Your commercial supply partner for innovation and productivity

OEM reagent guide for PCR, qPCR, and reverse transcription

ThermoFisher
SCIENTIFIC

Innovation and quality to drive your ideas

For over two decades, we have been offering innovative thermophilic DNA polymerases and reverse transcriptases (RTs) to enable sensitivity, speed, and reproducibility in PCR, qPCR, and RT applications. The unique properties, quality, and reliability of our products help you succeed in development and commercialization of nucleic acid–based assays with the highest accuracy, reproducibility, and validity.

Leverage unique capabilities of our enzymes to drive your innovative solutions

- Over 40 years of expertise in the development and manufacturing of enzymes and nucleotides
- Trusted, industry-leading brands such as the Invitrogen™ SuperScript™ and Platinum™ portfolio of enzymes
- Next-generation enzymes with improved properties derived from *in vitro* protein evolution
- Availability of lyo-ready enzyme formulations without glycerol for compatibility with lyophilized assays
- qPCR-grade dNTPs to enable reliability for the most demanding applications
- Custom functional testing tailored to meet your assay requirements
- High batch-to-batch consistency
- Sample availability for testing and validation

Integrative quality systems are the cornerstone of our business

- ISO 9001– and ISO 13485–certified facilities
- Manufacturing and product filling in facilities that meet 100,000 (ISO 8, class D) clean room standards
- Integral quality systems covering the supply chain, manufacturing, and quality control processes
- Raw material and vendor qualification to assure consistent supply
- Rigorous documentation, complete traceability, and process control
- Adherence to comprehensive standard operating procedures (SOPs)
- Monitoring of control processes to ensure consistency, compliance, and conformance of the products
- Implementation of complaint management and corrective and/or preventive action systems
- Openness to customer visits and audits

Trusted and flexible partner

We develop integrative partnerships with our customers, providing high-quality products and tailored support services from assay development strategy through manufacturing scale-up. By adhering to best practices or implementing novel approaches and devoting special attention to individual needs, we establish a durable supply chain in partnership with our customers. Whether you are a large corporation or a start-up company, we offer you high-quality reagents with the security of stringent process control, allowing you to get breakthrough products to market faster and with less risk.

We provide long-term supply assurance

- Worldwide recognition with an exemplary reputation, financial stability, and global supply capabilities
- Commercial supply and licensing agreements—securing long-term relationships
- Business continuity through contingency planning, risk management, and availability of multiple manufacturing sites
- Seamless integration and compatibility with multiple products from our product portfolio
- Safe and efficient product delivery
  - Cold supply chain management—helps ensure product quality and performance
  - Direct shipping to customers—helps reduce lead time and increases speed to market
  - Temperature-controlled containers—helps prevent damage to products

We facilitate your product's path to market with tailor-made solutions to fit applications and formats

- Comprehensive development and customization capabilities—custom product formulation, configuration, and quality control
- Supply of products at any scale and in any format—from bulk formats to finished goods
- Custom product labeling and packaging capabilities with outer packing—from specific finish to box design

We are your partner rather than your vendor

- Over 25 years in the OEM and commercial supply business
- Dedicated team of professionals to support your project and to provide you with world-class customer service and support
- Strict adherence to confidentiality obligations

Make us part of your team: contact our licensing and commercial supply specialist at **thermofisher.com/oem-partner**

Superior reliability in DNA amplification

Enhanced thermophilic DNA polymerases for qPCR and PCR applications

We are dedicated to providing PCR enzymes that meet the most demanding customer requirements. Our knowledge and expertise of enzymology and *in vitro* evolution allows us to develop enzymes with new or improved properties. Our customers can select enzymes from a spectrum of DNA polymerases based on a combination of hot-start technology, speed, level of resistance to PCR inhibitors, or lyophilization compatibility. A high level of performance, lot-to-lot consistency, and extensive quality-control testing enable the highest sensitivity, accuracy, and reproducibility of PCR and qPCR assays developed with our enzymes.

Benefits

- High sensitivity and specificity for detection of low-copy DNA targets
- Minimal activation time for faster sample to result
- Robust amplification of difficult-to-amplify targets, including those of suboptimal purity
- Lyophilization-compatible (lyo-ready) formulations available

Table 1. DNA polymerase selection chart.

