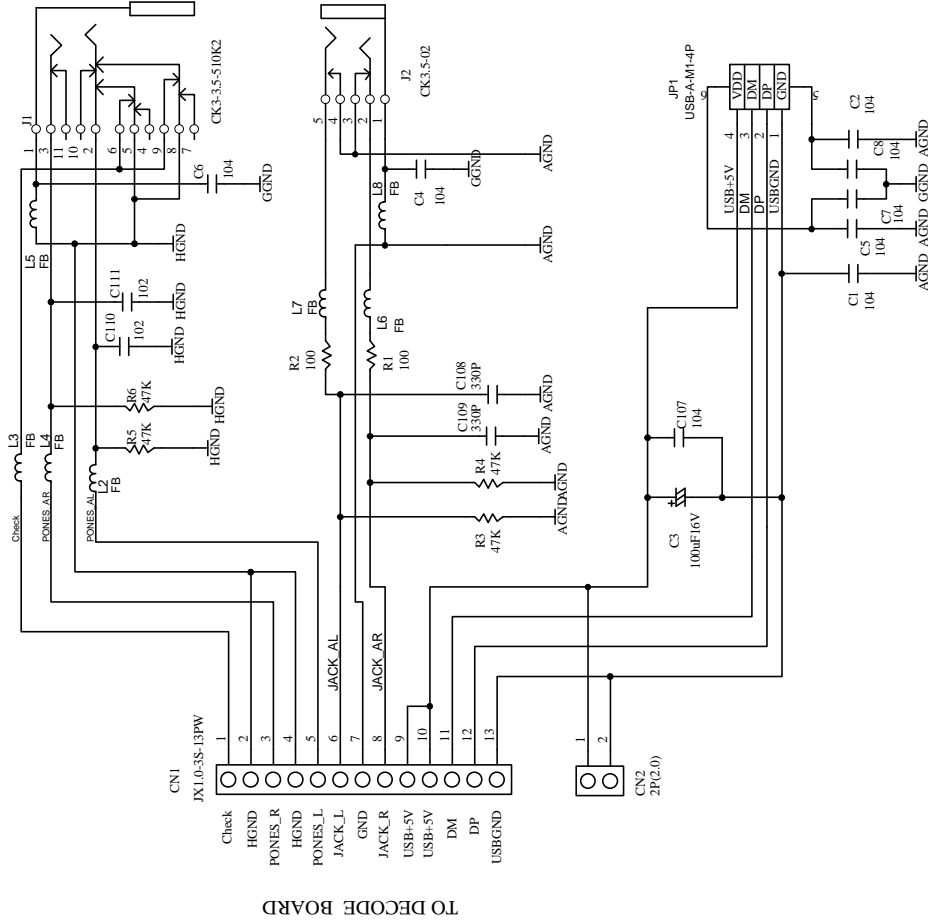
CD MAIN SCH 7/7



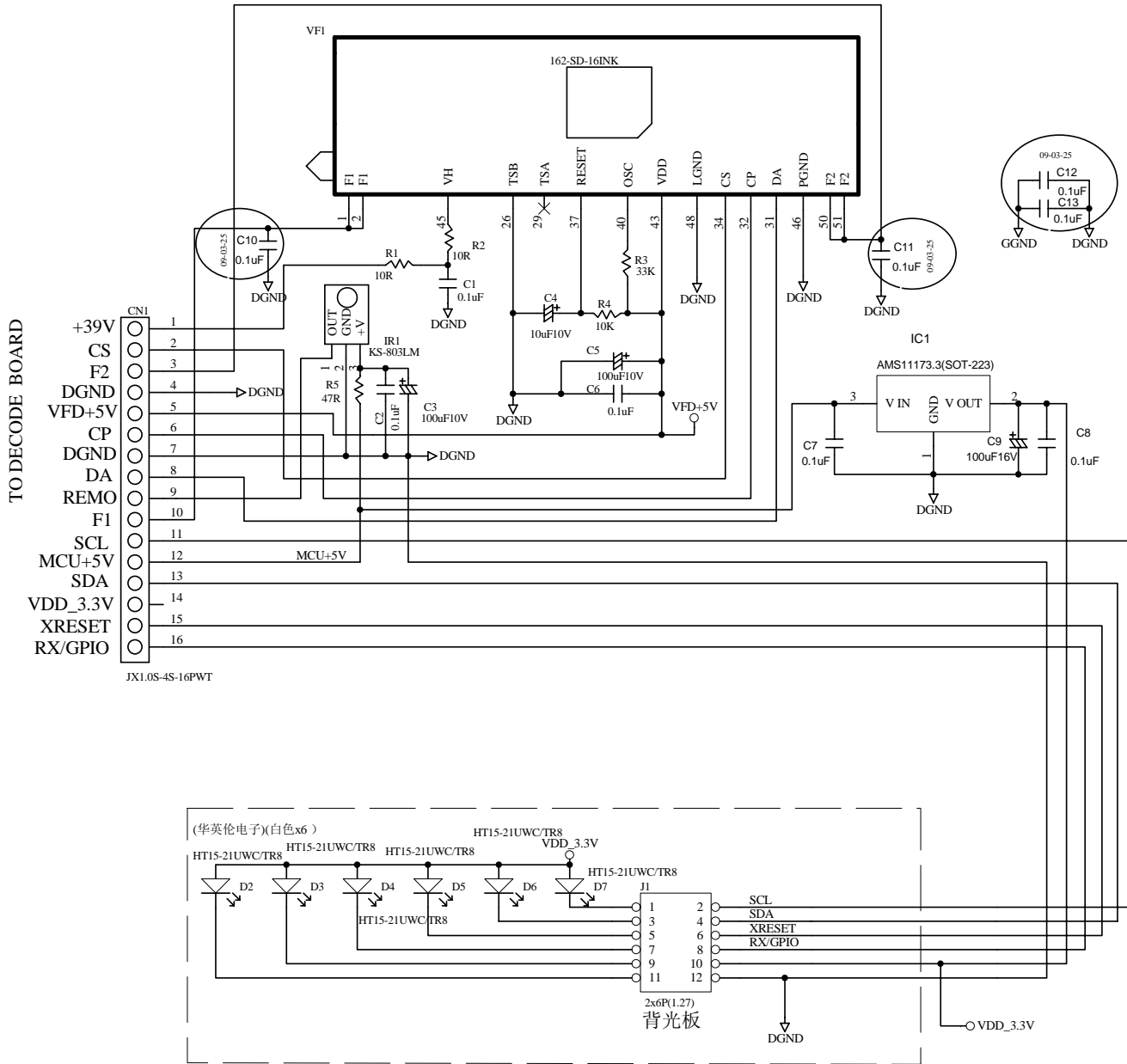
