ESA-QCA00108T-C

ESTEC Working Paper

EWP–1648

Analogue-to-Digital Converters for Space Applications

Max Allman

Radiation Effects and
Analysis Techniques Unit, ESTEC

February 1992

Young Graduate Trainee Report

Prepared by; D.M.Allman (QCA)

Approved by; B.Johlander (QCA)

NOTE

ESTEC Working Papers are non-official documents intended for the presentation of material for discussion purposes only. The contents of this document do **NOT** represent approved ESA procedures, practices, or standards. This document, or any part of it, may not be issued in any form other than the present without the approval of the European Space Agency.

Signal-to-Noise Ratio, THD and Power Figures

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	116	74	59.2	58.9	59.0	58.6	58.8
5	118	73	59.0	59.4	59.0	58.9	58.6
10	121	63	49	17.1	9.1	6.3	1.3
15	135	33	16	14.8	14.7	14.3	13.6
20	168	Measurements not possible					

Table C.1: SNR, THD and power measurements for Analog Devices ADC7672 #1

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	24	n/a	56	54	51.3	49	47.5
5	25.5	n/a	33.7	33.5	33.5	33.4	33.4
10	30	n/a	6.1	6.1	6.1	6.1	6.1

Table C.2: SNR and power measurements for Analog Devices AD7880 #1

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	9.7KHz	19.5KHz	29.3KHz	38.5KHz
0	71	73	n/a	59.4	58.8	58.7	58.5
5	72	70	n/a	58.5	58.2	58.3	58.0
10	81	58	n/a	49.2	48.9	48.9	49.0
15	88	54	n/a	44.1	45.0	45.0	43.7
20	78	55	n/a	46.5	46.6	46.2	46.1
25	84	53	n/a	44.4	45.3	44.3	43.9
32	84	51	n/a	43.2	43.7	43.1	42.4

Table C.3: SNR, THD and power measurements for Burr-Brown ADS774 #1

Dose (Krads)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
		1.0KHz	9.7KHz	19.5KHz	29.3KHz	38.5KHz
0	74	59.1	59.1	59.3	58.8	59.1
5	74	59.1	59.3	59.0	59.0	59.3
10	67	58.0	57.6	57.8	57.8	57.7
15	62	56.0	55.9	55.7	55.9	55.8
20	62	55.6	55.4	55.3	55.5	55.5
Sampling rate of 60 KHz						
41	63	55.9	56.2	56.6	55.9	56.8

Table C.4: SNR and THD measurements for Burr-Brown ADS774 #2

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	23.3KHz	46.8KHz	70.2KHz	92.5KHz
0	225	72	56.6	59.5	59.3	59.3	59.1
5	231	64.5	45.3	57.9	57.5	57.4	57.5
10	286	41.7	0.01	0.01	0.01	1.5	3.3

Table C.5: SNR, THD and power measurements for Burr-Brown ADS7800 #2

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	2.3KHz	4.6KHz	6.9KHz	9.0KHz
0	152	79	63.4	63.6	63.4	63.5	63.2
5	155	79	64	62.3	62.1	62.3	61.6
10	162	56	53.9	53.9	53.9	53.7	53.5
16	158	78	62.8	63.3	63.1	63.0	62.6
20	164	55	53.0	53.0	53.2	53.0	52.8
25	167	52	42.8	42.9	42.7	42.6	42.5
30	167	53	45.6	47	45.6	44.4	44.6
30	158	80	62.5	62.7	62.9	62.4	62.0
40	167	53	45.0	46	46	44.6	44.8
40	160	80	62.6	63.2	62.7	62.6	62.5
50	168	53	45.0	46	45	44.8	44.6
50	168	53	46	46.9	45.5	45.1	45.0
60	165	53	45	48	47	44.6	44.5
60		53	45	48	44.9	44.8	44.8
60		78	62.3	63.1	62.7	62.5	61.1
75		53	45.4	48	49.5	44.6	44.6
75		77	62.0	62.5	62.2	61.9	61.7
100		54	46.6	46.7	46.3	46.1	46.1
100		75	61.3	61.3	61.7	61.4	61.3
125		63	57.5	57.9	57.4	54.6	49.8

Table C.6: SNR, THD and power measurements for Crystal CS5012a #1

Dose (Krads)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
		1.0KHz	9.1KHz	18.3KHz	27.4KHz	36.1KHz
0	77	63.3	63.0	62.3	60.9	59.7
5	77	63.3	62.9	62.0	60.7	59.5
10	77	63.3	62.7	62.2	60.6	59.6
15	78	63.3	63.0	62.2	60.5	59.7
20	78	63.5	63.1	62.1	60.7	59.5
41	79	63.0	62.6	61.9	60.6	59.3

Table C.7: SNR and THD measurements for Crystal CS5012a #2

Dose (Krads)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
		1.0KHz	9.1KHz	18.3KHz	27.4KHz	36.1KHz
0	78	63.6	63.4	62.3	61.1	59.9
5	77	63.6	63.0	62.1	60.6	59.3
10	77	63.3	62.8	62.2	61.4	59.5
15	77	63.3	62.4	62.0	60.5	59.5
20	77	63.2	62.6	62.0	60.8	59.4
41	76	63.0	62.3	61.4	60.2	59.3

Table C.8: SNR and THD measurements for Crystal CS5012a #3

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	n/a	n/a	60	60	59.6	59.7	59.4
5	134	74.5	59.8	59.5	59.7	59.0	59.1
10	134	74.5	60	37	32	33	36.6

Table C.9: SNR, THD and power measurements for Maxim ADC174 #1

Dose (Krads)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
		1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	71	56.9	57	57.0	56.7	56.9
5	74	60.0	60.1	60.0	59.8	60.3

Table C.10: SNR, THD and power measurements for Maxim ADC174 #2

Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	4.9KHz	9.7KHz	14.6KHz	19.3KHz
0	37	68	57.5	49	43	39.4	36.9
5	39	66	58.9	48.3	42.8	39.4	36.9
10	39	72	59.0	48.3	42.8	39.4	36.9
15	41	71	58.9	48.3	42.6	39.4	36.9
20	39	60	53.2	49.1	42.7	39.4	36.9
25	42	61	53.3	48.1	43	39.3	36.8
30	48	62	53.2	50	42.2	39.2	36.8
40	(61)/36	63	50	39.3	33	35	34

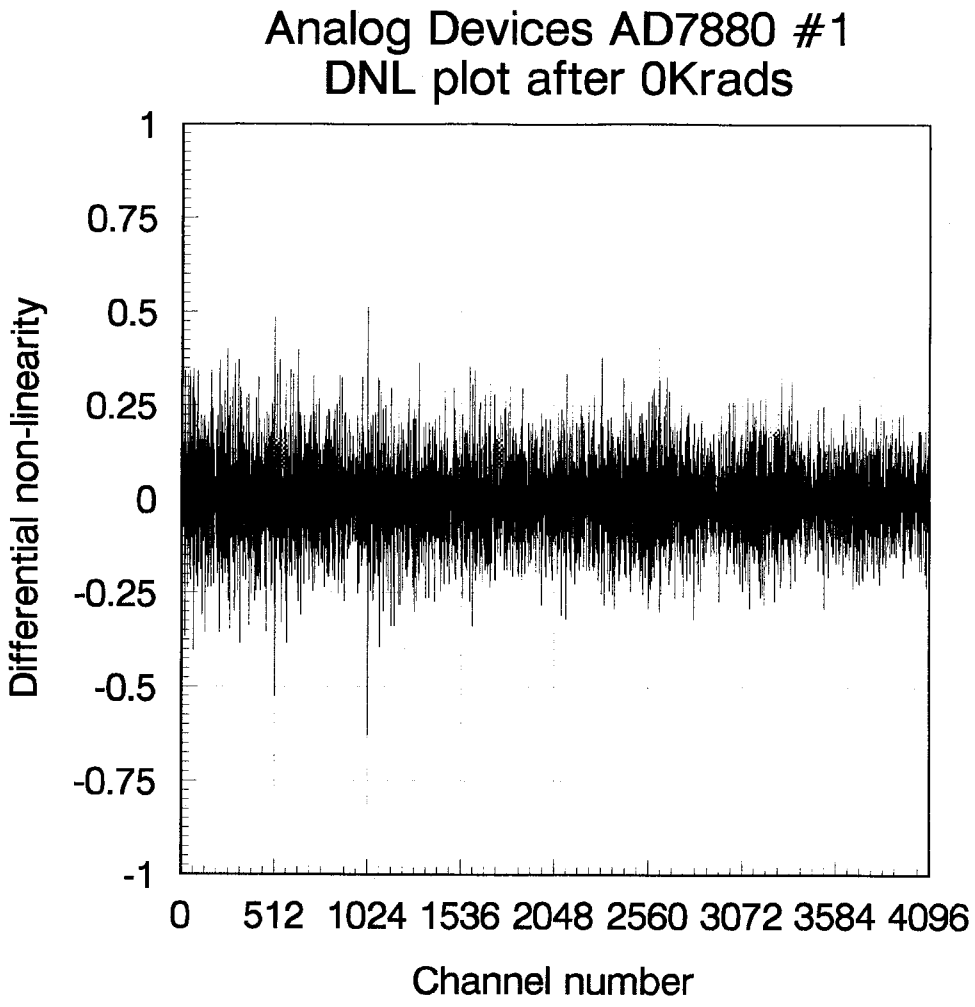
Table C.11: SNR, THD and power measurements for Nat. Semiconductor ADC1241 #2

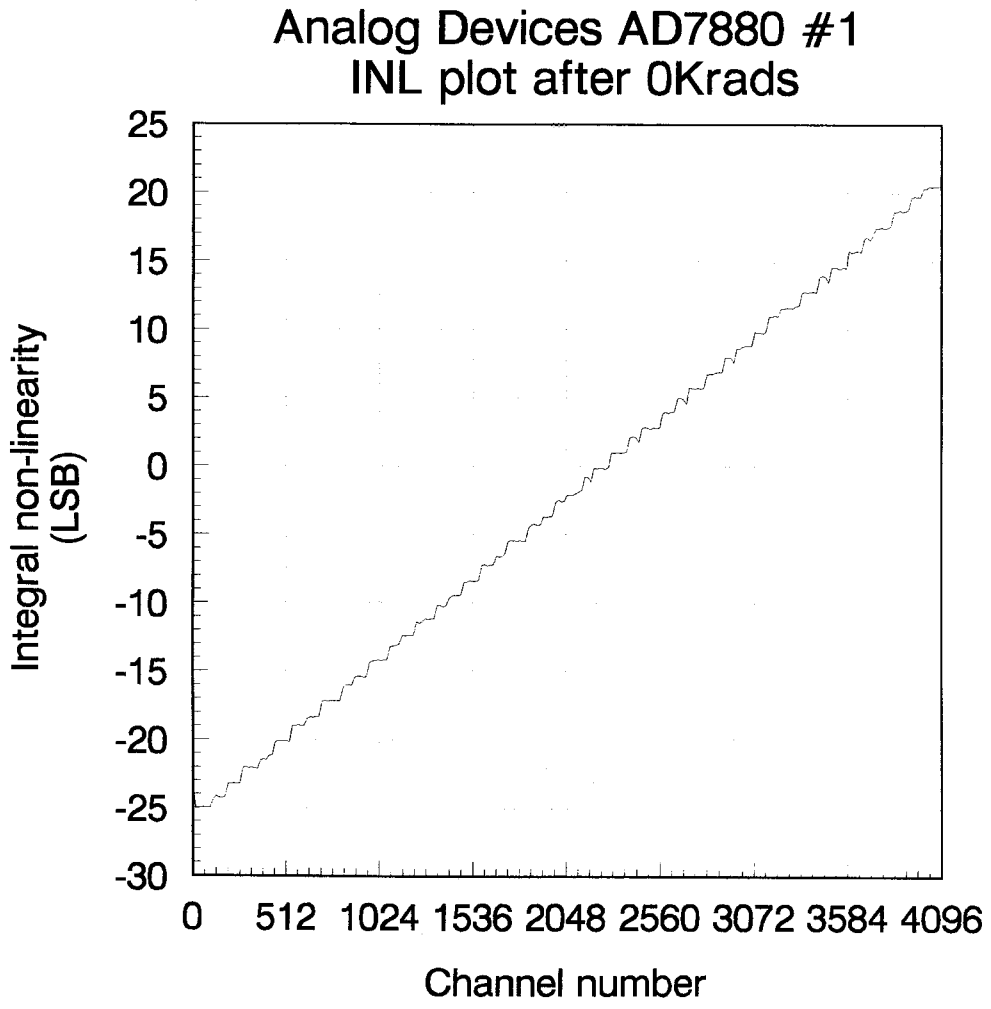
Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	91	72	59.8	59.6	59.4	59.2	59.3
5	96	58	55.1	55	53.7	53.7	53.7
10	106	Measurements not possible					

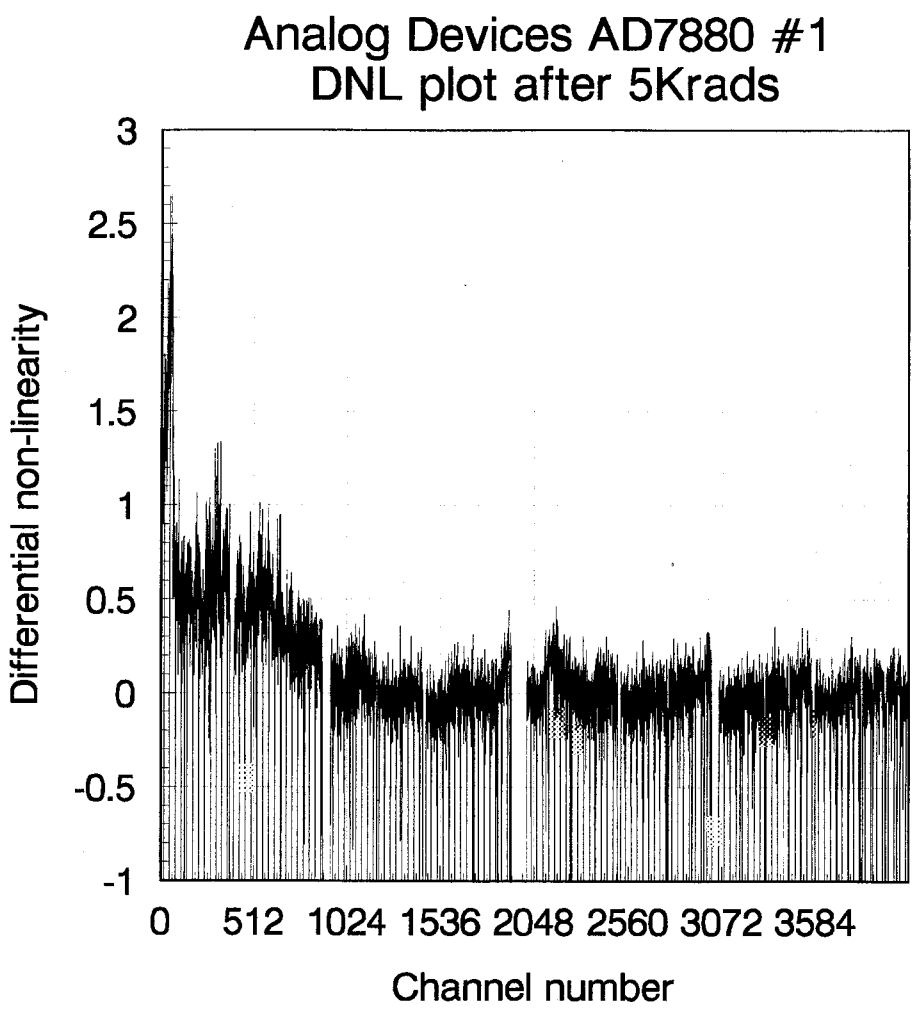
Table C.12: SNR, THD and power measurements for SPT HADC674 #3

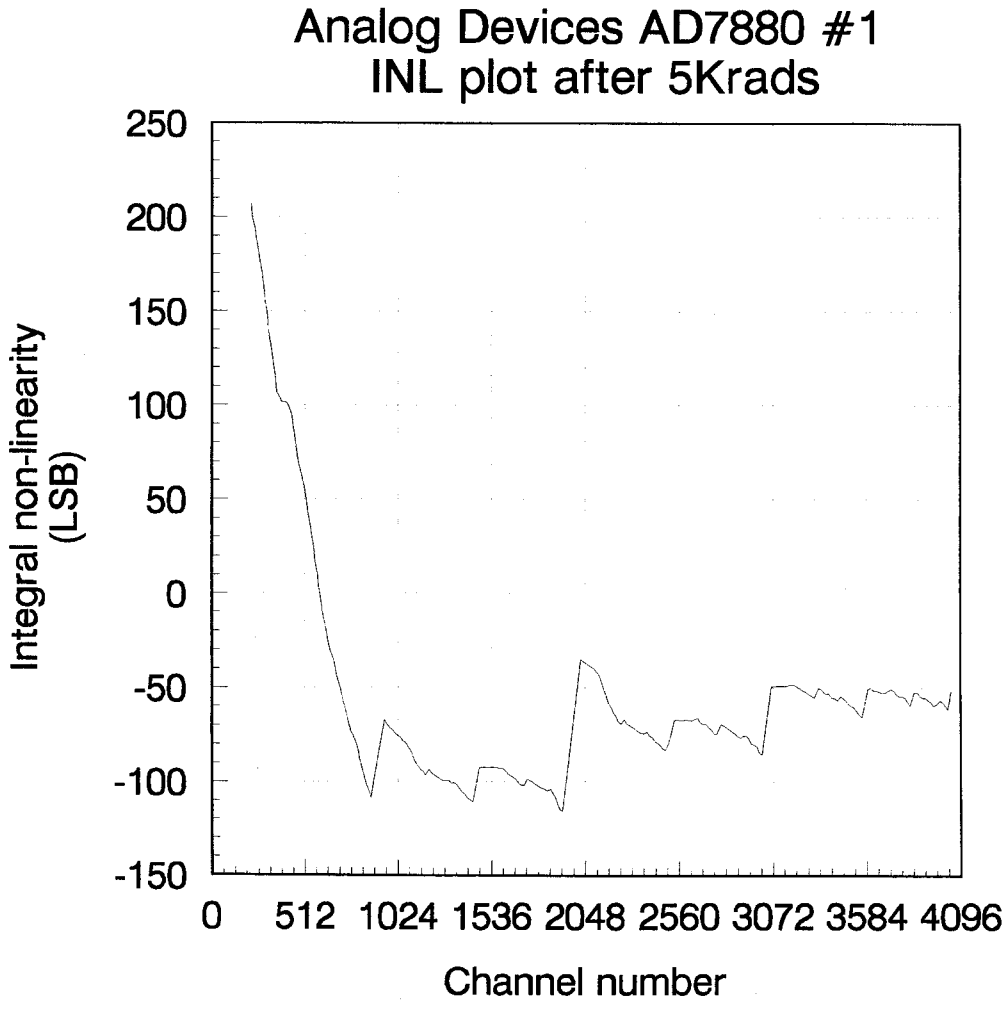
Dose (Krads)	Power (mW)	THD_{1KHz} (dB)	Signal-to-Noise Ratio (dB)				
			1.0KHz	5.8KHz	11.7KHz	17.5KHz	23.1KHz
0	95	63	58	56.1	55.6	55.7	56.0
5	102	43	31	15.4	9.8	7.2	6.2
10	135	Measurements not possible					

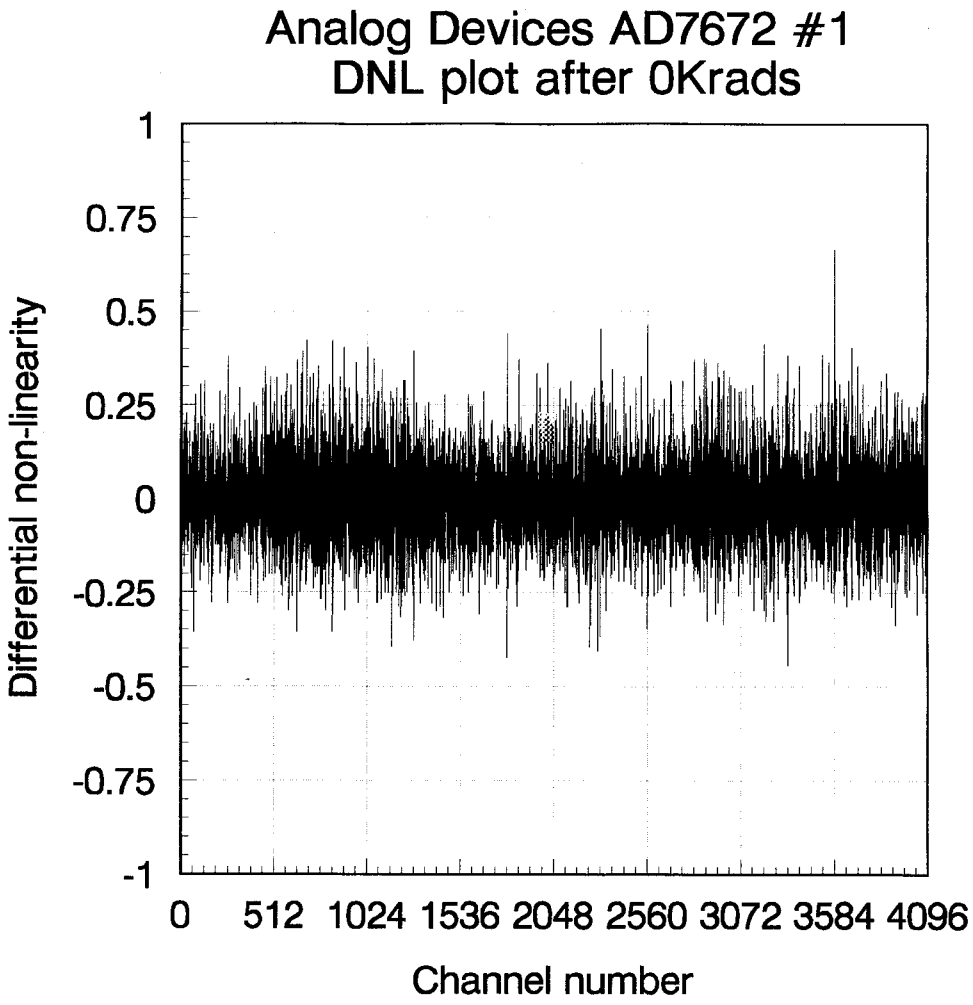
Table C.13: SNR, THD and power measurements for Sipex SP674 #1

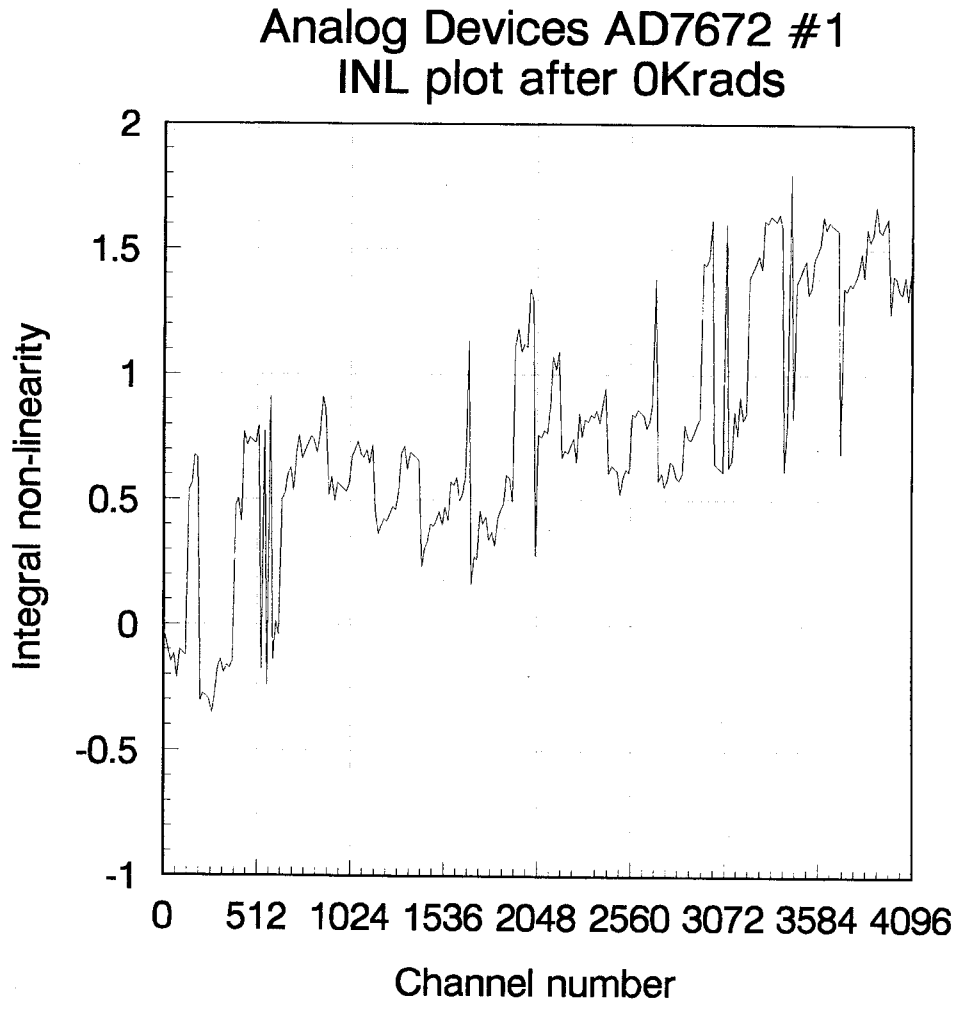

Analog Devices AD7880 #1
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

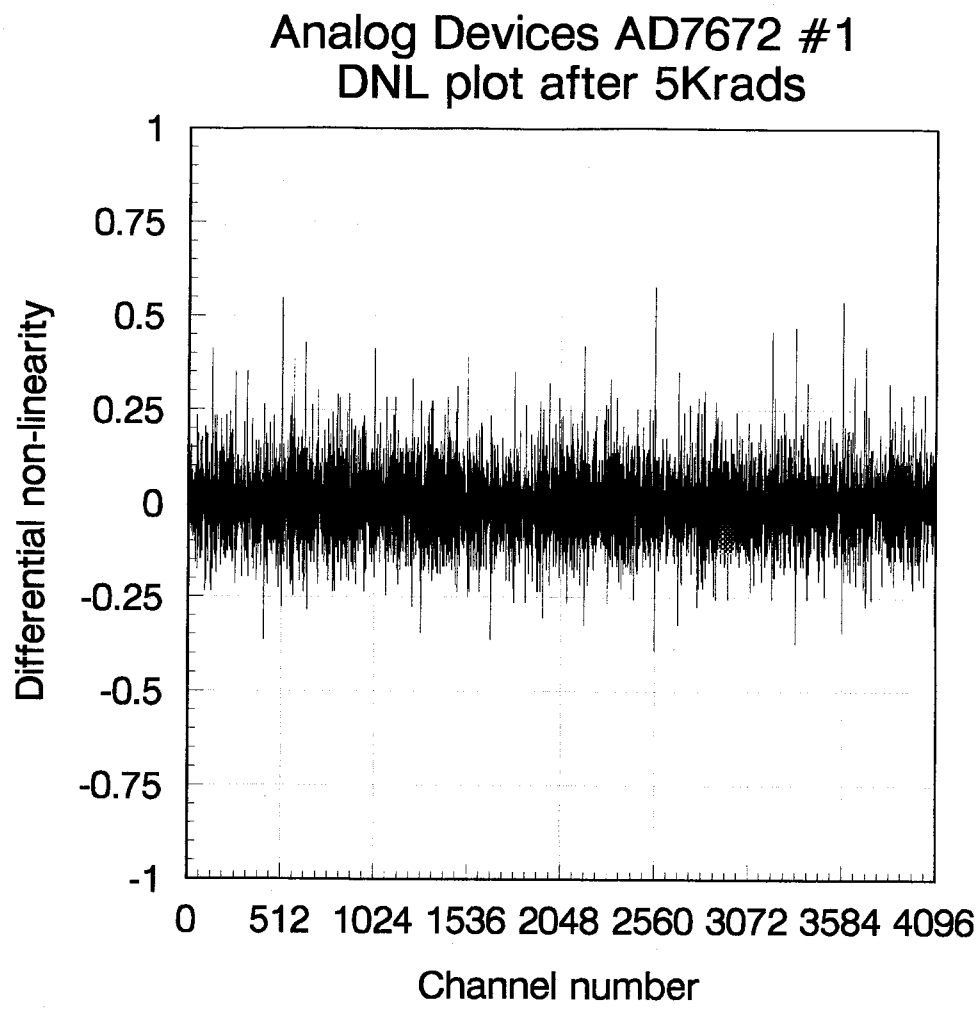

Analog Devices AD7880 #1
INL plot after 0Krads
Integral non-linearity
(LSB)
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

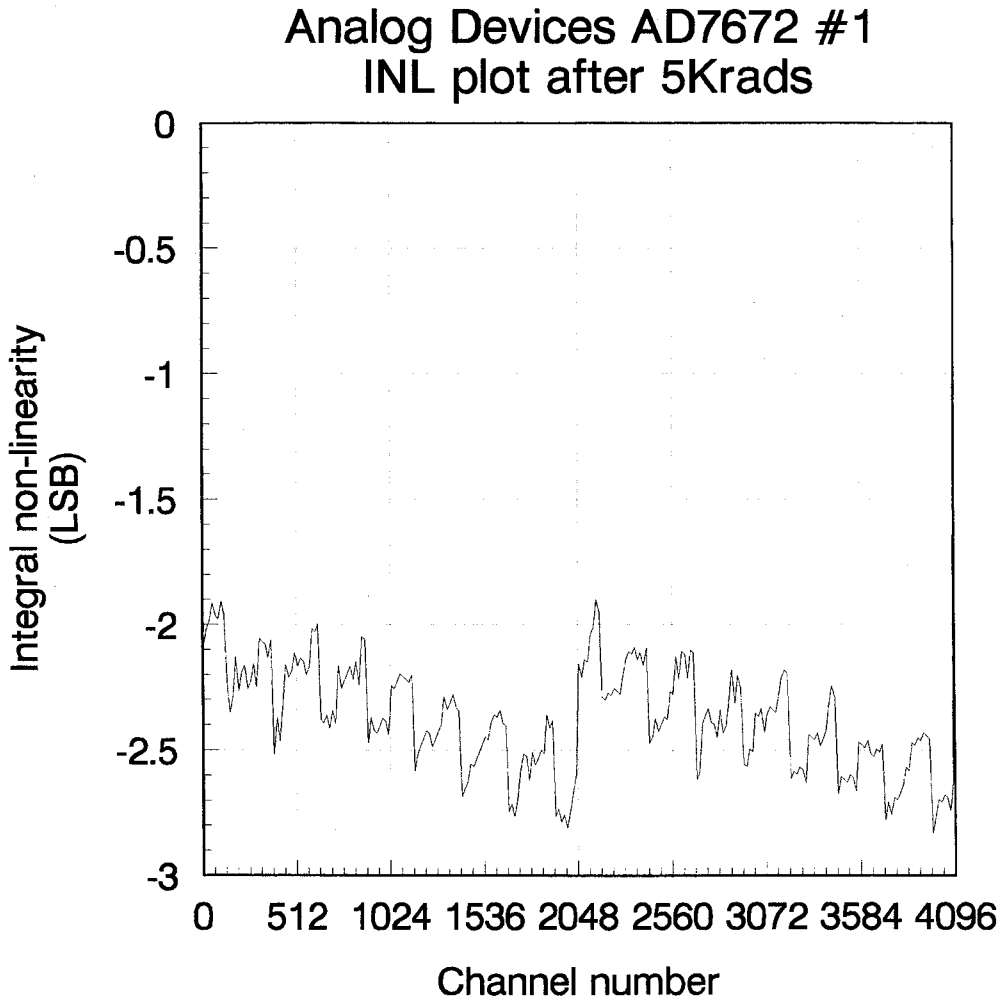

Analog Devices AD7880 #1
DNL plot after 5Krads
Differential non-linearity
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
Channel number

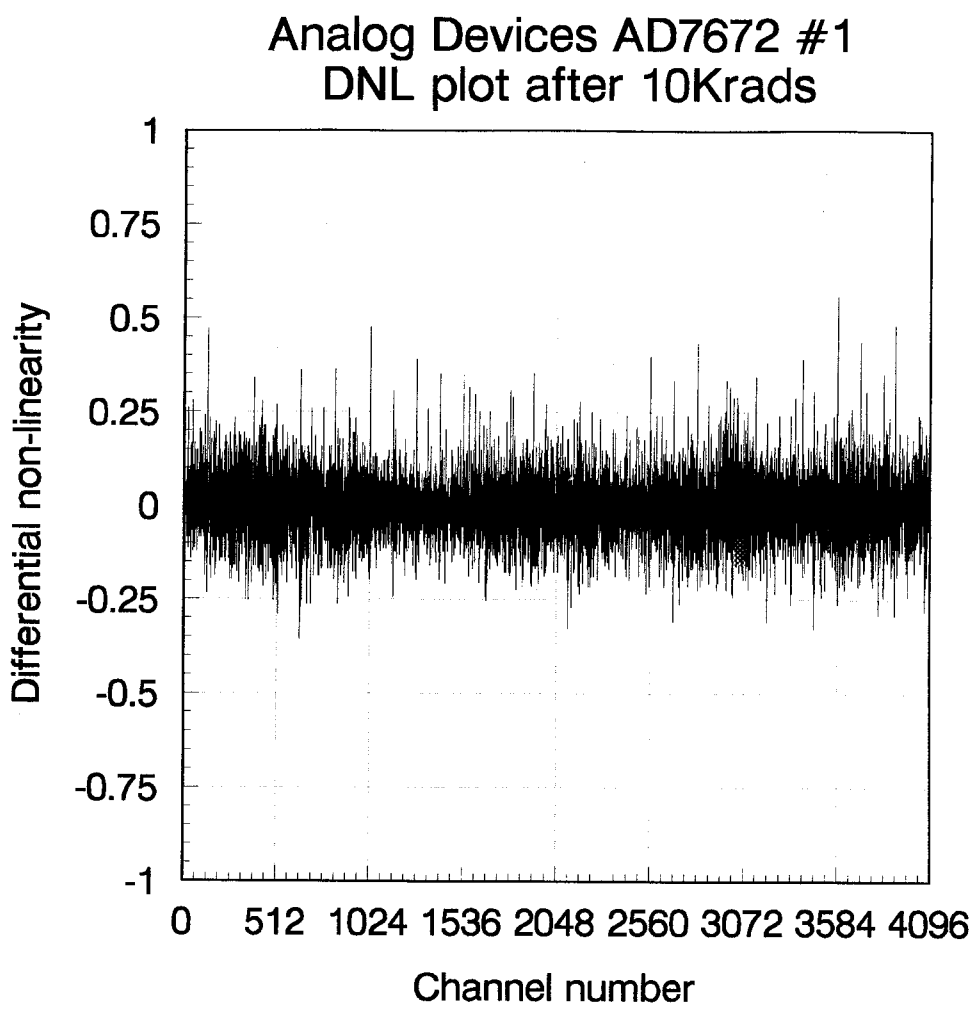

Analog Devices AD7880 #1
INL plot after 5Krads
Integral non-linearity
(LSB)
250
200
150
100
50
0
-50
-100
-150
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

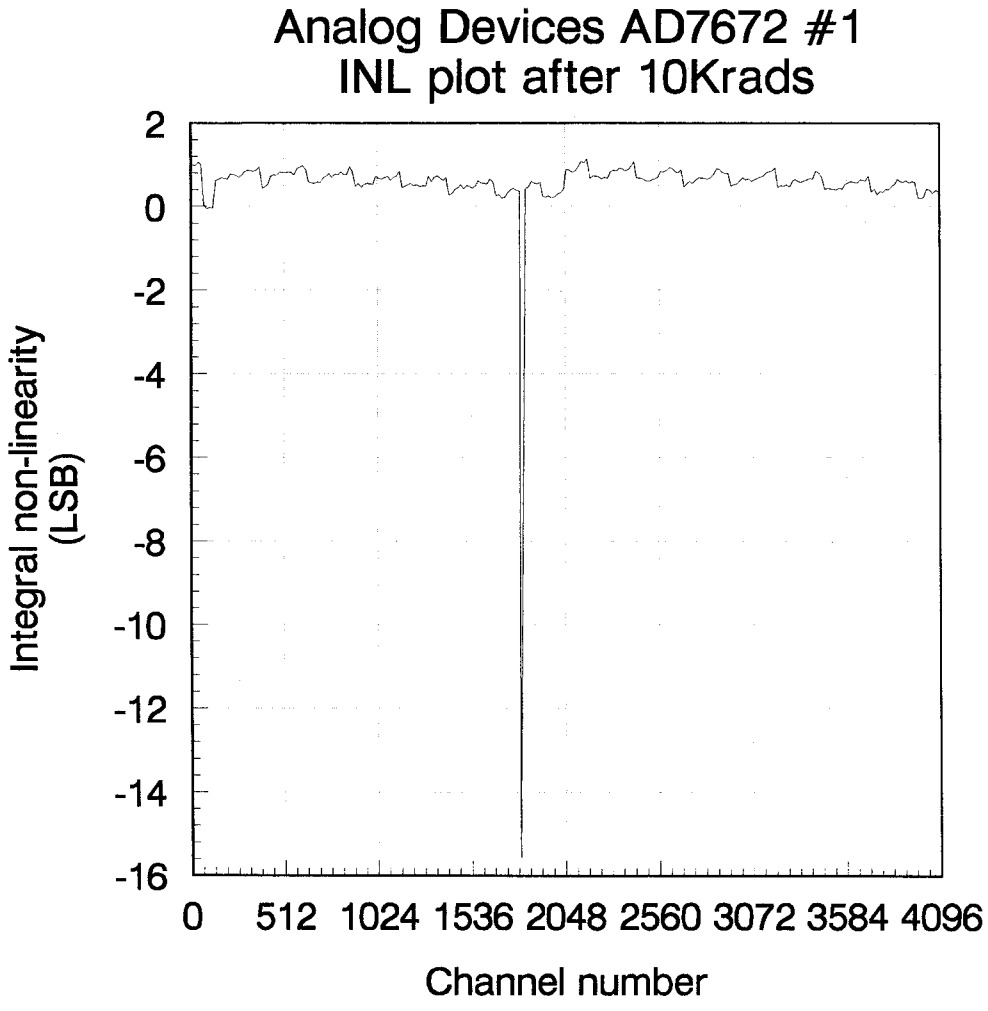

Analog Devices AD7672 #1
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

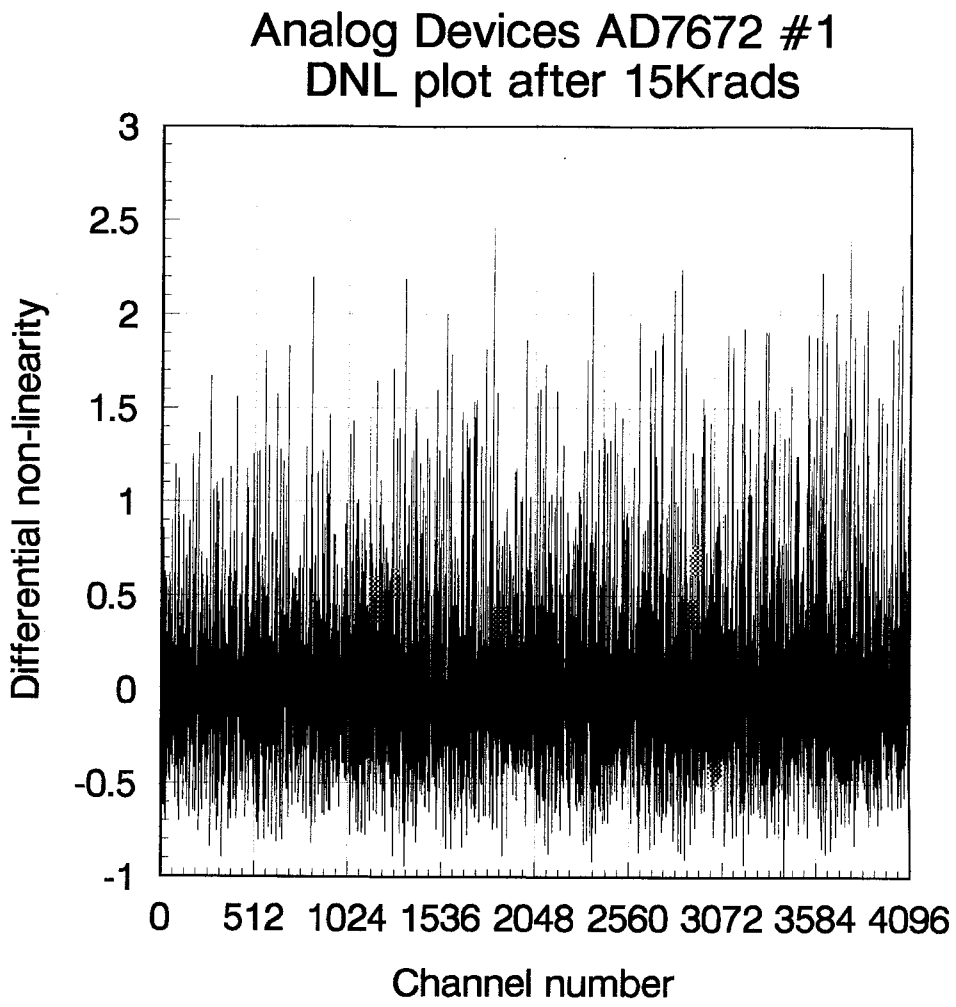

Analog Devices AD7672 #1
INL plot after 0Krads
Integral non-linearity
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

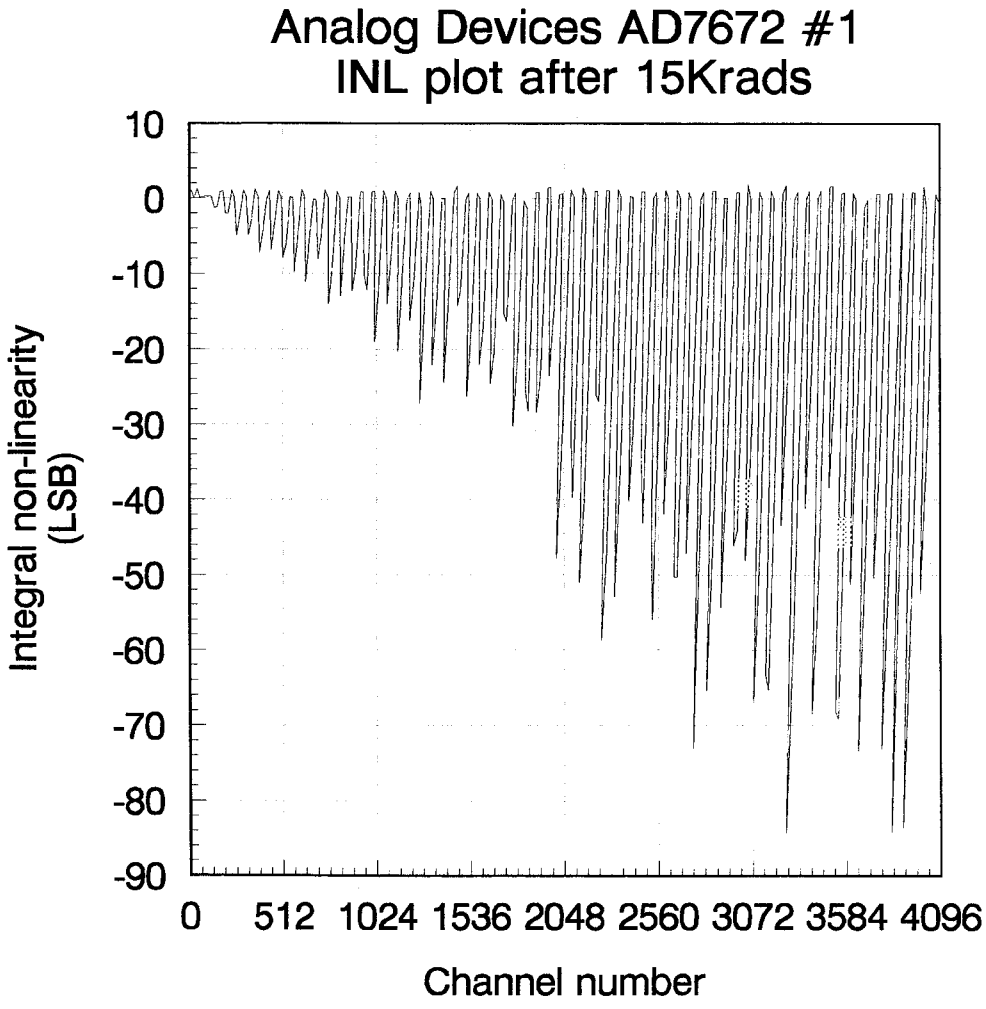

Analog Devices AD7672 #1
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

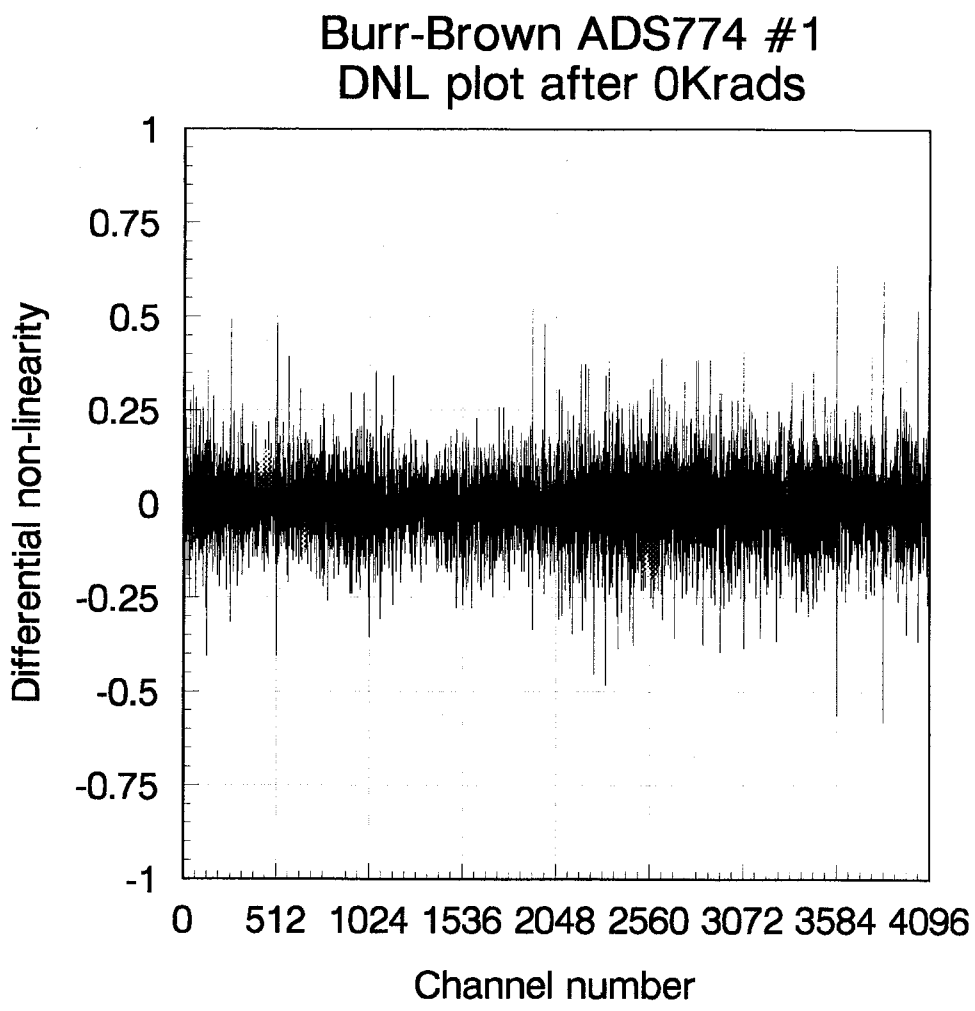

Analog Devices AD7672 #1
INL plot after 5Krads
Integral non-linearity
(LSB)
0
-0.5
-1
-1.5
-2
-2.5
-3
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

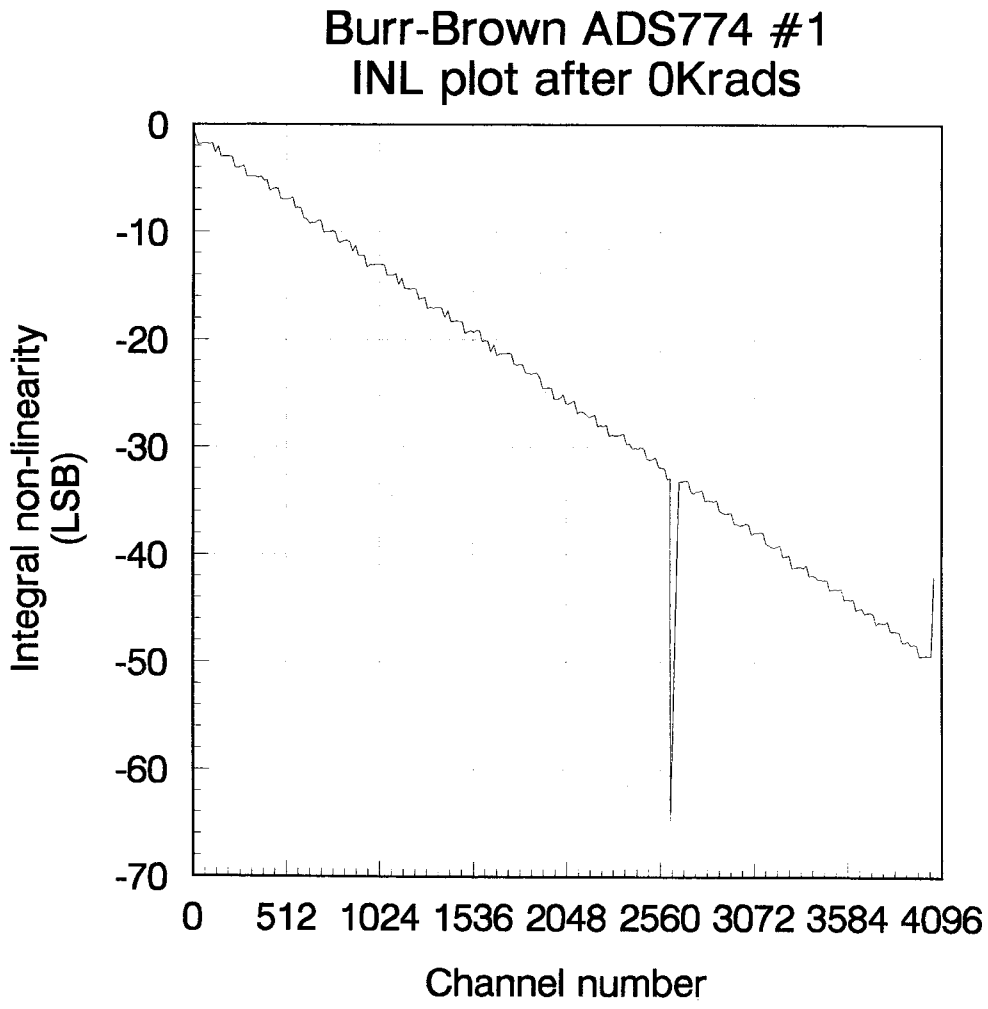

Analog Devices AD7672 #1
DNL plot after 10Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

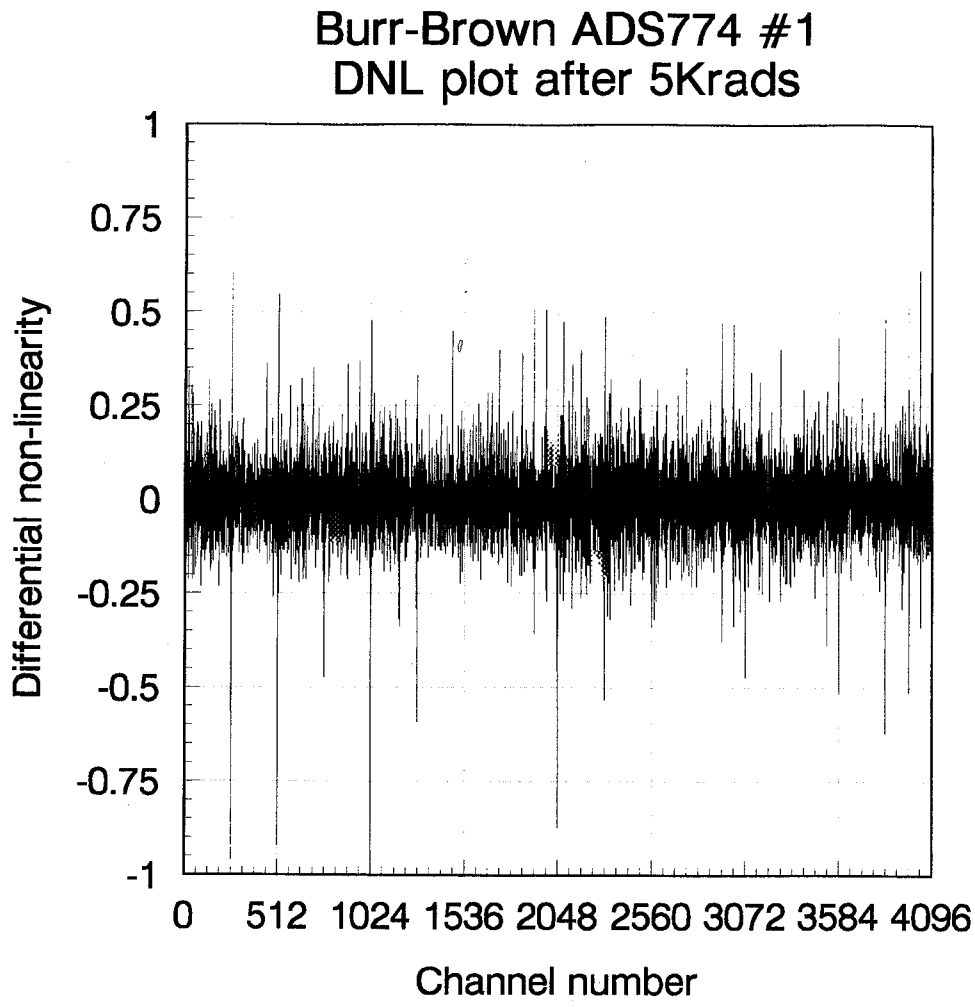

Analog Devices AD7672 #1
INL plot after 10Krads
Integral non-linearity
(LSB)
2
0
-2
-4
-6
-8
-10
-12
-14
-16
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

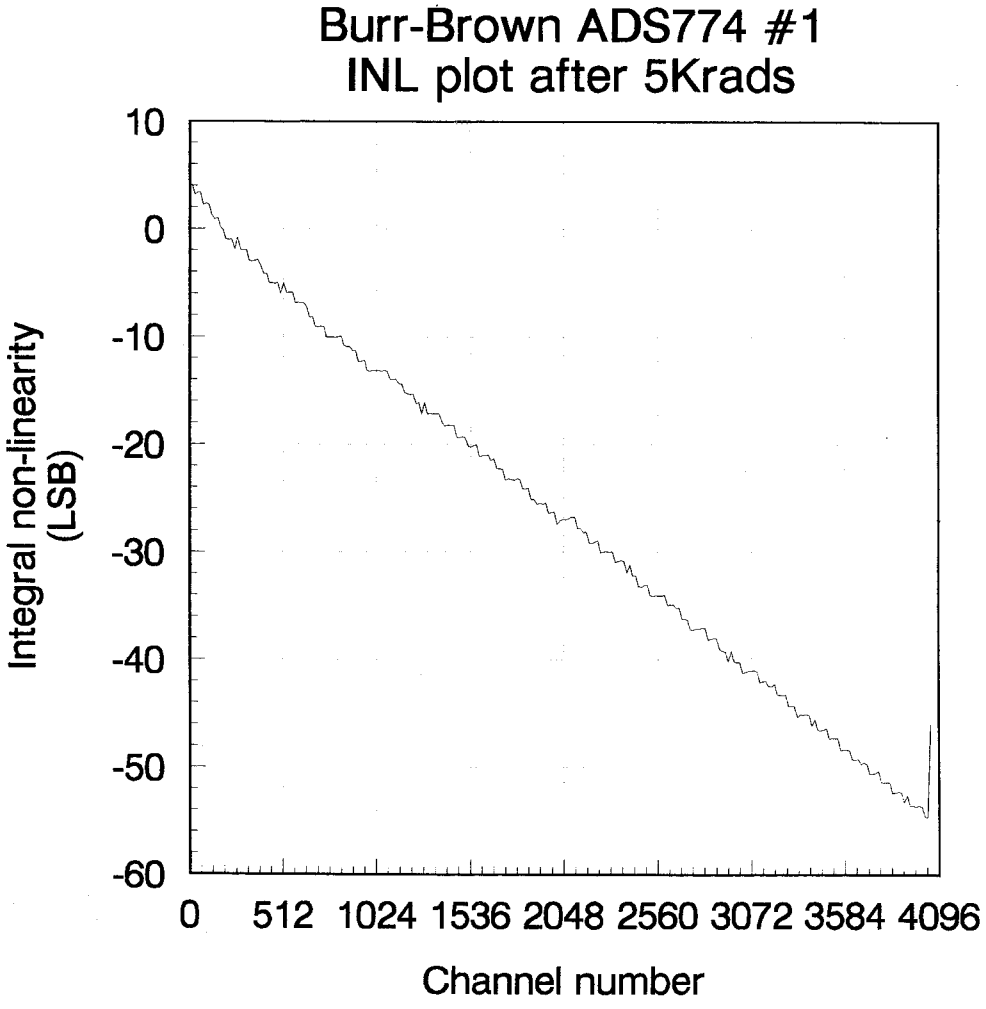

Analog Devices AD7672 #1
DNL plot after 15Krads
Differential non-linearity
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