Characteristics	Platinum *Taq* DNA Polymerase, inhibitor-resistant	Platinum *Taq* DNA Polymerase	AmpliTaq Gold DNA Polymerase	LibertyTaq DNA Polymerase	Wild type *Taq* DNA polymerase	Phire Hot Start II DNA Polymerase
Hot-start PCR	Antibody-based	Antibody-based	Chemically modified	Proprietary	No	Affibody-based
TaqMan probe–compatible	Yes	Yes	Yes	Yes	Yes	No
Reactivation time	2 min	2 min	10 min	0 min	0 min	0 min
Extension rate	15–30 sec/kb	30–60 sec/kb	30–60 sec/kb	30–60 sec/kb	30–60 sec/kb	10–15 sec/kb
Sensitivity	+++	+++	+++	+	+	+
Specificity	+++	+++	+++	+	+	++
Inhibitor resistance	+++	+	+	+	+	+++
Lyo-ready*	On request	Yes	On request	Yes	Yes	Yes

* Lyo-ready is a lyophilization-compatible enzyme composition without glycerol.
Note: "+" = poor; "++" = medium; "+++" = recommended choice.

Featured *Taq* DNA polymerases

Platinum *Taq* DNA Polymerase, inhibitor-resistant

Invitrogen™ Platinum™ *Taq* DNA Polymerase is derived from *in vitro* evolution, which allows for development of unique characteristics, such as increased inhibitor resistance and enhanced speed. These attributes combined with a robust hot-start feature opens new possibilities in DNA- and RNA-based assay design.

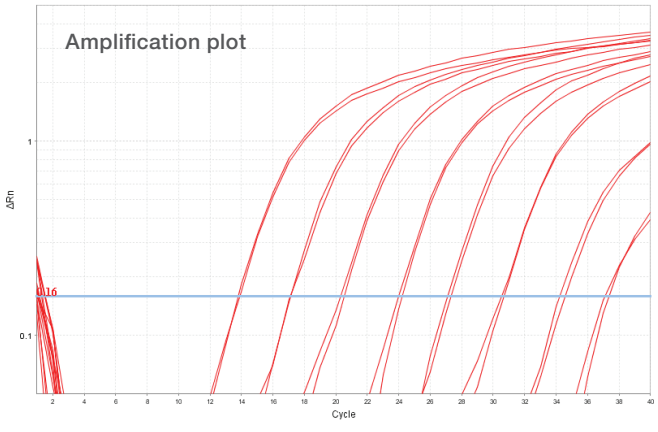
- **Resistance to inhibitors**—reliable amplification of challenging samples
- **Rapid amplification**—time savings with shorter PCR cycling times (Figure 1)
- **Stringent hot-start technology**—high specificity, sensitivity, and yields

Platinum *Taq* DNA Polymerase

- **Stringent hot-start technology**—high specificity and sensitivity for superior results (Figure 2)
- **Robust amplification of both low- and high-complexity DNA of different GC content**—enabling accurate and reliable results from any type of template DNA
- **Human and *E. coli* DNA contamination control**—helps minimize potential false-positive results

LibertyTaq DNA Polymerase

- **Innovative hot-start technology**—zero enzyme activation time, with high specificity and sensitivity (Figure 2)
- **High enzyme concentration without glycerol buffer**—convenient for lyophilization, individually or with other assay components
- **Human and *E. coli* DNA contamination control**—helps minimize potential false-positive results



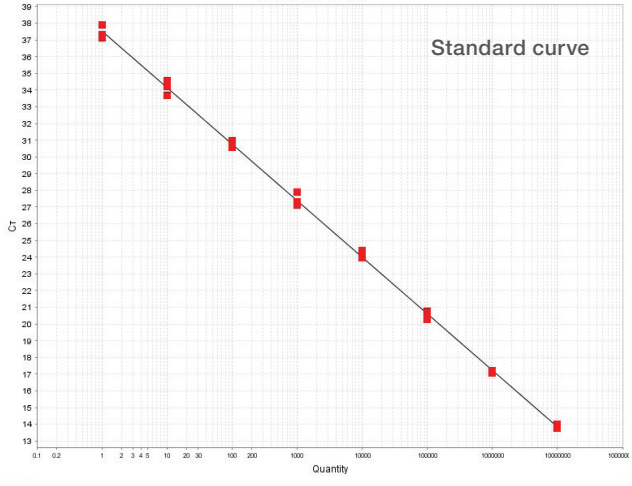


Figure 1. Fast and sensitive one-step RT-qPCR using Invitrogen™ Platinum™ *Taq* DNA Polymerase, inhibitor-resistant. Amplification of GAPDH RNA (from 1 x 10^7 to 1 copy) using Thermo Scientific™ Maxima™ Reverse Transcriptase (RT) and Platinum *Taq* DNA Polymerase, inhibitor-resistant in one-step RT-qPCR. GAPDH target was amplified using fast cycling conditions: 15 min at 50 °C (RT reaction); 3 min at 95°C (RT inactivation); followed by 40 cycles of amplification (one cycle—15 sec at 60˚C).