RS232 SCH

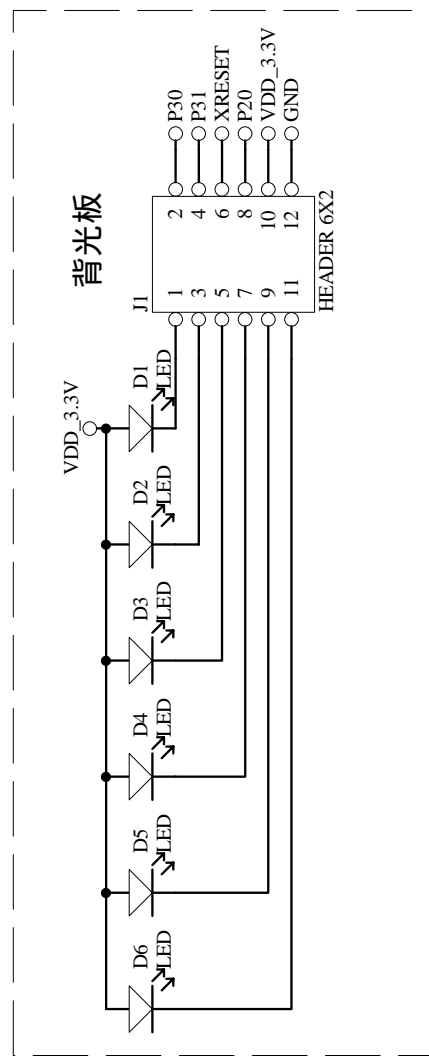
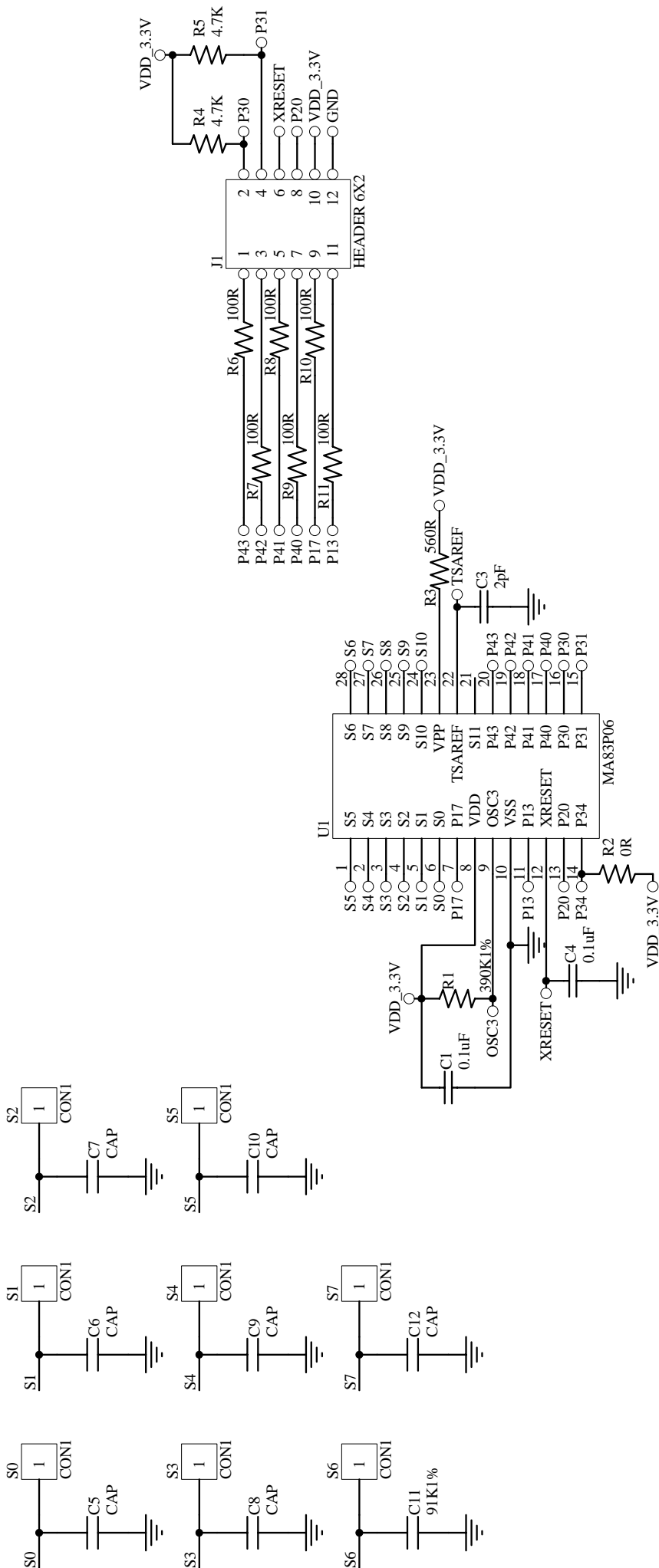


