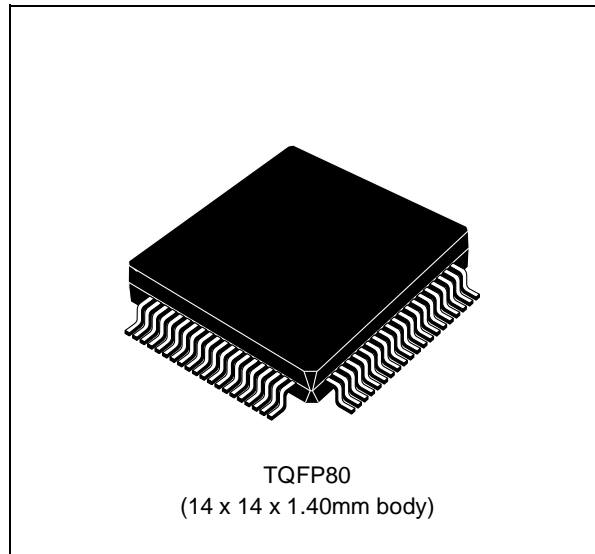




## Digital Servo & Decoder

PRODUCT PREVIEW

- **BUILT IN 8Bit MICROCONTROLLER** (STANDARD ST7) with:
  - 24 KByte ROM available for ST7 & Servo-Audio DSP
  - 1024Byte RAM, including 128byte stack
  - 4KByte RAM for CD-Text memory (for 1block)
  - Built in R-W subcode buffer (Max. 144Byte 8packs) for CD-Text
  - 24 bit general I/O port (PoartA[7-0], PortB[7-0], PortC[7-0])
  - One External Interrupt (16 IRQ encoder inside)
  - 16bit free running counter timer
  - 8bit 1ch general purpose A/D
  - I<sup>2</sup>C bus I/F
  - Watch dog
  - Kenwood I/F
- **STAND-BY MODE** (Stop all clocks and Shut down power of Peripheral (PON pin))
- **BUILT IN SERVO & AUDIO DIGITAL SIGNAL PROCESSOR (SAC-DSP)** inclusive of:
  - 1024x19bit Program RAM
  - 512x16bit Coefficient RAM
  - 1024x20bit Data RAM
  - 128x6bit Decimation RAM
  - MAC: 16 bit (Coefficients) x 20 bit (data) multiplier with 38 bit adder
  - Instruction execution rate as high as 56MIPS
- **BUILT IN PROGRAMMABLE CLOCK GENERATOR PLL**
- **PERIPHERALS for CD PLAYER APPLICATION**
  - Data Acquisition, Erasure correction, CLV&CAV controller
  - Subcode decoder (CD-Text, CD-Graphic I/F)
  - Shock proof memory controller, Disturbance detector
  - Decimation filter
- **ACTUATORS DRIVING MODE SELECTABLE** between PWM or PDM MODE
- **256Fs / 384Fs (16.9344MHz) CLOCK INPUT.**



### 1.0 DESCRIPTION

**TDA7522** is a single chip processor consisting of Decoder, Servo and 1bit D/A for 4times CD-ROM / CD-Audio. Main concept of this IC is that it is based on embedded System Micro Controller which allows customer to develop system software very easily: just based on provided commands. Further the microcontroller is fully customer dedicated in terms of both software and general purpose Port.

By combination of ST Analog front-end IC (**TDA7521**), all CD functions including Shock Proof Memory Controller and CD-Text function can be realized.

The TDA7522 portfolio is constituted by three different versions:

- 'development': which gives the possibility to have at disposal the complete sw development environment, by means of a dedicated package
- 'in field development': standard package but with selection of program memory: on chip RAM, on chip ROM. The program RAM is fully patchable through the standard IIC interface, giving the possibility of sw changing while chip is working in the real environment.
- 'production': standard package, but with software permanently stored in the on chip ROM.

### 2.0 TECHNOLOGY

All version are produced using the HCMOS6 0.35um technology which works @3.3Vdc; to avoid interface problem with existing logics, all digital Inputs are 5V tolerant. When interfacing logic on TDA7522 outputs, user should take care of output levels that are at CMOS level @3.3V. Depending on output type the  $I_{o1}$  and  $I_{oh}$  value are guaranteed at 4mA or 8mA; the TDA7522 output driving specification will be included in a next issue of this data sheet.

### 3.0 ADDITIONAL FEATURES

- 16Mbit DRAM I/F allows maximum 9 seconds shock proof
- Built-in 1bit Delta Sigma modulation for DAC
- Subcode P,Q and R-W decoding
- Error Correction is capable of Dual C1 and quadruple C2 erasure corrections
- Jitter absorbing capability: +/- 6 frames
- Automatic fine gain/balance/offset adjustment for tracking and focus servos
- Built-in Digital Silence detection
- Built-in EFM Demodulation/Sync Rear and Forward protection
- Soft audio mute
- Built-in Digital PLL with large capture range from 0.5 to 4 times speed
- Digital Servo control for all servo loops
- Capable of 2x and 4x speeds for shock proof and CD-ROM applications
- Capable of wide temperature range (-40C to +85C) stable operation
- Fast access times for CD-ROM applications due to wide Capture range and CAV mode run at max 4 times overspeed
- CLV or CAV (lock-to-disk mode) spindle servo operations
- Digital Output SPDIF (DIT CP340)
- Sony LSI Output Interface (for Audio & CD-ROM)
- Pulsate SLED mode support
- Built in 8times Audio Over sampling filter.

