

User Guide

# MILLIPLEX® Mouse Immuno-Oncology Checkpoint Protein Panel 1

## 96-Well Plate Assay

**MCKP1-110K**  
**MCKP1-110K-PX28**  
**MCKP1-110K-PBK28**

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## Introduction

Immune checkpoint proteins are key regulators of the immune system and drug targets of cancer immunotherapy. Immune checkpoint molecules have been found on the cell surface of immune cells and tumor cells as activating receptors or inhibitory receptors. Immune checkpoint inhibitors, such as blocking antibodies to cytotoxic T lymphocyte-associated antigen-4 (CTLA-4), programmed cell death protein-1 (PD-1) and programmed cell death ligand 1 (PD-L1), have demonstrated significant efficacy in the treatment of a variety of cancers. Recent studies have also shown many immune checkpoint proteins can undergo alternative splicing or proteolytic cleavage to produce soluble checkpoint proteins. The expression levels of soluble and cell-surface immune checkpoint proteins in the circulation and in tumor-microenvironment (TME) may be used as putative immune-based biomarkers for cancer research and biomarker discovery in immunological diseases.

The MILLIPLEX® portfolio offers the broadest selection of analytes across a wide range of disease states and species. Once the analytes of interest have been identified, you can rely on the quality that we build into each kit to produce results you can trust. In addition to the assay characteristics listed in the protocol, other performance criteria evaluated during the verification process include: cross-reactivity, dilution linearity, kit stability, and sample behavior (for example, detectability and stability).

Each MILLIPLEX® panel and kit includes:

- Quality controls (QCs) provided to qualify assay performance
- Comparison of standard (calibrator) and QC lots to a reference lot to ensure lot-to-lot consistency
- Optimized serum matrix to mimic native analyte environment
- Detection antibody cocktails designed to yield consistent analyte profiles within panel

In addition, each panel and kit meets stringent manufacturing criteria to ensure batch-to-batch reproducibility. The MILLIPLEX® Mouse Immuno-Oncology Checkpoint Protein Panel 1 thus enables you to focus on the therapeutic potential of immune-oncology checkpoint proteins and the modulation of checkpoint protein expression. Coupled with the Luminex® xMAP® platform in a magnetic bead format, you receive the advantage of ideal speed and sensitivity, allowing quantitative multiplex detection of dozens of analytes simultaneously, which can dramatically improve productivity.

The MILLIPLEX® Mouse Immuno-Oncology Checkpoint Protein Panel 1 is part of the most versatile system available for immune-oncology research. From our single to multiplex biomarker solutions, we partner with you to design, develop, analytically verify and build the most comprehensive library available for protein detection and quantitation.

MILLIPLEX® products offer you:

- The ability to select a 28-plex or premixed option or
- The ability to choose any combination of analytes from our panel of 28 analytes to design a custom kit that better meets your needs.
- A convenient “all-in-one” box format that gives you the assurance that you will have all the necessary reagents you need to run your assay.

The MILLIPLEX® Mouse Immuno-Oncology Checkpoint Protein Panel 1 is a 28-plex kit to be used for the simultaneous quantification of any or all of the following analytes in serum, plasma, cell culture supernatant, cell lysate, and tissue/tumor extract samples: 4-1BBL/TNFSF9, 5'-NT/CD73, B7-H2/ICOSL, B7-H3/CD276, BCA-1/CXCL-13, BTLA, CD137/4-1BB, CD226/DNAM-1, CD25/IL-2R $\alpha$ , CD27, CD40, CD80/B7-1, CTLA-4/CD152, E-cadherin, Galectin-1, Galectin-3, GITR, Granzyme B, HVEM, IFN $\gamma$ , IL-10, LAG-3, PD-1, PD-L1, PD-L2, TIM-3, TLR-2, and TNF $\alpha$ .

**For research use only. Not for use in diagnostic procedures.**

**Please read entire protocol before use.**

**It is important to use same assay incubation conditions throughout your study.**

## Principle

MILLIPLEX® products are based on the Luminex® xMAP® technology — one of the fastest growing and most respected multiplex technologies offering applications throughout the life-sciences and capable of performing a variety of bioassays including immunoassays on the surface of fluorescent-coded magnetic beads known as MagPlex®-C microspheres.

- Luminex® products use proprietary techniques to internally color-code microspheres with two fluorescent dyes. Through precise concentrations of these dyes, distinctly colored bead sets of 500-5.6  $\mu$ m polystyrene microspheres or 80-6.45  $\mu$ m magnetic microspheres can be created, each of which is coated with a specific capture antibody.
- After an analyte from a test sample is captured by the bead, a biotinylated detection antibody is introduced.
- The reaction mixture is then incubated with Streptavidin-PE conjugate, the reporter molecule, to complete the reaction on the surface of each microsphere.
- The following Luminex® instruments can be used to acquire and analyze data using two detection methods:
  - The Luminex® analyzers, Luminex® 200™, FLEXMAP 3D®, and xMAP® INTELLIFLEX, are flow cytometry-based instruments that integrate key xMAP® detection components, such as lasers, optics, advanced fluidics and high-speed digital signal processors.
  - The Luminex® analyzer (MAGPIX®), a CCD-based instrument that integrates key xMAP® capture and detection components with the speed and efficiency of magnetic beads.

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- Each individual microsphere is identified and the result of its bioassay is quantified based on fluorescent reporter signals. We combine the streamlined data acquisition power of Luminex® xPONENT® acquisition software with sophisticated analysis capabilities of the new MILLIPLEX® Analyst 5.1, integrating data acquisition and analysis seamlessly with all Luminex® instruments.
  - xMAP® INTELLIFLEX runs on INTELLIFLEX software for instrument control, run setup and generating high quality data with flexible output options. Data can be exported in xPONENT® style CSV files for compatibility with many existing analytical applications, or in the new, customizable INTELLIFLEX file format. The INTELLIFLEX file format is intended for flexibility and simplicity, allowing the user to freely select which data points to include and to reduce the time to analysis.

The capability of adding multiple conjugated beads to each sample results in the ability to obtain multiple results from each sample. Open-architecture xMAP® technology enables multiplexing of many types of bioassays reducing time, labor and costs over traditional methods.

## Storage Conditions Upon Receipt

- Recommended storage for kit components is 2–8 °C.
- For long-term storage, freeze reconstituted standards and controls at  $\leq -20$  °C. Avoid multiple ( $> 2$ ) freeze/thaw cycles.
- **DO NOT FREEZE** Antibody-Immobilized Beads, Detection Antibody, and Streptavidin-Phycoerythrin.

