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Ai-760 Analog Test Instrument

Versatile C-size VXI Instrument for Defense and Aerospace Applications

Teradyne's Ai-760 analog test instrument allows systems integrators to create powerful, mixed-signal test equipment that yields lower costs for test systems and test programs.

The Ai-760 is a standards-based analog test solution that provides high-performance and flexibility for Defense and Aerospace test applications. The Ai-760 combines legacy functionality with advanced, parallel test capabilities. This powerful combination of features makes the Ai-760 the ideal analog test instrument to leverage past test program set (TPS) investment as well as capture the benefits of operational test.



As with all instruments in Teradyne's Core Systems Instrumentation (CSi) family, the Ai-760 combines greater levels of functionality and high-performance in a small form factor. The Ai-760 consolidates moderate frequency source and measurement instruments and provides solid coordination of analog subsystem test functions. With parallel source and measure capability to implement operational test of units under test (UUTs) and to increase TPS throughput, the Ai-760 is perfect for reducing test costs while increasing test coverage. This combination of functional density and unified control of multiple instruments enables system integrators to decrease tester footprint and increase test performance.

Features

- Physical Consolidation of traditional instruments into a single system with increased functionality and decreased footprint
- Complete Analog Subsystem with Multi function Analog (MFA) Channels that increases system capabilities while lowering system operating costs and TPS development costs
- Parallel Test capability that facilitates operational test for higher throughput and quality of test
- (8) MFA Tester-Per-Pin Channels
    - 200 MHz Timer/Counter
    - 200 MS/s, 14 Bit ARB
    - 50 MS/s, 12 Bit Digitizer
- (1) 6.5 Digit Digital Multimeter (DMM)
- (1) 2-Channel 1 GS/s Digital Sampling Oscilloscope (DSO)

A Complete Analog Subsystem Optimized for Operational Test

The Ai-760-20 is a full-featured analog subsystem with a digital sampling oscilloscope (DSO), digital multimeter (DMM) and eight (8) multifunction analog (MFA) tester-per-pin channels, each with an arbitrary waveform generator, a timer/counter, and a digitizer. This powerful combination of test assets makes the Ai-760-20 an ideal instrument for securing the benefits of operational and parallel testing.

Operational Test Capability

Operational test, where the tester emulates the operating conditions of the UUT, reduces overall test costs and risks because it expands the fault capture envelope during production and field testing. By reducing both the incidence of bad units passing production test and reducing the incidence of Return Test OK (RTOK) for failed UUTs, operational test leads to lower costs for both the UUT manufacturer and user.

Testing devices under operational conditions involves applying multiple stimuli and making multiple measurements in parallel. All stimulus and measurement channels must have full test capability while operating both independently and simultaneously. With this capability, the Ai-760 can expose the UUT to operational conditions and measure the UUT's response.

Parallel Test Capability

In addition to being a pre-requisite for operational testing, parallel test capability leads to reduced costs and risks through improved test quality and reduced TPS run time. Finding defects that involve interactions between multiple UUT ports is difficult using sequential testing and single-channel, single-function test instruments. By contrast parallel testing makes it possible to test multiple ports simultaneously searching for problems caused by faulty UUT channel interaction.

Tester-Per-Pin Architecture

Complete, cost-effective parallel test requires multiple test channels where each channel can both provide stimulus and measure response. Also, channels must operate independently and simultaneously. Systems that depend on switch matrices and multiplexers to route signals to scarce central test resources cannot adequately provide parallel test capability.

The tester-per-pin architecture of the Ai-760 MFA provides effective parallel analog test. Each MFA channel has dedicated stimulus and measurement test instruments that can be used simultaneously to perform tests either independently of, or in synchronization with, other MFA channels.

Ai-760 Configurations

Four single-slot Ai-760 configurations are available to fit the systems integrator's analog test requirements:

1. Ai-760-20
2. Ai-760-10
3. Ai-761-20
4. Ai-761-10

Ai-760-20

This full featured analog subsystem offers the highest level of instrument consolidation. The Ai-760-20 consists of a 1 GSa/s DSO with a 600 MHz input bandwidth, an 8-channel MFA module, and a 6.5 digit DMM.



