



# KAPA HiFi HotStart ReadyMix PCR Kit

KR0370 – v8.17

## Product Description

KAPA HiFi HotStart DNA Polymerase is a novel B-family DNA polymerase, engineered to have increased affinity for DNA, without the need for accessory proteins or DNA binding domains. The intrinsic high processivity of the enzyme results in significant improvement in yield, speed and sensitivity when compared with wild-type B-family DNA polymerases. In addition, the ability to amplify long targets, as well as GC- and AT-rich targets, is significantly improved. The enzyme is combined with a proprietary antibody that inactivates the enzyme until the first denaturation step. This prevents nonspecific amplification during reaction setup, increases sensitivity, and improves reaction efficiency.

In the ReadyMix PCR Kit, KAPA HiFi HotStart DNA Polymerase is supplied in a convenient 2X ReadyMix format, containing all reaction components except primers and template. The ReadyMix contains KAPA HiFi HotStart DNA Polymerase (0.5 U per 25  $\mu$ L reaction) in a proprietary reaction buffer containing dNTPs (0.3 mM of each dNTP at 1X), MgCl<sub>2</sub> (2.5 mM at 1X) and stabilizers.

KAPA HiFi HotStart ReadyMix is designed for routine, high-fidelity PCR of a wide range of targets and fragment sizes. It offers error rates approximately 100 times lower than wild-type *Taq* DNA polymerase, and higher success rates and yields than achievable with wild-type B-family (proofreading) DNA polymerases. In addition, KAPA HiFi HotStart requires significantly shorter reaction times than wild-type B-family DNA polymerases.

KAPA HiFi HotStart DNA Polymerase has 5'→3' polymerase and 3'→5' exonuclease (proofreading) activity, but no 5'→3' exonuclease activity. The strong 3'→5' exonuclease activity results in superior accuracy during DNA amplification, lending to KAPA HiFi HotStart DNA Polymerase the lowest published error rate of all B-family DNA polymerases (1 error per 3.6 x 10<sup>6</sup> nucleotides incorporated). This fidelity is approximately 100 times higher than that of wild-type *Taq* DNA polymerase, and up to 10 times higher than that of other B-family DNA polymerases and polymerase blends.

DNA fragments generated with KAPA HiFi HotStart ReadyMix may be used for routine downstream analysis and applications, including restriction enzyme digestion, cloning and sequencing. PCR products generated with KAPA HiFi HotStart ReadyMix are blunt-ended, but may be 3'-dA-tailed for cloning into TA cloning vectors (see **Important Parameters: TA cloning**).

Kapa/Roche Kit Codes and Components		
<b>KK2600</b> 07958919001	KAPA HiFi HotStart ReadyMix (2X)*	0.25 mL
<b>KK2601</b> 07958927001	KAPA HiFi HotStart ReadyMix (2X)*	1.25 mL
<b>KK2602</b> 07958935001	KAPA HiFi HotStart ReadyMix (2X)*	6.25 mL

\* Contains 2.5 mM MgCl<sub>2</sub> at 1X

Quick Notes
<ul style="list-style-type: none"> <li>• KAPA HiFi HotStart ReadyMix PCR Kits contain the engineered KAPA HiFi HotStart DNA Polymerase – developed for fast and versatile high-fidelity PCR.</li> <li>• Buffer, MgCl<sub>2</sub>, dNTPs and enzyme are supplied in a convenient 2X ReadyMix – just add primers and template.</li> <li>• KAPA HiFi HotStart DNA Polymerase has the lowest published error rate of all B-family DNA polymerases (1 error per 3.6 x 10<sup>6</sup> nucleotides incorporated).</li> <li>• Amplify targets up to 15 kb from genomic DNA or 20 kb from less complex targets.</li> <li>• Denature at 98°C for 20 sec per cycle.</li> <li>• Optimal annealing temperatures are typically higher than in other PCR buffer systems. Use an annealing temperature gradient to determine the optimal annealing temperature.</li> <li>• To ensure the highest fidelity, use high quality DNA and the lowest possible number of cycles.</li> </ul>

## Product Applications

The KAPA HiFi HotStart PCR Kit is ideally suited for:

- PCR for conventional sequencing (direct sequencing or sequencing of cloned PCR products)
- Next-generation sequencing library amplification (when used in conjunction with the KAPA Library Amplification protocol)
- Amplification of DNA fragments for cloning and protein expression or genomic characterization
- Site-directed mutagenesis.

