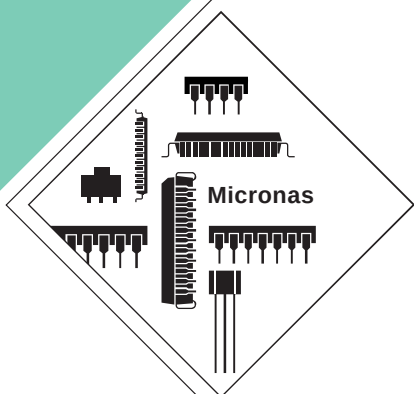


APPLICATION NOTE IC

MSP 34x0/x1/x2G Micronas Dynamic Bass



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Micronas Dynamic Bass

1. Principles of MDB Operation

The **Micronas Dynamic Bass** system (MDB) was developed to extend the frequency range of loudspeakers or headphones below the cutoff frequency of the speakers. Due to the parametric implementation of MDB, it can be customized to create different bass effects, as well as to fit MDB to various loudspeaker characteristics.

The MDB is placed in the subwoofer path. For applications without a subwoofer, the enhanced bass signal can be added back onto the Left/Right channels (see Fig. 1–1). Micronas Dynamic Bass combines two effects: dynamic amplification and additional harmonics.

1.1. Dynamic Amplification

Low frequency signals can be boosted while the output signal amplitude is measured. If the amplitude comes close to a definable limit, the gain is reduced automatically. Therefore, the system adapts to the signal amplitude which is really present at the output of the MSP device. It is irrelevant if a change in the amplitude was caused by a level change of the input signal, or a change of the volume. Clipping effects are avoided.

1.2. Adding Harmonics

MDB exploits the psychoacoustic phenomenon of the 'missing fundamental'. Adding harmonics of the frequency components below the cutoff frequency gives the impression of actually hearing the low frequency fundamental, while at the same time retaining the loudness of the original signal. In other words: The listener has the impression that a loudspeaker system reproduces frequencies which it cannot play back physically.

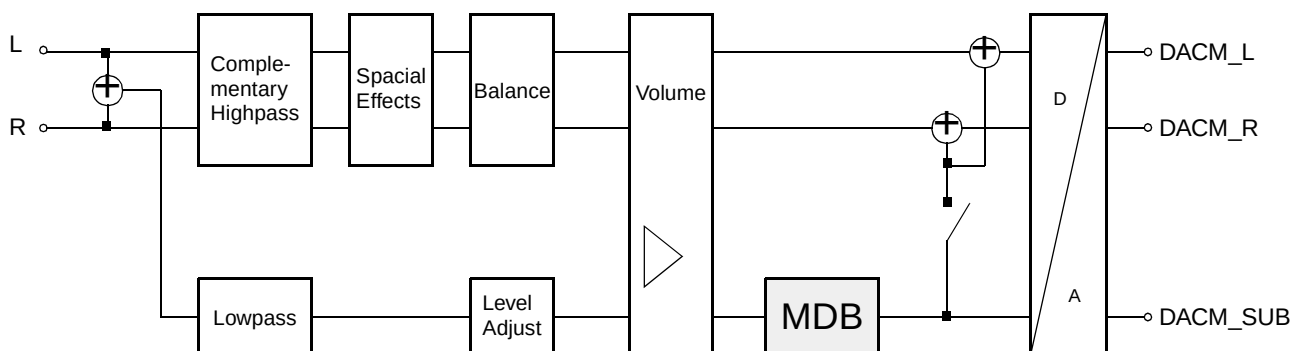


Fig. 1–1: Signal flow diagram of MDB

2. MDB Parameters

Several parameters allow tuning the characteristics of MDB according to the TV loudspeaker, the cabinet, and personal preferences. This section describes the basic functionality behind every adjustable parameter. For the procedure of adapting MDB to your individual application, please refer to sect. 3. "How to set up MDB".

MDB Effect Strength:

MDB_STR, register 00 68_{hex}

sets the strength of the dynamic amplification (see Fig. 2–1), ①.

MDB Harmonic Content:

MDB_HMC, register 00 6A_{hex}

specifies the ratio of harmonics mixed in, compared to the original (fundamental) signal (see Fig. 2–2), ②.

MDB High/Low Pass Corner Frequency:

MDB_HP and MDB_LP, reg. 00 6C_{hex} and 00 6B_{hex}

sets lower and upper corner frequency for the frequency band in which the MDB dynamic amplification takes place. Harmonics are created from below the MDB_HP frequency. MDB_HP can be set to the same value (frequency) as MDB_LP. Thus, only a narrow frequency range is selected which is sufficient in most cases (see Fig. 2–1), ③ and ④.