PHONE SCH

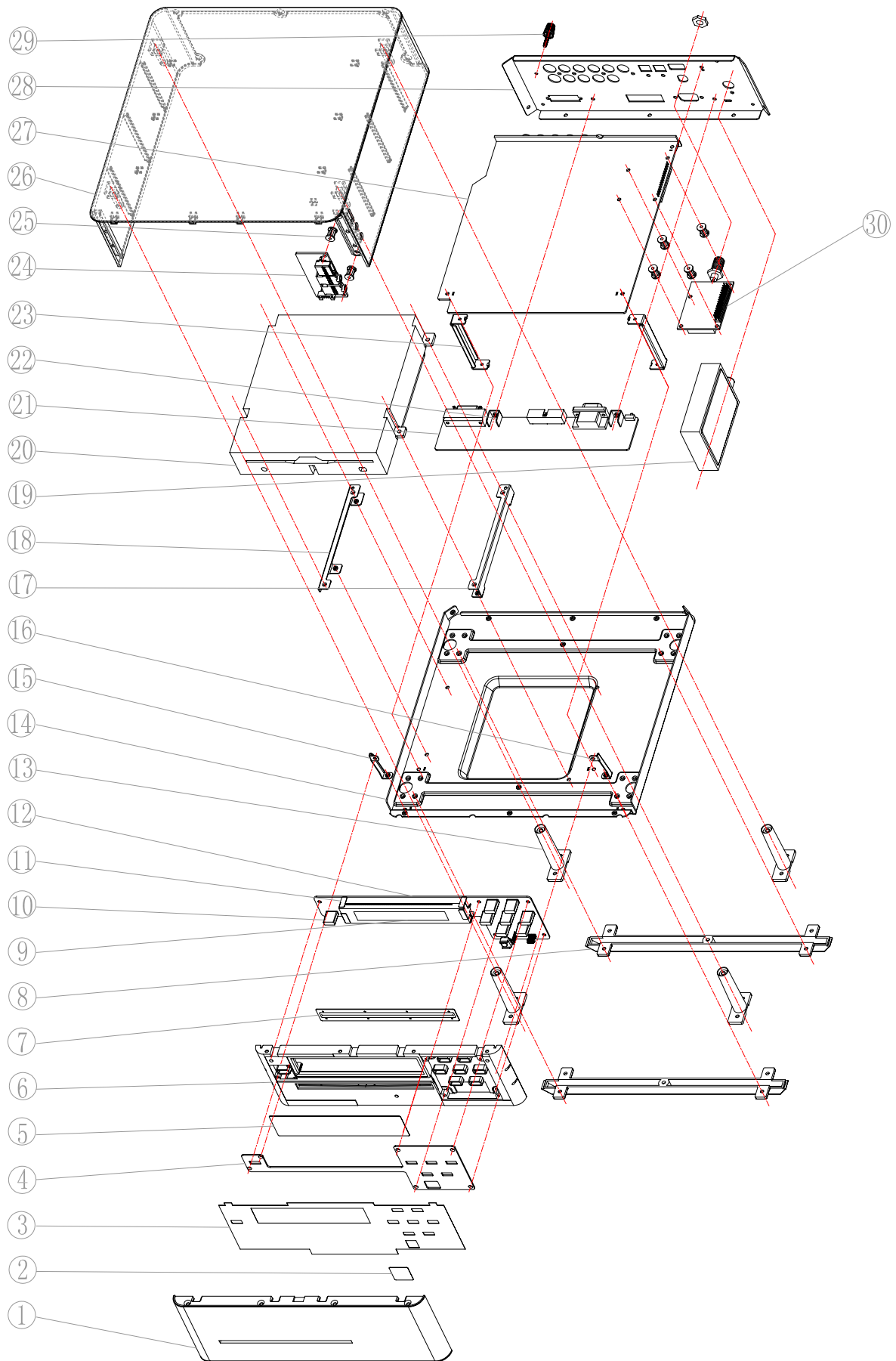


DISPLAY SCH





| Sensor | Led | Function |
|--------|-----|----------|
| S0 | | 无键按下 |
| S1 | | ▶▶ |
| S2 | | |
| S3 | | KK |
| S4 | | ▶/ |
| S5 | | □ |
| S6 | | ⌂ |
| S7 | | |
| | | |
| | | |
| | | |



MAS CD Explode List

| NO | PART.NO | DESCRIPTION | QTY |
|-----|-----------------|----------------------------------|-----|
| 1 | 7450 5010 0000 | DISPLAY LENS | 1 |
| 2 | 7750 5040 0000 | BLUE PVC SHEET | 1 |
| 3 | 7750 501D 0000 | FRONT PANEL PVC SHEET | 1 |
| 4 | 0082 5003 0000 | TOUCH PCB | 1 |
| 5 | 7450 503A 0000 | FILTER LENS | 1 |
| 6 | 7550 501A 0000 | SUB PANEL | 1 |
| 7 | 7950 503C 0000 | DUSTPROOF CLOTH | 1 |
| 8 | 7950 5020 0000 | FOOT | 2 |
| 9 | 1521 6216 0101 | 162-SD-16INK | 1 |
| 10 | 7450 502A 0000 | LIGHTGUIDE | 6 |
| 11 | 5337 5010 0000 | DISPLAY BRACKET | 2 |
| 12 | 0082 5010 0000 | DISPLAY PCB | 1 |
| 13 | 7550 502A 0000 | PLASTIC POST | 4 |
| 14 | 6250 501B 0011 | BUTTOM COVER | 1 |
| 15 | 5350 5010 0000 | SUB PANEL LEFT BRACKET | 1 |
| 16 | 5350 5020 0000 | SUB PANEL RIGHT BRACKET | 1 |
| 17 | 5350 503A 0000 | LOADER LEFT BRACKET | 1 |
| 18 | 5350 504A 0000 | LOADER RIGHT BRACKET | 1 |
| *19 | 0082 3270 0000 | TUNER PCB(MAS101 MAS102 MAS111) | 1 |
| *19 | 0082 3271 0000 | TUNER PCB(SAS101) | 1 |
| 20 | 7500 0070 0000 | DLM1D07 BRACKET | 1 |
| 21 | 0082 1332 0000 | RS232 PCB | 1 |
| 22 | 5331 1080 0060 | U FORM PCB BRACKET (A) | 2 |
| 23 | 5349 105A 0000 | DECODER BRACKET | 2 |
| 24 | 0082 5170 0001 | PHONE PC | 1 |
| 25 | 8730 1000 0000 | KDDT-382 | 4 |
| 26 | 7950 5010 0000 | TOP COVER | 1 |
| 27 | 0082 5202 0000 | CD MAIN PCB | 1 |
| *28 | 6350 5030 001 1 | BACK COVER(MAS111) | 1 |
| *28 | 6350 5040 001 1 | BACK COVER(MAS101 MAS102 SAS101) | 1 |
| 29 | 5017 3012 0000 | GROUNDING SCREW S-056B M3x12 | 1 |
| *30 | 9520 2500 0001 | DAB MODULE(MAS111) | 1 |

