ESS Technology, Inc.

DESCRIPTION

The ES1888 *Audio*Drive® is a mixed-signal single-chip solution that adds 16-bit stereo sound and FM music synthesis to personal computers. It includes an embedded microprocessor, a 20-voice **ESFM**™ music synthesizer, 16-bit stereo wave ADC and DAC, 16-bit stereo music DAC, MPU-401 UART mode serial port, dual game ports, hardware master volume control, two serial port interfaces to external DSP and external wavetable music synthesizer, DMA control logic with FIFO, and ISA bus inferface logic. There are three stereo inputs (typically line, CD Audio, and auxiliary line) and a mono microphone input to an internal preamp. All of this on a single chip that can be designed into a motherboard, add-on card, or integrated into other peripheral cards such as Fax/Modem, VGA, LAN, I/O, etc.

The ES1888 *Audio*Drive® can record, compress, and play back voice, sound, and music with built-in 7-channel mixer controls. Using two high-performance DMA channels, the ES1888 supports full-duplex operation for simultaneous record and playback. The **ESFM**™ synthesizer has extended capabilities within native mode operation providing superior sound and power-down capabilities. The ES1888 is register compatible to OPL3™.

The MPU-401 serial port is for interfacing with an external MIDI device. The dual game port supports two joysticks both having X,Y resistor value settings and two pushbutton switches. The PC speaker volume can be modified by software. Two software address selection modes allow for motherboard Plug and Play configuration.

A DSP serial interface allows an external DSP to take over DAC or ADC resources. A wavetable serial port allows the ES1888 to interface with either the ES689 or ES690 wavetables. I/O address, DMA, and interrupt selection can be controlled through system software.

Advanced power management features include suspend/resume from disk or host-independent self-timed power-down and automatic wake-up.

The ES1888 *Audio*Drive® is available in an industry-standard 100-pin Plastic Quad Flat Pack (PQFP) package.

APPLICATIONS

- PC Audio
- PC Games
- Business Audio
- Multimedia PCs
- Music Synthesis

FEATURE HIGHLIGHTS

- Single, high-performance, mixed-signal, 16-bit stereo VLSI chip for digital audio
- High-quality, 20-voice **ESFM**™ music synthesizer; patents pending
- Patented **ESPCM**® compression

Record and Playback Features

- Record, compress, and play back voice, sound, and music
- 16-bit stereo ADC/DAC for digital audio
- Programmable sample rate from 4 kHz to 44.1 kHz for record and playback
- 3-button hardware volume control for up, down, and mute
- Full-duplex operation for simultaneous record and playback using two DMA channels

Inputs and Outputs

- MIDI serial port compatible with MPU-401 UART mode
- ESS high-performance integrated dual game port
- Single or Demand transfer DMA
- Software address mapping, DMA and IRQ selections for motherboard Plug and Play
- Wavetable serial port interface to ES689/ES690 for direct access to the music DAC
- PC speaker input/output with volume control
- 3 stereo DACs with independent sample rate and filter control for simultaneous game, music, and system playback of digital data streams
- Serial port interface to external DSP optionally controls full-duplex operation