MDB Amplitude Limit:

MDB_LIM, register 00 69_{hex}

has to be set in order to avoid overload of the amplifier and speakers. The value is set in dBFS and is related to the maximum obtainable amplitude at the output of the MSP. Thus, it is a fixed level in the complete application, independent of any input signal levels or volume settings (see Fig. 2–1), ⑤.

Subwoofer Level Adjustment:

SUBW_LEVEL, register 00 2C_{hex}

is only in use when the MDB-processed bass signals are fed to the subwoofer output of the MSP device. In this case, the subwoofer level can be adapted (trimmed) to the levels of the left/right speakers with this register. Subwoofer volume is set by writing into left/right channel volume register 00 00_{hex}.

Subwoofer Corner Frequency:

SUBW_FREQ, register 00 2D_{hex}

sets the corner frequency for the subwoofer lowpass filter. This frequency must be set equal to or greater than MDB Low Pass Corner Frequency, MDB_LP (see Fig. 2–1), ⑥. By shifting SUBW_FREQ closer to MDB_LP, the effective filter characteristics become sharper and the bass sounds harder. SUBW_FREQ must be specified and written in all cases, regardless of whether a subwoofer is used in the application or MDB processed bass signals are fed back to left/right channels. The output of the MSP used for bass signals is chosen by writing bits[7:0] of register 00 2D_{hex}. Bits[7:0] can also be used to switch a complementary highpass to left and right channels.

Volume Loudspeaker:

VOL_MAIN, register 00 00_{hex}

is already known from all MSP devices. A new Clipping Mode was added for MDB operation. Bits[3:0] must be set to 3_{hex} whenever MDB is used.

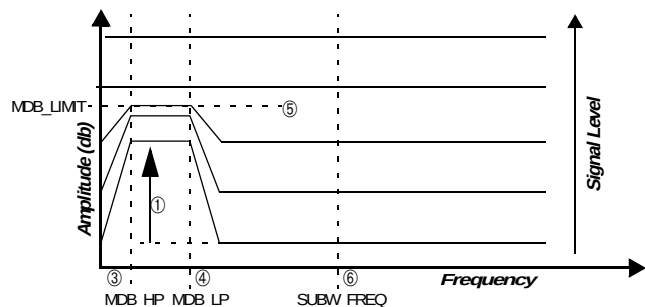


Fig. 2–1: Dynamic Amplification

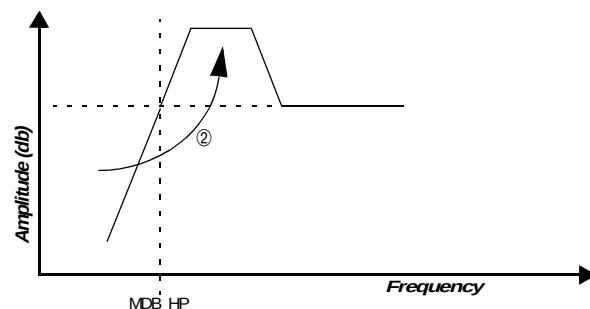


Fig. 2–2: Adding Harmonics

Table 2–1: MDB Control Registers

Register Address	Function	Name
00 68 _{hex}	MDB Effect Strength bit[15:8] 00 _{hex} MDB OFF (default) 7F _{hex} maximum MDB The MDB effect strength can be adjusted in 1dB steps. A value of 44 _{hex} will yield a medium MDB effect. bit[7:0] 00 _{hex} must be zero	MDB_STR
00 6A _{hex}	MDB Harmonic Content bit[15:8] 00 _{hex} no harmonics are added (default) 64 _{hex} 50% fundamentals + 50% harmonics 7F _{hex} 100% harmonics The MDB exploits the psychoacoustic phenomenon of the 'missing fundamental' by creating harmonics of the frequencies below the highpass frequency of the MDB (MDB_HP). This enables a loudspeaker to reproduce frequencies that are below its cutoff frequency. The Variable MDB_HMC describes the ratio of the harmonics towards the original signal. bit [7:0] 00 _{hex} must be zero	MDB_HMC
00 6C _{hex}	MDB High Pass Corner Frequency bit[15:8] 2 20 Hz 3 30 Hz ... 30 300 Hz The MDB highpass corner frequency defines the lower corner frequency of the MDB bandpass filter. The highpass filter avoids loading the loudspeakers with low frequency components that are below the speakers' cut off frequency. Recommended values for subwoofer systems are around 5 (=50 Hz), for regular TV sets around 10 (=100 Hz). bit[7:0] 00 _{hex} must be zero	MDB_HP
00 6B _{hex}	MDB Low Pass Corner Frequency bit[15:8] 5 50 Hz 6 60 Hz ... 30 300 Hz The MDB lowpass corner frequency (range 50...300 Hz) defines the upper corner frequency of the MDB bandpass filter. Recommended values are the same as for the MDB highpass corner frequency (MDB_HP). bit[7:0] 00 _{hex} must be zero	MDB_LP
00 69 _{hex}	MDB Amplitude Limit bit[15:8] 00 _{hex} 0 dbFS (default, no limitation) FF _{hex} -1 dbFS ... E0 _{hex} -32 dbFS The MDB Amplitude Limit defines the maximum allowed amplitude at the output of the MDB relative to 0 dbFS. If the amplitude exceeds MDB_LIM, the gain of the MDB is automatically reduced. Set this value to avoid overloading the speakers. bit[7:0] 00 _{hex} must be zero	MDB_LIM

