

## 2Gsps Dual-Stage Differential Track-and-Hold TH723

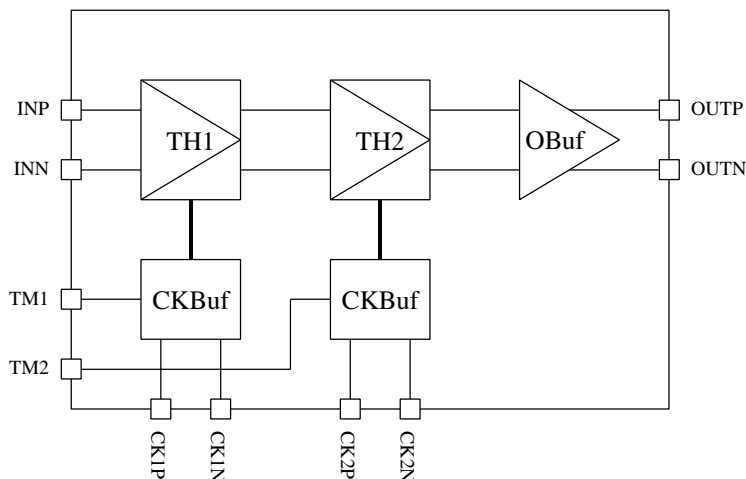
### PRODUCT DESCRIPTION

TH723 is a dual-stage differential Track-and-Hold amplifier with independent clock inputs. TH723 is able to sample 2 GHz signal with 11 bits of resolution, making it an ideal solution for high-speed high-resolution data acquisition systems like instrumentation, radio, radar, tester, etc.

### KEY FEATURES

- > 9 GHz small-signal bandwidth
- > 8 GHz large-signal bandwidth (1 V<sub>p-p</sub> differential)
- 200-2000 MHz sampling rate
- -70 dB THD (single-ended 250mV<sub>p-p</sub> 2GHz input)
- -59 dB THD (single-ended 250mV<sub>p-p</sub> 4GHz input)
- -56 dB THD (single-ended 250mV<sub>p-p</sub> 6GHz input)
- < 70 fs aperture jitter
- < 200 ps acquisition time
- < 30 ps rise time (20-80%)
- Differential analog input/output
- Excellent performance with single-ended input
- Adjustable output common mode voltage
- Independent track mode enable on both stages

### BLOCK DIAGRAM



## ELECTRICAL SPECIFICATIONS

Parameter	Conditions/Note	Min	Typical	Max	Unit
<b>ANALOG INPUT</b>					
Full Scale Range	Differential		1		V <sub>p-p</sub>
Common Mode Voltage		-100	0	100	mV
Input Resistance	Single-ended to GND	45	50	55	Ω
Input Capacitance	Single-ended to GND		100		fF
<b>CLOCK INPUT</b>					
Amplitude	Differential, sinusoidal	250	500	1000	mV
Common Mode Voltage		-200	0	200	mV
Input Resistance		45	50	55	Ω
Input Capacitance			100		fF
<b>DIGITAL INPUT</b>					
TM1/2 High	Track mode	-0.5	0	0.3	V
TM1/2 Low	Hold mode	-5	Open	-2	V
Max Current Draw	Into each lead, TM1/2 high		0.6		mA
<b>ANALOG OUTPUT</b>					
Ext. Termination Voltage	V <sub>to</sub>	1.5		3.5	V
Ext. Termination Resistor	R <sub>to</sub> , from outputs to V <sub>to</sub>		50		Ω
Max Swing	Differential		1		V <sub>p-p</sub>
Common Mode Voltage	Relative to GND	0.5		2.5	V
Average Current	Into each output lead		TBD		mA
Max Current	Into each output lead		TBD		mA
<b>DC CHARACTERISTIC</b>					
Gain			1		
Offset Voltage		-15		15	mV
<b>DYNAMIC PERFORMANCE</b>					
Bandwidth, small signal	-3dB, signal < 0.1V <sub>pp</sub>	9		TBD	GHz
Bandwidth, large signal	-3dB, signal=1V <sub>pp</sub>	8		TBD	GHz
Gain Variation	100MHz to 800MHz	-0.5		0.5	dB
Integrated Noise	Input referred		TBD		μV
Noise Floor	Input referred		TBD		nV/ns
TH1 Hold Feedthrough	1V <sub>pp</sub> 500MHz input		-75		dB

Notes:

-Above measurements are with differential 1000MHz out-of-phase CK1 &amp; CK2.