| Qty | Part Type | Ref. Designator | Part Number |
|-----|--|---|----------------|
| | CD Decoder .Bom P/N: 0082-5202-0000 | | |
| 1 | SST25VF020-20-4C-SAE (SST) 2MBIT SPI SERIAL FLASH | U32 | 1025 0200 7387 |
| 2 | 74HCU04D (PHILIPS) HEX INVERTER | U19,U16 | 1049 1004 1200 |
| 2 | HEF4094BT (PHILIPS) 8 STAGE SHIFT AND STORE REGISTER | U4,U6 | 1004 0940 4912 |
| 1 | AMS1117-1.8 (AMS) LOW DROPOUT VOLTAGE REGULATOR | U37 | 1011 7180 0156 |
| 4 | AMS1117-3.3V (AMS) LOW DROPOUT VOLTAGE REGULATOR | U30,U34,U36,U38 | 1011 7330 0128 |
| 1 | AMS1117-5V (AMS) LOW DROPOUT VOLTAGE REGULATOR | U41 | 1011 7500 0129 |
| 1 | AM5888S (AMTEK) MOTOR DRIVER | U33 | 1005 8880 9753 |
| 1 | BD3841FS (ROHM) 9CH FUNCTION SWITCH | U23 | 1003 8410 5122 |
| 1 | CS42516-CQZR (CIRRUS LOGIC) 6CH CODEC WITH S/PDIF RECEIVER | U17 | 1042 5160 0934 |
| 1 | CS48540 (CIRRUS LOGIC) DSP | U18 | 1048 5400 0934 |
| 1 | M5673 (ALI) CD CONTROLLER | U31 | 1005 6732 2034 |
| 7 | NJM2068M (JRC) DUAL OP AMP | U1,U3,U12,U14,U22,U24, U26 | 1002 0680 3113 |
| 1 | NJM4580M (JRC) DUAL OP AMP | U2 | 1004 5800 3113 |
| 1 | SM59128-C40JP (SYNCMOS) FLASH MCU | U5 | 1059 1280 9125 |
| 1 | 24C02ASN-SOIC8 (ATMEL) SERIAL EEPROM | U8 | 1002 4020 0601 |
| 1 | LM317T-TO220 (NATIONAL) ADJUSTABLE REGULATOR | U9 | 1043 0317 0861 |
| 1 | LMV832 (NATIONAL) EMI HARDENED OPERATIONAL AMPLIFIER | U25 | 1000 8320 4313 |
| 1 | LM9022M (NATIONAL) VFD FILAMENT DRIVER | U39 | 1009 0220 4313 |
| 1 | FAN1112S (FAIRCHILD) LOW DROPOUT REGULATOR | U35 | 1000 0050 5133 |
| 1 | HT1381-SOP8 (HOLTEK) SERIAL TIMEKEEPER CHIP | U40 | 1001 3810 8113 |
| 4 | 2SA950 - TRANSISTOR | Q8,Q17,Q18,Q27 | 1110 9500 0162 |
| 3 | 2SA1162 - TRANSISTOR | Q4,Q6,Q39 | 1111 1620 7100 |
| 1 | 2SC2120 - TRANSISTOR | Q16 | 1130 1200 0162 |
| 3 | 2SC2712 - TRANSISTOR | Q3,Q5,Q31 | 1132 7120 7100 |
| 12 | 2SC3326 - TRANSISTOR | Q1,Q2,Q9,Q10,Q11,Q12,Q13,Q14,Q26,Q29, | 1133 3260 1000 |
| | | Q30,Q38 | |
| 7 | 2SC3361 - TRANSISTOR | Q7,Q19,Q23,Q28,Q35,Q42,Q43 | 1133 3610 6100 |
| 1 | S8050LT1 - TRANSISTOR | Q20 | 1108 0502 1828 |
| 1 | S8550LT1 - TRANSISTOR | Q21 | 1108 5502 1828 |
| 1 | SS8550C - TRANSISTOR | Q41 | 1108 5500 1988 |
| 2 | DMP3020LSS-13 - TRANSISTOR | Q40,Q22 | 1153 0200 1900 |
| 1 | SR360 - DIODE , RECT | D8 | 1360 7000 3602 |
| 2 | 2.5V - DIODE ZENER | D9,D21 | 1300 2500 0001 |
| 2 | 7.5V - DIODE ZENER | D6,D5 | 1300 7500 0001 |
| 18 | IN4148 - DIODE | D1,D2,D3,D4,D7,D10,D12,D13,D14,D15,D16, | 1320 1004 1480 |
| | | D17,D18,D19,D20,D141,D142,D143 | |
| 1 | 16.9344MHz(49US) - CRYSTAL | Y5 | 2705 1693 4010 |
| 1 | 22.1184MHz(49US) - CRYSTAL | Y1 | 2705 2211 8429 |
| 1 | 24.576MHz(49US) - CRYSTAL | Y2 | 2705 2457 6020 |
| 1 | 32.768KHz(3x8) - CRYSTAL | Y6 | 2705 3276 8029 |
| 39 | FB-0603 FERRITE , CHIP BEAD | FB1,FB2,FB3,FB4,FB5,FB6,FB7,FB8,FB9,FB10, | 1871 6081 8201 |
| | | FB11,FB12,FB14,FB18,FB19,FB23,FB24,FB25, | |
| | | FB26,FB27,FB28,FB29,FB30,FB31,FB32,FB33, | |
| | | FB34,FB35,FB36,FB37,FB38,FB40,FB41,FB42, | |
| | | FB43,FB44,FB45,FB46,FB47 | |
| 2 | FB-0805 FERRITE , CHIP BEAD | FB20,FB39 | 1852 0120 9100 |

