



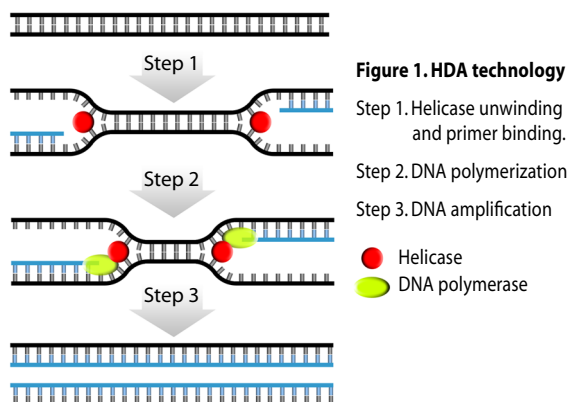
## IsoAmp® II Universal tHDA Kit

(tHDA : thermophilic Helicase-Dependent Amplification)

Catalog # H0110S  
Store at -20°C

### INSTRUCTION MANUAL

Thermophilic Helicase-Dependent Amplification (tHDA) is a novel method for isothermal amplification of nucleic acids. Like PCR, the tHDA reaction selectively amplifies a target sequence defined by two primers. However, unlike PCR, tHDA uses an enzyme called a helicase to separate DNA, rather than heat. This allows DNA amplification without the need for thermocycling. The tHDA reaction can also be coupled with reverse transcription for RNA analysis.



IsoAmp® II Universal tHDA kit can be used to amplify and detect short DNA sequences (70 bp - 120 bp) at a constant temperature. The kit can be used with a variety of templates, including microbial genomic DNA, viral DNA, plasmid DNA, and cDNA. A single copy of target DNA can be amplified by tHDA and detected by agarose gel electrophoresis when optimized primers and buffer are used.

IsoAmp® II Universal tHDA kit is based on a second-generation thermophilic Helicase-Dependent Amplification platform. The reactions supported by IsoAmp® II Universal tHDA kit include tHDA, reverse transcription HDA (RT-HDA), real-time quantitative HDA (qHDA) and real-time quantitative RT-HDA (qRT-HDA), from a single reaction buffer. IsoAmp® II Universal tHDA kit contains an enzyme mix, dNTP solution and buffer, allowing flexibility in reaction setup. A Control Template and a set of specific primers are supplied for the positive control reaction.

Recommended storage conditions for the tHDA kit are -20°C for storage shorter than 6 months and -80°C for storage greater than 6 months. Please avoid repeated freeze-thaw cycles as this may decrease performance of the kit.

### KIT COMPONENTS

IsoAmp® Enzyme Mix (50 reactions)	175 µl
IsoAmp® dNTP Solution (50 reactions)	175 µl
10X Annealing Buffer II	0.5 ml
MgSO <sub>4</sub> (100 mM)	1 ml
NaCl (500 mM)	1 ml
Control Template (Plasmid: 1 ng/µl)	15 µl
Control Forward Primer (5 µM)	16 µl
Control Reverse Primer (5 µM)	16 µl

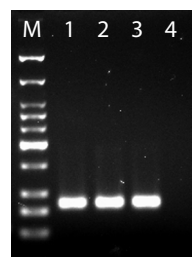
### REAGENTS TO BE SUPPLIED BY USER

Recommended for use with the IsoAmp® II Universal tHDA kit when applicable:

- Primers (Operon Biotechnologies)
- ThermoScript RT (Invitrogen, Cat# 12236-022)
- EvaGreen (Biotium, Cat# 31000)
- ROX Reference Dye (Invitrogen, Cat# 12223-012)