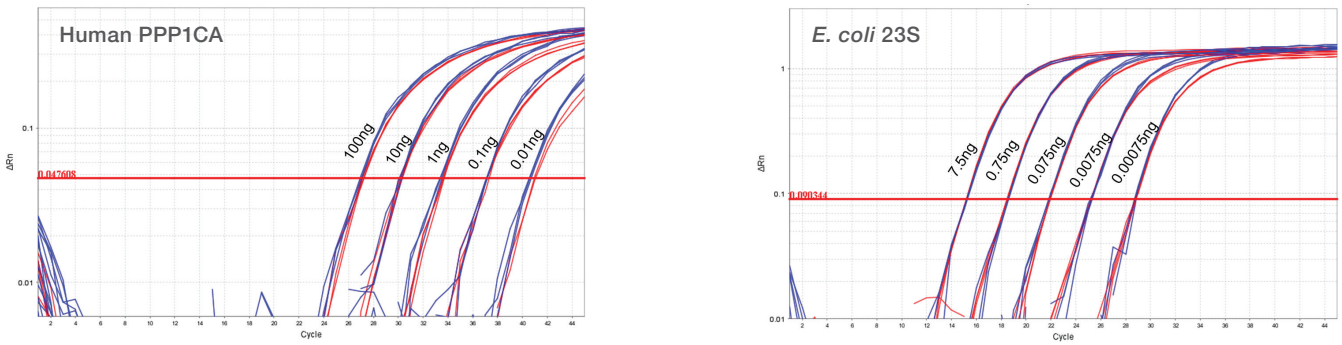
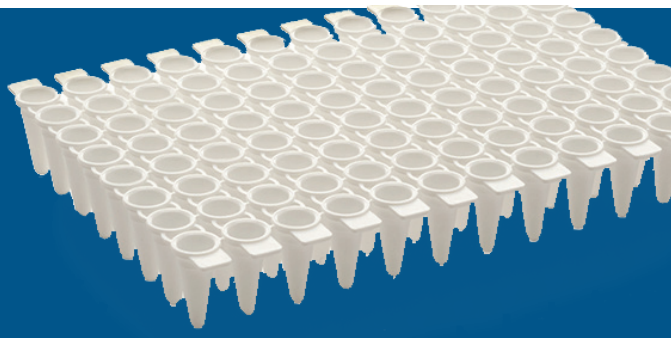


Figure 2. Sensitive, reproducible, and specific qPCR assays. Performance of lyo-ready Invitrogen™ LibertyTaq™ (blue curves) and Platinum *Taq* (red curves) DNA Polymerases were evaluated by qPCR using Applied Biosystems™ TaqMan® Assays for human PPP1CA and *E. coli* 23S ribosomal RNA (rRNA) genes and varying amounts of human or *E. coli* input genomic DNA (gDNA). Equally efficient and sensitive amplification was achieved with both DNA polymerases. No amplification was observed in no-template controls, confirming that formulations are free of contaminating human and *E. coli* DNA.

Did you know?

White plastics are recommended for qPCR applications to enable sensitive and accurate fluorescence detection by preventing refraction out of the tube and increasing the signal-to-noise ratio.

Learn more at **thermofisher.com/oemplastics**



Quality control

Quality testing tailored to ensure high performance of DNA polymerases in your DNA/RNA-based assays.

Parameter*	Method used
Unit concentration	Incorporation of radiolabeled dNTP into polynucleotide fraction by enzyme during the selected time interval
Endo- and exodeoxyribonucleases	Incubation of radiolabeled, single- and double-stranded oligonucleotides with enzyme
Ribonucleases	Incubation of radiolabeled RNA transcript with enzyme
Residual activity assay	Extension of labeled, double-stranded oligonucleotides by enzyme without heat reactivation
Functional testing	Quantitative PCR containing 10-fold dilutions over five orders of magnitude of human and *E. coli* gDNA
Human gDNA	Quantitative PCR test, which uses amplification of selected human gDNA fragments
E. coli gDNA	Quantitative PCR test, which uses amplification of an *E. coli* 23S rRNA gene fragment

* Scope of standard quality-control program varies for different enzymes. Quality control methods for Applied Biosystems™ AmpliTaq Gold™ DNA Polymerase differ from the ones described above.

Choose the gold standard for high-fidelity applications

Proofreading DNA polymerases

Invitrogen™ and Thermo Scientific™ High-Fidelity DNA Polymerases are designed to amplify DNA fragments with exceptional robustness and fidelity, and to generate PCR products with high accuracy and speed even for the most difficult templates. Choose from a collection of our high-fidelity enzymes, their formats, buffers, and dNTP solutions depending on the sophistication of your DNA-based assay and your needs for flexibility.

Benefits

- Highest fidelity on the market (>100x *Taq* polymerase)
- Robust amplification of versatile targets
- Exceptional tolerance to PCR inhibitors
- Shorter cycling times for faster sample to result
- High yields without optimization
- Minimized nonspecific amplification
- Available as a stand-alone enzyme or in a master mix format

Table 2. High-fidelity DNA polymerase selection chart.

