



TECHNICAL BULLETIN

Access RT-PCR System

Instructions for Use of Products
A1250, A1260 and A1280

Access RT-PCR System

All technical literature is available at: www.promega.com/protocols/
 Visit the website to verify that you are using the most current version of this Technical Bulletin.
 Email Promega Technical Services if you have questions on use of this system: techserv@promega.com

1. Description	2
2. Product Components and Storage Conditions	3
3. Optimizing RT-PCR.....	4
3.A. RNA Template.....	4
3.B. Control Reactions.....	4
3.C. Avoiding Contamination of Nucleic Acids	5
3.D. Magnesium Concentration	6
3.E. Primer Design.....	6
3.F. Temperature.....	6
3.G. Incubation Times and Number of Cycles	7
4. Synthesis and Analysis of RT-PCR Products Using the Access RT-PCR System	7
4.A. Protocol	8
4.B. Analysis	9
5. Troubleshooting	11
6. References	13
7. Appendix.....	13
7.A. Composition of Buffers and Solutions.....	13
7.B. Control Primer Sequences	13
8. Summary of Changes	14

1. Description

Numerous techniques have been developed to measure gene expression in tissues and cells. These include Northern blots, coupled reverse transcription and PCR amplification (RT-PCR), RNase protection assays, in situ hybridization, dot blots and S1 nuclease assays. Of these methods, RT-PCR is the most sensitive and versatile. This technique can be used to determine the presence or absence of a transcript, estimate expression levels and clone cDNA products without the necessity of constructing and screening a cDNA library.

The Access RT-PCR System^(a) is designed for the reverse transcription (RT) and polymerase chain reaction (PCR) amplification of a specific target RNA from either total RNA or mRNA (1). This one-tube, two-enzyme system provides sensitive, quick and reproducible analysis of even rare RNAs. The system uses AMV Reverse Transcriptase (AMV RT) from Avian Myeloblastosis Virus for first strand DNA synthesis and the thermostable *Tfl* DNA Polymerase from *Thermus flavus* (2) for second strand cDNA synthesis and DNA amplification. The Access RT-PCR System includes an optimized single-buffer system that permits extremely sensitive detection of RNA transcripts without a requirement for buffer additions between the reverse transcription and PCR amplification steps (Figure 1). This simplifies the procedure and reduces the potential for contaminating the samples. In addition, the improved performance of AMV Reverse Transcriptase at elevated temperatures [45°C^(a)] in the AMV/*Tfl* 5X Reaction Buffer minimizes problems encountered with secondary structures in RNA.

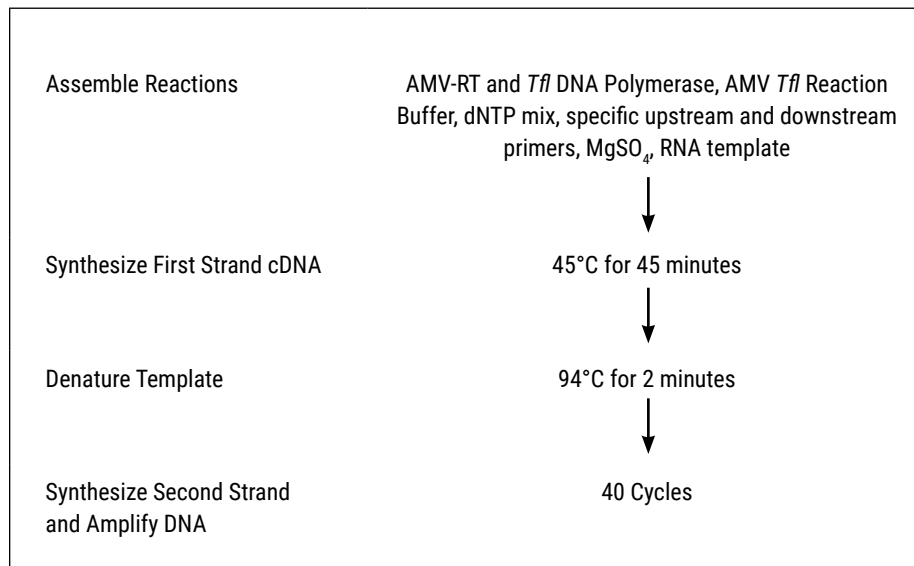


Figure 1. Outline of the Access RT-PCR System protocol.

