

MAGNETIC REFERENCE LABORATORY, INC.

c/o Booye, 165 Wyandotte Dr ♦ San Jose, CA 95123 ♦ Tel&FAX +1.408.227.8631 ♦ mrltapes@flash.net

Publication CART
2006-11-04

Calibration Cartridges for NAB and IEC Audio Broadcast Cartridge Reproducers

NOTE: We have discontinued this product, but we can still record a Cart Cal Tape on lubricated tape and send it to you to load yourself. Inquire if interested.

0 INTRODUCTION

Altho Audio Broadcasting Professional Cartridges are standardized in essentially-identical NAB and IEC standards, those standards are obsolescent—they no longer describe some of the most-commonly-used practices. In particular, the improved cartridge tape now in common use should be recorded at a higher level than that given in the NAB standard. Also, there is now a recognition that different models of cartridge shells that all conform to the standards may perform somewhat differently in different cartridge transports.

In order to guide you thru the resulting maze, we have organized this publication as follows: §1, the most-commonly-used cartridge calibration tapes; §2, those with other fluxivities, tracks, fringing, and packages; §3, those with the non-standard IEC1 open-reel equalization and G320 nWb/m fluxivity; §4, those with 3.75 and 15 in/s speeds; §5, technical details; §6, special cue test signals; and finally, if your requirement is "none of the above", §7, how to build your own MRL part number.

1 MOST-COMMONLY-USED CARTRIDGE CALIBRATION TAPES

Table 1 below lists the most-commonly-used cartridge calibration tapes.

1.1 Speeds and Equalizations: The current standards (NAB Cartridge Standard, 1976; and the IEC Standard 94-1, 4th ed, 1981) both provide only for the 190 mm/s (7.5 in/s) speed in broadcasting cartridges, and both specify the same equalization transition frequencies of 0 Hz and 3150 Hz, corresponding to time constants of ∞ μ s and 50 μ s. In practice this speed and equalization are used almost exclusively. (For other speeds and equalizations, see §3 and §4.)

1.2 Reference Fluxivity: High-output cartridge tapes such as ITC/3M 219 and Audiopak SGS4 are now commonly used. Because of this, Otari, ITC, and Pacific Research (nee Recorders) and Engineering (and probably other manufacturers) now use 250 nWb/m for the reference fluxivity for the main audio channels, rather than the 160 nWb/m given in the NAB Standard. (For other reference fluxivities, see §2 and §3.)

The Cue Channel is *in all cases* still recorded using the NAB Standard fluxivity of 160 nWb/m.

Note that the reference fluxivity of 80 nWb/m shown in Table 1 for the fast-swept frequency test signal is just another way of saying

that the level is 10 dB below 250 nWb/m.

1.3 Test Signals shown in Table 1 are Multifrequency, 1 kHz Level Set, Fast-swept frequency, Flutter and Speed Test, and Cue Test. See "Choosing and Using MRL Calibration Tapes" (MRL Publication Choo&U) for more detailed descriptions. See the MRL publications referenced below for complete descriptions and application notes, and §7 for a listing of other test signals that are available on special order, and the MRL Publications that contain the details.

1.3.1 Multifrequency Test Signals: The MRL Multifrequency Reproducer Calibration Tapes contain three separate sections. The Reference Fluxivity Section is usually used to set the reproducer gain to give the reference deflection (0 dB) of the program level meter. The Azimuth, Phase, and Preliminary Response Section is used to set the azimuth of the heads, and to perform preliminary equalization measurement and adjustment. The Frequency Response Calibration

Table 2 Contents of the Multifrequency Tapes

Section	Frequency	Duration of Tone
Reference Fluxivity	1000 Hz	20 s
Azimuth, Phase, & Preliminary Response	500 Hz	10 s
	8 kHz	20 s
	16 kHz	20 s
Amplitude/frequency Response	32 Hz	6 s
	63 Hz	6 s
	125 Hz	6 s
	250 Hz	6 s
	500 Hz	6 s
	1 kHz	6 s
	2 kHz	6 s
	4 kHz	6 s
	8 kHz	6 s
	10 kHz	6 s
	12.5 kHz	6 s
16 kHz	6 s	
20 kHz	6 s	
Reference Fluxivity	1000 Hz	20 s
Approximate Total Duration		4 min

