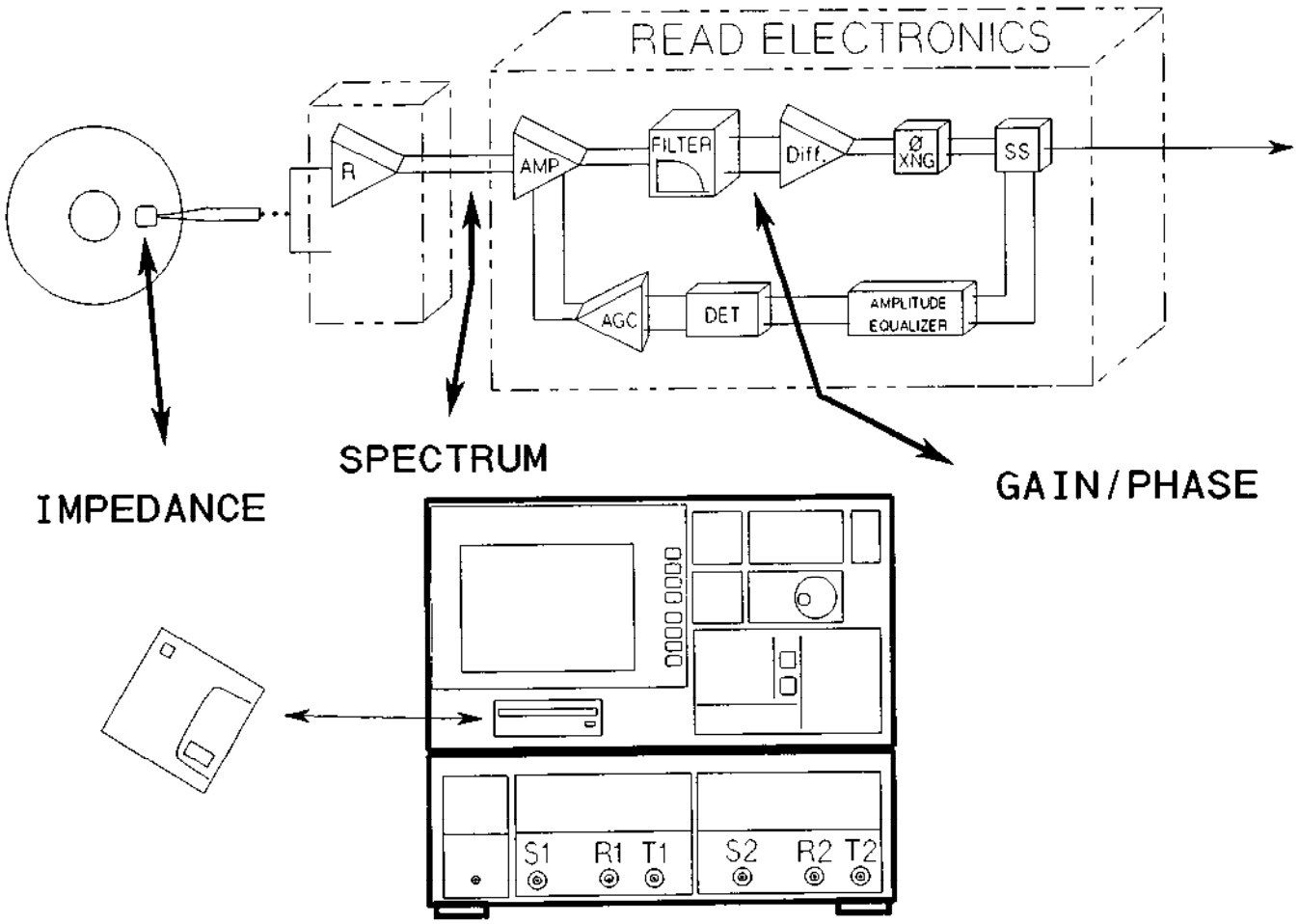
HEWLETT PACKARD

AN 357-4

# TESTING MAGNETIC DISK READ CIRCUITS

# USING THE HP 4195A




## HP 4195A
## NETWORK / SPECTRUM / IMPEDANCE
## ANALYZER

New hard disk designs are pushing cost/performance limits, and the required design cycle times required to be competitive in today's market are quickly decreasing. The HP 4195A gives the hard disk circuit design engineer the combined power of Spectrum Analysis, Network Analysis, and Impedance Analysis with standalone programability or under control of an external computer via its built in HP-IB interface. The HP 4195A is a flexible test system.

An important feature often overlooked is: when using a combined instrument such as the HP 4195A the operating technique is common for Impedance, Network, and Spectrum Analysis, thus much greater measurement efficiency is realized. You learn the operation of a single instrument and one easy instrument programming technique, but you have the power of a test system at your command.

