MAKING A GREAT MASTER:

Essential information for musicians, engineers, and producers.

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Introduction

At Disc Makers, scores of masters come through our doors for audio manufacturing every month. Because of our volume and our experience handling virtually every format available, we have acquired a wealth of information on the best methods for preparing your master, as well as the pitfalls to avoid. This guide, the result of our experience, is intended to clarify and simplify your transition from the artistic stage of your recording to the nuts-and-bolts manufacturing stage. Whether you choose Disc Makers for album manufacturing or not, using this booklet as a guide will give you the means to produce a quality product with confidence and satisfaction. Good luck with your project!

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Preface

THE AUDIO RECORDING AND MANUFACTURING PROCESS

The process of transforming your musical ideas into a finished product that you can share with others involves a series of steps leading from the original recording sessions through to the delivery of your packaged CDs, cassettes, or vinyl records. Because the choices you make at each step affect the quality of your final product, familiarizing yourself with this process will help ensure the best possible results for your project. There are many possible variations, but in general the process runs as follows:

- Recording involves capturing instrumental and vocal sounds (using microphones or direct inputs), and storing them either on digital or analog tape, or on a stand-alone or computer-based Digital Audio Workstation (DAW). Some recordings are made direct to stereo, but the vast majority are recorded "multitrack," meaning that the sounds of the different instruments are recorded and stored individually.

- Mixing is the art of blending individually recorded sounds through a console or on a DAW, controlling the level and pan (stereo speaker placement) of each sound to create a final "mix" of your musical selection (song). Mixes may either be recorded to tape or stored on the hard drive of a DAW.

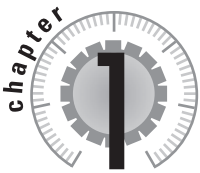
- Master assembly means editing a collection of individual song mixes into a complete "master" that flows from start to finish in the desired order and with the desired amount of space between selections. Due to the ease and control offered by digital waveform editing, digitally recorded songs are frequently compiled on a DAW, with the material then transferred in assembled form to a recordable CD (CD-R) or a digital master tape. A final master may also be assembled by transferring between two digital recorders (such as DAT machines), or by physically editing mixes on analog tape.

- Pre-mastering/mastering are the links between the production process and the manufacturing facility where copies will be made. Disc Makers' SoundLab™ professional mastering services add the final touches to your recordings. During pre-mastering and mastering, overall program level is set, as well as song-to-song or "relative" levels. EQ, compression and other digital or analog processing may be used to make the material sound as good as possible when it is played in the listening environment (i.e. home or car) of the customers who

buy the end product. Once optimized in this way, the resulting program is transferred to an appropriate "Production Master" for the plant that will make the actual copies:
– a CD-R, PMCD, DDP/Exabyte Tape, or PCM-1630 tape for the CD plant; or
– a "master lacquer" for the vinyl record pressing plant.

- Manufacturing is when the actual copies are made and packaged for distribution and sale:
  – For CDs, the master is transferred to a "glass master" from which molds are made for replication, a multi-step process involving injection molding.
  – For vinyl records, the master lacquer is used to make molds that are used to press the records.

In the following chapters we will cover some of the factors that influence quality during these various steps, and help you learn how to get the most out of the audio recording and manufacturing process.



Formats

There was a time when everything was simple: Tape was tape and disk was vinyl. Today tapes are reel-to-reel, cassette, analog, digital, DAT, and U-matic. A "disk" could be a 7" single, 12" single or 12" LP, or it might be a hard drive in a DAW. A "disc," meanwhile (as it is called in the age of optical media) might mean CD, CD-5 single, CD-ROM, CD-V, CD-I, and contain different file types such as .AIFF, .WAV and Sound Designer II. Sound confusing? It can be, but the range of available options can certainly work to your advantage. Use this guide to help you make the best choices for your needs.

ANALOG

Analog recording had been the traditional method of storing signals on various media since Edison developed the cylinder phonograph. The signal is continuous and variable (analog) just like natural sound. The stored signal correlates directly to the source captured by the microphone.

The two most common analog storage media are magnetic, usually tape, and mechanical, usually disks such as vinyl records. While analog systems can create high-quality master recordings, the various media have some inherent flaws that can introduce variations in the recorded signal, thus altering the original to some degree. By contrast, digital chops up the signal into small pieces, assigns each a value, and stores the values numerically, and thus is immune to minor anomalies of the storage medium.

TAPE SPEED

There are six standard analog tape speeds:

- 15/16 inches per second (ips): the slowest speed, used almost exclusively for broadcast station logging purposes.
- 1 7/8 ips: the standard speed for audio cassettes.
- 3 3/4 ips: a home use reel-to-reel speed for voice or other non-critical recording. Also used occasionally for running masters in high-speed tape duplication (64:1 or 80:1).
- 7 1/2 ips: used professionally for running masters in high-speed tape duplication (32:1) or in non-critical professional recording.
- 15 ips: the most-used professional speed.
- 30 ips: universally accepted as the highest quality analog commonly available. A very popular speed three to four decades ago that fell into disuse, although it has made a comeback in recent years.

GENERATION LOSS

Each time an analog copy is made, the quality is degraded by a certain amount – some degree of distortion and noise (electronic circuit noise and tape hiss) are added to the program. By the time a consumer hears a top-quality, mass-produced program, it is at best a fifth-generation copy. Even starting with the very best program source, the final market product quality has deteriorated.

DROPOUTS AND TAPE HISS

Magnetic tape suffers from several maladies. One of these, dropouts, are areas of tape that simply cannot be magnetized and therefore cannot hold the signal. As the tape is played back, the dropout does not reproduce the signal. For a very brief instant (usually), there is no sound. Every tape suffers from dropouts, although they may be too brief to be detectable by the human ear.

