SGS-THOMSON MICROELECTRONICS

APPLICATION NOTE

ST75C502 - RAM MAPPING

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I - INTRODUCTION

The purpose of this application note is to explain what are the "interesting internal variables" that can be Read, Written or Modified using the **MR**, **MW**, **CR** commands.
Some of these variables have dedicated commands to modify them, like SETGN for _**TXGAIN** or tone detector. However the whole RAM (even external when using the ST18933) and also the DUAL RAM and internal peripherals can be accessed using the three above mentioned commands.

The address, characteristic (R = Read, W = Write, R/W = Read or Write), and function of key data pump variables is listed below by basic modem functional blocks.

Caution : The Mapping of the variables, given in the appendix is only valid for Revision 2.0 of the ST75C502.
There is no guarantee that it will remain exactely the same for further revisions.

II - ECHO CANCELLER (V.32bis only)

_RTDELAY (R) Round trip delay in number of bauds.

_EC_STA (R/W) Echo canceller execution status word. the echo canceller can be frozen in data mode by reading _EC_STA and performing a logical or with the value $0002 before writing to _EC_STA (i.e. other bits must not be changed).

PWREST (R) Residual echo power estimator for determining loss of connection. The ABS() value of this variable will be greater than $20 to indicate connection loss, otherwise near 0.

FREQOFF (R) Far-end echo frequency offset. offset = FREQOFF x 0.0366 in Hz typically, FREQOFF = $1b(27) for 1Hz.

DELTA (R) Initial far-end echo power after near end echo canceller convergance. This variable can be read in data mode and has the following typical values.

	VALUE	POWER
$FFF6	(-10)	- 9dBm
$FFF7	(- 9)	-12dBm
.	.	.
$0000	(0)	-39dBm
.	.	.
$000A	(+10)	-69dBm

FEECENBL (R) Far end echo canceller is enabled. $FFFF = Enabled, $0000 = Disabled (when initial far-end power is less than -69dBm).

III - TIMING RECOVERY

FRQOFFLT (R) Receive clock frequency offset.

PSITHRSH (R) 0.94 Degree timing phase adjustement threshold for timing signal dpll.

Comments : The local-to-remote modem timing offset can be calculated using the following formula :

$$\text{TIMING OFFSET} = \frac{\text{FRQOFFLT}}{\text{PSITHRSH}} \cdot \frac{0.94}{360}$$

The normal timing offset is within $\pm 10^{-4}$ for most connections.

IV - CARRIER RECOVERY

FRQOFF (R) Receive carrier frequency offset. OFFSET = FRQOFF x 0.0366 in Hz. Typically, FRQOFF = $1B(27) for 1Hz.

V - EQUALIZER, AGC

_RX_STA (R/W) Equalizer and AGC can be frozen independently or simultaneously.

Bit 0 : Freeze Equalizer (the Equalizer is frozen if this bit is 1).

Bit 2 : Freeze AGC (the AGC is frozen if this bit is 1).

_RX_STA must be modified in data mode and the other bits must be unchanged. Read the value and change only the corresponding bits in the _RX_STA word.

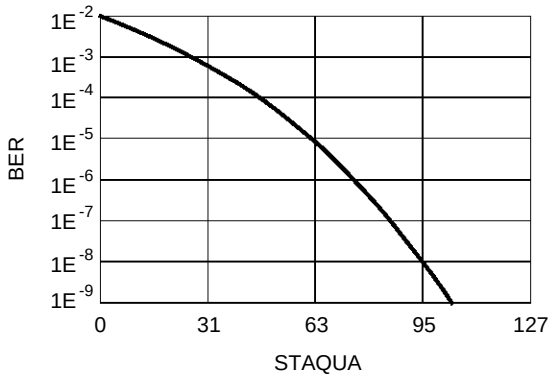
_AGCSCA (R/W) Automatic gain control level for receive signal varies from $80 (0dBm) to $7fff (48dBm).

RDQUA (R) Equalizer error energy gives an idea of signal to noise ratio seen by the receiver. RDQUA has the following typical values.