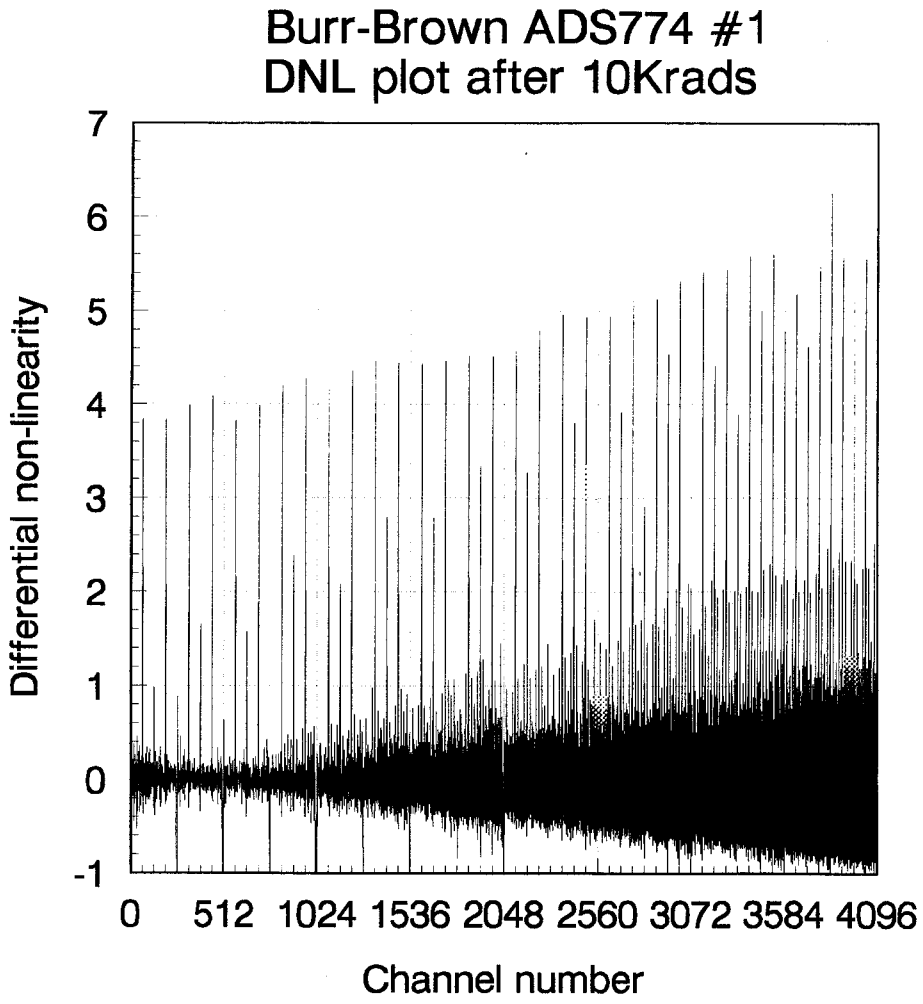

Analog Devices AD7672 #1
INL plot after 15Krads
Integral non-linearity
(LSB)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

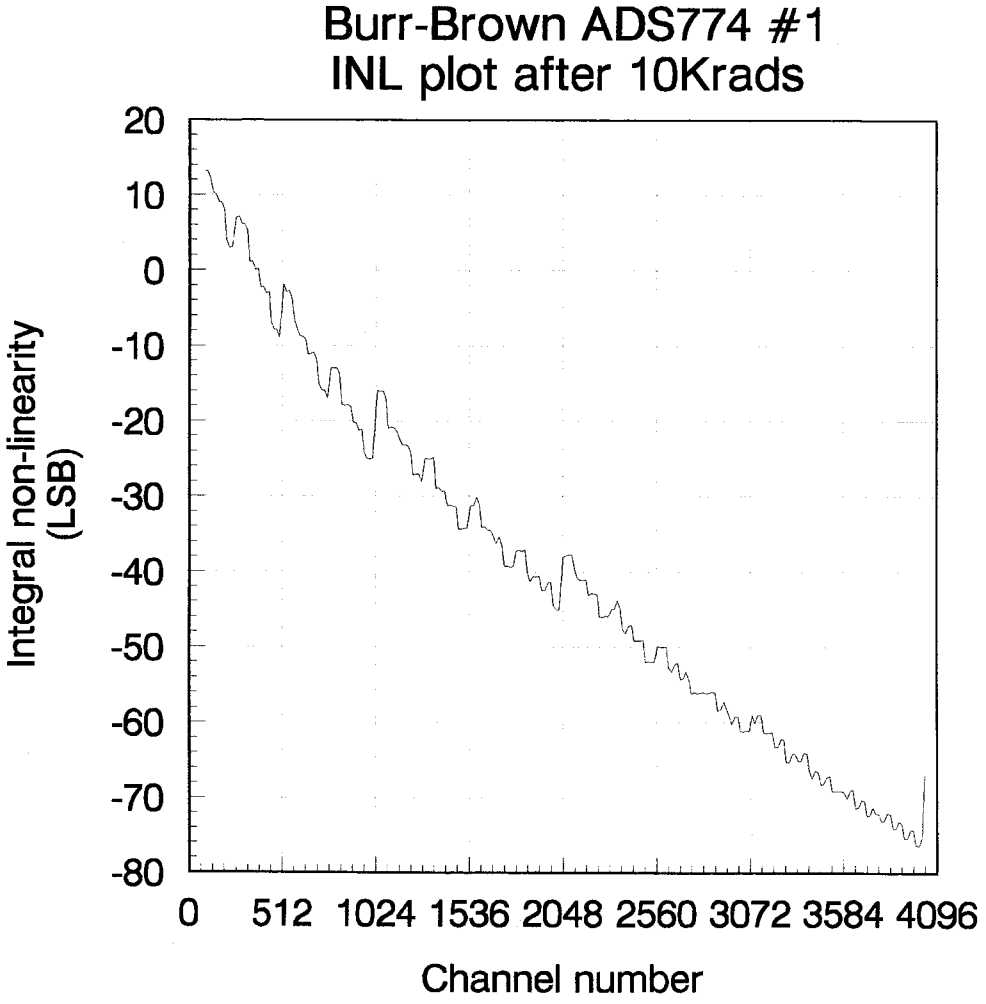

Burr-Brown ADS774 #1
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


Burr-Brown ADS774 #1
INL plot after 0Krads
Integral non-linearity
(LSB)
0
-10
-20
-30
-40
-50
-60
-70
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

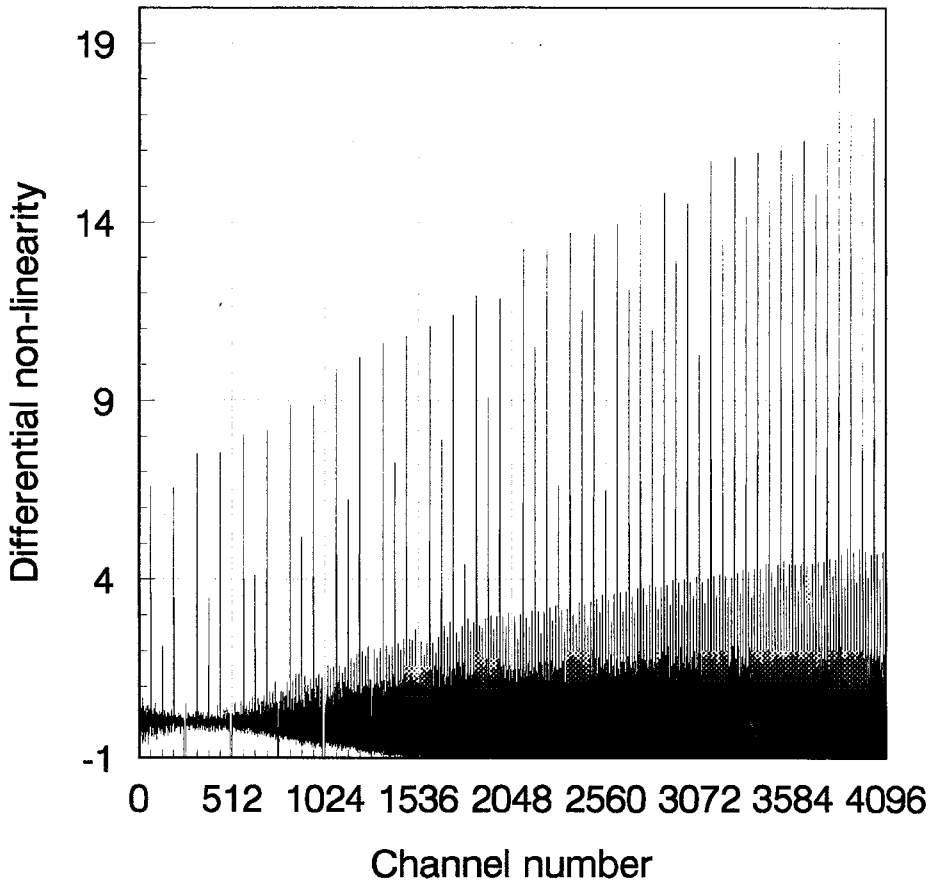

Burr-Brown ADS774 #1
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


Burr-Brown ADS774 #1
INL plot after 5Krads
Integral non-linearity
(LSB)
10
0
-10
-20
-30
-40
-50
-60
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

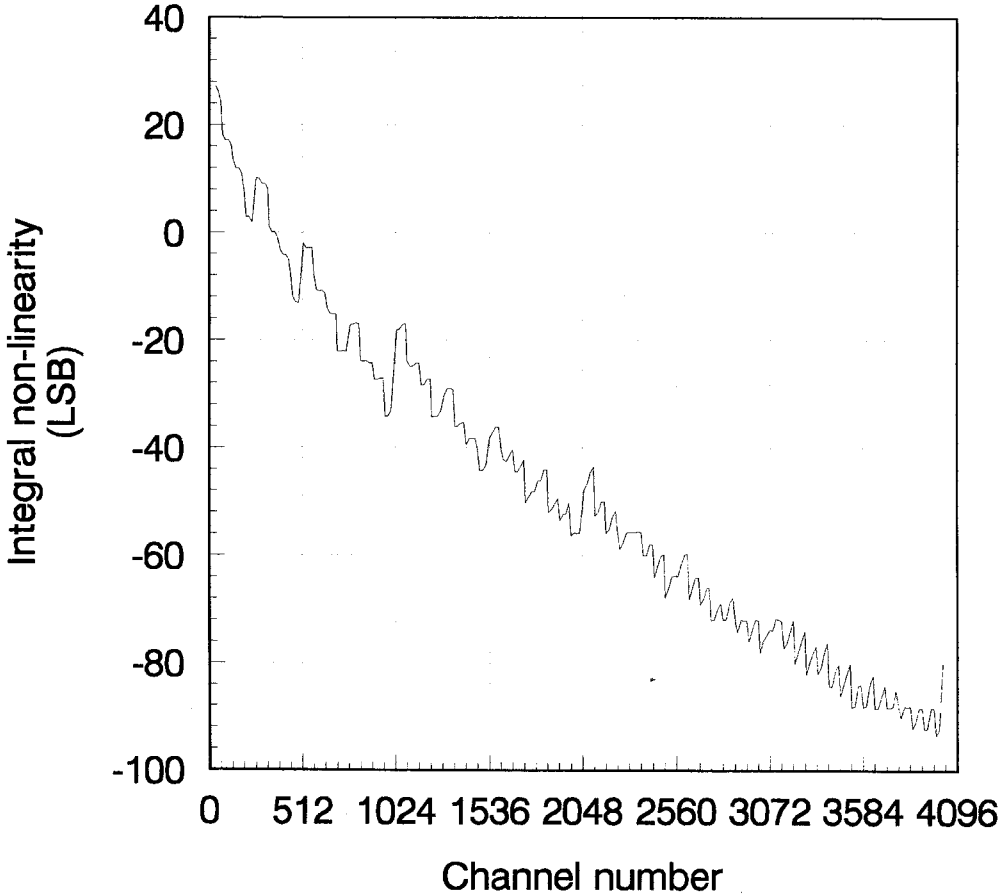

Burr-Brown ADS774 #1
DNL plot after 10Krads
Differential non-linearity
7
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

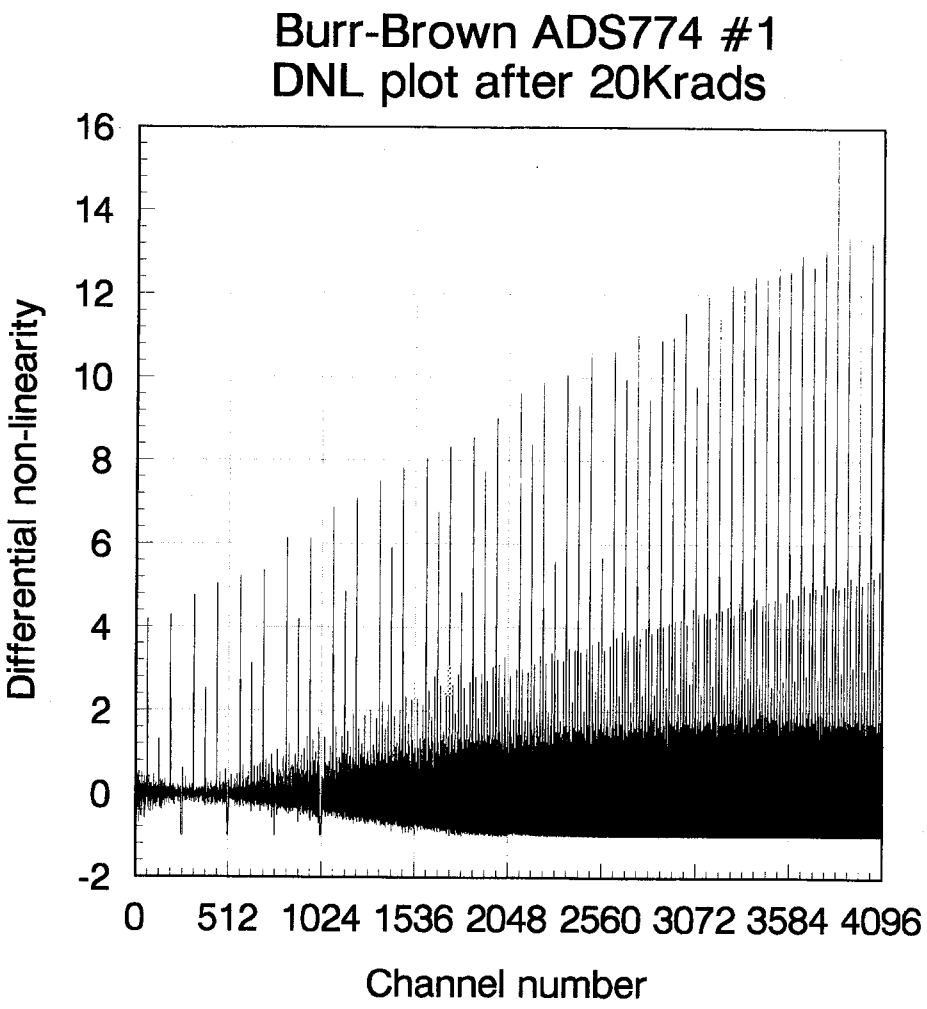

Burr-Brown ADS774 #1
INL plot after 10Krads
Integral non-linearity
(LSB)
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

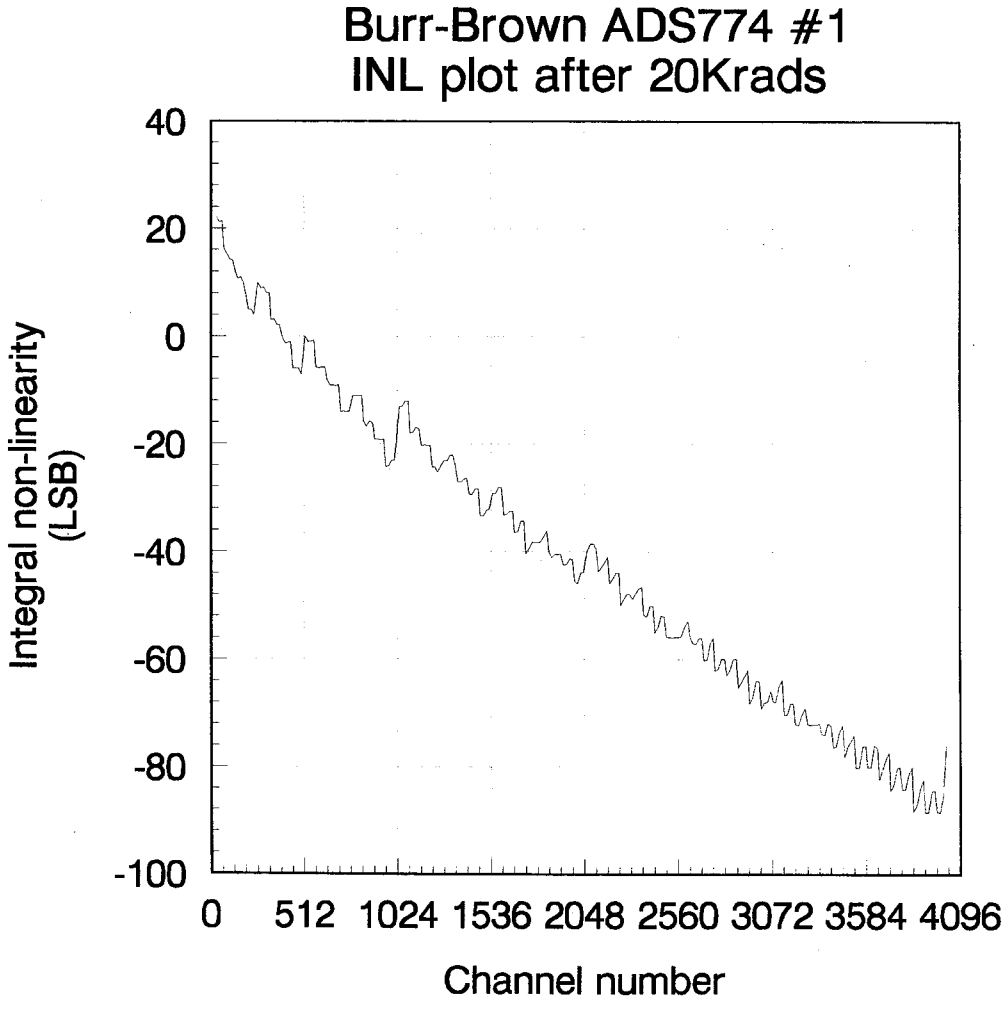
Burr-Brown ADS774 #1
DNL plot after 15Krads

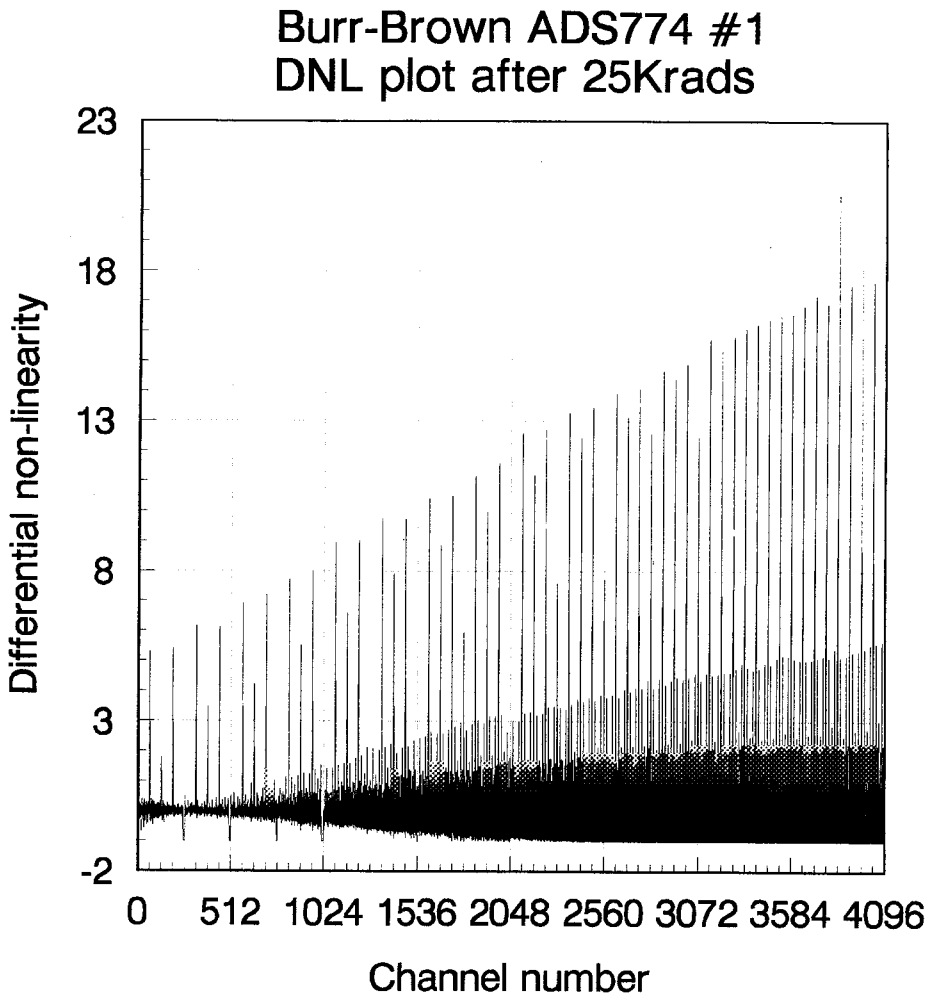


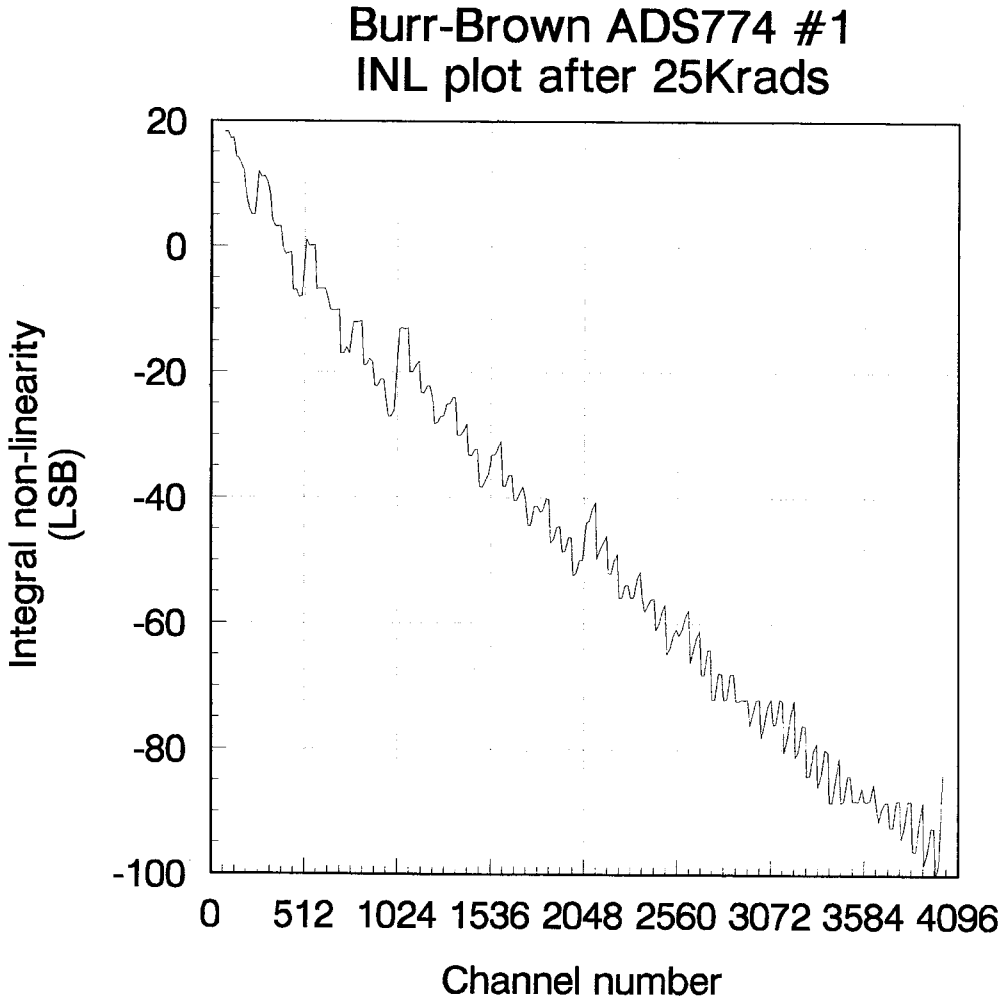
Burr-Brown ADS774 #1
INL plot after 15Krads

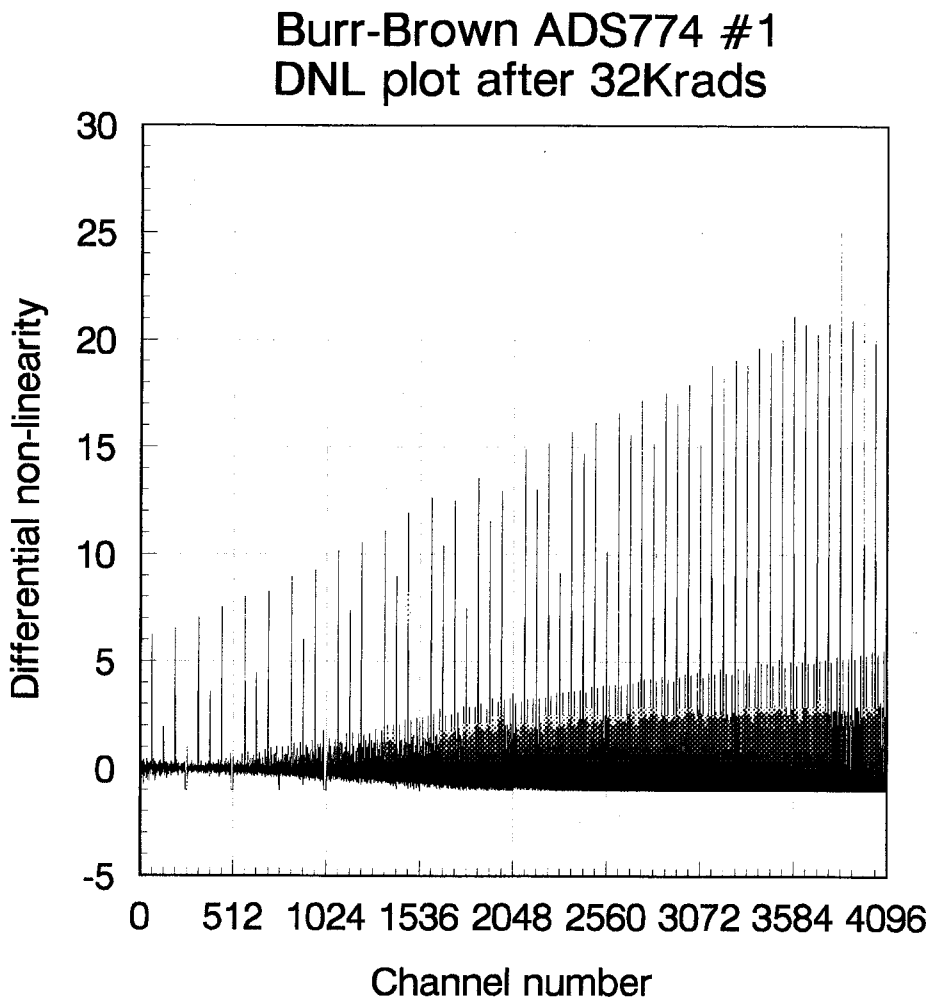


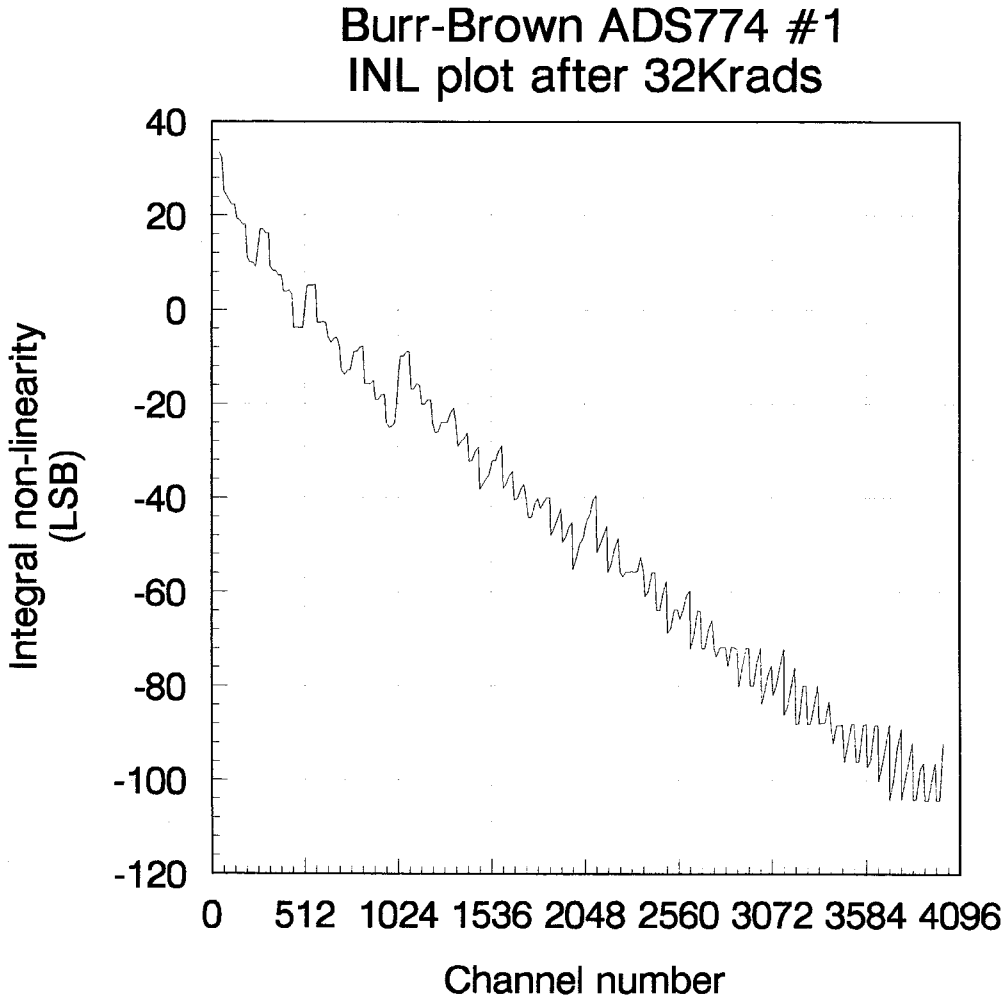

Burr-Brown ADS774 #1
DNL plot after 20Krads
Differential non-linearity
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

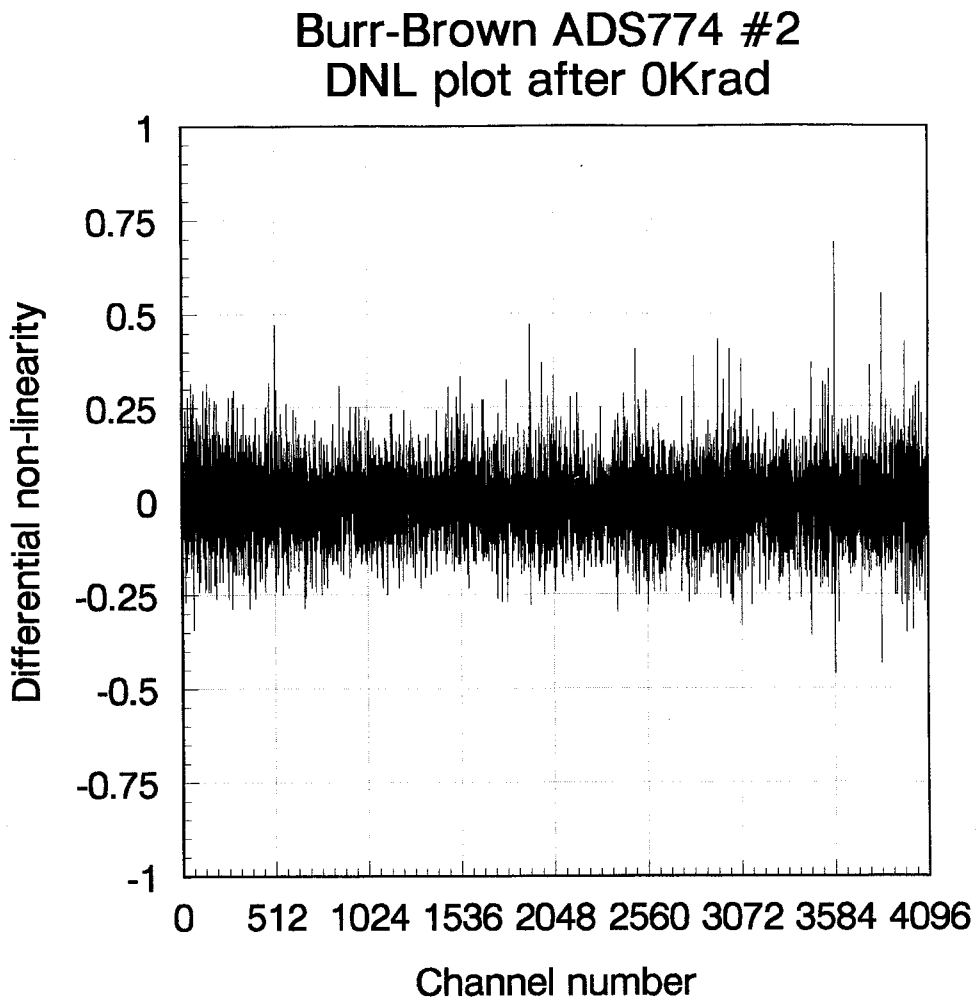

Burr-Brown ADS774 #1
INL plot after 20Krads
Integral non-linearity
(LSB)
40
20
0
-20
-40
-60
-80
-100
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

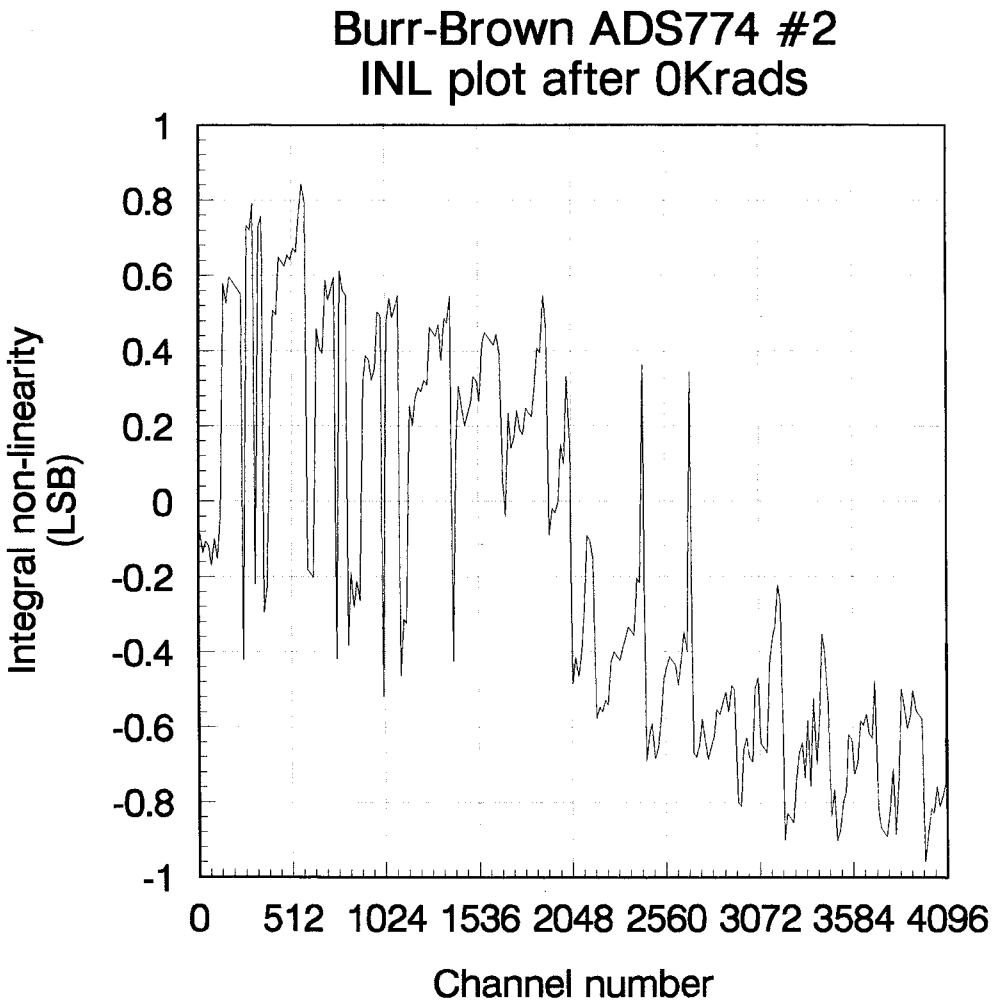

Burr-Brown ADS774 #1
DNL plot after 25Krads
Differential non-linearity
23
18
13
8
3
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

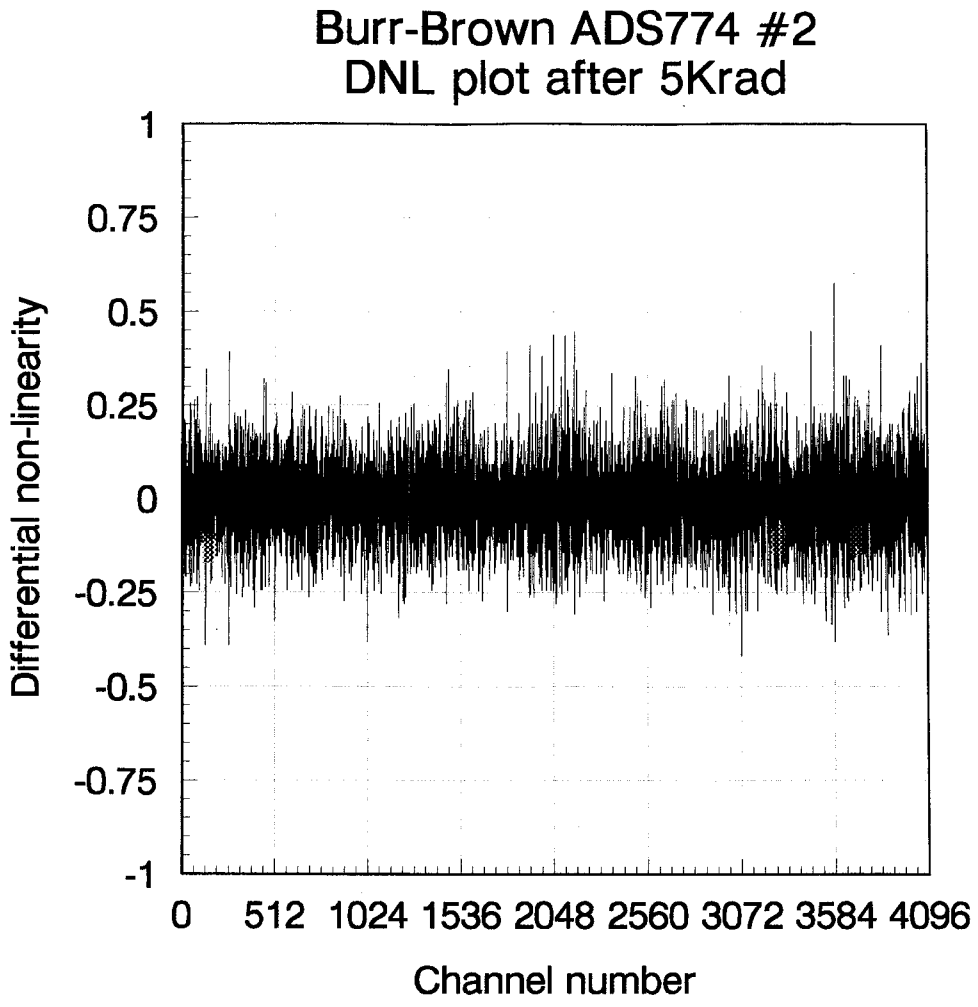

Burr-Brown ADS774 #1
INL plot after 25Krads
Integral non-linearity
(LSB)
20
0
-20
-40
-60
-80
-100
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

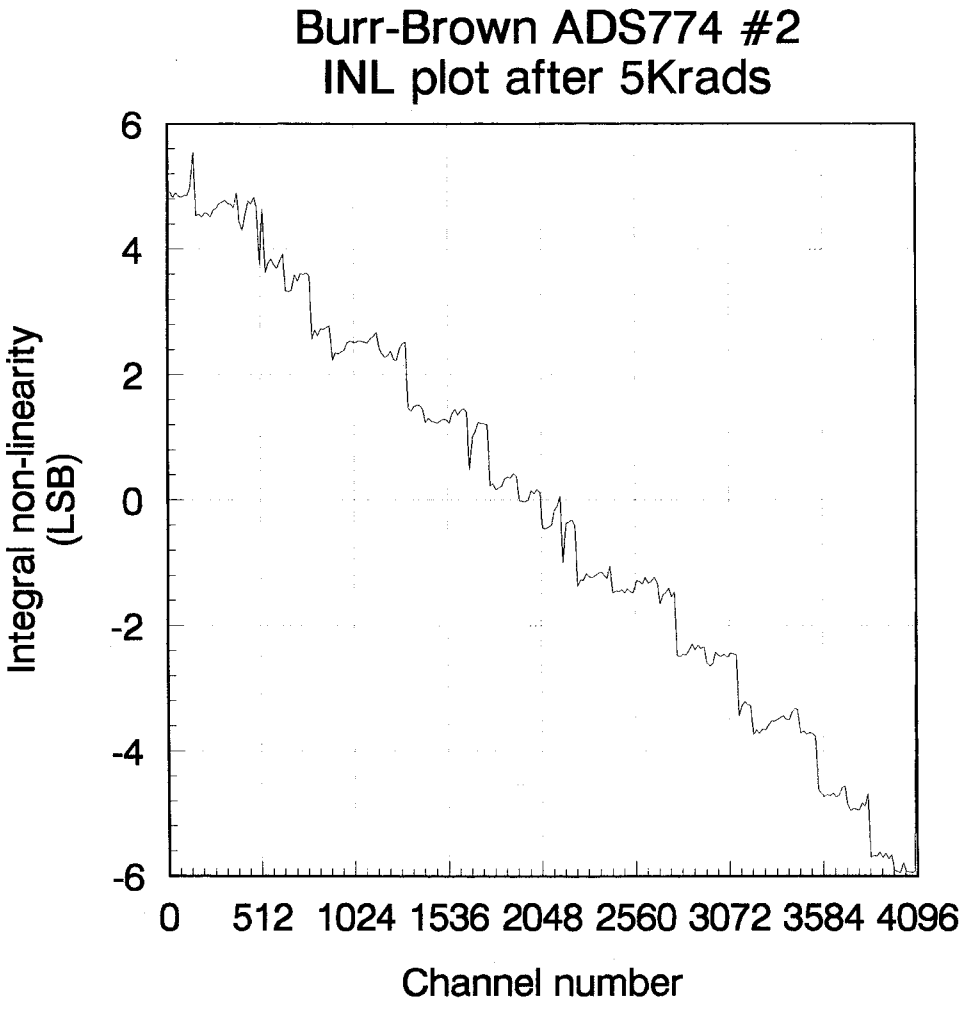

Burr-Brown ADS774 #1
DNL plot after 32Krads
Differential non-linearity
30
25
20
15
10
5
0
-5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

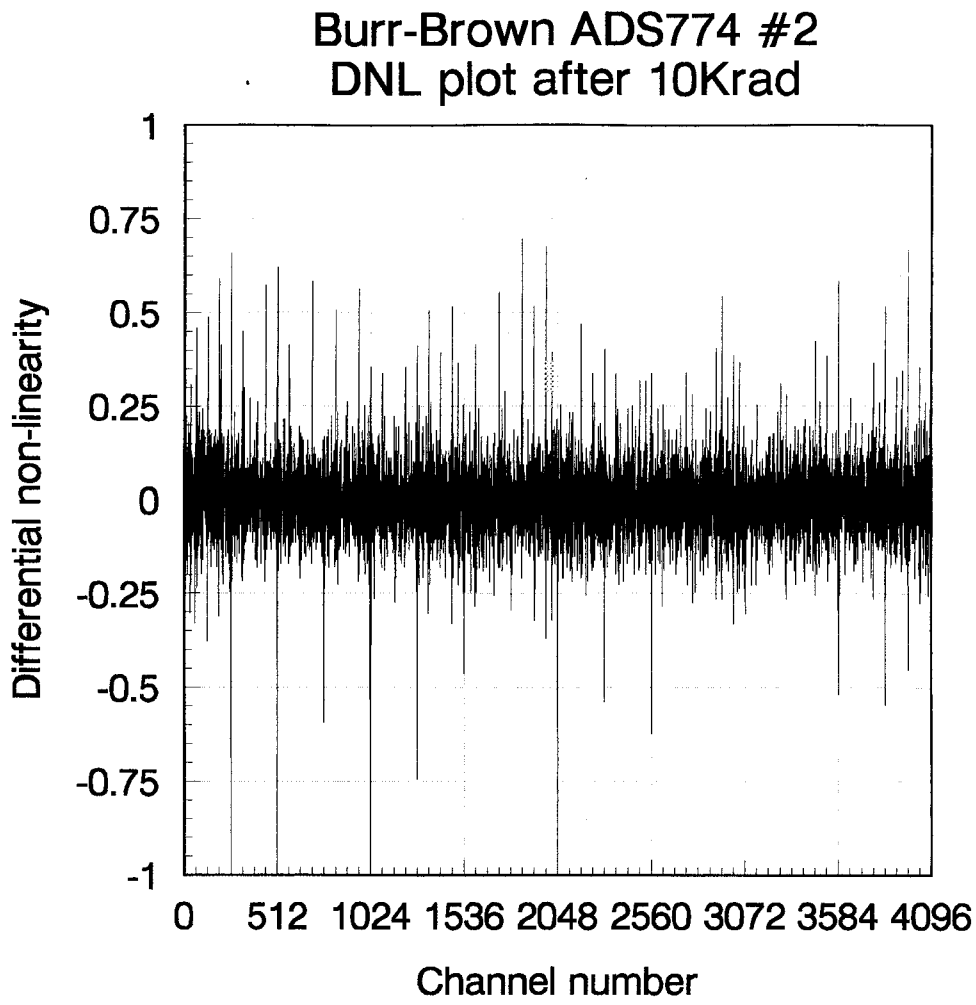

Burr-Brown ADS774 #1
INL plot after 32Krads
Integral non-linearity
(LSB)
40
20
0
-20
-40
-60
-80
-100
-120
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

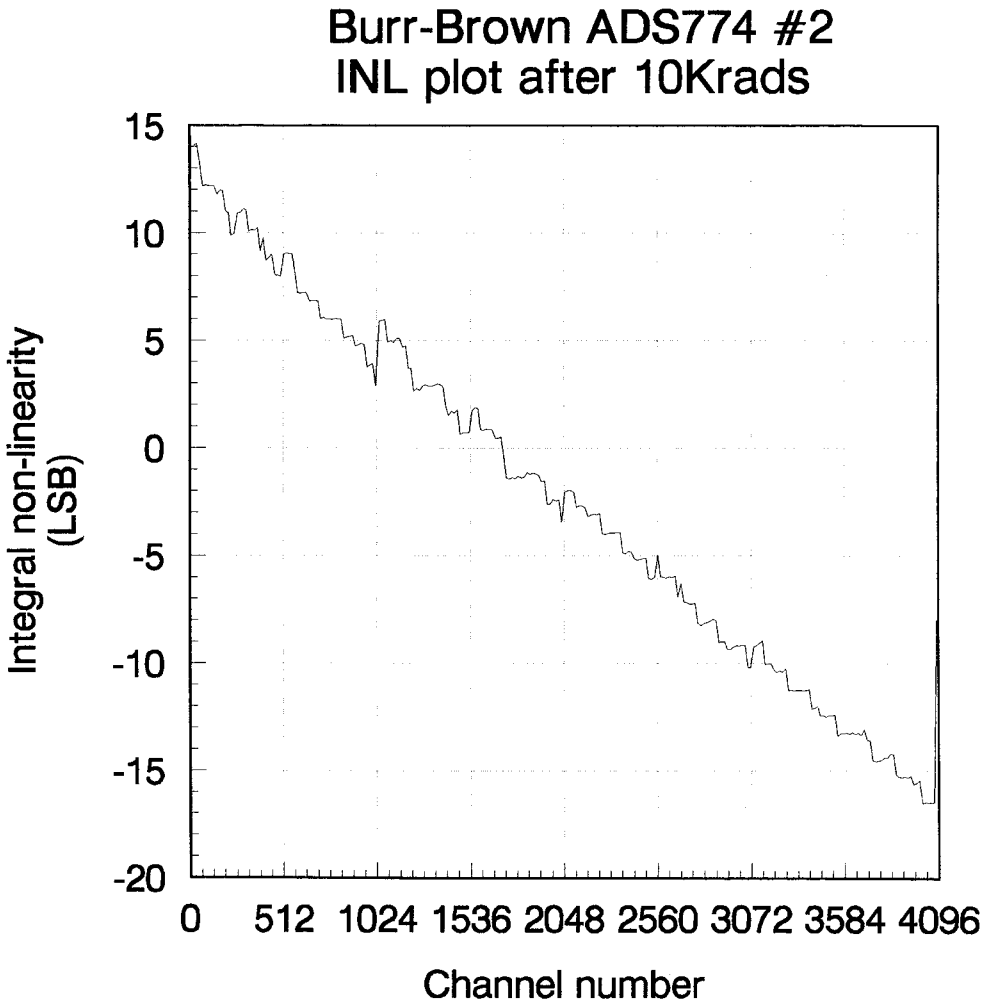

Burr-Brown ADS774 #2
DNL plot after 0Krad
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

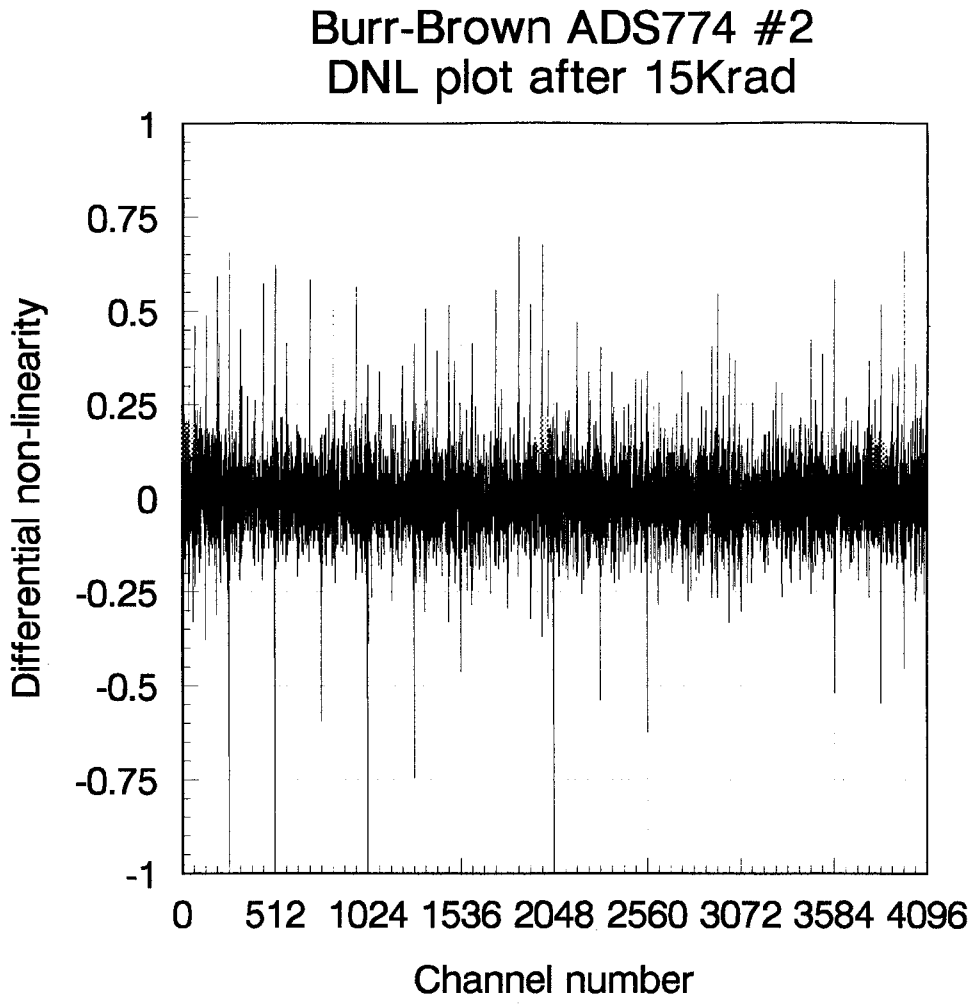

Burr-Brown ADS774 #2
INL plot after 0Krads
Integral non-linearity
(LSB)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

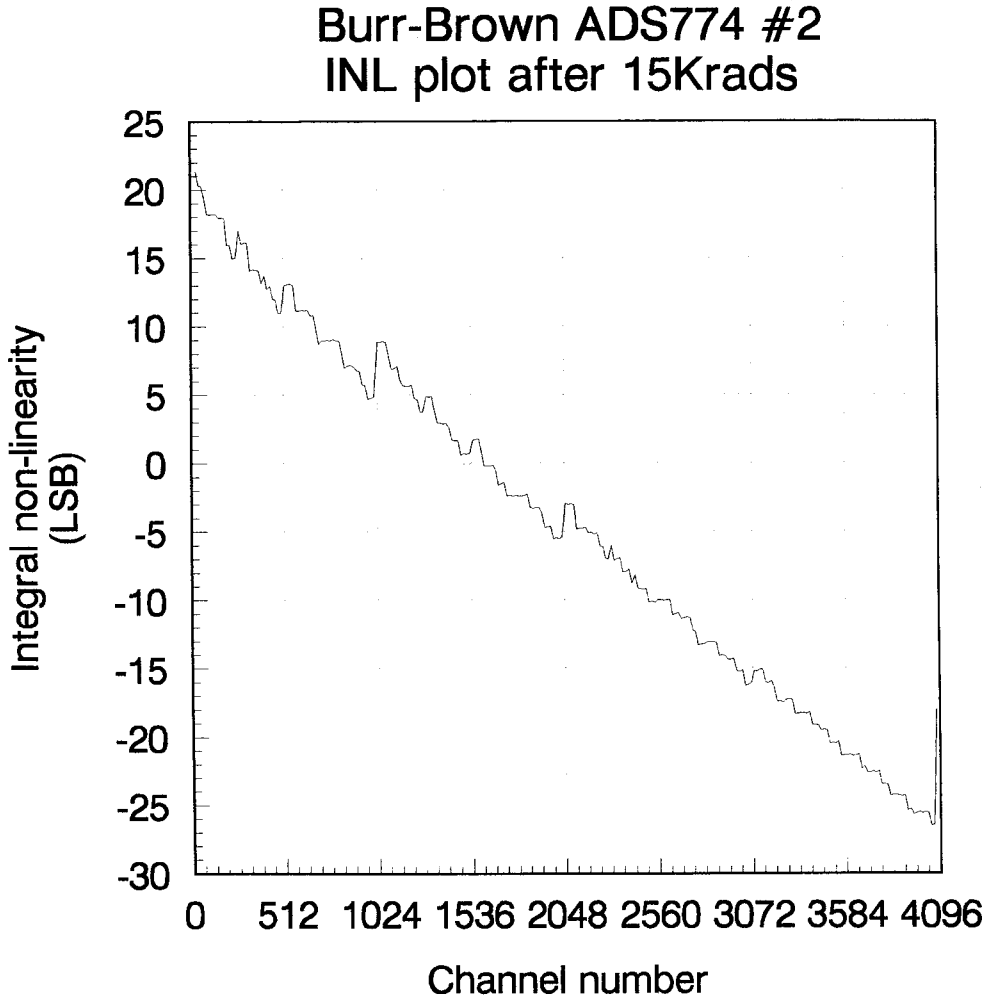

Burr-Brown ADS774 #2
DNL plot after 5Krad
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

