



DYNACORD

C-Series

White Paper: 70 V / 100 V operation
direct drive power amplifiers

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Suitability of Dynacord C Series power amplifiers for 70 V/100 V direct drive applications

Motivation

As well as driving low-impedance loudspeakers (typical rated impedance 8 Ω or 4 Ω), Dynacord's C Series power amplifiers also offer the highly attractive option of running 70 V /100 V speakers by direct drive, i.e. transformerless.

70 V/100 V technology is normally used for driving several distributed loudspeakers. The resulting current is comparatively low because of the high rated voltage. This means it is possible to supply even long loudspeaker lines economically. Thanks to direct drive, the amplifiers do not need any expensive, heavy output transformers – the power amplifiers supply the 70 V/100 V lines direct (hence “direct drive”).

Explanation of 70 V/100 V operation

70 V/100 V loudspeakers differ fundamentally from conventional low-impedance speakers in their power setting technology.

Most low-impedance loudspeakers have a rated impedance of 4 Ω or 8 Ω. According to the converted formula 1 below, an 8 Ω low-impedance loudspeaker with a wattage of 100 W achieves its rated power at 28 V. On the other hand, a 200 W loudspeaker, also with a rated impedance of 8 Ω, must be driven at 40 V. Thus, the power of the low-impedance loudspeaker is set based on the output voltage of the amplifier.

Formula 1

$$P := \frac{U^2}{R}$$

Conversely, 70 V/100 V high-impedance loudspeakers are standardized for a maximum voltage of 70 V or 100 V at the terminals of the loudspeaker box (or wall loudspeaker, ceiling loudspeaker, horn, etc.). Every loudspeaker has an internal transformer, which transforms the rated voltage of 70 V or 100 V and reduces it to the loudspeaker's required maximum operating voltage.

Therefore, the power for 70 V/100 V loudspeakers is adapted not by means of the maximum admissible input voltage at the loudspeaker input terminals, but via the transmission ratio of the internal transformer. This technology may seem confusing at first glance, but it offers substantial advantages for fixed installations:

- Several distributed loudspeakers can be driven at different wattages in parallel on one loudspeaker line (= loudspeaker cable).
- The wattage (and therefore volume) of the loudspeaker can be individually reduced by tapping the transformer in the loudspeaker box.
- The use of the comparatively high rated operating voltage of 70 V or 100 V results in relatively low currents in the loudspeaker line. The cable cross-section can usually be reduced compared with low-impedance operation.

Once you know this, the meaning of 70 V or 100 V is also clear. In no way does it mean that a 100 V loudspeaker absolutely has to be run at 100 V. It simply means that the loudspeaker reaches its maximum wattage at the standardized voltage of the audio signal, which is 100 V. In practice, signal peaks of 100 V occur, at most. If a 100 V loudspeaker line is driven e.g. at 10 dB below its full signal level – which, subjectively perceived, is half the maximum volume – there will only be around 32 V on the 100 V line.

Requirements for direct drive amplifiers for fixed installations

The use of audio amplifiers in fixed installations, particularly in transformerless direct drive mode, subjects the amplifiers in question to some very particular requirements:

- The amplifiers must be designed for uninterrupted, continuous operation, because fixed installations frequently have to be operational around the clock.
- To keep the operating costs of the audio system down, amplifiers used in fixed installations must feature low standby power consumption and high efficiency during level control.
- The user interface and connectivity must be adapted to suit the requirements of the fixed installation, e.g. a standby switch on the rear panel must prevent the amplifier from being inadvertently switched off. Using screw terminals for inputs and outputs facilitates installation. Further features, such as the capacity for remote control via network and/or GPIO contacts, enable the power amplifiers to be controlled and monitored remotely.
- The rated voltage of 70 V or 100 V must not be exceeded, or only to a very minor extent. This is because the transformers in 70 V/100 V loudspeakers are in the appropriate dimensions for this rated voltage. Exceeding this limit, e.g. at low frequencies, leads to saturation of the transformer, which can result in audible distortions or, in the worst case, failure of the loudspeaker.
- The frequency range of the audio signal must be restricted in the very low frequencies, i.e. a 70 V/100 V loudspeaker must not be subjected to bass frequencies below 50 – 70 Hz, in normal cases. This is because of the dimensions of the

transformers in the loudspeakers. Loudspeakers for 70 V/100 V operation are generally not designed to run at very low frequencies. Moreover, the size – and therefore cost – of the transformer is indirectly proportional to the lower limit of the frequency range to be transmitted. In other words, it also makes financial sense to restrict the lower limit frequency as necessary.

