

**Kimball Physics Faraday Cup Detectors:
 FC-66, FC-70, FC-71, FC-72, FC-73, and FC-86**

APPLICATIONS:

- Continuous Collection and Measurement of Charged Particle Current
- Measurement of Emitted Beam for Electron or Ion Gun

FEATURES / OPTIONS:

- Apertures from 1 to 11 mm, User Changeable
- Input Power Continuous from 100 mW to 1250 watts.
- Option Grids, Energy Analyzing
- Option Phosphor Screens around Entrance Aperture
- Biased Cups (Collector cup floated away from ground)
- Water Cooling



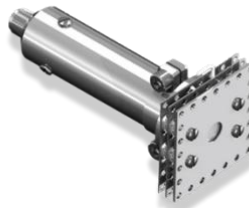
Faraday Cup FC-86



Faraday Cup FC-66



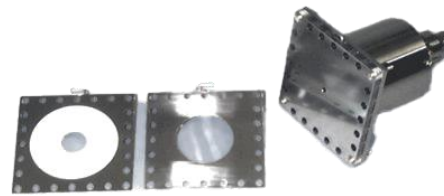
Faraday Cup FC-73



Faraday Cup FC-71



Faraday Cup FC-70 with cable and connection options



Faraday Cup FC-72

Figure 1. Examples of Faraday Cup Detectors available from Kimball Physics (not to scale).

INTRODUCTION

Kimball Physics Faraday Cup Detectors are stand-alone units with no moving parts that are intended to be mounted in the vacuum system. Most of these assemblies mount directly on the housing of electron guns for direct sampling of the beam and can be moved in and out of the beam path using pneumatic or mechanical actuators (Figure 3). Please refer to the table later in this document for comparison of features available with Kimball Physics Faraday Cup Detectors.

The Faraday Cups are available in various configurations and capabilities, with continuous input power ranges from 100 mW to 1250 watts, aperture sizes from 1 mm to 11.00 mm, with features and options including one or multiple

grids and phosphor screens. Configurations are available to be 1) placed and mounted within the vacuum space (FC-66, FC-70, FC-71, FC-72) and then connected externally to the ammeter through a vacuum flange feedthrough (see Kimball Physics product: In-Vacuum BNC Cable

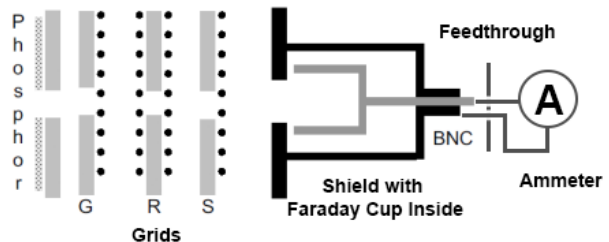


Figure 2. Faraday Cup (FC) schematic showing standard shield with FC inside and optional grids and phosphor screen.

and Feedthrough(1.33"CF) or 2) the Faraday Cup is integrated into an assembly mounted directly on the CF flange of the vacuum chamber (FC-73, FC-86).

The Kimball Physics Faraday Cup Detectors, connected to an ammeter, are used to collect and measure charged particle current, such as the beam emitted from an electron or ion gun. Most models are UHV compatible and fully bakeable.

The Faraday cup basically consists of a hollow stainless steel cylinder closed at the base, with an appropriately sized aperture for collecting the electrons or ions. An outer, grounded cylinder provides shielding. An electrical connection is made to the base of the Faraday cup, terminating in a connector.

The current is then conducted from the Faraday cup via an electrical Feedthrough Flange from the vacuum space and then connected to an external ammeter for measurement and recording. Kimball Physics has optional feedthroughs available for 0.95" and 1.33" CF flanges (see figure 4). Custom designed feedthroughs are also available from Kimball Physics as a separate option.

STANDARD AND OPTIONAL GRIDS

The Kimball Physics Faraday Cup FC-73 comes with a set of three grids so that it can be used also as an *energy analyzer*. The FC-71 and FC-72 also have these grids available as options. These grids are, in the order that the electrons or ions go through them: ground, retarding, and

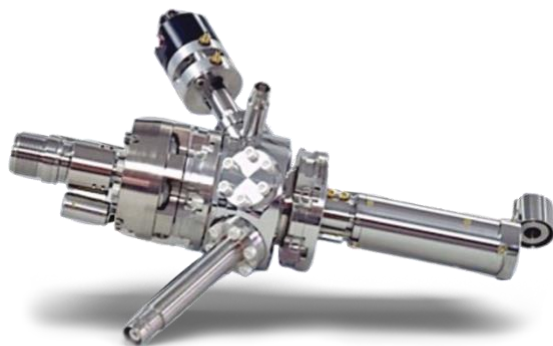


Figure 3. Faraday Cup (FC) mounted on the end of an electron gun with a mechanical actuator to move FC in and out of the beam.

suppression, labeled G, R and S in the Figure 2 schematic above.