For any given dropout, a wider track width and/or a faster tape speed will reduce the audible effect. Thus, a stereo master running at 30 ips on 1/2" tape will provide excellent protection against dropouts. At the other end of the spectrum, a cassette running at 1 7/8 ips is far more vulnerable to dropouts in normal use, although it still can give surprisingly good results. More on that in Chapter 7.

Higher speeds also improve many other qualities of a recorded signal. Without getting into the technical aspects, extended high frequency response, signal-to-noise ratio, and phase shift problems are all improved with increased tape speed and, to some degree, track width.

Another of analog tape's inherent maladies is tape hiss. This background noise basic to all analog tape recording is also, in varying degrees, a function of tape speed and track width. Tape noise is also accumulated from generation to generation, so care must be used to minimize the number of tape generations used from tracking to production master.

DIGITAL

Digital recording is achieved by transforming audio signals into the language of computers. Electrical impulses are translated into signals that are either on or off (in binary terms, 1 or 0), nothing in between. The major advantage of digital sound recording is that there is no perceivable generation loss and no tape hiss. It is possible, in theory, to make a 100th-generation copy that is bit-for-bit indistinguishable from the original master.

As mentioned previously, analog signals are represented by a continuous, uninterrupted waveform. Digital technology takes the analog signal and cuts it

up into many little slices, taking a sample of the analog signal at every cut. The more often a sample is taken, the closer the digital curve reflects the analog wave signal, and thus the more the digital signal will sound like the analog original. A CD plays back at a sampling rate of 44.1 kHz (kiloHertz), which means that a sample of the analog signal is taken 44,100 times per second.

Digital recording comes in a variety of formats, including tape-based recorders, stand-alone hard-disk recorders, computer-hosted DAWs, and studio workstation DAWs. At the consumer level, the most familiar format by far is the Compact Disc (CD). For professional multi-track recording, DAWs and stand-alone digital recorders are frequently used. For professional stereo masters, CD-Rs are widely used, DATs and Sony PCM-1610/1630 tapes are rarely used for CD mastering.

CD-R

The recordable CD, or CD-R, in our experience, is the single most common digital format today. Studio workstations can generate master CD-Rs. CD-Rs may also be made on standalone CD-R decks and on computer-based DAWs equipped with CD-R drives and CD-audio recording software. Disc Makers' Proof Positive® Reference CD is a CD-R that clients use for tests when ordering CDs. Most of the masters received at Disc Makers are CD-Rs.

DAT

DAT, or Digital Audio Tape, was originally intended as a consumer format, but it became the format of choice for mixdown and/or safety copies in many recording and project studios before the CD-R became available. Because physical editing of DAT tape is impossible, individual DAT mixes are often transferred digitally to a computer-based DAW for editing and assembly, then re-transferred to DAT or CD-R to be sent out for mastering or manufacturing.

SONY PCM-1610/1630

Used since the introduction of the CD as a mastering medium from which glass masters are cut, this format uses an encoder to store digital audio information in video form on the 3/4" video cassettes and videotape recorders of the professional U-Matic video standard. Although CD-Rs such as the Disc Makers Proof Positive® Reference CD are now frequently used for CD glass master preparation, the U-matic/1630 combination remains a preferred mastering standard in many manufacturing facilities.

DIGITAL VS. ANALOG

The development of technology is blurring distinctions between analog and digital in cost as well as quality. In some cases, analog can produce the highest quality detectable by the human ear, but it suffers from generation losses and

tape hiss. Other times digital recording offers clear sonic and economic advantages over analog.

While an analog recording captures the entire sound wave, it also adds all the idiosyncrasies of the medium (e.g. tape hiss, phase errors, distortion, wow and flutter, dropouts, etc.). So when digital arrived on the scene it was hailed for its perfectly clean representation of sound. However, some listeners are less than fully satisfied with the current CD sampling rate and word length (44.1 kHz, 16 bit) because it is actually an incomplete representation of the original sound wave. A number of audio equipment manufacturers have addressed this concern by increasing the resolution of their professional systems (i.e. making the representation of the sound wave more complete). Some of these systems also support higher sample rates, up to 88.2 or 96 kHz, though the complex sample rate conversion required to go from 96 kHz to the 44.1 kHz required for CD release can introduce its own sonic artifacts.

How does all this affect you? If you decide to use an analog master, make sure you do all you can to eliminate the aforementioned analog problems. If you decide to use a digital master, record at the highest word length you can. If you are planning on recording at a high sample rate (88 and 96 kHz), keep in mind that if you are releasing your music on a CD, your music would have to be converted to the CD spec of 44.1 kHz, which would negate the effect of recording at 88 or 96 kHz.

CHOOSING A FORMAT

So how do you choose? First you have to set your priorities. What is important to you? Do you need the highest quality and do you have the financial resources to indulge this need? If the answer to both questions is yes, then you want the format that affords that quality. There are several top quality formats. If you wish to stay in the analog realm, you will choose 30 ips, 1/2" two-track (or 15 ips with Dolby SR encoding), and all the multi-tracking will be at professional widths and 30 ips as well. If you choose to enter the digital domain, your choices widen. You will probably want to go with CD-R or DDP/Exabyte Tape for your final 2-track master, mixed down from a DAW or digital multi-track. If you are sending it to The Soundlab™ at Disc Makers for mastering, then you would choose either the 30 ips reel to reel or a CD-R with high bit rate files in the .wav or .aiff file formats.

What if you don't have money to burn? Many affordable studios are now based around studio workstations (such as Roland's V-Studios or DAWs). CD-R/RW drives built into studio workstations provide a cost-effective way to mix down to 2-track digitally without adding an extra analog generation. Whichever way you go, we recommend working in studios that offer professional quality. Many smaller studios do excellent work at relatively inexpensive rates.

Disc Makers offers a helpful recording studio search engine, studiofinder.com, that features over 10,000 recording studios and lets you find one according to your needs (location, price, equipment, genre, etc.).

