



MERIDIAN

McLaren 12C

Meridian in-car audio



The Meridian Advantage

Conventional consumer audio systems, whether in-home or in-car, have followed a traditional pattern in which the power amplifiers supply a full-range audio signal to the loudspeakers, where a passive crossover divides the signal into frequency bands to be supplied to woofer and tweeter.

This approach requires a number of significant compromises in the design of the system, including the need for excessively large power amplifiers to overcome the low efficiency of passive systems, and the need for the passive crossover to employ components chosen for their power-handling capacity rather than their audio quality.

Thirty years ago, Meridian's founders turned their back on convention and instead developed some of the first active loudspeakers available, going on to use digital signal processing (DSP) to create crossovers that would be impossible in the analogue domain, and becoming the first consumer audio manufacturer to do so.

Meridian DSP-based digital active loudspeakers use a fully-digital crossover followed by digital to analogue converters (DACs) to drive individual amplifiers which power the loudspeaker drivers directly,

maximising efficiency and allowing a level of performance usually associated with loudspeakers at least four times the size.

Meridian's successful application of digital audio technology in its award-winning luxury home entertainment systems made it an obvious choice when McLaren Automotive came to specify a custom audio system for their new 12C high performance sports car, from the home of the world's most successful racing car company, where revolutionary engineering and an absolute focus on efficiency are second nature.

Meridian was commissioned to develop two different systems, one stereo and one surround. Both deliver high sound output levels with minimal distortion; a balanced, extended frequency response; plus minimum weight and package size. The two systems share common hardware and interconnects as much as possible and feature common door-mounted sealed loudspeaker enclosures for (front) left and right.

Meridian's DSP Digital Active approach to audio systems design is particularly appropriate in a luxury sports vehicle, where it is important to maximise performance while minimising the size and weight of the installation. In this case, the DSP approach

System Highlights

Ground-breaking digital in-car entertainment system, custom-designed for the 12C

2.2 stereo and 5.2 surround-sound models

Digital Active loudspeaker system featuring Meridian DSP Loudspeaker technology

High sound output level with minimal distortion

Full frequency range with deep bass extension

Advanced DSP technology automatically adjusts audio settings to compensate for environmental sounds

Exceptionally high efficiency, power-to-weight ratio and compact size

Standard components and interconnects shared between 2.2 and 5.2 systems

Fine-tuned DSP to match vehicle interior acoustic space

Meridian Audio Limited

www.meridian-audio.com



The amplifier/DSP unit

allows the maximum performance to be developed from smaller, lighter loudspeaker assemblies. DSP active crossover technology also dispenses with heavy, bulky conventional crossover components while at the same time dramatically increasing audio performance, while permitting the use of smaller, more efficient and lighter amplification. The use of Class D amplification delivers maximum power in a very compact and lightweight package, without the slightest compromise in audio performance.

The unique Meridian DSP-based approach delivers a whole new level of performance and excitement to high-quality stereo and surround audio in the luxury high-performance sports vehicle market.

The Systems

The two systems created for the 12C provide stereo and surround capability. In the case of the stereo system, two door-mounted loudspeaker installations are employed, left and right. In the case of the surround system, these are augmented with three additional full-range drivers.

The door-mounted assemblies (see below) include both bass and full-range drivers, which are driven by independent amplifier channels. The bass drivers in the doors provide the bass for the entire system, whether stereo or surround: thus the system can be described as either 2.2 (stereo) or 5.2 (surround). Each driver is energised by its own super-efficient Class D power amplifier fed by individual location-specific equalisation and delay algorithms.

Amplifier unit

Amplification and DSP capability are contained in a digital amplifier unit, which is supplied from the system's head-end source unit with either two or six channels of digital audio at up to 96kHz sample rate, plus RS232 control data, via a single RJ45 connector. The amplifier unit has a DC power connector and a 16-pin connector for analogue audio output to the loudspeakers. It includes either four (2.2) or seven (5.2) channels of Class D amplification, depending on the system, each channel delivering in excess of 40W into 4Ω.

DSP Features

The amplifier unit also contains the system's DSP (Digital Signal Processing) capability in the form of a 200MHz dual core processor delivering 400 MIPS (million instructions per second). The DSP in the amplifier unit carries out a series of functions:

- System Volume
- Bass, Treble and Balance controls
- Rear Gain Control (Hi-Line system)
- Dynamic Range Control
- Automatic Volume Control (AVC)
- Automatic Tone Control (ATC)
- Loudness filtering
- Channel format conversion (including re-matrixing and stereo width, and converting 2-channel input to 5.2 and 5.1 input to 2.2)
- Crossovers and bass management
- Driver equalisation
- Limiters and delay

The bass, treble, balance and rear gain controls provide the user with the ability to

adjust the frequency balance of the system to suit their taste.

