

THIC Inc.

The Premier Advanced Recording Technology Forum

**Wideband Analog Recorders:
The Next Step in S-VHS Format**

Asa Watanabe

Metrum-Datatape, Inc

605 E Huntington Dr

Monrovia CA 91017-7170

Phone: +1-626-930-9422; FAX: +1-626-930-9478

e-mail: awatanabe@metrum-datatape.com

**Presented at the THIC meeting at the Embassy Suites Hotel South
Englewood CO 80112 on July 13, 1999**

METRUM-DATATAPE

Wideband Anal og Recorders:
The Next Step in S-VHS Format

Wideband Analog Recorders: The Next Step Overview

- **Paper Will Make a Case for an Analog vs a Digital Recorder and How Money Can Be Saved on Media Alone**
- **Paper Will Show That an Analog Recorder with TDM(s) Can Replace a Longitudinal Recorder**

Wideband Analog Recorders: The Next Step

Analog BW vs Digital Mbps

- Analog Bandwidth vs Digital Data Rates

<u>Analog</u>	<u>Digital</u>
6 MHz	120 Mbps
8 MHz	160 Mbps
16 MHz	320 Mbps
25 MHz	500 Mbps
50 MHz	1000 Mbps
100 MHz	2000 Mbps

Wideband Analog Recorders: The Next Step

Media Cost Comparison

- Analog Recorder with SVHS ST-120 Cassette

<u>Bandwidth</u>	<u>Record Time</u>	<u>Cost/Hour</u>
6 MHz	40 min.	\$15
8 MHz (SP)	40 min.	\$15
8 MHz (LP)	80 min.	\$8
16 MHz	20 min.	\$30
24 MHz	~13 min.	\$46

Wideband Analog Recorders: The Next Step

Media Cost Comparison

- Digital Recorder with ID-1 Cassette

<u>Cassette Type</u>	<u>Data Rate</u>	<u>Record Time</u>	<u>Cost/Hour</u>
D1, Medium	120 Mbps	54 min.	\$150
D1, Large	160 Mbps	79 min.	\$140
D1, Large	320 Mbps	39 min.	\$283

Wideband Analog Recorders: The Next Step

Media Cost Comparison

- IRIG 1" Tape on 14" Reel

<u>Media Type</u>	<u>Record Time</u>	<u>Media Cost</u>	<u>Cost/Hour</u>
14" Reel	15 min.	\$200	\$800
		\$150	\$600
		\$100	\$400

Wideband Analog Recorders: The Next Step

Recorder Physical Comparisons

- **Recorder Comparisons: Size and Weight**
-

Recorder Type	Volume (ft ³)	Weight (lb)
Analog	< 1.0	< 25
Digital	up to 4.5	170
Longitudinal	4.6 +	170 +

Wideband Analog Recorders: The Next Step

Case Study on Media Costs

- Analysis of tape requirements for 8-hour mission (480 minutes)

Product	Record Time	Tapes Needed	Cost	Storage (ft ³)	Weight (lb)
SVHS @ 80 min.	80 min.	6	\$60	.166	4.86
SVHS @ 20 min.	20 min.	24	\$240	.664	19.44
ID-1 @ 160 Mbps	79 min.	7	\$1,288	1.465	37.87
ID-1 @ 320 Mbps	39 min.	13	\$2,392	2.721	70.33
14" Reel @ 120 ips	15 min.	32	≥ \$3,200	7.36	336.64

Wideband Analog Recorders: The Next Step

Case Study on Media Costs

- **Savings on Media**
 - **Number of 8-hour missions (difference in media costs) = savings**

8 MHz Analog vs. 160 Mbps	16 MHz vs. 320 Mbps
50 (\$1,228) = \$61,400	50 (\$2,152) = \$107,600
75 (\$1,228) = \$92,100	75 (\$2,152) = \$161,400

8 MHz Analog vs. Longitudinal	16 MHz vs. Longitudinal
50 (\$3,140) = \$157,000	50 (\$2,960) = \$148,000
75 (\$3,140) = \$235,500	75 (\$2,960) = \$222,000