VALUE	POWER
$00C0	30dB
$0180	27dB
$0300	24dB
$0600	21dB
$0C00	18dB
$1800	15dB
$3000	12dB

STAQUA (R) A 16-bit number between 0 and 127 indicating the receive quality (also available in 8-bit status word byte 2, STAQUA in dual port RAM). The following formula is implemented in DSP software :
STAQUA = 127 – SCAQUA · RDQUA
and is limited between 0 and 127. A value of 127 indicates a very good receive signal quality while 0 indicates a very poor signal quality. The coefficient SCAQUA is mode dependendentand was chosen to give a value for STAQUA of 63 when the receive SNR is such that the expected bit error rate is 10e-5, that is, 1 error for every 100 000 bits received.
Refer to the following charts for expected values of STAQUA, BER on flat telephone line.

Figure 1



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SCAQUA (R/W) The coefficient for calculing STAQUA above is automatically programmed according to the mode specified in the CONF command and it is possible to overwrite its value at the end of the synchronization sequence if the user desires a different value for the quality indication. Generally, reducing the value read by 1/2 will imply that an STAQUA value of 31 will correspond with a 10^{-5} BER and doubling the value will imply that an STAQUA value of 127 will correspond with a 10^{-5} BER in the above table.

_SUCTH (R/W) A threshold value for STAQUA for determining the programming of PNSUCS bit in HSHK_PHA word described below. The default value is programmed to 64 at the execution of a CONF command and can be modified there after.

_RDCPT (R) Output of demodulator. Complex number, can be used to display the received eye.

EQFRK0E (R/W) 32 Complex even equalizer coefficients.

EQFRK1E (R/W) 32 Complex odd equalizer coefficients.

VI - HANDSHAKE, RETRAIN, RATE NEGOTIATION

_SSPEED (R) Negociated speed. This 8-bit number is available in STAOP0 in modem mode (refer to Data Sheet for values).

_STAV54E (R) this 8-bit number is available in STAOP1 in modem mode and indicates status V.54 and V.22bis test logs (refer to Data Sheet for values).

HSHK_PHA (R) Handshake progression counter contains information about the progress of the handshake in V.32 and V.22bis modes. This 8-bit value is available in STAOP2 in modem mode. It can be read to examine the progression of the handshake and it contains normal values and error values as below :

AUTOBAUD ORIG MODE

EVENT	HSHK_PHA Value
Wait Answer Tone	$01
Wait End Answer Tone	$02
No Autobaud and Waiting USC1	$03
Autobaud Waiting AC or USC1	$04

AUTOBAUD ANSW MODE

EVENT	HSHK_PHA Value
Waiting HSK Command	$10
Generating Answer Tone	$11
Generating Silence	$12

V.32 ORIG MODE

EVENT	HSHK_PHA Normal Value	HSHK_PHA Error Value
AC_DET	$20	
AC/CA DET	$21	$1
CA/AC DET	$22	$2
NO AC DET	$23	$B for RTRN, $C for RRN
S_DET	$24	$4
SB_DET	$25	$5
R1_DET	$26	$6
S_DET	$27	$7
SB_DET	$28	$8
R3_DET	$29	$9, $D no R5 det after RRN
E_DET	$2A	$A
DATA_MODE	$30	

V.32 ANSW MODE

EVENT	HSHK_PHA Normal Value	HSHK_PHA Error Value
AA_DET	$40	$8 for RTRN, $9 for RRN
AA/CC DET	$41	$1
NO CC DET	$42	$2
S_DET	$43	$3
S_DET2	$44	$4
SB_DET	$45	$5
R2_DET	$46	$6, $A no R det after RRN
E_DET	$47	$7
DATA_MODE	$50	

V.22bis ORIG MODE

EVENT	HSHK_PHA Normal Value
HSHK	$60
USC1_DET	$61
SCR1_DET	$62
S1_DET	$63
DATA_MODE	$70

V.22bis ANSW MODE

EVENT	HSHK_PHA Normal Value
HSHK	$80
SCR1_DET	$82
S1_DET	$83
DATA_MODE	$90

FAX MODE

While Transmiting	
P1s	= %00000001 generate echo protection tone
P2s	= %00000010 generate phase reversals
PNs	= %00000100 generate training sequence
PRs	= %00001000 generate rate sequence
SCR1s	= %00010000 generate scrambled one's
While Receiving	
P2s	= %00000010 detect phase reversals
PNDETs	= %00100000 detect training sequence (latched)
PNs	= %00000100 detect training sequence
PRDETs	= %01000000 detect rate sequence (latched)
PNSUCs	= %10000000 equalizer trainning succes (latched)
SCR1s	= %00010000 detect scrambled one's

Note that PRs and PRDET are only valid in V.17 and V.33 modes.