Characteristics	Platinum SuperFi DNA Polymerase	Phusion Hot Start II High-Fidelity DNA Polymerase	Phusion U Hot Start DNA Polymerase	Phusion High-Fidelity DNA Polymerase
Fidelity vs. *Taq* polymerase	>100x	52x	25x	52x
Hot-start PCR	Antibody-based	Affibody-based	Affibody-based	No
Target length	≤20 kb	≤20 kb	≤20 kb	≤20 kb
Extension rate	15–30 sec/kb	15–30 sec/kb	15–30 sec/kb	15–30 sec/kb
TaqMan probe–compatible	No	No	No	No
Inhibitor resistance	++++	+++	++	++
dUTP tolerance	No	No	Yes	No
Multiplexing	Yes	Yes	Yes	No
Lyo-ready*	On request	Yes	On request	On request

* Lyo-ready is a lyophilization-compatible enzyme composition with low glycerol (<1%).
Note: "++" = medium; "+++" = recommended choice; "++++" = outstanding.

Featured high-fidelity DNA polymerases

Platinum SuperFi DNA Polymerase

Invitrogen™ Platinum™ SuperFi™ DNA Polymerase is designed for success in PCR, combining the highest fidelity with trusted Platinum™ hot-start technology. Featuring >100x *Taq* fidelity, Platinum SuperFi DNA Polymerase is ideally suited for applications benefiting from supreme sequence accuracy.

- Exceptionally high fidelity
- High specificity and increased yields with Platinum hot-start technology
- Robust amplification of a wide range of targets with resistance to common PCR inhibitors
- Convenient workflow with room-temperature reaction setup

High fidelity

The Platinum SuperFi DNA Polymerase provides the highest level of confidence for preserving DNA sequence accuracy with its extremely low error rate (>100x higher fidelity than *Taq* polymerase, as shown in Figure 3).

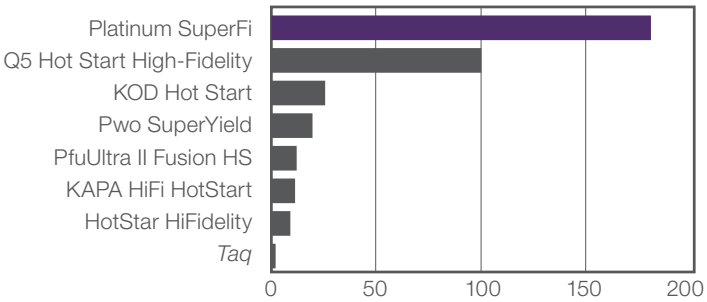


Figure 3. Relative fidelity values of different DNA polymerases. The fidelity of DNA polymerases was measured by next-generation sequencing. The background level of experimental errors was estimated from PCR-free library sequencing data. The polymerase fidelities were normalized to *Taq* polymerase. It is difficult to determine the fidelity values that are greater than 100x *Taq* polymerase in a statistically significant manner, because the extremely low error rates are at the background level.

Resistance to inhibitors

Platinum SuperFi DNA Polymerase is engineered with a DNA-binding domain exhibiting high processivity and increased resistance to common PCR inhibitors such as heparin, xylan, and humic acid (Figure 4).

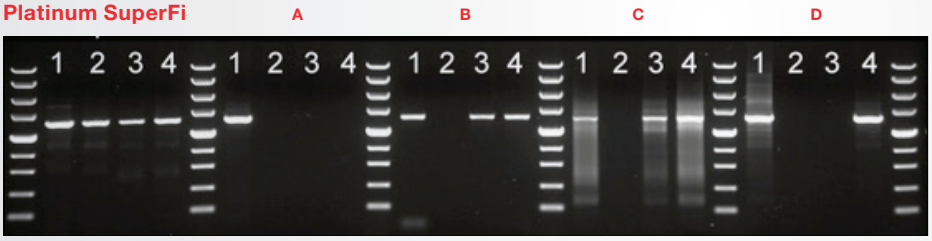


Figure 4. Resistance to inhibitors. Amplification of a 2 kb human gDNA fragment using Platinum SuperFi DNA Polymerase or high-fidelity DNA polymerases from other suppliers (A–D) in reaction mixtures containing 1 = no inhibitor, 2 = heparin (0.15 µg/µL), 3 = xylan (0.5 µg/µL), or 4 = humic acid (0.5 ng/µL).

Since the introduction of Thermo Scientific™ Phusion™ High-Fidelity DNA Polymerase in 2003, a new standard of performance was established for high-fidelity PCR. During the last decade, our high-fidelity DNA polymerases have been proven in demanding PCR applications, including the creation of the first functional synthetic genome.

Using a unique fusion technology, with a DNA-binding domain fused to a *Pyrococcus*-like proofreading polymerase, Phusion DNA polymerases generate PCR products with very high accuracy and speed. In addition, Phusion DNA polymerases are tolerant of various inhibitors—allowing robust amplification of PCR products with minimal optimization.

