

Primerdesign Ltd

# SNPsig® SARS-CoV-2 (E484K)

**Variants with the E484K mutation**

SNPsig® real-time PCR  
SARS-CoV-2 mutation detection/allelic discrimination kit

96 tests

Kits by Primerdesign

For general laboratory and research use only

## Kit contents

- **SARS-CoV-2 E484K genotyping primer/probe mix (96 reactions BROWN)**  
FAM and HEX labelled
- **Wild-type positive control template (RED)**
- **Mutant positive control template (RED)**
- **RNase/DNase free water (WHITE)**  
for resuspension of primer/probe mix
- **Template preparation buffer (YELLOW)**  
for resuspension of positive control templates
- **Onestep lyophilised mastermix(RED)**  
contains complete Onestep RT-qPCR mastermix
- **Master mix resuspension buffer (BLUE)**  
for resuspension of the lyophilized mastermix

## Reagents and equipment to be supplied by the user

### Real-time PCR Instrument

Must be able to read fluorescence through FAM and HEX channels (plus Cy5 if using optional internal control)

### Pipettes and Tips

### Vortex

### Centrifuge

### Suitable qPCR 96W plates or qPCR reaction tubes

## Kit storage and stability

This kit is stable at room temperature but should be stored at -20°C on arrival. Primerdesign does not recommend using the kit after the expiry date stated on the pack. Once the lyophilised components have been resuspended, unnecessary repeated freeze/thawing should be avoided. The kit is stable for six months from the date of resuspension under these circumstances.

## Suitable sample material

SNPsig® SARS-CoV-2 E484K is intended for use as a **reflex test** only. Thus, a primary confirmation test for SARS-CoV-2 would be carried out using suitable methodology, and the extracted RNA from patient samples (or any material suited for PCR amplification) thereafter applied to this test. Please ensure that the samples are suitable in terms of purity, concentration, and RNA integrity. Always run at least one negative control with the samples. To prepare a negative control, replace the template RNA sample with RNase/DNAse free water.

## Notices and disclaimers

This product is developed, designed and sold for research purposes only. It is not intended for human diagnostic or drug purposes or to be administered to humans unless clearly expressed for that purpose by the Food and Drug Administration in the USA or the appropriate regulatory authorities in the country of use. During the warranty period Primerdesign SNPsig® detection kits allow precise and reproducible data recovery combined with excellent sensitivity. For data obtained by violation to the general GLP guidelines and the manufacturer's recommendations the right to claim under guarantee is expired. PCR is a proprietary technology covered by several US and foreign patents. These patents are owned by Roche Molecular Systems Inc. and have been sub-licensed by PE Corporation in certain fields. Depending on your specific application you may need a license from Roche or PE to practice PCR. Additional information on purchasing licenses to practice the PCR process may be obtained by contacting the Director of Licensing at Roche Molecular Systems, 1145 Atlantic Avenue, Alameda, CA 94501 or Applied Biosystems business group of the Applera Corporation, 850 Lincoln Centre Drive, Foster City, CA 94404. In addition, the 5' nuclease assay and other homogeneous amplification methods used in connection with the PCR process may be covered by U.S. Patents 5,210,015 and 5,487,972, owned by Roche Molecular Systems, Inc, and by U.S. Patent 5,538,848, owned by The Perkin-Elmer Corporation.

## Trademarks

Primerdesign™ is a trademark of Primerdesign Ltd.

The PCR process is covered by US Patents 4,683,195, and 4,683,202 and foreign equivalents owned by Hoffmann-La Roche AG. BI, ABI PRISM® GeneAmp® and MicroAmp® are registered trademarks of the Applera Genomics (Applied Biosystems Corporation).

BIOMEK® is a registered trademark of Beckman Instruments, Inc.; iCycler™ is a registered trademark of Bio-Rad Laboratories, Rotor-Gene is a trademark of Corbett Research.

LightCycler™ is a registered trademark of the Idaho Technology Inc. GeneAmp®, TaqMan® and AmpliTaqGold® are registered trademarks of Roche Molecular Systems, Inc., The purchase of the Primerdesign reagents cannot be construed as an authorization or implicit license to practice PCR under any patents held by Hoffmann-LaRoche Inc.