## GROUP DELAY ANALYSIS

Group delay (the derivative of phase with respect to frequency) measurements are critical for the new breed of high density/thin film head R/W circuit designs. The most apparent result of group delay is the pulse shifting, and with today's closely spaced pulses there is little margin for pulse shifting without causing data errors. Hard disk read circuits must be carefully designed with emphasis placed on a circuit's Group Delay characteristics.

Group delay analysis using the HP 4195A's is straight forward. The HP 4195A's **THRU** calibration function, a differential probe, a North Hills wide band Balun Transformer (PN 0001 BB) at the input of the circuit under test, selecting an aperture setting, and simple test procedures allow accurate routine group delay measurements to be made. Figure 1 shows the measurement setup and gives a brief description of Group Delay. Figure 2 shows sample group delay measurement results.

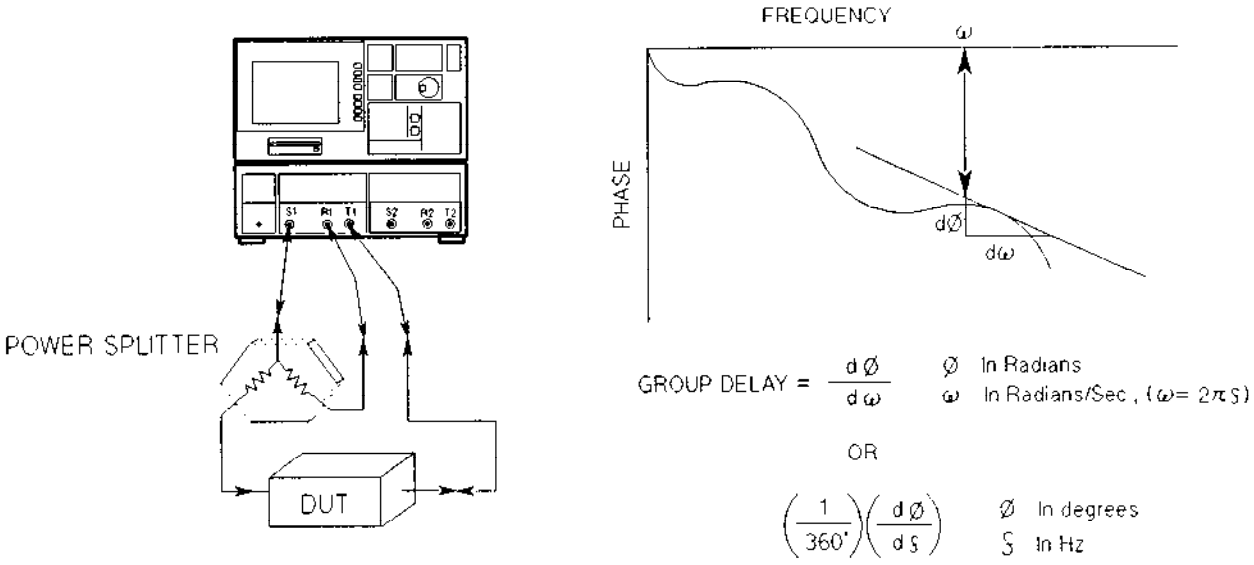



Figure 1. Group Delay Measurement Setup and Description

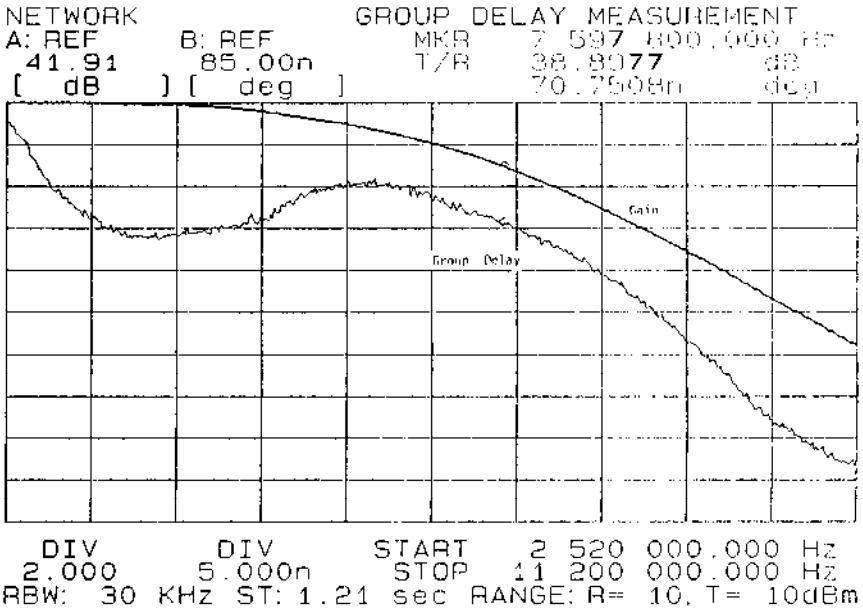



Figure 2. Group Delay Measurement Results