Ai-760-10

This lower cost configuration consists of an 8-channel MFA module and 6.5 digit DMM.



Ai-761-20

The Ai-761-20 consists of 16 high-performance MFA channels in a single-slot VXI card.

Ai-761-10

The Ai-761-10 consists of 8 high-performance MFA channels in a single-slot VXI card.

Multiple Ai-760 and Ai-761 cards can be added to a tester to provide the right level of test performance.

Each of the four standard Ai-760 configurations is comprised of one or more the following instrument modules:

1. Ai-760 DSO
2. Ai-760 DMM
3. Ai-760 MFA

Ai-760 DSO

Teradyne's Ai-760 DSO is designed to meet ATE system integrators' needs. It provides high-speed, high-bandwidth data acquisition channels, and has four (4) front panel inputs multiplexed to the two acquisition channels. Each channel is independently capable of a 1 GHz sample rate. The 2:1 multiplexer of each channel is optimized to maintain the Ai-760 DSO's 600MHz input bandwidth for all inputs. As a result integrators can wire each of the two acquisition channels to their ICA and still have a second probe input signal for each channel.



The Ai-760 DSO also has an external trigger input and an external clock input. By connecting the test system trigger to the external trigger, signal capture can be synchronized with other test system test events.

Ai-760 DMM

The Ai-760 DMM is a high-performance 6.5 digit multimeter designed for ATE system demands, having a wide spectrum of measurement ranges as well as robust protection from overvoltage/overcurrent conditions. Measurement capabilities for AC and DC voltage range from millivolt readings with nanovolts of resolution to 300 V with microvolts of resolution. Similarly for current measurements, the Ai-760 DMM can measure milliamps of current with nanoamp resolution up to 3 Amps with microamp resolution. The multimeter has both 2-wire and 4-wire resistance modes offering integrators the ability to optimize for either measurement speed or measurement accuracy. These measurement capabilities are protected with a maximum, non-destructive input range of 450 V, a ± 200 V maximum common mode voltage, and a 3A 250V fuse.



Ai-760 MFA

Teradyne's Ai-760 MFA is an eight channel multi-function analog instrument subsystem that gives the system integrator the ability decrease test program costs while increasing test coverage not just by providing more instrumentation in a smaller package but by also enabling parallel test via the tester-per-pin architecture. Each MFA channel offers the following high-performance functions on a per-pin basis:



- 200 MSa/s Arbitrary Waveform Generator (AWG)
- 50 MHz Digitizer
- 200 MHz Timer/Counter

Waveform Generation

Each of the eight AWGs can be used as an independent AWG, or multiple channel AWGs can be used as a single, multi-channel AWG providing compatibility with legacy AWGs and TPS programming methods. Every AWG has its own 2 Msamples of memory for specifying either a single waveform or for segmenting into up to 4096 different waveform. Each AWG is also a standard function generator for producing the following standard waveforms:

- Sine
- Square
- Triangle
- AM
- FSK
- Half-sine
- Legacy half-sine
- Ramp
- FM
- Frequency Hopping

Digitizing Waveforms

Each of the 8 Ai-760 MFA digitizers can be used independently to acquire data at up to 50 MHz. Every MFA digitizer has its own 2 Msamples of memory for data capture. In addition to the selectable input impedance (50Ω or 1 MΩ) of each MFA channel the digitizer also provides integrators with flexibility of three input voltage ranges (100 mV, 1 V, 10 V) for optimizing the 14-bit resolution to the voltage range of the input signal.

The digitizer of an MFA channel can be used simultaneously with the AWG and timer/counter of the same channel. This makes it possible to monitor the stimulus signal from the Ai-760 MFA to verify that the desired test signal is being output during load conditions and to test for unexpected load conditions that may indicate a failed UUT, failed ITA, or failed instrument to UUT connection.

Timer/Counter Measurements

Each of the 8 Ai-760 MFA timer/counters can be used independently to perform accurate time and event measurements. With an input signal frequency range of 1 mHz to 200 MHz and an event count range of 1012 -1, these timer/counters can handle a wide range of test applications.