# Introduction

## E484K

Novel Coronavirus Disease 2019 (COVID-19) pandemic, caused by SARS-CoV-2 virus, represents a major threat to health. COVID-19 has resulted in widespread morbidity and mortality. SARS-CoV-2 is known to have infected more than 90 million people (1). As the virus has spread across the world, mutations have arisen results in divergent clusters (clades) with different prevalence in different geographic regions (2,3).

These later strains have been observed to share E484K, a mutation which raised particular concern because of its ability to evade antibodies (4–6). This variant has raised concerns internationally around antibody neutralization capabilities, disease severity and potential impacts on vaccines (7–11). E484K has been identified in variants of concern (VOC): 20H/501Y.V2 and 20J/501Y.V3 (12,13). More recently, this mutation was identified in a sub-lineage of VOC 20I/501Y.V1 within the UK (14).

E484K has been demonstrated to impact on vaccine efficacy with enormous implications for public health approaches to combatting COVID-19 cases. Current testing approaches rely upon sequencing to identify cases with E484K with delays in reporting of approximately 2 weeks. Applications of this RT-PCR assay will allow for rapid and scalable identification of E484K positive cases to ensure rapid public health responses.

## Principles of the test

### Genotyping by real-time PCR using hydrolysis probes

Each genotyping primer/probe mix contains two labelled probes homologous to the two genotypes under investigation. During qPCR amplification of the reverse-transcribed target RNA, the probes will compete for binding across the variant region. The probe that is 100% homologous to the binding site will preferentially bind and give a fluorescent signal as PCR proceeds. It follows that the wild-type sequence will give a strong amplification plot through one channel whilst giving a very weak signal through the alternative channel. Variant samples will give an exactly inverse result. Most hardware platforms can perform this analysis automatically. The SNPsig® assays are compatible with all qPCR instruments capable of detecting fluorescence in FAM and HEX (plus Cy5 if using internal control) emission channels, including selected genesig® family instruments.

### Positive controls

The kit contains positive control templates for each of the two genotypes. These can be run as parallel samples to give control signals for each genotype. Positive control templates are a potential contamination risk to subsequent tests so must be handled carefully.

### **Negative control**

To confirm the absence of contamination, a negative control reaction should be included every time the kit is used. In this instance, the RNase/DNAse free water should be used instead of template RNA. A negative result in FAM and HEX channels indicates that the reagents have not become contaminated while setting up the run. If a positive result is obtained, this indicates contamination, therefore the sample results will be invalid and the run should be repeated. Possible sources of contamination should first be explored and removed.

### **Master mix compatibility**

Onestep lyophilised mastermix contains the enzyme, nucleotides, buffers and salts at precisely the correct concentration for this application. The annealing temperatures of the primer and probe have been carefully calibrated and any change in the reaction buffer can significantly alter the performance of the assay. For this reason, Primerdesign can only guarantee accurate genotyping results when Onestep lyophilised mastermix is used.

# Resuspension Protocol

To minimize the risk of contamination with foreign RNA/DNA, we recommend that all pipetting be performed in a PCR clean environment. Ideally this would be a designated PCR lab or PCR cabinet. Filter tips are recommended for all pipetting steps. The positive control template is a significant contamination risk and should therefore be pipetted after negative control and sample wells.

## 1. Pulse-spin each tube in a centrifuge before opening.

This will ensure lyophilised primer and probe mix is in the base of the tube and is not spilt upon opening the tube.

## 2. Resuspend the primer/probe mix in the RNase/DNase free water supplied, according to the table below.

To ensure complete resuspension, vortex the tube thoroughly.

Component - Resuspend in water	Volume
SARS-CoV-2 E484K genotyping primer/probe mix (BROWN)	110 µl

## 3. Resuspend the mastermix in resuspension buffer supplied, according to the table below.

Component - Resuspend in resuspension buffer	Volume
Oonestep lyophilised mastermix (RED)	525 µl

## 4. Resuspend the positive control templates in the template preparation buffer supplied, according to the table below.

To ensure complete resuspension, vortex each tube thoroughly.

Component - Resuspend in template preparation buffer	Volume
Wild-type Positive Control Template (RED) *	500 µl
Mutant Positive Control Template (RED) *	500 µl

\* This component contains high copy number template and is a VERY significant contamination risk. It must be opened and handled in a separate laboratory environment, away from the other components.