Digital Audio Workstations

A significant percentage of recordings are now recorded and mixed digitally in their entirety, without ever hitting tape, on a Digital Audio Workstation. A Digital Audio Workstation, or DAW, is an integrated device for recording, mixing, editing and even mastering audio. A DAW may be an all-in-one studio workstation device, or may be computer-based, using one or more software programs and additional installed hardware. DAWs are usually a cost-effective way of producing a high-quality recording, and can function as stand-alone tapeless configurations.

All DAWs are actually built around a computer. In a studio workstation the computer is built-in, as are its hard-disk recorder, mixer, effects, and CD-burning tools. The tight integration of a studio workstation's components, and the fact that all of its hardware is optimized for recording, means that a studio workstation can offer simplicity without sacrificing power. A computer-based DAW is a standard personal computer with an added audio input/output interface, a hard disk for storing audio data, and a recording/mixing/editing software package. Like most areas involving computers in recent years, DAWs have become both far more powerful and far more affordable.

With a high-quality interface and analog-to-digital converters, DAWs can record digital audio with the same fidelity as the best stand-alone digital recorders. But a DAW is more than just a recorder; once your tracks are recorded, DAWs offer a single working environment for all your subsequent production tasks:

- enhance individual tracks with reverb, EQ, compression and other effects, or digital signal processing using either built-in or third-party software tools;

- edit tracks with great precision and control while looking at a display of the actual waveform on screen, cutting and pasting individual pieces of music to create the exact arrangement you want;

- mix the tracks into a final stereo version using a virtual on-screen mixer that in some cases allows automation of nearly every level and effects process;

- pre-master your mixes, optimizing the final overall program level of a group of songs, adjusting the "relative" (song-to-song) levels, and enhancing the sound of the mixes with EQ, compression and/or other built-in or third-party processing;
- create a playlist of the mixed masters that you want on your album, including

fade-ins, fade-outs and the duration of the “spreads” (silence between tunes); and

• record that playlist to CD-R.

The ease and control with which DAWs can perform these steps makes them particularly well-suited for preparing a master that conforms with the guidelines laid out in the following chapter on master preparation.

Digital Master Preparation

To the recording engineer, digital recording can reveal faults and problems in the studio that were undetectable using analog. If your goal is a killer CD, there are certain steps that must be taken in preparing your master.

First, your mix should come out of and go back into total silence. To do this, record for at least 15 seconds at the beginning and end of the song, or audio program, with levels set at minimum. Check each track for clicks, bumps, thumps, and other strange sounds that somehow sneak into almost every recording. Make sure your mixer's output is as clean and quiet as possible by listening to each track open all the way on headphones. Is there a hum or hash that could be reduced or removed with proper grounding or a cleaner power supply? Experiment to find the optimal output level for your mixer.

If you have experience mixing to analog tape, you know how to take advantage of two well-known tape effects. Bass levels sometimes slightly increase on playback and a pleasant type of distortion eases in when the tape is driven into saturation. This addition of even-numbered harmonics and bass boost is especially noticeable on drums, bass, and vocals, and is featured on many great rock and pop recordings. For better or worse, digital recording does none of this. Mix the bass in exactly the way you want it to play back. If you need analog warmth and crunch, you'll have to add it with tube equalizers and pre-amps or compressors.

DYNAMIC RANGE

The dynamic range (the difference between the quietest and loudest sounds on the tape) of a digital recorder is in excess of 90 dB, compared with the 30 or 40 dB dynamic range of an analog cassette. So, make sure the dynamic range of your mix is not greater than that of your planned release format.

Care must be taken to keep each cut in a project at the same general dB level on a digital recorder. A delicate musical moment in your mix recorded at -60 dB will play back digitally with almost no background noise. But when analog cassettes are manufactured from a digital master, the loudest level on the master will control the maximum duplicated level of the cassette. Now, upon cassette playback, your -60 dB material will be submerged in the ever-present noise floor of the cassette. This can be avoided by keeping the dynamic range within the bounds of what the analog cassette can handle if you plan to manufacture cassettes of your recordings.

EDITING

If you need to re-sequence a group of individual songs (selections that have complete silence between them), assemble them as desired on your DAW. A DAW can provide powerful editing capabilities and options not available with other methods, especially when a project calls for precise control over the lengths of the silences between tunes, for crossfades or segues, or for making edits within the program (a radio version, for instance).

If you're working with a DAT, you can transfer from one DAT machine (playback) to another (record). If need be, you can add fade-ins and fade-outs by going into the analog domain (playback DAT line out to record DAT line in); if done carefully with good equipment and cables, this step does not usually cause significant degradation to the program material. Depending on the level controls available on the DAT machines, however, you may need to use a console between them for fades, which may add some to the noise level. Another approach is to edit your DAT materials on a DAW. In this case material on DAT is transferred to the DAW, edited, and then transferred back to DAT.

WHAT TO PROVIDE ON A DIGITAL MASTER

Before you submit a master CD-R or DAT or any other master tape to a duplicating house such as Disc Makers, take time to sit down and listen to the final master you plan to submit. Listen from beginning to end. Hear for yourself what is on the master and make sure you know what to expect when your test comes back. If, at this point, there is anything you want to change, go back to the studio and fix it. Understand that whatever is on your master will be on your finished product.

Make sure that all songs are in the proper order with the correct spacing between them. Decide now whether you are satisfied with the way the master sounds, taking into account the acoustics of the room in which you are listening. Any post production required at the mastering and manufacturing stage will add to the cost of your project and the time required to complete it. Post production is the process of adjusting, sequencing, equalizing and compressing your program, and eliminating unwanted sounds or noises. The SoundLab™ at Disc Makers offers professional post production that includes all of the above. See Chapter 10 for more information.

Choosing a CD-R

When you are deciding what CD-R to use for your product, check the owner's manual of your CD burner. Typically they mention which media brand was used in the calibration of the burner itself.

THE BASICS

During mixdown, if you are not mastering, set levels to PEAK at 0 (zero) dB on the machine recording the master. Then set the desired selection sequence and

the space between the selections exactly as you want them to be heard by your audience.

