Pulse/echo response of 52 micron PVDF with silver ink electrodes

R H Brown 29 March 2002

A 30 x 12 mm active area (screen-printed Ag-ink electrodes) 52 µm PVDF element was bonded using thin layer of epoxy resin to a PMMA block of thickness 9.4 mm.

The transducer was driven by an Accu-tron pulser/receiver Type 1035PR, with settings: gain +20 dB, attenuation –10 dB, energy 1, damping 5. Signals were captured using a Gould 5110 digital storage oscilloscope (8 bit x 1024 dp), and saved, post-processed and displayed on a HP9000/310 controller.

The test sample was set up with a spacer on the front PVDF surface, which provided a 3.2 mm depth of cavity which was filled with water. A thin (0.5 mm) brass sheet was placed over the spacer, to provide a reflecting surface. Note that much of the acoustic energy travelled into the PMMA backing medium, which created an echo at 7.29 µs after trigger.

Although the pulser/receiver has high bandwidth on the receiver amplifier (35 MHz quoted), the spectrum of the transmit pulse is heavily biased towards the lower frequencies. Therefore, the FFT of the received echo signal was later divided by the spectrum of the transmit pulse, in order to arrive at an estimate of the true shape of the frequency response curve for this transducer.

Note that the center frequency is approximately 12 MHz, with –6 dB bandwidth from 6.0 to 17 MHz (BW = 11 MHz) and thus Q = 1.09

Note also that the capacitance of this sensor was measured at 670 pF at 10 kHz, but was expected to drop to around 350 pF at 10 MHz. The expected impedance at center frequency of 12 MHz is thus around 50 ohms.

The attached traces show full time waveform (NB: on this trace, 0 µs does NOT correspond to time t=0; a slight delay of approx 1 µs was set on the B timebase), edited echo response, and the transmit pulse waveform. Spectra (FFT results) are presented for the edited echo signal, the transmit pulse signal, and the division of these two spectra.

Any questions regarding the above notes should be directed to:

