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|-------------------------|-------------------------------------------------------------------------------------------------|
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PL- LFI- OAT- ME- 019

Planck/ LFI: Setup of FM End- To- End
test

21 June 2006

Michele Maris,
Marco Frailis

Index

1. Presentation
2. HW setup
3. Tests

1. Presentation

- This memo is the photographic documentation of the setup for the End-To-End tests performed at Alcatel/ Alenia – Milano from 13 June 2006 to 15 June 2006.
- See PL- LFI- ME- 018 for a quick account.

The FM/AVM REBA

CRISA H - P SPU/REBA

SPU
The hardware will be
supported by the
host system (REBA)
in which the hardware

SPU
The hardware will be
supported by the
host system (REBA)
in which the hardware

J14

J34

J15

J16

J17

J18

J19

J20

J21

J22

J23

EW-2-3



The FM/ AVM REBA

CRISA

H-P SPU/REBA

AvM - SPU

C.I. No : N / 16 / 01

ABCL :

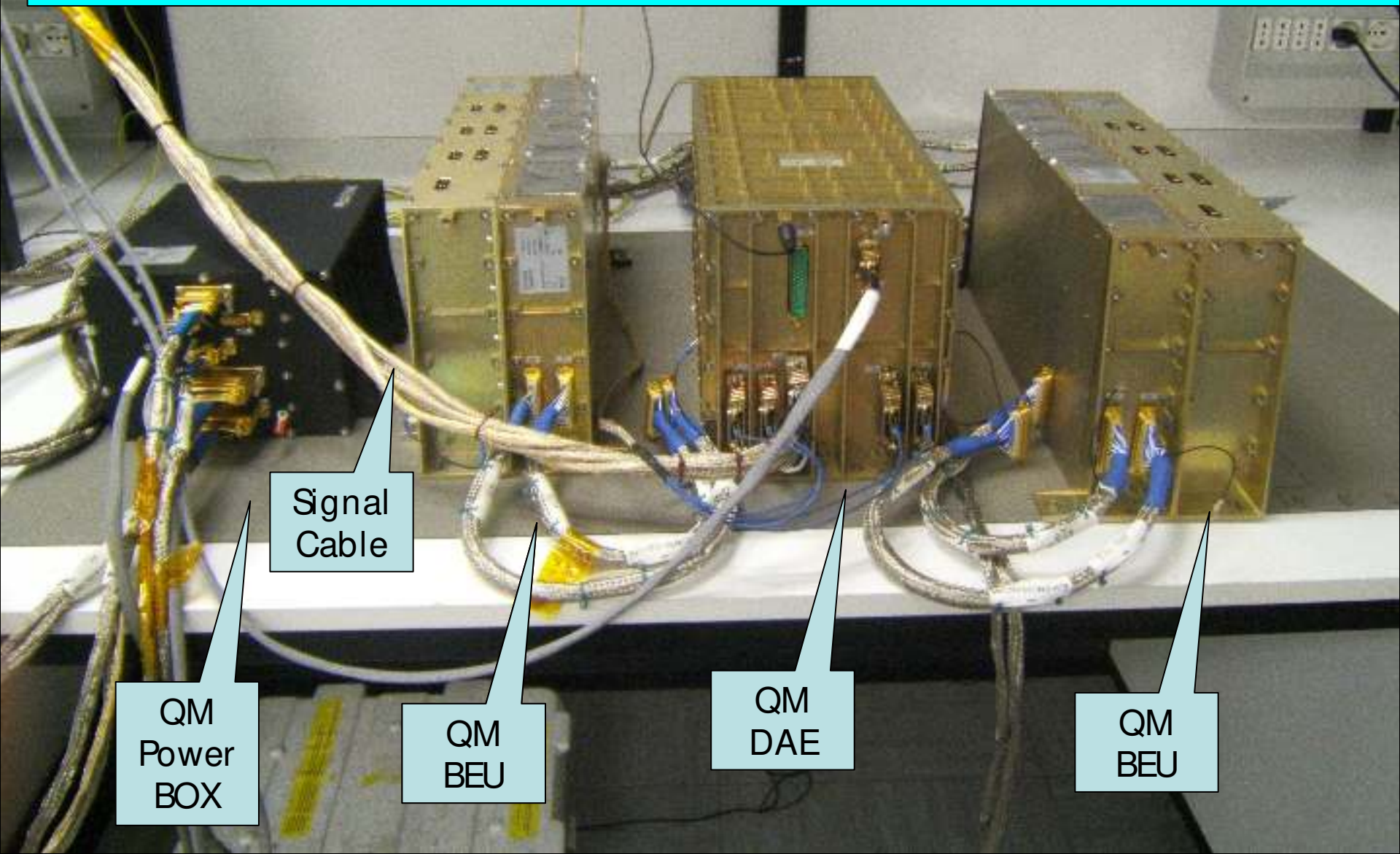
P/N :

S/N :

02

The QM HW With cabling

Note that cables carries to all the inputs of DAE the same signal, also the DAE module only is connected in.



Signal
Cable

QM
Power
BOX

QM
BEU

QM
DAE

QM
BEU

The QM Power Box

LABEN

| | |
|-----------|---------------|
| PROGRAM: | PLANCK LFI |
| EQUIPMENT | DAE POWER BOX |
| P. N. | 740800115-01B |
| S.N. | 001 |
| MODEL | QM |

The QM DAE

| | |
|--------------|---------------------|
| PROGRAM: | PLANCK LFI |
| EQUIPMENT | DAE LEFT BEM BOX |
| MANUFACTURER | LABEN |
| P. N. | 740800118-01B |
| S.N. | 001 |
| MODEL | QM |

The QM HW With cabling

| | |
|--------------|--------------------|
| PROGRAM: | PLANCK LFI |
| EQUIPMENT | DAE DAE BEU BOX |
| MANUFACTURER | LABEN |
| P. N. | 740800117-01B |
| S.N. | 001 |
| MODEL | QM |

The QM DAE BEM box

| | |
|--------------|----------------------|
| PROGRAM: | PLANCK LFI |
| EQUIPMENT | DAE RIGHT BEM BOX |
| MANUFACTURER | LABEN |
| P. N. | 740800119-01B |
| S.N. | 001 |
| MODEL | QM |

The QM DAE FEM box

| | |
|--------------|----------------------|
| PROGRAM: | PLANCK LFI |
| EQUIPMENT | DAE RIGHT FEM BOX |
| MANUFACTURER | LABEN |
| P. N. | 740800171-01B |
| S.N. | 001 |
| MODEL | QM |

