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## FEATURE EXTRACTION OF ARC TRACKING PHENOMENON

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### ARC TRACKING

ELECTRIC ARC BETWEEN CONDUCTING WIRES DUE TO INSULATION  
BREAKDOWN

KAPTON INSULATOR

PROBLEM FOR AEROSPACE INDUSTRY

NASA (SPACELAB)  
US NAVY

### OBJECTIVE

TO OBTAIN THE SALIENT FEATURES OF ARC TRACKING PHENOMENON

### DATA ACQUISITION

#### CABLES

GAGES 20, 22, 24 (WITH KAPTON INSULATION)  
TKV (WITH KAPTON AND TEFLON INSULATION)

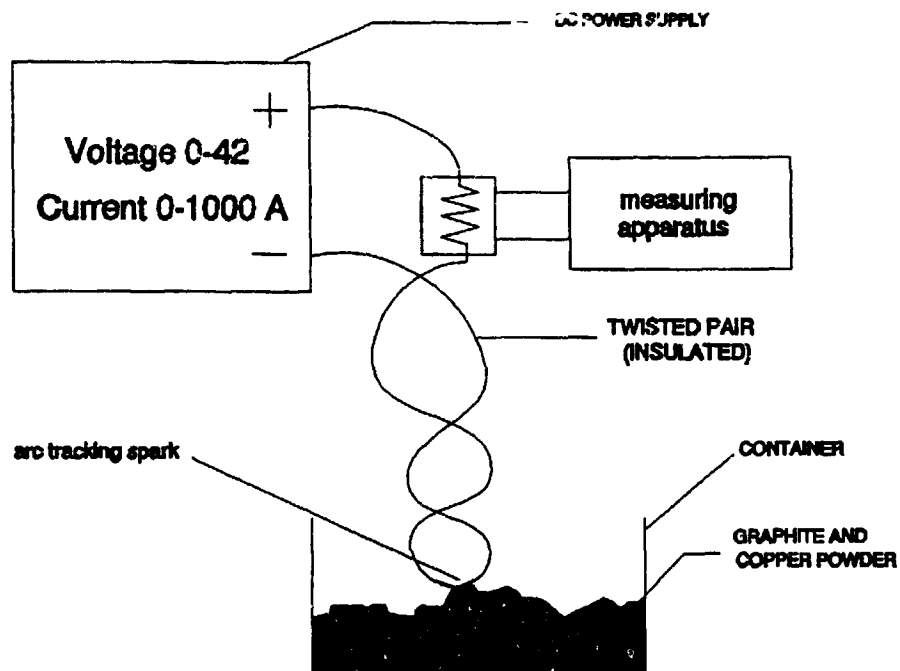
#### DC POWER SUPPLY

CAPABLE OF SUPPLYING UP TO 1000 A  
DC VOLTAGE OF THE SUPPLY - 10 V, 30 V AND 42 V

RECORD TIME - 2 SECONDS

SAMPLING RATE - 2000 Hz

DATA ACQUISITION SYSTEM



The lockheed experimental setup