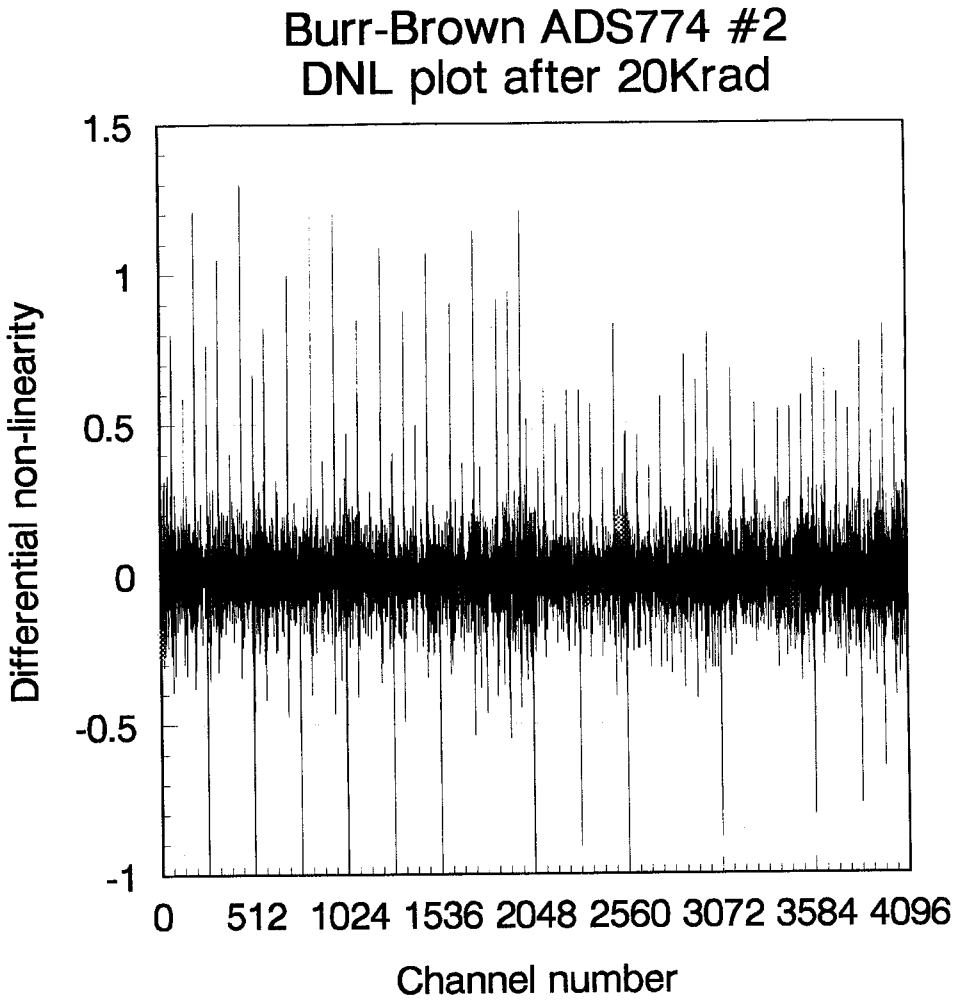

Burr-Brown ADS774 #2
INL plot after 5Krads
Integral non-linearity
(LSB)
6
4
2
0
-2
-4
-6
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

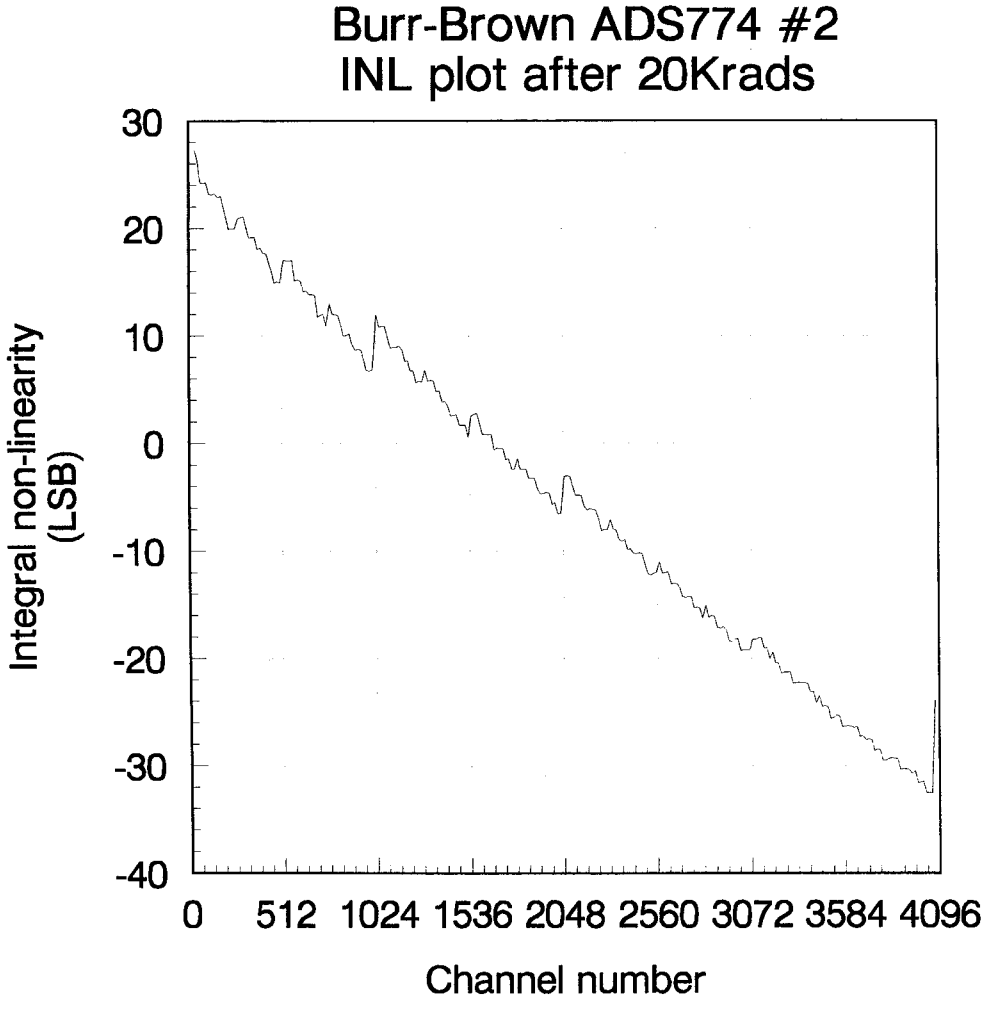

Burr-Brown ADS774 #2
DNL plot after 10Krad
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

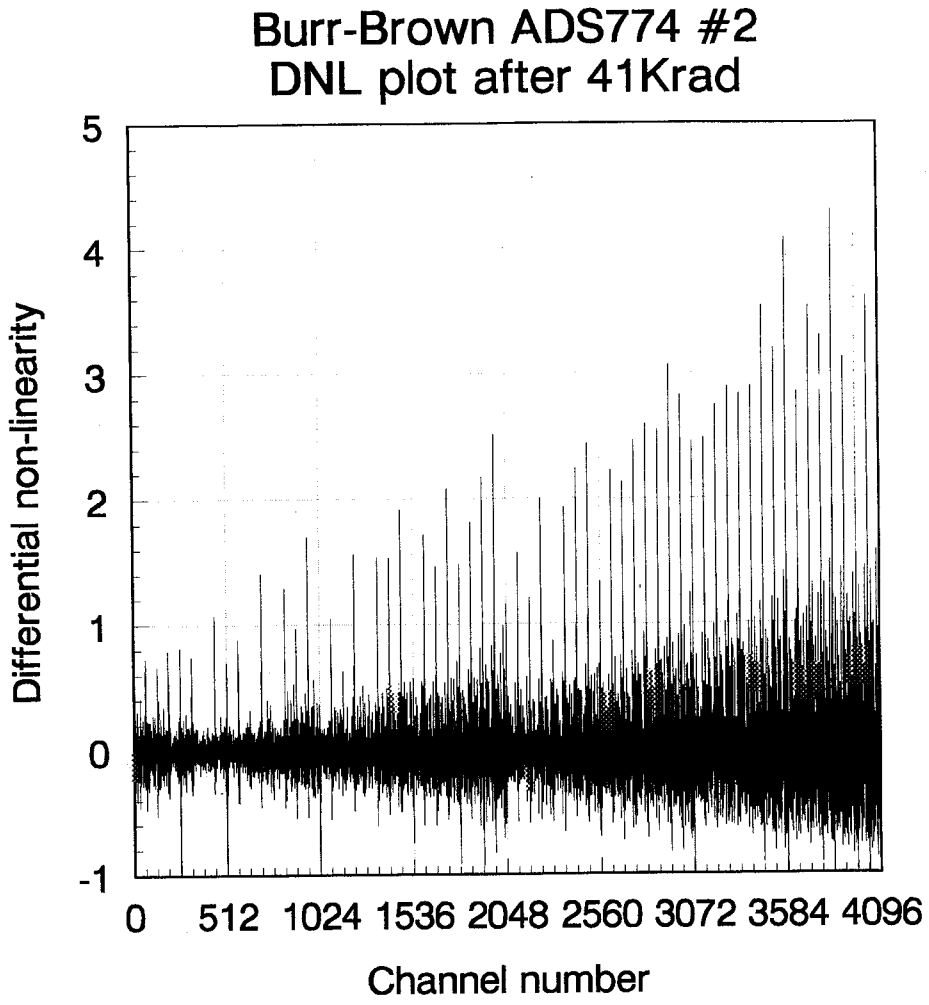

Burr-Brown ADS774 #2
INL plot after 10Krads
Integral non-linearity
(LSB)
15
10
5
0
-5
-10
-15
-20
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

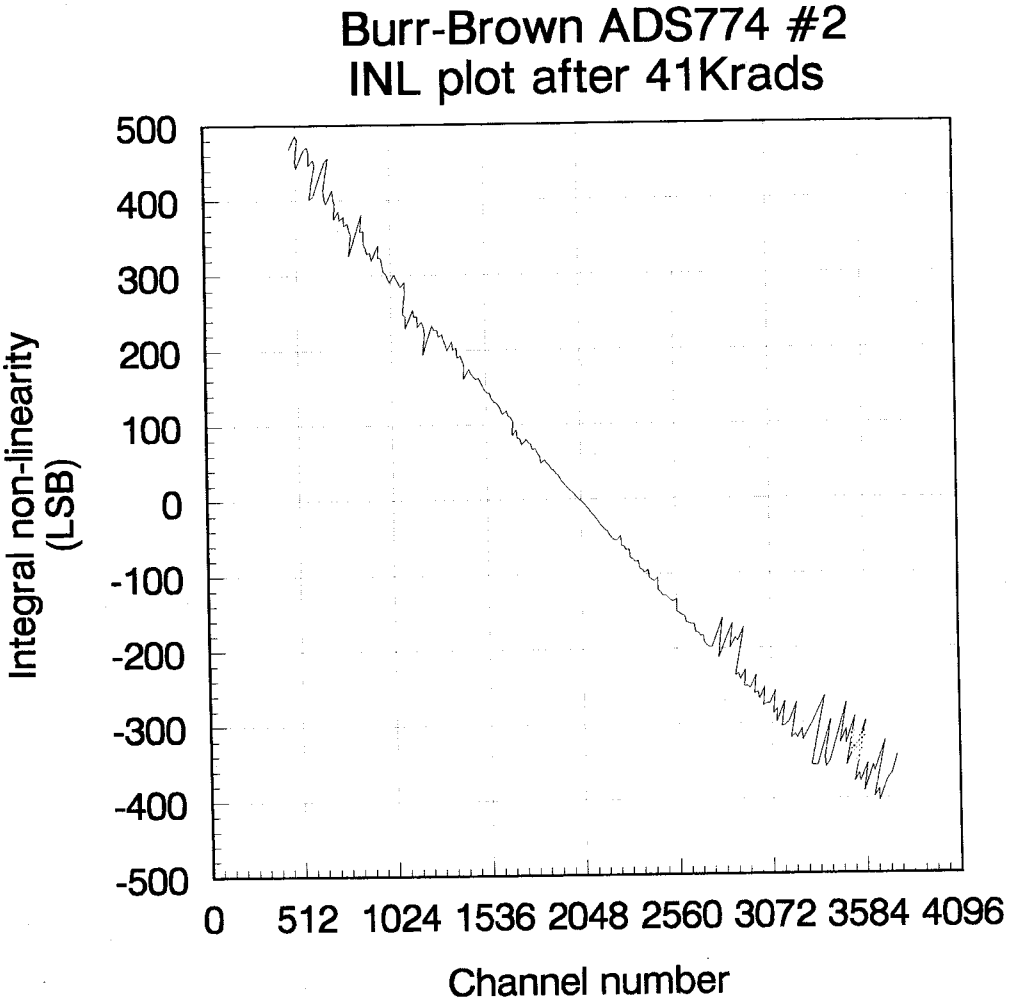

Burr-Brown ADS774 #2
DNL plot after 15Krad
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

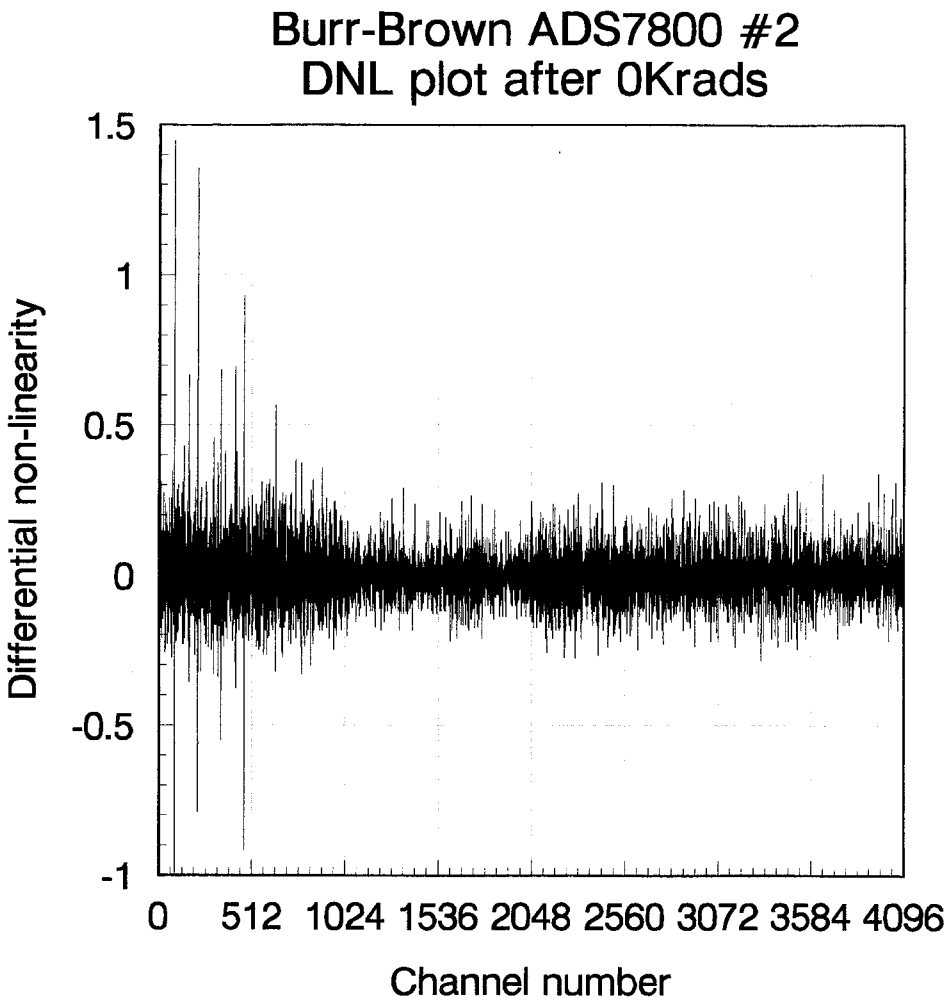

Burr-Brown ADS774 #2
INL plot after 15Krads
Integral non-linearity
(LSB)
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

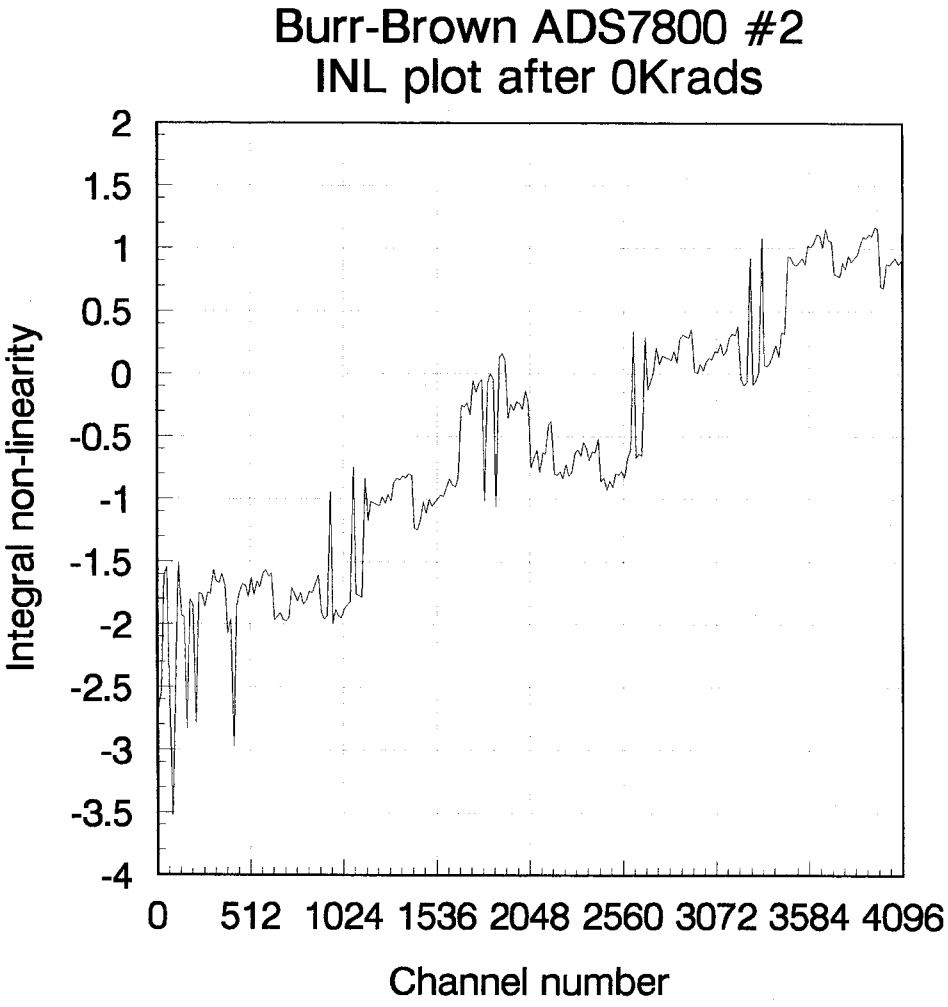

Burr-Brown ADS774 #2
DNL plot after 20Krad
Differential non-linearity
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

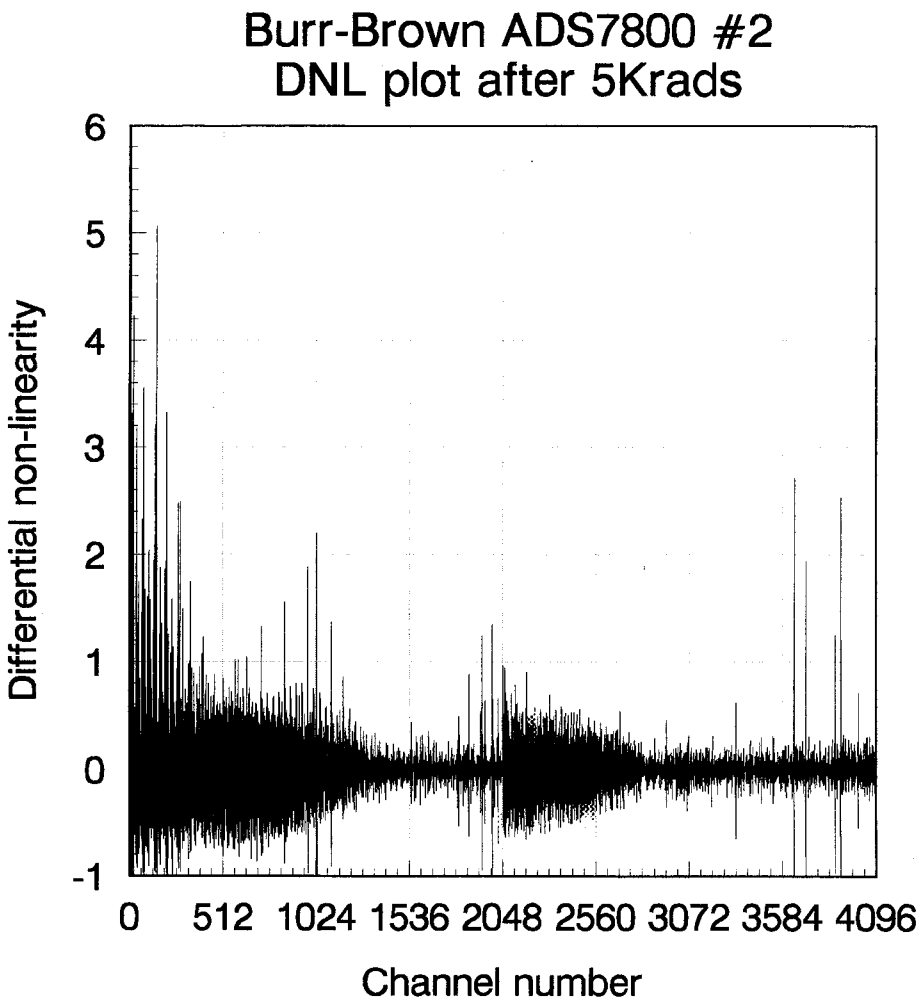

Burr-Brown ADS774 #2
INL plot after 20Krads
Integral non-linearity
(LSB)
30
20
10
0
-10
-20
-30
-40
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

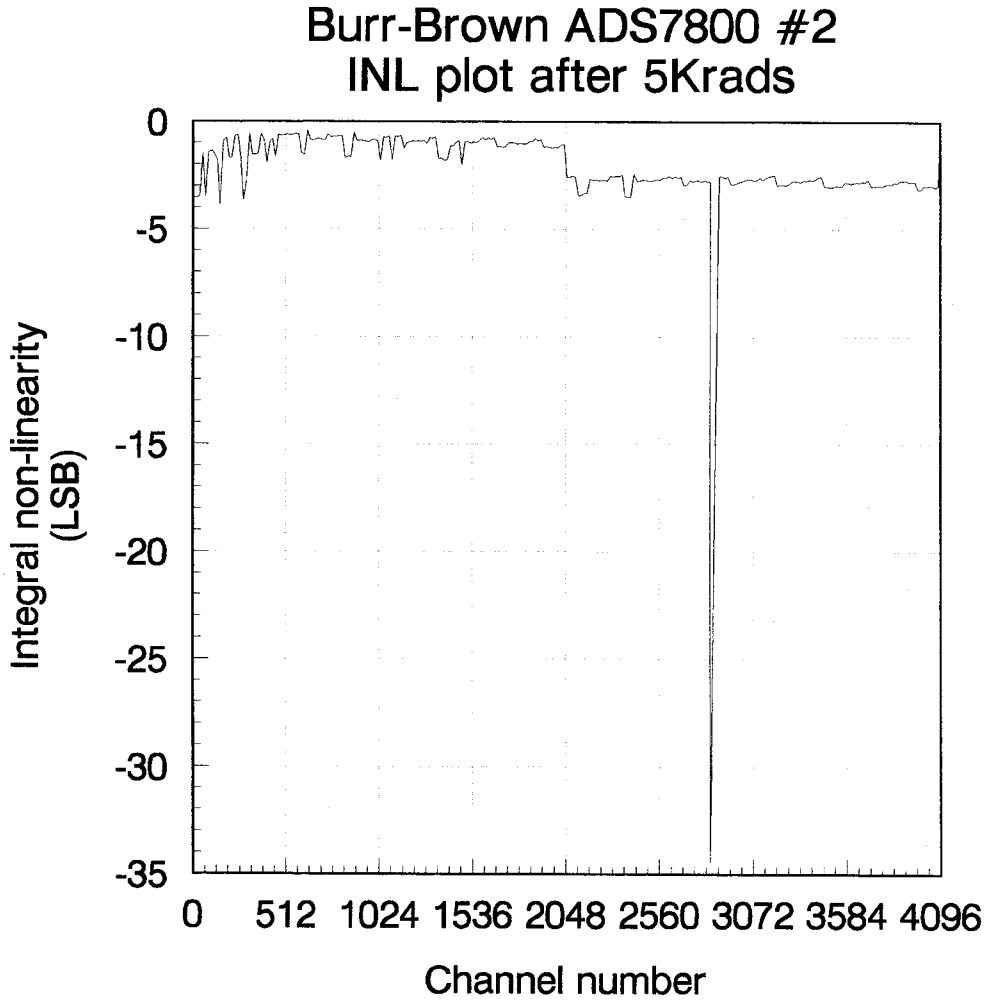

Burr-Brown ADS774 #2
DNL plot after 41Krad
Differential non-linearity
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

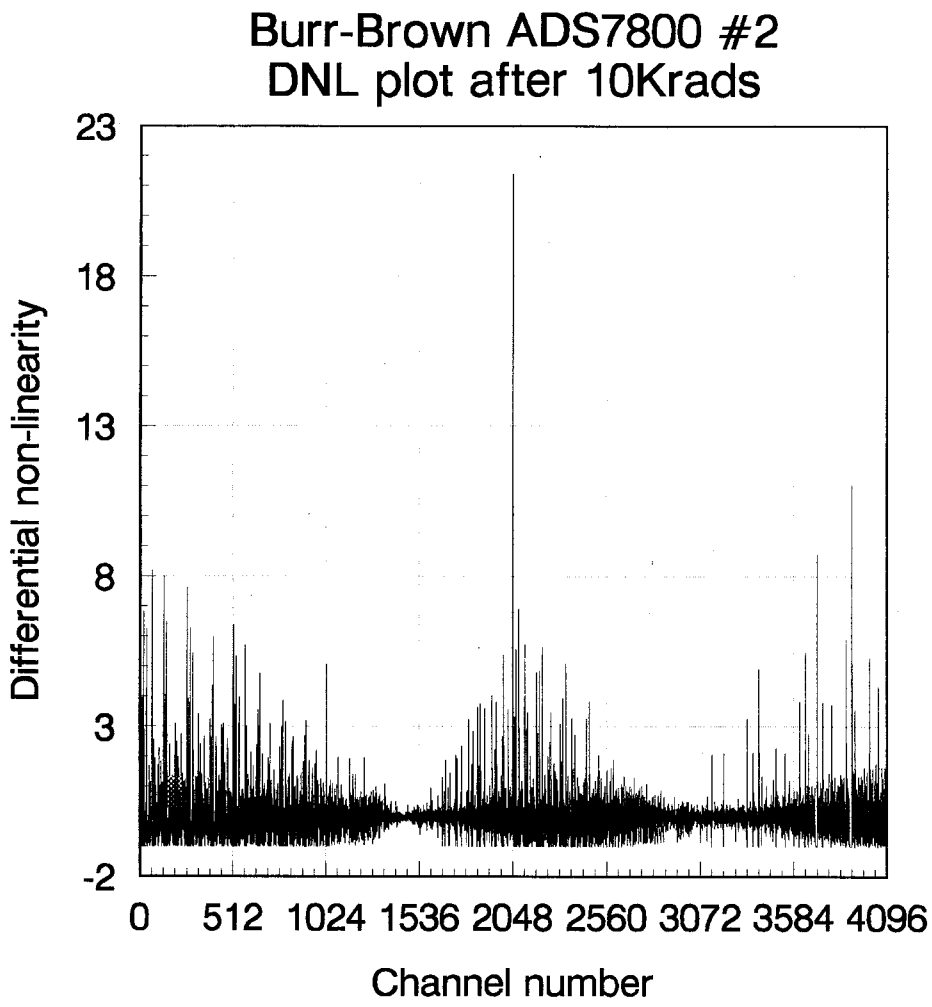

Burr-Brown ADS774 #2
INL plot after 41Krads
Integral non-linearity
(LSB)
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

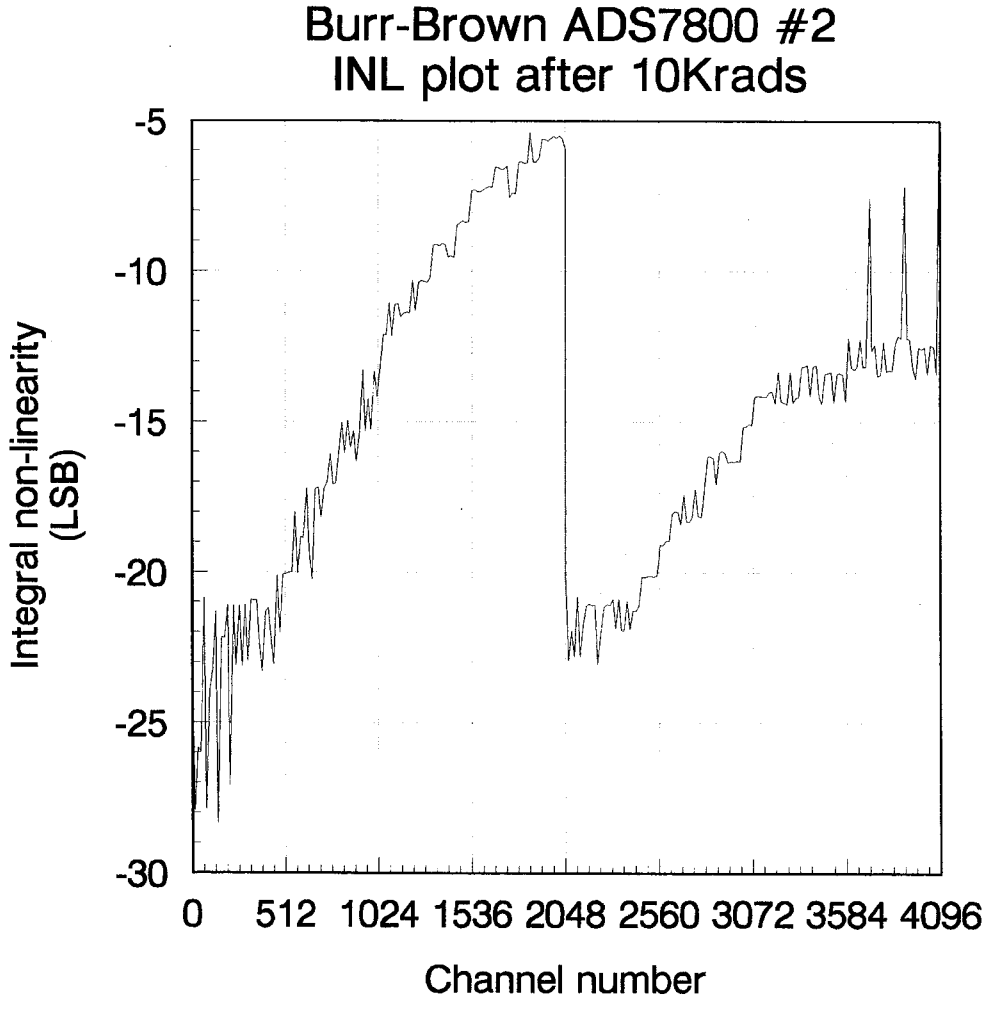

Burr-Brown ADS7800 #2
DNL plot after 0Krads
Differential non-linearity
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

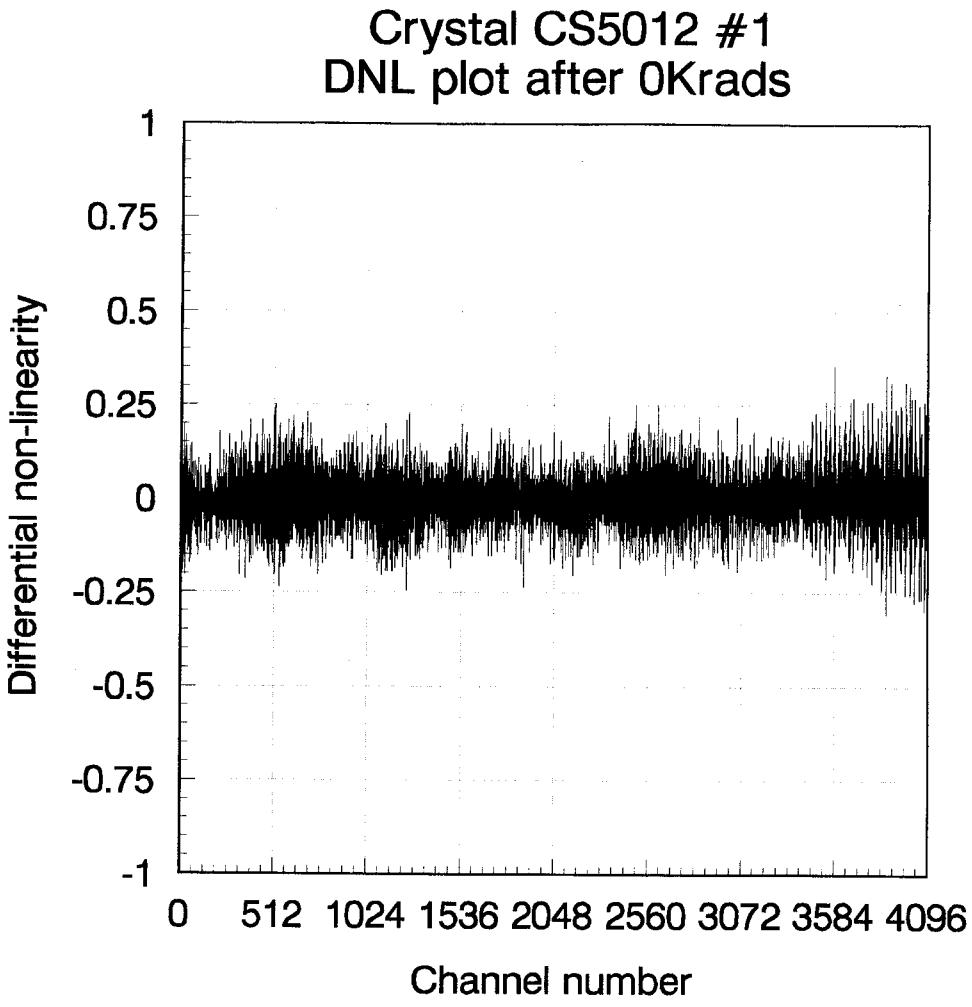

Burr-Brown ADS7800 #2
INL plot after 0Krads
Integral non-linearity
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

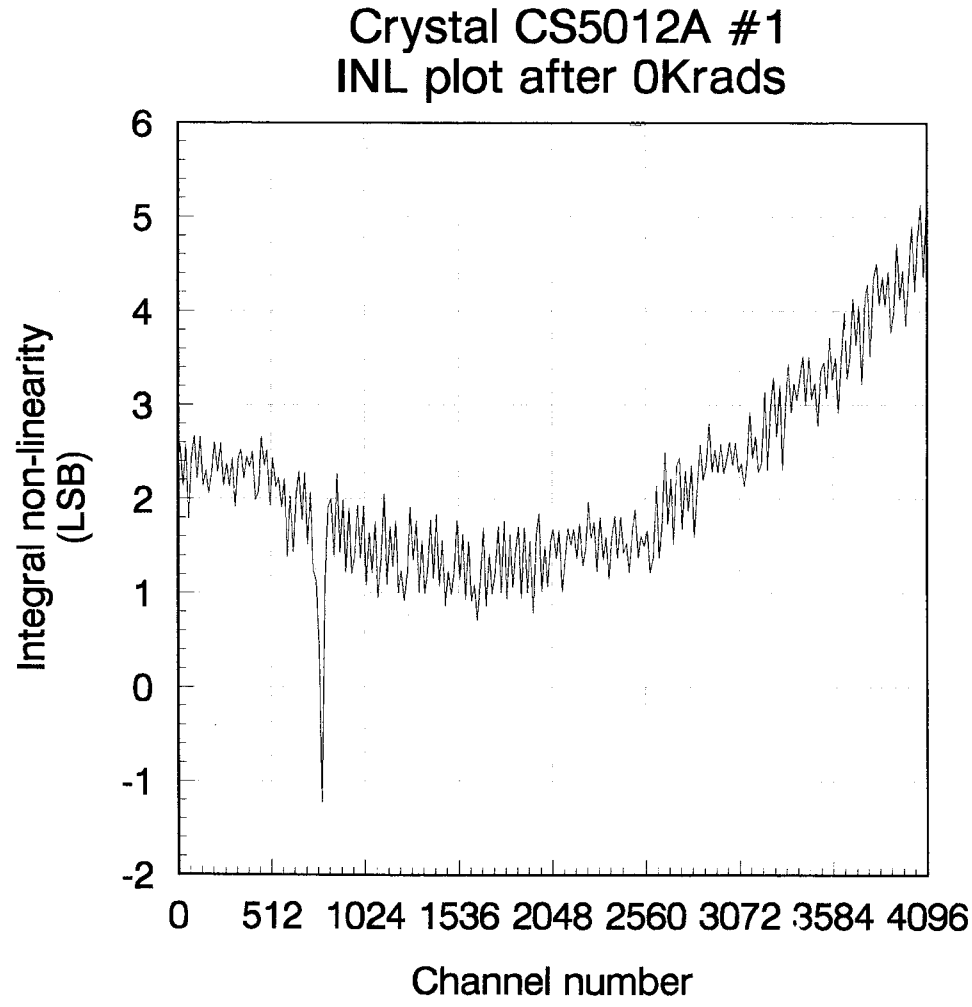

Burr-Brown ADS7800 #2
DNL plot after 5Krads
Differential non-linearity
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

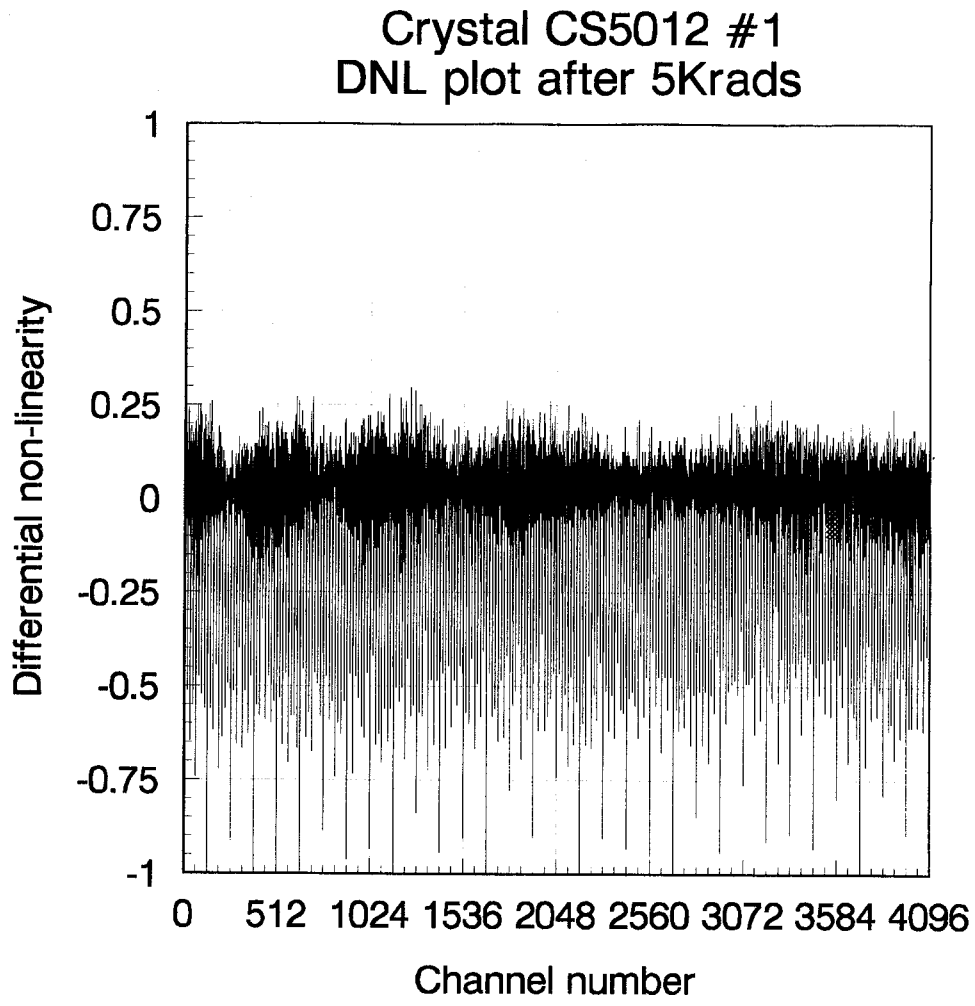

Burr-Brown ADS7800 #2
INL plot after 5Krads
Integral non-linearity
(LSB)
0
-5
-10
-15
-20
-25
-30
-35
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

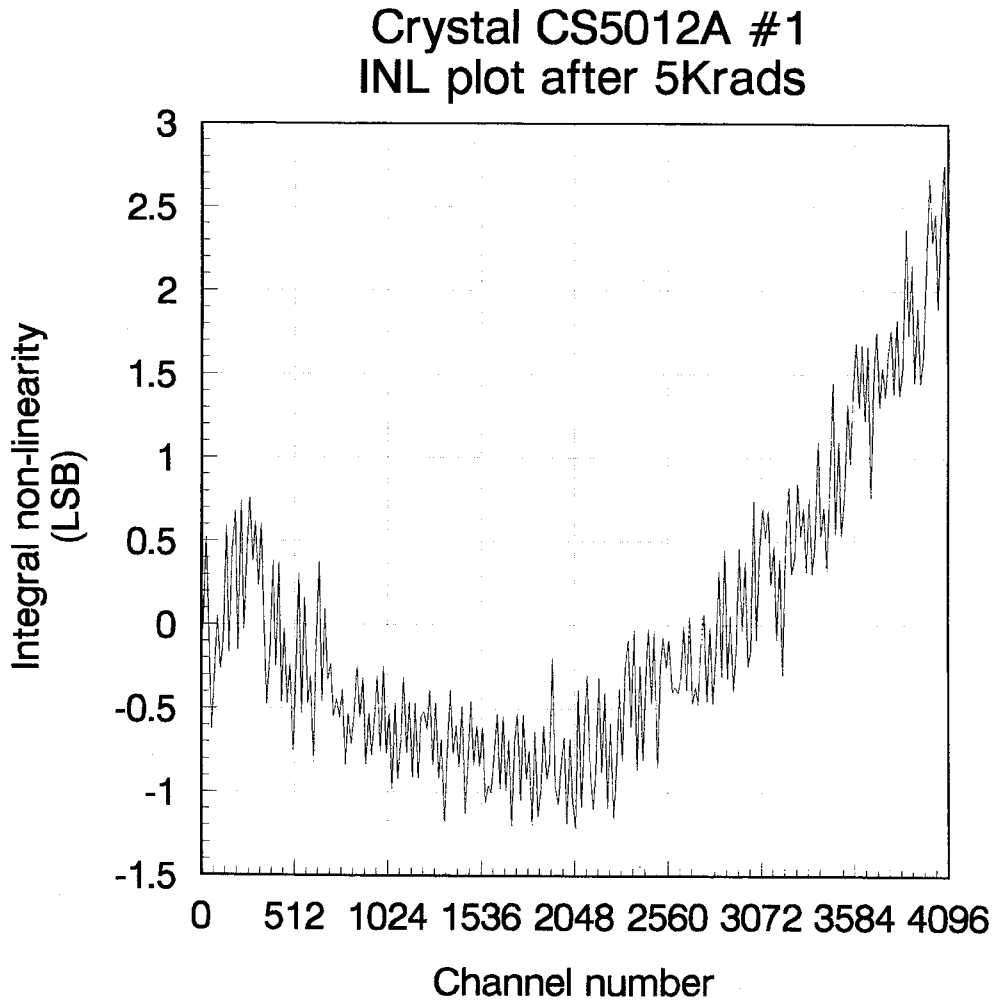

Burr-Brown ADS7800 #2
DNL plot after 10Krads
Differential non-linearity
23
18
13
8
3
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

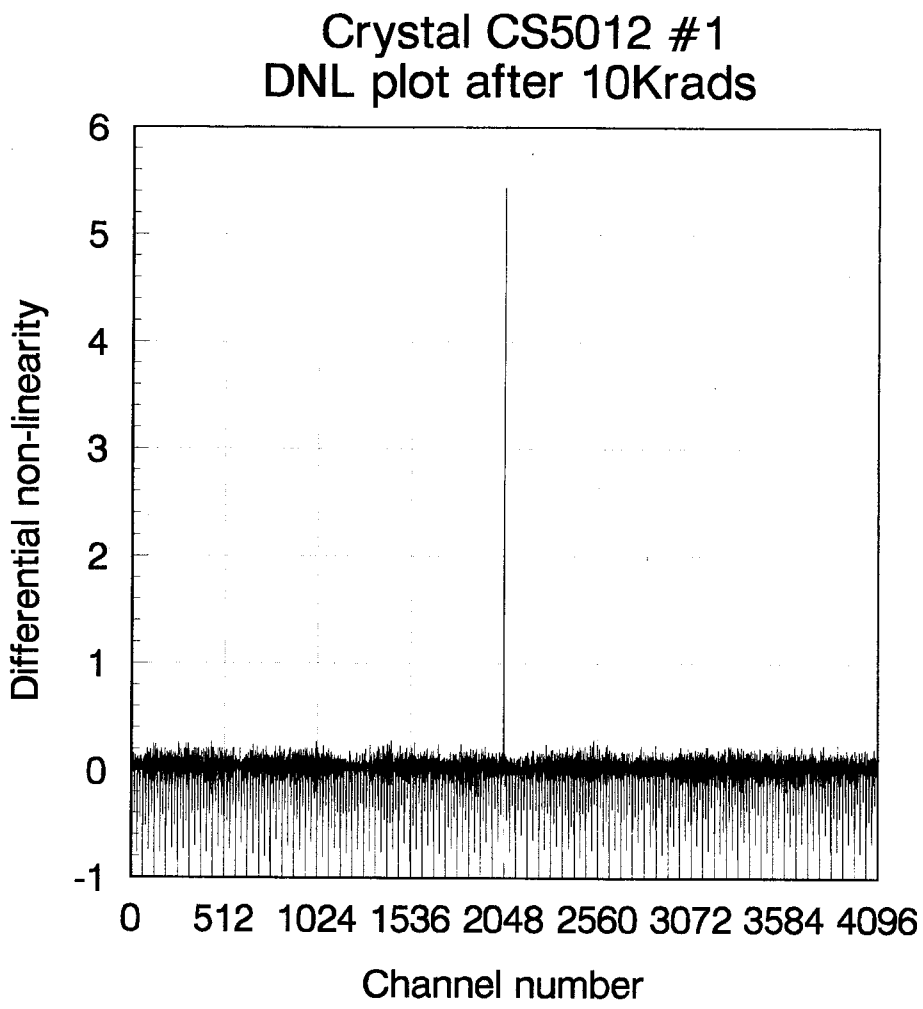

Burr-Brown ADS7800 #2
INL plot after 10Krads
Integral non-linearity
(LSB)
-5
-10
-15
-20
-25
-30
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

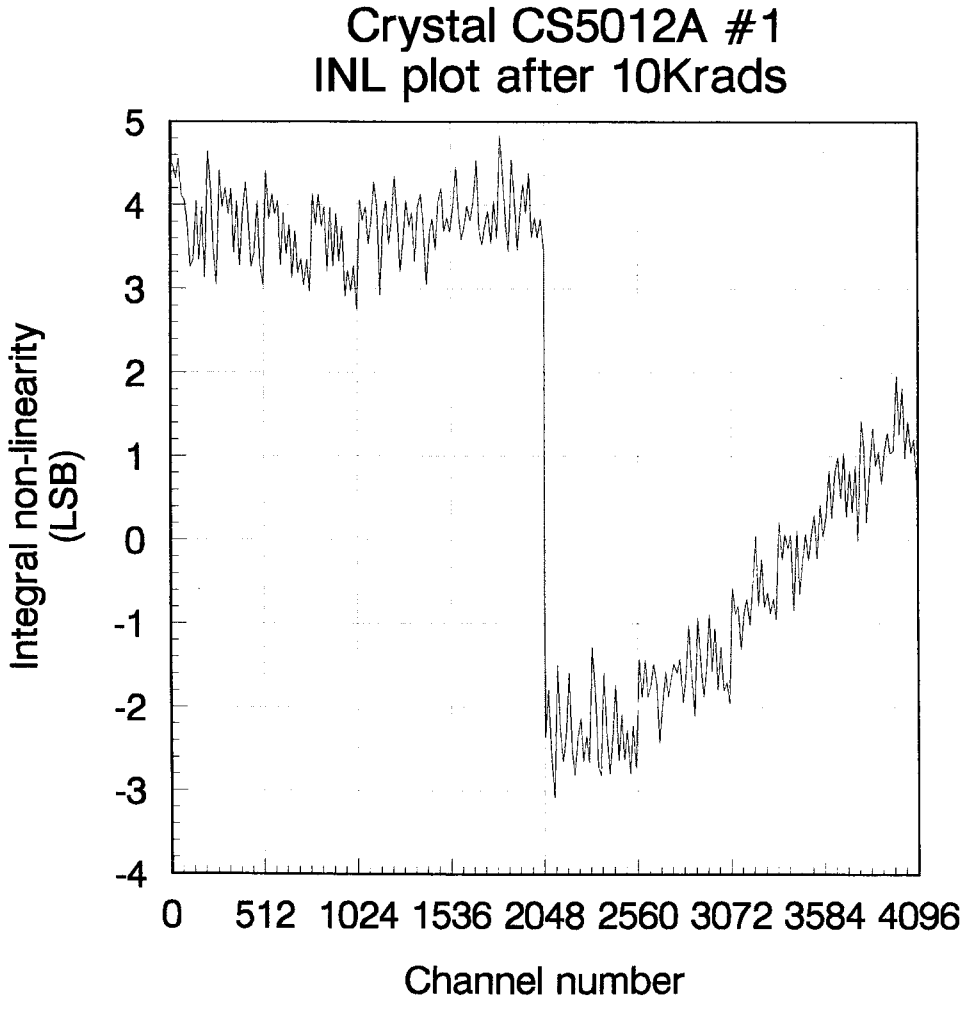

Crystal CS5012 #1
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

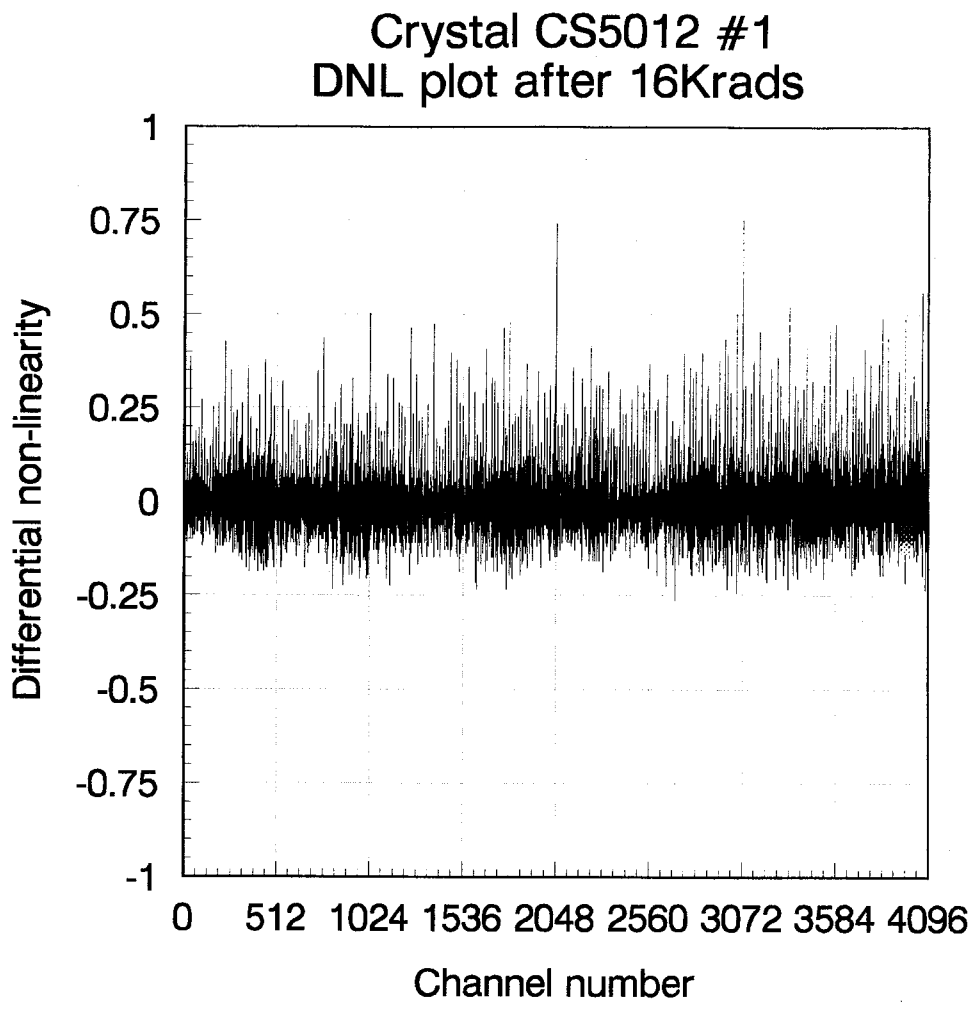

Crystal CS5012A #1
INL plot after 0Krads
Integral non-linearity
(LSB)
6
5
4
3
2
1
0
-1
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

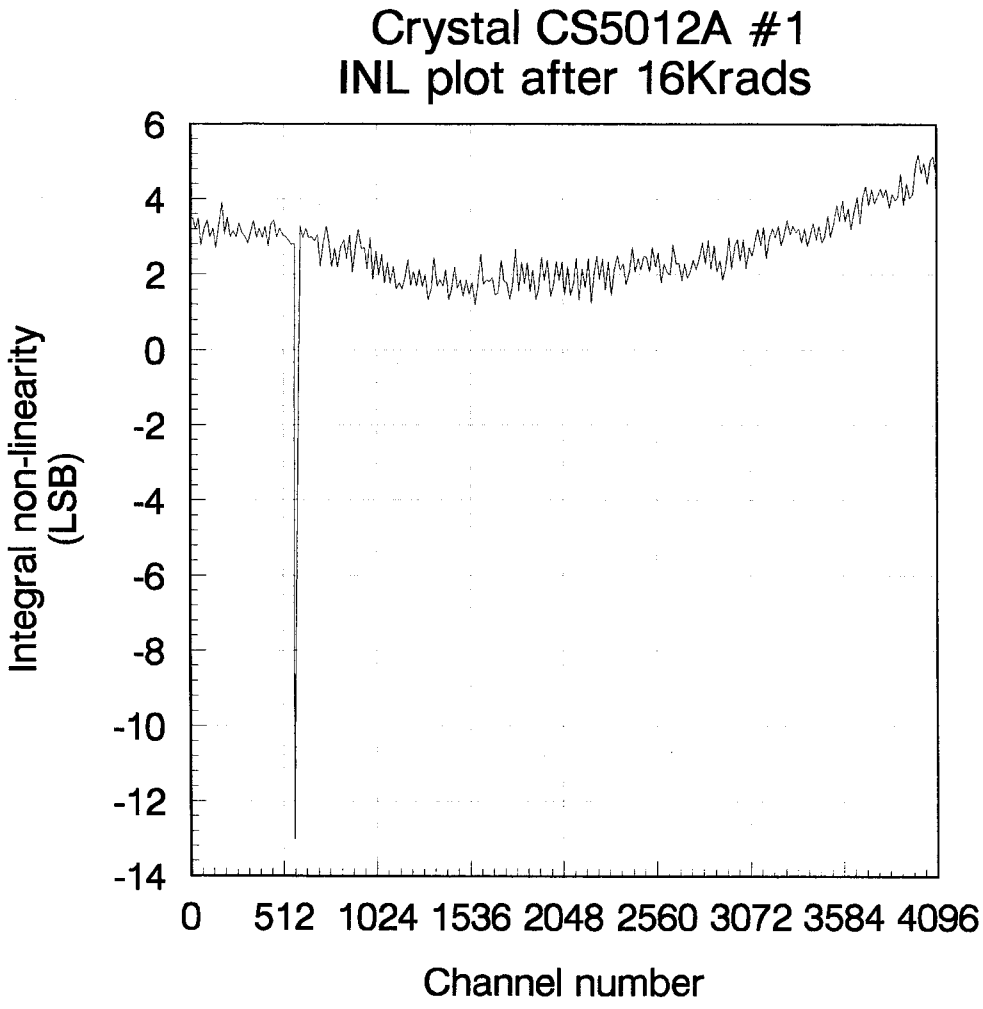

Crystal CS5012 #1
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

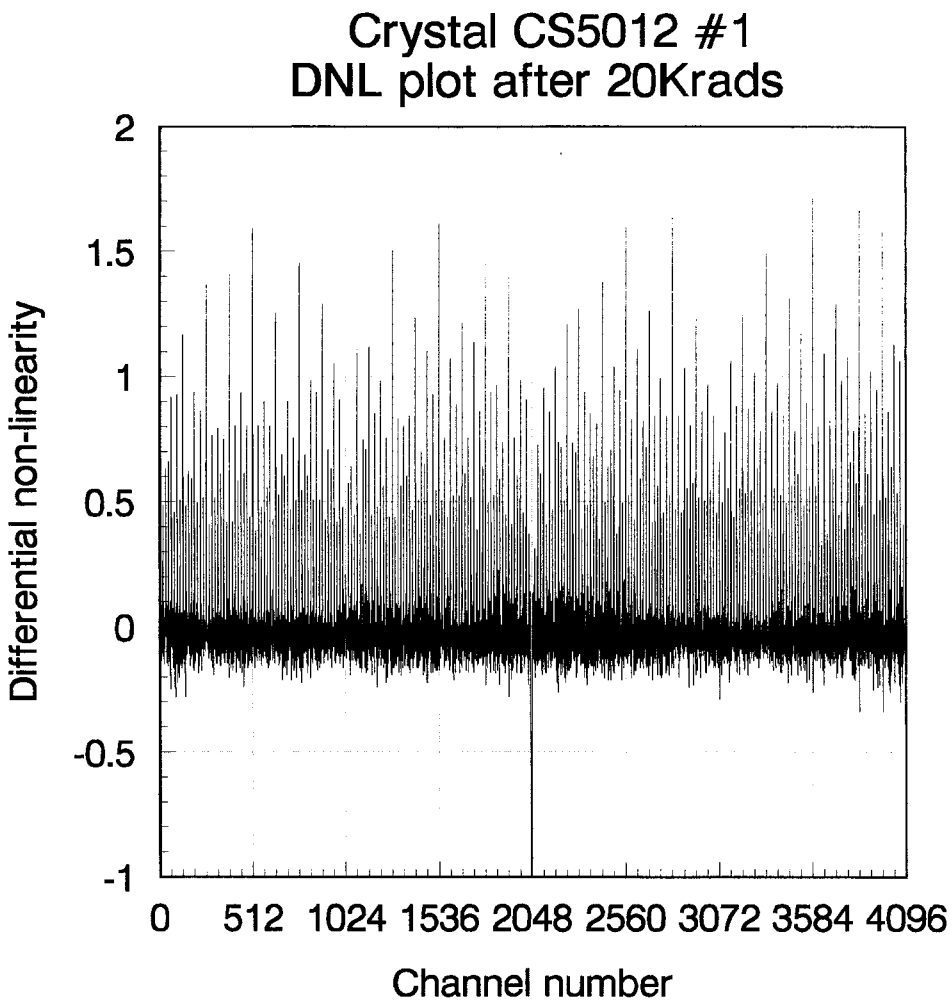

Crystal CS5012A #1
INL plot after 5Krads
Integral non-linearity
(LSB)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