Phusion Hot Start II High-Fidelity DNA Polymerase

With a combination of hot-start and high-fidelity PCR, Thermo Scientific™ Phusion™ Hot Start II High-Fidelity DNA Polymerase is an ideal choice, allowing high specificity and improved robustness (Figure 5).

- High fidelity (52x higher fidelity than *Taq* polymerase, 6x more accurate than *Pfu* polymerase)
- Increased processivity allows shorter reaction times
- Exceptional product yields with minimal enzyme amounts
- Enhanced specificity with unique affibody ligand–based hot-start technology with no time required for reactivation

Figure 5. Direct PCR amplification of blood sample using Phusion Hot Start II High-Fidelity DNA Polymerase. Phusion Hot Start II High-Fidelity DNA Polymerase as part of Thermo Scientific™ Phusion™ Blood Direct PCR Kit was compared to other kits designed for PCR directly from blood. A 588 bp genomic DNA fragment was amplified in the presence of increasing blood concentration in the reaction mixture. PCR was performed according to the suppliers' instructions. Total protocol times indicated at the bottom. Positive- and negative-control reactions are denoted by "+" and "–", respectively.

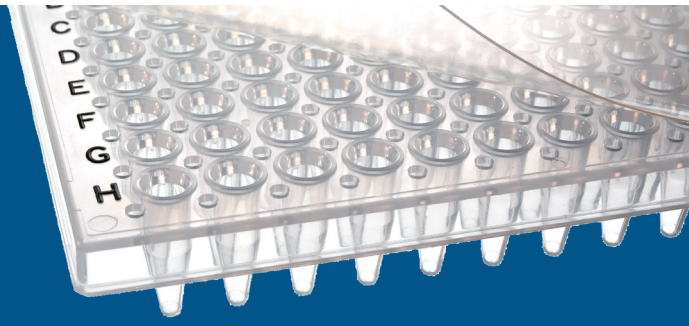
Phusion U Hot Start DNA Polymerase
The Thermo Scientific™ Phusion™ U Hot Start DNA Polymerase is a high-fidelity DNA polymerase engineered for uracil-tolerant PCR. Phusion U Hot Start DNA Polymerase carries a mutation in the dUTP-binding pocket of the Phusion enzyme and is tolerant to dUTP present in DNA templates and able to incorporate dUTP.

- Engineered high-fidelity polymerase for uracil-tolerant PCR
- High accuracy (25x higher fidelity than *Taq* polymerase)
- High processivity allows shorter reaction times
- Ideal for PCR-based assays with the need for carryover contamination control

Did you know?

Off-the-shelf plastics options are available for many instruments, including Applied Biosystems™ thermal cyclers and real-time PCR instruments: PCR tubes, strip tubes, 24- to 384-well PCR plates, and a wide range of plate seals.

Learn more at **thermofisher.com/oemplastics**



Quality control

Quality of high-fidelity DNA polymerases is ensured by extensive quality testing.

Parameter*	Method used
Unit concentration	One unit of enzyme incorporates 10 nmol of dNTPs into a polynucleotide fraction at 74ºC in 30 min
Endodeoxyribonucleases (nicking activities)	Incubation of supercoiled plasmid DNA with 10 U of enzyme at 37ºC for 4 hr and analysis on agarose gel
Residual activity assay	Extension of labeled, double-stranded oligonucleotide with 5'-overhangs after incubation for 4 hr at 37°C in presence of dNTPs
Functional testing in PCR	PCR amplification of 7.5 kb fragments from human gDNA and 20 kb fragments from lambda DNA, and analysis on agarose gel
Human gDNA	Quantitative PCR test, which uses amplification of Alu repeats in human gDNA, performed on DNA purified from enzyme

* Scope of standard quality-control program varies for different enzymes.

Superior performance in cDNA synthesis

Reverse transcriptases for RT-PCR and RT-qPCR applications

We offer a comprehensive portfolio of reverse transcriptases from the wild type Moloney murine leukemia virus (M-MuLV) RT to the Invitrogen™ SuperScript™ line of RTs with superior characteristics such as enhanced sensitivity and reduced reaction time. Our proprietary technology of *in vitro* protein evolution has enabled the introduction of multiple favorable mutations into the traditional M-MuLV reverse transcriptase. This has dramatically improved the enzyme thermostability, resistance to inhibitors, and processivity. Our RT enzymes are also available in lyo-ready formulation (no glycerol; compatible with lyophilization), offering additional flexibility for RT-qPCR–based assay development.

Benefits

- Robust performance with challenging samples
- Enhanced thermostability and processivity
- High efficiency and sensitivity, even in the presence of inhibitors
- Minimal false-positive results with low residual host-cell DNA
- Lyophilization compatibility with lyo-ready formulation

Table 3. Reverse transcriptase selection chart.