Mixer Features

- 7-channel stereo mixer inputs for line, auxiliary A (CD audio), auxiliary B, digital audio for voice files, digital audio for wave files, music synthesizer, plus a mono channel mixer input for microphone
- 4-channel record mixer with stereo inputs for line, auxiliary A (CD audio), auxiliary B, plus a mono input for microphone
- Programmable 6-bit (64 step) logarithmic master volume control
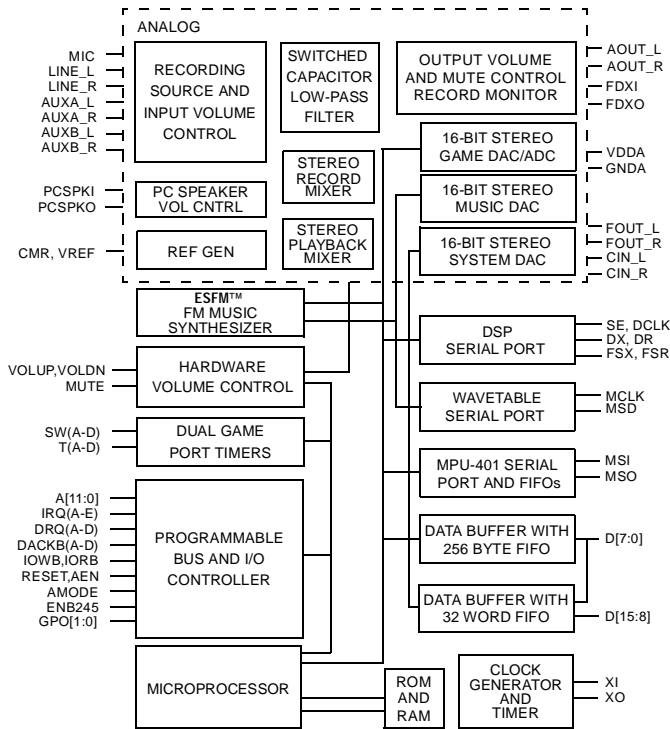
Power

- Advanced power management with self-timed power-down, automatic wake-up, and suspend/resume to and from disk
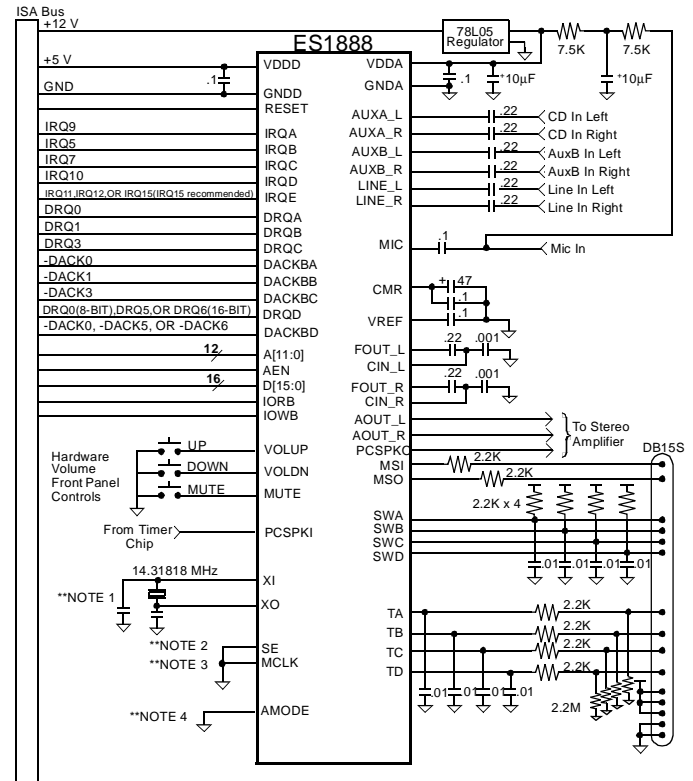- Supports 3.3 or 5.0 V operation

