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MICROELECTRONICS

APPLICATION NOTE

ST75C52/ST75C520 - SINGLE ENDED AND SINGLE POWER SUPPLY HYBRID CIRCUIT

CONTENTS   **Page**

I - INTRODUCTION

The ST75C52/520 uses basically a hybrid interface which allows to receive a V.17 signal between 0dBm and -45dBm with very good performances (see test report of the ST75C52/520). Such hybrid interface is perfect for high end equipment. The drawback is that the user has to use 4 operationnal amplifiers rather than 3 usally. As some manufactuers need to reduce the cost of their design we are going to introduce in this application note a simpler hybrid circuit which will save cost but also provide high performances.

II - FEATURES
II.1 - Transmission

The hybrid will use the differential output **TXA1** and **TXA2** of the ST75C52/520.

The nominal output level for each tone and each carrier must be equal to **0dBm** when no attenuation is selected in the ST75C52/520 (default setting of the ST75C52/520).

II.2 - Reception

The hybrid will only use the **RXA1** input of the ST75C52/520 rather than **RXA1** and **RXA2** differential inputs in the basic hybrid.

The far end carrier (modem signal) can be received between **-1dBm** and **-44dBm**.

II.3 - Power Supply

Uses only one +12V power supply.

III - ELECTRICAL SCHEMATIC

The Figures 1 and 2 show the complet electronic used (ST75C52/520 connection and its hybrid interface). As the telephone line interface is particular for each country we did not provide it on the figure.

The return loss is adjusted by the following components : R5, C7 and C8 (the values will change if the reference impedance change). In our example the reference impedance is a 600Ω resistor.

The 2 wires to 4 wires part (duplexer) is obtained by R6, R7, R8 and R9. The rejection of the unwanted signal (transmit signal at the **RXA1** Pin) is equal to 30dB which is enough for the full duplex modulations V.21, V.23 and BELL 103.

The transmit gain is fixed by the ratio R4/R3 and is adjusted to have an output level at 0dBm on 600Ω when no attenuation is selected in the ST75C52/520. A filter at 9.6kHz is installed on the **TXA1** and the **TXA2** output.

The receive gain is fixed by the ratio R9/R8 and must be adjusted each time the customer changes is telephone line interface components (mainly the transformer could have an insertion loss between 1 and 2dB). The received signal is connected to **RXA1** input and **RXA2** input is tied to VCM. The signal at **RXA1** must not be higher than 2.5V.

The tuning of such a hybrid interface could be done as indicated below :
- adjust your telephone line interface (DC current...),
- adjust the return loss,
- adjust the transmit gain,
- adjust the receive gain,
- adjust the duplexor.

Note : an iteration between step 4 and 5 could be necessary.

III.1 - Return Loss

Adjust R5, C7 and C8 to meet the technical requirements in your country which imposes the reference impedance (600Ω or complex impedance), and the different parameters as DC voltage and DC current on the line.

III.2 - Transmit Gain

We recommand the following procedure :
- keep the **SETGN** default value (0x7FFF) which selects no attenuation on the transmit signal,
- adjust the ratio R4/R3 to have 0dBm,
- adjust the attenuation (parameter of the **SETGN** command) for each signal which will be sent by the ST75C52/520. We suggest to adjust the output level at **-9dBm** for the tones and the carriers. For the DTMF we suggest an output level equal to **-4.4dBm**.

The method to compute the **SETGN** 's parameter is :
- no attenuation $\rightarrow$ parameter equals to 0x7FFF (hexa decimal value),
- convert this value in decimal $\rightarrow$ 32767,
- multiply 32767 by the absolute decimal value of the wanted attenuation (usally you know it in dB, so you must convert dB to absolute value),
- convert the result in hexadecimal, you have now the parameter of the **SEGTN** command.

Example :
Parameter for an attenuation equal to -10dB or a gain equal to 0.3162.
SETGN 's parameter in decimal value =
32767 x 0.3162 = 10361
SETGN 's parameter in hexadecimal value =
0x2879.

There is no limitation when using **SETGN** command, you can make a very fine tuning which is not necessarily equal to 1dB.

III.3 - Receive Gain

Adjust the ratio R9/R8 to detect carrier at -44dBm.

III.4 - Duplexer

Adjust the resistors R7 and R6 to remove unwanted carrier when in full duplex mode.