- For cassette releases, it is good practice to make the A side a little longer than the B side so that any blank tape will be found at the end of side B and not A.
- For CD releases, since there are no A and B sides, the standard two- to four-second spacing is generally placed between what would have been the last selection on side A and the first selection on side B.
- If you want both CDs and cassettes, sequence the songs for CD – straight through with no extra break between sides.

Calibration tones are not required on CD or DAT masters submitted to Disc Makers. However, if you choose to include tones on a DAT master, do NOT record them at 0 level. Try -12 dB, which seems to have become the standard. Also, do not number the start ID for the tones on a DAT master tape.

We cannot emphasize enough how crucial it is to get what you want in the studio before you get to the mastering stage. In mastering, the engineer has the whole mix on two tracks, so correcting one problem will affect the whole recording. If you point out to your engineer that something is not quite right, and s/he tells you it can be taken care of in mastering, fly, do not run, to another studio.

Remember: Listen closely to your master tape. Make sure it is what you want and what you paid for before you leave the studio. Once you get to mastering for mass duplication, your problem can be cured only with a compromise, and an expensive one at that.

FREQUENTLY ASKED QUESTIONS ABOUT DIGITAL MASTERS

Q: I have a cassette master. Should I make a CD or DAT copy to send to Disc Makers?

A: Definitely. It simplifies the mastering process. However, due to the quality limitations inherent in cassettes, we recommend you stay away entirely from that as a master tape format.

Q: My engineer just gave me this CD or PMCD. I don't know what's on it besides the order and length of the songs. Should I send it in anyway?

A: If at all possible, listen to it first. We strongly discourage sending in a master if you do not know exactly what's on it. Most problems in mastering are easily avoided by spending a little time in the studio listening to the entire tape one last time.

Q: At what level should I digitally record my material?

A: It depends on where you're going next. If you are not mastering the project, then have your peaks go up to zero. Remember, it'll be exactly the same on the replicated disc. If you are having it mastered then leave some headroom for the mastering engineer. Anywhere near the –6 dB range will be adequate.

Q: Can I compile my master from MP3, AAC or Ogg Vorbis files?

A: No. These file types are heavily compressed and intended for transferring over the Internet. Use WAVE (.wav.) or AIFF (.aif) files to avoid a loss in audio quality.

Q: Can I upload my master to Disc Makers?

A: No. Chances are your master is going to take up a lot of space (a typical 60 minute album about be as much as 650 megs). We prefer having a physical format.

Q: One song is a little louder than the others. Can you make sure that one gets lowered a little bit? or: Everything's fine. It just needs a little compression.

A: If you know how much you want it changed, the adjustment is relatively simple. If you don't know, we charge for the service because it involves the time to listen, make a judgment, and edit. Any mastering studio will charge you for the time required for editing and equalization. The SoundLab™ at Disc Makers can provide this post production affordably.

Q: Should I have a safety of my digital master CD made?

A: Definitely. A CD can get damaged or lost in shipping and a DAT can go bad at any time. Consequently you would lose the only copy of your master.

CD Master Preparation

When you submit a CD master to Disc Makers, you want to submit an audio CD that sounds just like you want the final CD to sound. All of the songs must be in the proper order, with the desired spacing between them.

It's important to note that you'll need to provide an audio CD for manufacture, not a data CD. Studio workstations and other DAWs allow you to back up your project to CD, however, the backup is a data CD that is only understandable to the DAW itself. Make sure that your CD master is an audio CD that can be played on any standard audio CD player.

Most DAWs allow you to control the level of each selection in an assembled project. As you prepare the master, pay attention to making each song flow naturally into the next in terms of volume, so that each song starts at a pleasing volume relative to the song before it.

If you don't have pre-mastering tools at your disposal, or would like to take advantage of a fresh perspective on your material, The SoundLab™ at Disc Makers can provide mastering services at an additional charge.

Place a CD track, or "index," marker at the start of each selection on the CD. These index markers will be transferred to your CDs, and will make it easy for buyers of your CD to jump to each selection as desired.

To help ensure compatibility, create your CD master on a CD-R disc, not a CD-RW. While Disc Makers can successfully work with either medium, not all production facilities can.

All computer-based DAWs give you the option of mixing down (or "bouncing") your mix to various digital formats. When preparing your master be sure that this setting (adjusted within the native audio program) is set to an uncompressed audio format, usually a WAVE (.wav) or AIFF (.aif) file. Along with this setting make sure the files you are creating are not split stereo files. Make sure you select the option for "interleaved stereo" files. WAVE and AIFF files can contain stereo (2 track, L + R) information in a single file.

In the same place where this can be adjusted in your program you will find settings for bit rates and sampling rates. Audio CDs can only play back at a sampling rate of 44.1Khz and a bit rate of 16-bits. Adjust these settings accordingly.

Please note: be very careful to not bounce your songs to a compressed audio format because significant loss of audio-quality will occur. In other words, do not compile your audio master from MP3, AAC, or Ogg Vorbis files. These file formats are great for Internet file transfers, but not for your audio CDs.

SUMMARY

If you're submitting an assembled master CD, make sure of the following:

- Listen to the CD carefully. It should sound exactly the way you want your finished product to sound.
- Make sure the disc surface is clean and scratch free
- Place a CD track marker at the start of each selection.

FREQUENTLY ASKED QUESTIONS ABOUT CD MASTERS

Q: What should I do if my songs are on different CDs?

A: If at all possible, consolidate your sources on your DAW before you submit your project to Disc Makers. Any post production editing done by your replicator adds to the cost of the project and the time required to complete it.

Q: What brand of CD do you recommend?

A: Check to see what brand the manufacturer of your burner recommends. See if they calibrated their machine with a certain brand or at a certain speed and use their recommendations.

Q: Does the speed that I burn my master matter?