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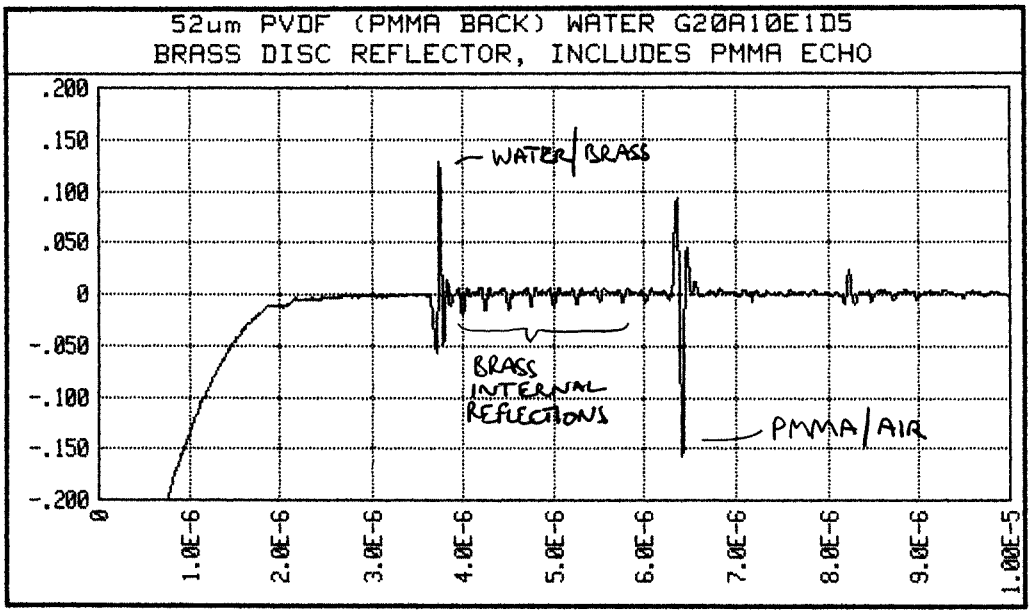
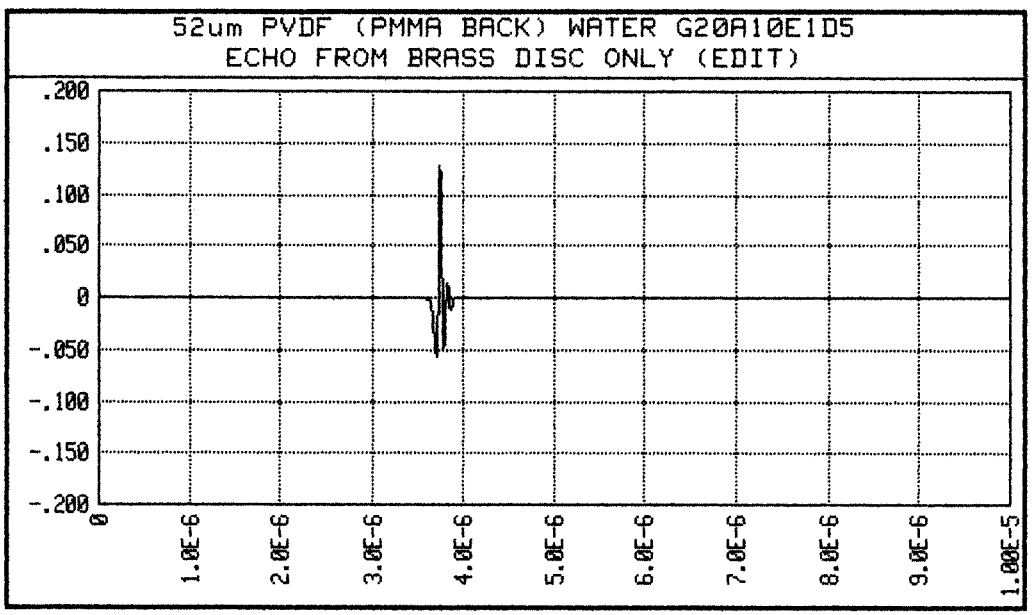