Figure 1. Pin Connection

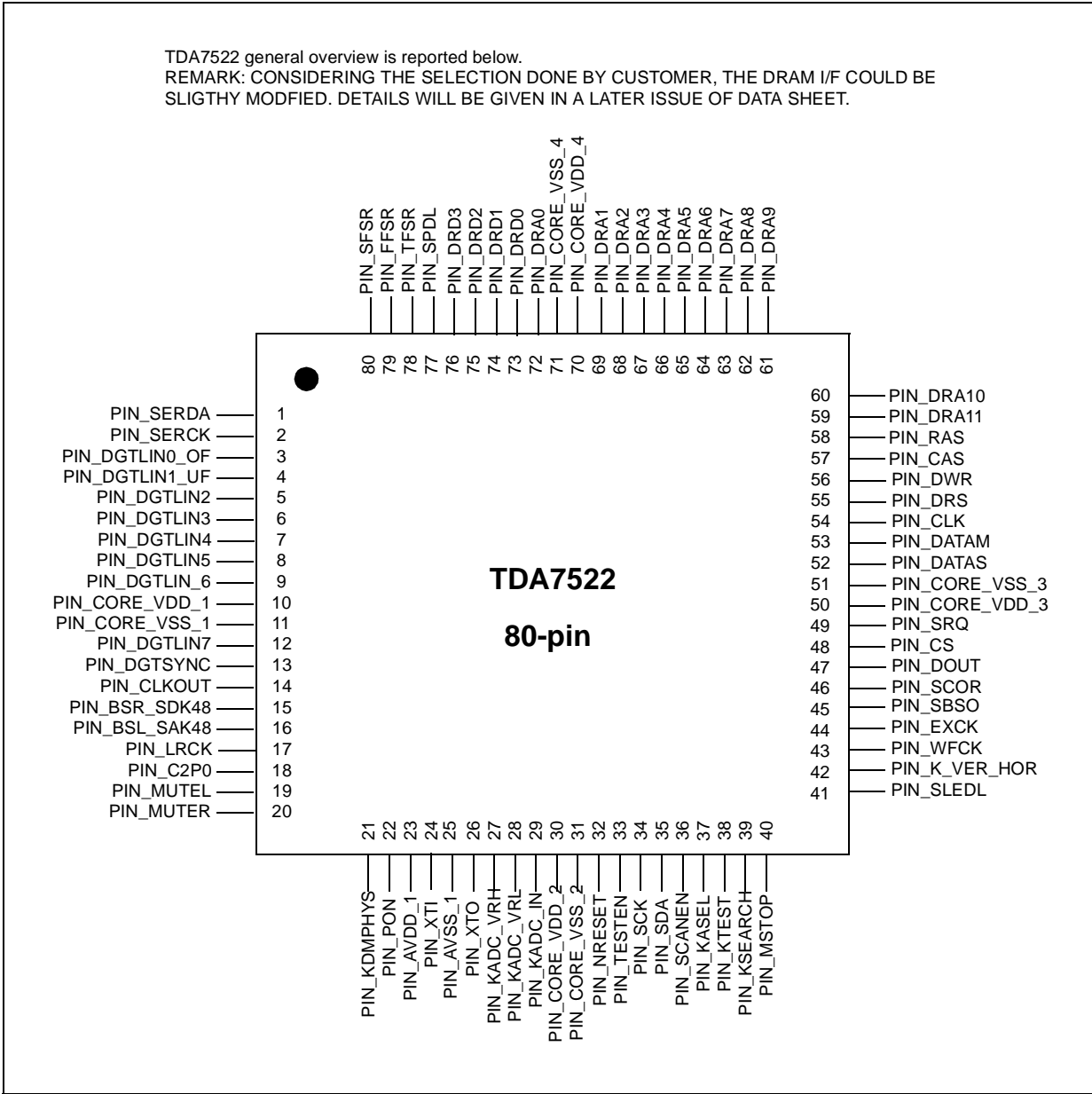


Table 1. Pin Description

Pin Number	Name	Function	Description
01	SERDA	I/O	Data line for Serial I/F
02	SERCK	O	Clock line for Serial I/F
03	DGTLIN0_OF	I	HF bit 0 and Servo overflow
04	DGTLIN1_UF	I	HF bit 1 and Servo underflow
05	DGTLIN2	I	HF bit 2 and Servo bit 0
06	DGTLIN3	I	HF bit 3 and Servo bit 1
07	DGTLIN4	I	HF bit 4 and Servo bit 2
08	DGTLIN5	I	HF bit 5 and Servo bit 3
09	DGTLIN6	I	HF bit 6 and Servo bit 4
10	CORE_VDD_1	Vdd	Digital Power supply
11	CORE_VSS_1	Gnd	Digital Ground
12	DGTLIN7	I	HF bit 7 and Servo bit 5
13	DGTSYNC	I	Sync strobe for Multiplexer
14	CLKOUT	O	System clock output to TDA7521
15	BSR_SDK48	O	LSI I/F clock output or DAC bit stream right channel output
16	BSL_SAK48	O	LSI I/F data output or DAC bit stream left channel output
17	LRCK	O	LSI I/F L/R signal
18	C2PO	O	Validity flag output for CD-ROM decoder
19	MUTEL	O	Mute left signal (active high)
20	MUTER	O	Mute right signal (Active high)
21	KDMPHYS	I/O	De-emphasis indication or ST7 GPIO PA2
22	PON	I/O	System shutdown pin for power saving mode or ST7 GPIO PC7
23	AVDD_1	Vdd	Analog power supply
24	XTI	I	Crystal input
25	AVSS_1	Gnd	Analog ground
26	XTO	O	Crystal output
27	KADC_VRH	I	ADC top reference Voltage input
28	KADC_VRL	I	ADC bottom reference Voltage input
29	KADC_IN	I	ADC input
30	CORE_VDD_2	Vdd	Digital Power supply
31	CORE_VSS_2	Gnd	Digital Ground
32	Nreset	I	Hardware reset