-V<sub>to</sub>=2V

## ELECTRICAL SPECIFICATIONS (CONTINUED)

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
SFDR, 60 MHz input	Single-ended 250mVpp input		81		dB
SFDR, 2060 MHz input	Single-ended 250mVpp input		68		dB
SFDR, 4060 MHz input	Single-ended 250mVpp input		56		dB
SFDR, 6060 MHz input	Single-ended 250mVpp input		53		dB
THD, 60 MHz input	Single-ended 250mVpp input		-78		dB
THD, 2060 MHz input	Single-ended 250mVpp input		-63		dB
THD, 4060 MHz input	Single-ended 250mVpp input		-52		dB
THD, 6060 MHz input	Single-ended 250mVpp input		-49		dB
SFDR, 60 MHz input	Single-ended 500mVpp input		75		dB
SFDR, 2060 MHz input	Single-ended 500mVpp input		57		dB
SFDR, 4060 MHz input	Single-ended 500mVpp input		47		dB
SFDR, 6060 MHz input	Single-ended 500mVpp input		43		dB
THD, 60 MHz input	Single-ended 500mVpp input		-73		dB
THD, 2060 MHz input	Single-ended 500mVpp input		-55		dB
THD, 4060 MHz input	Single-ended 500mVpp input		-45		dB
THD, 6060 MHz input	Single-ended 500mVpp input		-39		dB
SFDR, 60 MHz input	Single-ended 1Vpp input		64		dB
SFDR, 2060 MHz input	Single-ended 1Vpp input		44		dB
SFDR, 4060 MHz input	Single-ended 1Vpp input		36		dB
SFDR, 6060 MHz input	Single-ended 1Vpp input		31		dB
THD, 60 MHz input	Single-ended 1Vpp input		-64		dB
THD, 2060 MHz input	Single-ended 1Vpp input		-44		dB
THD, 4060 MHz input	Single-ended 1Vpp input		-38		dB
THD, 6060 MHz input	Single-ended 1Vpp input		-32		dB

Notes:

-Above measurements are with single-ended 2000MHz out-of-phase CK1 &amp; CK2.

-Vto=2V

**ELECTRICAL SPECIFICATIONS (CONTINUED)**

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
SFDR, 60 MHz input	Differential 250mVpp input		80		dB
SFDR, 2060 MHz input	Differential 250mVpp input		67		dB
SFDR, 4060 MHz input	Differential 250mVpp input		64		dB
SFDR, 6060 MHz input	Differential 250mVpp input		56		dB
THD, 60 MHz input	Differential 250mVpp input		-76		dB
THD, 2060 MHz input	Differential 250mVpp input		-66		dB
THD, 4060 MHz input	Differential 250mVpp input		-62		dB
THD, 6060 MHz input	Differential 250mVpp input		-54		dB
SFDR, 60 MHz input	Differential 500mVpp input		74		dB
SFDR, 2060 MHz input	Differential 500mVpp input		54		dB
SFDR, 4060 MHz input	Differential 500mVpp input		48		dB
SFDR, 6060 MHz input	Differential 500mVpp input		44		dB
THD, 60 MHz input	Differential 500mVpp input		-73		dB
THD, 2060 MHz input	Differential 500mVpp input		-53		dB
THD, 4060 MHz input	Differential 500mVpp input		-47		dB
THD, 6060 MHz input	Differential 500mVpp input		-43		dB
SFDR, 60 MHz input	Differential 1Vpp input		67		dB
SFDR, 2060 MHz input	Differential 1Vpp input		42		dB
SFDR, 4060 MHz input	Differential 1Vpp input		39		dB
SFDR, 6060 MHz input	Differential 1Vpp input		32		dB
THD, 60 MHz input	Differential 1Vpp input		-65		dB
THD, 2060 MHz input	Differential 1Vpp input		-42		dB
THD, 4060 MHz input	Differential 1Vpp input		-38		dB
THD, 6060 MHz input	Differential 1Vpp input		-31		dB

Notes:

-Above measurements are with differential 2000MHz out-of-phase CK1 &amp; CK2.