A: Yes, it can matter. With some burners and media type the faster the speed the more chance of errors on the disc. This is going to be the master used to make your entire run. Take the extra 20-30 minutes and ensure a good burn by using a slower burn speed.

DAT Master Preparation

When preparing your DAT master, sequentially number the start IDs, one per song, precisely at the start of each selection, to enable easy access to the information on the DAT. This will be automatic in the standard process of recording on DAT, but any deviation from straight programming (i.e.: long, slow fade-ins, segues, crossfades, live background noise) calls for setting new start IDs manually. Auto ID tip: Take the deck out of auto ID mode during the song to avoid false ID placement at a break or quiet section. Flip back to auto as the song is ending.

If you choose to include tones on your DAT, do NOT record them at 0 level. Try -12 dB, which seems to have become the standard. Remember, 0 on a digital meter is not at all the same as 0 VU on an analog meter. Also, do not number the start ID for the tones. Calibration tones are not required on DAT masters submitted to Disc Makers.

Set the sampling rate on the DAT recorder to 44.1kHz. Professional DAT decks have the ability to sample not only at 44.1 kHz, but also at 48 kHz. Many consumer decks have only 48 kHz, which is fine for analog cassette production, but not CDs. Although a DAT master can be digitally converted from 48 kHz to 44.1 kHz, even if you have access to a very high quality sampling rate converter, it is preferable to record your original master at 44.1kHz. You can do a sample rate conversion using the analog outputs and inputs of two DAT machines, but this means your music would go through two extra conversions. The program will not actually be re-recorded on analog tape, but it will go through the D/A (digital to analog) and A/D (analog to digital) converters as it's recorded. This introduces a very slight alteration of signal, usually a minor consideration, which is outweighed by the advantages of DAT use. It involves no extra cost.

DIGITAL TIME LOG

Your master tape must have a complete and accurate time log. This means that running times should be accurately recorded for everything on the tape, including tones, false starts, and any other sounds, wanted or not. If you are supplying a DAT master, there should be one start ID for each selection and it should be positioned precisely at the beginning of each song. These steps enable the mastering engineer to be certain of your intention if questions arise during the mastering process. The log sheet should look something like the chart on page 19.

PROGRAM	LENGTH	TIME
1-Pre-roll/Digital Black/Blank *(recorded)*		START TIME: 0:00 END TIME: 0:15
2-1st song title	2:23	START TIME: 0:15 END TIME: 2:38
3-2nd song title	4:35	START TIME: 2:42 END TIME: 7:17
" " "	" " "	" " "
10-Last song title	2:03	START TIME: 26:52 END TIME: 28:55
11-Post-roll/Digital black/Blank *(recorded)*		START TIME: 28:55 END TIME: 29:10

SUMMARY

Please listen to your master before submitting it to make certain it includes the following:

- Pre-roll: at least 10-15 seconds recorded with inputs set at minimum.
- Start IDs, sequentially numbered, placed at the very start of each selection, one ID per song.
- Sampling rate of 44.1 kHz: while optional for cassette duplication, it is recommended for CD.
- Complete, accurate running time log, including any wanted or unwanted out-takes, false starts, noises, etc.
- Digital meters set to peak at 0, maximum.
- Program-ready songs in the correct order, needing no equalization, compression, or level adjustments.
- Post-roll: 10-15 seconds recorded with inputs set at minimum.

Please make any necessary notes at the bottom of the time log. For example, suppose your engineer forgot to edit out the count-off on one of your songs. Without your telling us, we have no idea whether it was left on the tape intentionally. Or, suppose there is an ad-lib, which doesn't seem to belong to the preceding track any more or less than the track following it. Without your instructions, we cannot know where to place the start- and end-of-the-track marks (or whether you even want the ad-lib). Situations like these present our engineers with problems, and can delay your job until we can contact you. It can also end up costing you money.

If you do not fill out the time log or write detailed notes, we have no choice but to assume that your tape is to be transferred exactly as is. For instance, if we find 20 seconds between the last two tracks, we will leave that 20-second spacing alone (plenty of artists request we leave a 20-second gap for a hidden or bonus track).

FREQUENTLY ASKED QUESTIONS ABOUT DAT MASTERS

Q: If my DAT player has copy protection, will it affect my CDs?

A: No. The duplicating process at Disc Makers does not involve copy protection. You are not recording from a protected, commercially available digital source.

Q: If I put start IDs on the songs, it shouldn't matter if they are out of order, right? or: I programmed skip IDs for songs I don't want on the CD.

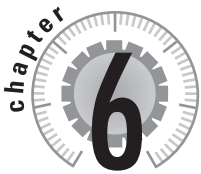
A: Any post production editing done by your replicator, including resequencing, adds to the cost of the project as well as the turnaround time. Remember, it's not a CD – it takes more time to shuttle from place to place on a DAT, and we may have to re-record your entire tape on an intermaster before doing the mastering.

Q: Do I need a start ID for the pre-roll and tones?

A: We recommend it. Do not number the ID.

Q: Do you want two masters if I'm making both CDs and cassettes?

A: Not necessarily, although it is recommended if there is a significant difference in the program between the two formats (i.e. sequence change, an equalization adjustment, an extreme difference in dynamic range, or a bonus cut anywhere but at the end).



Analog Tape Preparation

This section refers primarily to analog masters. However, many points apply to the handling of digital master tapes as well.

LEADERING

It is necessary to leader analog tape. Leader is simply a length of paper or plastic tape spliced onto the very beginning and very end of each selection. Leaders eliminate the possibility of print-through, and make it easy to find selections.

SPLICING

All splices should be tight and professional. If any portion of the splicing tape is hanging over the edge of the tape, it may get caught in the tape guides of certain machines, causing unwanted variations in tape speed. Make sure that no portion of the splice is visible when looking at it from the oxide, or dull, side of the tape. The life of a splice is approximately 10 years, so be prepared for re-splicing when reproducing from older analog tapes.