## MAGNETIC HEAD EVALUATION USING IMPEDANCE ANALYSIS

The magnetic heads used today and the thin film heads currently being designed must meet increasingly stringent requirements. The impedance characterization of magnetic heads alone and with their associated cabling must be measured accurately. The following measurement results were taken from standard type magnetic heads. Among the possible measurement techniques are: current drive, constant bias current, frequency,drive level sweep, linear and log sweep. Figure 3 shows the measurement setup and Figure 4 shows the shift in the resonance point as the capacitance and inductance of the cable assembly is added to the magnetic head.

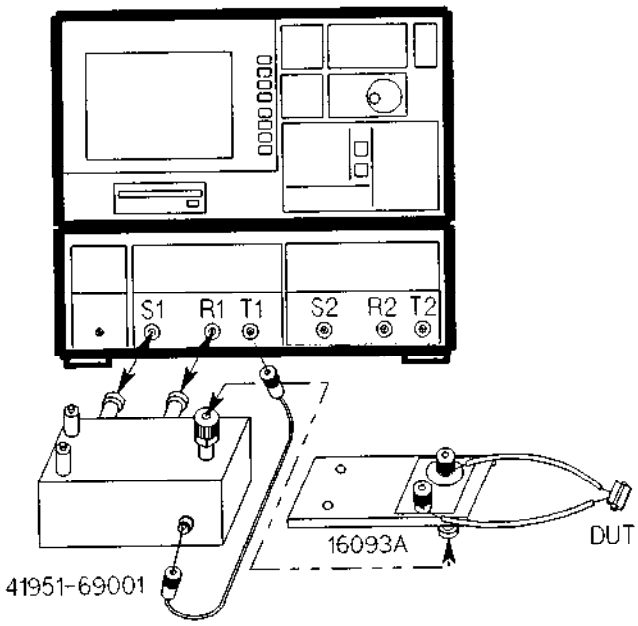



Figure 3. Impedance Measurement Setup

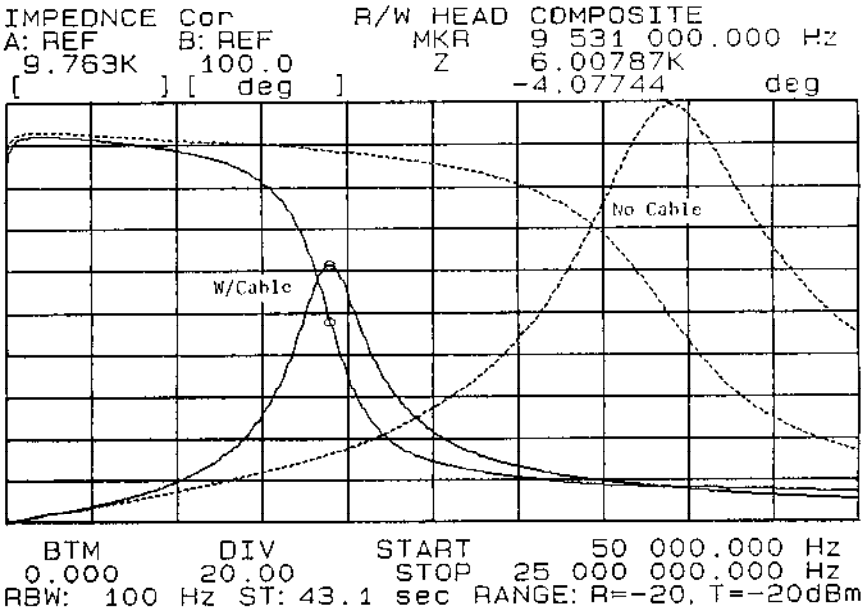



Figure 4. Magnetic Head Impedance Characteristics

## PREAMPLIFIER AND AMPLIFIER ANALYSIS USING SPECTRUM ANALYSIS

Low distortion preamplifier and amplifier design is very critical with today's increased data rates and resolution requirements. In addition to Harmonic related signal analysis, the HP 4195A is used to detect amplifier instabilities and oscillation problems. The HP 4195A has two spectrum analyzer inputs which can be connected to different points in a circuit and then switched as needed, you don't have to physically move the circuit connections. Figure 5 shows the measurement setup and Figure 6 shows sample measurement results.