Wideband Analog Recorders: The Next Step

Conclusion: Analog vs. Digital Recorders

- **Analog recorders are more cost-effective and more economical than digital recorders**
 - **Smaller size: 1 ft³ vs 4.5ft³**
 - **Media costs less: \$30/hr vs. \$140 or \$283/hr**
 - **Media savings can justify analog recorder**
 - **Savings on acquisition cost**

Wideband Analog Recorders: The Next Step

Analog Performance Tradeoffs

- Performance is balanced between three key parameters: Bandwidth; Dynamic Range; Record Time
- Other Variables: Head Width; Carrier Frequencies

<u>Bandwidth</u>	<u>SNR</u>	<u>Record Time</u>
4 MHz	46 dB	0.5 hr.
	43 dB	
8 MHz	40 dB	1.0 hr.
	37 dB	
16 MHz	34 dB	2.0 hr.

Wideband Analog Recorders: The Next Step

Applications and Product Requirements

- **Instrumentation**
 - Wideband analog signals
- **Telemetry**
 - Pre-detection signals: 2 MHz, 4 MHz, 8 MHz, etc.
- **Replacement for Longitudinal Recorders**
 - 8 channels @ 2 MHz and 2 channels @ 20 kHz for 10 channels
 - 16 channels @ 1 MHz and 2 channels @ 20 kHz for 18 channels
- **Flexible channel/bandwidth capabilities**
 - Ideal is mix and match: channels, bandwidths
- **Low life-cycle costs**
 - COTS media
 - Low maintenance
 - Proven reliability

Wideband Analog Recorders: The Next Step Genealogy

- Metrum-Datatape developed the DTR-6, the first small format SVHS wideband analog recorder, in 1990
- DTR-6 has become *de facto* standard in wideband Sigint community
- DTR-8 was released in 1994 to provide extended bandwidth
- DTR-8E was released in 1996 to provide latest SVHS transport technology and extended record times
- A line of compatible Time Division Multiplexers (TDM) has been developed to provide multiple wideband channel recording capability
 - TDM-6, TDM-8 and TDM-8E
- Over 1500 DTR recorders have been delivered to date
 - Ground based applications
 - Airborne applications
 - Naval applications

Wideband Analog Recorders: The Next Step

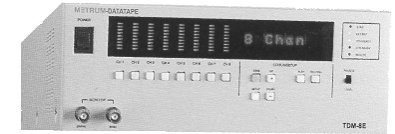


DTR-16 Specifications

- **Bandwidth:** DC to 16 MHz, Single Channel
DC to 8 MHz, Dual Channel
- **Auxiliary Channels:** 2 linear phase @ 100 Hz to 20 kHz
- **Media:** SVHS ST-120 cassettes
- **Record Times:** 20 minutes with SVHS ST-120
- **Input/Output Impedance:** 50/75 ohms, selectable
- **Volume:** 1029 in³ (0.6 ft³)
- **Weight:** < 25 pounds (without cassette)
- **Power:** 90-264V AC; 47-400 Hz; < 100 W
- **Remote Interfaces:** IEEE-488; Serial RS-422 or RS-232;
Parallel TTL

Wideband Analog Recorders: The Next Step

Multi-Channel Recording



TDM-8E



DTR-16

- Using DTR-16 with 1 Mux/Demux
 - Mux/Demux: 2-8 channels

Recorder		Mux A		<u>Total # Channels</u>
<u># chan</u>	<u>BW (MHz)</u>	<u># chan</u>	<u>BW (MHz)</u>	
1	8	2	4	3
1	8	4	2	5
1	8	8	1	9

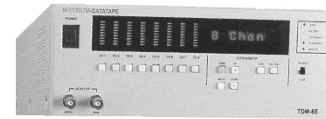
- Some flexibility in number of channels and bandwidths
- Record different bandwidth signals on same tape
- Have 2 Aux channels for IRIG and Voice

Wideband Analog Recorders: The Next Step

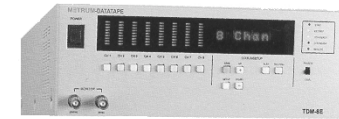
Multi-Channel Recording



DTR-16



TDM-8E



TDM-8E

- Using DTR-16 with 2 Mux/Demux

Mux A		Mux B		<u>Total # channels</u>
<u># chan</u>	<u>BW (MHz)</u>	<u># chan</u>	<u>BW (MHz)</u>	
2	4	2	4	4
2	4	4	2	6
4	2	4	2	8
8	1	2	4	10
8	1	4	2	12
8	1	8	1	16