CALIBRATION TONES

All analog tapes should have the following calibration tones at either the head or the end of the tape: A 1 kHz tone at 0 dB operating level, a 10 kHz tone, and a 100 Hz (not kHz) tone, also at 0 dB, in that order (If the tape is Dolby encoded, either with Dolby A or Dolby SR, it must also have the appropriate Dolby tone, or there is no way to decode it properly). The reason? The tones will verify that the equipment is functioning properly. They also offer a means of compensating for a machine that is slightly out of spec.

All of these tones should be recorded just before the session begins, on the same machine on which the recording will be made, and the machine should be warmed up for at least 1/2 hr. Warming up the machine keeps it stable throughout the recording session. If the tones are put on at a later time or by another machine, they will not function as an accurate reference and can do more harm than good.

Ordinarily, the tones are “printed” on the tape with a signal generator (a.k.a. oscillator, tone generator, audio generator). If you have no signal generator, CDs with test and calibration tones are currently available through mail order companies like Music Books Plus (1-800-265-8481). Buy one and use it. You can also use these test CDs to calibrate your studio equipment, just be sure to use the sine wave mode.

Here is the correct procedure to use whether you are using a signal generator or a calibration CD:

- Switch any noise reduction system out, whether or not you will be encoding the tape. Feed a 1 kHz tone into the console. Adjust the console for 0 VU out of both channels to your two-channel recorder. Then adjust the recorder for 0 VU record level. Record this tone for about 15 seconds.
- Then switch the signal generator to 10 kHz. Adjust the console for 0 VU out as you did before, but – and this is important – do not adjust the recorder. Record about 15 seconds of this tone also, regardless of what the VU meter on the recorder indicates.
- Next set the signal generator to 100 Hz and again adjust the console for 0 VU (but not the recorder) and record 15 seconds of this tone.
- If you intend to encode your tape with Dolby A or Dolby SR, record about 15 seconds of the appropriate Dolby tone at this point.

You now have a meaningful set of calibration tones and you can begin mixing.

If the tones do not come out right, leave them as they were recorded. That way if the recording machine is misaligned in any way, our playback machine at Disc Makers can be adjusted to match. This is one of the few times two wrongs do make a right. Be sure to indicate the tape machine's operating record level on the tape log and the tape box (see FAQs in this chapter).

NOISE REDUCTION

Whether or not to use noise reduction depends on the type of music you are recording, the machinery used to reproduce it, and individual taste. Professional studios typically use Dolby A, Dolby SR, or dbx noise reduction for analog recording. At some replicators, your tapes will be decoded before a cassette running master is made. For cassettes, Dolby B can be encoded onto the running master. Dolby S is another type of noise reduction that may occasionally be used.

TAKE SHEET/TAPE LOG

If your master tape is analog, be sure it has a take sheet (like the time log discussed under DAT recording in the previous chapter) indicating everything on the tape (including tones), and what order it is in (see example on page XX). This is important because some things are not as obvious to the engineer as they are to you.

Leave space at the beginning and end of each tape. Don't start the recording two inches from the front of the tape. It takes several feet of tape just to thread a professional deck. That's a bar or two of music on some songs. If your recording ends at the last foot of tape, the deck will shut down before the end of the song. Without enough of a pad the tape cannot be started at the beginning and will not play to the end. You also run the risk of destroying your valuable master by

damaging the tape at the beginning or end of the program. Avoid extra charges and delays by providing ample leadering.

OTHER ANALOG MASTER TAPE CONCERNS

Reels should have head and tail leaders of at least five seconds. Albums should have head and tail leaders of at least ten seconds per reel, and each selection on the album should be separated with about two to four seconds of leader.

The master tape should be supplied tails out, slow wound, in a proper box. All necessary information, such as times, titles, any noise reduction that was used and any instructions or special problems you may want the mastering engineer to consider, should be included with the tape.

Download the master time log here: www.discmakers.com/mtg1/.

FREQUENTLY ASKED QUESTIONS ABOUT ANALOG MASTERS

Q: At what level should I record my program on my analog tape deck?

A: As long as you know the level and tell us what it is, we can deal with your master. It is helpful if the recording level is noted on the master tape box (i.e., 180 nW/m, 250 nW/m), and whether the engineer recorded a certain number of dB above or below this operating level (i.e. +3/180 nW/m).

Q: What should I do if my songs are on different tapes?

A: If at all possible, consolidate your sources before you submit your project to Disc Makers. Any post production editing done by Disc Makers adds to the cost of the project and the time required to complete it.

Q: Can I put my tones on after my recording is complete?

A: Tones should be recorded just before the session begins or immediately afterwards, on the same machine on which the recording is made, without any changes in its calibration. The tape machine should be warmed up and calibrated before the recording session begins.

Q: What if I don't have a tone generator?

A: We recommend you include tones on your master, especially if you are planning to make an analog recording. Most studios should have a generator, but if yours does not, you can buy a CD with tones that can get the job done. They can be purchased through mail-order houses like Music Books Plus (1-800-265-8481).

Handling Your Master

A master is the result of months of hard work, many dollars spent, and represents an irreplaceable artistic expression that cannot be described in monetary terms. Certainly the care of this master deserves as much consideration as was given the creation of the entire project.

SAFETY COPY

It is absolutely critical that a safety copy be made of your master before you ship or deliver it anywhere. CDs and tapes can easily be damaged or lost during shipping and handling. A safety copy is a small price to pay to preserve your irreplaceable performances. If you are working on a DAW, you can also protect your work by backing up your entire session for each song on a removable medium such as a data CD or DVD, or on a backup hard drive.

Keep the safety in a safe place and send the master to be mastered. This may seem obvious, but it's especially important with DAT and analog master tapes. Often a producer will keep his master DAT or analog tape and send a copy or safety to be mastered. Unfortunately, sometimes the second machine is out of alignment and the safety does not match the original exactly. After spending money and effort to create the best product you know how, why start the manufacturing process off at a disadvantage with a second generation tape?

