

**THIC Inc.**

The Premier Advanced Recording Technology Forum

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

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# 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 <sup>3</sup> )	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 <sup>3</sup> )	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 ft<sup>3</sup> vs 4.5ft<sup>3</sup>**
  - **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

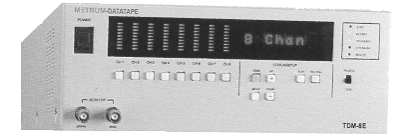


## DTR-16 Specifications

- **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 in<sup>3</sup> (0.6 ft<sup>3</sup>)
- **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

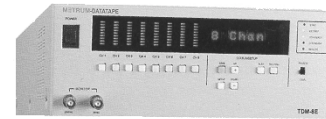


# Wideband Analog Recorders: The Next Step

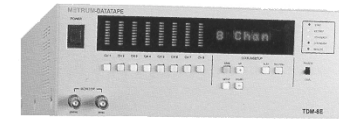
## Multi-Channel Recording



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
- $\pm 5$  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
- $\pm 150$  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 $\mu$ s
Flutter	not applicable	0.25% p-p
Dynamic Skew	not applicable	0.3 - 2 $\mu$ 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 <sup>3</sup>	0.14 ft <sup>3</sup>
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 <sup>3</sup>	4.62 ft <sup>3</sup>

# **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**