2. Product Components and Storage Conditions

PRODUCT	CAT. #
----------------	---------------

Access RT-PCR System	A1250
-----------------------------	--------------

Each system contains sufficient reagents for 100 reactions (50µl), including 25 reactions containing Positive Control RNA and Primers. Includes:

- 500u AMV Reverse Transcriptase, 5u/µl
- 500u *Tfl* DNA Polymerase, 5u/µl
- 1ml AMV/*Tfl* 5X Reaction Buffer
- 1.25ml MgSO₄, 25mM
- 100µl dNTP Mixture, 10mM each of dATP, dCTP, dGTP and dTTP
- 50µl Positive Control RNA with Carrier (1.25 attomole/µl)
- 100µl Upstream Control Primer, 15µM
- 100µl Downstream Control Primer, 15µM
- 13ml Nuclease-Free Water

PRODUCT	CAT. #
----------------	---------------

Access RT-PCR System	A1280
-----------------------------	--------------

Each system contains sufficient reagents for 500 reactions (5 kits × 100 reactions, 50µl each), including 25 reactions containing Positive Control RNA and Primers (provided in one of the kits).

PRODUCT	CAT. #
----------------	---------------

Access RT-PCR Introductory System	A1260
--	--------------

Each system contains sufficient reagents for 20 reactions (50µl) and includes reagents for positive control reactions (Positive Control RNA and Primers). Includes:

- 100u AMV Reverse Transcriptase, 5u/µl
- 100u *Tfl* DNA Polymerase, 5u/µl
- 1ml AMV/*Tfl* 5X Reaction Buffer
- 1.25ml MgSO₄, 25mM
- 20µl dNTP Mixture, 10mM each of dATP, dCTP, dGTP and dTTP
- 50µl Positive Control RNA with Carrier (1.25 attomole/µl)
- 100µl Upstream Control Primer, 15µM
- 100µl Downstream Control Primer, 15µM
- 13ml Nuclease-Free Water

Storage Conditions: Store all system components at -30°C to -10°C. For long-term storage, the Positive Control RNA with Carrier may be stored at less than -65°C. See the expiration date on the kit label.

3. Optimizing RT-PCR

3.A. RNA Template

Successful reverse transcription is dependent on the integrity and purity of the mRNA used as the template. Procedures for creating and maintaining an RNase-free environment are described in reference 3. Use sterile tubes, pipette tips, gloves and diethyl pyrocarbonate (DEPC)-treated water. When isolating RNA from samples high in ribonuclease activity, use of a ribonuclease inhibitor such as Recombinant RNasin® Ribonuclease Inhibitor (Cat.# N2511) is recommended.

For the routine and rapid purification of total RNA from eukaryotic sources, we recommend the SV Total RNA Isolation System (Cat.# Z3100).

Poly(A)+ RNA can be efficiently isolated from total RNA using the PolyATtract® mRNA Isolation Systems (Cat.# Z5200, Z5300) or directly from eukaryotic sources using the PolyATtract® System 1000 (Cat.# Z5420, Z5400). These systems enable the isolation of total or poly(A)+ RNA from crude cell or tissue lysates and result in RNA preparations sufficiently pure for use in the Access RT-PCR System.

For optimal results using this system, the RNA template, whether a total RNA preparation, an mRNA population or a synthesized RNA transcript, should be DNA-free. The *Tfl* DNA Polymerase included with this system has no reverse transcriptase activity under the standard reaction conditions (1), but amplification product will be generated out of these reactions if trace amounts of DNA with similar sequences are present in the template preparation.