-Vto=2V

**ELECTRICAL SPECIFICATIONS (CONTINUED)**

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
SFDR, 60 MHz input	Single-ended 250mVpp input		90		dB
SFDR, 1060 MHz input	Single-ended 250mVpp input		78		dB
SFDR, 2060 MHz input	Single-ended 250mVpp input		71		dB
SFDR, 3060 MHz input	Single-ended 250mVpp input		66		dB
SFDR, 4060 MHz input	Single-ended 250mVpp input		59		dB
SFDR, 5060 MHz input	Single-ended 250mVpp input		55		dB
SFDR, 6060 MHz input	Single-ended 250mVpp input		52		dB
SFDR, 7060 MHz input	Single-ended 250mVpp input		50		dB
SFDR, 60 MHz input	Single-ended 500mVpp input		80		dB
SFDR, 1060 MHz input	Single-ended 500mVpp input		68		dB
SFDR, 2060 MHz input	Single-ended 500mVpp input		60		dB
SFDR, 3060 MHz input	Single-ended 500mVpp input		54		dB
SFDR, 4060 MHz input	Single-ended 500mVpp input		50		dB
SFDR, 5060 MHz input	Single-ended 500mVpp input		46		dB
SFDR, 6060 MHz input	Single-ended 500mVpp input		41		dB
SFDR, 7060 MHz input	Single-ended 500mVpp input		40		dB
SFDR, 60 MHz input	Single-ended 1Vpp input		69		dB
SFDR, 1060 MHz input	Single-ended 1Vpp input		55		dB
SFDR, 2060 MHz input	Single-ended 1Vpp input		47		dB
SFDR, 3060 MHz input	Single-ended 1Vpp input		43		dB
SFDR, 4060 MHz input	Single-ended 1Vpp input		40		dB
SFDR, 5060 MHz input	Single-ended 1Vpp input		34		dB
SFDR, 6060 MHz input	Single-ended 1Vpp input		32		dB
SFDR, 7060 MHz input	Single-ended 1Vpp input		31		dB

Notes:

-Above measurements are with single-ended 1000MHz out-of-phase CK1 &amp; CK2.

-Vto=2V

## ELECTRICAL SPECIFICATIONS (CONTINUED)

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
THD, 60 MHz input	Single-ended 250mVpp input		-89		dB
THD, 1060 MHz input	Single-ended 250mVpp input		-76		dB
THD, 2060 MHz input	Single-ended 250mVpp input		-70		dB
THD, 3060 MHz input	Single-ended 250mVpp input		-64		dB
THD, 4060 MHz input	Single-ended 250mVpp input		-53		dB
THD, 5060 MHz input	Single-ended 250mVpp input		-50		dB
THD, 6060 MHz input	Single-ended 250mVpp input		-50		dB
THD, 7060 MHz input	Single-ended 250mVpp input		-51		dB
THD, 60 MHz input	Single-ended 500mVpp input		-82		dB
THD, 1060 MHz input	Single-ended 500mVpp input		-67		dB
THD, 2060 MHz input	Single-ended 500mVpp input		-60		dB
THD, 3060 MHz input	Single-ended 500mVpp input		-54		dB
THD, 4060 MHz input	Single-ended 500mVpp input		-47		dB
THD, 5060 MHz input	Single-ended 500mVpp input		-41		dB
THD, 6060 MHz input	Single-ended 500mVpp input		-40		dB
THD, 7060 MHz input	Single-ended 500mVpp input		-43		dB
THD, 60 MHz input	Single-ended 1Vpp input		-77		dB
THD, 1060 MHz input	Single-ended 1Vpp input		-63		dB
THD, 2060 MHz input	Single-ended 1Vpp input		-56		dB
THD, 3060 MHz input	Single-ended 1Vpp input		-50		dB
THD, 4060 MHz input	Single-ended 1Vpp input		-45		dB
THD, 5060 MHz input	Single-ended 1Vpp input		-40		dB
THD, 6060 MHz input	Single-ended 1Vpp input		-41		dB
THD, 7060 MHz input	Single-ended 1Vpp input		-38		dB

Notes:

-Above measurements are with single-ended 1000MHz out-of-phase CK1 & CK2.

