50X1-HUM [redacted]

INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

[redacted]

This material contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C. Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

50X1-HUM

~~SECRET~~

50X1-HUM

COUNTRY	East Germany	**REPORT**	[redacted]
SUBJECT	Temporary Technical Requirements for a Pulse-Spectrum Analyzer Designed by the Koepenick Radio Plant	**DATE DISTR.**	10 JUL 1962
		NO. PAGES	8
		REFERENCES	RD

[redacted]

50X1-HUM

DATE OF INFO. [redacted]

PLACE & DATE ACQ. [redacted]

[redacted] 50X1-HUM

THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

[redacted]

50X1-HUM

~~SECRET~~

GROUP 1
Excluded from automatic downgrading and declassification

50X1-HUM

STATE	#X	ARMY	#X	NAVY	#X	AIR	#X	NSA	X	[redacted]		DIA	X	SCS X
										USIA-X				

(Note: Washington distribution indicated by "X"; Field distribution by "#".)

50X1-HUM

INFORMATION REPORT INFORMATION REPORT

[redacted]

50X1-HUM

S-E-C-R-E-T

REPORT [redacted]

[redacted]

COUNTRY : East Germany

DATE DISTR. 11 JUN 62

SUBJECT : Temporary Technical Requirements for a Pulse-Spectrum Analyzer Designed by the Koepenick Radio Plant

NO. OF PAGES 7

REFERENCES:

50X1-HUM

DATE OF INFORMATION [redacted]

PLACE ACQUIRED

THIS IS UNEVALUATED INFORMATION

50X1-HUM

[redacted]

S-E-C-R-E-T

50X1-HUM

[redacted]

Introduction.

At the request of the Dresden Aircraft Plant (Plant 803) in 1958, a study was prepared at the Koepenick Radio Plant (VEB Funkwerk Koepenick) on a pulse-spectrum analyzer the latter was designing for Plant 803. The study was written by Ing. Walter Hasse, a member of the Koepenick plant Radar Development Department [redacted] The following is a translation [redacted]

50X1-HUM

Pulse-Spectrum Analyzer

[redacted]

50X1-HUM

I. Preliminary Technical Requirements.

1.1	Frequency range	$10,000 : 10^6$ cps range
1.2	Pulse duration	$0.1 \cdot 10^{-6}$ to $2 \cdot 10^{-6}$ seconds
1.3	Pulse sequence	500 - 3000 cps
1.4	Intermediate-frequency input sensitivity ? 62 megacycles	Better than $1 \cdot 10^{-3}$ volts relative to a pulse duration of $0.1 \cdot 10^{-6}$ seconds for 50-millimeter amplitudes
1.5	Intermediate-frequency band width	$50 \cdot 10^3$ cps
1.6	Allowable interference voltage for the (intermediate-frequency) signal	$\leqq$ 1 percent
1.7	Frequency for the X-deflection (frequency of the saw-tooth voltage for the carcinotron)	20 to 51 cps continually adjustable
1.8	Allowable amplitude change with frequency change	$\leqq$ 3 percent
1.9	Amplitude for the saw-toothed voltage	
	a) Frequency modulation of the carcinotron:	0 to 200 volts constantly adjustable
	b) X-deflection on the fluorescent screen:	1.5 x screen diameter deflection symmetrical to the center of the screen
1.91	Linearity of the voltage in 1.9a	$\leqq$ 2 percent
1.92	Pulsation factor of the voltage in 1.9a	$\leqq 1 \cdot 10^{-3}$ volts ptp

50X1-HUM

[redacted]

II. Other Requirements.

2.1 The deflection frequency must be able to be synchronized with the respective pulse frequency.

2.2 In order to produce the zero-line, the X-signal must become zero for every 2.), 4.), 6.), etc. deflection, i.e., the intermediate-frequency input must be short-circuited by a switch (flip-flop).

2.3	The size of the spectrum (maximum amplitude)	100 millimeters
2.4	Linear range of adjustment of the intermediate-frequency channel	20 : 1
2.5	Maximum input amplitude of the intermediate-frequency channel	20 millivolts
2.6	Net voltage	220 V $^{+15\text{ V}}_{-30\text{ V}}$ 50 cps
2.7	Operating conditions	Operated in the laboratory for 8 hours without interruption.

Pulse-Spectrum Analyzer

(Extracted from 1552)

1.1 A high-frequency pulse-spectrum analyzer, that automatically resolves a Fourier analysis, is represented electronically. The required measuring marks for the analysis of the spectrum are gated into the electronic image. The size may be read directly from calibrated scales.

1.2 Pulse-Spectrum Analyzer

1.3 Tech. Object

In order to be able to determine the power losses that result as an echo in radar instruments which the high-frequency pulse generator emits, a spectrum analysis is to be made, because all the well-known output meters integrate, i.e., they do not give any information as to the distribution of the high-frequency spectrum.

The analyzer is to allow spectrums to be analyzed according to Fourier with an impulse duration from $0.1 \cdot 10^{-6}$ to $2 \cdot 10^{-6}$ seconds in connection with a pulse-recurrence frequency of 500 to 3000 cps.