The minimum amount of RNA that can be amplified using RT-PCR is both template- and primer-dependent. For the Positive Control RNA provided, the minimum amount of RNA required is 10³ molecules (1.66 zeptomoles, 1.66 × 10⁻²¹ moles) (Figure 2, Panel A). Excellent amplification results can be obtained with the Access RT-PCR System using total RNA template levels in the range of 10pg–1µg per reaction (Figure 2, Panel B), or poly(A)+ RNA template levels in the range of 1pg–100ng.

3.B. Control Reactions

To facilitate optimization and troubleshooting, perform both positive and negative control reactions. For positive control reactions, use the supplied Positive Control RNA with Carrier (see Section 7.A) and the Upstream and the Downstream Control Primers (see Figure 2, Panel A). For a negative control, substitute sterile nuclease-free water for the RNA template in the reaction.

Note: The Upstream and Downstream Control Primers will only amplify the Positive Control RNA.

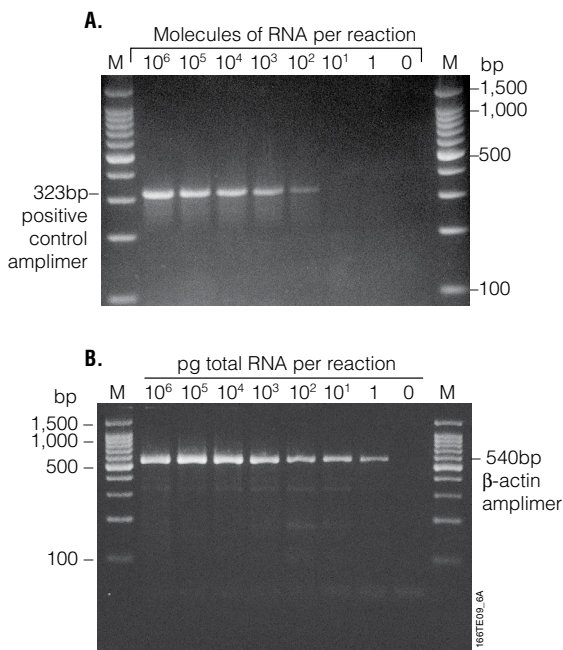


Figure 2. Amplification of specific RNAs using the Access RT-PCR System. Panel A. Serial tenfold dilutions of the Positive Control RNA supplied with the system were prepared in Nuclease-Free Water. RT-PCR reactions containing the indicated amounts of Positive Control RNA were performed as described in Section 4 using the control oligonucleotide primers provided. Equivalent aliquots of each amplification reaction were separated on a 3% NuSieve®/1% agarose gel in 1X TAE buffer containing 0.5µg/ml ethidium bromide. The specific 323bp amplicon is indicated. Lane M, 100bp DNA Ladder (Cat.# G2101). **Panel B.** RT-PCR reactions containing the indicated amounts of mouse liver total RNA were performed as described in Section 4 using oligonucleotide primers specific to the mouse β-actin transcript. The specific 540bp amplicon is indicated. Equivalent aliquots of each amplification reaction were separated on a 3% NuSieve®/1% agarose gel in 1X TAE buffer containing 0.5µg/ml ethidium bromide. Lane M, 100bp DNA Ladder (Cat.# G2101).

3.C. Avoiding Contamination of Nucleic Acids

Take care to minimize the potential for cross-contamination between samples and prevent carryover of nucleic acid (RNA and DNA) from one experiment to the next. Use a separate work area and pipettor for pre- and post-amplification steps. Use positive displacement pipettes or aerosol-resistant tips to reduce cross-contamination during pipetting. Wear gloves and change them often. Use UNG (4) or another sterilization technique to prevent DNA carryover to subsequent reactions.