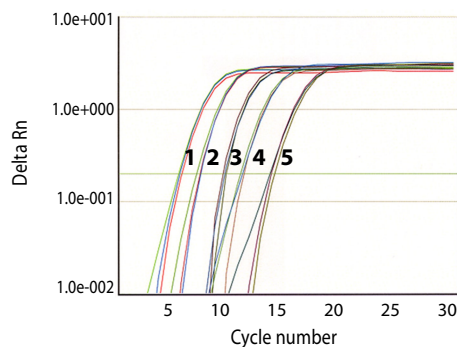
### POSITIVE CONTROL ASSAYS

The Control Template and Control Primers provided in this kit can be used as a positive control in tHDA (Fig. 2A) and qHDA (Fig. 2B) reactions. This control reaction amplifies a 85 bp target sequence. The expected melting temperature (*T<sub>m</sub>*) of the amplicon in the melt-curve analysis is 79°C ± 1°C. To set up a positive control, follow the one-step or two-step tHDA or qHDA protocols using 1 µl of Control Template (Plasmid: 1 ng/µl), 0.75 µl of Control Forward Primer (5 µM) and 0.75 µl of Control Reverse Primer (5 µM).



**Figure 2A**

M: LMW DNA ladder (100 ng; NEB)  
1: 1 ng  
2: 100 pg  
3: 10 pg  
4: 0 pg



**Figure 2B**

1: 5 ng  
2: 500 pg  
3: 50 pg  
4: 5 pg  
5: 500 fg

**Figure 2.** Positive control assays with varying amount of Control Template.  
A, two-step tHDA positive control with 10 pg – 1 ng Control Template.  
B, two-step qHDA positive control using 500 fg – 5 ng, in triplicate.

### PROTOCOLS

- One-Step tHDA (thermostable HDA)
- One-Step RT-HDA (Reverse Transcription tHDA)
- One-Step qHDA (Real-time quantitative tHDA)
- One-Step qRT-HDA (Real-time quantitative RT-HDA)
- Two-Step tHDA (thermostable HDA)

- F. Two-Step RT-HDA (Reverse Transcription tHDA)
- G. Two-Step qHDA (Real-time quantitative tHDA)
- H. Two-Step qRT-HDA (Real-time quantitative RT-HDA)

All reactions supported by the IsoAmp® II Universal tHDA kit can be performed using either a one-step (the entire reaction at 65°C) or a two-step protocol (template denaturation at 95°C, followed by amplification at 65°C). For maximal sensitivity, the two-step protocol is recommended. The sensitivity of the tHDA, RT-HDA, qHDA and qRT-HDA reactions may be up to 10-fold higher using a two-step protocol than using a one-step protocol for some amplicons and/or primer sets.

### One Step Protocols

#### A. One-Step tHDA (thermostable HDA)

A.1. Set up a 50 µl reaction in a 0.2-ml or a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	5 µl
MgSO <sub>4</sub> (100 mM)*	2 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl
IsoAmp® Enzyme Mix	3.5 µl
<b>Total volume</b>	<b>50 µl</b>

A.2. Mix the reaction by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

A.3. Incubate at 65°C for 90 minutes using a thermocycler, a water bath or an incubator.

A.4. Load 10 µl of the tHDA product on a 2% agarose gel.

#### B. One-Step RT-HDA (Reverse Transcription tHDA)

B.1. Prepare a fresh 7-fold dilution of ThermoScript RT (15 U/µl, Invitrogen, Cat# 12236-022).

B.2. Set up a 50 µl reaction in a 0.2-ml or a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	5 µl
MgSO <sub>4</sub> (100 mM)*	1.75 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl
IsoAmp® Enzyme Mix	3.5 µl
ThermoScript RT (2.1 U/µl, Invitrogen)*	0.5 µl
<b>Total volume</b>	<b>50 µl</b>

B.3. Mix the reaction by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

B.4. Incubate at 65°C for 120 minutes using a thermocycler, a water bath or an incubator.

B.5. Load 10 µl of the RT-HDA product on a 2% agarose gel.

#### The following protocols are intended for real-time detection using the Applied Biosystems 7300 Real-Time PCR System.

The kit also can be coupled with real-time detection methods to conduct real-time quantitative tHDA (qHDA) and RT-HDA (qRT-HDA) to monitor amplification as it progresses. For optimal performance, use EvaGreen as a reporter dye and ROX as a passive reference dye. Sequence-specific probes can also be designed for qHDA experiments.

