



Resilient Vertical Forest Renovation of Reinforced
Concrete Structures in Seismic Prone Areas
(H.F.R.I. Project Number 015376)

Recorded results and photos of damages of tested
renovated 3d VF structure.

Deliverable D2.4 Work package 2

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LIST OF ACRONYMS

VF	Vertical Forest
RC	Reinforced Concrete
PZT	Piezoelectric sensors or piezoelectric transducers
3D	3 Dimensions
etc	et cetera
D24	Deliverable 24
PUFJ	Polyurethane Flexible Joints
FRPU	Fiber Reinforced Polyurethane
SHM	Structural Health Monitoring
EMI	Electromechanical Impedance
DUTH	Democritus University of Thrace
e.g.	for example
SG	Strain gauges
AUTH	Aristotle University of Thessaloniki

ABSTRACT

This deliverable concerns the recorded results and the photographs of damage from experimental tests on the VF renovated structure. The structure is further instrumented with strain gauges and PZTs related to the PUFJs and basalt ropes. The seismic excitations refer to the seismic table acceleration levels followed during the first phase. Furthermore, additional excitation levels cover the equivalent (mass times acceleration) levels because of the additional top slab mass due to VF renovations (simulations of vertical living walls and planters with trees within GREENERGY project). That is, gradually increasing maximum input intensity level (peak acceleration of the excitation based on Thessaloniki 1978 earthquake) from 0.07g, to 0.1g, 0.14g, 0.2g, 0.34g, 0.5g, 0.55g, 0.74g, 0.8g, 1.10g, 1.30g and up to 1.40g. Dynamic table tests for the determination of the dynamic characteristics of the VF renovated rc structure were included for each different level as well. The innovative full green basalt rope wrapping of bottom and top critical regions of rc columns, the innovative construction of PUFJs between the wrapped concrete columns and the brick infills as well as of the one-sided FRPU jacketing of the brick infills resulted in increased stiffness and strength of the structure when compared to the as-built tested structure. The different detailing of attachment, of the vertical living wall constructions and of the planters with wooden sticks, with the use of basalt ropes and PU pads offered remarkable alternatives for innovative Vertical Forest renovations. The Vertical Forest renovations resulted in a significant increase of the top slab mass. Yet, the innovative renovations of the structure prevented out of plane or in plane collapse of brick infill walls as well as rc structure collapse for advanced ULS limit states. It prevented damage of the simulated vertical living walls or of the planters. The PZTs reveal remarkable sensitivity to the damage accumulation inside concrete core or at the brick – mortar joints, feeling also the rocking behavior of planters. Finally, the report gathers the results on brick to brick mortar joints when jacketed with one-side FRPU (brick triplets). Next deliverable D26 will conclude the assessment of the performance of the VF renovated structure

Keywords: experiment, seismic table, reinforced concrete, brick wall infills, seismic excitation, intervention, Vertical Forest, resilience, renovation, structural, structural health monitoring, PZT, polyurethane, basalt, planters, vertical living walls, glass fiber grid jacket, greenery

ΠΕΡΙΛΗΨΗ

Το παραδοτέο αφορά τα καταγεγραμμένα αποτελέσματα των διαφορετικών οργάνων καθώς και χαρακτηριστικές φωτογραφίες βλαβών από τα πειραματικά αποτελέσματα κτηρίου με ανακαίνιση με κάθετο δάσος. Η κατασκευή είναι περαιτέρω εντονοργανωμένη με παραμορφωσιόμετρα και ΡΖΤs στους αρμούς ΡUFJ και στα σχοινιά βασάλτη. Οι σεισμικές διεγέρσεις αναφέρονται στα επίπεδα επιταγύνσεων της σεισμικής τράπεζας που ακολουθήθηκαν κατά τη διάρκεια της πρώτης φάσης. Επιπλέον, πρόσθετα επίπεδα διέγερσης καλύπτουν ισοδύναμα επίπεδα μάζας επί την επιτάγχυνση (οιωνεί τέμνουσα βάσης) εξαιτίας της πρόσθετης μάζας που τοποθετήθηκε πάνω στην πλάκα από την ανακαίνιση με Κάθετο Δάσος (προσομοιώματα κάθετων ζωντανών τοίχων και γλαστρών με δέντρα στα πλαίσια του έργου GREENERGY). Δηλαδή, διενεργήθηκαν σεισμικές διεγέρσεις σταδιακά αυξανόμενου επιπέδου μέγιστης επιτάγχυνσης (βασισμένες στο σεισμό Θεσσαλονίκης 1978) από 0,07g, σε 0.1g, 0.14g, 0.2g, 0.34g, 0.5g, 0.55g, 0.74g, 0.8g, 1.1g, 1.3g, 1.4g. Περιλαμβάνονται επίσης δυναμικές διεγέρσεις για την διερεύνηση των δυναμικών χαρακτηριστικών της κατασκευής με την ανακαίνιση ΚΔ πριν και μετά από τα διαφορετικά επίπεδα σεισμικών διεγέρσεων. Η καινοτόμος πλήρως πράσινη εξωτερική περιτύλιξη των κάτω και πάνω κρίσιμων περιοχών των υποστυλωμάτων με σχοινί βασάλτη, η καινοτόμος κατασκευή αρμών ΡUFJ μεταξύ των ενισχυμένων υποστυλωμάτων και των τοιχοπληρώσεων με τούβλα καθώς και ο καινοτόμος μονόπλευρος εξωτερικός μανδύας FRPU στις τοιχοπληρώσεις, οδήγησε σε αυξημένη δυσκαμψία και αντοχή της κατασκευής όταν συγκρίνεται με αυτήν της υφιστάμενης κατασκευής. Οι διαφορετικές λεπτομέρειες των στηρίξεων των κατασκευών κάθετων ζωντανών τοίχων καθώς των γλαστρών, με την χρήση σχοινιών βασάλτη και ενθέματα PU προσέδωσαν αξιοσημείωτες εναλλακτικές για καινοτόμες ανακαινίσεις Κάθετων Δασών. Οι ανακαινίσεις Κάθετου Δάσους οδήγησαν σε σημαντική αύξηση της μάζας της πλάκας οροφής. Ωστόσο, οι καινοτόμες επεμβάσεις της κατασκευής απέτρεψαν την εκτός και εντός επιπέδου κατάρρευση των τοιχοπληρώσεων καθώς και την κατάρρευση της κατασκευής ΩΣ για αναβαθμισμένη επιτελεστικότητα σε Οριακή Κατάσταση Αστοχίας. Απέτρεψαν την βλάβη στις κατασκευές κάθετων ζωντανών τοίχων και γλαστρών. Τα ΡΖΤs εμφανίζουν αξιοσημείωτη ευαισθησία σε συσσώρευση βλαβών μέσα στο σκυρόδεμα ή στους αρμούς τούβλου-κονιάματος, καθώς και στον λικνισμό των γλαστρών. Τέλος, η ερευνητική αναφορά συγκεντρώνει τα αποτελέσματα από δοκιμές διάτμησης σε τριπλέτες τούβλων με αρμό κονιάματος και μονόπλευρο μανδύα FRPU. Το επόμενο παραδοτέο Π26 θα συνοψίσει την αποτίμηση της επιτελεστικότητας της ανακαινισμένης με ΚΔ κατασκευής.

Λέξεις κλειδιά: πείραμα, σεισμική τράπεζα, οπλισμένο σκυρόδεμα, τοιχοπληρώσεις, τούβλα, σεισμική διέγερση, ενίσχυση, Κάθετα δάση, ανθεκτικότητα, ανανηπτικότητα, ανακαίνιση, δομικός, δομοστατικός, παρακολούθηση δομικής υγείας SHM, ΡΖΤ, πολυουρεθάνη, μανδύας υαλοπλέγματος, βασάλτης, γλάστρες, κάθετοι ζωντανοί τοίχοι, φύτευση

1 EARTHQUAKE EXCITATION TIME HISTORY AND INSTRUMENTATION FOR THE VERTICAL FOREST (VF) RENOVATED STRUCTURE

The excitation executed by the shake table of DUTH is based on the severe Thessaloniki (Volvi) earthquake of 1978. The building is excited gradually based on the excitation levels of the as built structure, while additional levels are referred to equivalent mass X acceleration levels and up to severe infill damage or concrete column damage or up to displacement drift higher than 3%.

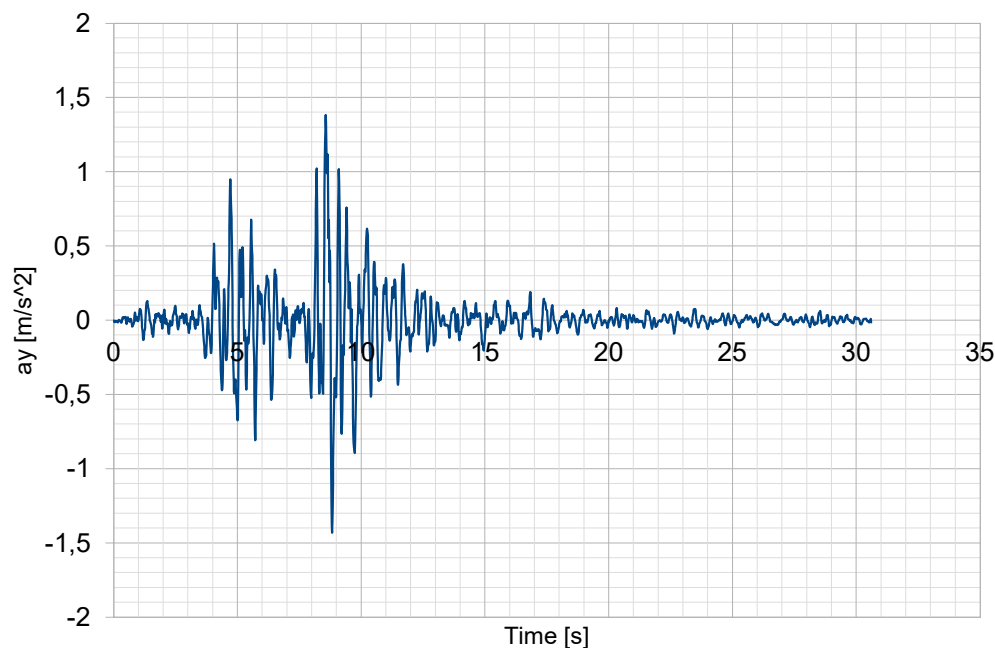


Figure 1.1 Basis for the time history executed by the DUTH seismic table (ay component of Thessaloniki (Volvi) 1978 earthquake excitation record)

The instrumentation includes 12 uniaxial accelerometers (ACC) positioned at four locations as shown in Figure 1.2 (identical to the instrumentation of as-built specimen). At each location, three accelerometers capture the acceleration components in three directions, covering both in-plane and out-of-plane motions at the center of the full infill walls, as well as accelerations of the top slab and the bottom foundation beam. Additionally, eight in total draw wire sensors (W) monitor the horizontal displacements of the foundation beams and of the top slab, as illustrated in Figure 1.3 and presented in Table 1.1. These sensors measure linear displacement through a highly flexible yet tensioned steel wire connected to a cable drum, which provides an output signal proportional to displacement.

Except for the already installed 20 strain gauges in the as-built structure, two more strain gauges were placed on the polyurethane PM at the PUFJ joint. The joint is located between column 1 and the partial brick infill while the 2 strain gauges are placed on the PUFJ surface (opposite to each other: internal-external), 5cm under the slab along direction x. Another 2 strain gauges are bonded on the basalt ropes wrapped at the bottom of columns 3 and 4. That is total of 24 strain gauges.

Additionally, PZTs are installed as patches at specific locations to monitor the health of the retrofits and the connection (anchoring) of the structures created by the presence of the vertical forest. More specifically, 11 extra PZTs were placed on the strengthened structure:

- 2 on basalt rope at the top and the bottom of column 2,
- 1 at the surface of the infill connected to column 2, inside the polyurethane
- 1 on basalt rope at the top of column 1
- 1 at the surface on the infill connected to column 1
- 1 on the basalt rope at the bottom of column 3
- 1 on the basalt rope at the bottom of column 4
- 2 on the surface of the roof
- 2 on the anchoring metal structures, 1 at the planter's and 1 at the living wall's.

Accelerometers

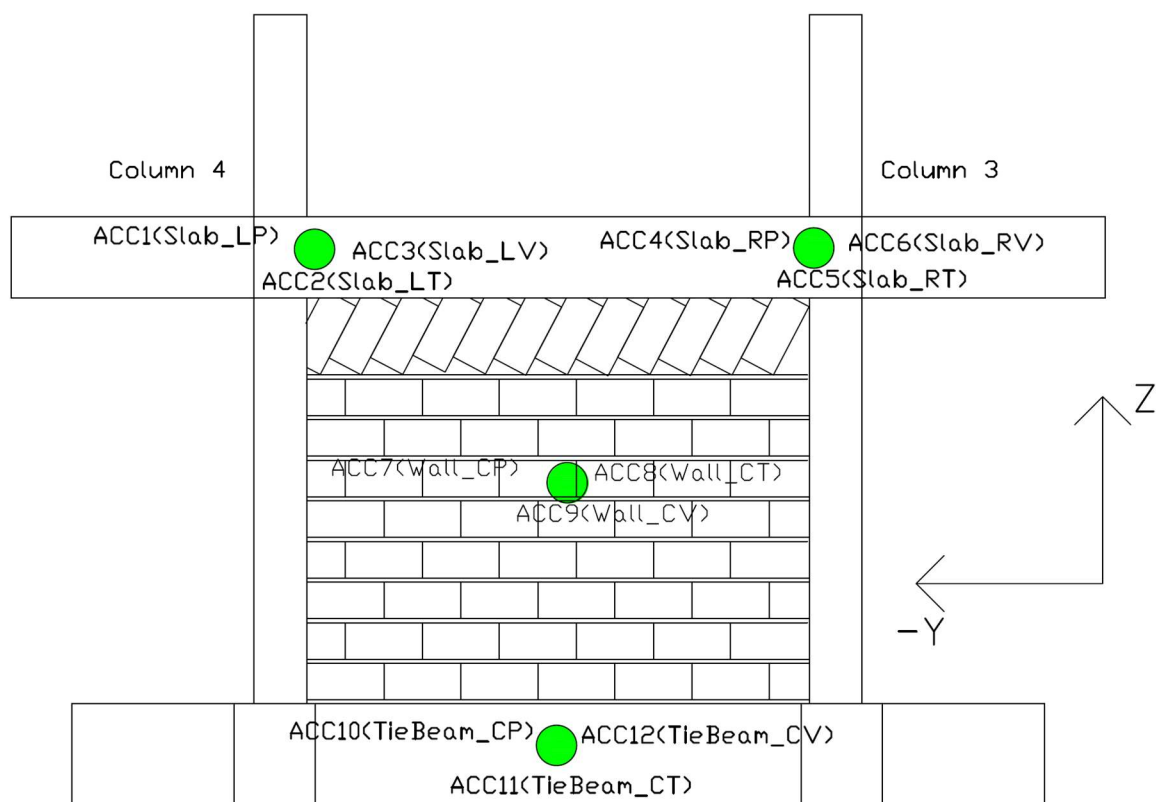


Figure 1.2 Position of accelerometers (specimen's view perpendicular to the direction of the seismic table movement)

Draw wire sensors

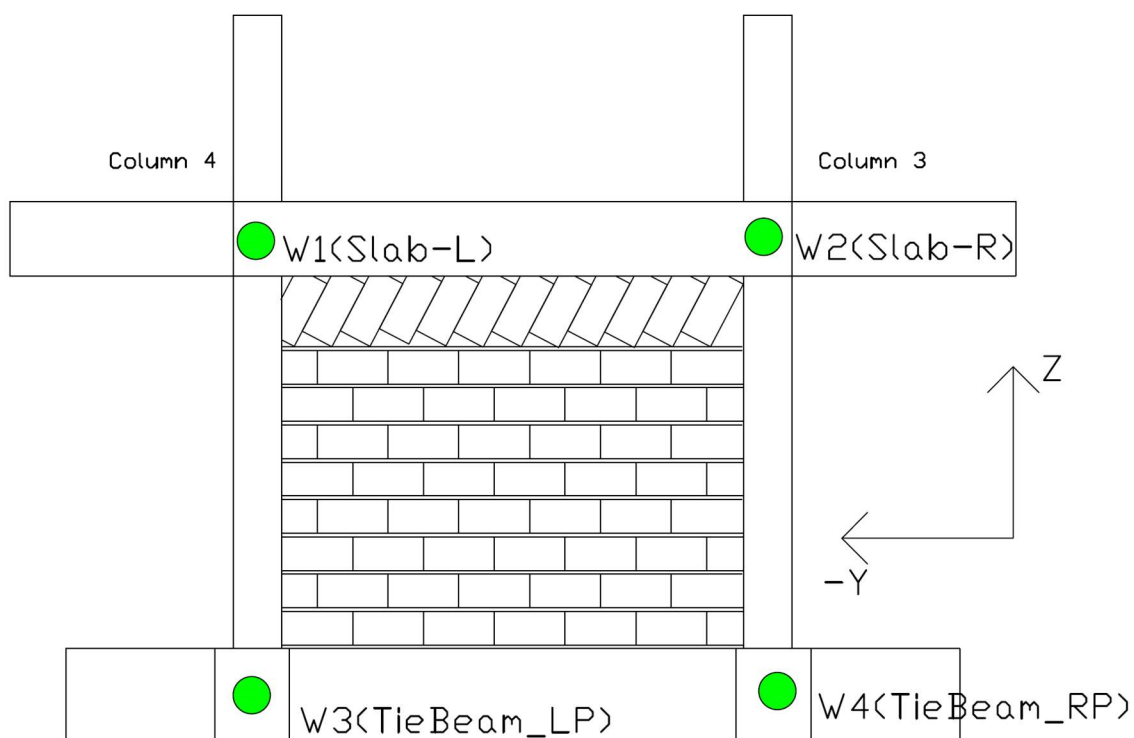


Figure 1.3 Position of the draw wire sensors on the concrete structure slab and foundation beams (specimen's view parallel to the direction of the seismic table movement)

Table 1.1: List of accelerometers, draw wire meters and strain gauges placed inside and on the structure

Ch No.	Channel name	Type of instrument	Measured quantity (units)	Position
1	ACC 1	Accelerometer	Acceleration (g)	On the slab, on the left corner, dir. (x)
2	ACC 2			On the slab, on the left corner, dir. (y)
3	ACC 3			On the slab, on the left corner, dir. (z)
4	ACC 4			On the slab, on the right corner, dir. (x)
5	ACC 5			On the slab, on the right corner, dir. (y)
6	ACC 6			On the slab, on the right corner, dir. (z)
7	ACC 7			On the infill, on the center, dir (x)
8	ACC 8			On the infill, on the center, dir (y)
9	ACC 9			On the infill, on the center, dir (x)
10	ACC 10			On the foundation, on the center, dir (x)
11	ACC 11			On the foundation, on the center, dir (y)
12	ACC 12			On the foundation, on the center, dir (z)
13	W 1	Draw wire sensors	Length (mm)	On the slab, on the left side
14	W 2			On the slab, on the right side
15	W 3			On the foundation, on the left side
16	W 4			On the foundation, on the right side
17	W 5			along the partial masonry infill diagonal
18	W 6			along the partial masonry infill diagonal
19	W 7			along the partial masonry infill diagonal
20	W 8			along the partial masonry infill diagonal
21	S1	Strain gauges	Strain	In the longitudinal reinforcement, on the underside
22	S2			
23	S3			
24	S4			
25	S5			
26	S6			
27	S7			
28	S8			
29	S9			In the longitudinal reinforcement, on the upper side
30	S10			
31	S11			
32	S12			

33	S13			
34	S14			
35	S15			
36	S16			
37	S17	Strain gauges	Strain	On the centre of partial masonry 1 along direction x
38	S18			On the centre of partial masonry 1 along direction z
39	S19			On the centre of partial masonry 2 along direction x
40	S20			On the centre of partial masonry 2 along direction z
41	S21			On the polyurethane (PM) at the joint between column 1 and the partial masonry, 5cm under the slab along direction x
42	S22			On the polyurethane (PM) at the joint between column 2 and the partial masonry, 5 cm under the slab along direction x
43	S23			On the rope, column 3
44	S24			On the rope, column 4

2 DEVELOPMENTS OF A SMART PZT MONITORING SYSTEM FOR THE VF RENOVATED STRUCTURE

The instrumentation is further expanded for the renovated structure as presented in D22. The recordings are presented in detail in section 4.

3 APPLIED TESTING METHODOLOGY FOR THE VF STRUCTURE

The dynamic shake table tests comprised of increasing maximum input intensity level (peak acceleration of the excitation) from 0.07g to 1.4g based on the adopted earthquake Thessaloniki 1978. On the following Table, a complete list of performed dynamic and seismic tests is shown for the second phase of testing presented in this report. ST1 refers to Seismic Test 1. WNb0,07 (without) refers to White Noise Test, without bottom fixing of the vertical living walls. Seismic Test 2 refers to White noise Test, with bottom fixing of the vertical living walls, before the execution of Thessaloniki – based excitation with maximum acceleration 0.07g. WNb0.07g (without) and WNb0,07g have a maximum acceleration of 0,05g. All subsequent excitations maintained the bottom attachments of the vertical living walls fixed. EQ0.07g refers to earthquake excitation with maximum acceleration of 0,07g. Also WNb0,14g has a maximum acceleration of 0,08g and is identical to WNb0,34g or WNb0,5g or WNb0,55g or WNb0,74g or WNb0,8g or WNb1,10g or WNb1,3g or WNb 1,3g(2) or WNb1,4g or WNb0,2g and WNa0,2g which stands for White Noise Test after the last earthquake excitation of 0,2g. Finally, EQ0,07g or EQ0,1g or EQ1,4g or EQ0,2g or EQ0,34g or EQ0,5g or EQ0,55g or EQ0,74g or EQ0,8g or EQ1,1g or EQ1,3g or EQ1,3g(2) or EQ1,4g or EQ0,2g refer to Earthquake excitation based on Thessaloniki recording with maximum acceleration of 0,07g or 0,1g or 1,4g or 0,2g or 0,34g or 0,5g or 0,55g or 0,74g or 1,1g or 1,3g or 1,4g or 0,2g accordingly.

Table 3.1: List of all performed tests

Performed tests			
Test No.	Name	Type of excitation	Intensity (g)
Phase B			
ST1	WNb0,07g (without)	White noise	0,05g
ST2	WNb0,07g	White noise	0,05g
ST3	EQ0,07g	Earthquake	0,07g
ST4	EQ0,1g	Earthquake	0,1g
ST5	WNb0,14g	White noise	0.08g
ST6	EQ0,14g	Earthquake	0,14g
ST7	EQ0,2g	Earthquake	0.2g
ST8	WNb0,34g	White noise	0,08g
ST9	EQ0,34g	Earthquake	0,34g
ST10	WNb0,5g	White noise	0,08g
ST11	EQ0,5g	Earthquake	0,5g
ST12	WNb0,55g	White noise	0,08g
ST13	EQ0,55g	Earthquake	0,55g
ST14	WNb0,74g	White noise	0,08g
ST15	EQ0,74g	Earthquake	0,74g
ST16	WNb0,8g	White noise	0,08g
ST17	EQ0,8g	Earthquake	1,1g
ST18	WNb1,1g	White noise	0,08g
ST19	EQ1,1g	Earthquake	1,3g
ST20	WNb1,3g	White noise	0,08g
ST21	EQ1,3g	Earthquake	1,3g
ST22	WNb1,3g(2)	White noise	0,08g

ST23	EQ1,3g(2)	Earthquake	1,3g
ST24	WNb1,4g	White noise	0,08g
ST25	EQ1,4g	Earthquake	1,4g
ST26	WNb0,2g	White noise	0,08
ST27	EQ0,2g	Earthquake	0,2g
ST28	WNa0,2g	White noise	0,08g

3.1 White noise before EQ0,07g (without bottom fixing of the vertical living walls)

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,07g, without bottom fixing of the vertical living walls. The max acceleration at the slab level on the accelerometer acc4 is 0,09g. The max acceleration at the foundation level on the accelerometer acc10 is 0,04g.

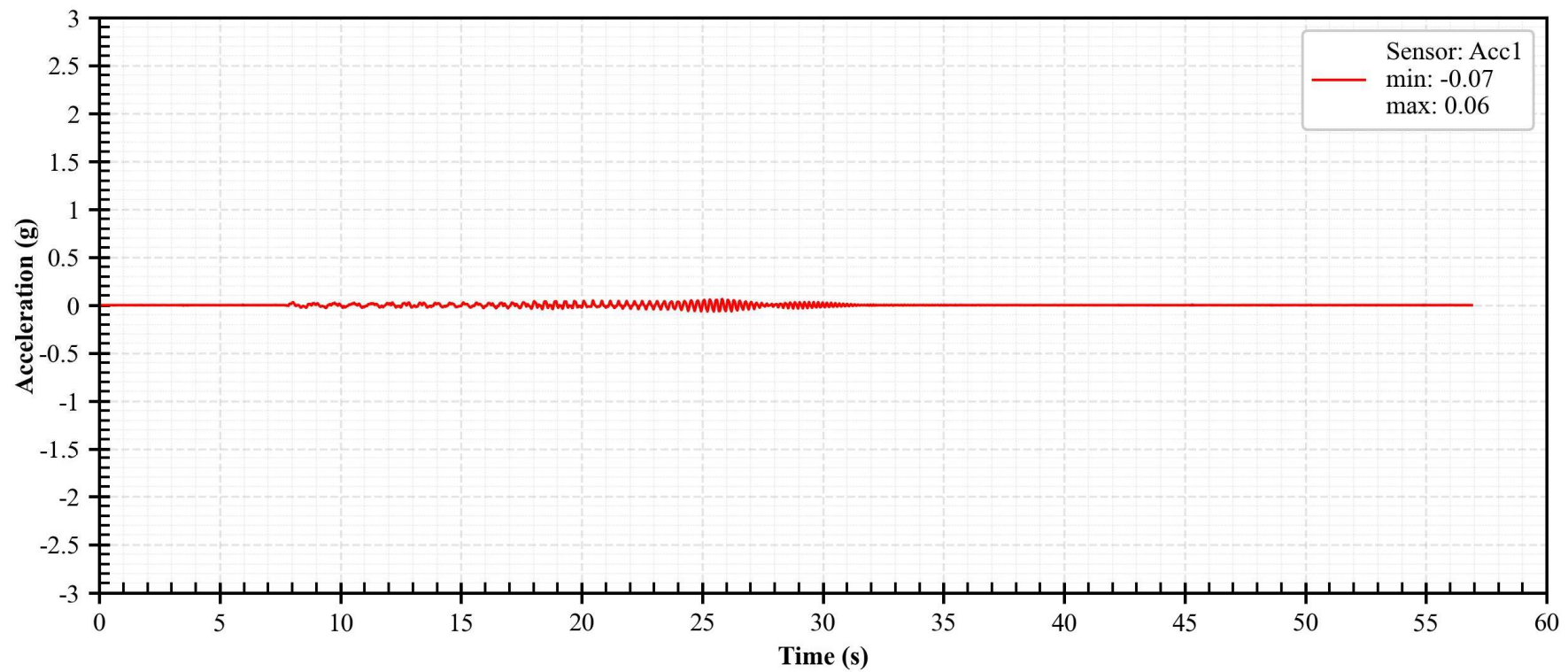


Figure 3.1.1 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 1

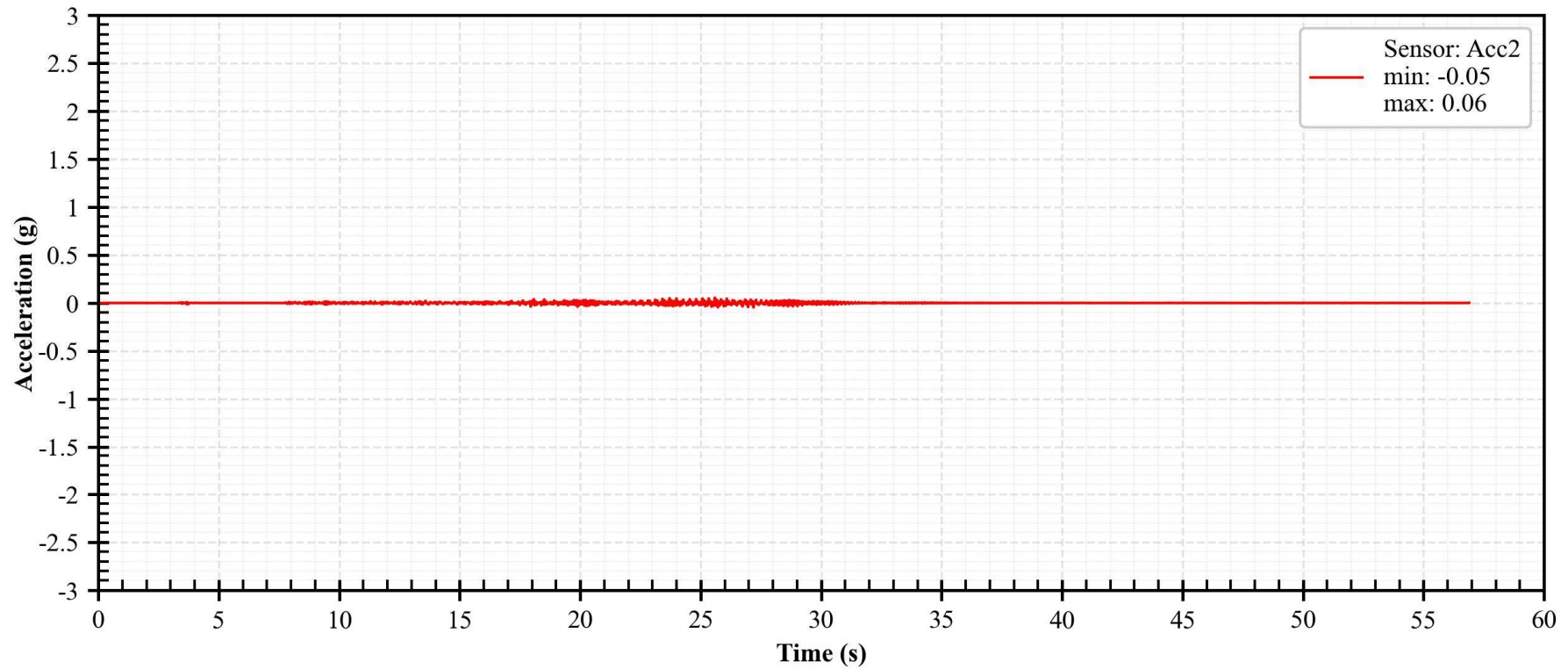


Figure 3.1.2 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 2

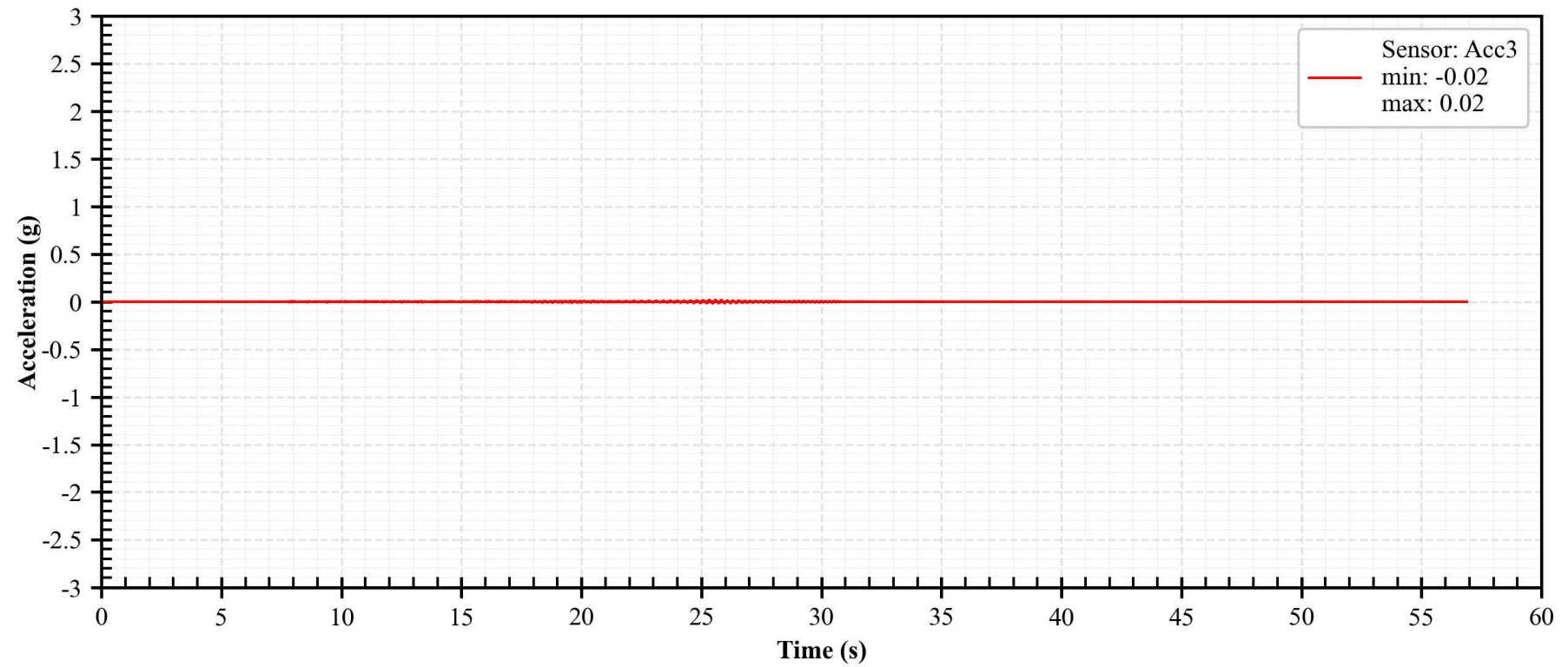


Figure 3.1.3 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 3

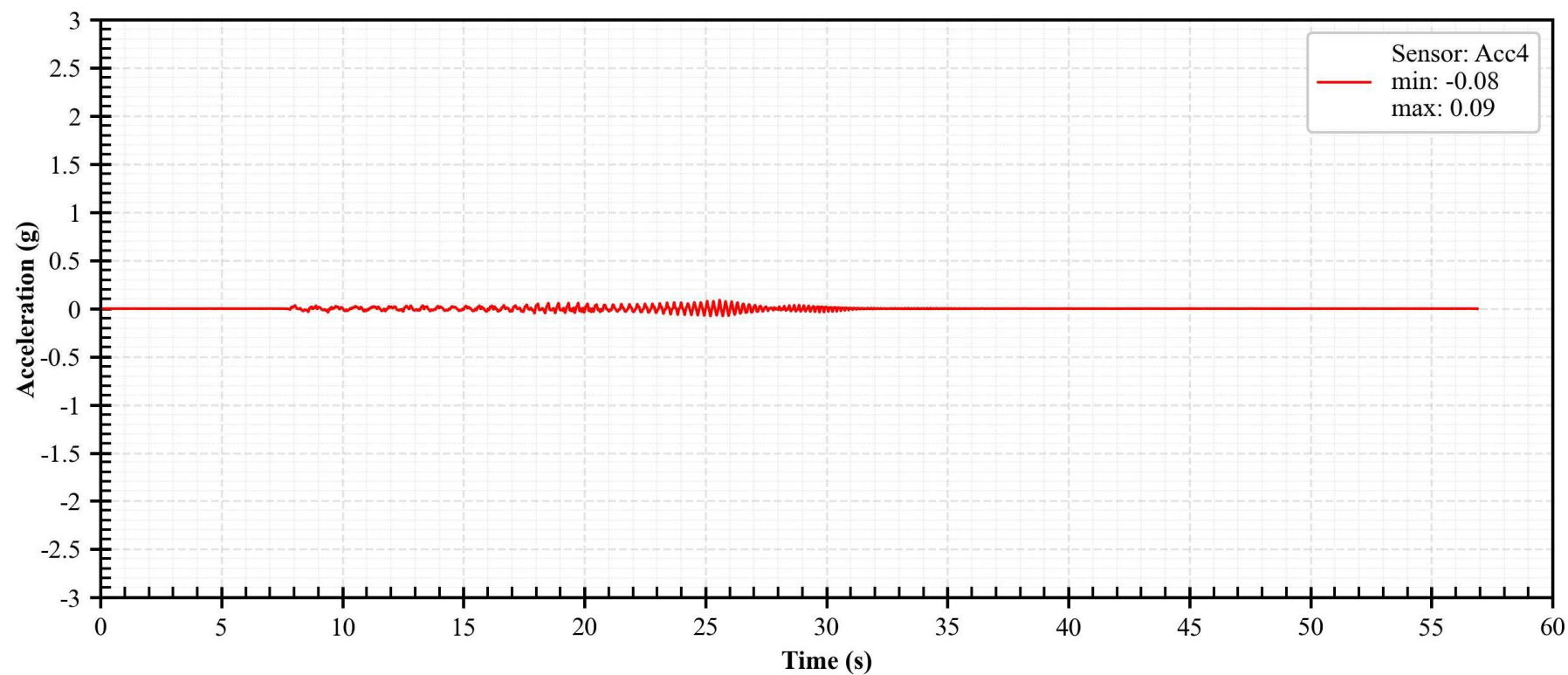


Figure 3.1.4 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 4

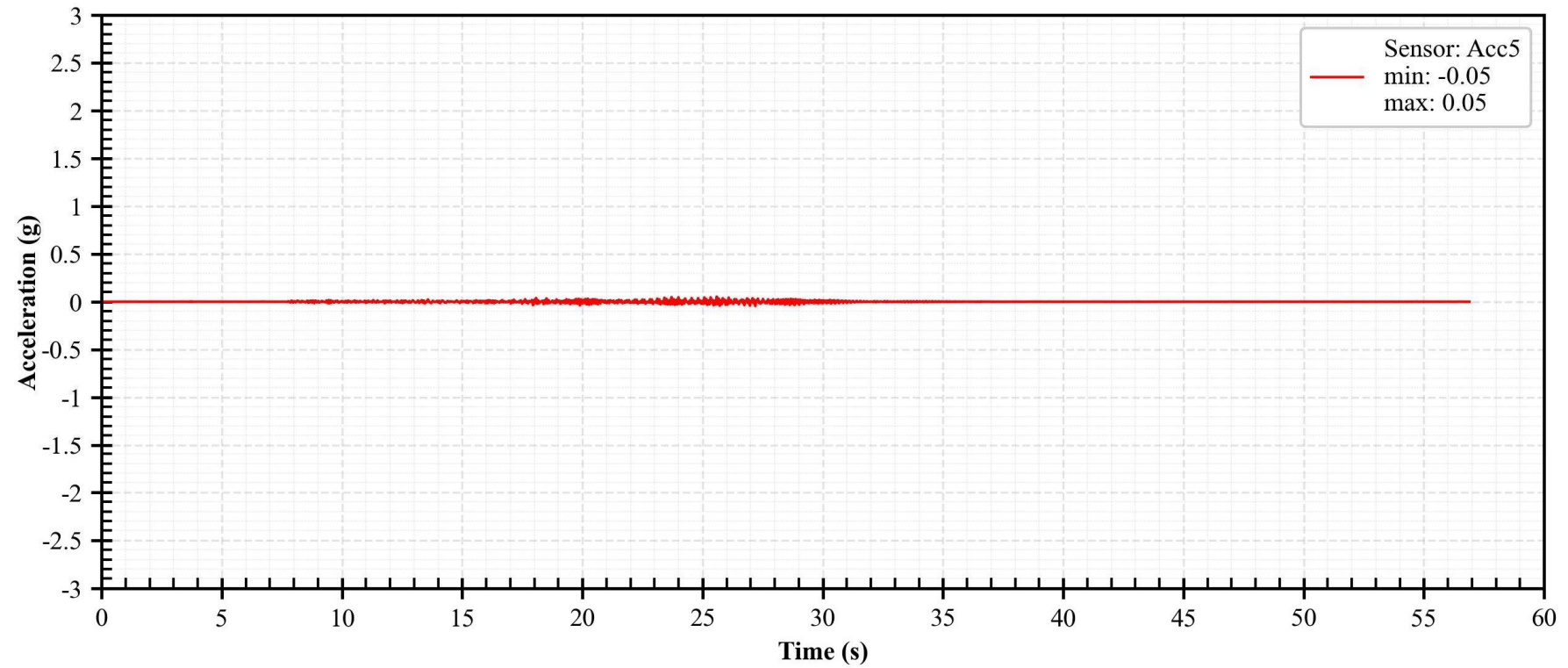


Figure 3.1.5 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 5

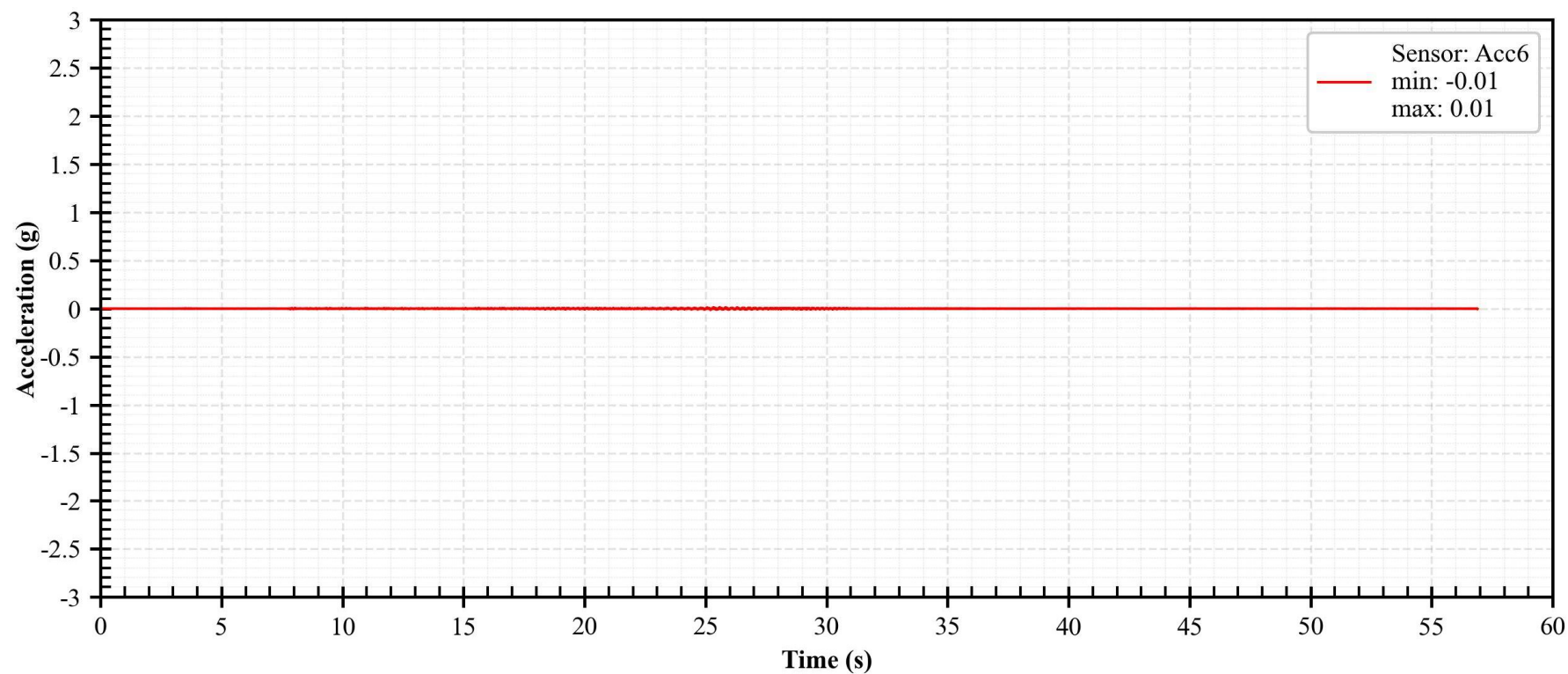


Figure 3.1.6 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 6

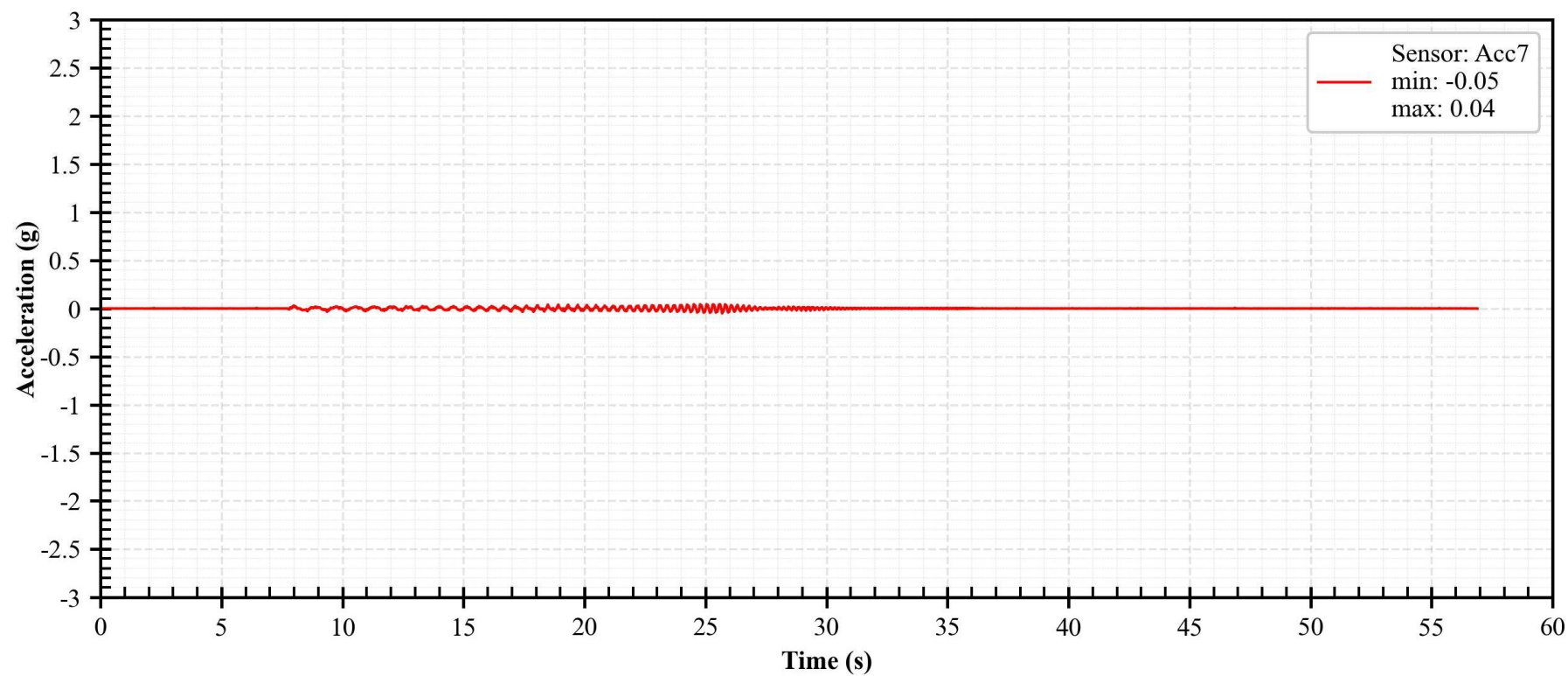


Figure 3.1.7 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 7

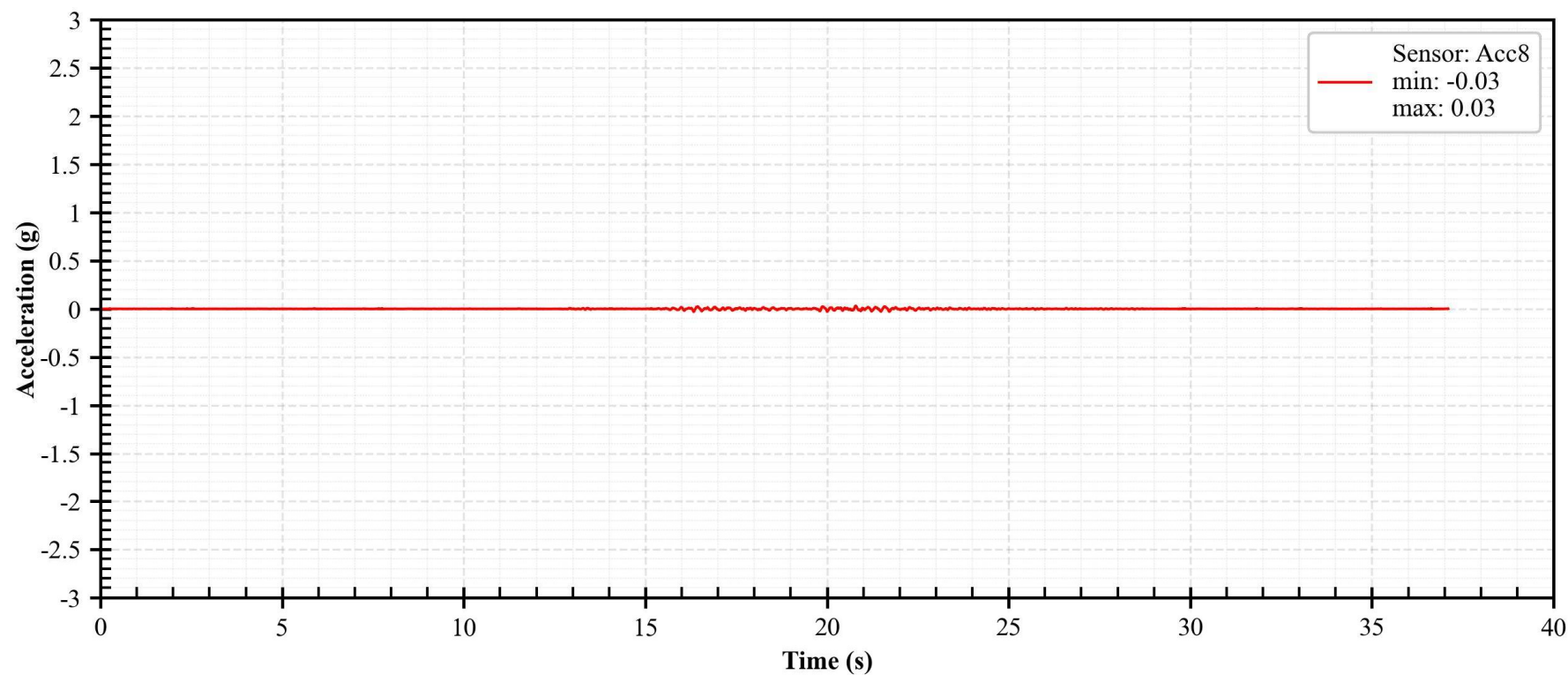


Figure 3.1.8 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 8

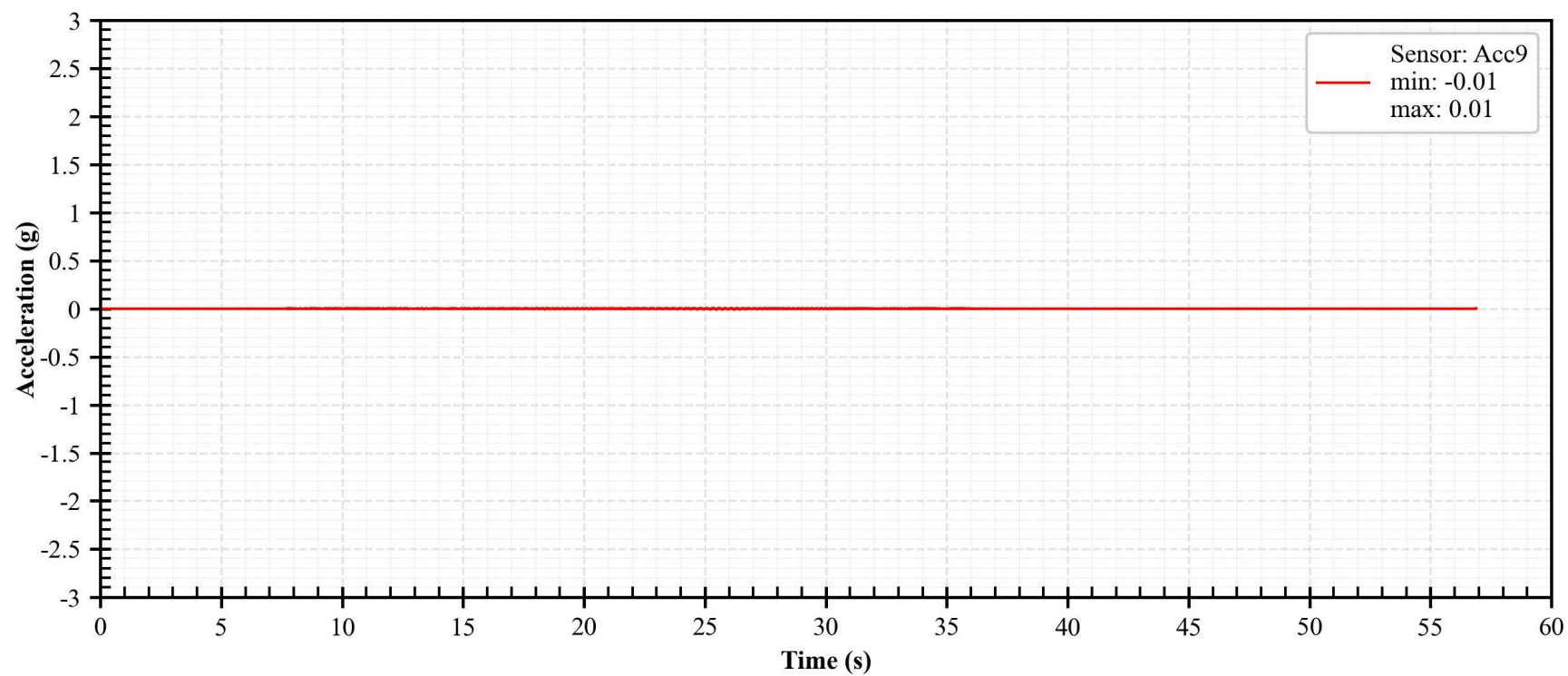


Figure 3.1.9 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 9

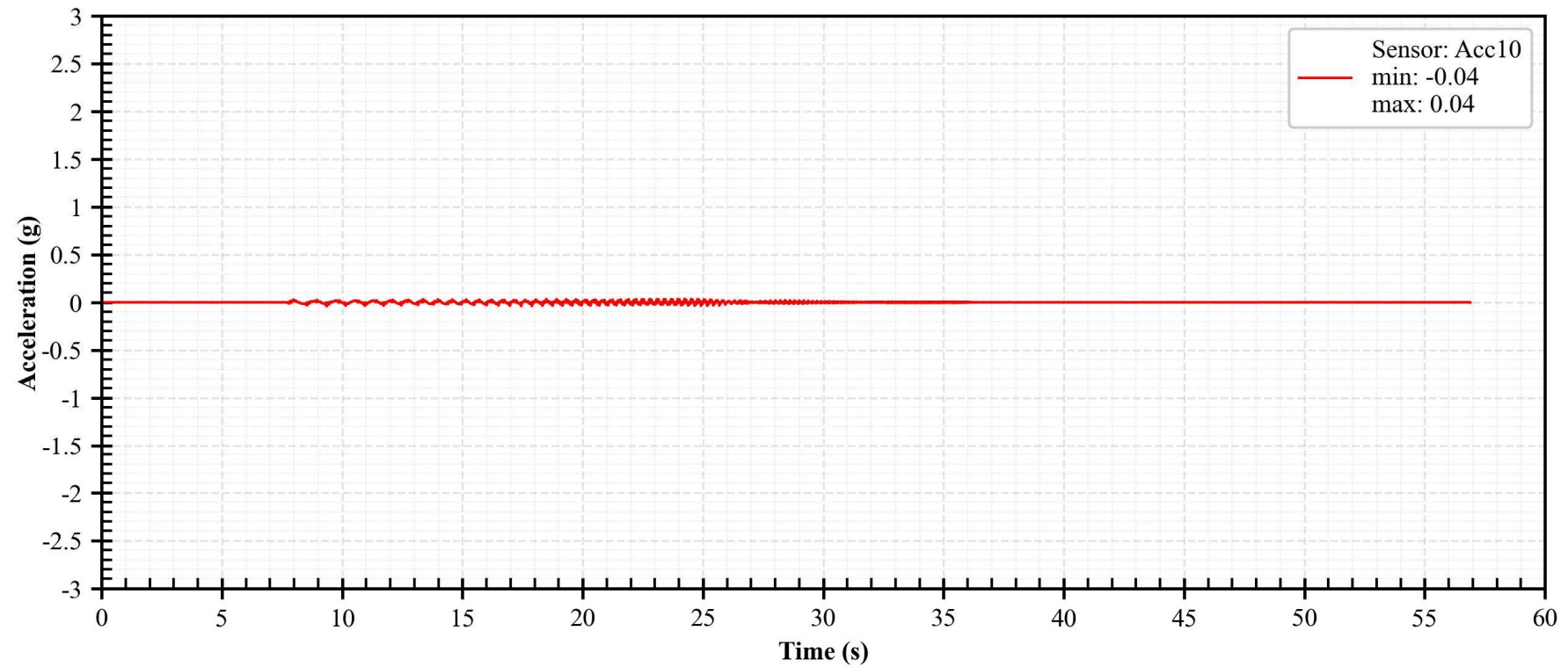


Figure 3.1.10 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 10

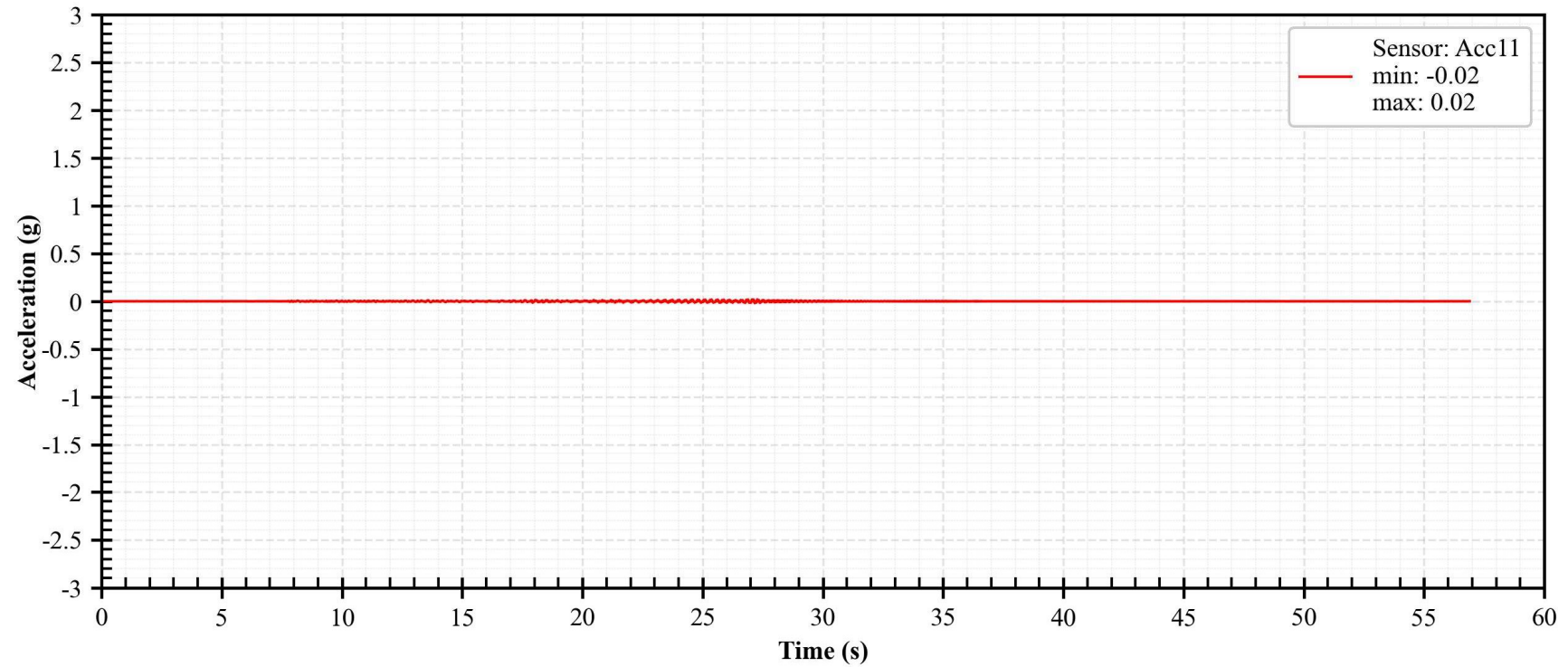


Figure 3.1.11 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 11

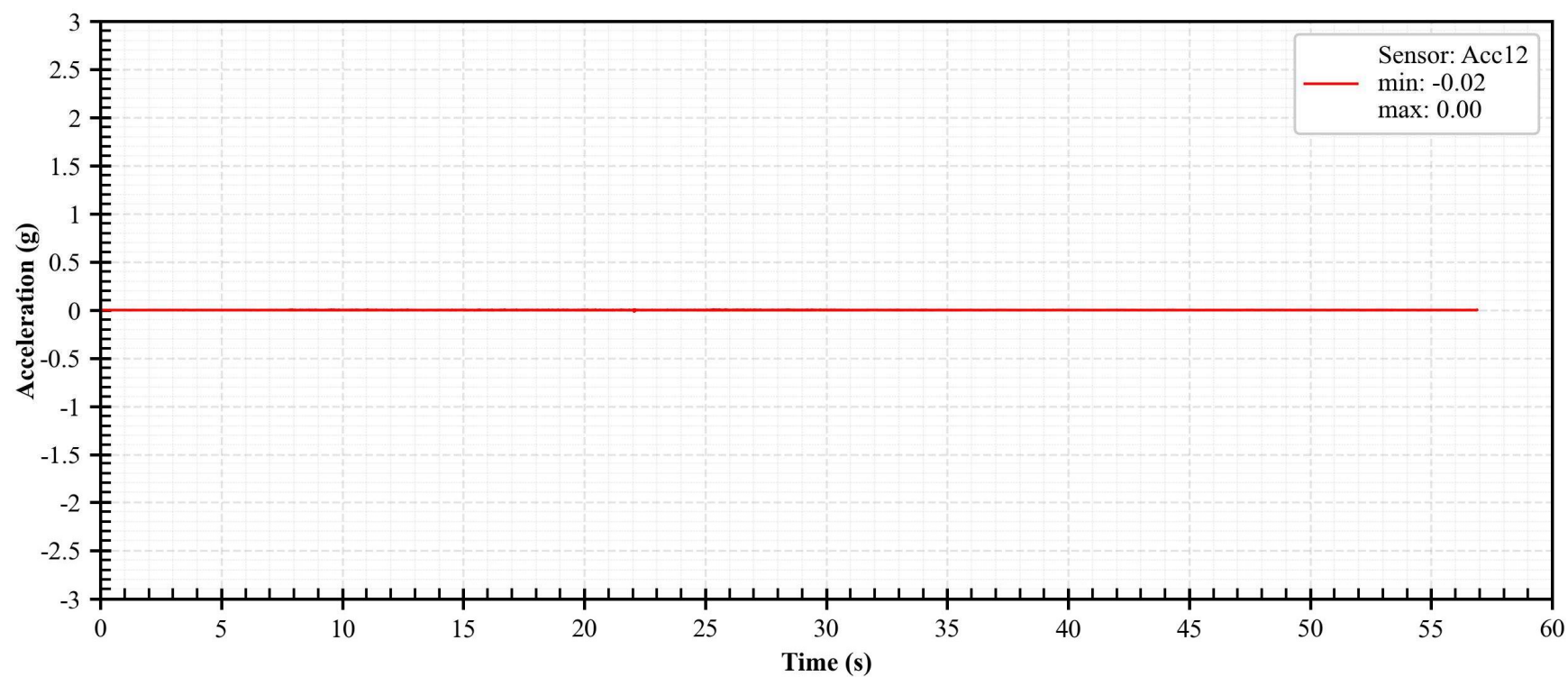


Figure 3.1.12 Characteristic results for phase B (white noise before 0,07g without): Accelerometer 12

Draw wire sensors

Figures 3.1.13 – 3.1.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 13.41 mm while the minimum is -10.79 mm. The maximum movement detected by draw wire sensor W2 is 13.70 mm while the minimum is -10.67 mm. The maximum movement detected by draw wire sensor W3 is 13.56 mm while the minimum is -10.61 mm. The maximum movement detected by draw wire sensor W4 is 13.84 mm while the minimum is -10.73 mm. The maximum drift is $(1.69/1.225) = 1.38 \text{ ‰}$ and minimum drift is $(-1.77/1.225) = -1.44 \text{ ‰}$.