3.D. Magnesium Concentration

The magnesium requirement of both the AMV Reverse Transcriptase and the *Tfl* DNA Polymerase in the Access RT-PCR System reactions is affected by the final concentration of nucleotides, oligonucleotide primers and template. The magnesium sulfate concentration should be optimized for each experimental target/primer combination. Although 1.0–2.5mM magnesium sulfate is suitable for most applications, titration of the magnesium sulfate concentration can significantly improve the sensitivity, specificity and quality of the reverse transcription and amplification products.

To determine the optimal magnesium concentration for a specific template/ primer combination, prepare a reaction series containing 1.0–3.0mM magnesium sulfate in 0.5mM increments by adding 2, 3, 4, 5 or 6µl of the 25mM Magnesium Sulfate stock to 50µl reactions.



Vortex the magnesium stock prior to use.

3.E. Primer Design

A specific primer should be used for first strand synthesis. Specific primers anneal only to defined sequences and can be used to synthesize cDNA from particular mRNAs rather than from the entire mRNA population in the sample. To differentiate between amplification of cDNA and amplification of contaminating genomic DNA, primers may be designed to anneal to sequences in exons on opposite sides of an intron. An amplification product derived from genomic DNA will be much larger than the product of the RT-PCR amplification reaction. This size difference not only makes it possible to differentiate the two products by gel electrophoresis, it also favors the synthesis of the smaller cDNA-derived product (PCR favors the amplification of smaller fragments). Regardless of primer choice, the final concentration of the primer in the reaction may need to be optimized. We recommend adding 50pmol of primer (1µM final concentration in reaction) as a starting point for optimization.

3.F. Temperature

The Access RT-PCR System does not require a template denaturation step prior to initiation of the reverse transcription reaction. If desired, a denaturation step may be incorporated by incubating a separate tube containing the primers and RNA template at 94°C for 2 minutes. The template/primer mixture can then be added to the RT-PCR reaction mix for the standard reverse transcription incubation at 45°C.



Do not incubate the AMV RT at 94°C; it will be inactivated.

AMV Reverse Transcriptase is active in the AMV/*Tfl* 5X Reaction Buffer at temperatures between 37°C and 45°C. We recommend that the reverse transcription reaction be performed at 45°C to minimize the effects of RNA secondary structure and to encourage full-length cDNA synthesis. Following the reverse transcription incubation, we recommend a two-minute incubation at 94°C to denature the RNA/cDNA hybrid and inactivate the AMV Reverse Transcriptase. It has been reported that the AMV Reverse Transcriptase enzyme must be inactivated to obtain high yields of amplification product using thermophilic DNA polymerases such as *Tfl* DNA Polymerase (5,6).

The sequences of the primers are a major consideration in determining the temperature of the PCR amplification cycles. An amplification cycle typically consists of a denaturation step (94°C), a template/primer annealing step (42–60°C) and an extension step (68°C). For primers with a high T_m , it may be advantageous to increase the suggested annealing and extension temperatures. The higher temperature minimizes nonspecific primer annealing, thus increasing the amount of specific product produced. For primers with a low T_m , it may be necessary to decrease the annealing temperature to allow the primer to anneal to the target template.

3.G. Incubation Times and Number of Cycles

Efficient first strand cDNA synthesis can be accomplished in a 15- to 60-minute incubation at 37–45°C. We recommend a 45-minute incubation at 45°C as a general starting point.

Following the first strand cDNA synthesis, the AMV Reverse Transcriptase is inactivated and the RNA/cDNA hybrid denatured using a 2-minute incubation at 94°C. This step leads directly into the second strand cDNA synthesis and PCR amplification phase of the procedure. Most RNA samples can be detected using 40 cycles of amplification. If the target RNA is rare or if only a small amount of starting material is available, it may be necessary to increase the number of cycles to 45 or 50. During the extension step, allow approximately 1 minute for every 1kb of amplicon (minimum extension time = 1 minute). A final 7-minute extension at 68°C improves the quality of the final product by extending truncated product to full-length.