_RE_HSK (R) Stored R and E word values which were sent and received in their chronological order during the handshake, retrain, or rate negotiation. Positions _RE_HSK to (_RE_HSK+4) contain history during handshake or retrain while (_RE_HSK+5) to (_RE_HSK+8) contain history during a rate negotiation request.

_TSPEED (R/W) Target speed initialized by CONF or RTRA commands but can be changed in data mode for the case of a remote RTRA or RRN requests.

%0000000000000010 = 1200 BPS
%0000000000000011 = 2400 BPS
%0000000000000100 = 4800 BPS
%0000000000000101 = 7200 BPS
%0000000000000110 = 9600 BPS
%0000000000000111 = 12000 BPS
%0000000000001000 = 14400 BPS

_TRWORD **_RWORD** (R/W) Target RWORD initialized by CONF or RTRA commands but can be changed (both of them) in data mode for the case of remote RTRA or RRN requests. In reference to the CCITT recommendation the bits are programmed in the following order :

(ITU-T RECOMMENDATION)

B00, B01, B02, B03, B04, B05, B06, B07, B08, B09, B10, B11, B12, B13, B14, B15

. . . . . .

D15, D14, D13, D12, D11, D10, D09, D08, D07, D06, D05, D04, D03, D02, D01, D00

(_TRWORD)

RNTHRSH (R/W) Threshold for rate negotiation during handshake or retrain. The quality of the receive signal is observed (can be disabled by the command MODC) and the corresponding R word is proposed in the handshake or retrain rate negotiation. The default value is $300. This gives the typical R word authorization characteristics as shown below :

SPEED Authorized	SNR
14400	> 24dB
12000	< 24dB
9600	< 21dB
7200	< 18dB

Doubling the threshold will decrease the corresponding snr by 3dB approximately.

_CURMOD (R/W) To give the final negotiated mode for Autobaud applications (especially useful for FSK) or data mode configuration.

D7	D6	D5	D4	D3	D2	D1	D0
CCITT	QAMMD	TCMMD	FDUMD	LOWMD	ECCMD	Not Used	ANSMD

CCITT : 1 : CCITT modes.
0 : Bell modes.
QAMMD : 1 : QAM V.32bis, V.32, V.22bis, V.22, B212A, V.17, V.33, V.29, V.27.
0 : V.21, V.23, B103 FSK modes.
TCDMMD: 1 : Trellis mode (V.17, V.33 or V.32(bis)).
0 : Non-trellis mode.
FDUMD : 1 : Full duplex mode such as V.32(bis), V.22(bis), B212A, V.21, V.23, B103.
0 : Half duplex modes (fax) V.21ch2, V.17, V.33, V.29, V.27.
LOWMD : 1 : V.27 or V.32 or V.22 or V.21 or B103.
0 : V.29 or V.32bis or V.22b or V.23.
ECCMD : 1 : Echo canceller mode V.32(bis).
0 : No echo canceller mode (others).
ANSMD : 1 : Answer mode.
0 : Originate mode.

VII - CARRIER DETECT

DETH1 (R/W) Fast detection threshold.
DETH (R/W) Slow detection threshold.
LOSSTH1 (R/W) Slow loss threshold.
LOSSTH (R/W) Fast loss threshold.

The carrier detect contains 2 signal level integrators, a fast integrator for quick detection with a limited precision and a slow integrator for enhanced precision. There are four thresholds programmed with default values for each of the modes V.22bis, V.33, V.17, FSK, V.29, and V.27 which can be modified by the user after the conf command. Typical values are shown below and doubling the value will increase the threshold by approximately 6dB :

(-40dBM)	$B0	DETH1 (fast detection threshold)
(-44dBM)	$90	DETH (slow detectiion threshold)
(-47dBM)	$60	LOSSTH1 (slow loss threshold)
(-51dBM)	$40	LOSSTH (fast loss threshold)

VIII - TRANSMIT FILTER COEFICIENTS

TXCOEF (R/W) Address of first pulse shaping/compromise equalizer complex coefficient (16-bit real,16-bit imag).