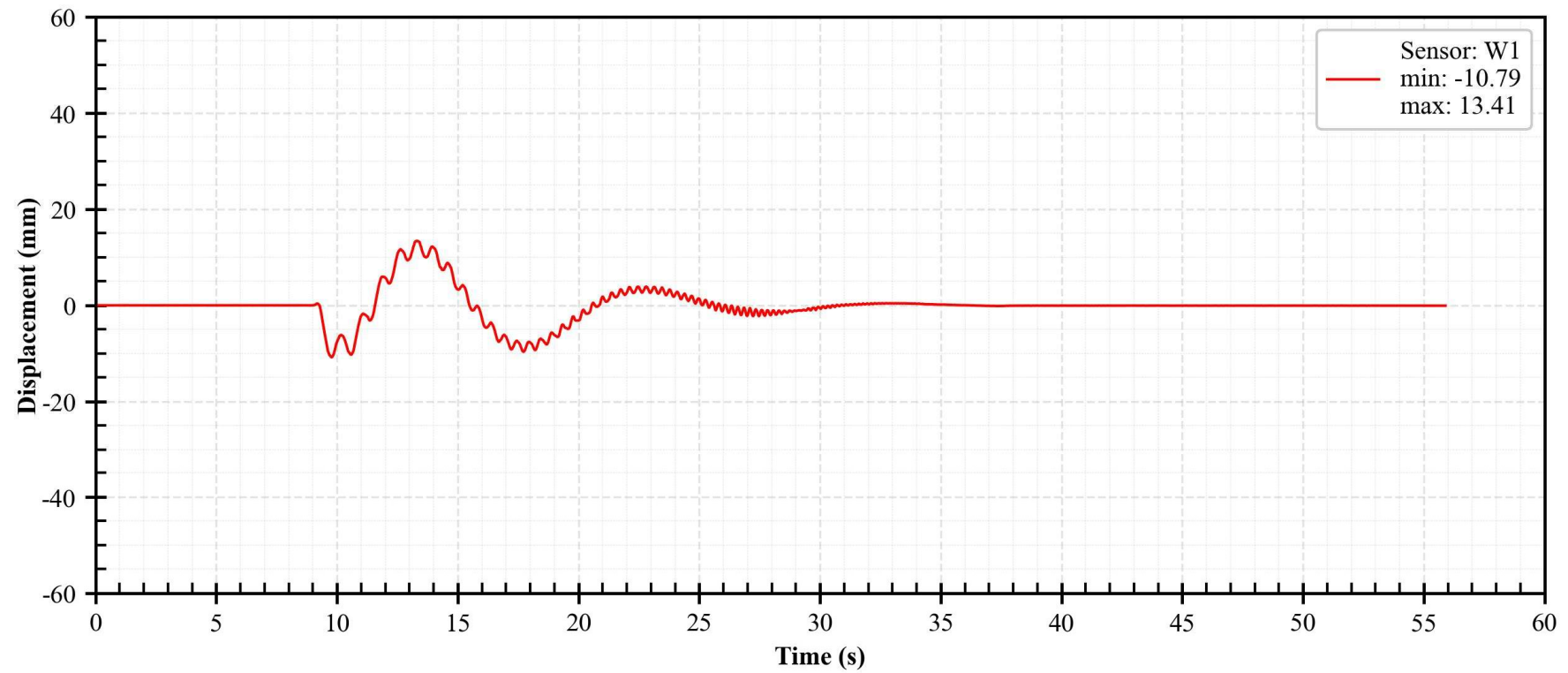


Figure 3.1.13 Characteristic results for phase B (white noise before 0,07g without): Draw wire sensor 1

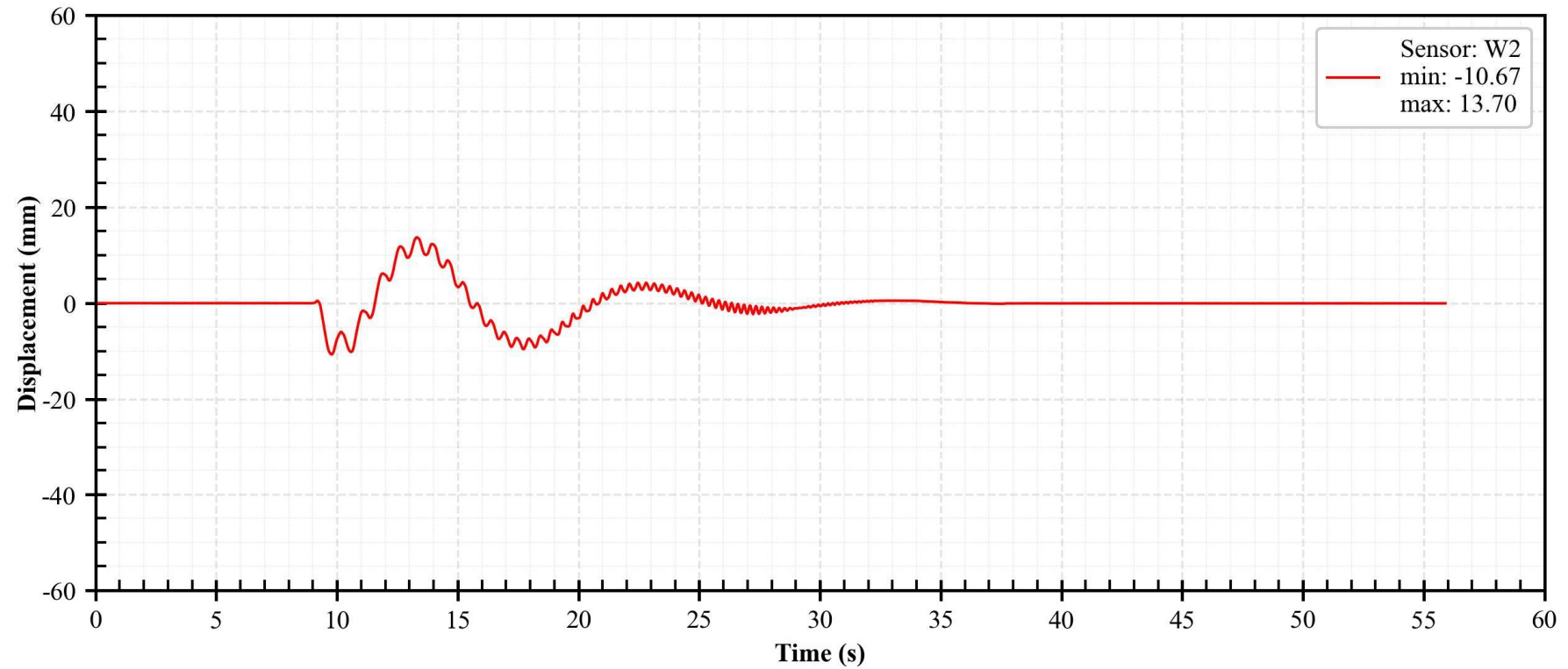


Figure 3.1.14 Characteristic results for phase B (white noise before 0,07g without): Draw wire sensor 2

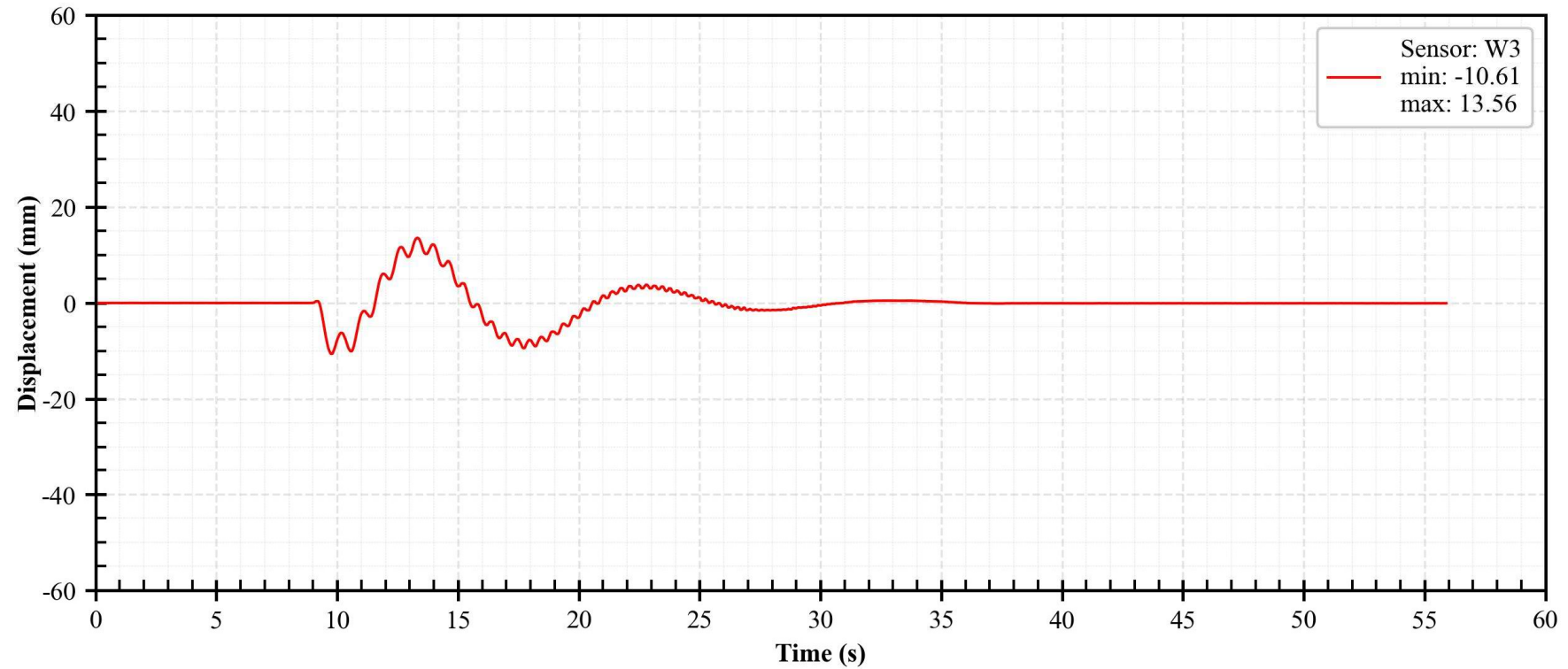


Figure 3.1.15 Characteristic results for phase B (white noise before 0.07g without): Draw wire sensor 3

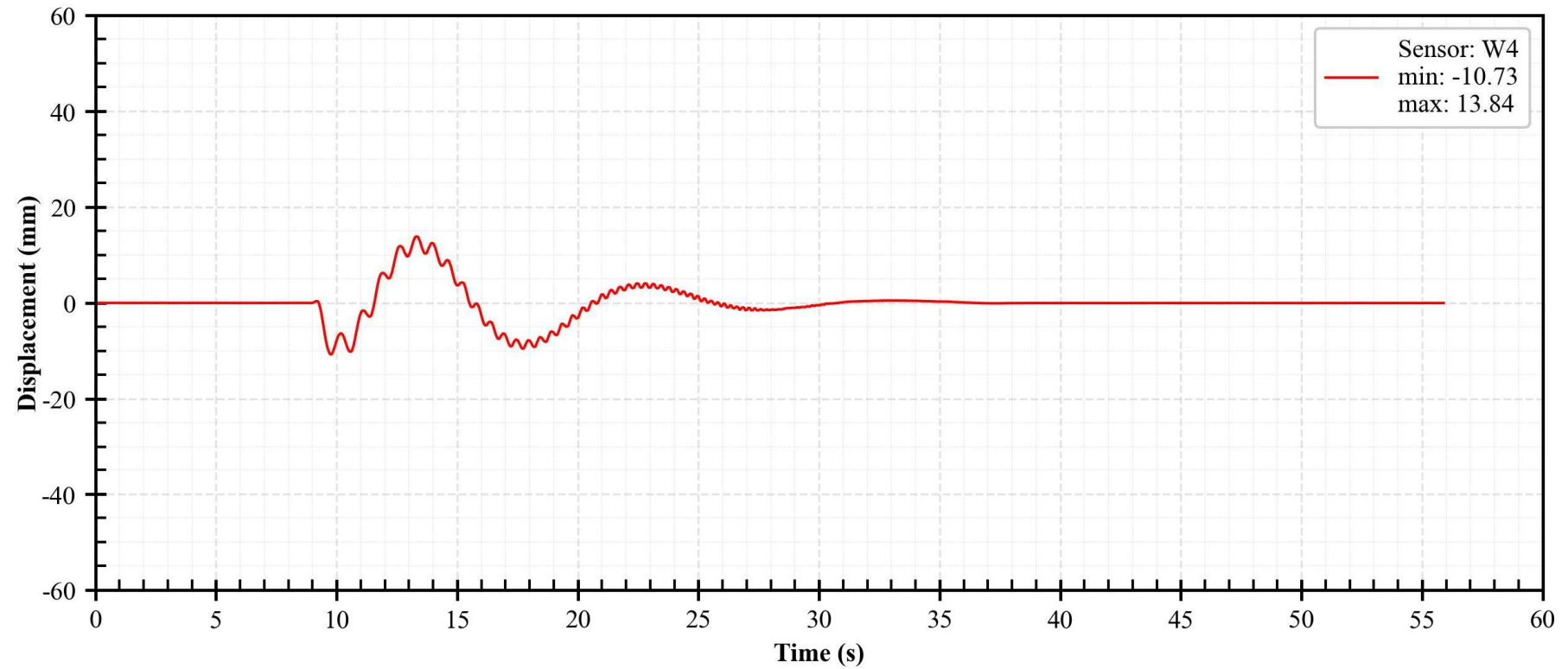


Figure 3.1.16 Characteristic results for phase B (white noise 0.07g before without): Draw wire sensor 4

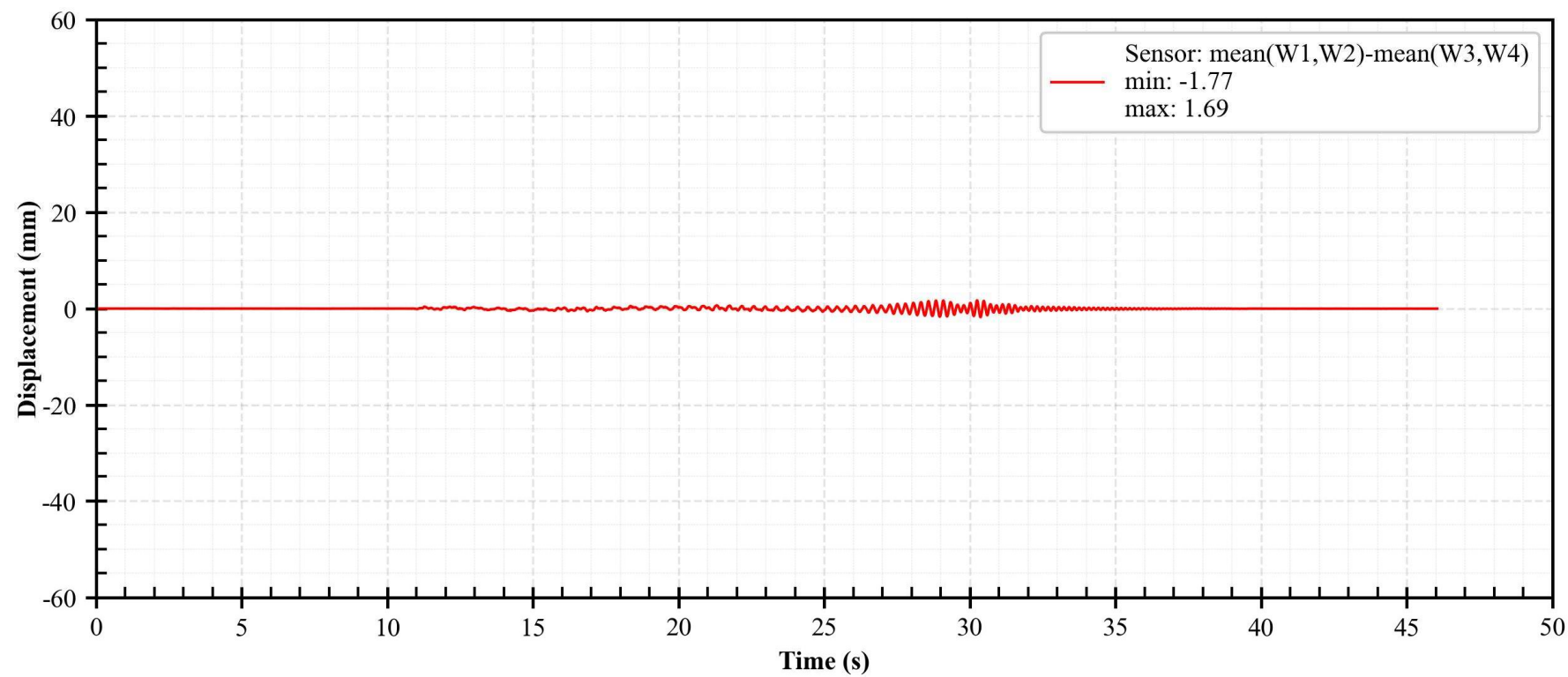


Figure 3.1.17 Characteristic results for phase B (white noise before 0.07g without): $\text{mean}(W1, W2) - \text{mean}(W3, W4)$

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.1.18, 3.1.19, 3.1.20, 3.1.21, 3.1.22, 3.1.23, 3.1.32, 3.1.33 are located on the longitudinal reinforcement, at the bottom of the column. More specifically, strain gauge SG1 has maximum strain 58 μ strain and minimum strain -48 μ strain. The residual strain is 2 μ strain. Strain gauge SG2 has maximum strain 19 μ strain and minimum -30 μ strain. The residual strain is -5 μ strain. Strain gauge SG3 has 28 μ strain and -18 μ strain maximum and minimum strain respectively. The residual strain is 5 μ strain. Strain gauge SG4 has maximum 48 μ strain and minimum -48 μ strain strain. The residual strain is 3 μ strain. Figure 3.1.32 and figure 3.1.33 show strain gauges SG5 and SG6, respectively. Strain gauge 5 has 120 μ strain and -119 μ strain maximum and minimum strain respectively. Strain gauge SG5 presents 2 μ strain residual strain. Strain gauge SG6 has 55 μ strain maximum strain, -45 μ strain minimum strain and 2 μ strain residual. Finally in figure 3.1.22 we see strain gauge SG7 and in figure 3.1.23 strain gauge 8. Strain gauge SG7 has maximum strain 23 μ strain. Strain gauge SG7 has -27 μ strain minimum deformation. Strain gauge SG8 has maximum strain 64 μ strain and minimum strain -55 deformation. The residual strain for strain gauge SG7 and SG8 -3, -2 respectively.

Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. More specifically strain gauge 17 has 20 μ strain maximum strain. Strain gauge 17 has minimum deformation -22 μ strain and strain gauge 18 -17 μ strain. Finally strain gauge 17 presents 3 μ strain residual. Strain gauge 18 doesn't present residual.

The strain gauges shown in the figures 3.1.24, 3.1.25, 3.1.26, 3.1.27, 3.1.28, 3.1.29 and 3.1.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG9 has 86 μ strain maximum strain, -47 μ strain minimum strain and 0 residual. Strain gauge SG11 has 88 μ strain maximum strain and minimum -67 μ strain deformation. The residual strain is -6 μ strain for strain gauge SG11. Strain gauge SG12 has 19 μ strain maximum strain and -34 μ strain minimum strain. The residual strain is -11 μ strain for strain gauge SG12. Strain gauge SG13 has maximum strain 23 μ strain, minimum -18 μ strain and 1 μ strain residual. Strain gauge SG14 has maximum strain 67 μ strain and minimum strain -56 μ strain. The residual value is -2 μ strain. Finally strain gauges SG15 has maximum strain 107 μ strain and minimum strain -69 μ strain. Strain gauge SG16 has maximum strain 28 μ strain, minimum strain -23 μ strain and residual strain -4 μ strain.

SG21 & SG22 are located on PUFJ. Strain gauge SG21 has 49 μ strain maximum strain, -39 μ strain minimum strain and 12 μ strain residual. Strain gauge SG22 has maximum 56 μ strain and minimum -48 μ strain. Strain gauge 20 has maximum strain 31 μ strain and minimum -35 μ strain. The residual strain for strain gauge SG20 is 2 μ strain.

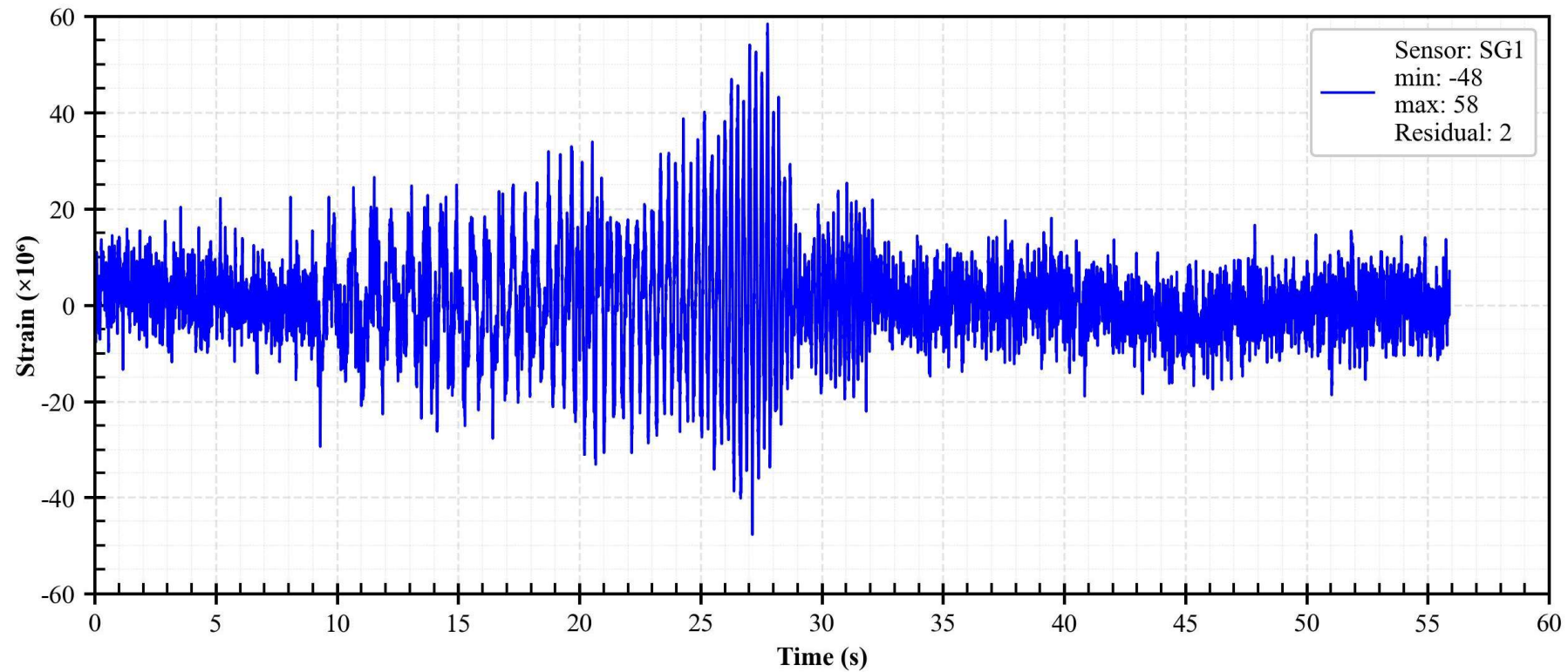


Figure 3.1.18 Characteristic results for phase B (white noise before 0.07g without): strain gauge 1

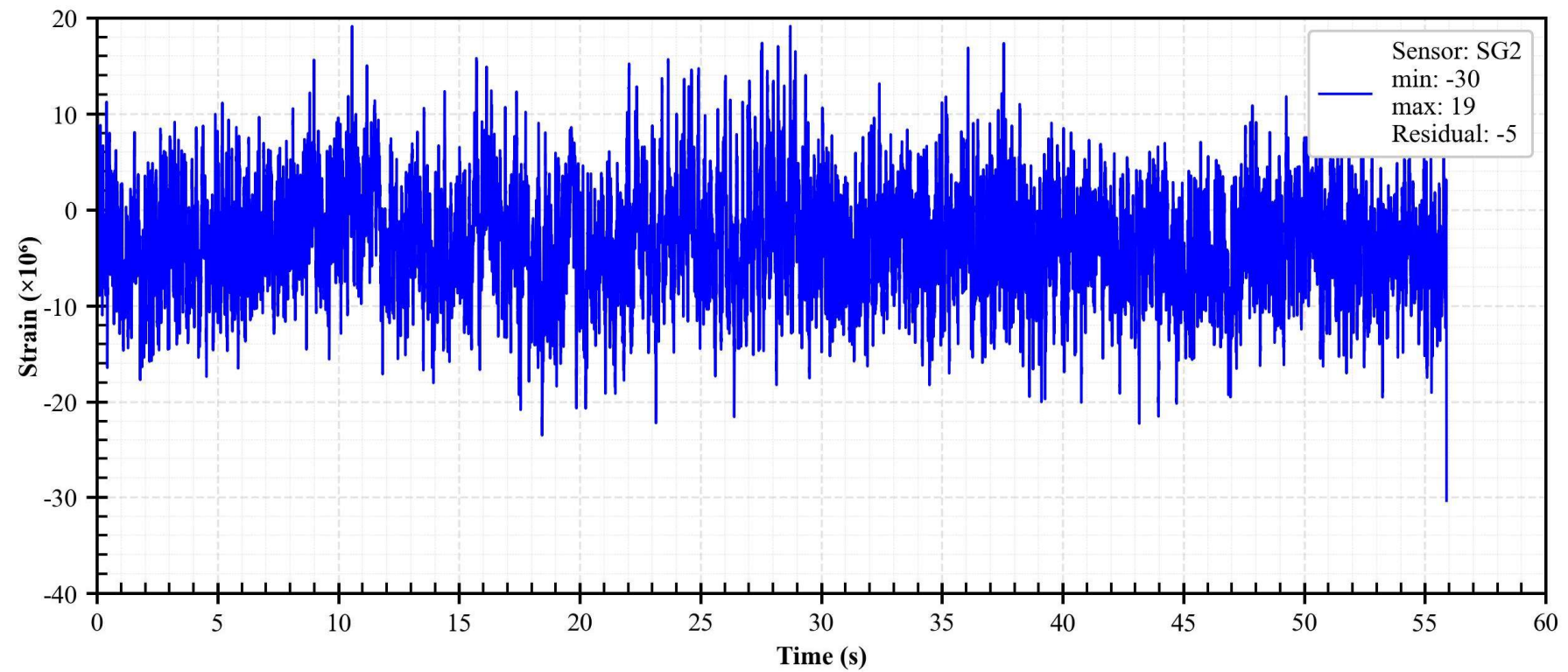


Figure 3.1.19 Characteristic results for phase B (white noise before 0.07g without): strain gauge 2

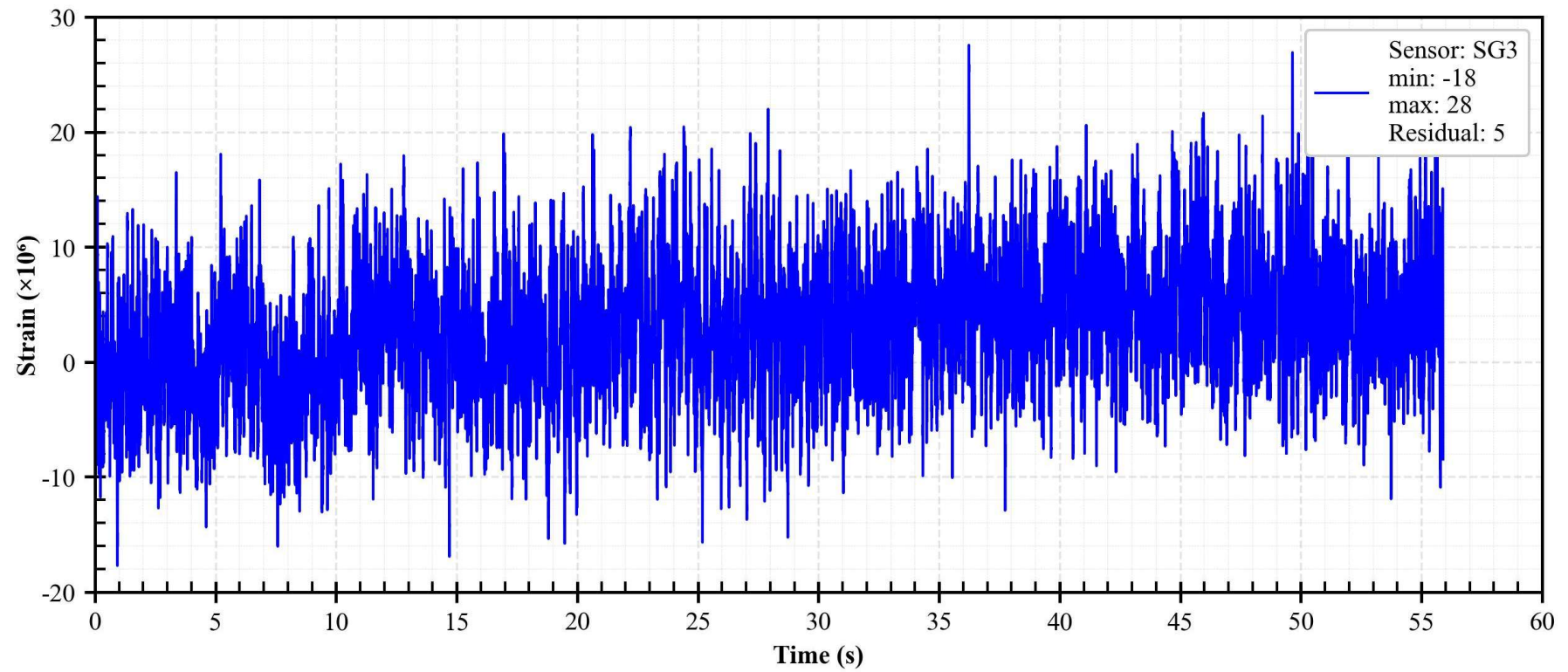


Figure 3.1.20 Characteristic results for phase B (white noise before 0.07g without): strain gauge 3

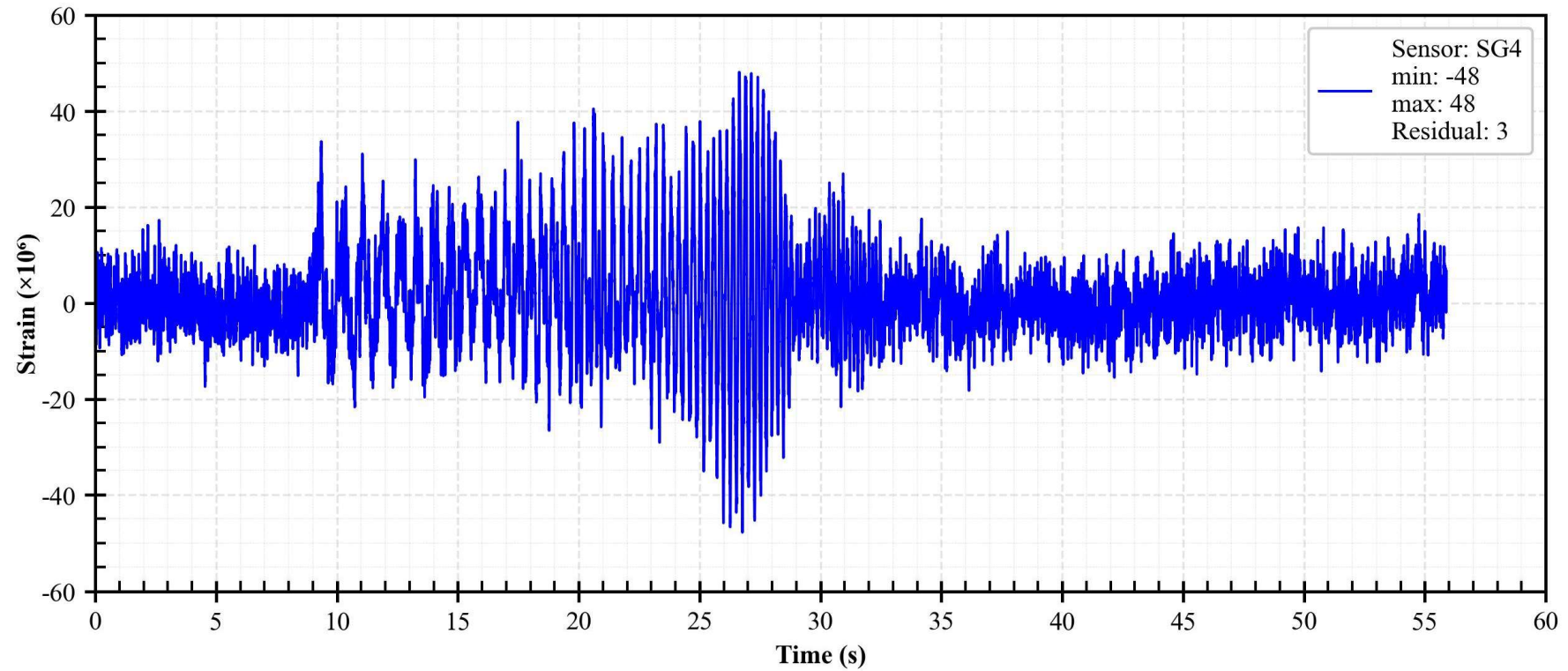


Figure 3.1.21 Characteristic results for phase B (white noise before 0.07g without): strain gauge 4

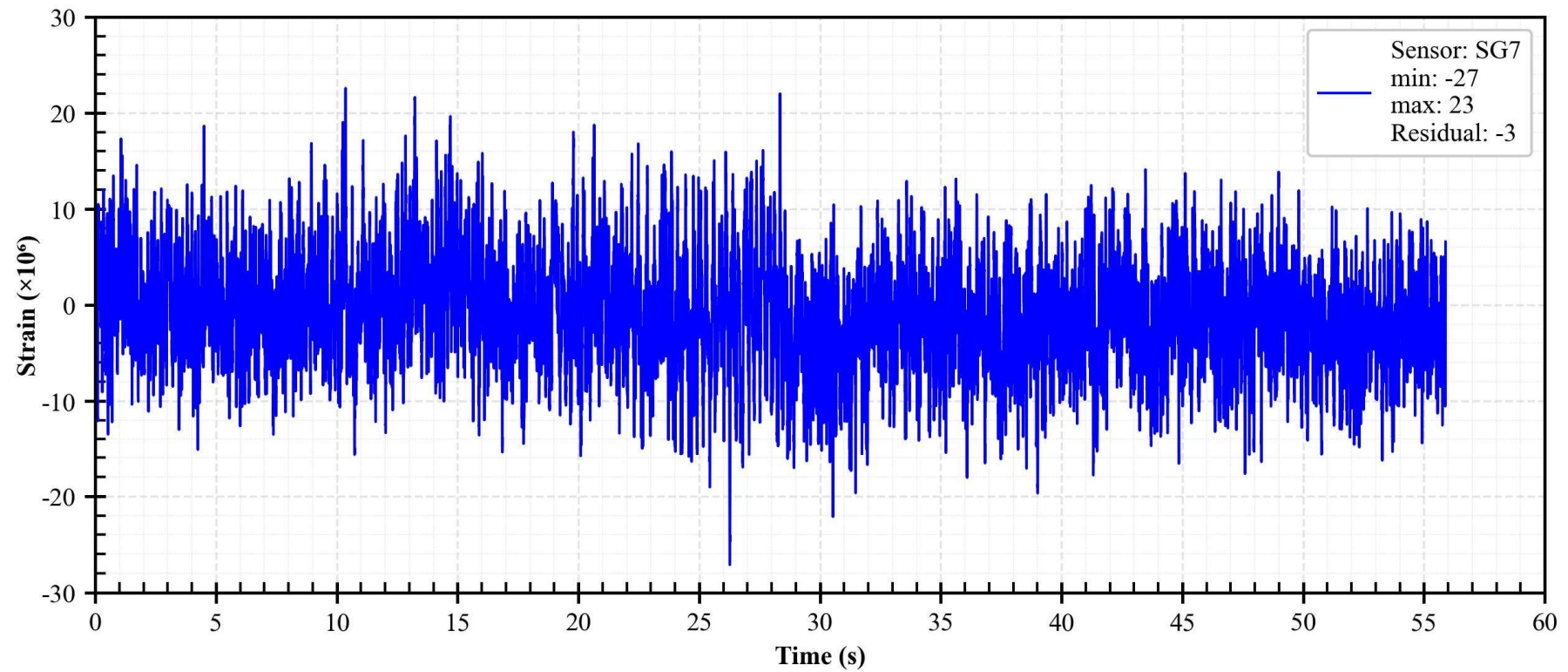


Figure 3.1.22 Characteristic results for phase B (white noise before 0.07g without): strain gauge 7

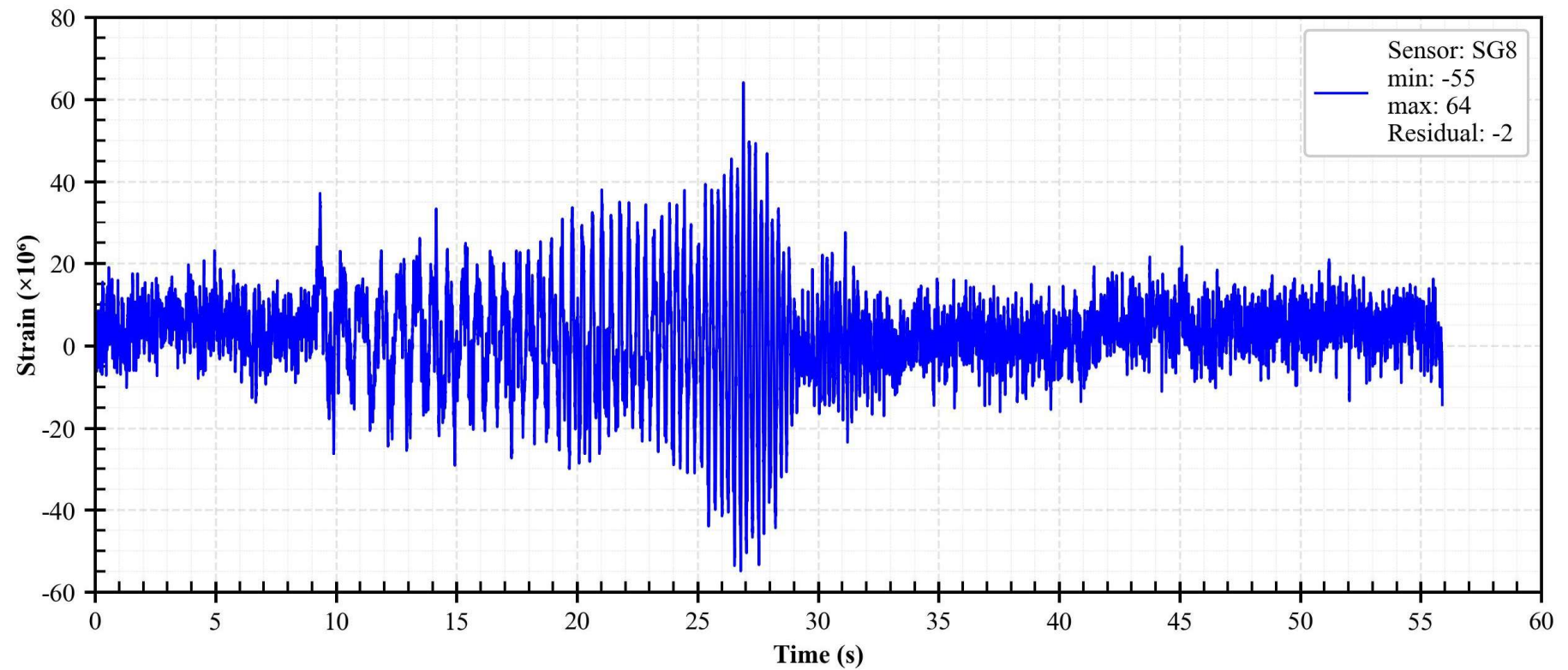


Figure 3.1.23 Characteristic results for phase B (white noise before 0.07g without): strain gauge 8

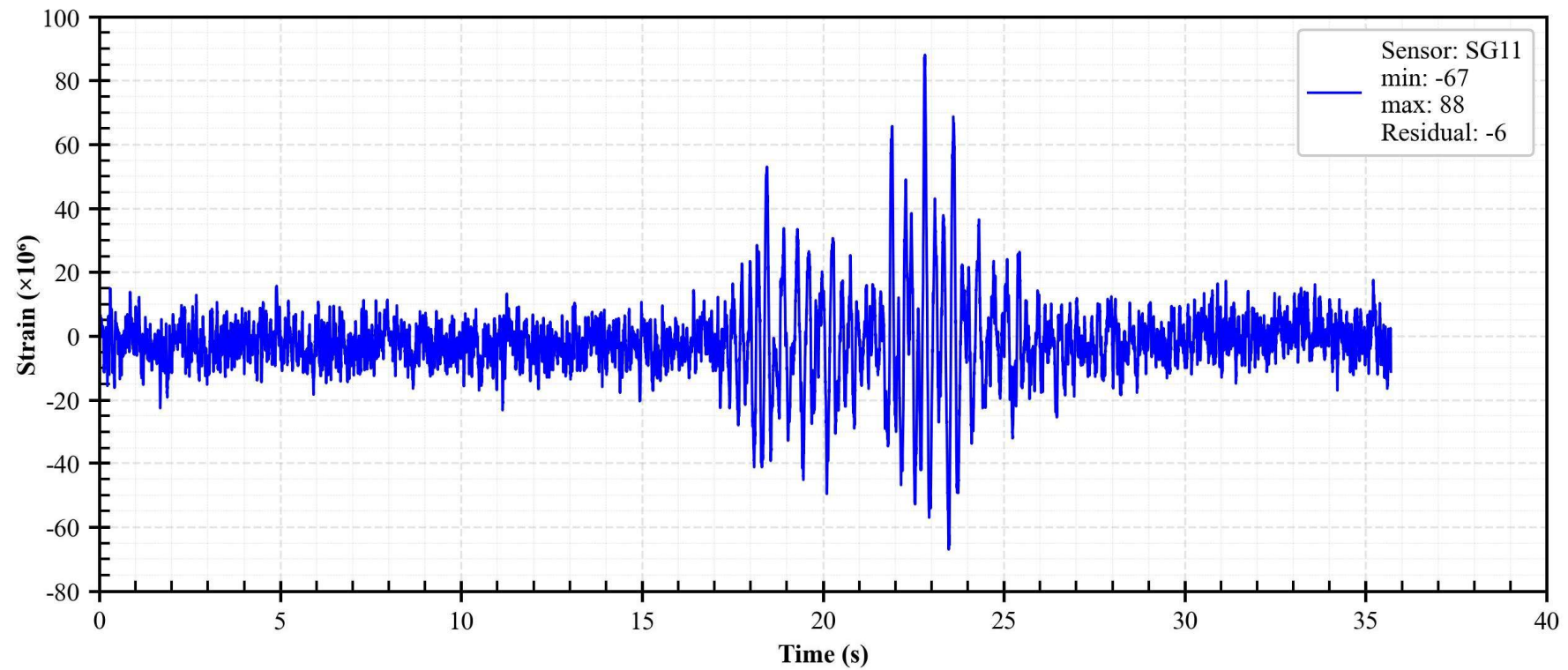


Figure 3.1.24 Characteristic results for phase B (white noise before 0.07g without): strain gauge 11

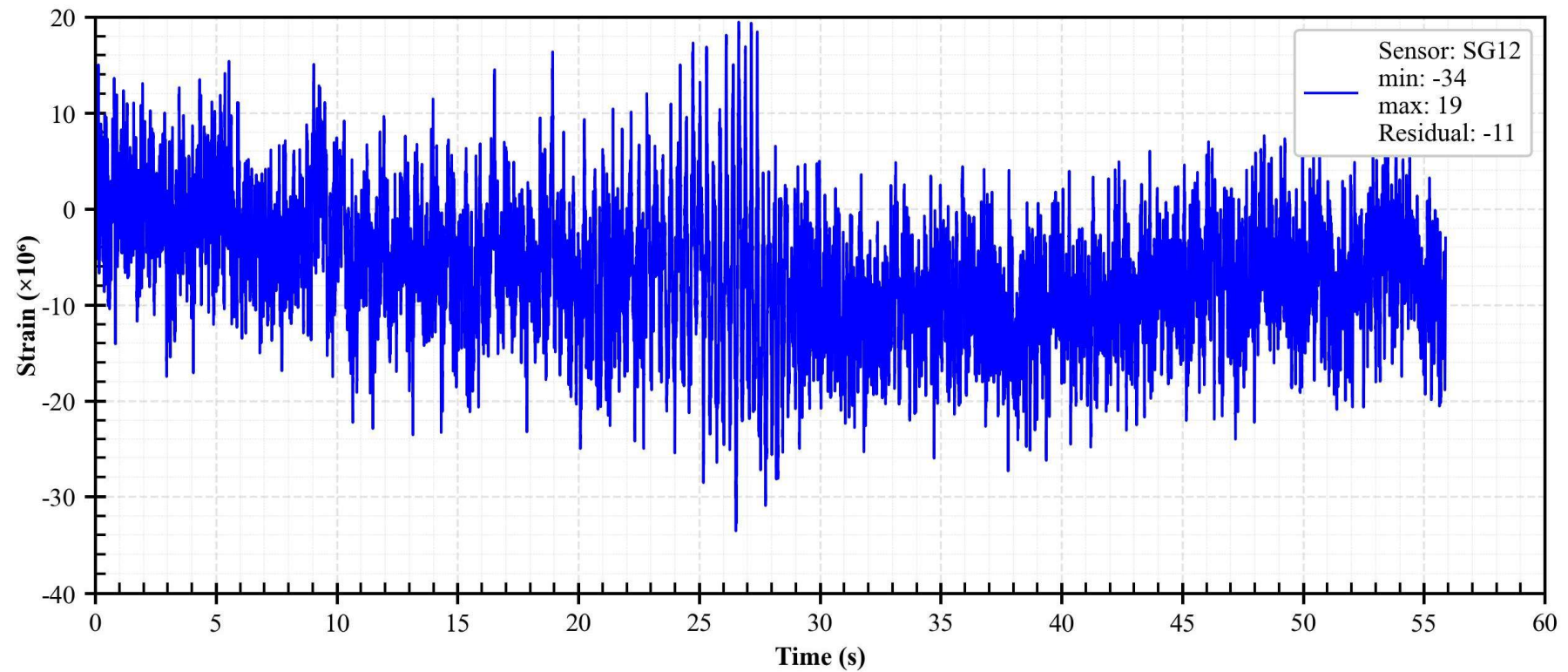


Figure 3.1.25 Characteristic results for phase B (white noise before 0.07g without): strain gauge 12

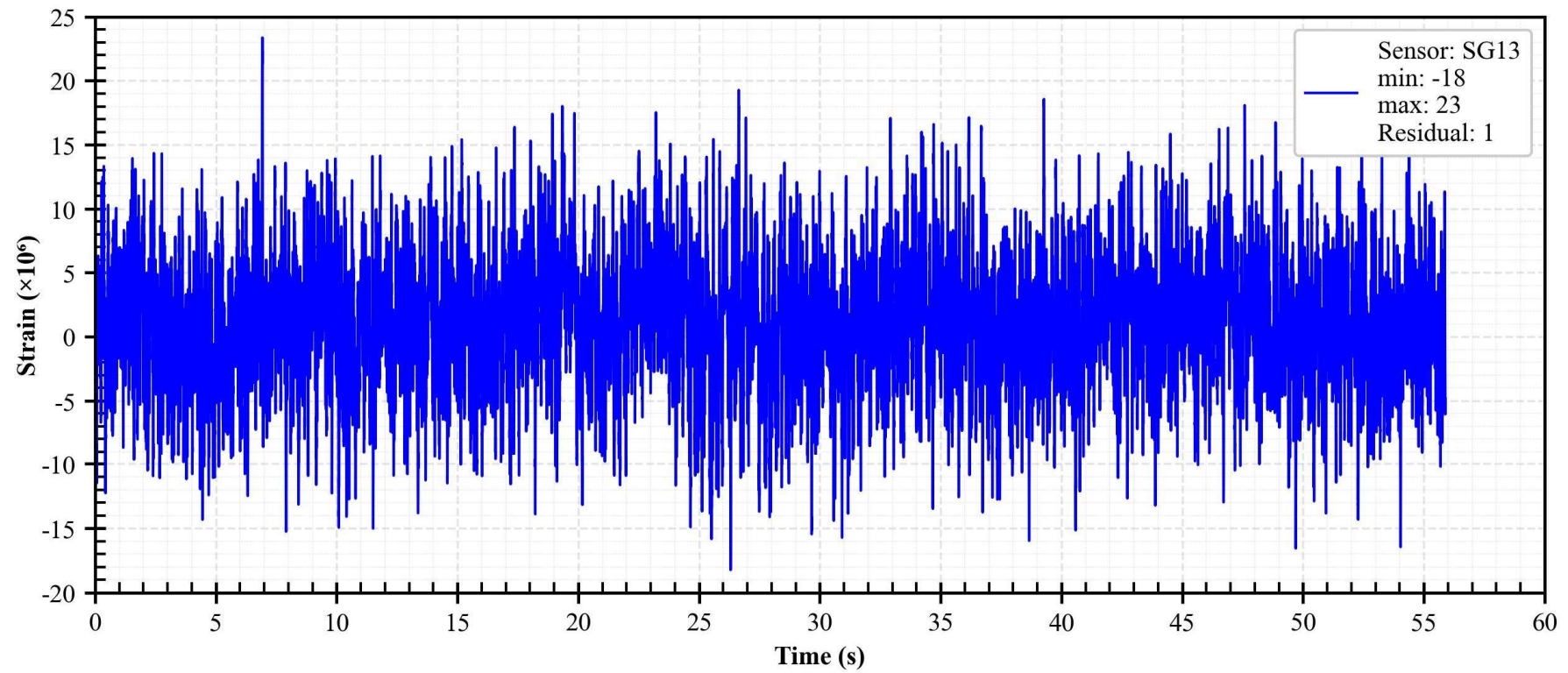


Figure 3.1.26 Characteristic results for phase B (white noise before 0.07g without): strain gauge 13