| | | | |
|----|------------------------------------|--|----------------|
| 1 | 1445NDPA/(BUZZER) | BU1 | 7982 5010 0101 |
| 1 | VENICE7(DAB/DAB+A/FM) DAB MODULE | CON6 | 9500-0000-0004 |
| 3 | JRC-27F-005M- RELAY | RL2,RL3,RL4 | 4712 0000 2700 |
| 1 | D100-SSA-5 - CONNECTOR | CON2 | 3104 0105 0050 |
| 2 | D100-SSA-13 - CONNECTOR | CON1,CON10 | 3104 0113 0050 |
| 2 | D100-SSA-16 - CONNECTOR | CON4,CON9 | 3104 0116 0050 |
| 1 | 2P*2.0 - CONNECTOR | CON8 | 3100 4020 0200 |
| 1 | 6P*2.0 - CONNECTOR | CON3 | 3100 4060 0200 |
| 1 | 7P*2.0 - CONNECTOR | CON11 | 3100 4070 0200 |
| 1 | 9P*2.0 - CONNECTOR | CON7 | 3100 4090 0250 |
| 1 | 10P*2.0 - CONNECTOR | CON5 | 3100 4100 0200 |
| 1 | AV-8.4-8/PB - JACK | JK2 | 2910 1032 3383 |
| 1 | AV2-8.4-13/PB - JACK | JK3 | 2910 2051 0310 |
| 2 | AV4-8.4-13/PB - JACK | JK1,JK4 | 2910 4002 0310 |
| 2 | JSR1162-002 - MODULE , OPTICAL(RX) | P2,P1 | 1341 1621 0100 |
| 1 | USB/18004-1111102 - USB JACK | USB1 | 2800 1018 0040 |
| 1 | 15R_1/4W - RES, CARBON | R122 | 2401 0321 5011 |
| 6 | 51.1K 0.1% - RES, CHIP | R290,R296,R303,R307,R314,R393 | 2402 1265 1103 |
| 2 | 1.74K 1% - RES, CHIP | R439,R440 | 2401 1211 7203 |
| 1 | 2.1k 1% - RES, CHIP | R311 | 2401 1212 1203 |
| 1 | 5.1K/1% - RES, CHIP | R235 | 2401 1215 1203 |
| 17 | 0R - RES, CHIP | R2,R6,R9,R13,R15,R20,R31,R33,R34,R38,R123, R226,R362,R365,R366,R394,R395R130,R412,R413 | 2401 1220 0003 |
| 2 | 6R8 - RES, CHIP | R294,R313 | 2401 1226 8903 |
| 4 | 10R - RES, CHIP | R197,R206,R243,R255 | 2401 1221 0003 |
| 1 | 15R - RES, CHIP | R373 | 2401 1221 5003 |
| 57 | 33R - RES, CHIP | R45,R48,R49,R50,R67,R68,R69,R70,R71,R72, R73,R74,R75,R76,R77,R78,R79,R80,R81,R82, R83,R84,R85,R86,R88,R90,R91,R98,R102,R116, R121,R127,R133,R210,R211,R212,R213,R214, R215,R216,R219,R220,R221,R319,R320,R322, R323,R324,R325,R334,R335,R336,R337,R340, R404,R425,R428 | 2401 1223 3003 |
| 5 | 47R - RES, CHIP | R1,R4,R14,R19,R418 | 2401 1224 7003 |
| 4 | 75R - RES, CHIP | R199,R208,R228,R232 | 2401 1275 0203 |
| 4 | 91R - RES, CHIP | R273,R282,R291,R304 | 2401 1291 0203 |
| 6 | 100R - RES, CHIP | R241,R332,R375,R424,R432,R435 | 2401 1221 0103 |
| 13 | 220R - RES, CHIP | R87,R101,R111,R147,R148,R152,R153,R267, R268,R272,R274,R283,R285 | 2401 1222 2103 |
| 1 | 300R - RES, CHIP | R240 | 2401 1223 0103 |
| 2 | 332R - RES, CHIP | R284,R305 | 2403 1233 2003 |
| 6 | 634R - RES, CHIP | R269,R275,R280,R289,R293,R300 | 2403 1263 4003 |
| 33 | 1K - RES, CHIP | R16,R17,R32,R35,R40,R112,R113,R114,R117, R118,R119,R120,R125,R129,R135,R139,R146, R155,R165,R169,R179,R182,R292,R301,R308, R309,R346,R370,R380,R391,R397,R419,R426 | 2401 1221 0203 |
| 10 | 1.2K - RES, CHIP | R138,R141,R151,R157,R167,R171,R187,R192 R246,R260 | 2401 1221 2203 |
| 2 | 1.5K - RES, CHIP | R357,R358 | 2401 1221 5203 |
| 2 | 2K - RES, CHIP | R297,R312 | 2401 1222 0203 |
| 6 | 2.2K - RES, CHIP | R60,R61,R115,R225,R227,R384 | 2401 1222 2203 |
| 2 | 2.4K - RES, CHIP | R131,R132 | 2401 1222 2403 |
| 4 | 2.7K - RES, CHIP | R137,R140,R150,R156 | 2401 1222 7203 |