Compatibility

- Supports PC games in Sound Blaster™ and Sound Blaster™ Pro and OPL3 FM synthesizers
- Supports Microsoft® Windows™, Windows NT™, Windows for Workgroups™, Windows®95 and Windows Sound System®
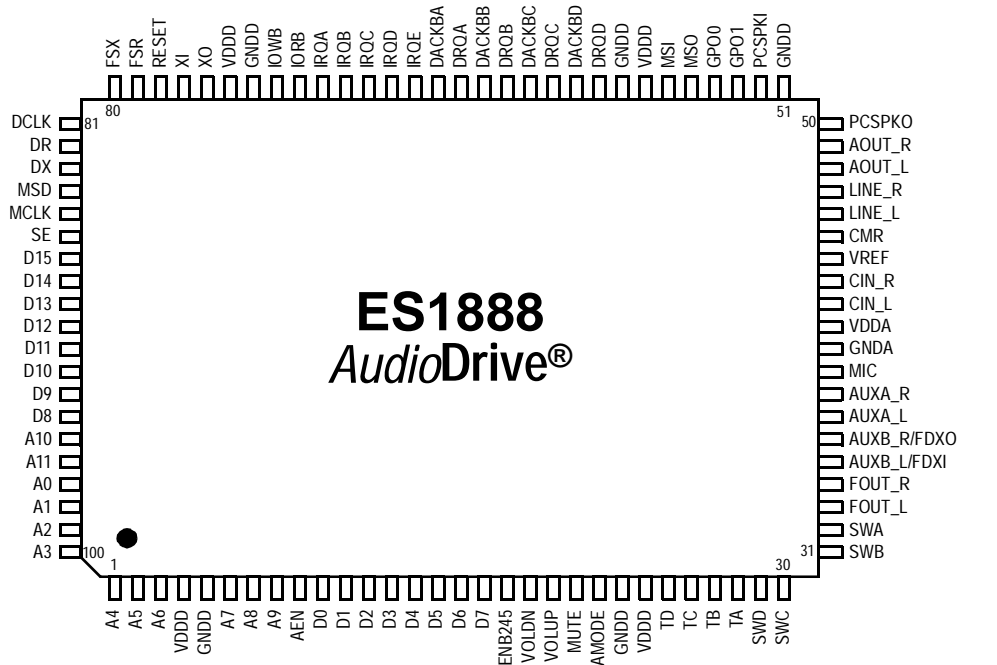- Supports IBM® OS/2®

BLOCK DIAGRAM

ANALOG

MIC
LINE_L
LINE_R
AUXA_L
AUXA_R
AUXB_L
AUXB_R

RECORDING SOURCE AND INPUT VOLUME CONTROL

SWITCHED CAPACITOR LOW-PASS FILTER

OUTPUT VOLUME AND MUTE CONTROL RECORD MONITOR

AOUT_L
AOUT_R
FDXI
FDXO

PCSPKI
PCSPKO

PC SPEAKER VOL CNTRL

STEREO RECORD MIXER

16-BIT STEREO GAME DAC/ADC

VDDA
GNDA

CMR, VREF

REF GEN

STEREO PLAYBACK MIXER

16-BIT STEREO MUSIC DAC

16-BIT STEREO SYSTEM DAC

FOUT_L
FOUT_R
CIN_L
CIN_R

ESFM™ FM MUSIC SYNTHESIZER

DSP SERIAL PORT

SE, DCLK
DX, DR
FSX, FSR

VOLUP, VOLDN
MUTE

HARDWARE VOLUME CONTROL

WAVETABLE SERIAL PORT

MCLK
MSD

SW(A-D)
T(A-D)

DUAL GAME PORT TIMERS

MPU-401 SERIAL PORT AND FIFOs

MSI
MSO

A[11:0]
IRQ(A-E)
DRQ(A-D)
DACKB(A-D)
IOWB,IORB
RESET,AEN
AMODE
ENB245
GPO[1:0]

PROGRAMMABLE BUS AND I/O CONTROLLER

DATA BUFFER WITH 256 BYTE FIFO

D[7:0]

DATA BUFFER WITH 32 WORD FIFO

D[15:8]

MICROPROCESSOR

ROM AND RAM

CLOCK GENERATOR AND TIMER

XI
XO

TYPICAL APPLICATION

ISA Bus
+12 V
+5 V
GND
IRQ9
IRQ5
IRQ7
IRQ10
IRQ11,IRQ12,OR IRQ15(IRQ15 recommended)
DRQ0
DRQ1
DRQ3
-DACK0
-DACK1
-DACK3
DRQ0(8-BIT),DRQ5,OR DRQ6(16-BIT)
-DACK0, -DACK5, OR -DACK6

ES1888

VDDD
GNDD
RESET
IRQA
IRQB
IRQC
IRQD
IRQE
DRQA
DRQB
DRQC
DACKBA
DACKBB
DACKBC
DRQD
DACKBD
A[11:0]
AEN
D[15:0]
IORB
IOWB

78L05 Regulator
VDDA
GNDA

7.5K   7.5K

*10µF   *10µF

AUXA_L
AUXA_R
AUXB_L
AUXB_R
LINE_L
LINE_R

.22 CD In Left
.22 CD In Right
.22 AuxB In Left
.22 AuxB In Right
.22 Line In Left
.22 Line In Right