The 2020 signal generator with signal splitting plug



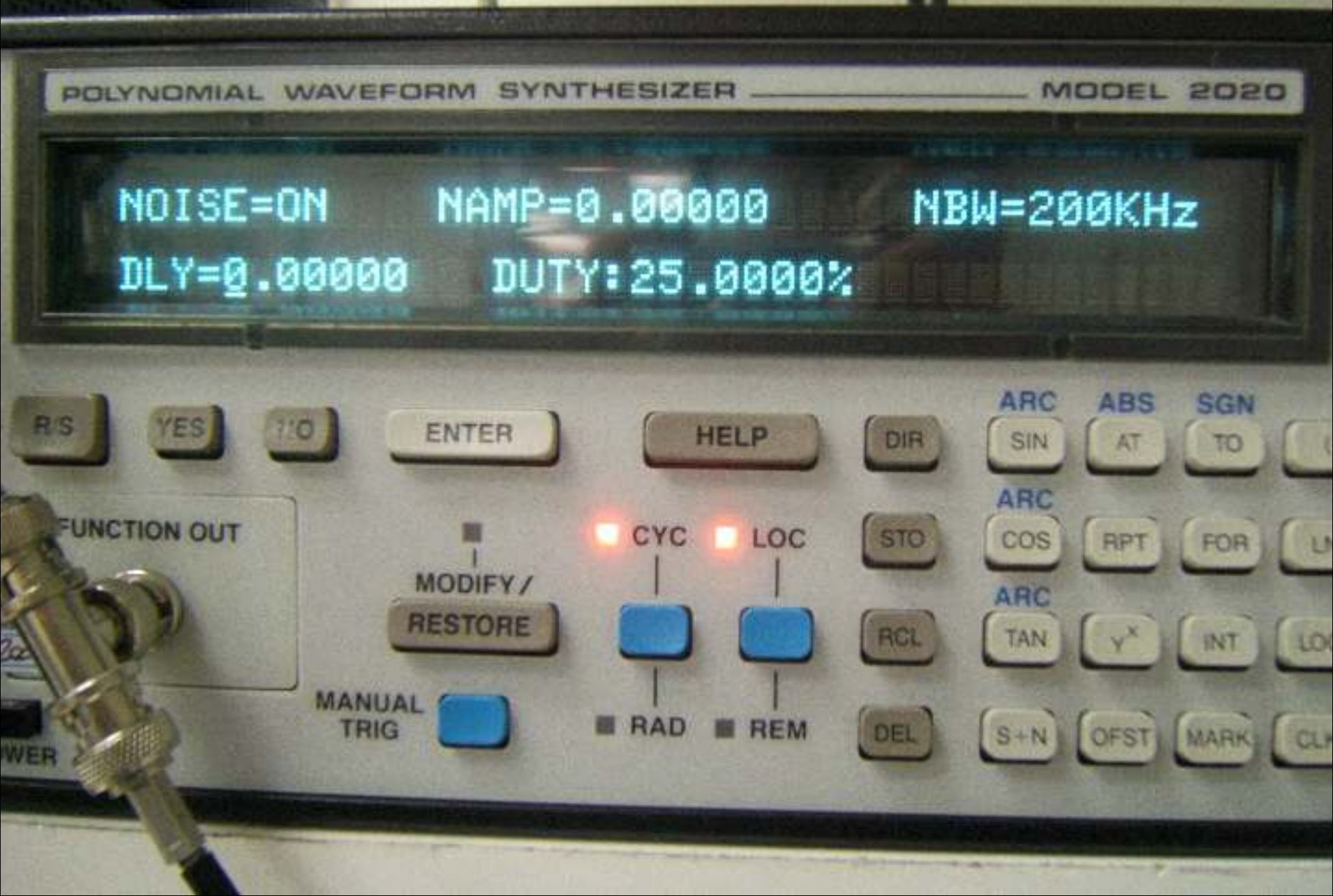
The 2020 signal generator 1ST menu



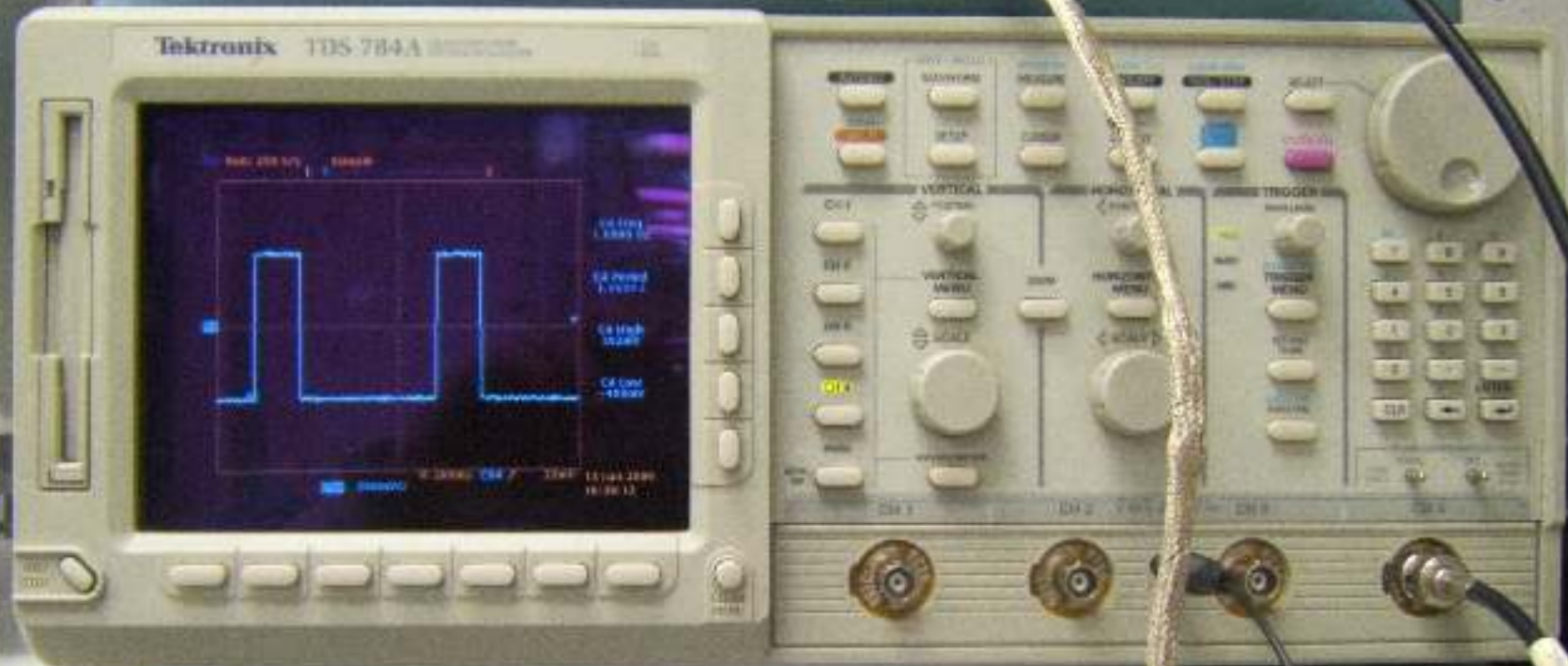
The 2020 signal generator 2nd menu



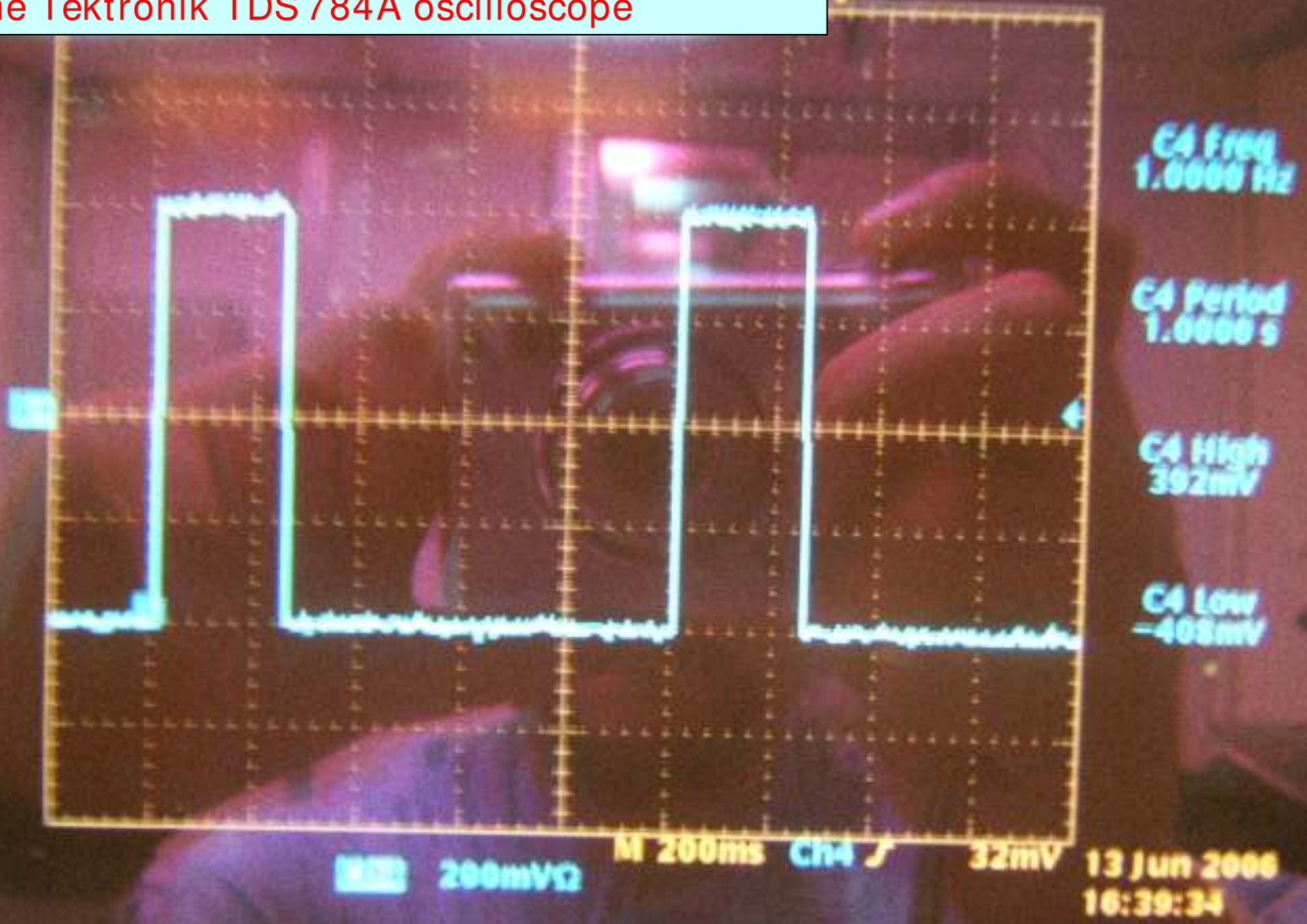
The 2020 signal generator 3rd menu



The Tektronik TDS 784A oscilloscope



The Tektronik TDS 784A oscilloscope



The Tektronik TDS 784A oscilloscope Setup

Signal splitter

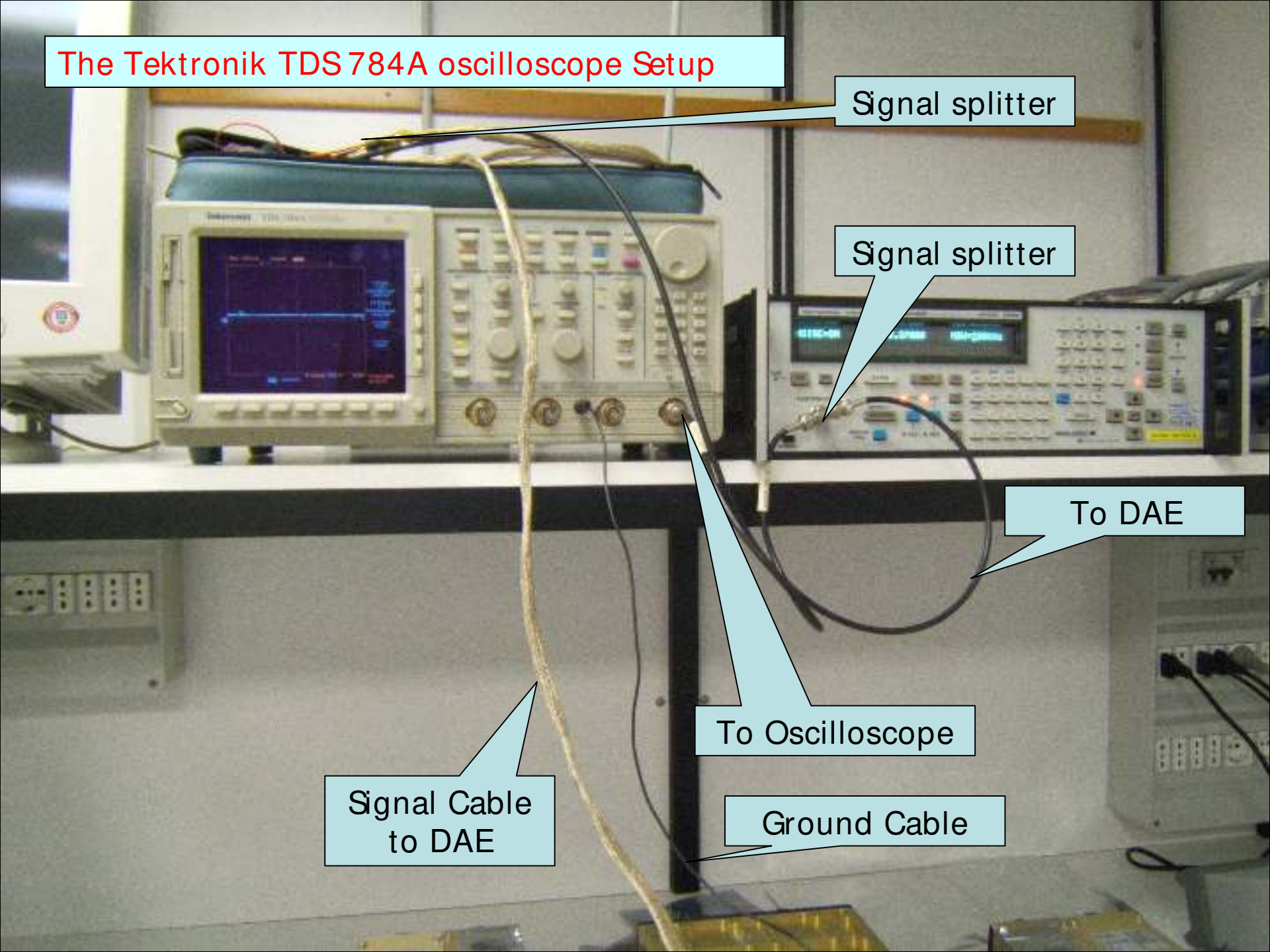
Signal splitter

To DAE

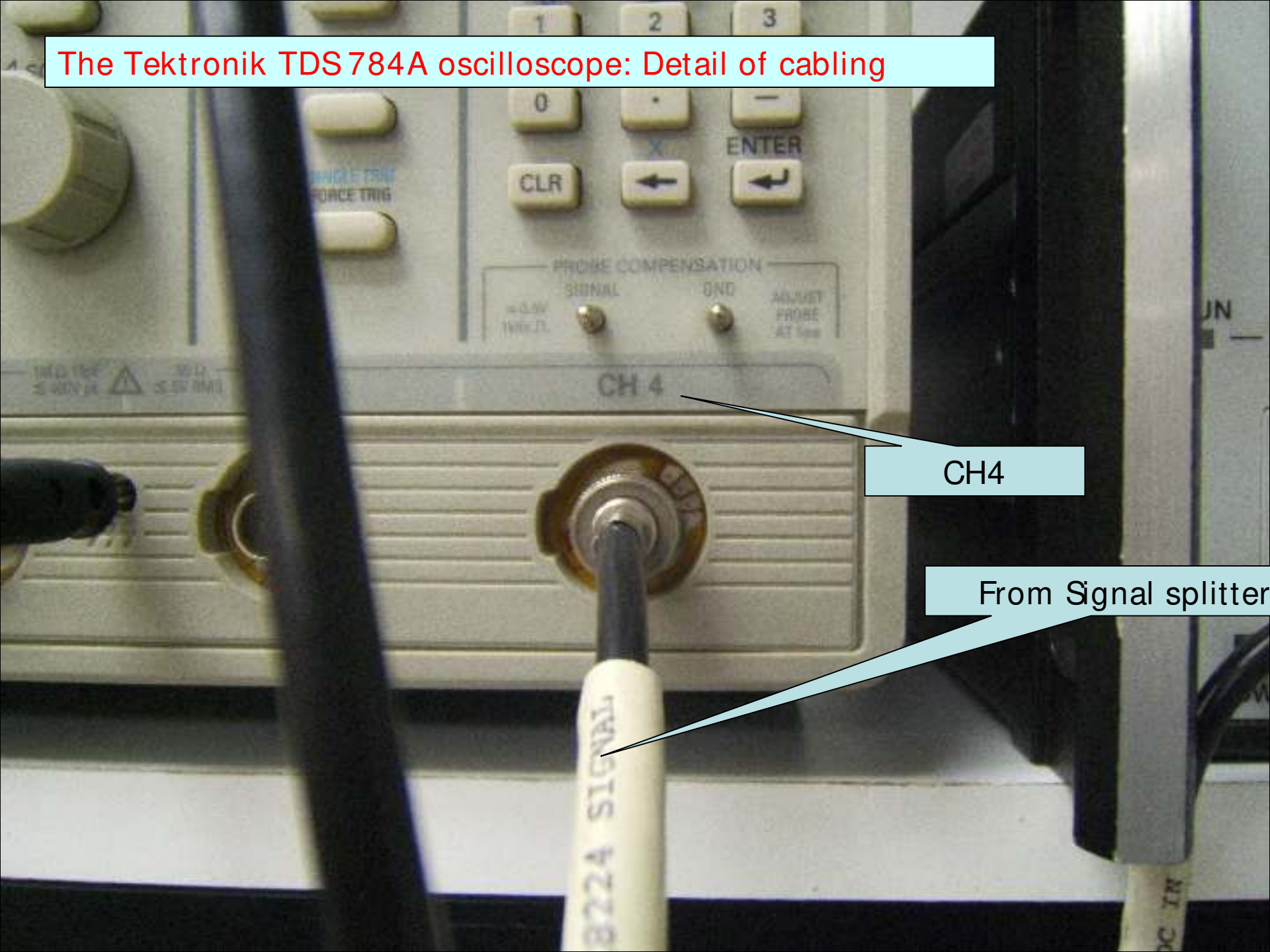
To Oscilloscope

Ground Cable

Signal Cable
to DAE



The Tektronik TDS 784A oscilloscope: Detail of cabling



CH4

From Signal splitter

8224 SIGNAL

3 Tests

- XXX_9103
- XXX_9105
- XXX_9106
- XXX_9108
- XXX_9111
- XXX_9113
- XXX_9114
- XXX_9115

XXX_9103

- Square Wave

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 299.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