WINDING DAT AND ANALOG MASTER TAPES

After use and before being placed in its box, every master tape should be slow-wound and left tails out. That is, it should be played through from beginning to end at play or shuttle speed, not fast forward or rewind. (This is especially important for analog tapes.)

This ensures the tape is wound under constant and proper tension, allowing it to pack smoothly, which protects the tape edges and minimizes tape stretching. The tails-out position forces you to rewind the tape before playing, which reduces print-through. It also frees up any mechanical problems such as sticky splices. Also, after the duplication facility's mastering department has processed your tape for cassette, CD, DVD or LP, it will already be in its slow-wound, tails-out state, and ready for storage.

TRANSPORTING MASTER TAPES

Caring for master tapes during transportation is as important as caring for

them in your tape library. There are many physical and environmental factors you should consider when shipping a master.

Keep tapes away from magnetic fields: motors, magnets, cables carrying heavy current, vacuum cleaners, etc. If you are traveling by plane, hand-carry the tape. Don't leave it in your baggage and let it run through the x-ray machine and don't walk through the metal detector with it. Hand it to the security person for inspection. When shipping tapes, clearly mark them with a message such as:

```
MAGNETIC MEDIA.
KEEP AWAY FROM ELECTROMAGNETIC FIELDS!
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When shipping your master via UPS, Federal Express or some other courier, double box the tape(s). Place the tape box inside another larger box with plenty of insulating or shock absorbing material between the two containers. If you can't use double containers, use a plastic library shipping case designed for the medium you are shipping. Use a reputable shipper and insure the tape for the reasonable replacement value of the recordings it contains.

STORING MASTER CDS AND TAPES

Precautions for storing CD-Rs are often marked on the packaging of blank CD-R media. CD-Rs should never be left in direct sunlight or for long periods of time in hot, humid locations.

Analog or digital tapes should be clearly marked and boxed whenever they are not on or in a tape deck.

- When storing tapes, the conditions are simple to remember. If you're comfortable, so is the tape: 65 to 75 degrees (Fahrenheit) and 40 to 60% relative humidity. (Professional media storage facilities often use even lower temperature and humidity for long-term storage: 45 degrees at 25% humidity, for instance.) Make any necessary climatic adjustments where the tape is stored, or move it elsewhere to ensure its safety.
- Store tapes in a clean, dry environment with stable temperature and humidity in the ranges indicated above.
- Store tapes in acid free cardboard or plastic library boxes. Tape boxes and tapes should stand on end so that the wound tape is supported by the hub of the tape reel.
- Keep master tapes away from smoke and dust as much as humanly possible. Hair, dust and smoke particles are major contributors to dropouts in the digital world.

CD Mastering

With the growing popularity of DAWs, many clients today prepare CD masters on their own studio workstations, using a CD-R drive and built-in pre-mastering software. At Disc Makers, we also give you the option of having your master professionally prepared by our own experienced staff. Our mastering process for compact disc utilizes the best available media and methods for minimizing generation losses. Digital masters are loaded into our Sonic Solutions or SADIE Artemis digital editing and pre-mastering environment entirely in the digital domain with no generation loss. Analog masters are immediately converted into digital files and loaded into the system without any interim tape copies. We load the data into a computer, add the digital subcoding (commonly known as P and Q codes), do the frame-accurate time log, and record this data directly onto two CD-Rs, Disc Makers' Proof-Positive® Reference CDs.

We send one of these identical discs to you for approval and keep the second copy. Once you approve your reference CD, we will proceed with glass mastering from our copy. If you are submitting a CD, DAT or analog master, refer to other sections of this book for additional information on preparing your master. A professionally prepared PreMaster CD (PMCD) master is also acceptable for CD replication. Contact Disc Makers or your mastering facility for details.

U-MATIC MASTER

If you decide to submit a U-matic master to Disc Makers, you need to be aware of a few new formatting procedures. First, the U-matic tape will be in the Sony PCM 1630 format. Second, a new tape must either be pre-striped or striped during recording with continuous SMPTE time code (an industry-standard analog signal) on Channel 2. The PQ burst should go on Channel 1 and should begin at 00:00:15:00 (HH:MM:SS:FF). Record time code in non-drop frame mode at 30 frames per second. Record audio at the 44.1 kHz sampling rate.

The tape must include a minimum of two minutes of digital black pre-roll and one minute of digital black post-roll. Digital black is essentially tape recorded with no input signal or "0" level. It is like leader tape in the analog media, except that it must be programmed in. Pre-roll is simply a section of tape that precedes the program. It provides a place to insert digital information during the transfer to compact disc, gives the video deck a chance to get up to speed and stabilize, and gives the operator time to check that all is functioning smoothly. Reminder: Any digital master tape must have a running time log.

In the case of U-matic masters, the log must be frame-accurate; that is, times are noted to the nearest frame (1/30 of a second, since there are 30 frames per second).

PROOF POSITIVE® REFERENCE CD

Before we glass-master your CD, you will receive a Disc Makers Proof Positive Reference CD. This disc will sound and perform like your mass-produced finished CD in every way, including programmed and shuffle plays. What makes the Proof Positive Reference CD distinct from a normal one-off CD, or a store-bought CD for that matter, is that only the Proof Positive is a true PMCD that can be used to generate the glass master needed for mass replication. In addition to playing in your CD player just like any other CD, the Proof Positive disc contains P and Q codes, which must be present before a glass master is made. Currently, most CD manufacturing facilities can cut the CD glass master directly from a Proof Positive CD. If you approve your reference copy and then change your mind later it will result in extra charges.

When Problems Occur

Unfortunately, problems do occasionally arise during the manufacturing process. They can occur both during the test stage, and on the final product. What do you do when your test or finished product does not match your supplied master?

If your test doesn't sound right, don't panic. During the test stage there is still time to correct any problems you hear. Play the test on several different pieces of equipment. Ask your friends for their unbiased opinions – without coaching them. You may well find that what sounds like a disaster to you is really quite acceptable to everyone else. Don't forget, you lived with this project for a long time; it's your baby. Above all, try to keep things in perspective – it is impossible for you to hear your own work with total objectivity and clarity.