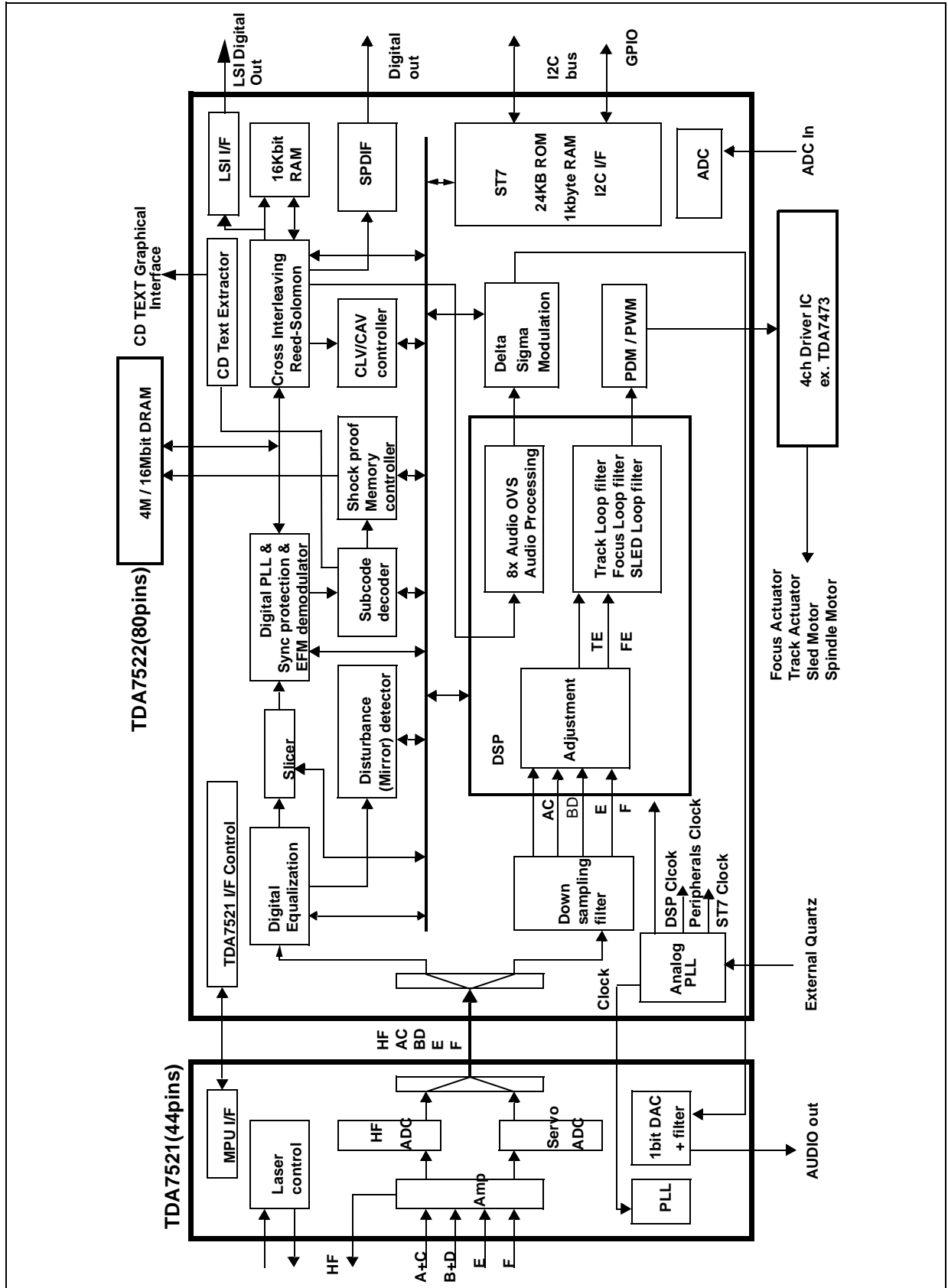
Pin Number	Name	Function	Description
33	TESTEN	I	Test enable signal (Active low)
34	SCK	I	IIC I/F clock signal
35	SDA	I/O	IIC I/F data
36	SCANEN	I	Scan enable (active high) or select DRAM outputs as TEST outputs when TESTEN is inactive
37	KASEL	I/O	DAC polarity selection pin or ST7 GPIO PA0
38	KTEST	I/O	User test mode selection or ST7 GPIO PA1
39	KSEARCH	I/O	Gain change during search or ST7 GPIO PA3
40	MSTOP	I/O	interrupt request/stand-by pin or ST7 GPIO PC5
41	SLEDL	I/O	SLED limit switch or ST7 GPIO PC6
42	K_VER_HOR	I/O	Indication of vertical or horizontal operation or ST7 GPIO PA4
43	WFCK	O	Write Frame clock for Subcode P-W output
44	EXCK	I	SBSO readout clock input
45	SBSO	O	Subcode P-W serial output
46	SCOR	O	Subcode sync output
47	DOUT	O	SPDIF Digital audio output
48	CS	I/O	ST7 GPIO PC4
49	SRQ	I/O	ST7 GPIO PC3
50	CORE_VDD_3	Vdd	Digital Power supply
51	CORE_VSS_3	Gnd	Digital Ground
52	DATAS	I/O	ST7 GPIO PC2
53	DATAM	I/O	ST7 GPIO PC1
54	CLK	I/O	ST7 GPIO PC0
55	DRS	I/O	Shock proof memory Read control
56	DWR	I/O	Shock proof memory Write control
57	CAS	I/O	Shock proof memory Column address select
58	RAS	I/O	Shock proof memory Row address select
59	DRA11	I/O	DRAM Address 11
60	DRA10	I/O	DRAM Address 10
61	DRA9	I/O	DRAM Address 9 or Mirror signal output
62	DRA8	I/O	DRAM Address 8 or TZC (Tracking Zero Cross) signal output
63	DRA7	I/O	DRAM Address 7 or FOK (Focus OK) signal output
64	DRA6	I/O	DRAM Address 6 or ST7 GPIO PB7 or PLLINF signal output

## TDA7522

Pin Number	Name	Function	Description
65	DRA5	I/O	DRAM Address 5 or ST7 GPIO PB6 or OFS (FIFO Overflow) signal output
66	DRA4	I/O	DRAM Address 4 or ST7 GPIO PB5 or WFCK (Write Frame Clock) signal output
67	DRA3	I/O	DRAM Address 3 or ST7 GPIO PB4 or RFCK (Read Frame Clock) signal output
68	DRA2	I/O	DRAM Address 2 or ST7 GPIO PB3
69	DRA1	I/O	DRAM Address 1 or ST7 GPIO PB2
70	CORE_VDD_4	Vdd	Digital Power supply
71	CORE_GND_4	Gnd	Digital Ground
72	DRA0	I/O	DRAM Address 0 or ST7 GPIO PB1
73	DRD0	I/O	DRAM Data 0 or ST7 GPIO PA5
74	DRD1	I/O	DRAM Data 1 or ST7 GPIO PA6
75	DRD2	I/O	DRAM Data 2 or ST7 GPIO PA7
76	DRD3	I/O	DRAM Data 3 or ST7 GPIO PB0
77	SPDL	O	PWM/PDM Spindle motor control signal output
78	TFSR	O	PWM/PDM Tracking actuator control signal output
79	FFSR	O	PWM/PDM Focusing actuator control signal output
80	SFSR	O	PWM/PDM SLED motor control signal output

Note: 1. Depending from new DRAM selection pin nr.59 could be not used in production version.

Figure 2. Block Diagram



**Table 2. Main DC Characteristics (I)**

Current input	Condition	Min	Typ	Max	Unit
A+C diode input		1		16	μA
B+D diode input		1		16	μA
E diode input		1		16	μA
F diode input		1		16	μA

**Table 3. Main DC Characteristics (II)**

Voltage input	Condition	Min	Typ	Max	Unit
A+C diode input		45		700	mVpp
B+D diode input		45		700	mVpp
E diode input		45		700	mVpp
F diode input		45		700	mVpp

**4.0 STANDARD VERSION MEMORY MAP**

The memory spase, as seen by ST7 is defined in table 4; please take note that there are registers which are used for less than 8 bit or, on the other side, when read only certain bit contain useful information. Reffer to appendix a to have a complete list of register structure.

**Table 4. TDA7522 Memory Map**

Address	Block	Register name	Reset Status	Remarks
0000h 0001h 0002h 0003h	Port A	Data Register Data Direction Register Option Register Pull Up Register	00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register
0004h 0005h 0006h 0007h	Port B	Data Register Data Direction Register Option Register Pull Up Register	00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register
0008h ..... 000Bh	Reserved			
000Ch	ST7 Miscellaneous Register		00h	See specifications
000Dh				Not Available
000Eh 000Fh 0010h	Reserved for ST7 TEST			