RT

YES

NO

ENTER

HELP

ON

ARC

SIN

ABS

AT

SGN

TO

1

2

3

4

5

6

7

8

9

0

EE

+

FUNCTION OUT

CYC

LOC

STO

SRL

COS

RPT

TCR

1

2

3

4

5

6

7

8

9

0

EE

+

RESTORE

RCL

ARC

TAN

y*

INT

LOG

1

2

3

4

5

6

7

8

9

0

EE

+

SPACE

▲

▼

▶

◀

FORMAT

↑

SELECT

↓

FIELD

NOISE

LABKIT 100
ANALOGIC CORPORATION
10000 UNIVERSITY AVENUE
DALLAS, TEXAS 75243
APRIL 2007

ANALOGIC

INTEGRAL IRIG VETO TB

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

REFY /

REST

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG

0

REM

RCL

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

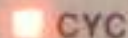
TO

FUNCTION OUT

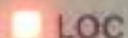


KEY /

RESTORE



CYC



LOC



STO

ARC

COS

RPT

FOR

LN

t

ARC

TAN

y^x

INT

LOG

T

MANUAL
TRIG



REM

DEL

S+N

OFST

MARK

CLK

FILT

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

DUTY: 25.0000%

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE



RCL

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



REM

DEL

S+N

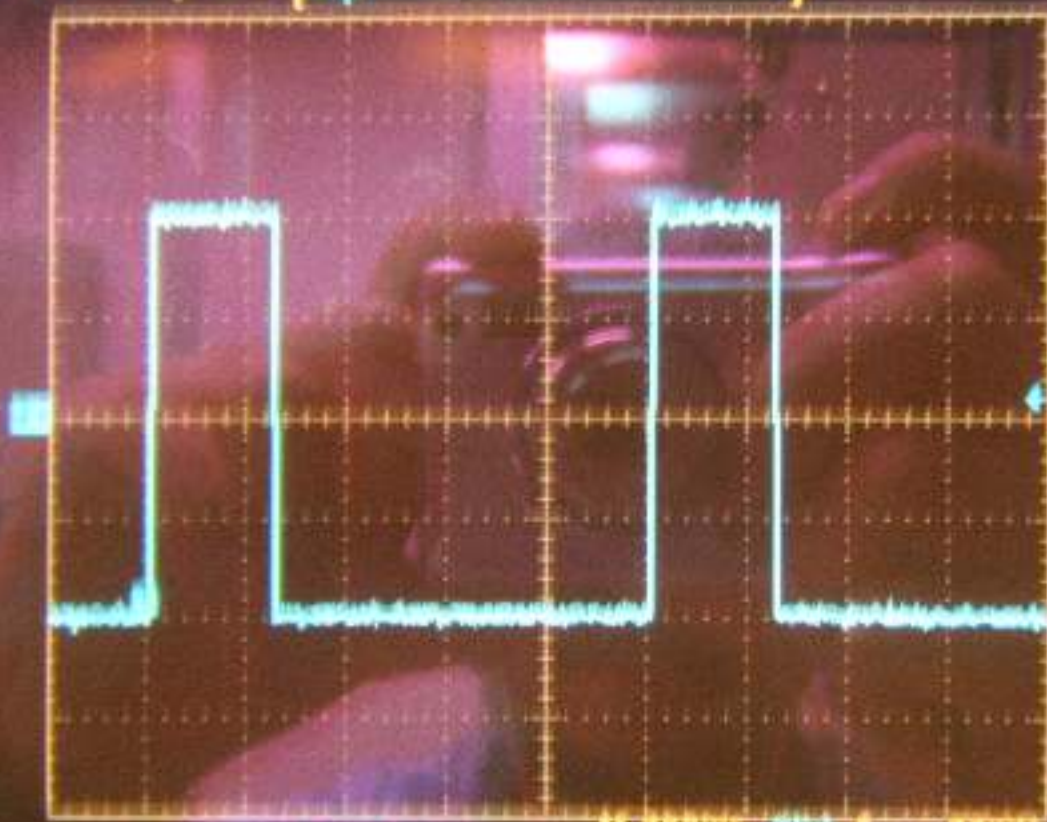
OFST

MARK

CLK

POWER

Tek Run: 250 S/s Sample



C4 freq
1.0000 Hz

C4 Period
1.0000 s

C4 High
392mV

C4 Low
-408mV

200mV

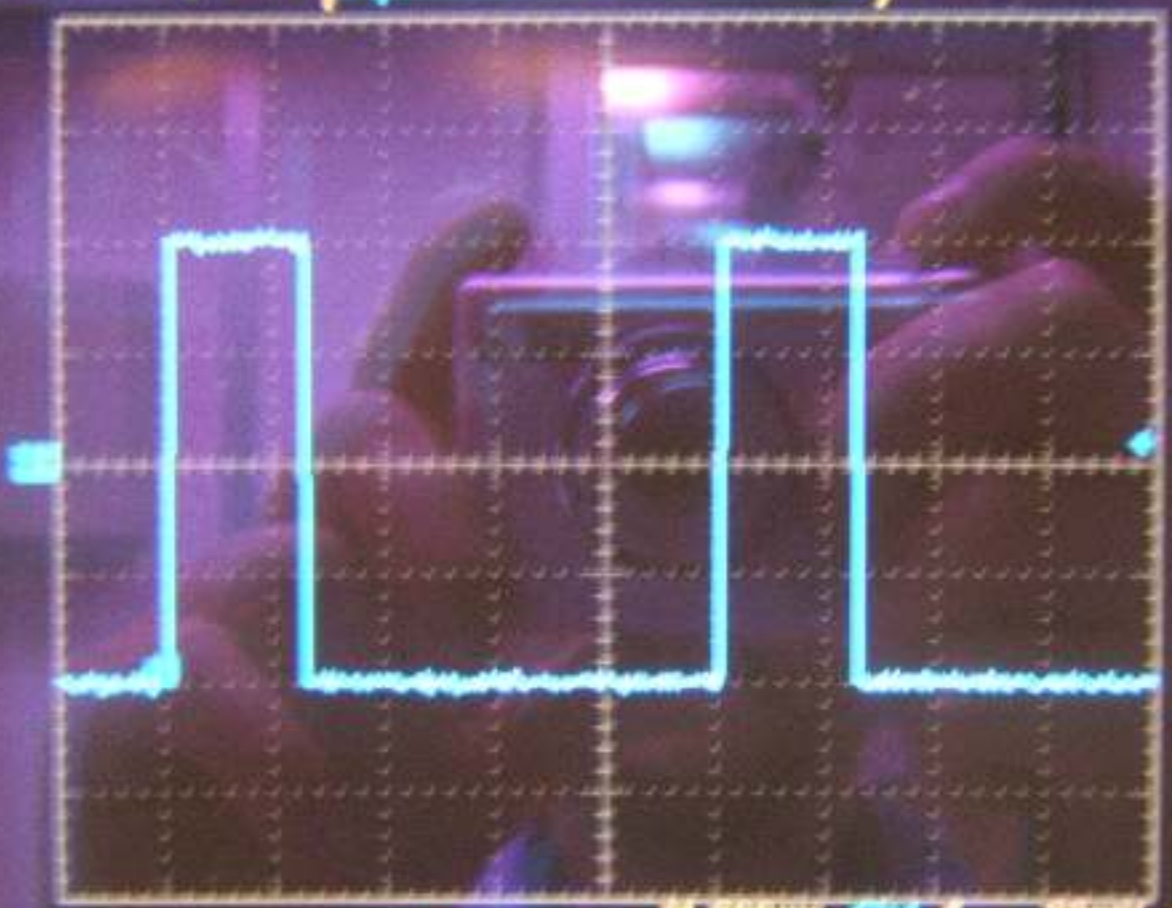
M 200ms CH4

32mV

14 Jun 2006
00:58:11

Run: 250 S/s

Sample (200ns)



C4 Freq
1.000 Hz

C4 Period
1.000 s

C4 High
302mV

C4 Low
-402mV

200mV

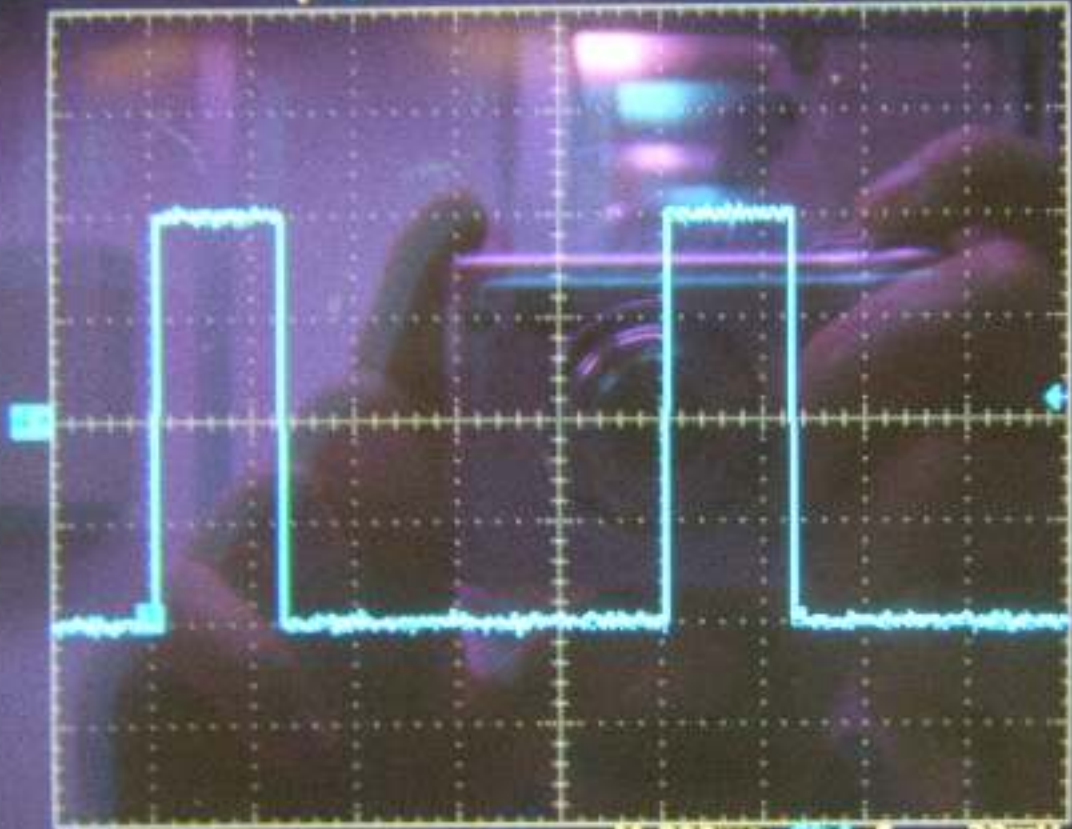
M 200ms CH4 J

32mV

14 Jun 2006
09:58:17

Tek Run: 250 S/s

Sample



C4 Freq
1.0000 Hz

C4 Period
1.0000 s

C4 High
392mV

C4 Low
-408mV

200mV

M 200ms

CH4

32mV

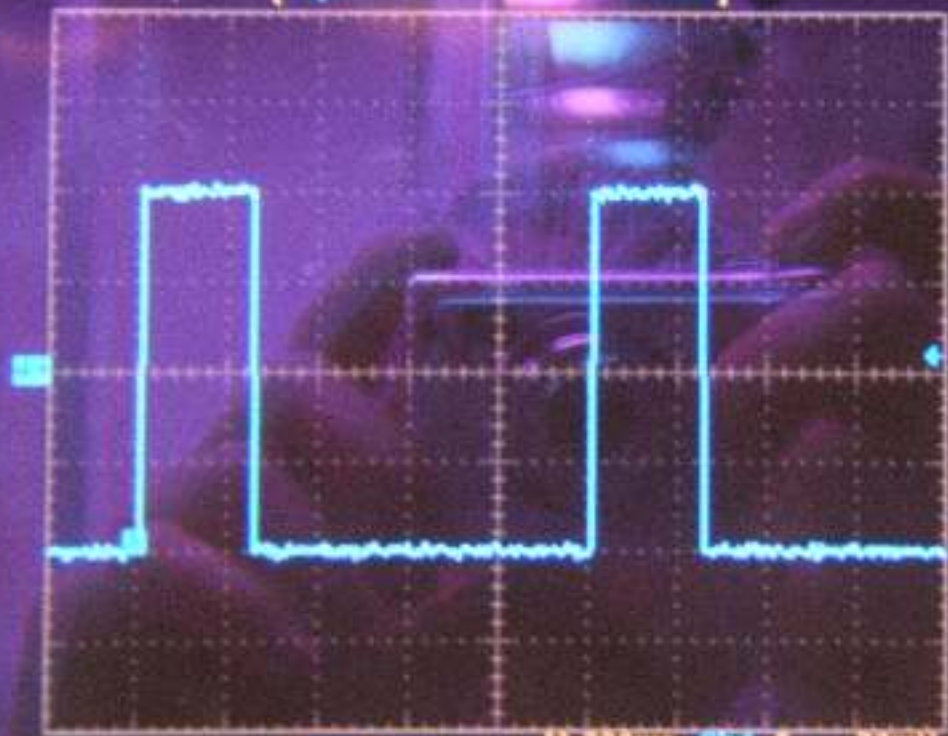
14 Jun 2006

09:58:23

Task Run: 250 S/s

Sample

100ns



C4 Freq
1.0000 Hz

C4 Period
1.0000 s

C4 High
392mV

C4 Low
-405mV

200mV

M 200ms

Ch4

32mV

14 Jun 2006

09:59:12

XXX_9105

- Constant signal
- Square wave
- Triangular Wave
- Sinusoidal wave

XXX_9105

- Constant Signal
- Square wave 1Hz $A=0.4V$, duty = 25%
- Triangular wave 1Hz $A=0.4V$ duty = 25%

