

Filterbank Service Guide

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Introduction

The Forbes Filterbank system is designed to be repairable by the telescope operator. The instrument is built on Eurocards to facilitate repair by card swapping. A complete set of spare cards is available at the site. Post-repair calibration is automatic.

Repair methods

The filterbank system is designed for ease of repair to the board level. All filter cards and downconverter cards are easily field-swappable. Each type of converter card operates over a different number of channels, so it is fairly easy to deduce which card is bad by considering which channels are affected.

The filter crate has a few other replaceable parts. There is a fuse on the AC power input. The fans may be replaced with a screwdriver. The input power splitters are standard SMA connectorized devices.

The IF processors are not as easy to fix as the filter crates, but the IF cables are easily swapped to isolate a failure to a particular section. A few spare controller cards, IF amplifiers and relays are available to repair the most commonly failing items. The controller card can be replaced with a screwdriver. The other parts require soldering.

The power supplies are modular but heavy. Two persons are needed to remove or install the power supply units. A spare power supply section is provided in the 250Khz filter rack. This unit may be swapped with a failed unit in either of the other two racks if needed to get the system running until an engineer can come up to repair the defective power supply box. Spare power supply modules and fans are available on-site. The fans have power plugs, but the power supplies require soldering.

System trouble

There are a number of problems that are caused by little-understood software or hardware glitches. These typically manifest themselves as a part of the filterbank system refusing to take data, or taking all zero data instead of a proper noise spectrum. Logging these events accurately is an important step in helping the engineering team get to the bottom of these problems.

The first step to cure this symptom is to perform a calibration run. If this doesn't produce valid data, then restart the `ffb_accum` task. This will reinitialize the filterbank system, reloading all the converter PLLs with proper frequencies and calibrating the zero and gain of each filter channel. This restart action takes about a minute to complete.

If the filterbank still refuses to take data, or if `ffb_accum` will not restart, then it may be necessary to reboot the computer `smtofb`. This is done by logging in as root and typing the command "reboot" to the Linux shell. The computer takes about a minute to reboot. After the computer has rebooted, start `ffb_control` and `ffb_accum`.

After the system is back to running condition, please make a log entry describing what was going wrong and what actions were taken to correct the problem, as well as how successful the actions were.

Spare cards

The filterbank system has a set of spare cards to be used in case of trouble. The cards are identified by color tape stripes on the front panel. The 250 kHz

converters have stripes at the top of the panel; the 1 MHz converter cards have stripes at the bottom. Some cards are used in both filter crates; these have stripes at both positions. The stripes form a rainbow. There are also colored tape segments on the blank panels near the converter cards to serve as guides.

Filter crates and cards

There are three racks full of filter crates and IF processors. The filter crates are labeled with their identifier numbers 0 through 4. Crate 4 is the 250 kHz crate; all others are 1 MHz resolution.

Each filter crate contains two rows of cards. The top row of small 3U cards are the downconverters. Each of these cards converts two or four IF signal segments to a lower frequency. These cards exist in many different flavors, which is why they have color tape stripes on their front panels. The important thing is to replace a card only with one that has the same color coding stripe color in the same place. The cards also have mechanical keying tabs to prevent installation of the wrong card in the wrong slot.

The lower row of cards in each filter crate contains two groups of eight filter cards and one mux card in the center. The filter cards are numbered 0 on the left end and 15 on the right end. They are also color-coded - no stripe is 1 MHz resolution and a red stripe is 250 kHz resolution. The masking tape labels are card identifiers used during system testing to keep track of which card is where. These numbers are useful for keeping track of bad cards, although the serial numbers on the cards are the final authority for card identification.

Locating the bad card

Three card location charts follow. Each chart has five columns of channel numbers and a column of color codes for converter cards. The channel numbers are in the range 1-2560 and will match those reported by the CLASS plots. Take note of how many adjacent channels are bad. If it's only one channel, then suspect a filter card. If there are one or more groups of 16, 64 or 128 bad channels, then suspect a converter card. Details follow.

The CON2 cards each have two groups of 128 channels separated by 128 channels. Thus a failure of one or two non-adjacent groups of 128 channels is most likely a CON2 card.

The CON3 cards each have two groups of 64 channels separated by 192 channels. Thus a failure of one or two non-adjacent groups of 64 channels is most likely a CON3 card.

The filter cards and CON4 cards both operate in groups of 16 channels. Each CON4 card handles four groups of 16 channels separated by 48 channels. The filter cards have two groups of 16 channels separated by 48 channels. If only 16 channels are bad, it is necessary to first try replacing the CON4 card to see if that solves the problem. If not, then replace the filter card.

It is possible for an entire converter card to stop working, rather than just one section. In this case, all channels associated with that card will fail. This results in four separate groups of 16 channels to fail if a CON4 card fails, or two separate groups of 64 channels if CON3 fails, or two separate groups of 128 channels if a CON2 fails.