If there is a clear defect or you believe there is a real problem, call the manufacturer and explain the situation. Be calm and explain the problem as clearly and objectively as possible. Any reputable firm will appreciate the opportunity to correct a true problem. Many problems are fairly easy to fix. Simply re-doing the master or the reference test may correct the problem.

Should you be unfortunate enough to wind up with a whole shipment of defective CDs or cassettes you will have to do some detective work together with your rep at the manufacturing plant to figure out what went wrong. First step: Does the finished product match the test? If it doesn't match the test you approved within commercial standards, the plant should re-do your product. Remember, though, facilities will manufacture product to match the test you approved. If the glitch on your finished CDs was on the reference disc you approved, you may be out of luck. Therefore, we can't stress enough that you listen carefully to each test you receive before approving it! It may sound obvious, but listen to the whole test without interruptions. Otherwise minor glitches or dropouts could go unnoticed and you'll have to live with the consequences.

A-B TEST

When a problem occurs on a test or finished product, there is only one valid listening test to accurately compare one source against another. It is called the A-B test. Very simply, you first listen to the master and then instantly switch to the reference or final product that you want to appraise. You must be playing both formats simultaneously, on similar players, using the same amp and speakers (or headphones). It is absolutely essential that both playback machines, be they any combination of CD players, DAT players, cassette decks, or turntables, be perfectly

calibrated and aligned for the A-B test to be valid. This means that not only must their frequency response be flat to professional standards but their output levels must match each other. While there is little problem with the frequency response of CD or DAT players, the output levels can be quite different. And a difference of as little as one half dB (1/2 dB), which is almost inaudible to most people, will skew the results in favor of the louder source. A-B tests can be quite difficult to set up for people inexperienced with their use, so ask an engineer to assist you.

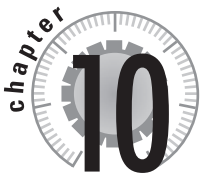
COMMON PROBLEMS

My reference CD doesn't sound as hot as other CDs I own.
When Disc Makers masters for CD, we search for the hottest spot on the master and maximize that to 0 dB (the maximum allowable level on a CD). This peak determines your overall level. Without sound processing (such as EQ, compression, or limiting) your levels cannot be raised any more. The SoundLab™ at Disc Makers offers affordable sound processing including equalization, limiting, and compression that may help.

Remember, most of the CDs you own were probably recorded with top budgets, in top studios, with top engineers and producers. If your master has a very wide dynamic range, the apparent recording level may be low, even though the actual level still peaks at 0 dB. Only through compression or limiting can your apparent level be raised. Disc Makers' engineers generally do not recommend a lot of compression during the mastering stage. Some studios choose to start compressing tracks as early as in the multi-track stage, to give the finished recording that nice, fat sound.

There is a digital glitch or dropout on my reference CD.
If your master was a DAT, at times the incompatibilities between two different machines can cause a digital scratching sound due to DAT tracking problems during playback. This glitch is usually correctable by redoing the digital conversion and reference CD, but occasionally a new DAT is needed. A silence, or mute, in the middle of a program can be caused by the same thing, and would require a new DAT master. It may also be a compatibility issue between the reference disc we sent and the CD player. Try the reference in a couple different players to see if the glitch happens in the same spot every time.

One song sounds hotter (or quieter) than the others.
Disc Makers' mastering engineers set the overall recording levels when mastering. They do not match levels on every song unless it is specifically requested (there is an extra charge for this service, done by The SoundLab™ at Disc Makers). If the recording levels are not consistent on your master, they won't be consistent on your reference either. Please be sure to fill out the master questionnaire on the back of the Disc Makers order form if you need any editing or sound processing done.



Post Production/Mastering

Many people don't understand the mastering process and see it as an unnecessary expense. Having committed months of devoted work to a project, and having taken advantage of the pre-mastering tools at your disposal, it is often difficult to understand how a total stranger could improve the final product. After all, if your mix didn't sound right, you wouldn't have left the studio.

As explained in the Preface, this step occurs after your recording is mixed, and before CD and cassette manufacturing are done. It is both the last creative process in the making of an album and the first step in the manufacturing process. Every major-label release is mastered to prepare it for radio play and retail sale. The reason? A good mastering engineer puts the whole album in perspective, subtly enhancing and balancing the connection between songs and the focus of the project as a whole.

In the studio you record one song at a time, resulting in songs that all peak at different levels (volume) and have different EQs, etc. A mastering engineer attempts to unify the album with skillful use of EQ, gain, and compression to give it a consistent sound from track to track, and to make sure that it will translate the way you want it to on ordinary stereo systems. This mastering process also allows the engineer to raise the overall level so your album is as hot as a major-label release, if that is your desire.

Mastering can also be helpful for fixing problems such as "pops," out-of-phase tracks, and overall noise reduction, but the main advantage is that an unbiased sound professional has the opportunity to evaluate your master tape and determine whether you are getting the most out of your production.

The SoundLab™ at Disc Makers previews masters at no charge to determine what benefits can be achieved, and offers affordable packages that include signal processing, equalization, limiting, and compression to raise your master to optimal commercial industry standards.

If you would like to know more about mastering and post production at The SoundLab™ at Disc Makers, contact us at 1-800-468-9353 or at www.discmakers.com.

Resources

THE SOUNDLAB™ AT DISC MAKERS

The mastering facility at Disc Makers. This site offers our packages, prices, equipment, and more.
www.discmakers.com/soundlab

MORE GUIDES FROM DISC MAKERS

Our catalog and complimentary guides are full of tips and expert advice written by industry professionals.
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