-Vto=2V

**ELECTRICAL SPECIFICATIONS (CONTINUED)**

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
SFDR, 60 MHz input	Differential 250mVpp input		94		dB
SFDR, 1060 MHz input	Differential 250mVpp input		80		dB
SFDR, 2060 MHz input	Differential 250mVpp input		74		dB
SFDR, 3060 MHz input	Differential 250mVpp input		67		dB
SFDR, 4060 MHz input	Differential 250mVpp input		65		dB
SFDR, 5060 MHz input	Differential 250mVpp input		59		dB
SFDR, 6060 MHz input	Differential 250mVpp input		56		dB
SFDR, 7060 MHz input	Differential 250mVpp input		60		dB
SFDR, 60 MHz input	Differential 500mVpp input		82		dB
SFDR, 1060 MHz input	Differential 500mVpp input		67		dB
SFDR, 2060 MHz input	Differential 500mVpp input		61		dB
SFDR, 3060 MHz input	Differential 500mVpp input		54		dB
SFDR, 4060 MHz input	Differential 500mVpp input		53		dB
SFDR, 5060 MHz input	Differential 500mVpp input		47		dB
SFDR, 6060 MHz input	Differential 500mVpp input		44		dB
SFDR, 7060 MHz input	Differential 500mVpp input		47		dB
SFDR, 60 MHz input	Differential 1Vpp input		75		dB
SFDR, 1060 MHz input	Differential 1Vpp input		57		dB
SFDR, 2060 MHz input	Differential 1Vpp input		48		dB
SFDR, 3060 MHz input	Differential 1Vpp input		43		dB
SFDR, 4060 MHz input	Differential 1Vpp input		43		dB
SFDR, 5060 MHz input	Differential 1Vpp input		39		dB
SFDR, 6060 MHz input	Differential 1Vpp input		34		dB
SFDR, 7060 MHz input	Differential 1Vpp input		37		dB

Notes:

- Above measurements are with differential 1000MHz out-of-phase CK1 & CK2.
- Vto=2V

**ELECTRICAL SPECIFICATIONS (CONTINUED)**

Parameter	Conditions/Note	Min	Typical	Max	Unit
DYNAMIC PERFORMANCE (continued)					
THD, 60 MHz input	Differential 250mVpp input		-90		dB
THD, 1060 MHz input	Differential 250mVpp input		-78		dB
THD, 2060 MHz input	Differential 250mVpp input		-71		dB
THD, 3060 MHz input	Differential 250mVpp input		-66		dB
THD, 4060 MHz input	Differential 250mVpp input		-64		dB
THD, 5060 MHz input	Differential 250mVpp input		-59		dB
THD, 6060 MHz input	Differential 250mVpp input		-54		dB
THD, 7060 MHz input	Differential 250mVpp input		-59		dB
THD, 60 MHz input	Differential 500mVpp input		-81		dB
THD, 1060 MHz input	Differential 500mVpp input		-66		dB
THD, 2060 MHz input	Differential 500mVpp input		-60		dB
THD, 3060 MHz input	Differential 500mVpp input		-53		dB
THD, 4060 MHz input	Differential 500mVpp input		-53		dB
THD, 5060 MHz input	Differential 500mVpp input		-47		dB
THD, 6060 MHz input	Differential 500mVpp input		-43		dB
THD, 7060 MHz input	Differential 500mVpp input		-47		dB
THD, 60 MHz input	Differential 1Vpp input		-78		dB
THD, 1060 MHz input	Differential 1Vpp input		-63		dB
THD, 2060 MHz input	Differential 1Vpp input		-53		dB
THD, 3060 MHz input	Differential 1Vpp input		-52		dB
THD, 4060 MHz input	Differential 1Vpp input		-52		dB
THD, 5060 MHz input	Differential 1Vpp input		-45		dB
THD, 6060 MHz input	Differential 1Vpp input		-40		dB
THD, 7060 MHz input	Differential 1Vpp input		-41		dB

Notes:

-Above measurements are with differential 1000MHz out-of-phase CK1 &amp; CK2.

-Vto=2V

TRACK-TO-HOLD AND HOLD STATE, TH1					
Aperture Delay	After CK1 goes negative		50		ps
Aperture Jitter	Jitter free 0.5 V <sub>pp</sub> 1 GHz CK1		70		fs
Settling Time	To 1 mV		200		ps
Differential Pedestal	Relative to Vin		-1		%
Differential Droop Rate	Relative to Vin		-0.5		%/ns
Hold Noise			TBD		μV/√Hz
Min Clock Frequency	50% duty cycle clock		200		MHz
Max Clock Frequency	50% duty cycle clock		2000		MHz
Max Hold Time			5		ns
HOLD-TO-TRACK AND TRACK STATE, TH1					
Acquisition Time	To 1 mV, FSR step input		200		ps
Max Acquisition Slew Rate	FSR step input		30		V/ns
Rise Time	20-80%		30		ps
Min Track Time			0.2		ns
Recovery Time			1		ns
TRACK-TO-HOLD AND HOLD STATE, TH2					
Aperture Delay	After CK1 goes negative		60		ps
Settling Time	To 1 mV		200		ps
Differential Pedestal	Relative to Vin		-0.5		%
Differential Droop Rate	Relative to Vin		-0.1		%/ns
Hold Noise			TBD		μV/√Hz
Min Clock Frequency	50% duty cycle clock		200		MHz
Max Clock Frequency	50% duty cycle clock		2000		MHz
Max Hold Time			5		ns
HOLD-TO-TRACK AND TRACK STATE, TH2					
Min Track Time	After TH1 in Hold Mode		0.5		ns
Recovery Time			2		ns