MIC   .1   Mic In

CMR   47
VREF   .1
FOUT_L   .22   .001
CIN_L
FOUT_R   .22   .001
CIN_R

AOUT_L
AOUT_R   To Stereo Amplifier
PCSPKO

Hardware Volume Front Panel Controls

UP
DOWN
MUTE

VOLUP
VOLDN
MUTE

MSI   2.2K
MSO   2.2K
SWA
SWB   2.2K x 4
SWC
SWD

DB15S

.01 .01 .01 .01

From Timer Chip

PCSPKI

14.31818 MHz

XI
XO

TA   2.2K
TB   2.2K
TC   2.2K
TD   2.2K

**NOTE 1

**NOTE 2
**NOTE 3

SE
MCLK

.01 .01 .01 .01

2.2M

**NOTE 4   AMODE

**NOTE 1: Use a crystal for the ES1888 if the accuracy of the ISA Bus OSC signal is not sufficient. The XI pin can be driven by an external clock if the clock has CMOS logic levels.
**NOTE 2: In designs where the DSP interface is not used, it is recommended to tie the SE pin low.
**NOTE 3: In designs where the ES689/ES690 serial interface is not used, it is recommended to tie the MCLK pin low.
**NOTE 4: AMODE selects one of the two software address configuration methods. In this example, the Read-Sequence-Key method is selected.

PINOUT

ES1888 AudioDrive®

Top pins: FSX, FSR, RESET, XI, XO, VDDD, GNDD, IOWB, IORB, IRQA, IRQB, IRQC, IRQD, IRQE, DACKBA, DRQA, DACKBB, DRQB, DACKBC, DRQC, DACKBD, DRQD, GNDD, VDDD, MSI, MSO, GPO0, GPO1, PCSPKI, GNDD

Left pins (81-100/1): DCLK, DR, DX, MSD, MCLK, SE, D15, D14, D13, D12, D11, D10, D9, D8, A10, A11, A0, A1, A2, A3

Right pins (51-50 to 31): PCSPKO, AOUT_R, AOUT_L, LINE_R, LINE_L, CMR, VREF, CIN_R, CIN_L, VDDA, GNDA, MIC, AUXA_R, AUXA_L, AUXB_R/FDXO, AUXB_L/FDXI, FOUT_R, FOUT_L, SWA, SWB

Bottom pins: A4, A5, VDDD, GNDD, A6, A7, A8, A9, AEN, D0, D1, D2, D3, D4, D5, D6, D7, ENB245, VOLDN, VOLUP, MUTE, AMODE, GNDD, VDDD, TD, TC, TB, TA, SWD, SWC