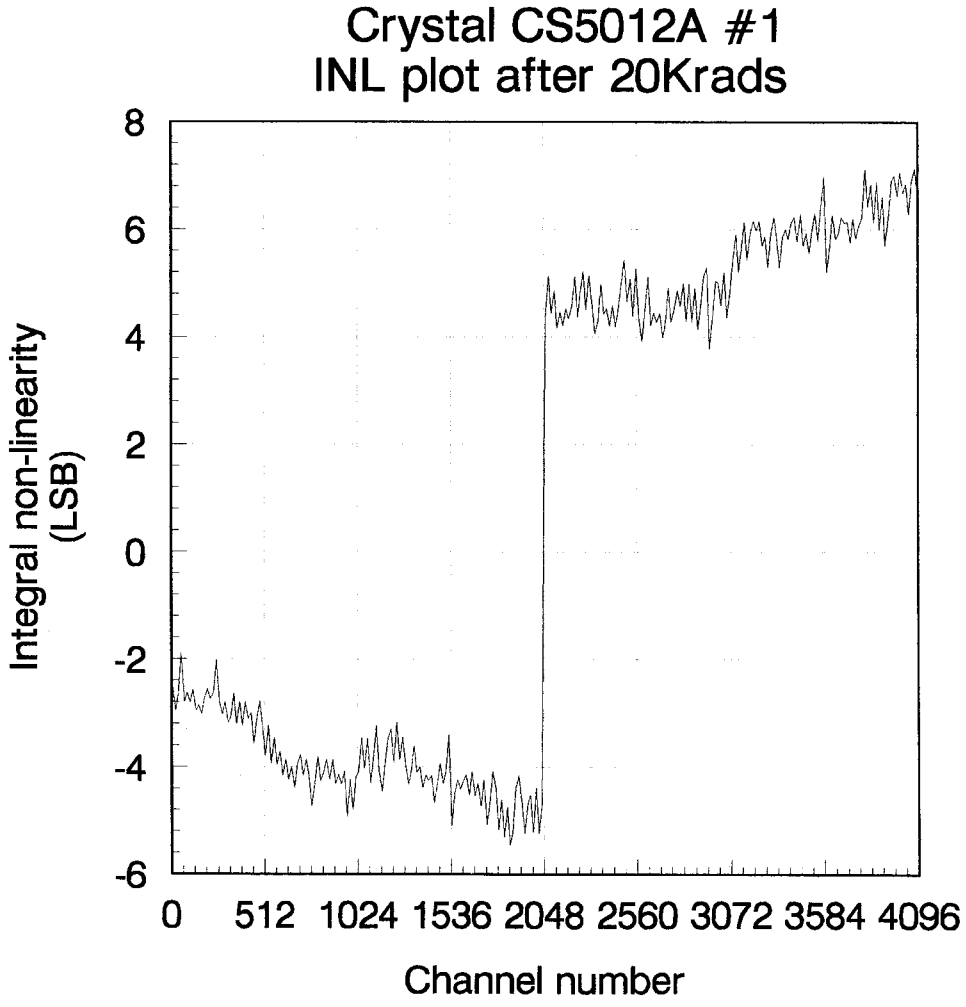

Crystal CS5012 #1
DNL plot after 10Krads
Differential non-linearity
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

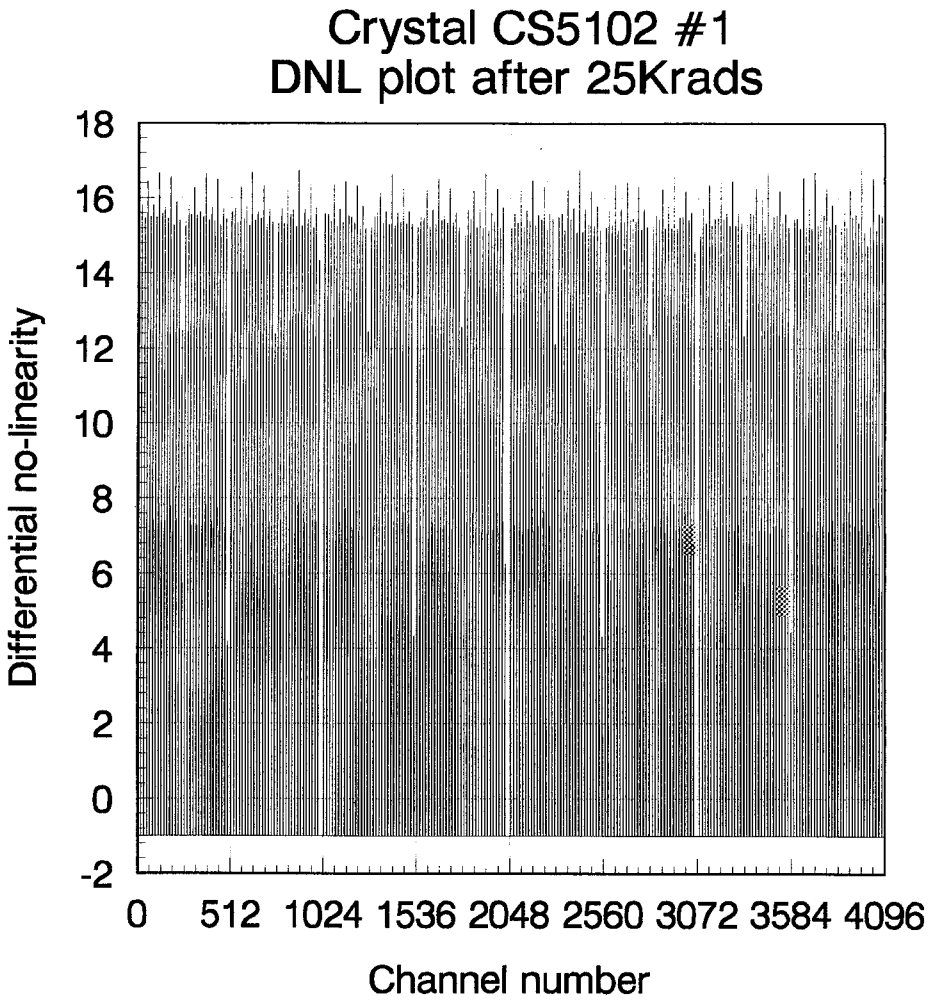

Crystal CS5012A #1
INL plot after 10Krads
Integral non-linearity
(LSB)
5
4
3
2
1
0
-1
-2
-3
-4
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

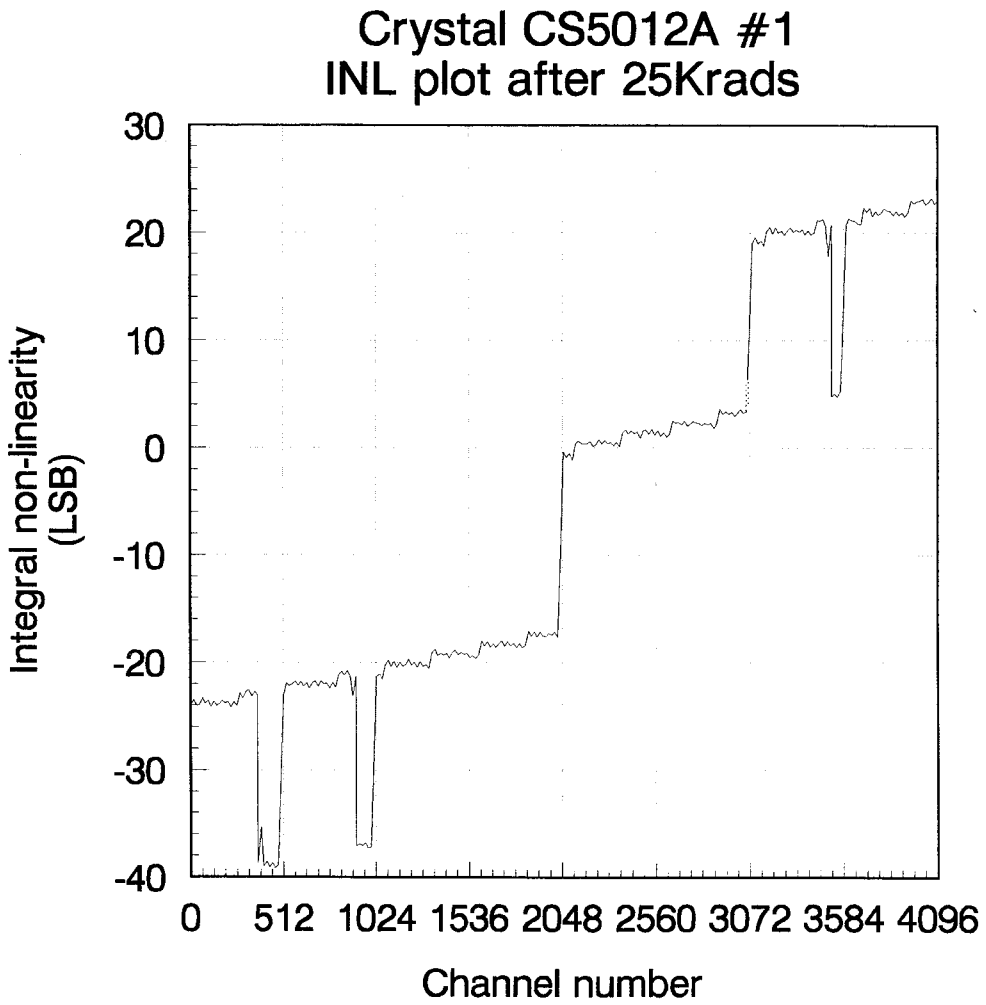

Crystal CS5012 #1
DNL plot after 16Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

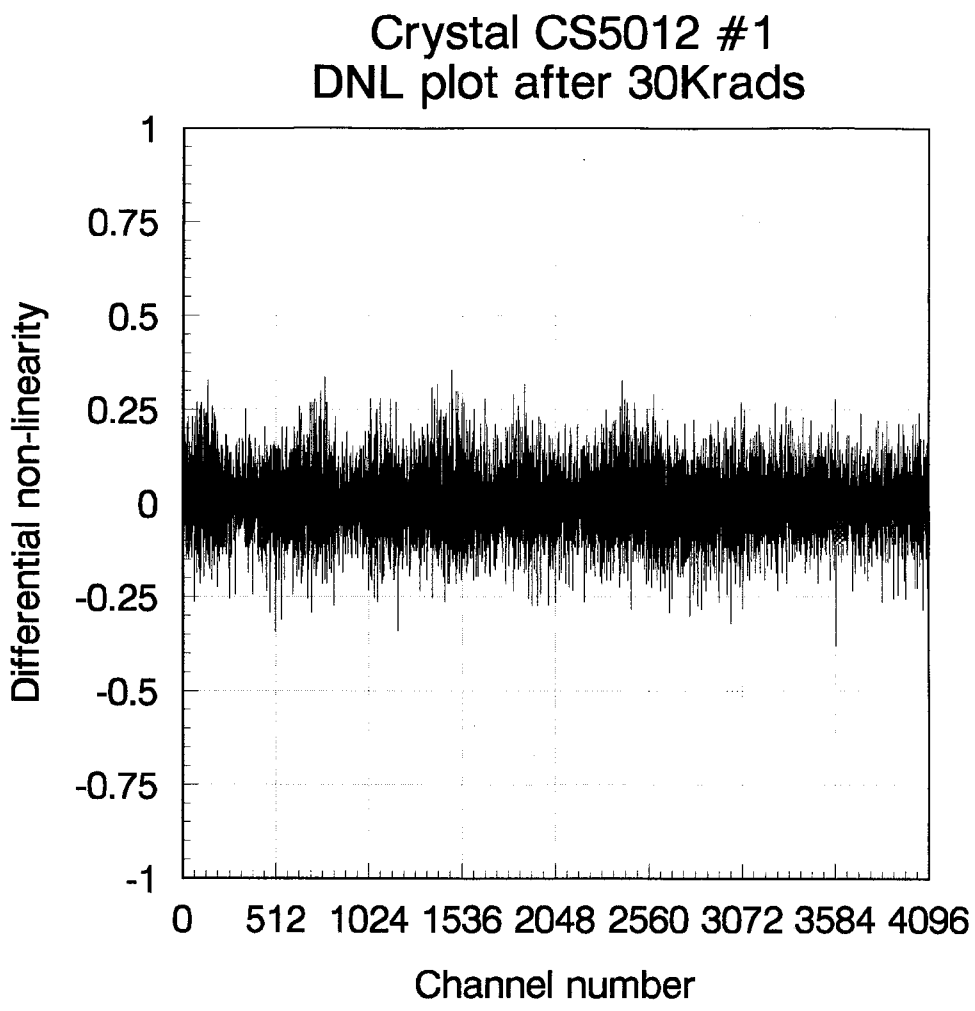

Crystal CS5012A #1
INL plot after 16Krads
Integral non-linearity
(LSB)
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

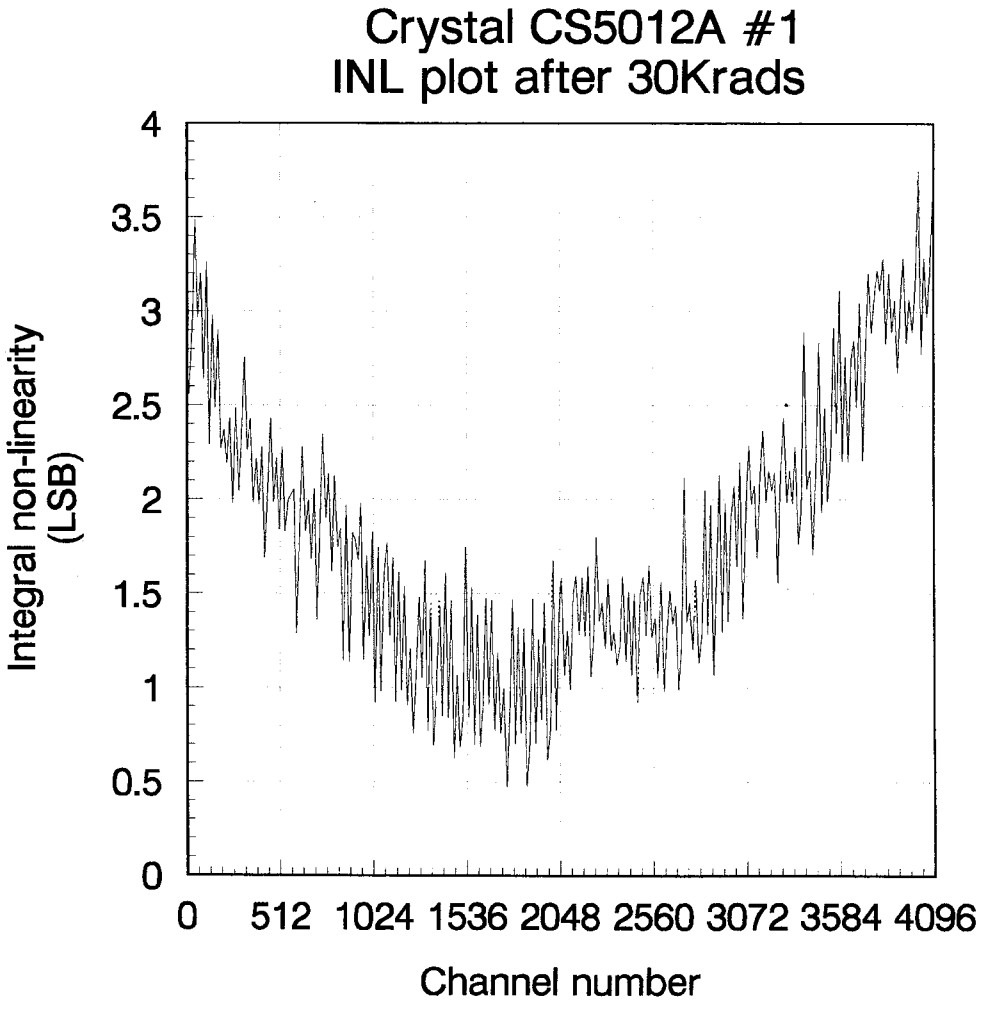

Crystal CS5012 #1
DNL plot after 20Krads
Differential non-linearity
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

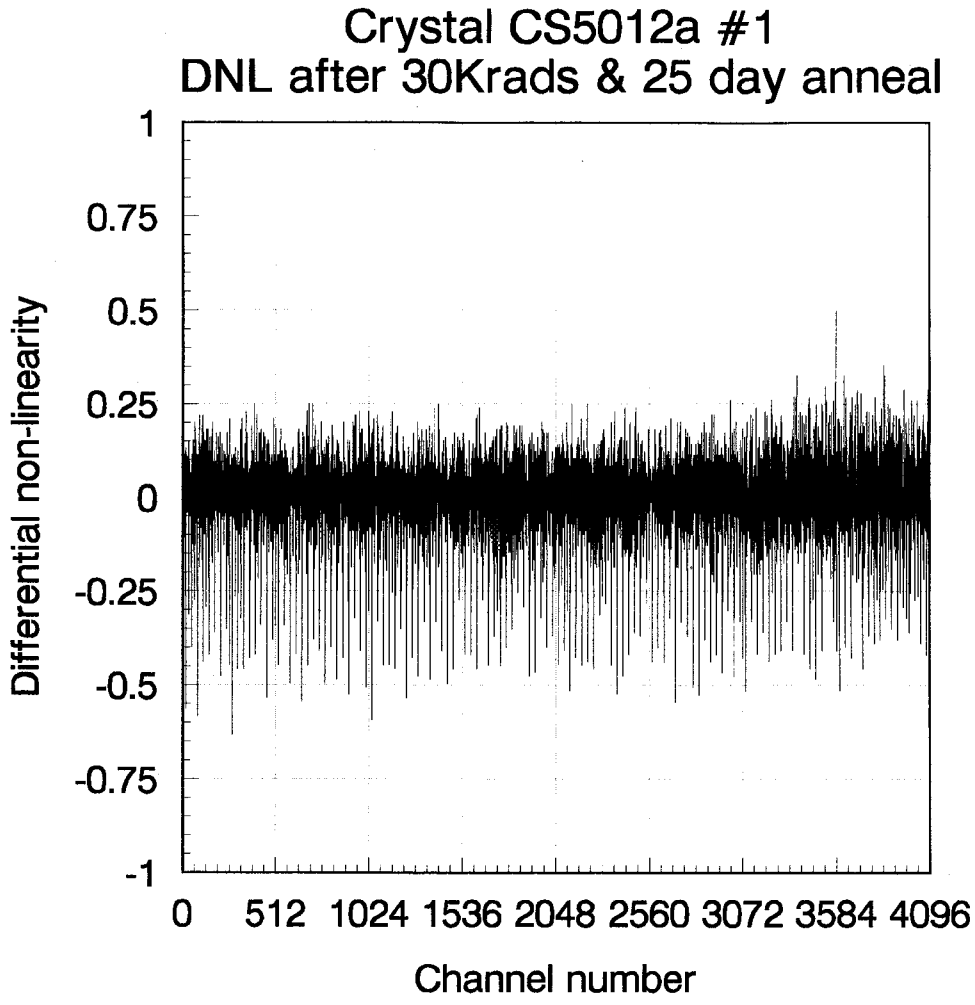

Crystal CS5012A #1
INL plot after 20Krads
Integral non-linearity
(LSB)
8
6
4
2
0
-2
-4
-6
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

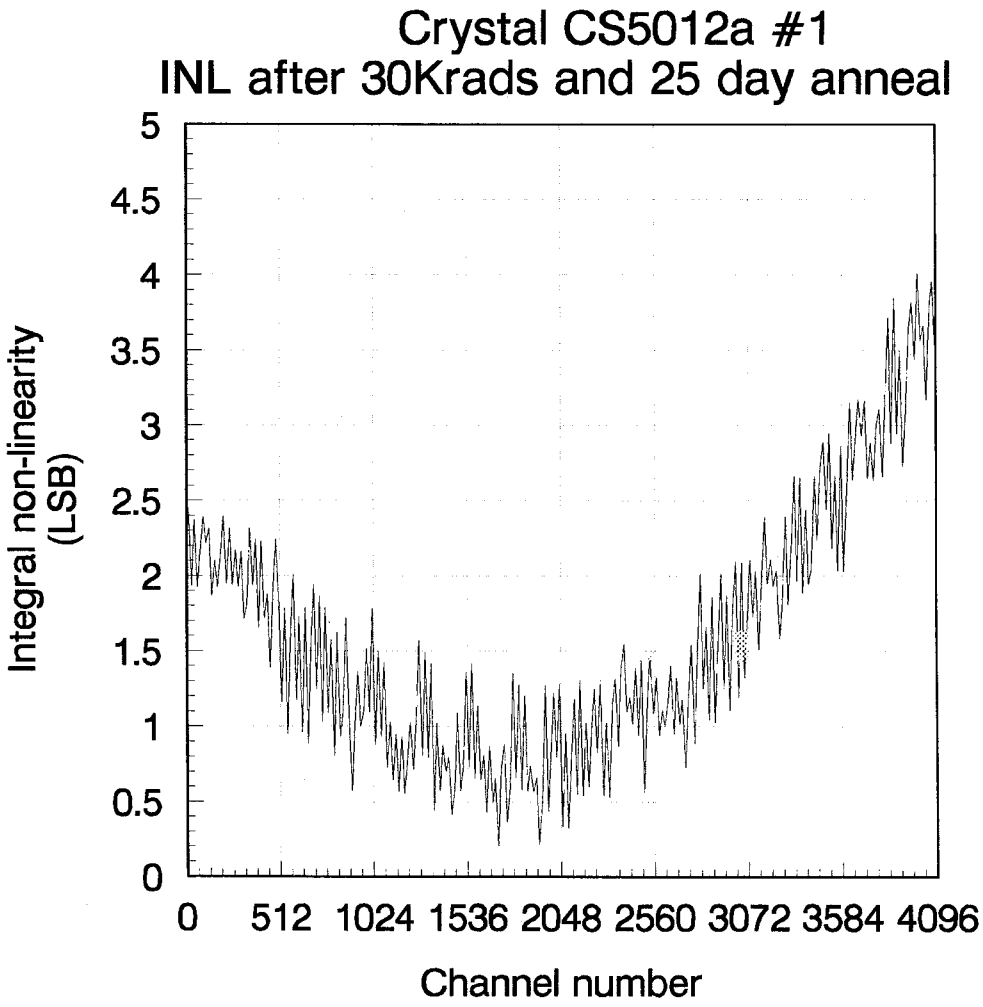

Crystal CS5102 #1
DNL plot after 25Krads
Differential no-linearity
18
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

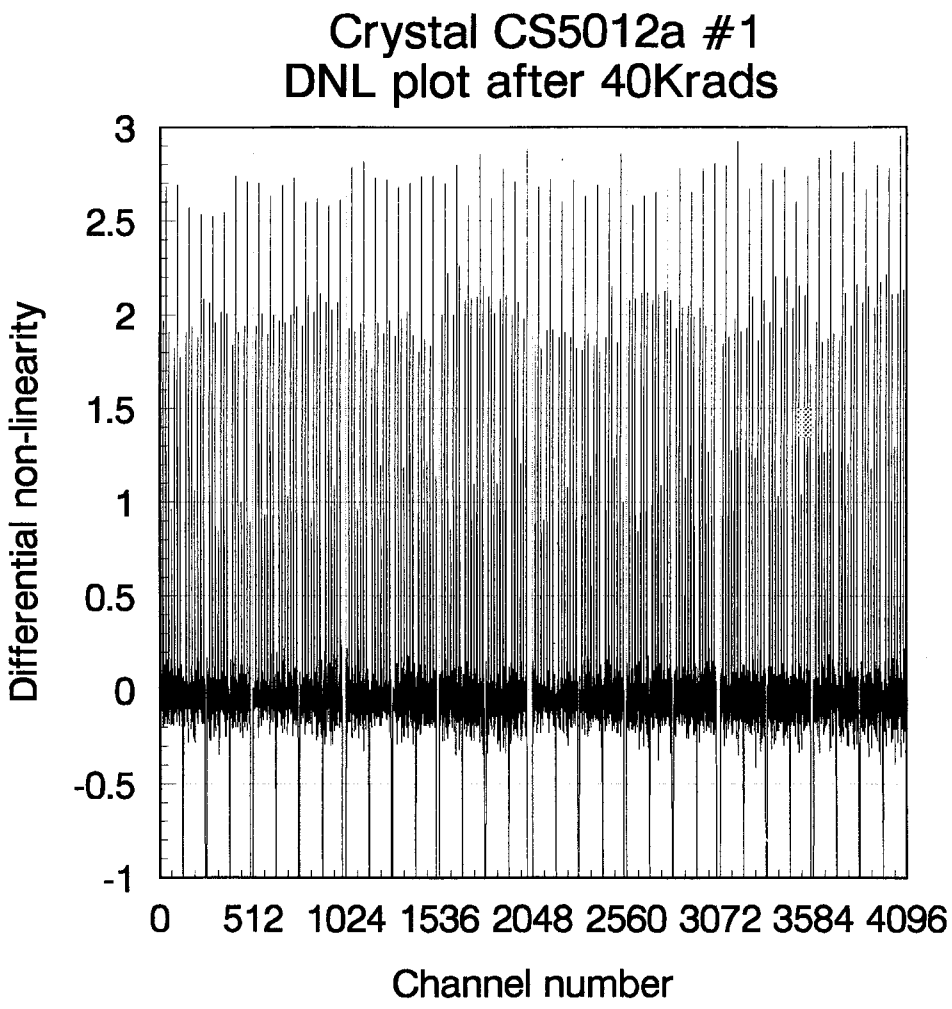

Crystal CS5012A #1
INL plot after 25Krads
Integral non-linearity
(LSB)
30
20
10
0
-10
-20
-30
-40
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

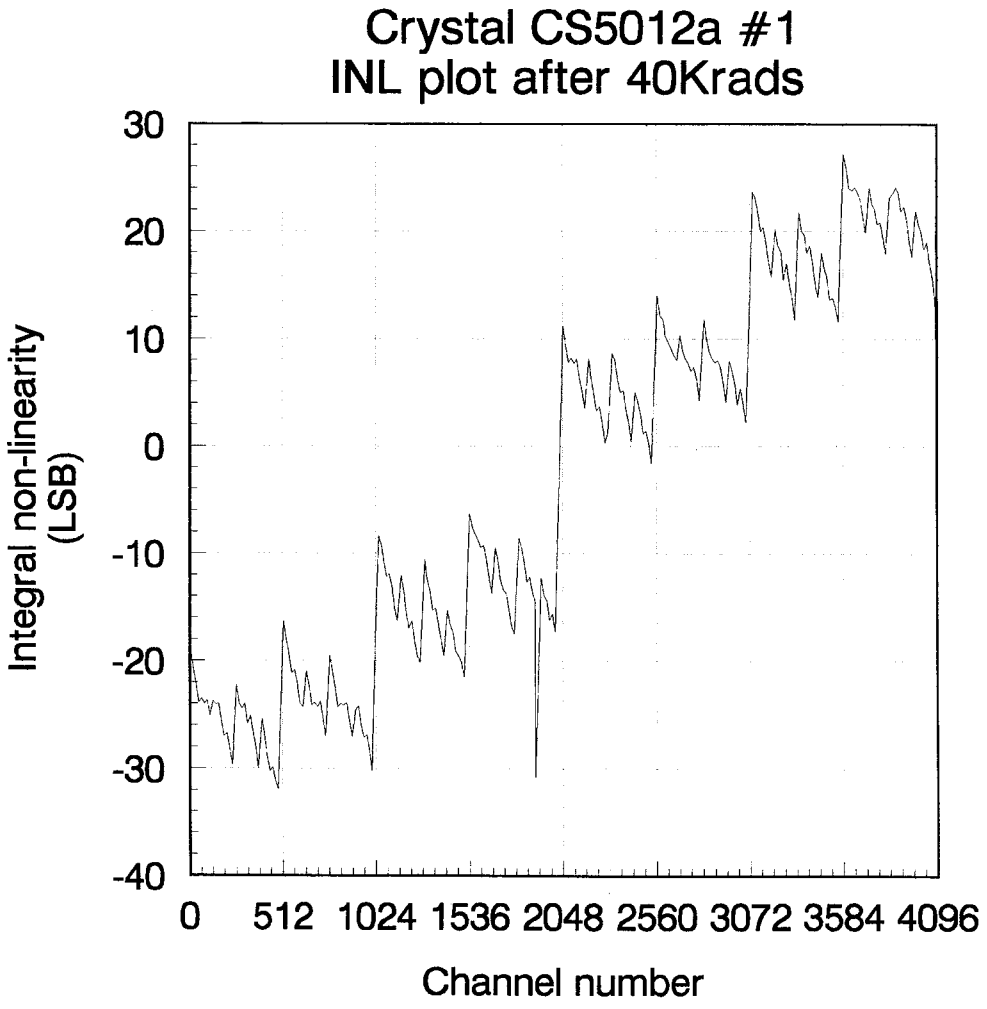

Crystal CS5012 #1
DNL plot after 30Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

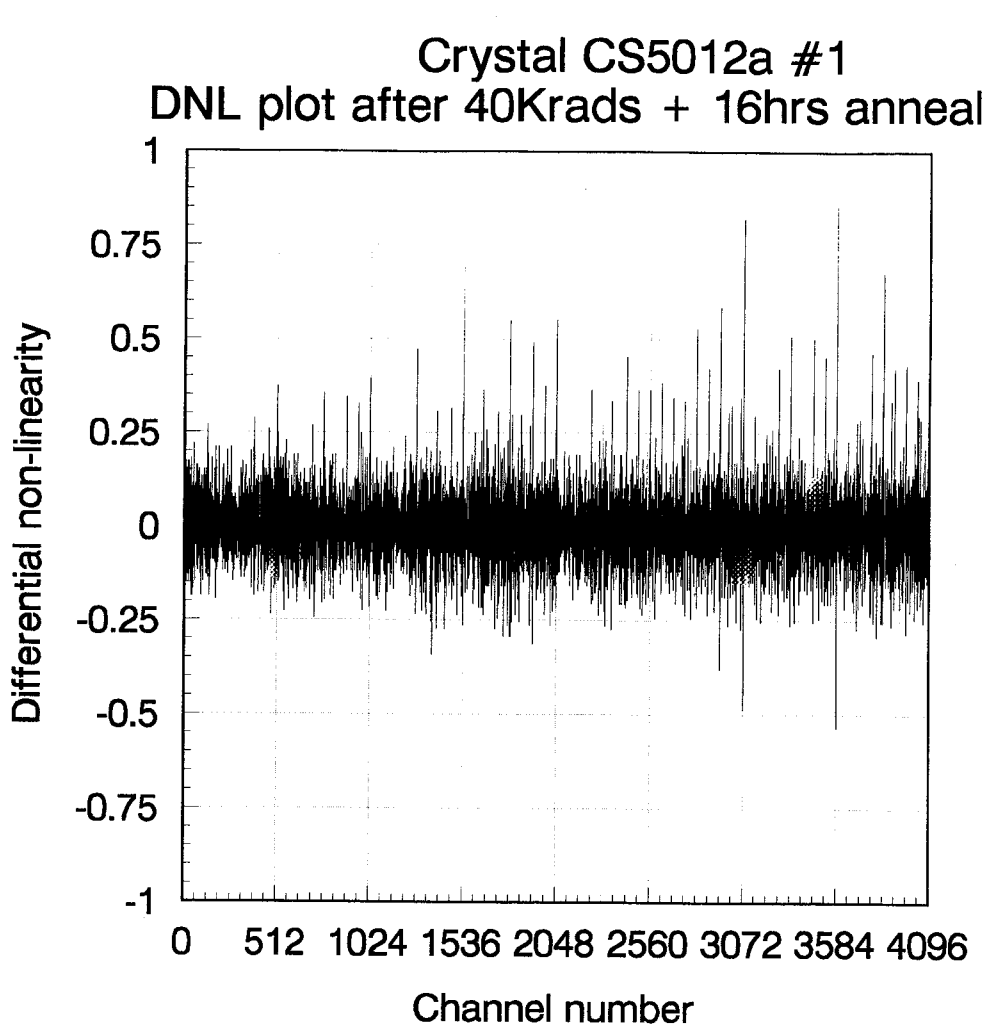

Crystal CS5012A #1
INL plot after 30Krads
Integral non-linearity
(LSB)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

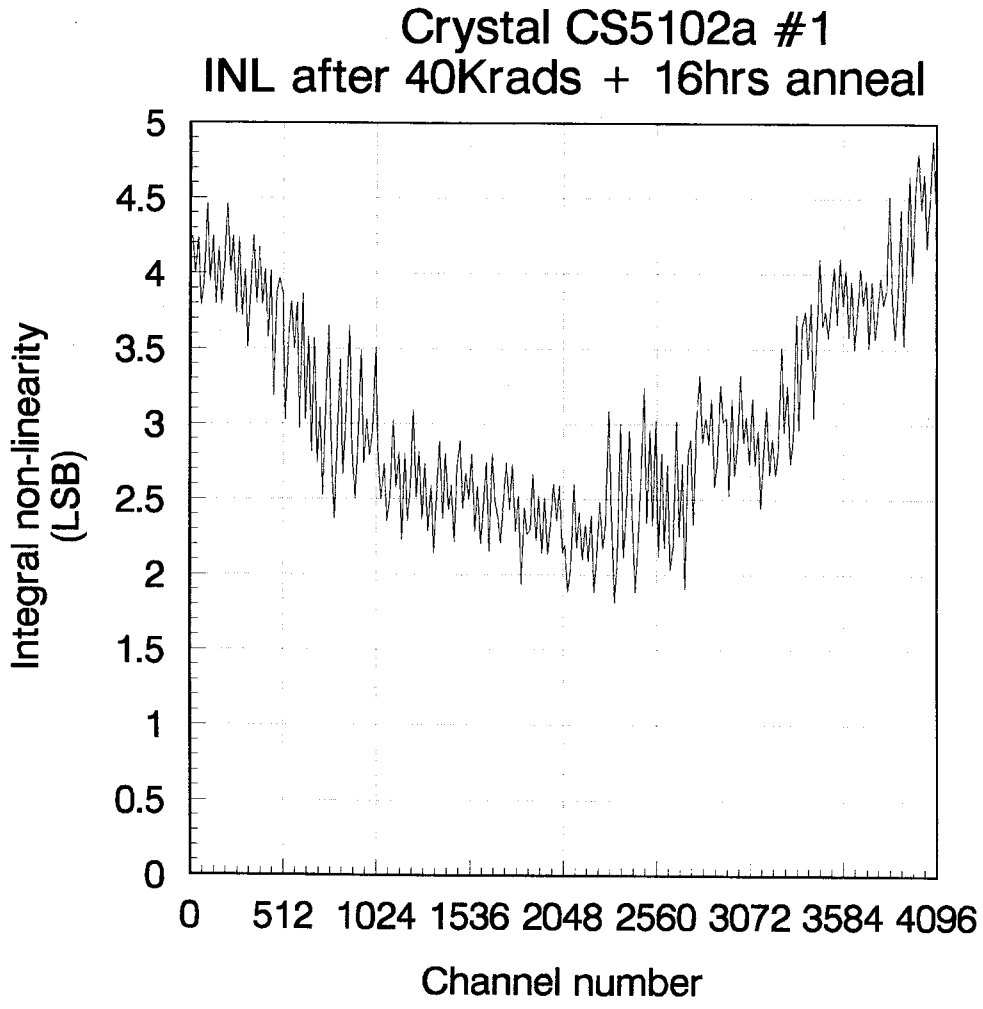

Crystal CS5012a #1
DNL after 30Krads & 25 day anneal
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

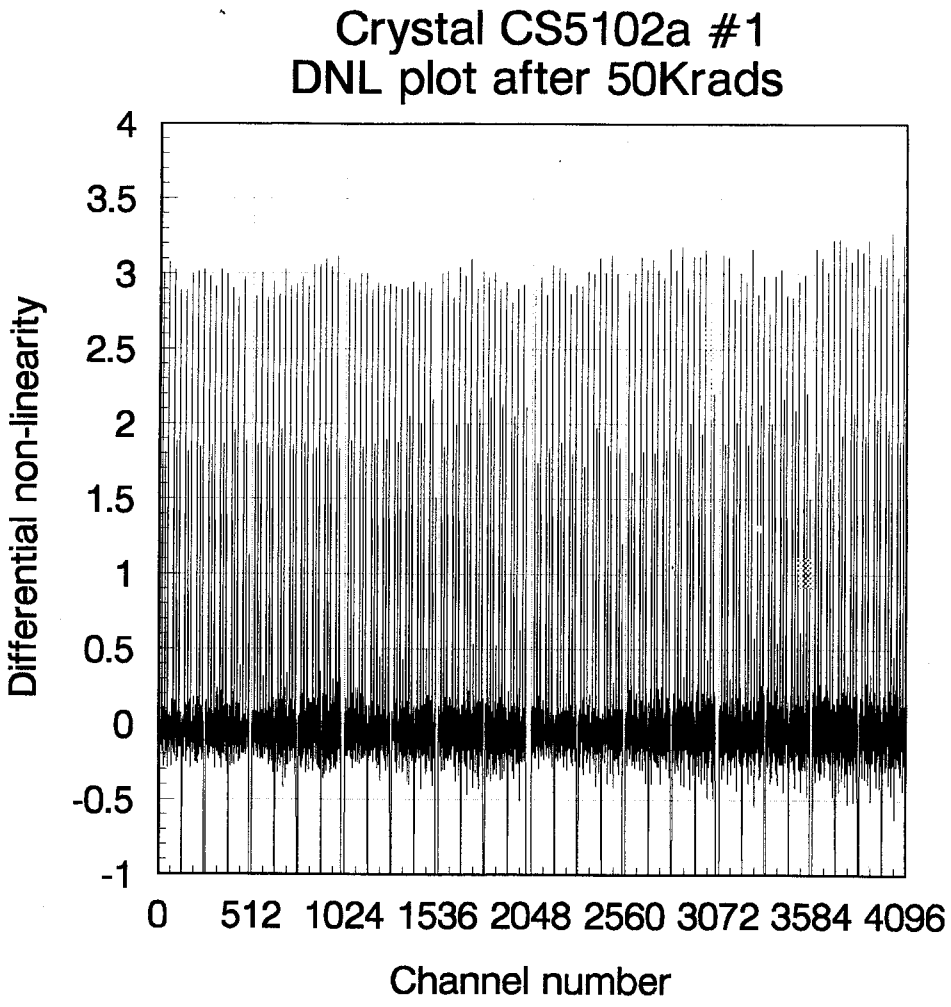

Crystal CS5012a #1
INL after 30Krads and 25 day anneal
Integral non-linearity
(LSB)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

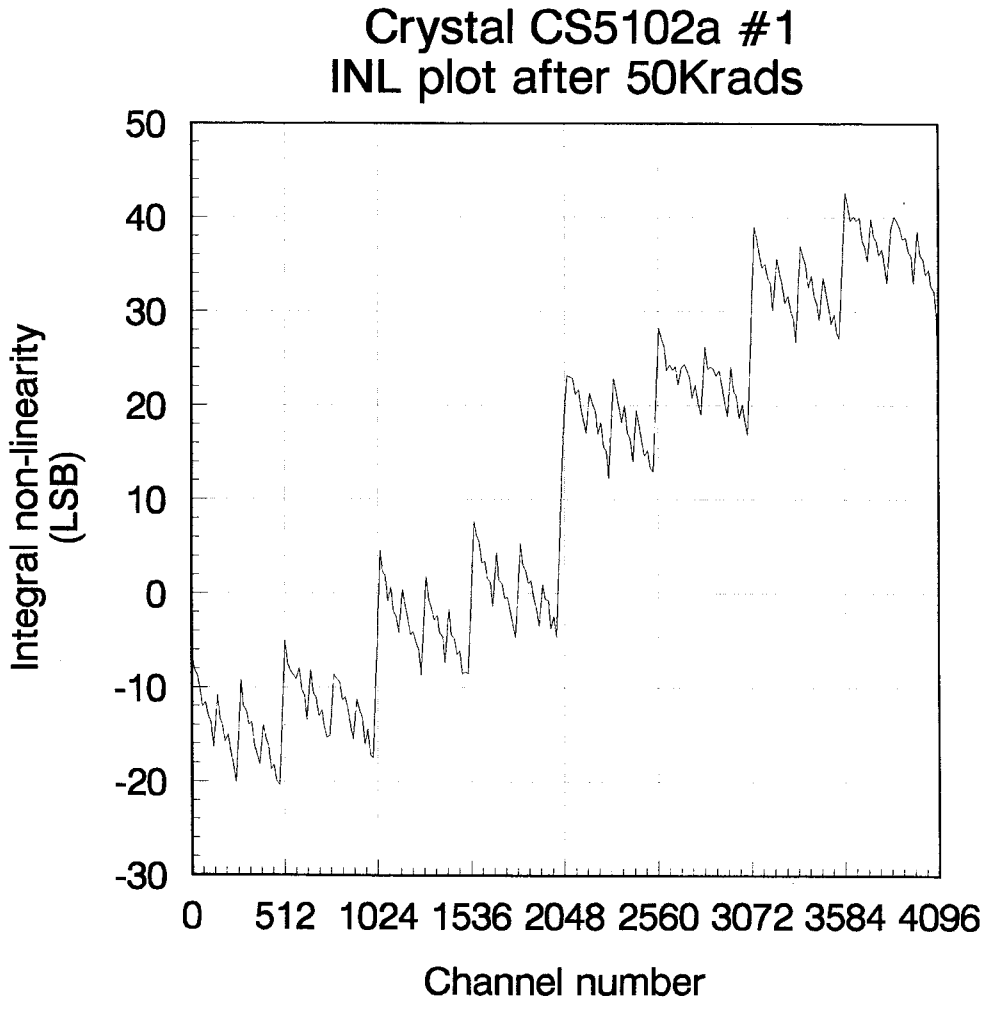

Crystal CS5012a #1
DNL plot after 40Krads
Differential non-linearity
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

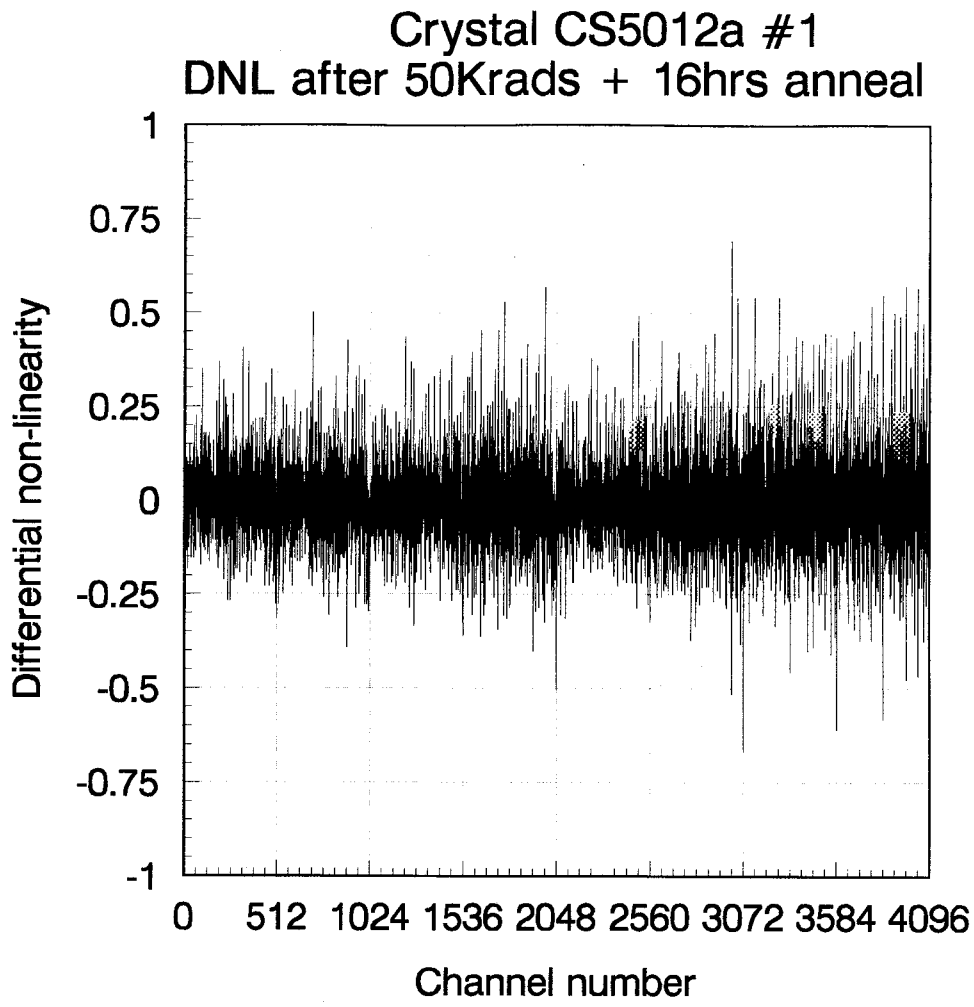

Crystal CS5012a #1
INL plot after 40Krads
Integral non-linearity
(LSB)
30
20
10
0
-10
-20
-30
-40
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

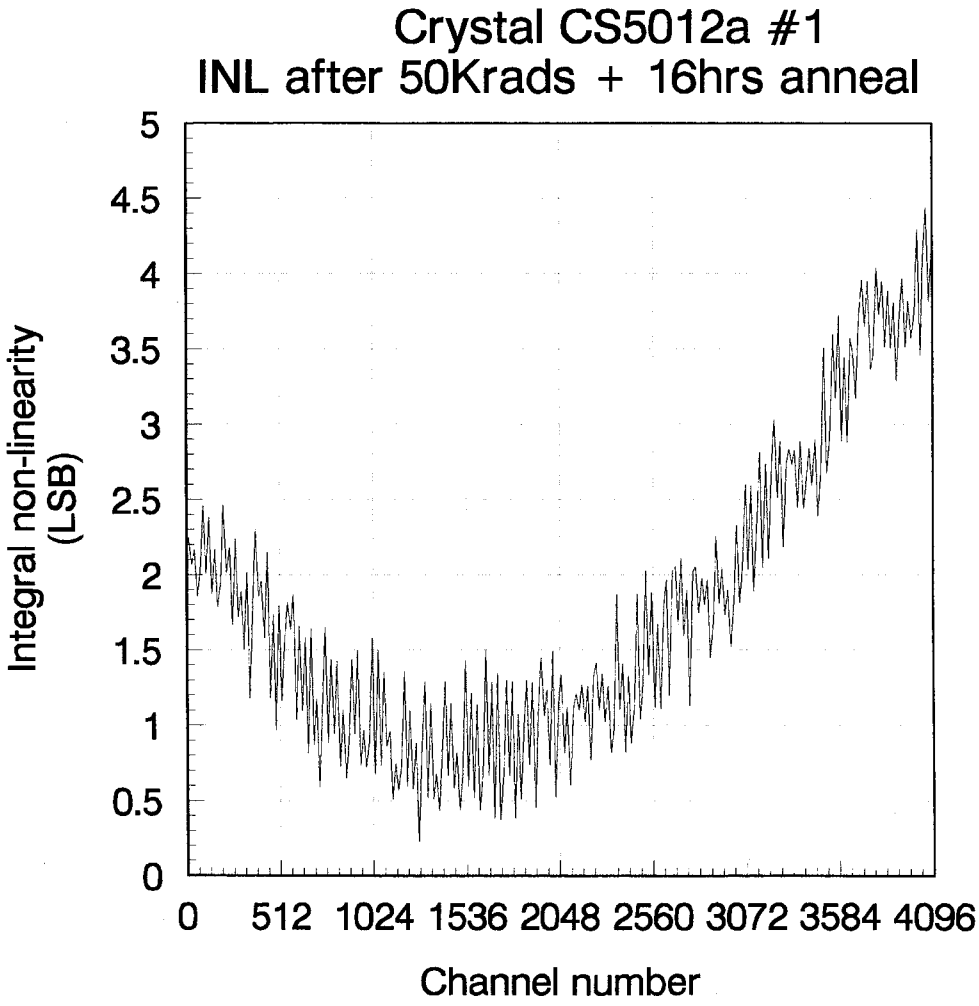

Crystal CS5012a #1
DNL plot after 40Krads + 16hrs anneal
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

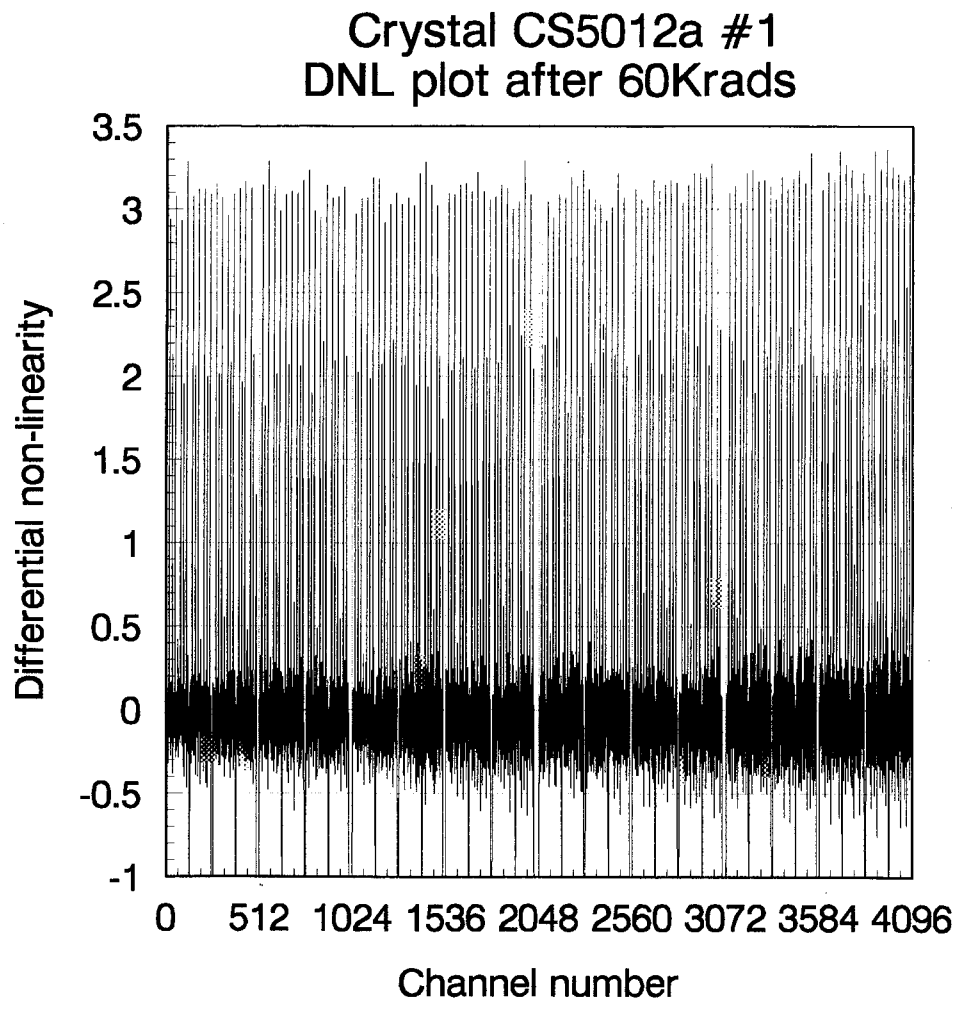

Crystal CS5102a #1
INL after 40Krads + 16hrs anneal
Integral non-linearity
(LSB)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

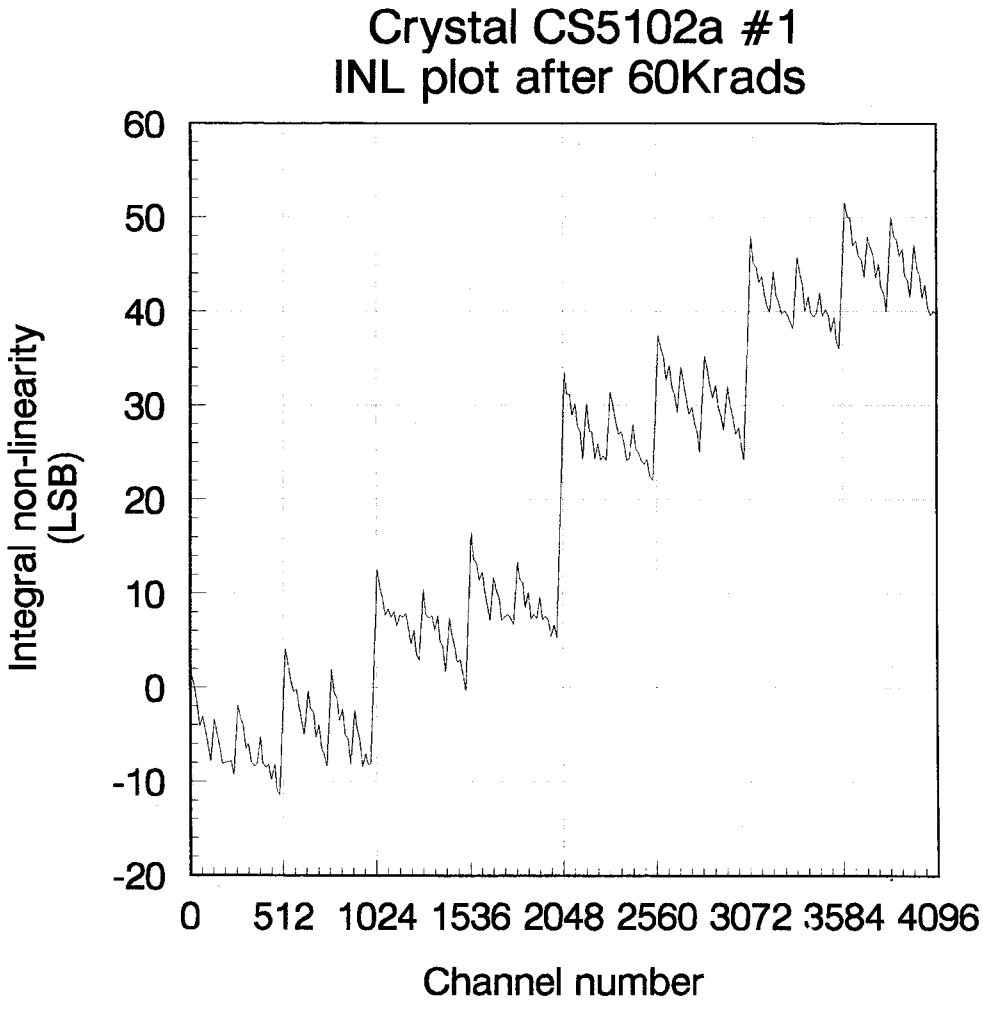

Crystal CS5102a #1
DNL plot after 50Krads
Differential non-linearity
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

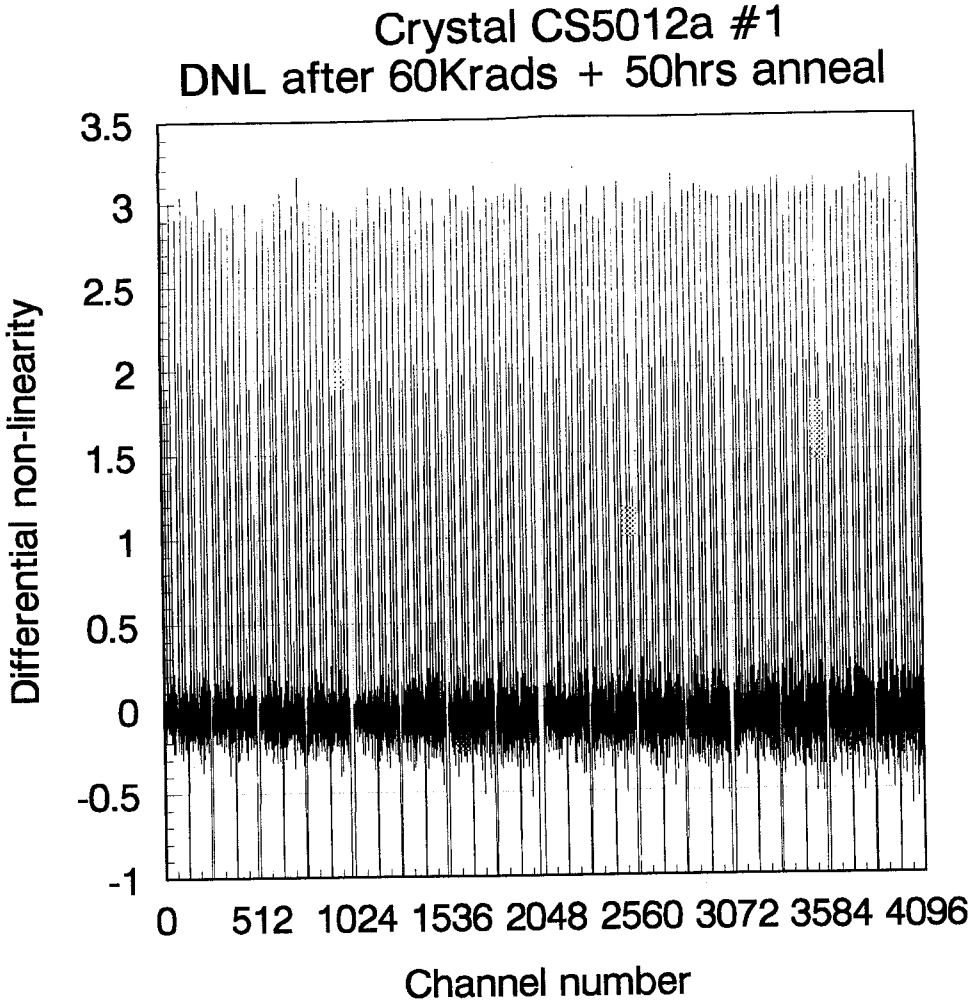

Crystal CS5102a #1
INL plot after 50Krads
Integral non-linearity
(LSB)
50
40
30
20
10
0
-10
-20
-30
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