If a converter card stops working, first note which channels failed in the log, then restart ffb_accum to reinitialize the converter cards. If this solves the problem, then the log note will aid in future troubleshooting should the problem manifest itself again later. Don't forget to note in the log how the problem was solved.

If the act of restarting ffb_accum did not solve the problem, then suspect a bad card and proceed to the card_replacement procedure located after the charts.

The CON2 card location chart is below. There is only one type of CON2 card. L or R refer to the position in the crate - there are two rainbows, the left half (L) and the right half (R).

Crate 0	Crate 1	Crate 2	Crate 3	Crate 4	CON2
1-128	513-640	1025-1152	1537-1664	2049-2176	L yellow
129-256	641-768	1153-1280	1665-1792	2177-2304	R yellow
257-384	769-896	1281-1408	1793-1920	2305-2432	L yellow
385-512	897-1024	1409-1536	1921-2048	2433-2560	R yellow

The CON3 card location chart is below. There are two types of CON3 cards, and one type is used in both positions of the 250 kHz crate. However, the filler panels next to the CON3 cards have the color codes shown below. Thus, the colors listed are for slot location, not card type. L or R refer to the position in the crate - there are two rainbows, the left half (L) and the right half (R).

Crate 0	Crate 1	Crate 2	Crate 3	Crate 4	CON3
1-64	513-576	1025-1088	1537-1600	2049-2112	L orange
65-128	577-640	1089-1152	1601-1664	2113-2176	L green
129-192	641-704	1153-1216	1665-1728	2177-2240	R orange
193-256	705-768	1217-1280	1729-1792	2241-2304	R green
257-320	769-832	1281-1344	1793-1856	2305-2368	L orange
321-384	833-896	1345-1408	1857-1920	2369-2432	L green
385-448	897-960	1409-1472	1921-1984	2433-3496	R orange
449-512	961-1024	1473-1536	1985-2048	2497-2560	R green

The filter cards and CON4 cards share a chart, since they cover similar channel groups. Filter cards are counted starting at 0 on the left end of the crate and ending 15 on the right end. The 250 kHz filter cards in Crate 4 have a red stripe; the other 1 MHz cards have unmarked panels. L or R refer to the position in the crate - there are two rainbows, the left half (L) and the right half (R).

Crate 0	Crate 1	Crate 2	Crate 3	Crate 4	CON4	Filter
1-16	513-528	1025-1040	1537-1552	2049-2064	L brown	0
17-32	529-544	1041-1056	1553-1568	2065-2080	L red	2
33-48	545-560	1057-1072	1569-1584	2081-2096	L green	4
49-64	561-576	1073-1088	1585-1600	2097-2112	L violet	6
65-80	577-592	1089-1104	1601-1616	2113-2128	L brown	0
81-96	593-608	1105-1120	1617-1632	2129-2144	L red	2
97-112	609-624	1121-1136	1633-1648	2145-2160	L green	4
113-128	625-640	1137-1152	1649-1664	2161-2176	L violet	6
129-144	641-656	1153-1168	1665-1680	2177-2192	R brown	8
145-160	657-672	1169-1184	1681-1696	2193-2208	R red	10
161-176	673-688	1185-1200	1697-1712	2209-2224	R green	12
177-192	689-704	1201-1216	1713-1728	2225-2240	R violet	14
193-208	705-720	1217-1232	1729-1744	2241-2256	R brown	8
209-224	721-736	1233-1248	1745-1760	2257-2272	R red	10
225-240	737-752	1249-1264	1761-1776	2273-2288	R green	12
241-256	753-768	1265-1280	1777-1792	2289-2304	R violet	14
257-272	769-784	1281-1296	1793-1808	2305-2320	L brown	1
273-288	785-800	1297-1312	1809-1824	2321-2336	L red	3
289-304	801-816	1313-1328	1825-1840	2337-2352	L green	5
305-320	817-832	1329-1344	1841-1856	2353-2368	L violet	7
321-336	833-848	1345-1360	1857-1872	2369-2384	L brown	1
337-352	849-864	1361-1376	1873-1888	2385-2400	L red	3
353-368	865-880	1377-1392	1889-1904	2401-2416	L green	5
369-384	881-896	1393-1408	1905-1920	2417-2432	L violet	7
385-400	897-912	1409-1424	1921-1936	2433-2448	R brown	9
401-416	913-928	1425-1440	1937-1952	2449-2464	R red	11
417-432	929-944	1441-1456	1953-1968	2465-2480	R green	13
433-448	945-960	1457-1472	1969-1984	2481-2496	R violet	15
449-464	961-976	1473-1488	1985-2000	2497-2512	R brown	9
465-480	977-992	1489-1504	2001-2016	2513-2528	R red	11
481-496	993-1008	1505-1520	2017-2032	2529-2544	R green	13
497-512	1009-1024	1521-1536	2033-2048	2545-2560	R violet	15

Replacing a converter card

If the converter card just plain doesn't work, then it must be replaced. This is done by first stopping ffb_accum, then turning off power to the filter crate containing the card in question. Finally the card may be removed.