Notes:

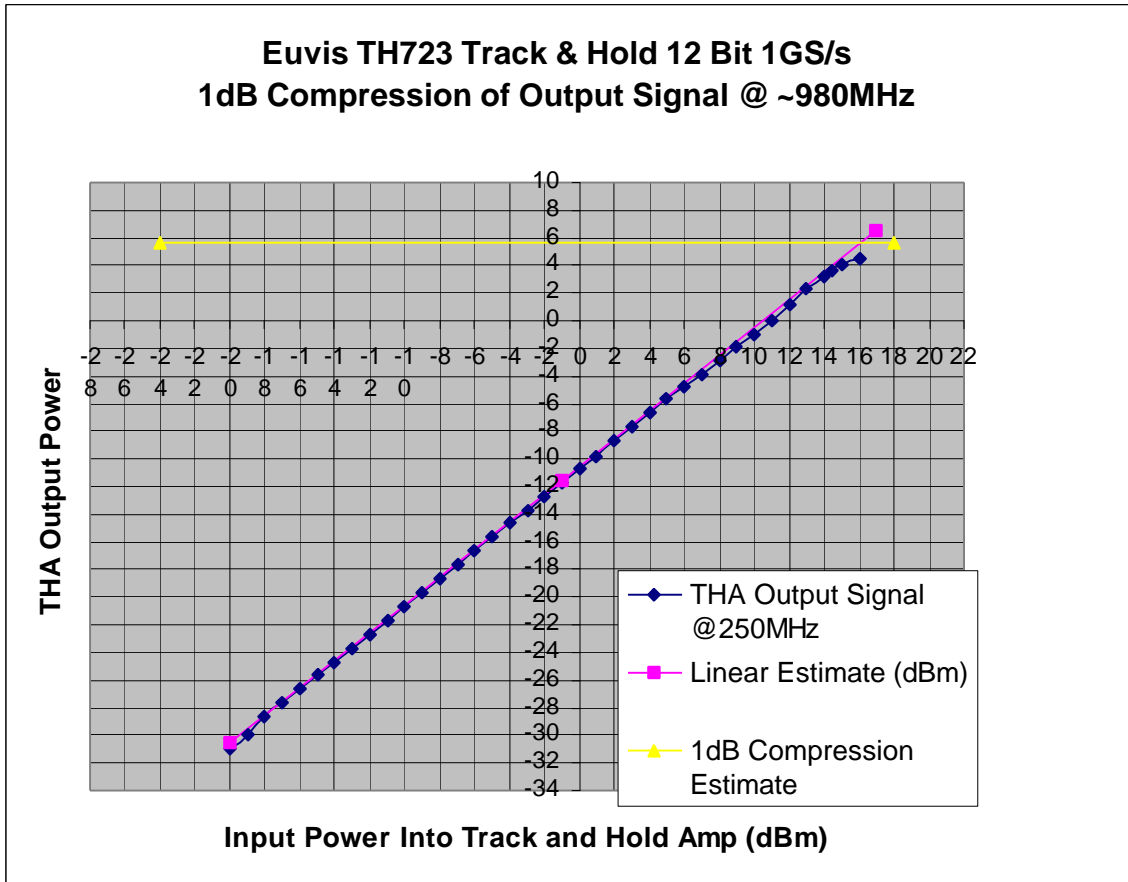
-Above measurements are with differential 1000MHz out-of-phase CK1 & CK2 clocks.

-V<sub>to</sub>=2V

**ELECTRICAL SPECIFICATIONS (CONTINUED)**

Parameter	Conditions/Note	Min	Typical	Max	Unit
<b>POWER SUPPLY</b>					
Positive Supply Voltage	Vcc	4.75	5	5.25	V
Vcc Current	Icc		120		mA
Negative Supply Voltage	Vee	-5.45	-5.2	-4.95	V
Vee Current	Iee		270		mA
Vto Current	Ivto		70		mA
Power Dissipation			2.1		W
Warm Up Time			10		s