# qPCR detection protocol

If using optional internal control, refer to page 11 for protocol amendments.

## 1. Prepare a complete genotyping reaction mix for the primer/probe mix according to the table below:

Include sufficient reactions for all samples, positive and negative controls.

Component	Volume
Oonestep lyophilised mastermix	10 µl
SARS-CoV-2 E484K genotyping primer/probe mix (BROWN)	1 µl
RNase/DNase free water (WHITE)	4 µl
<b>Final Volume</b>	<b>15 µl</b>

## 2. Pipette 15µl of this mix into each well according to your qPCR experimental plate set up.

## 3. Prepare RNA templates for each of your samples.

As this is a reflex test, the RNA obtained from the confirmatory primary assay for SARS-CoV-2 will be used.

## 4. Pipette 5µl of RNA template into each well, according to your experimental plate set up.

For negative control wells use 5µl of RNase/DNase free water. The final volume in each well is 20µl.

## 5. Pipette 5µl of each positive control RNA according to your experimental plate set up.

# qPCR amplification protocol

The following protocol is recommended for optimum resolution between genotypes:

Protocol for Onestep lyophilised mastermix

	Step	Time	Temp
Cycling x45	Reverse transcription	10 min	55 °C
	Enzyme activation	2 min	95 °C
	Denaturation	10s	95 °C
	Annealing and extension (DATA COLLECTION) *	60s	60 °C

\* Fluorogenic data should be collected during this step through the **FAM** and **HEX** channels

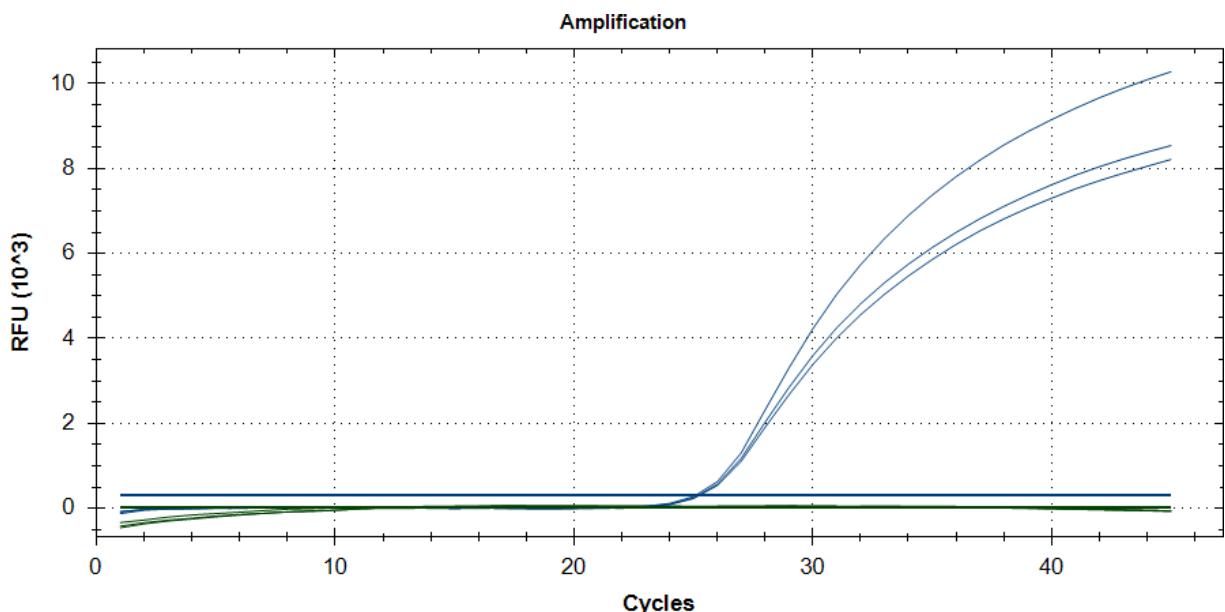
# Interpretation of results

The wild-type probe is labelled to read through the FAM channel whilst the mutant probe is labelled to read through the HEX channel. On wild-type sequences the FAM channel will give a strong amplification plot and the HEX channel none or very low detection. The signals are reversed on mutant samples. Cq values >40 should be disregarded and counted as inconclusive.