Characteristic	SuperScript IV RT	SuperScript III RT	Maxima RT	RevertAid RT (M-MuLV)
Optimal reaction temperature	50˚C	50˚C	50˚C	42˚C
RNase H activity	No	No	Yes	Yes
RNase H minus version available	NA	NA	Maxima H Minus RT	RevertAid H Minus RT
Reaction time	10 min	50 min	30 min	60 min
Inhibitor resistance	++++	+	+++	+
Sensitivity	++++	+++	+++	++
Lyo-ready*	Yes	Yes	Yes	Yes

* Lyo-ready is a lyophilization-compatible enzyme composition without glycerol.
Note: "+" = poor; "++" = medium; "+++" = good; "++++" = recommended choice.

Featured reverse transcriptases

SuperScript IV Reverse Transcriptase

Invitrogen™ SuperScript™ IV RT is an M-MuLV RT mutant with superior robustness and reliability in cDNA synthesis (Figure 6). This RT enzyme exhibits strong inhibitor resistance, high processivity, thermostability, highly efficient full-length cDNA synthesis, and reduced RNase H activity.

SuperScript IV RT demonstrates its ability of reliable cDNA synthesis in the presence of common PCR reaction inhibitors, typical to situations where clinical or environmental samples of optimal quality are not available.

- Robust cDNA synthesis with a variety of gene targets, including degraded RNA and RNA samples of suboptimal purity
- High sensitivity and linearity in a 10-minute reaction
- Linear dynamic range across a broad range of RNA input, crucial for detection of low-abundance samples

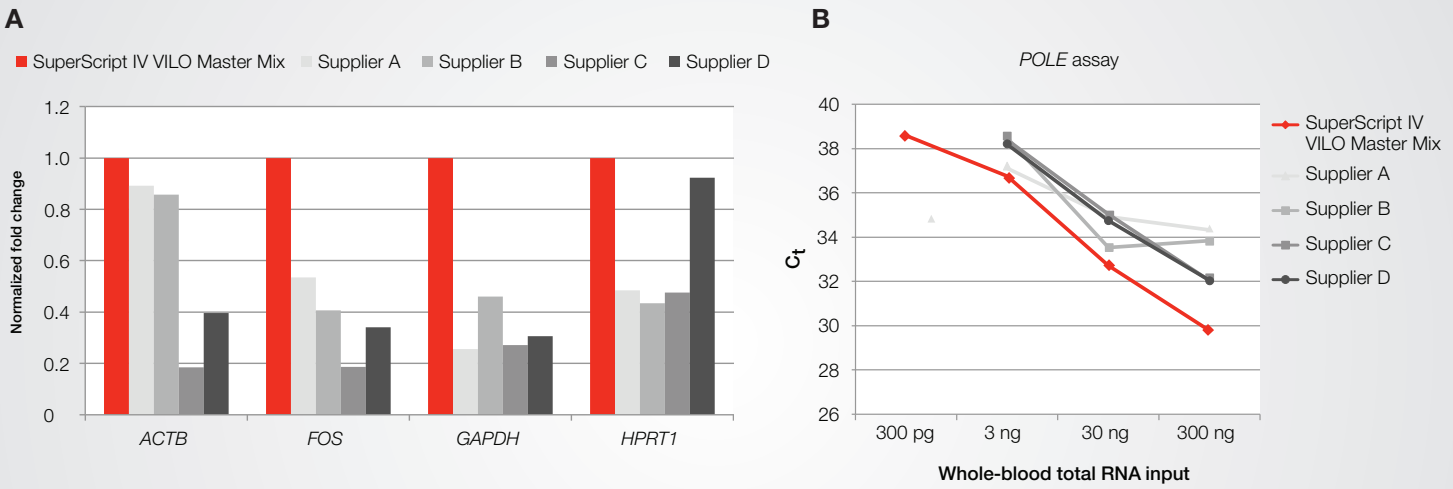


Figure 6. SuperScript IV RT provides higher sensitivity of target detection with whole-blood RNA. SuperScript IV and four other RTs (Suppliers A, B, C, and D) were used in RT-qPCR with 1 ng of partially degraded (RIN 4–6) blood RNA **(A)**, or with a dilution series of total whole-blood RNA **(B)**. Results in **(A)** are shown as normalized fold change relative to SuperScript IV RT, calculated as $2^{(C_t \text{ SuperScript IV} - C_t \text{ other product})}$.

SuperScript III Reverse Transcriptase

Widely used and with thousands of citations, Invitrogen™ SuperScript™ III RT offers higher cDNA yields and sensitivity than wild type M-MuLV RT enzymes.