DIGITAL PIN DESCRIPTIONS

Name	I/O	Description
VDDD	I	Digital supply voltage (3.0V to 5.5V).
GNDD	I	Digital ground.
VOLDN	I	Active-low volume decrease button input.
VOLUP	I	Active-low volume increase button input.
MUTE	I	Active-low mute toggle button input.
GPO0	O	Output that is set low by external reset and thereafter controlled by bit 0 of port 2x7h. Available to system software for power management or other applications.
GPO1	O	Output that is set high by external reset and thereafter controlled by bit 1 of port 2x7h. Available to system software for power management or other applications.
MSI	I	MIDI serial input. Either MPU-401 or SoundBlaster formats. Schmitt trigger input with internal pull-up resistor.
MSO	O	MIDI serial data output.
RESET	I	Active-high reset from ISA bus.
XO	O	Crystal oscillator output.
XI	I	Crystal oscillator input.
IORB	I	Active-low read strobe from ISA bus.
IOWB	I	Active-low write strobe from ISA bus.
A[9:0]	I	Address inputs from ISA bus.
A[11:10]	I	Address inputs from ISA bus. The ES1888 requires these pins to be low for all address decodes.
AEN	I	Active-low address enable from ISA bus.
D[7:0]	I/O	Bidirectional data bus. These pins have weak pull-up devices to prevent these inputs from floating when not driven.
D[15:8]	I	High byte input data bus. This is used for the system DAC when the 16-bit DMA transfer mode is selected.
ENB245	O	Active-low output when the ES1888 is being read or written to. Intended to be connected to the enable control of an external 74LS245.
SW(A-D)	I	Four (A,B,C,D) active-low joystick switch setting inputs. These SW pins have an internal 2k ohm pull-up resistor. The joystick port is typically at address 201.
T(A-D)	I/O	Four (A,B,C,D) joystick timer pins. These pins connect to the X,Y positioning variable resistors for the two joysticks.
AMODE	I	Input pin with pull-down device. The ES1888 is disabled following a hardware reset and must be configured by one of two methods (optioned by AMODE) of software address selection: 0: Read-Sequence-Key method 1: System-Control-Register method
IRQ(A-D)	O	Four (A,B,C,D) active-high interrupt requests to the ISA bus. Unselected IRQ outputs are high impedance. IRQs are software configurable.
IRQE	O	Active-high interrupt request to the ISA bus. Reserved for MPU-401 or hardware volume control.
DRQ(A-C)	O	Three (A,B,C) active-high DMA requests to the ISA bus. Unselected DRQ outputs are high impedance. When DMA is not active, the selected DRQ output has a pull-down device that holds the DRQ line inactive unless another device that shares the same DRQ line can source enough current to make the DRQ line active. DRQs are software configurable.

Name	I/O	Description
DACKB(A-C)	I	Three (A,B,C) active-low DMA acknowledge inputs from the ISA bus.
DRQD	O	DMA request for the system DAC. This can be selected to be either 8-bit or 16-bit DMA transfers.
DACKBD	I	Active-low DMA acknowledge for the system DAC.
PCSPKI	I	Normally low digital PC speaker signal input. This signal is converted to an analog signal with volume control and appears on analog output PCSPKO.
FSR	I	Input with internal pull-down. Frame sync for receive data from external DSP. Programmable for active-high or active-low.
FSX	I	Input with internal pull-down. Frame sync for transmit request from external DSP. Programmable for active-high or active-low.
DCLK	I	Input with internal pull-down. Serial data clock from external DSP. Typically 2.048 MHz.
DR	I	Input with internal pull-down. Data receive pin from external DSP.
DX	O	Tri-state output. Data transmit to external DSP. High impedance when not transmitting.
MSD	I	Input with internal pull-down. Music serial data from external ES689 or ES690 Wavetable Music Synthesizer.
MCLK	I	Input with internal pull-down. Music serial clock from external ES689 or ES690 Wavetable Music Synthesizer.
SE	I	Input with internal pull-down. Active-high to enable serial mode, i.e., enables an external DSP to control analog resources of the ES1888 through the DSP serial interface.

DIGITAL CHARACTERISTICS

Symbol	Parameter	Min	Max	Unit	Conditions
VIH1	Input high voltage: All except GPI1	2.0		V	VDDD=min
VIH2	Input high voltage: GPI1	3.0		V	VDDD=min
VIL	Input low voltage		0.8	V	VDDD=max
VOL1	Output low voltage: All except D[7:0], DRQx, IRQx		0.4	V	IOL=4 mA, VDDD=min
VOH1	Output high voltage: All except D[7:0], DRQx, IRQx	2.4		V	IOH=-3 mA, VDDD=max
VOL2	Output low voltage: D[7:0], DRQx, IRQx		0.4	V	IOL=16 mA, VDDD=min
VOH2	Output high voltage: D[7:0], DRQx, IRQx	2.4		V	IOH=-12 mA, VDDD=max
VOL3	Output low voltage: Select DRQx when DMA inactive		0.4	V	IOL=0.8 mA
ICC1	VDDD active		60	mA	VDDD=max osc. rate at 14.32 MHz
ICC2	VDDA active		60	mA	VDDA=max