Table 2 Most-Commonly-Used Cartridge Calibration Tapes

Tape Speed	Equalization Standard	Test Signals and Approximate Playing Time	Level/ [dB]	Reference Fluxivity/ [nWb/m]	MRL Part Number	Price/ [US\$]
190 mm/s 7.5 in/s	NAB and IEC Cartridge	Multifrequency, 32 Hz...20 kHz, 4 min	0/-10	250	132-102-482-407	Not Avail.
		Level Set, 1 kHz, 4 min	0	250	132-560-482-401	Not Avail.
		Fast-swept frequency, 500 Hz...20 kHz, 4 min	0	80	132-301-382-409	Not Avail.
		Flutter and Speed Test, 3150 Hz, 4 min	0	250	132-570-482-400	Not Avail.
		Cue Test, 1 kHz, 150 Hz, 8 kHz, 3 min	0	160	132-261-442-401	Not Avail.

Section is used to calibrate the frequency response of the reproducer. Each section is voice announced. More details are given in Table 2 below, and in Publication 101.

The 1000 Hz tones at the beginning and end are recorded at 0 dB; the other tones are recorded at -10 dB to prevent saturating the tape at the higher frequencies.

1.3.2 Level Set Test Signal: A single 1000 Hz tone at 0 dB, usually used for setting the gain of the reproducer so the program level meter reads 0 dB.

1.3.3 Fast-Swept Frequency Test Signal: A repeated sweep from 500 Hz to 20 kHz in 100 ms, to be read out using an oscilloscope and an MRL graticule (sold separately). See also Publication 301.

1.3.4 Flutter and Speed Test: A single 3150 Hz tone. See also Publication 570.

1.3.5 Cue Test: One minute each of the NAB Standard Primary Cue Tone (1 kHz), Secondary Cue Tone (150 Hz), and Tertiary Cue Tone (8 kHz), at the standard frequencies and levels. For other Cue Test programs, see §6.

1.4 Packaging: These Calibration Tapes are loaded into ITC Cart2 (formerly 3M ScotchCart2) cartridges, for use in NAB and IEC Audio Broadcast Cartridge Tape Recorders and Reproducers, such as the Otari Model CTM-10w and the ITC models. (For calibration tapes in other cartridges see §2.)

1.5 Track Configuration: These recordings are all full track, recorded with fringing compensation for reproduction with a 2-mm-wide reproducing head, as used for "mono" carts. Less than 1 dB error results when they are used with a 1-mm-wide reproducing head, as used for "stereo" carts. (For calibration tapes having the cue track erased, see §2.)

2 OTHER FLUXIVITY, TRACKS, FRINGING, AND

PACKAGES WITH STANDARD SPEED AND EQUALIZATION

Table 3 below lists multifrequency cartridge calibration tapes with the standard speed and equalization, but with various combinations of fluxivity, track configuration, fringing compensation, and packaging. §5 below gives the technical details about why you might use one of these tapes rather than those in Table 1. The "Usage" column in Table 3 reflects MRL's relative sales of these tapes during 1992, if you are interested in popularity.

3 IEC1 OPEN-REEL EQUALIZATION AND G320 nWb/m FLUXIVITY WITH STANDARD SPEED

Table 4 below lists a few multifrequency cartridge calibration tapes at the standard speed and with the non-standard IEC1 Open-Reel Equalization, with fluxivity of G320 nWb/m. §5 below gives the technical details about why you might use one of these tapes rather than those in Table 1.

4 NON-STANDARD SPEEDS & EQUALIZATIONS

Table 5 is similar to Table 1, but now for the non-standard speeds of 3.75 in/s and 15 in/s.

For cartridge recording at non-standard speed of 95 mm/s (3.75 in/s), Otari uses the NAB and IEC Open-Reel equalization (transition frequencies 50 Hz and 1800 Hz, corresponding to time constants 3150 μ s and 90 μ s).