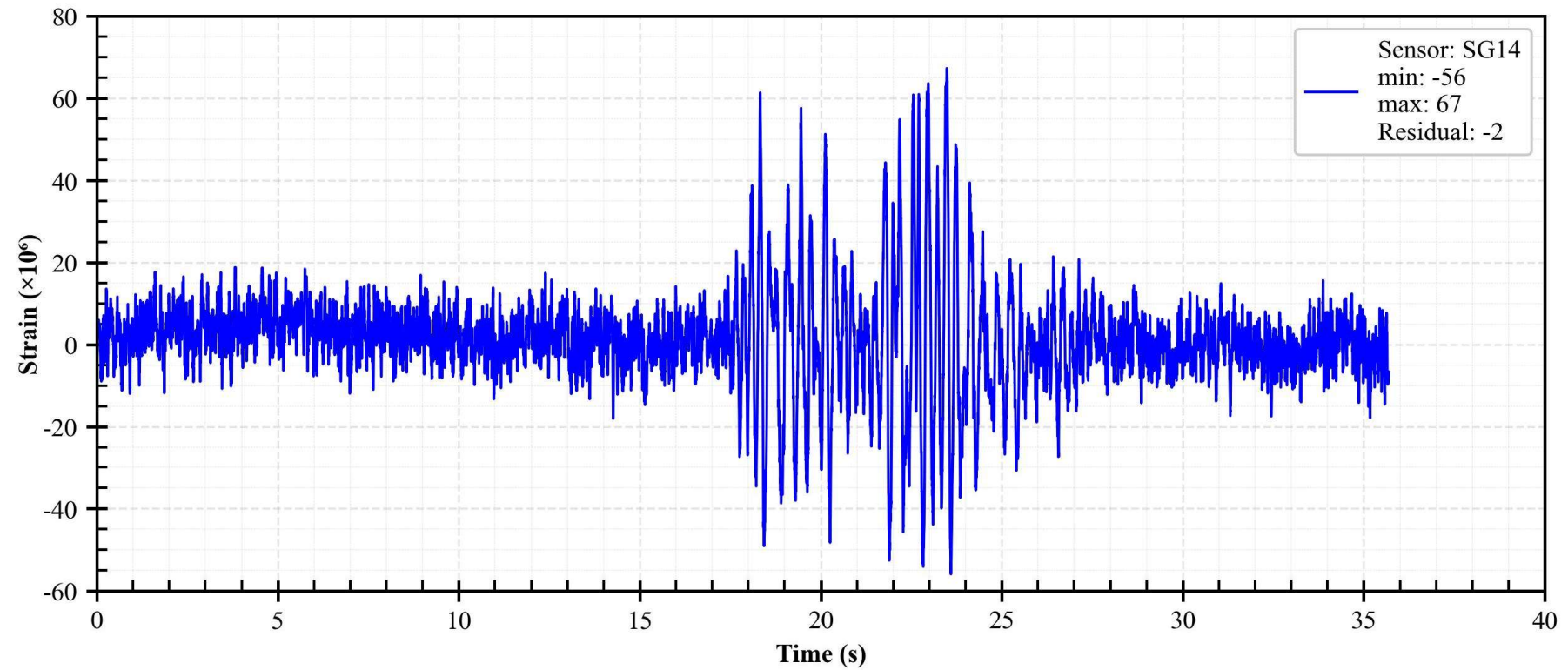


Figure 3.1.27 Characteristic results for phase B (white noise before 0.07g without): strain gauge 14

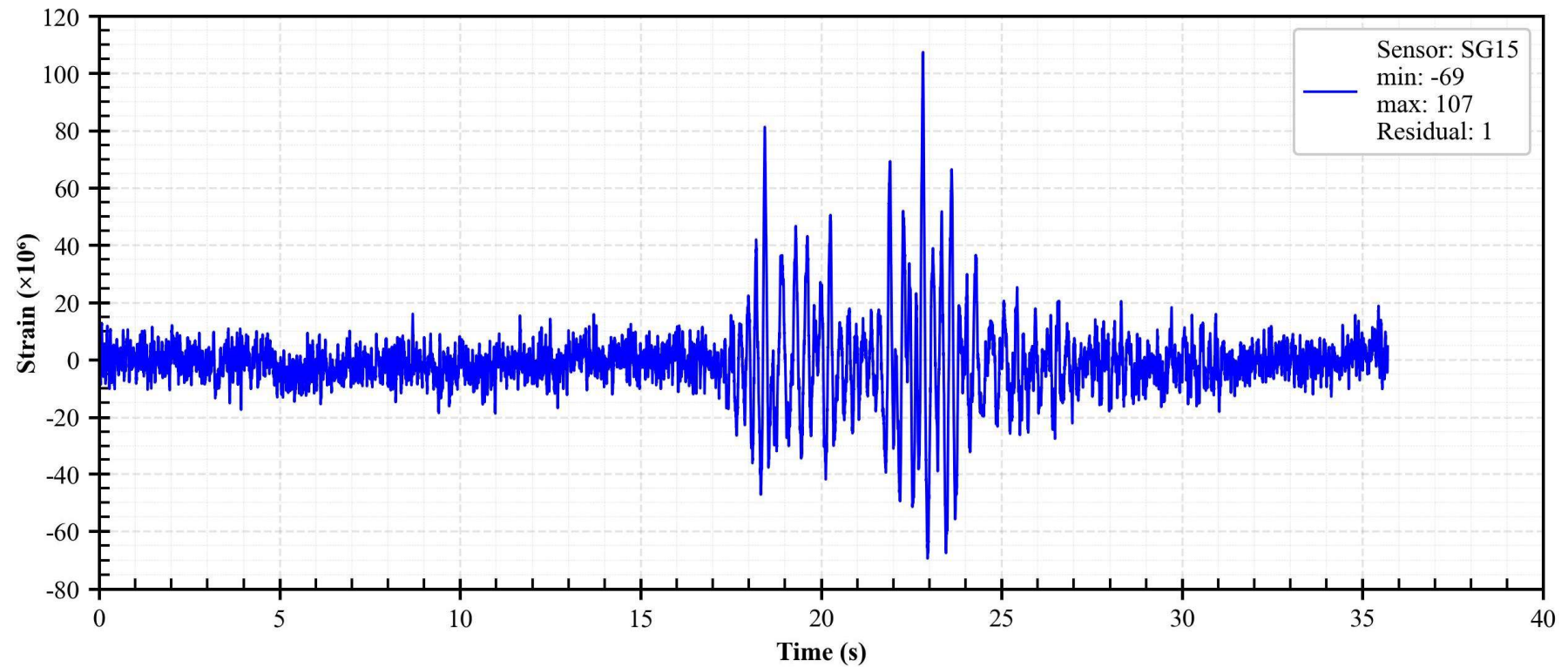


Figure 3.1.28 Characteristic results for phase B (white noise before 0.07g without): strain gauge 15

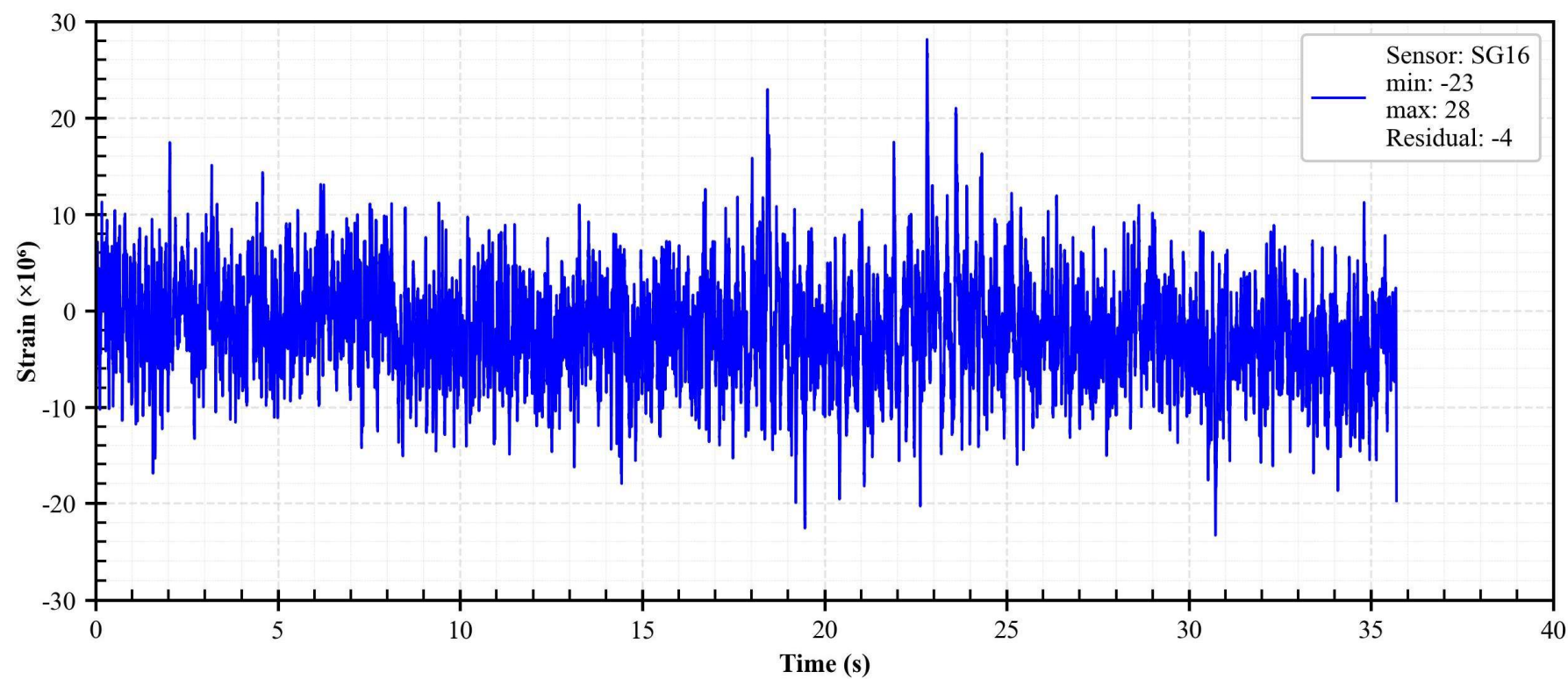


Figure 3.1.29 Characteristic results for phase B (white noise before 0.07g without): strain gauge 16

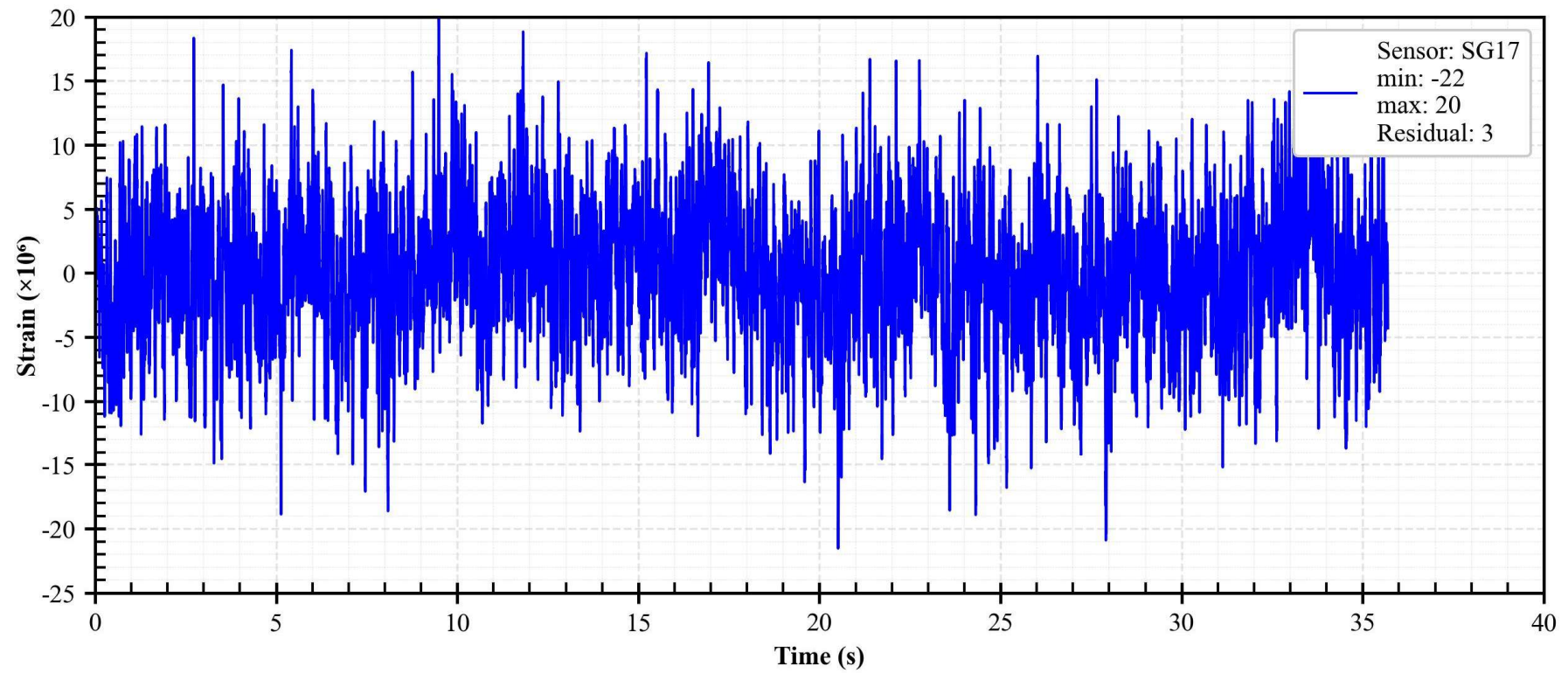


Figure 3.1.30 Characteristic results for phase B (white noise before 0.07g without): strain gauge 17

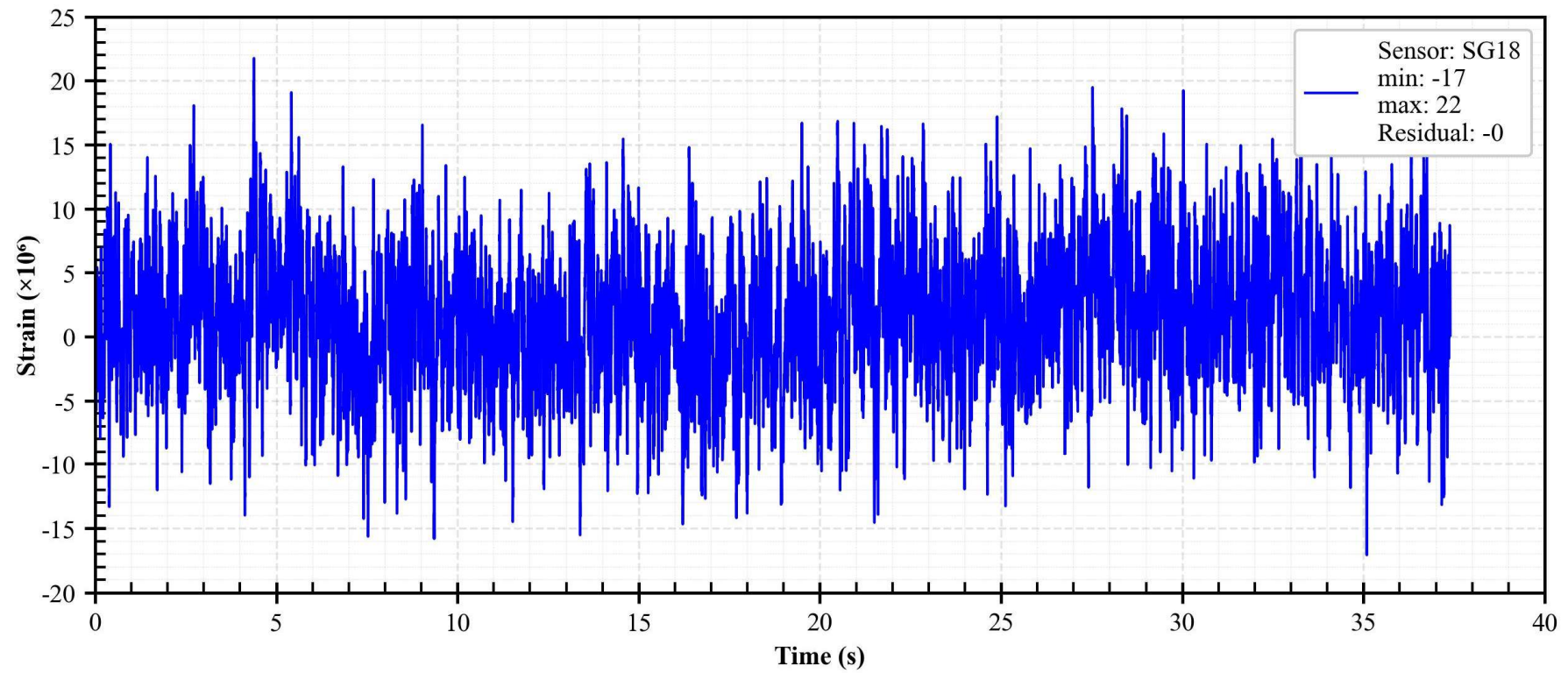


Figure 3.1.31 Characteristic results for phase B (white noise before 0.07g without): strain gauge 18

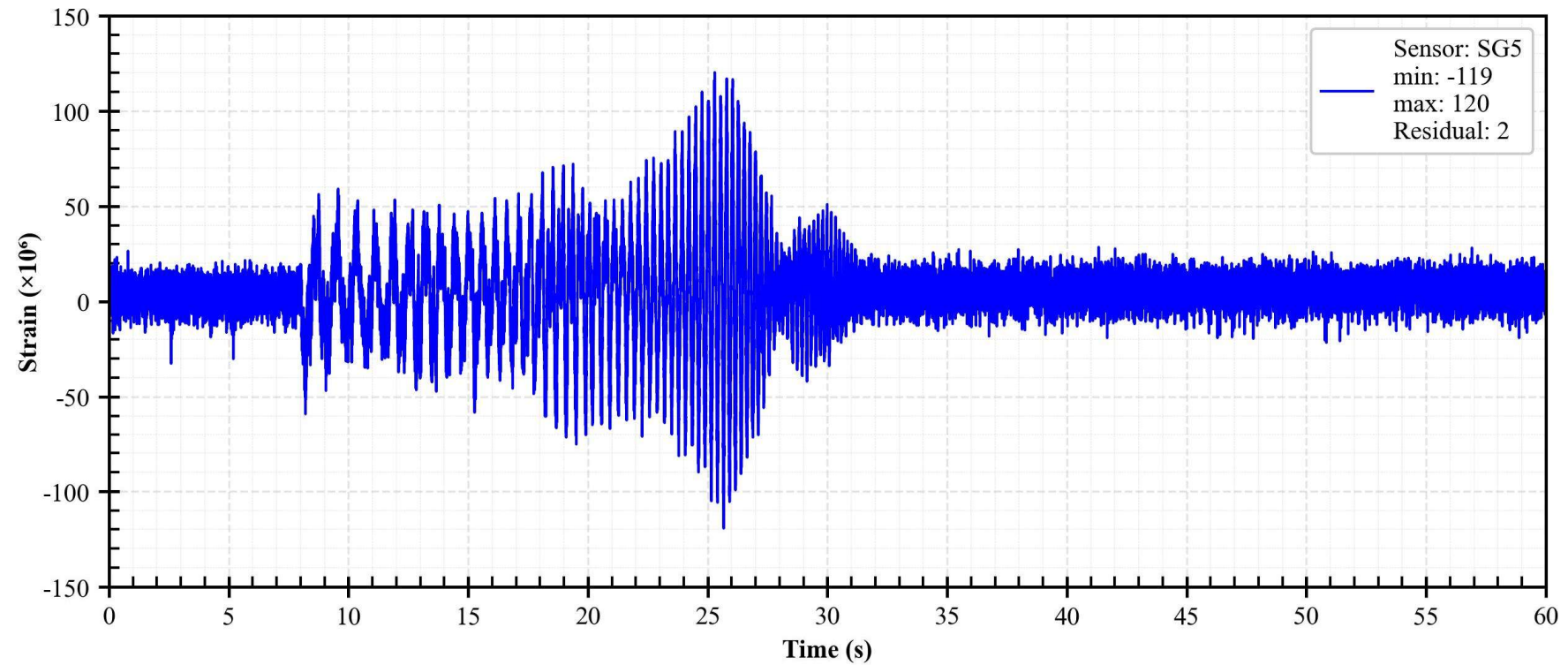


Figure 3.1.32 Characteristic results for phase B (white noise before 0.07g without): strain gauge 5

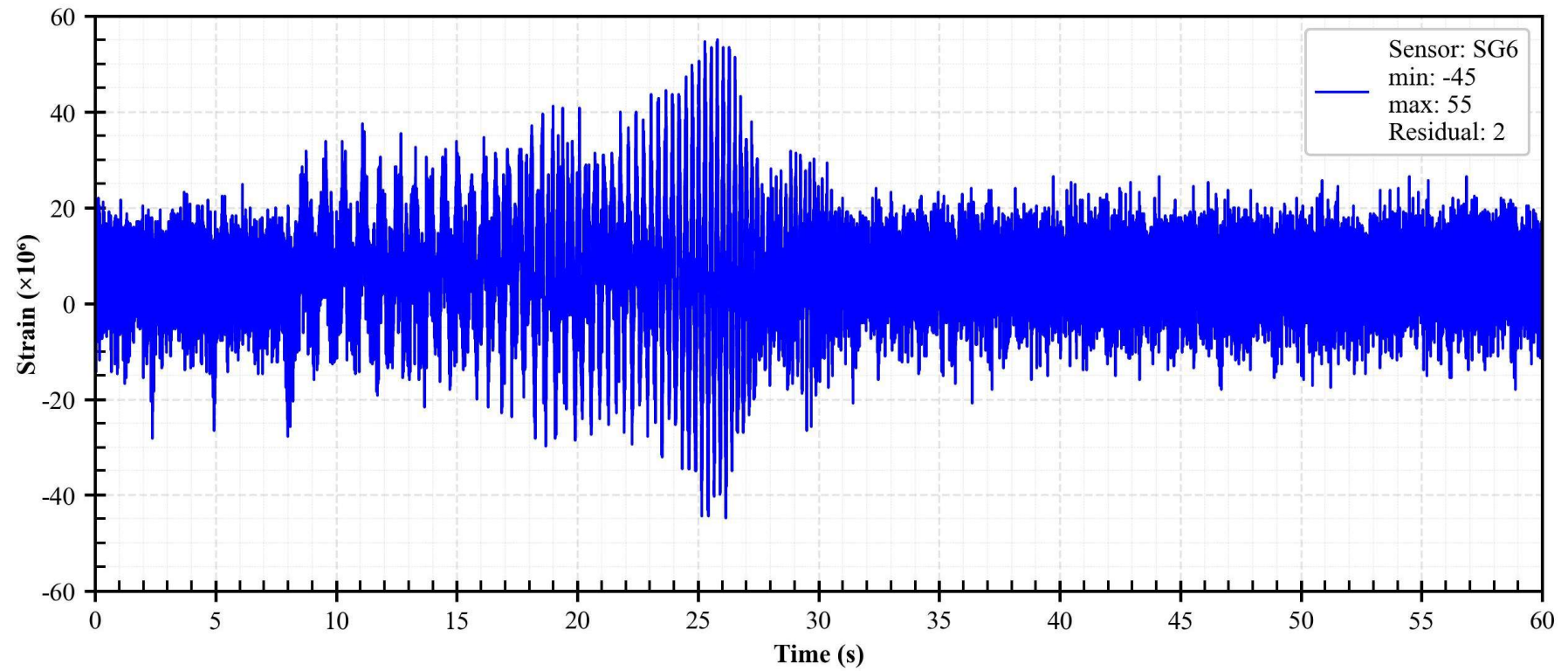


Figure 3.1.33 Characteristic results for phase B (white noise before 0.07g without): strain gauge 6

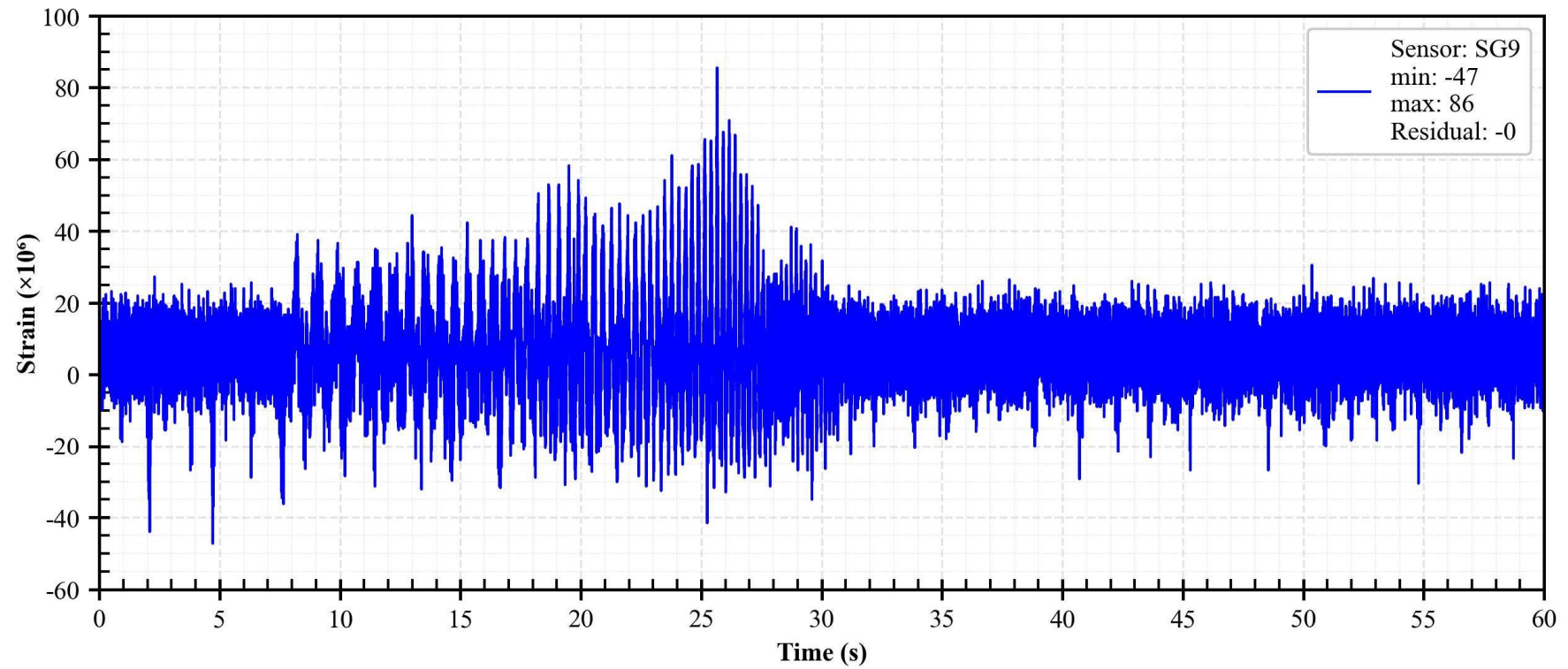
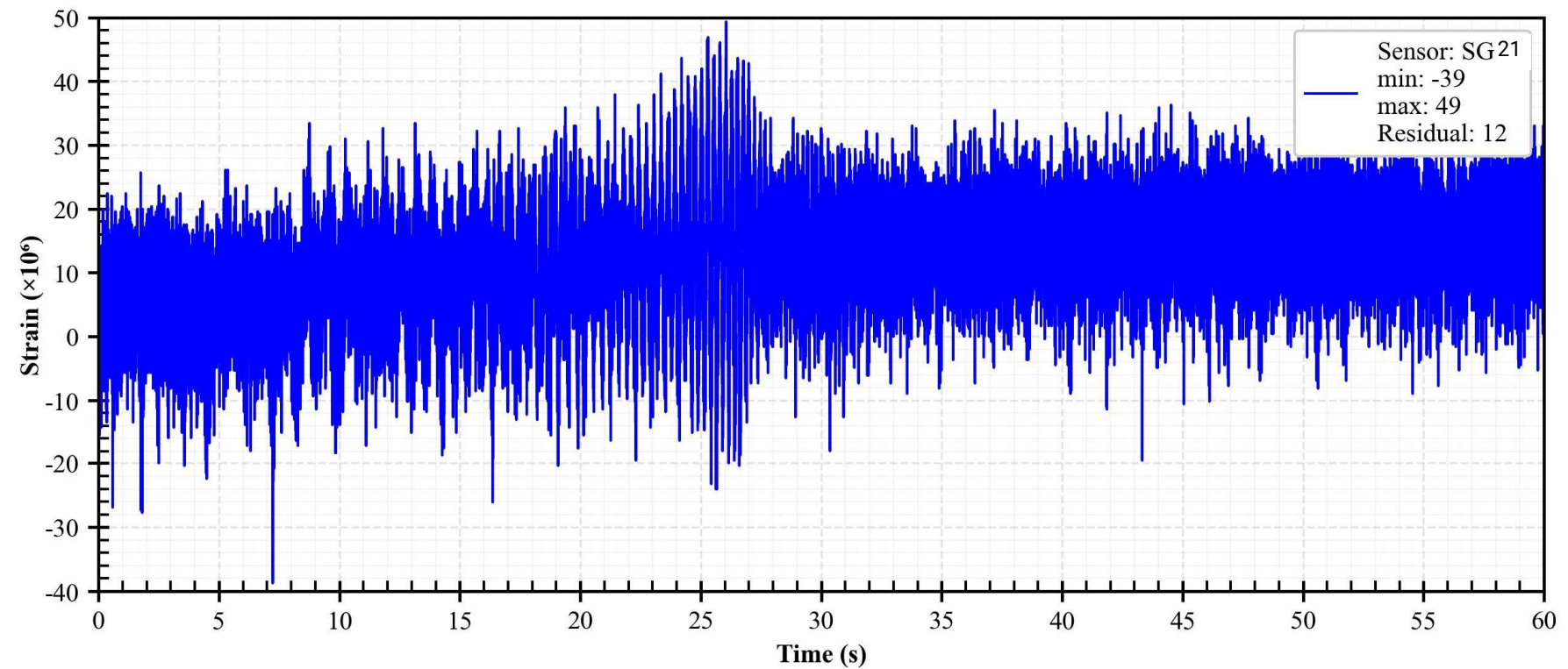


Figure 3.1.34 Characteristic results for phase B (white noise before 0.07g without): strain gauge 9



0

Figure 3.1.35 Characteristic results for phase B (white noise before 0.07g without): strain gauge 21 (PUFJ, column 1)

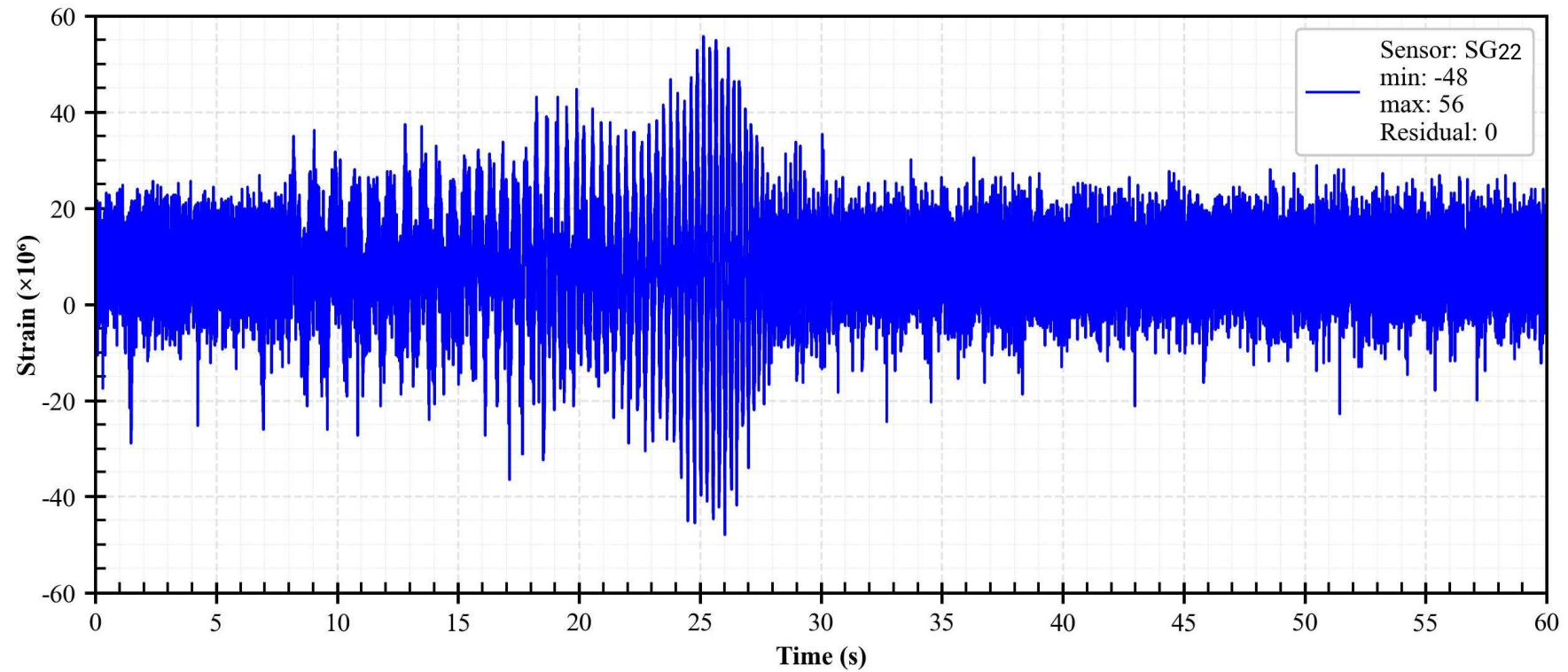


Figure 3.1.36 Characteristic results for phase B (white noise before 0.07g without): strain gauge 22 (PUFJ, column 2)

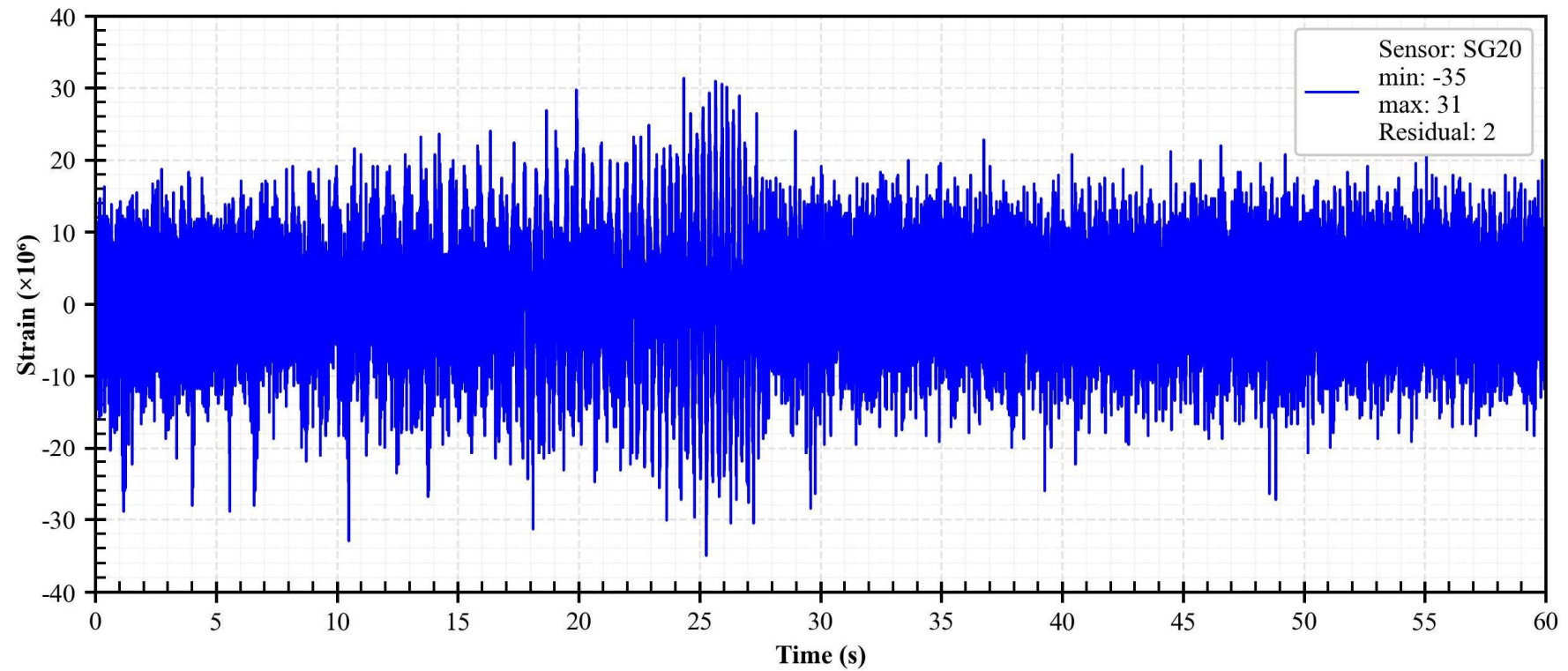


Figure 3.1.37 Characteristic results for phase B (white noise before 0.07g without): strain gauge 20

3.2 White noise before EQ0,07g

Recordings for vertical living walls with bottom fixing. The same is valid for all subsequent excitations.

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,07g. The max acceleration at the slab level on the accelerometer acc4 is 0,11g. The max acceleration at the foundation level on the accelerometer acc10 is 0,04g.

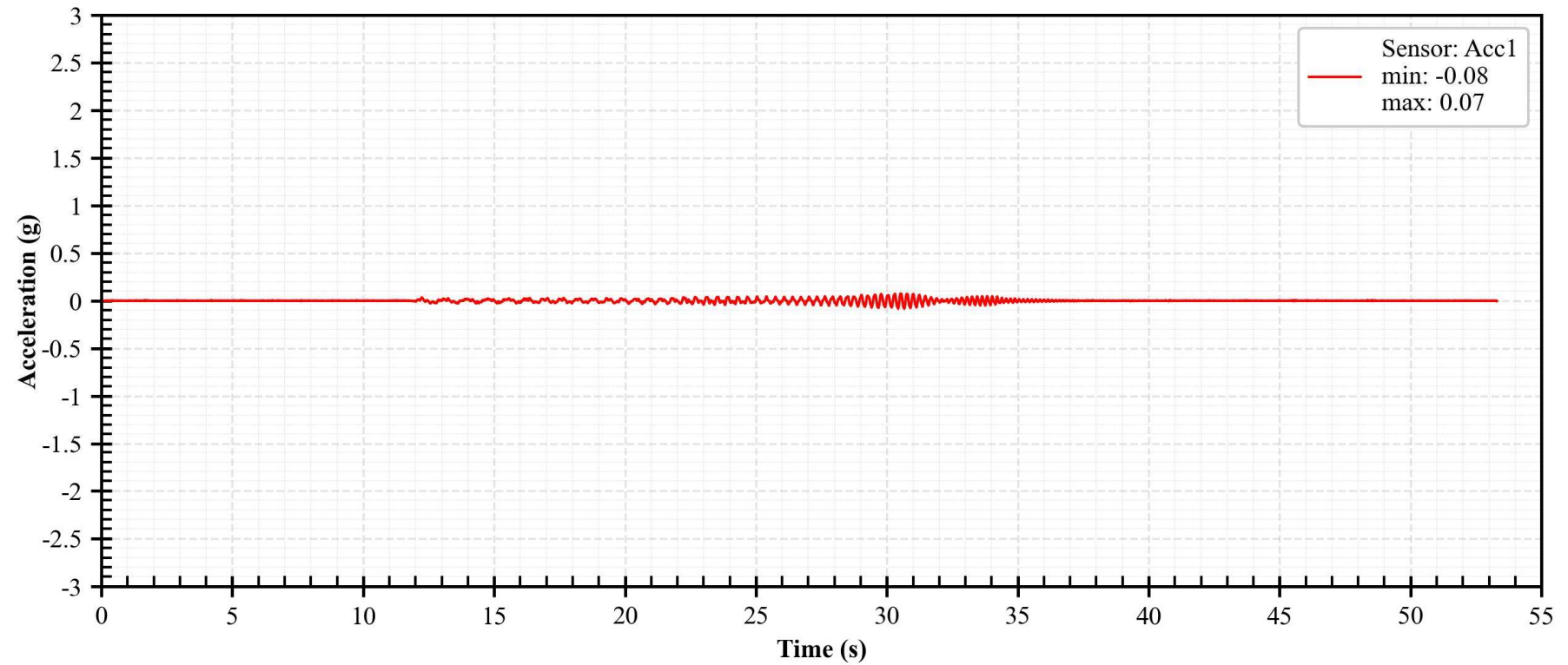


Figure 3.2.1 Characteristic results for phase B (white noise before 0,07g) Accelerometer 1

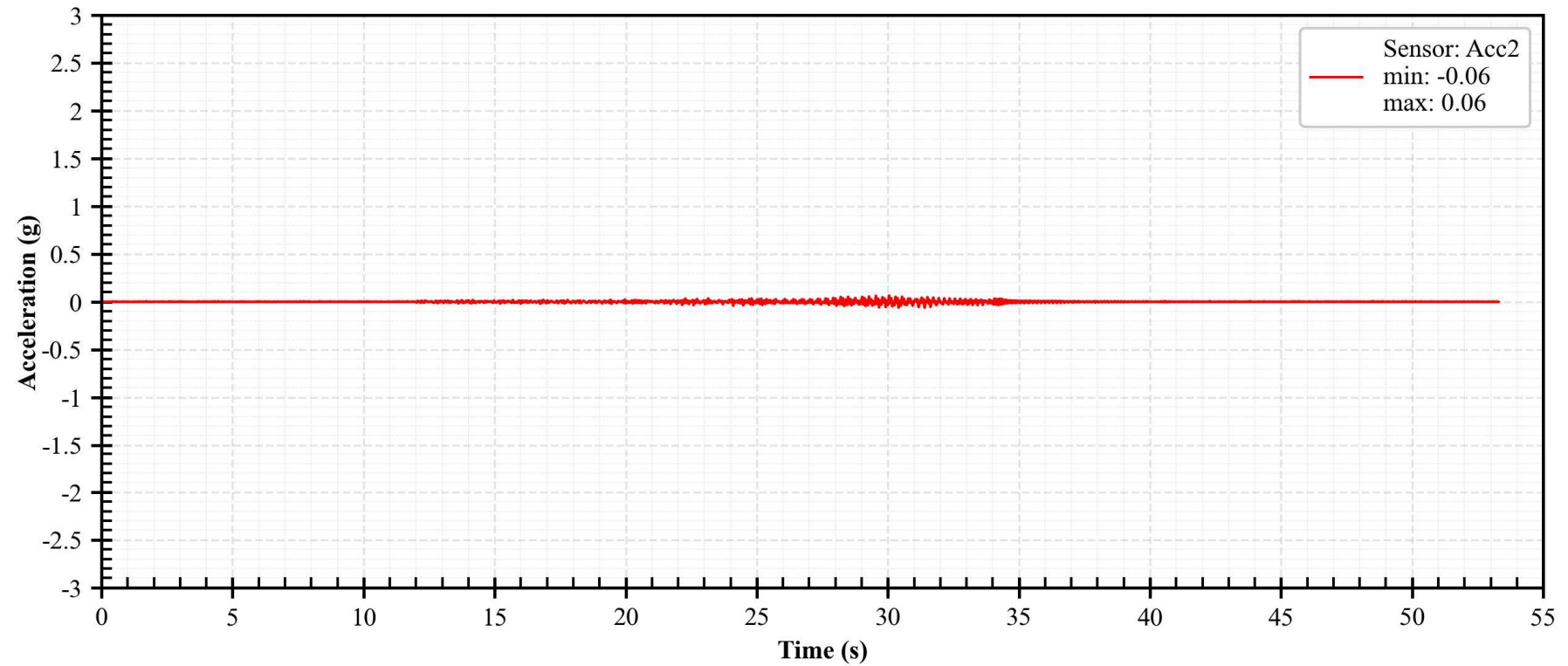


Figure 3.2.2 Characteristic results for phase B (white noise before 0,07g): Accelerometer 2

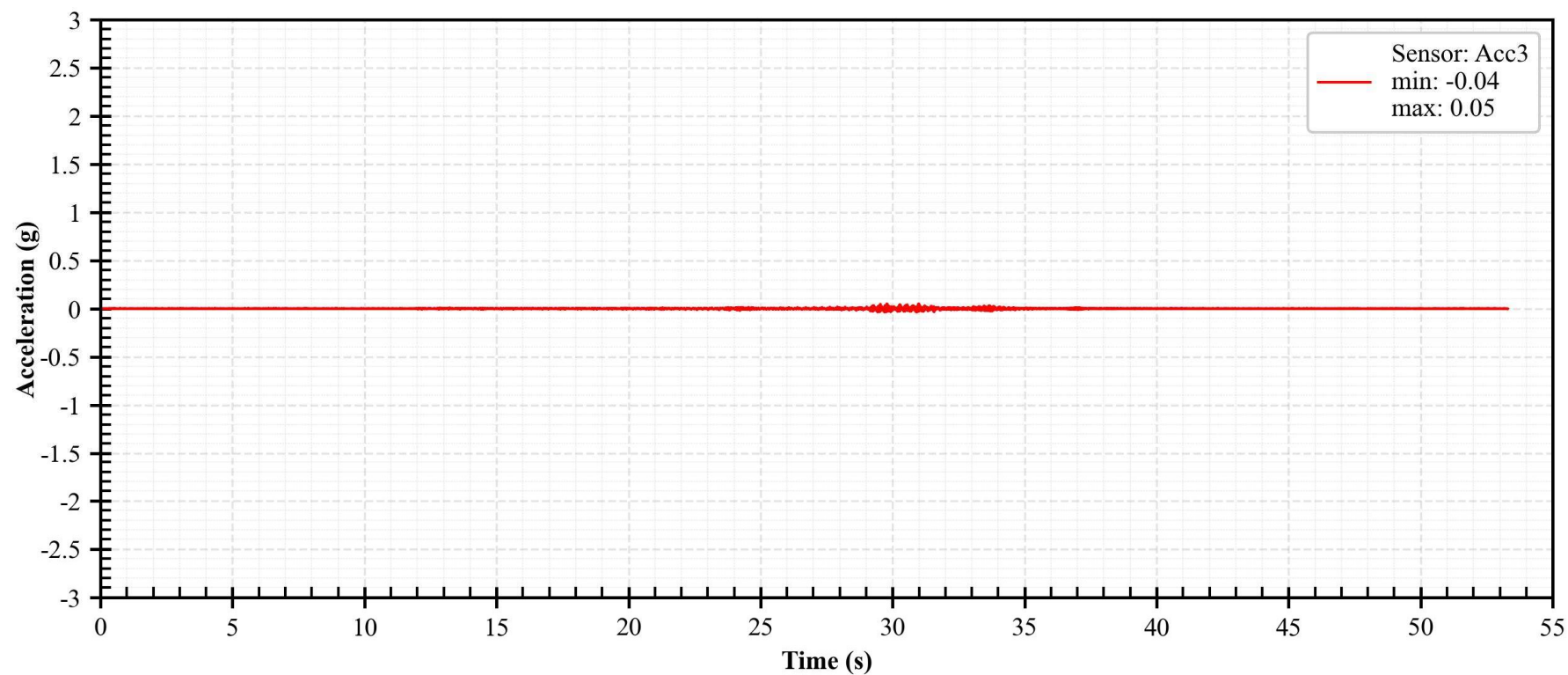


Figure 3.2.3 Characteristic results for phase B (white noise before 0,07g): Accelerometer 3

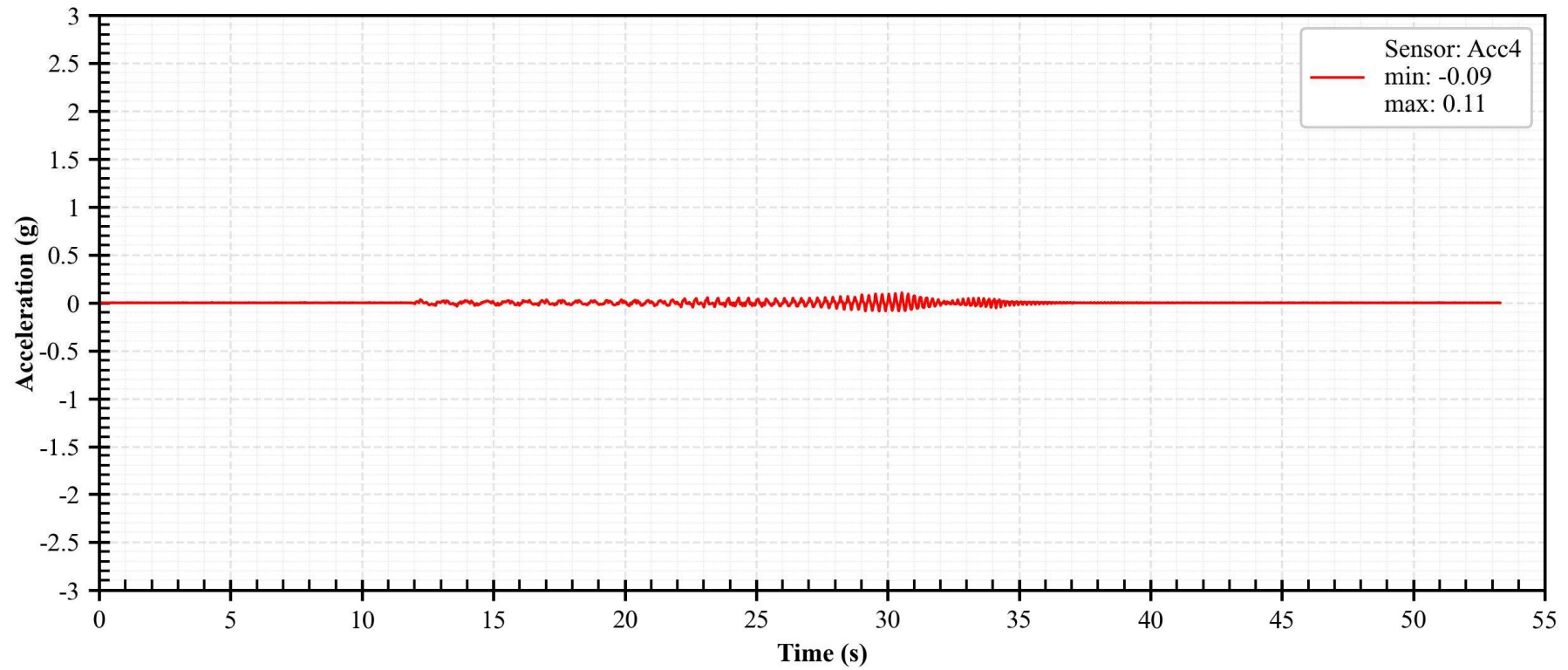


Figure 3.2.4 Characteristic results for phase B (white noise before 0,07g): Accelerometer 4

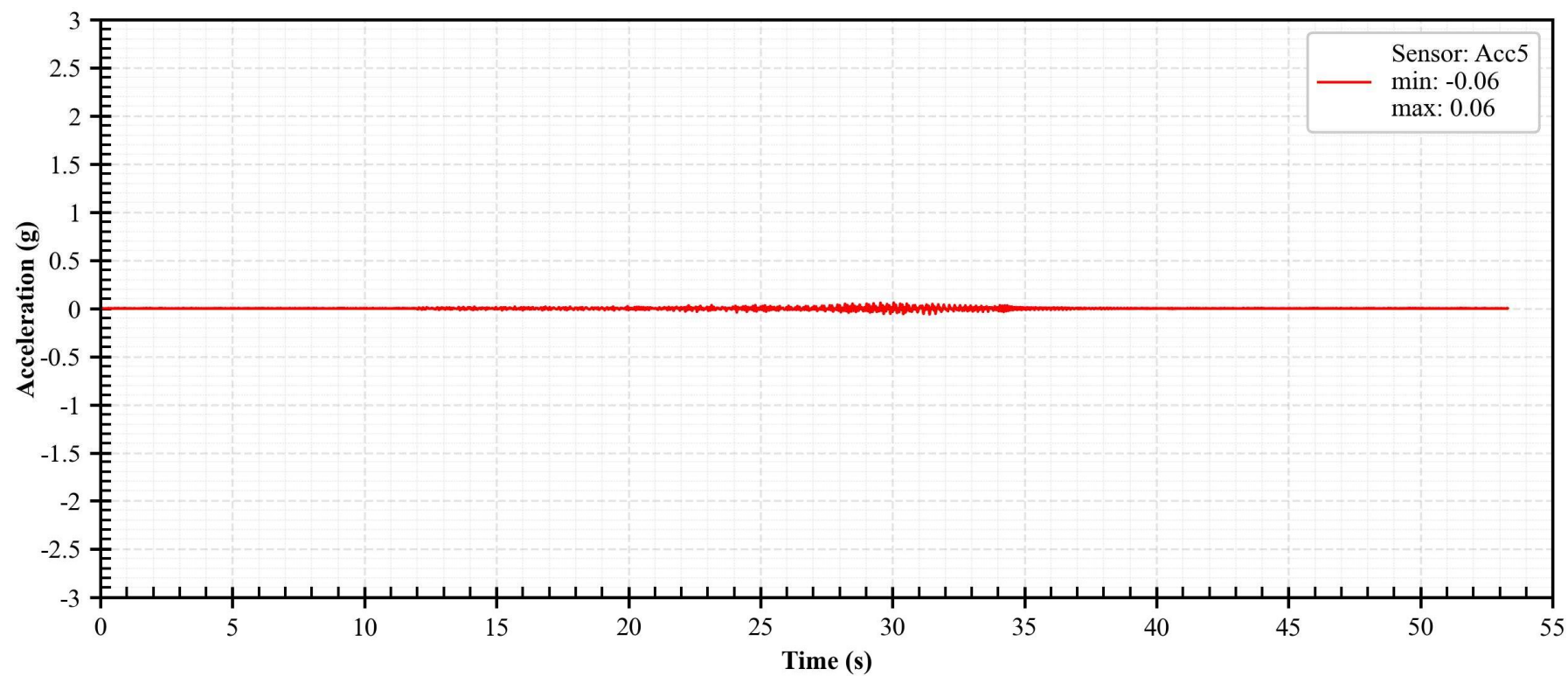


Figure 3,2.5 Characteristic results for phase B (white noise before 0,07g): Accelerometer 5

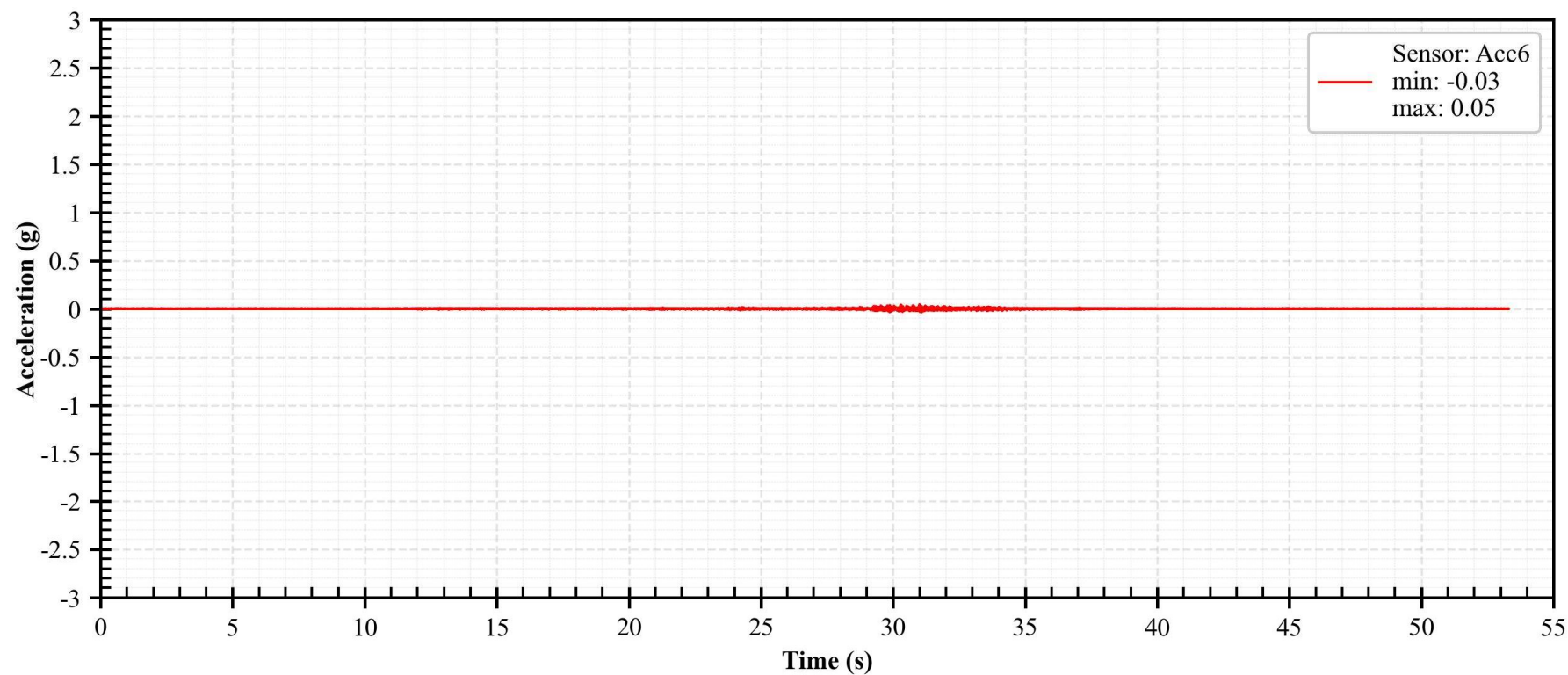


Figure 3.2.6 Characteristic results for phase B (white noise before 0,07g): Accelerometer 6