## Reagents Supplied

Store all reagents at 2–8 °C

Reagents	Volume	Quantity	Cat. No.
Mouse I-O Checkpoint Protein Panel 1 Standard	Lyophilized	1 vial	MCKP1-8110
Mouse I-O Checkpoint Protein Panel 1 Quality Controls 1 and 2	Lyophilized	1 vial each	MCKP1-6110
Serum Matrix*	Lyophilized	1 vial	MXMSM-MCKP
Set of one 96-Well Plate with 2 sealers	-	1 set	-
Assay Buffer	30 mL	2 bottle	L-AB
10X Wash Buffer**	60 mL	1 bottle	L-WB
Mouse I-O Checkpoint Protein Panel 1 Detection Antibodies	3.2 mL	1 bottle	MCKP1-1110
Streptavidin-Phycoerythrin	3.2 mL	1 bottle	L-SAPE4
Mixing Bottle ( <i>not provided with premixed panel</i> )	-	1 bottle	-

\* Contains 0.08% Sodium azide

\*\* Contains 0.05% ProClin™

### Mouse Immuno-Oncology Checkpoint Protein Antibody-Immobilized Premixed Magnetic Beads:

	Volume	Quantity	Cat. No.
Premixed 28-plex Beads	3.5 mL	1 bottle	MCKP1PX-MAG

Included Mouse Immuno-Oncology Checkpoint Protein Panel 1 Antibody-Immobilized Beads are dependent on customizable selection of analytes within the panel.

## Mouse Immuno-Oncology Checkpoint Protein Panel 1

### Antibody-Immobilized Beads

Bead/Analyte Name	Luminex® Magnetic Bead Region	Customizable 28 Analytes (50X concentration, 90 µL)		28-Plex Magnetic Premixed Beads
		Available	Cat. No.	
Anti-Mouse CD137	12	✓	MCD137-MAG	✓
Anti-Mouse HVEM	13	✓	MHVEM-MAG	✓
Anti-Mouse BTLA	14	✓	MBTLA-MAG	✓
Anti-Mouse TIM-3	15	✓	MTIM3-MAG	✓
Anti-Mouse Granzyme B	18	✓	MGRNZMB-MAG	✓
Anti-Mouse IFNγ	19	✓	MIFNG-MAG	✓
Anti-Mouse LAG-3	21	✓	MLAG3-MAG	✓
Anti-Mouse PD-1	22	✓	MPD1-MAG	✓
Anti-Mouse PD-L1	25	✓	MPDL1-MAG	✓
Anti-Mouse PD-L2	27	✓	MPDL2-MAG	✓
Anti-Mouse CTLA-4/CD152	29	✓	MCTLA4-MAG	✓
Anti-Mouse GITR	33	✓	MGITR-MAG	✓
Anti-Mouse B7-H2/ICOSL	34	✓	MB7H2-MAG	✓
Anti-Mouse B7-H3/CD276	36	✓	MB7H3-MAG	✓
Anti-Mouse CD25/IL-2Ra	39	✓	MCD25-MAG	✓
Anti-Mouse IL-10	43	✓	MIL10-MAG	✓
Anti-Mouse BCA-1/CXCL-13	44	✓	MBCA1-MAG	✓
Anti-Mouse CD27	46	✓	MCD27-MAG	✓
Anti-Mouse CD40	48	✓	MCD40-MAG	✓
Anti-Mouse CD80/B7-1	51	✓	MCD80-MAG	✓
Anti-Mouse CD226/DNAM-1	53	✓	MCD226-MAG	✓
Anti-Mouse 4-1BBL/TNFSF9	54	✓	M41BBL-MAG	✓
Anti-Mouse TLR-2	62	✓	MTLR2-MAG	✓
Anti-Mouse Galectin-1	66	✓	MGAL1-MAG	✓
Anti-Mouse Galectin-3	72	✓	MGAL3-MAG	✓
Anti-Mouse 5'-NT/CD73	73	✓	MCD73-MAG	✓
Anti-Mouse E-Cadherin	75	✓	MECAD-MAG	✓
Anti-Mouse TNFα	77	✓	MCTYNFA-MAG	✓

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## Materials Required (not included)

### Reagents

MAGPIX® Drive Fluid PLUS (Cat. No. 40-50030), xMAP® Sheath Fluid PLUS (Cat. No. 40-50021), or xMAP® Sheath Concentrate PLUS (Cat. No. 40-50023)

### Instrumentation/Materials







- Adjustable pipettes with tips capable of delivering 25 µL to 1000 µL
- Multichannel pipettes capable of delivering 5 µL to 50 µL, or 25 µL to 200 µL
- Reagent reservoirs
- Polypropylene microfuge tubes
- Rubber bands
- Aluminum foil
- Absorbent pads
- Laboratory vortex mixer
- Sonicator (Branson Ultrasonic Cleaner Model No. B200 or equivalent)
- Titer Plate Shaker (VWR® Microplate Shaker Cat. No. 12620-926 or equivalent)
- Luminex® 200™, HTS, FLEXMAP 3D®, MAGPIX® instrument with xPONENT® software, or xMAP® INTELLIFLEX instrument with INTELLIFLEX software by Luminex® Corporation
- Automatic Plate Washer for magnetic beads (BioTek® 405 LS and 405 TS, Cat. No. 40-094, 40-095, 40-096, 40-097 or equivalent) or Handheld Magnetic Separation Block (Cat. No. 40-285 or equivalent).

**Note:** If a plate washer or handheld magnetic separation block for magnetic beads is not available, one can use a microtiter filter plate (Cat. No. MX-PLATE) to run the assay using a vacuum filtration unit (Vacuum Manifold, Cat. No. MSVMHTS00 or equivalent with Vacuum Pump, Cat. No. WP6111560 or equivalent).




## Safety Precautions

- All blood components and biological materials should be handled as potentially hazardous. Follow universal precautions as established by the Centers for Disease Control and Prevention and by the Occupational Safety and Health Administration when handling and disposing of infectious agents.
- Sodium azide or ProClin™ has been added to some reagents as a preservative. Although the concentrations are low, Sodium azide and ProClin™ may react with lead and copper plumbing to form highly explosive metal azides. Dispose of unused contents and waste in accordance with international, federal, state, and local regulations.