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 DFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

YES

NO

ENTER

HELP

STOP

ARC ABS SGN

SIN COS TAN

LOG LN

EXP

2nd

F

CE

K 1 2 3
M 4 5 6
7 8 9
0

TRIG
+
-
*
/

SPACE
FAST
DOWN

FORMAT

SELECT

FIELD

LANEY
ANALOGIC
INTEGRAL

INTEGRAL 100 VOLT 10

FUNCTION OUT

CYC

LOC

MANUAL TRIG

ANALOGIC

LANEY

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

1

FUNCTION OUT

■

KEY/

■

CYC

■

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE



RCL

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



■

■

REM

DEL

S-N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

UN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE

RCL

ARC

TAN

\sqrt{x}

INT

LOG

MANUAL TRIG

RAD

REM

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE

RCL

ARC

TAN

γ^x

INT

LOG

MANUAL TRIG

RA

REM

DEL

S+N

OFST

MARK

CLK

POWER

Run: 250 S/s Sample



C4 Freq
998.7MHz
Low signal
amplitude

C4 Period
1.0012 s
Low signal
amplitude

C4 High
112mV
Unstable
histogram

C4 Low
-176mV
Unstable
histogram

200mV M 200ms Ch4 J 32mV 14 Jun 2006 10:34:19

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS YES NO ENTER HELP DIR ARC SIN ABS SGN
FUNCTION OUT RESTORE MANUAL TRIG CYC LOC STO RPT FOR LN
RCL TAN Y² INT LOG
DEL S+N OFST MARK CLK

MANUAL TRIG (blue button)
CYC (red light, blue button)
LOC (red light, blue button)
REM (black square)



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY /



CYC



LOC

RESTO



STO

ARC

COS

RPT

FOR

LN

ARC

TAN

Y^x

INT

LOG

MANUAL
TRIG



REM

DEL

S+N

OFST

MARK

CLK

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

PHS=0.00000

SYM=50.0000%

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

RESTORE

RCL

ARC

TAN

Y^X

INT

MANUAL TRIG

REM

DEL

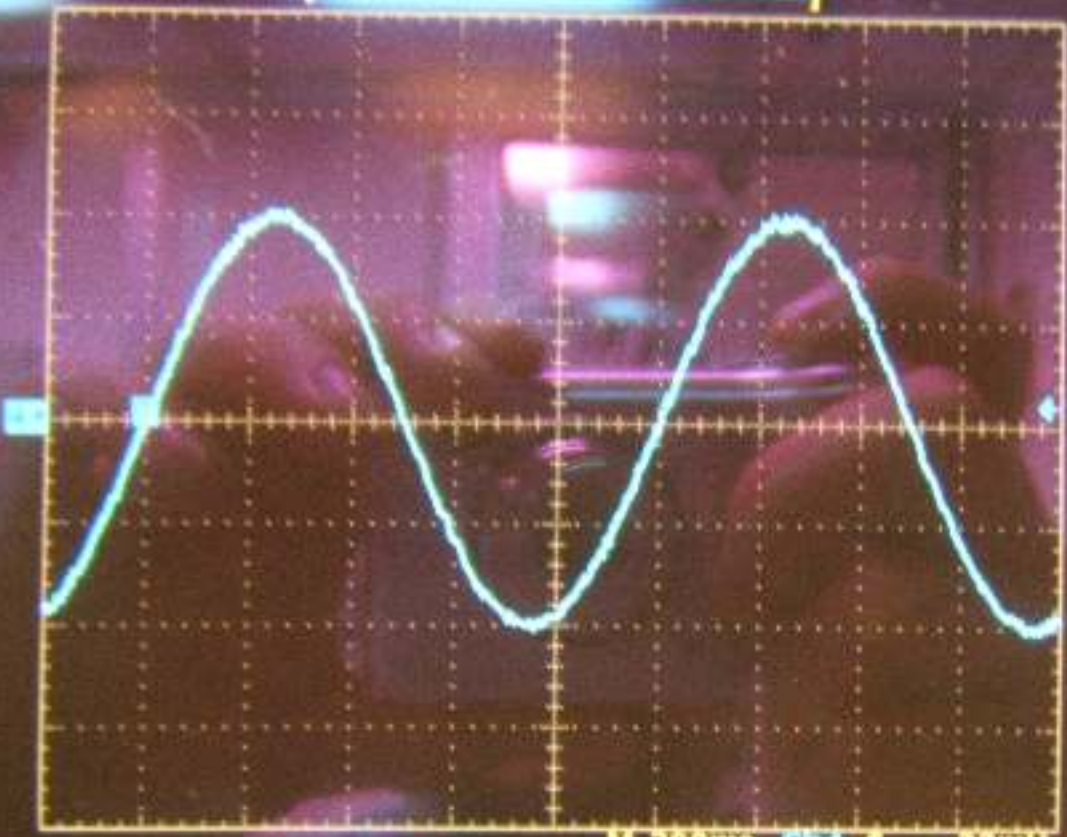
S+N

OFST

MARK

CL

Tek Run: 250 S/s



C4 Freq
1.0005 Hz

C4 Period
999.6ms

C4 High
384mV

C4 Low
-408mV

200mV

M 200ms Ch4 J

32mV

14 Jun 2006
10:57:47

XXX_9106

- Constant Signal
- Square wave

XXX_9106

- Constant Signal
- Square wave 1Hz $A=0.4V$, duty = 25%

I

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

Calculator keypad with function keys: K, M, =, -, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, EE, +, TRIG, IT, F, CE, 2nd, F, CE, SPACE, FAST, INTEGRAL IRIS

Control panel with buttons: RUN, YES, NO, ENTER, HELP, DIR, ARC, ABS, SGN, SIN, AT, TO, COS, RPT, FOR, IN, I, TAN, y^x, INT, LOG, T, DEL, SIN, OFST, MARK, CLK, FILT, MANUAL TRIG, RESTORE, CYC, LOC, REM, POWER, FUNCTION OUT

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000

OFST: 0.00000

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

MODIFY /
REST



CYC



LOC

STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

MANUAL
TRIG



0

REM

RCL

DEL

S-N

OFST

MARK

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

Control panel with buttons: R/S, YES, NO, ENTER, HELP, DIR, ARC SIN, ABS AT, SGN TO, STO, RCL, DEL, ARC COS, RPT, FOR, ARC TAN, Y^x, INT, S+N, OFST, MARK, MANUAL TRIG, CYC, LOC, REM.

POLYNOMIAL WAVEFORM SYNTHESIZER MODEL 202

NOISE=ON NAMP=0.00000 NBW=200KHz
DLY=0.00000 DUTY:25.0000%

FUNCTION OUT

YES NO ENTER HELP DIR ARC SIN ABS SGN
SIN AT TO

MODIFY /

REST

MANUAL TRIG

CYC LOC

STO ARC COS RPT FOR

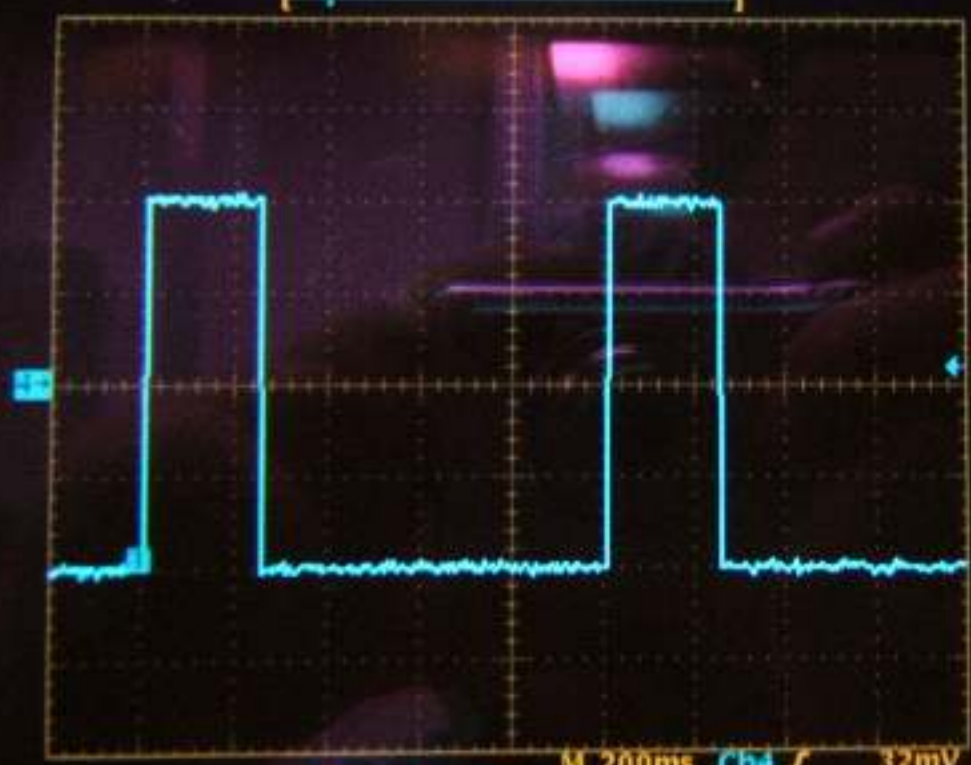
RCL ARC TAN Y^x INT

DEL S+N OFST MARK

REM

Tek Run: 250 S/s

Sample [1000000]



C4 Freq
1.0000 Hz

C4 Period
1.0000 s

C4 High
392mV

C4 Low
-408mV

200mV

M 200ms

Ch4

32mV

14 Jun 2006

11:31:19

XXX_9106

- Triangular wave

XXX_9106

- Constant Signal
- Square wave 1Hz $A=0.4V$, duty = 25%
- Triangular wave 1Hz $A=0.4V$ duty = 25%

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RT YES NO ENTER HELP DIP ARC ABS SGN SIN AT TO I I TRIG TT EE + NOISE

FUNCTION OUT RESTORE **CYC** **LOC** STO ARC COS RPT FOR LN 1 3rd F CLR CE

MANUAL TRIG **MAN** **REM** DEL SIN CFST MARK CLK FILT ANALOGIC

POWER



INTEGR

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000

OFST: 0.00000

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY /



CYC



LOC

RESTORE



STD

ARC

COS

RPT

FOR

LN

ARC

TAN

y^x

INT

LOG

MANUAL TRIG



REM

RCL

DEL

S+N

OFST

MARK

CLK

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK=0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY /



CYC



LOC

STO

ARC

COS

RPT

FOR

RESTORE



RCL

ARC

TAN

Y^x

INT

MANUAL TRIG



REM

DEL

S+N

OFST

MARK

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

FUNCTION OUT

YES NO ENTER HELP DIR ARC ABS SGN SIN AT TO (STO RPT FOR LN RCL TAN Y^x INT LOG DEL S+N OFST MARK CLK

MANUAL TRIG

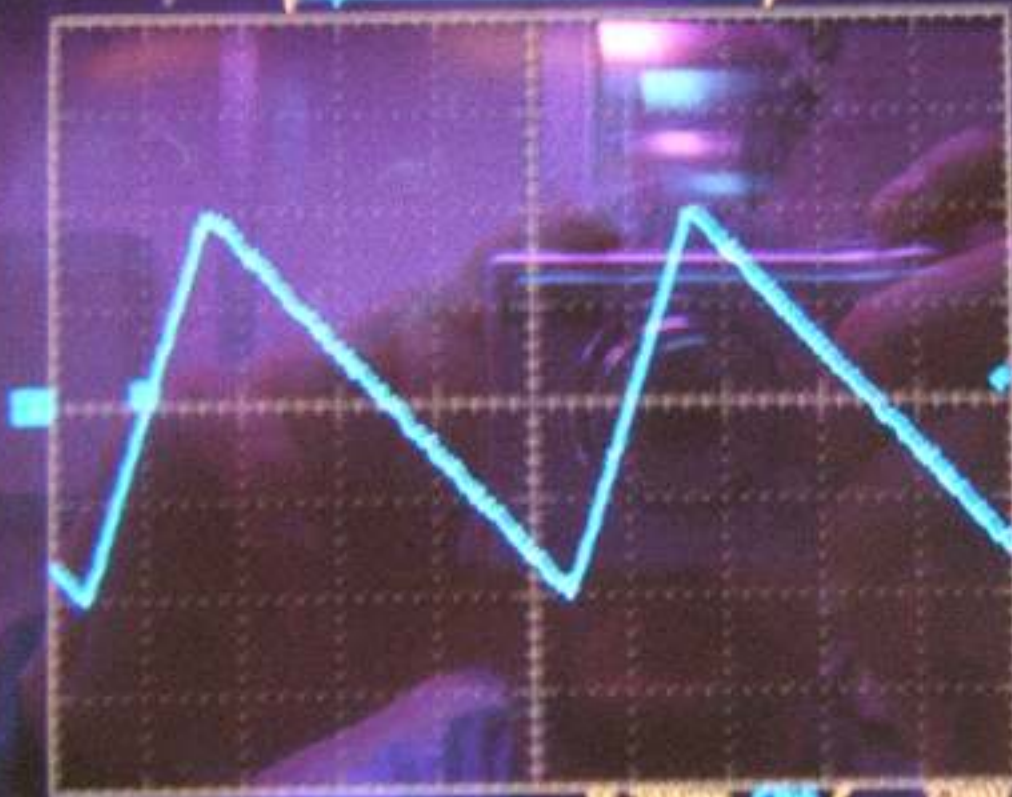
CYC LOC

MODIFY / REST

REMAINDER

Test Run: 250 S/s

Sample 



C4 Freq
99.7 mHz
Unstable
Histogram

C4 Period
1.000 s
Unstable
Histogram

C4 High
112 mV
Unstable
Histogram

C4 Low
-200 mV
Unstable
Histogram

 200mV

200ms

CN4

32mV

14 Jun 2008

12:05:27

XXX_9108

- Square wave

XXX_9108

- Constant Signal
- Square wave 1Hz $A=0.4V$, duty = 25%

I



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

Control panel with buttons: R/S, YES, NO, ENTER, HELP, DIR, ARC SIN, ABS AT, SGN TO, STO, RPT, FOR, RCL, TAN, Y^x, INT, LO, DEL, S+N, OFST, MARK, CL.