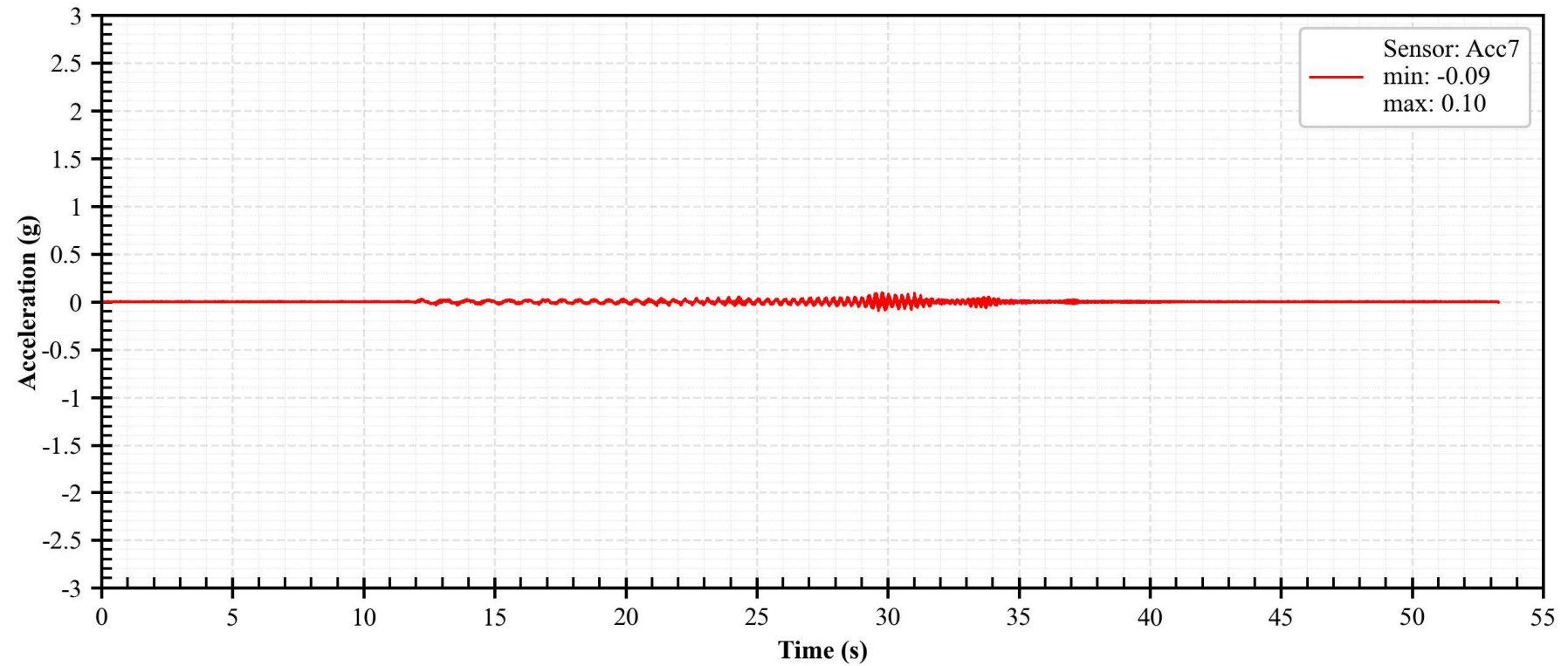


Figure 3.2.7 Characteristic results for phase B (white noise before 0,07g): Accelerometer 7

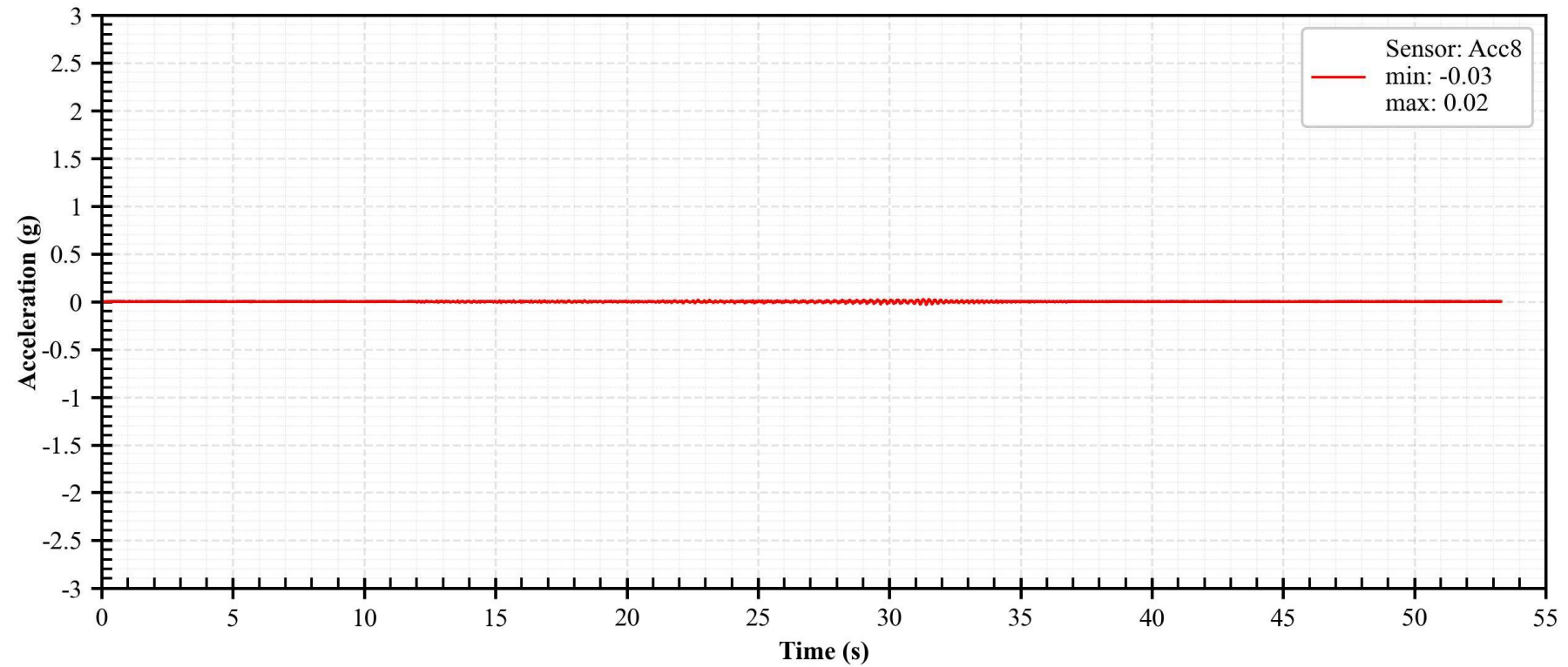


Figure 3.2.8 Characteristic results for phase B (white noise before 0,07g): Accelerometer 8

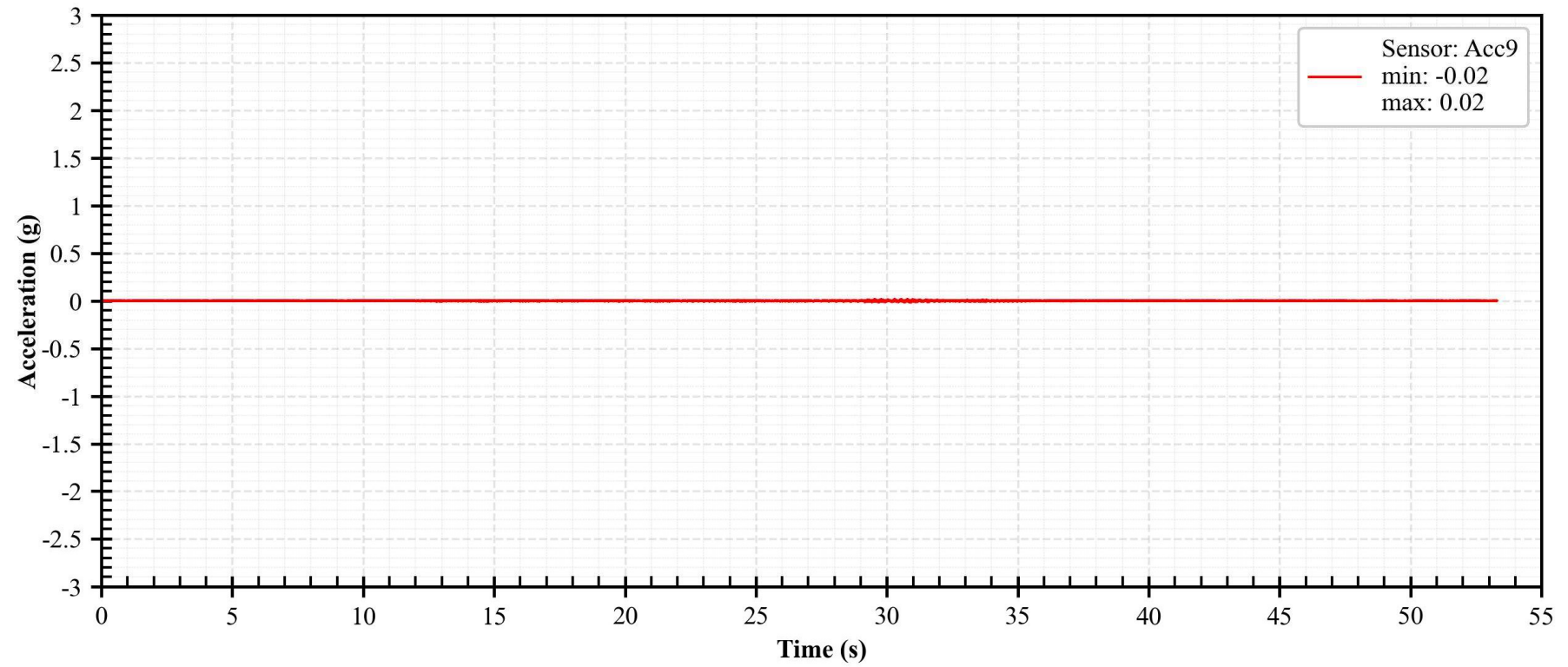


Figure 3.2.9 Characteristic results for phase B (white noise before 0,07g): Accelerometer 9

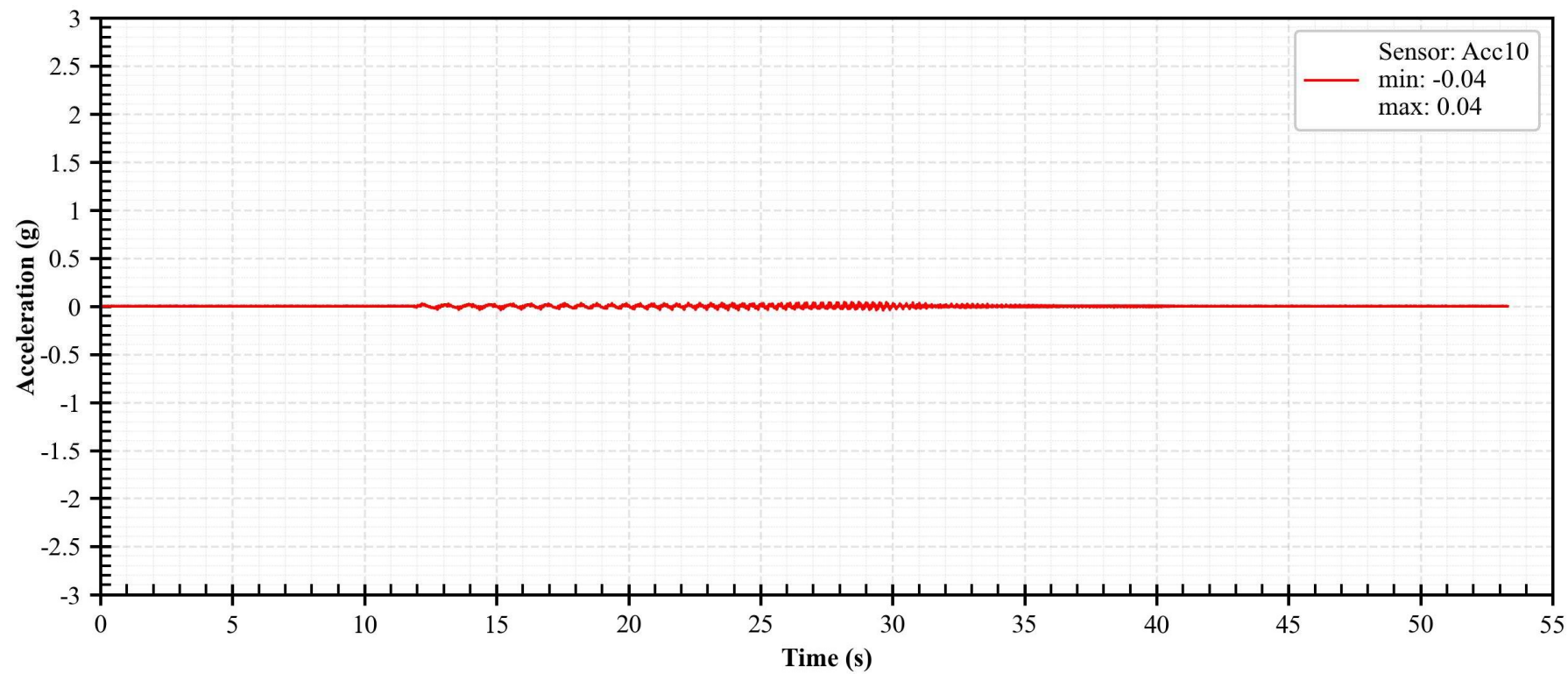


Figure 3.2.10 Characteristic results for phase B (white noise before 0,07g): Accelerometer 10

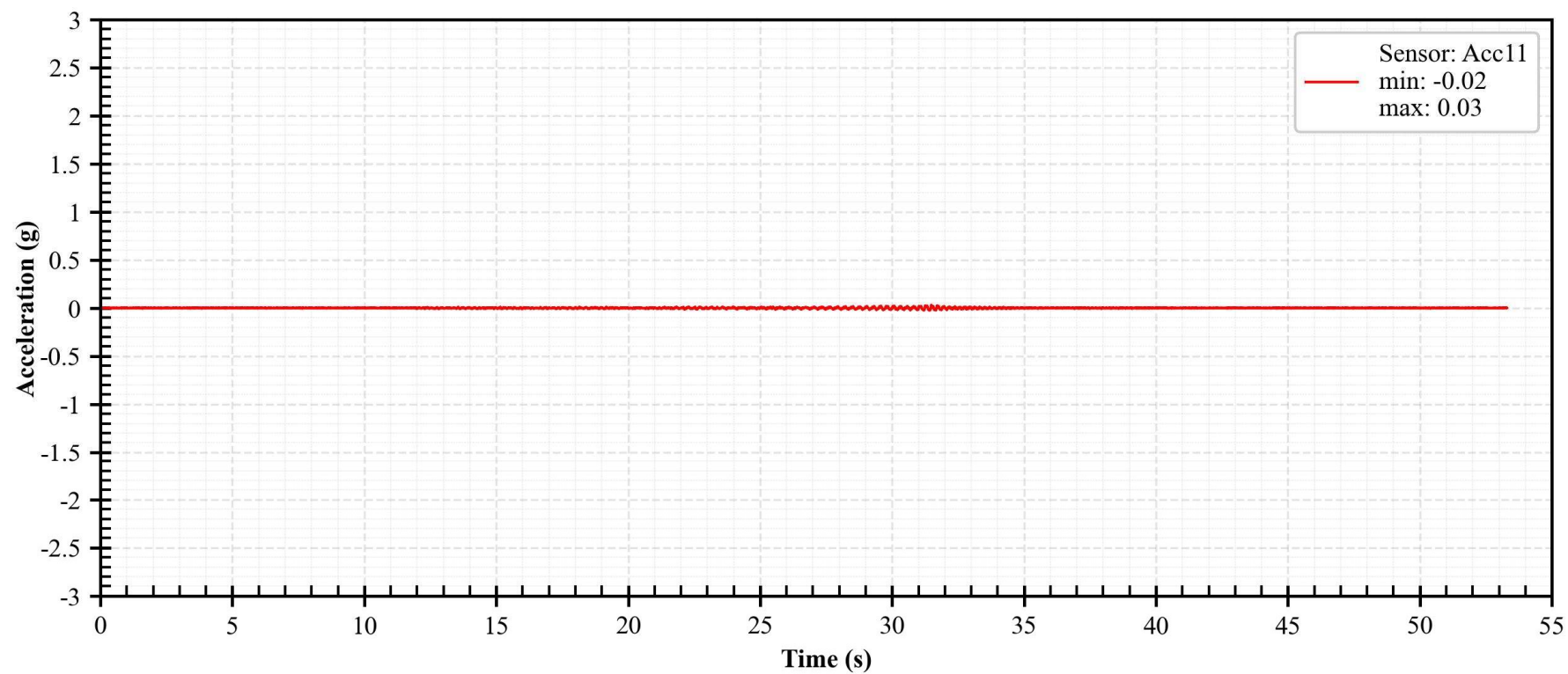


Figure3.2.11 Characteristic results for phase B (white noise before 0,07g): Accelerometer 11

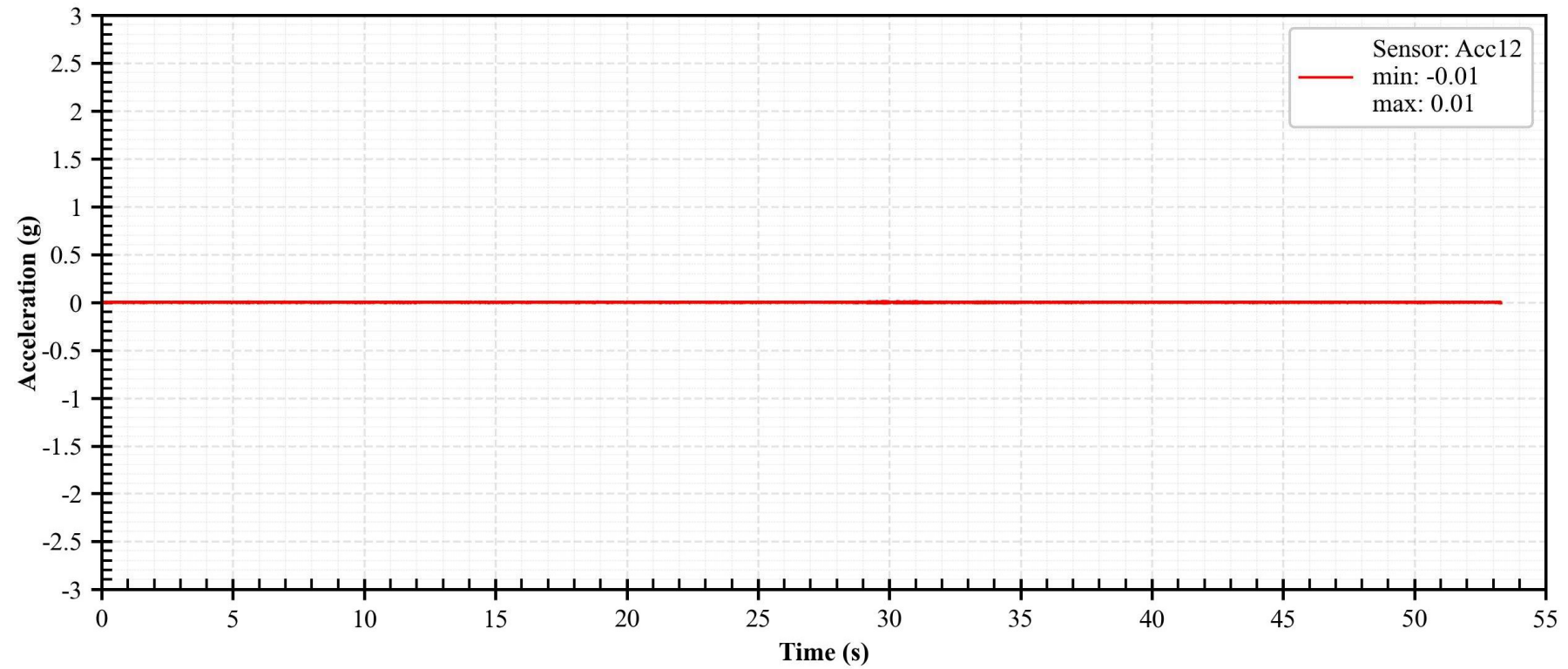


Figure 3.2.12 Characteristic results for phase B (white noise before 0,07g): Accelerometer 12

Draw wire sensors

Figures 3.2.13 – 3.2.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 13.53 mm while the minimum is -10.65 mm. The maximum movement detected by draw wire sensor W2 is 13.76 mm while the minimum is -10.59 mm. The maximum movement detected by draw wire sensor W3 is 13.58 mm while the minimum is -10.55 mm. The maximum movement detected by draw wire sensor W4 is 13.95 mm while the minimum is -10.64 mm. The maximum drift is $(0.80/1.225) = 0.65 \text{ ‰}$ and minimum drift is $(-0.84/1.225) = -0.69 \text{ ‰}$.

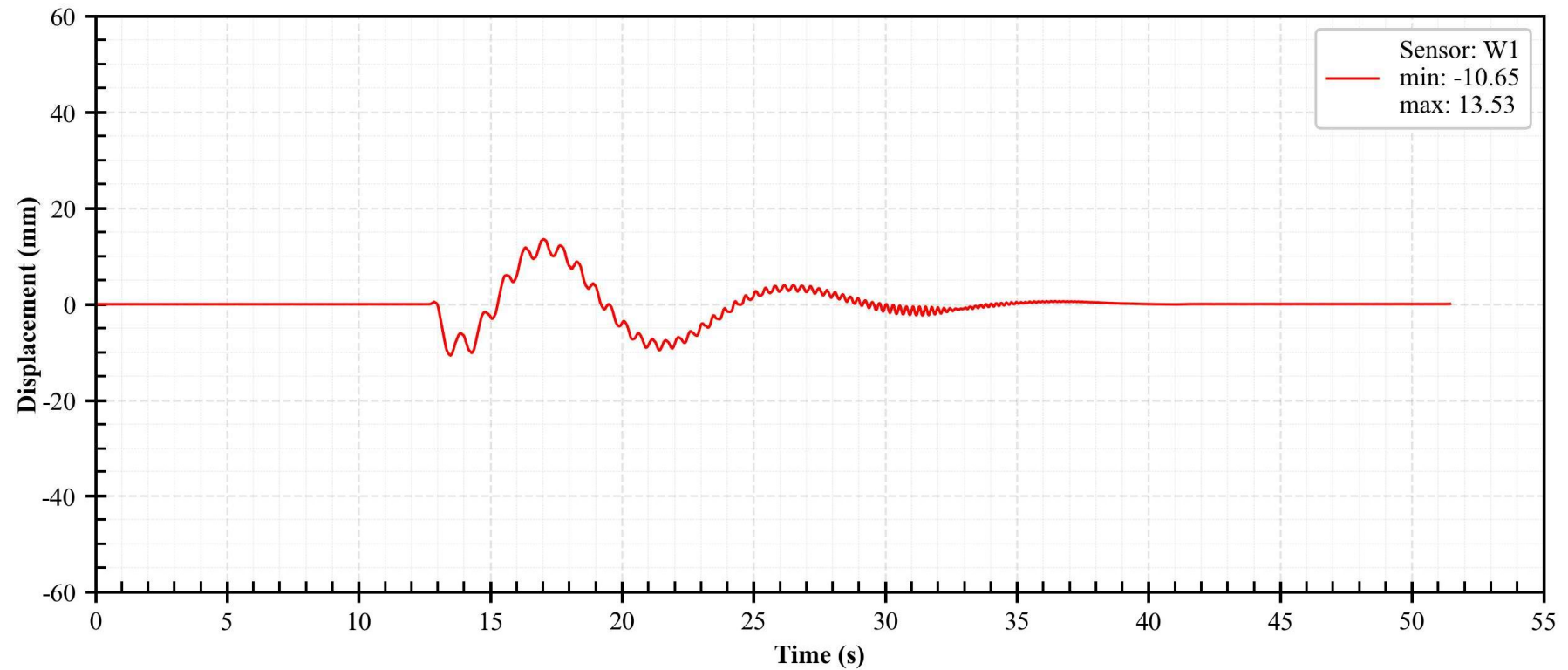


Figure 3.2.13 Characteristic results for phase B (white noise before 0,07g): Draw wire sensor 1

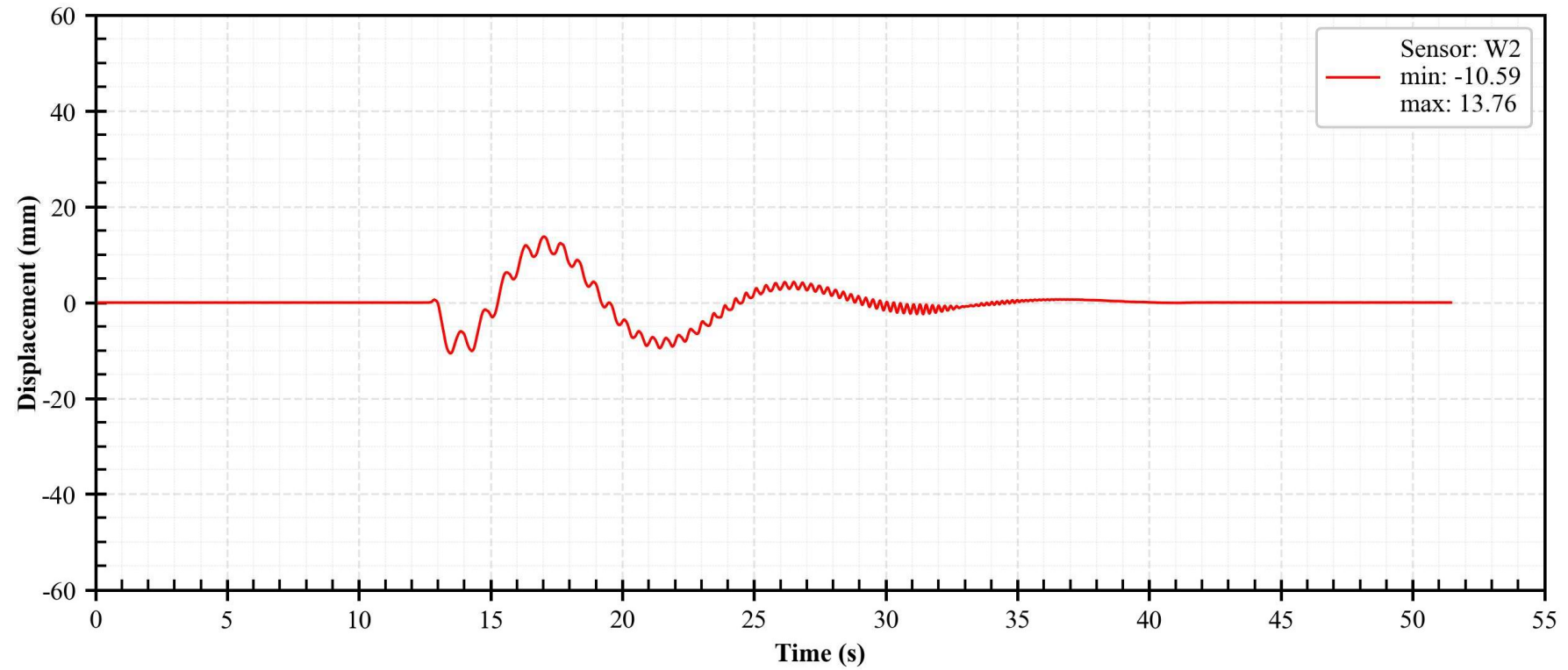


Figure 3.2.14 Characteristic results for phase B (white noise before 0,07g): Draw wire sensor 2

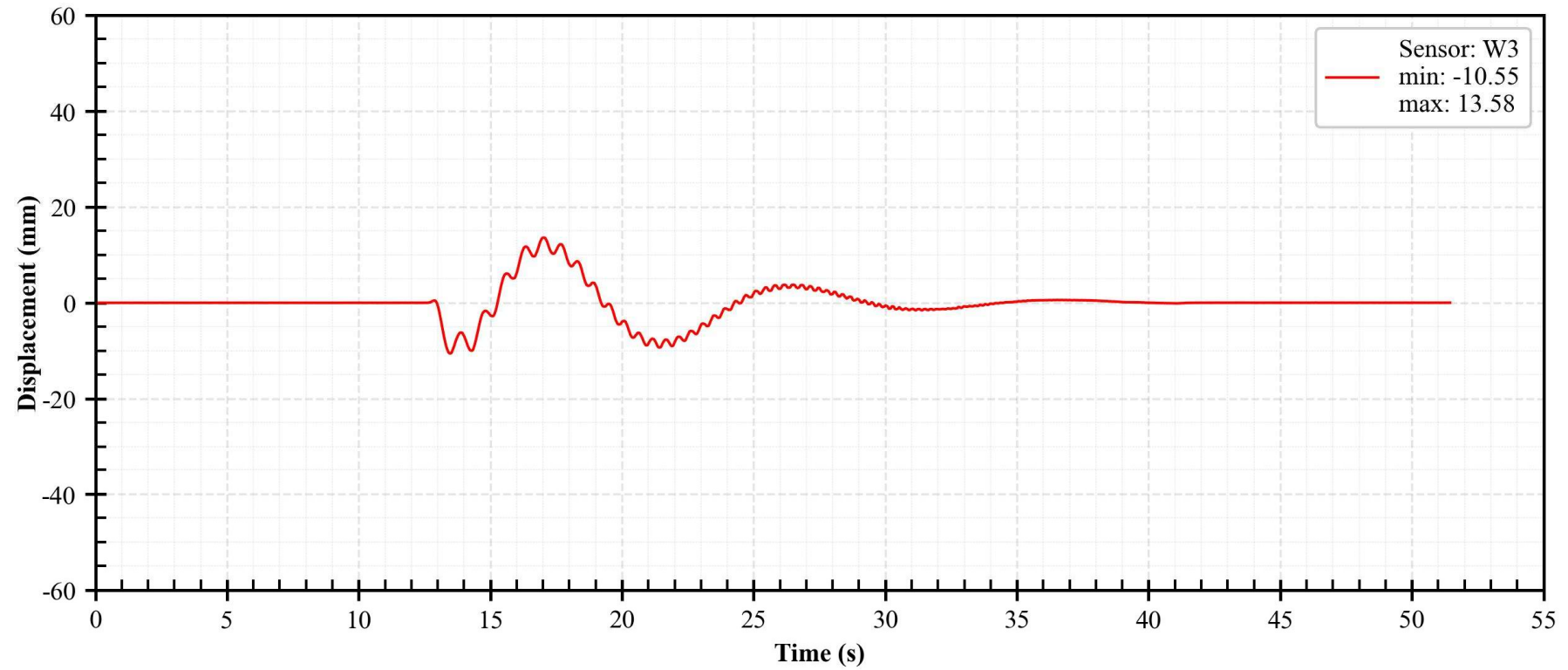


Figure 3.2.15 Characteristic results for phase B (white noise before 0,07g): Draw wire sensor 3

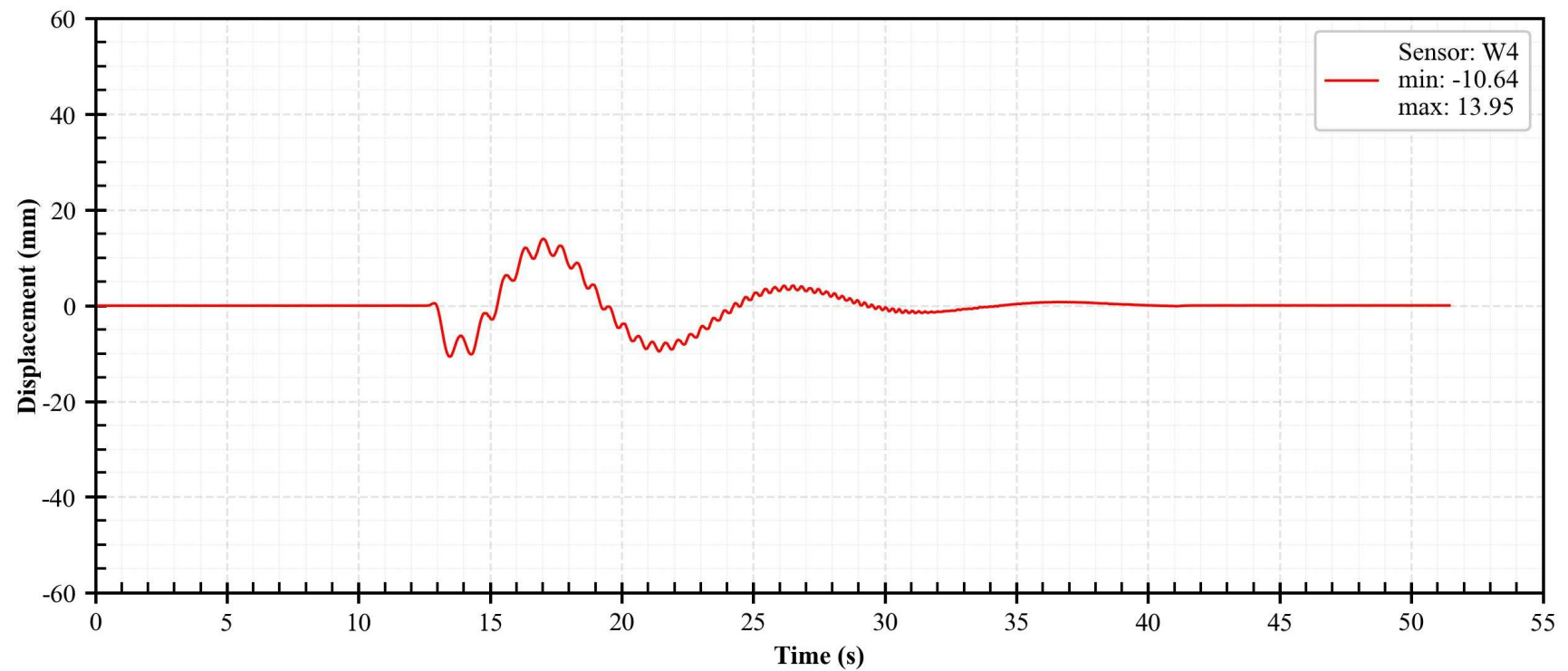


Figure 3.2.16 Characteristic results for phase B (white noise before 0,07g): Draw wire sensor 4

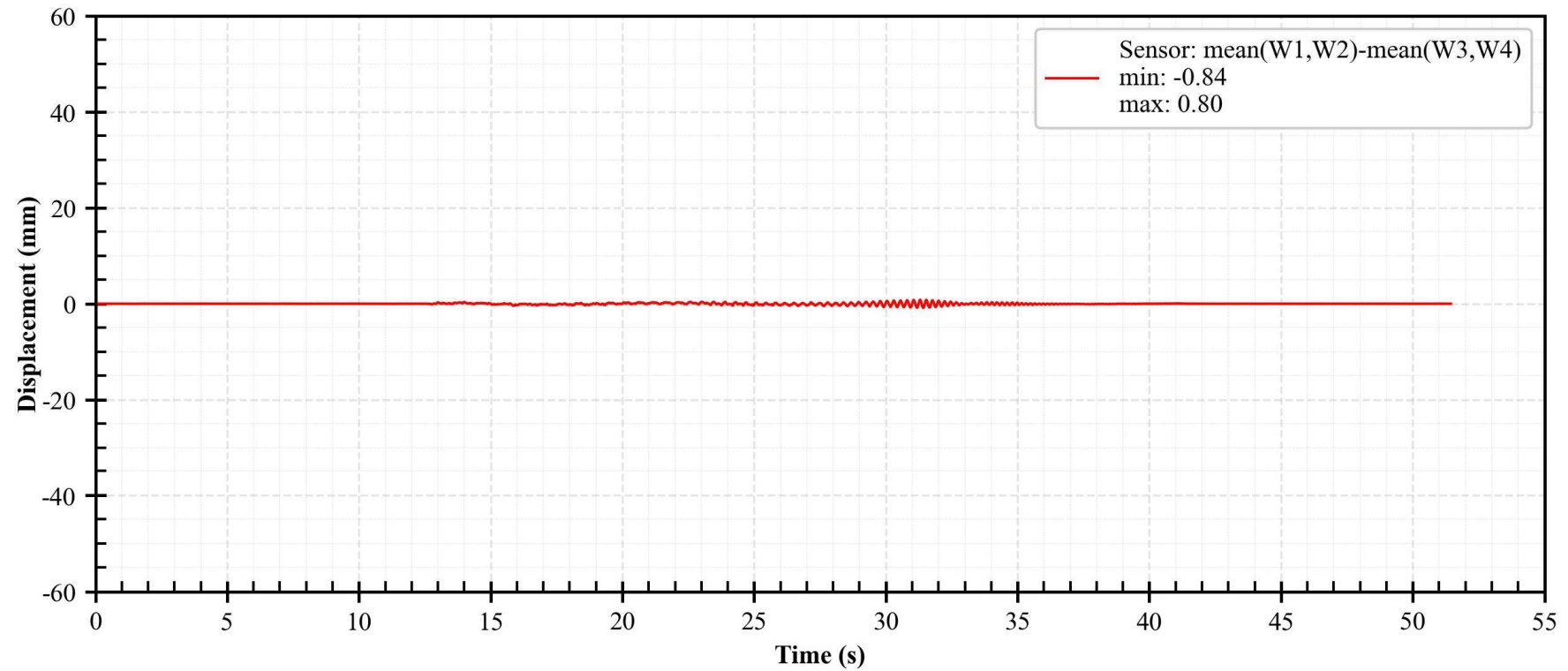


Figure 3.2.17 Characteristic results for phase B (white noise before 0,07g): mean (W1,W2) - mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

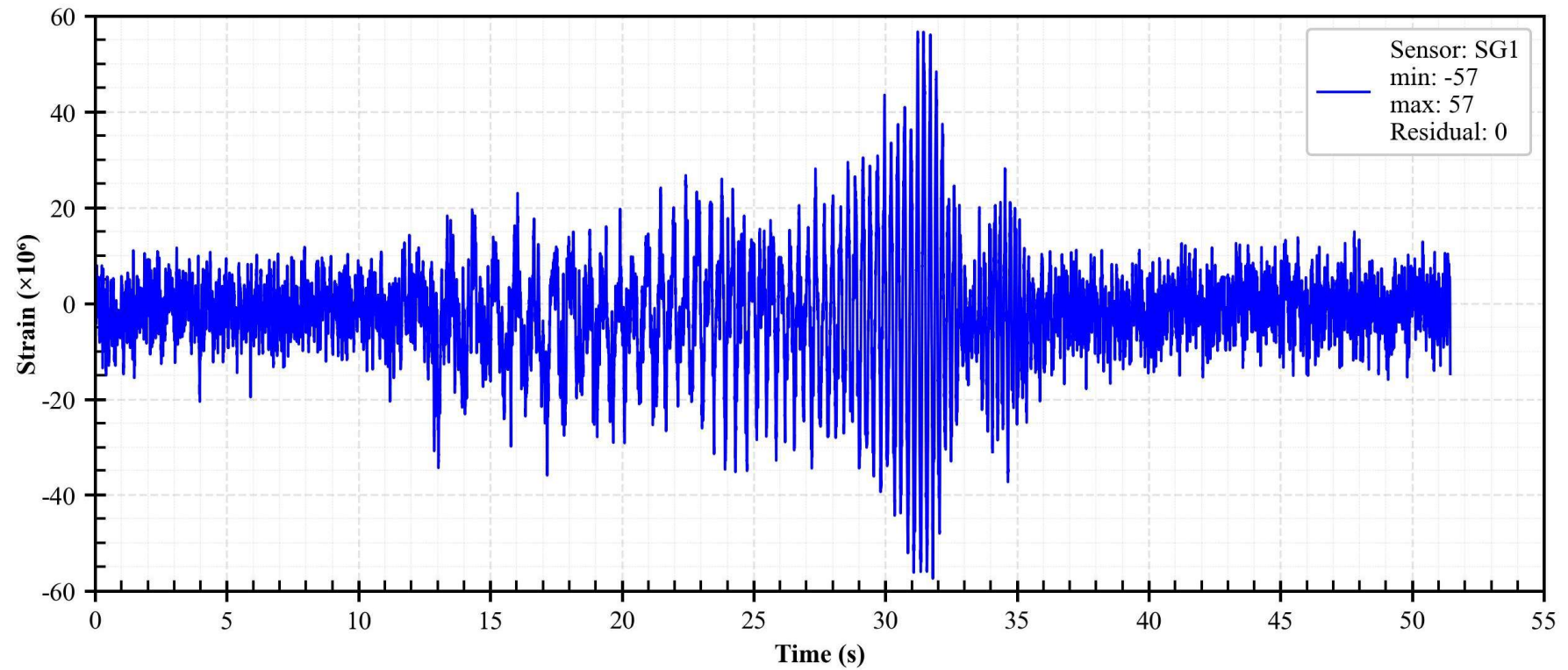


Figure 3.2.18 Characteristic results for phase B (white noise before 0,07g): strain gauge 1

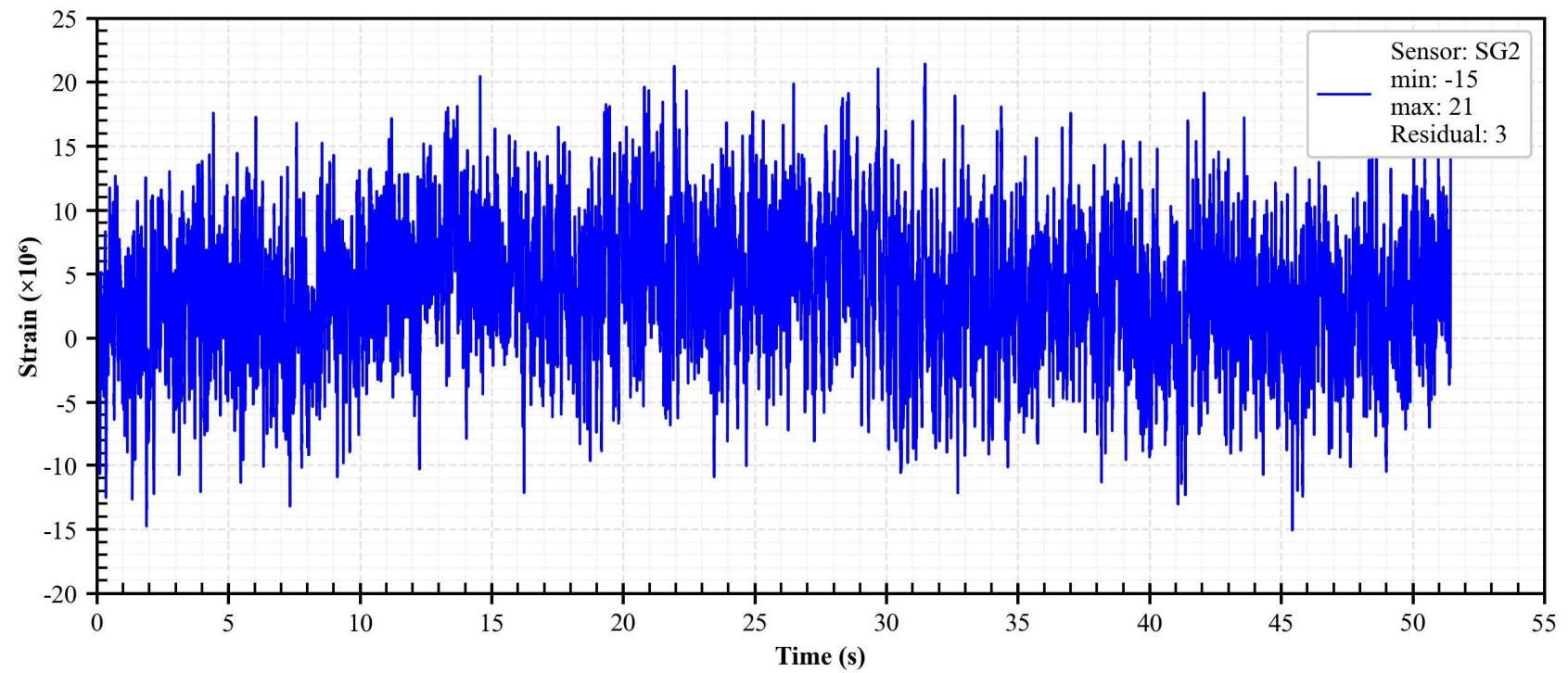


Figure 3.2.19 Characteristic results for phase B (white noise before 0,07g): strain gauge 2

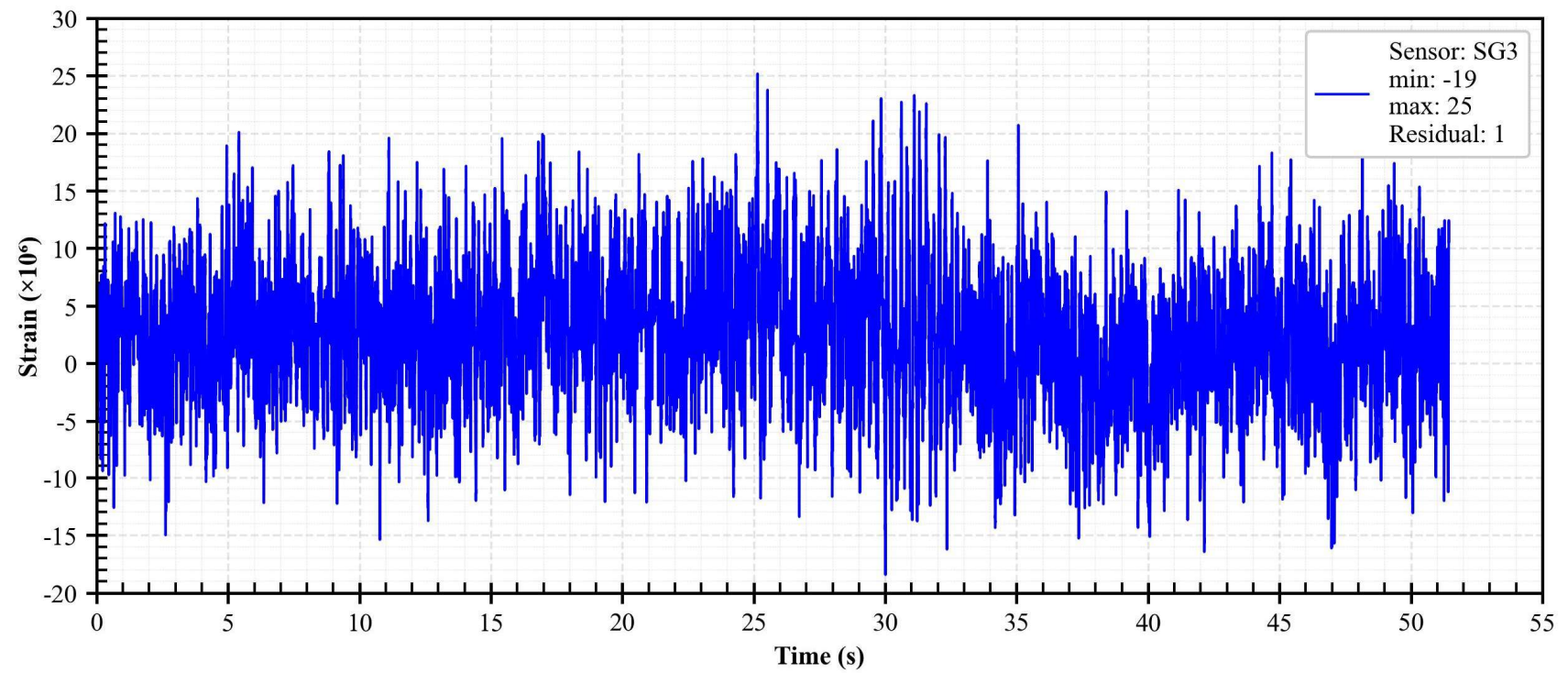


Figure 3.2.20 Characteristic results for phase B (white noise before 0,07g): strain gauge 3

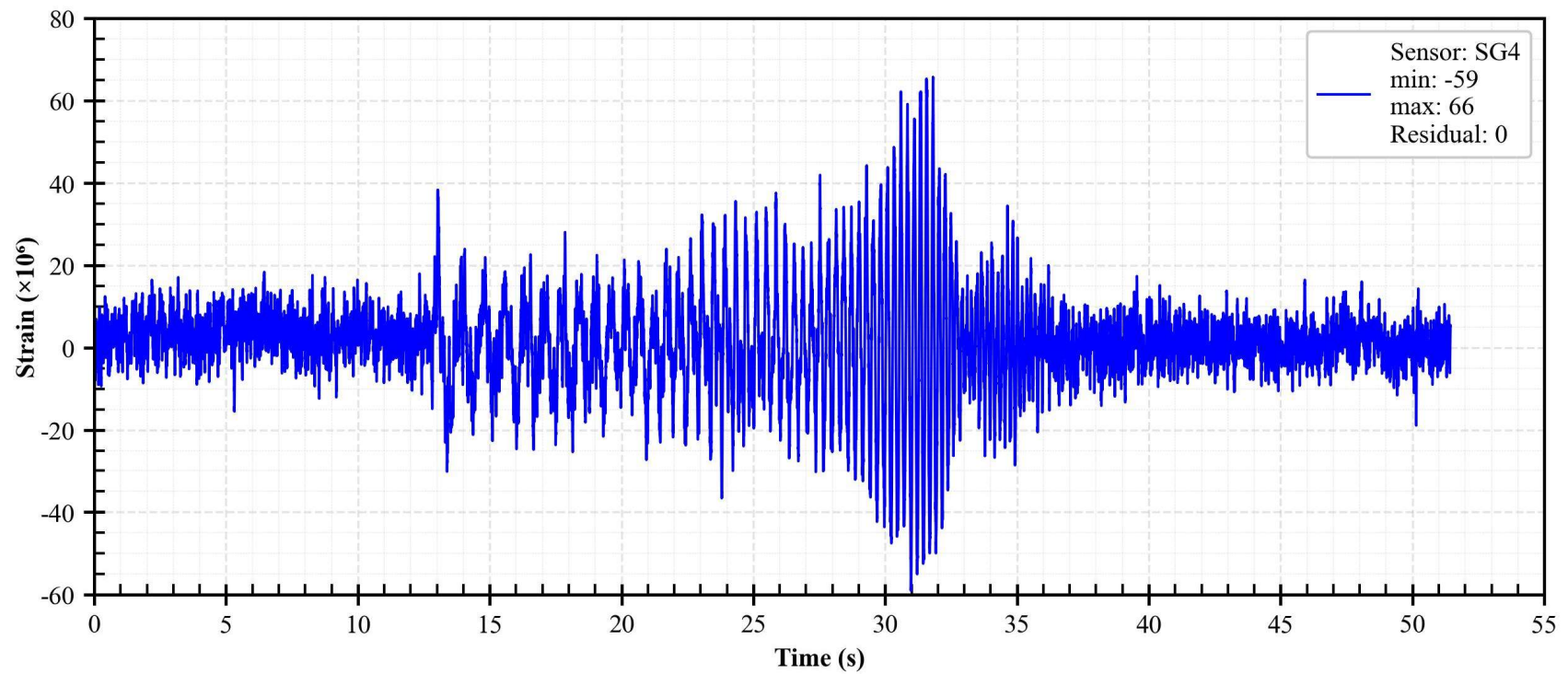


Figure 3.2.21 Characteristic results for phase B (white noise before 0,07g): strain gauge 4

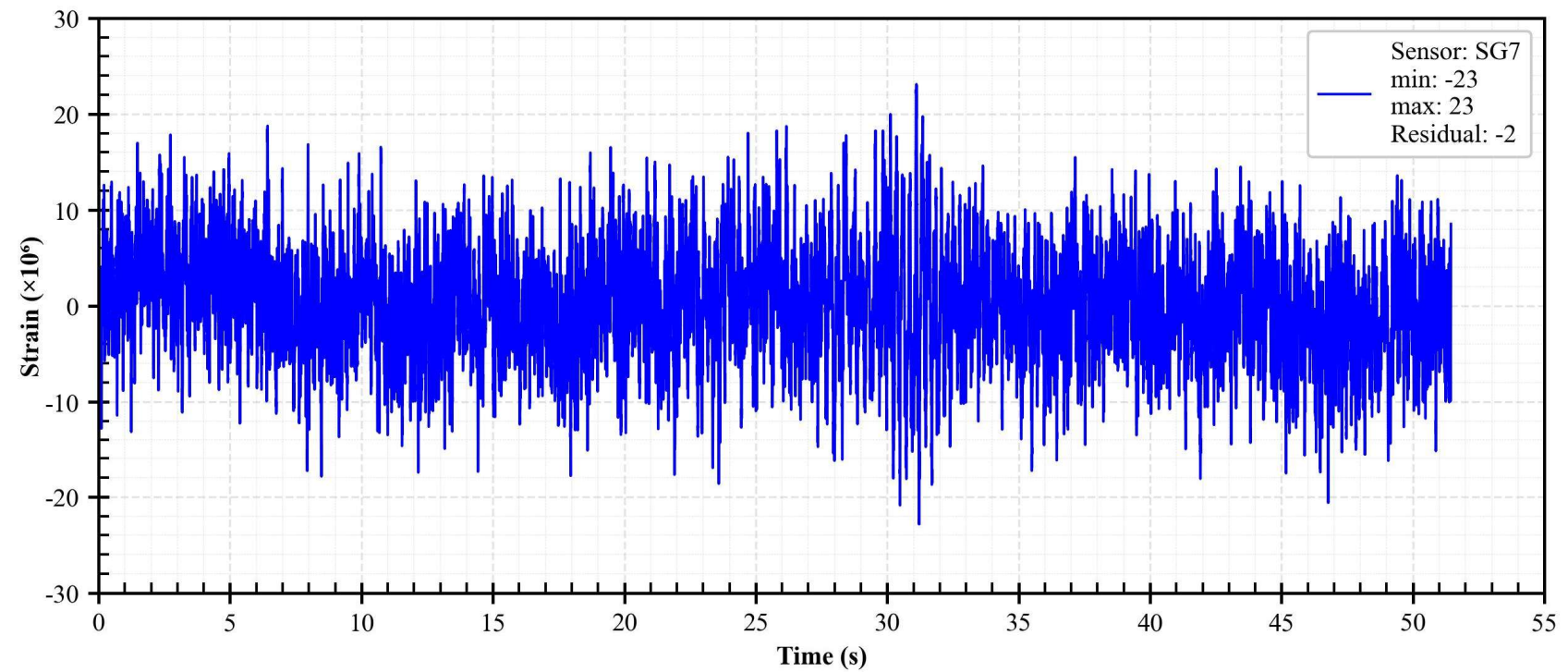


Figure 3.2.22 Characteristic results for phase B (white noise before 0,07g): strain gauge 7

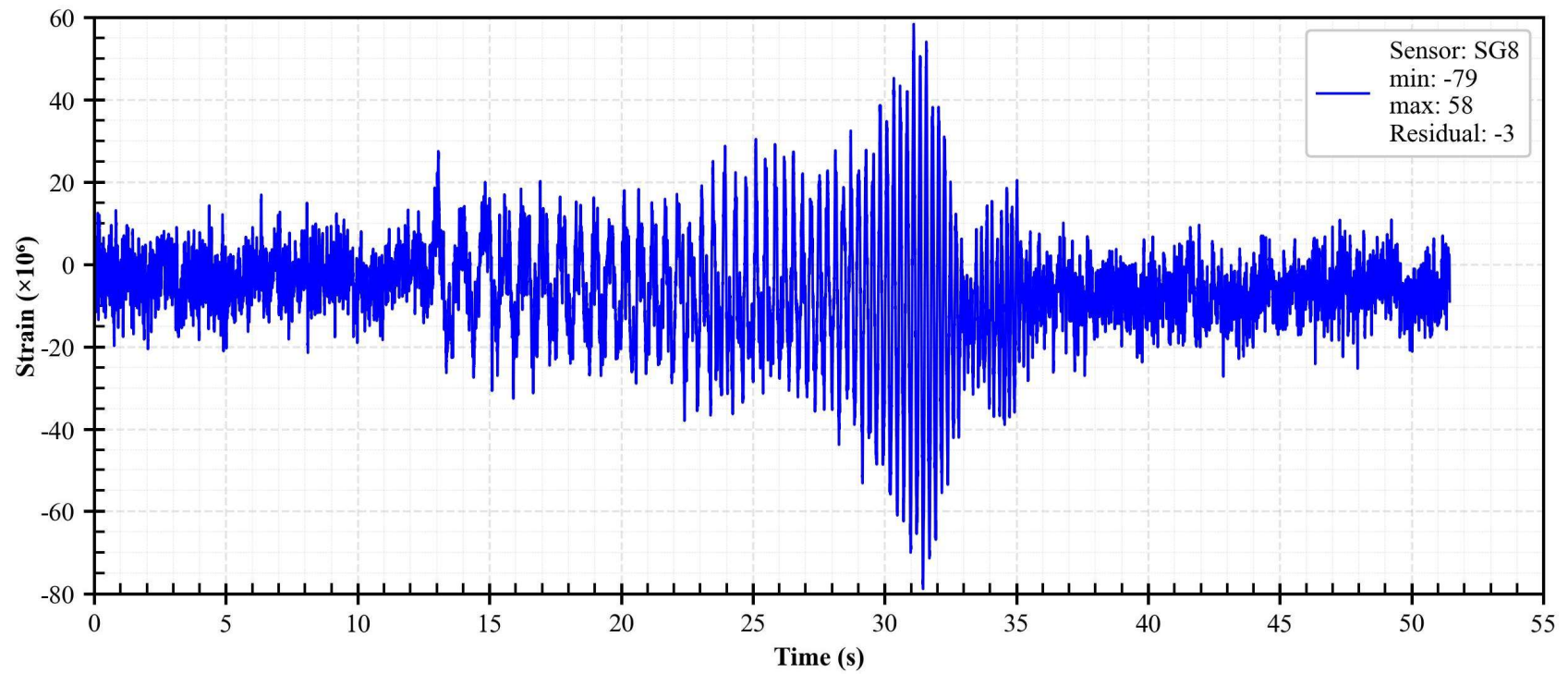


Figure 3.2.23 Characteristic results for phase B (white noise before 0,07g): strain gauge 8