## Symbol Definitions

Ingredient	Cat No.	Label	
10X Wash Buffer	L-WB		<b>Warning.</b> May cause an allergic skin reaction. Wear protective gloves. IF ON SKIN: Wash with plenty of soap and water.
Mouse I-O Checkpoint Protein Panel Standard/Mouse I-O Checkpoint Protein Panel Quality Control 1 & 2	MCKP1-8110 MCKP1-6110	  	<b>Danger.</b> Harmful if swallowed or inhaled. Toxic in contact with skin. Causes serious eye damage. May cause damage to Respiratory Tract through prolonged or repeated exposure. May cause damage to Brain through prolonged or repeated exposure if swallowed. Harmful to aquatic life with long lasting effects. Do not breathe dust/fume/gas/mist/vapours/ spray. Wash skin thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Wear protective gloves/ protective clothing/ eye protection/ face protection. IF SWALLOWED: Call a POISON CENTER/ doctor if you feel unwell. Rinse mouth. IF ON SKIN: Wash with plenty of water. Call a POISON CENTER/ doctor if you feel unwell. IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/doctor if you feel unwell. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical advice/attention if you feel unwell. Take off contaminated clothing and wash before reuse. Store locked up. Dispose of contents/ container to an approved waste disposal plant.
Mouse I-O Checkpoint Protein Panel 1 Detection Antibodies	MCKP1-1110	 	<b>Warning.</b> Causes serious eye irritation. May cause damage to organs Respiratory Tract through prolonged or repeated exposure. Do not breathe dust/fume/gas/mist/vapours/ spray. Wash skin thoroughly after handling. Wear eye protection/ face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical advice/ attention if you feel unwell. If eye irritation persists: Get medical advice/ attention. Dispose of contents/ container to an approved waste disposal plant.



<b>Ingredient</b>	<b>Cat No.</b>	<b>Label</b>	
Streptavidin-Phycoerythrin	L-SAPE4		<b>Warning.</b> Causes serious eye irritation. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Serum Matrix	MXMSM-MCKP	 	<b>Warning.</b> Harmful in contact with skin. May cause damage to organs Brain through prolonged or repeated exposure if swallowed. Harmful to aquatic life with long lasting effects. Do not breathe dust/fume/gas/mist/vapours/spray. Avoid release to the environment. Wear protective gloves/protective clothing. IF ON SKIN: Wash with plenty of water. Call a POISON CENTER/doctor if you feel unwell. Get medical advice/attention if you feel unwell. Wash contaminated clothing before reuse. Dispose of contents/container to an approved waste disposal plant.

## Technical Guidelines

To obtain reliable and reproducible results, the operator should carefully read this entire manual and fully understand all aspects of each assay step before running the assay. The following notes should be reviewed and understood before the assay is set up.

- FOR RESEARCH USE ONLY. NOT FOR USE IN DIAGNOSTIC PROCEDURES.
- Do not use beyond the expiration date on the label.
- Do not mix or substitute reagents with those from other lots or sources.
- The Antibody-Immobilized Beads are light sensitive and must be protected from light at all times. Cover the assay plate containing beads with opaque plate lid or aluminum foil during all incubation steps.
- It is important to allow all reagents to warm to room temperature (20-25 °C) before use in the assay.
- Incomplete washing can adversely affect the assay outcome. All washing must be performed with the Wash Buffer provided.
- The standards prepared by serial dilution must be used within 1 hour of preparation. Discard any unused standards except the standard stock which may be stored at  $\leq -20\text{ }^{\circ}\text{C}$  for 1 month and at  $\leq -80\text{ }^{\circ}\text{C}$  for greater than one month.
- If samples fall outside the dynamic range of the assay, further dilute the samples with the appropriate diluent and repeat the assay.
- Any unused mixed Antibody-Immobilized Beads may be stored in the Mixing Bottle at 2-8 °C for up to one month.
- During the preparation of the standard curve, make certain to mix the higher concentration well before making the next dilution. Use a new tip with each dilution.

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- The plate should be read immediately after the assay is finished. If, however, the plate cannot be read immediately, seal the plate, cover with aluminum foil or an opaque lid, and store the plate at 2-8 °C for up to 24 hours. Prior to reading, agitate the plate on the plate shaker at room temperature for 10 minutes. Delay in reading a plate may result in decreased sensitivity for some analytes.
- The titer plate shaker should be set at a speed to provide maximum orbital mixing without splashing of liquid outside the wells. For the recommended plate shaker, this would be a setting of 5-7 which is approximately 500-800 rpm.
- Ensure that the needle probe is clean. This may be achieved by sonication and/or alcohol flushes.
- When reading the assay on the Luminex® 200™ instrument, adjust probe height according to the protocols recommended by Luminex® to the kit solid plate or to the recommended filter plates using 3 alignment discs. When reading the assay on the MAGPIX® instrument, adjust probe height according to the protocols recommended by Luminex® to the kit solid plate or to the recommended filter plates using 2 alignment discs. When reading the assay on the FLEXMAP 3D® instrument, adjust probe height according to the protocols recommended by Luminex® to the kit solid plate using 1 alignment disc.
- For the FLEXMAP 3D® instrument, when using the solid plate in the kit, the final resuspension should be with 150 µL Sheath Fluid PLUS in each well and 75 µL should be aspirated.
- For the xMAP® INTELLIFLEX instrument, adjust probe height based on the type of plate you are using, place an alignment disk or an alignment sphere in the well according to the protocol recommended by Luminex®.
- For cell culture supernatants or tissue extraction, use the culture or extraction medium as the matrix solution in background, standard curve and control wells. If samples are diluted in Assay Buffer, use the Assay Buffer as matrix.
- For serum/plasma samples that require further dilution beyond 1:2, use the Assay Buffer provided in the kit.
- For cell/tissue homogenate, the final cell or tissue homogenate should be prepared in a buffer that has a neutral pH, contains minimal detergents or strong denaturing detergents, and has an ionic strength close to physiological concentration. Avoid debris, lipids, and cell/tissue aggregates. Centrifuge samples before use.
- Vortex all reagents well before adding to plate.