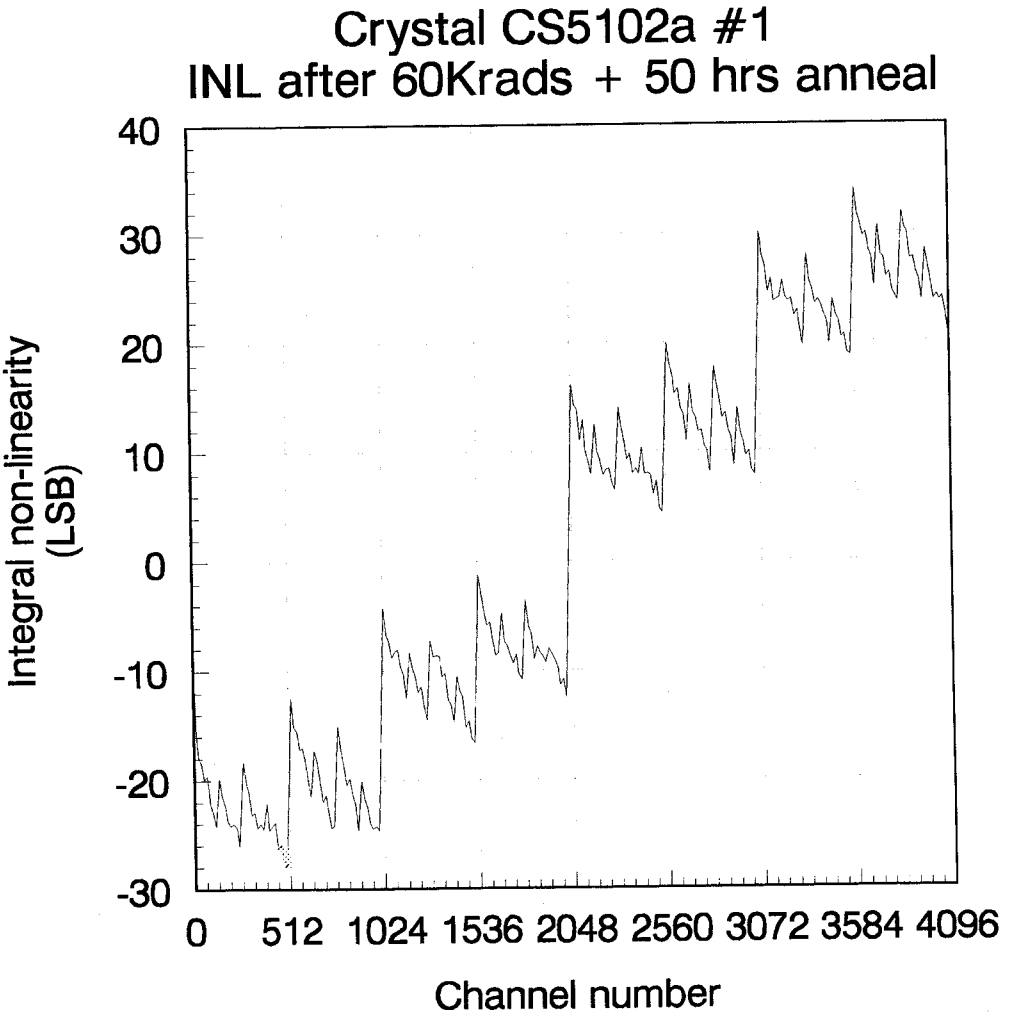

Crystal CS5012a #1
DNL after 50Krads + 16hrs anneal
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

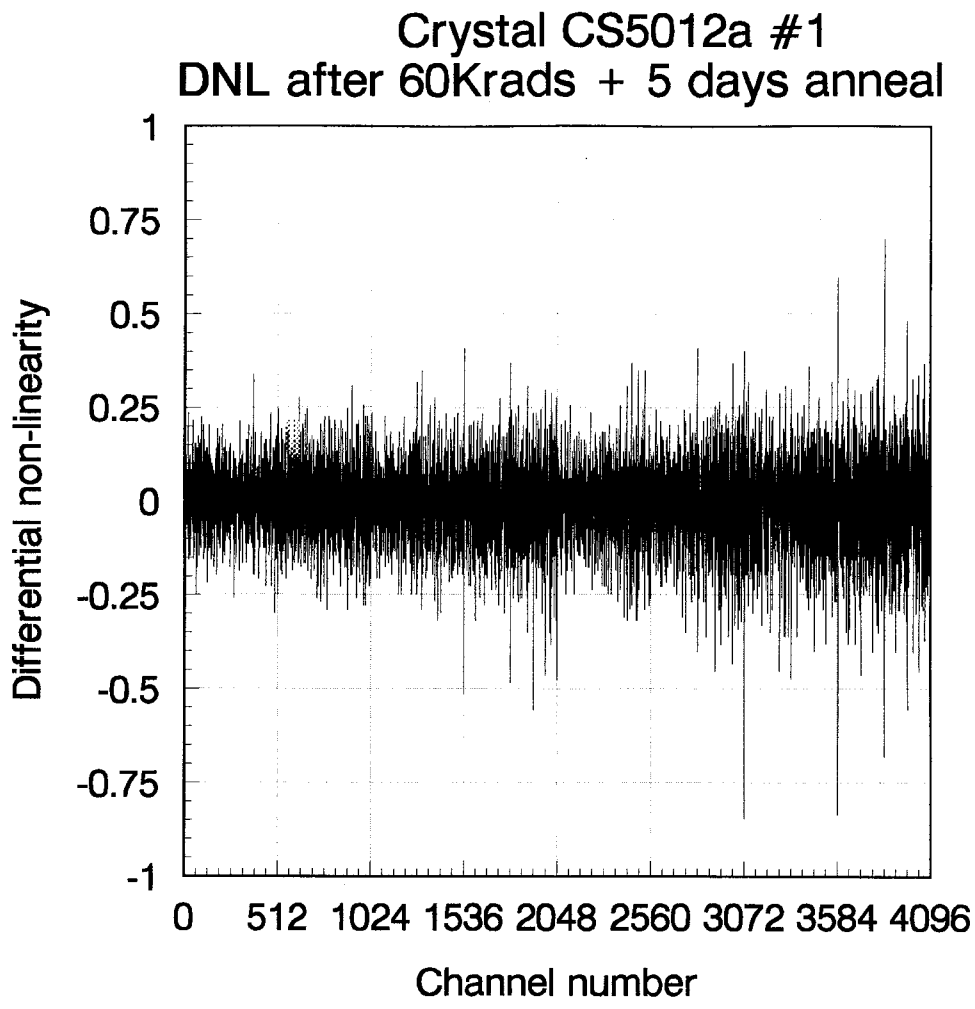

Crystal CS5012a #1
INL after 50Krads + 16hrs anneal
Integral non-linearity (LSB)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

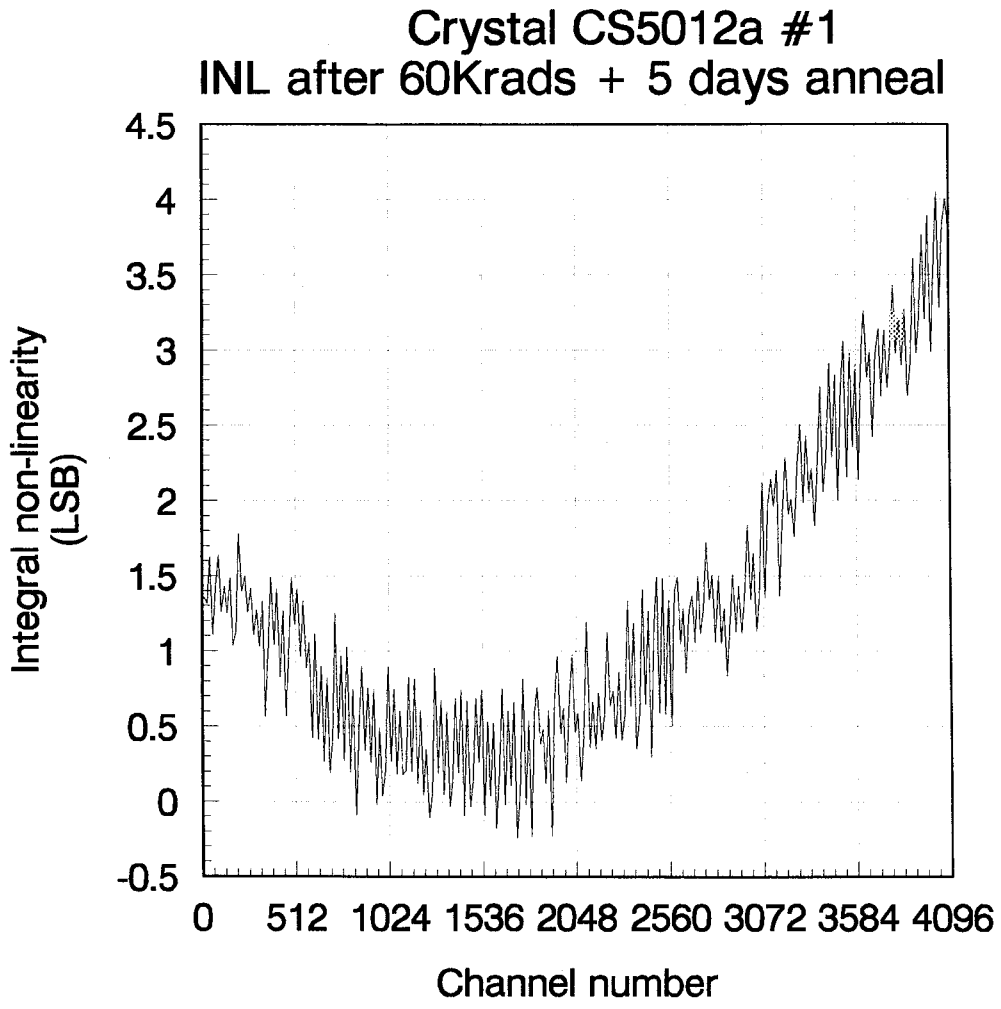

Crystal CS5012a #1
DNL plot after 60Krads
Differential non-linearity
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

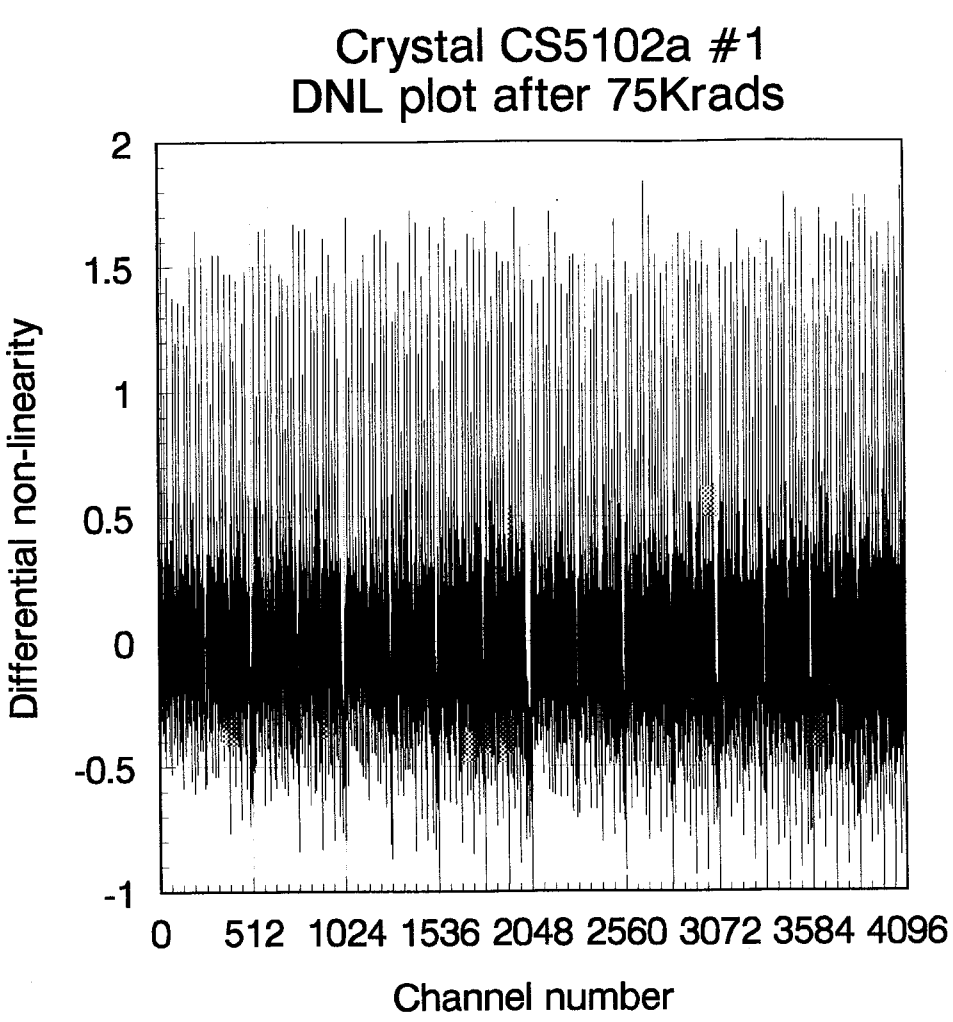

Crystal CS5102a #1
INL plot after 60Krads
Integral non-linearity
(LSB)
60
50
40
30
20
10
0
-10
-20
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

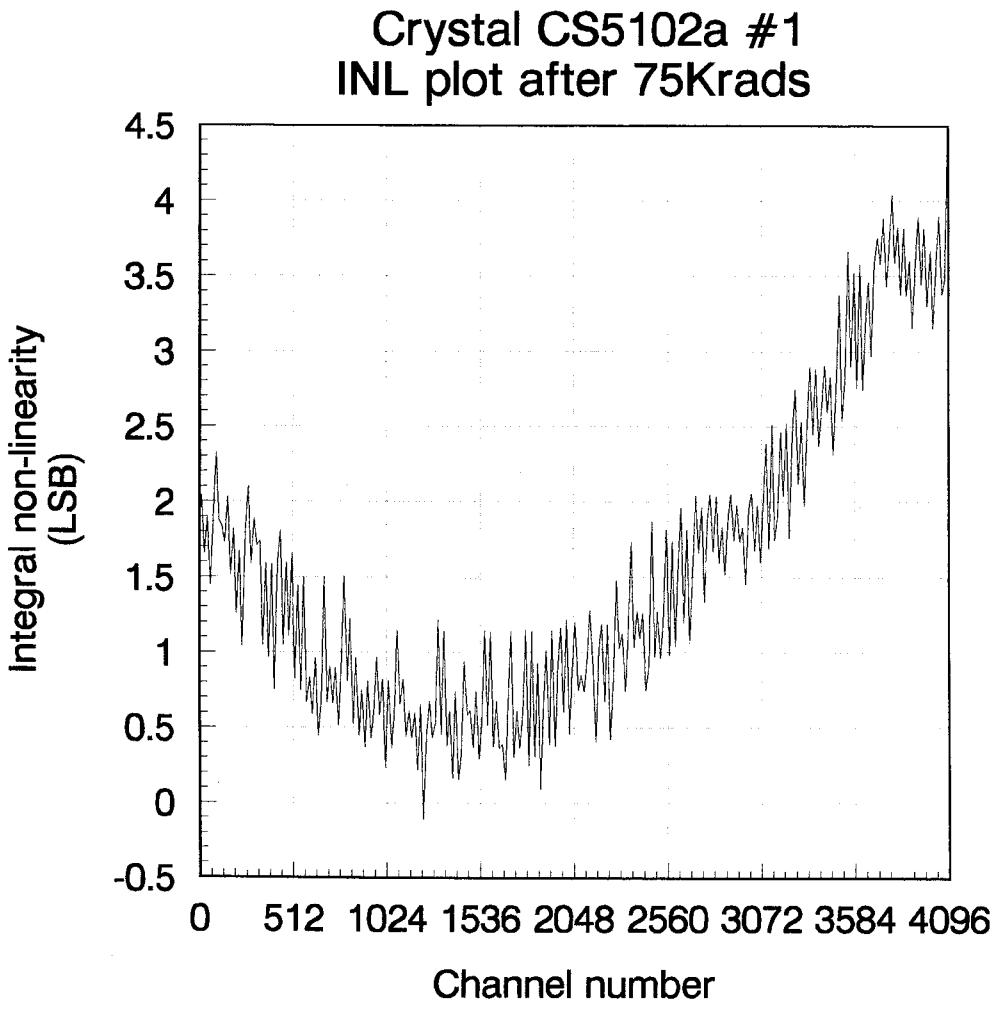

Crystal CS5012a #1
DNL after 60Krads + 50hrs anneal
Differential non-linearity
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

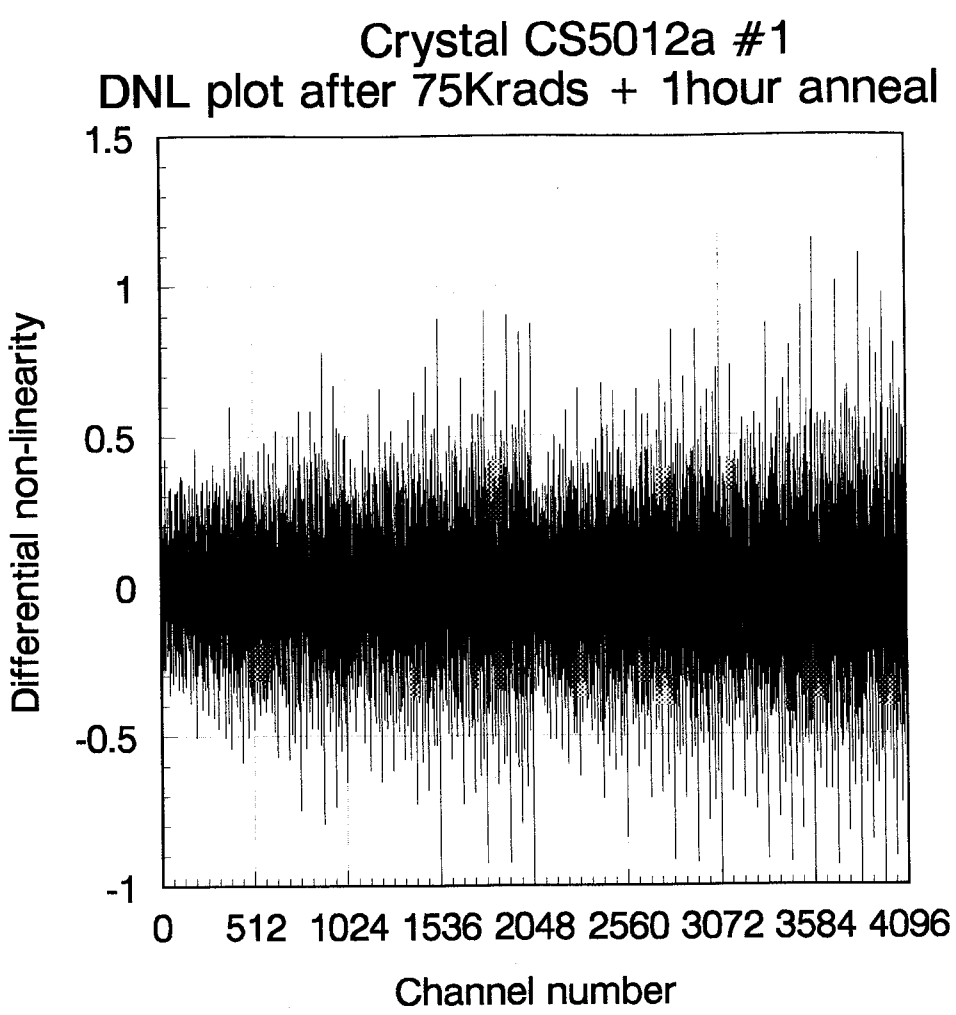

Crystal CS5102a #1
INL after 60Krads + 50 hrs anneal
Integral non-linearity
(LSB)
40
30
20
10
0
-10
-20
-30
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

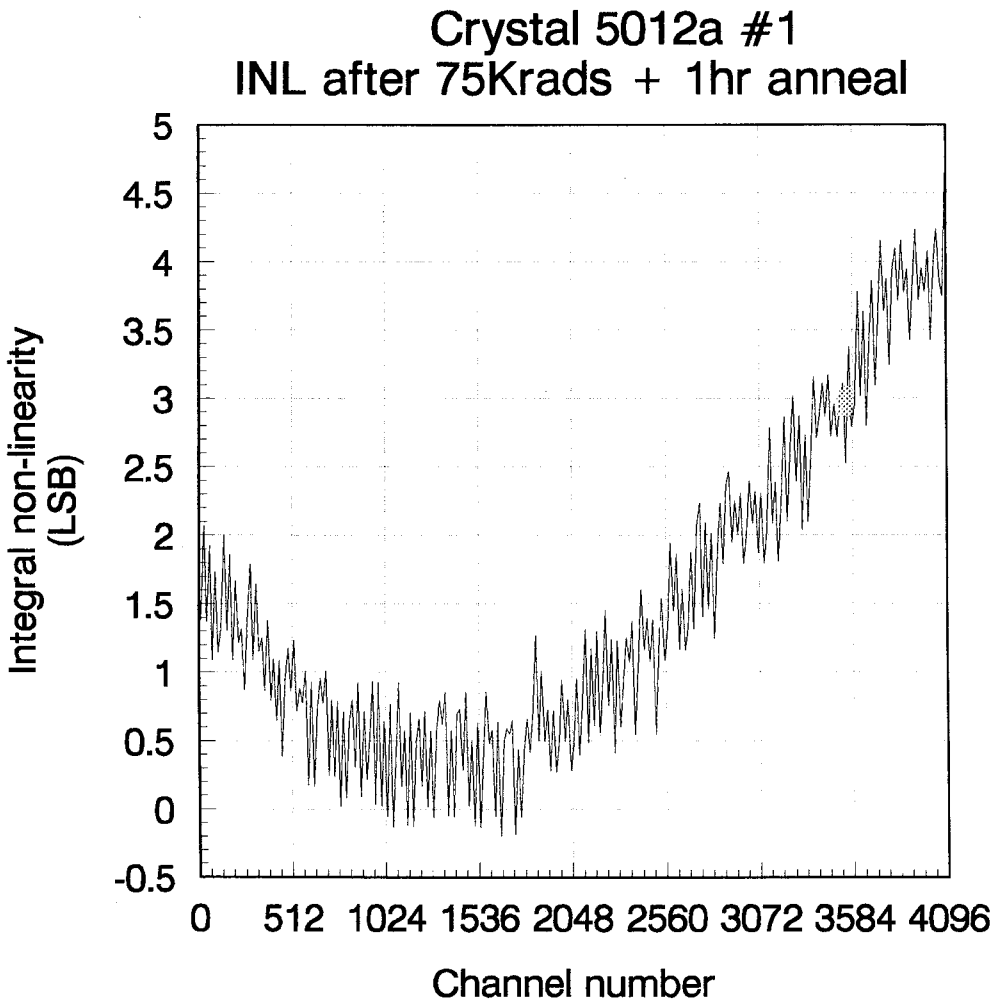

Crystal CS5012a #1
DNL after 60Krads + 5 days anneal
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

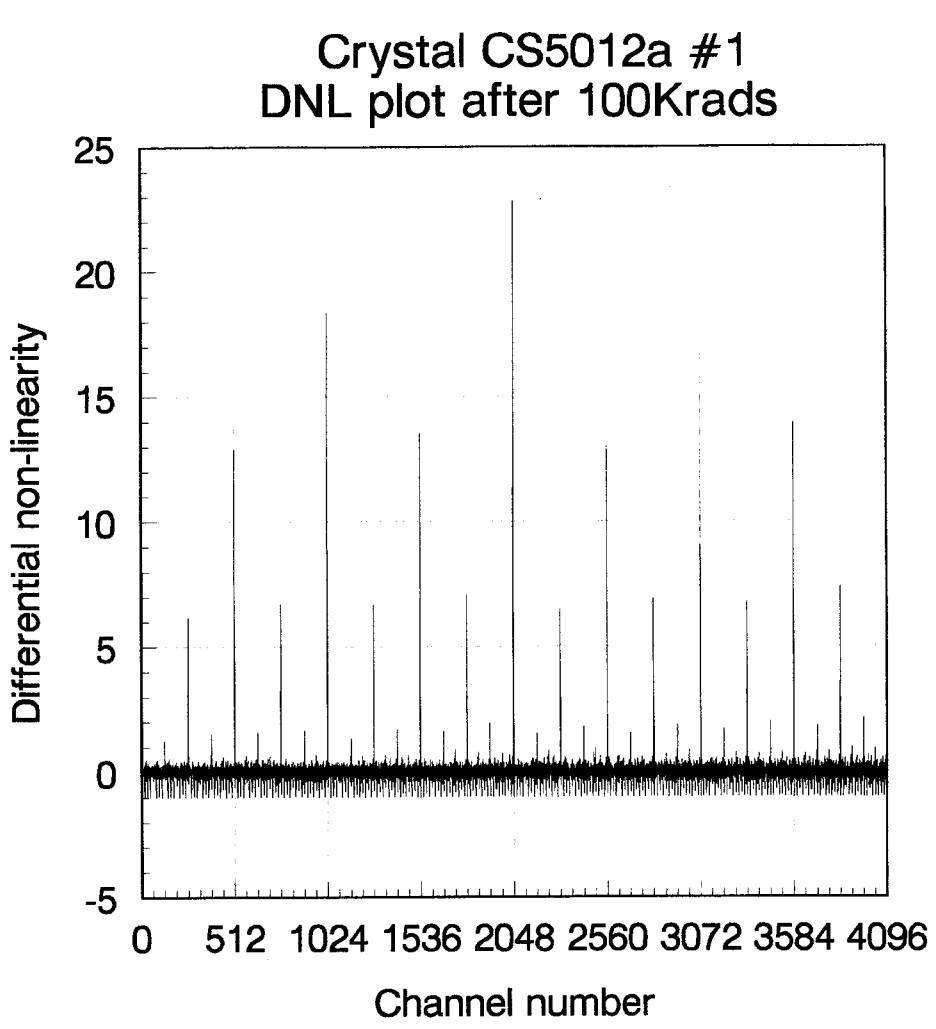

Crystal CS5012a #1
INL after 60Krads + 5 days anneal
Integral non-linearity (LSB)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

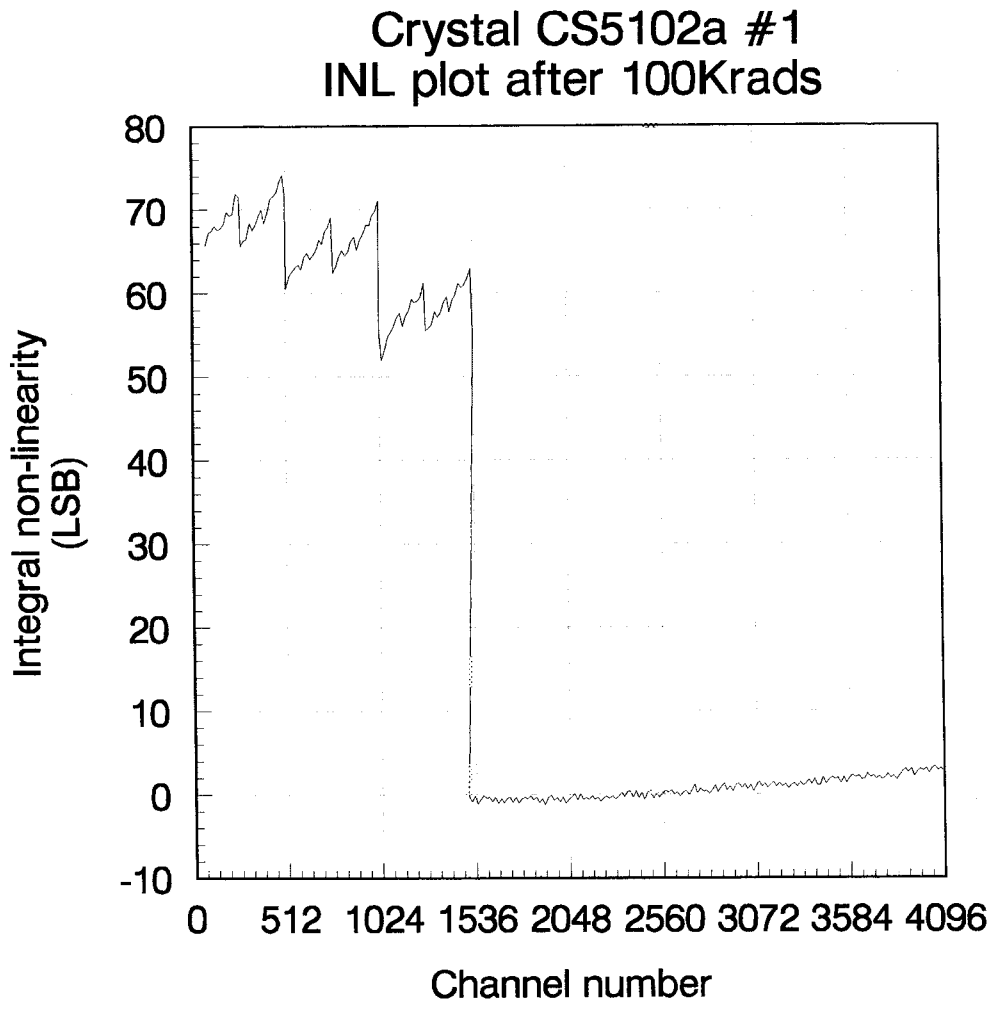

Crystal CS5102a #1
DNL plot after 75Krads
Differential non-linearity
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

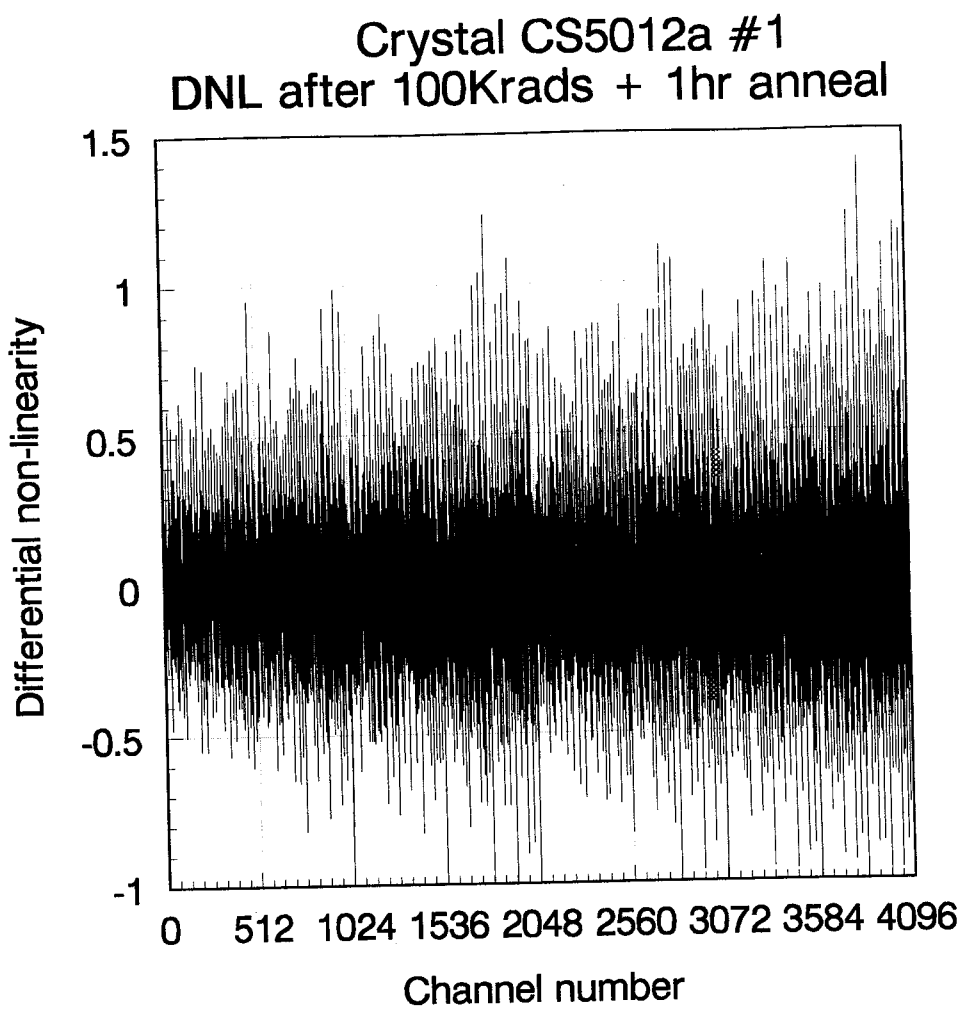

Crystal CS5102a #1
INL plot after 75Krads
Integral non-linearity
(LSB)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

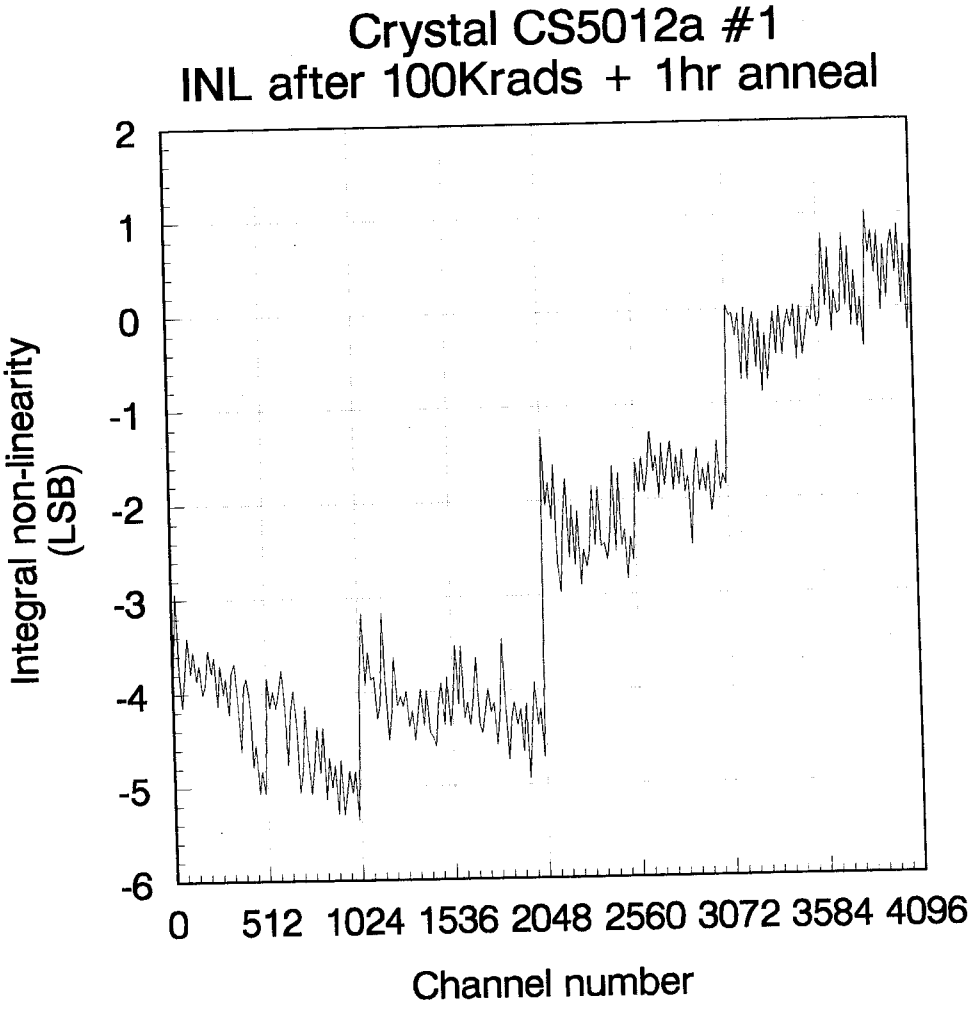

Crystal CS5012a #1
DNL plot after 75Krads + 1hour anneal
Differential non-linearity
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

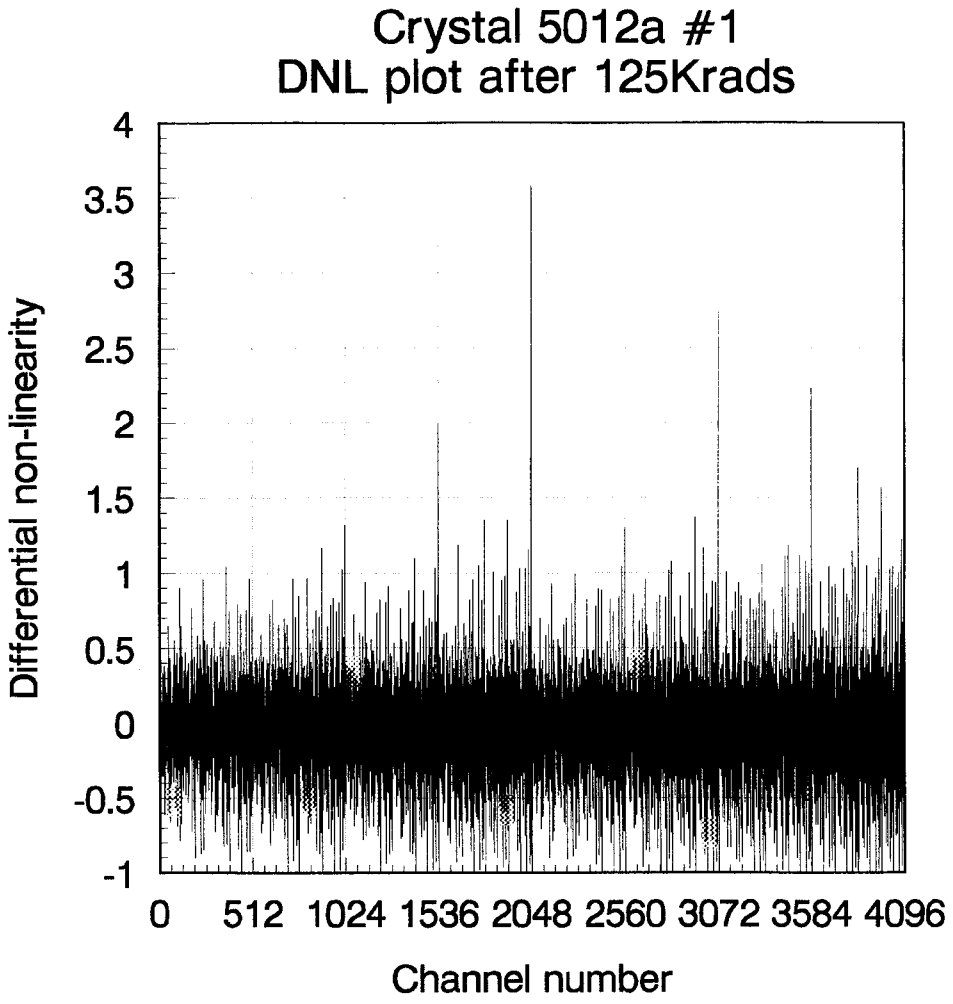

Crystal 5012a #1
INL after 75Krads + 1hr anneal
Integral non-linearity
(LSB)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

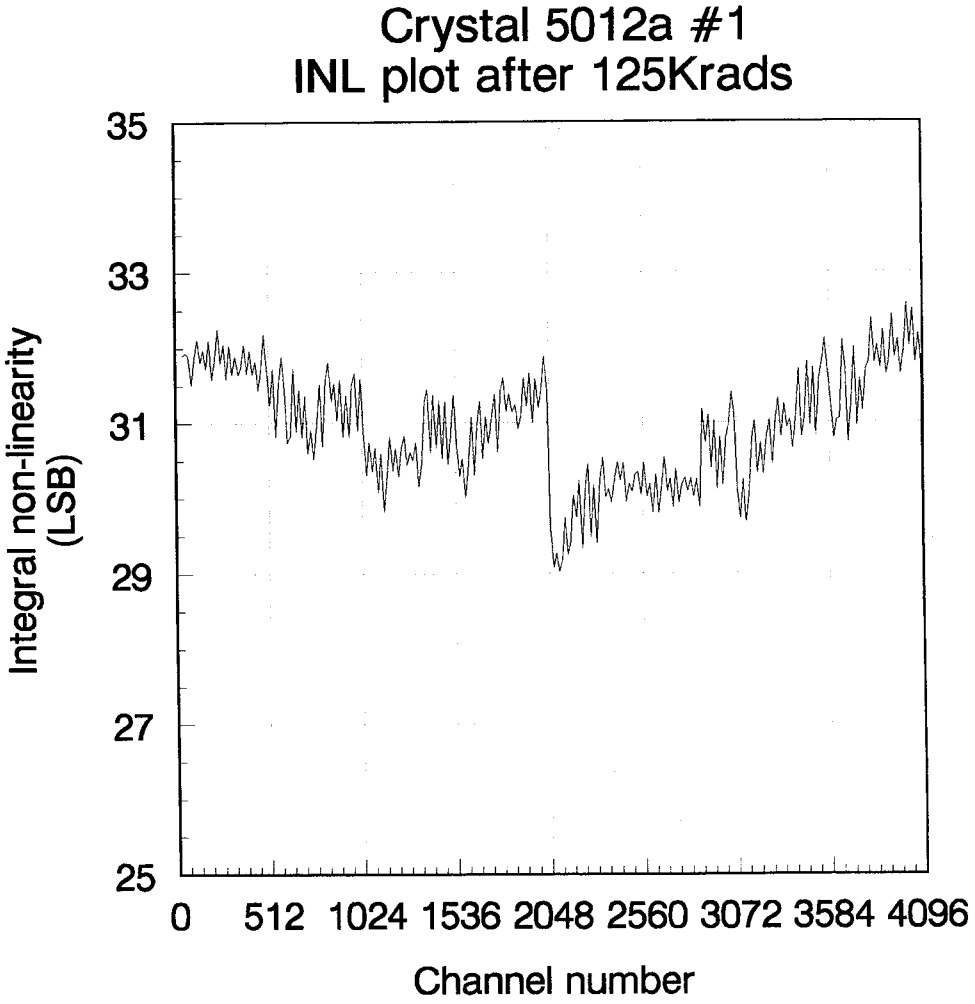

Crystal CS5012a #1
DNL plot after 100Krads
Differential non-linearity
25
20
15
10
5
0
-5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

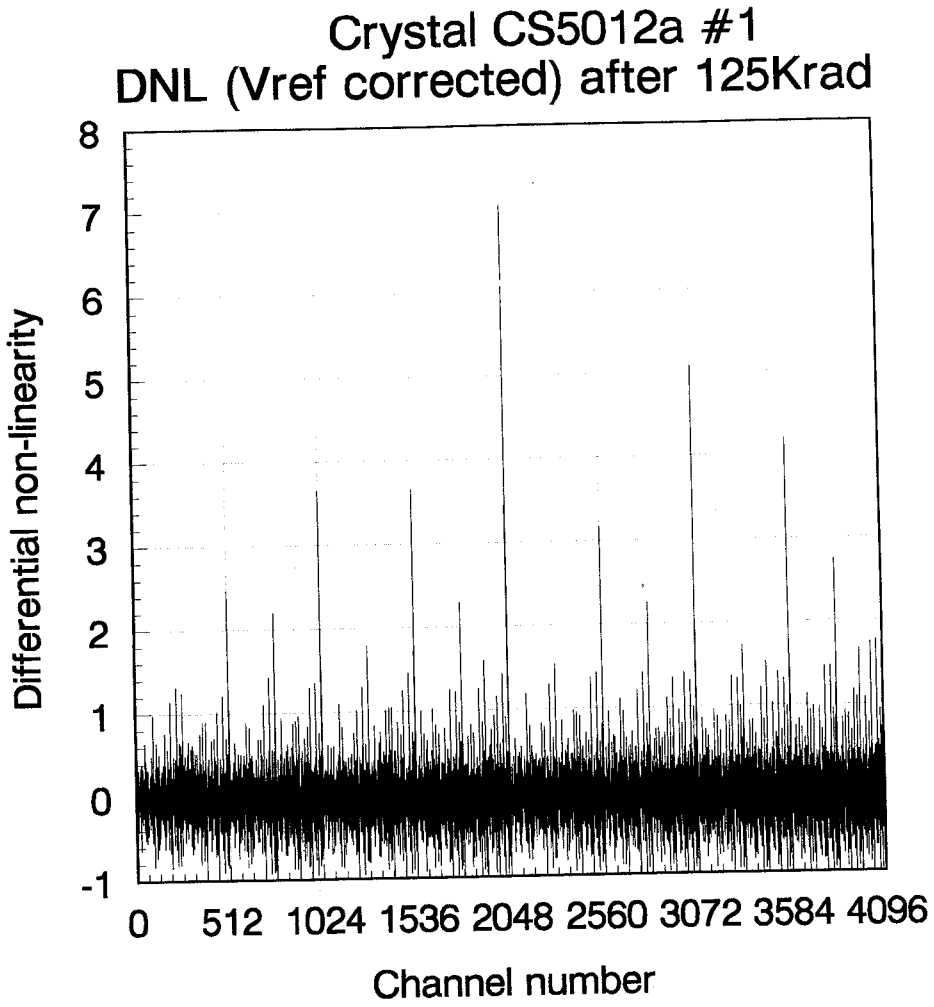

Crystal CS5102a #1
INL plot after 100Krads
Integral non-linearity
(LSB)
80
70
60
50
40
30
20
10
0
-10
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

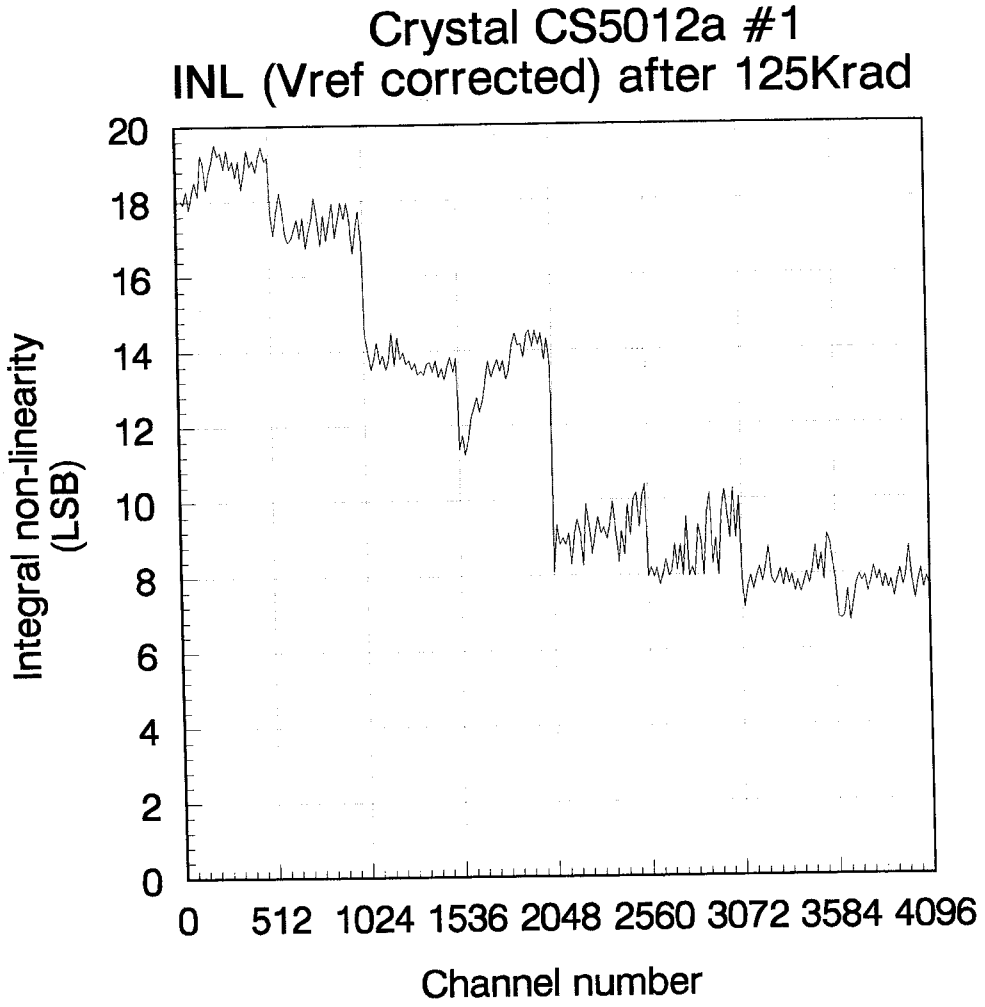

Crystal CS5012a #1
DNL after 100Krads + 1hr anneal
Differential non-linearity
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

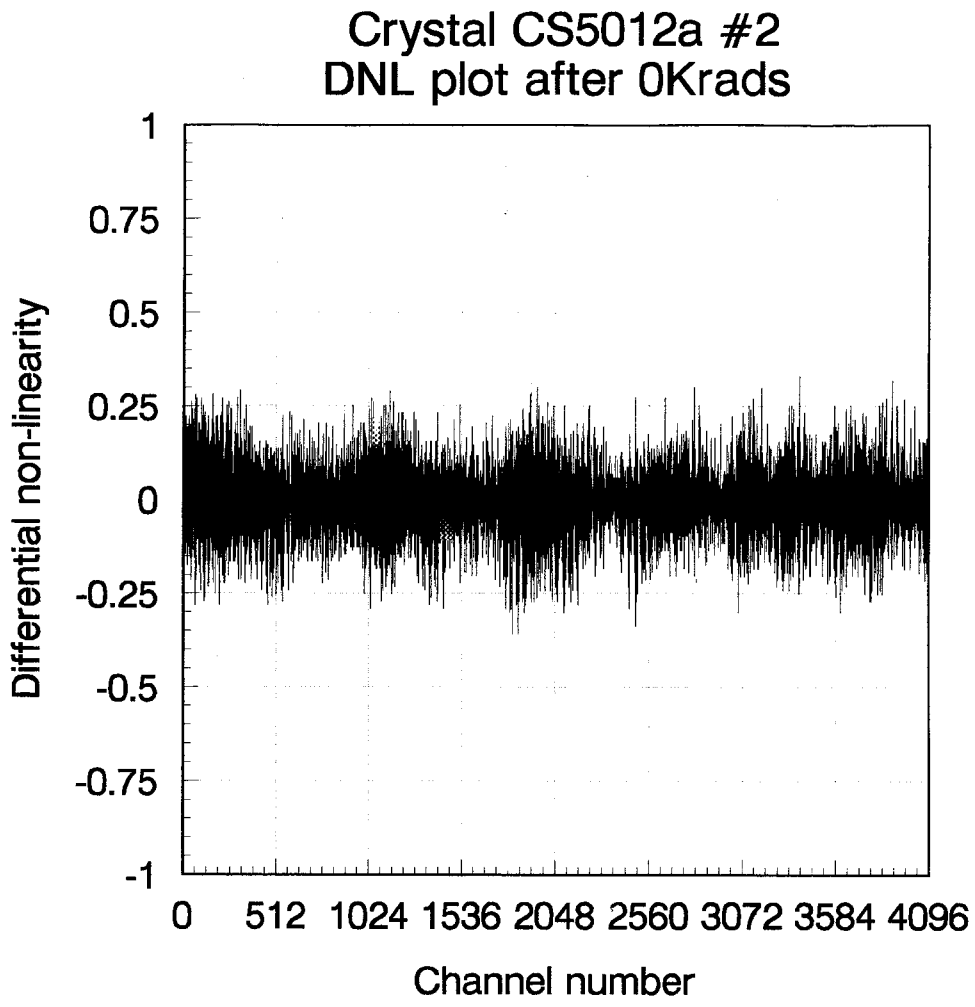

Crystal CS5012a #1
INL after 100Krads + 1hr anneal
Integral non-linearity
(LSB)
2
1
0
-1
-2
-3
-4
-5
-6
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

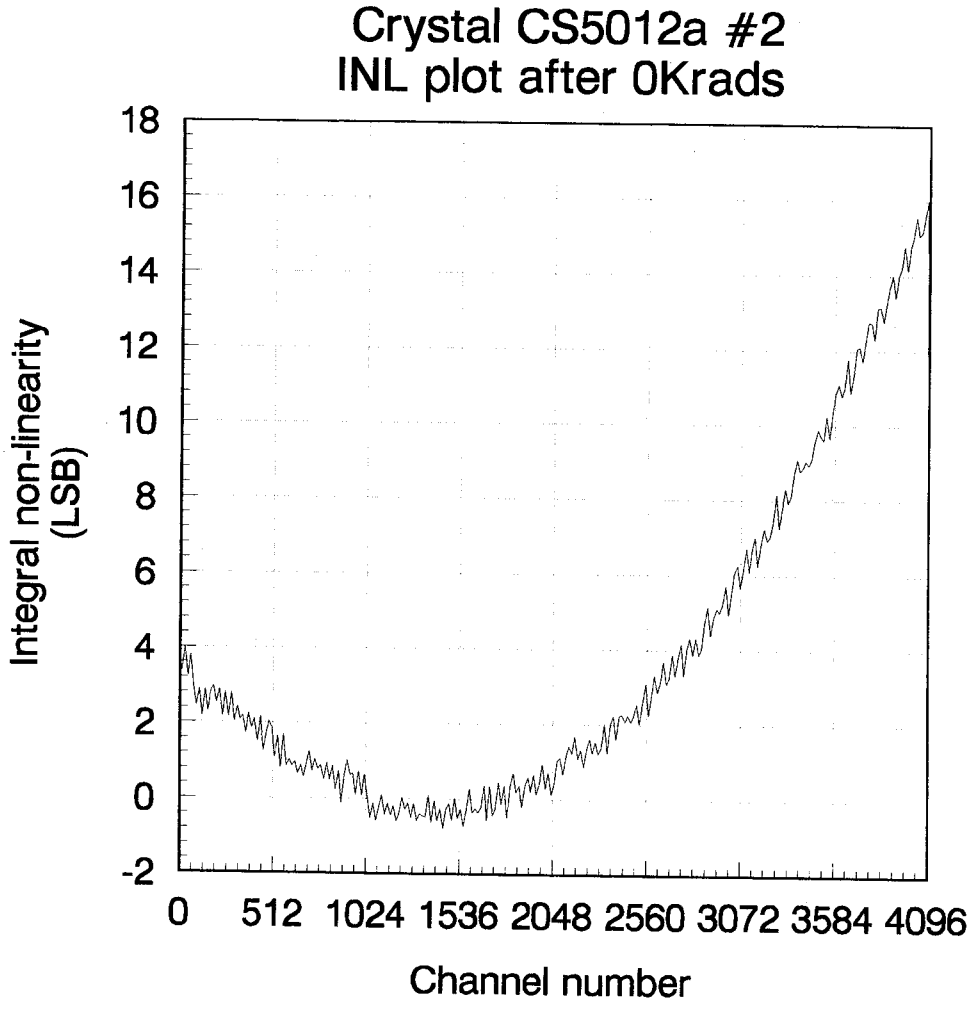

Crystal 5012a #1
DNL plot after 125Krads
Differential non-linearity
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

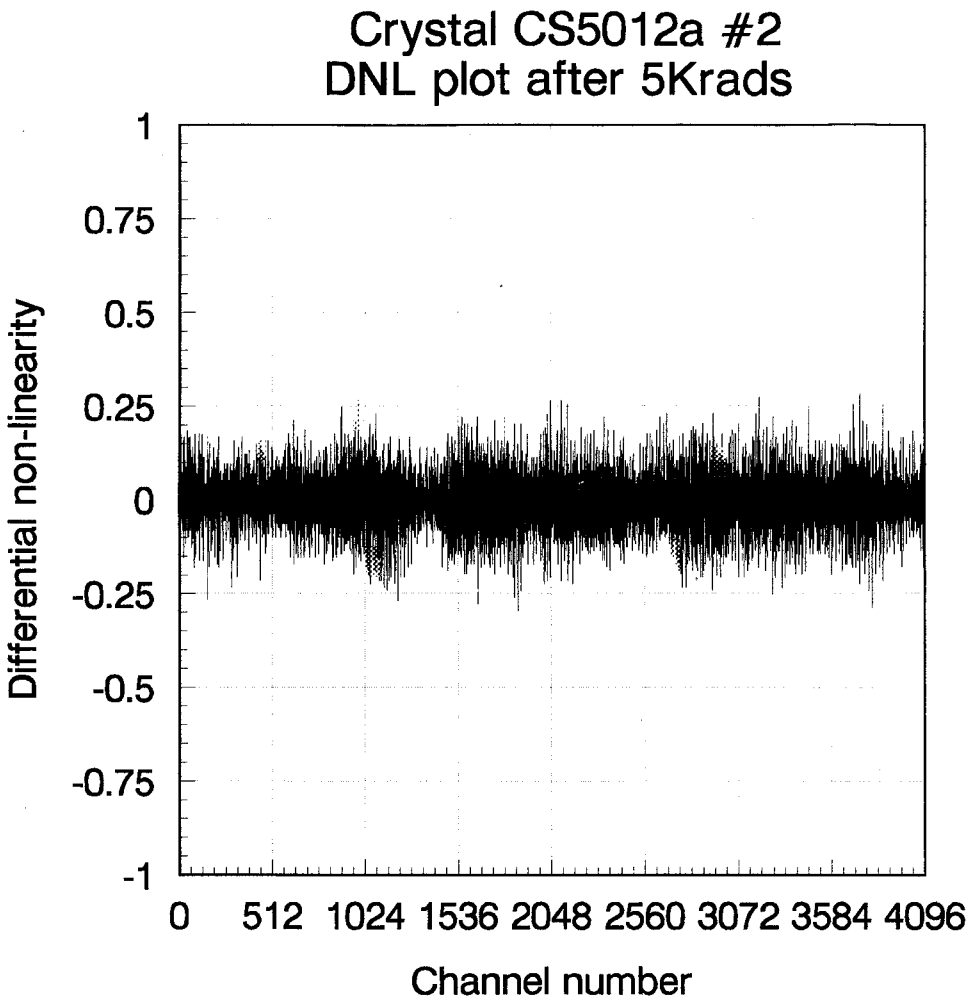

Crystal 5012a #1
INL plot after 125Krads
Integral non-linearity
(LSB)
35
33
31
29
27
25
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