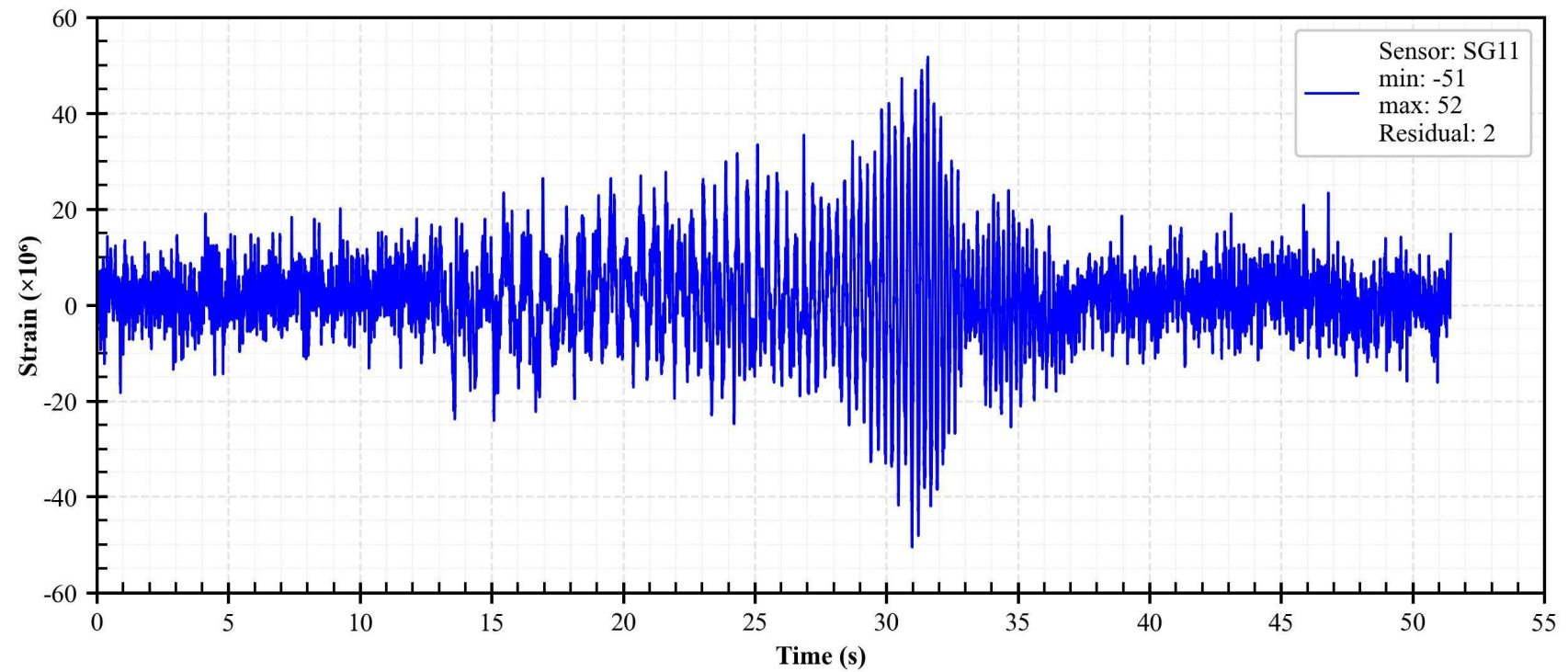


Figure 3.2.24 Characteristic results for phase B (white noise before 0,07g): strain gauge 11

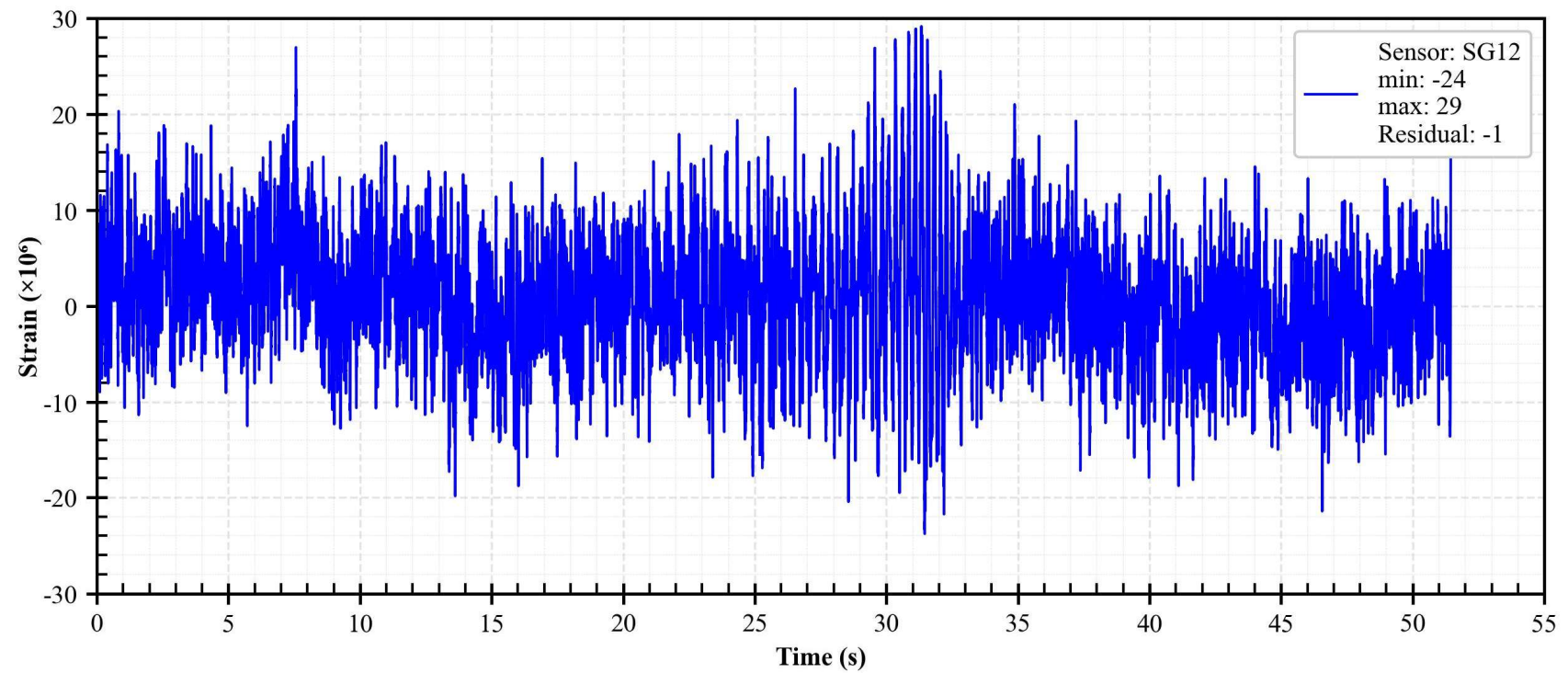


Figure 3.2.25 Characteristic results for phase B (white noise before 0,07g): strain gauge 12

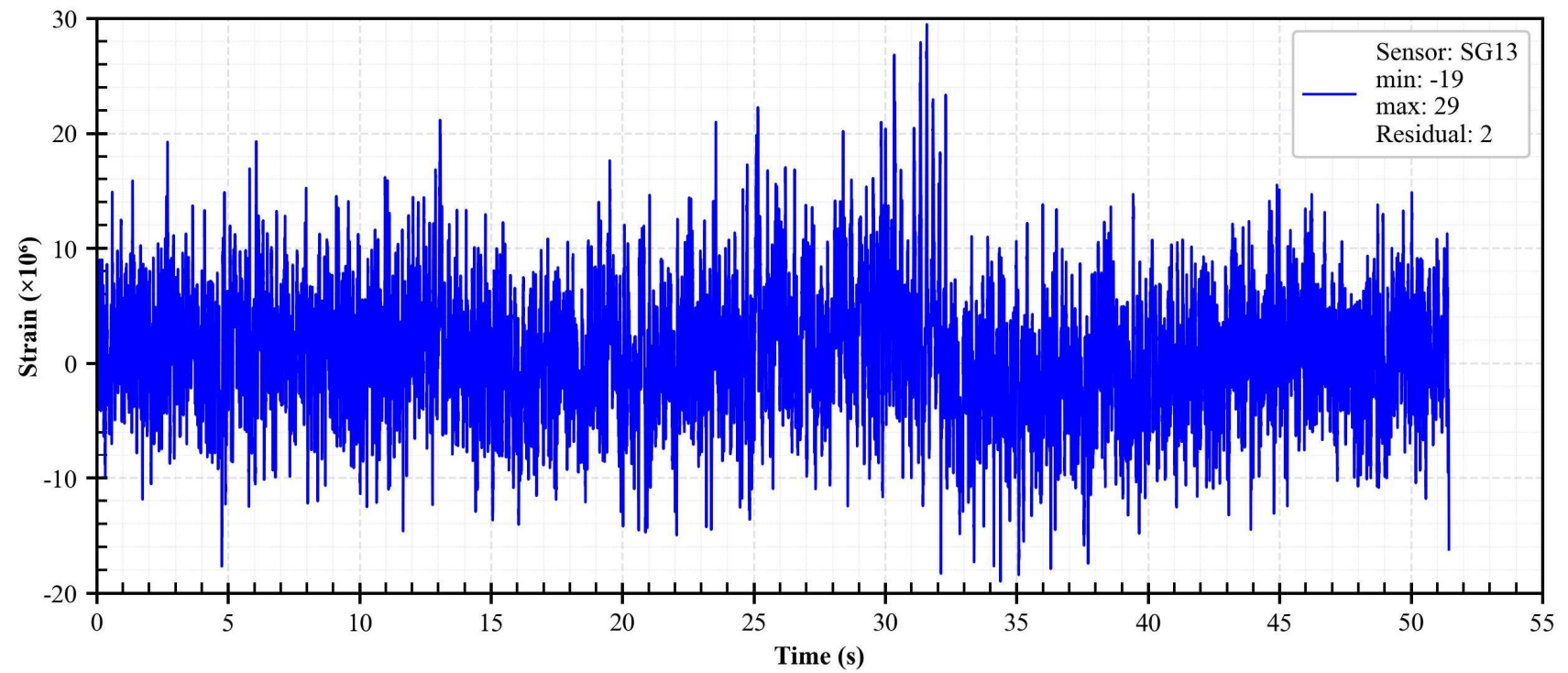


Figure 3.2.26 Characteristic results for phase B (white noise before 0,07g): strain gauge 13

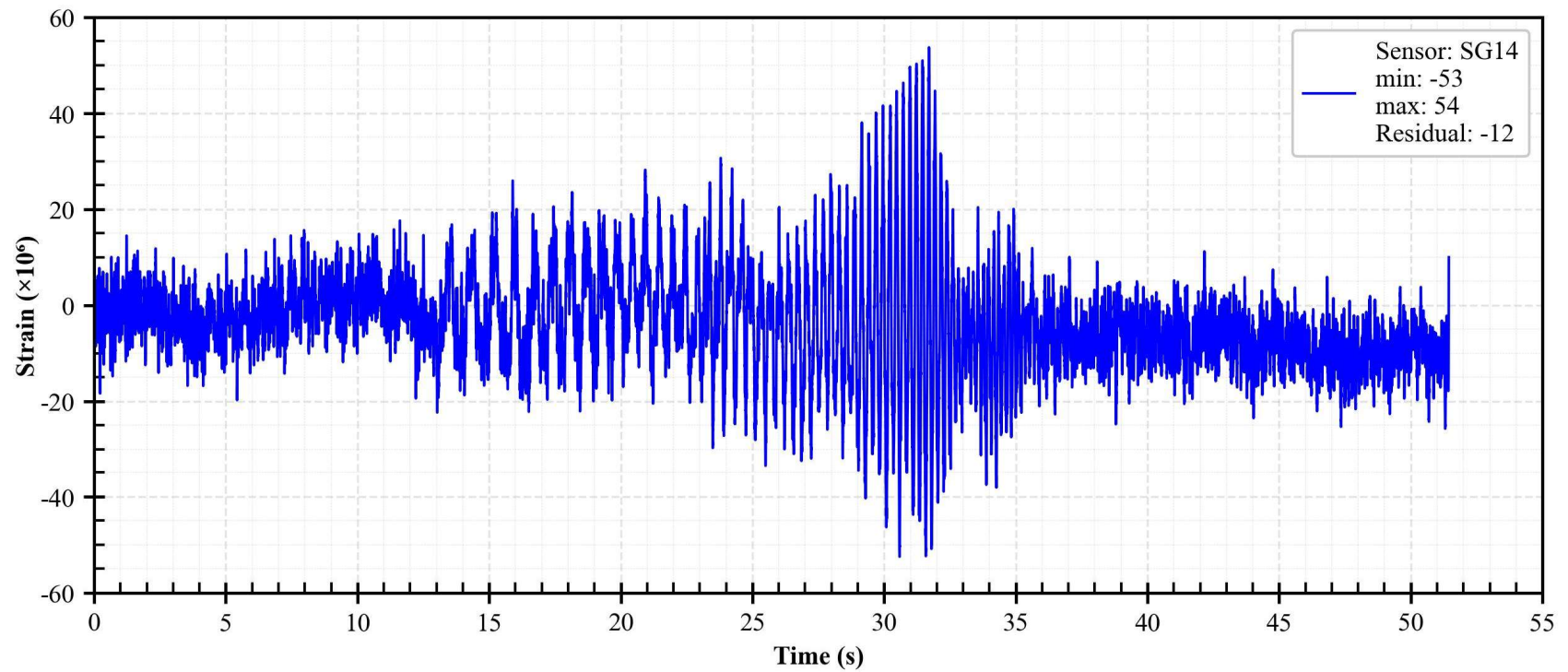


Figure 3.2.27 Characteristic results for phase B (white noise before 0,07g): strain gauge 14

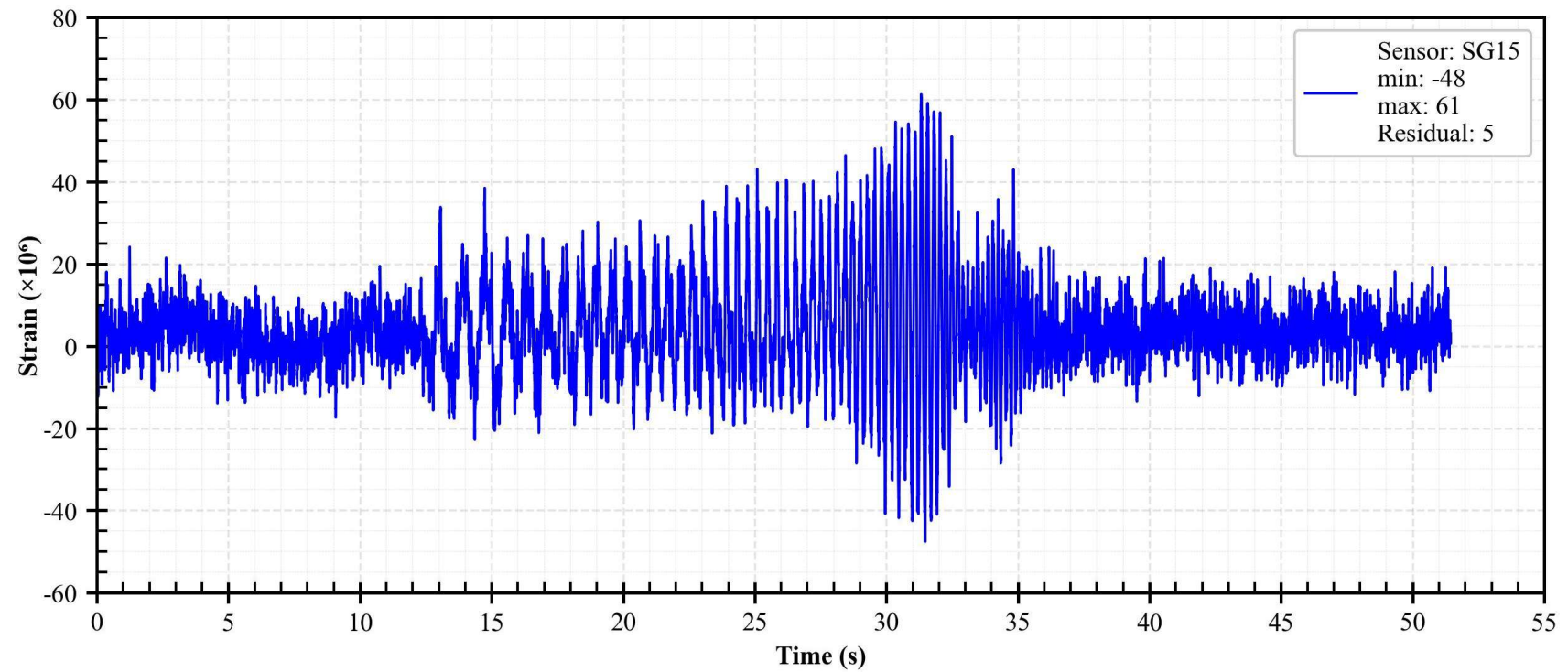


Figure 3.2.28 Characteristic results for phase B (white noise before 0,07g): strain gauge 15

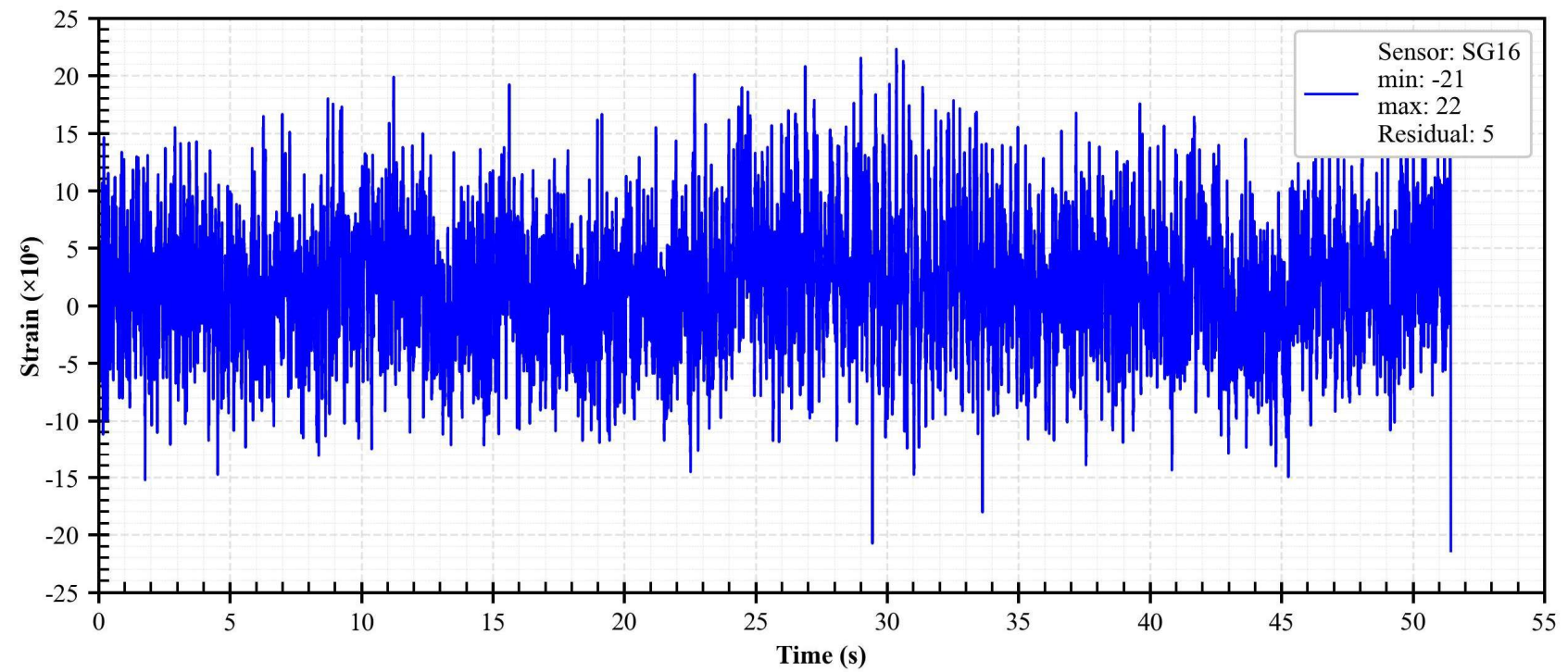


Figure 3.2.29 Characteristic results for phase B (white noise before 0,07g): strain gauge 16

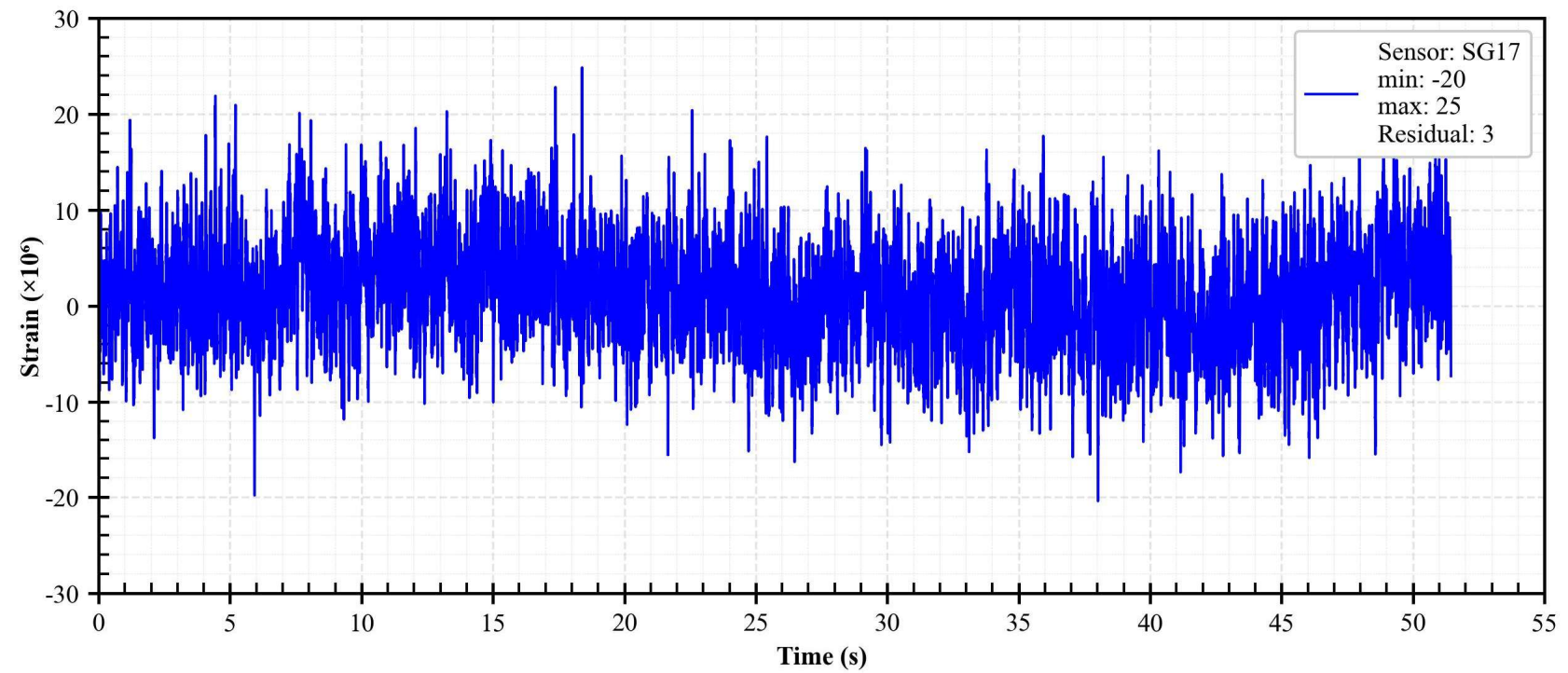


Figure 3.2.30 Characteristic results for phase B (white noise before 0,07g): strain gauge 17

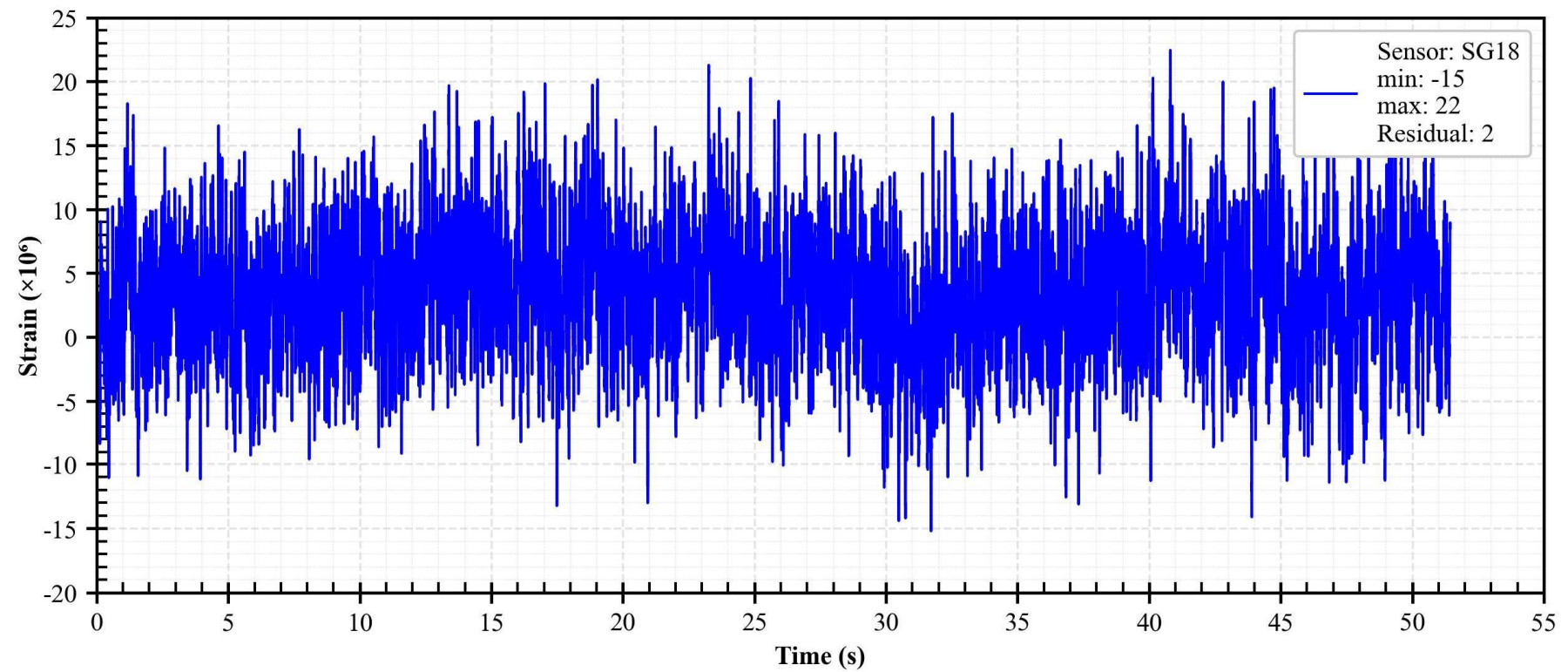


Figure 3.2.31 Characteristic results for phase B (white noise before 0,07g): strain gauge 18

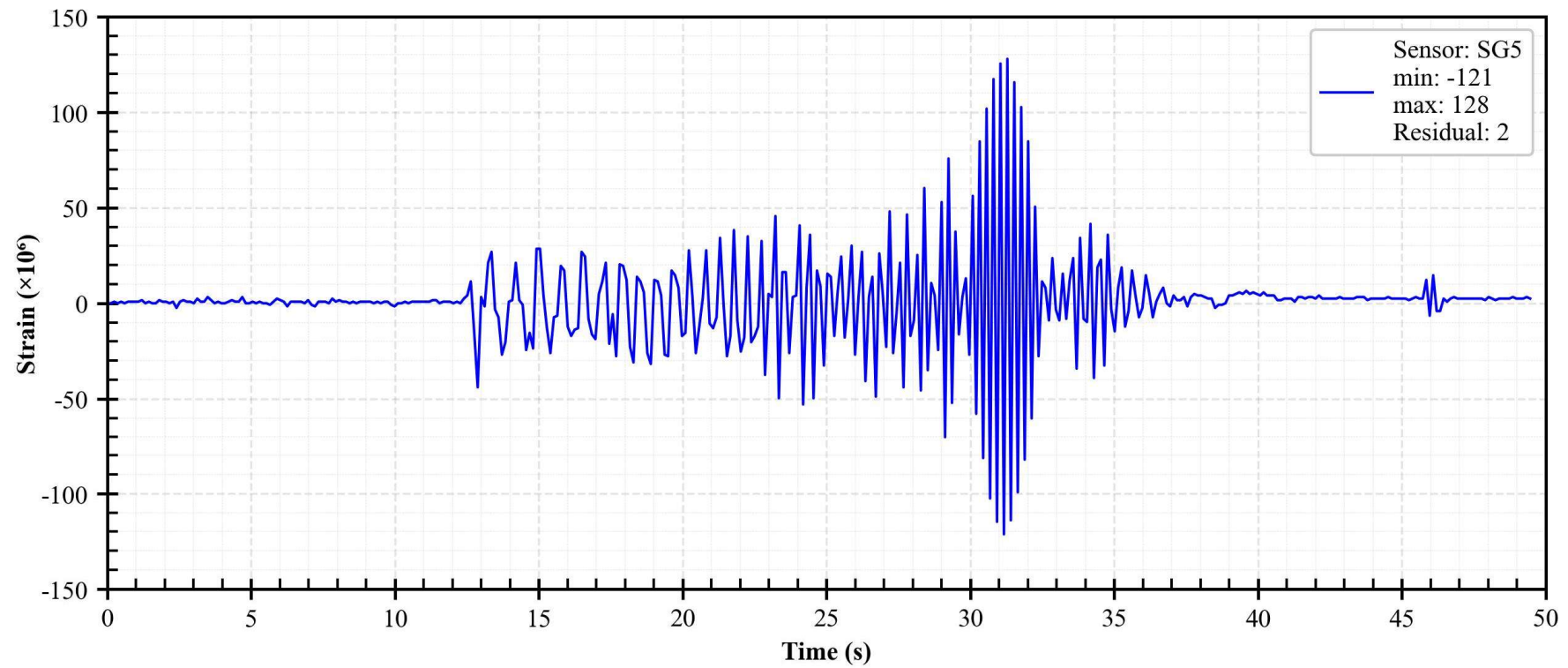


Figure 3.2.32 Characteristic results for phase B (white noise before 0,07g): strain gauge 5

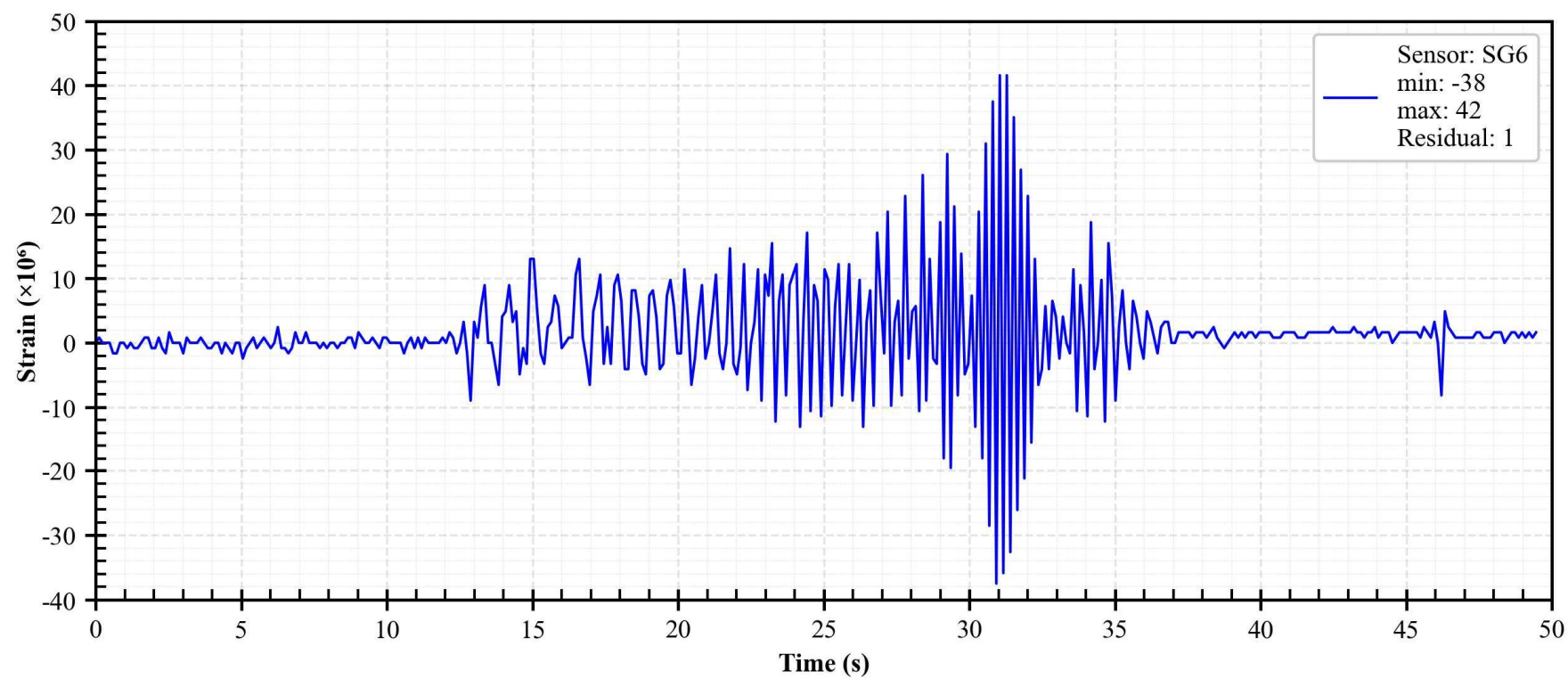


Figure 3.2.33 Characteristic results for phase B (white noise before 0,07g): strain gauge 6

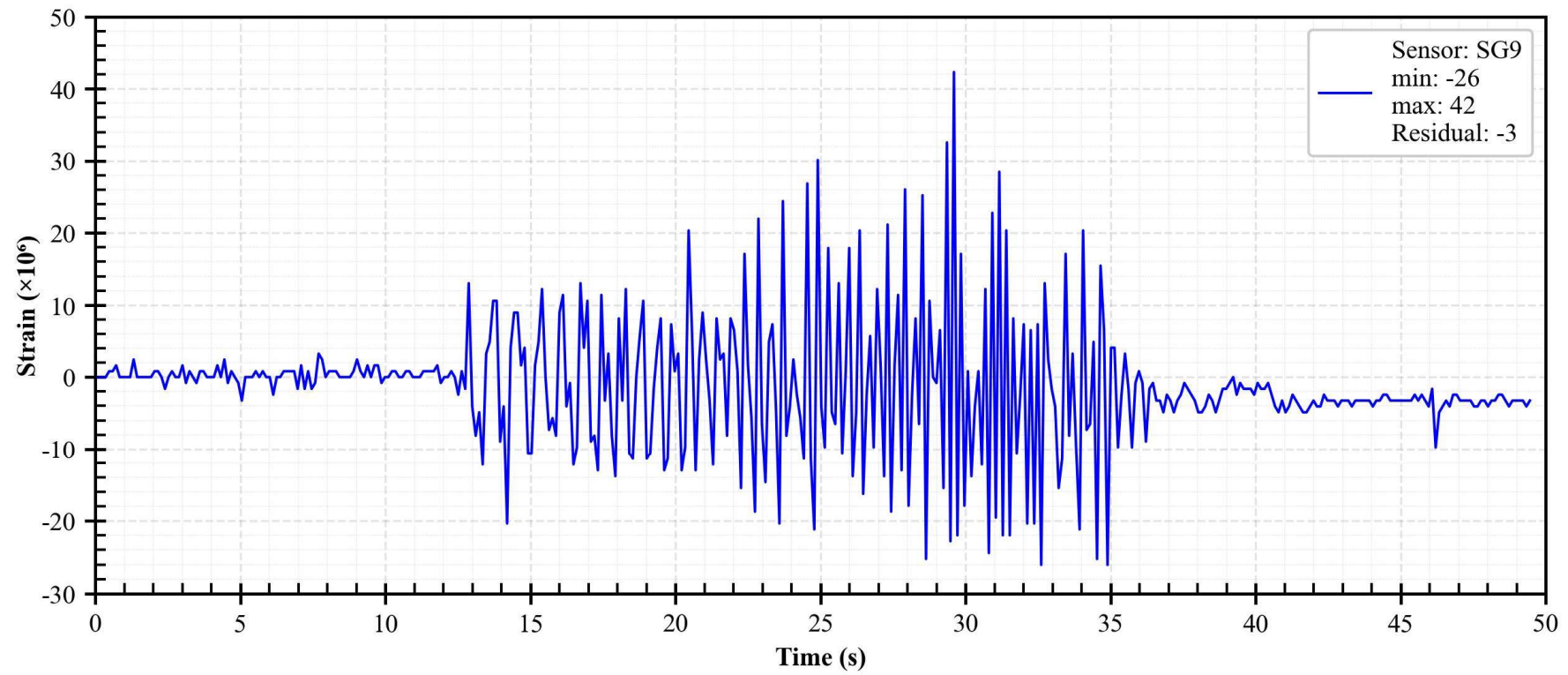


Figure 3.2.34 Characteristic results for phase B (white noise before 0,07g): strain gauge 9

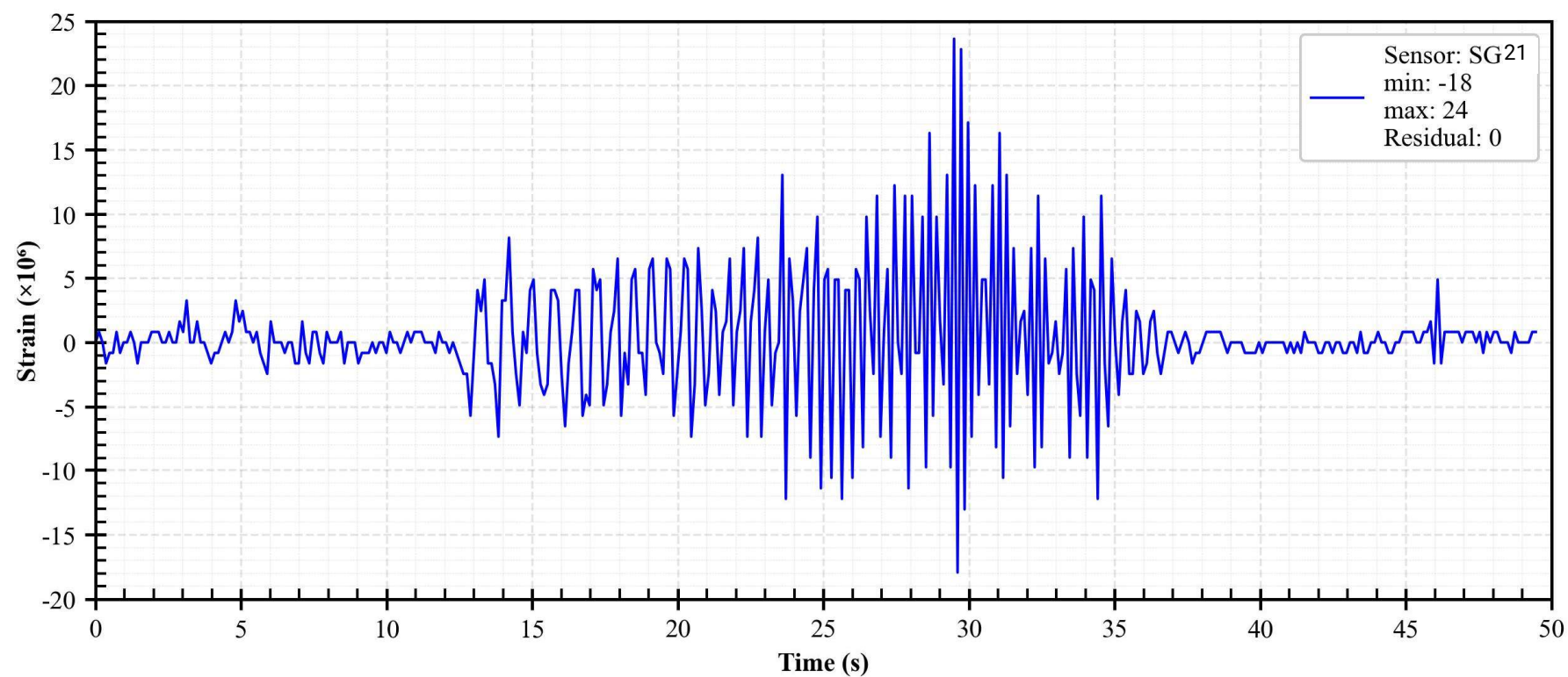


Figure 3.2.35 Characteristic results for phase B (white noise before 0,07g): strain gauge 21 (PUFJ, column 1)

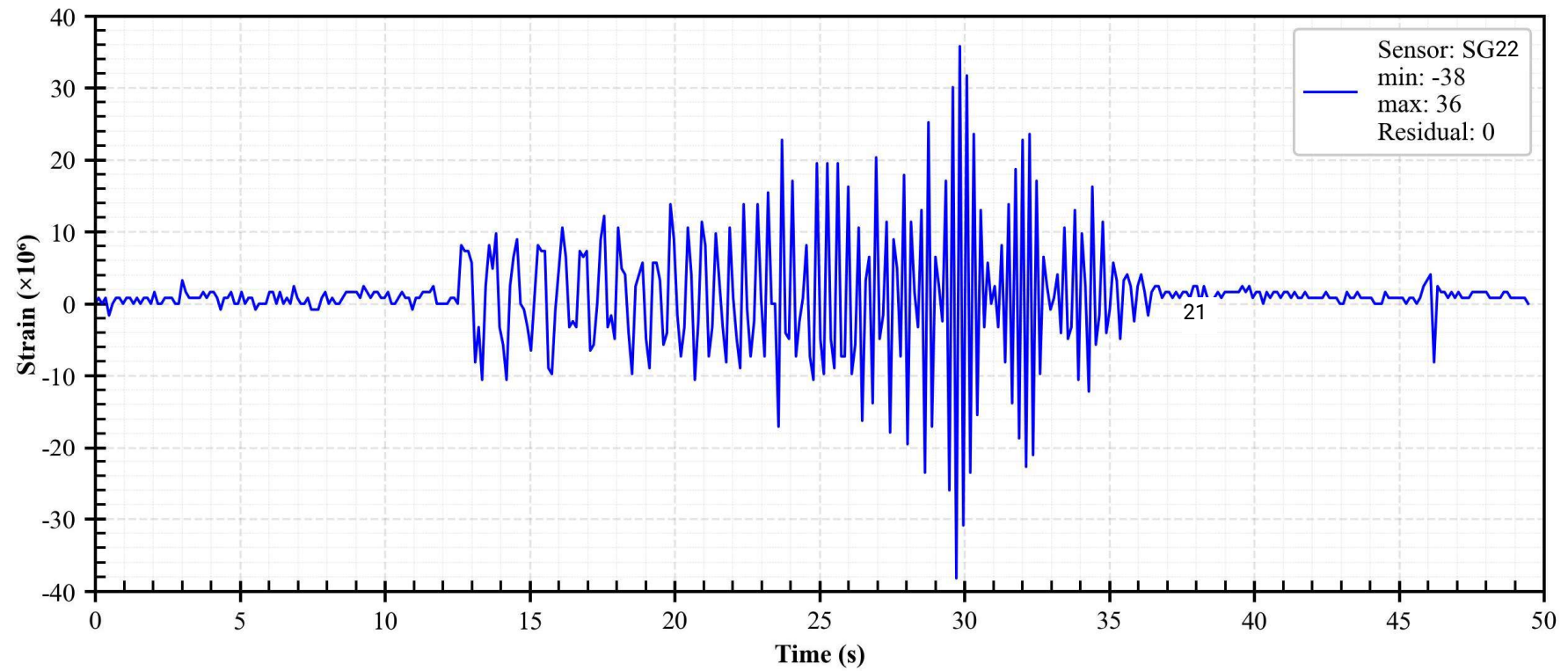


Figure 3.2.36 Characteristic results for phase B (white noise before 0,07g): strain gauge 22 (PUFJ, column 2)

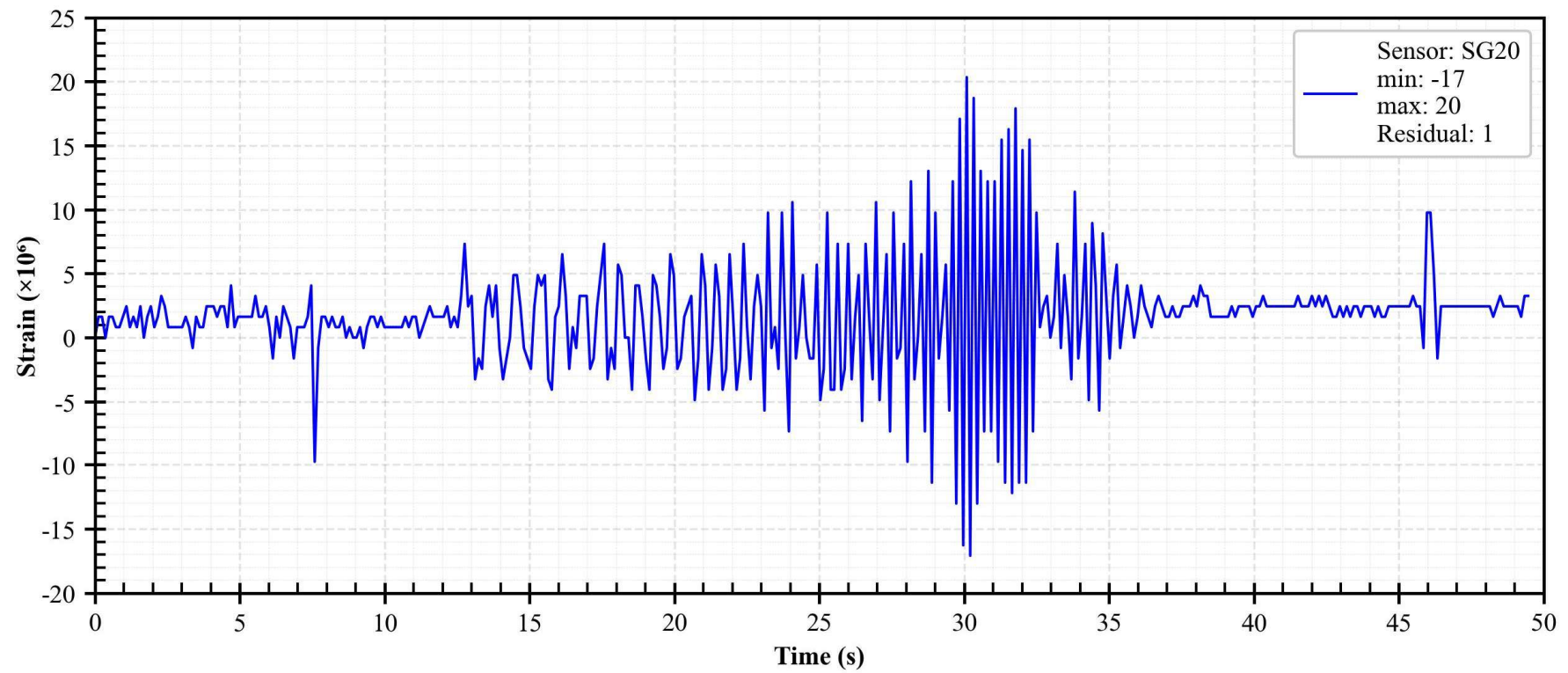


Figure 3.2.37 Characteristic results for phase B (white noise before 0,07g): strain gauge 20

3.3 Earthquake EQ0,07g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below earthquake EQ0,07g. The max acceleration at the slab level on the accelerometer acc4 is 0,13g. The max acceleration at the foundation level on the accelerometer acc10 is 0.07g.