Address	Block	Register name	Reset Status	Remarks
0011h 0012h 0013h 0014h 0015h 0016h 0017h 0018h 0019h 001Ah 001Bh 001Ch 001Dh 001Eh 001Fh	Timer	Control Register 2 Control Register 1 Status Register Input Capture 1 High Register Input Capture 1 Low register Output Compare 1 High register Output Compare 1 Low Register Counter High Register Counter Low Register Alternate Counter High Register Alternate Counter Low Register Input Capture 2 High Register Input Capture 2 Low register Output Compare 2High register Output Compare 2Low Register	00h 00h 00h 00h 00h 00h 00h FFh FCh 00h 00h 00h 00h 00h 00h	R/W Register R/W Register Read only Register Read only Register Read only Register R/W Register R/W Register Read only Register Read only Register Read only Register Read only Register R/W Register R/W Register
0020h 0021h 0022h 0023h	Port C	Data Register Data Direction Register Option Register Pull Up Register	00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register
0024h	WD	Watch Dog Configuration Register	7Fh	R/W Register
0025h				Not Available
0026h 0027h 0028h 0029h 002Ah 002Bh 002Ch	I <sup>2</sup> C	CR: Control Register SR1: Status Register 1 SR2: Status Register 2 Not Used (CCR: Clock Control Register) OAR1: Own Address Register 1 TX_DATA: Transmission Data RX_DATA: Received Data	00h 00h 00h 00h 00h 00h 00h	R/W Register Read only Register Read only Register R/W Register R/W Register R/W Register
002Dh 002Eh 002Fh 0030h 0031h 0032h 0033h	Equalizer	EQU_HPFF: Controll & HP Filter Coefficient EQU_FIR0: FIR Filter Coefficient EQU_FIR1: FIR Filter Coefficient EQU_FIR2: FIR Filter Coefficient EQU_FIR3: FIR Filter Coefficient EQU_FIR4: FIR Filter Coefficient EQU_FIR5: Gain Register	00h 00h 00h 00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register
0034h 0035h 0036h 0037h	Subcode Extraction	QSR: Q Subcode Status Register QSD: Q Subcode Data Register CDTSR: CD Text Status Register CDTDR: CD Text Data Register	00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register
0038h 0039h 003Ah				Not Available Not Available Not Available

Address	Block	Register name	Reset Status	Remarks
003Bh 003Ch 003Dh 003Eh 003Fh 0040h 0041h 0042h	Shock Proof	WP1: Preset of Write Pointer Lower WP2: Preset of Write Pointer Upper CSR: Control/Status Register WA1: Latest Stored valid Audio Frame Lower WA2: Latest Stored valid Audio Frame Upper RL1: Ram Level Lower RL2: Ram Level Upper DRR: Dummy Read to reset W/R Counter	00h 00h 00h 00h 00h 00h 00h 00h	R/W Register R/W Register R/W Register Read only Register Read only Register Read only Register Read only Register
0043h 0044h 0045h 0046h 0047h 0048h 0049h 004Ah 004Bh 004Ch 004Dh 004Eh 004Fh	(HSY) Bit Detection and Clock Recovery	PHIGAIN: Phase Gain FRQCFG: Frequency Loop Configuration FRQGAIN: Frequency Loop Gain FRQ_L: Present Loop Output Freq Lower FRQ_U: Present Loop Output Freq Upper FRQI_L: Initial Loop Output Freq Lower FRQI_U: Initial Loop Output Freq Upper BD_INTEN: Interrupt Enable BD_INTSRC: Interrupt Source Register PHICFG: Configuration for Phase Loop PLLGAIN: LP Filter Coefficients for ADPLL PLL_SETUP: Overall control/configuration PLL_STATUS: PLL mode Status Flag	00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h	R/W Register R/W Register R/W Register R Register R Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R Register
0050h 0051h 0052h 0053h 0054h 0055h 0056h 0057h 0058h 0059h 005Ah 005Bh 005Ch	Event Detection	SETUP: Overall control/configuration STATUS: Status Flag RAMP: Peak detector decoding rate DROPTHR: Dropout Threshold DROPTIM: Dropout Timeout FOCTHR: Focus Thres. Quality MIRRPCRS: Parameters for mirror signal MIRRTHR: Thr for mirror env. for trk search MIRRHYS: Hysteresis for MIRRTHR TRK_CNTL: Tracking Counter Lower TRK_CNTU: Tracking Counter Upper ED_INTEN: Interrupt Enable ED_INTSRC: Interrupt Source Register	00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h	R/W Register R Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register
005Dh 005Eh  005Fh  0060h	SERVO	SV_Servo_CR: Servo Control Register SV_TWC_CR: Tracking Window Comparator CR SV_TWC_CSR: TWC Control/Status Register FS_CR: Focus Search Control Register	00h 00h  00h  00h	R/W Register R/W Register  R/W Register  R/W Register
0061h 0062h				Not Available
0063h 0064h 0065h 0066h 0067h	SPDIF Interface	CRSR: Status Register CSLO: Left Channel, LSBs CSL1: Left Channel, MSBs CSR0: Right Channel, LSBs CSR1: Right Channel, MSBs	00h 00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register R/W Register

Address	Block	Register name	Reset Status	Remarks
0068h 0069h 006Ah 006Bh	PWM /PDM	SLED_CR: Sled Control Register SLED_DR: Data to control the sled by ST7 SPDL_DR: Data to control spindle motor PWM_CR: Pwm output control register,	00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register
006Ch				Not Available
006Dh 006Eh	PLL	PLL_CR1: Control Register 1 CLKCNTL: Clock Control Register	40h 00h	R/W Register R/W Register
006Fh 0070h 0071h	CLV/CAV	CLV_CR1: Control Register 1 CLV_CR2: Control Register 2 CLV_CR3: Control Register 3	05h 00h 40h	R/W Register R/W Register R/W Register
0072h 0073h	Decimation	DEC_SR: Decimation Status Register DEC_CR: Decimation Control Register	00h 00h	R Register R/W Register
0074h				Not Available
0075h 0076h	KIF Interface	KENWOOD I/F: Register 1 KENWOOD I/F: Register 2	00h 00h	R/W Register R/W Register
0077h 0078h	Interrupt MASK	MASK1: Interrupt Mask Enable Register MASK2: Interrupt Mask Enable Register	00h 00h	R /W Register R/W Register
0079h 007Ah 007Bh 007Ch 007Dh 007Eh	CIRC	CONFIG1: Configuration register for CIRC CONFIG2: Configuration register for CIRC FIFO1: Offset between read & write pointer FIFO2: Status register for FIFO C1ERRS: Error number by C1 decoder C2ERRS: Error number by C2 decoder	1Ah 19h C0h 00h 00h 00h	R/W Register R/W Register R Register R/W Register R/W Register R/W Register
007Fh	DAC	DAC_CSR: Control /Status Register	00h	R/W Register
0080h 0081h 0082h 0083h 0084h 0085h 0086h 0087h 0088h 0089h 008Ah 008Bh	SAC_DSP	DATA_LB: Lower Byte Data Register DATA_MB: Middle Byte Data Register DATA_UP: Upper Nibble Data + service bit DATA_AR_LB: Data Address COEF_AR_LB: Coefficient Address PROG_AR_LB: Program Address DCPSR: Miscellaneous Control/Data Reg. DSP_ALU1: ALU contains, LSBs DSP_ALU2: ALU contains, MSBs AUDIOC: Audio Control Register DSP_CR: Control Register SHOCK_CMP: Shock Comparor	00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h 00h	R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R/W Register R Register R Register R/W Register R/W Register R/W Register
008Ch 008Dh 008Eh 008Fh				Not Available Not Available Not Available Not Available
0090h 0091h 0092h	CXD (Crossover Detection)	G1-EQUALISER: Coefficient Value G2-EQUALISER: Coefficient Value G3-EQUALISER: Coefficient Value	00h 00h 00h	R/W Register R/W Register R/W Register
0093h 0094h	TEST SELECTION	MUX_1: used only on development version MUX_2: used only on development version		R/W Register R/W Register

## TDA7522

Address	Block	Register name	Reset Status	Remarks
0095h 0096h 0097h 0098h 0099h 009Ah 009Bh				Not Available Not Available Not Available Not Available Not Available Not Available Not Available
009Ch 009Dh	ADC TEMP.	ADC_CR:Control Register ADC_DATA: ADC Readout Value		
009Eh 009Fh	UART	TDA7521 I/F: Data Register TDA7521 I/F: Controll Register	00h 00h	R/W Register R/W Register
00A0h to 049Fh	RAM 1024Bytes including (STACK 128Byte)			
04A0h to 8FFFh	Not Available			
9000h to 9FFFh	4KBytes of CDTEXT RAM			
A000h to FFDFh	ROM 24KBytes			
FFE0h to FFFFh	User Vectors	Interrupt and Reset Vectors		

### 4.1 ST7 Scratch Memory Map

As far as concern ST7 scratch memory, it is mapped as follow:

```

00A0 - 00FF  RAM
0100 - 017F  Stack
0180 - 049F  RAM

```

total is 1024 Kbyte.