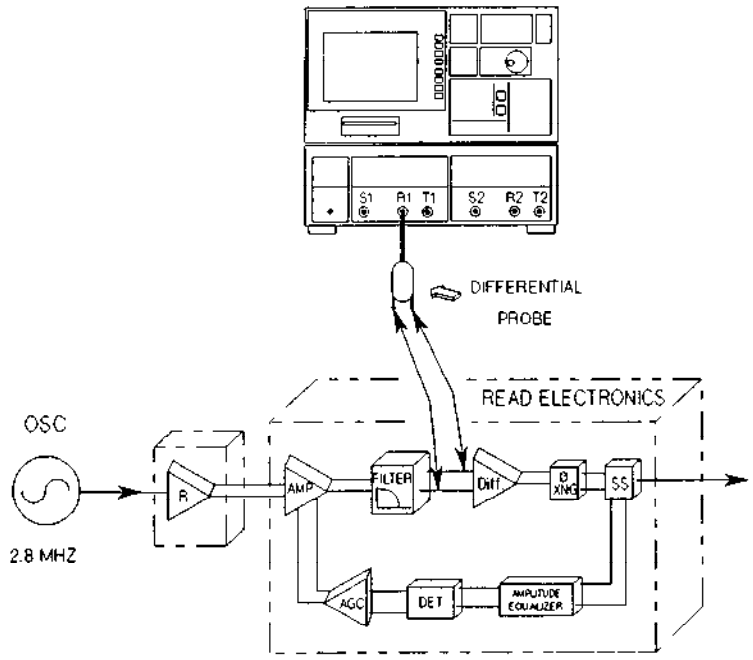



Figure 5. Spectrum Analysis Setup

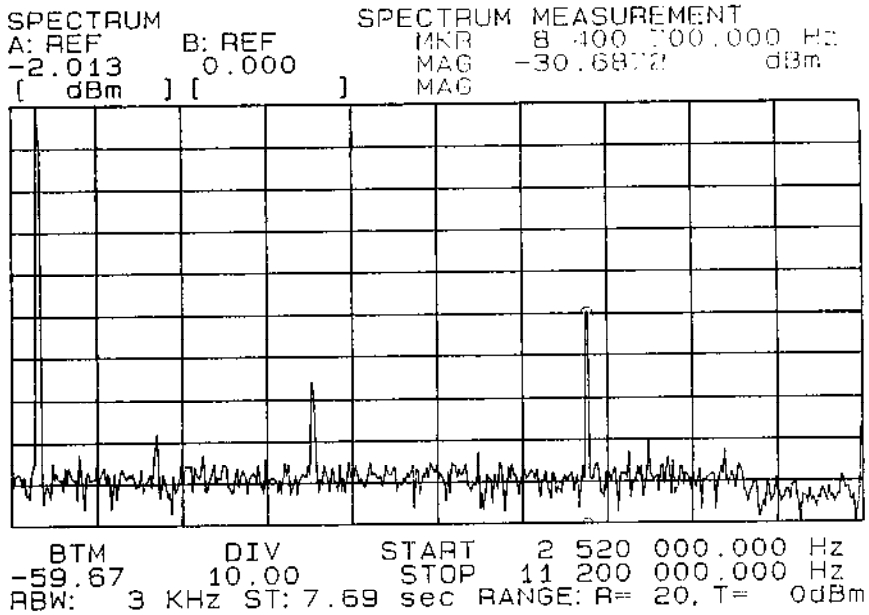



Figure 6. Spectrum Analysis Measurement

**OVERWRITE MEASUREMENT**

Traditional R/W heads and electronics have used the overwrite measurement as an overall indicator of the analog read/write channel's quality. The spectrum analysis function, used in the manual mode or with an ASP program (the ASP program given for THD measurement can be modified and used), makes this spectrum analysis 1f/2f measurement a snap. Figure 7 shows the Overwrite measurement setup and Figure 8 shows a sample of overwrite measurement results.