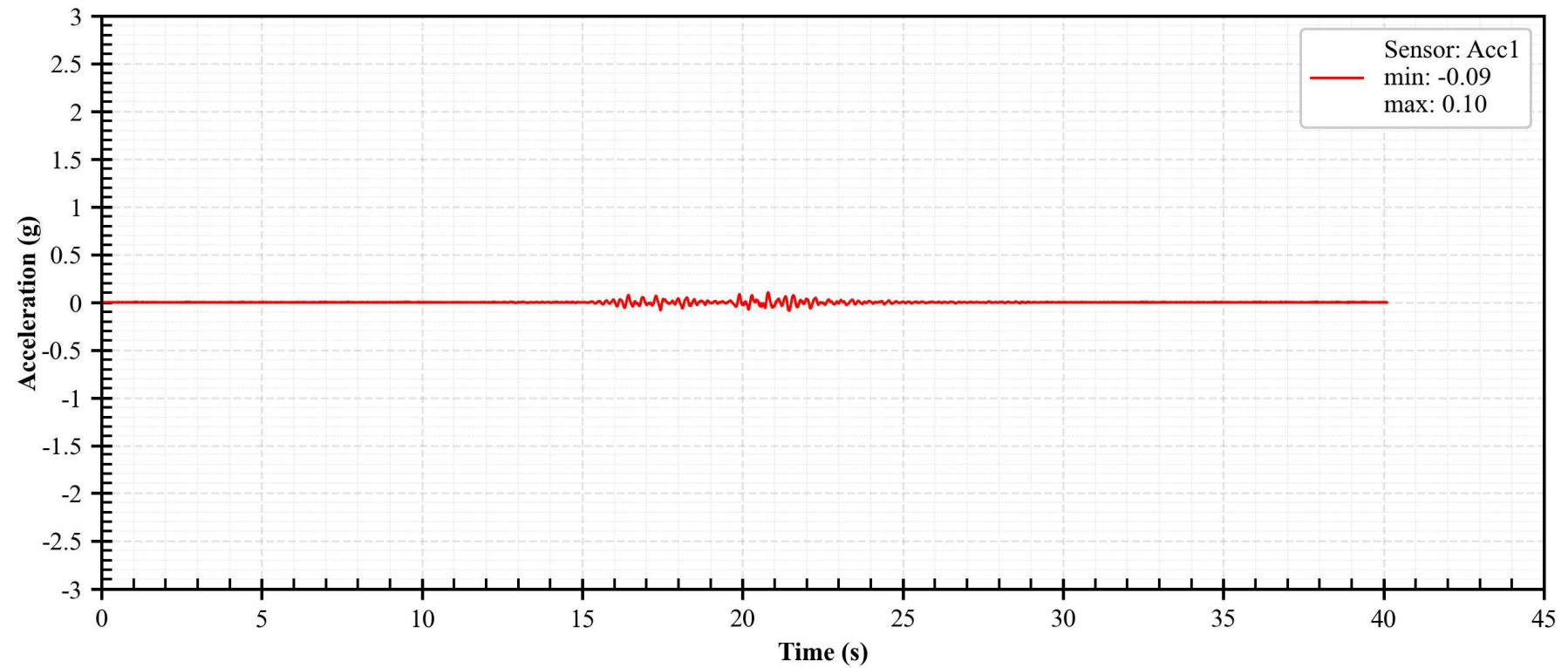


Figure 3.3.1 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 1

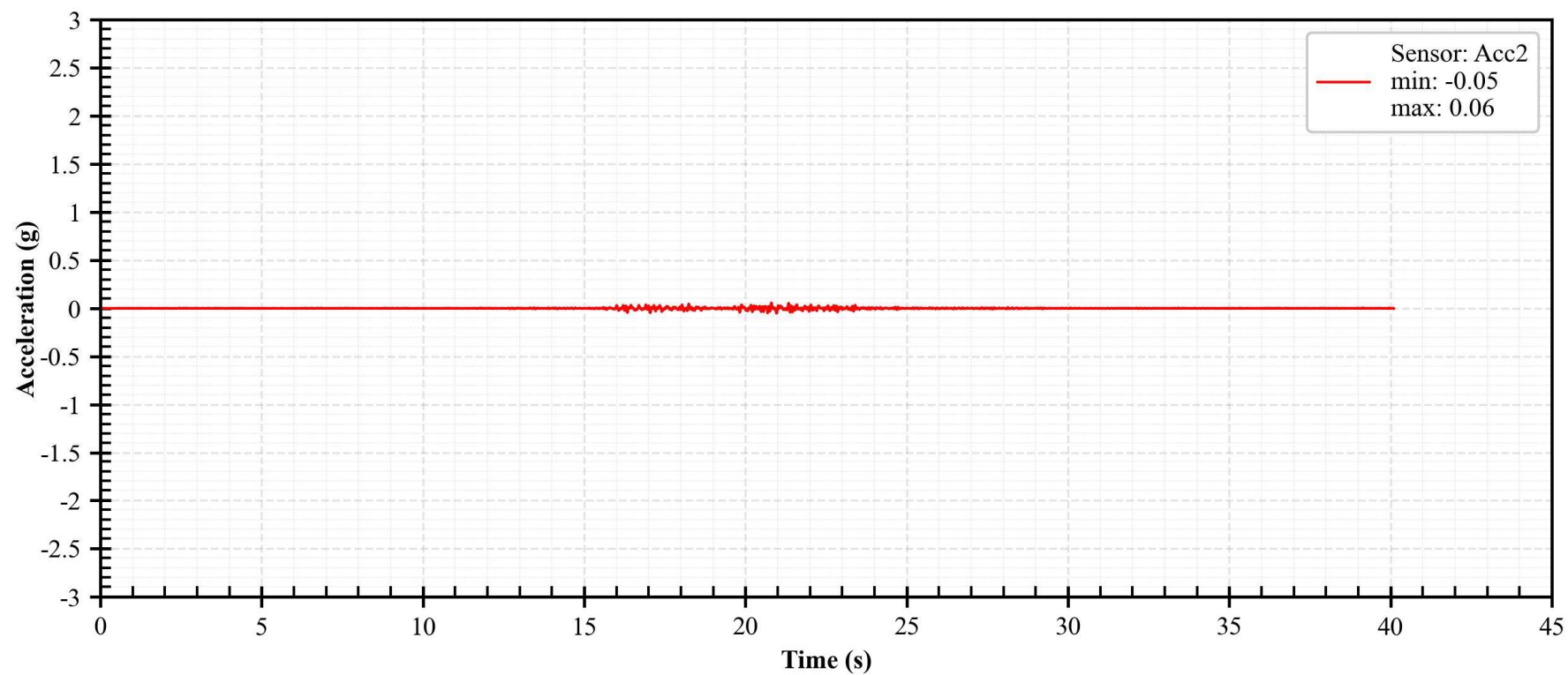


Figure 3.3.2 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 2

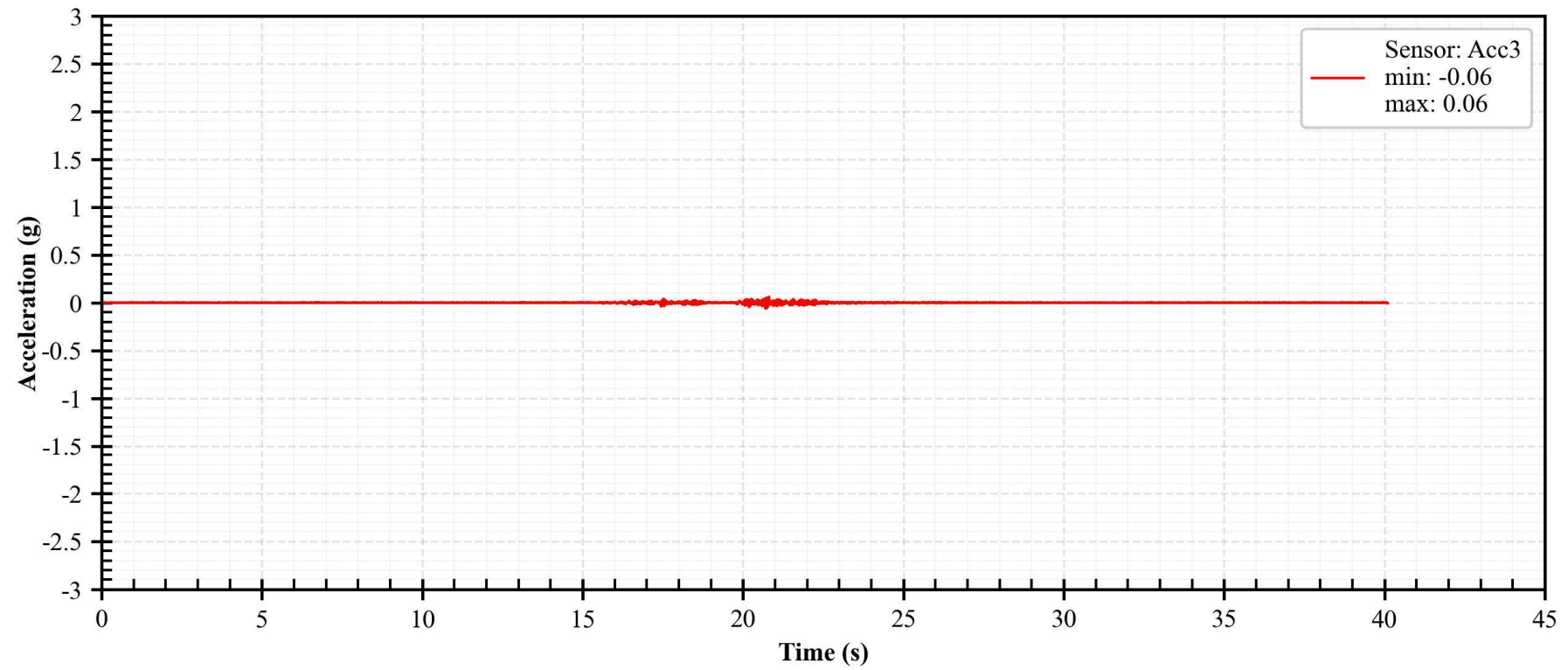


Figure 3.3.3 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 3

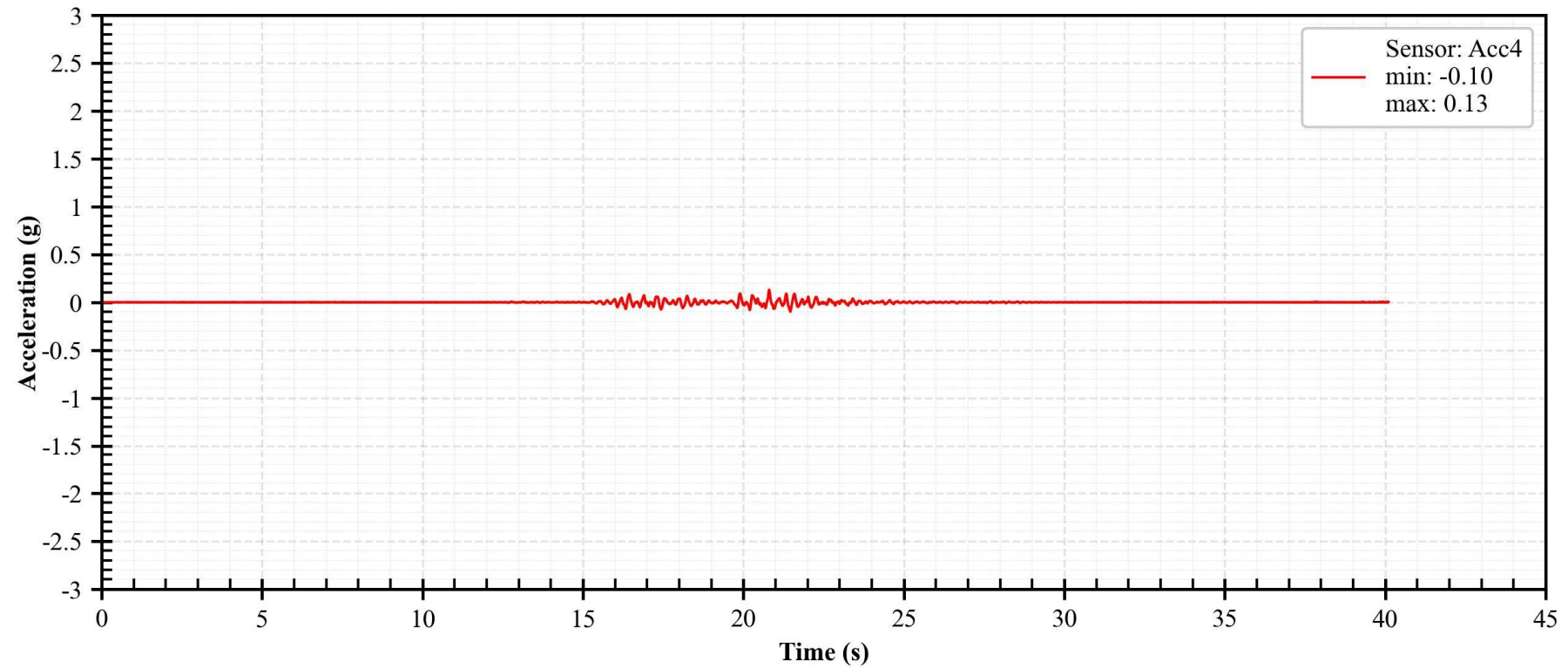


Figure 3.3.4 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 4

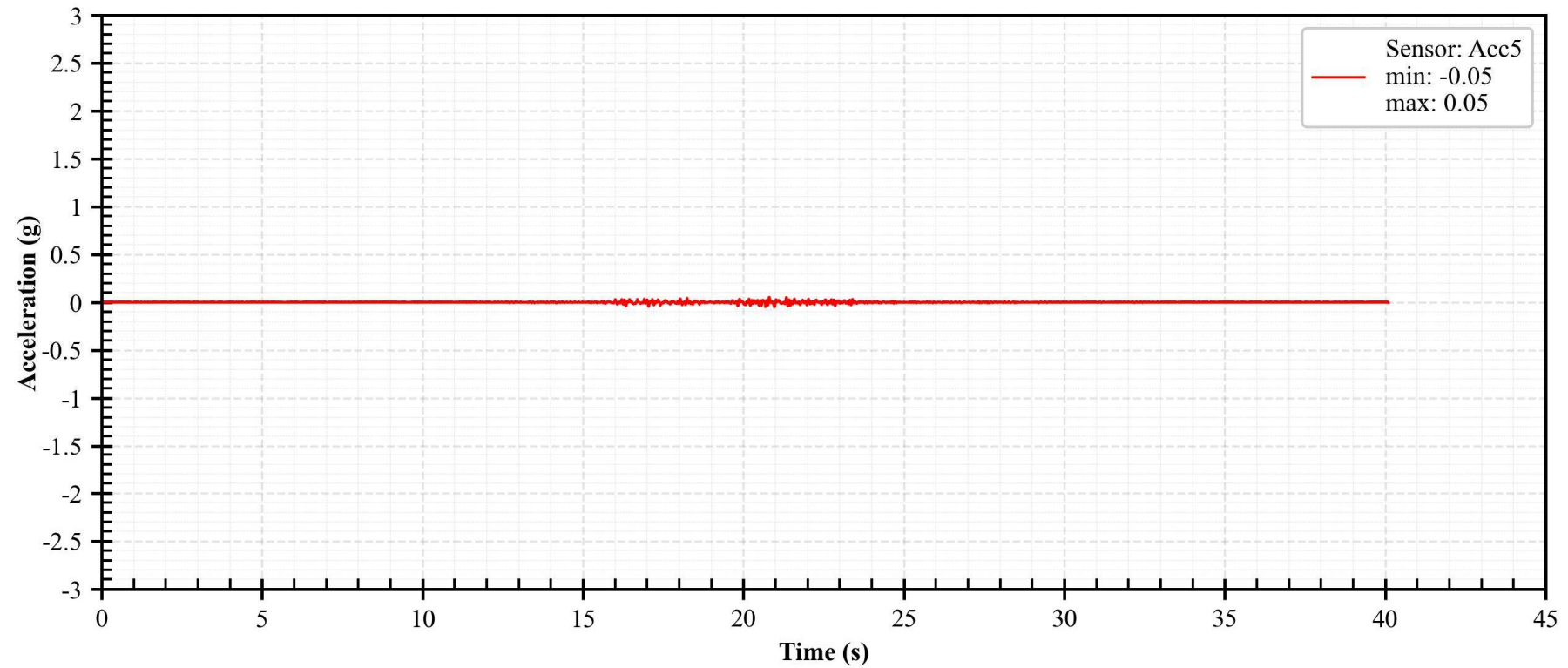


Figure 3.3.5 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 5

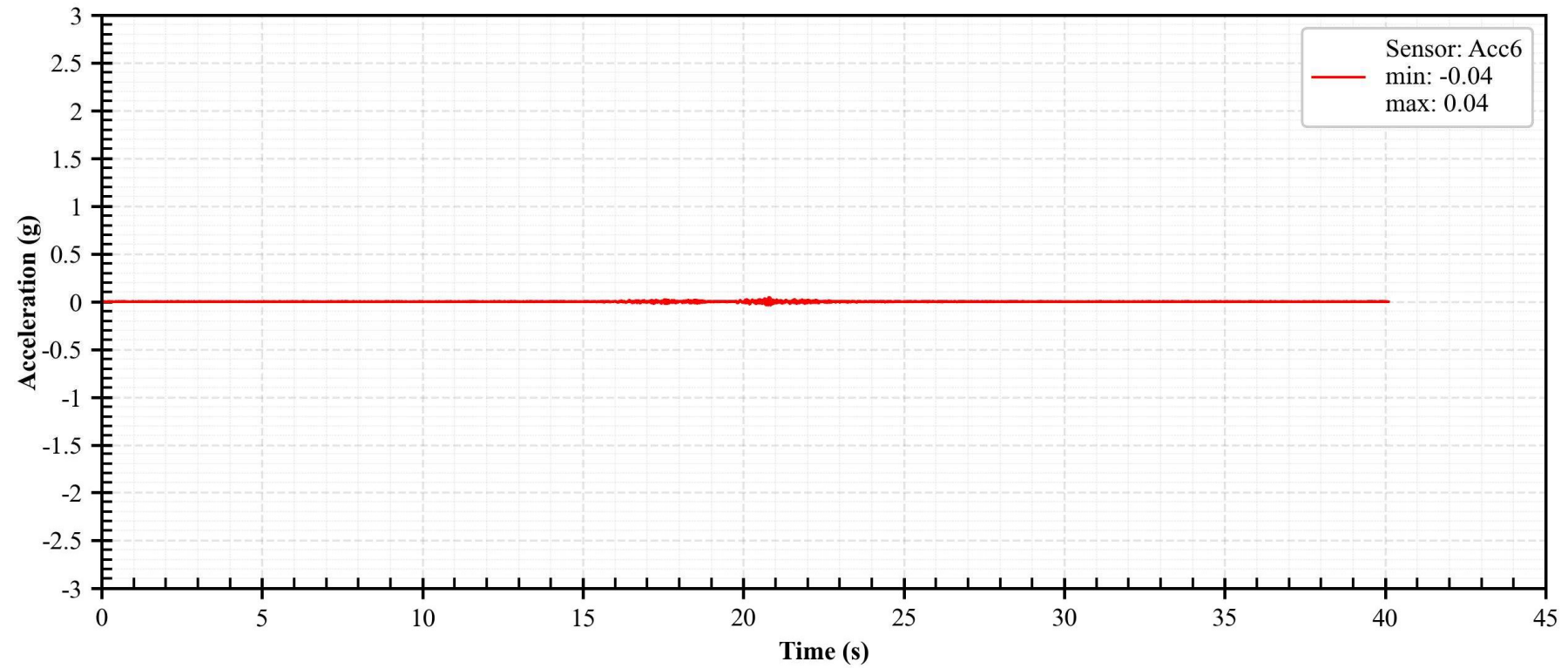


Figure 3.3.6 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 6

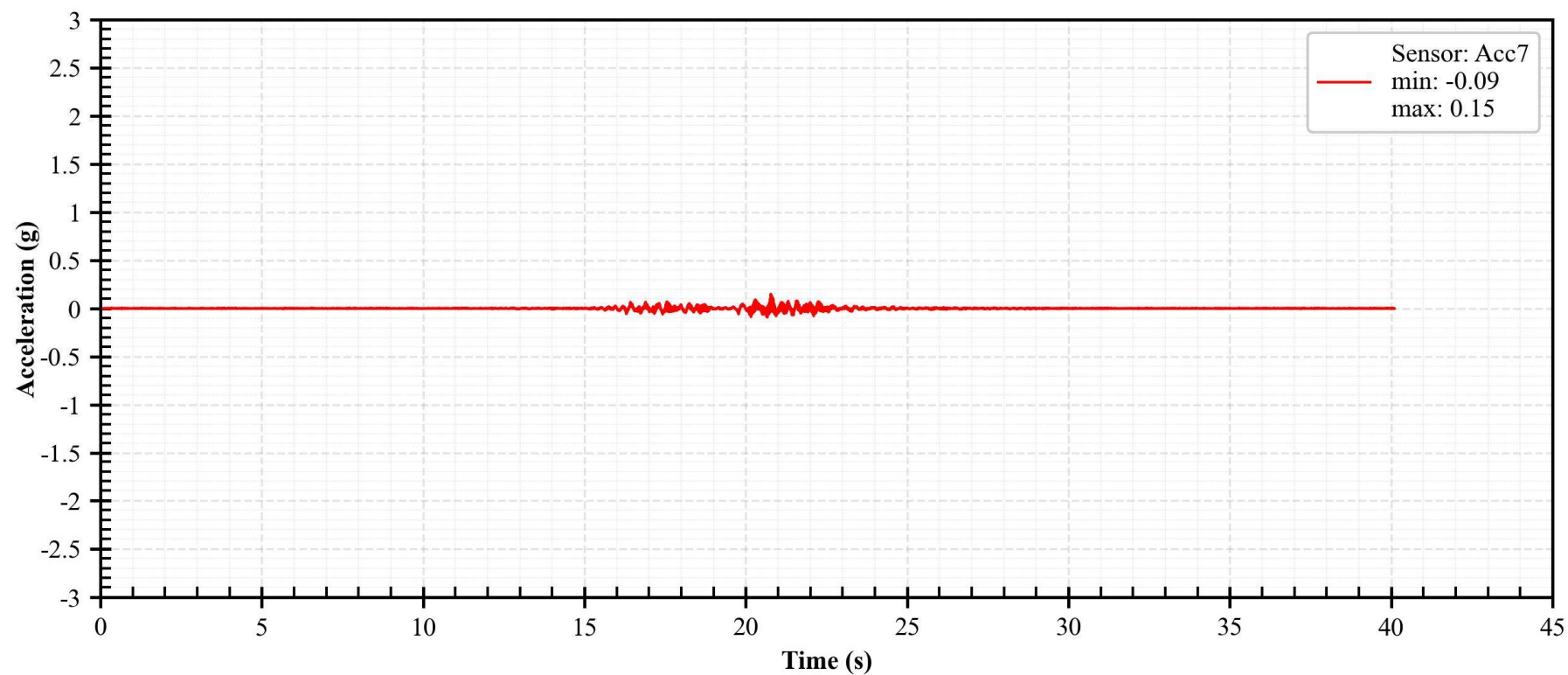


Figure 3.3.7 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 7

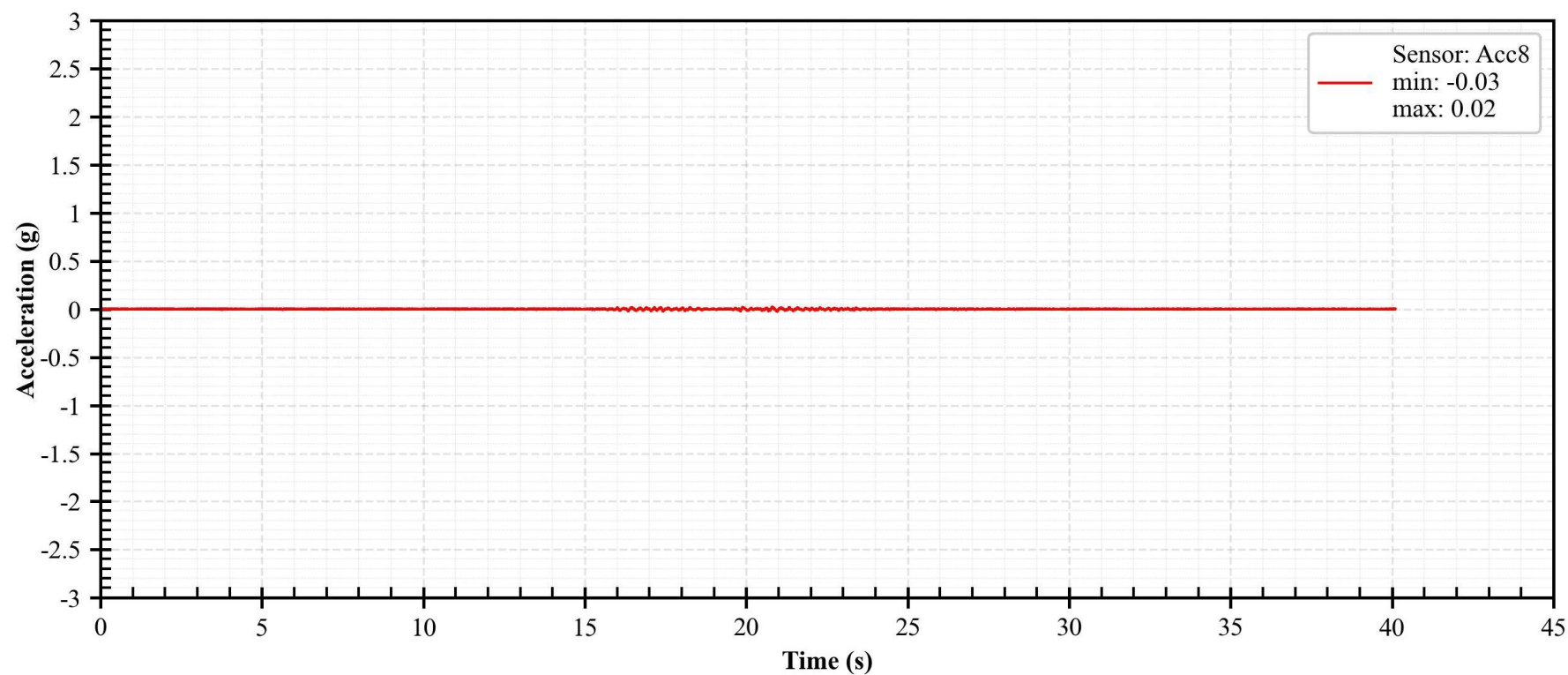


Figure 3.3.8 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 8

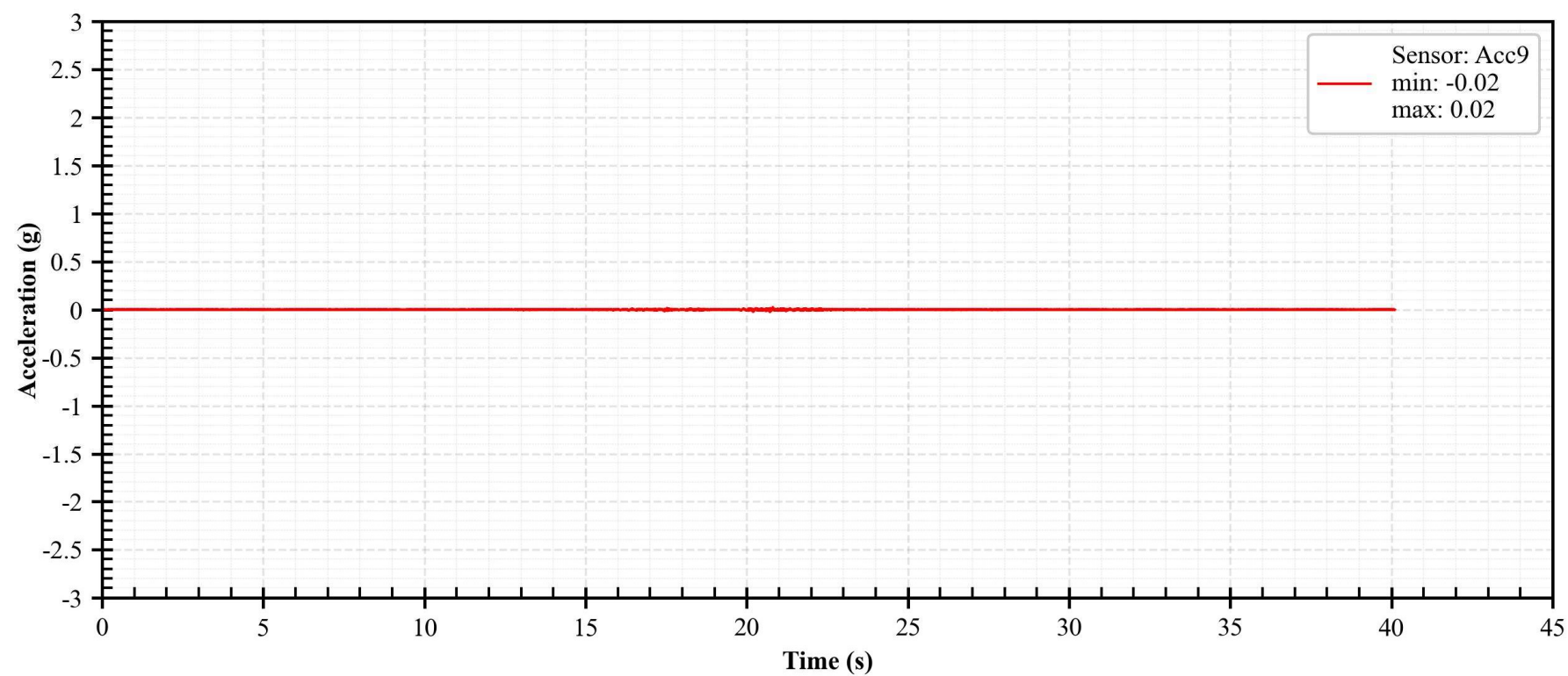


Figure 3.3.9 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 9

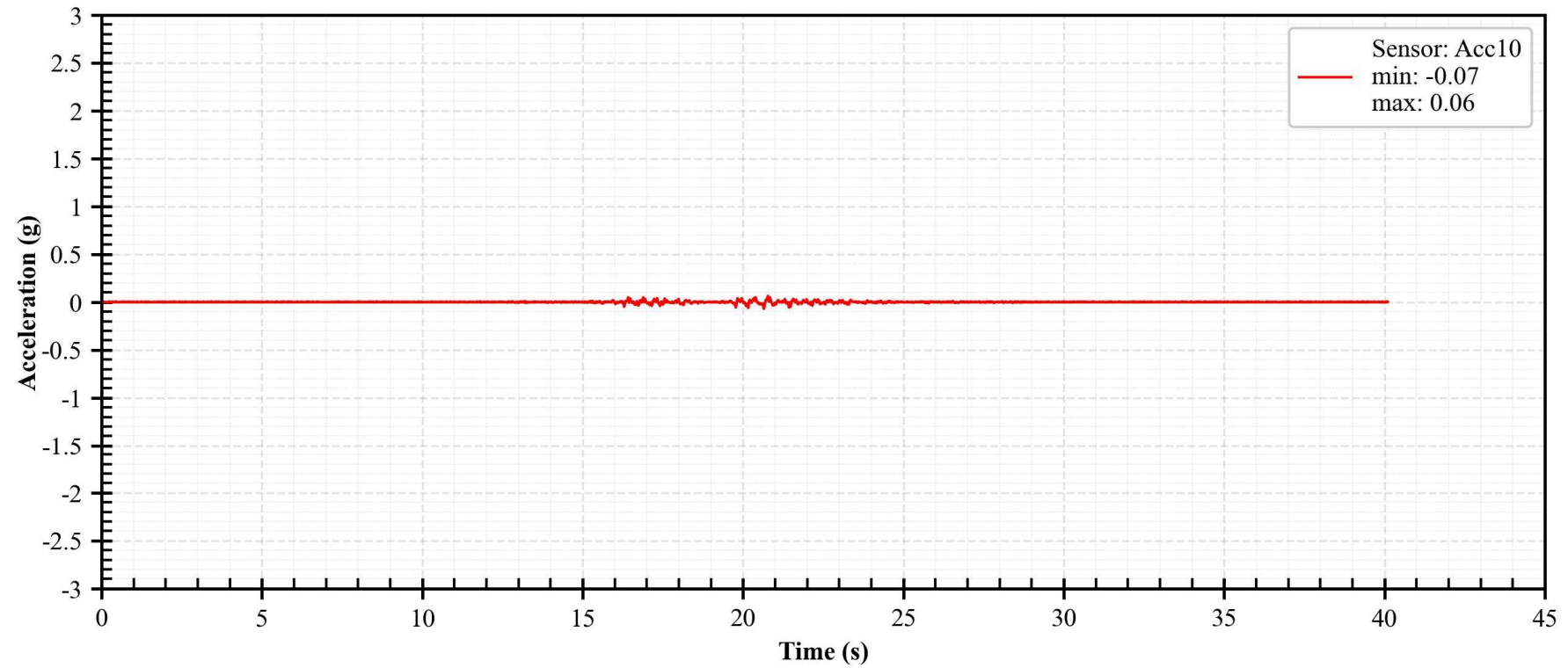


Figure 3.3.10 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 10

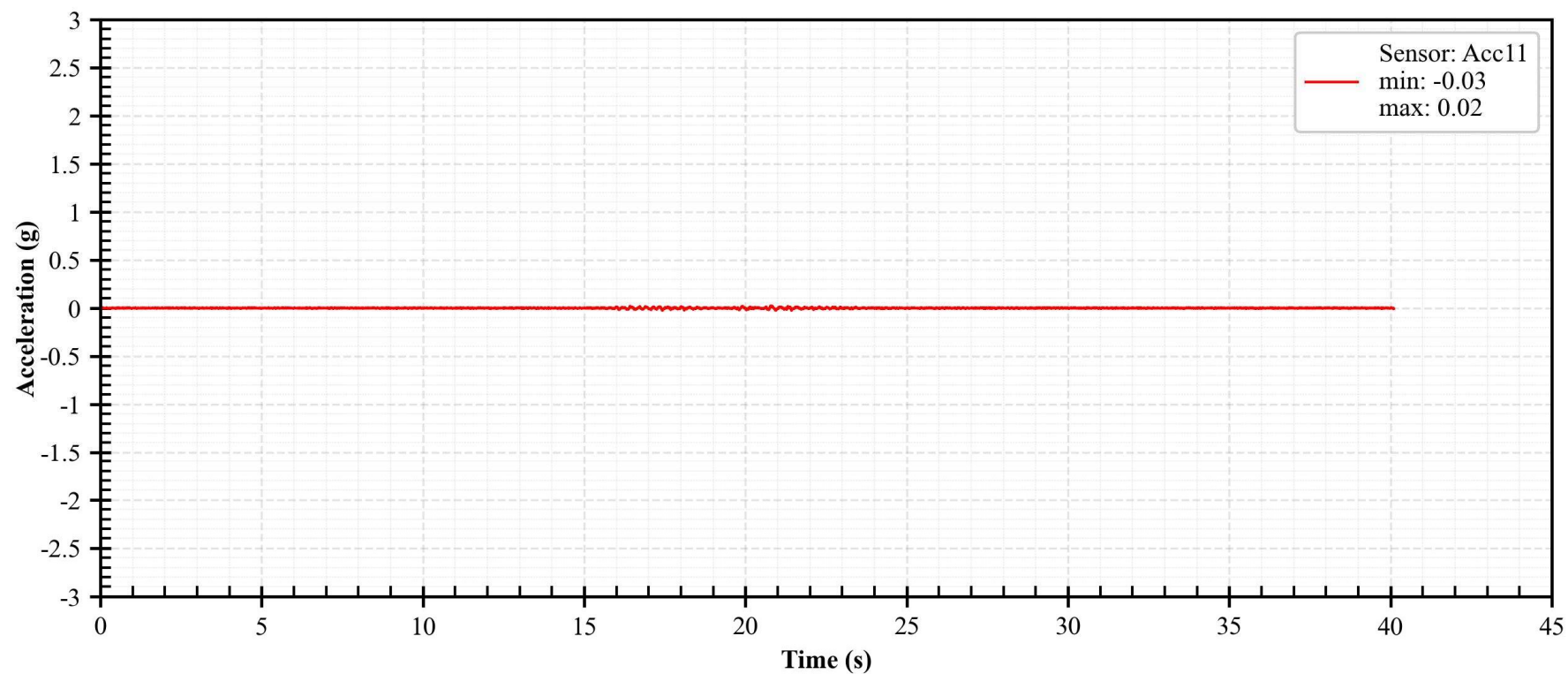


Figure 3.3.11 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 11

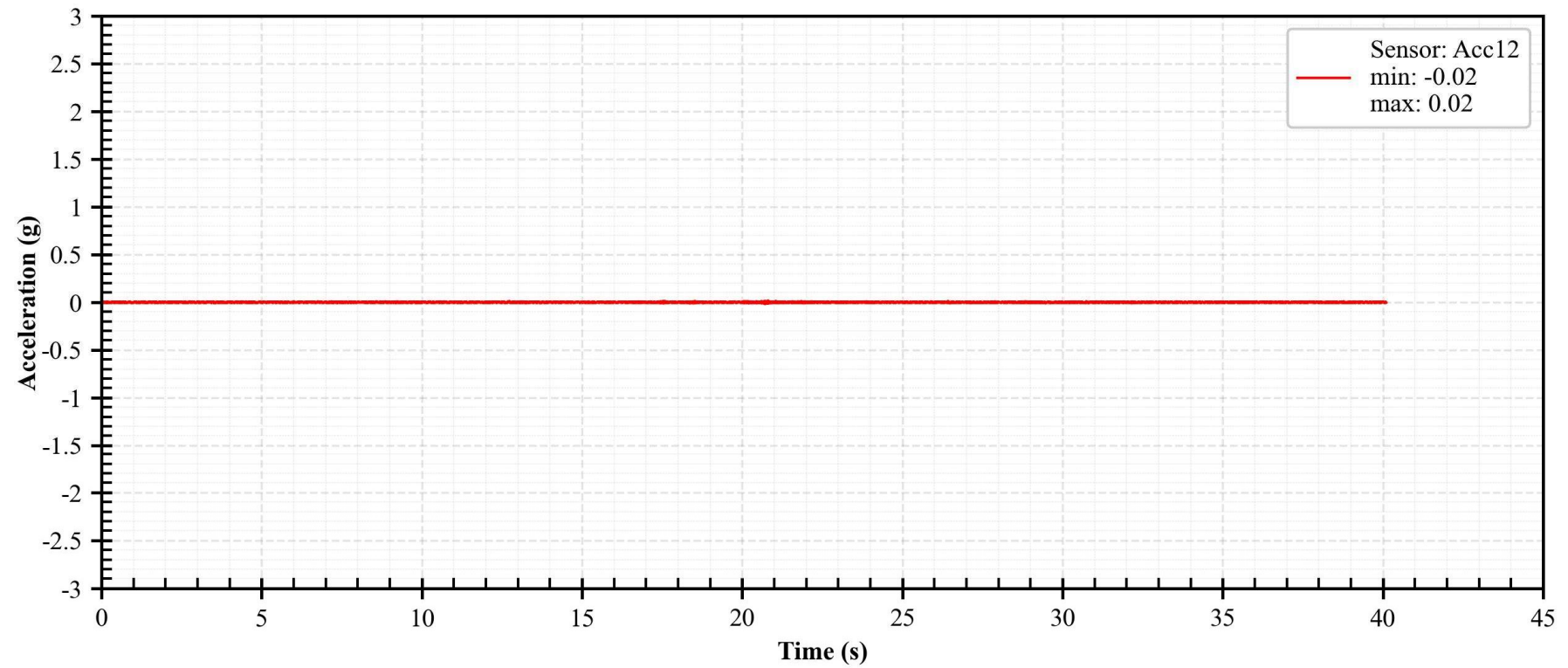


Figure 3.3.12 Characteristic results for phase B (earthquake EQ0,07g): Accelerometer 12

Draw wire sensors

Figures 3.3.13 – 3.3.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 2.06 mm while the minimum is -1.89 mm. The maximum movement detected by draw wire sensor W2 is 2.38 mm while the minimum is -1.81 mm. The maximum movement detected by draw wire sensor W3 is 1.48 mm while the minimum is -1.42 mm. The maximum movement detected by draw wire sensor W4 is 1.72 mm while the minimum is -1.46 mm. The maximum drift is $(0.81/1.225) = 0.66 \%$ and minimum drift is $(-0.96/1.225) = -0.78 \%$.

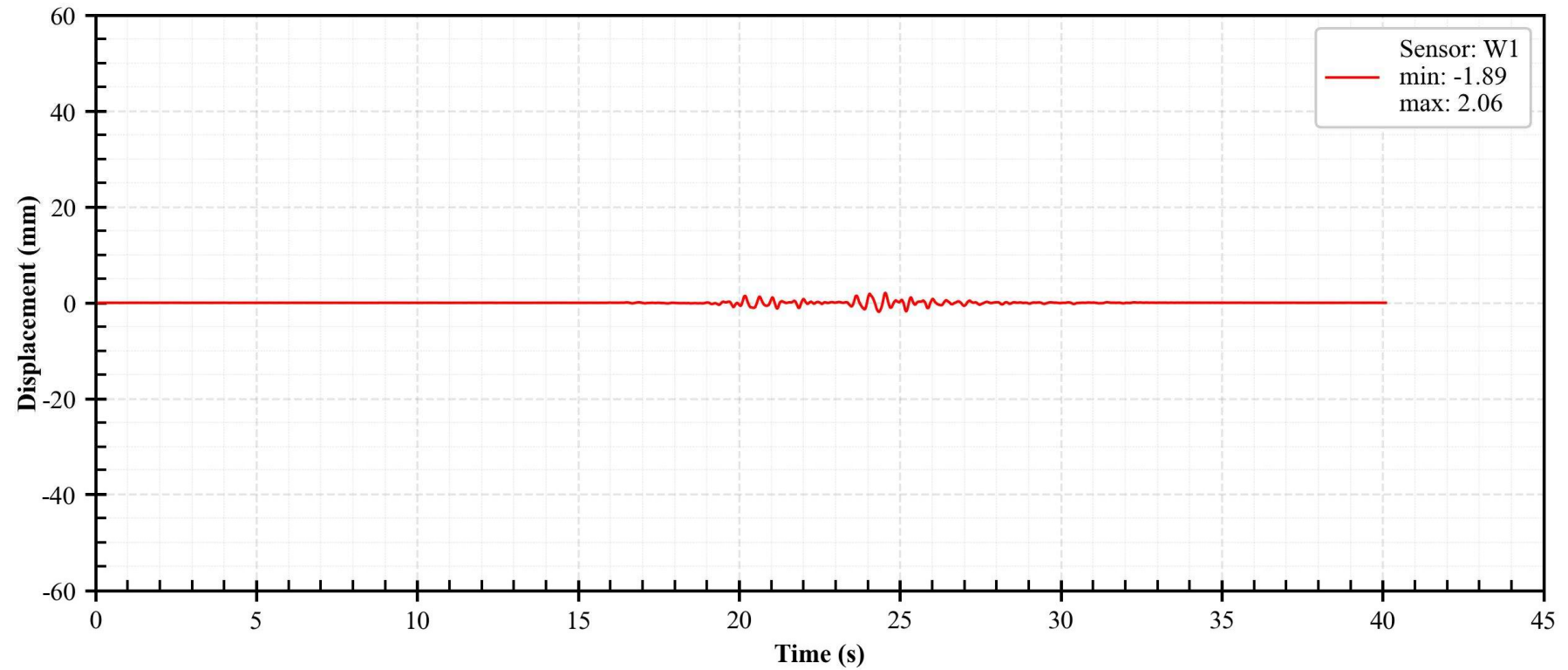


Figure 3.3.13 Characteristic results for phase B (earthquake EQ0,07g): Draw wire sensor 1

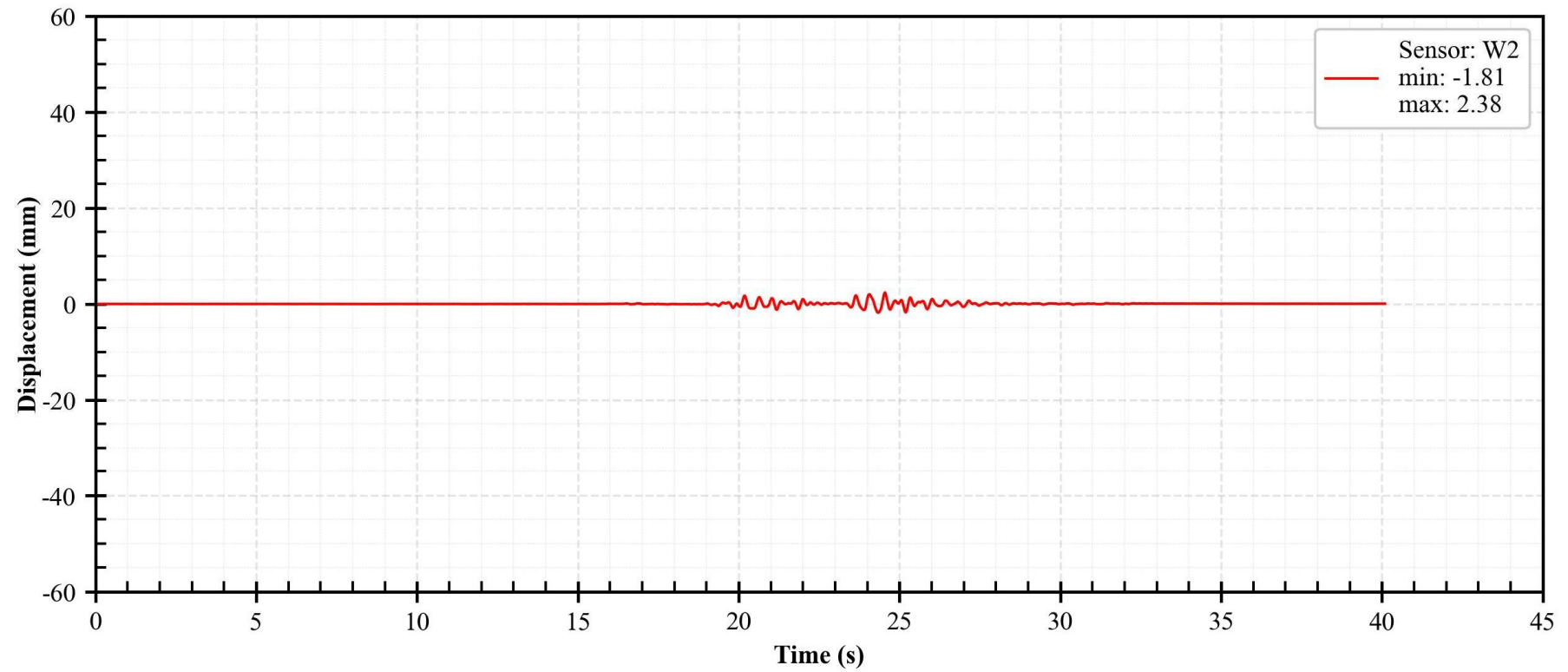


Figure 3.3.14 Characteristic results for phase B (earthquake EQ0,07g): Draw wire sensor 2

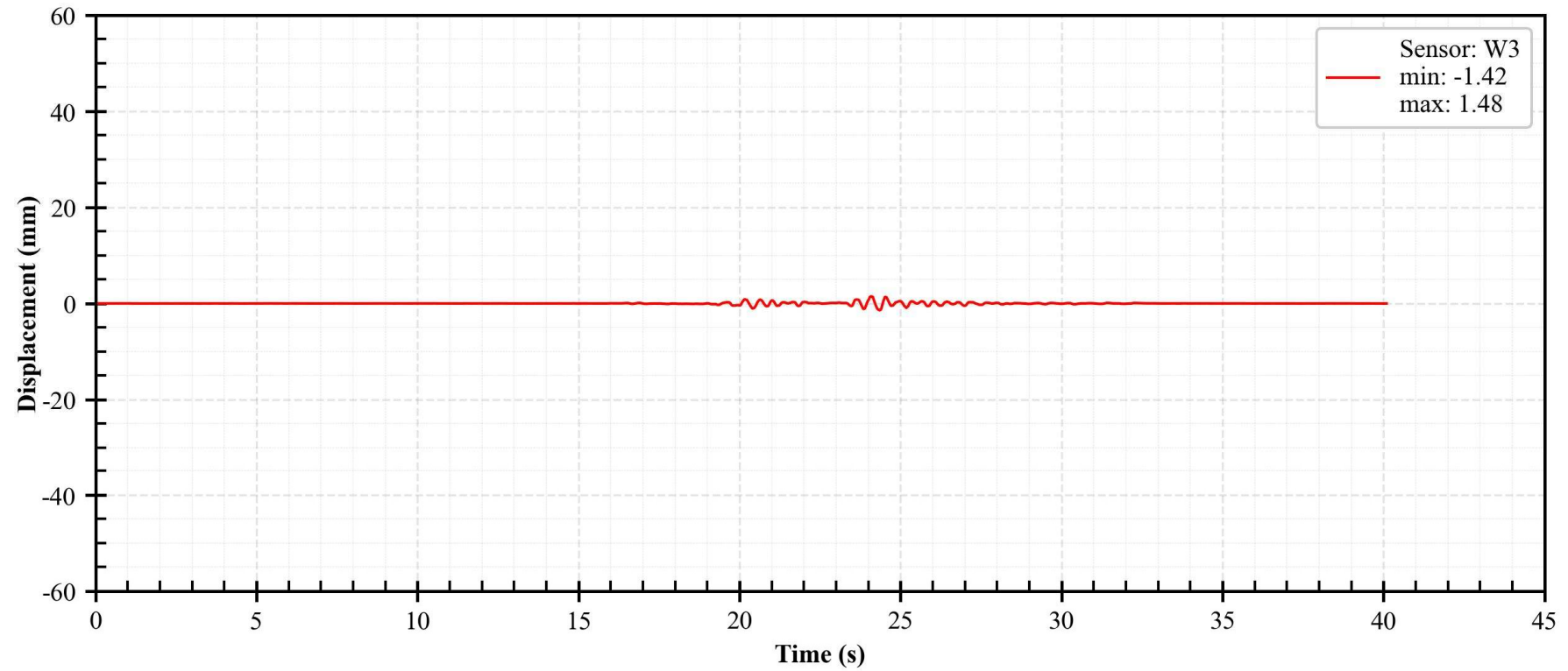


Figure 3.3.15 Characteristic results for phase B (earthquake EQ0,07g): Draw wire sensor 3

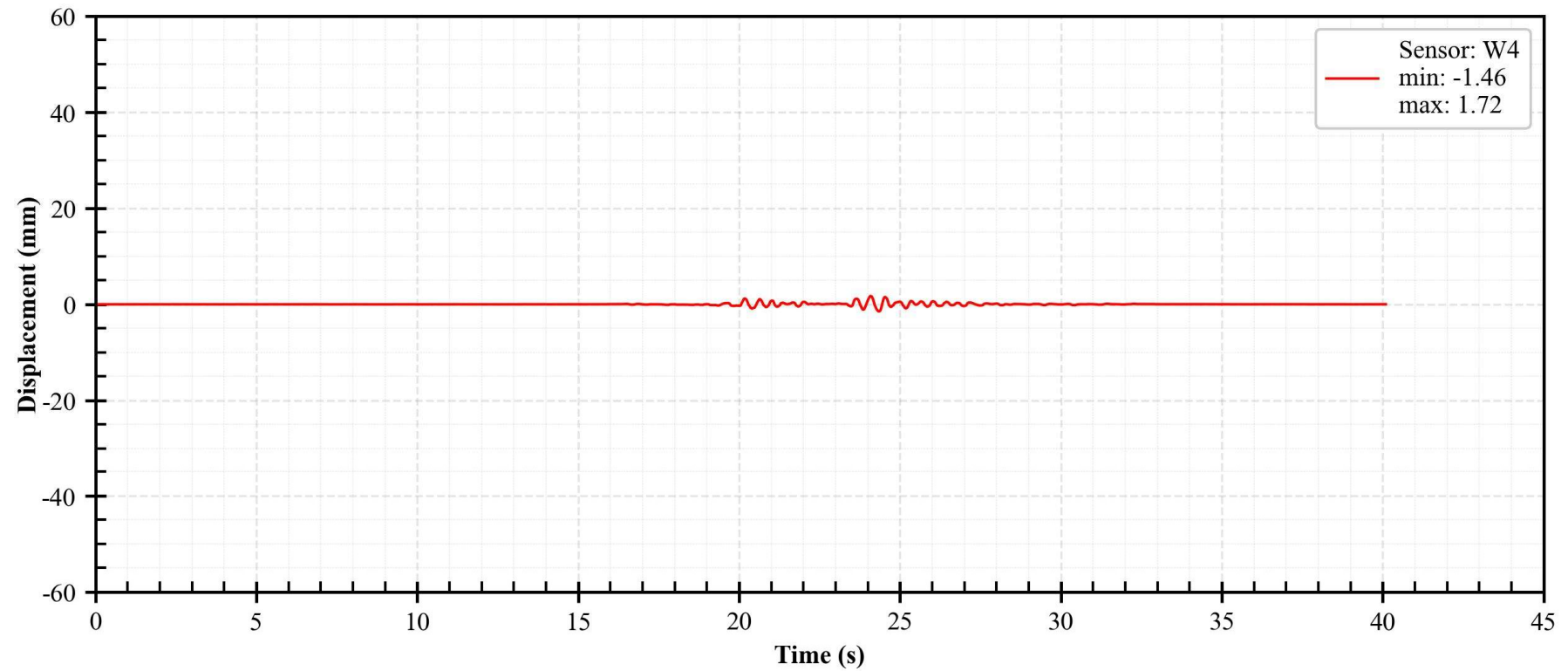


Figure 3.3.16 Characteristic results for phase B (earthquake EQ0,07g): Draw wire sensor 4

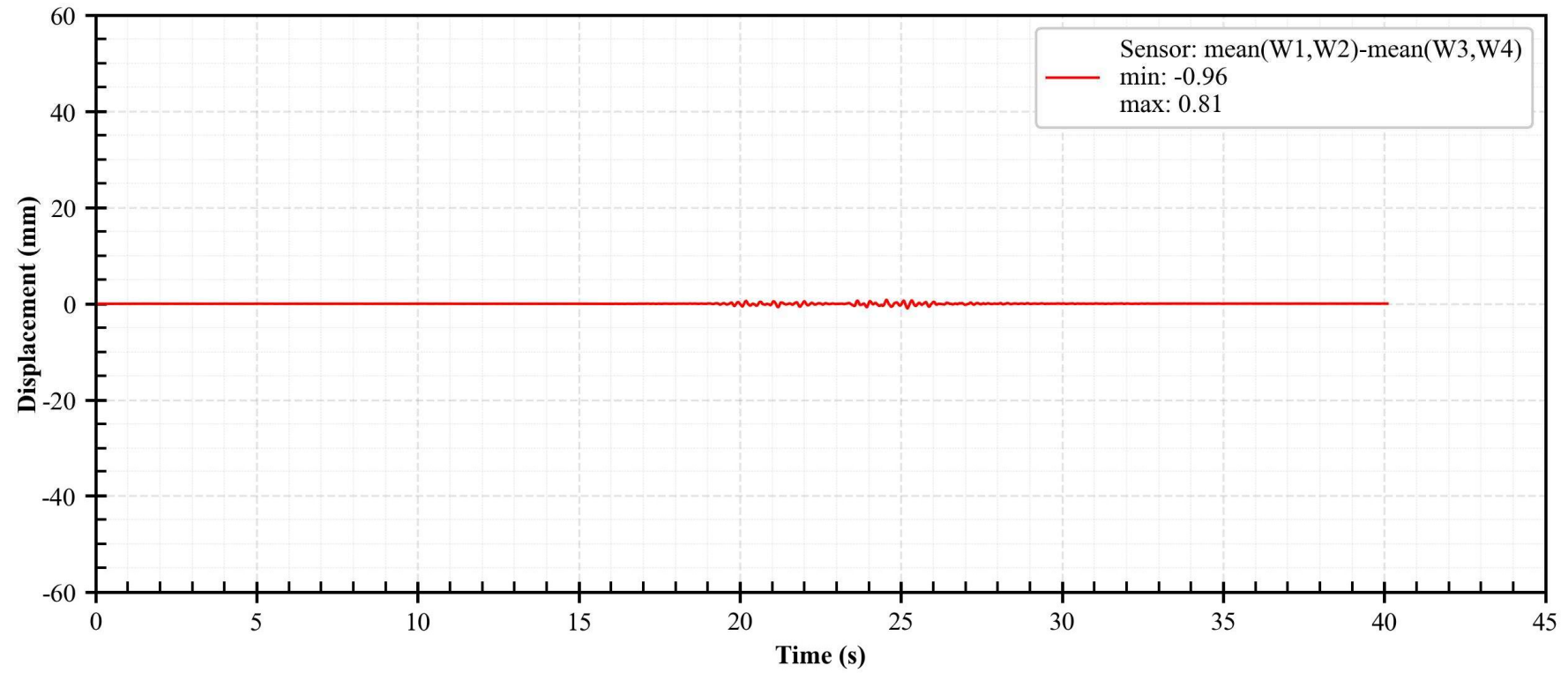


Figure 3.3.17 Characteristic results for phase B (earthquake EQ0,07g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.3.18, 3.3.19, 3.3.20, 3.3.21, 3.3.22, 3.3.23, 3.3.32, 3.3.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.3.24, 3.3.25, 3.3.26, 3.3.27, 3.3.28, 3.3.29 and 3.3.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 103 μ strain and minimum strain -134 μ strain. The residual strain is -1 μ strain. SG21 & SG22 are located on PUFJ.