It will be possible to investigate spectra from 1 to 100 milliwatts.

1.4 Methods of Solution

Maximum-frequency superheterodyne receiver, the oscillator of which will be frequency modulated over a range from ±40 to 60 megacycles, in connection with which the frequency fluctuation can be continuously changed from zero up to the maximum value mentioned. The receiver, therefore, scans a frequency range up to the maximum frequency fluctuation in which the pulse spectrum that is to be investigated is situated. The carrier frequency of the oscillator and, therewith, the receiver may be changed over a wide range.

In order to produce a line spectrum which corresponds to the enveloping spectrum pattern, a small frequency sector is selected for each individual sweep of the pulse spectrum.

50X1-HUM

[redacted]

Small intermediate-frequency selectivity-curve by converting to a second intermediate frequency of lower nominal frequency with which a band width from 50 kilocycles or less can be obtained. The scanned small frequency-range is rectified and amplified and conducted to the J-scope. The time axis (X-axis of the oscillograph) was modulated synchronously with the frequency modulation of the scanning generator, so that a steady image of the spectrum resulted.

By using a magnetic-T in the high-frequency section of the analyzer, a cavity frequency meter will produce a pulse by passing through the resonance frequency, which is conducted to the tubes of the oscillograph after rectification and amplification of the Z-axis. In this way, of course, a bright or dark mark is produced on the fluorescent screen after the polarity is selected, which corresponds to the position of the instantaneous frequency that passes through. By detuning the frequency meter, it is possible to determine the frequency by an arbitrary point on the screen of the oscillograph.

50X1-HUM

[redacted]

Subject: Preliminary Technical Requirements for a Pulse-Spectrum Analyzer of the Institute of Electrotechnology, Main Department High-Frequency

In recalculating the data presented for the projected pulse-spectrum analyzer, it is shown that we must ask for some changes in the data in order to make the instrument usable for our purposes. Basically they are the same requirements which you too have made on the measuring instrument, because the wavelength and the pulse width are the same as with us. In the following the individual data in regard to the pulse-spectrum-analyzer are taken into consideration:

1. Intermediate Frequency. The value of the intermediate frequency is not indicated in your technical specifications. In order to avoid overlapping the two pulse spectra by a frequency of $f_{sign} \pm f_{ZF}$, the intermediate frequencies must be expressed as

Equation 1: $\chi_{ZF} = \frac{4}{\tau_{min}}$

if the shorter impulse(s) to be investigated is designated with τ_{min}, provided we take it as a basis that in the output in 4. the secondary radiation is 1/3 percent of the output in the primary radiation of the spectrum and contributes a small important contribution to the amplitude of the spectrum. In order to make the spectrum of the 0.1 microsecond-long pulse visible, the intermediate frequency must, therefore, be at least 40 megacycles.

[redacted]

50X1-HUM

50X1-HUM

[redacted]

3. The Required Sensitivity of the Input. The sensitivity of the intermediate-frequency amplifier, which was given by you as < 1 millivolt is not adequate in our opinion. If one assumes that the proportionality between intermediate frequency and the signal amplitude should be guaranteed, then the following relationship should exist:

Oscillator voltage = 10 x signal voltage
or
Oscillator output = 100 x signal output.

For an optimum degree of mixing action from the 1 N 23 B mixing detectors or similar crystals, the oscillator output must amount to 1 millivolt.

For this reason the signal output may be a maximum of 10 microwatts. With a degree of mixing action of from 10 to 25 percent (mixing damping from 10 to 6 decibels), an output of only about 1 microwatt reaches the receiver input. With an assumed mixing crystal resistance of 300 ohms, an intermediate-frequency voltage of

Equation 2: $U_{Zf} = \sqrt{N \cdot R_{Krist}} = \sqrt{10^{-6} \cdot 300} = 17.3$ millivolts.

is, therefore, in the crystal. By using a small-band intermediate-frequency amplifier, the portion of the transmitted impulse voltage is proportional to

Equation 3: $\alpha = \frac{3\tau \cdot \Delta f}{2}$

in which τ = impulse length (s) and Δf is the band width of the intermediate-frequency amplifier (cps). If this factor is taken into consideration, the intermediate-frequency amplifier sensitivity must, therefore, amount to

Equation 4: $U_{Eing} = U_{Zf} \cdot \alpha = 17.3 \cdot 10^{-3} \cdot \frac{3 \cdot 0.1 \cdot 10^{-6} \cdot 50 \cdot 10^{3}}{2} \approx 130$ microvolts.

In order to have a reserve, the input sensitivity must amount to about 50 microvolts.

The adjustment of the intermediate-frequency amplifier sensitivity should be between 20 and 100-fold in order to be adjusted to the optimum interference interval.