| | | | |
|-----|--------------------------|--|----------------|
| 1 | 3.3K - RES, CHIP | R99 | 2401 1223 3203 |
| 4 | 3.6K - RES, CHIP | R166,R170,R186,R191 | 2401 1223 6203 |
| 1 | 3.9K - RES, CHIP | R369 | 2401 1223 9203 |
| 34 | 4.7K - RES, CHIP | R47,R51,R52,R53,R54,R56,R57,R58,R59,R62, R63,R64,R65,R66,R93,R94,R95,R96,R97,R103, R104,R105,R106,R107,R108,R109,R110,R386, R387,R388,R389,R390,R410,R429 | 2401 1224 7203 |
| 8 | 5.1K - RES, CHIP | R134,R145,R149,R163,R164,R177,R178,R195 | 2401 1225 1203 |
| 1 | 6.8K - RES, CHIP | R234 | 2401 1226 8203 |
| 54 | 10K - RES, CHIP | R3,R7,R8,R18,R21,R23,R46,R55,R100,R126, R196,R201,R236,R237,R238,R239,R278,R279, R298,R299,R331,R333,R341,R342,R343,R344, R345,R347,R350,R353,R354,R355,R356,R359, R382,R383,R385,R398,R399,R400,R401,R402, R403,R405,R406,R407,R408,R409,R411,R430, R431,R433,R434,R436 | 2401 1221 0303 |
| 7 | 15K - RES, CHIP | R10,R24,R89,R136,R142,R374,R376 | 2401 1221 5303 |
| 1 | 18.3K - RES, CHIP | R367 | 2403 1218 3203 |
| 16 | 22K - RES, CHIP | R27,R28,R29,R41,R42,R43,R124,R128,R144, R160,R175,R190,R361,R381,R396,R427 | 2401 1222 2303 |
| 3 | 27K - RES, CHIP | R281,R302,R360 | 2401 1222 7303 |
| 6 | 33K - RES, CHIP | R251,R265,R286,R306,R351,R352 | 2401 1223 3303 |
| 3 | 39K - RES, CHIP | R364,R368,R371 | 2401 1223 9303 |
| 9 | 47K - RES, CHIP | R245,R259,R270,R271,R276,R277,R287,R288,R363 | 2401 1224 7303 |
| 4 | 47.5K - RES, CHIP | R143,R162,R176,R194 | 2403 1247 5203 |
| 8 | 100K - RES, CHIP | R5,R22,R39,R247,R261,R348,R349,R372 | 2401 1221 0403 |
| 2 | 220K - RES, CHIP | R30,R44 | 2401 1222 2403 |
| 3 | 470K - RES, CHIP | R26,R252,R266 | 2401 1224 7103 |
| 2 | 560K - RES, CHIP | R209,R200 | 2401 1225 6103 |
| 1 | 39R/2W - RES, CARBON | R420 | 2413 0623 9012 |
| 2 | 8PF - CAP , CHIP | C241,C242 | 2115 5809 0135 |
| 6 | 30PF - CAP , CHIP | C26,C27,C28,C29,C216,C217 | 2115 5809 0135 |
| 3 | 33PF - CAP , CHIP | C142,C149,C302 | 2103 5330 0130 |
| 18 | 39PF - CAP , CHIP | C17,C24,C303,C304,C305,C306,C307,C308, C309,C310,C311,C312,C313,C314,C315,C316, C317,C318 | 2103 5390 0130 |
| 2 | 47PF - CAP , CHIP | C246,C250 | 2103 5470 0130 |
| 2 | 68PF - CAP , CHIP | C106,C113 | 2103 5680 0130 |
| 2 | 100PF - CAP , CHIP | C12,C7 | 2103 5101 0130 |
| 10 | 330PF - CAP , CHIP | C5,C10,C107,C115,C119,C120,C126,C127, C130,C131 | 2103 5331 0130 |
| 9 | 560PF(NPO) - CAP , CHIP | C16,C41,C42,C50,C54,C60,C66,C76,C80 | 2103 5561 0130 |
| 2 | 820PF - CAP , CHIP | C214,C215 | 2103 5821 0130 |
| 21 | 1000PF(NPO) - CAP , CHIP | C37,C38,C39,C40,C43,C46,C48,C57,C59,C69, C75,C81,C99,C137,C148,C243,C244,C248,C252, C255,C256 | 2103 5102 0130 |
| 4 | 1500PF(NPO) - CAP , CHIP | C293,C295,C297,C299 | 2103 5152 0145 |
| 4 | 1800PF(NPO) - CAP , CHIP | C294,C296,C298,C300 | 2103 5182 0145 |
| 6 | 0.01uF - CAP , CHIP | C11,C85,C88,C195,C197,C231 | 2115 6103 0130 |
| 2 | 0.033uF - CAP , CHIP | C143,C145 | 2115 6333 0130 |
| 1 | 0.047uF - CAP , CHIP | C196 | 2115 6473 0130 |
| 1 | 0.056uF - CAP , CHIP | C100 | 2115 6563 0130 |
| 149 | 0.1uF - CAP , CHIP | C1,C2,C3,C4,C6,C8,C9,C13,C14,C15,C18,C19, | 2115 6104 0145 |

