

Clarus 590/690 Wide Range FID (WRFID) Detector Parameters

INTRODUCTION

The new Wide-Range FID (WRFID) recently introduced on the Clarus 590 and 690 GCs is able to handle a much wider range of signals than was possible with previous PerkinElmer designs. The key to this enhancement is a new amplifier board that uses a compression/decompression algorithm to accept a much larger detector signal. The signal is compressed, converted it into digital data and then rescaled back to the original voltage range. The need for the detector "Range" control is now eliminated completely. Any signal from the FID will now be collected, stored, displayed and processed without the user needing to manipulate Range and/or Attenuation settings.

Firstly, the Wide-Range (WRFID) amplifier was delivering much larger numbers because of the bigger peaks being processed. In some instances, these values were too big to fit into the 4-byte digital values being transmitted to the CDS systems, and for the CDS systems to properly display and process them. Some modifications to the GC firmware and the CDS software were required to handle these larger values and scale them back to usable values.

Secondly, the way the amplifier handled the signal compression required a reversal of the FID jet polarization voltage in order to function. Some changes to the FID collector geometry and the magnitude of the polarization voltage were required in order for the new amplifier and detector to work together and deliver good performance.

SPECIFICATIONS

The performance of the new Wide-Range FID system is similar in most respects to the previous FID system. The notable improvements are in the dynamic and linear quantifiable ranges of the system and in the lower background signal noise which leads to better detection limits.

Specifications for Current and New Wide-Range FID systems

Metric	Current FID	Wide-Range FID (WRFID)
Air flow designed to minimize contamination and residue buildup	Yes	Yes
1/8-in. fittings	Yes	Yes
Manual Pneumatic Controls	Option	Option
PPC pneumatics - electronic flow control of hydrogen and air	Option	Option
Flame out warning and ready interlock	Yes	Yes
Auto ignite if flame out detected	Yes	Yes
Operating temperature	100°C to 450°C in 1°C increments	100°C to 450°C in 1°C increments
Minimum detectable quantity	< 3x10 ⁻¹² g Carbon/sec octane at a S/N of 2 to 1	< 3x10 ⁻¹² g Carbon/sec octane at a S/N of 2 to 1
Sensitivity	0.013 Coulombs/g of carbon typical	0.013 Coulombs/g of carbon typical
Dynamic range	>10 ⁸ without range change	>10 ⁹
Quantifiable range	>10 ⁶ without range change	>10 ⁷
Max. amplifier signal on CDS	1,000mV	31,805mV
Signal filtration	50, 200, 800 msec	50, 200, 800 msec
Input range	x1, x20	Single range
Attenuation	x1 to x64 (x65536 for Analog O/P)	x1 to x64 (x65536 for Analog O/P)
Data Rate	1.5625 to 25 Hz (50Hz on 600 and 680)	1.5625 to 25 Hz (50Hz on 690)
Analog Integrator Output	1 Volt	1 Volt

Analog Recorder Output	1 mV	Not supported
Jet Internal Diameter	0.71mm (0.028")	0.28mm (0.011")
Polarizing Voltage	-190 Volts	+50 Volts
Air flow rate	450mL/min nominal	450mL/min nominal
Hydrogen flow rate	45mL/min nominal	30mL/min nominal
Makeup gas	Not required	Not required

THE NEW WIDE-RANGE FID AMPLIFIER

The new Wide-Range FID amplifier shown is designed to deliver the full 9 orders of data dynamic range without the need to touch the attenuation setting. A range setting should now always be set to 1. External CDS systems like TotalChrom will still have a Range setting in the instrument method and this should be set to 1 when a Wide-Range FID is being used.

SCALING THE WIDE-RANGE FID DATA

The attenuation should be left at x64 in order to deliver the maximum dynamic range. Reducing the attenuation will effectively reduce the dynamic range of the chromatography as large peaks may then go off-scale. Reducing the attenuation will place focus on very small peaks with some increase in peak size. Certain benefits can be gained by adjusting the attenuation with some analyses.

Chromatographic peaks from the new Wide-Range FID will be scaled 6x smaller than those from the earlier FID system at the same attenuation. This is because display rescaling is necessary to get the full data range into the 4-byte data stream. The sensitivity level is the same, despite this change in scale.

Data Scaling

Changes have been made in TotalChrom 6.3.3 to handle the rescaled, wide-range FID data, corresponding to the GC firmware changes made to scale the data to best fit the transmitted format. Scaling for other detectors and earlier GCs will remain unchanged.