- The power amplifier outputs must be completely free from direct current whatever the kind of operation. Even just a few millivolts of DC voltage can cause the transformers in the connected 70 V/100 V loudspeakers to reach saturation point.
- The amplifier must be stable over the entire load range. If a line is under very low load, i.e. practically no load, the amplifier must be stable at no load. If a line is under maximum load, the power amplifier must also be able to sustain low-impedance loads reliably and continuously even during 70 V/100 V operation (also see table below).
- With fixed installations, very long loudspeaker lines are typically used. The load is complex and in no way purely resistive. The power amplifier faces extremely stringent requirements concerning stability, to ensure no undesirable or hazardous oscillations occur under any load or at any phase angle.

The C Series amplifiers from Dynacord with integrated DSP (digital signal processing) satisfy these requirements in an ideal manner. For example, selecting a suitable preset effectively prevents the 70 V or 100 V rated voltage from being exceeded on the loudspeaker line. At the same time, a 50 Hz third-order high-pass filter prevents saturation of the transformers in the loudspeakers.

If the amplifiers are installed with loudspeakers that required a higher bottom limit frequency, e.g. of 70 Hz, this can easily be achieved by means of a suitable preset or via the EQ input of the DSP in the amplifier.

Selecting the right power amplifier model

The C Series from Dynacord consists of several models with different output power. The model guide below should help you decide which model from the C Series family best suits the application in question, depending on the desired technology (70 V or 100 V) and the loudspeakers to be driven (= total wattage on a loudspeaker line).

When designing a 70 V/100 V loudspeaker line, the planner selects the required 70 V/100 V loudspeakers on the basis of acoustics. Next, the wattages of the individual loudspeakers on the line (= cable) are added together. The wattage capacity of the amplifier per channel must lie above the total wattage of the loudspeakers per line.

An alternative method is to design the system based on the resistance of the loudspeakers. This technique is less clear in practice. However thanks to the conversion rule set out in formula 2, both methods are equivalent and lead to the same outcome.

Formula 2

$$R_{\text{line}} = \frac{(70\text{V})^2}{P_{\text{total}}} \quad \text{resp.} \quad R_{\text{line}} = \frac{(100\text{V})^2}{P_{\text{total}}}$$

The table below shows the relationship between the load of a 70 V/100 V line in watts and the resulting impedance in ohms for a few selected examples.

Total wattage of a loudspeaker line	1	2	5	10	20	40	80	150	300	625	1250	2500
Resulting impedance at 70 V in Ω	4900	2450	980	490	245	123	61	33	16	8	4	2
Resulting impedance at 100 V in Ω	10000	5000	2000	1000	500	250	125	67	33	16	8	4

The table shows why, with low power data, 70 V/ 100 V loudspeakers are referred to as "high-impedance loudspeakers".

The attached overview shows how to select the most suitable amplifier model for each particular application.

A C2800FDi model in dual channel mode (Figure 1) is used to explain the meaning of the characteristic curves in the attachment.

The diagram shows what total wattage can be connected in "70 V direct drive" mode (blue curve) and in "100 V direct drive" mode.

Furthermore, the diagram shows whether a delta can be expected for the 70 V/100 V rated voltage, as a function of the total load on the loudspeaker line.

From the diagram in Figure 1, you can see that the C2800FDi can drive loudspeaker lines in the range of 0 W to 1225 W with 70 V per channel. The delta to rated voltage is 0 dB; in other words, the power amplifier reaches the rated voltage of 70 V over the entire load spectrum.

Running on 100 V, the C2800FDi can drive speakers from 0 W to 2500 W per channel. The delta to 100 V rated voltage lies between 2 dB and 3 dB, depending on the total wattage on the line. If, in isolated cases, this is undesirable, e.g. because the loudspeakers in an installation must be operated at their maximum sound pressure level, the C3600FDi can either be used in dual channel mode or e.g. in bridged mode for 100 V direct drive.