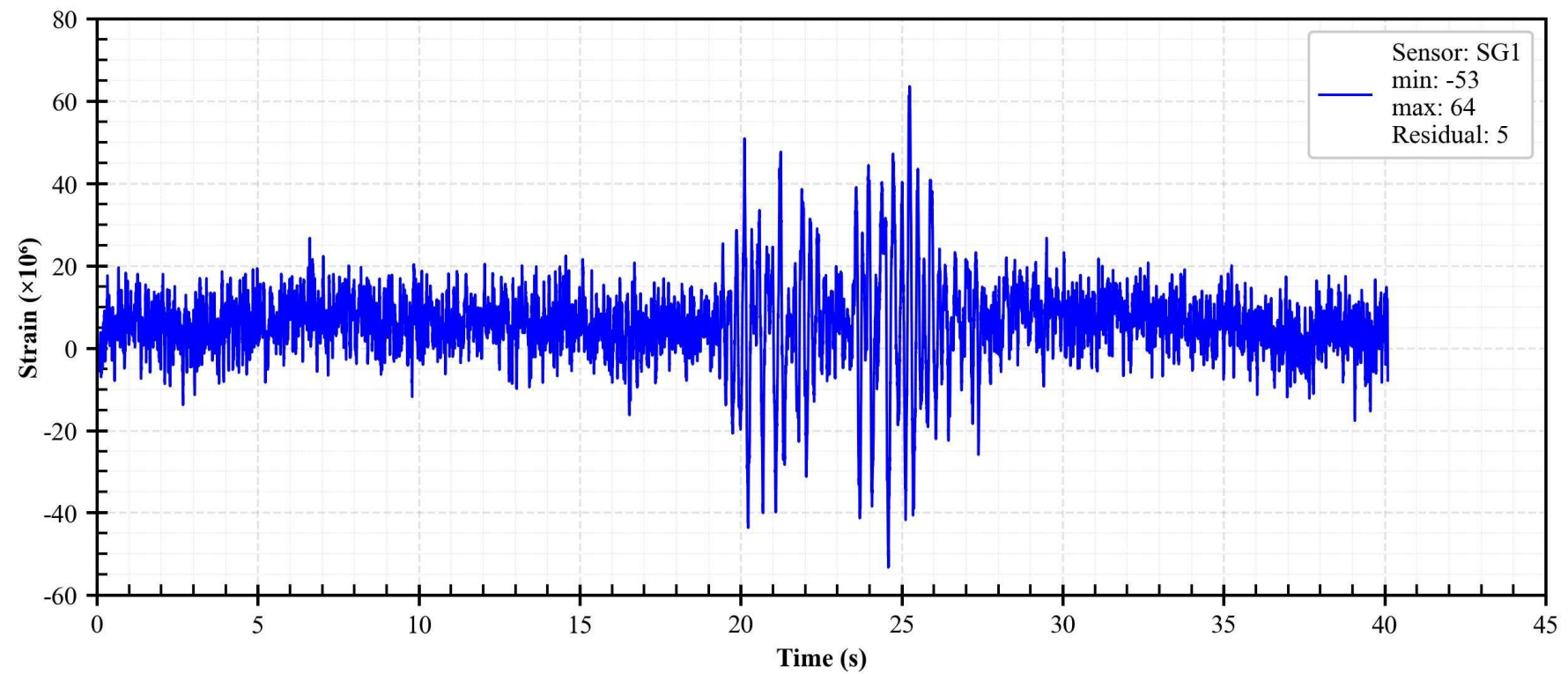


Figure 3.3.18 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 1

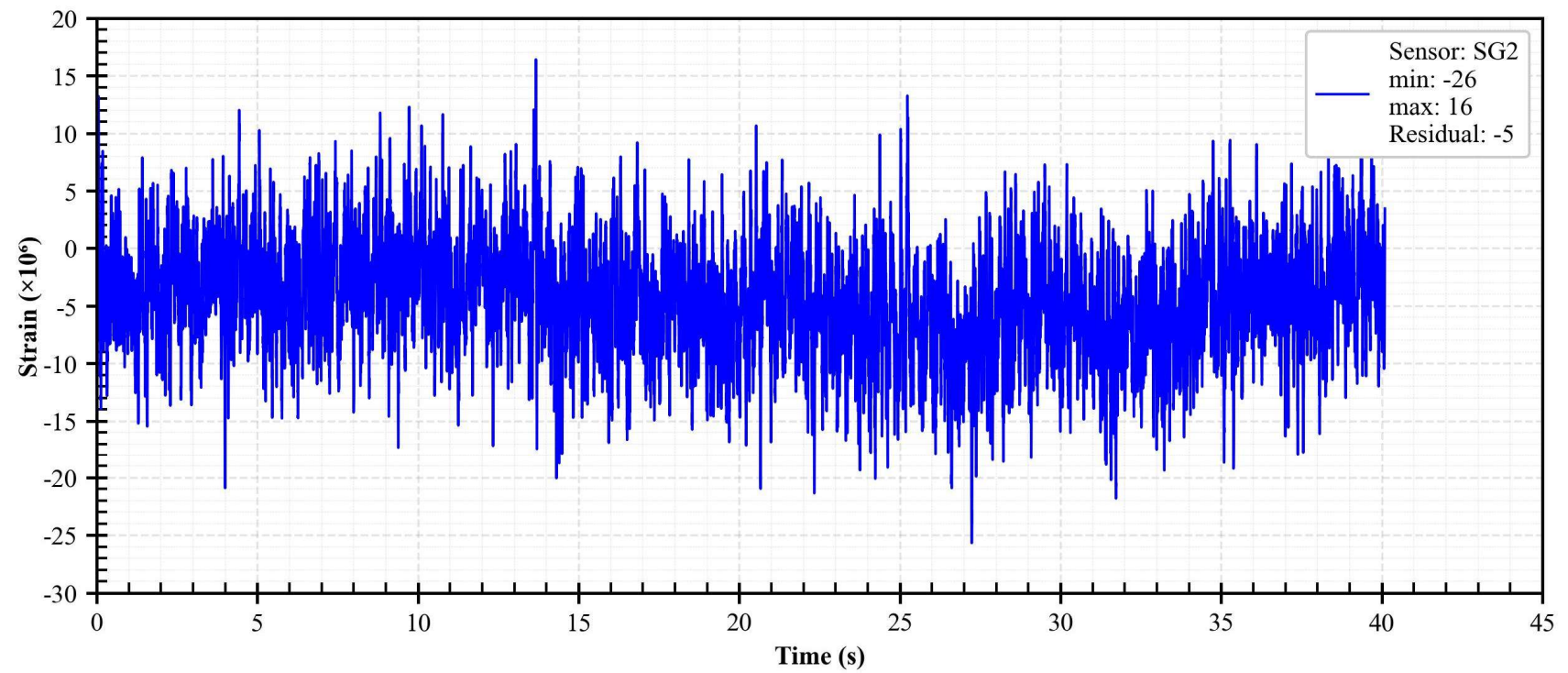


Figure 3.3.19 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 2

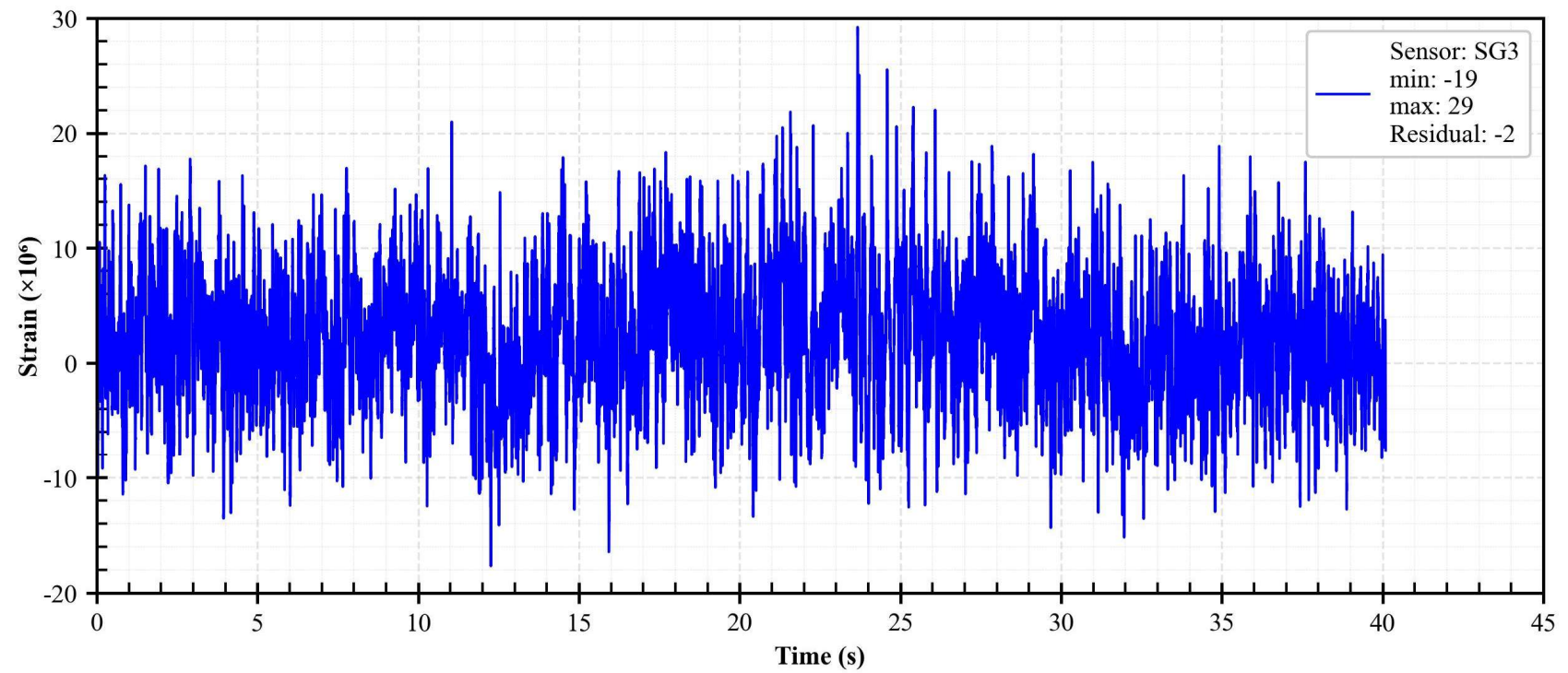


Figure 3.3.20 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 3

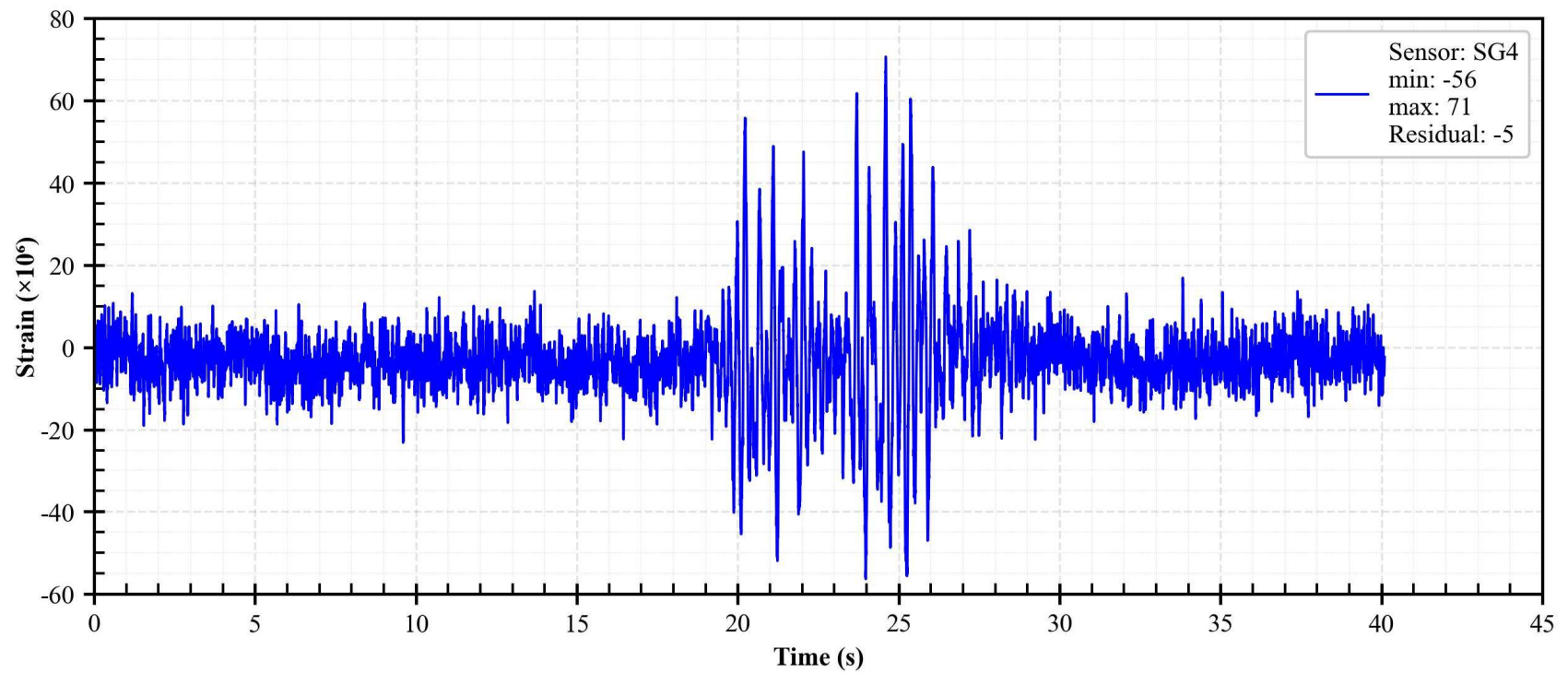


Figure 3.3.21 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 4

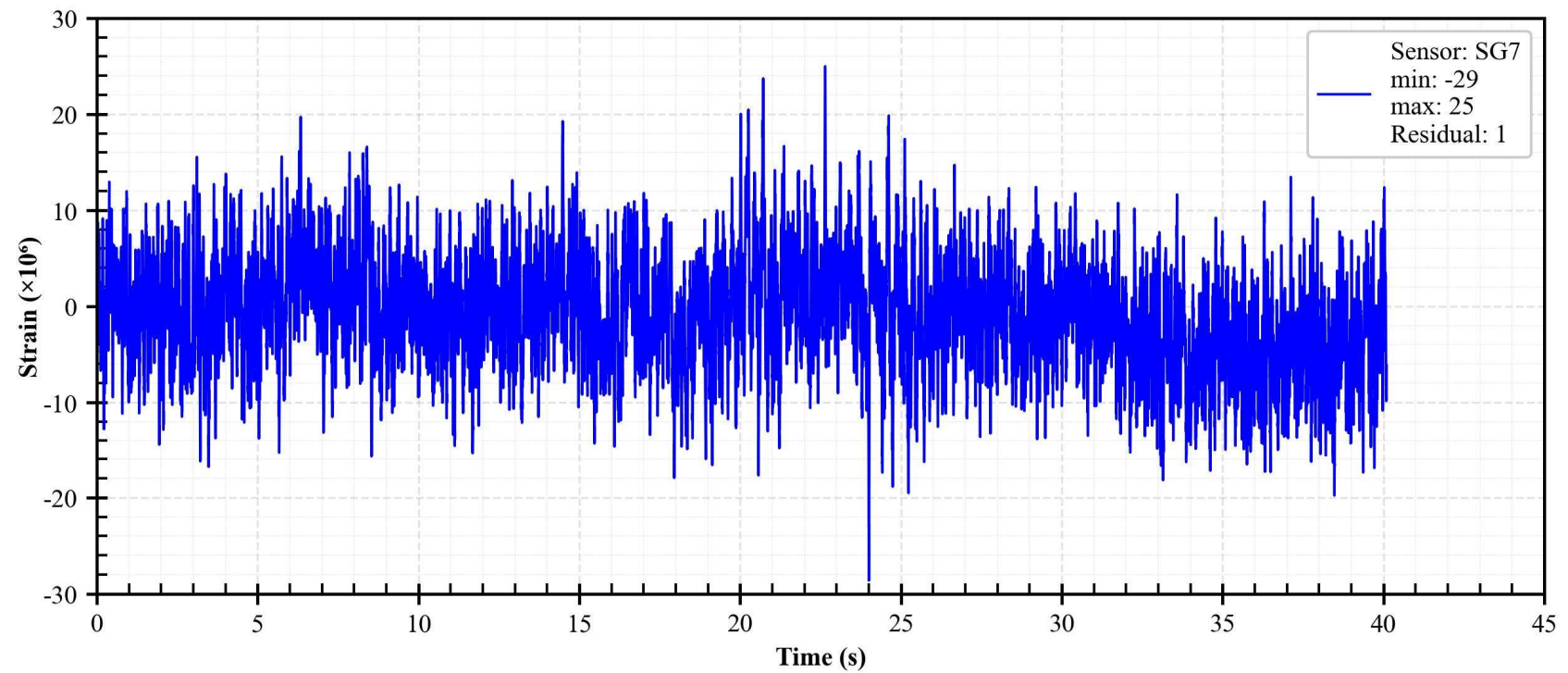


Figure 3.3.22 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 7

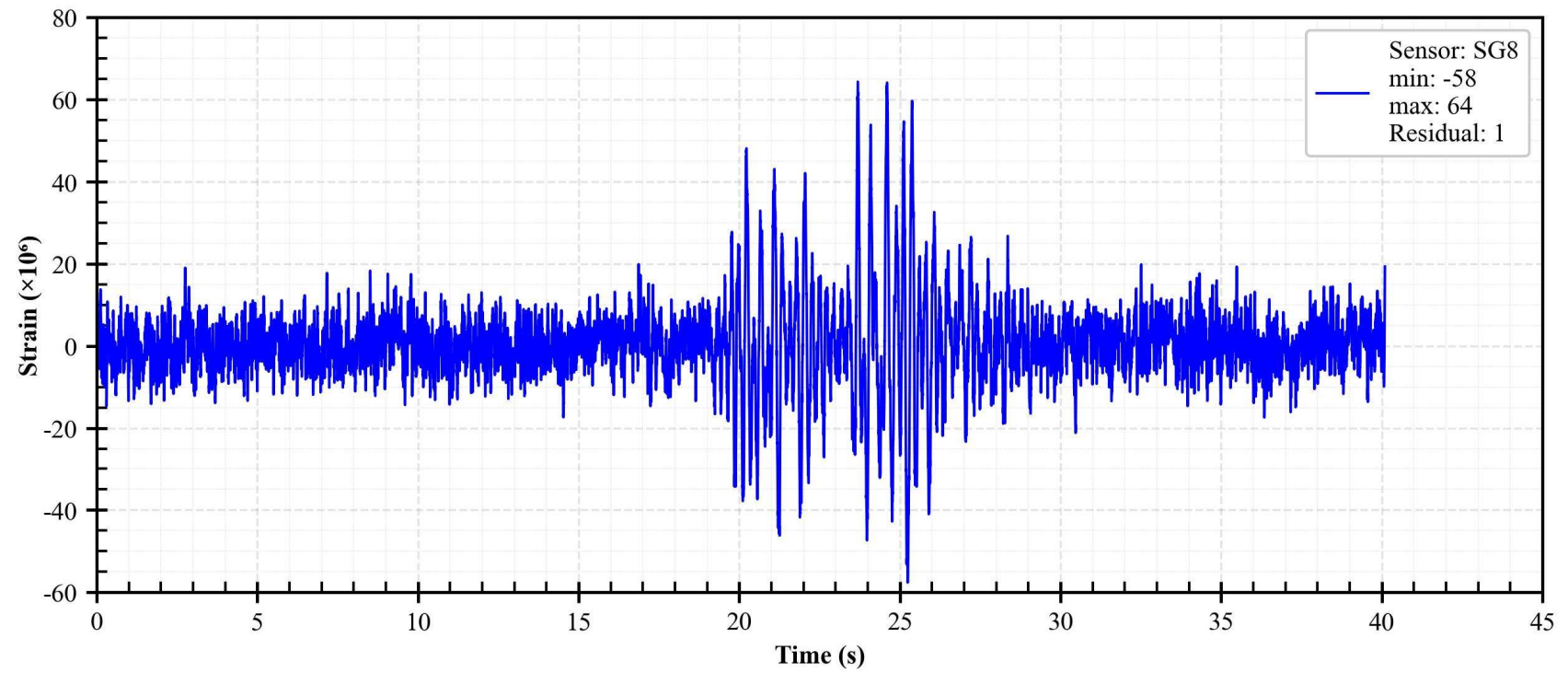


Figure 3.3.23 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 8

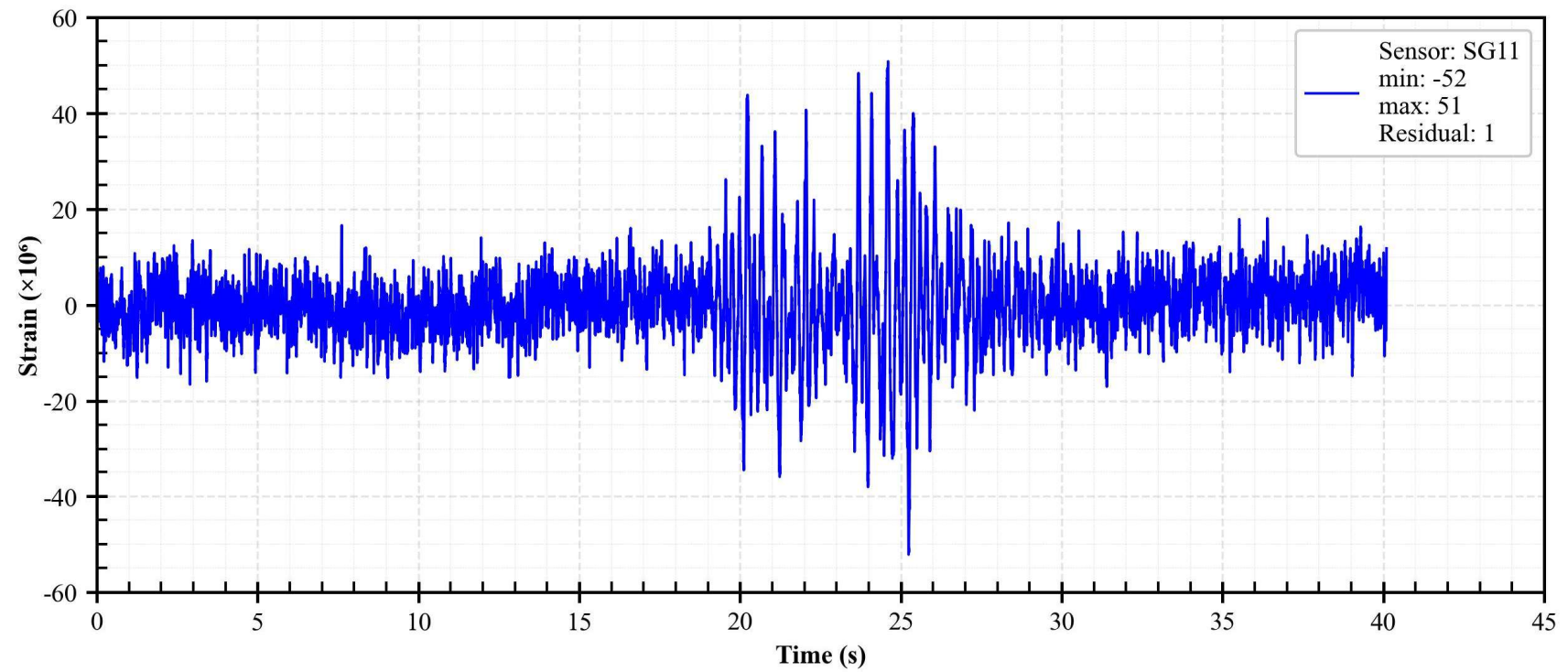


Figure 3.3.24 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 11

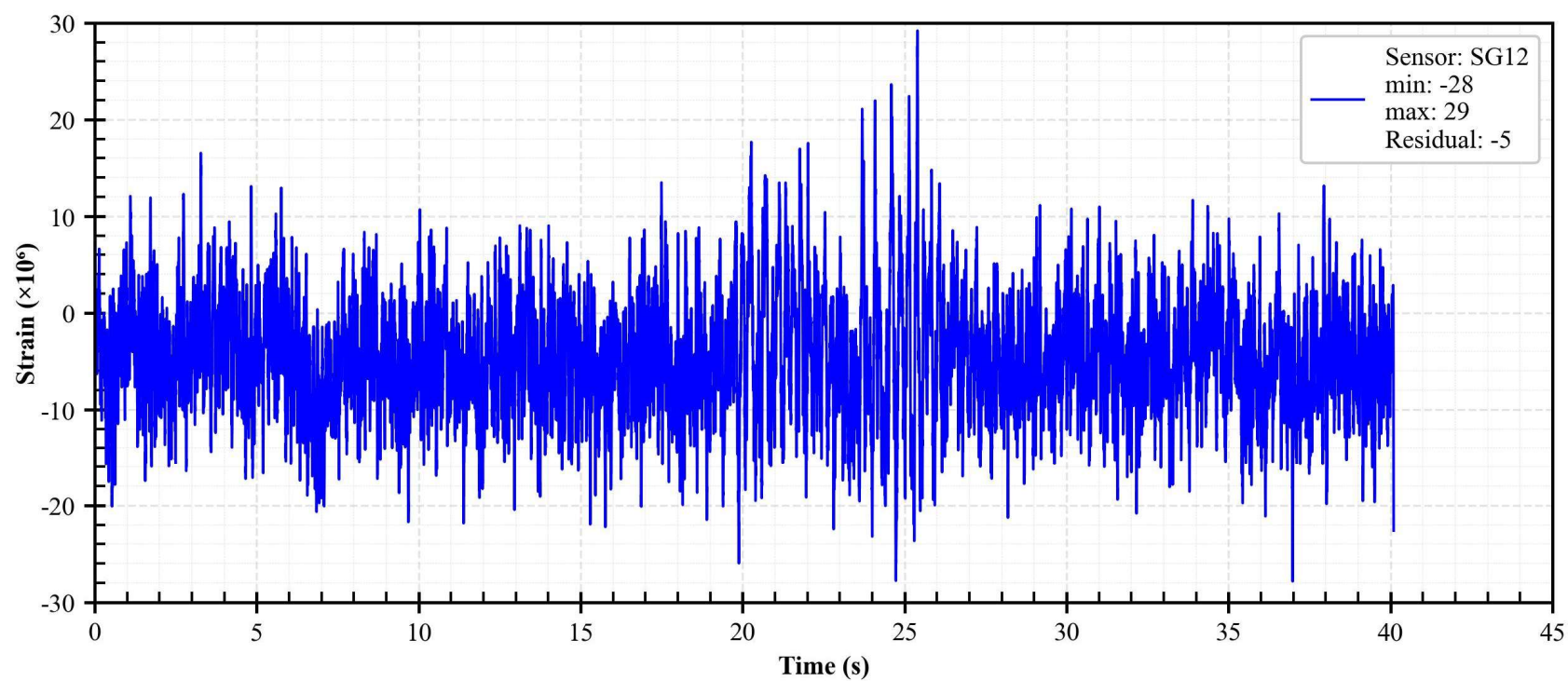


Figure 3.3.25 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 12

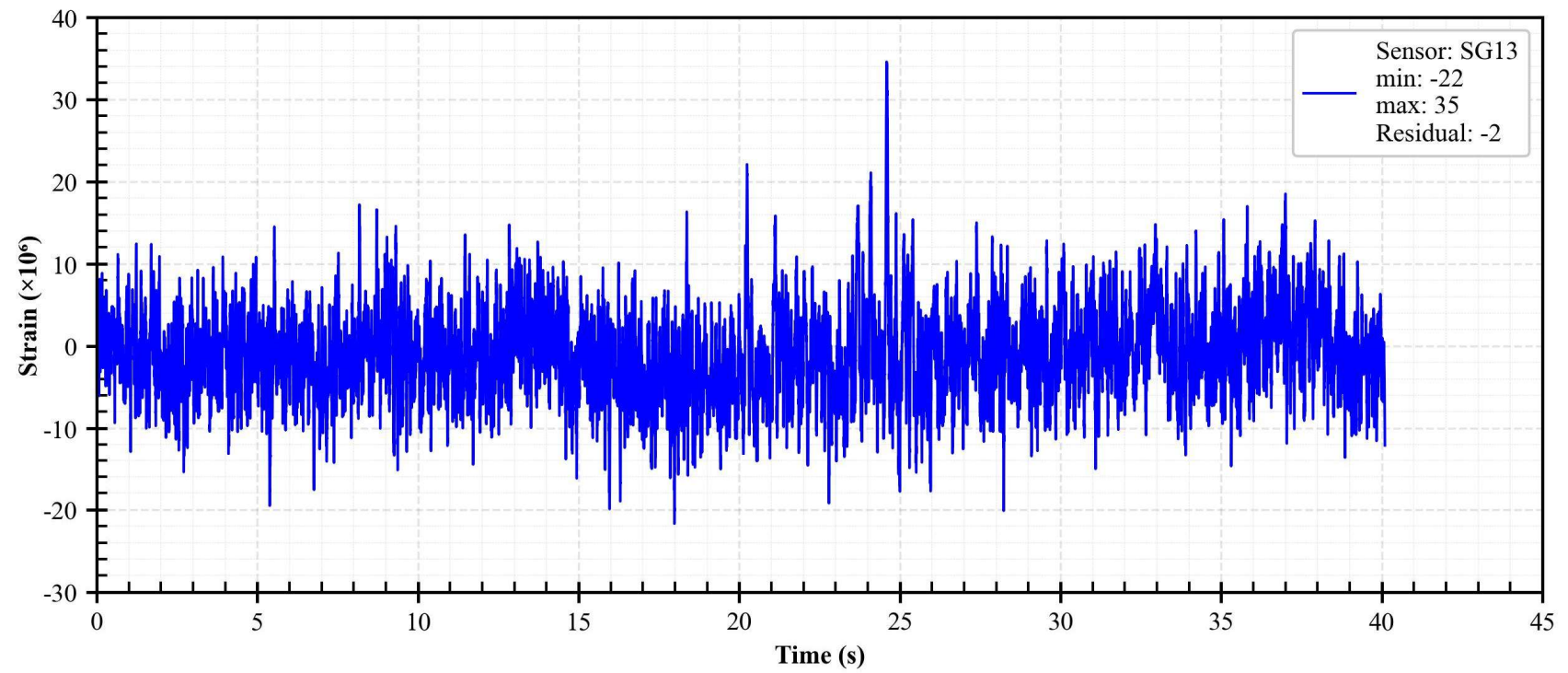


Figure 3.3.26 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 13

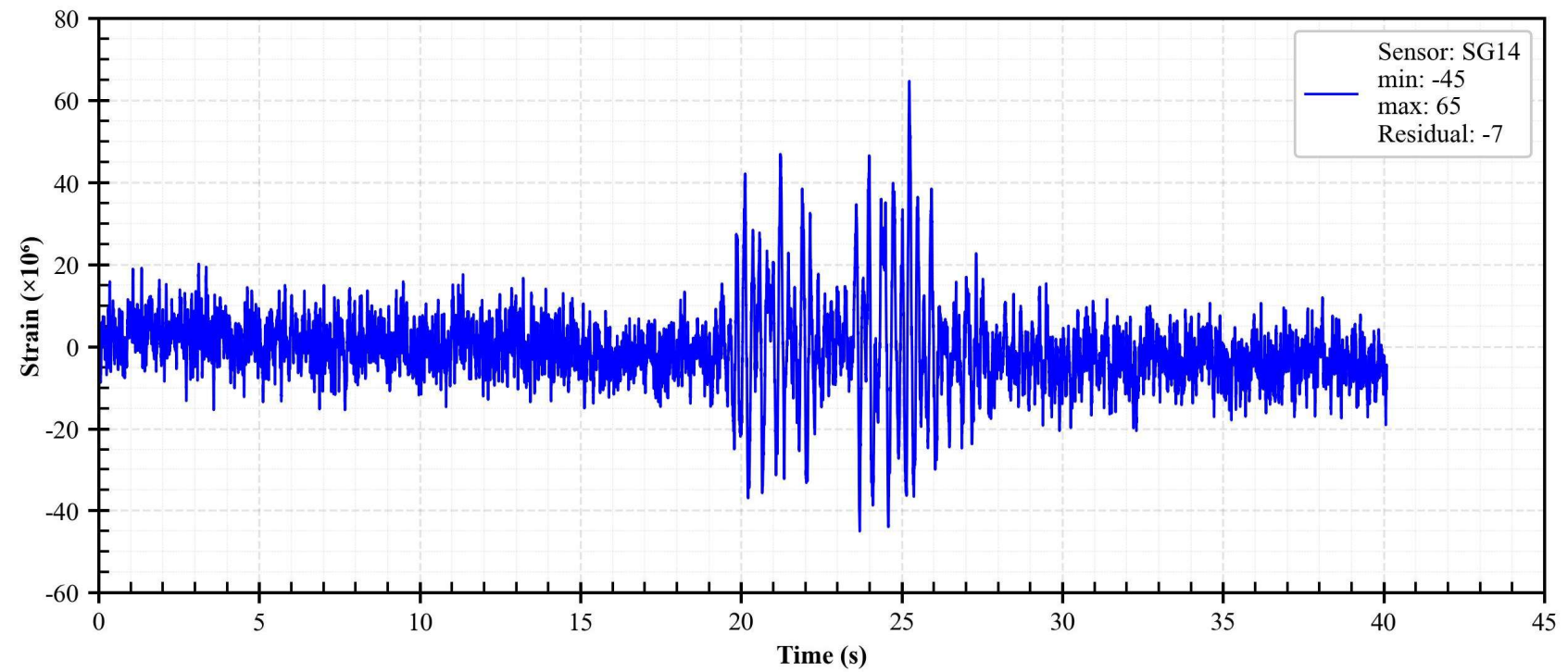


Figure 3.3.27 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 14

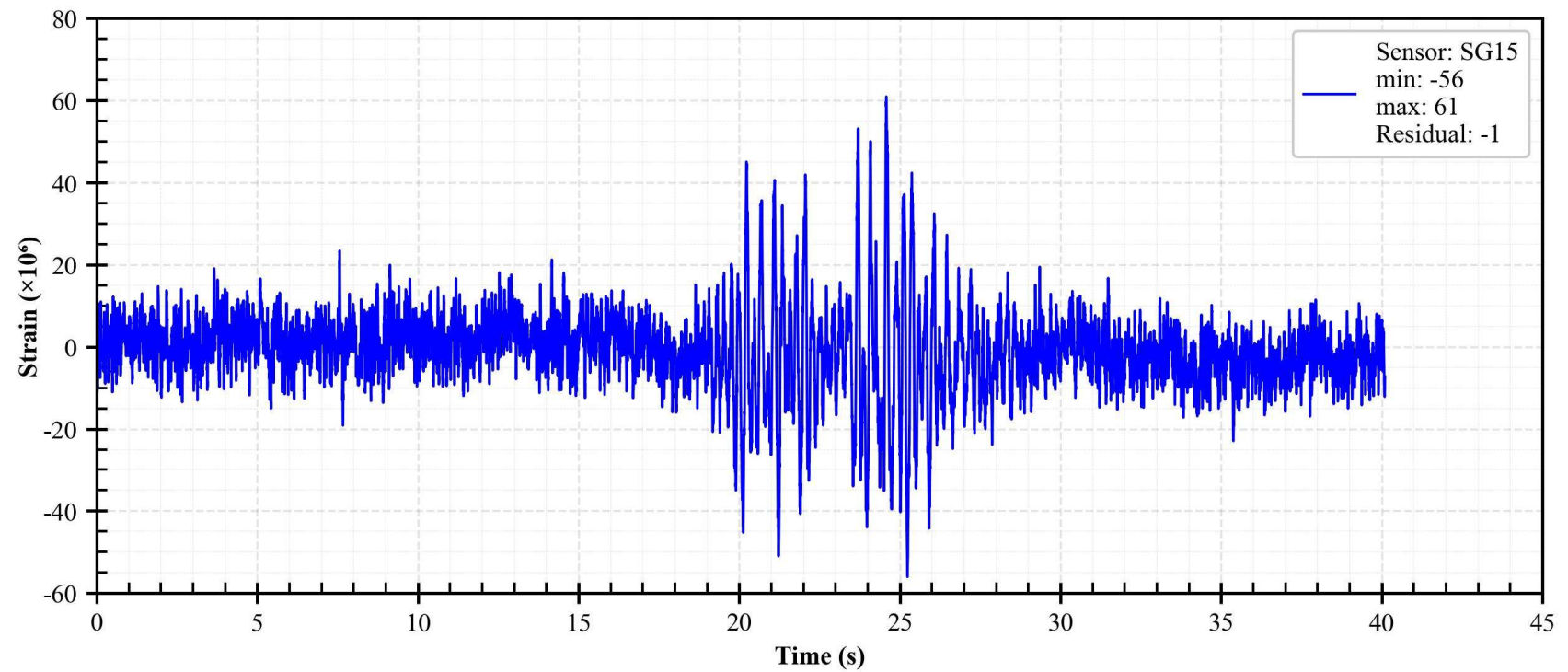


Figure 3.3.28 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 15

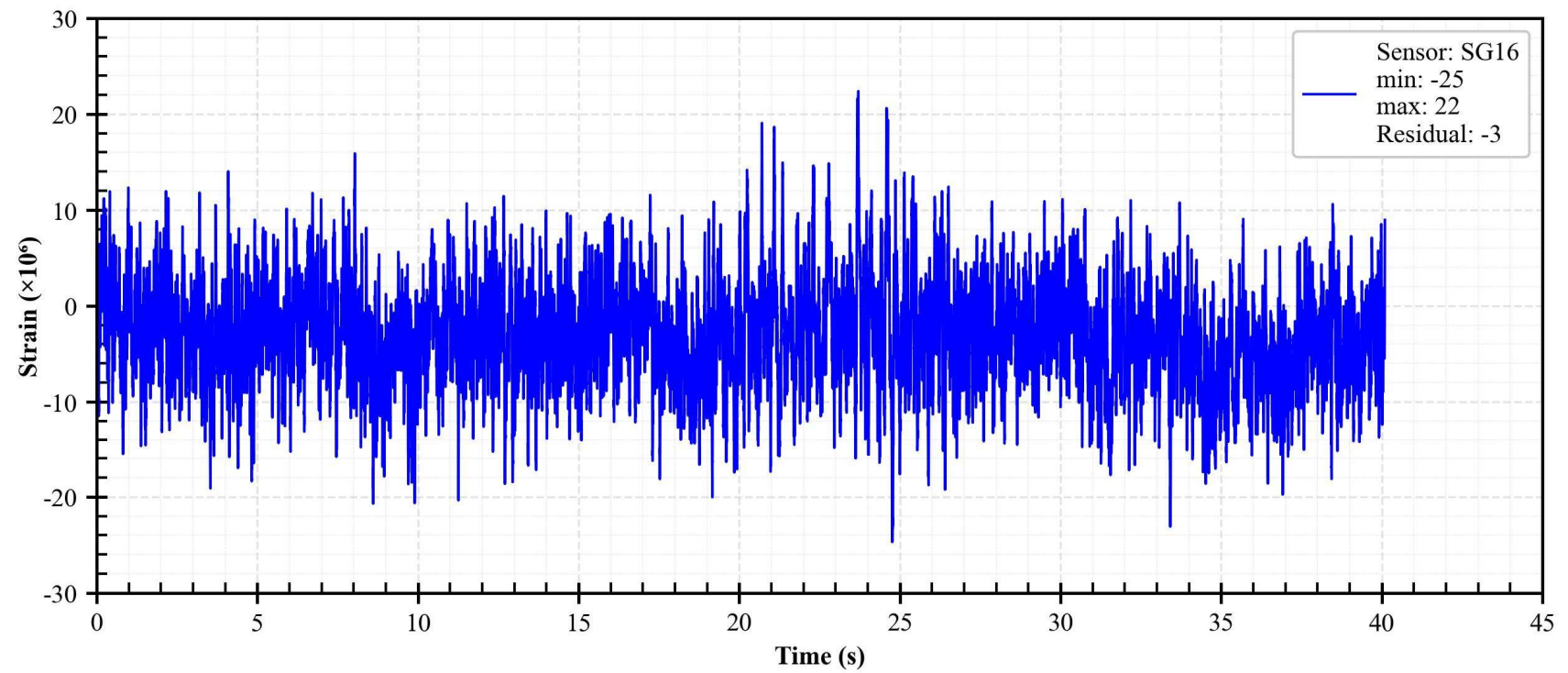


Figure 3.3.29 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 16

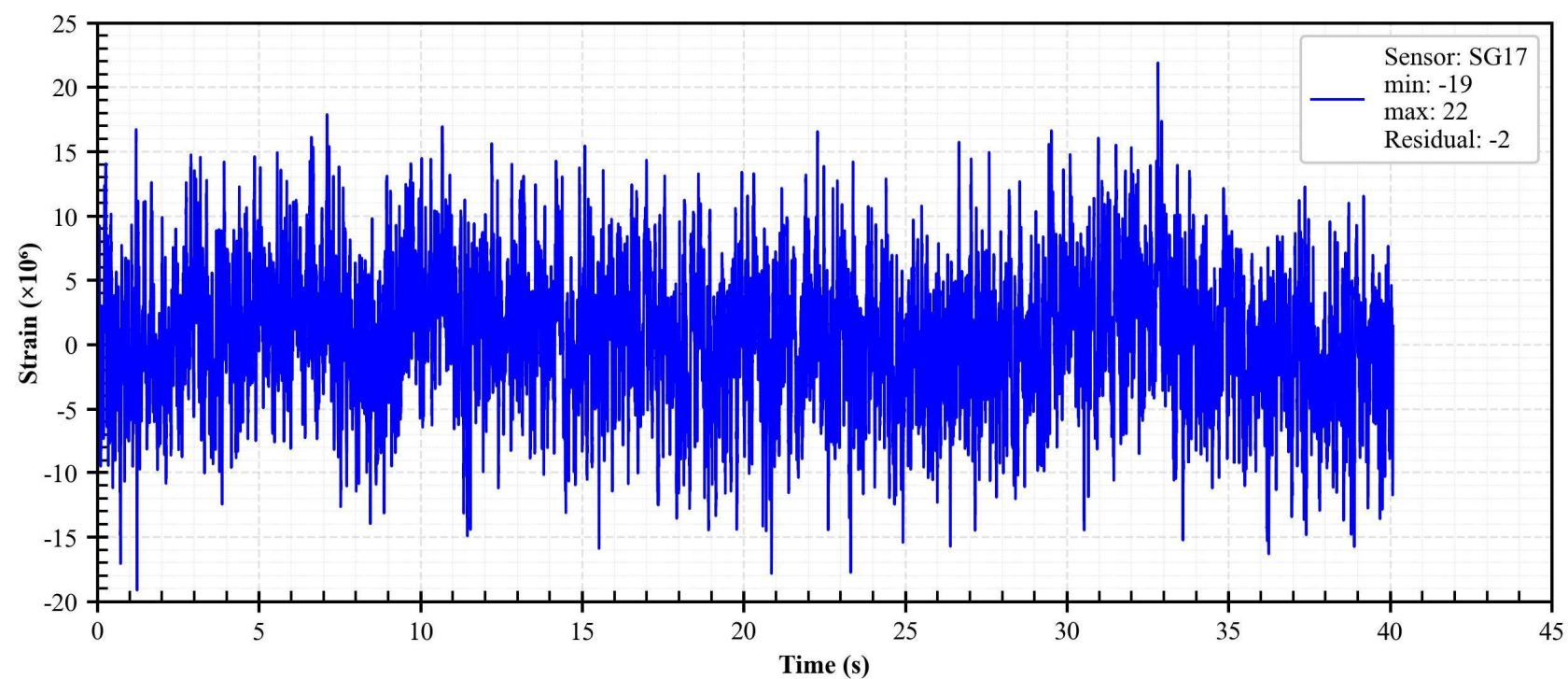


Figure 3.3.30 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 17

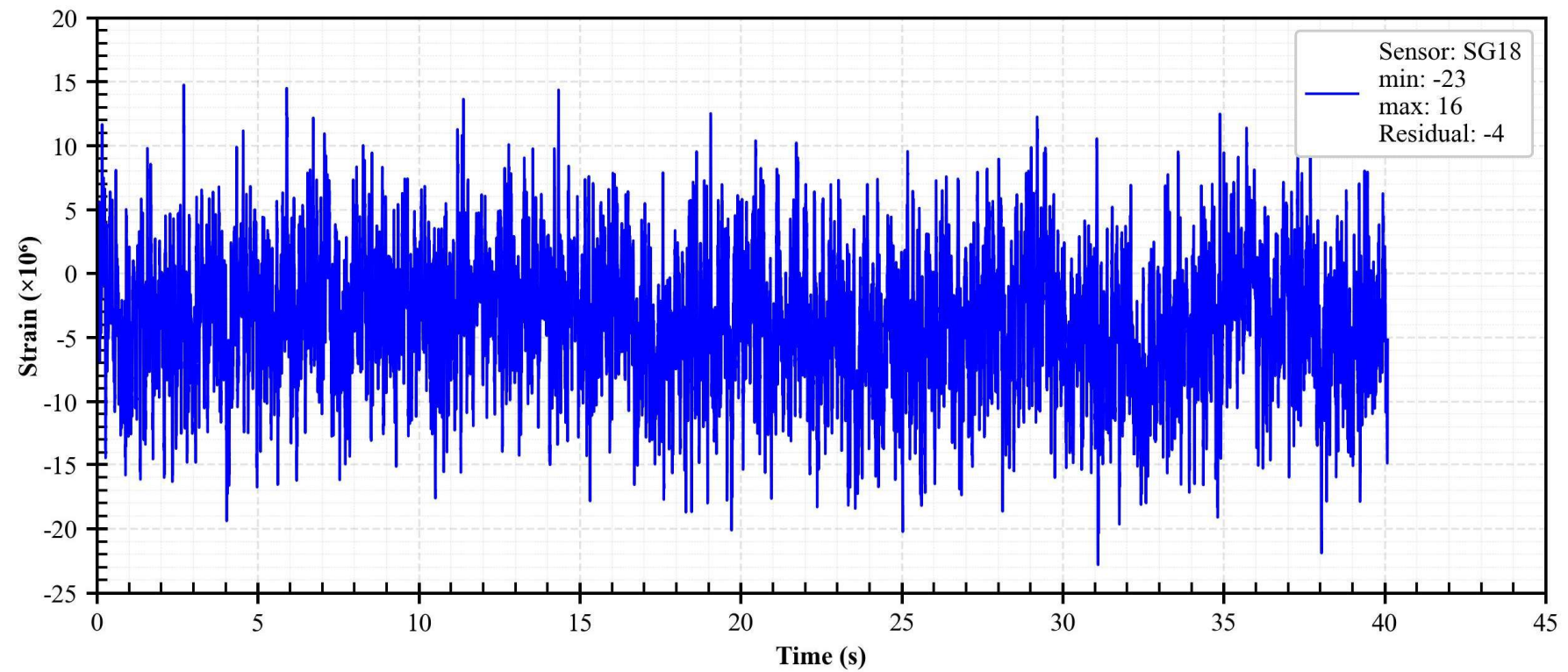


Figure 3.3.31 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 18

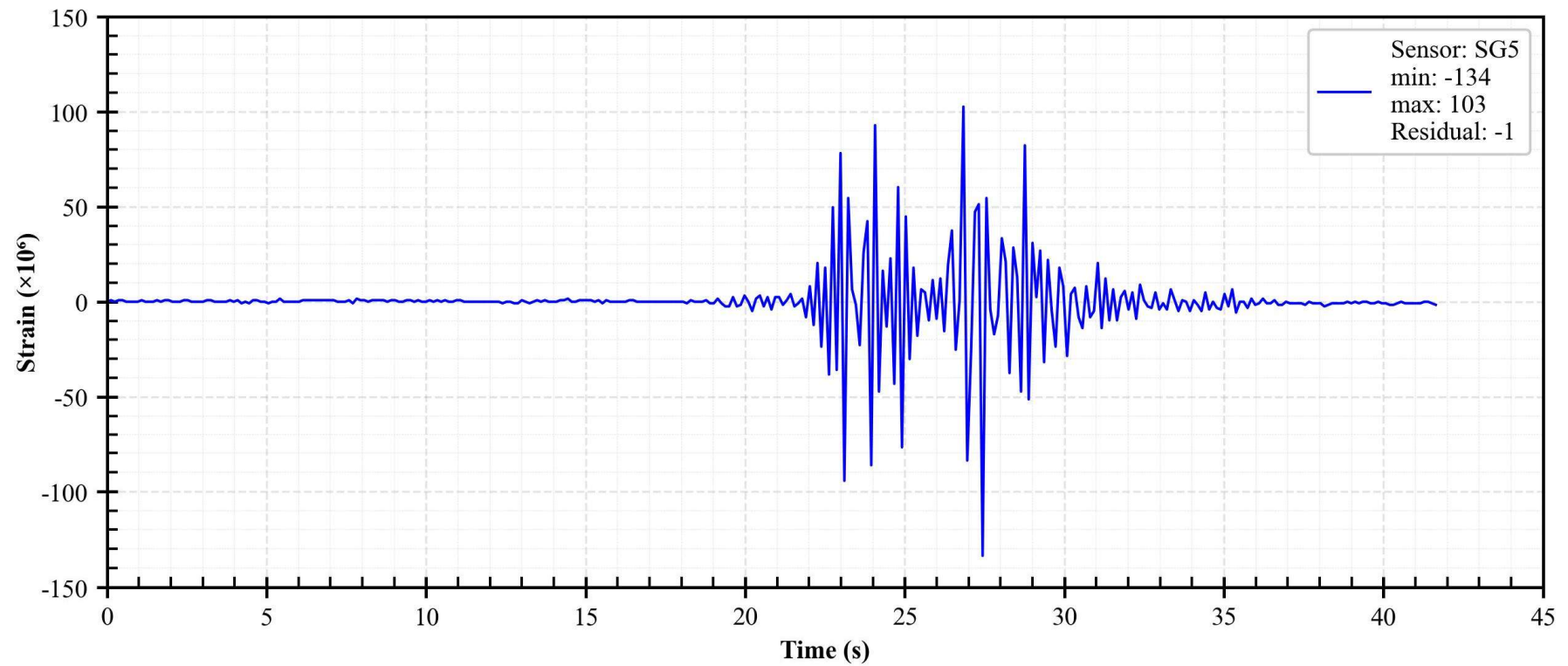


Figure 3.3.32 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 5

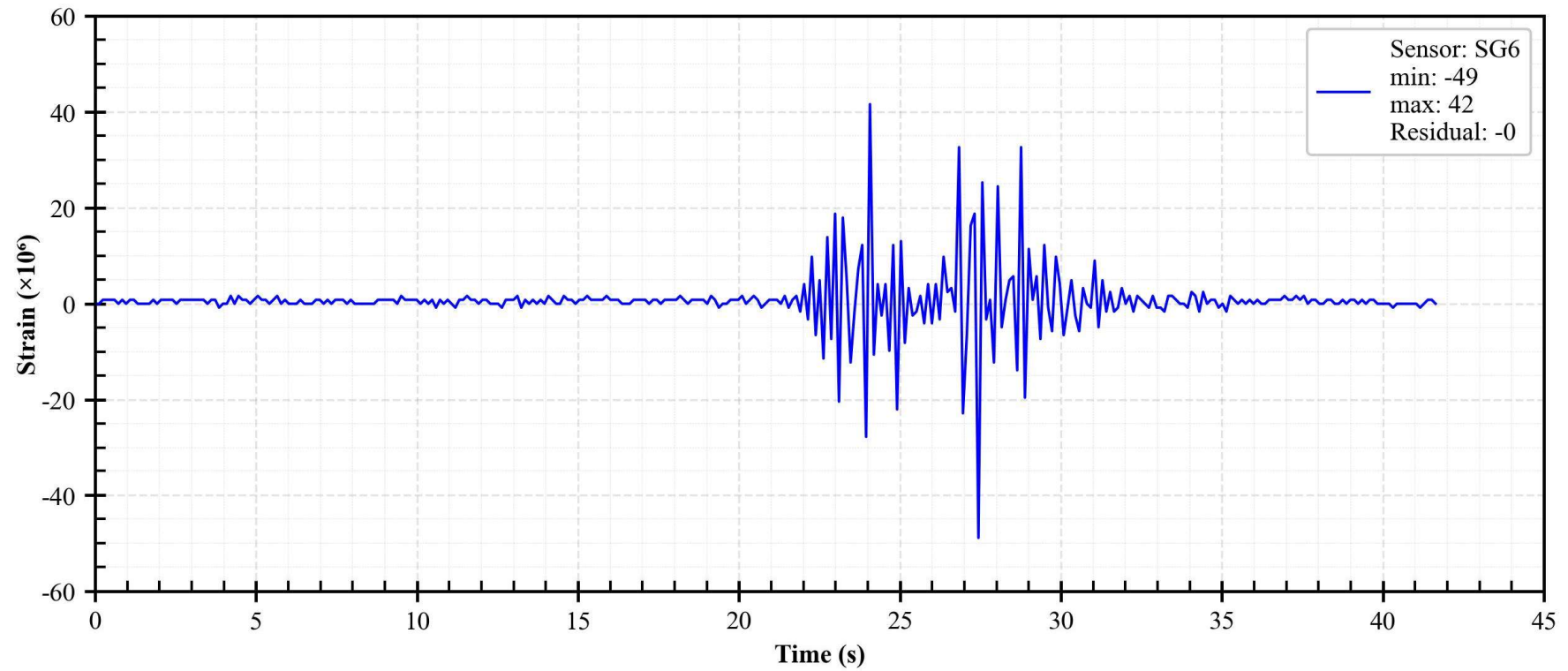


Figure 3.3.33 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 6

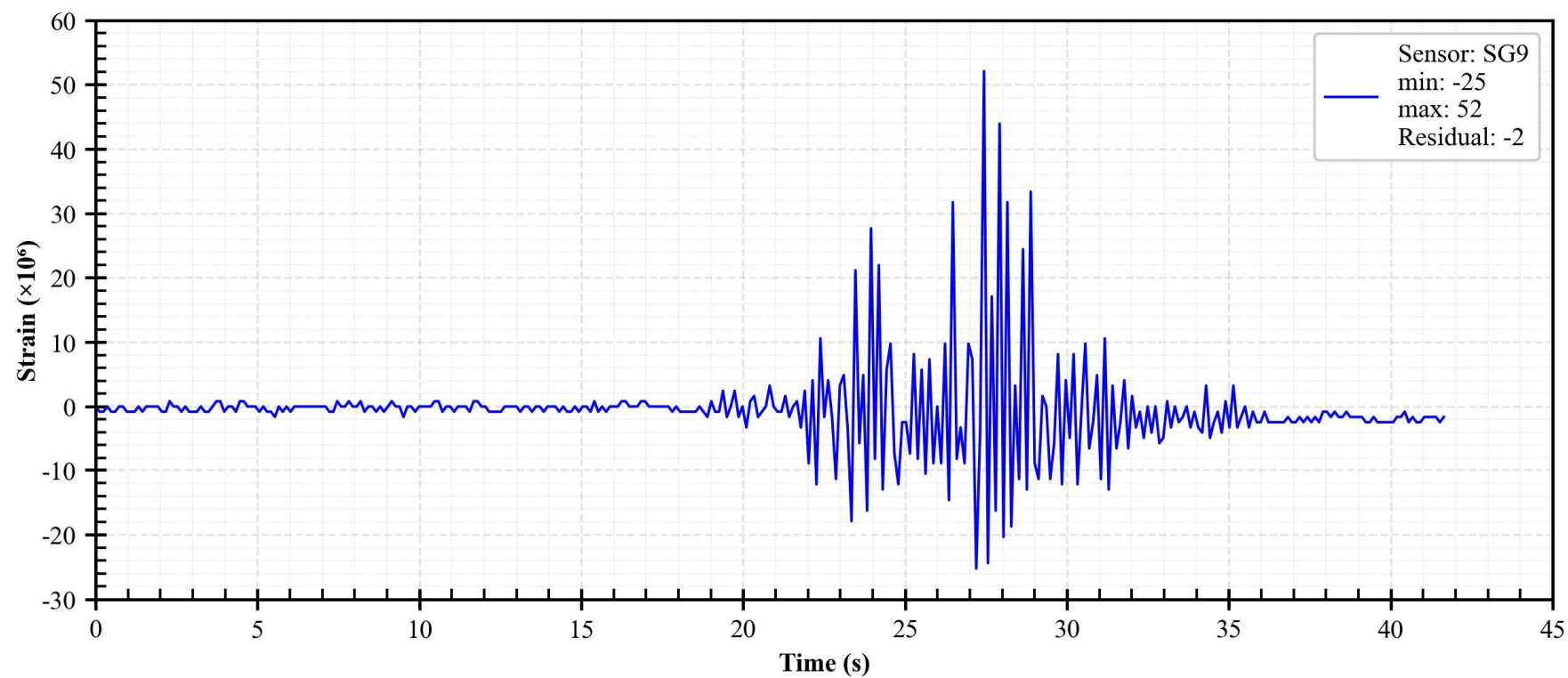


Figure 3.3.34 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 9

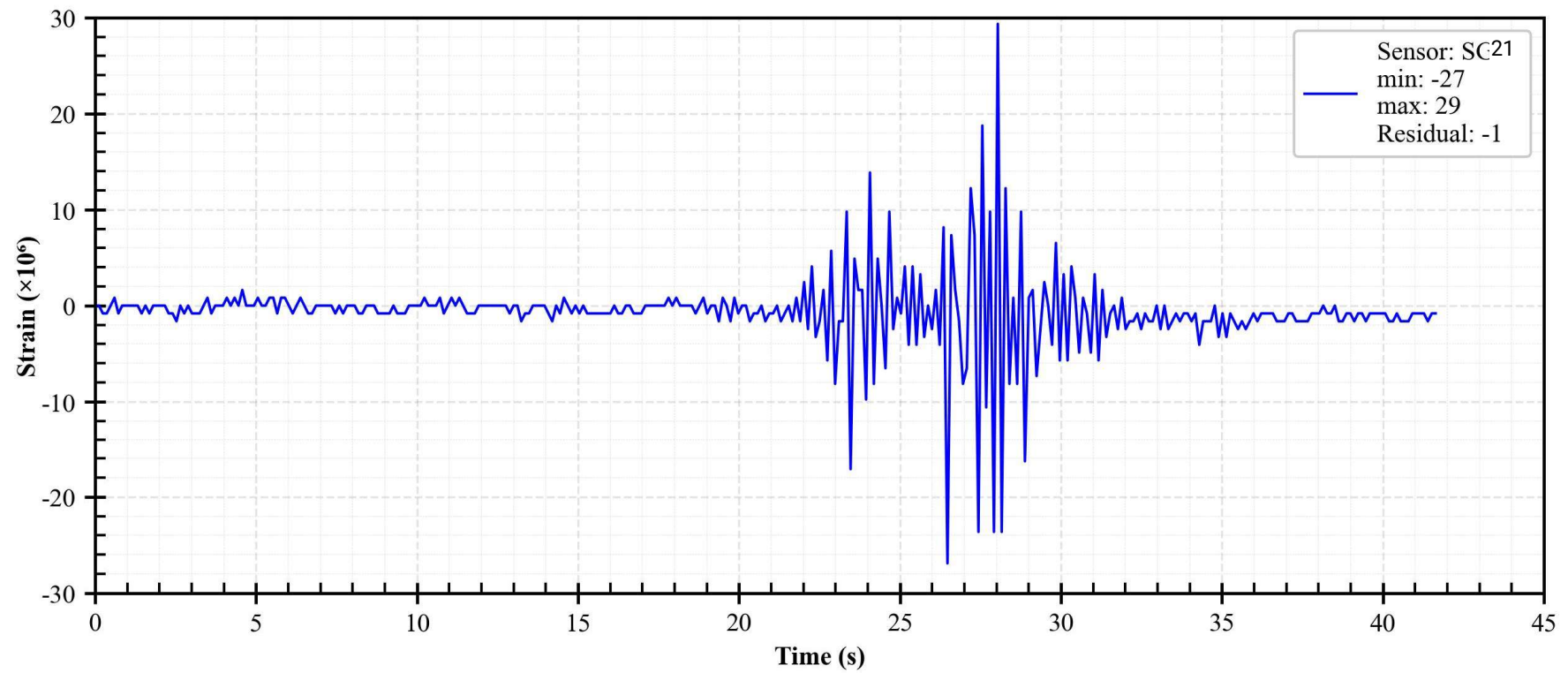


Figure 3.3.35 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 21 (PUFJ, column 1)

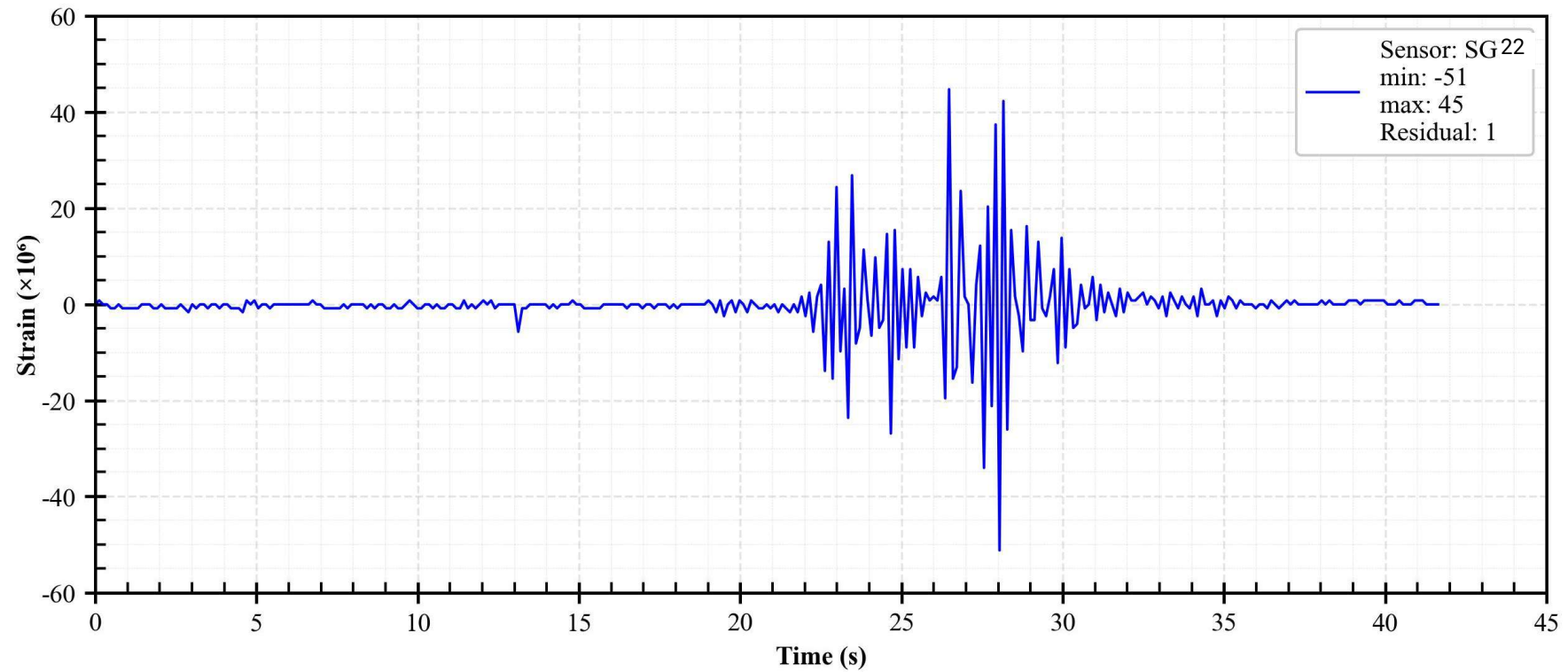


Figure 3.3.36 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 22 (PUFJ, column 2)

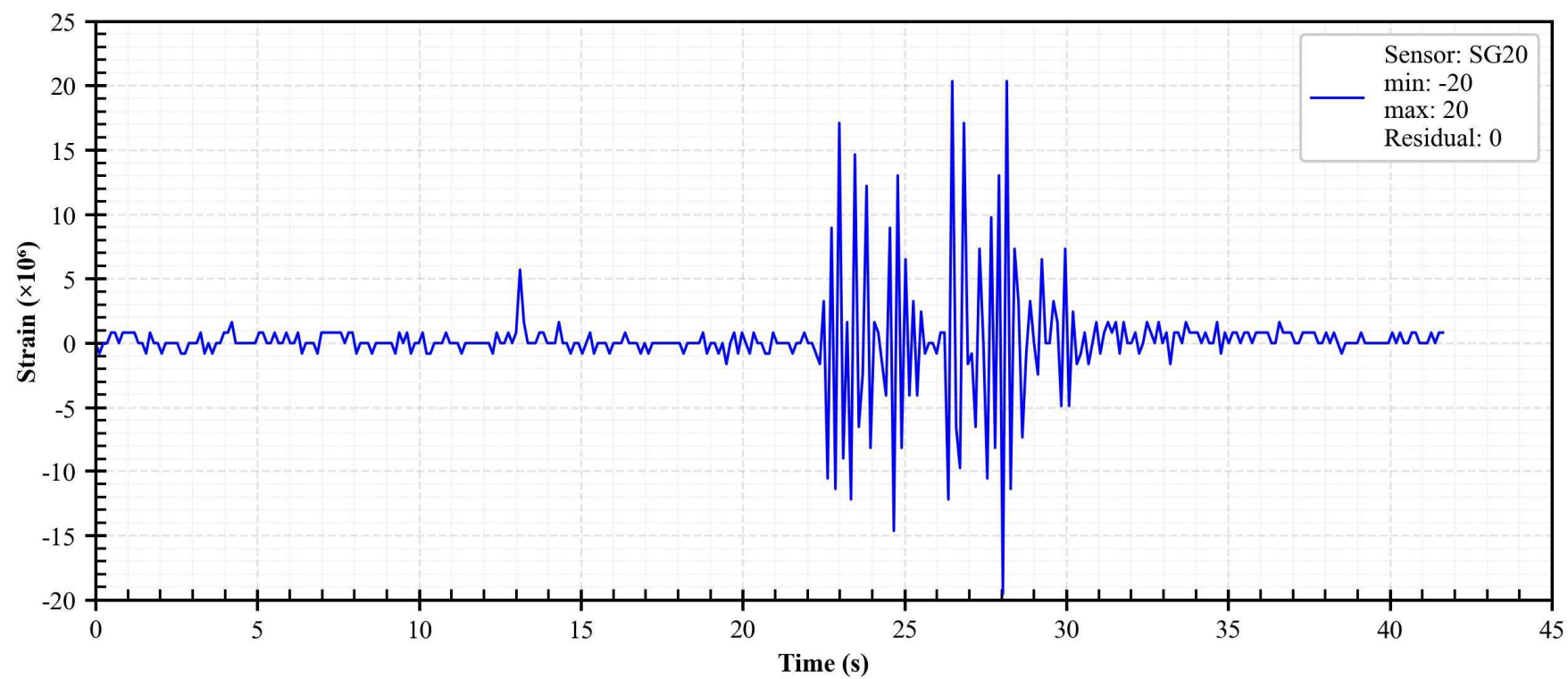


Figure 3.3.37 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 20

3.4 Earthquake EQ0,1g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,1g. The max acceleration at the slab level on the accelerometer acc4 is 0.19g. The max acceleration at the foundation level on the accelerometer acc10 is 0.09g.