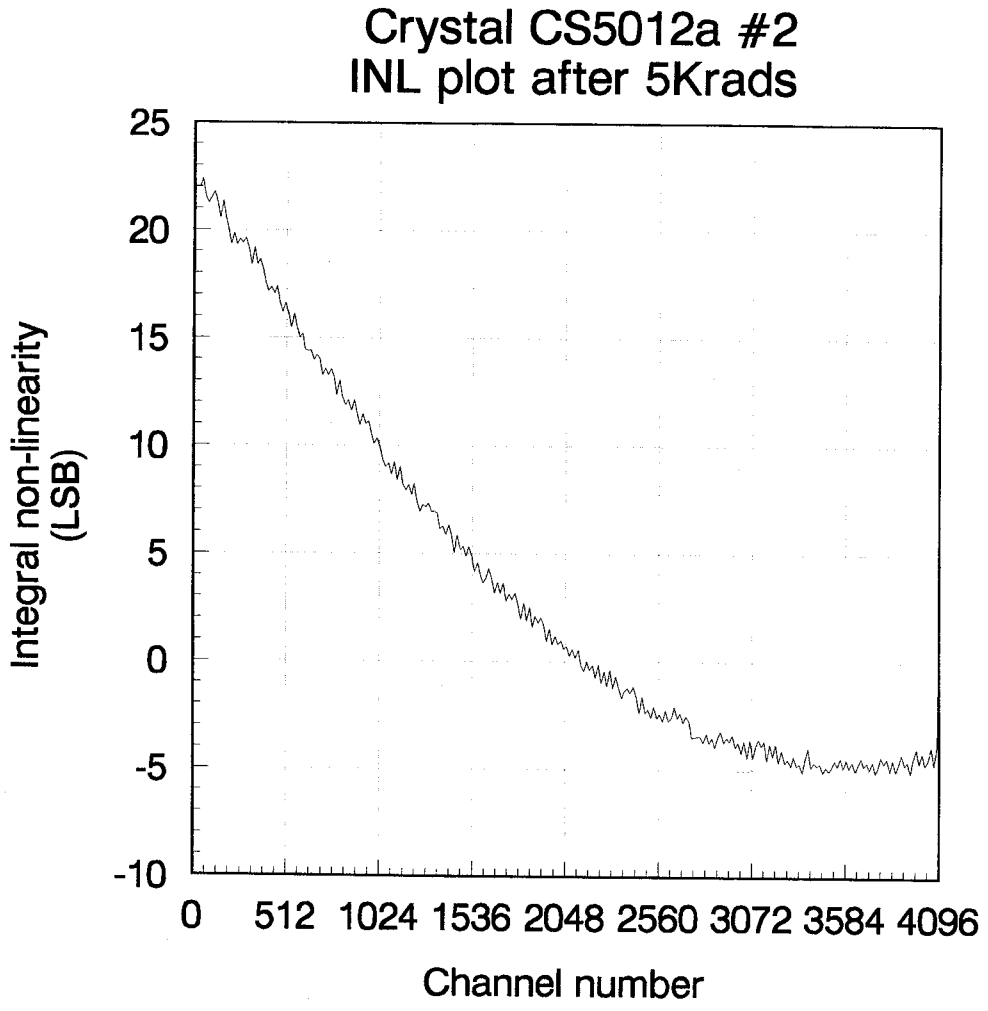

Crystal CS5012a #1
DNL (Vref corrected) after 125Krad
Differential non-linearity
8
7
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

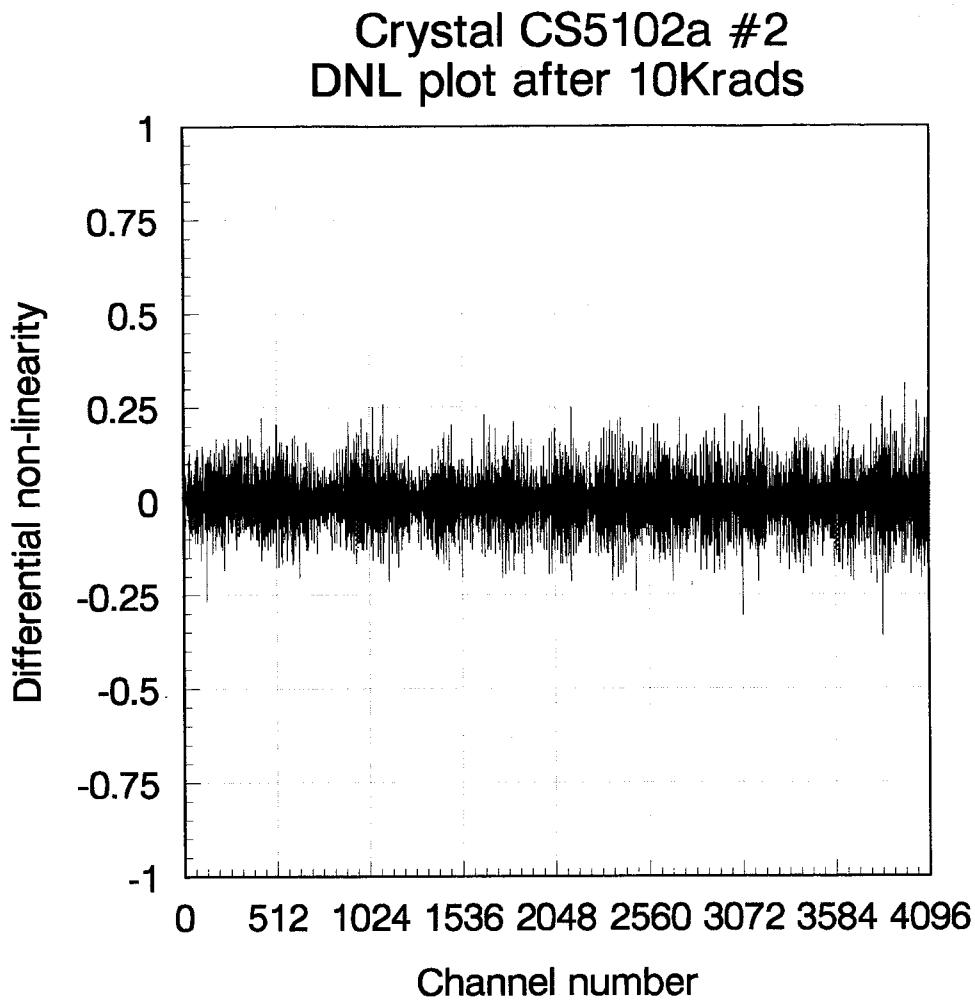

Crystal CS5012a #1
INL (Vref corrected) after 125Krad
Integral non-linearity
(LSB)
20
18
16
14
12
10
8
6
4
2
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

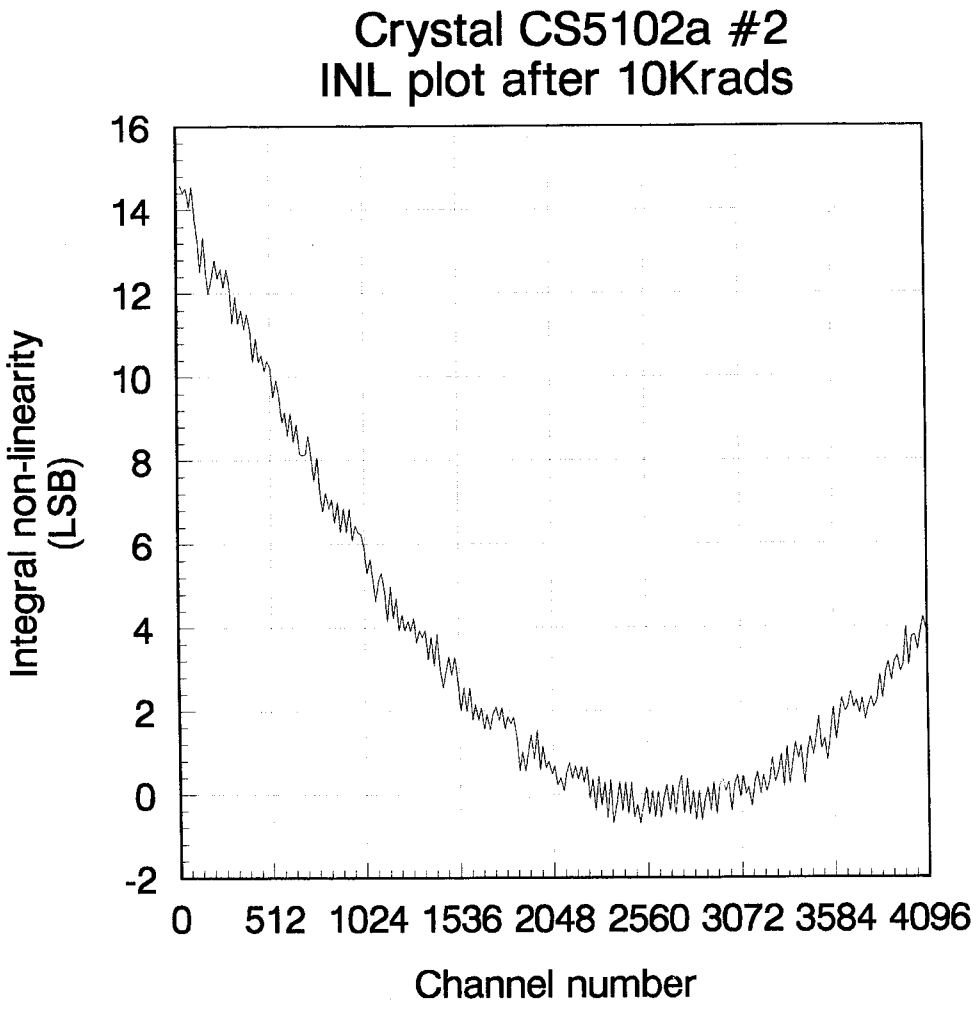

Crystal CS5012a #2
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

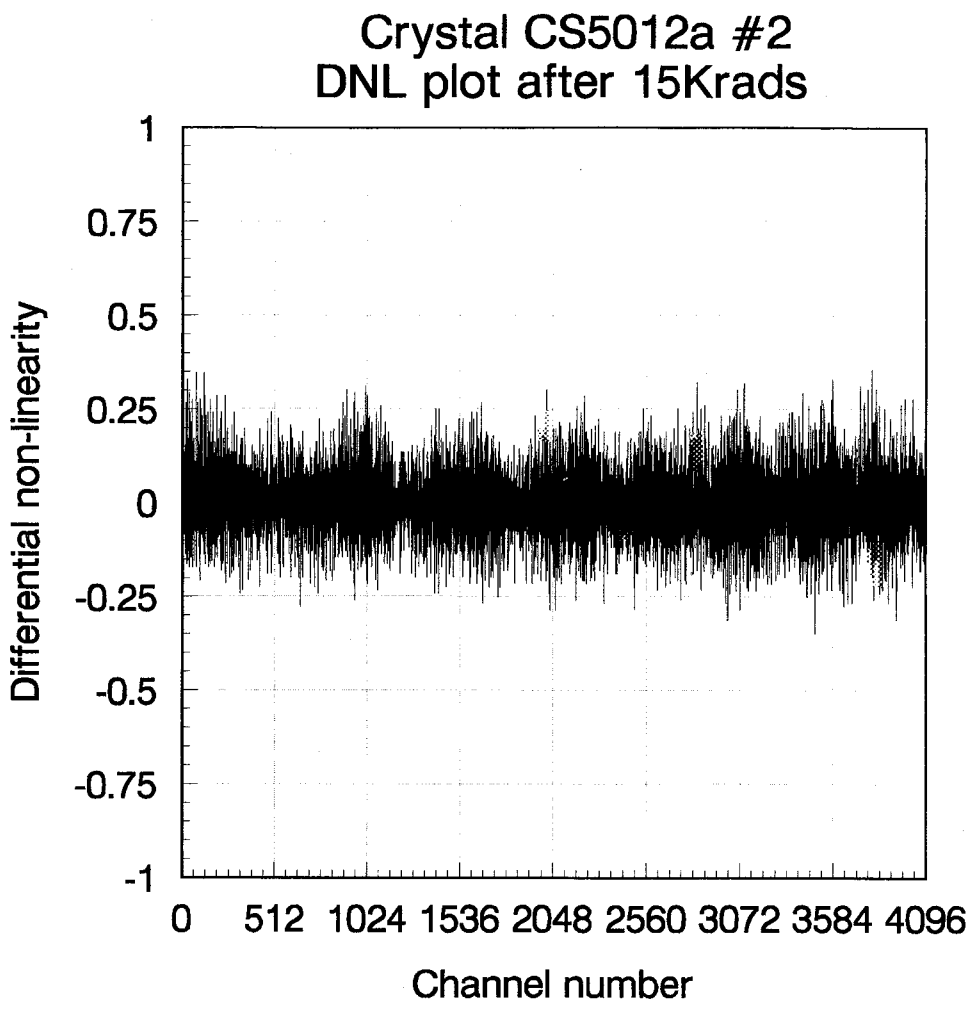

Crystal CS5012a #2
INL plot after 0Krads
Integral non-linearity
(LSB)
18
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

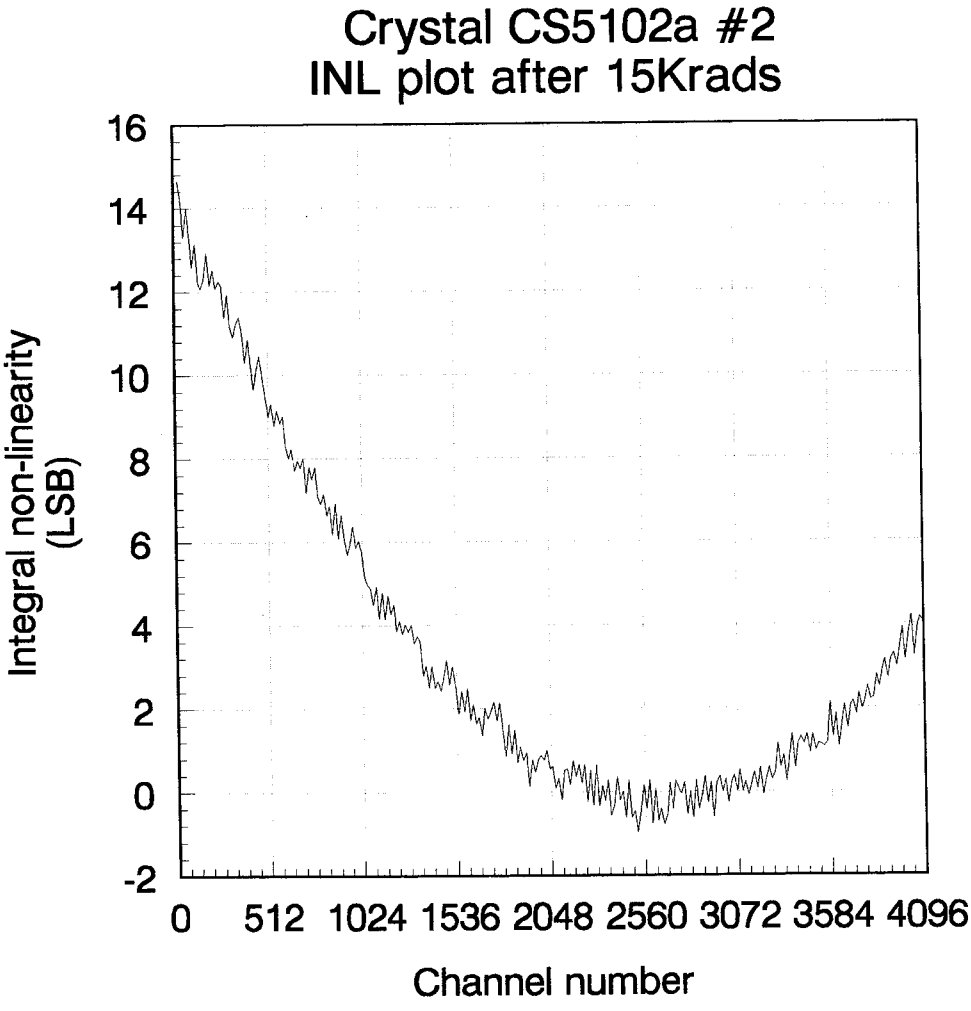

Crystal CS5012a #2
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

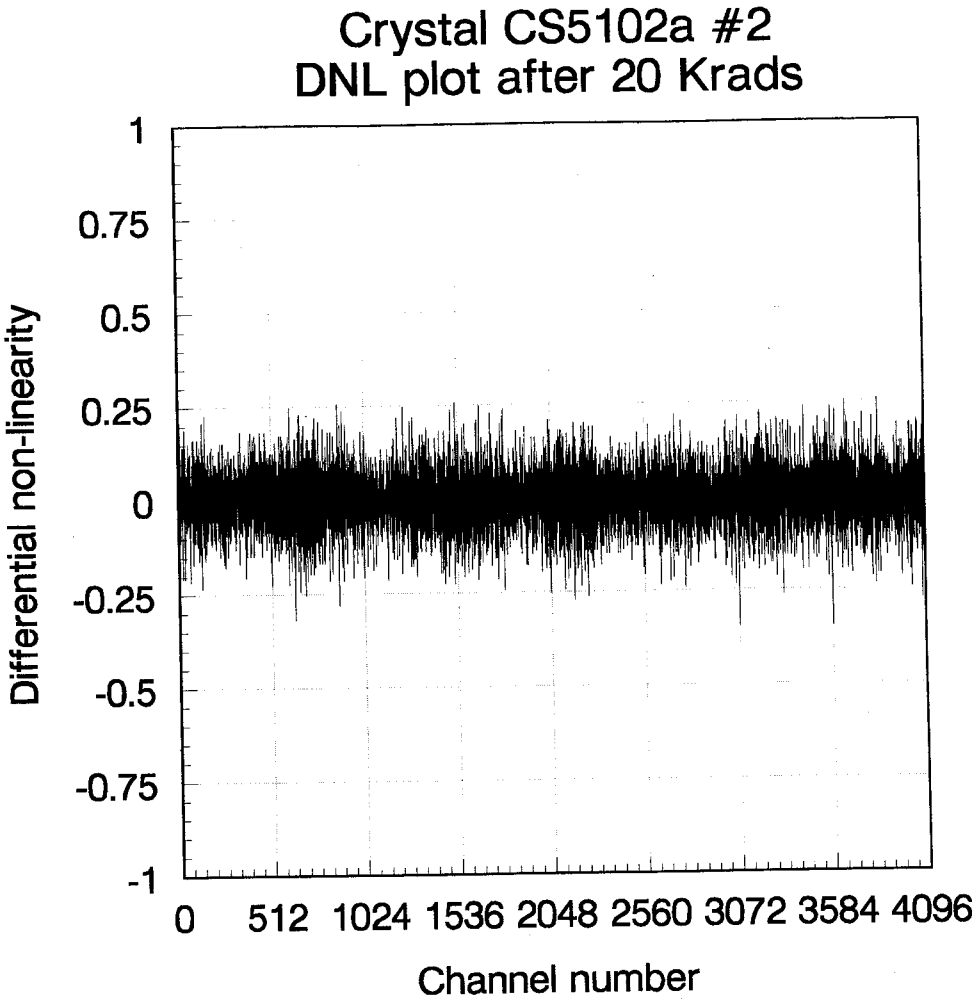

Crystal CS5012a #2
INL plot after 5Krads
Integral non-linearity
(LSB)
25
20
15
10
5
0
-5
-10
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

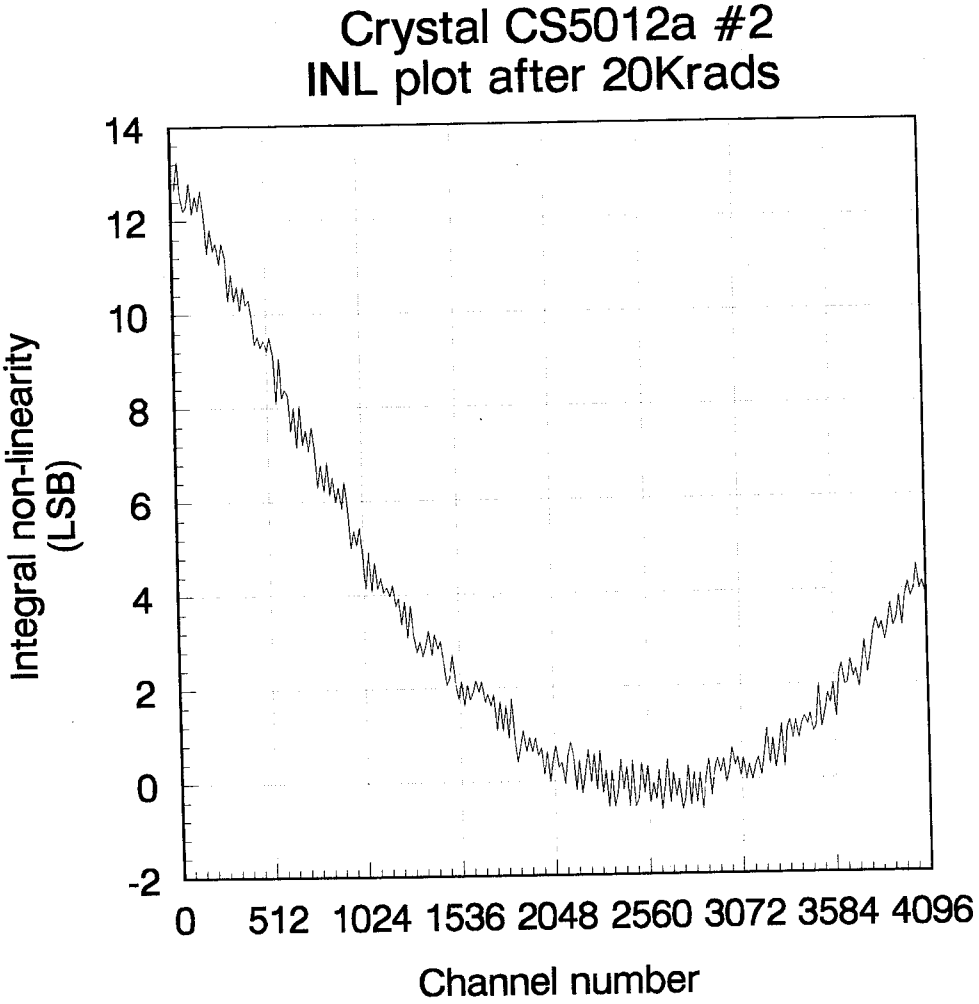

Crystal CS5102a #2
DNL plot after 10Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

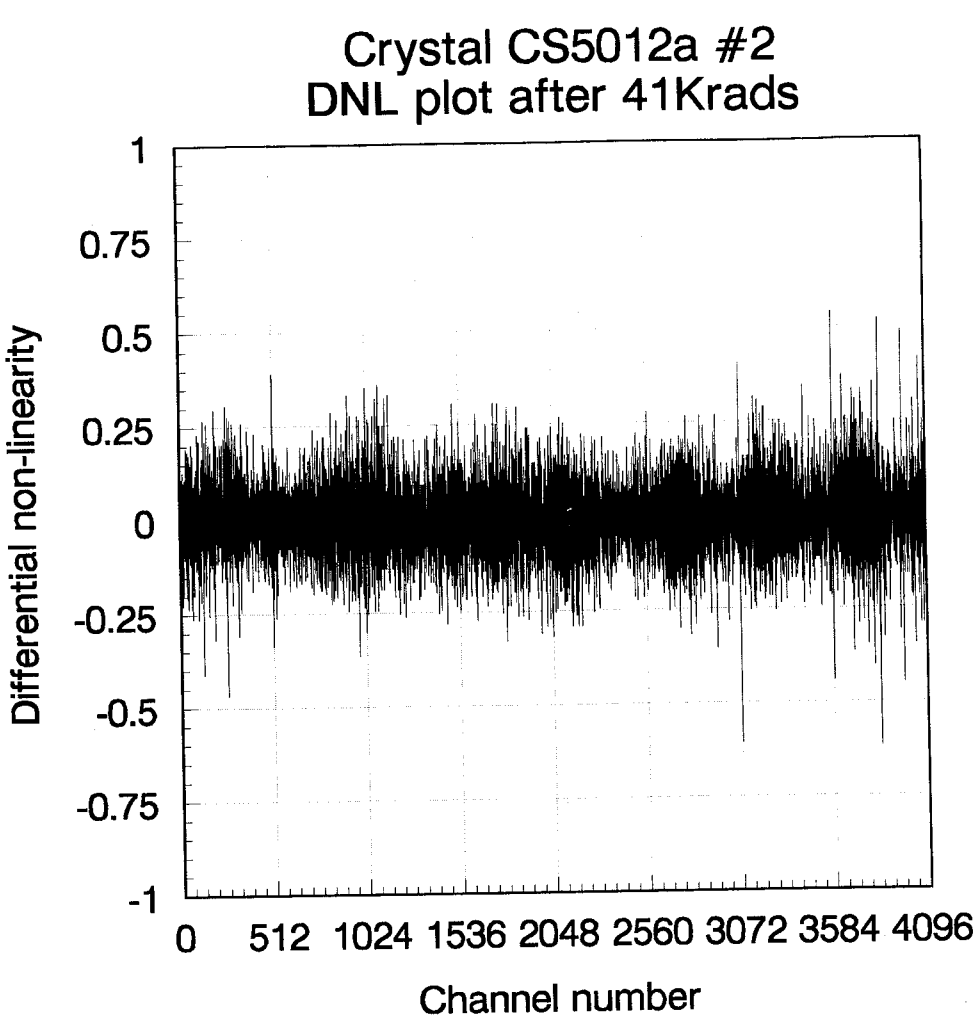

Crystal CS5102a #2
INL plot after 10Krads
Integral non-linearity
(LSB)
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

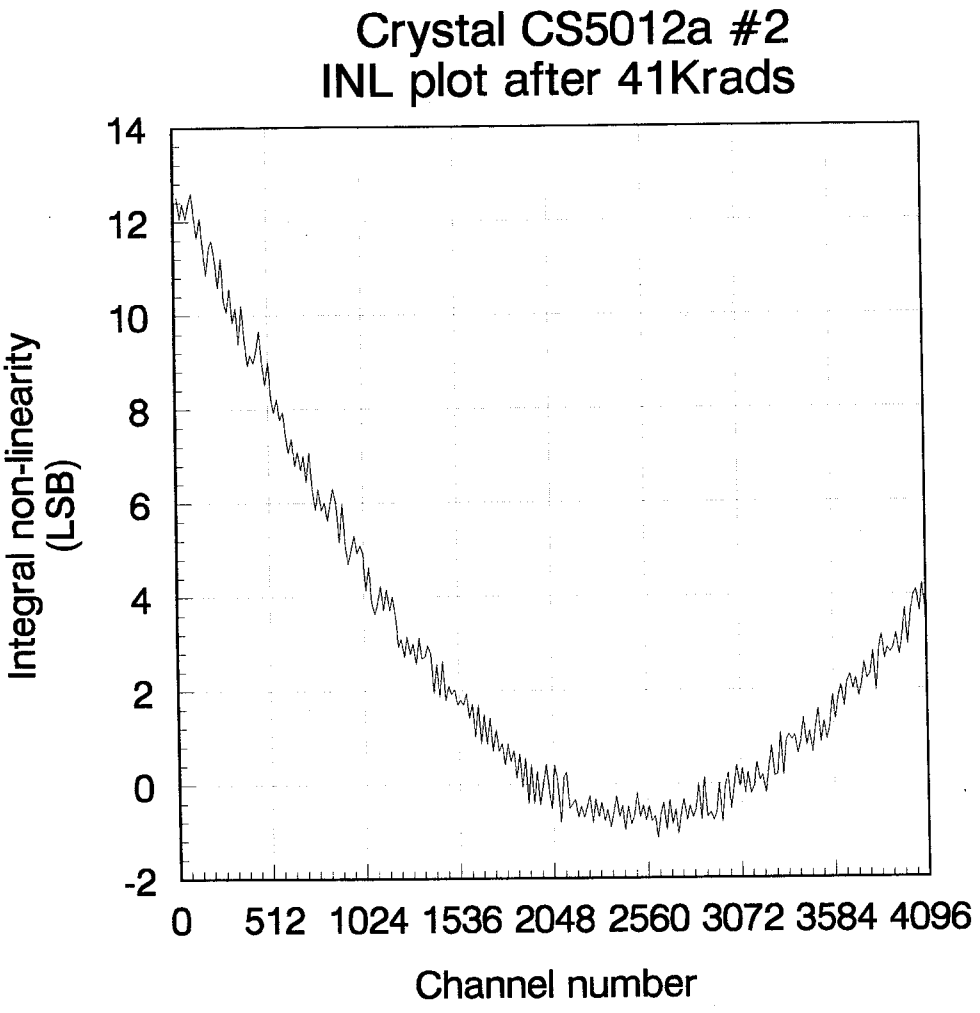

Crystal CS5012a #2
DNL plot after 15Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

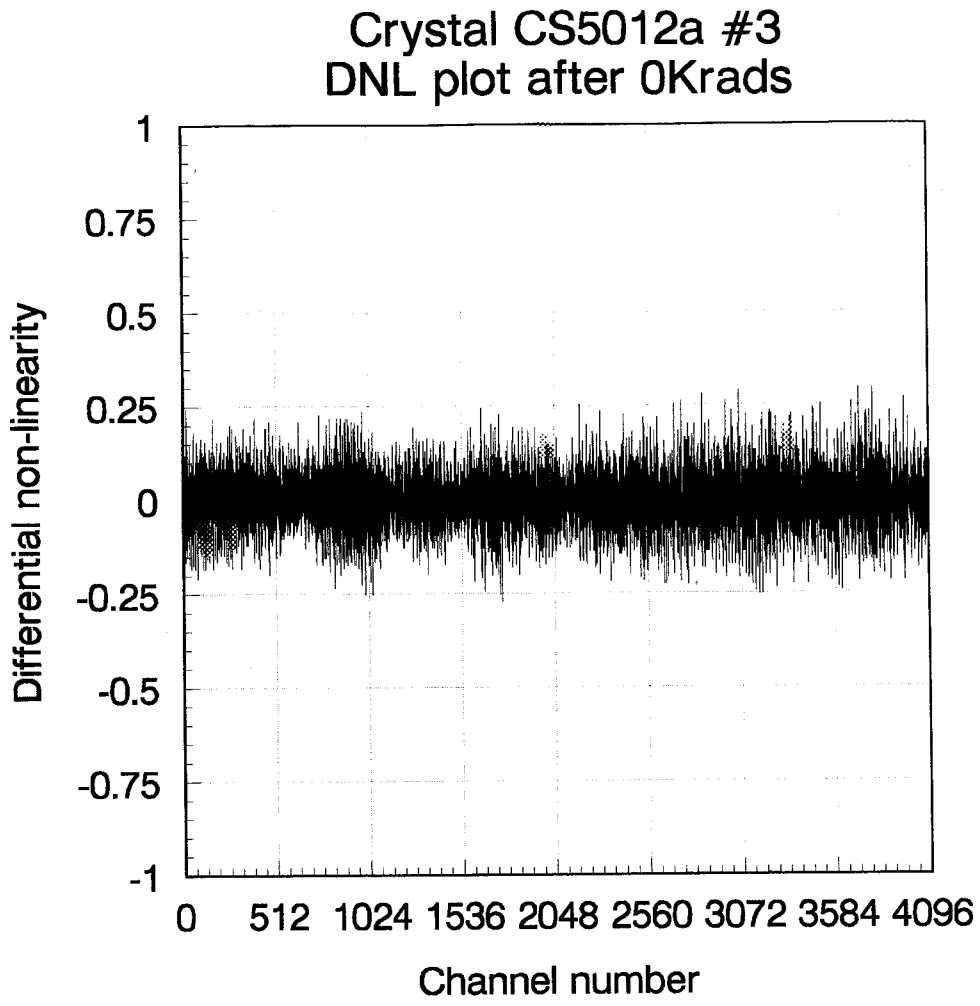

Crystal CS5102a #2
INL plot after 15Krads
Integral non-linearity
(LSB)
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

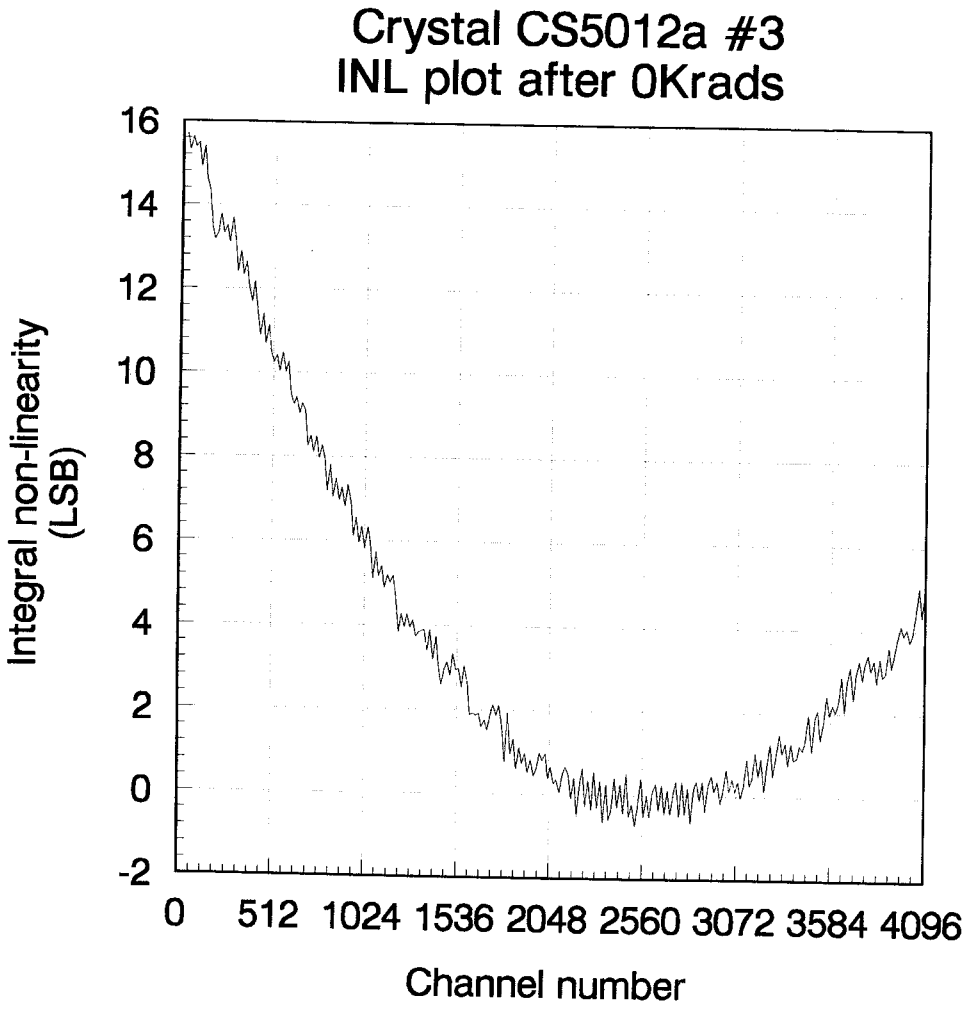

Crystal CS5102a #2
DNL plot after 20 Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

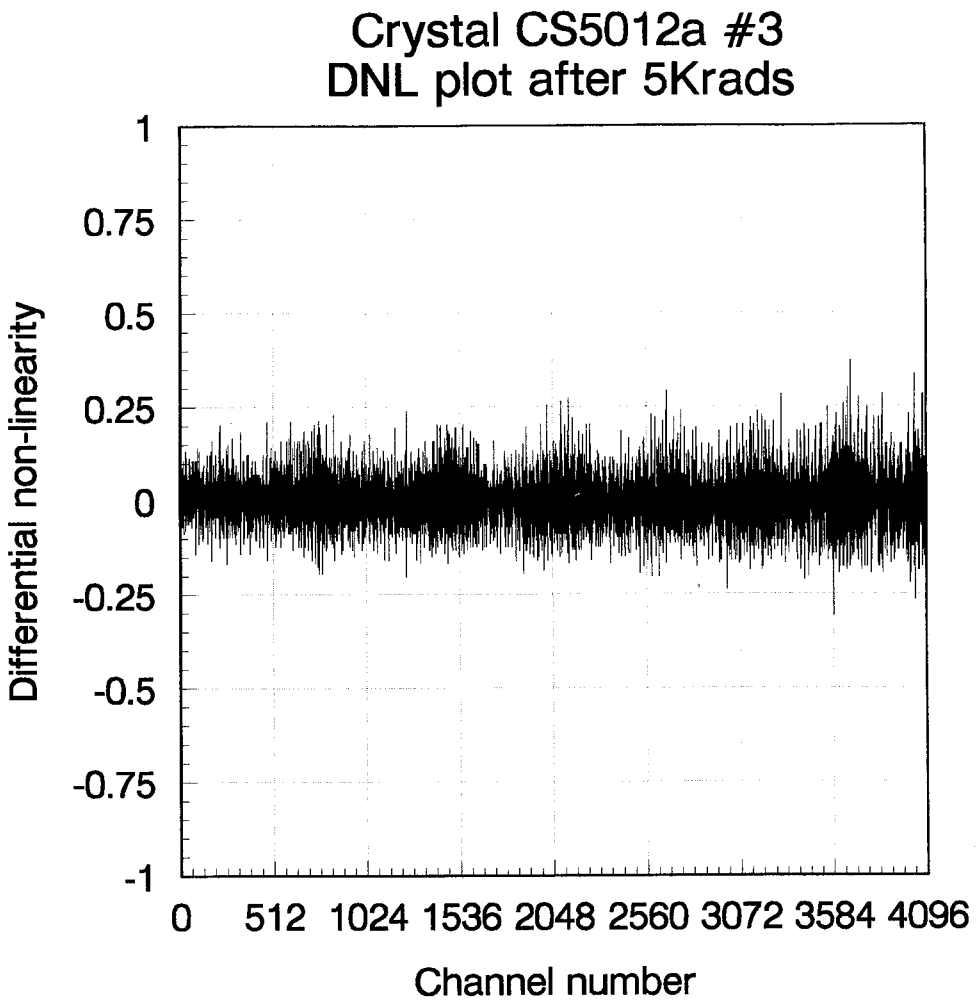

Crystal CS5012a #2
INL plot after 20Krads
Integral non-linearity
(LSB)
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

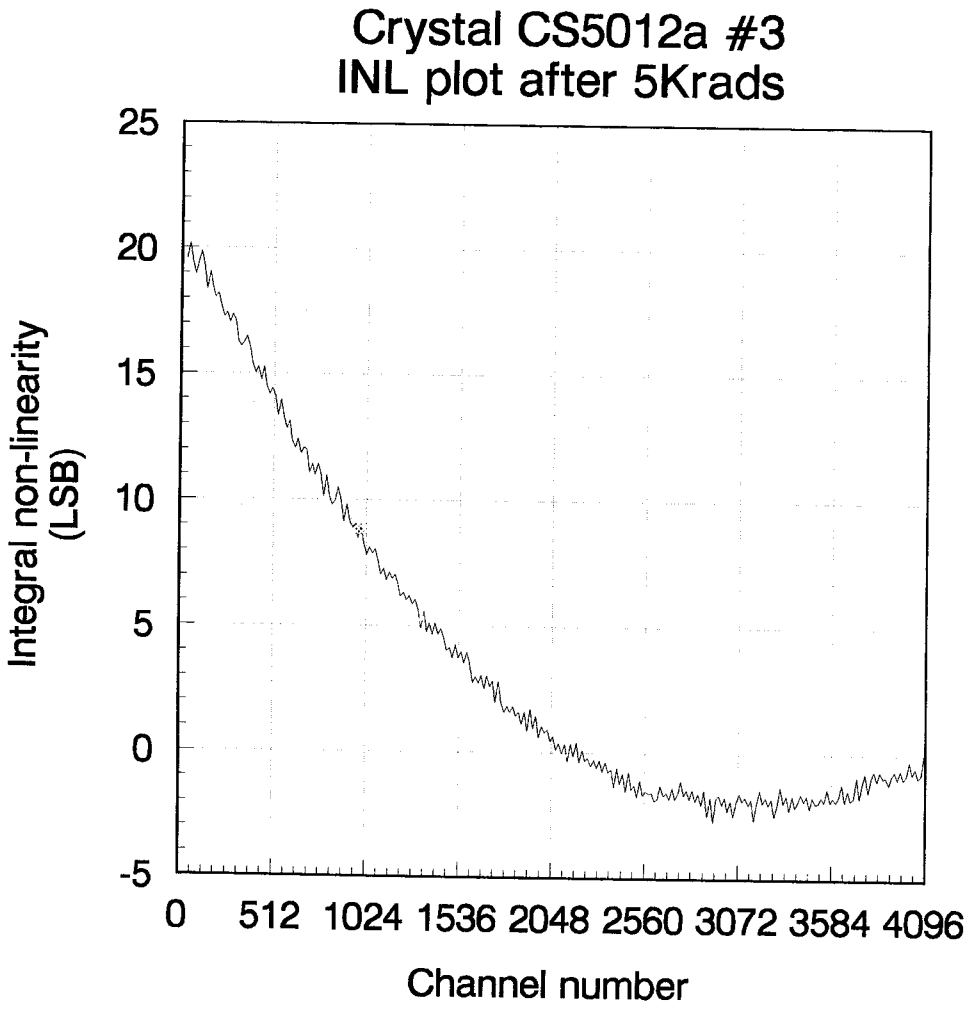

Crystal CS5012a #2
DNL plot after 41Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

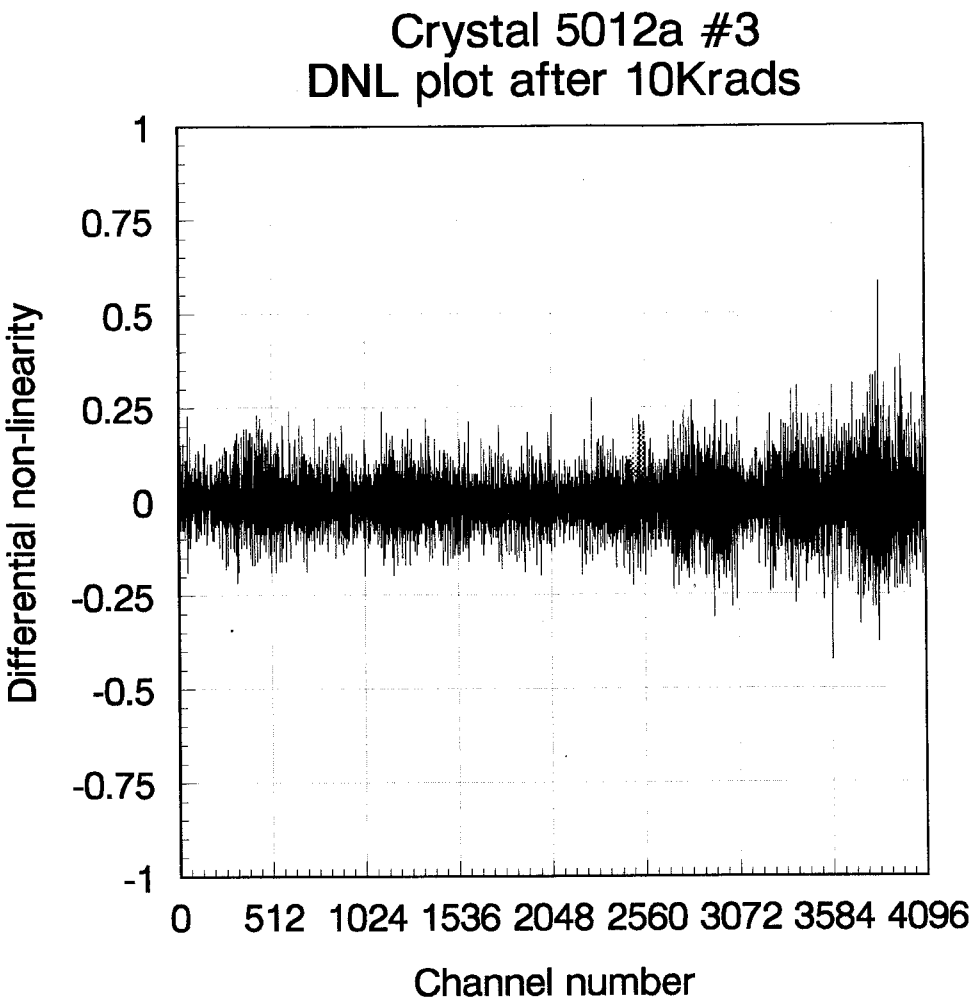

Crystal CS5012a #2
INL plot after 41Krads
Integral non-linearity
(LSB)
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

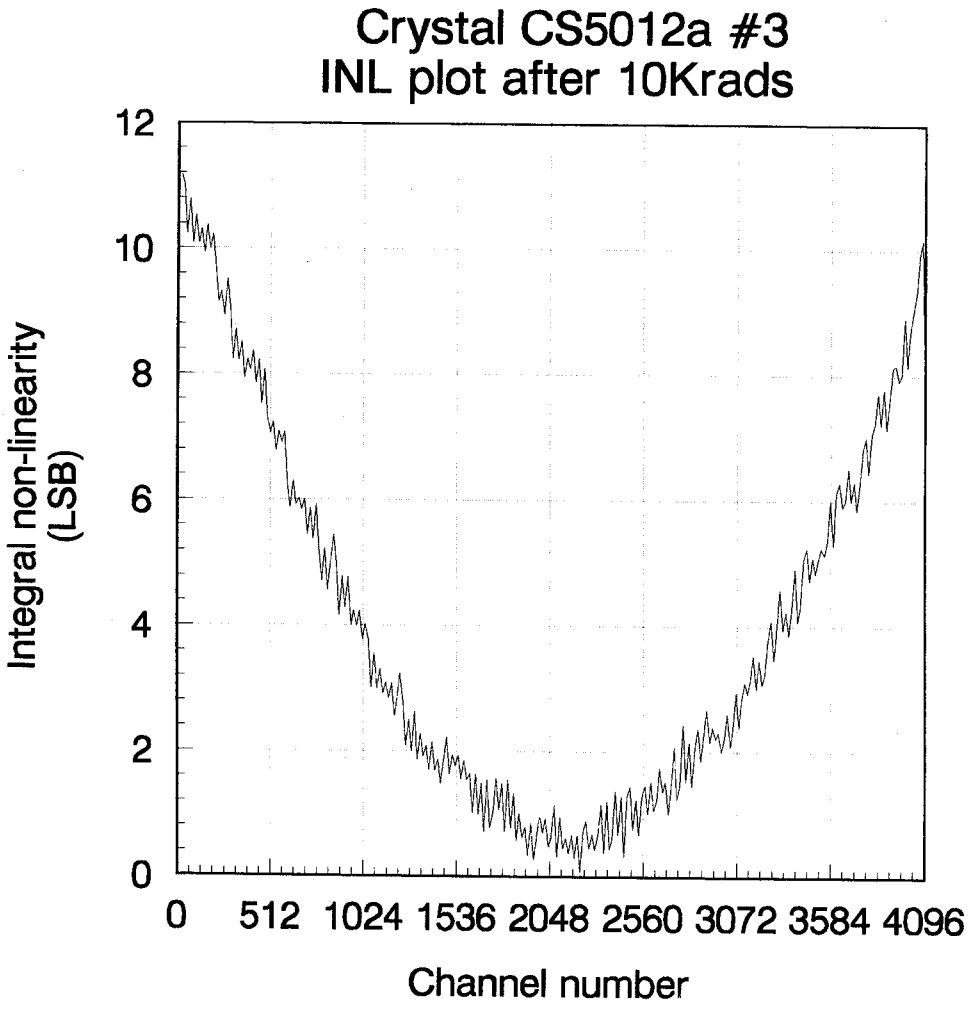

Crystal CS5012a #3
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

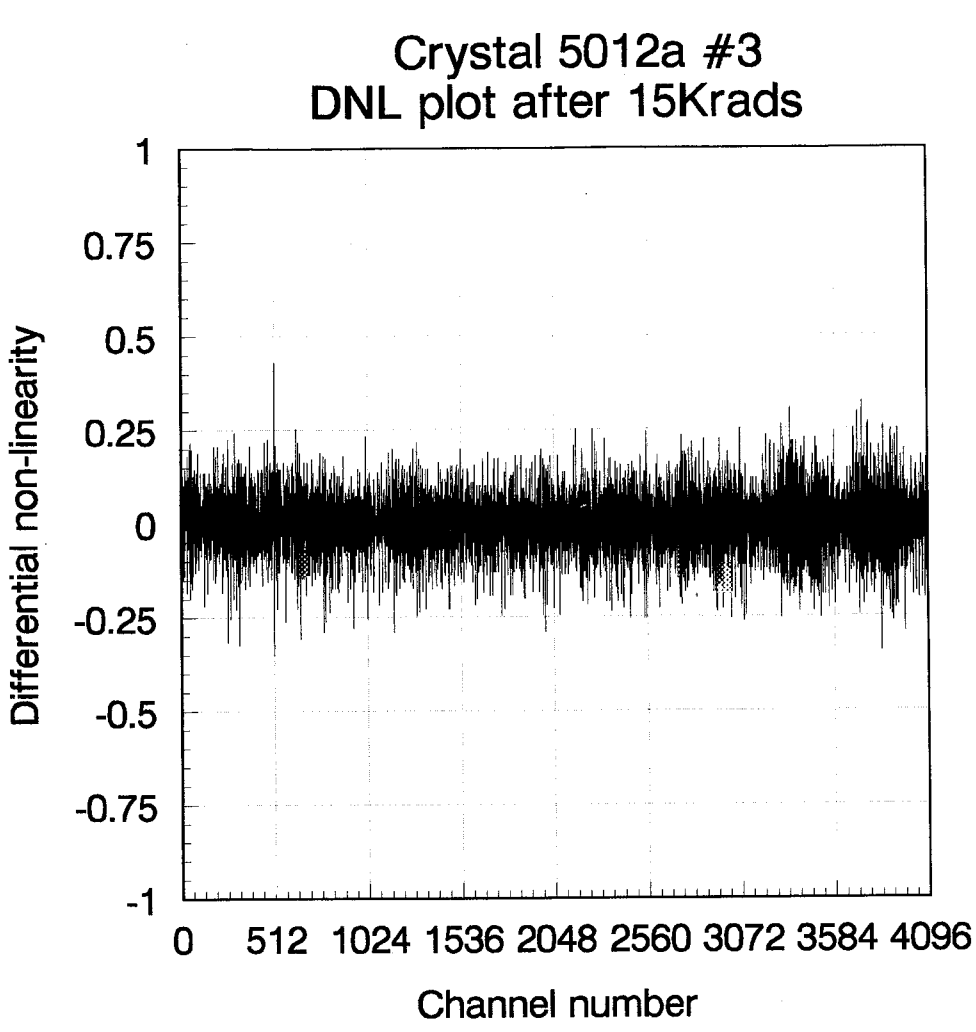

Crystal CS5012a #3
INL plot after 0Krads
Integral non-linearity
(LSB)
16
14
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

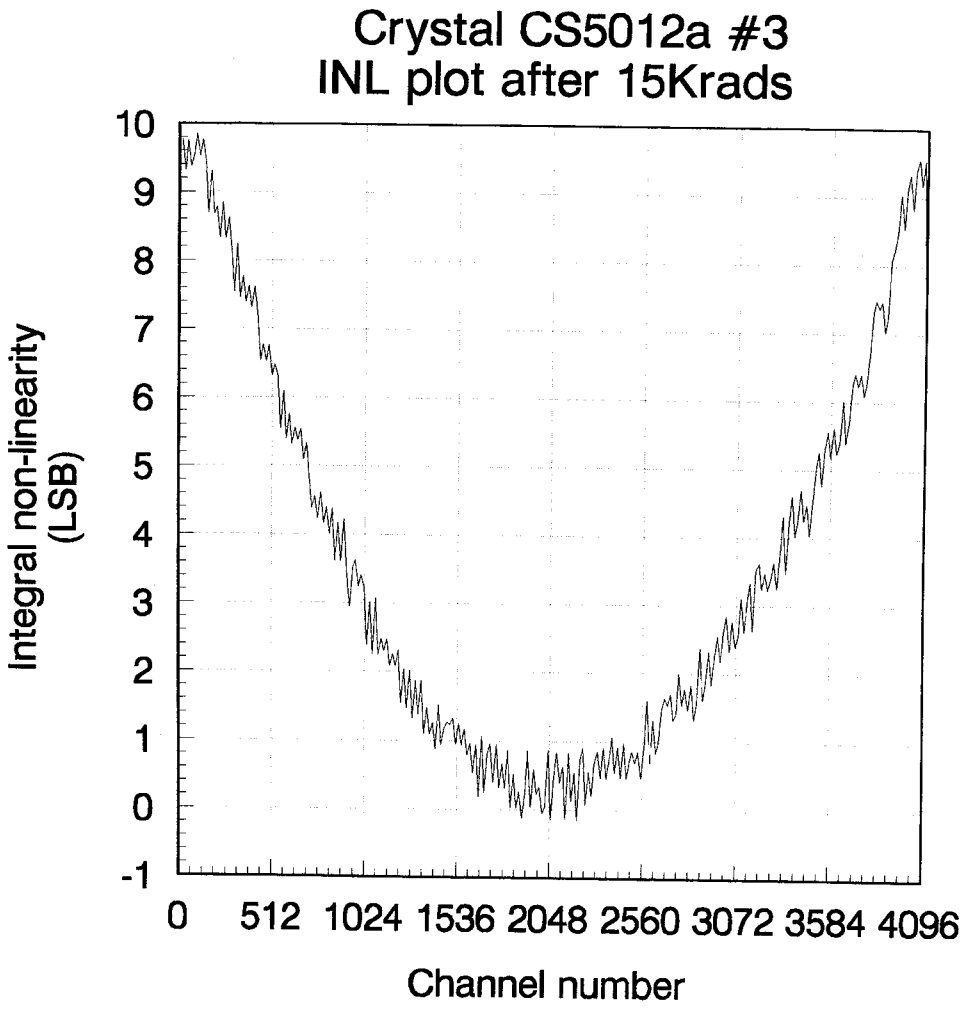

Crystal CS5012a #3
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

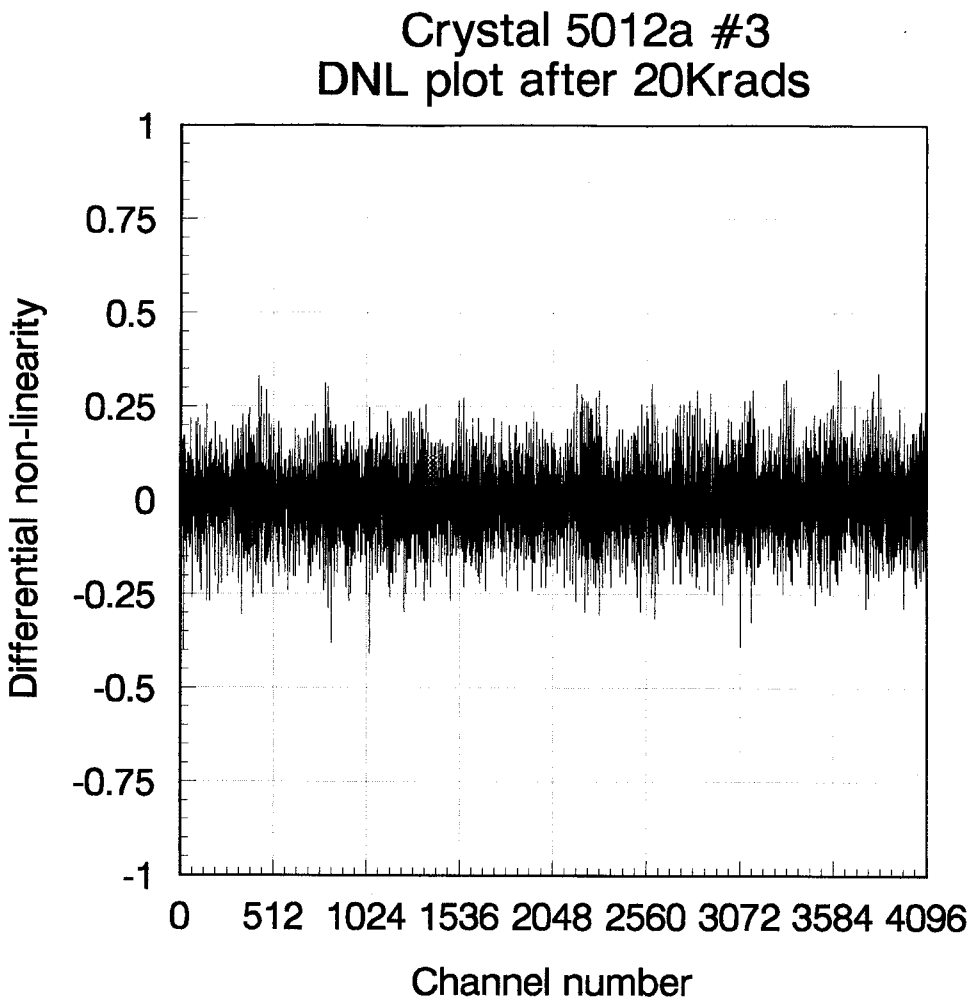

Crystal CS5012a #3
INL plot after 5Krads
Integral non-linearity
(LSB)
25
20
15
10
5
0
-5
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