IV - OUTPUT LEVELS

With this hybrid interface the typical output levels for the different carriers when no attenuation is selected (default value for **SETGN**'s parameter) are :

Carrier	Level (dBm on 600Ω)
Bell 103 Answer	0.88
Bell 103 Originate	0.97
V.21 Answer	0.8
V.21 Originate	1.1
V.23 Answer	0.65
V.23 Originate	0.87
V.27 ter	0.44
V.29	0
V.17	0
V.33	0
V.21 Channel 2	0.8

In the same conditions the output levels for the tones are :

Tones	Level (dBm on 600Ω)	Tones	Level (dBm on 600Ω)
DTMF 0	-0.35	DTMF A	-0.47
DTMF 1	-0.3	DTMF B	-0.47
DTMF 2	-0.35	DTMF C	-0.47
DTMF 3	-0.4	DTMF D	-0.47
DTMF 4	-0.35	DTMF *	-0.3
DTMF 5	-0.35	DTMF #	-0.35
DTMF 6	-0.4	2100Hz	0.15
DTMF 7	-0.3	1650Hz	0.52
DTMF 8	-0.35	2225Hz	0
DTMF 9	-0.4	1300Hz	0.75

To adjust the factory output level of your equipment use the **SETGN** command as explain on Chapter III. We simply recall the parameters for typical attenuation (see Table below).

Gain (dB)	Gain (Hex)	Gain (dB)	Gain (Hex)	Gain (dB)	Gain (Hex)
0	7FFF	-5	47FA	-10	287A
-1	7214	-6	4026	-11	2413
-2	65AC	-7	392C	-12	2026
-3	5A9D	-8	32F5	-13	1CA7
-4	50C3	-9	2D6A	-14	198A

V - PCB GUIDE LINE

For that application note we use a two layers board.

Analog (AV_{DD}) and digital (DV_{DD}) power supplies are connected together. The capacitors used for the power supply (DV_{DD}, AV_{DD}) decoupling are installed as close as possible to the power pins.
The capacitors used for the voltage refence (between V_{REFP}/VCM and V_{REFN}/VCM) are connected as close as possible to the pins.
Both analog ground **AGNDR** and **AGNDT** must be connected with very low impedance to a single point.
The 2.2nF connected beween **RXA1** and **RXA2** Pins must be as close as possible to them.
Provide a ground grid in all around and under components on both sides of the band and connect them to avoid small islands.

VI - OUT OF BAND POWER

This hybrid (Figure 2) needs a filter in the transmit side to avoid out of band power due to the sigma delta convertors. Two one pole filters are used. The first is built around the MC33174 operational amplifier (Pin 1, 2, 3) with the R3, R4, C4, R2, R1, C1 components (Fc is equal to 9.6kHz). The second pole is introduced with C7 in parallel with the line transformer.
In that case the out of band power (frequencies above 4kHz) is 60dB lower than the in band power.
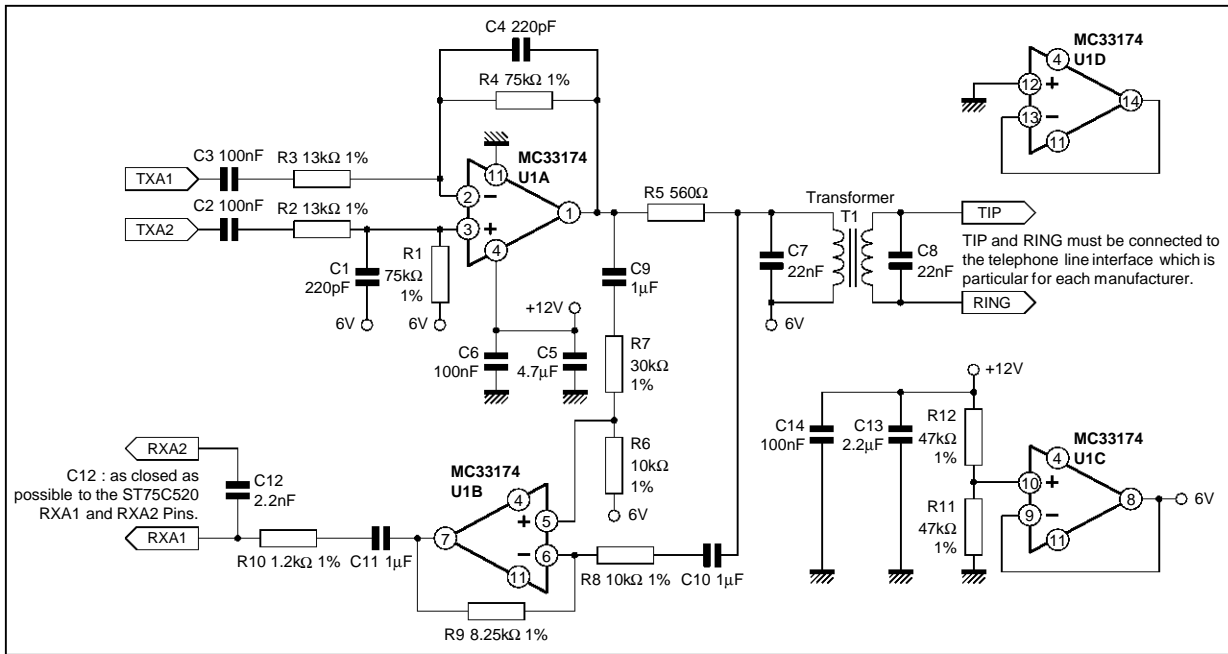
SINGLE ENDED AND SINGLE POWER SUPPLY HYBRID CIRCUIT