For cartridge recording at the non-standard speed of 380 mm/s (15 in/s), Otari uses the IEC1 Open-Reel equalization (transition frequencies 0 Hz and 4500 Hz, corresponding to time constants ∞ μ s and 35 μ s).

For cartridge recording at the non-standard speed of 380 mm/s (15 in/s), Pacific Research (nee Recorders) and Engineering uses a special equalization (transition frequencies 0 Hz and 6300 Hz, corresponding to time constants ∞ μ s and 25 μ s). Part numbers for Calibration

Table 3 Other Fluxivity, Tracks, Fringing, and Package Multifrequency Cartridge Calibration Tapes at 7.5 in/s with Standard NAB & IEC Cartridge Equalization

Fluxivity/ [nWb/m]	Tracks	Fringing Compensation	Package	MRL Part Number	Price / [US\$]	Usage / [%]
160	Full	N	Open Reel	132-102-440-104	95 \$	1
160	Full	N	Audiopak AA4	132-102-440-308	Not Avail.	3
160	Full	N	ITC Cart2	132-102-440-405	Not Avail.	1
160	Full	N	Other Cart	132-102-440-502	Not Avail.	1
160	Cue Erased	N	Open Reel	132-102-448-106	Not Avail.	7
160	Cue Erased	N	Audiopak AA4	132-102-448-300	Not Avail.	13
160	Cue Erased	N	ITC Cart2	132-102-448-407	Not Avail.	9
160	Cue Erased	N	Other Cart	132-102-448-504	Not Avail.	4
160	Cue Erased	Y	Audiopak AA4	132-102-449-309	Not Avail.	3
160	Cue Erased	Y	ITC Cart2	132-102-449-503	Not Avail.	3
250	Full	N	Audiopak AA4	132-102-480-302	Not Avail.	2
250	Full	N	ITC Cart2	132-102-480-409	Not Avail.	7
250	Full	Y	ITC Cart2	132-102-482-407	Not Avail.	40
250	Cue Erased	N	Audiopak AA4	132-102-488-304	Not Avail.	1
250	Cue Erased	N	ITC Cart2	132-102-488-401	Not Avail.	3
250	Cue Erased	N	Other Cart	132-102-488-508	Not Avail.	2
250	Cue Erased	Y	Audiopak AA4	132-102-489-303	Not Avail.	6
250	Cue Erased	Y	ITC Cart2	132-102-489-400	Not Avail.	8
250	Cue Erased	Y	Other Cart	132-102-489-507	Not Avail.	1

Table 4 Non-Standard IEC1 Open-Reel Equalization at 7.5 in/s Multifrequency Cartridge Calibration Tapes

Fluxivity/ [nWb/m]	Tracks	Fringing Compensation	Package	MRL Part Number	Price / [US\$]	Usage / [%]
G320	Cue Erased	N	Open Reel	131-102-498-103	Not Avail.	1
G320	Cue Erased	N	Audiopak AA4	131-102-498-307	Not Avail.	3
G320	Cue Erased	N	Other Cart	131-102-498-506	Not Avail.	1

Cartridges with this speed and equalization can be made up using the information in §7 and Table 6.

Cue-Tone Levels: For these non-standard speeds and equalizations, Otari has maintained the relationship between the cue-tone flux level and the main audio channel flux level the same as the value given for 190 mm/s (7.5 in/s) in the NAB Cartridge Standard. That is, if you play the Cue Test cart on a properly equalized audio channel that is set for 160 nWb/m reference fluxivity, you will get these levels: 1 kHz, 0 dB; 150 Hz, +6 dB; 8 kHz, -10 dB.

5 TECHNICAL DETAILS: Standards and Non-Standards

There are two current standards in use for cartridge recording, and they are essentially identical: the NAB Standard *Cartridge Tape Recording and Reproducing* (1975), and the IEC Standard 94 *Magnetic Tape Sound Recording and Reproducing Systems, Part 1 General Conditions and Requirements* (1981), and Part 9 *Magnetic Tape Cartridge for Professional Use* (1988).