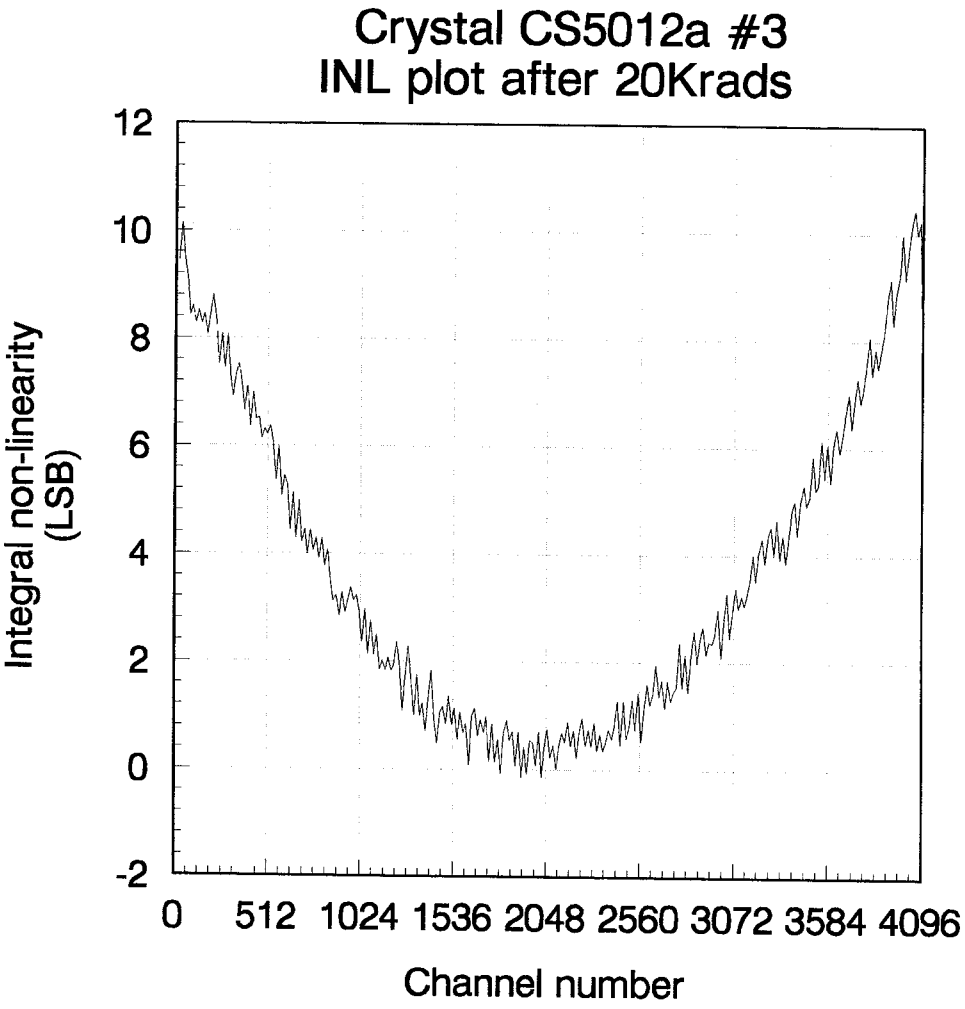

Crystal 5012a #3
DNL plot after 10Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

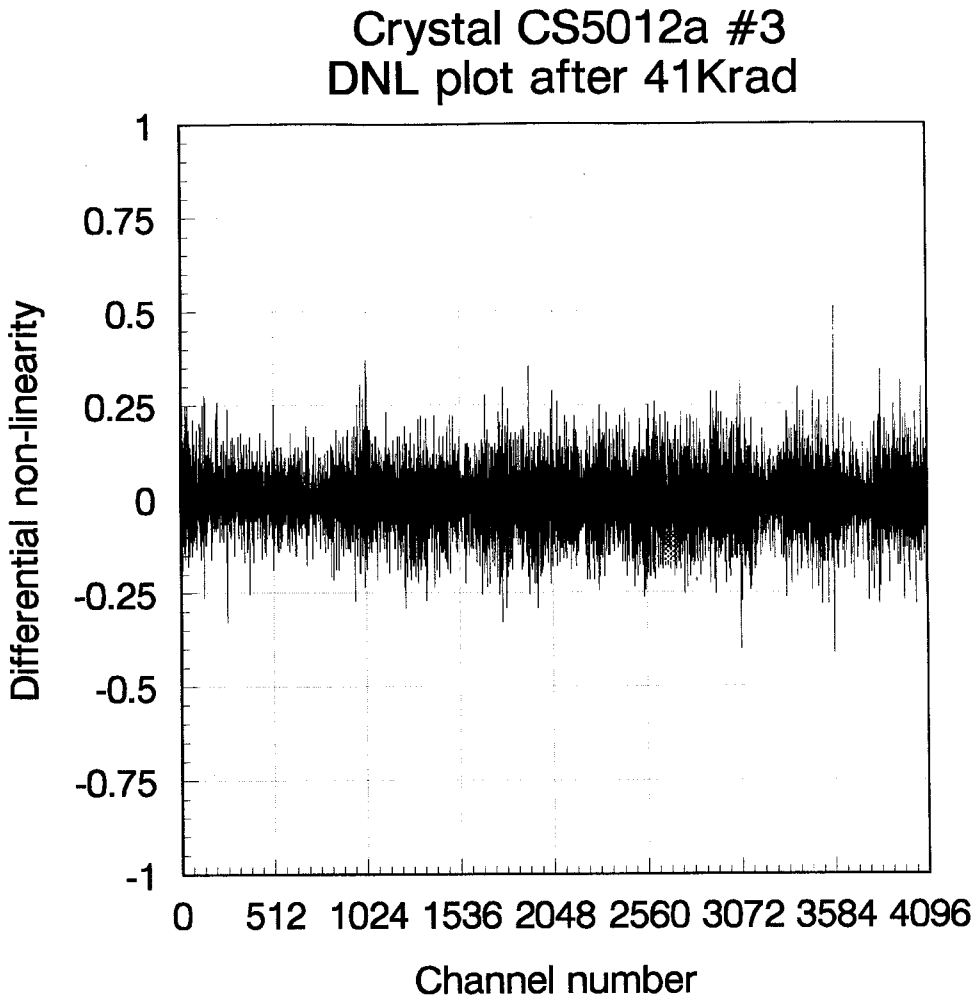

Crystal CS5012a #3
INL plot after 10Krads
Integral non-linearity
(LSB)
12
10
8
6
4
2
0
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

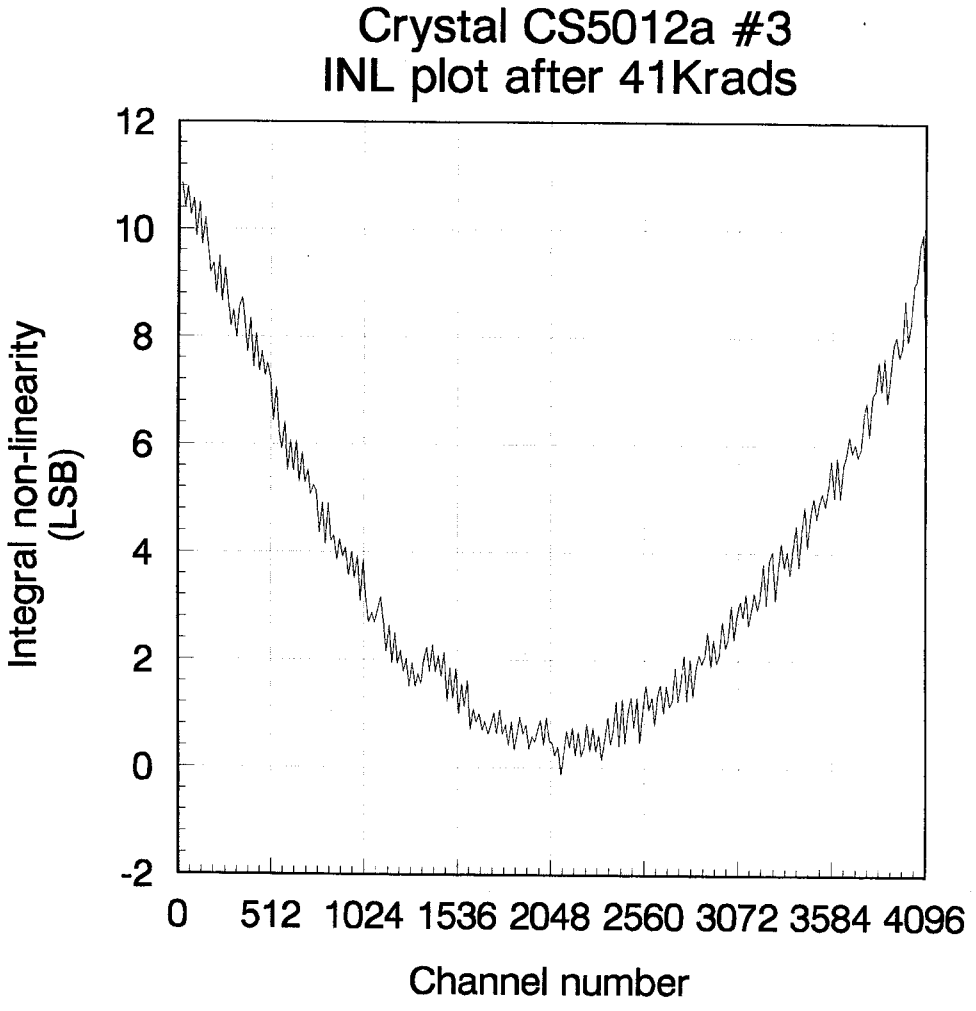

Crystal 5012a #3
DNL plot after 15Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

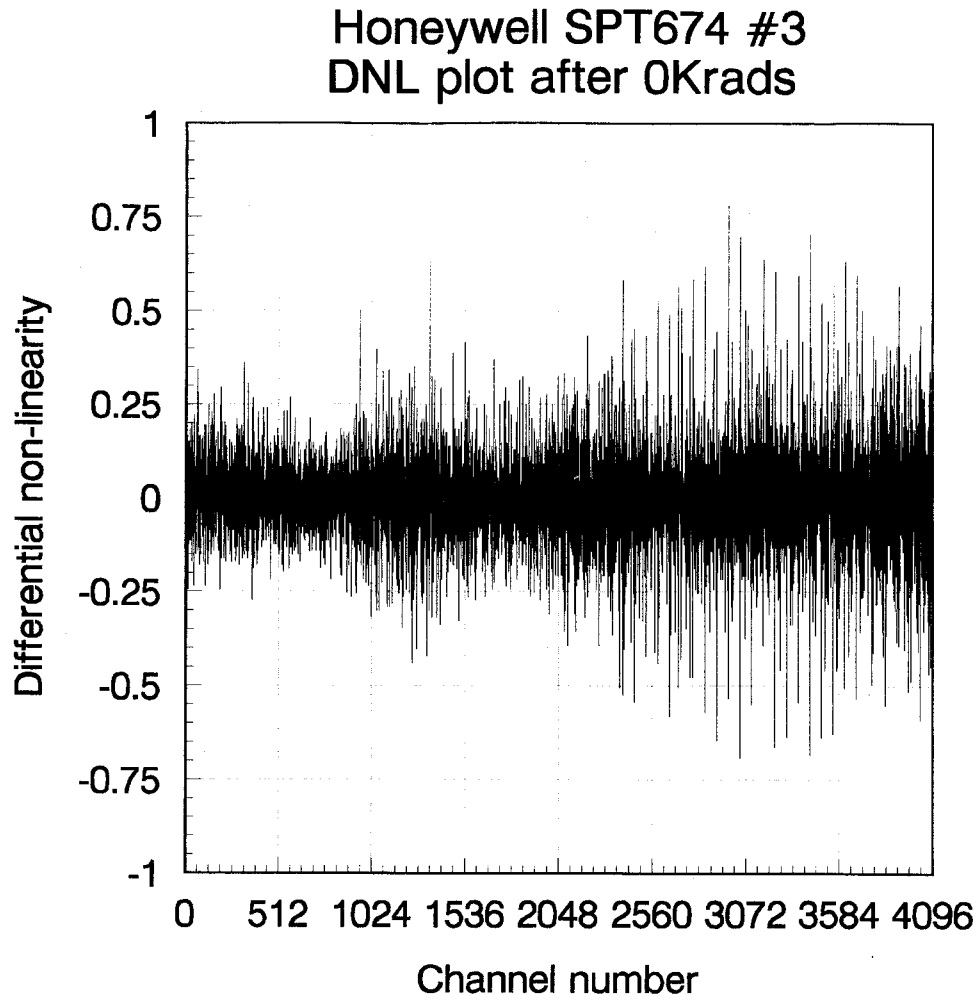

Crystal CS5012a #3
INL plot after 15Krads
Integral non-linearity
(LSB)
10
9
8
7
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

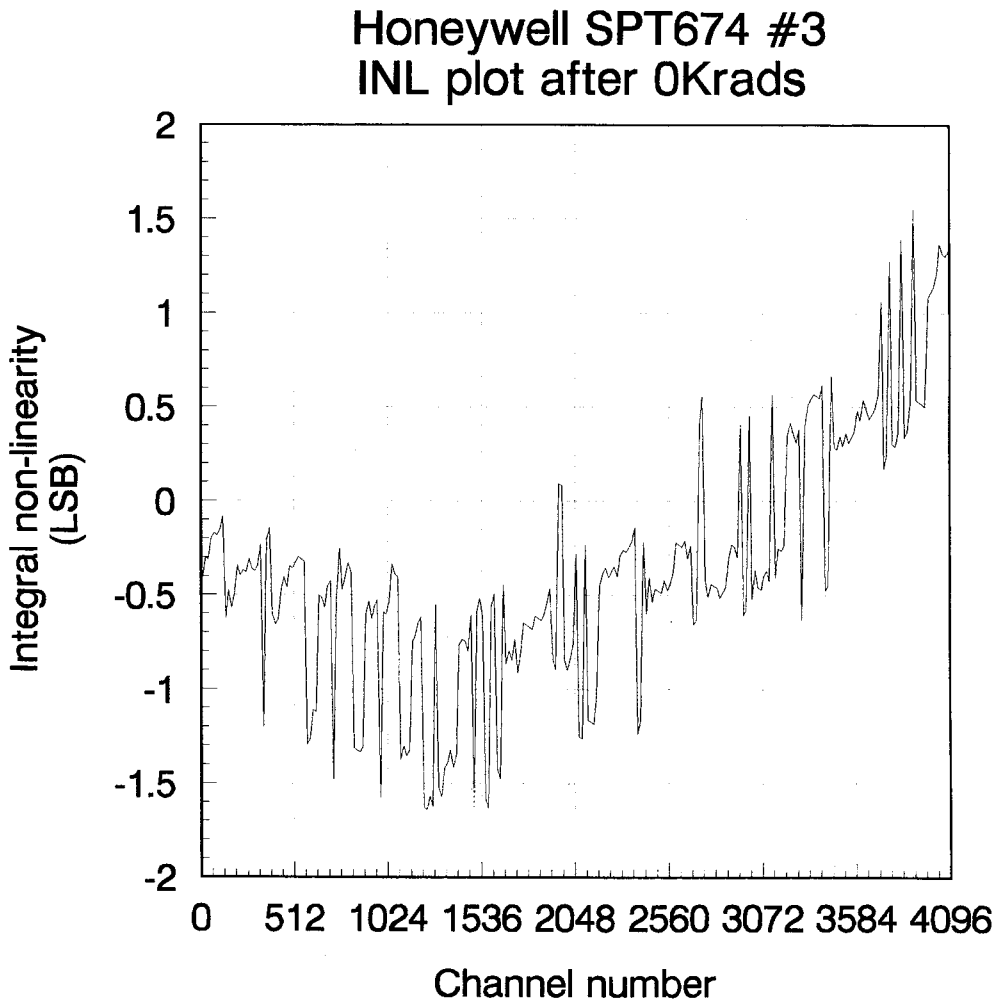

Crystal 5012a #3
DNL plot after 20Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

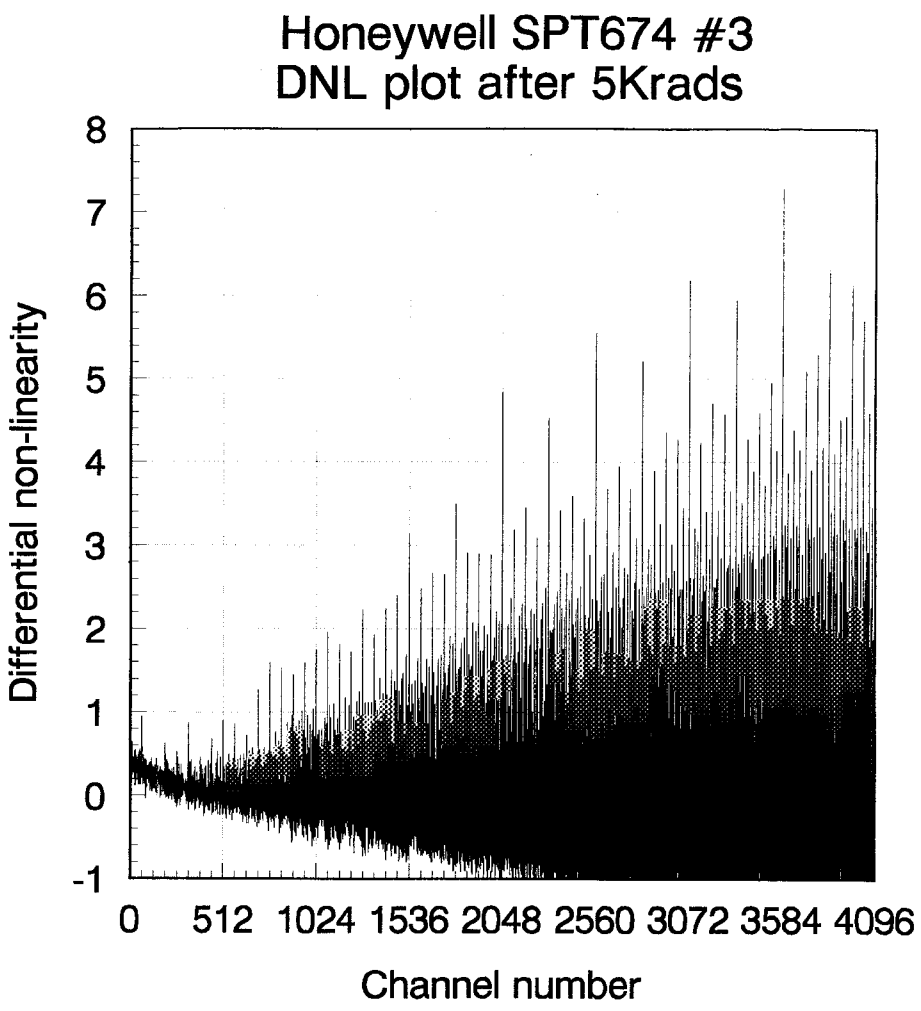

Crystal CS5012a #3
INL plot after 20Krads
Integral non-linearity
(LSB)
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

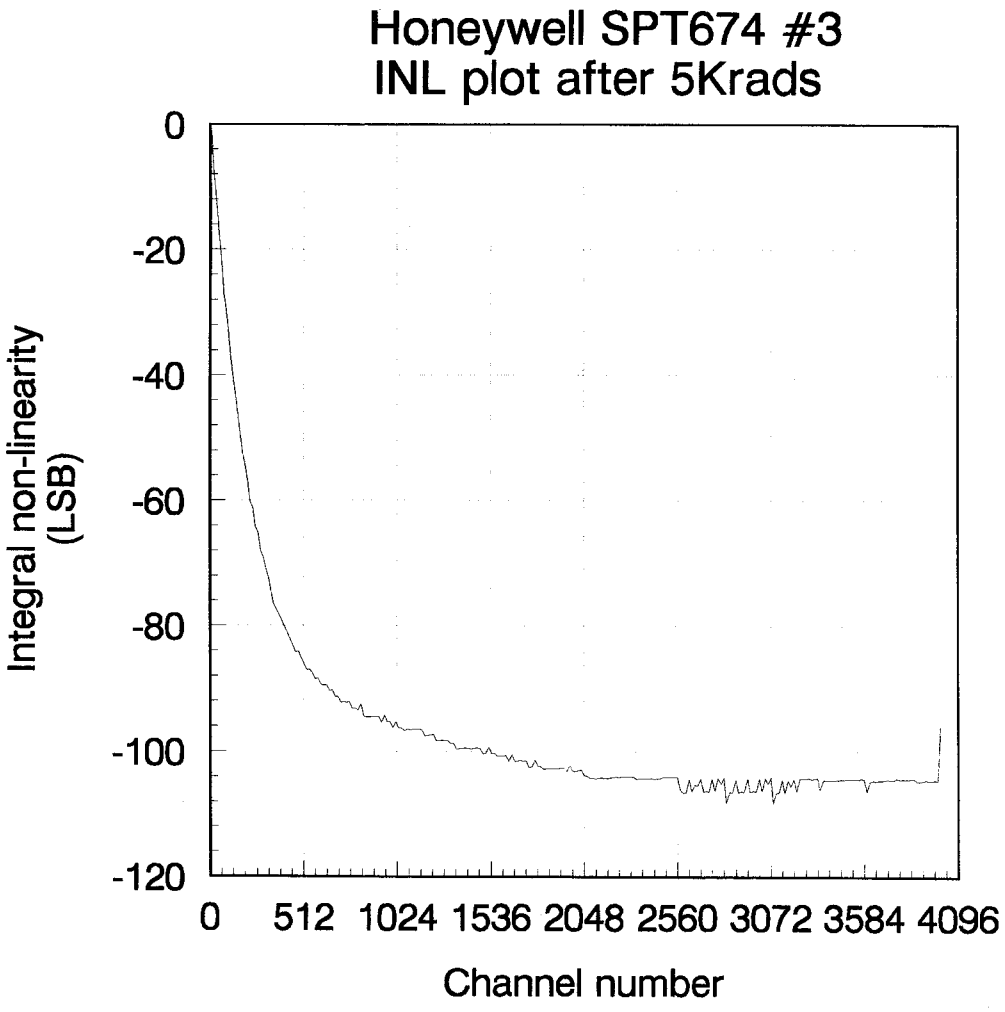

Crystal CS5012a #3
DNL plot after 41Krad
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

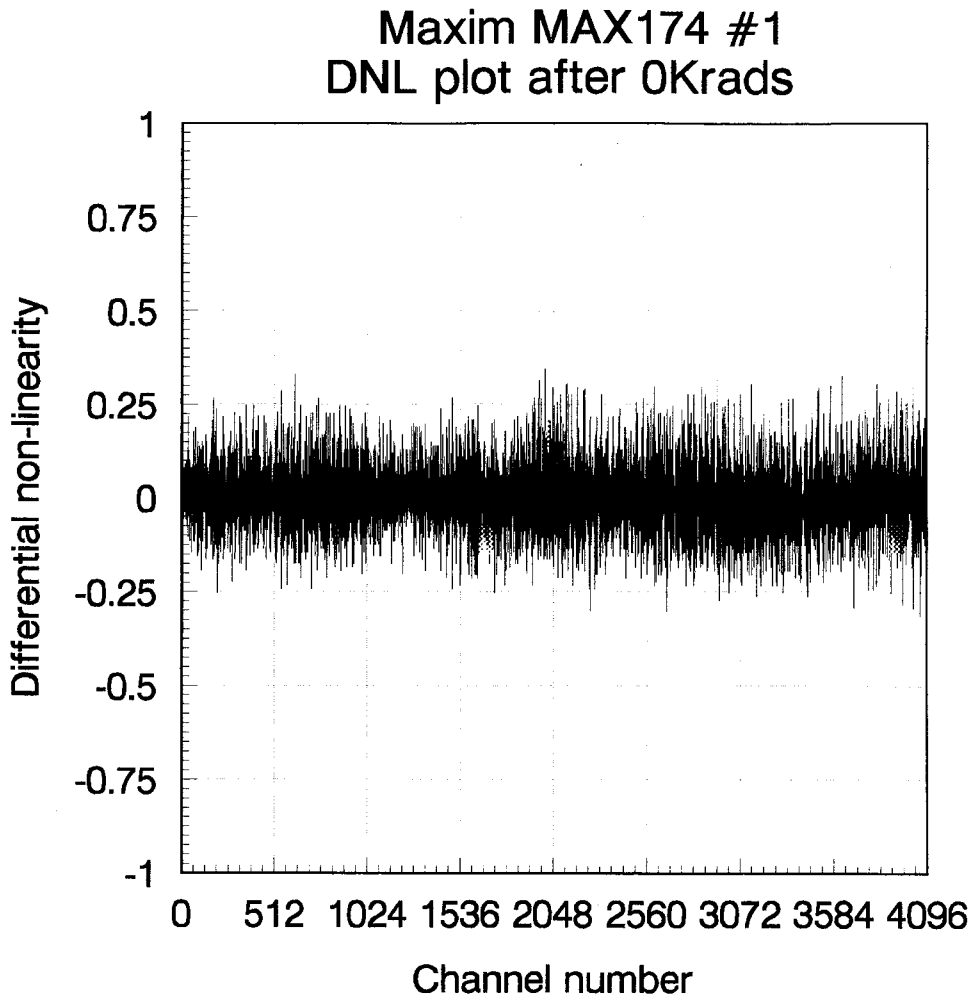

Crystal CS5012a #3
INL plot after 41Krads
Integral non-linearity
(LSB)
12
10
8
6
4
2
0
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

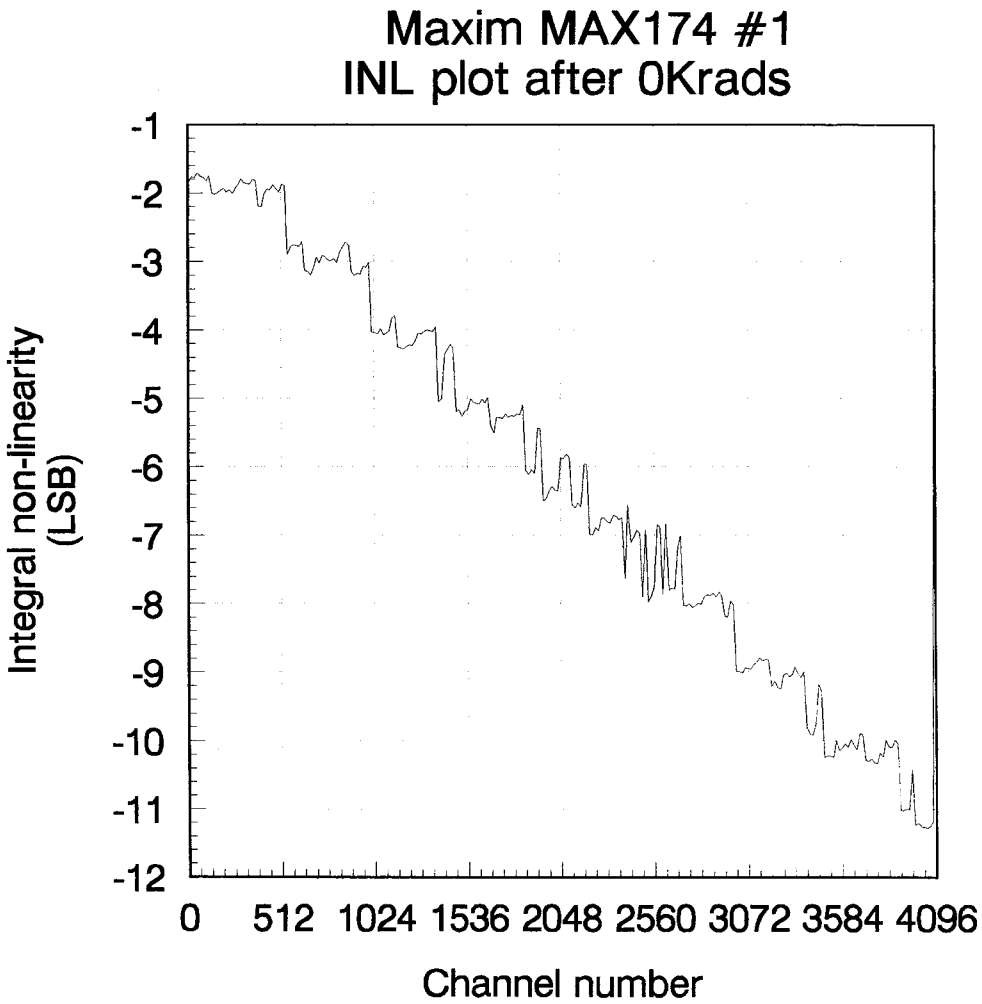

Honeywell SPT674 #3
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

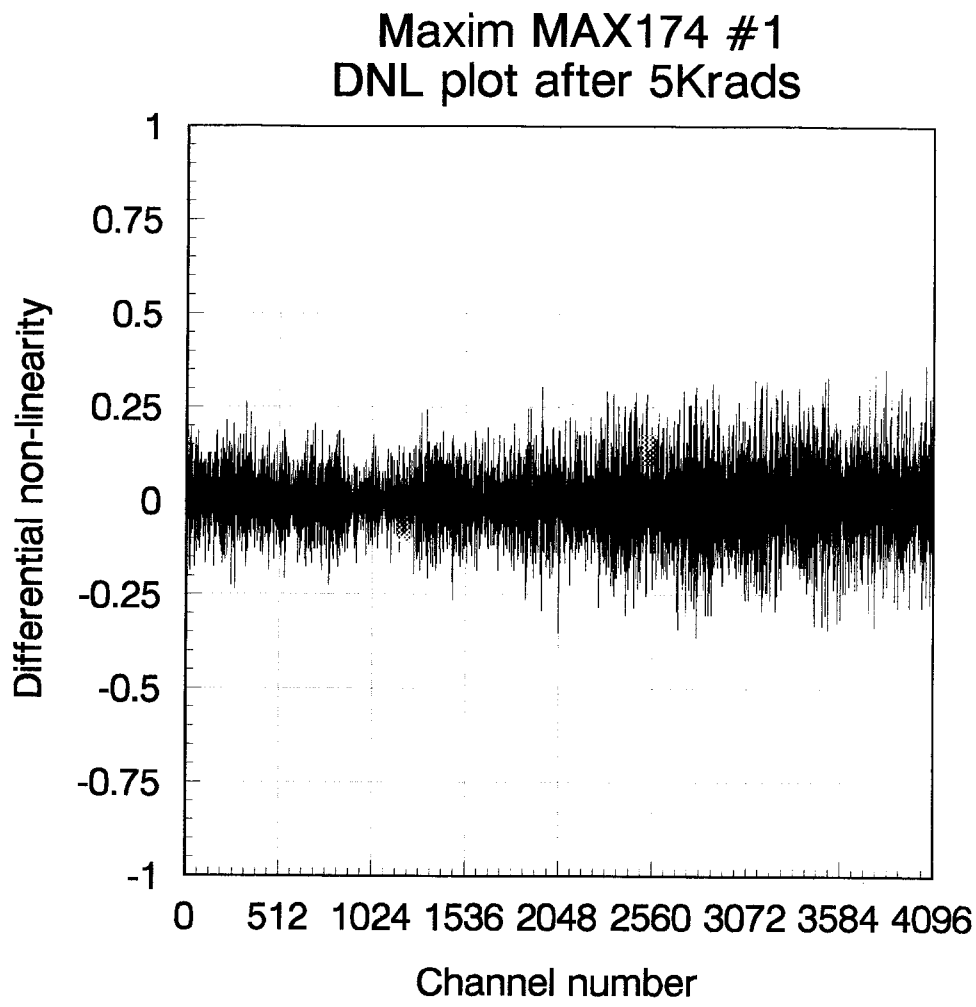

Honeywell SPT674 #3
INL plot after 0Krads
Integral non-linearity
(LSB)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

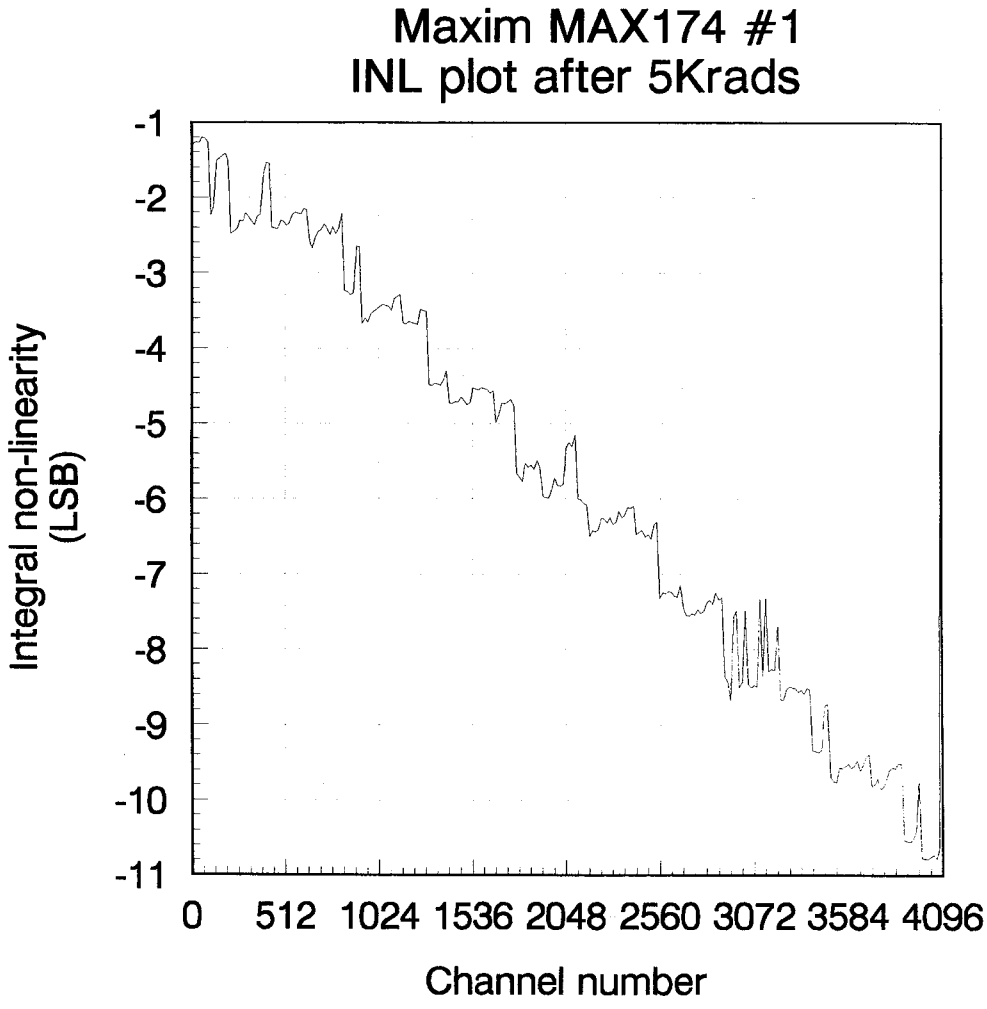

Honeywell SPT674 #3
DNL plot after 5Krads
Differential non-linearity
8
7
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

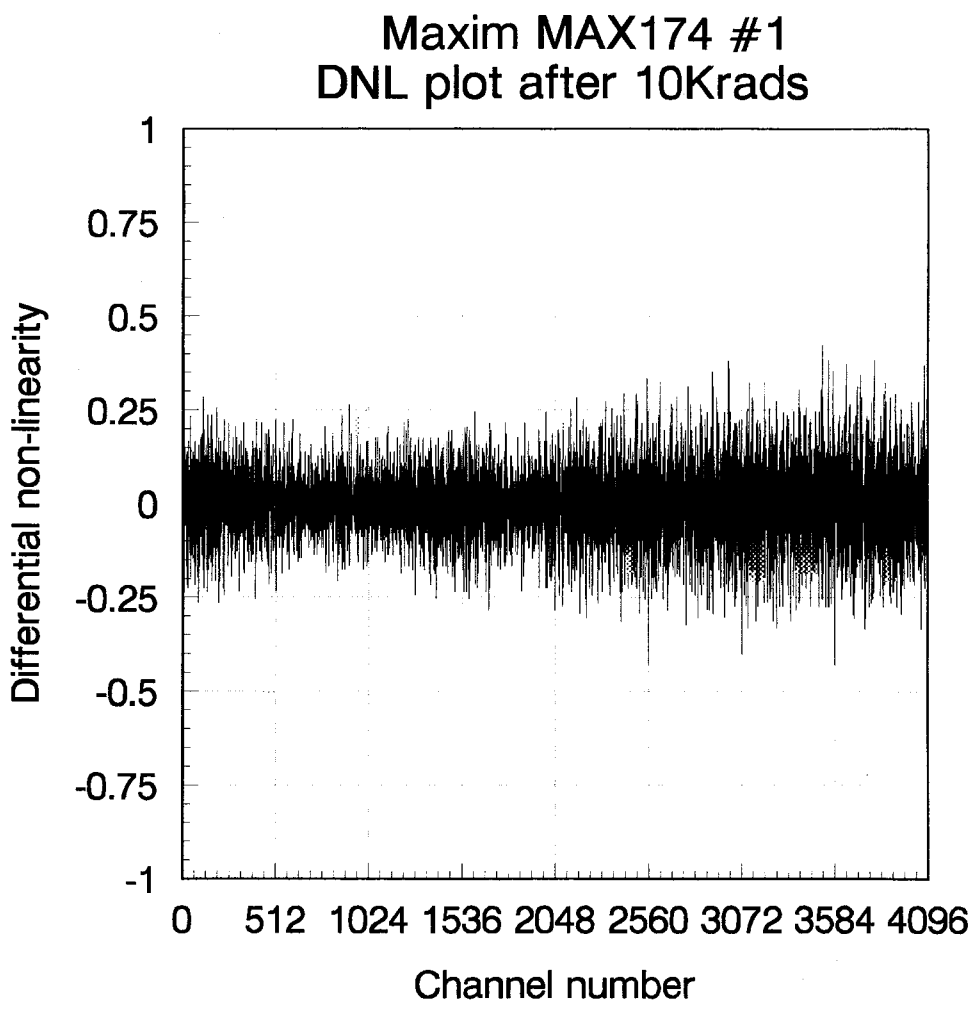

Honeywell SPT674 #3
INL plot after 5Krads
Integral non-linearity
(LSB)
0
-20
-40
-60
-80
-100
-120
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

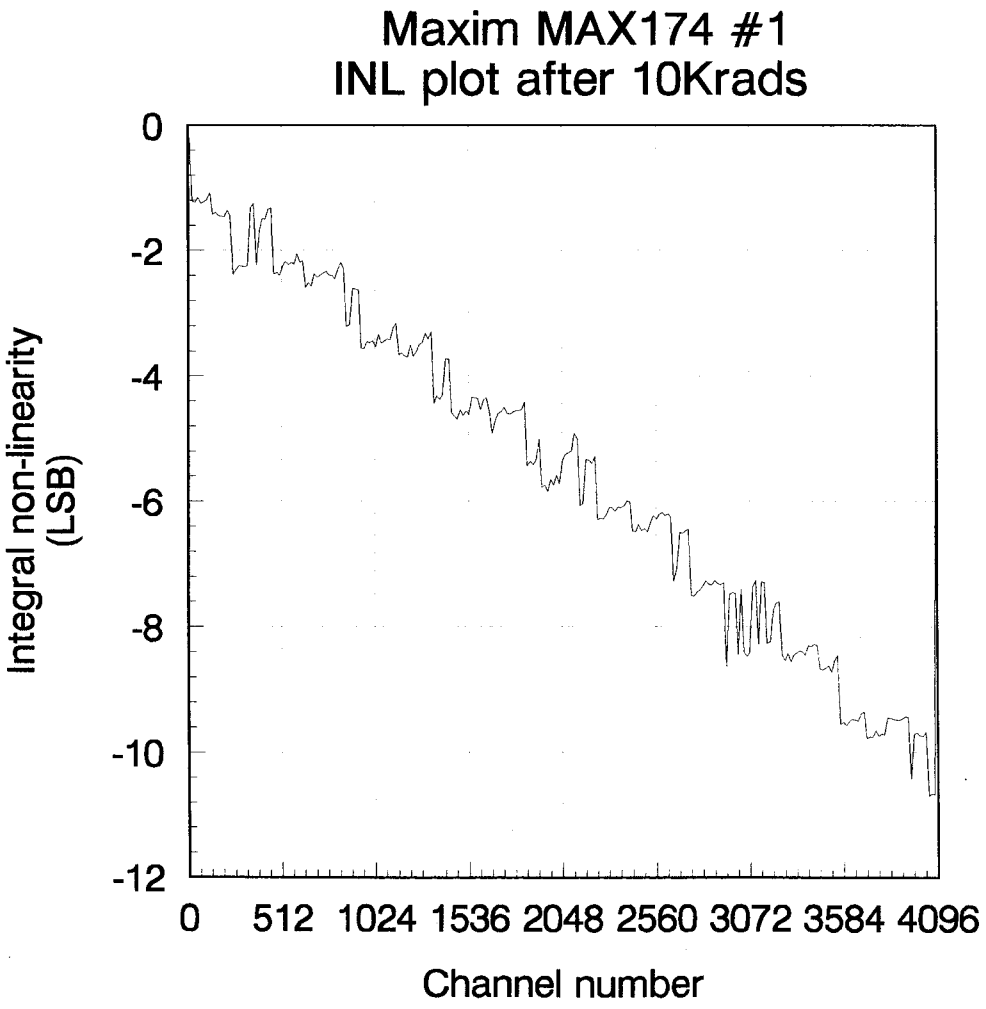

Maxim MAX174 #1
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

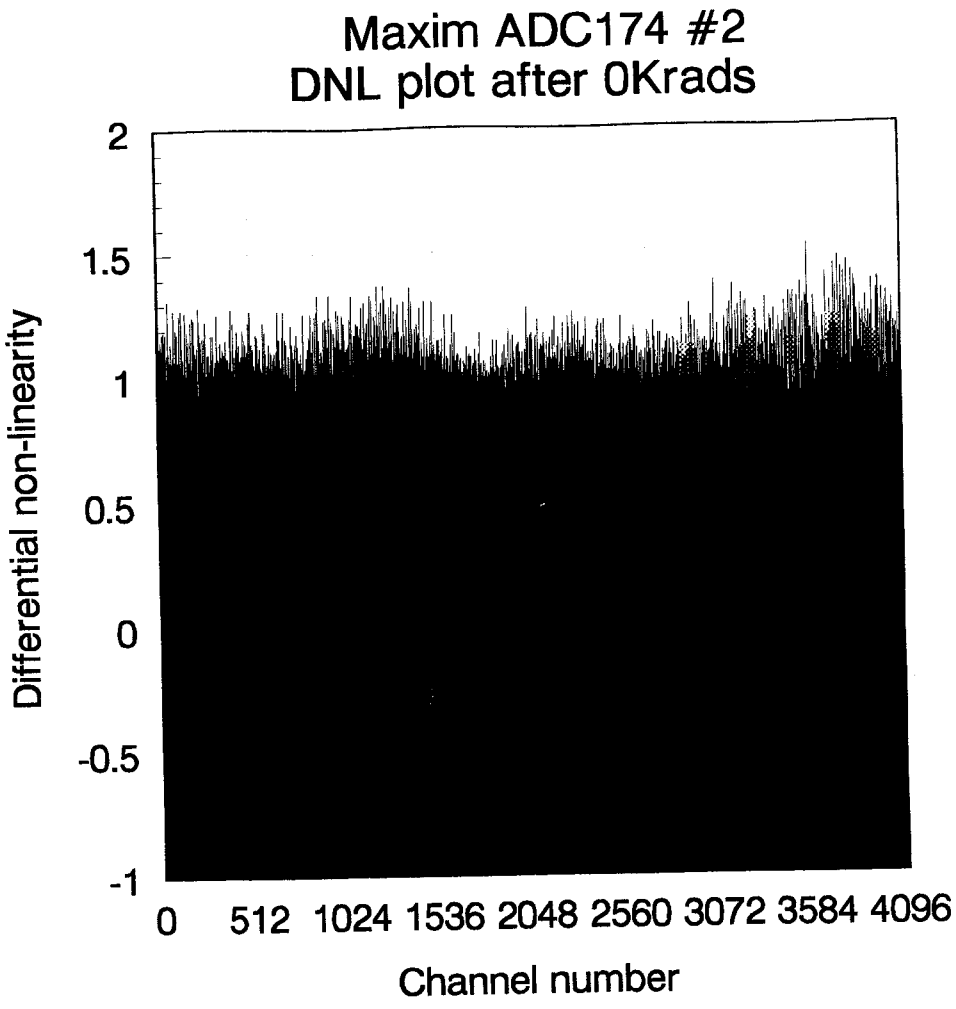

Maxim MAX174 #1
INL plot after 0Krads
Integral non-linearity
(LSB)
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

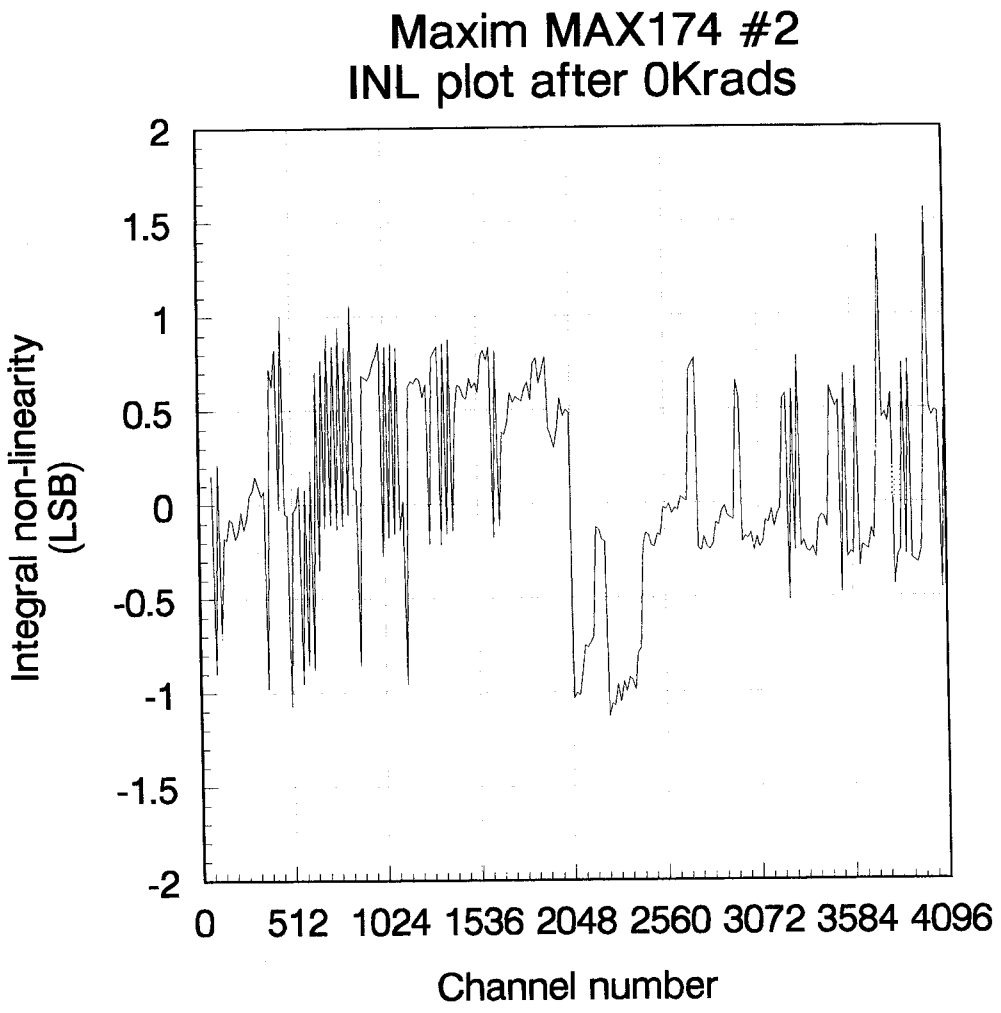

Maxim MAX174 #1
DNL plot after 5Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

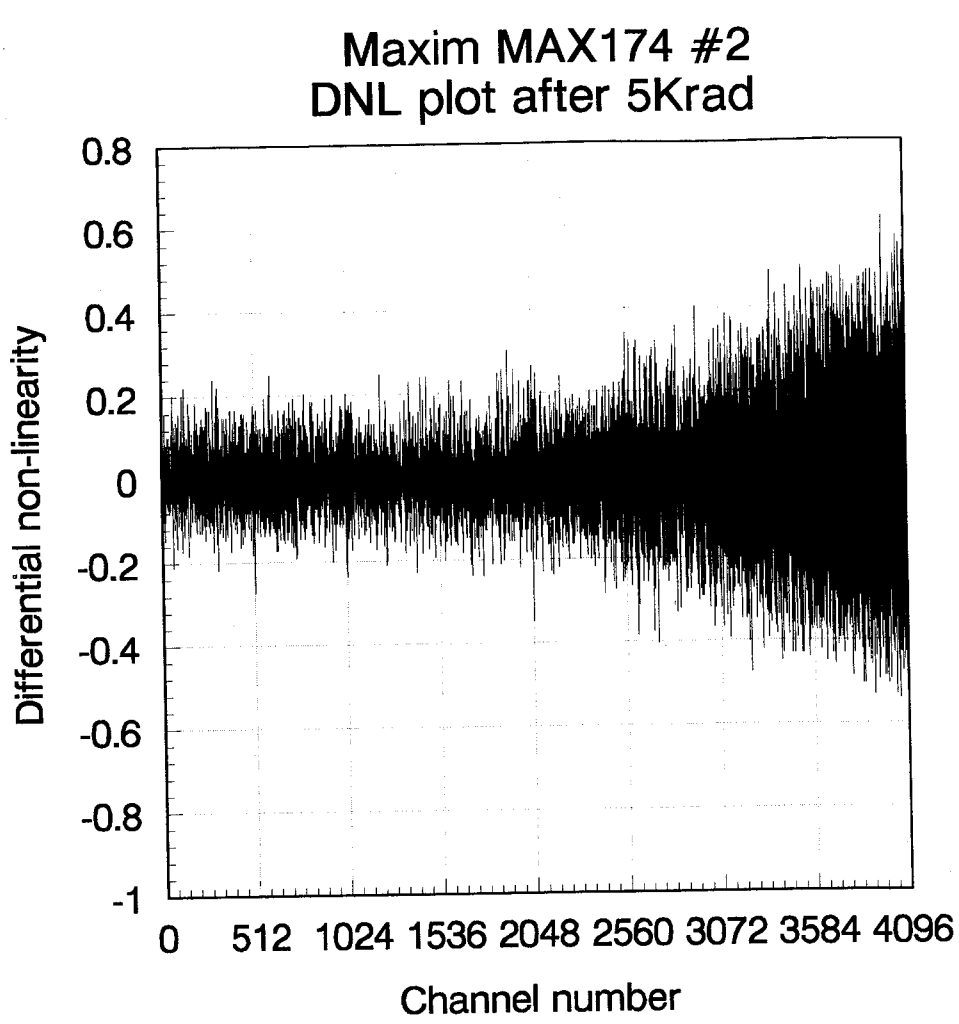

Maxim MAX174 #1
INL plot after 5Krads
Integral non-linearity
(LSB)
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

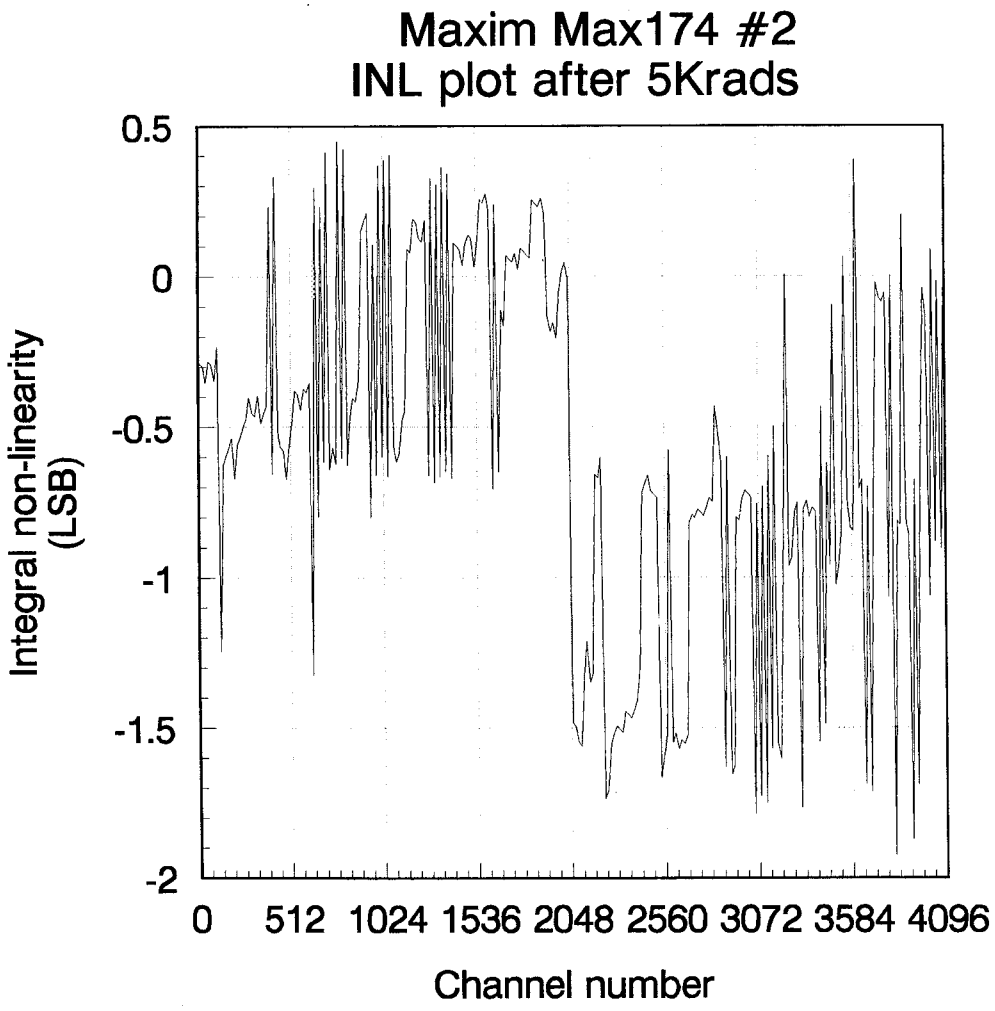

Maxim MAX174 #1
DNL plot after 10Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

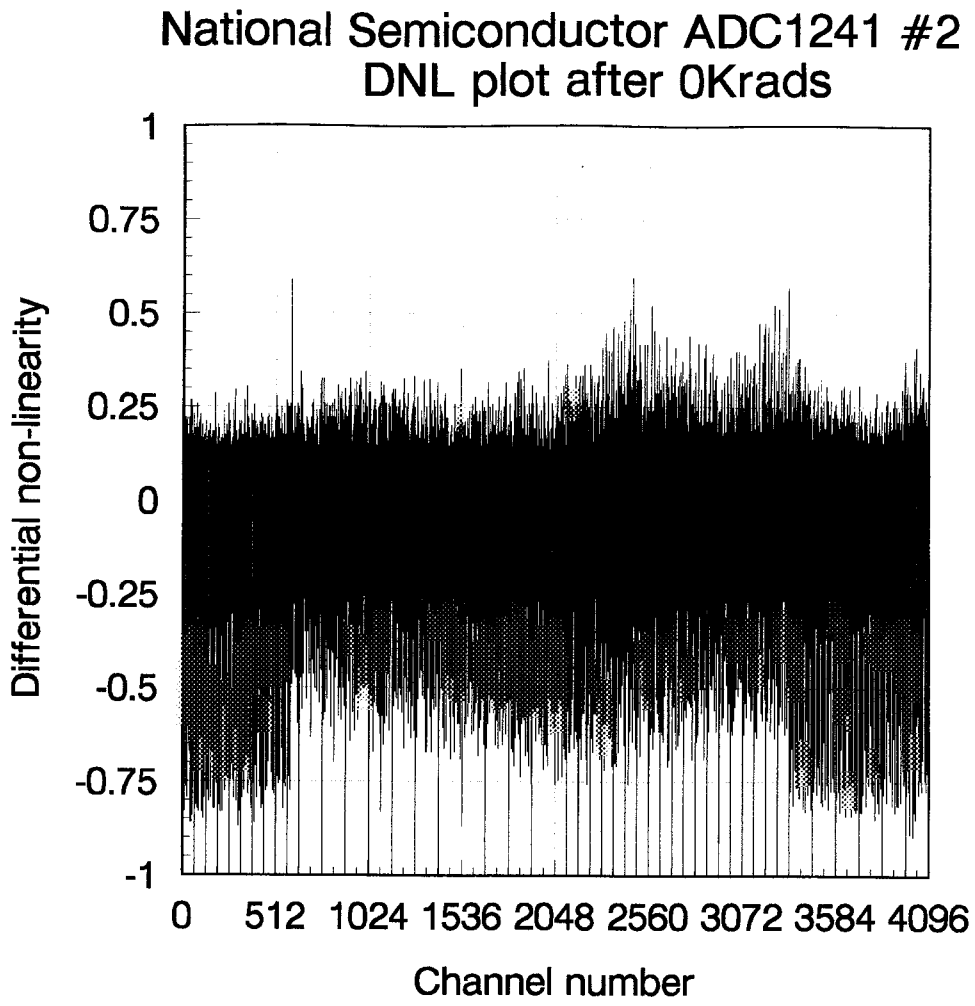

Maxim MAX174 #1
INL plot after 10Krads
Integral non-linearity
(LSB)
0
-2
-4
-6
-8
-10
-12
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