Figure 1
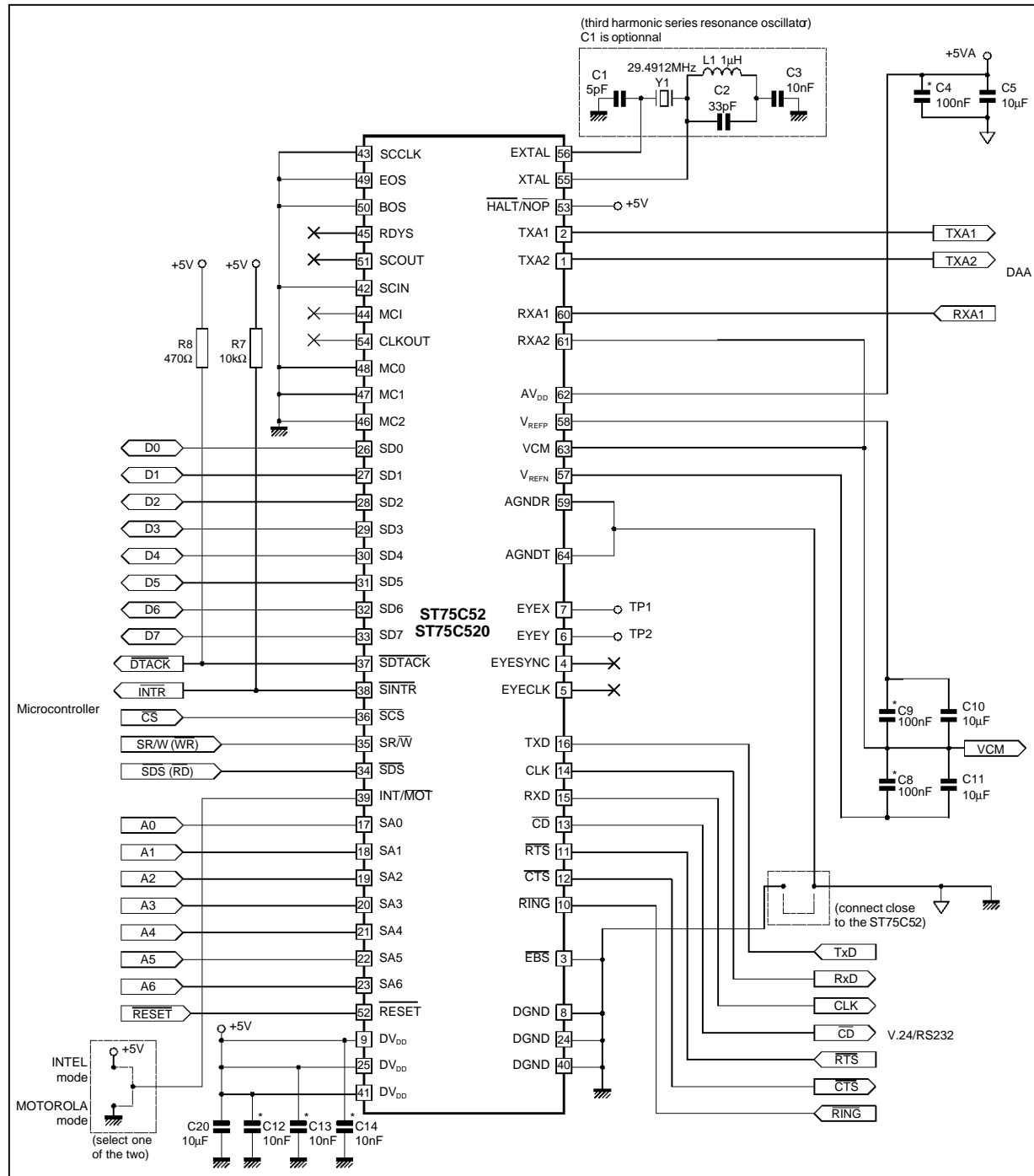
Note : All capacitor with a "*" must be implented close to the ST75C52/520 pin.