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# Sample Collection and Storage

## Preparation of Serum Samples

- Allow the blood to clot for at least 30 minutes before centrifugation for 10 minutes at 1000 x g. Remove serum and assay immediately or aliquot and store samples at  $\leq -20^{\circ}\text{C}$ .
- Avoid multiple ( $> 2$ ) freeze/thaw cycles.
- When using frozen samples, it is recommended to thaw the samples completely, mix well by vortexing and centrifuge prior to use in the assay to remove particulates.
- Serum samples should be diluted 1:2 in the Assay Buffer provided in the kit. For example, in a tube, 50  $\mu\text{L}$  of serum may be combined with 50  $\mu\text{L}$  of Assay Buffer. When further dilution beyond 1:2 is required, use Assay Buffer as the diluent.

## Preparation of Plasma Samples

- Plasma collection using EDTA as an anti-coagulant is recommended. Centrifuge for 10 minutes at 1000 x g within 30 minutes of blood collection. Remove plasma and assay immediately or aliquot and store samples at  $\leq -20^{\circ}\text{C}$ .
- Avoid multiple ( $> 2$ ) freeze/thaw cycles.
- When using frozen samples, it is recommended to thaw the samples completely, mix well by vortexing and centrifuge prior to use in the assay to remove particulates.
- Plasma samples should be diluted 1:2 in the Assay Buffer provided in the kit. For example, in a tube, 50  $\mu\text{L}$  of plasma may be combined with 50  $\mu\text{L}$  of Assay Buffer. When further dilution beyond 1:2 is required, use Assay Buffer as the diluent.

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## Preparation of Tissue Culture Supernatant

- Centrifuge the sample to remove debris and assay immediately or aliquot and store samples at  $\leq -20^{\circ}\text{C}$ .
- Avoid multiple ( $> 2$ ) freeze/thaw cycles.
- Tissue culture supernatant may require a dilution with an appropriate control medium prior to assay. Tissue/cell extracts should be done in neutral buffers containing reagents and conditions that do not interfere with assay performance. Excess concentrations of detergent, salt, denaturants, high or low pH, etc. will negatively affect the assay. Organic solvents should be avoided. The tissue/cell extract samples should be free of particles such as cells or tissue debris.

### NOTE:

- A maximum of 25  $\mu\text{L}$  per well of 1:2 diluted serum or plasma can be used. Tissue culture or other media may also be used.
- All samples must be stored in polypropylene tubes. **DO NOT STORE SAMPLES IN GLASS.**
- Avoid debris, lipids and cells when using samples with gross hemolysis or lipemia.
- Care must be taken when using heparin as an anti-coagulant since an excess of heparin will provide falsely high values. Use no more than 10 IU heparin per mL of blood collected.

# Preparation of Reagents for Immunoassay

## Preparation of Antibody-Immobilized Beads

- If premixed beads are used, sonicate the premixed bead bottle 30 seconds and then vortex for 1 minute before use.
- For individual vials of beads, sonicate each antibody-bead vial for 30 seconds; vortex for 1 minute. Add 60  $\mu$ L from each antibody-bead vial to the Mixing Bottle and bring final volume to 3.0 mL with Assay Buffer. Vortex the mixed beads well. Unused portion may be stored at 2-8 °C for up to one month.  
(**Note:** Due to the composition of magnetic beads, you may notice a slight color in the bead solution. This does not affect the performance of the beads or the kit.)

Example 1: When using 20 antibody-immobilized beads, add 60  $\mu$ L from each of the 20 bead vials to the Mixing Bottle. Then add 1.8 mL Assay Buffer.

Example 2: When using 9 antibody-immobilized beads, add 60  $\mu$ L from each of the 9 bead vials to the Mixing Bottle. Then add 2.46 mL Assay Buffer.

## Preparation of Quality Controls

Before use, reconstitute Quality Control 1 and Quality Control 2 with 250  $\mu$ L deionized water. Invert the vial several times to mix and vortex. Allow the vial to sit for 5-10 minutes. Transfer the reconstituted Quality Control 1 and Quality Control 2 into two polypropylene microfuge tubes and set in an ice bath. These should be added to the plate within 1 hour of reconstitution. Unused portion may be stored at  $\leq -20$  °C for up to one month.

## Preparation of Wash Buffer

Bring the 10X Wash Buffer to room temperature and mix to bring all salts into solution. Dilute 60 mL of 10X Wash Buffer with 540 mL deionized water. Store the unused portion at 2-8 °C for up to one month.

## Preparation of Serum Matrix

**This step is required for serum or plasma samples only.**

Add 1.0 mL deionized water to the bottle containing lyophilized Serum Matrix. Mix well. Allow at least 5 minutes for complete reconstitution then add 1 mL Assay Buffer. Leftover reconstituted Serum Matrix should be stored at  $\leq -20$  °C for up to one month.

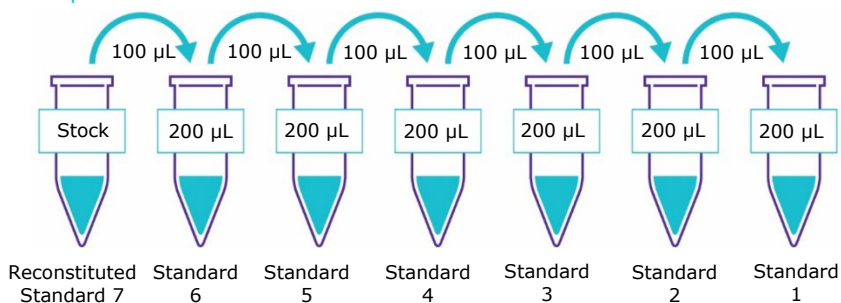
## Preparation of Mouse Immuno-Oncology Checkpoint Protein Panel 1 Standard

1. Prior to use, reconstitute the Mouse IO Checkpoint Protein Panel 1 Standard with 250  $\mu\text{L}$  deionized water. Refer to table below for analyte concentrations. Invert the vial several times to mix. Vortex the vial for 10 seconds. Allow the vial to sit for 5-10 minutes. Transfer the reconstituted standard to a polypropylene microfuge tube. This will be used as "Standard 7"; This reconstituted standard and the serially diluted standards in the following steps should be set in an ice bath, during the assay procedure. These need to be added to the plate within 1 hour of preparation. The unused portion of the "Standard 7" may be stored at  $\leq -20^\circ\text{C}$  for up to one month.
2. Preparation of Working Standards  
Label 6 polypropylene microfuge tubes Standard 1 through Standard 6. Add 200  $\mu\text{L}$  of Assay Buffer to each of the 6 tubes. Prepare serial dilutions by adding 100  $\mu\text{L}$  of the reconstituted standard to the Standard 6 tube, mix well and transfer 100  $\mu\text{L}$  of Standard 6 to the Standard 5 tube, mix well and transfer 100  $\mu\text{L}$  of Standard 5 to the Standard 4 tube, mix well and transfer 100  $\mu\text{L}$  of Standard 4 to the Standard 3 tube, mix well and transfer 100  $\mu\text{L}$  of Standard 3 to the Standard 2 tube, mix well and transfer 100  $\mu\text{L}$  of Standard 2 to the Standard 1 tube and mix well. The 0 pg/mL standard (Background) will be Assay Buffer.