4. Synthesis and Analysis of RT-PCR Products Using the Access RT-PCR System

The reverse transcription and PCR cycling profile provided in Figure 3 should serve as a guideline for initial experiments. These conditions work well for the detection of the 323bp PCR product generated from the Positive Control RNA using the Upstream and Downstream Control Primers provided with the Access RT-PCR System. We recommend optimizing the parameters discussed in Section 3 for each combination of primers and target RNA.

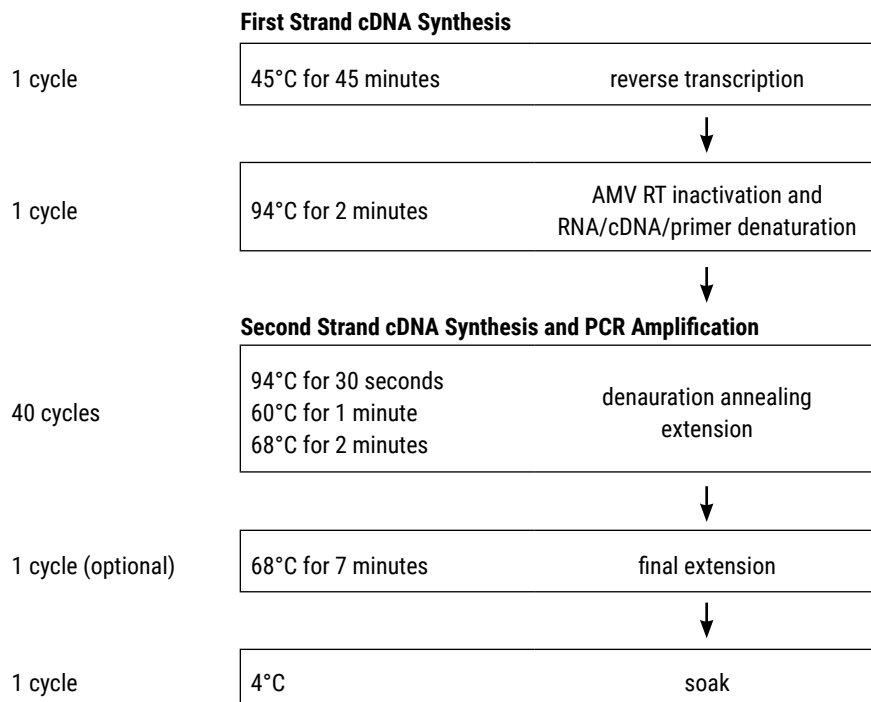


Figure 3. Reverse transcription and PCR cycling profile.

4.A. Protocol

Materials to Be Supplied by the User

- downstream oligonucleotide primer
- upstream oligonucleotide primer
- nuclease-free light mineral oil (e.g., Sigma Cat.# M5904)

1. Prepare the reaction mix by combining the indicated volumes of the first six components in a thin-walled 0.5ml reaction tube on ice. Mix by pipetting. Add the AMV Reverse Transcriptase and *Tfl* DNA Polymerase to the reaction. Gently vortex the tube for 10 seconds to mix the components. If working with multiple samples, a Master Mix may be assembled on ice by combining appropriate multiples of each of the indicated components and transferring 48µl of the master mix to each reaction tube. Initiate the reaction by adding the template. Use individual pipette tips for all additions, being careful not to cross-contaminate the samples.