## SIGNAL PROCESSING

### WELCH METHOD FOR COMPUTATION OF POWER SPECTRAL DENSITY

2 - SECOND DATA DIVIDED INTO 4 SECTIONS  
HAMMING WINDOW  
FFT PERFORMED AND ACCUMULATED

### MATLAB

WELCH METHOD WAS IMPLEMENTED USING MATLAB

ALL OTHER COMPUTATIONS ALSO DONE USING MATLAB

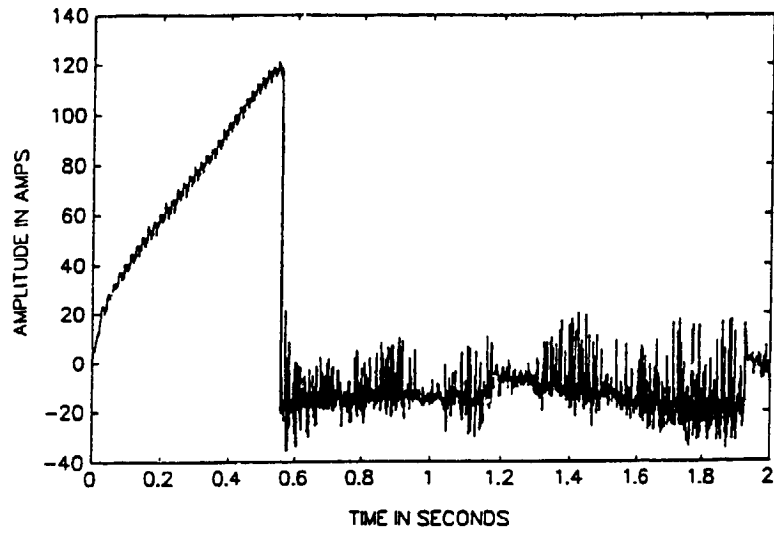
### PARAMETERS OBTAINED FROM DATA

STANDARD DEVIATION OF TIME DOMAIN DATA  
PEAK VALUE OF POWER SPECTRAL DENSITY  
MEAN VALUE OF POWER SPECTRAL DENSITY  
STANDARD DEVIATION OF POWER SPECTRAL DENSITY  
MEAN FREQUENCY CONTENT  
PERCENTAGE OF TIME ARC TRACKING OCCURRED  
PERCENTAGE OF TIME FOR CURRENT BUILD-UP

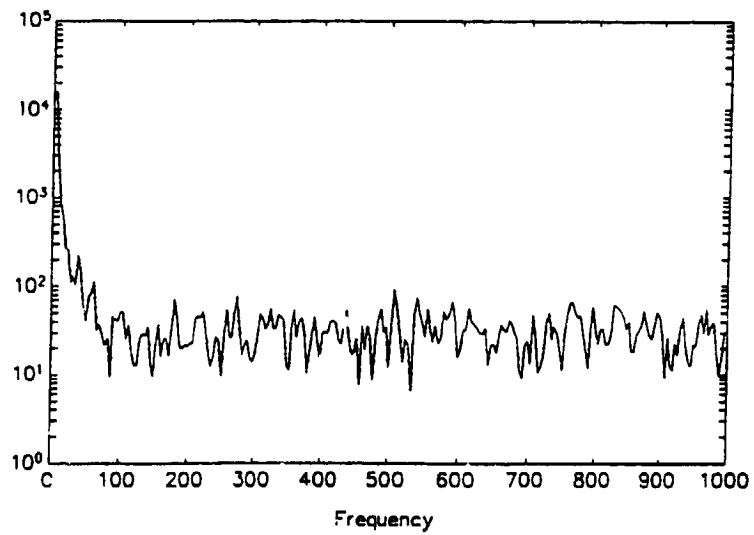
$$f_m = \frac{\sum_{i=1}^N P_i f_i}{\sum_{i=1}^N P_i}$$

where:

$P_i$  is the power spectral density at frequency  $f_i$

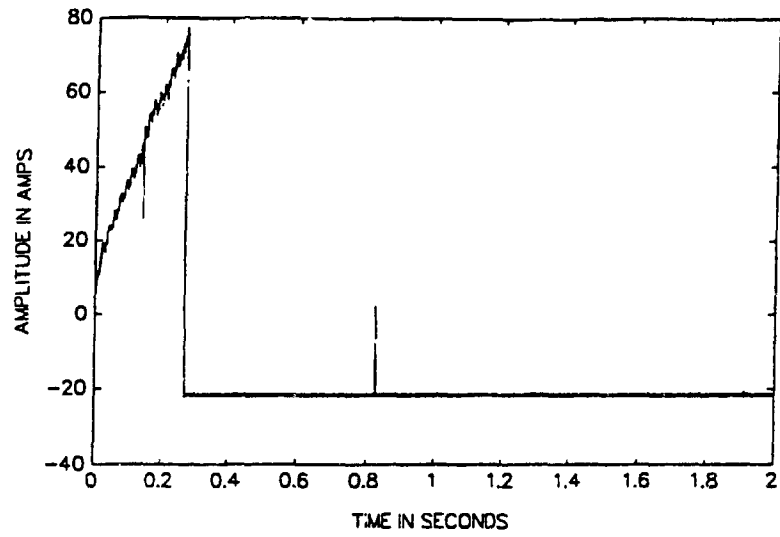


(a)