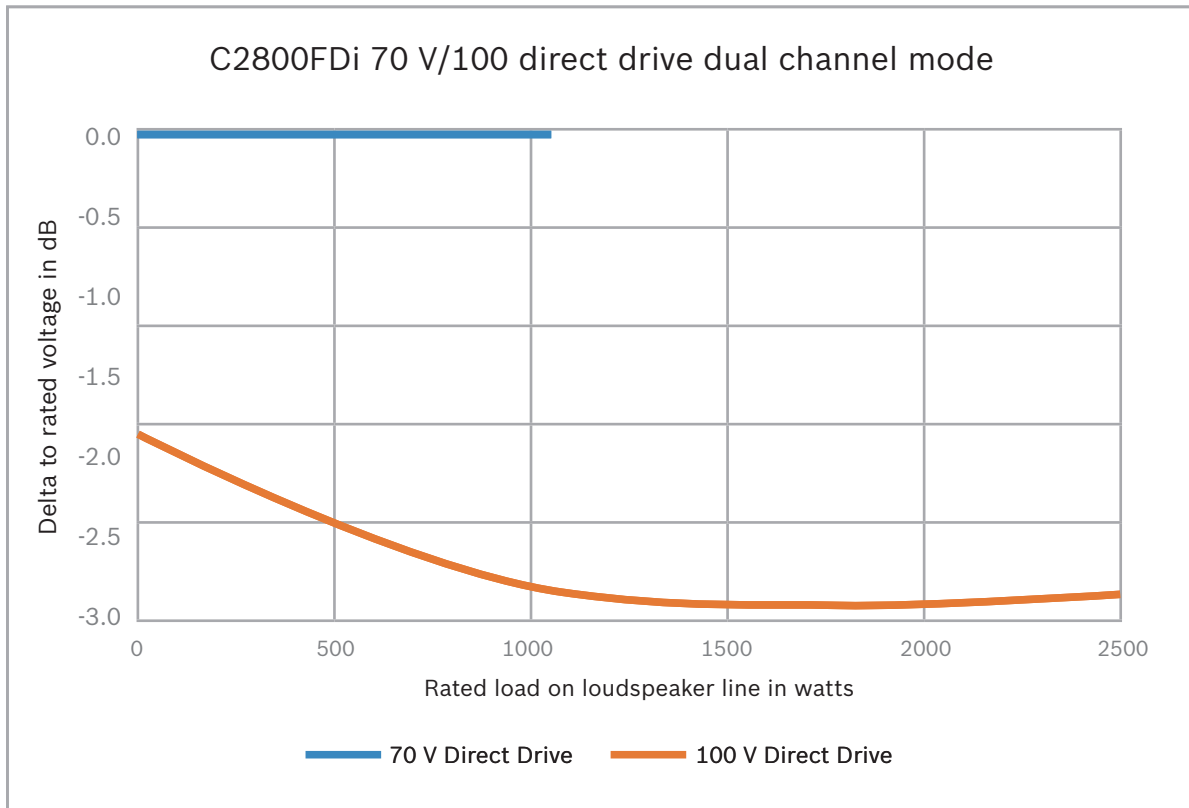


Figure 1

The following overview clearly illustrates which power amplifiers are best suited to direct drive:

70 V direct drive with Dynacord C Series

The **C2800FDi** model in dual channel mode is the ideal 70 V direct drive amplifier, and can drive two lines each with a total maximum wattage of 1225 W.

If cost pressure is high, the **C1800FDi** can be used in dual channel mode, whereby a deviation of approx. 1.5 dB from the maximum sound pressure level can be expected.

If just a single 70 V line with a maximum total wattage of 612 W is to be driven, the **C1300FDi** in bridged mode is the most cost-effective solution.

100 V direct drive with Dynacord C Series

The **C2800FDi** in bridged mode powers a 100 V line with a maximum total wattage of 1250 W without compromise.

If a delta of approx. 1.5 dB is acceptable for the application, the **C1800FDi** in bridged mode is a low-cost alternative.

The **C3600FDi** in dual channel mode is the cheapest solution for running two 100 V lines

with a maximum total wattage of 2500 W. A deviation of approx. 1.5 dB from the maximum sound pressure can be expected.

Under extreme cost pressure, the **C2800FDi** in dual channel mode is also a possibility; However, this is only suitable for instances where a deviation of up to 3dB in maximum sound pressure level is acceptable for the application in question.