Standard No.	Add Deionized Water ( $\mu\text{L}$ )	Add Standard (volume)
Standard 7	250	0

Standard No.	Add Assay Buffer ( $\mu\text{L}$ )	Add Standard (volume)
Standard 6	200	100 $\mu\text{L}$ of Standard 7
Standard 5	200	100 $\mu\text{L}$ of Standard 6
Standard 4	200	100 $\mu\text{L}$ of Standard 5
Standard 3	200	100 $\mu\text{L}$ of Standard 4
Standard 2	200	100 $\mu\text{L}$ of Standard 3
Standard 1	200	100 $\mu\text{L}$ of Standard 2

## Preparation of Standards



Standard	BTLA (pg/mL)	HVEM (pg/mL)	CD137, TIM-3, CTLA-4/ CD152 (pg/mL)	Granzyme B (pg/mL)	IL-10 (pg/mL)	LAG-3, TLR-2 (pg/mL)
Standard 1	21	1.4	5.5	8.2	11	412
Standard 2	62	4.1	16	25	33	1,235
Standard 3	185	12	49	74	99	3,704
Standard 4	556	37	148	222	296	11,111
Standard 5	1,667	111	444	667	889	33,333
Standard 6	5,000	333	1,333	2,000	2,667	100,000
Standard 7	15,000	1,000	4,000	6,000	8,000	300,000

<b>Standard</b>	<b>PD-1, CD27 (pg/mL)</b>	<b>PD-L1, CD40, CD226/ DNAM-1, 4-1BBL/ TNFSF9 (pg/mL)</b>	<b>PD-L2 (pg/mL)</b>	<b>IFN<math>\gamma</math> (pg/mL)</b>	<b>GITR, Galectin-3 (pg/mL)</b>	<b>B7-H2/ ICOSL, BCA-1/ CXCL-13 (pg/mL)</b>
Standard 1	55	14	6.9	2.1	41	27
Standard 2	165	41	21	6.2	123	82
Standard 3	494	123	62	19	370	247
Standard 4	1481	370	185	56	1,111	741
Standard 5	4,444	1,111	556	167	3,333	2,222
Standard 6	13,333	3,333	1,667	500	10,000	6,667
Standard 7	40,000	10,000	5,000	1,500	30,000	20,000

<b>Standard</b>	<b>B7-H3/ CD276, Galectin-1 (ng/mL)*</b>	<b>CD25/ IL-2Ra (pg/mL)</b>	<b>CD80/ B7-1 (pg/mL)</b>	<b>5'-NT/ CD73 (pg/mL)</b>	<b>E-Cadherin (pg/mL)</b>	<b>TNF<math>\alpha</math> (pg/mL)</b>
Standard 1	3.4	2.7	34.3	137	342	4.1
Standard 2	10	8.2	103	412	1,029	12
Standard 3	31	25	309	1,235	3,086	37
Standard 4	93	74	926	3,704	9,259	111
Standard 5	278	222	2,778	11,111	27,778	333
Standard 6	833	667	8,333	33,333	83,333	1,000
Standard 7	2,500	2,000	25,000	100,000	250,000	3,000

\* B7-H3/CD 276 and Galectin-1 are listed in ng/mL, all other analytes are pg/mL.



# Immunoassay Procedure

- Prior to beginning this assay, it is imperative to read this protocol completely and to thoroughly understand the Technical Guidelines.
- Allow all reagents to warm to room temperature (20-25 °C) before use in the assay.
- Diagram the placement of Standards [0 (Background), Standard 1 through 7, Controls 1 and 2, and Samples on Well Map Worksheet in a vertical configuration.

**(Note:** Most instruments will only read the 96-well plate vertically by default.) It is recommended to run the assay in duplicate.

- If using a filter plate, set the filter plate on a plate holder at all times during reagent dispensing and incubation steps so that the bottom of the plate does not touch any surface.

1. Add 200  $\mu$ L of Wash Buffer into each well of the plate. Seal and mix on a plate shaker for 10 minutes at room temperature (20-25 °C).
2. Decant Wash Buffer and remove the residual amount from all wells by inverting the plate and tapping it smartly onto absorbent towels several times.
3. Add 25  $\mu$ L of each Standard or Control into the appropriate wells. Assay Buffer should be used for 0 standard (Background).
4. Add 25  $\mu$ L of Assay Buffer to the sample wells.
5. Add 25  $\mu$ L of appropriate matrix solution to the background, standards, and control wells. When assaying serum or plasma, use the Serum matrix. When assaying tissue culture or other supernatant, use proper control culture medium as the matrix solution.
6. Add 25  $\mu$ L of Sample (1:2 Diluted) into the appropriate wells.
7. Vortex Mixing Bottle and add 25  $\mu$ L of the Mixed or Premixed Beads to each well. **(Note:** During addition of Beads, shake bead bottle intermittently to avoid settling.)
8. Seal the plate with a plate sealer. Wrap the plate with foil and incubate with agitation on a plate shaker overnight (16-18 hours) at 2-8 °C.

Add 200  $\mu$ L Wash Buffer per well



Shake 10 min, RT  
Decant

- Add 25  $\mu$ L Standard or Control to appropriate wells
- Add 25  $\mu$ L Assay Buffer to background and sample wells
- Add 25  $\mu$ L appropriate matrix solution to background, standards, and control wells
- Add 25  $\mu$ L 1:2 diluted Samples to sample wells
- Add 25  $\mu$ L Beads to each well



Incubate overnight (16-18 hours) at 2-8 °C

Gently remove well contents and wash plate 3 times following instructions listed in the Plate Washing section.

Add 25  $\mu$ L of Detection Antibodies into each well.

**(Note:** Allow the Detection Antibodies to warm to room temperature prior to addition.)

Seal, cover with foil and incubate with agitation on a plate shaker for 1 hour at room temperature (20-25  $^{\circ}$ C). **DO NOT ASPIRATE AFTER INCUBATION.**

Add 25  $\mu$ L Streptavidin-Phycoerythrin to each well containing the 25  $\mu$ L of Detection Antibodies.