If using an internal control (see protocol below), then the Cy5 channel should be consulted where the test is negative in both the FAM and HEX channels. If neither HEX or FAM amplify, but Cy5 channel is observed, then the reaction worked, and the test is a true negative. If no Cy5 amplification is observed, then the test failed.

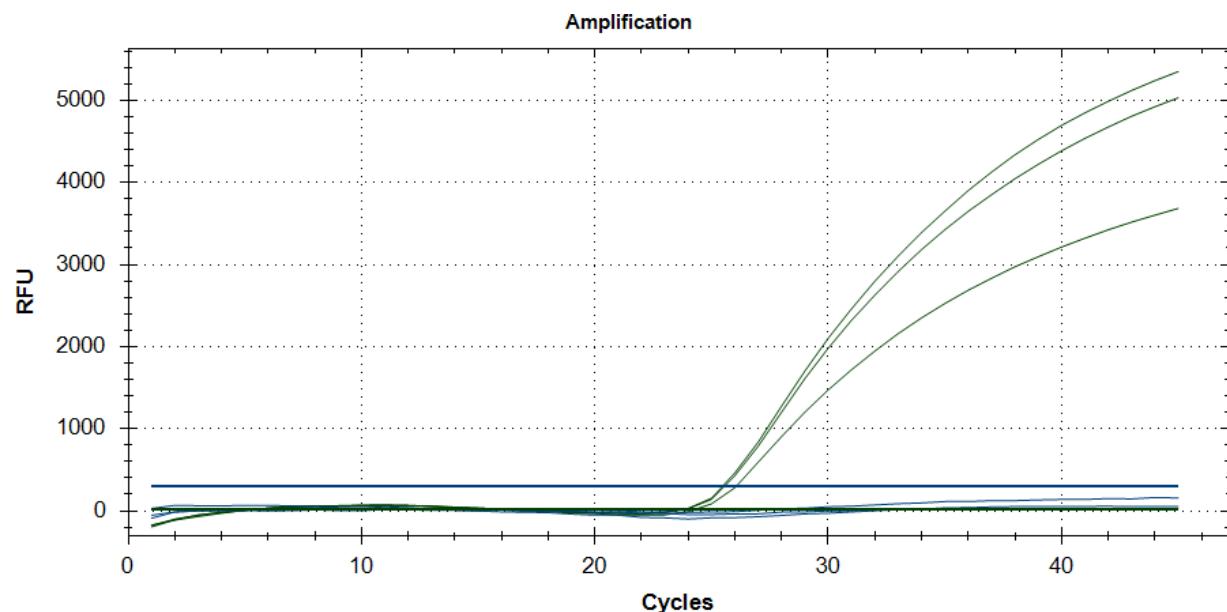
## Sample data

### Wild Type sample ([WT signal](#), [Mutant signal](#))



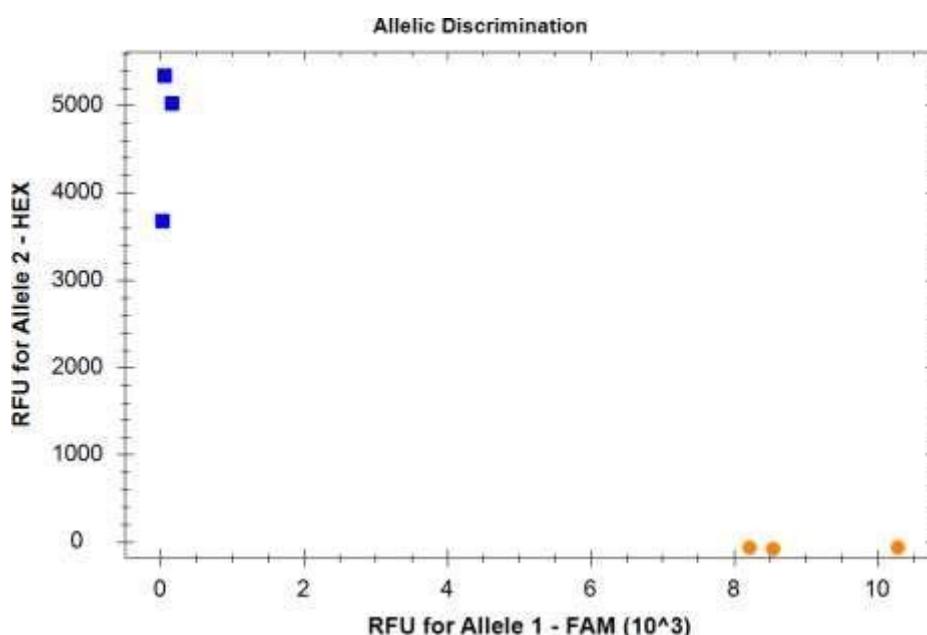
Amplification in the FAM (Blue) channel with no amplification in the HEX (green) channel indicates the presence of wild type template only.