## 4.2 ST7 Interrupts Registers Configuration & Jump Table

The TDA7522 peripheral interrupt vector is as follows:

*-Register MASK1[7:0]:*

bit position	Description	Interrupt Name
MASK1[7]	NOT USED	
MASK1[6]	NOT USED	
MASK1[5]	SUB_IRQ_Q	Subcode extraction channel Q
MASK1[4]	SUB_IRQ_RW	Subcode extraction channel RW
MASK1[3]	SP_OVER	Shock Proof
MASK1[2]	I2C_INT	IIC
MASK1[1]	PLL_int	Analog Plll
MASK1[0]	DSP_shock	SAC-DSP

*register MASK2[7:0]*

bit position	Description	Interrupt Name
MASK2[7]	NOT USED	
MASK2[6]	NOT USED	
MASK2[5]	HSY_int	Digital PLL
MASK2[4]	EVD_int	Event detector
MASK2[3]	CIRC_over	Cross Interleave RS Code
MASK2[2]	reserved	
MASK2[1]	reserved	
MASK2[0]	KIF_IRQ	Kenwood interface.

Interrupts vector is reported below:

Interrupt Vector	Jump Address	Source Event	Source Peripheral
ITCPU11 :	ffe6	CIR_over	CIRC
ITCPU10 :	ffe8	EVD_int	Event Detector
ITCPU9 :	ffea	HSY_int	HFSync
ITCPU8 :	ffec	DSP_shock	SAC-DSP
ITCPU7 :	ffee	PLL_int	Analog PLL
ITCPU6 :	fff0	I2C_int	I2C
ITCPU5 :	fff2	SP_over	Shock Proof
ITCPU4 :	fff4	SUB_IRQ_RW	Subcode/Control Extraction
ITCPU3 :	fff6	SUB_IRQ_Q	Subcode/Control Extraction
ITCPU2:	fff8	TIMERINT	TIMER interrupt
ITCPU1 :	fffa	OEXTIT	PORT C interrupt
TRAP :	fffc	OTRAPIT	software interrupt
RESET :	fffe	OSTART	external reset.

Interrupt management it is fairly flexible, in detail, when an interrupt is served the I flag of the ST7 is automatically set (that means no other interrupts are served) and it is reset again only when the routine ends. No interrupts can be missed because of the internal software-based acknowledgement scheme for peripherals. In order to reset an interrupt coming from a peripheral you have to write to '0' a relevant flag inside it. With the TDA7522 interrupt mask register you just prevent the interrupt signal from coming to the ITC (interrupt controller) and so you can change the priority without losing any interrupt.

### 4.3 Development Version Memory Configuration

For system application development a dedicated version will be available: the development version gives the possibility of:

- use the ST7 emulator, for sw debug purpose;
- use of program RAM or ROM for sw execution and modification.

See appendix B for detail about memory map and TDA7522 operating modalities as:

- TDA7522 booting through I2C
- TDA7522 booting from PROM
- TDA7522 booting from PRAM.

When RAM is selected, all application sw shall be loaded through I2C, using the facility as gives by the boot ROM.

When RAM configuration is selected, memory addresses are just overlapping the ROM defined in memory map reported in appendix B.

TDA7522 development version can work also with emulator; refer to appendix B about the way to enter in “ST7 emulation” mode.

**NOTICE: due to different environment the following registers can be different between various versions:**

- **IIC register 27h: boot bit will disappear in production version**
- **KIF registers 75h and 76h are not available on development version**
- **Mux Registers 93h and 94h will both be available on production version.**