As with the digitizer, the timer/counter of an MFA channel can be used simultaneously with the other instruments of the same channel. This makes it possible to not only monitor the stimulus signal to test for unexpected load conditions, but it also makes it possible to simultaneously perform fast, highly accurate timing/counting measurements while also acquiring and storing the input waveform for more detailed, post-capture analysis.

iStudio for the Ai-760

The Ai-760 is backed by iStudio, which is a comprehensive graphical user interface (GUI) driven development and debugging environment that complements existing Applications Development Environments (ADE) and test executives. This makes it a good tool to learn and experiment with the Ai-760 instruments. iStudio features an Analog Test Editor for programming and editing stimulus and measurement steps that create an analog test. iStudio can be used interactively on the test system, or can be used on a stand-alone computer with instrument simulation.

iStudio is an effective tool for increasing TPS developers productivity both as a development tool and a debugging tool. Using the iStudio Analog Test Editor, programmers can develop and test the configuration and control functions of the Ai-760 required to perform stimulus and measurement operations. Additionally, TPS developers have the option of creating an analog test sequence in the Analog Test Editor and saving the test sequence as a project that can be executed using a single call from a TPS written in standard programming language like C, C#, Visual Basic, or ATLAS.

Arbitrary Waveform Generator Specification (MFA Channel Function)

General Specifications

Number of Channels	8 single-ended, 4 differential
Standard Waveforms	Arbitrary, DC, Sine, Square, Triangle, Ramp, Pulse, Double-pulse, FSK, AM, FM
Max Sample Rate	200 MSa/s
Resolution	14 bits
Memory Depth	2 MSa per channel
Channel-to-channel Skew	≤ 10 ns for standard waveforms
Input Trigger Sources	Any MFA channel, Front panel triggers, Software or VXI triggers
Trigger Modes	Start, Advance Sample, Advance Segment, Retrigger
Trigger Delay Range	140 ns to 21s, 5 ns resolution
Trigger Event Count Range	1 to 65,535

Output Characteristics

Voltage Output	20 V_{pp} open, source/sink ±100 mA, programmable amplitude, slew rate > 1000 V/µs
Offset Resolution	5 mV
Amplitude & Offset Accuracy	1% of setting +40 mV

Sine Wave

Frequency Range	5 µHz to 25 MHz
Initial Phase Range	0 to 360°
Phase Resolution	0.05°
THD	-21 dBc (to 25 MHz)
SFDR	> 50dB

Square Wave

Frequency Range	5 µHz to 25 MHz

Triangle/Ramp Waveform

Frequency Range	Up to 2 MHz

Pulse Waveforms

Frequency Range	5 µHz to 25 MHz
Pulse Width Range	10 ns to 200,000 s

Double Pulse

Spacing (Delay) Range	200 ns to 21 s
Spacing Resolution	5 ns to 2M * Sample Clock Period

Timer/Counter Specification (MFA Channel Function)

General Specifications

Number of Channels	8 single-ended, 4 differential
Measure Modes	Count Events, Duty Cycle, Frequency, Frequency Ratio, Period, Period Averaging, Pulse Width, Time Interval
Input Trigger Sources	Any MFA channel input, Front panel triggers, Software, or VXI triggers

Input Characteristics & Resolution

Max Frequency	200 MHz, Pulse and repetitive
Input Impedance	1MΩ or 50Ω
Max Input	40 V_{RMS} (1 MΩ), 5.5 V_{RMS} (50Ω)
Time Interval Range	4 ns – 17,592s
Frequency Resolution	± 4 ns (additive errors: trigger, frequency/gate, and time)
Event Count Range	1 to 10^{12} -

Specifications

Digitizer Specification (MFA Channel Function)

General Specifications

Number of Channels	8 single-ended, 4 differential
Sample Rate	85 s to 20 ns per sample (11.8 mHz to 50 MHz)
Resolution	12 bits
Acquisition Memory	2 Million samples per channel
Input Trigger Sources	Any MFA channel input, Front panel triggers, Software, or VXI triggers