Seal, cover with foil and incubate with agitation on a plate shaker for 30 minutes at room temperature (20-25  $^{\circ}$ C).

Gently remove well contents and wash plate 3 times following instructions listed in the Plate Washing section.

Add 150  $\mu$ L of Sheath Fluid PLUS (or Drive Fluid PLUS if using MAGPIX<sup>®</sup>) to all wells. Resuspend the beads on a plate shaker for 5 minutes.

Run plate on Luminex<sup>®</sup> 200™, HTS, FLEXMAP 3D<sup>®</sup>, MAGPIX<sup>®</sup> instrument with xPONENT<sup>®</sup> software or xMAP<sup>®</sup> INTELLIFLEX instrument with INTELLIFLEX software.

Save and analyze the Median Fluorescent Intensity (MFI) data using a 5-parameter logistic or spline curve-fitting method for calculating analyte concentrations in samples.

**(Note:** For diluted samples, final sample concentrations should be multiplied by the dilution factor. For samples diluted as per protocol instructions, multiply by 2. If using another dilution factor, multiply by the appropriate dilution factor.)

(If using neat samples, change the note above to **Note:** No sample dilution is required for this assay. If samples were diluted, final sample concentrations should be multiplied by the dilution factor.)



Remove well contents and wash 3X with 200  $\mu$ L Wash Buffer

Add 25  $\mu$ L Detection Antibodies per well



Incubate 1 Hour at RT

Do Not Aspirate

Add 25  $\mu$ L Streptavidin-Phycoerythrin per well



Incubate for 30 minutes at RT

Remove well contents and wash 3X with 200  $\mu$ L Wash Buffer

Add 150  $\mu$ L Sheath Fluid PLUS or Drive Fluid PLUS per well

Read on Luminex<sup>®</sup> (100  $\mu$ L, 50 beads per bead set)

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## Plate Washing

If using a solid plate, use either a handheld magnet or magnetic plate washer.

### Solid Plate

- Handheld magnet (Cat. No.40-285)  
Rest plate on magnet for 60 seconds to allow complete settling of magnetic beads. Remove well contents by gently decanting the plate in an appropriate waste receptacle and gently tapping on absorbent pads to remove residual liquid. Wash plate with 200 µL of Wash Buffer by removing plate from magnet, adding Wash Buffer, shaking for 30 seconds, reattaching to magnet, letting beads settle for 60 seconds and removing well contents as previously described after each wash. Repeat wash steps as recommended in Assay Procedure.
- Magnetic plate washer (Cat. No. 40-094, 40-095, 40-096 and 40-097)  
Please refer to specific automatic plate washer manual for appropriate equipment settings. Please note that after the final aspiration, there will be approximately 25 µL of residual wash buffer in each well. This is expected when using the BioTek® plate washer and this volume does not need to be aspirated from the plate.

If using an automatic plate washer other than BioTek® 405 LS or 405 TS, please refer to the manufacturer's recommendations for programming instructions.

### Filter Plate (Cat. No. MX-PLATE)

If using a filter plate, use a vacuum filtration manifold to remove well contents. Wash plate with 200 µL/well of Wash Buffer, removing Wash Buffer by vacuum filtration after each wash. Repeat wash steps as recommended in the Assay Procedure.

## Equipment Settings

Luminex® 200™, HTS, FLEXMAP 3D®, MAGPIX® instruments with xPONENT® software and xMAP® INTELLIFLEX instrument with INTELLIFLEX software:

These specifications are for the above listed instruments and software. Luminex® instruments with other software (for example, MasterPlex®, StarStation, LiquiChip, Bio-Plex® Manager™, LABScan™100) would need to follow instrument instructions for gate settings and additional specifications from the vendors for reading Luminex® magnetic beads.

For magnetic bead assays, each instrument must be calibrated and performance verified with the indicated calibration and verification kits.

<b>Instrument</b>	<b>Calibration Kit</b>	<b>Verification Kit</b>
Luminex® 200™ and HTS	xPONENT® 3.1 compatible Calibration Kit (Cat. No. LX2R-CAL-K25)	Performance Verification Kit (Cat. No. LX2R-PVER-K25)
FLEXMAP 3D®	FLEXMAP 3D® Calibrator Kit (Cat. No. F3D-CAL-K25)	FLEXMAP 3D® Performance Verification Kit (Cat. No. F3D-PVER-K25)
xMAP® INTELLIFLEX	xMAP® INTELLIFLEX Calibration Kit (Cat. No. IFX-CAL-K20)	xMAP® INTELLIFLEX Performance Verification Kit (Cat. No. IFX-PVER-K20)
MAGPIX®	MAGPIX® Calibration Kit (Cat. No. MPX-CAL-K25)	MAGPIX® Performance Verification Kit (Cat. No. MPX-PVER-K25)

**NOTE:** When setting up a Protocol using the xPONENT® software, you must select MagPlex® as the Bead Type in the Acquisition settings.

**NOTE:** These assays cannot be run on any instruments using Luminex® IS 2.3 or Luminex® 1.7 software.

The Luminex® probe height must be adjusted to the plate provided in the kit. Please use Cat. No. MAG-PLATE, if additional plates are required for this purpose.

Events	50, per bead
Sample Size	100 µL
Gate Settings	8,000 to 15,000
Reporter Gain	Default (low PMT)
Time Out	60 seconds
Bead Set	Customizable 28-plex Beads
	<hr/>
CD137	12
HVEM	13
BTLA	14
	<hr/>
TIM-3	15
Granzyme B	18
IFNγ	19
	<hr/>
LAG-3	21
PD-1	22
PD-L1	25
	<hr/>
PD-L2	27
CTLA-4/CD152	29
GITR	33
	<hr/>
B7-H2/ICOSL	34
B7-H3/CD276	36
CD25/IL-2Ra	39
	<hr/>
IL-10	43
BCA-1/CXCL-13	44
CD27	46
	<hr/>
CD40	48
CD80/B7-1	51
CD226/DNAM-1	53
	<hr/>
4-1BBL/TNFSF9	54
TLR-2	62
Galectin-1	66
	<hr/>
Galectin-3	72
5'-NT/CD73	73
E-Cadherin	75
TNFα	77

## Quality Controls

The ranges for each analyte in Quality Control 1 and 2 are provided on the card insert or can be located at our website [SigmaAldrich.com](https://www.sigmaldrich.com) using the catalogue number as the keyword.