**LINEARITY MEASUREMENTS**

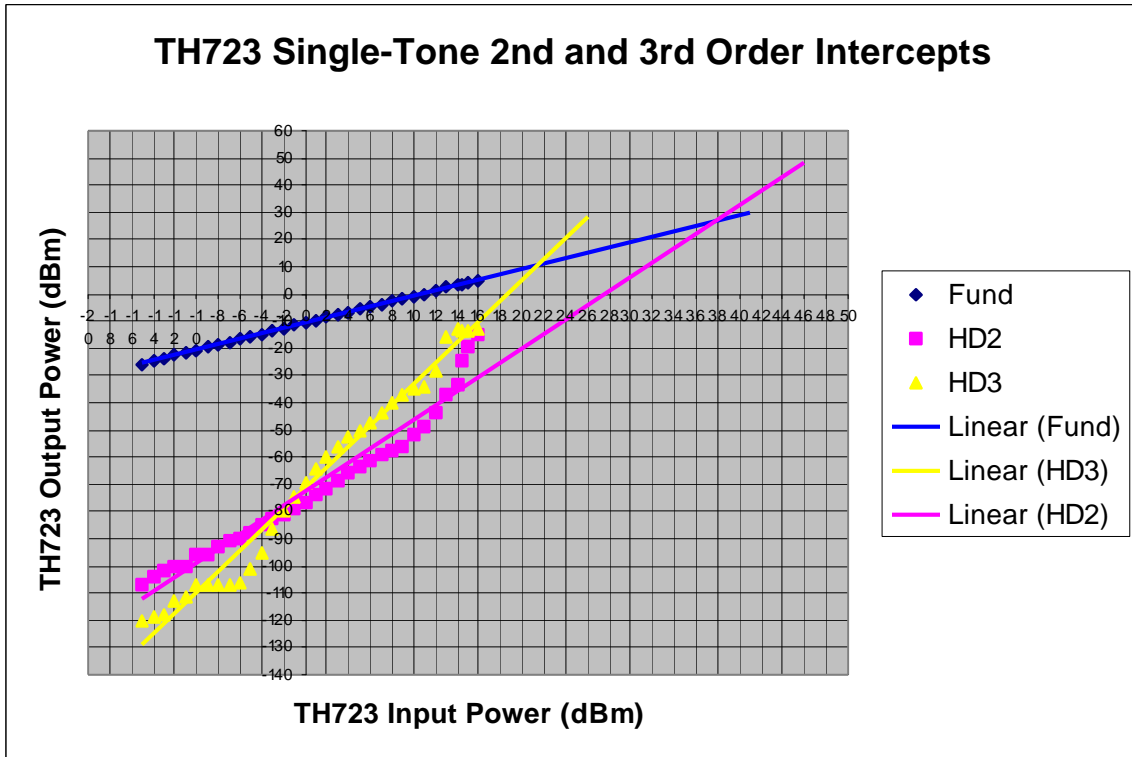


1 dB compression point = 5.6 dBm output  
 conversion gain @ 1 dB compression point = -5.5 dB

Notes:

-Input power into track and hold amplifier is single-ended. The single-ended output will be -6 dB lower than the single-ended input. Output power in the chart does not reflect the -6dB correction.

LINEARITY MEASUREMENTS CONTINUED

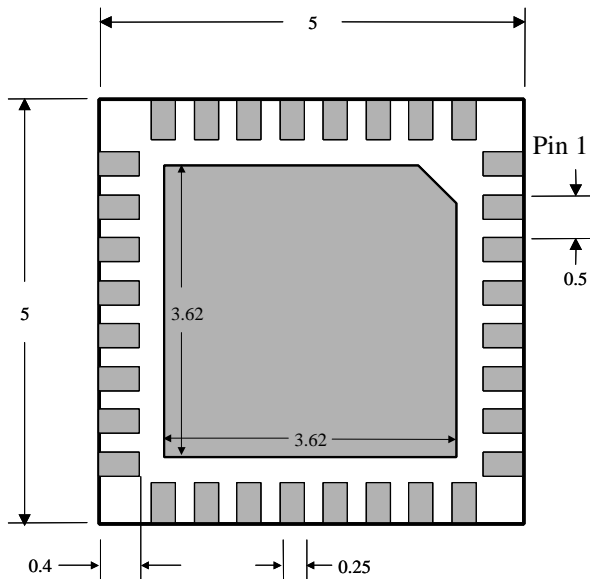
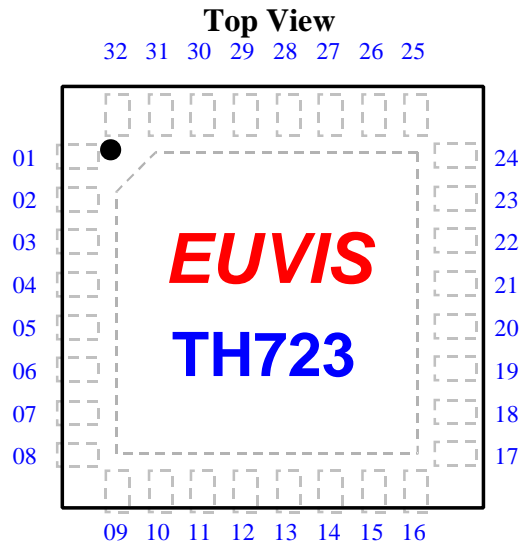