#### C. One-Step qHDA (Real-time quantitative tHDA)

C.1. Set up a 50 µl reaction in a MicroAmp optical tube (Applied BioSystems) in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	5 µl
MgSO <sub>4</sub> (100 mM)*	2 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl
IsoAmp® Enzyme Mix	3.5 µl
EvaGreen (20X, Biotium)	0.5 µl
ROX Reference Dye (50X, Invitrogen)	1 µl
<b>Total volume</b>	<b>50 µl</b>

C.2. Mix the reaction by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

C.3. Real-time detection is carried out on a 7300 Real-Time PCR System (ABI) with the following well inspector setting: reporter dye: SYBR; quencher: none; passive reference dye: ROX. Use the following program:

Stage 1: (60 X)

Step1: 66°C for 0:05

Step2: 65°C for 1:55

Data collection and real-time analysis enabled

Stage 2: (1 X)

Dissociation Stage (default settings of the machine)

Melt curve data collection and analysis enabled

#### D. One-Step qRT-HDA (Real-time quantitative RT-HDA)

D.1. Prepare a fresh 7-fold dilution of ThermoScript RT (15 U/µl, Invitrogen, Cat# 12236-022).

D.2. Set up a 50 µl reaction in a MicroAmp optical tube (Applied BioSystems) in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	5 µl
MgSO <sub>4</sub> (100 mM)*	1.75 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl
IsoAmp® Enzyme Mix	3.5 µl
ThermoScript RT (2.1 U/µl, Invitrogen)*	0.5 µl
EvaGreen (20X, Biotium)	0.5 µl
ROX Reference Dye (50X, Invitrogen)	1 µl
<b>Total volume</b>	<b>50 µl</b>

D.3. Mix the reaction by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

D.3. Real-time detection is carried out on a 7300 Real-Time PCR System (ABI) with the following well inspector setting: reporter dye: SYBR; quencher: none; passive reference dye: ROX. Use the following program:

Stage 1: (60 X)

Step1: 66°C for 0:05

Step2: 65°C for 1:55

Data collection and real-time analysis enabled

Stage 2: (1 X)

Dissociation Stage (default settings of the machine)

Melt curve data collection and analysis enabled



*Two Step Protocols*

**E. Two-Step tHDA (thermostable HDA)**

E.1. To set up a 50 µl tHDA reaction, prepare a 25 µl Mix A in a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.:

H <sub>2</sub> O	X µl
10X Annealing buffer II	2.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl

Total volume of Mix A 25 µl

In addition, prepare a 25 µl Mix B in a separate 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation:

H <sub>2</sub> O	9.5 µl
10X Annealing buffer II	2.5 µl
MgSO <sub>4</sub> (100 mM)*	2 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
IsoAmp® Enzyme Mix	3.5 µl

Total volume of Mix B 25 µl

E.2. Gently mix each of the mixes by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

E.3. Incubate Mix A at 95°C for 2 minutes and place promptly on ice. Add 25 µl of Mix B into Mix A underneath the oil layer and gently mix the reaction by pipetting. Place the tubes on ice.

E.4. Incubate at 65°C for 90 minutes using a thermocycler, a water bath or an incubator.

E.5. Load 10 µl of the tHDA product on a 2% agarose gel.

**F. Two-Step RT-HDA (Reverse Transcription tHDA)**

F.1. Prepare a fresh 7-fold dilution of ThermoScript RT (15 U/µl, Invitrogen, Cat# 12236-022).

F.2. To set up a 50 µl RT-HDA reaction, prepare a 25 µl Mix A in a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.:

H <sub>2</sub> O	X µl
10X Annealing buffer II	2.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl

Total volume of Mix A 25 µl

In addition, prepare a 25 µl Mix B in a separate 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation:

H <sub>2</sub> O	9.25 µl
10X Annealing buffer II	2.5 µl
MgSO <sub>4</sub> (100 mM)*	1.75 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
IsoAmp® Enzyme Mix	3.5 µl
ThermoScript RT (2.1 U/µl, Invitrogen)*	0.5 µl

Total volume of Mix B 25 µl

F.3. Gently mix each of the mixes by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

F.4. Incubate Mix A at 95°C for 2 minutes and place promptly on ice. Add 25 µl of Mix B into Mix A underneath the oil layer and gently mix the reaction by pipetting. Place the tubes on ice.