## Assay Characteristics

### Cross-Reactivity

There was no or negligible cross-reactivity between the antibodies for an analyte and any of the other analytes in this panel.

### Assay Sensitivities (minimum detectable concentrations, pg/mL)

Minimum Detectable Concentration (MinDC) is calculated using MILLIPLEX® Analyst 5.1. It measures the true limits of detection for an assay by mathematically determining what the empirical MinDC would be if an infinite number of standard concentrations were run for the assay under the same conditions.

<b>Overnight Protocol (n = 13 Assays)</b>		
<b>Analyte</b>	<b>MinDC (pg/mL)</b>	<b>MinDC+2SD (pg/mL)</b>
CD137	1.1	2.9
HVEM	0.6	1.8
BTLA	5.9	15.3
TIM-3	1.2	2.4
Granzyme B	3.2	8.0
IFN $\gamma$	0.7	1.8
LAG-3	163.0	372.1
PD-1	15.1	39.8
PD-L1	4.0	8.0
PD-L2	2.2	5.7
CTLA-4/CD152	1.9	4.8
GITR	13.0	31.9
B7-H2/ICOSL	8.3	16.4
B7-H3/CD276	2.0 (ng/mL)	4.5 (ng/mL)
CD25/IL-2R $\alpha$	0.9	2.3
IL-10	3.3	9.0
BCA-1/CXCL-13	8.2	13.2
CD27	15.5	41.0
CD40	4.7	8.5
CD80/B7-1	14.4	25.1
CD226/DNAM-1	4.0	11.0

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4-1BBL/TNFSF9	4.1	7.9
TLR-2	131.6	296.7
Galectin-1	2.1 (ng/mL)	5.0 (ng/mL)
Galectin-3	21.3	40.7
5'-NT/CD73	68.5	117.0
E-Cadherin	140.5	212.8
TNFα	2.3	5.3

## Precision

Intra-assay precision is generated from the mean of the %CV's from 16 reportable results across two different concentrations of analytes in a single assay. Inter-assay precision is generated from the mean of the %CV's across two different concentrations of analytes across 12 different assays.

Overnight Protocol		
Analyte	Intra-assay %CV	Inter-assay %CV
CD137	< 10	< 20
HVEM	< 10	< 20
BTLA	< 10	< 20
TIM-3	< 10	< 20
Granzyme B	< 10	< 20
IFN $\gamma$	< 10	< 20
LAG-3	< 10	< 20
PD-1	< 10	< 20
PD-L1	< 10	< 20
PD-L2	< 10	< 20
CTLA-4/CD152	< 10	< 20
GITR	< 10	< 20
B7-H2/ICOSL	< 10	< 20
B7-H3/CD276	< 10	< 20
CD25/IL-2R $\alpha$	< 10	< 20
IL-10	< 10	< 20
BCA-1/CXCL-13	< 10	< 20
CD27	< 10	< 20
CD40	< 10	< 20
CD80/B7-1	< 10	< 20
CD226/DNAM-1	< 10	< 20
4-1BBL/TNFSF9	< 10	< 20

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TLR-2	< 10	< 20
Galectin-1	< 10	< 20
Galectin-3	< 10	< 20
5'-NT/CD73	< 10	< 20
E-Cadherin	< 10	< 20
TNF $\alpha$	< 10	< 20

## Accuracy

Spike Recovery: The data represent mean percent recovery of spiked standards ranging from low, medium, and high concentration in serum matrices (n=6).

### Overnight Protocol

Analyte	% Recovery in Serum Matrix
CD137	107
HVEM	108
BTLA	111
TIM-3	106
Granzyme B	94
IFN $\gamma$	103
LAG-3	105
PD-1	106
PD-L1	96
PD-L2	104
CTLA-4/CD152	104
GITR	109
B7-H2/ICOSL	110
B7-H3/CD276	95
CD25/IL-2R $\alpha$	105
IL-10	105
BCA-1/CXCL-13	105
CD27	107
CD40	109
CD80/B7-1	103
CD226/DNAM-1	110
4-1BBL/TNFSF9	105

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TLR-2	104
Galectin-1	101
Galectin-3	108
5'-NT/CD73	106
E-Cadherin	108
TNF $\alpha$	106

## Troubleshooting

Problem	Probable Cause	Solution
Insufficient bead count	Plate washer aspirate height set too low	Adjust aspiration height according to manufacturers' instructions.
	Bead mix prepared inappropriately	Sonicate bead vials and vortex just prior to adding to bead mix bottle according to protocol. Agitate bead mix intermittently in reservoir while pipetting this into the plate.
	Samples cause interference due to particulate matter or viscosity	See above. Also sample probe may need to be cleaned with alcohol flushes, back flushes and washes; or, if needed, probe should be removed and sonicated.
	Probe height not adjusted correctly	When reading the assay on the Luminex <sup>®</sup> 200™ instrument, adjust probe height to the kit solid plate or to the recommended filter plates using 3 alignment discs. When reading the assay on the MAGPIX <sup>®</sup> instrument, adjust probe height to the kit solid plate or to the recommended filter plates using 2 alignment discs. When reading the assay on the FLEXMAP 3D <sup>®</sup> instrument, adjust probe height to the kit solid plate using 1 alignment disc. For the FLEXMAP 3D <sup>®</sup> instrument, when using the solid plate in the kit, the final resuspension should be with 150 $\mu$ L Sheath Fluid PLUS in each well and 75 $\mu$ L should be aspirated. When reading the assay on the xMAP <sup>®</sup> INTELLIFLEX instrument, adjust probe height based on the type of plate you are using, place an alignment disk or an alignment sphere in the well according to the protocol recommended by Luminex <sup>®</sup> .