GAIN (R/W) Attenuation factor for the transmit filter.

SHIFTVAL (R/W) Gain (Left shift value) from 0 to 15. To be use in conjonction with GAIN for fine adjustment of the transmit signal. Up and down scaling.

The pass-band pulse shaping and transmit compromise equalizer functions are combined in the transmit filter coeficients. The pulse shaping also performs the multi-phase interpolation from different baud rates to a fixed sample rate 7200Hz (14400Hz for V.27 4800) thus requiring multiple coeficient sub-tables containing complex (16-bit real,16-bit imag) coeficients. The number of coeficients depends on the shape, baud rate,and sampling rate. A default table depending on the compromise equalizer selected in the conf command is loaded from coeficient memory to external memory, after which, if desired, they can be modified by the user. The table below summarizes the location and the number of coeficients to be loaded.

(* = DEFAULT VALUES)

MODE	BAUD RATE	PHASE	COEF/PHS	STRT ADR	ROLL-OFF*	NO. OF COMPEQ*
V.32/33/17	2400	0 1 2	32	TXCOEF (TXCOEF+64) (TXCOEF+128)	0.125	3
V.29	2400	0 1 2	24	TXCOEF (TXCOEF+48) (TXCOEF+96)	0.20	2
V.27(2400)	1200	0 1 2 3 4 5	8	TXCOEF (TXCOEF+16) (TXCOEF+32) (TXCOEF+48) (TXCOEF+64) (TXCOEF+80)	0.50	1(FLAT)
V.27(4800)	1600	0 1 2 3 4 5 6 7 8	7	TXCOEF (TXCOEF+14) (TXCOEF+28) (TXCOEF+42) (TXCOEF+56) (TXCOEF+70) (TXCOEF+84) (TXCOEF+98) (TXCOEF+112)	0.50	1(FLAT)
V.22 ORIG/ANS	600	0 1 2 3 4 5 6 7 8 9 10 11	5	TXCOEF (TXCOEF+10) (TXCOEF+20) (TXCOEF+30) (TXCOEF+40) (TXCOEF+50) (TXCOEF+60) (TXCOEF+70) (TXCOEF+80) (TXCOEF+90) (TXCOEF+100) (TXCOEF+110)	0.50	1(FLAT)

IX - TONE DETECTOR PROGRAMMING

LEVOUT (R/W) 16 Programmable static levels.

BIQCOEF (R/W) 16*2*6 Biquad coeficients.
Coef. order for each of 16 4th order cells :
C0, C1, C2, C3, C4, C5, C6, C7, C8, C9, CA, CB
Where each 4th order cell has the following xfer function :

$$\frac{OUT}{IN} = C0 \cdot \frac{C5 \cdot Z^2 + 2 \cdot C3 \cdot Z + 2 \cdot C4}{Z^2 - 2 \cdot C1 \cdot Z - 2 \cdot Z} \cdot C6 \cdot \frac{CB \cdot Z^2 + 2 \cdot C9 \cdot Z + 2 \cdot CA}{Z^2 - 2 \cdot C7 \cdot Z - 2 \cdot C8}$$

POWCOEF (R/W) 16 Power coeficients p1 Power estimator using absolute value of the input signal :

$$\frac{OUT}{IN} = P1 \cdot \frac{1}{Z - (1 - P1)}$$

BPWIRE (R/W) 16 Biquad and pwr estimator input wiring addresses.
FORMAT = [4TH ORDER BIQ(MSB),PWR(LSB)]

CPWIRE (R/W) 16 Comparator input wiring addresses.
FORMAT = [COMPARATOR+(MSB),COMPARATOR-(LSB)]
The wiring addresses furnished in bpwire,cpwire are from the following possible sources :