Remove a converter card by first unscrewing the two screws, one at the top of the panel and one hiding under the black handle, that hold the card into the rack. Then push down on the black handle to eject the card. It will pop out about 1/4 inch from the crate. Finally, pull it straight out, touch the anti-static mat on the workbench with your free hand to discharge any static electricity, and set the card on the workbench mat.

The replacement card must have the same color stripe on the front. Check also that it has the same card type, which is a label starting with FBCON and ending with some combination of hand-written and silkscreened numbers. The -A, -B, etc. are board revision codes which are interchangeable.

To install the new card, first slide it straight into the card cage in the empty space left by the bad card. Then lift up on the black handle to inject it into the slot. It may not go the first time; don't force it. There are three ways the card can hang up: 1) the front panel, 2) the connector, or 3) the slot keying tabs.

The front panel hangup can be solved by removing a nearby blank panel to give some horizontal space in the panel area.

The connector hangup may only be solved by sliding the card out an inch and trying again, perhaps tilting the card slightly to one side or the other, or up or down slightly, to change the entry angle.

The keying code must be correct. The cards all had the correct keying code and stripes when installed, but things happen. Check that the keys are all straight and that they are in the matching positions in the slot and the card.

After the card is installed, replace any blank panels that were removed and turn on the filter crate power. Proceed to the section called "Restarting the system" below.

Replacing a filter card

A filter card may fail, causing a single channel or a group of 16 or 32 channels to work improperly. If a group of 16 channels is bad, first suspect the CON4 card and replace it in an attempt to solve the problem. If the symptoms do not change, only then replace the filter card.

There are two types of filter card, 1 MHz and 250 KHz. The 1 MHz cards have blank panels. The 250 KHz cards each have a red tape stripe at the bottom of the front panel. They are not interchangeable.

To replace a filter card, first turn off power to the filter crate in question. Then use a screwdriver to loosen the two panel hold-down screws, one above the top black handle and the other below the bottom black handle. Push the two black handles away from each other, and the card will be ejected about 1/4" out. Slide the card straight out of the card cage, touch the workbench static mat with your free hand, and place the card on the mat.

Plugging in a filter card may be difficult. The two coaxial inserts on P1 sometimes do not line up properly. Do not force the card; instead, try holding it by the center of the panel (instead of by the black handles) while inserting it. It may take several tries. Do not force the card! If the card is not going in, try removing a blank panel nearest the balky card to get more clearance in the front panel area.

After the card is installed, replace any blank panels that were removed and turn on the filter crate power.

Restarting the system

Turn on power to the filter crate that was just serviced. Wait for a few minutes for the temperature to stabilize a bit. Restart ffb_accum to initialize the filter crate. Try taking data again to see if the problem was resolved.

You will need to wait at least an hour before taking data, as the replaced card will need time to stabilize its temperature.

IF Processor troubles

The IF processor may fail with no signal on one section, or one section may not switch IF inputs, or the control card may fail completely. The most likely items to fail are the RF switches, as they have mechanical contacts.

To replace a switch, remove the IF processor from the rack, place it on the bench and remove the top cover. Desolder the wires, disconnect the three SMA connectors, and replace the switch. Reconnect the SMA connectors. The wires must be resoldered in the original positions. Use another switch for reference; they are all wired the same way. Replace the cover, reinstall the IF processor in the rack and restart ffb_accum and ffb_control to let the system know that it was replaced.

The FBIFC control card may fail; the symptom is often that the starting of ffb_accum fails due to a bad value read from the IF control card. The software expects to read a 0x5a from this card - a 0x00 or 0xff is returned if the card is not responding to commands.

To replace the card, remove the IF processor from the rack, turn it upside-down on the bench and remove the bottom cover. The cables connected to the control card are numbered. Remove them while making sure that you can match the numbers with the connectors which are arranged in increasing designator order. Each type of connector is a different size to reduce confusion. The power connector has two latches that need to be squeezed together before unplugging it.

After the plugs are all unplugged, unscrew the eight Allen head screws and remove the card. Install the replacement card, screw it in, and plug in all the connectors. Replace the cover and reinstall the IF processor in the rack. Reconnect all the cables to the rear panel of the IF processor.

Turn on power to the processor and wait 30 minutes for the amplifier temperature to stabilize. Restart ffb_accum and ffb_control to let the system know that it was replaced.