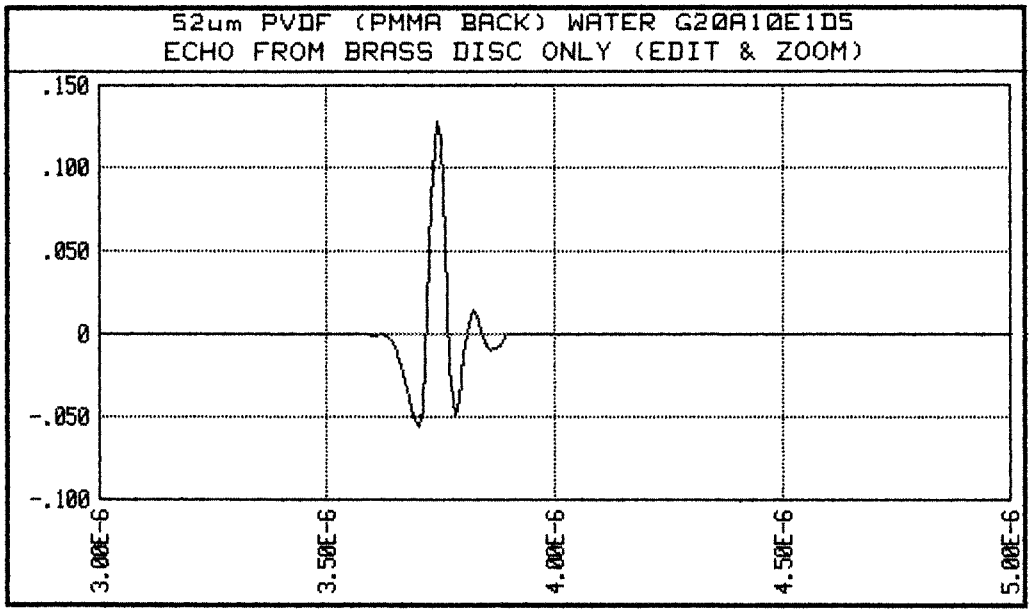
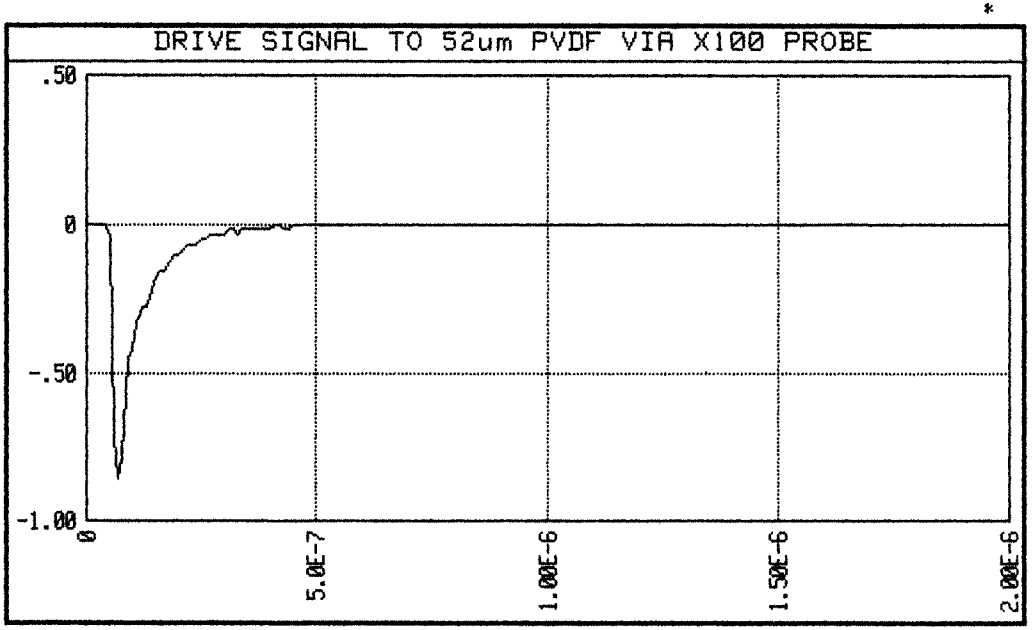
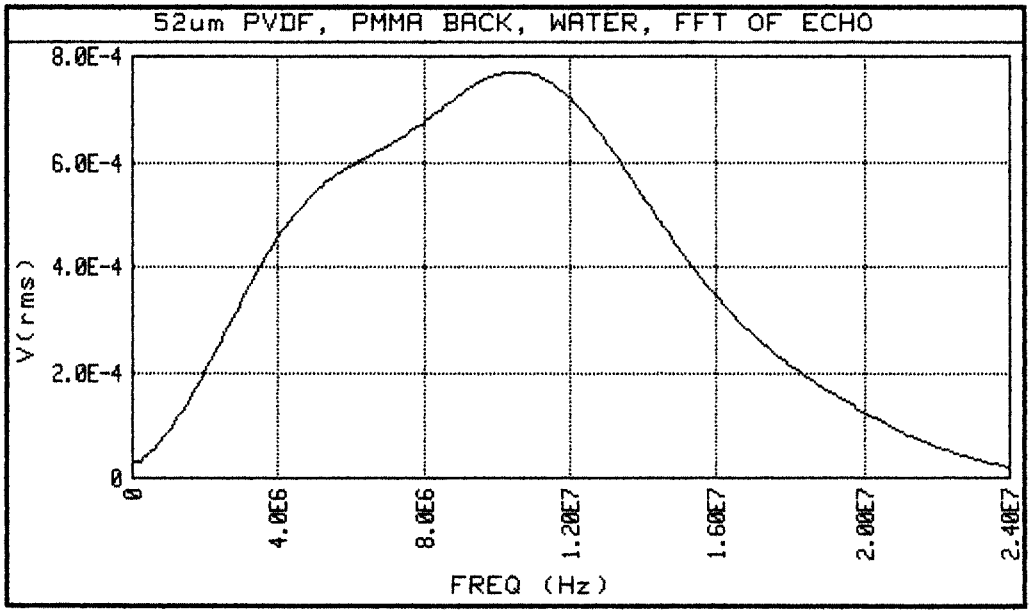