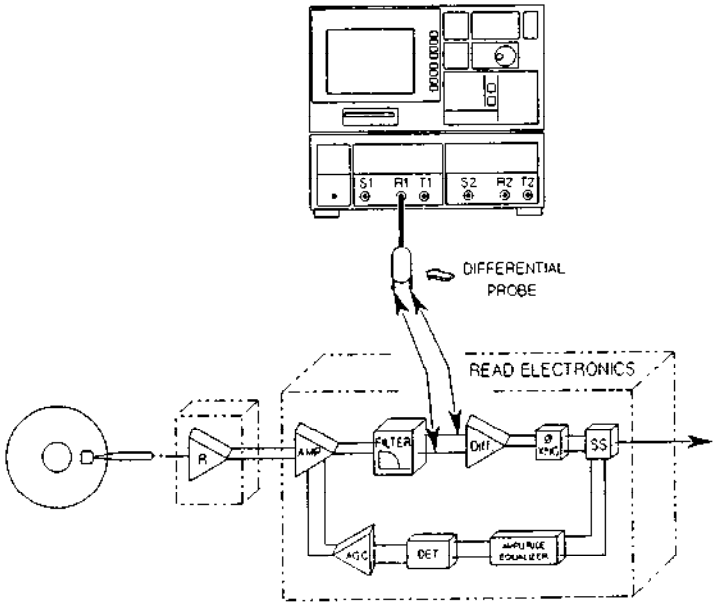



Figure 7. Overwrite Measurement Setup

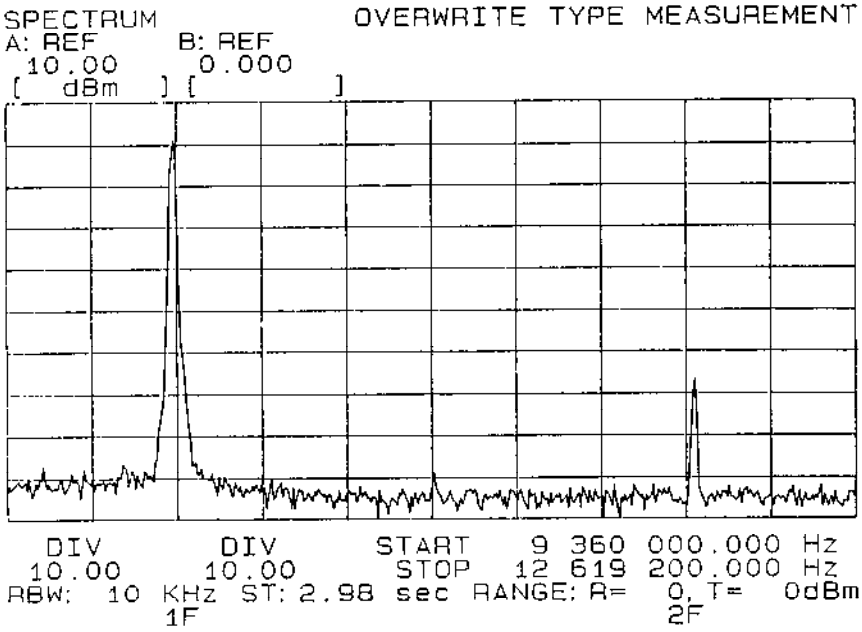



Figure 8. Overwrite Measurement Results

**TOTAL HARMONIC DISTORTION (THD) MEASUREMENT**

THD measurement using the HP 4195A can be realized using the following User Program function or can be performed manually. Figure 9 shows the measurement setup and Figure 10 show some example measurement results.

```
 10 FNC2                          ! Select Spectrum Function
 20 RST                           ! Initialize the HP 4195A
 30 ATR1=50;SWM2                  ! Spectrum, R1 Atten=50 DB, Single Sweep
 40 R4= 1.0 MHZ                   ! Enter fundamental frequency here
 50 START= 0.9 * R4 MHZ           ! Calculate START frequency
 60 STOP= 4 * R4                  ! Calculate STOP frequency
 70 REF= 10 DBM;BTM= -100 DBM     ! Initial scale values
 80 RBW= 100 HZ                   ! Initial RBW value
 90 !
100 DISP 'SETUP TEST AND HIT CONTINUE'
110 PAUSE

120 SWTRG                         ! Do a Single Sweep measurement
130 MKMX;MKREF;MKMN;R6=MKRA;BTM=R6  ! Rescale to real measurement value
140 CMT "THD MEASUREMENT"         ! Label screen
150 !
160 MCF2;MKACT1;ANA1              ! Select markers, turn Partial Analysis ON
170 !

180 FOR R9 = 1 TO 3, 1            ! Measure fundamental, 2nd, and 3rd
190     MKR= R9*R4 + R9*0.01*R4 MHZ
200     SMKR= R9*R4 - R9*0.01*R4 MHZ
210     ARSTR                     ! Store frequency window values
220     MKMX                      ! Move marker to MAX point in window
230     E(R9)= MKRA               ! Store at position R9 in array E
240     WAIT 1000                 ! This delay can be removed
250 NEXT R9
```

*In line 260 [ and ( are used for clarity, in the ASP program input to the 4195A only ( brackets are used.*

```
260 R0= SQR( [ (10**(E(2)/10)) + (10**(E(3)/10)) ] / [ 10**(E(1)/20) ] ) * 100
270 DISP 'THD= ',R0
280 ANA0                          ! Turn partial analysis OFF and HALT
290 END
```