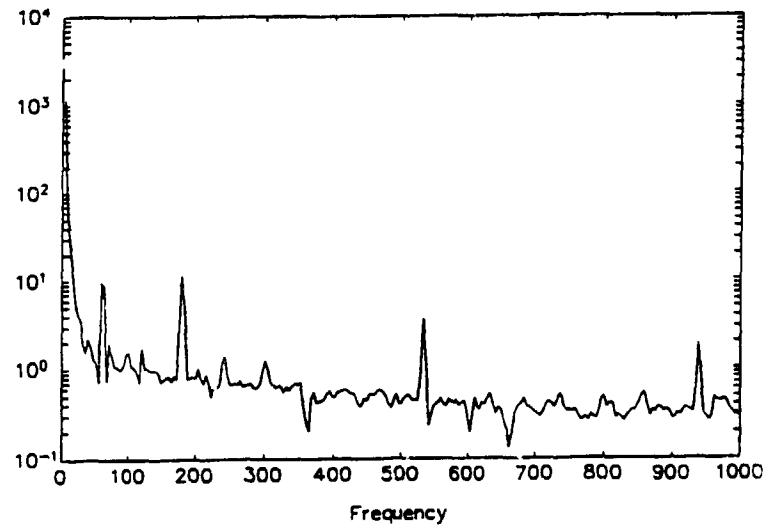


(b)

Figure 1 (a) Arc Tracking Signal in the time domain and (b) its power spectral density



(a)



(b)

Figure 2 (a) Non-Arc Tracking Signal in the time domain and (b) its power spectral density

Table 1

Categorization of data into arc tracking and no arc tracking.

CABLE AND VOLTAGE	DATA	REMARKS
G24V20E3	A1	STRONG ARC TRACKING
G24V20E4	A2	"
G22V20E2	A3	"
G22V20E1	A4	"
G22V30E3	A5	"
G20V30E2	A6	"
G22V30E1	A7	"
G20V42E4	A8	"
G20V42E3	A9	"
G22V30E4	A10	"
G20V30E5	A11	"
G20V42E5	A12	"
G20V42E2	A13	"
G22V42E3	A14	"
G22V10E3	B1	"
G22V42E5	B2	"
G22V42E2	B3	"
G20V30E1	B4	"
G20V42E1	B5	"
G22V42E4	B6	"
G22V30E2	C1	NO ARC TRACKING
G22V30E5	C2	"
TKV42E1	C3	"

TABLE 2

## Parameters Obtained from Arc Tracking Data

SD - standard deviation of time domain arc tracking data

MP - peak value of power spectral density

MVP - mean value of power spectral density

SDP - standard deviation of power spectral density

MFRQ - Mean frequency content

DATA	SD	MP X10 <sup>4</sup>	MVP	SDP X10 <sup>3</sup>	MFREQ
A1	31.9	1.6	238	1.51	102.12
A2	30.5	1.47	272	1.5	106.77
A3	41.7	1.59	176.2	1.4	96.6
A4	41.7	1.59	176	1.4	324.8
A5	15.23	1.7	231	.23	86.6
A6	38.8	2.7	476	2.7	136.9
A7	11.47	.27	141	0.358	31.28
A8	25.67	1.90	599	2.25	45.59
A9	32	1.9	1326	2.9	45.39
A10	1.45	20.21	4.9	.0052	236
A11	10.3	7.47	1292.5	8.04	35
A12	25.5	1.99	484	1.7	315
A13	60.3	3.2	319	2.9	36.28
A14	14	0.31	153	.375	23.26
B1	43.4	0.472	42.2	.417	14.4
B2	17.5	0.48	217	.665	90.6
B3	6.7	0.15	56.8	.0159	30.6
B4	10.6	0.12	35.8	.134	29.46
B5	9.5	0.71	229	.85	136.9
B6	7.6	505	37.5	.085	83.4
C1	45.4	0.16	14.2	.15	36.28
C2	23.7	0.116	10.19	.002	70.8
C3	5.5	.423	28.8	.078	115.7