Integration of Small Peaks

Typically, the detection and integration of very small peaks could be improved by reducing the attenuation and making the peaks bigger. To enable processing of very small peaks and still achieve the 7 orders of quantifiable range, TotalChrom 6.3.3 has been modified to enable lower values to be entered for the peak detection parameters area threshold and noise threshold. These changes allow peaks that are up to 200X times smaller than before to be detected and integrated. This change is functional with data from all detectors, including the new Wide-Range FID, but the very big peaks may now go off-scale with that detector.

Lower limits for entries for area and noise thresholds

Parameter	Previous Versions of TotalChrom	TotalChrom v.6.3.3
Area Threshold	5.00	0.01
Noise Threshold	1	0

These values can be inserted into methods in three ways:

- By direct entry into the Method
- By interactive input from the Graphic Method Editor
- As a timed event

CDS Systems Compatibility

TOTALCHROM 6.3.3

While generally compatible with TotalChrom, a few changes were needed in order to get the best performance out of the new detector. Earlier versions of the Clarus GC can still be used with TotalChrom 6.3.3 by selecting the appropriate instrument configuration option during set up.

TURBOMASS

The new Wide-Range FID is used with TurboMass, v 6.1.1.

EMPOWER

New driver v 3.2.0.425, developed to handle the scaling changes implemented in the GC firmware.

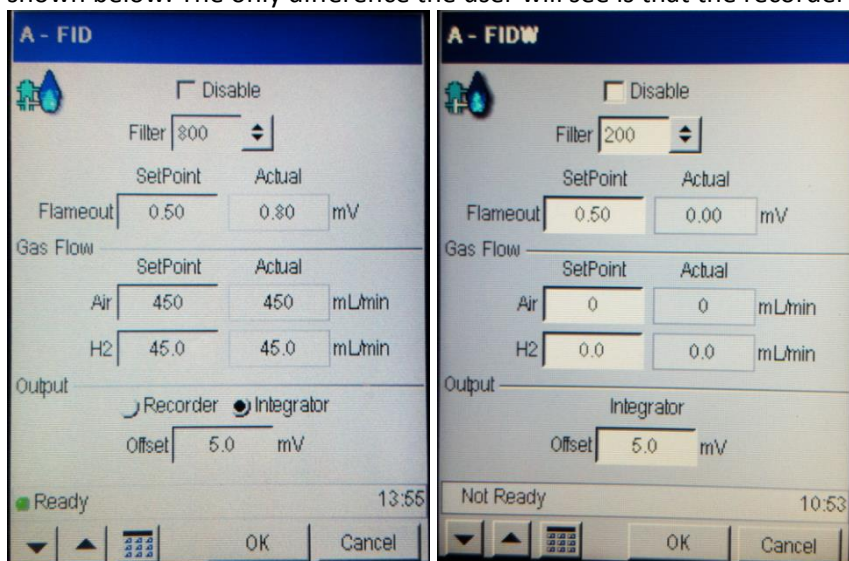
Compatibility Table

Software	500/600	580/680 Other Detectors	Upgrade x80 > x90	590/690 Other Detectors	590/690 FIDW
TotalChrom 6.3.3*	Yes	Yes	Yes Update GC F/W	Yes	Yes
TotalChrom 6.3.2 or earlier	Yes	Yes	No	Yes	No
TurboMass 6.1.0*	Yes	Yes	Turbomass 6.1.1 Also Update GC F/W	Yes	Turbomass 6.1.1
Empower 3 FR2/HF1 SR2/HF1/HF2 Windows 7 Pro	No	Yes	Upgrade to Empower Clarus GC Driver 3.2.0.4025* Also Update GC F/W	Yes	Upgrade Empower Clarus GC Driver 3.2.0.425*