The Dynamic Range Control system offers a comprehensive method of ensuring that the listening experience is maintained whatever the environmental conditions. A wide range of environmental signals is received by the unit, for example the fact that a window is open, and the speed of travel. This data is comprehensively and continually analysed to allow the system to compensate automatically for variations in such factors as ambient noise, so as to maintain a consistent level of perceived audio performance irrespective of driving activity.

The Automatic Volume Control function adjusts the volume of the sound system to compensate for estimated engine, road (tyre) and wind noise. There are three settings for AVC: Off, Min and Max. 'Off' disables the AVC function and the volume remains constant at the user-selected level regardless of vehicle speed. 'Min' is the lowest setting of the AVC system: the volume adapts gently to vehicle speed and other parameters. This mode has been calibrated for smooth road surfaces. 'Max' is the highest setting. Here, the volume adapts more aggressively to changes in vehicle speed and other parameters. This mode has been calibrated for rougher road surfaces.

The AVC also raises the volume when the engine is started, and compensates for a



Main drivers in sealed enclosure

lowered window by raising the volume on that side of the vehicle. The volume correction for the window function is road-speed dependent.

In Normal and Winter powertrain modes, the AVC operates with road speed and rpm. In Sport and Track powertrain modes, the AVC also uses throttle position to add compensation for the increased engine noise generated by the ISG. The correction curves for road speed and rpm are also slightly more aggressive to compensate for the additional noise and to add further aural excitement to these powertrain modes.

The Automatic Tone Control (selectable On/Off) boosts the bass when the engine is started to compensate for the masking effect of the low frequency noise of the engine. Both bass and treble are automatically adjusted with road speed to compensate for road and wind noise.

More aggressive correction is applied when the powertrain mode is set to Sport or Track.

Loudness Filtering allows the system to compensate for human hearing's reduced sensitivity to low and high frequencies at lower sound pressure levels, boosting these frequencies according to specially-developed filter curve characteristics that are modelled on psychoacoustic research. The Loudness Filtering technology builds on developments first employed in Meridian's F80, a luxury all-in-one entertainment system, which is very highly regarded for its audio performance and loudness compensation.

The system head unit provided in the vehicle is able to deliver both stereo (2-channel) and multichannel surround (5.1-channel) signals. These signals are re-matrixed by comprehensive algorithms designed to 'render' the incoming audio signal to suit the in-car installation exactly, while at the same time providing bass management functions

to ensure that bass signals from any channel are fed to the bass drivers on the correct side of the vehicle, maintaining spatial accuracy across the entire frequency range.

In the case of a 2.2-channel in-car installation, stereo source material is passed through a user-variable stereo-widening system based on that used in the Meridian M80. Bass information from left and right is separated to drive the bass units while the full-range drivers receive the mid and high frequencies, their locations optimised to deliver precise imaging and sonic accuracy.

Surround (5.1) source material is downmixed to drive the 2.2 output configuration, employing Meridian's unique psychoacoustic technologies to deliver the best possible spatial experience even though only two output channels are involved.

In the case of the 5.2 surround in-car installation, 2-channel stereo material is

Outline Specifications

165mm LF Driver

Electro-acoustical specifications:

Nominal Impedance:	4Ω
Power Handling RMS:	60W
Power Handling max:	100W
Sensitivity (1W/1m):	87dB ±2dB
Resonance Frequency:	48Hz ±10Hz
Operating Frequency Range:	20 Hz – 2 kHz
THD @ 10W:	
< 5% from 20Hz – 60 Hz (IEC 268-5)	
< 2% from 60Hz – 140 Hz (IEC 268-5)	
< 1% from 140Hz – 2 kHz (IEC 268-5)	
Linear Excursion:	±4mm
Maximum Excursion:	±12mm
Qts:	0.35 ±0.1

Mechanical specifications:

Chassis:	Die-cast aluminium
Chassis OD (max.):	178.0mm
Overall Depth:	70.5mm
Weight:	600g (± 5g)
Cone Material:	Polypropylene (Black)
Edge Material:	NBR
Voice Coil Former:	Polyamide / Fibreglass
Magnet Material:	NdFeB (N40H)/Fb2 (Y35)
Spider Material:	Cotton/Nomex

85mm Full-Range Driver

Electro-acoustical specifications:

Nominal Impedance:	4Ω
Power Handling RMS:	40W
Power Handling max:	60W
Sensitivity (1W/1m):	85dB ±2dB
Resonance Frequency:	95Hz ±10Hz
Operating Frequency Range:	100 Hz – 20 kHz

THD @ 10W:	<2%
Linear Excursion:	±2mm
Maximum Excursion:	±4mm
Qts:	0.30 ±0.1

Mechanical specifications:

Chassis:	Die-cast aluminium
Chassis OD (max.):	93.0mm
Overall Depth:	48.2mm
Weight:	225g (± 5g)
Cone Material:	Aluminium (Natural)
Edge Material:	SBR
Voice Coil Former Material:	Kapton
Magnet Material:	NdFeB (N45H)
Spider Material:	Cotton/Nomex

Loudspeaker Door Assemblies

General Features

Enclosure Material:	75% ABS / 25% PC Injection moulded.
Enclosure Construction:	4-part assembly – L & R assemblies.
Internal Damping:	Acoustic polyester fibre & mechanical silicone rubber motor damper.
Drive Unit Configuration:	1 x 165mm LF 1 x 85mm full range.
Terminal Layout:	4-way, locking audio input connector.

Audio Specifications:

Crossover:	DSP – Frequency 200Hz.
Frequency Response:	Each channel optimised for speaker.
Loudspeaker Impedance:	4 Ω.

Dimensions:

Overall Height:	232.0 mm
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Overall Width:	182.6 mm
Overall Depth:	246.0 mm
Weight:	1.6 Kg.

Amplifier

General Features:

Terminal Layout:	8-way RJ-45 digital S/PDIF 6 channel input connector, 2-way power connector, 16-way analogue audio out connector.
Power Requirements:	5-36V DC in.
Power Supply:	DC-DC PWM power supply.
Power Supply Design:	Synchronous buck-boost.
Thermal Regulation:	Thermal management control.
Board Circuitry:	6 layer PCB.
Current Protection:	Over-current, over-voltage transient, reverse polarity and thermal.

Audio Specifications:

Amplifier Type:	Class D with feedback.
Channels:	4 or 7.
RMS Power Rating:	4/7x > 40W/ch into 4 Ω.
Crossover:	DSP optimisation in digital domain.
Frequency Response:	Each channel optimised for loudspeaker.
Loudspeaker Impedance:	4 Ω.
Signal to Noise:	Better than –100dBFS.
DSP Devices:	200MHz Dual Core (400 MIPS).

Dimensions:

Footprint:	232 mm x 61 mm x 225 mm.
Weight:	1.35 Kg (5.2 version) 1.28 Kg (2.2 version)



Left: 165mm driver; right: 85mm driver (not to scale)

passed through an enhanced multichannel matrix. This dramatically increases the naturalness of stereo listening by using the three front loudspeakers to render stereo material with significantly increased localisational accuracy. At the same time, depth information, latent in many types of stereo recording, is extracted and fed to the rear channels, delivering an uncanny sense of presence and realism in surround, despite the source material being stereo only.

5.1 surround source material is enhanced for the 5.2 replay system via a comprehensive bass management strategy that enhances surround immersion and overall performance.

The DSP system continually monitors the performance and behaviour of all the loudspeaker drivers. As a result, it can instantaneously correct system characteristics to maintain optimum performance under all operating conditions,

whether you prefer soothing classical music, club dance or heavy metal at full volume. The same system protects your audio investment against overheating, overload and distortion.

Each loudspeaker is driven by a carefully-calculated delay algorithm that ensures that audio reaching your ears is timed exactly for maximum realism and precision, delivering the very best, most natural performance.

In all configurations, whatever the source material, the DSP-based crossover and bass management system ensures maximum performance and sonic accuracy are delivered at all times. The drivers are individually digitally equalised according to their location and enclosure characteristics, to create a completely integrated replay system in which all the loudspeakers work together to fill the in-car environment with pure, natural, digital sound, exactly tailored for the unique acoustic environment of the 12C.

Loudspeaker assemblies

The two primary loudspeaker enclosure assemblies are the same in both systems, and consist of a 165mm (6.5in) low frequency drive unit (illustrated above left) and an 85mm (3.5in) full range driver (illustrated above right: not to scale) installed in sealed enclosures, which are door-mounted. The low frequency drive units carry the bass signals for the entire system. These two units comprise the loudspeaker assemblies for the stereo (2.2) system.

In the case of the surround (5.2) system, these units are augmented by three additional 85mm full-range drivers (illustrated above), one mounted in the fascia and two behind the seats, left and right.



Exploded view of the amplifier/DSP unit