TABLE 3

## Other Parameters of Arc Tracking Data

TARC - Percentage of Time Arc Tracking occurred

BUPT - Percentage of Time for the Current to Build-Up

DATA	TARC	BUPT
A1	67.5	32.5
A2	75	25
A3	72.5	27.5
A4	71	29
A5	69	0
A6	77	78
A7	100	0
A8	90	0
A9	100	0
A10	27.5	0
A11	19	48
A12	92.5	0
A13	76	24
A14	22.5	0
B1	10	75
B2	40	0
B3	16	0
B4	60	0
B5	35	0
B6	7	0
C1	0	25
C2	0	14
C3	0	0



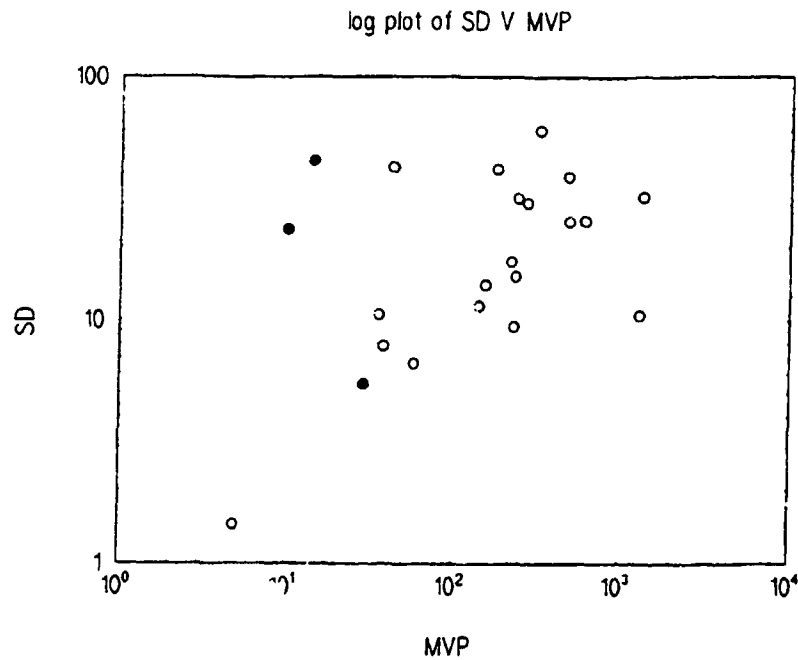


Figure 3 Standard deviation (SD) versus mean value of power spectral density (MVP)  
 o - arc tracking data  
 ● - non-arc tracking data

### CONCLUSIONS AND FUTURE WORK

#### USEFUL PARAMETERS FOR DETECTING ARC TRACKING

MEAN VALUE OF POWER SPECTRAL DENSITY  
 STANDARD DEVIATION OF TIME DOMAIN DATA  
 PERCENTAGE OF TIME ARC TRACKING OCCURRED

#### FEATURES OF ARC TRACKING SIGNAL

MEAN VALUE OF POWER SPECTRAL DENSITY IS GREATER THAN 30

OR

MEAN VALUE OF POWER SPECTRAL DENSITY IS LESS THAN 5  
 AND STANDARD DEVIATION OF TIME DOMAIN DATA IS LESS THAN 2

#### DESIGN OF "SMART" CIRCUIT FOR PROTECTION OF EQUIPMENT AGAINST ARC TRACKING

FAST FLOATING POINT DIGITAL SIGNAL PROCESSOR  
 INCORPORATE THE FEATURES OBTAINED IN THIS WORK