GND	$00
RX SIGNAL	$01
RX SIGNAL*2	$02
RX SIGNAL*4	$03
4TH ORDER BIQ BLOCK OUTPUT	$10 to $1F
POWER OUTPUT	$20 to $2F
STATIC LEVELS PROGRAMMED IN LEVOUT	$30 to $3F

_NTDCELL (R/W) Number of tone detector cells active (0-15)

_TONEDET (R) Outputs of tone detectors. The low byte of _TONEDET contains the outputs of tone detector cells 0 to 8. The low byte of _TONEDET+1 contains outputs of cells 9 to 15. When the corresponding bit is "1" the signal at the positive input of the comparator is higher than that at the negative input. Only _NTDCELL bits are valid at one time, the other one are 0.

	TONEDET0		TONEDET1
D0	CALL WAIT BPF 440Hz	D0	AN1300 BPF
D1	RXSIG < -21dBM	D1	ORG : AN1300 > AZ1800 ANS : AN1300 > OZ2100
D2	CPLOW LPF 650Hz	D2	AN1650 BPF
D3	CPHIGH HPF 600Hz	D3	ORG : AN1650 > AZ1800 ANS : AN1650 > OZ2100
D4	CPHIGH < CPLOW	D4	ORG : ANS2100 BPF ANS : ORG1800 BPF
D5	ORG: AZ1800 NOTCH ANS: OZ2100 NOTCH	D5	ORG : ANS2100 > AZ1800 ANS : ORG1800 > OZ2100
D6	AN600 BPF 600Hz	D6	ANS2225 BPF
D7	ORG : AN600 > AZ1800 ANS : AN600 > OZ2100	D7	ORG : ANS2225 > AZ1800 ANS : ANS2225 > OZ2100

X - GENERAL PURPOSE

_TXGAIN (R/W) Transmit gain. Any signal to transmit is multiplied by this number. This is the value modified by SETGN command.

XI - TONE GENERATOR

_TGNFLG (R/W) Tone generator flag. Each of the four low bits of this variable define if the corresponding tone generator is enabled. This is the value modified by a TGEN command.

_TG0PHC (R/W) Tone generator #0 phase reversal threshold. If different from 0, a phase reversal will be executed on the tone genarator #0 after _TG0PHC bauds. This is used in V.32 answer tone generation (default value is 1080 for 450ms).

_TGNBLK (R/W) For each of the four tone generators (i) contains:
_TGNBLK+(3*i): Frequence of tone (i.e. $4000 = 1800Hz).
_TGNBLK+1+(3*i): Instantanous phase.
_TGNBLK+2+(3*i): Amplitude ($7FFF refers to maximum signal).

XII - DEFAULT OPTIONAL STATUS

UADDR (R/W) Size 3 : address of the DSP's variable regulary displayed into the optionnal status word. These address can be modified with the DOSR command.

XIII - RING

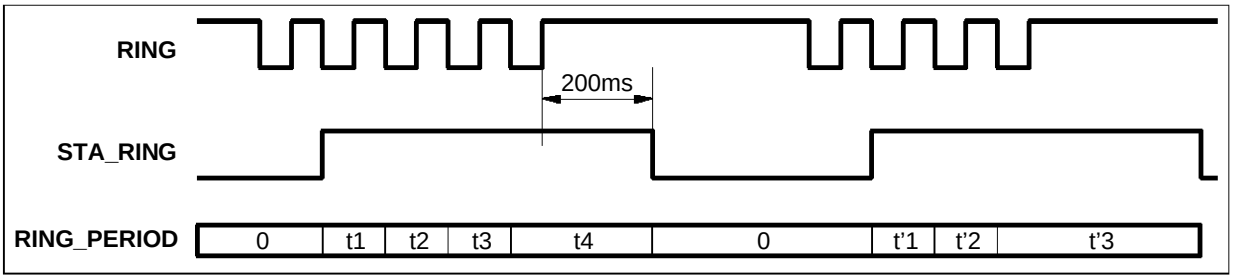
RNG_FMIN (R/W) The default value for this variable is 35. A ring signal of 68Hz is periodic every 35 bauds at 2400Hz.

RNG_FMAX (R/W) The default value for this variable is 160. A ring signal of 15Hz is periodic every 160 bauds at 2400Hz.