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|----|----------------------------|--|----------------|
| | | C20,C21,C22,C23,C25,C30,C31,C32,C33,C34, | |
| | | C35,C36,C44,C47,C49,C51,C52,C53,C55,C58, | |
| | | C61,C63,C64,C70,C72,C73,C82,C83,C84,C86, | |
| | | C87,C89,C90,C91,C92,C93,C94,C96,C97,C101, | |
| | | C103,C105,C112,C122,C123,C124,C129,C133, | |
| | | C134,C138,C144,C146,C150,C152,C153,C168, | |
| | | C169,C170,C171,C172,C173,C174,C175,C176, | |
| | | C177,C178,C179,C181,C182,C183,C184,C185, | |
| | | C186,C187,C188,C192,C193,C198,C201,C203, | |
| | | C205,C206,C207,C208,C209,C210,C211,C212, | |
| | | C213,C218,C220,C222,C223,C225,C230,C232, | |
| | | C233,C236,C237,C238,C239,C240,C253,C254, | |
| | | C257,C258,C259,C260,C261,C262,C263,C264, | |
| | | C265,C266,C267,C268,C269,C270,C271,C272, | |
| | | C273,C274,C275,C276,C277,C278,C279,C280, | |
| | | C281,C282,C283,C284,C287,C289,C290,C291,C292 | |
| 1 | 0.47uF - CAP , CHIP | C200 | 2115 6474 0130 |
| 15 | 1uF - CAP , CHIP | C45,C56,C68,C79,C189,C190,C191,C194, | 2115 6105 0130 |
| | | C199,C204,C219,C221,C224,C226,C229 | |
| 2 | 222M - CAP , MYLAR | C108,C117 | 2203 3222 0103 |
| 2 | 822M - CAP , MYLAR | C109,C118 | 2203 3822 0103 |
| 4 | 470PF(COG) - CAP , CHIP | C121,C125,C132,C136 | 2103 5471 0130 |
| 2 | 2700PF(COG) - CAP , CHIP | C139,C128 | 2115 6272 0130 |
| 2 | 22uF/10V - CAP , ELECT | EC12,EC14 | 2320 0210 1010 |
| 4 | 220uF/10V - CAP , ELECT | EC1,EC62,EC64,EC80 | 2321 0210 2015 |
| 1 | 2200uF/10V - CAP , ELECT | EC77 | 2322 2101 1000 |
| 2 | 1uF/16V - CAP , ELECT | EC95,EC85 | 2319 0310 1015 |
| 19 | 10uF/16V - CAP , ELECT | EC4,EC5,EC6,EC7,EC35,EC36,EC37,EC40, | 2310 0310 1015 |
| | | EC44,EC46,EC50,EC65,EC67,EC68,EC69, | |
| | | EC70,EC71,EC92,C180 | |
| 4 | 22uF/16V - CAP , ELECT | EC13,EC20,EC26,EC31 | 2320 0310 1015 |
| 3 | 47uF/16V - CAP , ELECT | EC52,EC57,EC73 | 2340 0310 1015 |
| 1 | 470uF/16V - CAP , ELECT | EC61 | 2341 0310 4025 |
| 26 | 100uF/16V - CAP , ELECT | EC8,EC9,EC21,EC23,EC28,EC33,EC34,EC38, | 2311 0310 2015 |
| | | EC47,EC53,EC54,EC58,EC60,EC66,EC72,EC74, | |
| | | EC75,EC76,EC78,EC79,EC96,EC97,EC98,EC99, | |
| | | EC100,EC101 | |
| 1 | 1000uF/16V - CAP , ELECT | EC3 | 2312 3104 4000 |
| 1 | 47uF/25V - CAP , ELECT | EC93 | 2340 0410 1015 |
| 3 | 470uF/25V - CAP , ELECT | EC10,EC11,EC91 | 2341 0410 4025 |
| 1 | 1000uF/25V - CAP , ELECT | EC90 | 2312 4105 4000 |
| 1 | 2.2uF/50V - CAP , ELECT | EC39 | 2329 0610 1015 |
| 2 | 4.7uF/50V - CAP , ELECT | EC42,EC45 | 2349 0610 1015 |
| 8 | 47uF/50V - CAP , ELECT | EC81,EC82,EC83,EC84,EC86,EC87,EC88,EC89 | 2340 0610 2015 |
| 1 | 100uF/50V - CAP , ELECT | EC2 | 2311 0610 3025 |
| 1 | 22UF/50V(NP) - CAP , ELECT | C301 | 2320 0610 1013 |
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| Connet.Bom P/N: 0082-1332-0000 | | | |
|--------------------------------|---|---|----------------|
| Qty | Part Type | Ref. Designator | Part Number |
| 1 | MP1423 (MPS) STEP DOWN CONVERTER | IC1 | 1001 4232 2971 |
| 1 | 2SA1162GR - TRANSISTOR | Q2 | 1111 1620 7100 |
| 3 | 2SC3361 - TRANSISTOR | Q1 Q3 Q4 | 1133 3610 6100 |
| 3 | 1N4148 - DIODE | D1 D2 D3 | 1310 4414 8000 |
| 1 | B340A - DIODE | D4 | 1180 3400 1901 |
| 2 | RSA5L - DIODE | D5 D6 | 1350 0050 0100 |
| 7 | BK1608LM182-T(Taiyo Yuten)FERRITE , CHIP BEAD | FB2 FB3 FB4 FB5 FB6 FB7 FB8 | 1871 6081 8201 |
| 2 | BLM18PG181SN1(Murata)FERRITE , CHIP BEAD | FB9 FB10 | 1871 1818 1001 |
| 1 | CDRH104RNP-220NC(sumida) COIL SMD POWER | L1 | 1871 0422 0001 |
| 1 | FB0805 FERRITE , CHIP BEAD | FB1 | 1852 0120 9100 |
| 1 | DB-09 - JACK | RS1 | 2806 0590 0000 |
| 1 | MSV-1260 - SWITCH | SW1 | 4330 3002 1311 |
| 1 | SCSI-36P-F-90 - JACK | JK2 | 3109-0536-4632 |
| 1 | IDC 2x10P2.54(90) - CONNECTOR | JK1 | 3109 0520 4632 |
| 1 | 1mH/800mA - COIL SMD POWER | L2 | 1808 0010 0001 |
| 1 | 7P(2.0) - CONNECTOR | CN1 | 3100 4070 0200 |
| 1 | 9P(2.0) - CONNECTOR | CN2 | 3100 4090 0250 |
| 1 | 10P(2.0) - CONNECTOR | CN3 | 1808 0010 0001 |
| 1 | 4.3K 1% - RES, CHIP | R25 | 2401 1214 3203 |
| 1 | 7.5K 1% - RES, CHIP | R28 | 2401 1217 5203 |
| 1 | 10K 1% - RES, CHIP | R27 | 2401 1211 0303 |
| 1 | 51K 1% - RES, CHIP | R26 | 2401 1215 1303 |
| 1 | 33R - RES, CHIP | R8 | 2401 1223 3003 |
| 1 | 220R - RES, CHIP | R7 | 2401 1222 2103 |
| 1 | 1.8K - RES, CHIP | R3 | 2401 1221 8203 |
| 1 | 4K7 - RES, CHIP | R6 | 2401 1224 7203 |
| 7 | 10K - RES, CHIP | R1 R2 R4 R5 R13 R23 R24 | 2401 1221 0303 |
| 1 | 100K - RES, CHIP | R15 | 2401 1221 0403 |
| 2 | 100P - CAP , CHIP | C2 C3 | 2103 5101 0130 |
| 1 | 120P(NPO) - CAP , CHIP | C33 | 2103 5121 0130 |
| 1 | 4700PF(NPO) - CAP , CHIP | C34 | 2103 5472 0130 |
| 2 | 103(0.01UF) - CAP , CHIP | C29 C30 | 2115 6103 0130 |
| 19 | 0.1uF - CAP , CHIP | C4 C5 C6 C8 C11 C16 C17 C18 C19 C20 C21 | 2115 6104 0130 |
| | | C22 C23 C24 C25 C26 C27 C28 C35 | |
| 2 | 22uF/25V(X7) - CAP , CHIP | C31 C32 | 2103 5226 0925 |
| 5 | 100uF16V - CAP , ELECT | C7 C9 C12 C14 C15 | 2311 0310 2015 |
| 1 | 2200uF/25V - CAP , ELECT | C10 | 2322 4105 5000 |
| 1 | 1uF/50 - CAP , ELECT | C1 | 2319 0610 1015 |
| | | | |
| | | | |
| | PHONE.Bom P/N: 0082-5170-0001 | | |
| Qty | Part Type | Ref. Designator | Part Number |
| 7 | FB FERRITE , CHIP BEAD | L2 L3 L4 L5 L6 L7 L8 | 1852 0120 9200 |
| 1 | CK3-3.5-510K2 - HEADPHONE JACK | J1 | 2821 2350 7000 |
| 1 | CK3.5-02 | J2 | 2801 1335 0203 |
| 1 | JX1.0-3S-13PW - CONNECTOR | CN1 | 3104 0113 1050 |
| 1 | USB-A-M1-4P - USB JACK | JP1 | 2800 1018 0040 |
| 1 | 2P(2.0) - CONNECTOR | CN2 | 3100 4020 0200 |
| 2 | 100 - RES, CHIP | R1 R2 | 2401 1221 0103 |
| 4 | 47K - RES, CHIP | R3 R4 R5 R6 | 2401 1224 7303 |
| 2 | 330P - CAP , CHIP | C108 C109 | 2103 5331 0130 |