2<sup>nd</sup> Order intercept located: (21.25 dBm input, 10.25 dBm output)

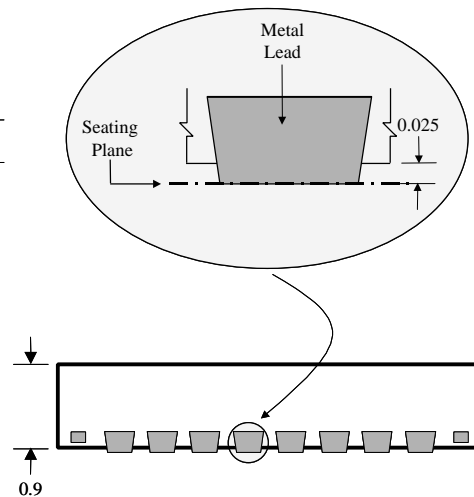
3<sup>rd</sup> Order intercept located: (37.8 dBm input, 26.6 dBm output)

**PACKAGE OUTLINE DIMENSIONS**

- Unit: mm
- Package Format: 32-pin QFN
- Package Size: 5 mm x 5 mm
- Pin Pitch: 0.5 mm



**Bottom View**



**Side View**

## PIN DESCRIPTION

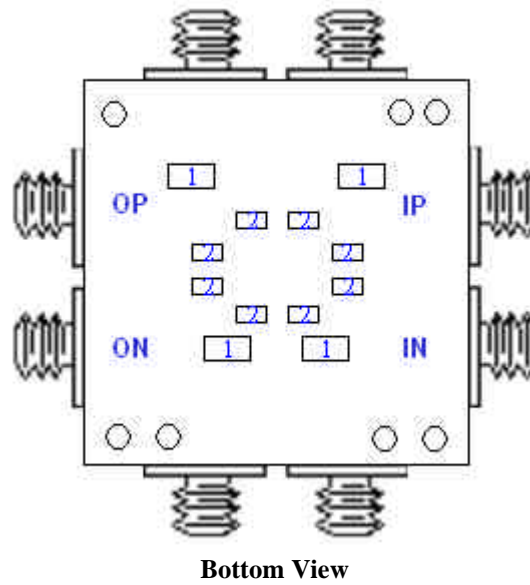
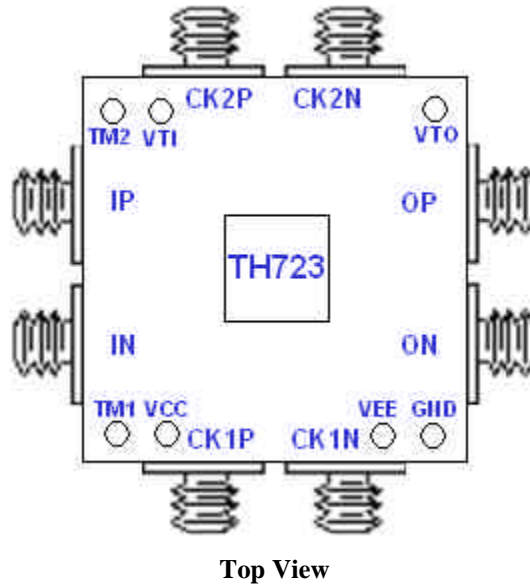
Pin	Name	Function
2, 23	VCC	Positive power supply
7, 18	VEE	Negative power supply
8, 17	VTO	Output termination voltage
28	INP	Positive input
29	INN	Negative input
13	OUTP	Positive output
12	OUTN	Negative output
4	CK1P	Clock 1 positive input
5	CK1N	Clock 1 negative input
21	CK2P	Clock 2 positive input
20	CK2N	Clock 2 negative input
31	TM1	Track mode select for T/H stage 1
26	TM2	Track mode select for T/H stage 2
3, 6, 9, 11, 14, 16, 19, 22, 25, 27, 30, 32	GND	Ground
1, 10, 15, 24	NC	No connection