Function Out section: FUNCTION OUT, POWER, MANUAL TRIG (blue button).

Indicator lights: CYC (red), LOC (red).

Other buttons: RESTORE, REM (blue button).

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R-S

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

TO

FUNCTION OUT

CYC

LOC

STO

ARC

RPT

FOR

LN

COS

FOR

INT

LOG

RESTORE



RCL

ARC

Y^x

INT

LOG

TAN

Y^x

INT

LOG

MANUAL TRIG



D

REM

DEL

S-N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

DUTY:25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



CYC



LOG

STO

ARC

COS

RPT

FOR

RESTORE



RCL

ARC

TAN

Y^X

INT

MANUAL TRIG



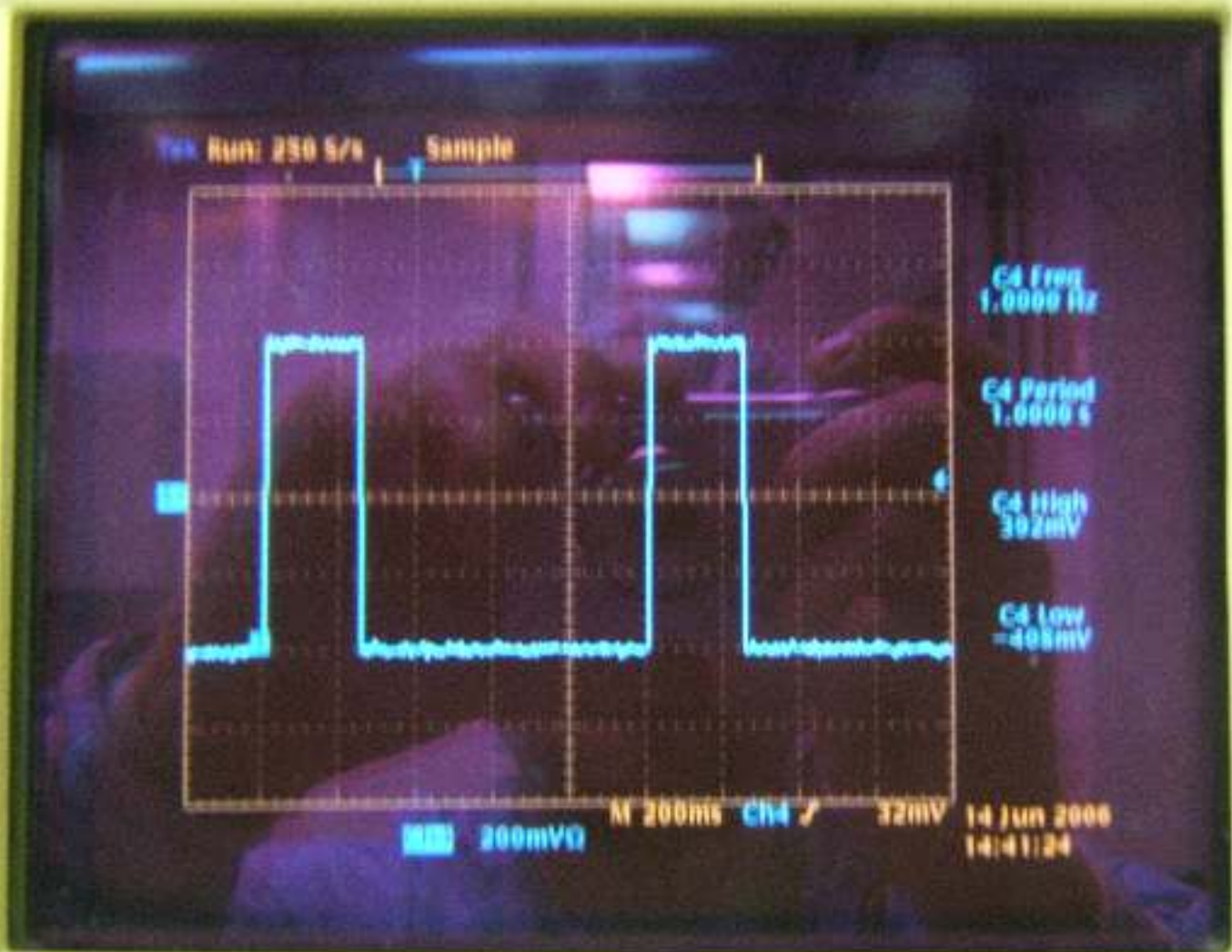
REM

DEL

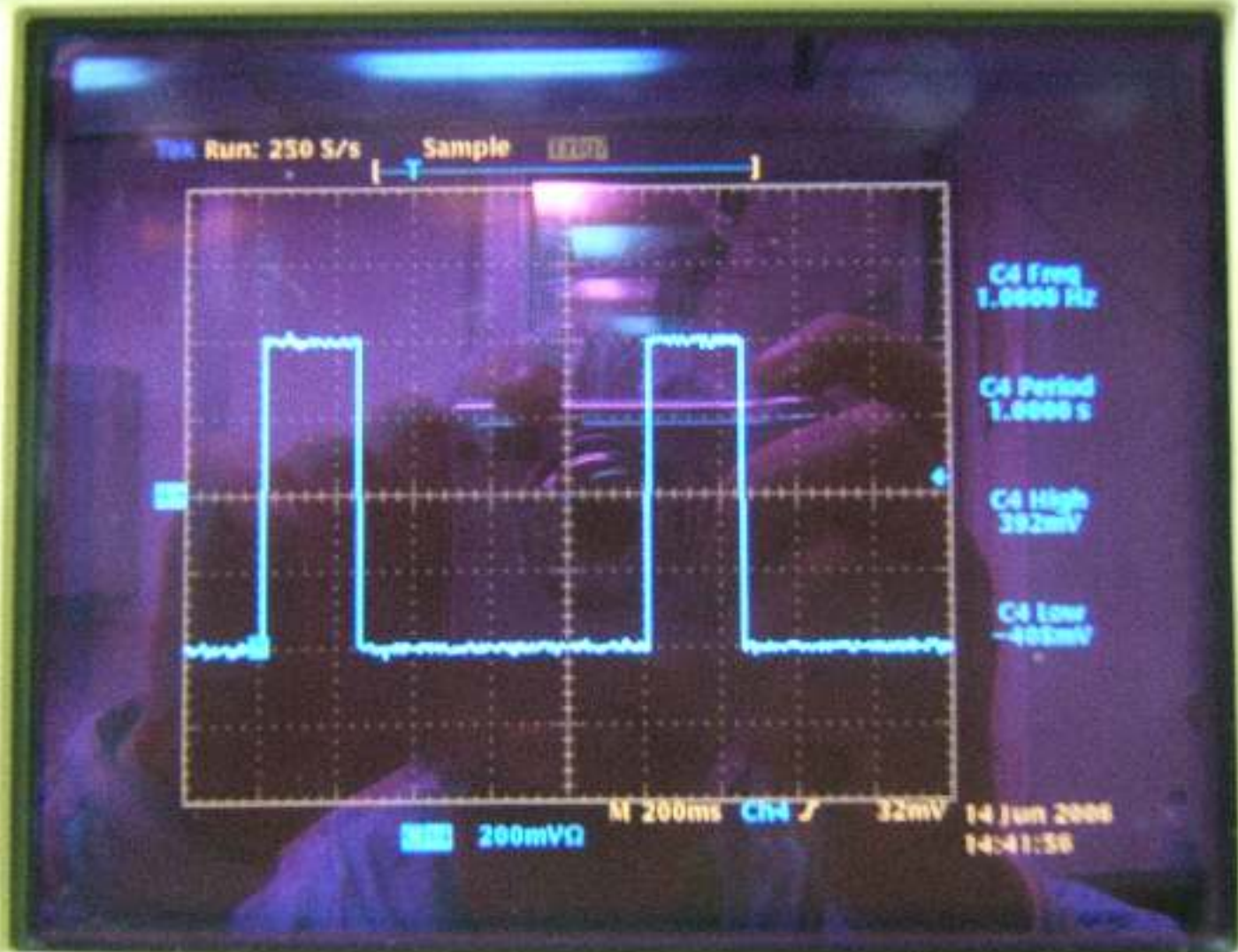
S+N

OFST

MARK



tektronix



XXX_9108

- Constant Signal
- Square wave 1Hz $A=0.4V$, duty = 25%
- Amp = 0.1 0.05 0.01|

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ:999.954m AMP:0.10000 OFST:0.00000
FILT=NONE MARK:0.00000 TRIG=FREE RUN

RUN

STOP

YES

NO

ENTER

HELP

OFF

ARC
SW

ABS
RT

SGN
TO

I

I

TRIG

TT

EE

+

+

NOISE

FIELD

SELECT

FORMAT

FUNCTION OUT

CYC

LOC

TRIG

ARC
DOE

ARC
TAN

ABS
NPT

SGN
FOR

I
LN

I
LOG

+

+

+

+

+

+

+

+

MANUAL TRIG

STOP

REM

TRIG

ARC
EIN

ABS
OFST

SGN
MARK

I
CLK

I
FLT

+

+

+

+

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+

+

ANALOGIC

INTEGRAL

INTEGRAL IBIS VETO TEST

LABEN
Circuit Design & Test
4000
1000
1000
1000

POLYNOMIAL WAVEFORM SYNTHESIZER _____ MODEL 2020

FREQ: 999.954m AMP: 0.10000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

FUNCTION OUT

RS YES NO ENTER HELP DIR

ARC ABS SGN
SIN AT TO

ARC
COS RPT FOR

ARC
TAN \sqrt{x} INT

DEL S+N OFST MARK

MANUAL TRIG

MODIFY /
RECALL

CYC LOC

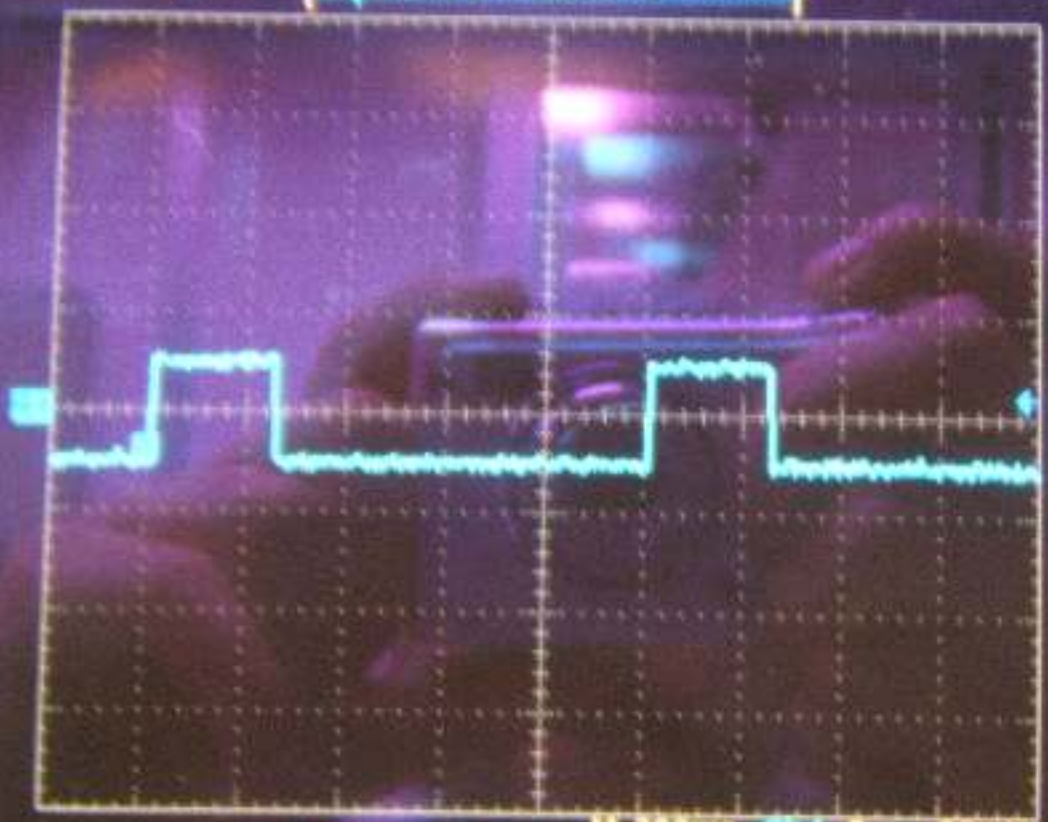
GRAD REM

STO RCL

Run: 250 S/s

Sample

00000



C4 Freq
1.0001 Hz
Low signal
amplitude

C4 Period
1.0000 s
Low signal
amplitude

C4 High
88mV

C4 Low
-112mV

200mV

M 200ms

CH4

32mV

14 Jun 2006

15:53:12

XXX_9109

- Constant Signal
- Square wave

XXX_9109

- Constant Signal
- Square wave 1Hz $A=0.1\text{ V}$, duty = 25%
- Triangular 1Hz $A=0.1\text{ V}$ duty=25%
- |