F.5. Incubate at 65°C for 120 minutes using a thermocycler, a water bath or an incubator.

F.6. Load 10 µl of the RT-HDA product on a 2% agarose gel.

**The following protocols are intended for real-time detection using the Applied Biosystems 7300 Real-Time PCR System.**

The kit also can be coupled with real-time detection methods to conduct real-time quantitative tHDA (qHDA) and RT-HDA (qRT-HDA) to monitor amplification as it progresses. For optimal performance, use EvaGreen as a reporter dye and ROX as a passive reference dye. Sequence-specific probes can also be designed for qHDA experiments.

**G. Two-Step qHDA (Real-time quantitative tHDA)**

G.1. To set up a 50 µl qHDA reaction, prepare a 25 µl Mix A in a 0.2-ml MicroAmp optical tube (ABI) and a 25 µl Mix B in a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	2.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl

Total volume of Mix A 25 µl

H <sub>2</sub> O	8 µl
10X Annealing buffer II	2.5 µl
MgSO <sub>4</sub> (100 mM)*	2 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
IsoAmp® Enzyme Mix	3.5 µl
EvaGreen (20X, Biotium)	0.5 µl
ROX Reference Dye (50X, Invitrogen)	1 µl

Total volume of Mix B 25 µl

G.2. Gently mix each of the mixes by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.

G.3. Incubate Mix A at 95°C for 2 minutes and place promptly on ice. Add 25 µl of Mix B into Mix A underneath the oil layer and gently mix the reaction by pipetting. Place the tubes on ice.

G.4. Real-time detection is carried out on a 7300 Real-Time PCR System (ABI) with the following well inspector setting: reporter dye: SYBR; quencher: none; passive reference dye: ROX. Use the following program:

Stage 1: (60 X)  
 Step1: 66°C for 0:05  
 Step2: 65°C for 1:55  
 Data collection and real-time analysis enabled  
 Stage 2: (1 X)  
 Dissociation Stage (default settings of the machine)  
 Melt curve data collection and analysis enabled

**H. Two-Step qRT-HDA (Real-time quantitative RT-HDA)**

H.1. Prepare a fresh 7-fold dilution of ThermoScript RT (15 U/µl,

Invitrogen, Cat# 12236-022).

- H.2. To set up a 50 µl qRT-HDA reaction, prepare a 25 µl Mix A in a 0.2-ml MicroAmp optical tube (ABI) and a 25 µl Mix B in a 0.5-ml micro centrifuge tube in a sterile hood or a PCR Workstation.

H <sub>2</sub> O	X µl
10X Annealing buffer II	2.5 µl
DNA template	X µl
Forward Primer (5 µM)*	0.75 µl
Reverse Primer (5 µM)*	0.75 µl

Total volume of Mix A 25 µl

H <sub>2</sub> O	8 µl
10X Annealing buffer II	2.5 µl
MgSO <sub>4</sub> (100 mM)*	1.75 µl
NaCl (500 mM)*	4 µl
IsoAmp® dNTP Solution	3.5 µl
IsoAmp® Enzyme Mix	3.5 µl
EvaGreen (20X, Biotium)	0.5 µl
ROX Reference Dye (50X, Invitrogen)	1 µl
ThermoScript RT (2.1 U/µl, Invitrogen)*	0.5 µl

Total volume of Mix B 25 µl

- H.3. Gently mix each of the mixes by brief vortexing or by pipetting followed by brief centrifugation. Overlay the reaction mixture with 50 µl mineral oil. Place the tubes on ice.
- H.4. Incubate Mix A at 95°C for 2 minutes and place promptly on ice. Add 25 µl of Mix B into Mix A underneath the oil layer and gently mix the reaction by pipetting. Place the tubes on ice.
- H.5. Real-time detection is carried out on a 7300 Real-Time PCR System (ABI) with the following well inspector setting: reporter dye: SYBR; quencher: none; passive reference dye: ROX. Use the following program:

Stage 1: (60 X)

Step1: 66°C for 0:05

Step2: 65°C for 1:55

Data collection and real-time analysis enabled

Stage 2: (1 X)