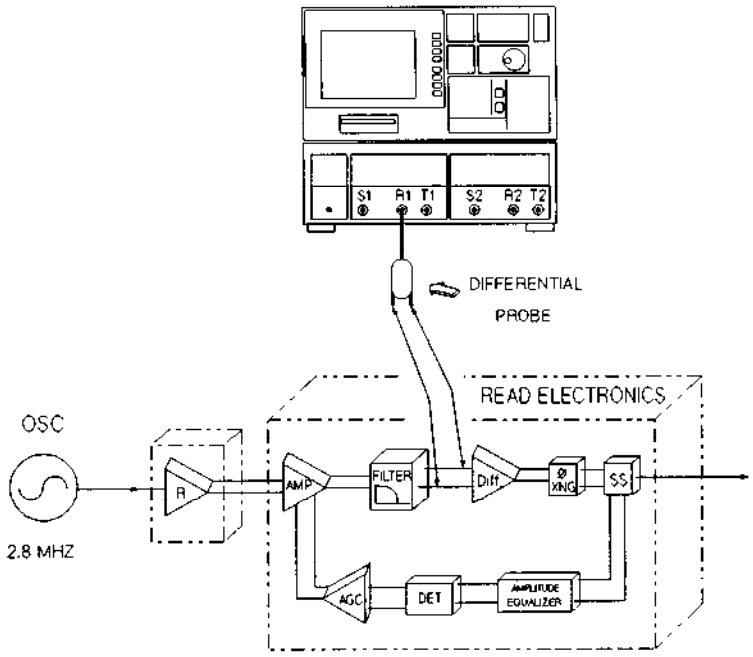



Figure 9. THD Measurement Setup

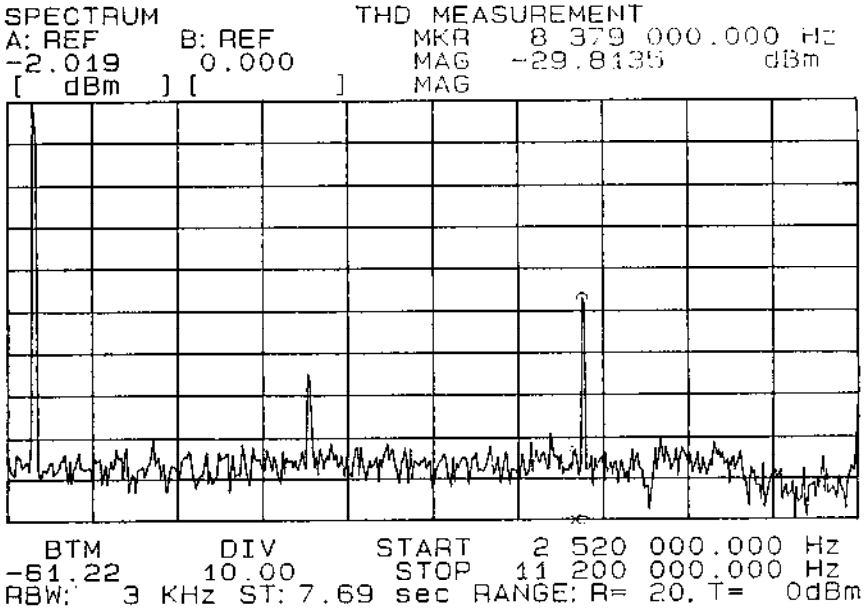



Figure 10. THD Measurement Results

## LOWPASS FILTER ANALYSIS USING NETWORK ANALYSIS

Precise characterization of the low pass filter circuits is critical for todays hard disk R/W circuits, not only must the impedance characteristics be known for impedance matching and the cut off frequency, but the low pass filter's group delay characteristics must be tailored to meet the design objectives. The -3 dB break point is quickly and accurately found using the HP 4195A's **oMKR&LCURS** softkey, **MKR->MAX** softkey, and the Δ **MODE** function. Figures 11 and 12 show the measurement setup and some sample test results.