5.1 Speeds: These standards specify one speed only: 7.5 in/s (190 mm/s). Some cartridge transports also run at 3.75 in/s (95 mm/s) and 15 in/s (380 mm/s), but there is very little use of either of these speeds.

5.2 Equalizations: These standards specify one equalization only: a high-frequency transition of 3150 Hz, corresponding to a "time constant" of 50 μ s. This high-frequency equalization is identical to that used in the previous (1964) NAB Cartridge Standard.

On the other hand, the low-frequency boost and cut of the 1964 Standard (50 Hz transition frequency: "time constant" of 3150 μ s) was eliminated in the 1975 Standard. This results in a "flat flux low end," also called 0 hertz transition frequency, or "time constant" of infinity. In practical program operation the difference in response is usually negligible (1 dB at 100 Hz, and 3 dB at 50 Hz.)

This change from the 1964 standard does simplify equalizer design and manufacture, resulting in improved interchangeability of equipment and records at low frequencies. It also reduces low frequency distortion.

Some designers of early cartridge recorders unfortunately misunderstood the standards, and mistakenly placed the equalization for the head bumps and the fringing from a full-track calibration tape into the recording equalizers. Between this error and the intentional low-frequency equalization change of the 1975 standard, you may find that the low-frequency response of older cartridge reproducers when playing a current-standard Calibration Tape is as much as -6 dB at 63 Hz. See §2.2 of MRL Publication "Choo&U" for more information on this problem. If you need an "old style" Calibration Tape, you can specify one (from Table 6, below) with the equalization of the 1964 NAB Standard, and without the fringing compensation. In practical program operation the difference in response is usually negligible (1 dB at 100 Hz, and 3 dB at 50 Hz.)

It appears that in a number of countries that nominally follow the IEC Standards, they do not use the IEC Standard equalization for

Broadcast Cartridges, but rather use the IEC1 "Open reel" equalization instead. We assume that they started this practice before the IEC Standard for Cartridges was published, and that they continue the now-non-standard practice because of the cost and confusion of converting the equipment and the libraries of recorded tapes from the non-standard to the standard equalization. Calibration Cartridges with this equalization are listed in Table 4.

It appears that even in countries where the non-standard IEC1 open-reel equalization is used for the signal channels, the NAB and IEC Standard equalization and levels are used for the cue channel.

At the non-standard speed 3.75 in/s (95 mm/s), Otari uses the NAB and IEC Open-Reel equalization, with transition frequencies 50 Hz and 1800 Hz, corresponding to time constants 3150 μ s and 90 μ s (see §4 and Table 5).

At the non-standard speed 15 in/s (380 mm/s), Otari uses the IEC1 Open-Reel equalization, with transition frequencies 0 Hz and 4500 Hz, corresponding to time constants ∞ μ s and 35 μ s (see §4 and Table 5).

At the non-standard speed of 380 mm/s (15 in/s), Pacific Research (nee Recorders) and Engineering uses a special equalization with transition frequencies 0 Hz and 6300 Hz, corresponding to time constants ∞ μ s and 25 μ s (see §7 and Table 6).

5.3 Reference Fluxivity, Program Channel: The reference fluxivity given in the standards is 160 nanowebers per meter (nWb/m). This is identical to the "Standard Reference Level" on older NAB Test Cartridges, such as the "NAB Test Tape Nr 3". This fluxivity is obsolescent: it is only appropriate to recording on older types of cartridge tapes.

The most commonly used reference fluxivity now is 250 nWb/m at 1000 Hz (4 dB above the Standard 160 nWb/m). It is appropriate to recording on newer types of cartridge tapes such as Audiopak SGS-4 and ITC 219 (formerly 3M ScotchCart Cat. Nr. 219). This fluxivity is used by Otari, Pacific Research (nee Recorders) and Engineering, and ITC in their cartridge recorders.

Cartridge calibration tapes from some other vendors have used a reference fluxivity of 185 nWb/m at 700 Hz (equivalent to 180 nWb/m at 1000 Hz); this fluxivity level is 1 dB above 160 nWb/m. In practical program operation the difference is usually negligible.