RING_PERIOD (R) Output of the RING detector. This word is identiqual to the STAOP2 byte when in tone mode (neither DTMF receiver neither modem mode). The content of that word is the duration of the RING period. The formula to compute the RING frequency is :

$$\text{RING\_frequency} = \frac{2400}{\text{RING\_PERIOD}} \text{ in Hz.}$$

Figure 2



XIV - ADPCM

NOISE (R/W) The default value is $C after CONF command and can be modified to increase or decrease the background noise level in the voice activity detection algorithm. The value is complemented at the sample rate giving a periodic signal at 3600Hz.

TRANSMAX (R/W) The default value is 90 after CONF command and represents, in each frame of 30ms, the maximum number of transitions or zero-crossings to keep the voice activity detector active. The internal signal, VOICE, represents the output of this detector and is updated every 30ms.

CNTMAX (R/W) The default value is 14400 (2s) after CONF command and represents the preload value for a counter. The counter is update at the sample rate of 7200Hz. It is either preloaded if VOICE (from above) is active or decremented if VOICE is inactive. If the counter is not 0, CARRIER DETECT is raised. Effectively, the user can increase (decrease) the duration of CARRIER DETECT after loss of a voice signal by increasing (decreasing) the value of CNTMAX.

PRGTHRSH (R/W) The voice activity detector has an absolute signal level threshold in parallel with the zero-crossing detector described above. The default value of PRGTHRSH is 0 after the CONF command and designates the threshold to be the average level measured during the previous detection of voice activity by the zero-crossing method. If PRGTHRSH is changed by the user to a non-zero value, the actual value programmed is the threshold for the detector. Thus, the absolute signal detector can be disabled by programming a large value such as $7fff for PRGTHRSH.

XV - APPENDIX : Address Equivalences for Version 1.0 and 1.2

Variable	Address
ECHO CANCELLER	
_RTDELAY	$1016
_EC_STA	$1019
PWREST	$1BAD
FREOFF	$1BB1
DELTA	$1BBD
FEECENBL	$1BCE
TIMING RECOVERY	
FRQOFFT	$1E8C
PSITHRSH	$1E97
CARRIER RECOVERY	
FRQOFF	$1EA3
EQUALIZER,AGC	
_RX_STA	$1017
_AGCSCA	$1193
RDQUA	$12A7
_RDCPT	$1048
EQFRK0E	$1CBC
EQFRK1E	$1CFC
STAQUA	$1058
SCAQUA	$12A6
_SUCTH	$1FCE
HANDSHAKE,RETRAIN, RATE NEGOTIATION	
HSHK_PHA	$11BB
_RE_HSK	$11BD
_TSPEED	$11AF
_TRWORD	$11B0
_RWORD	$1014
RNTHRSH	$12AA
_CURMOD	$1011
_SSPEED	$11BA
_STAV54E	$11A1
CARRIER DETECT	
DETH1	$1F9A
DETH	$1F99
LOSSTH1	$1F9C
LOSSTH	$1F9B

Variable	Address
TRANSMIT FILTER COEFICIENTS	
TXCOEF	$12E4
GAIN	$12E2
SHIFTVAL	$12E1
TONE DETECTOR PROGRAMMING	
LEVOUT	$13E6
BIQCOEF	$1476
POWCOEF	$1536
BPWIRE	$1456
CPWIRE	$1466
_NTDCELL	$1006
_TONEDET	$1007
GENERAL PURPOSE	
_TXGAIN	$1001
TONE GENERATOR	
_TGNFLG	$1002
_TG0PHC	$1003
_TGNBLK	$13A8
DEFAULT OPTIONNAL STATUS	
UADDR	$1E6E
_TONEDET	$1007
DTMF_DIGIT	$174A
NEG_MODE	$11BA
HSHK_PHA	$11BB
STA_LOOP	$11A1
RING_PERIOD	$1DD8
RING	
RNG_FMAX	$1DDC
RNG_FMIN	$1DDB
RING_PERIOD	$1DDA
ADPCM	
NOISE	$1595
TRANSMAX	$1596
CNTMAX	$1599
PRGTHRSH	$159F