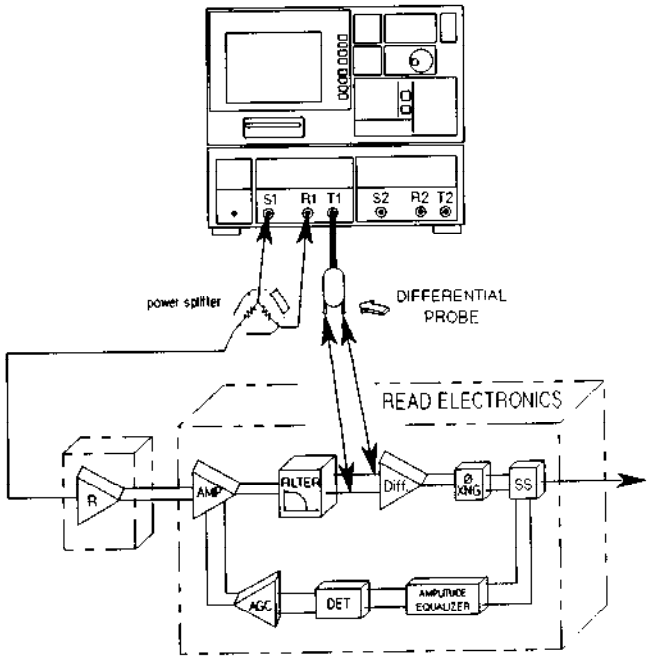



Figure 11. Lowpass Filter Measurement Setup

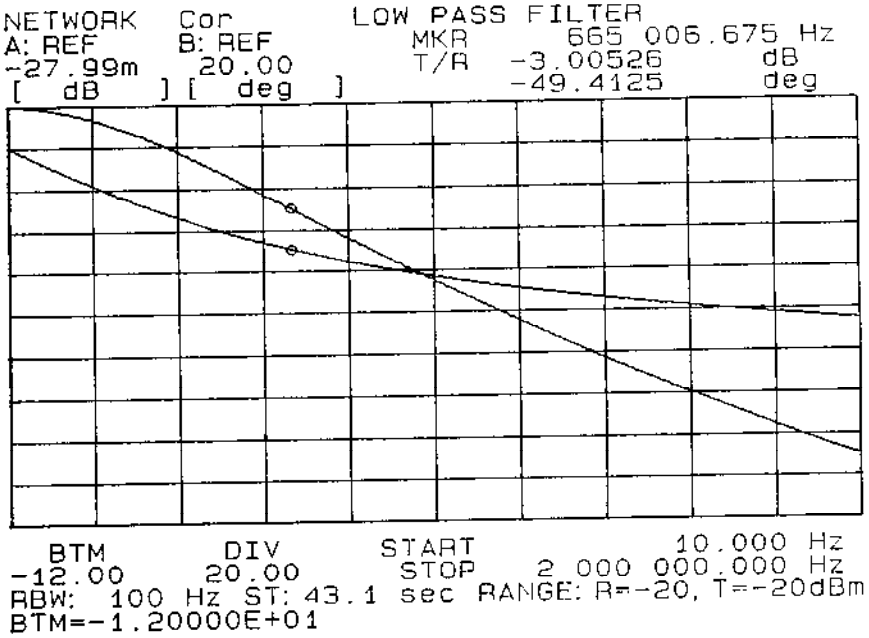



Figure 12. Lowpass Filter Measurement Results

## AGC MEASUREMENT

The AGC characteristics of the R/W electronics is an easy task for the HP 4195A. You set up for a Gain/Phase measurement, select a spot frequency, press the **SWEEP** function **MENU** key, the **PRMTR menu** softkey, and the **OSC LVL (dBm)** softkey, then select the start and stop levels for the sweep. The storage function was used in Figure 14 to show the measurement results for an AGC measurement for different supply voltages, and to show the effect of different filter settings on the AGC circuit response. Figure 13 shows the measurement setup.