For more information on these and other high-fidelity PCR applications, please refer to the KAPA HiFi Application Notes on **Site-Directed Mutagenesis**, **Routine High-Fidelity PCR**, and **High-Fidelity GC-rich PCR** available from [www.kapabiosystems.com](http://www.kapabiosystems.com).

## Standard PCR Protocol

**IMPORTANT!** The KAPA HiFi HotStart ReadyMix contains an engineered B-family (proofreading) DNA polymerase and uniquely-formulated buffers, and requires specialized reaction conditions. If these conditions are not adhered to, reaction failure is likely. Refer to **Important Parameters** for more information.

### Step 1: Prepare the PCR master mix

- KAPA HiFi HotStart reactions **MUST** be set up on ice since the high proofreading activity of the enzyme will result in rapid primer degradation at room temperature.
- Ensure that all reagents are properly thawed and mixed.
- Prepare a PCR master mix containing the appropriate volume of all reaction components common to all or a subset of reactions to be performed.
- Calculate the required volumes of each component based on the following table:

Component	25 $\mu$ L reaction <sup>1,2</sup>	Final conc.
PCR-grade water	Up to 25 $\mu$ L	N/A
2X KAPA HiFi HotStart ReadyMix <sup>3,4</sup>	12.5 $\mu$ L	1X
10 $\mu$ M Forward Primer	0.75 $\mu$ L	0.3 $\mu$ M
10 $\mu$ M Reverse Primer	0.75 $\mu$ L	0.3 $\mu$ M
Template DNA <sup>5</sup>	As required	As required

<sup>1</sup> Reaction volumes may be adjusted between 10–50  $\mu$ L. For volumes other than 25  $\mu$ L, scale reagents proportionally. Reaction volumes >50  $\mu$ L are not recommended.

<sup>2</sup> When using for next-generation sequencing library amplification, please use protocol provided with the KAPA Library Amplification Kit.

<sup>3</sup> KAPA HiFi HotStart ReadyMix contains 2.5 mM MgCl<sub>2</sub> (1X). Additional MgCl<sub>2</sub> may be added separately, but is unlikely to be required.

<sup>4</sup> KAPA HiFi HotStart ReadyMix contains 0.3 mM of each dNTP (1X), and 0.5 U of KAPA HiFi HotStart DNA Polymerase (per 25  $\mu$ L reaction) in a proprietary reaction buffer.

<sup>5</sup> Use <100 ng genomic DNA (10–100 ng) and <1 ng less complex DNA (0.1–1 ng) per 25  $\mu$ L reaction as first approach.

### Step 2: Set up individual reactions

- Transfer the appropriate volumes of PCR master mix, template and primer to individual PCR tubes or wells of a PCR plate.
- Cap or seal individual reactions, mix and centrifuge briefly.

### Step 3: Run the PCR

- Perform PCR with the following cycling protocol<sup>1</sup>:

Step	Temperature	Duration	Cycles
Initial denaturation <sup>2</sup>	95°C	3 min	1
Denaturation <sup>3</sup>	98°C	20 sec	15–35 <sup>7</sup>
Annealing <sup>4,5</sup>	60–75°C	15 sec	
Extension <sup>6</sup>	72°C	15–60 sec/kb	
Final extension	72°C	1 min/kb	1

<sup>1</sup> When using for next-generation sequencing library amplification, please use protocol provided with the KAPA Library Amplification Kit.

<sup>2</sup> Initial denaturation for 3 min at 95°C is sufficient for most applications. Use 5 min at 95°C for GC-rich targets (>70% GC content).

<sup>3</sup> KAPA HiFi HotStart ReadyMix has a higher salt concentration than conventional PCR ready-mixes, which affects DNA melting. To ensure that complex and GC-rich targets are completely denatured, use a temperature of 98°C for denaturation during cycling.