Table 2–1: MDB Control Registers

Register Address	Function	Name																																
00 2C _{hex}	Subwoofer Level Adjustment <table><tr><td>bit[15:8]</td><td>0C_{hex}</td><td>+12 dB</td><td></td></tr><tr><td>...</td><td>01_{hex}</td><td>+1 dB</td><td></td></tr><tr><td></td><td>00_{hex}</td><td>0 dB</td><td>(default)</td></tr><tr><td></td><td>FF_{hex}</td><td>−1 dB</td><td></td></tr><tr><td>...</td><td>E3_{hex}</td><td>−29 dB</td><td></td></tr><tr><td></td><td>E2_{hex}</td><td>−30 dB</td><td></td></tr><tr><td>...</td><td>80_{hex}</td><td>Mute</td><td></td></tr></table> If MDB is added onto the main channel, this register should be set to 00_{hex} <table><tr><td>bit[7:0]</td><td>00_{hex}</td><td>must be zero</td><td></td></tr></table>	bit[15:8]	0C _{hex}	+12 dB		...	01 _{hex}	+1 dB			00 _{hex}	0 dB	(default)		FF _{hex}	−1 dB		...	E3 _{hex}	−29 dB			E2 _{hex}	−30 dB		...	80 _{hex}	Mute		bit[7:0]	00 _{hex}	must be zero		SUBW_LEVEL
bit[15:8]	0C _{hex}	+12 dB																																
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	00 _{hex}	0 dB	(default)																															
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bit[7:0]	00 _{hex}	must be zero																																
00 2D _{hex}	Subwoofer Corner Frequency <table><tr><td>bit[15:8]</td><td>5...40</td><td>corner frequency in 10 Hz steps (range: 50...400 Hz)</td><td></td></tr></table> SUBW_FREQ must be set to a value higher than the MDB Lowpass Frequency (MDB_LP). Choosing the corner frequency of the subwoofer closer to MDB_LP results in a narrower MDB frequency range. The smaller this range, the harder the bass sounds. Recommended value: around 1.5×MDB_FC Subwoofer Complementary High-Pass Filter <table><tr><td>bit[7:0]</td><td>00_{hex}</td><td>loudspeaker channel unfiltered</td><td></td></tr><tr><td></td><td>01_{hex}</td><td>a complementary high-pass is processed in the loudspeaker output channel</td><td></td></tr><tr><td></td><td>02_{hex}</td><td>MDB added onto main channel</td><td></td></tr></table>	bit[15:8]	5...40	corner frequency in 10 Hz steps (range: 50...400 Hz)		bit[7:0]	00 _{hex}	loudspeaker channel unfiltered			01 _{hex}	a complementary high-pass is processed in the loudspeaker output channel			02 _{hex}	MDB added onto main channel		SUBW_FREQ SUBW_HP																
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00 00 _{hex}	Volume Loudspeaker <table><tr><td>bit[3:0]</td><td>Clipping Mode</td><td></td><td></td></tr><tr><td></td><td>0</td><td>reduce volume</td><td></td></tr><tr><td></td><td>1</td><td>reduce tone control</td><td></td></tr><tr><td></td><td>2</td><td>compromise mode</td><td></td></tr><tr><td></td><td>3</td><td>dynamic mode</td><td></td></tr></table> In dynamic mode, volume is reduced automatically if excessive signal amplitudes would cause clipping within the IC. For operation of the MDB, Volume Clipping Mode MUST be set to 3 (dynamic mode)!	bit[3:0]	Clipping Mode				0	reduce volume			1	reduce tone control			2	compromise mode			3	dynamic mode		VOL_MAIN												
bit[3:0]	Clipping Mode																																	
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3. How to set up MDB

MDB can only sound good when its parameters are carefully adjusted to the MSP's environment. This includes the TV loudspeaker, the cabinet, the power amplifier, and personal preferences, as well as preferences given by the target market. Therefore, it is absolutely necessary to run an adjustment procedure as soon as one of the mentioned components has changed or a new design is released.