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ:999.954m AMP:0.10000 OFST:0.00000
FILT=NONE MARK:0.00000 TRIG=FREE RUN

| | | | |
|-------|---|-----|---|
| K | M | = | |
| 1 | 2 | 3 | + |
| n | U | m | X |
| 4 | 5 | 6 | |
| OP | | | |
| 7 | 8 | 9 | - |
| TRIG. | 0 | EE | + |
| | | CLR | |
| | | CE | |

POWER RUN YES NO ENTER HELP

| | | | | | |
|-----|-----|----------------|------|-----|------|
| DIR | ARC | ABS | SGN | | |
| | SIN | AT | TC | | |
| STO | ARC | RPT | FOR | LN | I |
| | COS | | | | |
| RCL | ARC | Y ^x | INT | LOG | T |
| | TAN | | | | |
| DEL | S+R | OFST | MARK | CLK | FILT |

CYC LOC

RESTORE

D

REM

SPACE FAST

ANALOGIC DATA PRECISION



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.10000

OFST: 0.00000

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



VERIFY /



CYC

LOC



REST



STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

MANUAL TRIG



AD

REM

RCL

DEL

S+N

OFST

MARK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



DEFY/

REST



CYC



LOC



STO

ARC

COS

RPT

FOR

ARC

TAN

Y^X

INT

MANUAL TRIG



ND



REM

RCL

DEL

S+N

OFST

MARK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

DUTY:25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

MODIFY /

RES



CYC

LOC



STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

MANUAL TRIG



AD

REM

RCL

DEL

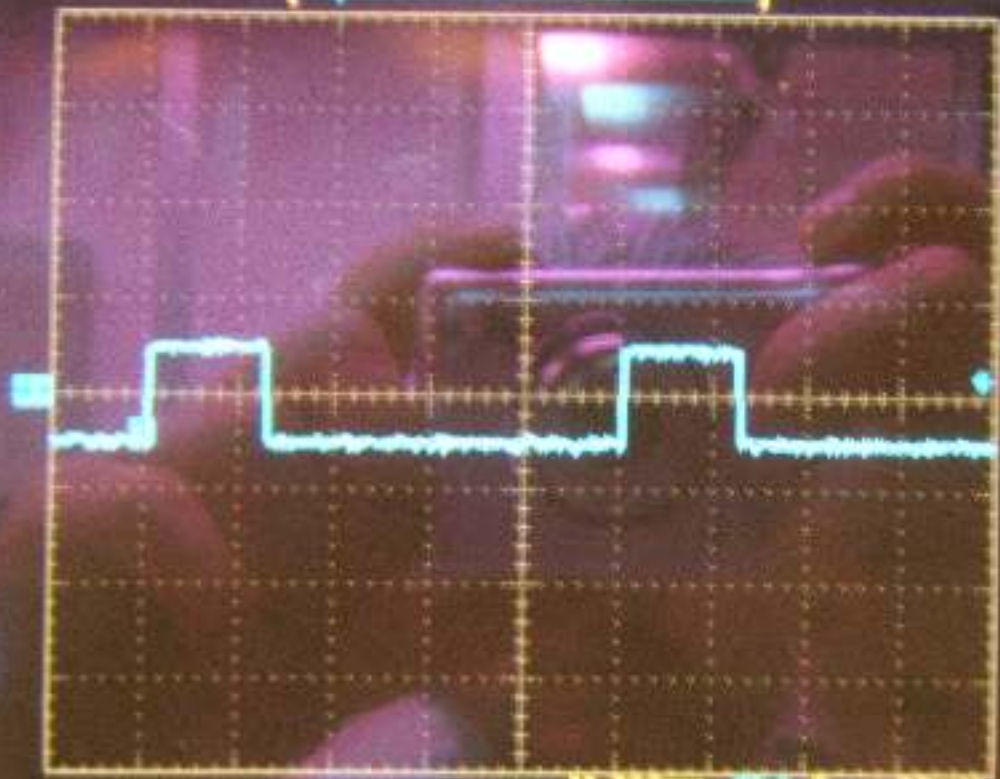
S+N

OFST

MARK

Tex Run: 250 S/s

Sample []



C4 Freq
1.0002 Hz
Low signal
amplitude

C4 Period
1.000 s
Low signal
amplitude

C4 High
20mV

C4 Low
-11.2mV

200mV

M 200ms CH1

32mV

14 Jun 2006

16:00:51

XXX_9109

- Triangular Wave

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.10000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE

RCL

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG

REM

DEL

S-N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK=0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



CYC



LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE



RCL

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



REM

DEL

S+N

OFST

MARK

CLR

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

RESTORE



RCL

ARC

TAN

Y^x

INT

MANUAL TRIG



REM

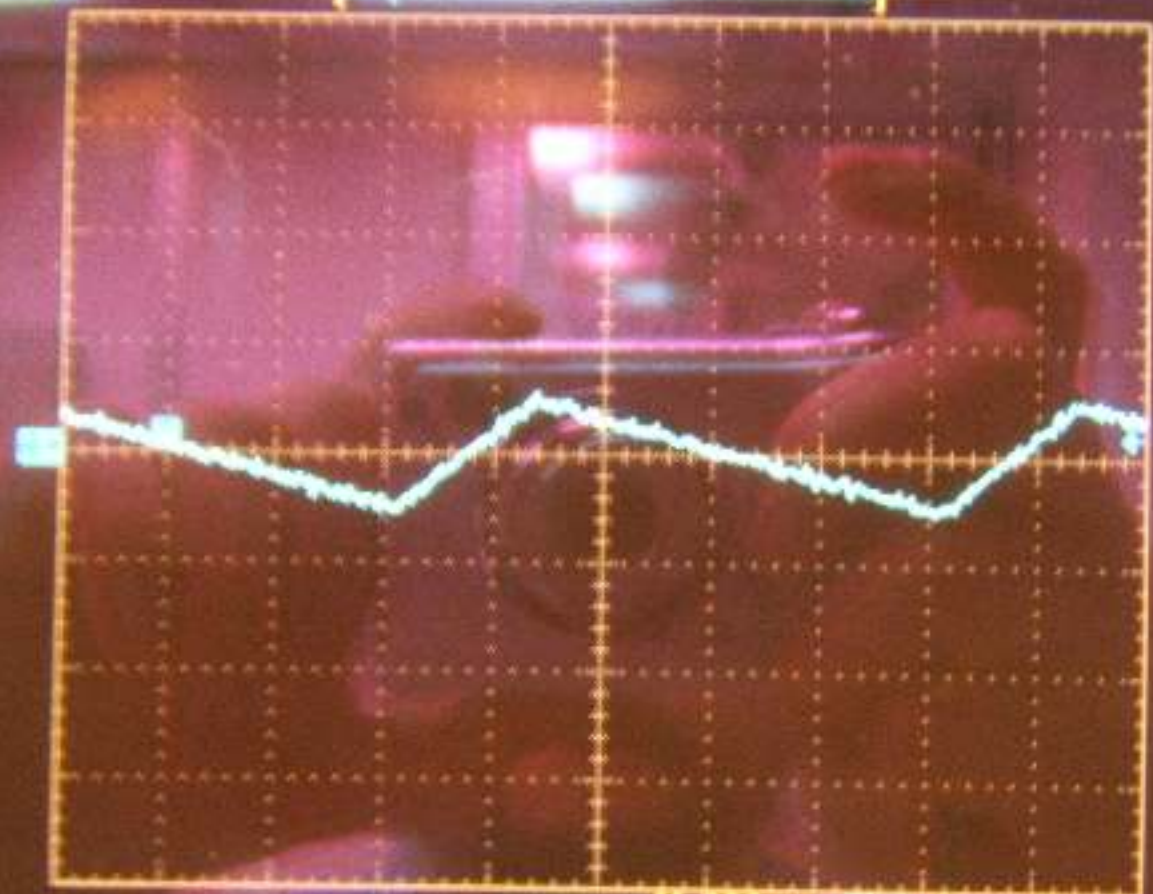
DEL

S+N

OFST

MARK

Run: 250 S/s



C4 Freq
1.0121 Hz
Low signal
amplitude

C4 Period
988.0ms
Low signal
amplitude

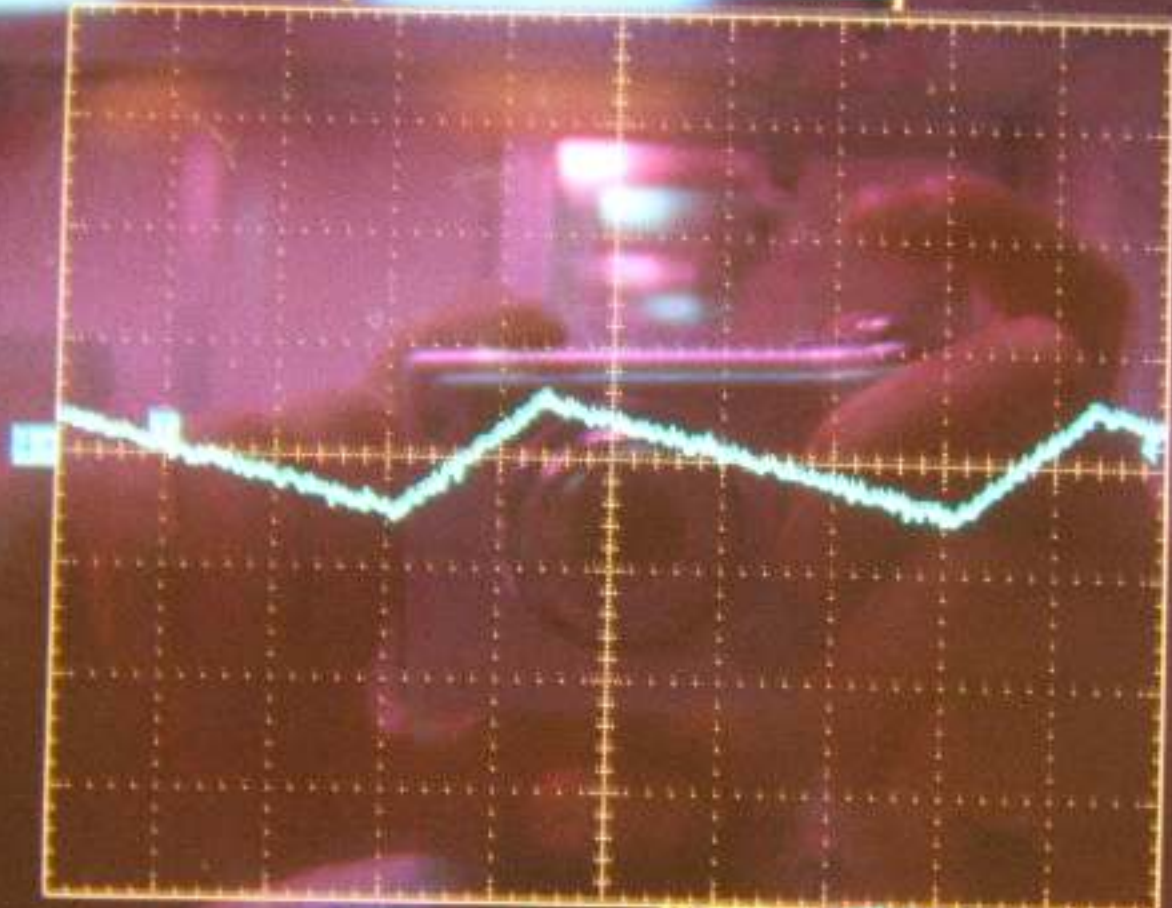
C4 High
16mV
Unstable
histogram

C4 Low
-32mV
Unstable
histogram

200mV M 200ms Ch4 / 32mV

14 Jun 2006
16:08:45

Run: 250 S/s



C4 Freq
961.5MHz
Low signal
amplitude

C4 Period
1.0400 s
Low signal
amplitude

C4 High
48mV
Unstable
Histogram

C4 Low
-72mV
Unstable
Histogram

200mV

M 200ms CH4 J

32mV

14 Jun 2006
16:08:49

XXX_9111

- Square Wave

XXX_9111

- Square wave Freq=1Hz Amp=0.4V 25% Duty
- Triangular wave Freq=1Hz Amp=0.4V 25% Duty
-