A variable potential is applied to the retarding grid to analyze the energies of electrons or ions. The grid voltage is negative for electrons/negative ions, or positive for positive ions. The current into the Faraday cup is measured while the retarding grid voltage is varied from zero to a voltage which cuts off the current completely.

OPTIONAL PHOSOPOR SCREEN

A phosphor screen, made with high luminosity P22 phosphor (ZnS: Ag), is available as an option on the front plate of the FC-70, FC-71, FC-72 and is included and removable on the FC-86 Faraday cup. The use of a grounded phosphor target screen is helpful as it allows visual, real-time observation of the spot. The phosphor screen emits a pale blue light (photons) when bombarded by high energy particles (threshold value approximately 500 eV for electrons and 1000 eV for ions).

The screen can be used for gun alignment and to set the proper operating parameters necessary to obtain maximum beam uniformity or minimum spot size. Note that excessive current or exposure may cause phosphor screen damage.

BIASING THE FARADAY CUP







The Faraday cup (FC-66, FC-72, FC-86) can be electrically biased to reduce scattering of electrons or ions collected in the Faraday cup and to reduce secondary electron emission. For electrons or negative ions, +50 V is typically adequate, and for positive ions, -50 V. This can be accomplished by placing a battery between the vacuum feedthrough and the ammeter.

ADDITIONAL INFORMATION

Please refer to the comparison table (Table 1) below to learn more about the various features in our Kimball Physics Faraday Cup Detector models.

And please reach out to Kimball Physics with any questions or to discuss a possible custom solution for your application.

Table 1: Comparison of Faraday Cup Model Features

Faraday Cup	FC-66	FC-70	FC-71	FC-72	FC-73	FC-86
						
APERTURE SIZE	5.1 mm diameter (20.42 mm ² area)	1.596 mm diameter (2 mm ² area)	5.00 mm diameter (19.63 mm ² area)	11.28 mm diameter (99.93 mm ² area). Custom small diameter available	5.00 mm diameter (up to 9.5 mm custom) (19.63 mm ² area)	1 mm diameter standard (0.785 mm ² area)
INPUT POWER CONTINUOUS	4 Watts maximum recommended	100 mW Maximum	4 Watts maximum recommended	4 Watts maximum recommended	4 Watts maximum recommended	1250 Watts maximum at 3 mm spot size •Water Cooled
PLATE SIZE	N/A	N/A	1" (2.54 cm) square	2" plate (5.08 cm) square	N/A	N/A
LENGTH	70 mm, include BNC	53 mm	6.95 cm	7.16 cm		
LENGTH INSERTION	N/A	N/A	N/A	N/A	2.6 cm with shield	5.6" (without 2-degree option port aligner)
OPERATING TEMPERATURE	350°C Max	150°C Maximum	350°C Max	350°C Max	350°C Max	150° C maximum with phosphor screen
BAKEOUT TEMPERATURE	350°C Max	250°C Maximum	350°C Max	350°C Max	350°C Max	•150°C with screen •350°C Max with screen and cables removed.
GRIDS	N/A	N/A	Optional: 3 grids, energy analyzing	Optional: 3 grids, energy analyzing	Standard with 3 grids, energy analyzing	No
GRID VOLTAGES	N/A	N/A	1000 V maximum retarding voltage	1000 V maximum retarding voltage	5000 V maximum retarding voltage	No, but shield and/or screen can be biased
MOUNTING					2.75" CF Flange Mounted	2.75" CF Flange Mounted
PHOSPHOR SCREEN	No	No	Optional	Optional-Ruggedized	Optional	Included, removable, can be biased
VACUUM LEVEL	UHV	UHV	UHV	UHV	UHV	UHV
BIASING AVAILABLE	Yes			Yes		Yes
CONNECTORS/CABLE LENGTHS	BNC, to optional cable and BNC feedthrough	UHV Kapton Cables- unterminated (19 in), Optional 16" with grounded shield, SMA, BNC termination	BNC, 12" in vacuum cable and 1.33" CF feedthrough flange available as option, SMA optional	BNC, to optional cable and BNC feedthrough	CF Flange Mounted, connection outside of vacuum	CF Flange Mounted, connection outside of vacuum

Notes

- UHV Pressure range: 1×10^{-7} to 1×10^{-10} Pa ($\sim 7.5 \times 10^{-10}$ to 7.5×10^{-13} torr)
- Please confirm specification values in this table with the Primary Document for each product available online.



Figure 4. In-Vacuum BNC cable and 1.33" CF feedthrough for Faraday Cup (FC) connection.

References

For more information about Kimball Physics Detectors, please visit our website at:
Kimball Physics Detectors

Notes:

1. **Cautions When Attaching to Vacuum Chamber CF flanges**
 - Silver Plated Bolts or Equivalent Lubrication must be used.
 - Please measure the hole depth and other flange / copper ring /part thicknesses
 - Choose a correct bolt length such that the bolt doesn't bottom in the tapped hole prior to tightening the structure. .
2. Specifications Subject to Change Without Notice.
3. DE Altobelli 01/17/2023

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