The detailed way to adjust MDB parameters is

- Set **MDB_LIM** to –3 dB and volume to a medium level (reg. 00 00_{hex} approx. –20 dB)
- Set **MDB_STR** to 50 dB (medium) and **MDB_HMC** to 0%.
- Usually, the value for **MDB_HP** is between 70 Hz and 100 Hz. The better the quality of the loudspeaker, the lower the value in **MDB_HP** should be set. **MDB_HP** should roughly correspond to the loudspeaker's cutoff frequency. A sinewave sweep (starting from 500 Hz down to 20 Hz) may help to find the cutoff frequency.
- **MDB_LP** and **MDB_HP** define the bandpass characteristic for MDB. Normally, the following equation leads to good results:

$$\text{MDB_LP} = \text{MDB_HP} \dots \text{MDB_HP} \times 1.5$$
 The narrower the frequency range used, the harder the bass sounds.
- Start with **SUBW_FREQ** = **MDB_HP** × 1.5 . Listen to different tracks of music. Reduce the value of **SUBW_FREQ** (maybe also **MDB_LP**) until the characteristics of the bass sound (hard / soft) meet your requirements.
- While still listening to medium volume levels, set **MDB_STR** to a value resulting in a moderate bass boost, creating a convenient bass level with your set.
- Change **MDB_HMC** until the timbre sounds natural and rich. Readjust **MDB_STR** (perhaps **MDB_HP** and **MDB_LP** as well) and return to **MDB_HMC** in an optimization circle.
- Increase volume now, use a full scale (loud) input signal, and set **MDB_LIM** so that the loudspeakers are not overloaded.
- Do extensive listening tests at different volume levels and play around with all the parameters in order to do a fine tuning. Take your time for finding correct values.
- Do some more listening tests!

The idea behind Table 3–1 is to provide some start values for all MDB related registers. Listening to different sound material (all with heavy bass content) will lead to a set of parameters while you are playing around with the settings and listening to the effects.

Table 3–1: MDB Start Values for different TV environments

	MDB_STR (68 _{hex})	MDB_HMC (6A _{hex})	MDB_HP (6C _{hex})	MDB_LP (6B _{hex})	MDB_LIM (69 _{hex})	SUBW_LEV (2C _{hex})	SUBW_FREQ SUBW_HP (2D _{hex})	VOL_MAIN (00 _{hex})
MDB off without subwoofer	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxx0 _{hex}	xxxx _{hex}
MDB off with subwoofer	0000 _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xxxx _{hex}	xx00/01 _{hex}	xxxx _{hex}
simple TVspeakers, medium effect	4400 _{hex}	2500 _{hex}	0900 _{hex}	0B00 _{hex}	FC00 _{hex}	0000 _{hex}	0C02 _{hex}	xxx3 _{hex}
simple TVspeakers, strong effect	5000 _{hex}	3500 _{hex}	0900 _{hex}	0B00 _{hex}	FC00 _{hex}	0000 _{hex}	0D02 _{hex}	xxx3 _{hex}
high end TVspeakers, medium effect	4400 _{hex}	2500 _{hex}	0700 _{hex}	0900 _{hex}	FC00 _{hex}	0000 _{hex}	0B02 _{hex}	xxx3 _{hex}
high end TVspeakers, strong effect	4900 _{hex}	3000 _{hex}	0700 _{hex}	0900 _{hex}	FC00 _{hex}	0000 _{hex}	0B02 _{hex}	xxx3 _{hex}
TV with subwoofer	4400 _{hex}	1500 _{hex}	0500 _{hex}	0700 _{hex}	FC00 _{hex}	0000 _{hex}	0A01 _{hex}	xxx3 _{hex}

4. Application Note History

1. Application Note IC: "MSP 34x0/x1/x2G Micronas Dynamic Bass", Aug. 9, 2000, 6251-530-1AN. First release of the application note IC.

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Printed in Germany
Order No. 6251-530-1AN

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