Safety information

IEC 60065 states that a 70 V/100 V audio signal does not present a shock hazard. Consequently, besides functional isolation, special precautions such as double insulation are not necessary. However, special attention should be paid to 70 V/100 V loudspeakers in which the power is set by switching transformer taps on the primary side (see Figure 2). Depending on the circumstances of operation, voltages considerably higher than 100 V can occur at the transformer taps. Example: If the loudspeaker is driven at the highest wattage level – here 6 W, as shown in Figure 2 – the transformer on the primary side works as an autotransformer. At the taps for the smaller power levels (here 3 W and 1.5 W), voltages over 100 V can occur in the signal peaks. These connections can be classified as constituting a shock hazard. In accordance with the applicable standards, the transformer taps and any connected conductive connections to these taps must be protected against contact, to exclude any danger to persons, e.g. during maintenance work.

In the case of 70 V/100 V loudspeakers designed with inaccessible transformer taps, loudspeakers without power switching, or loudspeakers with transformer taps on the secondary side, no special precautions need to be taken regarding shock protection.

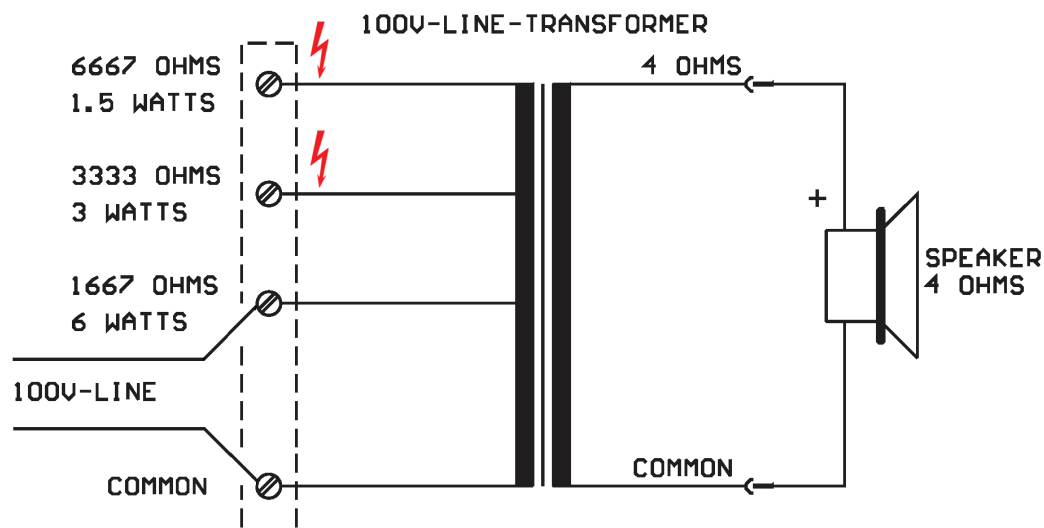
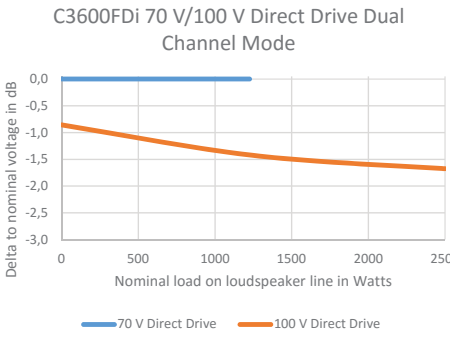
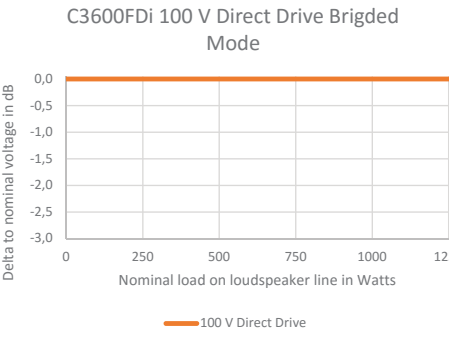
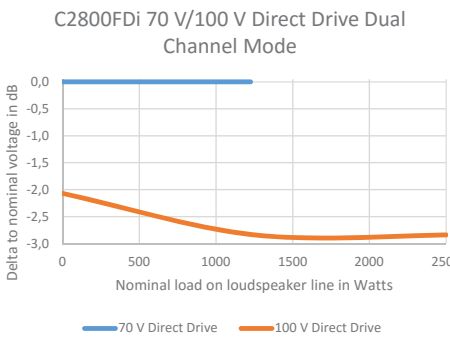
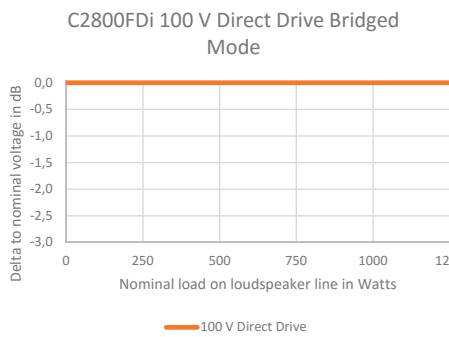
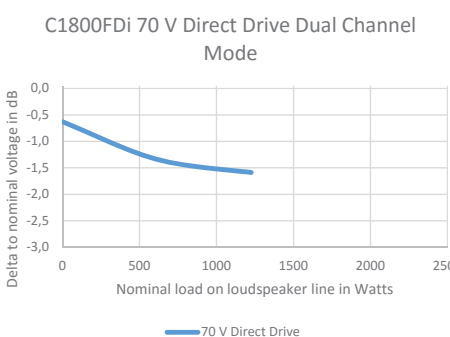
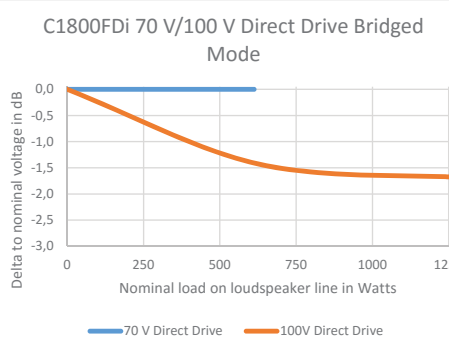
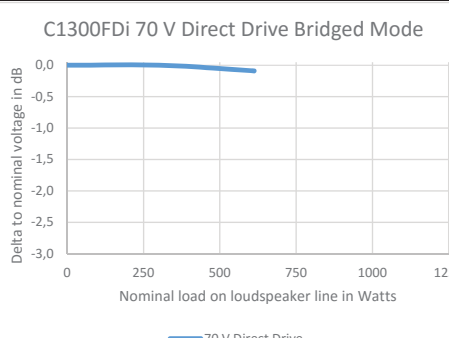