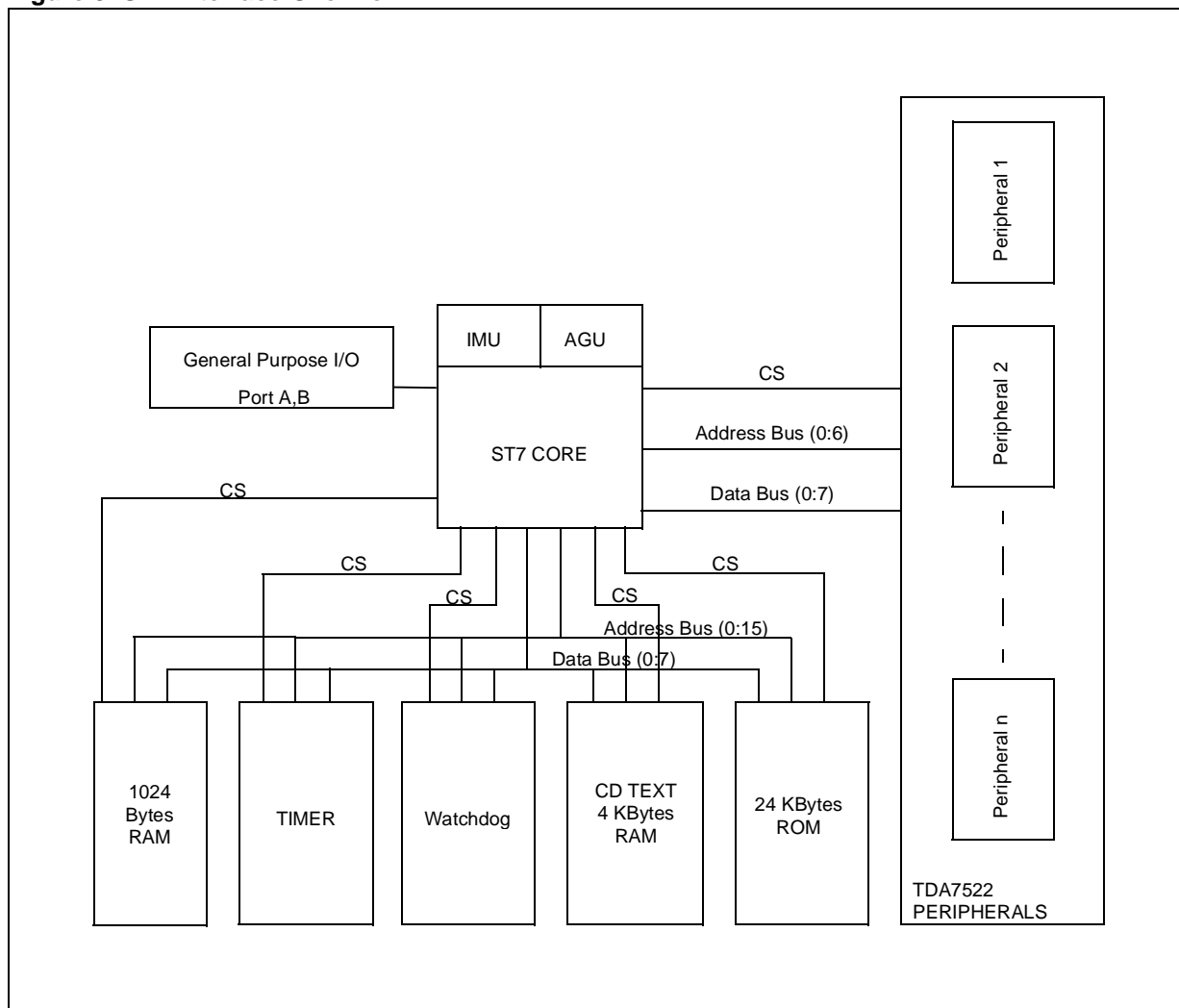
## 5.0 FUNCTION DESCRIPTION

### 5.1 ST7

ST7 is based around an industry standard 8 bit core and offers an enhanced instruction set. The processor runs with 8MHz internal clock. Due to fully static design of this device, operation down to DC is possible. Under software control the ST7 can be placed in Wait or Halt mode for reducing power consumption. ST7 can switch off crystal clock to disable complete functions of IC as well.

The enhanced instruction set and addressing modes afford real programming potential; in addition to standard 8 bit data management the ST7 features true bit manipulation, 8x8 unsigned multiplication and indirect addressing modes. The device includes a CPU, ROM, RAM, I/O, General I/O Port, 16 interrupt encoder, timer.

Figure 3. ST7 Interface Overview



ST7 is Supervisor of complete CD system such as Servo, Main Processor Communication, DSP control. Some Tasks of ST7 are as follows:

- Supervisor of all sub blocks
- Initialization of Coefficients for SAC-DSP Digital Servo
- Initialization of parameters of all sub blocks
- Focus search and quick restart
- Coarse Adjustments for Gain(Laser), Offset in Analog front end
- Fine Adjustments for Balance, Offset, Servo Gain in DSP
- Command interpreter and communication with external MPU
- Play & Subcode control, Music search, Random search, Program Play, Scan, Repeat etc.
- One, Ten and Long tracking jump and Pause implementation
- Linear velocity measurement (disc speed)
- Computation of the number of tracks for jump
- Shock proof memory control for data synchronization after shock

- Constant Angular Velocity Control
- TOC management
- CD-Text I/F.

**5.2 DSP (SACDSP : Servo Audio Control Digital Signal Processor)**

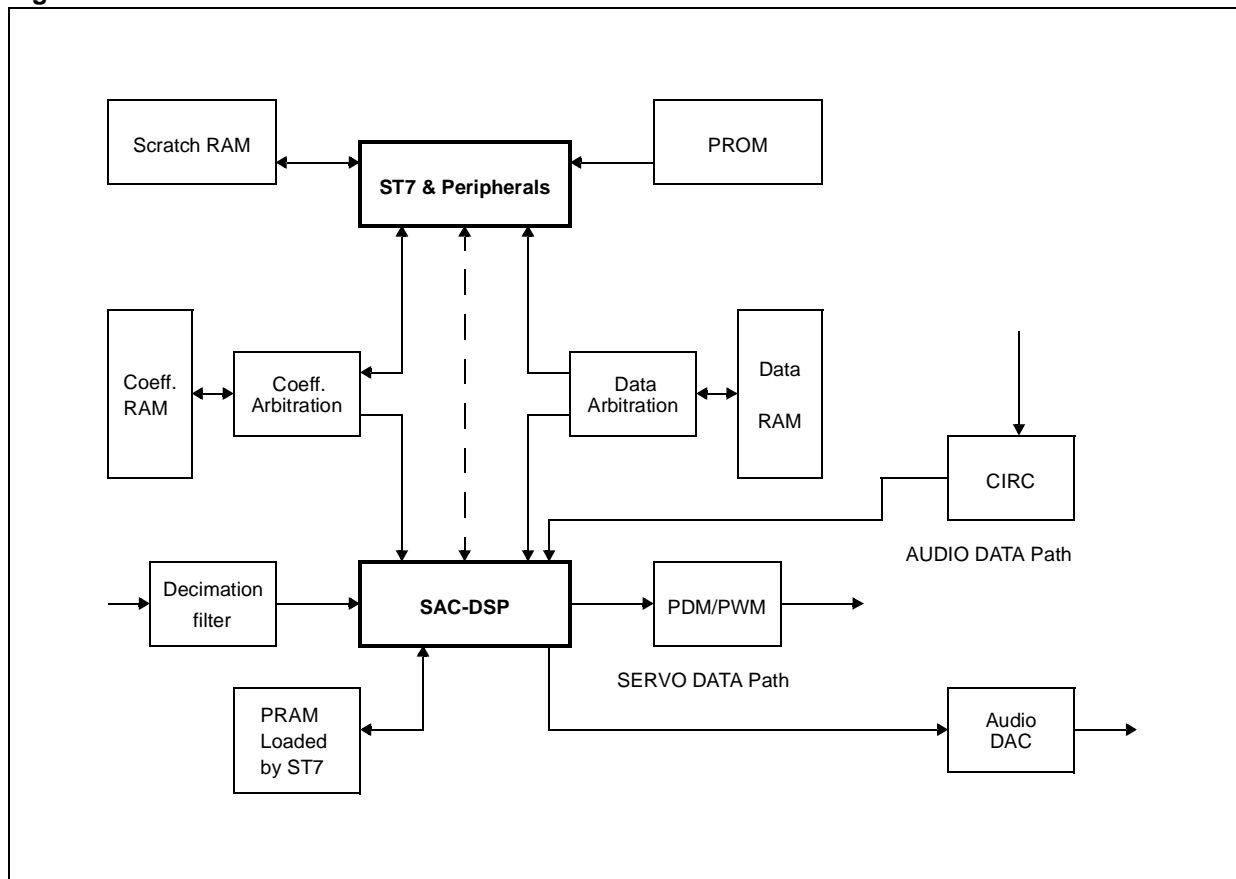
DSP is placed as a subset of ST7 MPU, which performs Digital Filter calculation.

It consists of 20bit (data) x 16bit (coefficient) multiplier, 38bit accumulator, 20bit Data RAM, Data Arbitration between ST7, and 19 bits wide program Opcode; it can be broken down into two instruction bindings:

- Instruction binding #1 :Arithmetic Instructions + Parallel Move Instructions
- Instruction binding #2 :Immediate moves and bit-test jumps

SACDSP is very powerful DSP which performs more than 50MIPS, and it is based on three level pipeline architecture in which concurrent instruction fetch, decode, and execution occur.