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

| | | | | | |
|------|---|---|----|---|--|
| K | M | = | | | |
| 1 | 2 | 3 | - | | |
| n | U | m | x | | |
| 4 | 5 | 6 | | | |
| OP | 7 | 8 | 9 | - | |
| TRIG | - | 0 | EE | + | |
| | | | | | |

RUN

YES NO ENTER HELP

DIR SH AT TO

FUNCTION OUT

CYC LOC

STO CLR F CLR

SPACE

FAST

MANUAL TRIG

AD REM

RC TAN y² INT LOG T

ANALOGIC

DATA PRECISION

INTEGRAL 1815 VETO TE

LABET
Laser Beam
Energy Transfer
Infrared
Spectroscopy



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY/

RESTORE

CYC

LOC

STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



D

REM

RCL

DEL

S+N

OFST

MARK

CL

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

REFY/

REST



CYC



LOC

STO

ARC

COS

RPT

FOR

ARC

TAN

Y'

INT

MANUAL TRIG



D

REM

RCL

DEL

S+N

OFST

MARK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 202

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

DUTY:25.0000%

FUNCTION OUT

YES NO ENTER HELP DIR

ARC ABS SGN
SIN AT TO

ARC
COS RPT FOR

ARC
TAN Y^x RT

DEL S=N OFST MATH

MANUAL TRIG

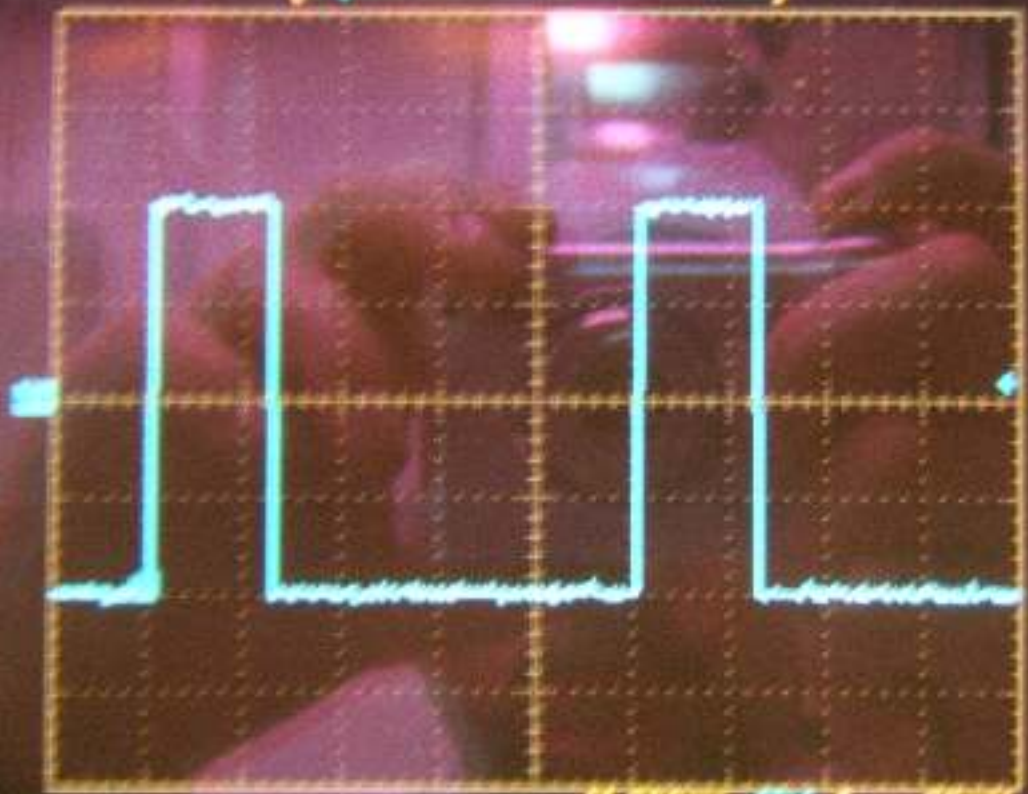
AD REM

CYC LOC

REST

Run: 250 S/s

Sample



C4 Freq
1.000 Hz

C4 Period
1.000 s

C4 High
392mV

C4 Low
-402mV

200mV

M 200ms CH4 J

32mV

15 Jun 2006
10:30:55

XXX_9111

- Triangular Wave

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RD

YES

NO

ENTER

HELP

DEF

ARC

ABS

SGN

K

M

=

1

2

3

+

n

U

m

x

4

5

6

x

OP

8

9

-

7

0

EE

+

TRIG

TT

e

+

NOISE

FUNCTION OUT

CYC

LOC

WTC

ARC

COS

RPT

FOR

LN

I

2nd

F

CLR

CE

SPACE

FAST

MANUAL TRIG

AD

REM

RCL

ARC

TAN

y^x

INT

LOG

T

BEL

S-H

OFST

MARK

CLK

FILT

ANALOGIC

DATA PRECISION

INTEGR

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

RESTORE

CYC

LOC

STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

MANUAL TRIG

REM

DEL

S+N

OFST

MARK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK: 0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

MODIFY /

REST

CYC

LOC

STO

ARC

COS

RPT

FOR

ARC

TAN

Y^x

INT

LO

MANUAL TRIG



AD

REM

RCL

S+N

OFST

MARK

CL

DEL

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

TO

FUNCTION OUT

MODIFY /



CYC



LOC

STO

ARC

COS

RPT

FOR

REST



RCL

ARC

TAN

Y^x

INT

MANUAL TRIG



AD

REM

DEL

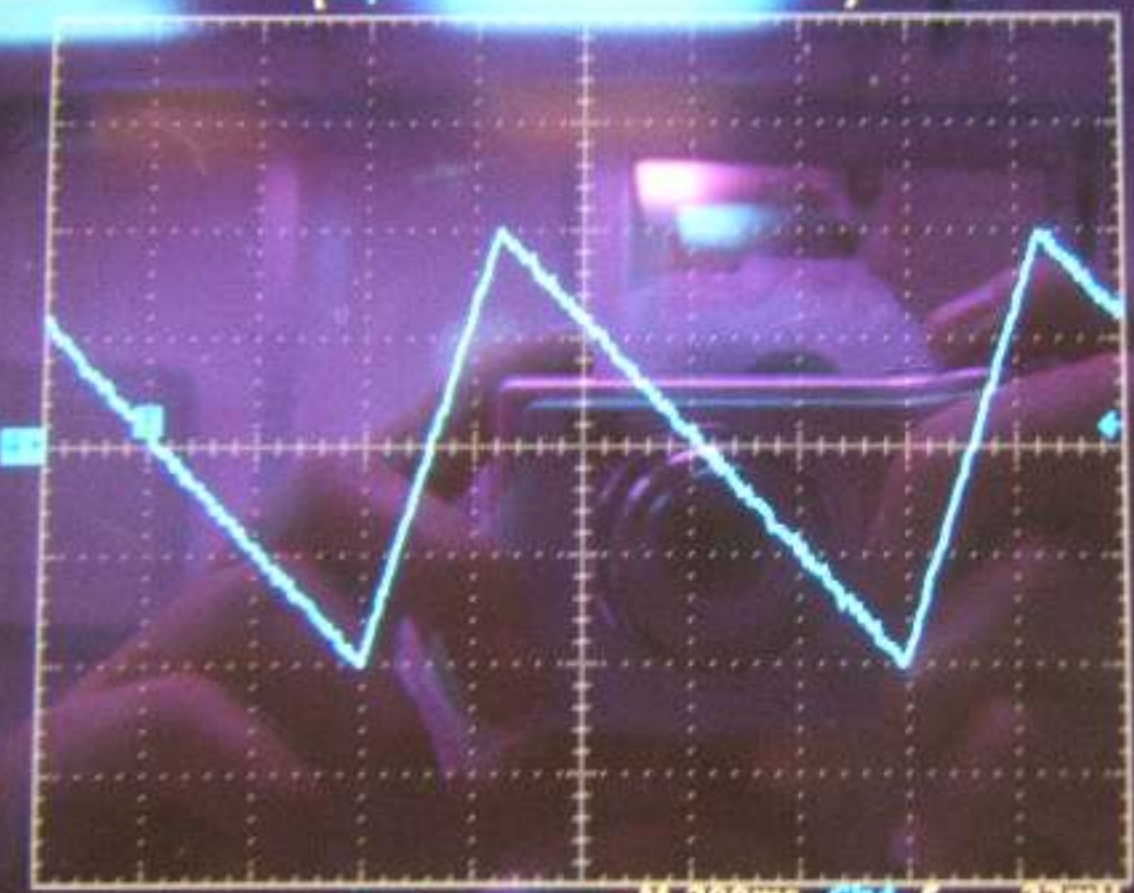
S+N

OFST

MARK

POWER

250 S/s



C4 Freq
1.0000 Hz
Unstable
histogram

C4 Period
1.0000 s
Unstable
histogram

C4 High
200mV
Unstable
histogram

C4 Low
-232mV
Unstable
histogram

200mV

M 200ms Ch4 J 32mV

15 Jun 2006
11:14:10

XXX_9113

- Triangular Waves of different frequencies

XXX_9113

- Triangular wave Freq=1Hz Amp=0.4V 25% Duty
-

I

Title 1

Paragraph 1, Row 1, Column 2:06 / 5:84

23.91 x 13.23

55%

Side 1 / 1

Default

Document file home file home X CCC wrap

Paragraph Kwite [12] OpenOffice

12:29

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

RT

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

SGN

1

TRIG

0

EE

+

NOISE

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

3rd

F

CLR

CE

RESTORE

CYC

LOC

RCL

ARC

TAN

y^x

INT

LOG

1

SPACE

FAST

INTS

MANUAL TRIG

MANUAL TRIG

REM

DEL

B+N

OFST

MARK

CLK

PKT

ANALOGIC

DATA PRECISION

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC
SIN

ABS
AT

SGN
TO

FUNCTION OUT

CYC

LOC

STO

ARC
COS

RPT

FOR

LN

RESTORE

RCL

ARC
TAN

Y^x

INT

LOG

MANUAL
TRIG

REM

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

UN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG

RE

REM

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY /

RESTORE



CYC



LOC

STO

ARC

COS

RPT

FOR

LN

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



0



REM

DEL

S+N

OFST

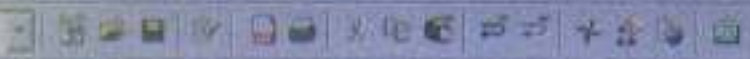
MARK

CLK



XXX_9113

- Triangular wave Freq = 0.1 Hz



XXX_9113

- Triangular wave Freq=1Hz Amp=0.4V 25% Duty
- Triangular wave Freq=0.1Hz Amp=0.4V 25% Duty
- |



Document1 Use Points No Points X Doc...