- Independent control of Mux A and Mux B
 - Great flexibility in number of channels and bandwidths
 - Record different bandwidth signals on same tape
 - Have 2 Aux channels for IRIG and Voice

Wideband Analog Recorders: The Next Step

Requirements for Longitudinal Replacement

- **Product Requirements**
 - **Number of channels and bandwidth**
 - **Minimum: 6-8 channels @ 2 MHz with 1-2 voice channels**
 - **Flexible channel and bandwidth configuration capabilities**
 - **Improved SNR**
 - **Less Time Base Error**
 - **No ITDE**
 - **Small size**
 - **Longer record time**
 - **Low-cost COTS media**
 - **Low maintenance costs**
 - **High reliability**

Wideband Analog Recorders: The Next Step

DTR-J16, AN/USH-24 Comparison

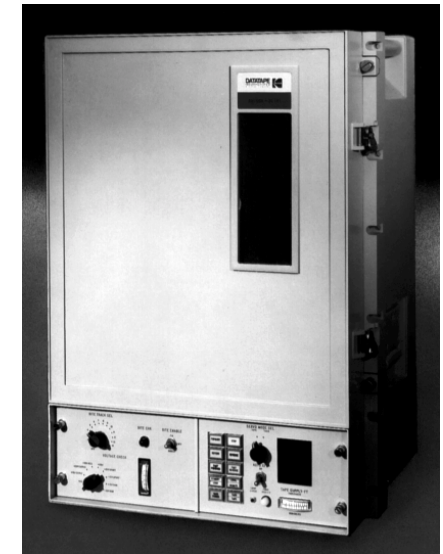


DTR-J16

- 16 Channels @ 1 MHz
- 8 Channels @ 2 MHz
- 14" Rack Height
- 63 pounds total weight
- 20 minutes record time
- 34 dB SNR
- ± 5 nsec TBE

USH-24

- 14 Channels @ 2 MHz
- 26.3" Rack Height
- 170 pounds total weight (not including reels)
- 15 minutes record time per 14" reel
- 26 dB SNR
- ± 150 nsec TBE



Wideband Analog Recorders: The Next Step

Comparison vs. Longitudinal Recorder

<u>Performance Parameter</u>	<u>New Analog Recorder</u>	<u>Longitudinal</u>
Number channels/bandwidth	8/2 MHz + 2/20 kHz	14/2 MHz
SNR (p-p signal/rms noise)	34 dB	26 dB
Time Base Error	10 ns	300 ns
Group Delay	30 ns	1 μ s
Flutter	not applicable	0.25% p-p
Dynamic Skew	not applicable	0.3 - 2 μ s
Record Time	20 minutes	15 minutes

Wideband Analog Recorders: The Next Step

Comparison vs. Longitudinal Recorder

<u>Performance Parameter</u>	<u>New Analog Recorder</u>	<u>Longitudinal</u>
Media	SVHS ST-120 Cassette	14" reel
Media Cost	< \$10	\$100-\$200
Media Volume	0.03 ft ³	0.14 ft ³
Rewind Time	2.8 minutes	8 minutes
Power Consumption	75 Watts	500 Watts
Rack Height	14-inches	6-feet
Weight	< 25 lbs.	170 lbs.
Volume	0.6 ft ³	4.62 ft ³

Wideband Analog Recorders: The Next Step

Conclusion: Analog vs. Longitudinal Recorders

- **The Case for Analog Recorders over Longitudinal Recorders**
 - Cost-effective wideband recording solution
 - Increased capacity on COTS media
 - Low-cost COTS media
 - Low maintenance costs
 - Reduction of media weight/volume that is critical for many deployment platforms

Wideband Analog Recorders: The Next Step Summary

- **Wideband Analog Recorder has Cost Advantages Over Equivalent Digital Recorders**
- **Wideband Analog Recorders with TDMs Make Great Replacement for Longitudinal Recorders**