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Figure 2 : Differential Output and Single Ended Reception Uses only One Power Supply


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VII - PERFORMANCES AT 14400bps (V.17)

We tested this hybrid doing Bit Error Rate Test (BERT) on a TAS equipment. Mainly we did BERT versus different Signal to Noise Ratio (SNR) for various lines.

The Figures 3 and 4 show the results on a Flat line (L1) while receiving between -1dBm and -43dBm. The ST75C52/520 begins to make error in reception at a SNR equals to 23dB ±1dB. These results are identical to thus obtained with the hybrid which uses the differential inputs *RXA1* and *RXA2*.

The Figure 5 shows the result when receiving via European line, US lines and Japanese lines. Also in that case the performances are equal to thus that we obtained with the first hybrid which uses the differential inputs *RXA1* and *RXA2*.

Figure 3 : Reception on Flat Line L1 at -1, -3, -6, -9, -20dBm

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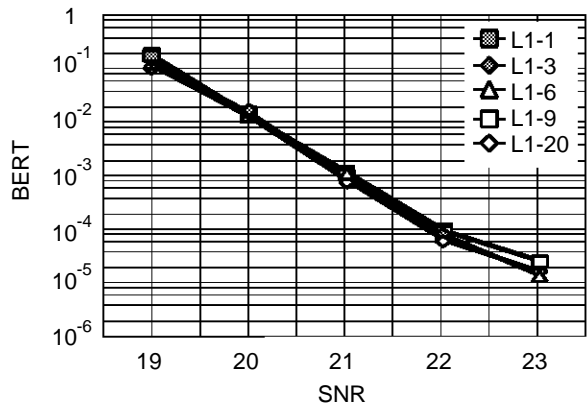
SINGLE ENDED AND SINGLE POWER SUPPLY HYBRID CIRCUIT

Figure 4 : Reception on Flat Line L1 at -30, -35, -38, -40, -43dBm
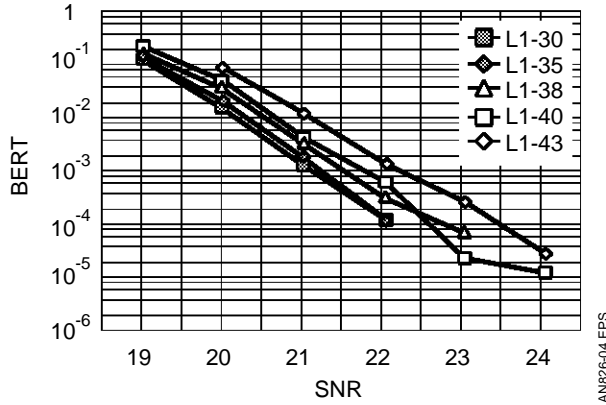
Figure 5 : BERT on M1040, C1, JPN1
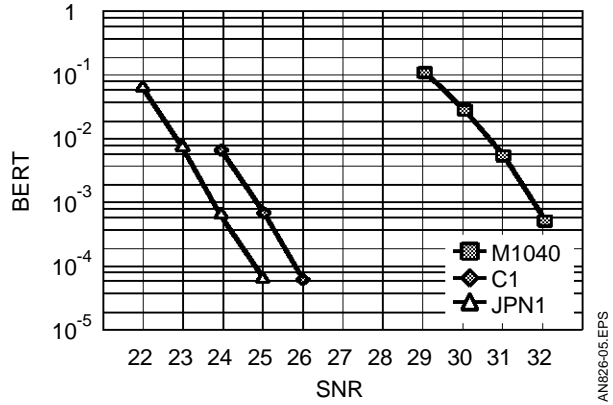
VIII - CONCLUSION

This new hybrid interface is simpler than the full differential (differential outputs and inputs) introduced in the Data Sheet.

It will be easier for the customer to adjust return loos again complex impedance with this new hybrid.

Single power supply is some times necessary to save cost of the power equipment.

The performances still remain very good.

We suggest this hybrid interface in some application where level has to be transmitted at high level (greater than -9dBm) and where single power supply schematic must be used.

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