Fluxivity measurements and standards are further described in "Choosing and Using MRL Calibration Tapes for Audio Tape Recorder Standardization", MRL Publication Choo&U.

5.4 Reference Fluxivity, Cue Channel: The standard reference fluxivity for the cue channel is the same as that for the program channel: 160 nWb/m. Even when modern high-output tapes are used, and the program channel is operated at higher fluxivity, *the cue system is always operated with a reference fluxivity of 160 nWb/m*. This is because noise in the cue system is never a problem, but cross-talk from the cue tones could be a problem. Therefore raising the cue level could only be disadvantageous.

Table 5 Cartridge Calibration Tapes at Non-Standard Speeds of 3.75 in/s and 15 in/s

Tape Speed	Equalization Standard	Test Signals and Approximate Playing Time	Level/ [dB]	Reference Fluxivity/ [nWb/m]	MRL Part Number	Price/ [US\$]
95 mm/s 3.75 in/s	NAB and IEC Open-Reel	Multifrequency, 32 Hz...20 kHz, 4 min	0/-10	250	121-102-482-407	Not Avail.
		Level Set, 1 kHz, 4 min	0	250	121-560-482-401	Not Avail.
		Fast-swept frequency, 500 Hz...20 kHz, 4 min	0	80	121-301-382-409	Not Avail.
		Flutter and Speed Test, 3150 Hz, 4 min	0	250	121-570-482-400	Not Avail.
		Cue Test, 1 kHz, 150 Hz, 8 kHz, 3 min	0	160	121-261-442-401	Not Avail.
380 mm/s 15 in/s	IEC1 Open-Reel	Multifrequency, 32 Hz...20 kHz, 4 min	0	250	141-101-482-404	Not Avail.
		Level Set, 1 kHz, 4 min	0	250	141-560-482-405	Not Avail.
		Fast-swept frequency, 500 Hz...20 kHz, 4 min	0	250	141-301-482-406	Not Avail.
		Flutter and Speed Test, 3150 Hz, 4 min	0	250	141-570-482-404	Not Avail.
		Cue Test, 1 kHz, 150 Hz, 8 kHz, 3 min	0	160	141-261-442-405	Not Avail.

6 SPECIAL CUE TEST SIGNALS

Various test signals are specified by the various manufacturers for testing the adjustment and operation of their cue systems. The following are shown below in Table 6:

“Contents and version” (CVV) 261, with 1 minute each of 1 kHz, 8 kHz, and 150 Hz, at the NAB & IEC Standards frequencies and fluxivities (recommended by Otari).

CVV 262, a stop tone test, with the Standard fluxivity and frequency, and minimum stop tone duration (500 ms), repeated every 7 s.

7 BUILD-YOUR-OWN MRL PART NUMBERS

The tables above have listed the catalog numbers for most of the practically-used cartridge calibration tapes. Because there are so many possibilities in standard and non-standard (but commercially used) Calibration Cartridges, it is not practical for us to list the catalog number for every Calibration Cartridge that someone might need. Instead, we list below in Table 6 the more-likely parts of the 12-digit MRL catalog numbers which allow you to "build your own" part

number for exactly what you need. **The NAB and IEC Standards items are shown in bold print.**

We represent the 12-digit numbers by letters as:

MSE-CVV-FFT-PDX,

where

M is the medium width and whether back-lubricated;

S is the tape speed;

E taken together with S is the equalization standard;

CVV is the contents and version of the test signals;

FF is the reference fluxivity ("level") of the signals;

T is the fringing compensation and whether cue-track erased;

P is the package (reel, cartridge, etc.);

D is the duration (playing time);

X is a check digit that we calculate according to a rule.