Input Characteristics

Bandwidth	DC to 25 MHz
Input Impedance	1 MΩ or 50Ω
Coupling	AC or DC
Maximum Input	±10 V (1MΩ), 5 V_{RMS} (50Ω)

Multi-Function Analog (MFA) Channel Specifications

General Specifications

Number of Channels	8 single-ended, 4 differential
Functions per Channel	Arbitrary Waveform Generator Digitizer Timer/Counter Trigger
Input Impedance	50Ω 1 MΩ in parallel with 130 pF
Input Range	50Ω: 5 V_{RMS} 1 MΩ: ±10 V
Maximum Input without Damage	50Ω: 5.5 V_{RMS} 1 MΩ: ±40 V (DC to 5 kHz, decreasing to 5 V_{RMS} above 5 kHz)

MFA Channels as Trigger Specifications

Input Voltage Range	50Ω: 5 V_{RMS} 1 MΩ: ±10 V
Input Frequency Range	DC to 20 MHz
Trigger Level Resolution	2.33 mV
Trigger Levels per Channel	2
Trigger Level Accuracy	± 150 ± 2% of level
Trigger Slope	Positive or negative
Sensitivity	100 mV for 5 ns or larger pulses

Digital Sampling Oscilloscope Specifications

Acquisition Input Channels

Number of Channels	4 inputs multiplexed to 2 channels
Bandwidth	DC to 600 MHz (50Ω) DC to 100 MHz (1 MΩ)
Maximum Sampling Rate	1 GSa/s for each of 2 channels
Minimum Sampling Rate	5 Sa/s for each channel
Equivalent Time Sampling Rate	50 GS/s
Resolution	8 bits
Time Base Sources	VXI CLK 10 or EXTCLK input
Maximum Input	±250 V(DC + peak AC) (1 MΩ 5 V_{RMS} (50Ω)
Full Scale Range	10 mV_{pp} to 500 V_{pp}, 1,400 steps
Input Filtering	Bypass or 19 MHz
Coupling	DC or AC
AC Coupling Cutoff	50Ω: > 200 kHz 1 MΩ: > 10 Hz
Impedance	50Ω or 1 MΩ with 22 pF (typ.)

Timebase

Channel Isolation	DC to 100 MHz: 40 dB 100 to 600 MHz: 30 dB
Channel-to-channel Skew	< 100ps (identical configurations)
Vertical Sensitivity	1 mV/Div to 5 V/Div

External Trigger Input

Input Impedance	50Ω: ± 5%
Input Coupling	AC, DC
Trigger Slope	Positive or negative
Threshold	50Ω: ±4.5 V 1 MΩ: ±10 V
Minimum Pulse Width	10 ns

DMM Specifications

General Specifications

Measurement Modes (Inputs)	DCV, ACV_{RMS} (HI, LO), DCI, ACI_{RMS} (I+, LO), 2-wire Resistance, Frequency/Period (HI, LO), 4-wire Resistance (HI, LO, Sense HI, Sense LO)
Voltage Measurements	Up to ±300 volts DC or AC
Current Measurements	Up to 3 Amps
Resistance Measurements	Up to 100 MΩ (full scale)
Trigger Modes	Start or Arm measurement

Ranges

DC/AC Voltage	100 mV, 1 V, 10 V, 100 V, 300 V
DC Current	1 mA, 10 mA, 100 mA, 1 A, 3 A
AC Current	10 mA, 100 mA, 1 A, 3 A
Resistance MΩ	100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, 30 MΩ, 100

Resolution

DC & AC Voltage Resolution	100 nV, 1 µV, 10 µV, 100 µV, 100 µV, respectively for each range
DC Current Resolution range	1 nA, 10 nA, 100 nA, 1µA, 1 µA, respectively for each
AC Current	10 nA, 100 nA, 1µA, 1µA, respectively for each range
Resistance	100 µΩ, 1 mΩ, 10 mΩ, 100 mΩ, 1 Ω, 10 Ω, 100 Ω, 100 Ω, respectively for each range

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