<sup>4</sup> In addition to DNA melting, high salt also affects primer annealing. The optimal annealing temperature for a specific primer set is likely to be different (higher) than when used in a conventional PCR ready-mix. An annealing temperature gradient PCR is recommended to determine the optimal annealing temperature with the KAPA HiFi HotStart ReadyMix. If gradient PCR is not feasible, anneal at 65°C as a first approach.

<sup>5</sup> Two-step cycling protocols with a combined annealing/extension temperature in the range of 68–75°C and a combined annealing/extension time of 30 sec/kb may be used.

<sup>6</sup> Use 15 sec extension per cycle for targets  $\leq$ 1 kb, and 30–60 sec/kb for longer fragments, or to improve yields.

<sup>7</sup> For highest fidelity, use  $\leq$ 25 cycles. In cases where very low template concentrations or low reaction efficiency results in low yields, 30–35 cycles may be performed to produce sufficient product for downstream applications.

## Important Parameters

### Annealing temperature

Due to the high salt concentration of the KAPA HiFi HotStart ReadyMix, the optimal annealing temperature for a given primer set is usually different when compared with a different buffer system. When using the kit with a specific primer pair for the first time, determine the optimal annealing temperature with annealing temperature gradient PCR. We recommend a gradient from 60–72°C, although some assays may require even higher annealing temperatures. For assays with optimal annealing temperatures of 68°C or higher, 2-step cycling may be performed at the optimal annealing temperature. Optimal annealing temperatures below 60°C are rare, but may be required when using primers with a high AT content.

If a gradient PCR is not feasible, use an annealing temperature of 65°C as a first approach, and adjust the annealing temperature based on the results obtained:

- If a low yield of only the specific product is obtained, lower the annealing temperature in 1–2°C increments.
- If nonspecific products are formed in addition to the specific product, increase the annealing temperature in 1–2°C increments.
- If no product is formed (specific or nonspecific), reduce the annealing temperature by 5°C. MgCl<sub>2</sub> concentration may have to be increased.
- If only nonspecific products are formed (in a ladder-like pattern), increase the annealing temperature by 5°C or try recommendations for GC-rich PCR (see **Important Parameters: GC-rich PCR**).

**NOTE:** The optimal annealing temperature for a specific primer pair with KAPA HiFi HotStart ReadyMix is typically 2–3°C lower than the optimal annealing temperature in KAPA HiFi Fidelity Buffer, and 2–3°C higher than the KAPA HiFi GC Buffer optimal annealing temperature.

#### Primer and Template DNA quality

Another critical factor for successful PCR with KAPA HiFi HotStart ReadyMix is primer design and quality. Primers should be carefully designed to eliminate the possibility of primer-dimer formation and nonspecific annealing as far as possible, and should have a GC content of 40–60%. Primers with GC content >60% may require higher denaturation temperatures and/or longer denaturation times, while primers with GC content <40% may require annealing temperatures <60°C, and/or increased MgCl<sub>2</sub> and primer concentrations. Furthermore, primer sets should be designed to have similar theoretical melting temperatures.

**NOTE:** Always dilute and store primers in a buffered solution (e.g. 10 mM Tris-HCl, pH 8.0–8.5) instead of PCR-grade water to limit degradation and maintain primer quality.

High-quality template DNA is essential for high-fidelity amplification. Degraded, damaged, or sheared template DNA is particularly problematic when amplifying longer fragments (>1 kb). To limit degradation and maintain template quality, always dilute and store DNA in a buffered solution (e.g. 10 mM Tris-HCl, pH 8.0–8.5) instead of PCR-grade water.

Amplification from low-complexity templates, such as plasmid DNA, generally requires minimal optimization. Applications based on low target copy numbers (e.g. when amplifying single-copy genes from genomic templates, or when using cDNA as template) are generally more challenging. For plasmid DNA, 1–10 ng template per 25 µL reaction is sufficient, whereas up to 100 ng complex genomic DNA or cDNA may be required.

#### MgCl<sub>2</sub> concentration

KAPA HiFi HotStart ReadyMix contains a final (1X) MgCl<sub>2</sub> concentration of 2.5 mM, which is sufficient for most applications. Applications which are likely to require higher MgCl<sub>2</sub> concentrations include long PCR (>10 kb) and AT-rich PCR, as well as amplification using primers with a low GC content (<40%).