Table 6 Build-Your-Own MRL Part Number

Characteristic	Description	Number
Medium	6.3 mm (0.25 inch) width, back-lubricated stock	1 _ _ _ _
Speed	Standard speed: 190 mm/s (7.5 in/s)	3 _ _ _ _
Speed & Equalization	NAB and IEC Professional Cartridge Standard (∞ & 50 μs)	32 _ _ _ _
	Non-standard open-reel equalization of IEC1 (∞ & 70 μs)	31 _ _ _ _
Speed	Non-standard speed: 95 mm/s (3.75 in/s)	2 _ _ _ _
Speed & Equalization	Non-standard (used by Otari) open-reel eq of NAB & IEC (3180 & 90 μs)	21 _ _ _ _
Speed	Non-standard speed: 380 mm/s (15 in/s)	4 _ _ _ _
Speed & Equalization	Non-standard (used by Otari) open-reel eq of IEC1 (∞ & 35 μs)	41 _ _ _ _
	Non-standard (used by Pacific Recorders) (∞ & 25 μs)	44 _ _ _ _
Contents & Version	Multi-frequency, 32 Hz to 20 kHz at 0 dB (for 380 mm/s only) [Pub 101]	_ -101- _ _
	Multi-frequency, 32 Hz to 20 kHz, Ref Flux 0 dB, all else -10 dB [Pub 101]	-102- _ _
	For use with Sound Technology Analyzer, at 0 dB (for 380 mm/s only) [Pub 211]	_ -211- _ _
	For use with Sound Technology Analyzer, at 0 and -10 dB [Pub 101]	_ -212- _ _
	Cue tone test at Standard Cue Levels, 1 kHz, 150 Hz, 8 kHz	_ -261- _ _
	Stop tone test, 1 kHz, 0 dB, 500 ms burst, repeated every 7 s	_ -262- _ _
	1 kHz, 10 kHz, Chromatic Sweep for readout on volume indicator [Pub CHROM]	_ -286- _ _
	Fast swept-frequency, repeating 500 Hz ... 20 kHz in 100 ms [Pub 301]	-301- _ _
	Slow swept-frequency, repeating 20 Hz ... 20 kHz in 50 s [Pub 402]	_ -402- _ _
	For use with Audio Precision System One 2HD-FREQ, 1/3 oct. steps [Pub 421]	_ -421- _ _
	Level set, 1000 Hz [Pub 560]	-560- _ _
	Flutter test, 3150 Hz [Pub 570]	-570- _ _
Azimuth test, 1 kHz 1 minute, 12.5 kHz rest, all at 0 dB	-293- _ _	
White noise, broadband [Pub 700/800]	_ -701- _ _	
Pink noise, broadband [Pub 700/800]	_ -801- _ _	
Fluxivity	80 nWb/m: -10 dB re 250 nWb/m, used at 7.5 & 3.75 in/s to prevent tape saturation at high-frequencies with test signals that are all at 0 dB: CVV = 286, 301, 402, 421, & 701	_ _ -38 _ _
	160 nWb/m: The NAB and IEC Standards reference fluxivity	_ _ -44 _ _
	250 nWb/m: For use with high-output tape on the Program Channel only	_ _ -48 _ _
	G320 nWb/m (actually only 1 dB above 250 nWb/m): Specified in IEC Pub 94-2 as the reference for testing in open-reel applications	_ _ -49 _ _
Tracks & fringing	Full-track recording, no fringing compensation	_ _ - 0 _ _
	Full-track recording, fringing compensated for 2 mm track	_ _ - 2 _ _
	NAB Standard 2.25 mm cue track erased*; no fringing compensation	_ _ - 8 _ _
	NAB Std 2.25 mm cue track erased*; fringing compensated for 2 mm track	_ _ - 9 _ _
Package	Open reel in box	_ _ - -1 _ _
	Loaded in Audiopak AA-4 Cartridge	_ _ - -3 _ _
	Loaded in ITC Cart2 (formerly 3M ScotchCart2) Cartridge	_ _ - -4 _ _
	Loaded in Other Cartridge (specify which)	_ _ - -5 _ _
Duration	4 minutes	_ _ - -0 _ _
	60 minutes (bulk, on open reel, for you to load; tell us which blank tape)	_ _ - -18 _ _
	90 minutes (bulk, on open reel, for you to load; tell us which blank tape)	_ _ - -19 _ _
Checkdigit	The final digit (calculated by rule from all of the other digits) is assigned by MRL	

* NOT for use on Maxtrax systems.