## Variant DNA sample (WT signal, Mutant signal)



Amplification in the HEX (green) channel with no amplification in the FAM (blue) channel indicates the presence of mutant template only.

The raw data above can also be visualised by using a cluster analysis; plotting the end point fluorescence data from the FAM channel on one axis and the end point fluorescence data from the HEX channel on the other axis. Most qPCR software platforms will perform this analysis automatically so follow the manufacturer's instructions for your software. The data are quickly resolved into clusters corresponding to the wild-type, and mutant variant samples.



## Optional: Use of Internal Control (CY5)

Internal RNA control (CY5) is available as a separate product, compatible with this kit (Product Code: Z-INT-RNA-CY5-LL).

To confirm the occurrence of PCR, an internal control reaction can be used. Successful real-time PCR amplification of the internal control indicates that PCR inhibitors are not present at a high concentration. An internal control primer/probe mix labelled with the CY5 fluorophore can be used with this kit to detect the exogenous RNA template following cDNA synthesis using qPCR. The primers and CY5 probe allow detection of the control cDNA alongside the target cDNA in a multiplex reaction. Amplification of the control cDNA does not interfere with detection of the target gene even when the target gene is present at low copy number. If a positive result is obtained, this indicates that the reaction was successful and that any negative result for the primary reaction is a true negative.

## Resuspension Protocol

To minimize the risk of contamination with foreign RNA, we recommend that all pipetting be performed in a PCR clean environment. Ideally this would be a designated PCR lab or PCR cabinet. Filter tips are recommended for all pipetting steps.

**1. Pulse-spin each tube in a centrifuge before opening.**

This will ensure lyophilised primer and probe mix is in the base of the tube and is not lost upon opening the tube.

**2. Resuspend the primer/probe mix in the RNase/DNAse free water supplied, according to the table below.**

To ensure complete resuspension, vortex the tube thoroughly.

Component - Resuspend in water	Volume
Internal Control primer/probe mix CY5 (BROWN)	165 µl

**3. Resuspend internal control in 500 µl Template Preparation Buffer.**

Component - Resuspend in template preparation buffer	Volume
Internal Control RNA template (BLUE)*	500 µl

\* This component contains high copy number template and is a VERY significant contamination risk. It must be opened and handled in a separate laboratory environment, away from the other components.

**4. Prepare a complete genotyping reaction mix including the internal control primer/probe mix and the resuspended internal control template according to the table below:**

Include sufficient reactions for all samples, positive and negative controls.

Component	Volume
Onestep lyophilised mastermix	10 µl
SARS-CoV-2 E484K primer/probe mix (BROWN)	1 µl
Internal Control primer/probe mix (BROWN)	1 µl
Internal Control RNA template	1 µl
RNase/DNAse free water (WHITE)	2 µl
<b>Final Volume</b>	<b>15 µl</b>

**5. Follow qPCR amplification directions on page 8 with the exception that fluorogenic data should be collected through the FAM, HEX and Cy5 channels.**