ANALOG PIN DESCRIPTIONS

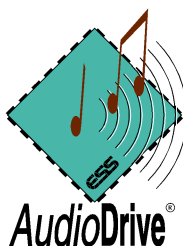| Name	I/O	Description
VDDA	I	Analog supply voltage (4.5 to 5.5 V). Should be greater than or equal to VDDD-0.3 V.
GNDA	I	Analog ground.
MIC	I	Microphone input. MIC has an internal pullup resistor to CMR.
LINE_L, LINE_R	I	Line inputs left and right. LINE_L, LINE_R have internal pullup resistors to CMR.
AUXA_L, AUXA_R	I	Auxiliary inputs left and right. AUXA_L, AUXA_R have internal pullup resistors to CMR. Normally intended for connection to an internal or external CD-ROM analog output.
AUXB_L, AUXB_R	I	Auxiliary inputs left and right. AUXB_L, AUXB_R have internal pullup resistors to CMR. Normally intended for connection to an external music synthesizer or other line-level music source. These pins are selectable with the FDXI, FDXO functions (See below).
FDXO	O	Normally connected to CMR via an internal resistor. Can be programmed to connect internal to FOUT_R pin during DSP serial mode. This function is shared with the AUXB_R input pin.
FDXI	I	Input with internal pullup to CMR. Alternate input to left channel filter stage in DSP serial mode. This function is shared with the AUXB_L input pin.
FOUT_L, FOUT_R	O	Filter outputs left and right. AC-coupled externally to CIN_L, CIN_R to remove DC offsets. These outputs have internal series resistors of about 5k ohms. Capacitors to analog ground on these pins can be used to create a low-pass filter pole that removes switching noise introduced by the switched-capacitor filters.
CIN_L, CIN_R	I	Capacitive coupled inputs left and right. These inputs have internal pull-up resistors to CMR of approximately 50k ohms.
VREF	O	Reference generator resistor divider output. Should be bypassed to analog ground with 0.1 µF capacitor.
CMR	O	Buffered reference output. Should be bypassed to analog ground with a 47 µF electrolytic capacitor with a 0.1 µF capacitor in parallel.
AOUT_L, AOUT_R	O	Line-level stereo outputs, left and right.
PCSPKO	O	Analog output of PCSPKI with volume control.

SERVICE AND SUPPORT

- Evaluation Kit
- Manufacturing Kit
- Reference Design

ANALOG CHARACTERISTICS

Parameter	Pins	Min	Typ	Max	Unit
Reference voltage	CMR, VREF		2.25		Volts (VDDA =5.0V)
Input impedance	LINE_L, LINE_R, AUXA_L, AUXA_R, AUXB_L, AUXB_R, MIC	30k		100k	Ohms
	CIN_L, CIN_R	35k	50k	65k	Ohms
Output impedance	FOUT_L, FOUT_R	3.5k	5k	6.5k	Ohms
	AOUT_L, AOUT_R max load for full-scale output range		5k		Ohms
Input voltage range	MIC	10		125	mVp-p
	LINE_L, LINE_R, AUXA_L, AUXA_R, AUXB_L, AUXB_R	0.5		VDDA -0.5	Volts
Output voltage range	AOUT_L, AOUT_R full-scale output range	0.5		VDDA -1.0	Volts
Gain	Mic preamp		26		dB

MAXIMUM RATINGS

Rating	Symbol	Value
Analog supply voltage	VDDA	-0.3 to 7.0 V
Digital supply voltage	VDDD	-0.3 to 7.0 V
Input voltage	VIN	-0.3 to 7.0 V
Operating temperature range	TA	0 to 70 °C
Storage temperature range	TSTG	-50 to 125 °C

BUNDLED SOFTWARE AND DRIVERS

- *Audio*Rack™

- Bundled Drivers for:
    - Microsoft Windows 3.1
    - Microsoft Windows for Workgroups
    - Microsoft Windows NT
    - Microsoft Windows95
    - IBM OS/2

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AudioDrive®