Figure 2: Example of a 100 V loudspeaker with primary taps that constitute a potential shock hazard

Recommendation for 70 V/ 100 V Direct Drive Operation of Dynacord C Series amplifier

Model of C Series	Direct Drive capability in Dual Channel Mode	Direct Drive capability in Bridged Mode
<p>C3600FDi</p>	<p>C3600FDi 70 V/100 V Direct Drive Dual Channel Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 70 V Direct Drive — 100 V Direct Drive</p>	<p>C3600FDi 100 V Direct Drive Bridged Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 100 V Direct Drive</p>
<p>C3600FDi is the recommended amplifier for 100 V Direct Drive in Dual Channel mode.</p>		<p>C3600FDi can drive a single 100 V line, although this can be done more efficiently in Dual Channel mode.</p>
<p>C2800FDi</p>	<p>C2800FDi 70 V/100 V Direct Drive Dual Channel Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 70 V Direct Drive — 100 V Direct Drive</p>	<p>C2800FDi 100 V Direct Drive Bridged Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 100 V Direct Drive</p>
<p>C2800FDi is the recommended amplifier for 70 V Direct Drive in Dual Channel mode.</p>		<p>C2800FDi can drive a single 100 V line with a maximum wattage of 1250 W.</p>
<p>C1800FDi</p>	<p>C1800FDi 70 V Direct Drive Dual Channel Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 70 V Direct Drive</p>	<p>C1800FDi 70 V/100 V Direct Drive Bridged Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 70 V Direct Drive — 100V Direct Drive</p>
<p>C1800FDi can drive efficiently two 70 V lines with some delta to the maximum SPL.</p>		<p>C1800FDi is a cost efficient solution for driving a single 100 V line with a maximum wattage of 1250 W.</p>
<p>C1300FDi</p>	<p>n.a.</p>	<p>C1300FDi 70 V Direct Drive Bridged Mode</p>  <p>Delta to nominal voltage in dB</p> <p>Nominal load on loudspeaker line in Watts</p> <p>— 70 V Direct Drive</p>
<p>C1300FDi is not recommended for Direct Drive Operation in Dual Channel Mode</p>		<p>C1300FDi is a cost efficient solution for driving a single 70 V line with a maximum wattage of 612 W.</p>

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