**Figure 4. Basic I/Fs to ST7**



Some Tasks of SACDSP are as follows;

- DSP: Digital Filter execution as slave of ST7
- Focusing and Tracking loop filter
- Sled Tracking control
- Pick-up Velocity control during Jump



- 
- Some Digital filters for Adjustments by ST7
  - Sine wave generator for reference of internal adjustment and DAC measurement
  - Filter for Shock detector
  - 8 times high end Audio Over sampling
  - De-emphasis filter
  - Audio attenuation, mute and balance
  - Internal Signal observation feature for user measurement
  - Soft mute and data concealment
  - Audio peak detection
  - Focus error, Tracking error generation
  - Equalization of Tracking Zero Cross signal
  - Sound Vector Enhancement filter.

### 5.3 DATA Acquisition

The digital HF signal is input to an digital equalizer to improved the bit detection. Different equalizer coefficients are selectable by MPU.

The digital data slicer is implemented and the internal slice level is calculated by using a leakage free integrator which is subtracted from HF. The properly levelled EFM is delivered to the edge detector and a digital bit clock PLL. On this stage, no analog VCO is necessary to obtain bit clock but DTO (Discrete Time Oscillator) is used.

The Digital PLL block consists of following functions;

- Adaptive HF Equalization
- HF HPF for disturbance rejection
- Digital Data slicer
- Linear interpolation for Phase error measurement
- Run length detection for Frequency error measurement
- Frequency & Phase Control loop
- DTO block
- EFM bit generation.

The serial bit stream signal from the phase detected is sent to a shift register block, which includes different functions as follows;

- serial to parallel conversion
- detection of frame sync pattern
- protection and insertion of frame sync
- bit clock counter (588 bits per frame)
- synchronization and sync window logic
- 14 to 8 bit demodulation
- subcode extraction.

### 5.4 Subcode extraction

This block receives the subcode data stream and the related S0/S1 synchronization information from Acquisition part.

Subcode processing consists of CRC parity check and Subcode decoder.

There are 2 different buffers for Q Subcode data and for R-W subcode data.

Q subcode data is transferred to ST7 every symbol by interruption and the result of CRC is also reported to ST7. R-W subcode data especially for CD-Text data through program area is arranged to 8bit format from 6bit of R to W, then ST7 stores max. 144byte (8pack data) as a FIFO to allow the tolerant of reading timing from external MPU for display and also 1block CD-Text data from TOC area can be transferred to ST7 4Kbyte CD-Text RAM.

### 5.5 CIRC (Error correction)

CIRC (Cross Interleaving Read Solomon code) consists of 2 following blocks;

- Memory control for
  - M1: The FIFO memory to absorb Jitter of input signals
  - M2: The De-interleaving memory

M1 FIFO memory compensates the speed deviations of the spindle motor and M2 is used for the de-interleaving between the C1 and C2 decoder. The size of the RAM is 16Kbit and the width is 9bit. Each 9 bit word consists of 8 bit data (symbols) and 1 bit validity flag.

- Error Correction
  - This block represents a Reed Solomon decoder which forms a CIRC decoder for CD in conjunction with CIRC RAM.

There are two decoder circuits:

- the first C1 decoder can correct up to two random errors in a 32-byte frame, marking uncorrectable errors as erasures
- the second C2 decoder can correct up to four erasures in a 28 byte frame.

### 5.6 Shock proof memory control

This is a shock proof memory controller which absorbs the interruption due to the shocks.

Namely, it controls external DRAM in order to store the audio data into RAM earlier than the reading. Therefore during shocks the data of the RAM can be played without any interruption of the data.

The controller handles the data from Acquisition and output into RAM&Timing block. It means the stored data into RAM is ADAT[7-0] before error correction. That is why complete 32 Symbols / Frame including CRC must be stored into RAM. It allows the use of Audio RAM (ARAM) with defects which is much cheaper than standard DRAM.

The difference between the classical shock proof memory controller like SONY and this new controller is that ARAM use with defects, the location of the memory and the controller, and also how to fill the data into RAM earlier than reading. In case of our controller, CLV servo (Disk motor controller) varies the disk speed in order to store certain amount of data into RAM earlier than the reading. Then as long as certain amount of data is kept in the RAM in advance, the disk speed is controlled with single speed (normal speed) operation, not always double speed operation like classical solution.

Mainly the shock proof memory controller consists of 3 controllers.

One is the writing pointer controller which controls the memory address for writing data, the another is the reading pointer controller which controls the memory address for reading data, the other is timing arbitration between the reading and writing procedure of the data and address.

The output data from the memory is delivered always with fixed data rate without jitters, however the incoming data is not delivered with fixed rate because of the jitters from the disk and the varied speed of the

disk motor, so the data rate changes within the capture range of the digital PLL in the Acquisition part. So output data has no jitters that M1 buffer memory in RAM&Timing can be replaced with the shock proof memory. (as a huge time base collector instead of M1 buffer memory).

### 5.7 CLV & CAV

This is a spindle motor (Disc motor) servo controller which performs Constant Linear Velocity. (CLV)

The normal velocity is about from 1.2m/s to 1.4m/s, it means disc speed is of course depending on the location of the pick-up. When pick-up is inside of the disc, disc speed reaches about 8 rotations/sec, and in case of outside, the speed is about 3 rotations/sec.

Mainly the CLV servo consists of 3 controllers, one is rough servo controller which controls to reach certain speed which is within the capture range of the PLL (See Acquisition part).

The another one is frequency servo controller which controls to keep certain frequency of writing clock for FIFO memory (M1 memory) comes from CIRC or shock proof memory controller in future.

The other one is phase servo which controls to keep certain constant phase between the writing clock and reading clock for FIFO memory.

As long as PLL is locked, the frequency servo and the phase servo work and normally there is no overflow or underflow of the FIFO memory. (FIFO memory works as a time base corrector).

CAV (Constant Angular Velocity) control is done by ST7 by detecting the period of eccentricity from the disc.

### 5.8 Audio I/F & DAC

This block represents both of Standard Audio serial format based on Sony LSI I/F for external DAC or CD-ROM decoder, and Audio bit stream with 1bit Delta Sigma technic for Analog stage of 1bit DAC (in TDA7521).

The Delta Sigma block consists of functions shown in figure 7.8-1.