## References

1. World Health Organisation (WHO). WHO Coronavirus Disease (COVID-19) Dashboard | WHO Coronavirus Disease (COVID-19) Dashboard [Internet]. [cited 2021 Feb 5]. Available from: <https://covid19.who.int/>
2. Hadfield J, Megill C, Bell SM, Huddleston J, Potter B, Callender C, et al. NextStrain: Real-time tracking of pathogen evolution. *Bioinformatics* [Internet]. 2018 [cited 2021 Jan 13];34(23):4121–3. Available from: <https://pubmed.ncbi.nlm.nih.gov/29790939/>
3. Tang X, Wu C, Li X, Song Y, Yao X, Wu X, et al. On the origin and continuing evolution of SARS-CoV-2 [Internet]. [cited 2021 Jan 13]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>
4. Andreano E, Piccini G, Licastro D, Casalino L, Johnson N V, Paciello I, et al. SARS-CoV-2 escape in vitro from a highly neutralizing COVID-19 convalescent plasma. *bioRxiv* [Internet]. 2020;2020.12.28.424451. Available from: <http://biorkxiv.org/content/early/2020/12/28/2020.12.28.424451.abstract>
5. Greaney AJ, Loes AN, Crawford KH, Starr TN, Malone KD, Chu HY, et al. Comprehensive mapping of mutations to the SARS-CoV-2 receptor-binding domain that affect recognition by polyclonal human serum antibodies. [cited 2021 Jan 19]; Available from: <https://doi.org/10.1101/2020.12.31.425021>
6. Cele S, Gazy I, Jackson L, Hwa S-H, Tegally H, Lustig G, et al. Escape of SARS-CoV-2 501Y.V2 variants from neutralization by convalescent plasma. *medRxiv* [Internet]. 2021 [cited 2021 Jan 25];1–19. Available from: <https://www.medrxiv.org/content/10.1101/2021.01.26.21250224v1>
7. COG-UK. COG-UK report on SARS-CoV-2 Spike mutations of interest in the UK [Internet]. Vol. 1. 2021. Available from: [https://cov-lineages.org/global\\_report.html](https://cov-lineages.org/global_report.html)
8. Wu K, Werner AP, Moliva JI, Koch M, Choi A, Stewart-Jones GBE, et al. mRNA-1273 vaccine induces neutralizing antibodies against spike mutants from global SARS-CoV-2 variants. *bioRxiv* [Internet]. 2021 [cited 2021 Jan 29]; Available from: <https://doi.org/10.1101/2021.01.25.427948>
9. Wang Z, Schmidt F, Weisblum Y, Muecksch F, Finkin S, Schaefer-Babajew D, et al. mRNA vaccine-elicited antibodies to SARS-CoV-2 and circulating variants 2 3. *bioRxiv* [Internet]. 2021 [cited 2021 Jan 25]; Available from: <https://doi.org/10.1101/2021.01.15.426911>
10. Novavax Inc. - IR Site. Novavax COVID-19 Vaccine Demonstrates 89.3% Efficacy in UK Phase 3 Trial [Internet]. [cited 2021 Feb 1]. Available from: <https://ir.novavax.com/news-releases/news-release-details/novavax-covid-19-vaccine-demonstrates-893-efficacy-uk-phase-3>
11. Johnson | Johnson & Johnson. Johnson & Johnson Announces Single-Shot Janssen COVID-19 Vaccine Candidate Met Primary Endpoints in Interim Analysis of its Phase 3 ENSEMBLE Trial [Internet]. [cited 2021 Feb 1]. Available from: <https://www.jnj.com/johnson-johnson-announces-single-shot-janssen-covid-19-vaccine-candidate-met-primary-endpoints-in-interim-analysis-of-its-phase-3-ensemble-trial>
12. Nuno F, Claro IM, Candido D, Franco LAM, Andrade PS, Colletti TM, et al. Genomic characterisation of an emergent SARS-CoV-2 lineage in Manaus: preliminary findings - SARS-CoV-2 coronavirus / nCoV-2019 Genomic Epidemiology [Internet]. *Virological*. 2021 [cited 2021 Feb 5]. Available from: <https://virological.org/t/genomic-characterisation-of-an-emergent-sars-cov-2-lineage-in-manaus-preliminary-findings/586>
13. Tegally H, Wilkinson E, Giovanetti M, Iranzadeh A, Fonseca V, Giandhari J, et al. Emergence and rapid spread of a new severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) lineage with multiple spike mutations in South Africa. *medRxiv* [Internet]. 2020; Available from: <https://doi.org/10.1101/2020.12.21.20248640>
14. Public Health England. PHE statement on Variant of Concern and new Variant Under Investigation [Internet]. Uk Government. 2021 [cited 2021 Mar 1]. Available from: <https://www.gov.uk/government/news/phe-statement-on-variant-of-concern-and-new-variant-under-investigation>