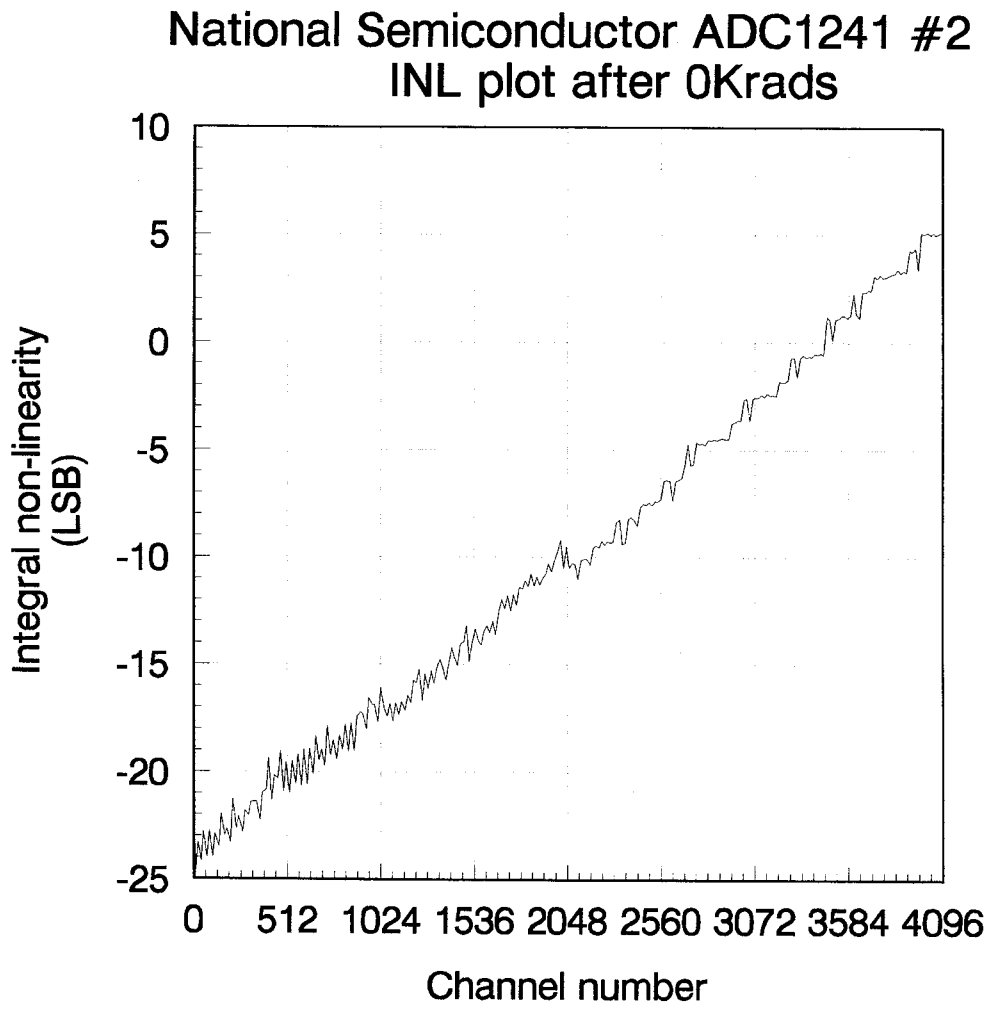

Maxim ADC174 #2
DNL plot after 0Krads
Differential non-linearity
2
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


Maxim MAX174 #2
INL plot after 0Krads
Integral non-linearity
(LSB)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

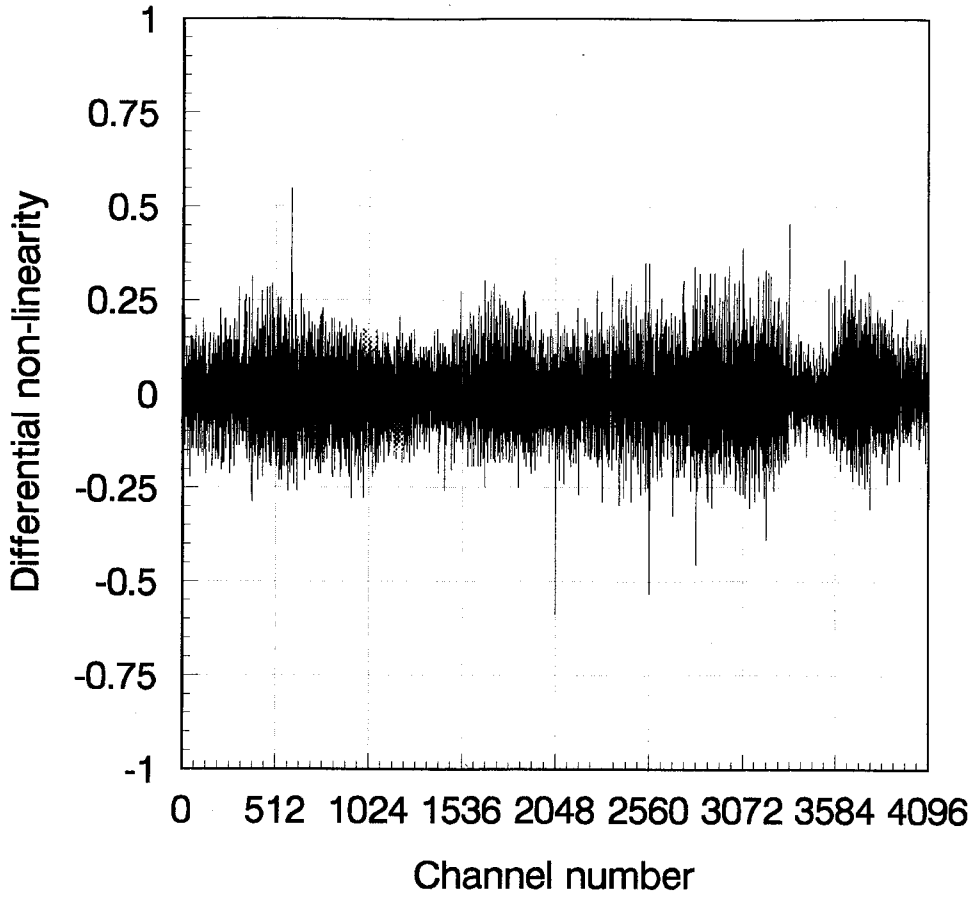

Maxim MAX174 #2
DNL plot after 5Krad
Differential non-linearity
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0 512 1024 1536 2048 2560 3072 3584 4096
Channel number


Maxim Max174 #2
INL plot after 5Krads
Integral non-linearity
(LSB)
0.5
0
-0.5
-1
-1.5
-2
0 512 1024 1536 2048 2560 3072 3584 4096
Channel number

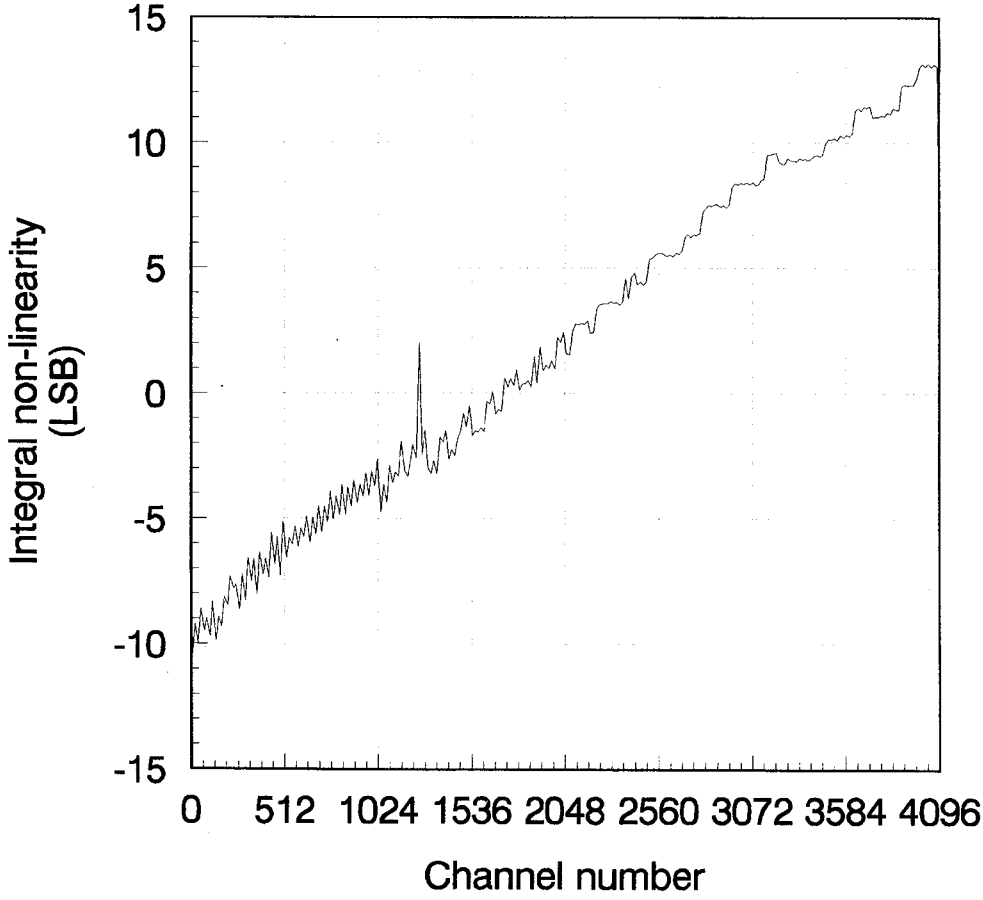

National Semiconductor ADC1241 #2
DNL plot after 0Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

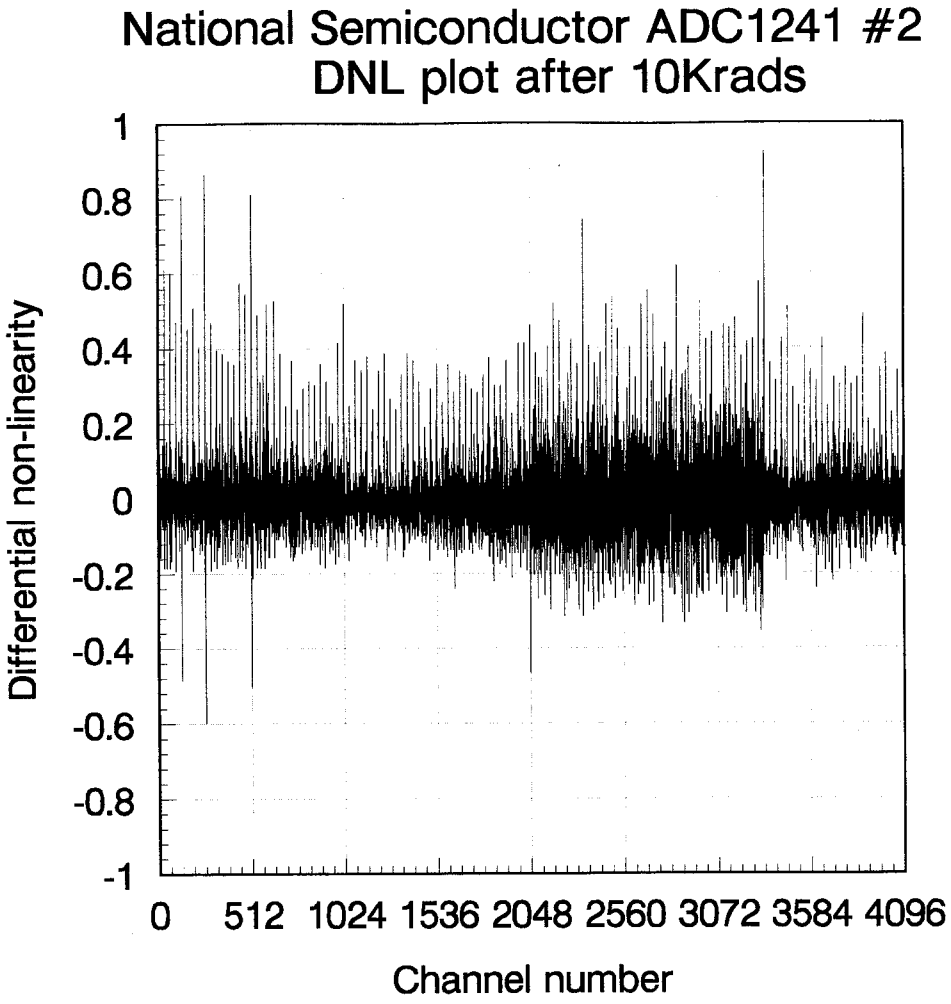

National Semiconductor ADC1241 #2
INL plot after 0Krads
Integral non-linearity
(LSB)
10
5
0
-5
-10
-15
-20
-25
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

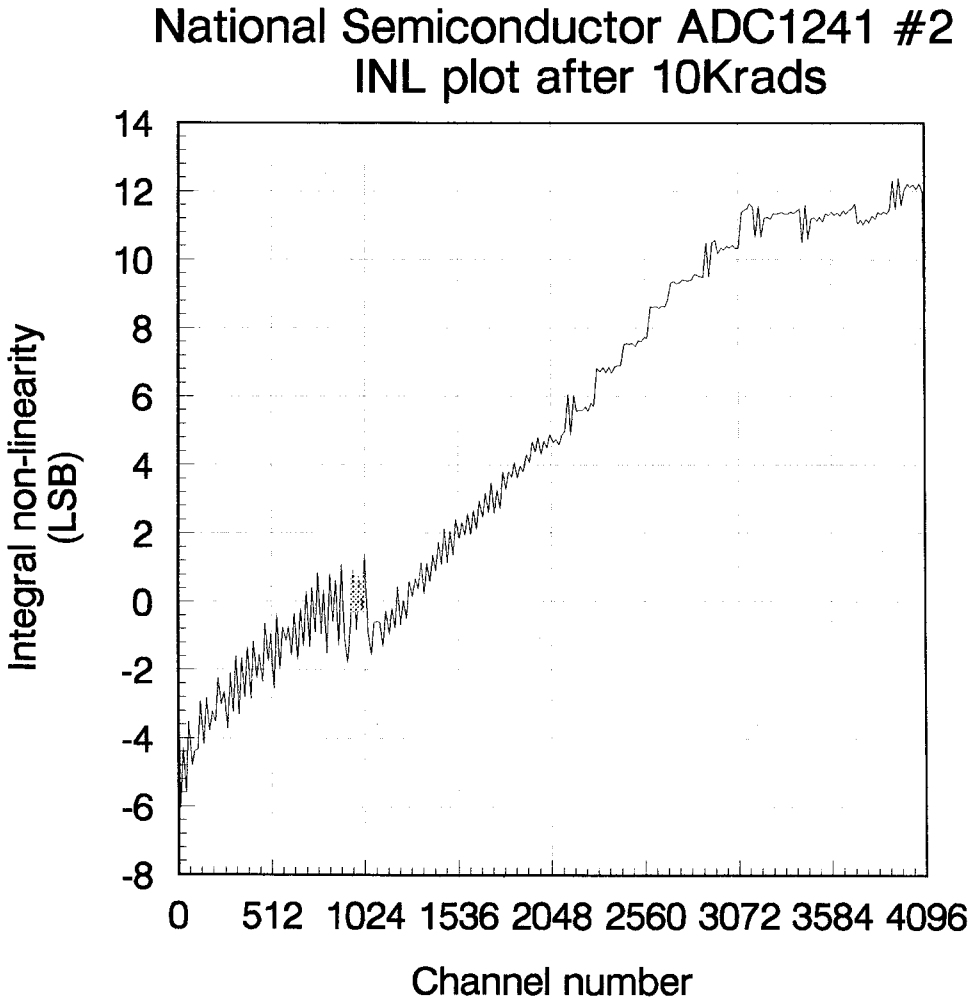
National Semiconductor ADC1241 #2
DNL plot after 5Krads

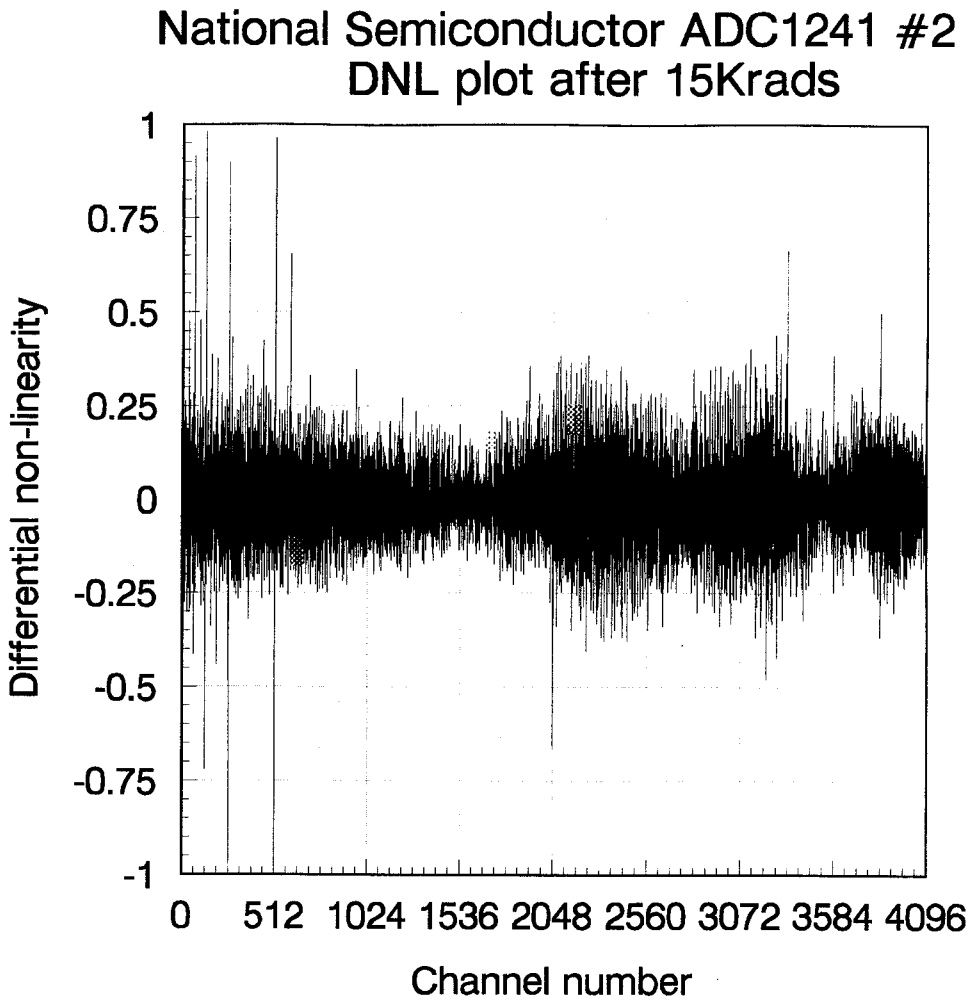


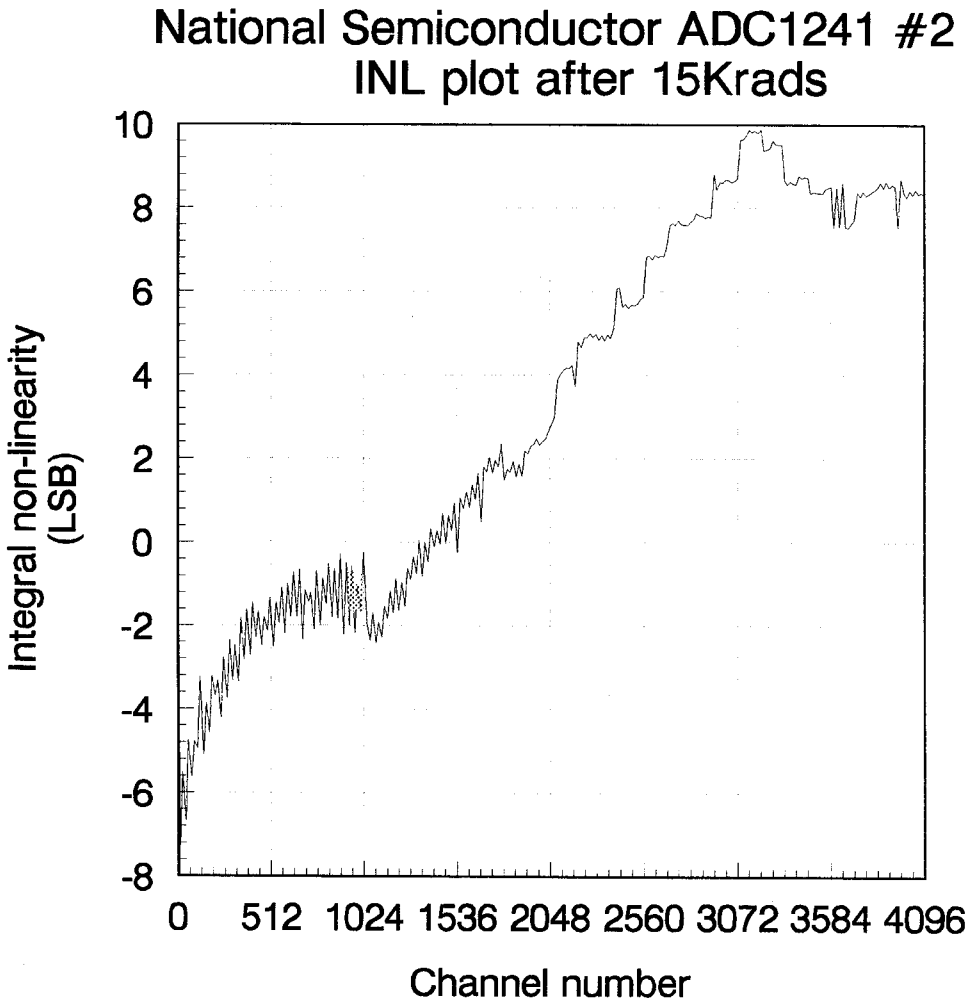
National Semiconductor ADC1241 #2
INL plot after 5Krads



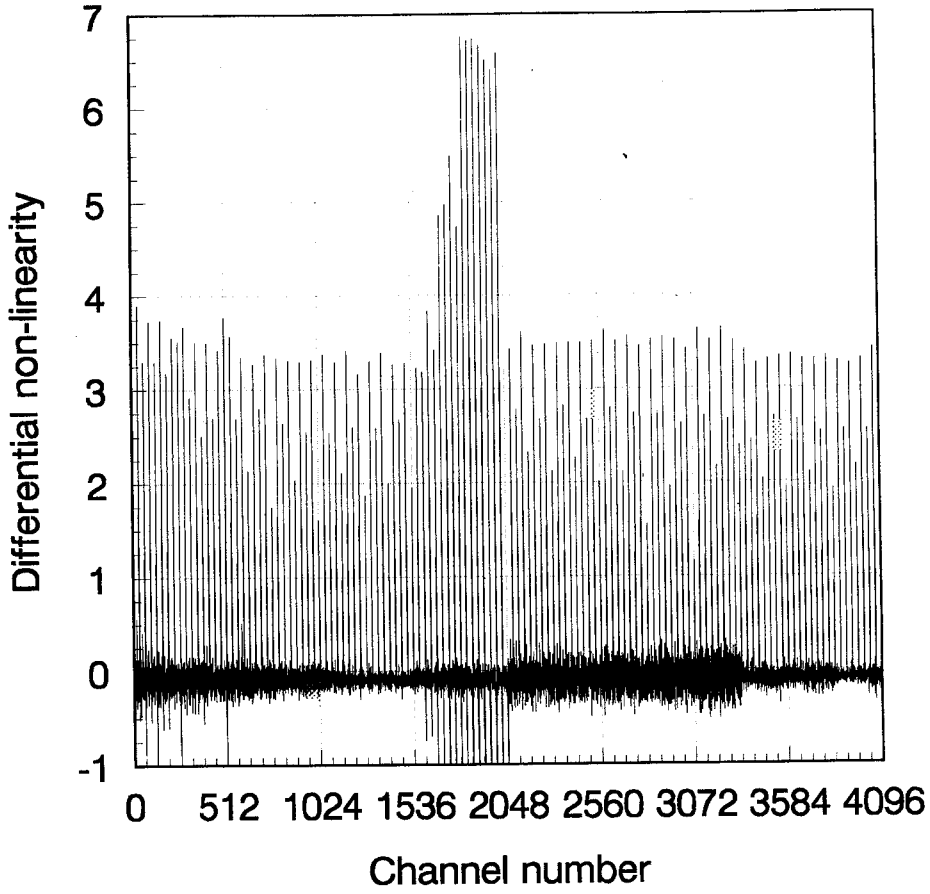

National Semiconductor ADC1241 #2
DNL plot after 10Krads
Differential non-linearity
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


National Semiconductor ADC1241 #2
INL plot after 10Krads
Integral non-linearity
(LSB)
14
12
10
8
6
4
2
0
-2
-4
-6
-8
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

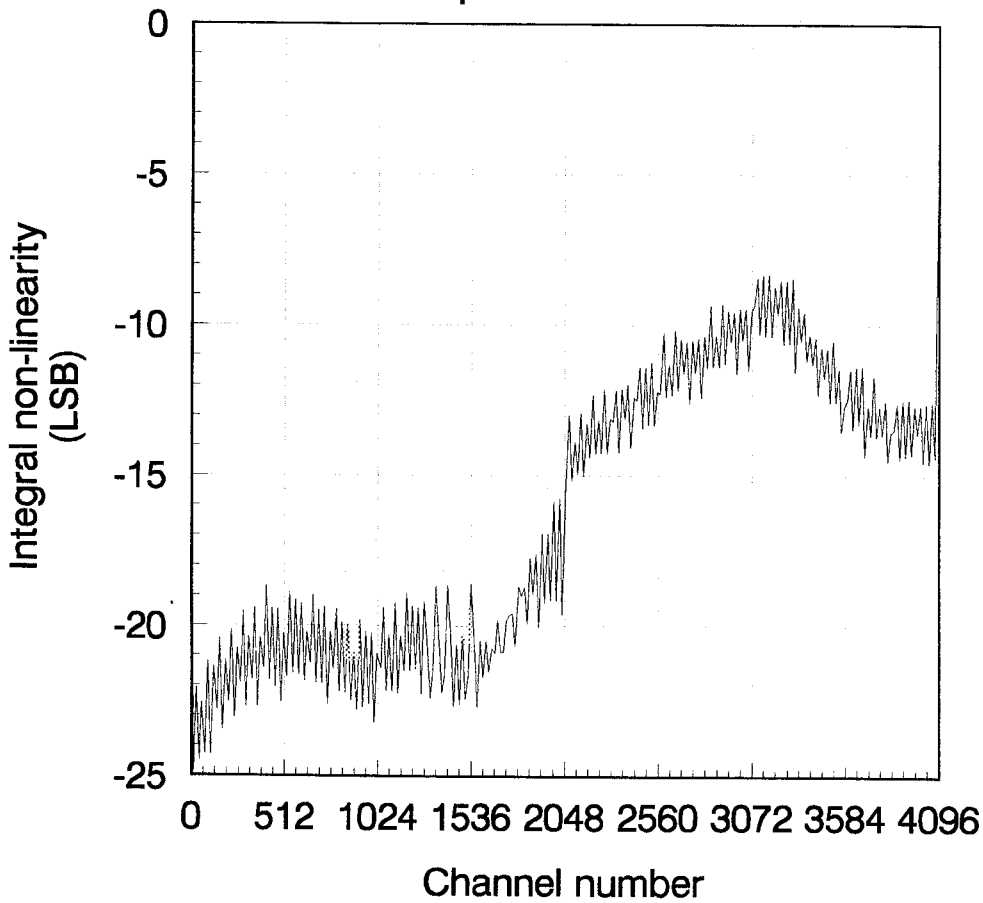

National Semiconductor ADC1241 #2
DNL plot after 15Krads
Differential non-linearity
1
0.75
0.5
0.25
0
-0.25
-0.5
-0.75
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


National Semiconductor ADC1241 #2
INL plot after 15Krads
Integral non-linearity
(LSB)
10
8
6
4
2
0
-2
-4
-6
-8
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number

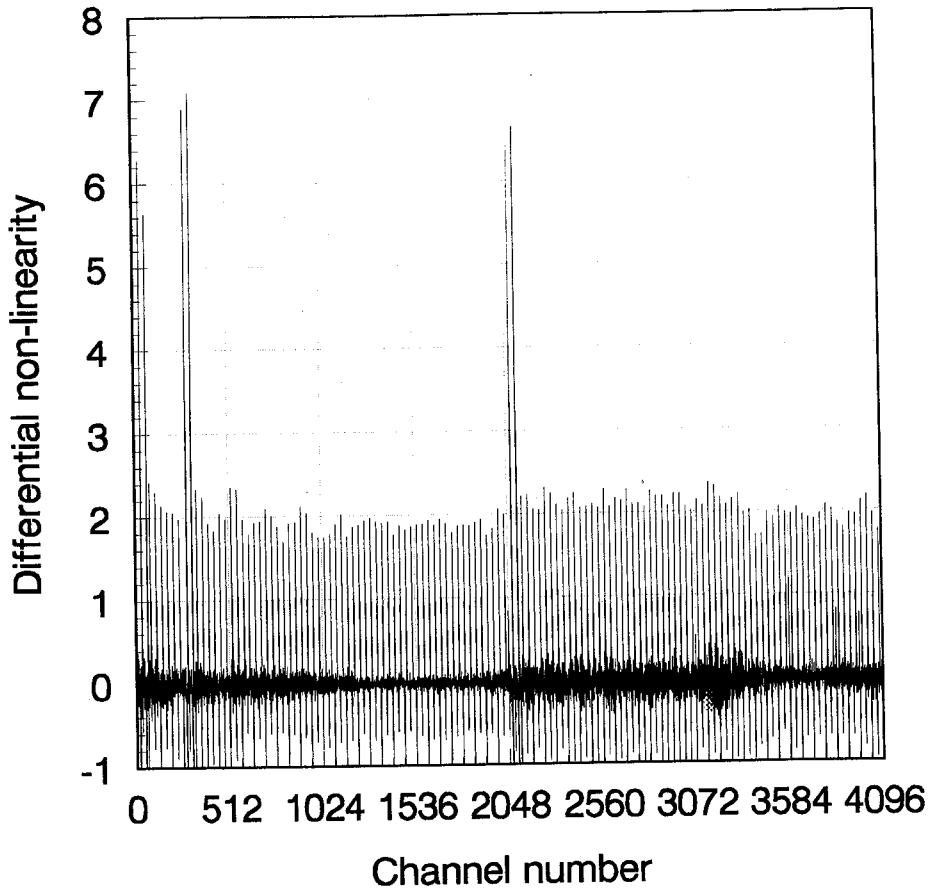
National Semiconductor ADC1241 #2
DNL plot after 20Krads



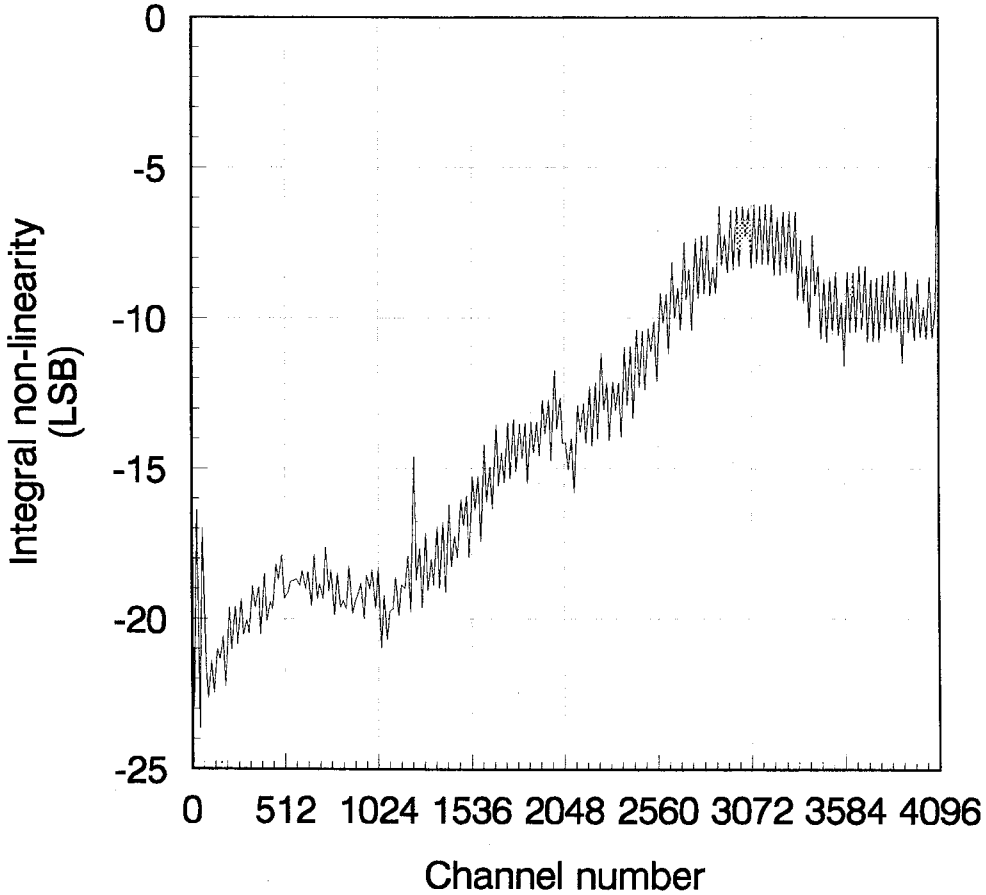
National Semiconductor ADC1241 #2
INL plot after 20Krads



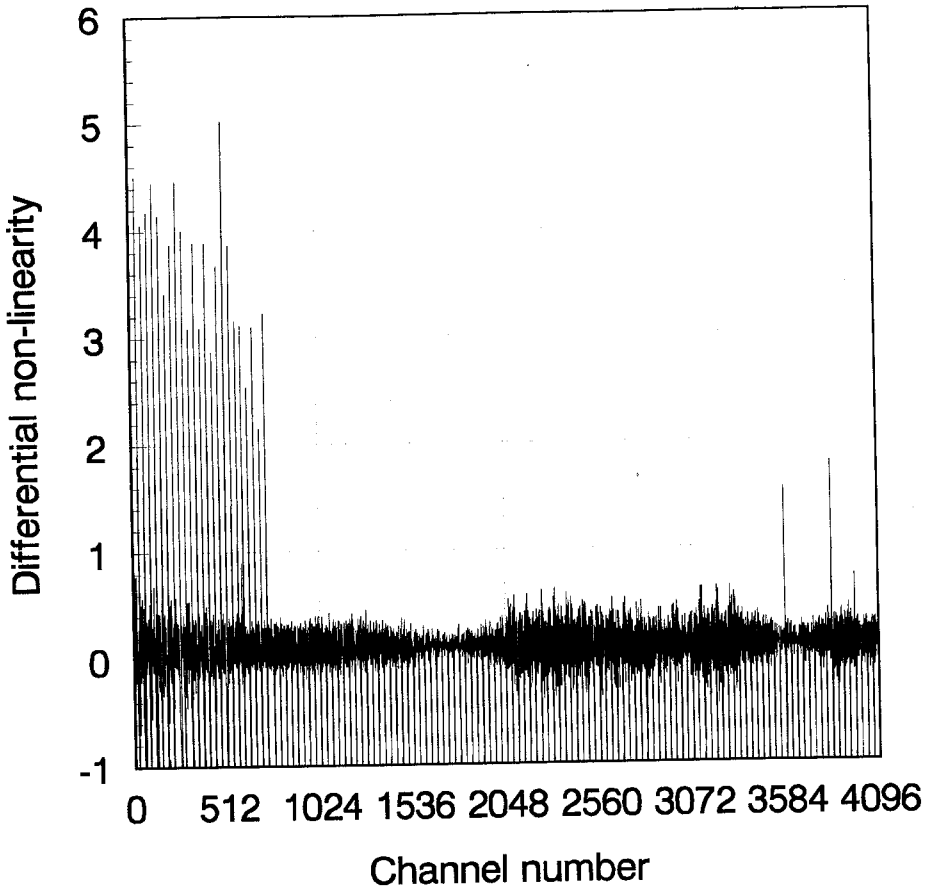
National Semiconductor ADC1241 #2
DNL plot after 25Krads



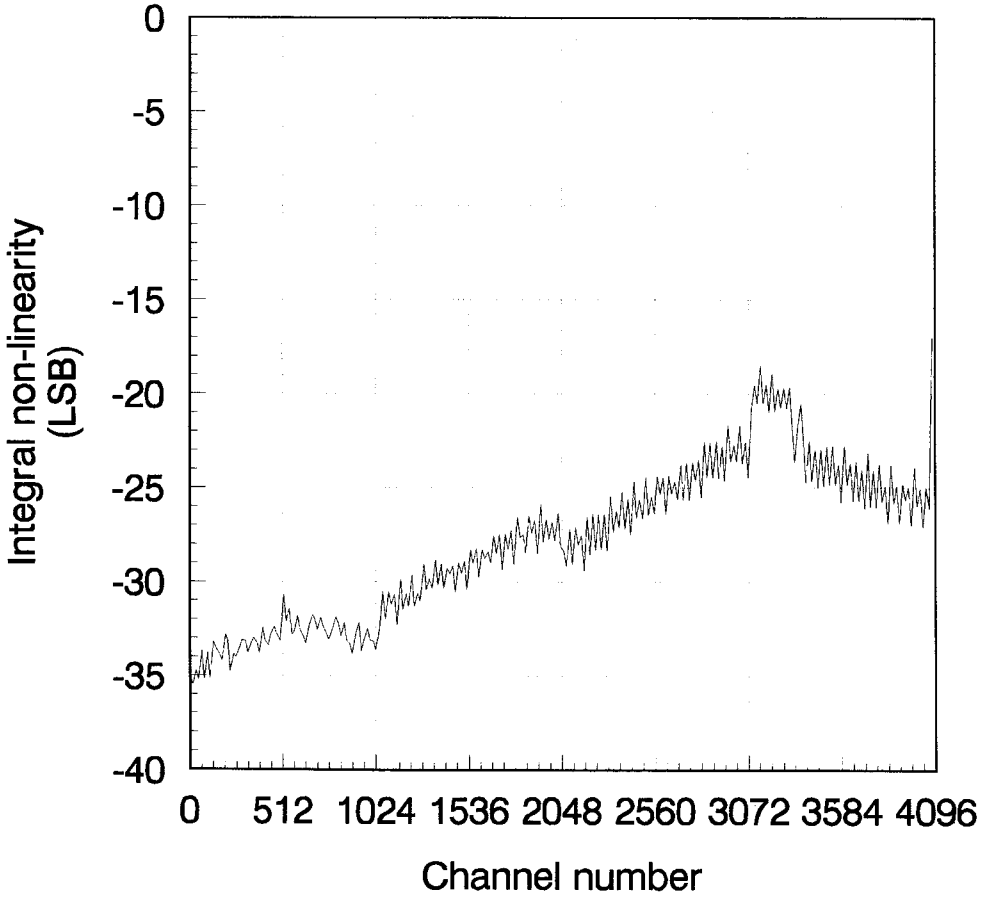
National Semiconductor ADC1241 #2
INL plot after 25Krads



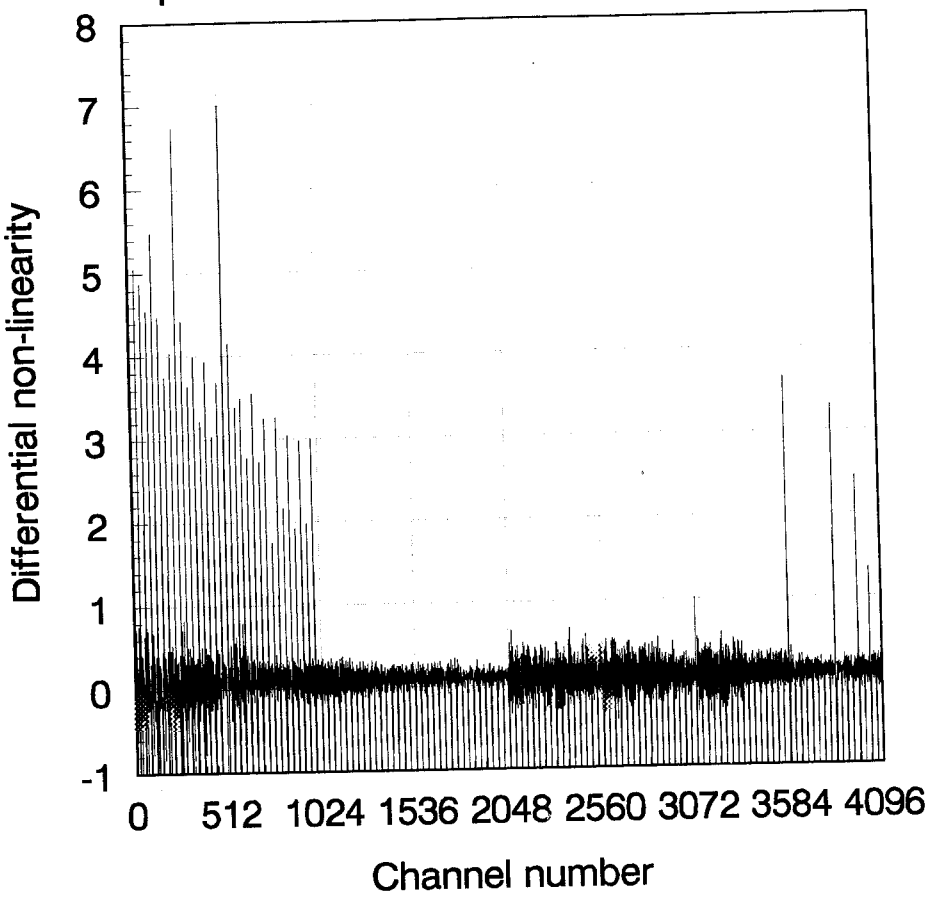
National Semiconductor ADC1241 #2
DNL plot after 30Krads



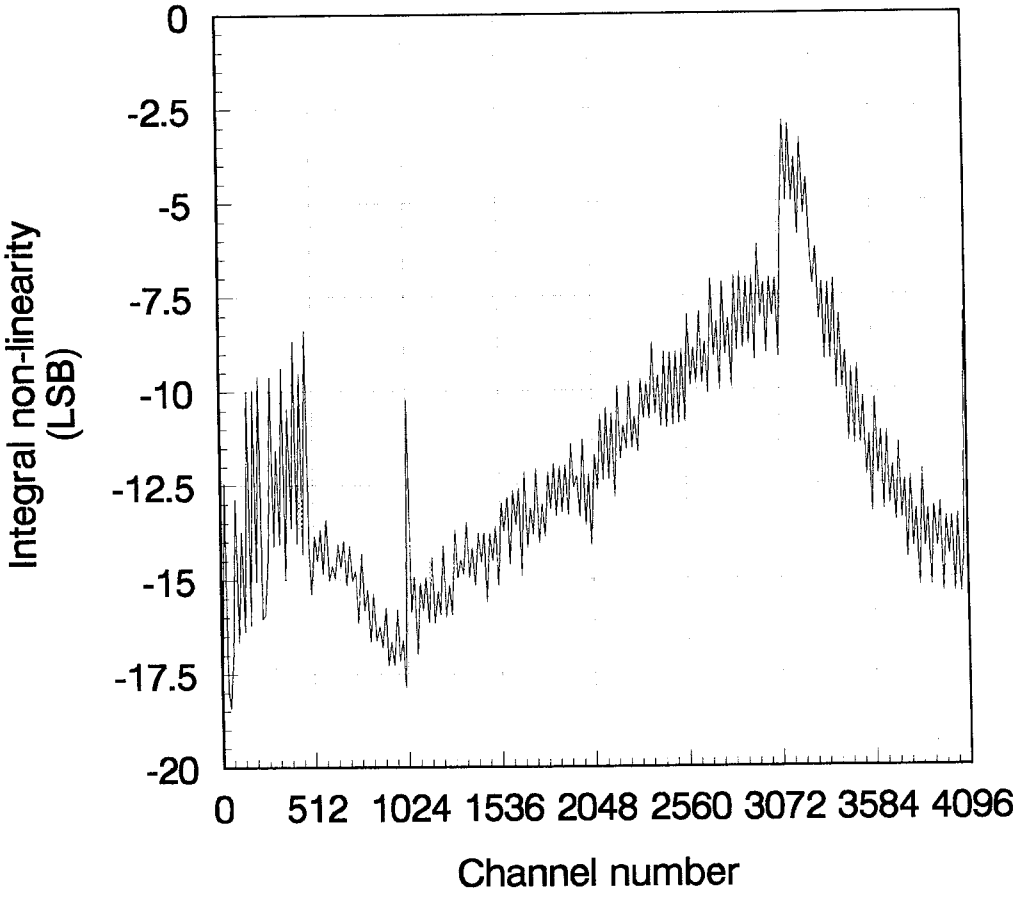
National Semiconductor ADC1241 #2
INL plot after 30Krads

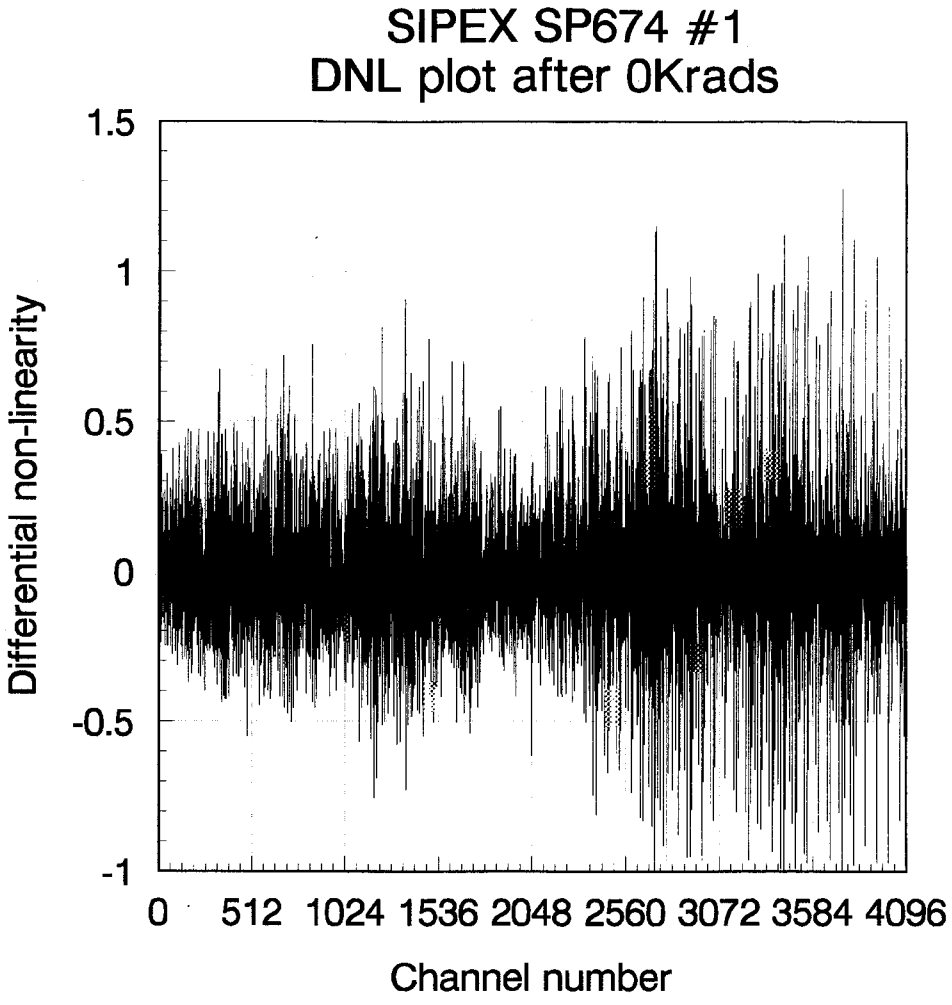


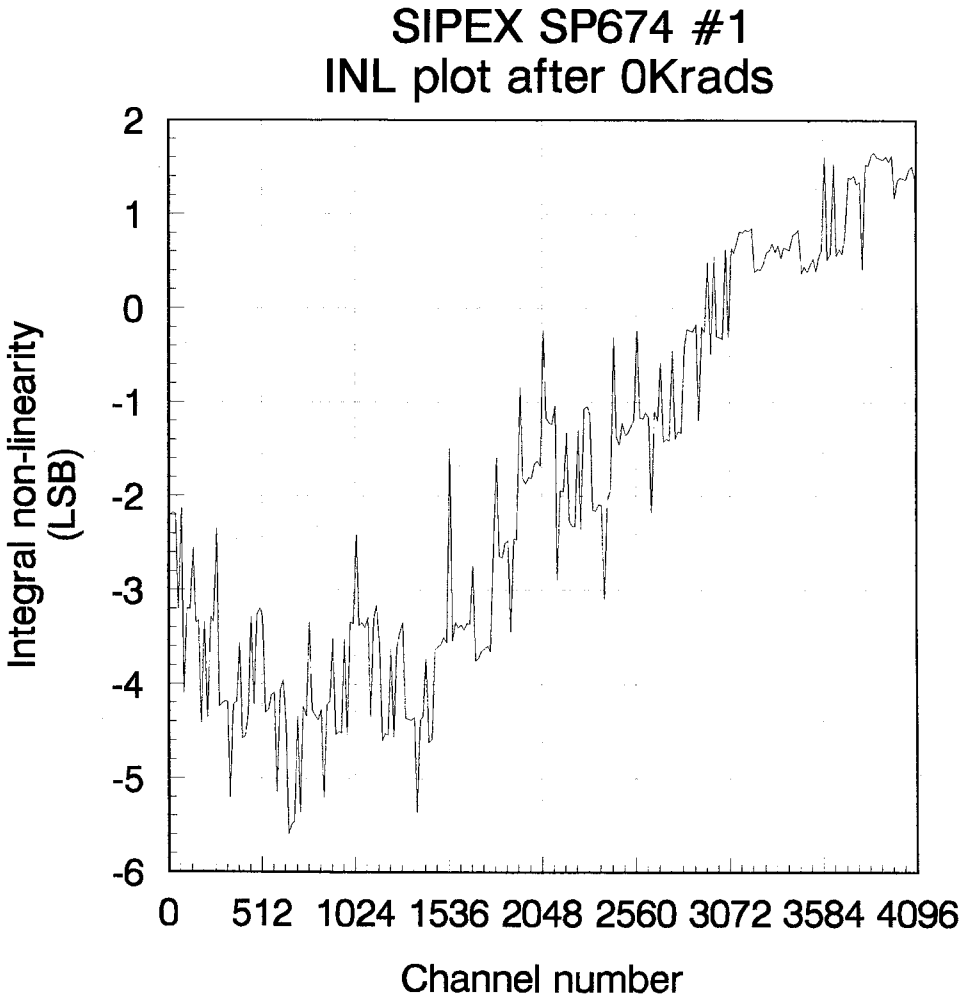
National Semiconductor ADC1241 #2
DNL plot after 40Krads + overnight anneal

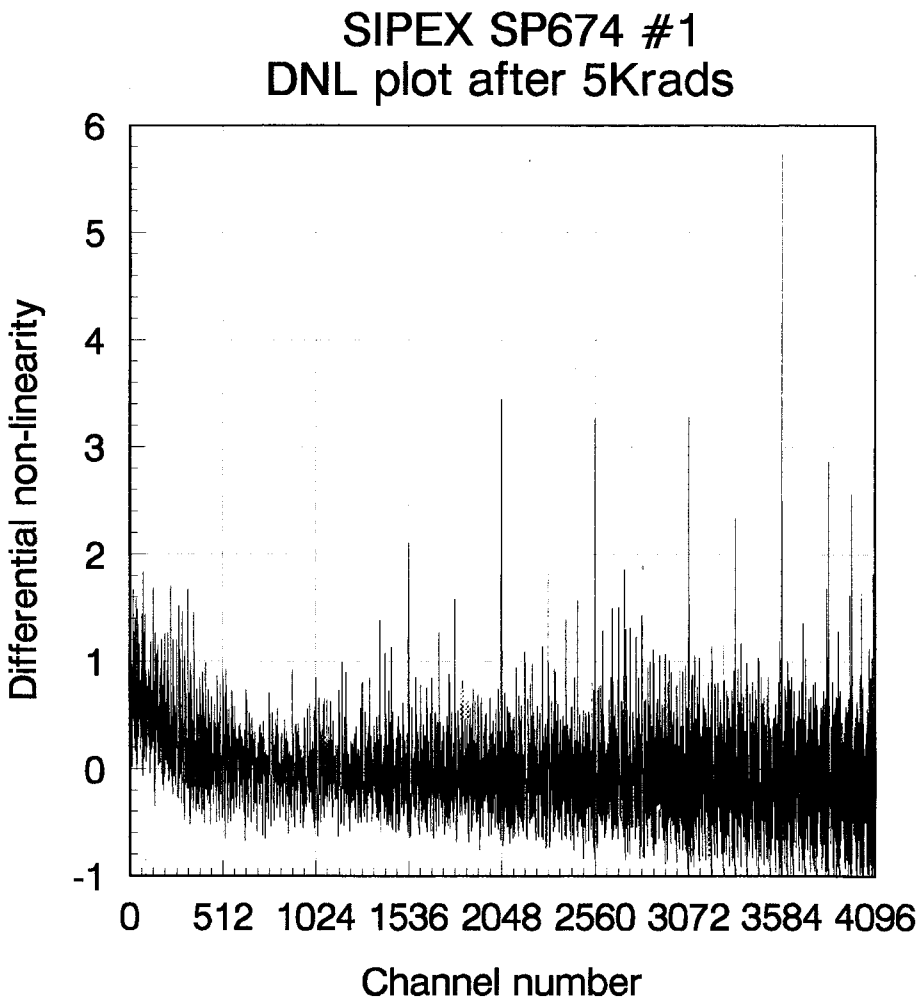


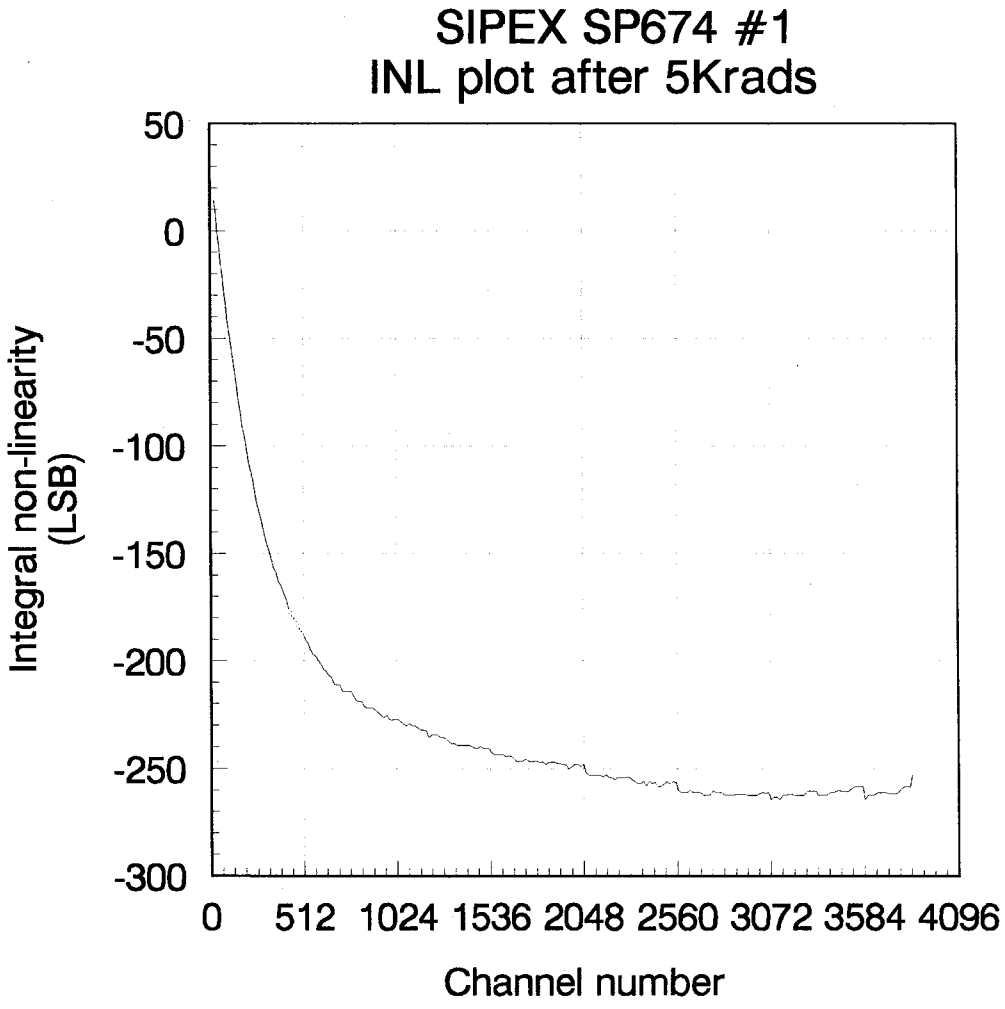
National Semiconductor ADC1241 #2
INL after 40Krads + overnight anneal




SIPEX SP674 #1
DNL plot after 0Krads
Differential non-linearity
1.5
1
0.5
0
-0.5
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


SIPEX SP674 #1
INL plot after 0Krads
Integral non-linearity
(LSB)
2
1
0
-1
-2
-3
-4
-5
-6
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


SIPEX SP674 #1
DNL plot after 5Krads
Differential non-linearity
6
5
4
3
2
1
0
-1
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number


SIPEX SP674 #1
INL plot after 5Krads
Integral non-linearity
(LSB)
50
0
-50
-100
-150
-200
-250
-300
0
512
1024
1536
2048
2560
3072
3584
4096
Channel number