| 2 | 102(1000pF) - CAP , CHIP | C110 C111 | 2103 5102 0130 |
|-----|--|--------------------------------|----------------|
| 8 | 104(0.1uF) - CAP , CHIP | C1 C2 C4 C5 C6 C7 C8 C107 | 2115 6104 0130 |
| 1 | 100uF16V - CAP , ELECT | C3 | 2311 0310 2015 |
| | | | |
| | Display bom P/N: 0082-5010-0000 | | |
| Qty | Part Type | Ref. Designator | Part Number |
| 1 | AMS1117-3.3V (AMS) LOW DROPOUT VOLTAGE REGULATOR | IC1 | 1011 7330 0128 |
| 1 | KS-803LM (REMOTE SENSOR) | IR1 | 1304 0008 0301 |
| 6 | HT15-21UWC/TR8 (LED) WHITE | D2 D3 D4 D5 D6 D7 | 1403 0712 0603 |
| 1 | 162-SD-16INK - VFD | VF1 | 1521 6216 0101 |
| 1 | JX1.0S-4S-16PWT - CONNECTOR | CN1 | 3109 0116 3103 |
| 1 | 2x6P(1.27) - CONNECTOR | J1 | 3112 0200 5022 |
| 2 | 10R±5% 0603 - RES, CHIP | R1 R2 | 2401 1221 0003 |
| 1 | 47R±5% 0603 - RES, CHIP | R5 | 2401 1224 7003 |
| 1 | 10K±5% 0603 - RES, CHIP | R4 | 2401 1221 0303 |
| 1 | 33K±5% 0603 - RES, CHIP | R3 | 2401 1223 3303 |
| 9 | 0.1uF/50V±10% 0603 - CAP , CHIP | C1 C2 C6 C7 C8 C10 C11 C12 C13 | 2115 6104 0130 |
| 1 | 10uF10V±20% - CAP , ELECT | C4 | 2310 0210 1015 |
| 2 | 100uF10V±20% - CAP , ELECT | C3 C5 | 2311 0210 1015 |
| 1 | 100uF16V±20% - CAP , ELECT | C9 | 2311 0310 2015 |
| | | | |
| | TOUCH-PCB P/N: 0082-5003-0000 | | |
| Qty | Part Type | Ref. Designator | Part Number |
| 1 | MA83P06(SSOP-28) (MOSART) TOUCH SENSOR | U1 | 1008 3062 2514 |
| 1 | HEADER 6X2 - CONNECTOR | J1 | 3113 0200 6002 |
| 1 | 0R±5% 0603 - RES, CHIP | R2 | 2401 1220 0003 |
| 6 | 100R±5% 0603 - RES, CHIP | R6 R7 R8 R9 R10 R11 | 2401 1221 0103 |
| 1 | 560R±5% 0603 - RES, CHIP | R3 | 2401 1225 6103 |
| 2 | 4.7K±5% 0603 - RES, CHIP | R4 R5 | 2401 1224 7203 |
| 1 | 91K±1% 0603 - RES, CHIP | C11 | 2403 1219 1303 |
| 1 | 390K±1% 0603 - RES, CHIP | R1 | 2401 0913 9405 |
| 1 | 2pF/50V±10% 0603 - CAP , CHIP | C3 | 2115 5209 0135 |
| 2 | 0.1uF/50V±10% 0603 - CAP , CHIP | C1 C4 | 2115 6104 0130 |

LM9022

Vacuum Fluorescent Display Filament Driver

General Description

The LM9022 is a bridged power amplifier capable of delivering typically 2W of continuous average power into a 10Ω filament load when powered by a 5V power supply.

To conserve power in portable applications, the LM9022's micropower shutdown mode ($I_{OQ} = 0.6\mu A$, typ) is activated when V_{DD} is applied to the SHUTDOWN pin.

Additional LM9022 features include thermal shutdown protection, unity-gain stability, and external gain set.

Key Specifications

- I_{DD} during shutdown
- Thermal Shutdown Protection

0.6μA (typ)

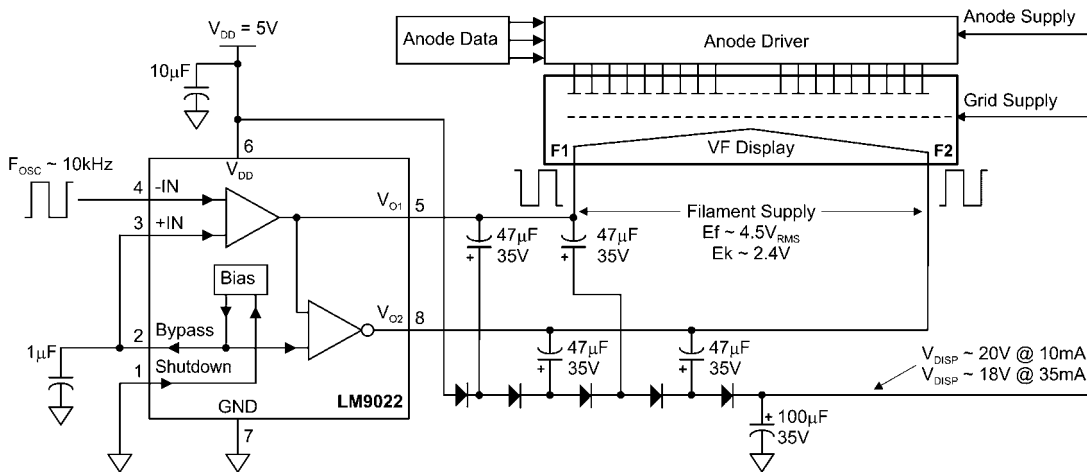
Features

- No transformers required
- SO or DIP packaging

Applications

- VCR/DVD Displays
- RADIO/TUNER Displays

Typical Application $T_A = 25^\circ C$, $V_{DD} = 5V$, unless otherwise specified.

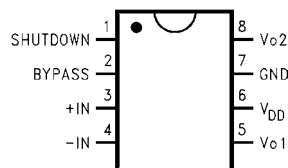


20021501

FIGURE 1. Typical Application Circuit

Connection Diagram

MSOP, Small Outline, and DIP Package



20021502

Top View

Order Number LM9022M or LM9022N
See NS Package Number M08A or N08E