- High thermostability for reduction of RNA secondary structures
- Reduced RNase H activity, delivering long RNA transcripts
- Robust enzyme with a half-life of 220 min at 50°C

Maxima Reverse Transcriptase

Thermo Scientific™ Maxima™ Reverse Transcriptase and Maxima™ H Minus Reverse Transcriptase are derived from *in vitro* evolution with unique attributes to maximize performance in cDNA synthesis.

- Reproducible cDNA synthesis and low variability levels across a wide range of starting RNA amounts
- Increased enzyme processivity for fast cDNA synthesis
- Tolerance to RT inhibitors

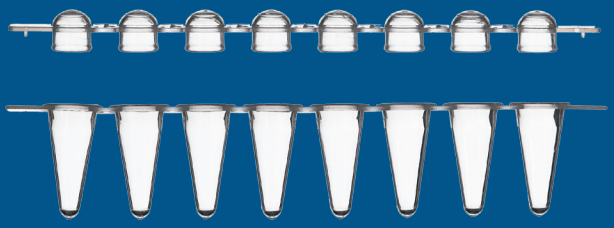
RevertAid Reverse Transcriptase

Thermo Scientific™ RevertAid™ Reverse Transcriptase is a wild type M-MuLV RT and offers routine performance of cDNA synthesis. Variants with and without RNase H activity are available.

Did you know?

Our plastic consumables are produced in injection-molding facilities that meet 10,000 or 100,000 clean room (ISO 4 or ISO 5 clean room) standards.

Learn more at **thermofisher.com/oemplastics**



Quality control

Quality testing is tailored to help ensure high performance of reverse transcriptases in your RNA-based assays.

Parameter*	Method used
Unit concentration	One unit of the enzyme incorporates 1 nmol of dTMP into a polynucleotide fraction in 10 min at 37°C
Endo- and exodeoxyribonucleases	Incubation of radiolabeled, single- and double-stranded oligonucleotides with enzyme
Endodeoxyribonucleases (nicking activity)	Incubation of supercoiled plasmid DNA with enzyme
Ribonucleases	Incubation of radiolabeled RNA transcript with enzyme
Functional testing	Functionally tested in first-strand cDNA synthesis
Human gDNA*	Quantitative PCR test, which uses amplification of selected human gDNA fragments
E. coli gDNA*	Quantitative PCR test, which uses amplification of *E. coli* 23S rRNA gene fragment

* Scope of standard quality-control program may vary for a specific enzyme.

Outstanding performance and reliability for the most demanding applications

qPCR-grade dNTPs

Our dNTPs have been extensively tested and verified for use in a wide variety of molecular biology applications, including highly sensitive techniques such as RT-qPCR (Figure 7) and next-generation sequencing.

All dNTP formulations are designed for convenience and flexibility. Standard nucleotides (dATP, dCTP, dGTP, dTTP, and dUTP) are supplied as 100 mM solutions, and nucleotide mixes can be formulated up to a 100 mM concentration for each nucleotide in the mix.

Benefits

- Manufactured using dedicated equipment for each dNTP
- Tested to be free of contaminating RNase or DNase activities, and inhibitors of qPCR, PCR, and RT
- High stability—36-month shelf life; remains stable after >100 freeze-thaw cycles
- Large-scale manufacturing (>1,000 L)
- Available as individual dNTP solutions and mixes
- High purity (≥99%) according to HPLC (Figure 8)

Did you know?

Our OEM PCR and qPCR plastics can be tailored to meet your complete needs, from concept through design, prototyping, molding, and quality control to the label on the box.