4. Time-Base Frequency. Designing the equipment with a time-base frequency of from 20 to 51 cps is not sufficient. The 50-kilocycle-wide filter of the intermediate-frequency amplifier must pass through a wide frequency band. Since each band width has a transient period that is characteristic only for it, the sweep time through the frequency range must not be too great, i.e., the sawtooth time-base frequency for time deflection and the synchronous wobbling of the reflectors must not exceed a definite value in meagacycles per second, so that one of the real voltages present gives a proportional indication.

The transient period for a band filter is defined as

Equation 5: $\tau = \frac{1}{2 \cdot \Delta f_{[cycles]}} \quad [s]$

50X1-HUM

[redacted]

and for the 50-kilocycle-wide filter used, it therefore amounts to

Equation 6: $\tau = \frac{1}{2.50 \cdot 10^3} = 0.010 \cdot 10^{-3} s = 10$ microseconds.

The duration of the filter must amount to at least 20τ for a sufficient indication (according to data by Kuepfmueller in System Theory of Electrical Communication Transmission), i.e., 20τ = 200 microseconds.

The range of frequencies the filter must go through differs for various pulse lengths. The greatest area to pass through belongs to the shortest pulse, the spectrum of which is still to be determined. In our case, the 0.1 microsecond long pulse amounts to about 60 megacycles, which is the extent of frequency range required for a good analysis of the frequency spectrum.

The time required to sweep 60 megacycles must, therefore, at least amount to

Equation 7: $\frac{60 \cdot 10^6 \text{ cycles}}{0.05 \cdot 10^6 \text{ cycles}} \cdot 200$ microseconds = 240 milliseconds.

This corresponds to a deflection frequency of at least

Equation 8: $\frac{1}{240 \cdot 10^{-3}} = 4$ kilocycles.

As the upper limit of the adjustable frequency for broader pulses with a narrower spectrum, 25 cps was proposed, because this produces a flicker-free picture and the spectrum can be analyzed by increasing the time-base frequency by decreasing the number of lines in the spectrum (see also Chapter 5). The synchronization of the deflection frequency with the impulse frequency is of no consequence for the analysis of the impulse spectra in that it only causes the lines in the spectrum to stop.

5. Oscillator. The oscillator wobbling of ±40 to 60 megacycles, which you anticipated, should in your instrument be dealt with by a carcinotron. It would be desirable to use one of them because then it would be possible to detune the frequency even more. If, however, we take into consideration that a tube such as this is not available in East Germany at the time nor in the year to come - we were, therefore, informed as to imports - a reflex klystron adequately fills the requirements after scanning a range from ±30 to 45 megacycles. In an extreme case it is necessary only to sweep 60 megacycles for the broadest spectrum, i.e., one 0.1 microsecond impulse with two secondary radiations at a time to the right and to the left of the primary radiation. A 723 A/B reflex klystron for the frequency of 9375 megacycles is, however, manufactured in East Germany.

6. Zero-Line Sweep. In our opinion, the flip-flop circuit which you have provided for alternately opening and closing the receiver input by sweeping the zero-line is unnecessary.

In chapter 4 it was calculated that the base-time frequency had to amount to from 4 to 25 cps. A Δf = 50-kilocycle-wide filter, therefore, continues through in beat from, for example, $f_1 = 4$ cps, i.e., all $1/f_1 = 250$ msec in an extreme case a frequency range from 60 megacycles. This means that it passes through 240 kilocycles per msec with an impulse sequence of $f_1 = 1000$ cps in [redacted] 50X1-HUM

connection with impulsing, i.e., an impulsing every 1 msec still gives enough time in which the filter that is integrated in excess of 50 kilocycles does not receive a voltage. In

Equation 9: $\frac{240\text{ kilocycles} - 50\text{ kilocycles}}{240\text{ kilocycles}} = 0.79 = 79$ percent

of the time the zero line is already recorded. Lines then appear as deflections in the vertical $\frac{1}{f_1} \cdot f_1 = \frac{1}{4} \cdot 1000 = 250$. In connection with higher time-base frequencies the dead-time ratio is still more important. With a base-time frequency of approximately $f_2 = 25$ cps the frequency range of 60 Mc is swept in $\frac{1}{f_2} = 40$ msec, i.e., the speed amounts to 1.5 Mc/msec. This means that in

Equation 10: $\frac{1500\text{ kilocycles} - 50\text{ kilocycles}}{1500\text{ kilocycles}} = 0.97 = 97$ percent

of the time the zero line is recorded. Deflections in the vertical then appear as $\frac{1}{f_2} \cdot f_1 = 1000 = 40$ lines, which is already meager for analyzing an impulse spectrum. For this reason the base-time frequency must not exceed 25 cps.

7. Pre-Damping at the High-Frequency-Input. The signal energy on the mixing crystal should not be any greater than 10 microwatts, based on an output proportional recording on the picture screen according to point 2. By pre-damping the high-frequency power in order to decrease any transmitter power that is greater than 10 microwatts, a variable and a fixed calibrated attenuation line and a directional integrator are provided so that a maximum of 200 kilowatts transmitter output can be damped to 2 microwatts by a total of at least 110 decibels.

50X1-HUM

[redacted]