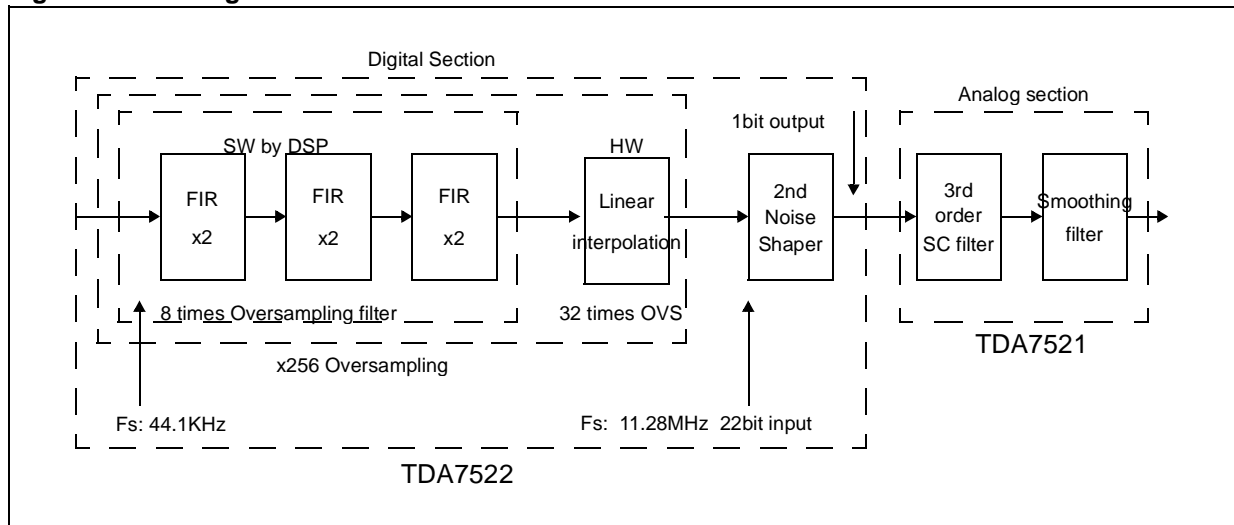
### 5.9 Disturbance detector

This block detects Focus OK, Mirror signal, Defect signals, (Shock is detected by DSP in a Tracking loop filter, and Interruption is detected in Data Acquisition block).

These disturbance signals are used mainly in Servo block to improve the Robustness of the controller.

Mirror signal is used for Track jump with TZC (Tracking Zero Cross) signal, it is handled by ST7 and also input to 16bit Track Up/Down counter which counts physical number of tracks during tracking Jump.

Figure 5. Delta Sigma Functions



**5.10 Decimation filter**

This is for Down sampling filter of Diode signals which have been digitized with Oversampling in Analog stage (TDA7521).

Input Signals are A+C, B+D, E, F diode signals;

Initial sampling frequency

48Fs (2.1168MHz) / 96Fs (4.2336MHz) for 2x, 4x speed  
6 bit resolutions from ADC

After Downsampling

2Fs (88.2KHz) / 4Fs (176.4KHz) for 2x, 4x speed  
10 bit resolutions into Servo Block

Downsampling ratio

24times.

**5.11 PDM/PWM**

This is a single end output stage of Tracking, Focusing actuator, Sled and Spindle motor signal using following technic.

Pulse-width modulation (PWM)

Pulse density modulation (PDM)

There are 8 bit Output accuracy.

**5.12 SPDIF**

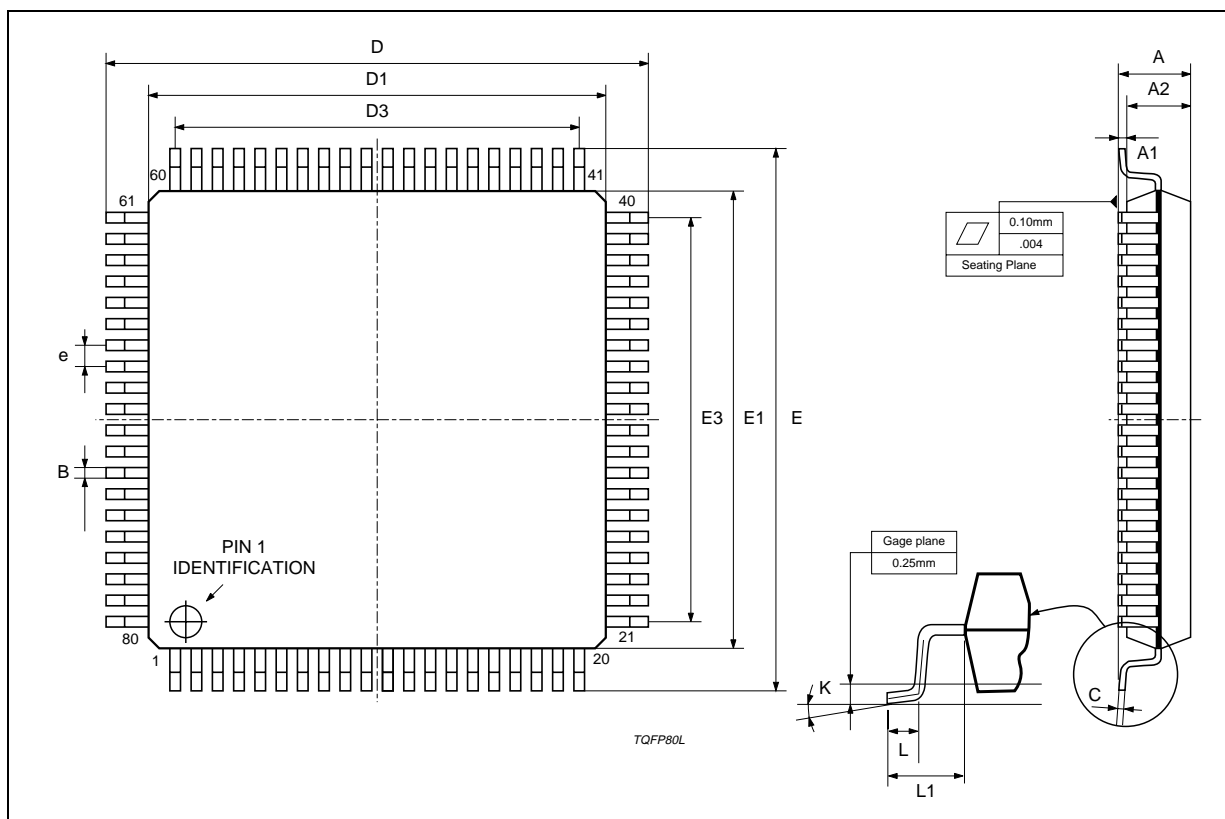
This is a decoder to output Audio&Subcode data based on standard format of AES/EBU digital output.

**5.13 ADC Characteristics**

Resolution:	8-bits
Conversion rate:	27.7 kHz (assuming a ST7 clock equal to 4 MHz)
Conversion type:	Successive approximation (12 sar cycles/conversion)
Operation mode:	Continuous conversion, asynchronous read/write
Power supply:	3.3 V +/- 10%
Voltage Reference:	1.25 V
Analogue input:	0 to 1.25 V

## TQFP80 - 80 lead Quad Flat Package

Symb	mm			inches		
	Min	Typ	Max	Min	Typ	Max
A			1.60			0.063
A1	0.05		0.15	0.002		0.006
A2	1.35	1.40	1.45	0.053	0.055	0.057
B	0.22	0.32	0.38	0.009	0.013	0.015
C	0.09		0.20	0.003		0.008
D		16.00			0.630	
D1		14.00			0.551	
D3		12.35			0.295	
e		0.65			0.0256	
E		16.00			0.630	
E1		14.00			0.551	
E3		12.35			0.295	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.0393	
k	3.5°		7°	3.5°		7°



Drawing is not to scale.

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