Learn more at **thermofisher.com/oemplastics**

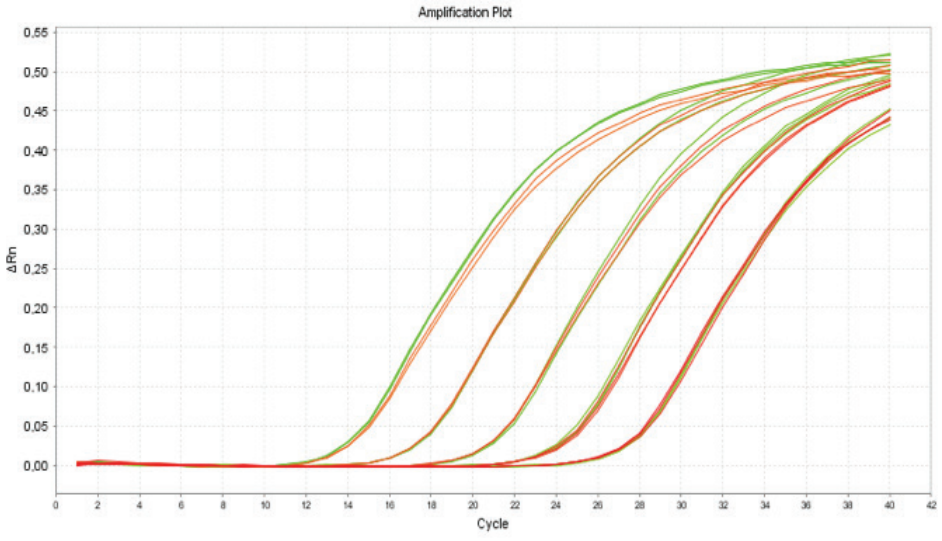


Figure 7. High quality of dNTPs ensures consistent C_t values in quantitative PCR, especially at low-input template concentrations. dNTPs are tested for detection of the *GAPDH* gene in two-step RT-qPCR using different amounts of RNA transcript (0.05 µg/µL RNA solution diluted from 1 x 10^7 to 1 x 10^3 copies) in reverse transcription reactions followed by amplification with hot-start *Taq* DNA polymerase.

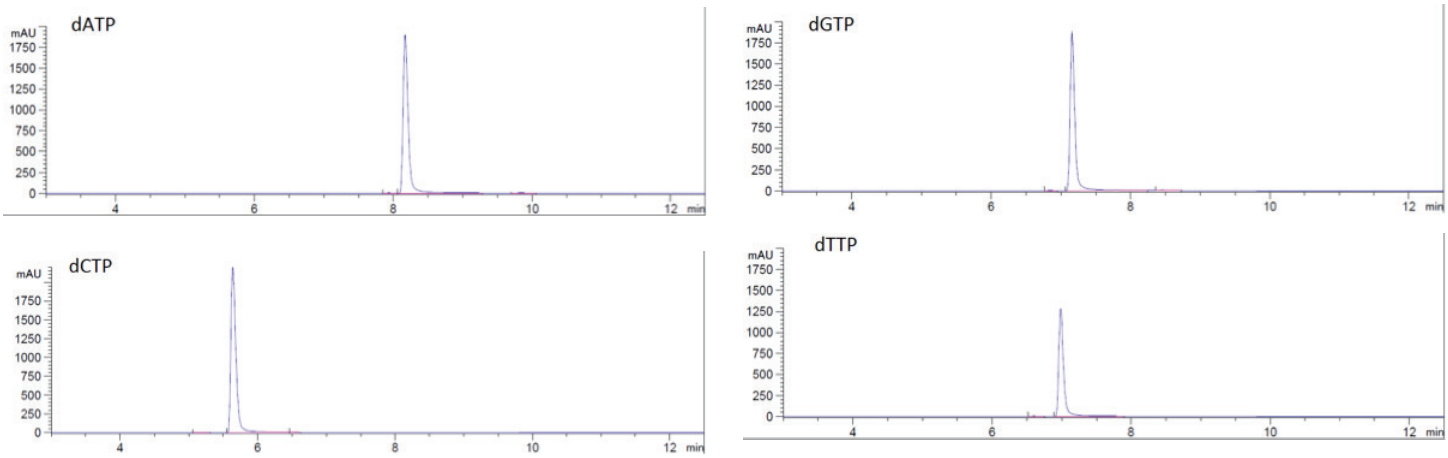


Figure 8. Relative HPLC profiles of ≥99% pure dNTPs. HPLC analysis shows greater than 99% triphosphate purity with undetectable mono-, di-, and tetraphosphate forms.

Quality control

Quality testing is tailored to help ensure high performance of dNTPs in your DNA- and RNA-based assays.

Parameter*	Method used
Appearance	Clear, colorless solution
pH value	7.3–7.5
Concentration	100 ±3 mM
Base purity (HPLC)	>99.5% deoxynucleoside
Purity (HPLC)	≥99% triphosphate
Pyrophosphate	<0.003 pmol PPi/pmol dNTP
Endodeoxyribonuclease and nicking activity	Undetectable after incubation of supercoiled plasmid DNA with dNTP
Endo- and exodeoxyribonucleases	Undetectable after incubation of radiolabeled, single- and double-stranded oligonucleotides with dNTP
Ribonucleases	Undetectable after incubation of RNA transcript with dNTP
Human DNA	Undetectable in quantitative PCR test, which uses amplification of Alu repeats in human gDNA
E. coli DNA	Undetectable in quantitative PCR test, which uses amplification of an *E. coli* 23S rRNA gene fragment
Functional test	Functionally tested in two-step RT-qPCR using different starting amounts of RNA transcript in reverse transcription reactions followed by amplification with hot-start *Taq* DNA polymerase

* Scope of standard quality-control program may vary for custom products.

Customer service

Maintaining long-term relationships with customers is our goal; understanding your needs, challenges, and requirements is the foundation of our business. We communicate openly and deliver on our promises.

- Your business will be assigned to a dedicated team of experts that specialize in OEM
- We provide prompt and accurate response to questions, documentation requests, and technical support
- We take your confidentiality very seriously

Find out more at **thermofisher.com/oem-partner**

ThermoFisher SCIENTIFIC