Component	Volume	Final Concentration
Nuclease-Free Water (to a final volume of 50µl)	Xµl	
AMV/ <i>Tfl</i> 5X Reaction Buffer (see Note 1)	10µl	1X
dNTP Mix (10mM each dNTP; see Note 2)	1µl	0.2mM
downstream primer (see Note 3)	50pmol	1µM
upstream primer (see Note 3)	50pmol	1µM
25mM MgSO ₄ (see Note 2)	2µl	1mM
AMV Reverse Transcriptase (5u/µl)	1µl	0.1u/µl
<i>Tfl</i> DNA Polymerase (5u/µl)	1µl	0.1u/µl
RNA sample or control (see Section 3.A and Note 4)	Yµl	
final volume	50µl	

2. Overlay the reaction with one or two drops (20–40µl) of nuclease-free mineral oil to prevent condensation and evaporation.
3. Place the tubes in a controlled temperature heat block equilibrated at 45°C and incubate for 45 minutes.
4. Proceed directly to thermal cycling the reactions for second strand cDNA synthesis and amplification (see the thermal cycling profile outlined above).

Notes:

1. If a precipitate forms in the AMV/*Tfl* 5X Reaction Buffer, resolubilize by incubating at 65°C for 15 minutes.
2. Vortex prior to use.
3. A general formula for calculating the number of nanograms of primer equivalent to 50pmol is:
 $50\text{pmol} = 16.3\text{ng} \times b$; where *b* is the number of bases in the primer. For the positive control reaction, use 3.3μl of both the Downstream and Upstream Control Primers (50pmol).
4. 10^3 – 10^6 copies of a specific target template or 1pg–1μg total RNA. Use 2μl of the Positive Control RNA with Carrier (2.5 attomoles or 1×10^6 copies).

4.B. Analysis

1. Analyze the PCR products by agarose gel electrophoresis of 5% of the total reaction. The products will be readily visible by UV transillumination of an ethidium bromide-stained gel. The amplification product obtained using the Positive Control RNA with the Upstream and Downstream Control Primers is 323bp long (Figure 4).
2. Store the reaction products at –20°C until needed. The reaction products may be purified using the Wizard® SV Gel and PCR Clean-Up System (Cat.# A9281; 7).

Note: An amplification product at approximately 220bp is occasionally observed with the Positive Control RNA. This product arises from the amplification of a sequence in the carrier *E. coli* RNA added to the Positive Control RNA.

1	GAATACAAGC	TTGGGCGTGT	CTCAAAATCT	CTGATGTTAC	ATTGCACAAG
51	ATAAAATAT	ATCATCATGA	ACAATAAAAC	TGTCTGCTTA	CATAAACAGT
101	AATACAAGGG	GTGTTATGAG	CCATATTCAA	CGGGAAACGT	CTTGCTCGAG
151	GCCGCGATTA	AATTCCAACA	TGGATGCTGA	TTTATATGGG	TATAAATGGG
201	CTCGCGATAA	TGTCGGGCAA	TCAGGTGCGA	CAATCTATCG	ATTGTATGGG
251	AAGCCCGATG	CGCCAGAGTT	GTTTCTGAAA	CATGGCAAAG	GTAGCGTTGC
301	CAATGATGTT	ACAGATGAGA	TGGTCAGACT	AAACTGGCTG	ACGGAATTTA
351	TGCCTCTTCC	GACCATCAAG	CATTTTATCC	GTACTCCTGA	TGATGCATGG
401	TTACTCACCA	CTGCGATCCC	CGGGAAAACA	GCATTCCAGG	TATTAGAAGA
451	ATATCCTGAG	TCAGGTGAAA	ATATTGTTGA	TGCGCTGGCA	GTGTTCTTGC
501	GCCGGTTGCA	TTCGATTCCT	GTTTGTAATT	GTCCTTTTAA	CAGCGATCGC
551	GTATTTTCGTC	TCGCTCAGGC	GCAATCACGA	ATGAATAACG	GTTTGTTGTA
601	TGCGAGTGAT	TTTGATGACG	AGCGTAATGG	CTGGCCTGTT	GAACAAGTCT
651	GGAAGAAAT	GCATAAGCTT	TTGCCATTCT	CACCGGATTC	AGTCGTCATC
Upstream Control Primer			5' -GCCATTCT	CACCGGATTC	AGTCGTC - 3'
701	CATGGTGATT	TCTCACTTGA	TAACCTTATT	TTTGACGAGG	GGAAATTAAT
751	AGGTTGTATT	GATGTTGGAC	GAGTCGGAAT	CGCAGACCGA	TACCAGGATC
801	TTGCCATCCT	ATGGAAGTGC	CTCGGTGAGT	TTTCTCCTTC	ATTACAGAAA
851	CGGCTTTTTTC	AAAAATATGG	TATTGATAAT	CCTGATATGA	ATAAATTGCA
901	GTTTCATTTG	ATGCTCGATG	AGTTTTTCTA	ATCAGAAATTG	GTTAATTGGT
951	TGTAACACTG	GCAGAGCATT	ACGCTGACTT	GACGGGACGG	CGGCTTTGTT
Downstream Control Primer			3' -GACTGAA	CTGCCCTGCC	GCCGA - 5'
1001	GAATAAATCG	AACTTTTGCT	GAGTTGAAGG	ATCAGATCAC	GCATCTTCCC
1051	GACAACGCAG	ACCGTTCCGT	GGCAAAGCAA	AAGTTCAAAA	TCACCAACTG
1101	GTCCACCTAC	AACAAAGCTC	TCATCAACCG	TGGCGACTCT	AGAGGATCCC
1151	CGGGCGAGCT	CCCAAAAAAA	AAAAAAAAAA	AAAAAAAAAA	AAACCGAATT