#### GC-rich PCR

For GC-rich amplicons, reactions may be supplemented with 5% DMSO, 1X KAPA Enhancer 1 (supplied with KAPA2G Robust PCR Kits) or 1 M betaine to improve yield and/or specificity.

#### TA cloning

DNA fragments generated with the KAPA HiFi HotStart ReadyMix may be used directly for blunt-end cloning, or cloning using restriction endonucleases. For TA cloning of KAPA HiFi HotStart ReadyMix PCR products, first purify the PCR product to remove the KAPA HiFi HotStart DNA Polymerase, as residual proofreading activity will remove any dA-overhangs added during the A-tailing reaction. Perform A-tailing by combining the purified PCR product, 1X *Taq* buffer (with 1.5 mM MgCl<sub>2</sub>), 0.2 mM dATP and 1 U of *Taq* DNA polymerase and incubating for 5 min at 72°C.

## Product Specifications

#### Shipping, storage and handling

KAPA HiFi HotStart ReadyMix is shipped on dry ice or ice packs, depending on the country of destination. Upon arrival, store kit components at -20°C in a constant-temperature freezer. When stored under these conditions and handled correctly, full activity of the kit is retained until the expiry date indicated on the kit label. KAPA HiFi HotStart ReadyMix contains isostabilizers and may not freeze solidly, even when stored at -20°C. This will not affect the shelf-life of the product.

Always ensure that the product has been fully thawed and mixed before use. Reagents may be stored at 4°C for short-term use (up to 1 month). Return to -20°C for long-term storage. Provided that all components have been handled carefully and not contaminated, the kit is not expected to be compromised if left (unintentionally) at room temperature for a short period of time (up to 3 days). Long-term storage at room temperature and 4°C is not recommended. Please note that reagents stored at temperatures above -20°C are more prone to degradation when contaminated during use, and therefore storage at such temperatures is at the user's own risk.

#### Quality Control

Each batch of KAPA HiFi HotStart DNA Polymerase is confirmed to contain <2% contaminating protein (Agilent Protein 230 Assay). KAPA HiFi HotStart ReadyMix is subjected to stringent quality control tests, is free of contaminating exo- and endonuclease activity, and meets strict requirements with respect to DNA contamination levels.

## Troubleshooting

Symptoms	Possible causes	Solutions
No amplification or low yield	Cycling protocol	Use the recommended 3–5 min initial denaturation at 95°C, and perform cycle denaturation for 20 sec at 98°C. Increase the extension time to a maximum of 1 min/kb. Increase the number of cycles.
	Annealing temperature is too high	Reduce the annealing temperature by 5°C. Optimize the annealing temperature by gradient PCR.
	Template DNA quantity and quality	Excess template DNA chelates Mg <sup>2+</sup> . Either reduce the template concentration to <100 ng, or increase MgCl <sub>2</sub> . Check template DNA quality. Store and dilute in a buffered solution, not water.
	Primer concentration	Some primers anneal more efficiently than others. Increase the primer concentration, or optimize MgCl <sub>2</sub> to improve primer binding. Store and dilute primers in a buffered solution, not water.
	MgCl <sub>2</sub>	Optimize MgCl <sub>2</sub> concentration. AT-rich PCR typically requires more MgCl <sub>2</sub> .
Nonspecific amplification or smearing	Template DNA	Use <100 ng of DNA per reaction, or reduce the number of cycles. Check template DNA quality.
	Cycling protocol	Excessive annealing and/or extension times will result in nonspecific amplification, typically of bands larger than the target band. Reduce the annealing and extension times to a minimum of 10 sec each. Reduce the number of cycles.
	Annealing temperature is too low	A sub-optimal annealing temperature will result in nonspecific amplicons that are typically smaller than the target band. See <b>Important Parameters: Annealing Temperature</b> .
	Target GC content	Add 5% DMSO, 1X KAPA Enhancer 1 or 1 M betaine to reactions to facilitate melting of GC-rich templates.
	Primer concentration	Some primers anneal more efficiently than others. Decrease the primer concentration. Store and dilute primers in a buffered solution, not water.



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