*or Later

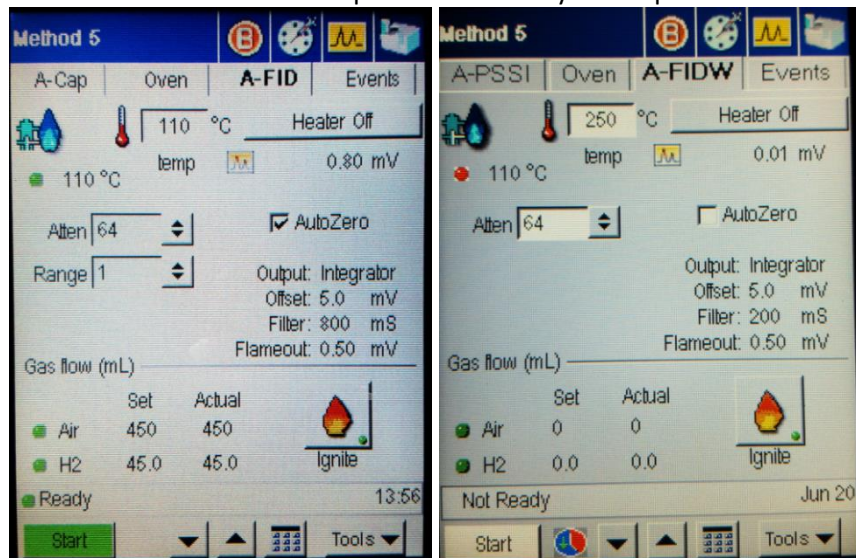
TOUCH-SCREEN OPERATION

When the new Wide-Range FID amplifier is installed, it is automatically identified by the Clarus 590/690 firmware as shown below. The only difference the user will see is that the recorder option has disappeared from the new FID.



Previous and New Wide-Range FIDs as identified on the Clarus Configuration page.
Note the absence of the Recorder Output option with the Wide-Range FID.

The methods for the two FIDs are again very similar. The only difference is that the Range setting has disappeared. The other functions are set up in the same way as the previous FID.



Previous and New Wide-Range FIDs as identified on the Clarus Configuration page. Note the absence of the Range entry with the Wide-Range FID.

WARNING: The attenuation setting with the new Wide-Range FID should be left at x64 to maximize the quantitative dynamic range. Different attenuation settings can be used but the quantitative range will be reduced as a result. Only use lower attenuation settings for getting more detail on peaks near the noise level and if wide dynamic range performance is not needed.

FREQUENTLY ASKED QUESTIONS (FAQ)

Q. Why do I need an amplifier that has 9 orders of dynamic range if I only want to process peaks with a 7 order dynamic range?

A. In order to process the smallest peak, we need to measure its area with reasonable accuracy. We also want to be able to measure the noise level if we're going to perform detection limit calculations. This means that we need another two orders of magnitude at the bottom end of the dynamic range in order to make such measurements.

Q. Can I install the new Wide-Range FID system on my existing Clarus GC?

A. The Wide-Range FID will only work on Clarus 590 and 690 GCs or Clarus 580 and 680 GCs with a firmware upgrade.

Q. Can I use my current CDS system to control the new Wide-Range FID and process the data coming from it?

A. You will need the latest versions of TotalChrom, TurboMass and Empower to support the new detector.

Q. Is the performance of the new Wide-Range FID better than the previous design?

A. A greater range of peak sizes is possible without recourse to Attenuation or Range changes for different peaks. A slight improvement in detection limits may be seen with the new 0.28mm jet.

Q. Can I still use the Attenuation and Range Controls with the new detector?

A. The Attenuation control is still active but should be left at x64 for optimum Wide-Range performance. The Range setting is no longer available.

Q. Why are my peaks 6x smaller with the new detector?

A. To get the full dynamic range of the detector into a 4-byte digital format for transmission, data from the new detector had to be scaled differently from the previous design.

Q. Can I use the previous design FID on a Clarus 590 or 690?

A. Yes

Q. Why has the recorder output disappeared?

A. It was difficult to decide how to scale the signal as recorders would not be able to represent 7 orders of magnitude changes in signal. We felt that few, if any, users would require a recorder output today. The integrator output is still active to allow analog processing devices to be connected.

Q. Why can't I use a narrow bore capillary column for wide dynamic range samples?

A. The amount of sample that can be injected into a capillary column before overloading occurs is much less than with a packed column. A typical 0.25mm i.d. column with a 0.25 μ m phase thickness could exhibit overloading with just 50ng of sample in the column. A packed column could take sample loadings approaching 1mg. Use packed columns (or thick-film 0.53mm capillary columns) for wide dynamic range work.

CONCLUSION

The Clarus 590/690 or an upgraded Clarus 580/680 is fully optimized to support Wide-Range detection. It also provides a few additional benefits in its performance and operation and with the necessary firmware and software support.

All Clarus 590 and 690 gas chromatographs configured with FIDs will ship with this new Wide-Range system.