Figure 4. Sequence of the Positive Control RNA, Upstream Control Primer and Downstream Control Primer. The expected cDNA product is 323bp long.

5. Troubleshooting

For questions not addressed here, please contact your local Promega Branch Office or Distributor. Contact information available at: **www.promega.com**. Email: **techserv@promega.com**

Symptoms	Causes and Comments
Low yield or no first strand product	RNA degraded: • Verify the integrity of the RNA by denaturing agarose gel electrophoresis. • Ensure that reagents, tips and tubes are RNase-free. Isolate the RNA in the presence of a ribonuclease inhibitor (e.g., Recombinant RNasin® Ribonuclease Inhibitor).
	AMV Reverse Transcriptase thermally inactivated. If an initial denaturation/annealing step is introduced into the protocol, be certain to add the enzyme mix containing AMV Reverse Transcriptase after the denaturation step and subsequent 45°C equilibration.
	Primer specificity. Verify that the “downstream” primer was designed to be complementary to the downstream sequence of the RNA.
	Primer annealing. If oligo(dT) was used as a “downstream” primer, verify that the annealing incubation was carried out at an appropriate temperature, such as 37°C, prior to reverse transcription.
	RNA purification problem. Carryover of reagents (e.g., SDS, NaCl, heparin, guanidine thiocyanate) from some RNA purification methods can interfere with RT-PCR. Reduce volume of target RNA, perform additional purification steps or change purification method.
Amplification product has a molecular weight higher than expected	Genomic DNA sequences related to the RNA template contaminate the RNA preparation. Digest the DNA using RQ1 RNase-Free DNase.