**ABSOLUTE MAXIMUM RATINGS**

V <sub>cc</sub>	0V to 6V
V <sub>ee</sub>	-6V to 0V
V <sub>to</sub>	0V to 6V
Inputs (INP/N, CK1P/N, CK2P/N)	-1V to 1V
Outputs (OUTP/N)	-2V to V <sub>cc</sub>
$\theta_{JA}$	TBD
Maximum Junction Temperature	150°C
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	-40°C to +125°C

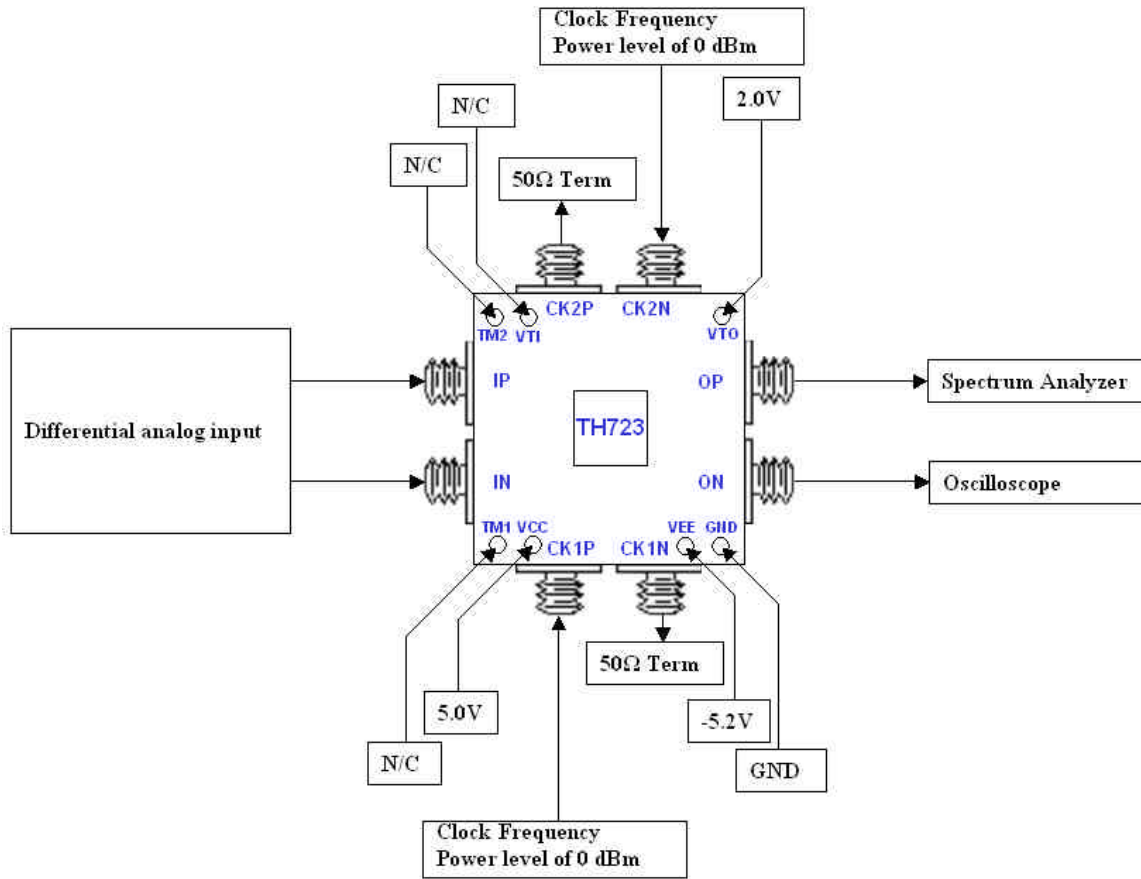
**LEAD TEMPERATURE RANGE (SOLDERING 60 SEC)                      TBD**

**EVALUATION PCB LAYOUT**



- Notes:
- Parts labeled "1" are 0603 10 uF Capacitors.
  - Parts labeled "2" are 0402 100 nF Capacitors.

## TYPICAL CONNECTION DIAGRAM



## Description:

The measurements in the TH723 data sheet were taken using the setup above. First, connect the output OP to a spectrum analyzer and output ON to an oscilloscope. Then, connect the differential analog input to IP and IN. Connect the clock frequency to CK1P and CK2N. Terminate the unconnected SMA connectors with a 50Ω termination caps. After the SMA connections are properly made, connect power supply outputs to the corresponding DC pins without turning on the power. When ready to use, supply a DC voltage of +5.0V to VCC, +2.0V to VTO, and -5.2V to VEE.

## Notes:

-Using appropriate band-pass filters for the input signal may improve performance.

**ORDERING INFORMATION**

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