52um PVDF (PMMA BACK) WATER G20A10E1D5
BRASS DISC REFLECTOR, INCLUDES PMMA ECHO
.200
.150
.100
.050
0
-.050
-.100
-.150
-.200
WATER/BRASS
BRASS INTERNAL REFLECTIONS
PMMA/AIR
0
1.0E-6
2.0E-6
3.0E-6
4.0E-6
5.0E-6
6.0E-6
7.0E-6
8.0E-6
9.0E-6
1.00E-5

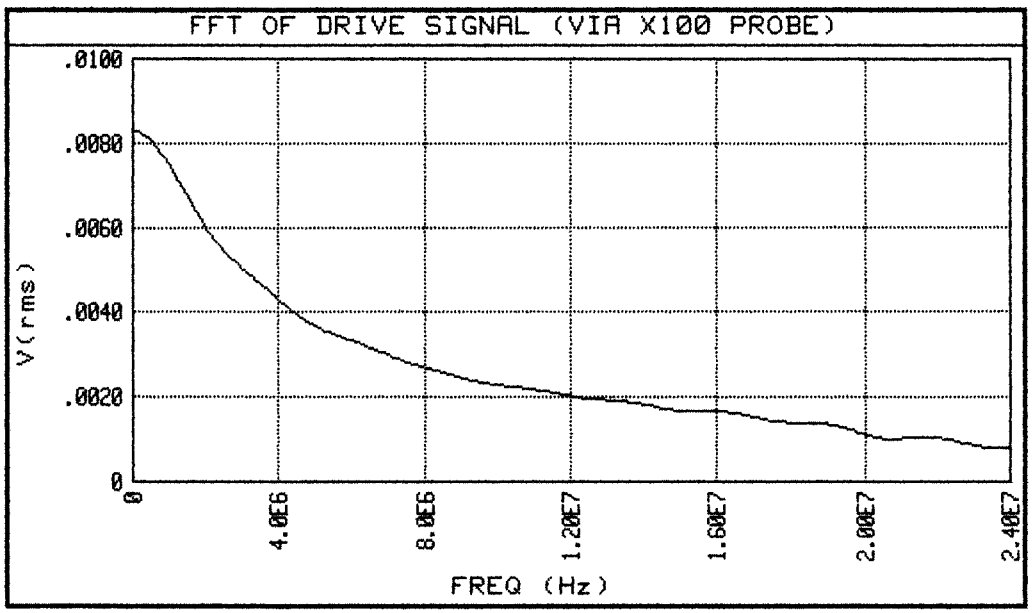
*

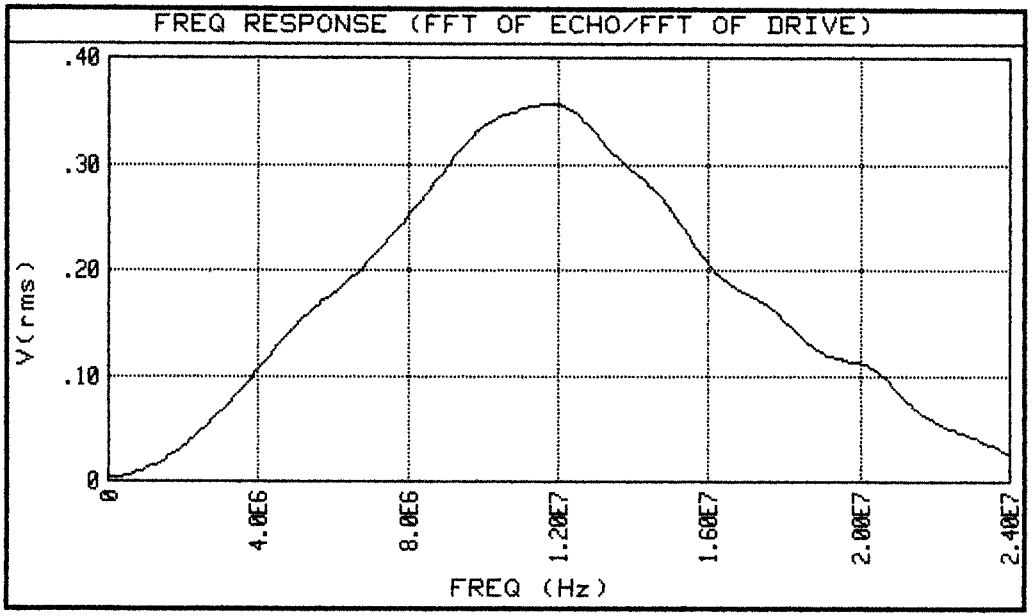

52um PVDF (PMMA BACK) WATER G20A10E1D5
ECHO FROM BRASS DISC ONLY (EDIT)
.200
.150
.100
.050
0
-.050
-.100
-.150
-.200
0
1.0E-6
2.0E-6
3.0E-6
4.0E-6
5.0E-6
6.0E-6
7.0E-6
8.0E-6
9.0E-6
1.00E-5


52um PVDF (PMMA BACK) WATER G20A10E1D5
ECHO FROM BRASS DISC ONLY (EDIT & ZOOM)
.150
.100
.050
0
-.050
-.100
3.00E-6
3.50E-6
4.00E-6
4.50E-6
5.00E-6


DRIVE SIGNAL TO 52um PVDF VIA X100 PROBE
.50
0
-.50
-1.00
0
5.0E-7
1.00E-6
1.50E-6
2.00E-6


52um PVDF, PMMA BACK, WATER, FFT OF ECHO
8.0E-4
6.0E-4
4.0E-4
2.0E-4
0
V(rms)
0
4.0E6
8.0E6
1.20E7
1.60E7
2.00E7
2.40E7
FREQ (Hz)


FFT OF DRIVE SIGNAL (VIA X100 PROBE)
.0100
.0080
.0060
.0040
.0020
0
V(rms)
0
4.0E6
8.0E6
1.20E7
1.60E7
2.00E7
2.40E7
FREQ (Hz)


FREQ RESPONSE (FFT OF ECHO/FFT OF DRIVE)
.40
.30
.20
.10
0
V(rms)
0
4.0E6
8.0E6
1.20E7
1.60E7
2.00E7
2.40E7
FREQ (Hz)

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