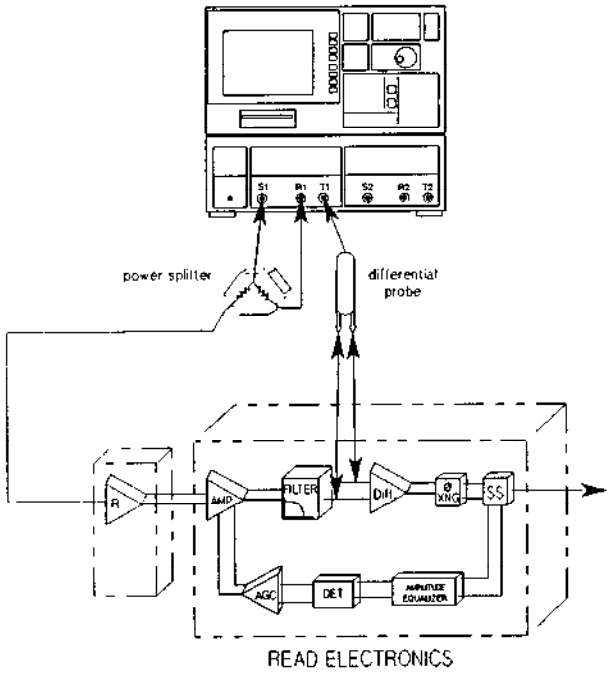



Figure 13. AGC Measurement Setup

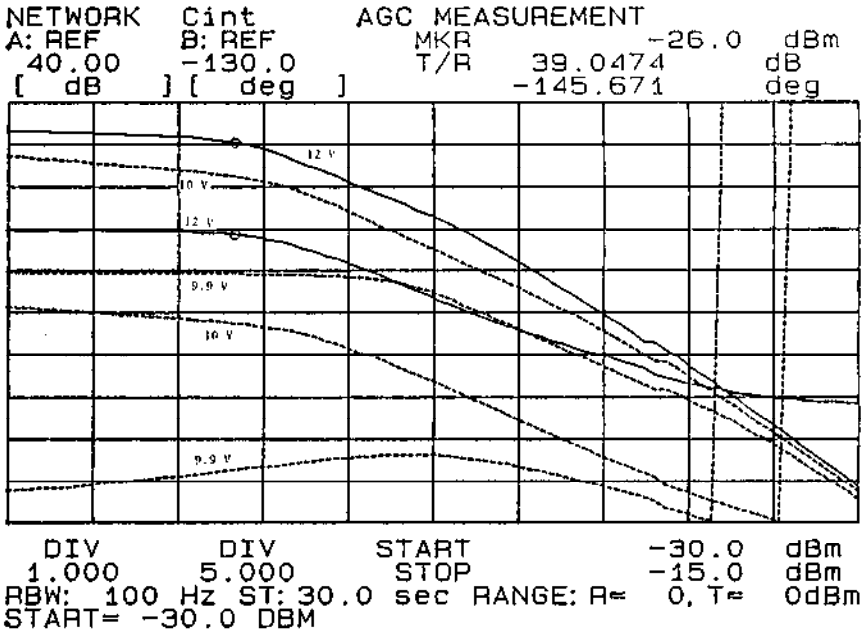



Figure 14. AGC Measurement Results (Supply Voltage Effects)

Figure 15 shows the effects on AGC response for different filter settings.

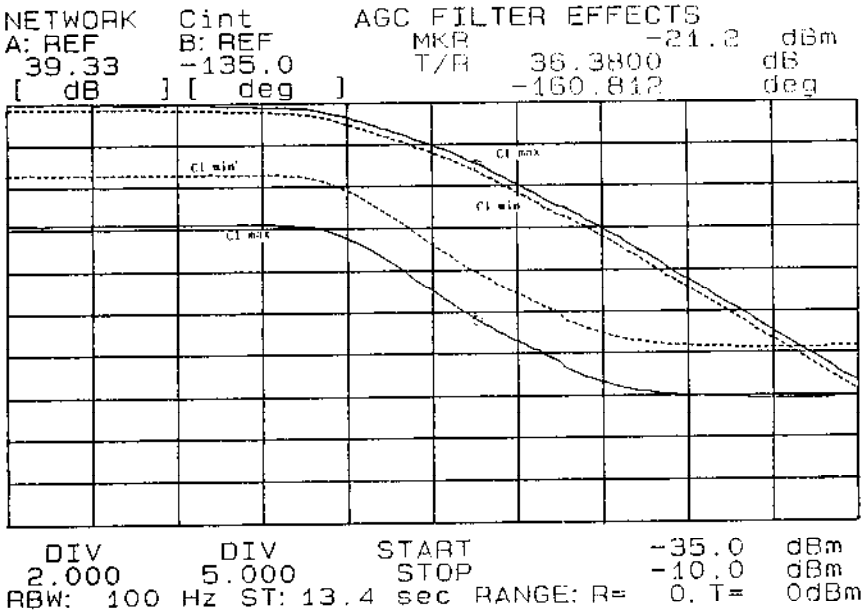



Figure 15. AGC Measurement (Filter Effects)

**STORING TEST SETUPS**

When test setups are created on the fly the design engineer must be able to save them, so they can be used again later as a **TOOL** which can be recalled, used, and modified if required. Select the **GET/SAVE** key, the '**SAVE**' softkey and choose from the '**STATE**' or '**PROG TABLE**' or '**DATA**' or '**PROGRAM**' softkeys, enter a file name and hit the **ENTER** key to create libraries of test routines, save measurement results, instrument setups, and ASP test programs. The HP 4195A is listed as an instrument, but in fact it is a *TEST SYSTEM IN A BOX*, a standalone automated test system.

**CREATING TEST TECHNIQUES**

Design is a creative art, so the measurement instruments used by design engineers must contribute to their creativity by being versatile and easily set up. The HP 4195A's combination of three instruments in one is really just the tip of the iceberg, with its standalone programability and its controllability from an outside source the HP 4195A is a flexible and configurable measurement system rather than just a measurement instrument. A combination instrument gives you a cleaner way to create new tools to help you get the job done! Your creativity will be enhanced and the people who keep an eye on the *"Bottom Line"*, will be happy!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