Problem	Probable Cause	Solution
Background is too high	Background wells were contaminated	Avoid cross-well contamination by using sealer appropriately and pipetting with multichannel pipettes without touching reagent in plate.
	Matrix used has endogenous analyte or interference	Check matrix ingredients for cross-reacting components (for example, interleukin modified tissue culture medium).
	Insufficient washes	Increase number of washes.
	Luminex® instrument not calibrated correctly or recently	Calibrate Luminex® instrument based on manufacturer's instructions, at least once a week or if temperature has changed by > 3 °C.
Beads not in region or gate	Gate settings not adjusted correctly	Some Luminex® instruments (for example, Bio-Plex®) require different gate settings than those described in the kit protocol. Use instrument default settings.
	Wrong bead regions in protocol template	Check kit protocol for correct bead regions or analyte selection.
	Incorrect sample type used	Samples containing organic solvents or if highly viscous should be diluted or dialyzed as required.
	Instrument not washed or primed	Prime the Luminex® instrument 4 times to rid it of air bubbles, wash 4 times with sheath fluid or water if there is any remnant alcohol or sanitizing liquid.
	Beads were exposed to light	Keep plate and bead mix covered with dark lid or aluminum foil during all incubation steps.
Signal for whole plate is same as background	Incorrect or no Detection Antibody was added	Add appropriate Detection Antibody and continue.
	Streptavidin-Phycoerythrin was not added	Add Streptavidin-Phycoerythrin according to protocol. If Detection Antibody has already been removed, sensitivity may be low.
Low signal for standard curve	Detection Antibody may have been removed prior to adding Streptavidin-Phycoerythrin	May need to repeat assay if desired sensitivity not achieved.
	Incubations done at inappropriate temperatures, timings or agitation	Assay conditions need to be checked.

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Problem	Probable Cause	Solution
Signals too high, standard curves are saturated	Calibration target value set too high	With some Luminex® instruments (for example, Bio-Plex®) default target setting for RP1 calibrator is set at high PMT. Use low target value for calibration and reanalyze plate.
	Plate incubation was too long with standard curve and samples	Use shorter incubation time.
	Samples contain no or below detectable levels of analyte	If below detectable levels, it may be possible to use higher sample volume. Check with technical support for appropriate protocol modifications.
Sample readings are out of range	Samples contain analyte concentrations higher than highest standard point	Samples may require dilution and reanalysis for just that particular analyte.
	Standard curve was saturated at higher end of curve	See above.
High variation in samples and/or standards	Multichannel pipette may not be calibrated	Calibrate pipettes.
	Plate washing was not uniform	Confirm all reagents are removed completely in all wash steps.
	Samples may have high particulate matter or other interfering substances	See above.
	Plate agitation was insufficient	Plate should be agitated during all incubation steps using an orbital plate shaker at a speed where beads are in constant motion without causing splashing.
	Cross-well contamination	Check when reusing plate sealer that no reagent has touched sealer. Care should be taken when using same pipette tips that are used for reagent additions and that pipette tip does not touch reagent in plate.

## FOR FILTER PLATES ONLY

Problem	Probable Cause	Solution
Filter plate will not vacuum	Vacuum pressure is insufficient	Increase vacuum pressure such that 0.2 mL buffer can be suctioned in 3-5 seconds.
	Samples have insoluble particles	Centrifuge samples just prior to assay set-up and use supernatant.
	High lipid concentration	After centrifugation, remove lipid layer and use supernatant.
Plate leaked	Vacuum pressure too high	Adjust vacuum pressure such that 0.2 mL buffer can be suctioned in 3-5 seconds. May need to transfer contents to a new (blocked) plate and continue.
	Plate set directly on table or absorbent towels during incubations or reagent additions	Set plate on plate holder or raised edge so bottom of filter is not touching any surface.
	Insufficient blotting of filter plate bottom causing wicking	Blot the bottom of the filter plate well with absorbent towels after each wash step.
	Pipette touching plate filter during additions	Pipette to the side of plate.
	Probe height not adjusted correctly	Adjust probe to 3 alignment discs in well H6.
	Sample too viscous	May need to dilute sample.

## Product Ordering

Replacement Reagents	Cat. No.
Mouse I-O Checkpoint Protein Panel 1 Standard	MCKP1-8110
Mouse I-O Checkpoint Protein Panel 1 Quality Controls 1 and 2	MCKP1-6110
Serum Matrix	MXMSM-MCKP
Mouse I-O Checkpoint Protein Panel 1 Detection Antibodies	MCKP1-1110
Streptavidin-Phycoerythrin	L-SAPE4
Assay Buffer	L-AB
Set of two 96-Well plates with sealers	MAG-PLATE
10X Wash Buffer	L-WB

## Antibody-Immobilized Magnetic Beads

Analyte	Bead No.	Cat. No.
CD137	12	MCD137-MAG
HVEM	13	MHVEM-MAG
BTLA	14	MBTLA-MAG
TIM-3	15	MTIM3-MAG
Granzyme B	18	MGRNZMB-MAG
IFN $\gamma$	19	MIFNG-MAG
LAG-3	21	MLAG3-MAG
PD-1	22	MPD1-MAG
PD-L1	25	MPDL1-MAG
PD-L2	27	MPDL2-MAG
CTLA-4/CD152	29	MCTLA4-MAG
GITR	33	MGITR-MAG
B7-H2/ICOSL	34	MB7H2-MAG
B7-H3/CD276	36	MB7H3-MAG
CD25/IL-2R $\alpha$	39	MCD25-MAG
IL-10	43	MIL10-MAG
BCA-1/CXCL-13	44	MBCA1-MAG
CD27	46	MCD27-MAG
CD40	48	MCD40-MAG
CD80/B7-1	51	MCD80-MAG
CD226/DNAM-1	53	MCD226-MAG
4-1BBL/TNFSF9	54	M41BBL-MAG
TLR-2	62	MTLR2-MAG
Galectin-1	66	MGAL1-MAG
Galectin-3	72	MGAL3-MAG
5'-NT/CD73	73	MCD73-MAG
E-Cadherin	75	MECAD-MAG
TNF $\alpha$	77	MCYTNFA-MAG

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## Well Map

	1	2	3	4	5	6	7	8	9	10	11	12
A	Background	Standard 4	QC-1 Control	Etc.								
B	Background	Standard 4	QC-1 Control									
C	Standard 1	Standard 5	QC-2 Control									
D	Standard 1	Standard 5	QC-2 Control									
E	Standard 2	Standard 6	Sample 1									
F	Standard 2	Standard 6	Sample 1									
G	Standard 3	Standard 7	Sample 2									
H	Standard 3	Standard 7	Sample 2									

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## Technical Assistance

Visit the tech service page at [SigmaAldrich.com/techservice](https://www.sigmaldrich.com/techservice).

## Standard Warranty

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## Safety Data Sheets (SDS)

Safety Data Sheets are available on the product page at [SigmaAldrich.com](https://www.sigmaldrich.com).

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