13:03

XXX_9113

- Triangular wave Freq=1Hz Amp=0.4V 25% Duty
- Triangular wave Freq=0.1Hz Amp=0.4V 25% Duty
-

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 99.9835m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN



YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

SIGN

TO

K

M

=

1

2

3

-

n

u

m

4

5

6

x

OP

7

8

9

-

TRIG

0

EE

+

FUNCTION OUT



CYC

LOC

RESTORE

RCL

ARC

COG

RPT

EDR

LN

2nd

F

CLR

CE

SPACE

FAST

MANUAL TRIG



REM

REM

DEL

S+N

OFST

MARK

CLK

FILT

ANALOGIC

DATA PROCESS

POWER



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 99.9835m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

R/S

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

TO

FUNCTION OUT

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE

RCL

ARC

TAN

y^x

INT

LOG

MANUAL TRIG

REM

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK=0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



CYC



LOC

RESTORE



STO

ARC

COS

RPT

FOR

ARC

TAN

y^x

INT

MANUAL TRIG



REM

RCL

DEL

S+N

OFST

MARK

ER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

FUNCTION OUT

YES NO ENTER HELP DIR ARC SIN ABS SGN TO

STO ARC COS RPT FOR

RCL ARC TAN Y^x INT

DEL S+N OFST MARK

MANUAL TRIG

AD REM

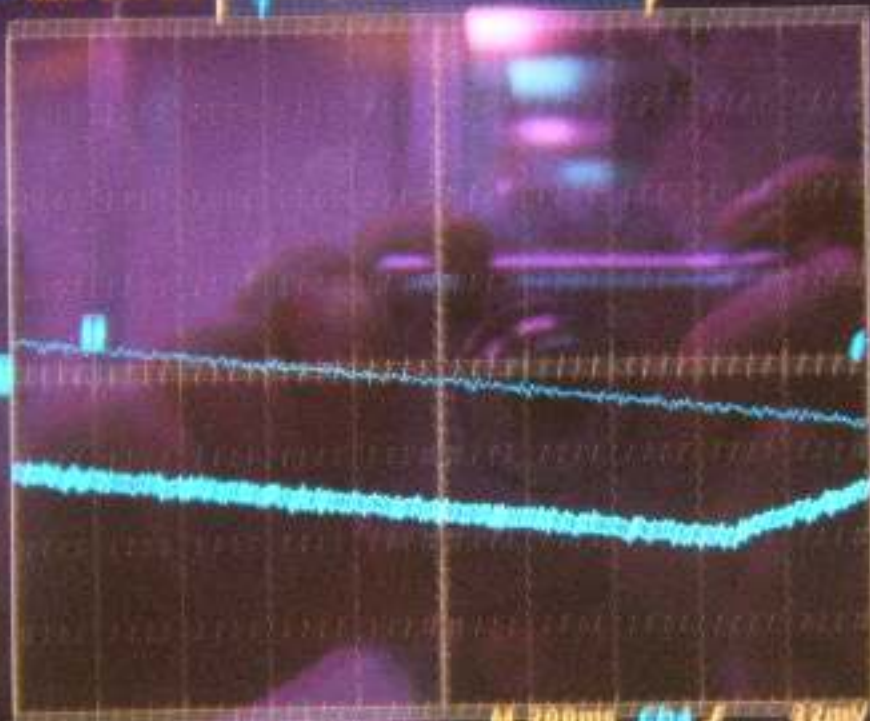
CYC LOC

REST



THE RUN: 250 9/8

Sample



EA Freq
76.325712

EA Period
1.311

EA High
1.000000

EA Low
0.500000

200mV

M 200ms CH4 7

32mV

15 Jun 2006

12:59:22

XXX_9114

- Triangular Wave

XXX_9114

- Triangular wave Freq=0.1Hz Amp=0.4V 25%
Duty
- Triangular wave Freq=0.05Hz Amp=0.4V 25%
Duty after OBT=7800
- |

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON NAMP=0.00000 NBW=200KHz
DLY=0.00000 SYM=25.0000%

PS YES NO ENTER

HELP

DRY

ARC SIN ABS AT SGN TD I I

K M =
1 2 3 +
n u m X
4 5 6
OP 7 8 9 -
TRIG TT / EE +
- 0 CE

FUNCTION OUT

CYC LOC

STD ARC COS RPT FOP LN I

2nd F CLR CE

RESTORE

AD

REM

RCL

ARC TAN Y^x NT LOG T

SPACE FAST

MANUAL TRIG

DEL SIN OFST MARK CLK FILE

ANALOGIC

ANALOG PRECISION

INTEG

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON NAMP=0.00000 NBW=200KHz
DLY=0.00000 SYM=25.0000%

Calculator keypad with scientific function keys:

- Row 1: K (1), M (2), μ (3), +, $\frac{1}{x}$
- Row 2: π (4), U (5), m (6), X, $\frac{1}{x^2}$
- Row 3: OP (7), 8, 9, -, $\frac{1}{x^3}$
- Row 4: TRIG (.), 0, EE, +, NOISE
- Row 5: 2nd, F, CLR
- Row 6: SPACE, \uparrow , FAST, \rightarrow
- Row 7: \downarrow , INTEGRATE

Control buttons and indicators:

- Buttons: P, FES, NO, ENTER, HELP, DIR, STO, RCL, DEL, MANUAL TRIG (blue), RESTORE, \square (square), \square (square)
- Indicators: CYC (red), LOC (red)
- Labels: FUNCTION OUT, POWER

Mathematical function keypad:

- Row 1: ARC SIN, ABS AT, SGN TO, I, I
- Row 2: ARC COS, RPT, FOR, LN, I
- Row 3: ARC TAN, y^x , INT, LOG, T
- Row 4: S-N, OFST, MARK, CLK, FILT

ANALOGIC

DATA PRECISION

INTEGRATE

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 99.9835m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RS

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

KEY /

RESTORE

CYC

LOC

STD

ARC

COS

RPT

FOR

LN

ARC

TAN

y^x

INT

LOG

MANUAL
TRIG



D

REM

RCL

DEL

S+N

OFST

MARK

CLK

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



CYC



LOC

STO

ARC

COS

RPT

FOR

LN

RESTORE



RCL

ARC

TAN

y^x

INT

LOG

MANUAL TRIG



REM

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

SYM=25.0000%

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT



KEY/



CYC



LOC

STO

ARC

COS

RPT

FOR

LN

RESTO



RCL

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG



D



REM

DEL

S+N

OFST

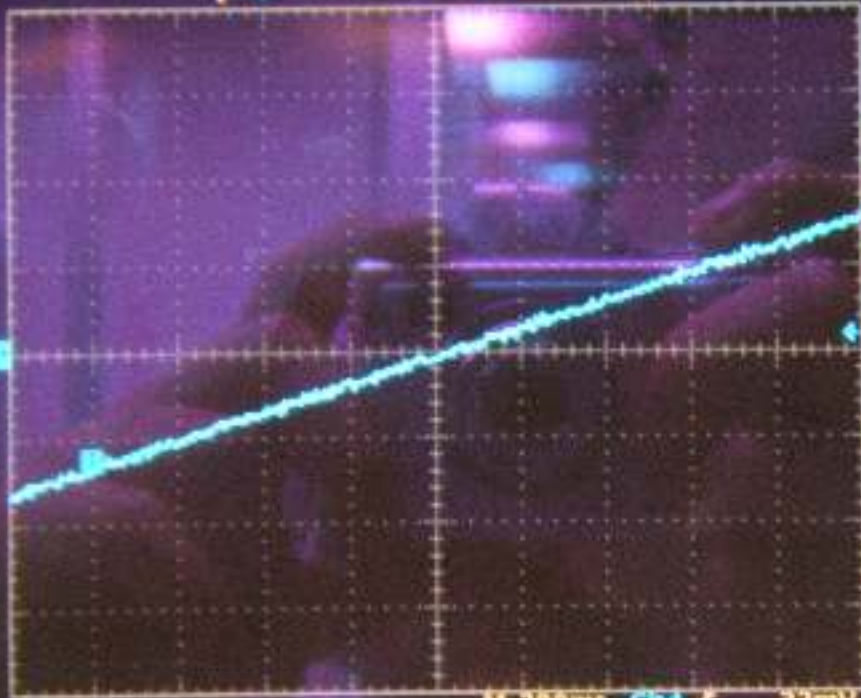
MARK

CLK

POWER

Tab Run: 250 S/s

Sample



C4 Freq
= Hz
No period
found

C4 Period
= s
No period
found

C4 High
88mV
Unstable
histogram

C4 Low
-80mV
Unstable
histogram

200mV

M 200ms Ch4 /

32mV

15 Jun 2006

13:04:06

CLEAR
MENU

XXX_9115

- Square Waves and Triangular Waves

XXX_9115

- Square wave Freq=1Hz Amp=0.4V 25% Duty
- Triangular wave Freq=0,05Hz Amp=0.4V 25% Duty
-

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000
FILT=NONE MARK: 0.00000 TRIG=FREE RUN

RUN

ON

YES

NO

ENTER

HELP

OFF

ARC

SIN

ABS

SGN

TO

I

I

ARC

COS

RPT

FOR

UN

I

ARC

TAN

V^A

RT

LOG

T

ANALOGIC

PRECISION

INTEGRAL TRIG VE

Calculator keypad with function keys: K, M, =, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, EE, +, -, x, /, %, ^, 1/x, 1/y, 1/z, 1/w, 1/v, 1/u, 1/t, 1/s, 1/r, 1/q, 1/p, 1/o, 1/n, 1/m, 1/l, 1/k, 1/j, 1/i, 1/h, 1/g, 1/f, 1/e, 1/d, 1/c, 1/b, 1/a, 1/z, 1/y, 1/x, 1/w, 1/v, 1/u, 1/t, 1/s, 1/r, 1/q, 1/p, 1/o, 1/n, 1/m, 1/l, 1/k, 1/j, 1/i, 1/h, 1/g, 1/f, 1/e, 1/d, 1/c, 1/b, 1/a. Additional keys: TRIG, OP, CLR, CE, SPACE, FAST, and a yellow 'INTEGRAL TRIG VE' label.

FUNCTION OUT

CYC

LOC

RESTORE

MANUAL TRIG

POWER



POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FREQ: 999.954m AMP: 0.40000 OFST: 0.00000

FILT=NONE MARK: 0.00000 TRIG=FREE RUN

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

RESTORE

CYC

LOC

STO

ARC

COS

RPT

FOR

LN

ARC

TAN

Y^x

INT

LOG

MANUAL TRIG

REM

RCL

DEL

S+N

OFST

MARK

CLK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

FILT=NONE

MARK:0.00000

TRIG=FREE RUN

NOISE=ON

NAMP=0.00000

NBW=200KHz

R/S

YES

NO

ENTER

HELP

DIR

ARC

SIN

ABS

AT

SGN

TO

FUNCTION OUT

DEFY /

REST

MANUAL TRIG



CYC



LOC



D



REM

STO

RCL

DEL

ARC

COS

ARC

TAN

S+N

RPT

Y^X

OFST

FOR

INT

MARK

POWER

POLYNOMIAL WAVEFORM SYNTHESIZER

MODEL 2020

NOISE=ON

NAMP=0.00000

NBW=200KHz

DLY=0.00000

DUTY: 25.0000%

RS

YES

NO

ENTER

HELP

DIR

ARC

ABS

SGN

SIN

AT

TD

FUNCTION OUT

MODIFY /

CYC

LOC

STD

ARC

COS

RPT

ROM

REST

MAN

REM

RCL

ARC

TAN

y^x

INT

MANUAL TRIG

END

REM

DEL

S-N

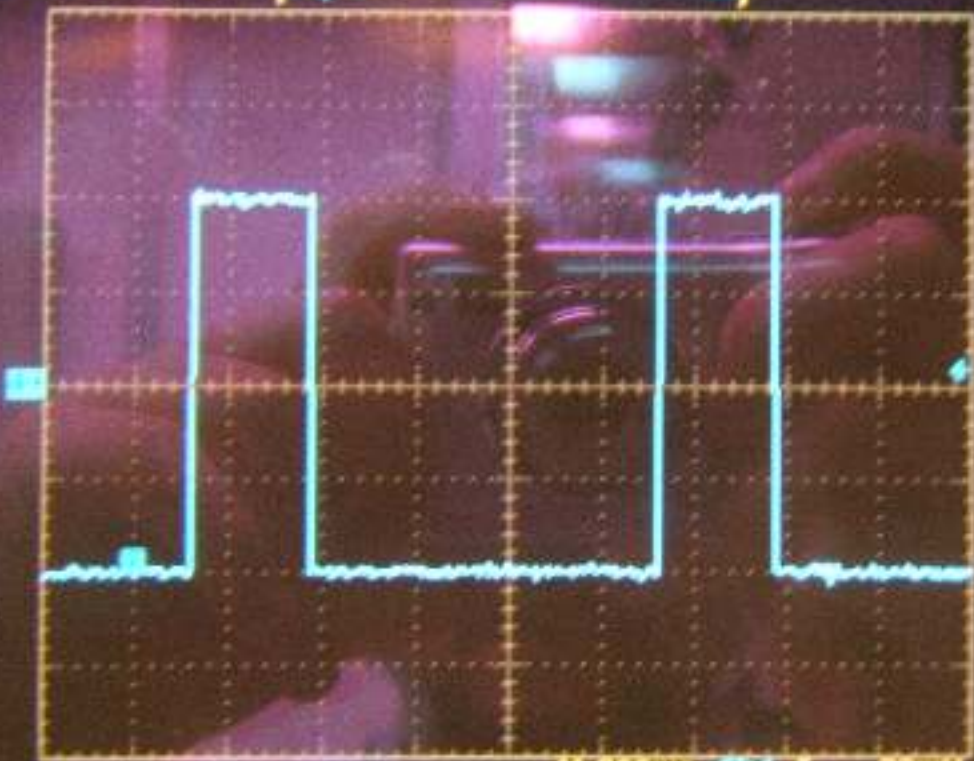
DPST

WASH

POWER

Tek Run: 250 S/s

Sample



C4 Freq
1.0000 Hz

C4 Period
1.0000 s

C4 High
392mV

C4 Low
-405mV

200mV

M 200ms CH4 / 32mV

15 Jun 2006

14:43:00