5. Troubleshooting (continued)

Symptoms	Causes and Comments
Low yield or no amplification product (continued)	Mineral oil problem. The reaction must be overlaid with high-quality, nuclease-free light mineral oil. Do not use autoclaved mineral oil.
	Reaction tubes not autoclaved. Autoclaving tubes eliminates contaminants that inhibit amplification.
	Insufficient first strand product. See discussion above under "low yield or no first strand product".
	Poor primer design. Make sure primers are not self-complementary or complementary to each other. Check the length and T_m of the PCR primers.
	Incorrect primer specificity. Verify that the primers were designed to be complementary to the appropriate strands.
	Suboptimal reaction conditions. Optimize $MgSO_4$ concentration, annealing temperature and extension time. Verify that primers are present in equal concentration. Vortex the $MgSO_4$ prior to use.
	Nucleotides degraded. Keep nucleotides frozen in aliquots, thaw quickly and keep on ice once thawed. Avoid multiple freeze-thaw cycles.
Multiple, nonspecific amplification products	Target sequence not present in target RNA. Redesign experiment or try other sources of target RNA.
	Suboptimal reaction conditions. Optimize $MgSO_4$ concentration and annealing temperature. Vortex the $MgSO_4$ prior to use.
	Poor primer design. Make sure primers are not self-complementary or complementary to each other, especially near the 3'-ends. Check the length and T_m of the PCR primers. Avoid using three G or C nucleotides in a row at the 3'-end of a primer.
	Contamination by another target RNA/DNA. Use positive displacement pipets or aerosol-resistant tips to reduce cross contamination during pipetting. Use a separate work area and pipettor for pre- and post-amplification. Wear gloves and change them often. Use UNG (4) or another sterilization technique to prevent DNA carryover to subsequent reactions.
	Multiple target sequences exist in the target RNA. Design new primers.

6. References

1. Miller, K. and Storts, D. (1995) PCR Access! A sensitive single-tube two-enzyme system for RT-PCR. *Promega Notes* **53**, 2–5.
2. Kaledin, A.S., Slyusarenko, A.G. and Gorodetskii, S.I. (1981) Isolation and properties of DNA polymerase from the extreme thermophilic bacterium *Thermus ruber*. *Biokhimiia* **46**, 1576–84.
3. Blumberg, D.D. (1987) Creating a ribonuclease-free environment. *Methods Enzymol.* **152**, 20–4.
4. Longo, M.C., Berninger, M.S. and Hartley, J.L. (1990) Use of uracil DNA glycosylase to control carry-over contamination in polymerase chain reactions. *Gene* **93**, 125–8.
5. Sellner, L.N., Coelen, R.J. and Mackenzie, J.S. (1992) Reverse transcriptase inhibits *Taq* polymerase activity. *Nucleic Acids Res.* **20**, 1487–90.
6. Chumakov, K.M. (1994) Reverse transcriptase can inhibit PCR and stimulate primer-dimer formation. *PCR Meth. Appl.* **4**, 62–4.
7. Wizard® SV Gel and PCR Clean-Up System Technical Bulletin #TB308, Promega Corporation.

7. Appendix

7.A. Composition of Buffers and Solutions

dNTP Mixture, 10mM

10mM each of dATP, dCTP, dGTP and dTTP in water

Positive Control RNA with Carrier

1.25amol/μl 1.2kb kanamycin resistance gene mRNA (prepared by in vitro transcription)
 3μg/ml *E. coli* tRNA (carrier)
 10mM Tris-HCl (pH 8.0)
 0.1mM EDTA

MgSO₄ Solution

25mM MgSO₄ in water

TAE 50X buffer

242g Tris base
 57.1ml glacial acetic acid
 100ml 0.5M EDTA (pH 8.0)
 Add deionized water to 1 liter.

7.B. Control Primer Sequences

Upstream Control Primer: 5'GCC ATT CTC ACC GGA TTC AGT CGT C 3'

Downstream Control Primer: 5'AGC CGC CGT CCC GTC AAG TCA G 3'



8. Summary of Changes

The following changes were made to the 8/26 revision of this document:

1. Removed an expired patent statement.
2. Removed Section 7.C, Related Products.

© 2010–2026 Promega Corporation. All Rights Reserved.

PolyATtract, RNasin and Wizard are registered trademarks of Promega Corporation.

Nonidet is a registered trademark of Shell International Petroleum Company, Ltd. NuSieve is a registered trademark of BioWhittaker. Tween is a registered trademark of ICI Americas, Inc.

Products may be covered by pending or issued patents or may have certain limitations. Please visit our website for more information.

All prices and specifications are subject to change without prior notice.

Product claims are subject to change. Please contact Promega Technical Services or access the Promega online catalog for the most up-to-date information on Promega products.