Dissociation Stage (default settings of the machine)

Melt curve data collection and analysis enabled

\* The condition of tHDA reactions can be further optimized by titering the following components:

Components	Recommended concentration	Recommended concentration for titering
MgSO <sub>4</sub>	3.5 to 4 mM	3 to 4.5 mM
NaCl	30 to 40 mM	20 to 50 mM
Primer	75 to 100 nM	50 to 200 nM
ThermoScript RT	1 to 2 units	0.5 to 10.5 units

### PRIMER DESIGN AND AMPLICON SELECTION

tHDA primers can be designed using either the PrimerQuest program (<http://www.idtdna.com/Scitools/Applications/Primerquest/Advanced.aspx>) or the Primer3 program ([http://frodo.wi.mit.edu/cgi-bin/primer3/primer3\\_www.cgi](http://frodo.wi.mit.edu/cgi-bin/primer3/primer3_www.cgi)). Recommended parameter settings:

Product size: 80 – 120 bp\*\*

Product Tm: Min. 68; Opt. 71; Max. 75†

Primer size: Min. 24; Opt. 27; Max. 33‡

Primer Tm: Min. 60; Opt. 68; Max. 74§

Primer GC%: Min. 35; Opt. 44; Max. 60

(\*\*) tHDA works most efficiently with a product size around 100 bp. Successful tHDA amplifications were achieved with a product as short as 85 bp and as long as 129 bp.

(†) The Tm of an amplicon with a product size around 100 bp and a G + C

content around 40% is approximately 71°C from the calculation of Primer3. Successful tHDA amplifications were achieved with a product Tm as low as 68 °C and as high as 77°C.

(‡) The optimal primer size may be set at 26 bases when the G + C content of target sequence is larger than 45%. Successful tHDA amplifications were achieved with a primer size as short as 22 bases and as long as 32 bases.

(§) The optimal primer Tm may be set at 64 - 66°C when the G + C content of target sequence is smaller than 37.5% and at 70 - 72°C when the G + C content of target sequence is larger than 45%. Successful tHDA amplifications were achieved with a primer Tm as low as 60 °C and as high as 75 °C.

Other considerations:

1) Amplicons (regions to be amplified) containing a G + C content of approximately 40% are preferable (the G + C content of amplicons and target sequences can be calculated using the Oligonucleotide Properties Calculator program found at: <http://www.basic.northwestern.edu/biotools/oligoalc.html>).

2) Primer sets obtained using Primer3 with an average G + C content closest to the G + C content of the corresponding amplicons are preferable.

3) To obtain ideal amplification performance, test several amplicon regions for each target gene and design several primer sets for each selected region. The efficiency of the tHDA reactions may vary dramatically for different amplicons as well as for different primer sets within the specific region. Using primers optimized for PCR reactions may not guarantee similar performance in tHDA reactions.

4) Once a set of primers yields a positive amplification result, serial primer sets longer or shorter than this set may be analyzed to generate optimal primers for increased amplification efficiency.

5) Due to the sensitivity of tHDA to changes in salt concentrations in the reaction, the use of desalted primers is recommended. Successful tHDA reactions were achieved using salt-free primers synthesized by Operon Biotechnologies.

### GENERAL RECOMMENDATIONS

As tHDA, RT-HDA, qHDA and qRT-HDA are exponential amplification reactions, extra attention should be paid to avoid sample cross-over and carry-over contamination. Reaction assembly, amplification, and gel electrophoresis-based detection steps should be carried out in physically separated locations. Always wear gloves. Open the reaction tubes only when adding reagents into them during reaction setup and keep them closed at any other time. Never open the tubes after qHDA or qRT-HDA reactions are done.

Performance of tHDA, RT-HDA, qHDA and qRT-HDA is extremely sensitive to changes in the magnesium and salt concentrations of the reaction. Avoid introducing any substances that may affect these concentrations.

Every freshly thawed reagent should be gently vortexed and spun down before being added to the reaction. Autoclaved Milli-Q water should be used for tHDA and qHDA reactions. DEPC-treated water should be used for RT-HDA and qRT-HDA reactions. Use sterilized filter tips only and change tips after each pipetting step.

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