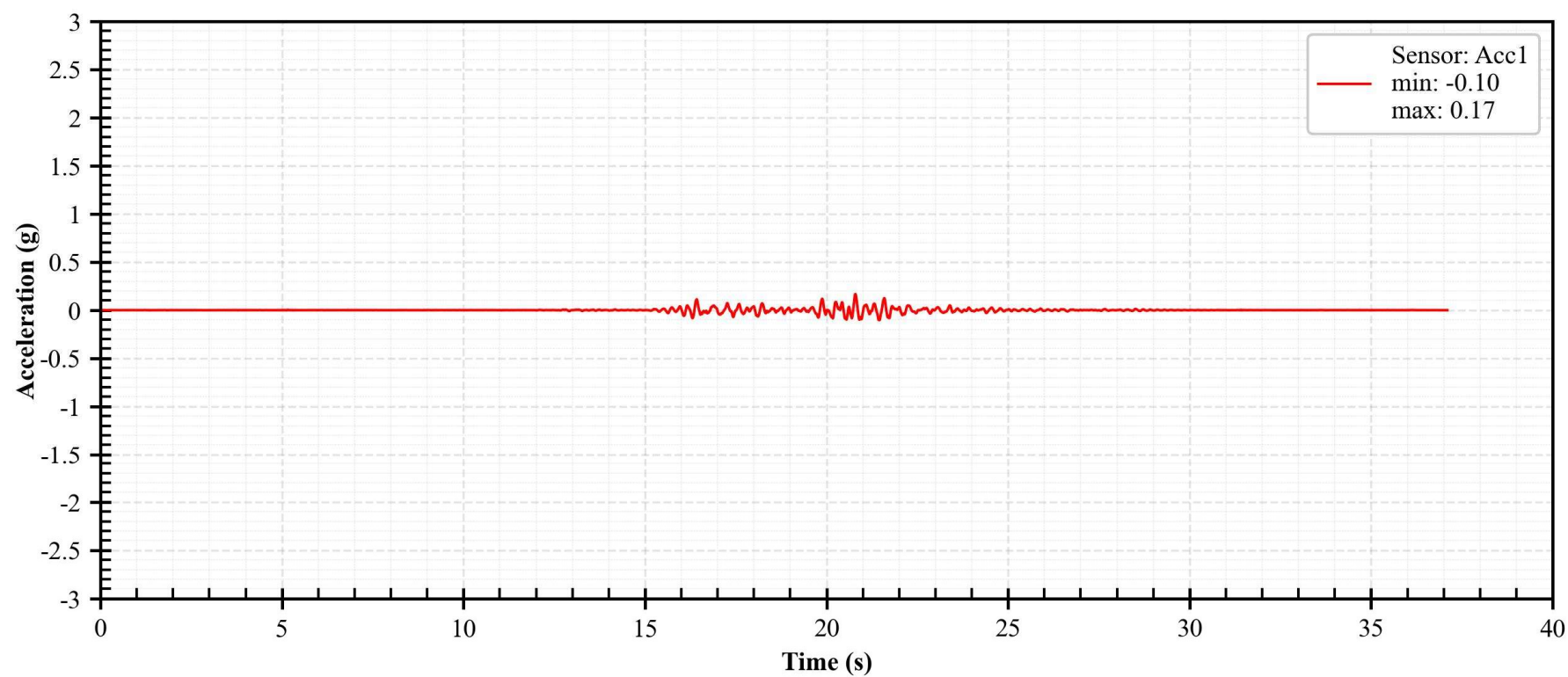


Figure 3.4.1 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 1

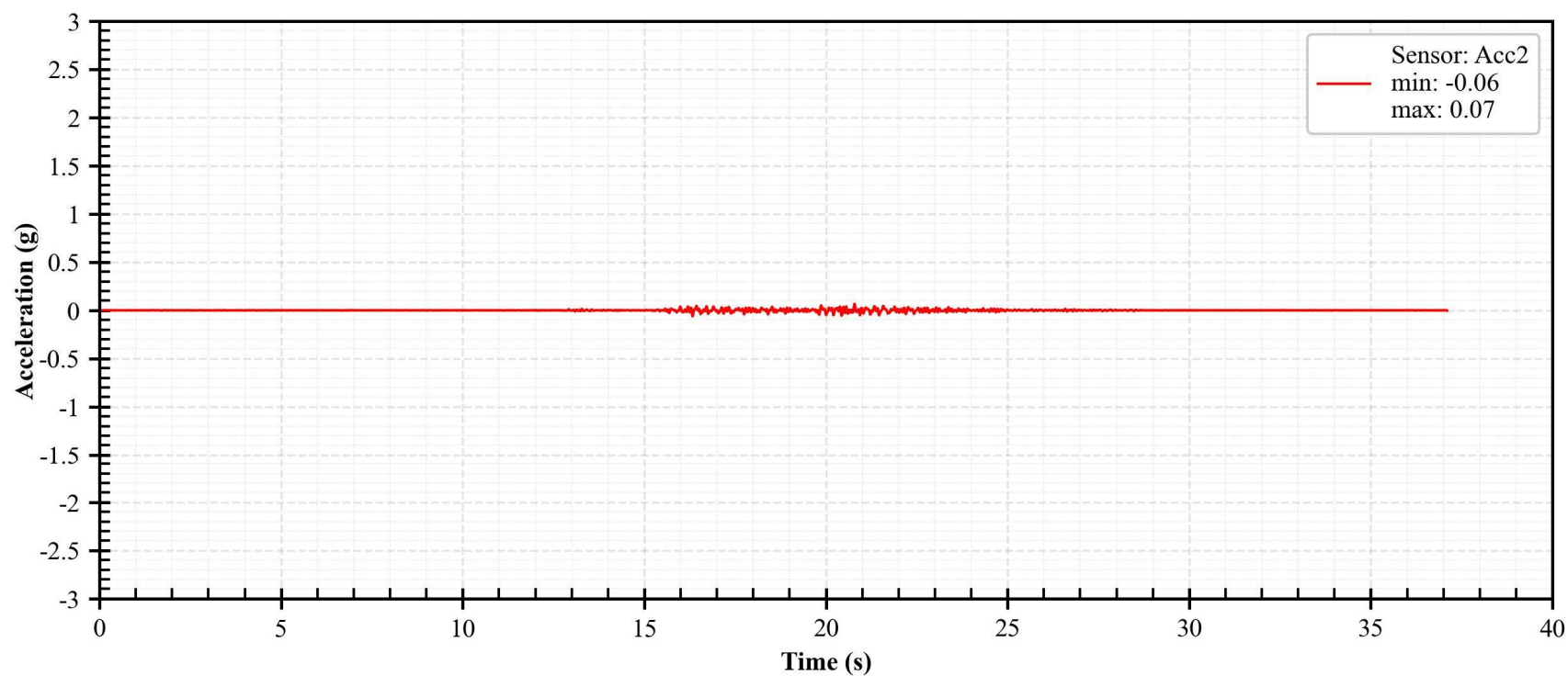


Figure 3.4.2 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 2

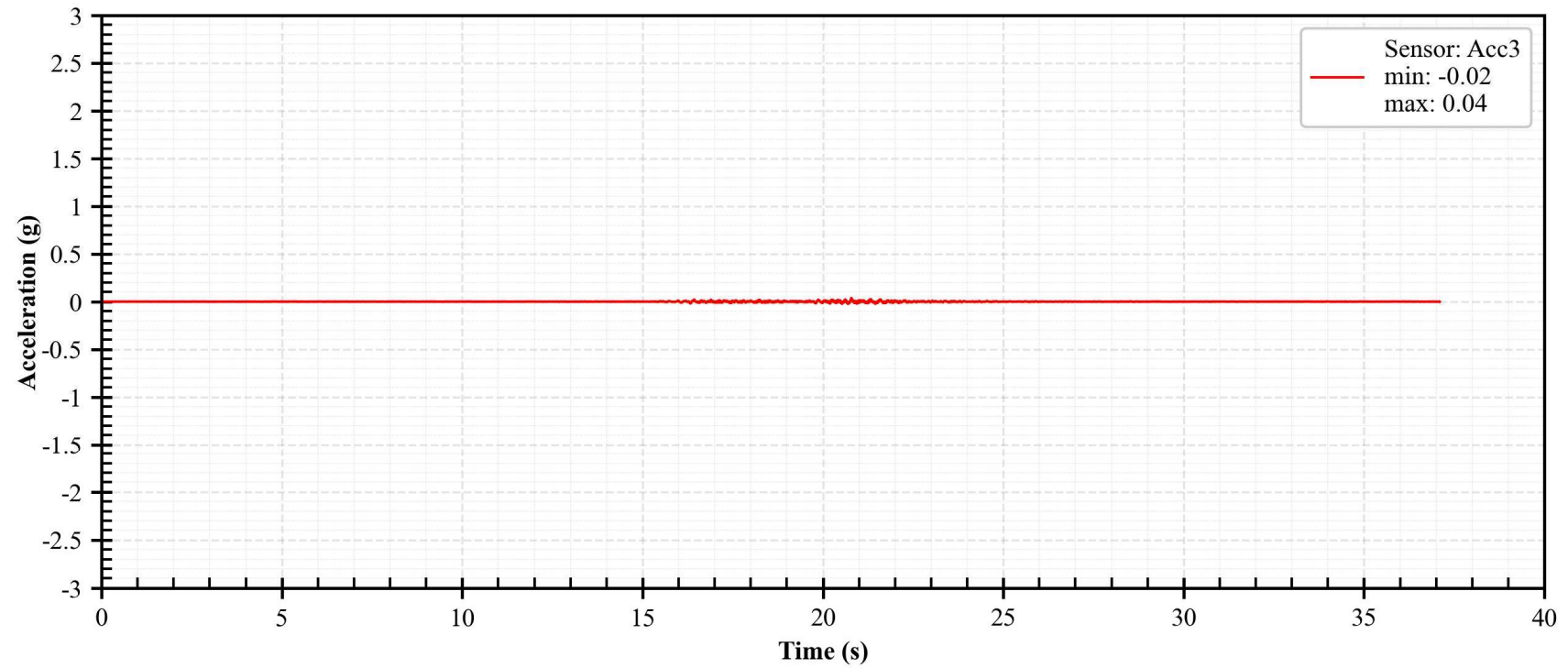


Figure 3.4.3 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 3

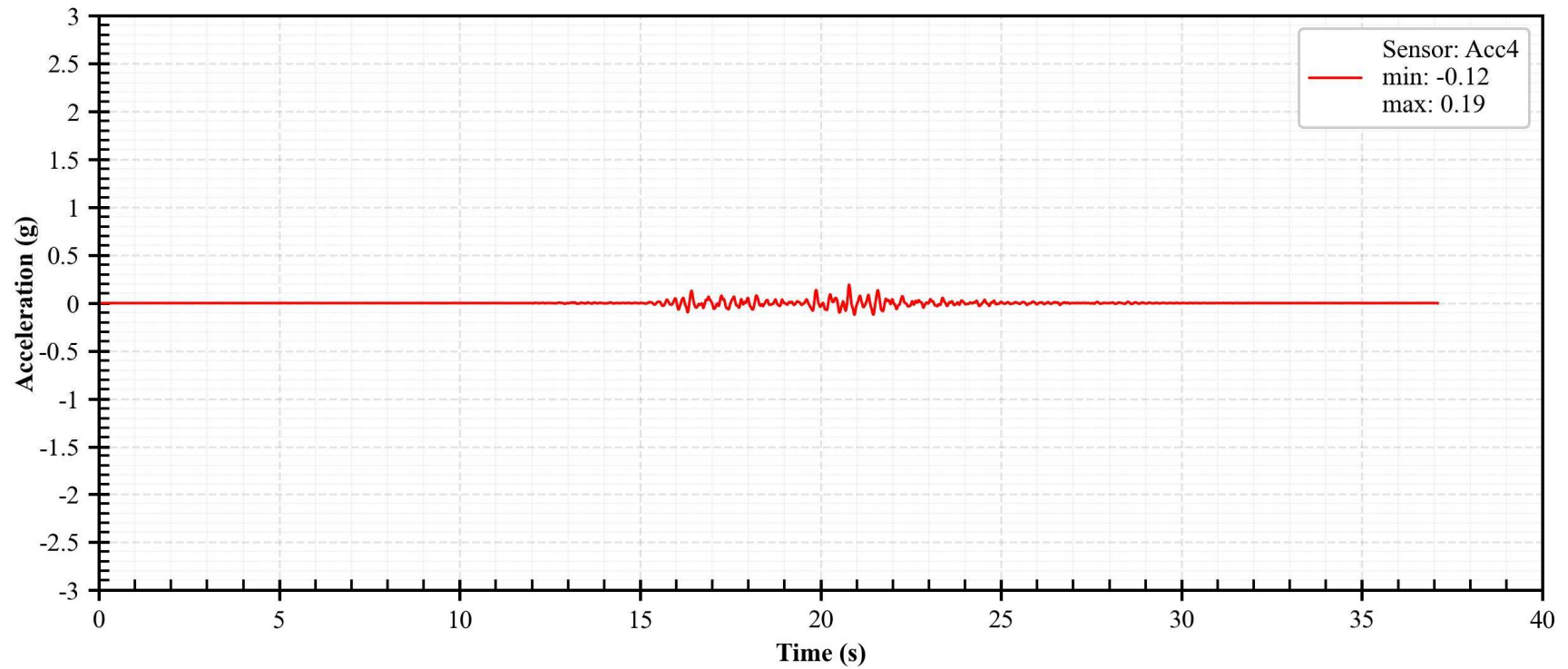


Figure 3.4.4 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 4

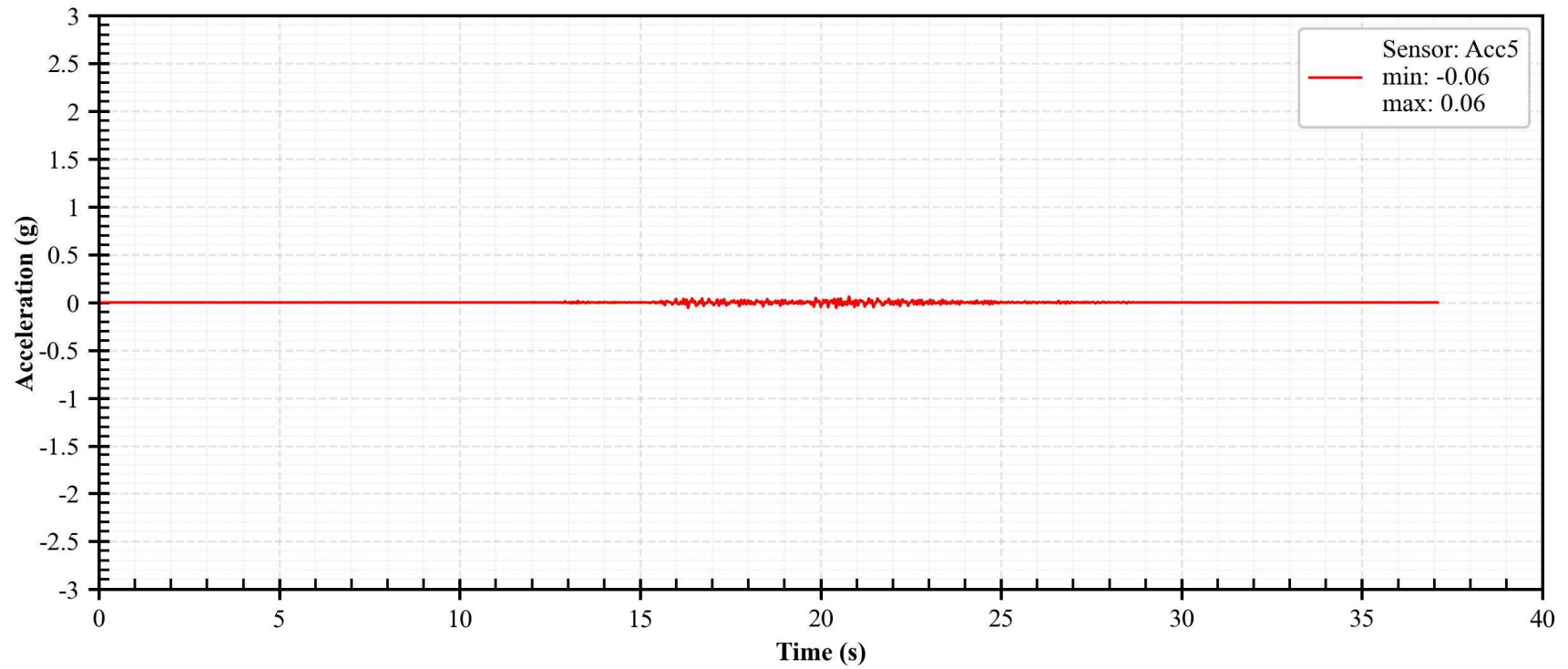


Figure 3.4.5 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 5

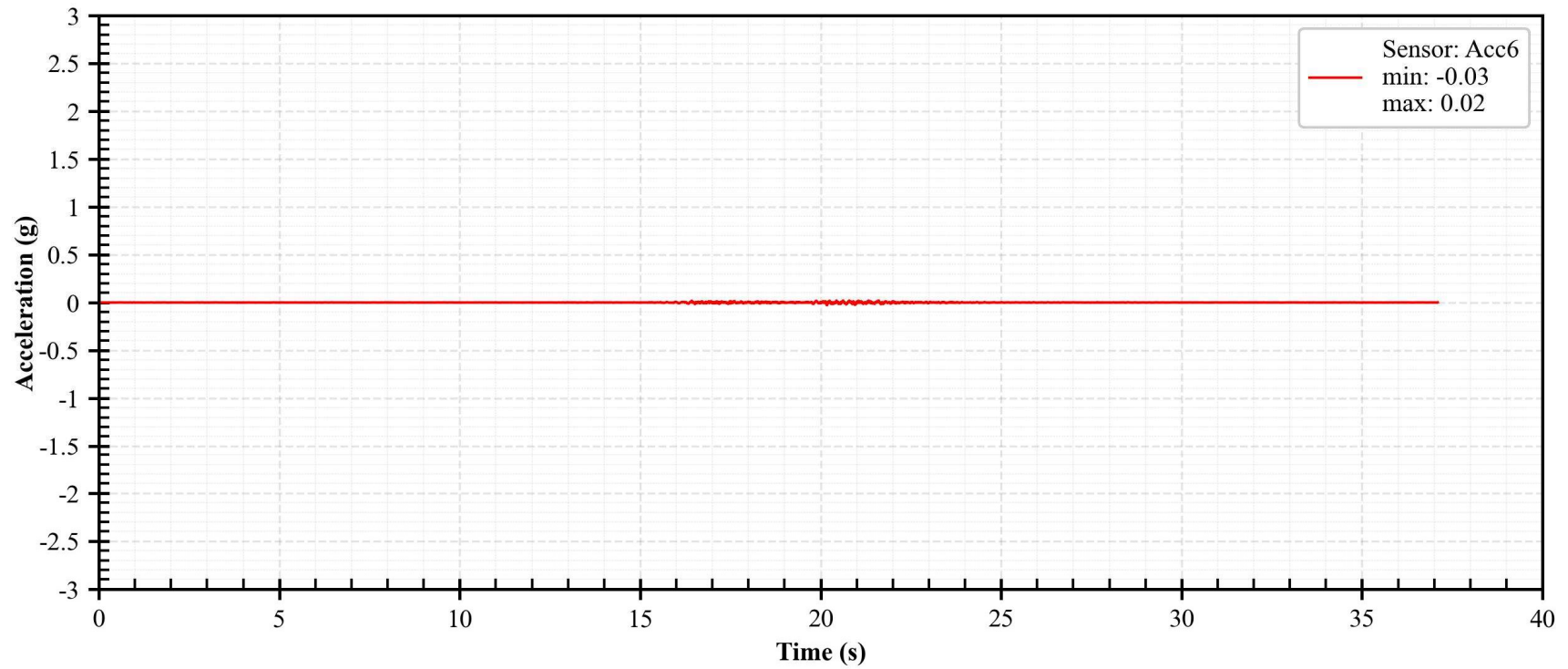


Figure 3.4.6 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 6

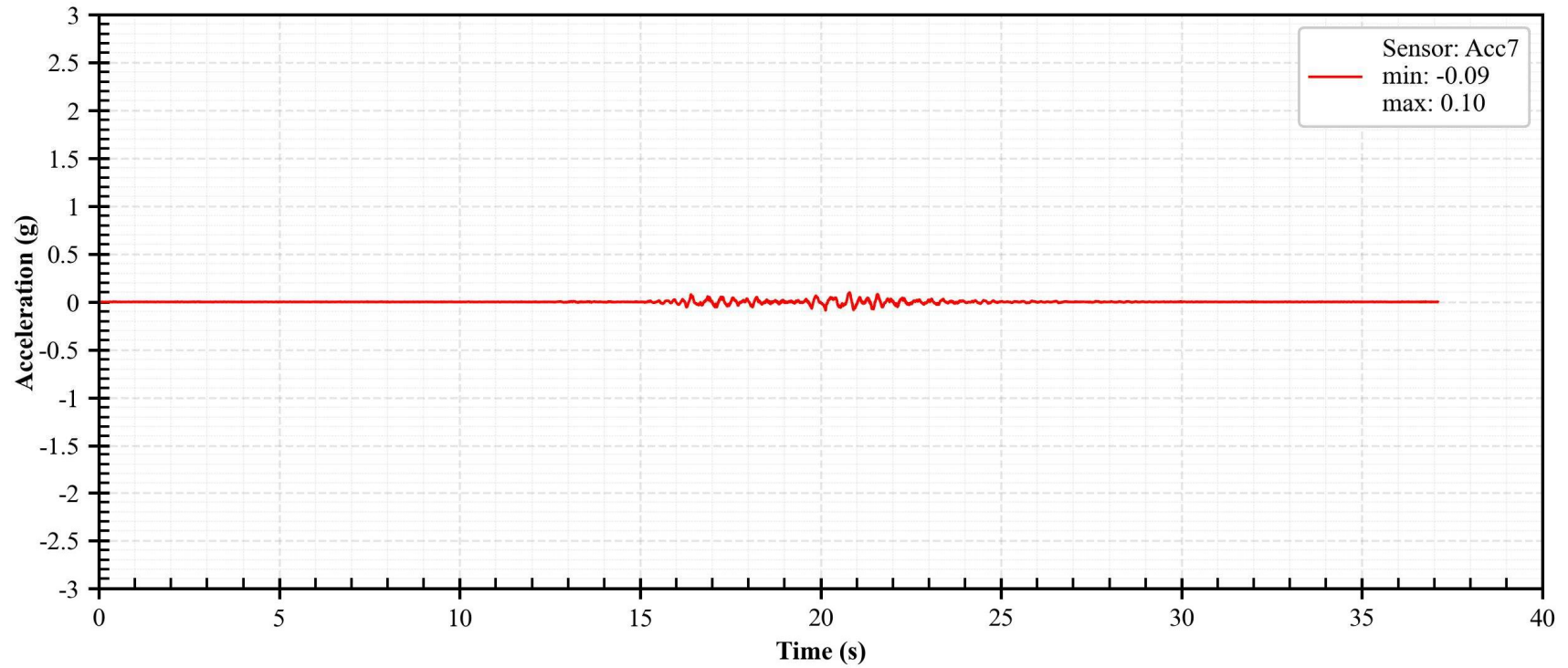


Figure 3.4.7 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 7

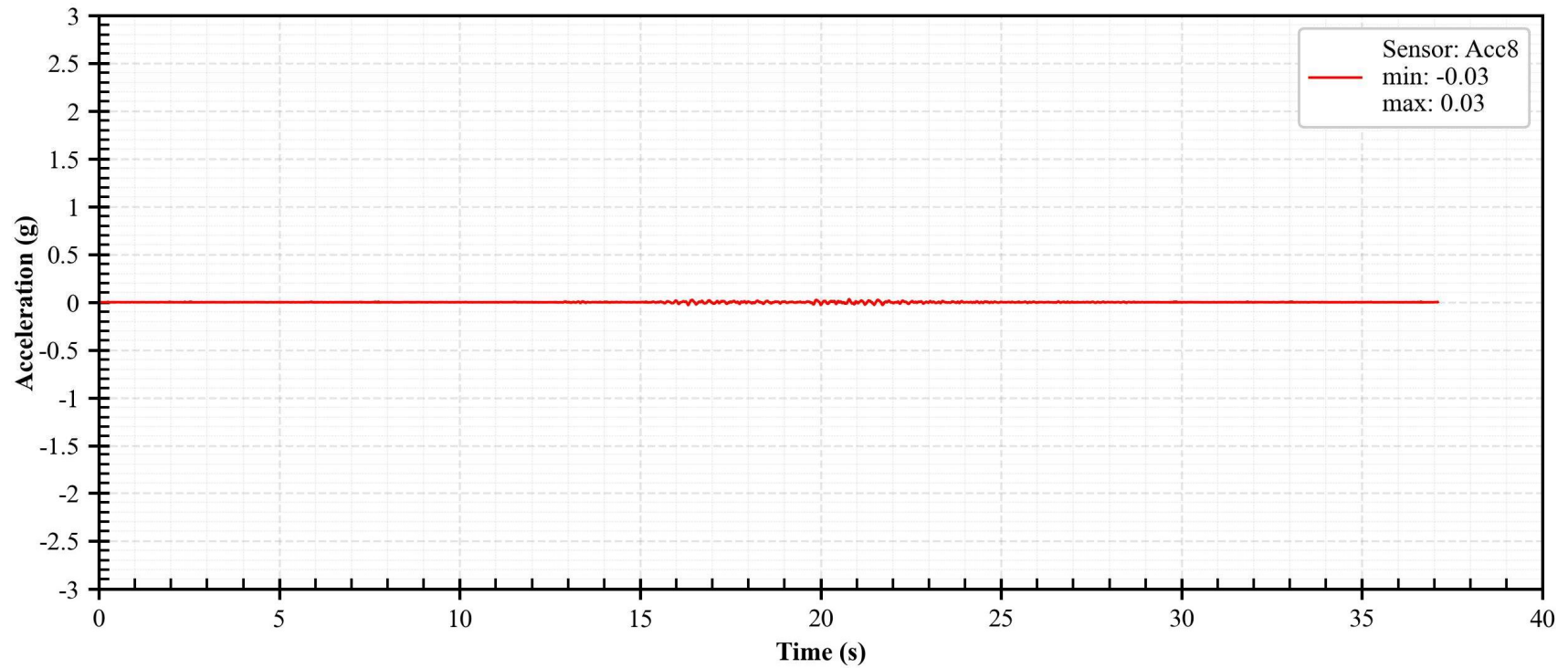


Figure 3.4.8 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 8

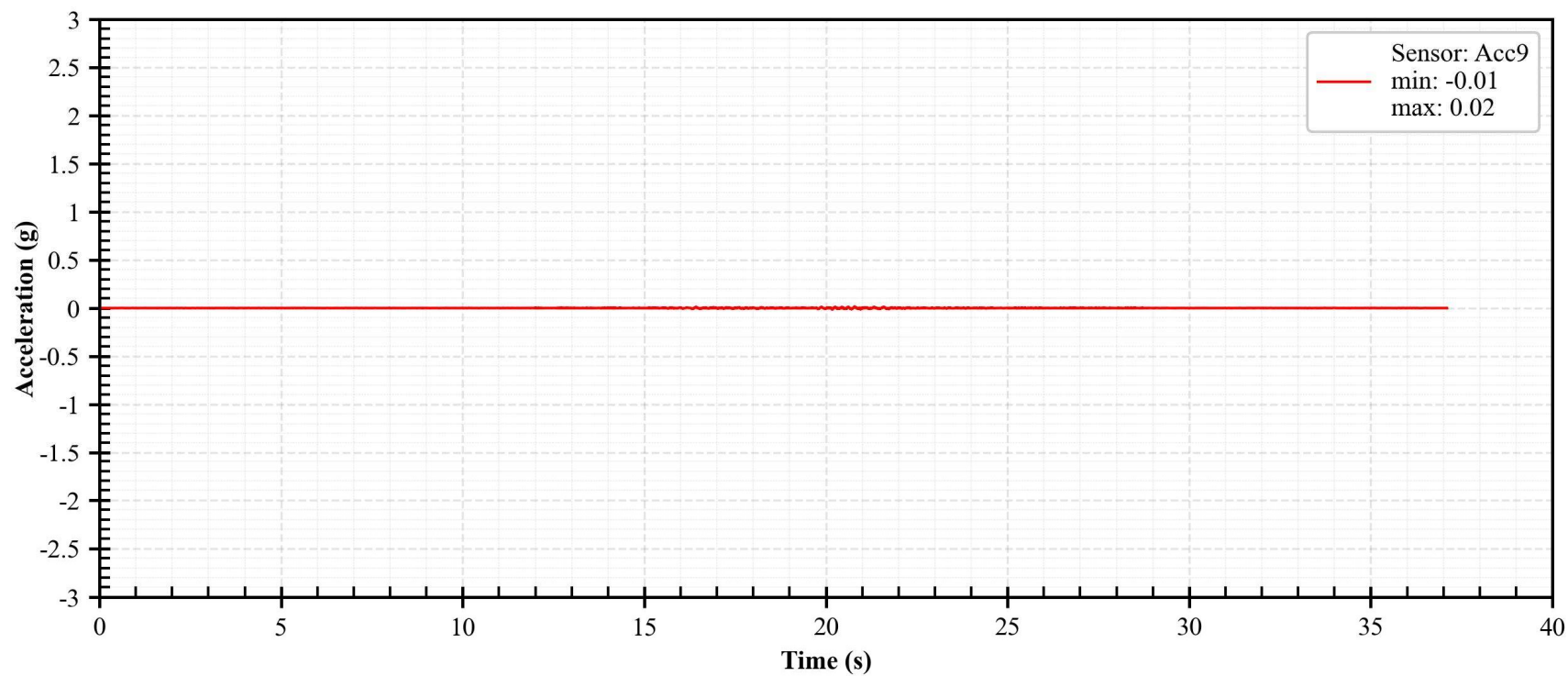


Figure 3.4.9 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 9

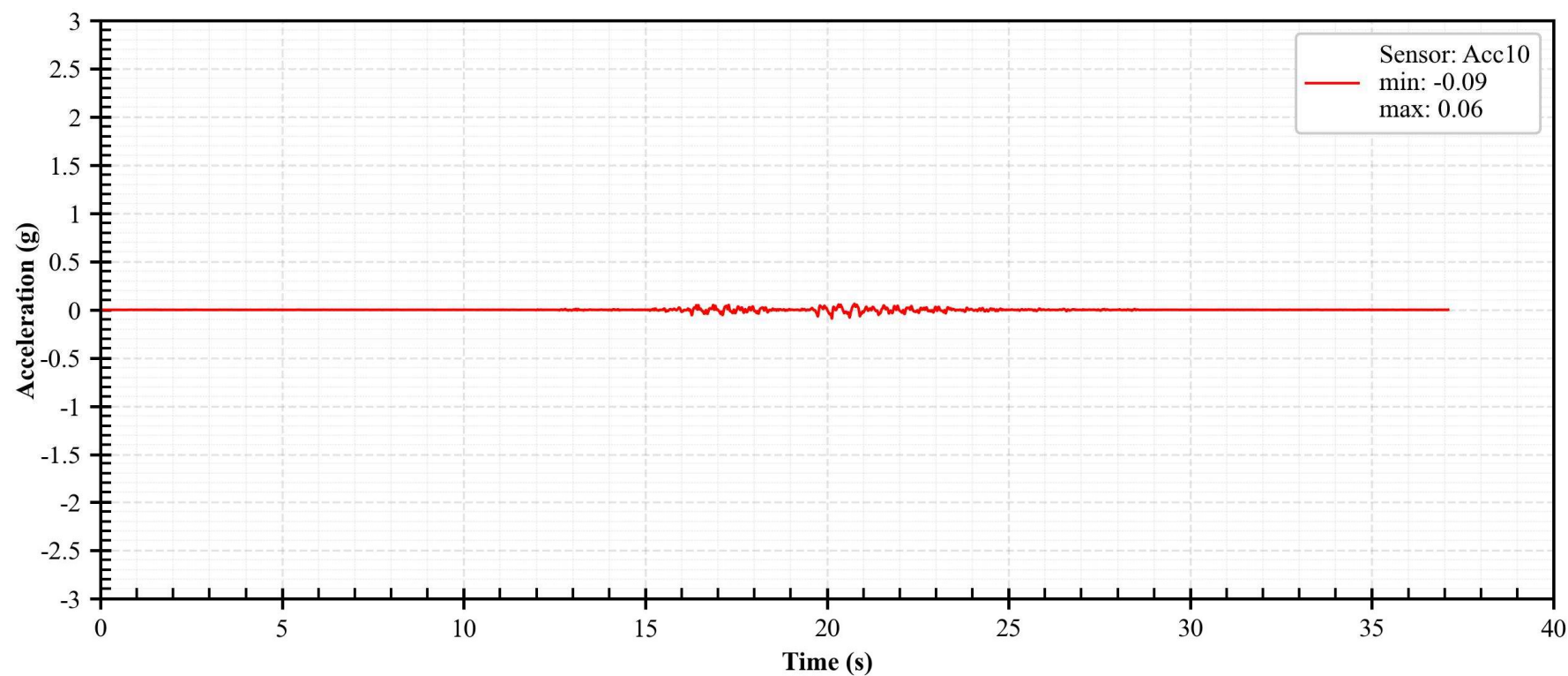


Figure 3.4.10 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 10

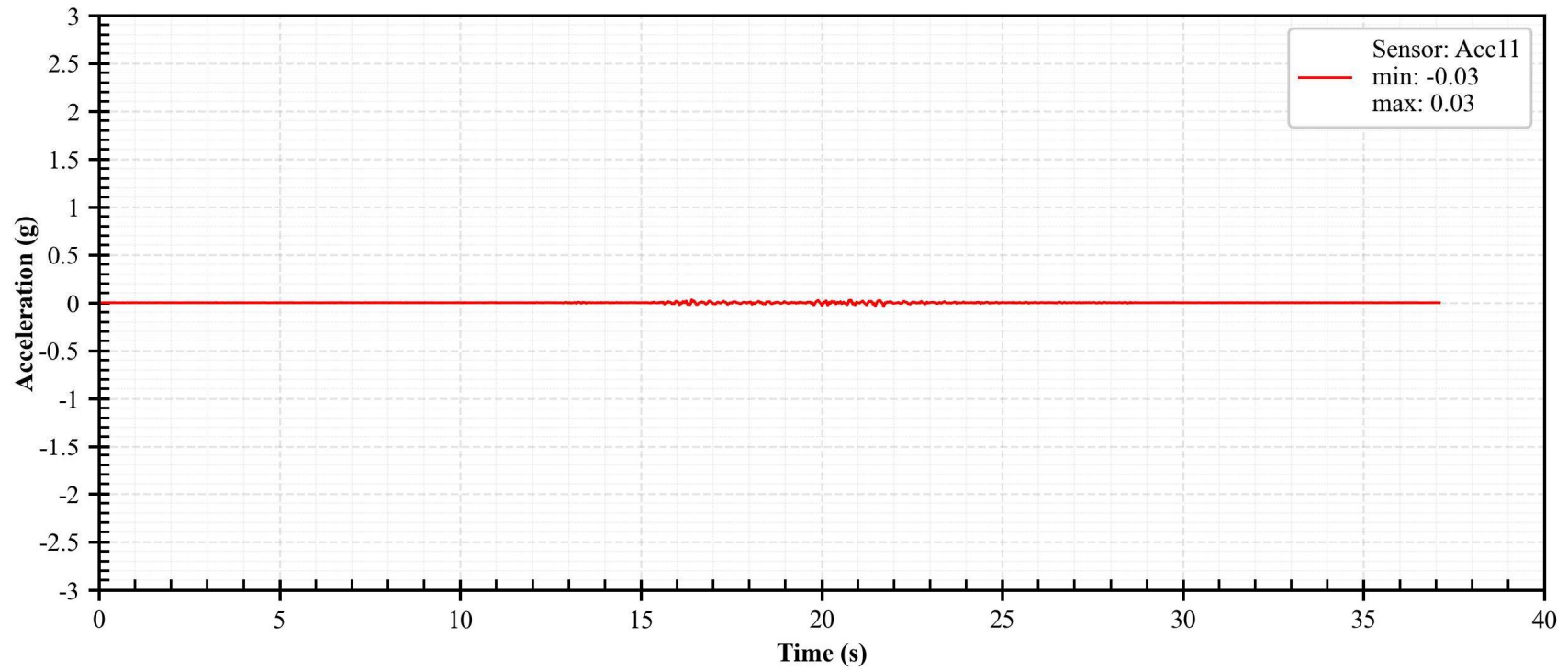


Figure 3.4.11 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 11

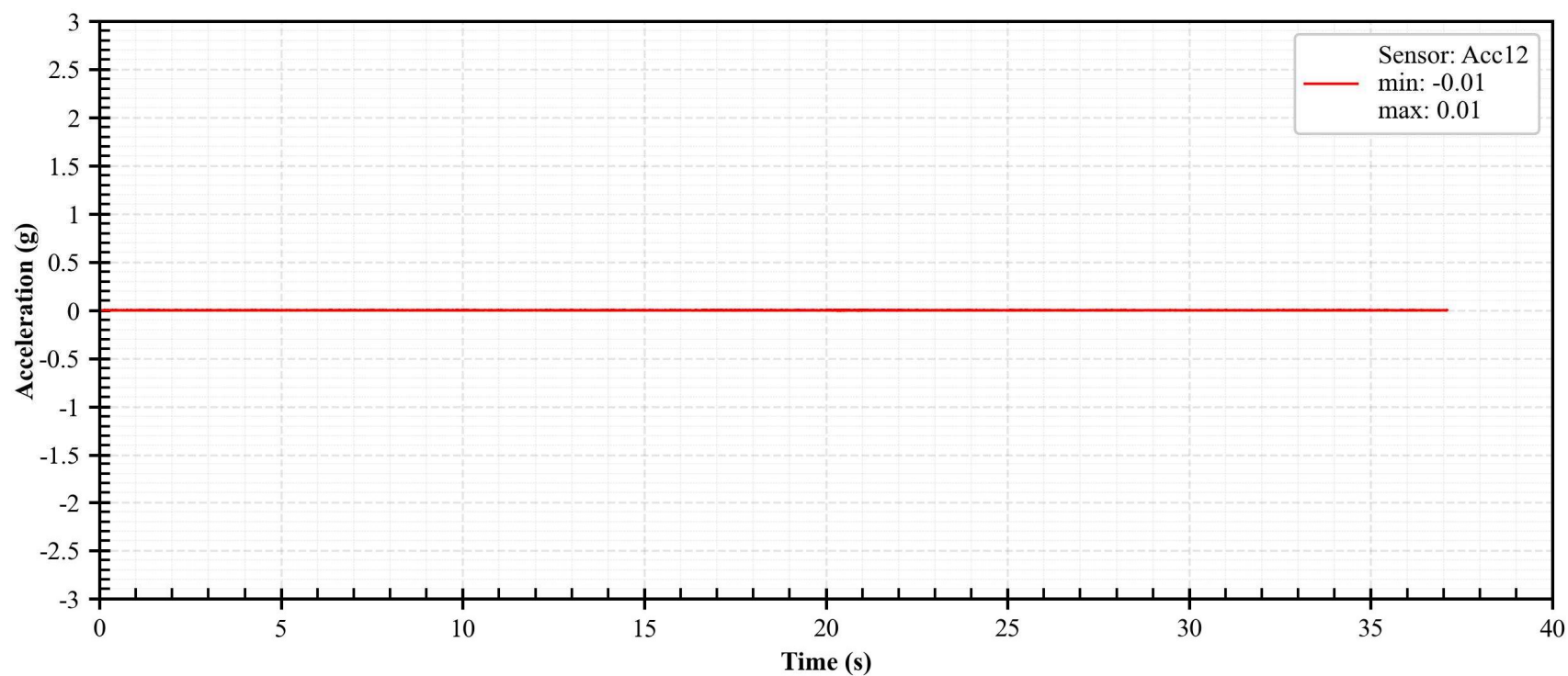


Figure 3.4.12 Characteristic results for phase B (earthquake EQ0,1g): Accelerometer 12

Draw wire sensors

Figures 3.4.13 – 3.4.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 3.28 mm while the minimum is -2.82 mm. The maximum movement detected by draw wire sensor W2 is 3.58 mm while the minimum is -2.78 mm. The maximum movement detected by draw wire sensor W3 is 2.18 mm while the minimum is -2.11 mm. The maximum movement detected by draw wire sensor W4 is 2.37 mm while the minimum is -2.15 mm. The maximum drift is $(1.53/1.225) = 1.25 \%$ and minimum drift is $(-1.21/1.225) = -0.99 \%$.

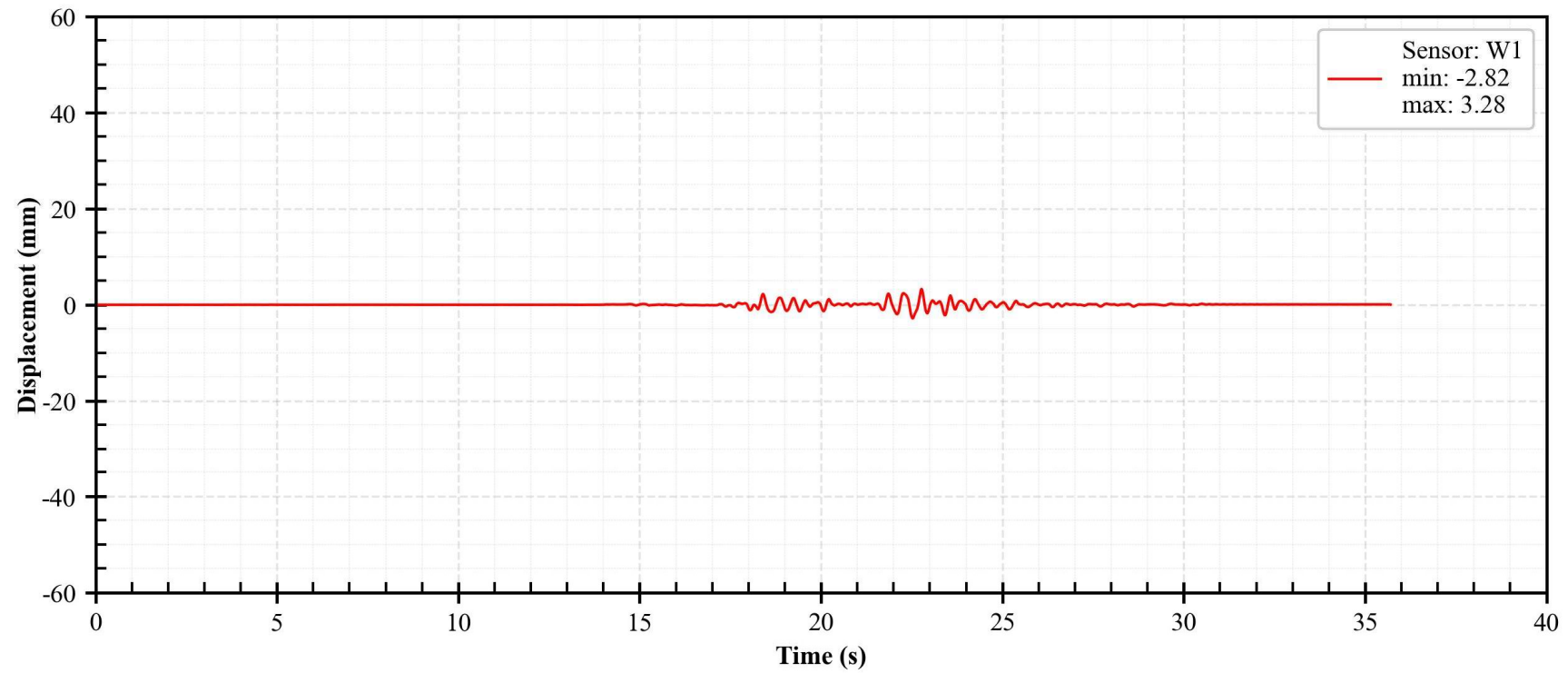


Figure 3.4.13 Characteristic results for phase B (earthquake EQ0,1g): Draw wire sensor 1

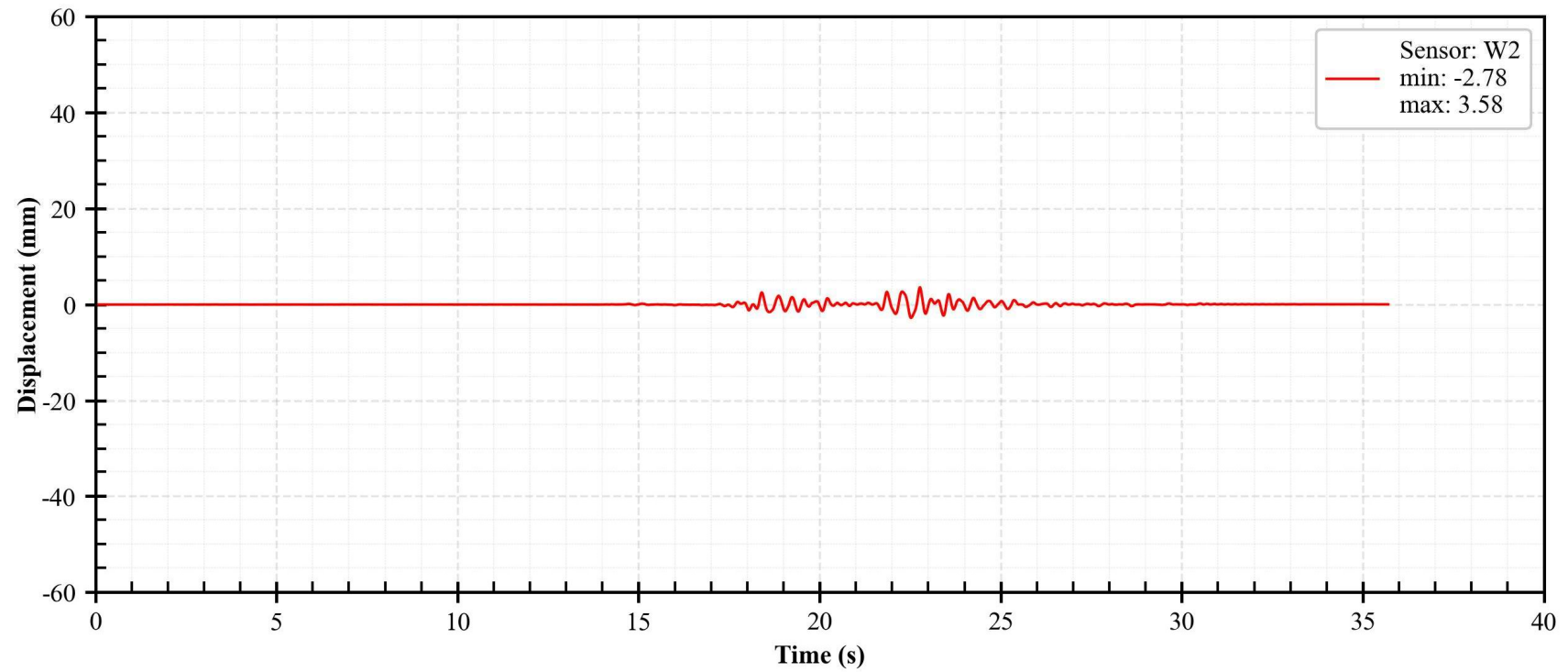


Figure 3.4.14 Characteristic results for phase B (earthquake EQ0,1g): Draw wire sensor 2

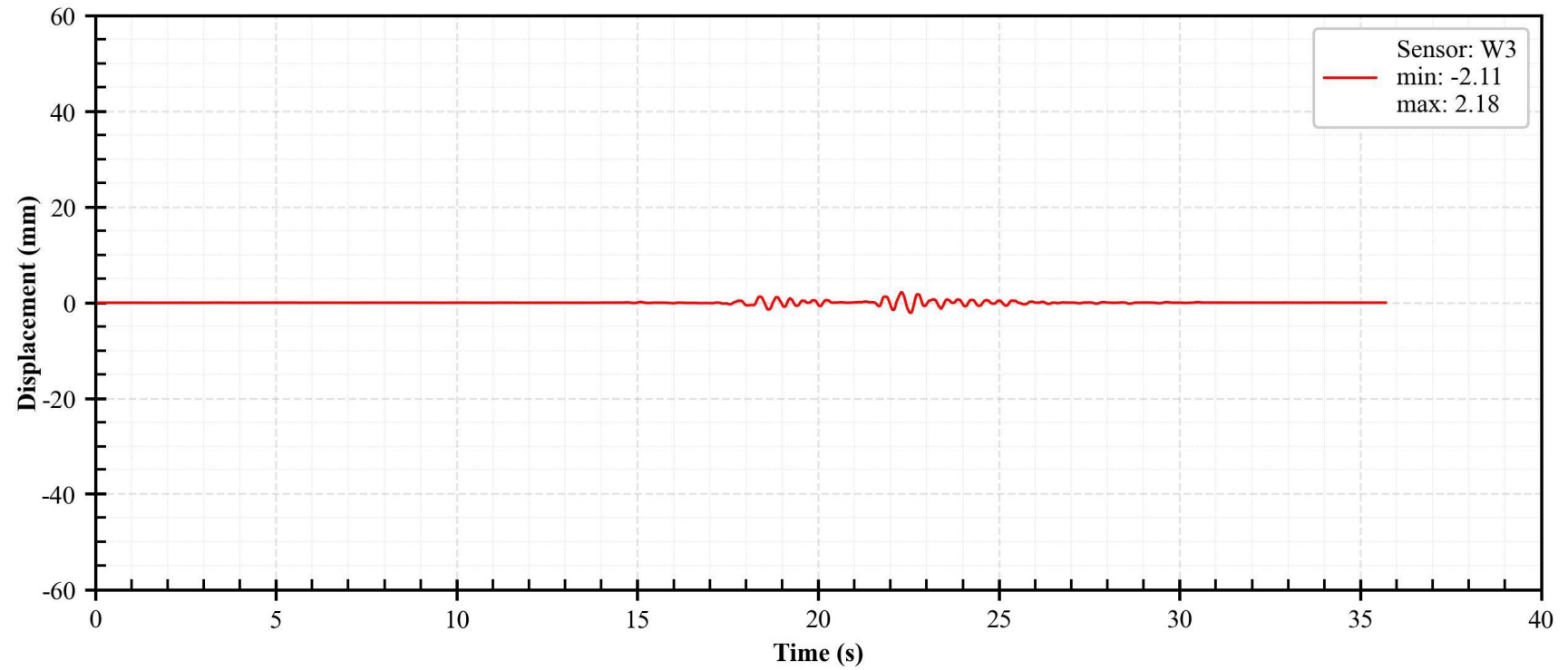


Figure 3.4.15 Characteristic results for phase B (earthquake EQ0,1g): Draw wire sensor 3

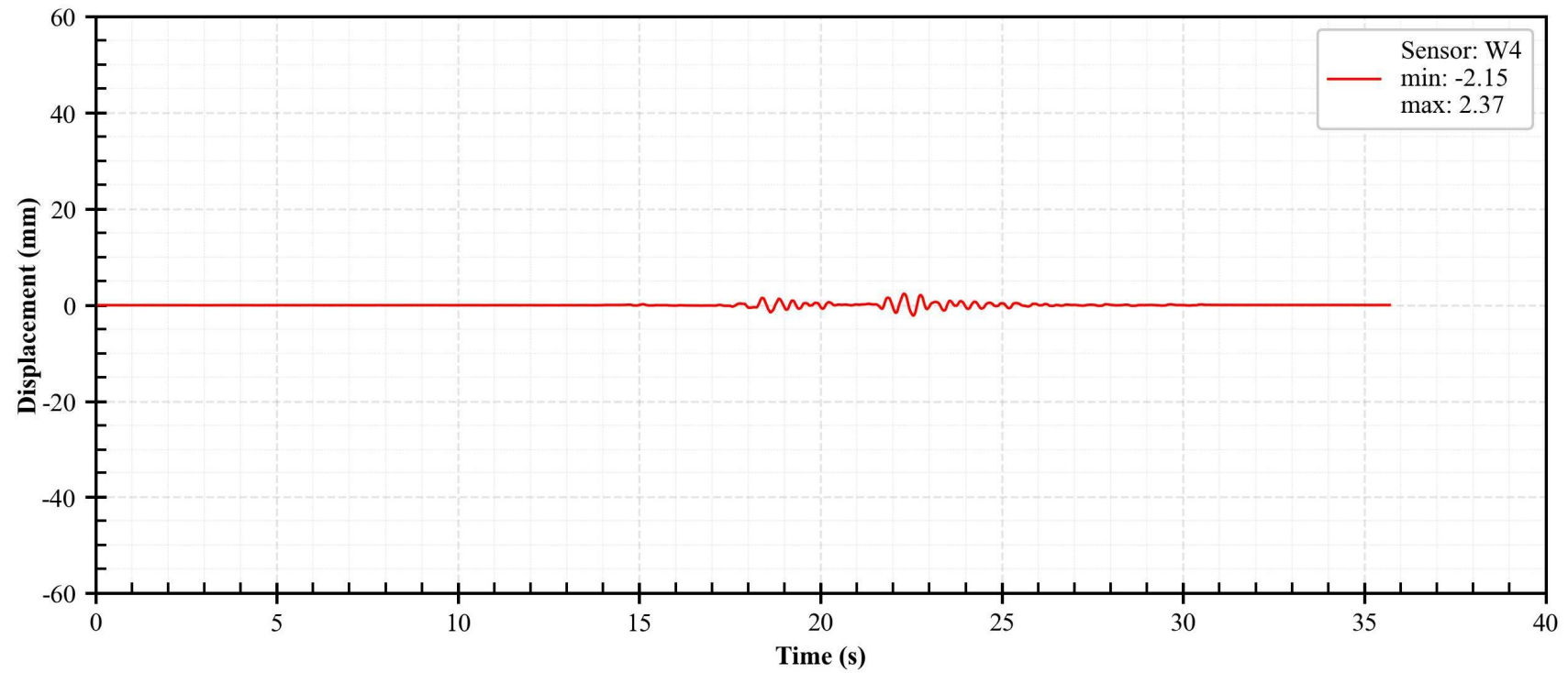


Figure 3.4.16 Characteristic results for phase B (earthquake EQ0,1g): Draw wire sensor 4

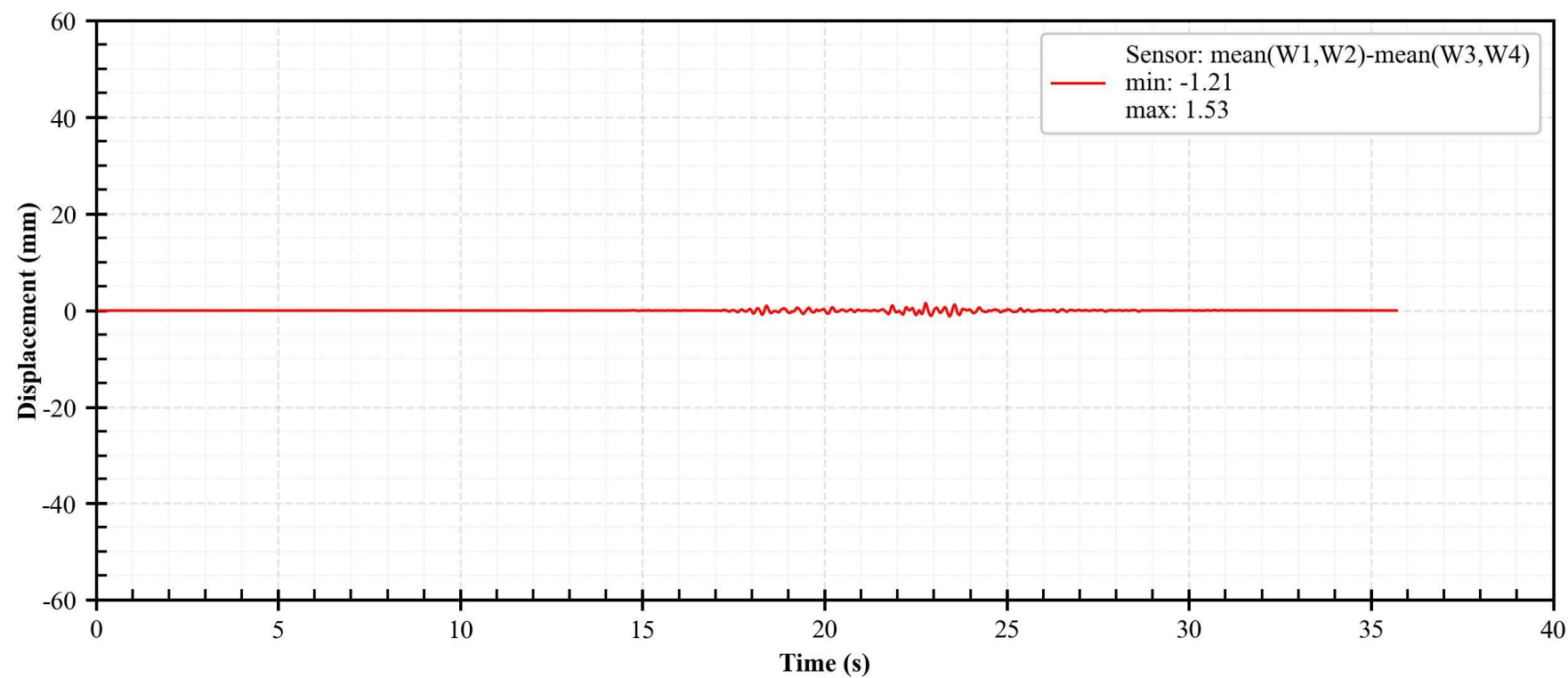


Figure 3.4.17 Characteristic results for phase B (earthquake EQ0,1g): mean (W1,W2) – mean (W3-W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.4.18, 3.4.19, 3.4.20, 3.4.21, 3.4.22, 3.4.23, 3.4. 32, 3.4.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.4.24, 3.4.25, 3.4.26, 3.4.27, 3.4.28, 3.4.29 and 3.4.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 165 μstrain and minimum strain -205 μstrain . The residual strain is -1 μstrain . SG21 & SG22 are located on PUFJ.

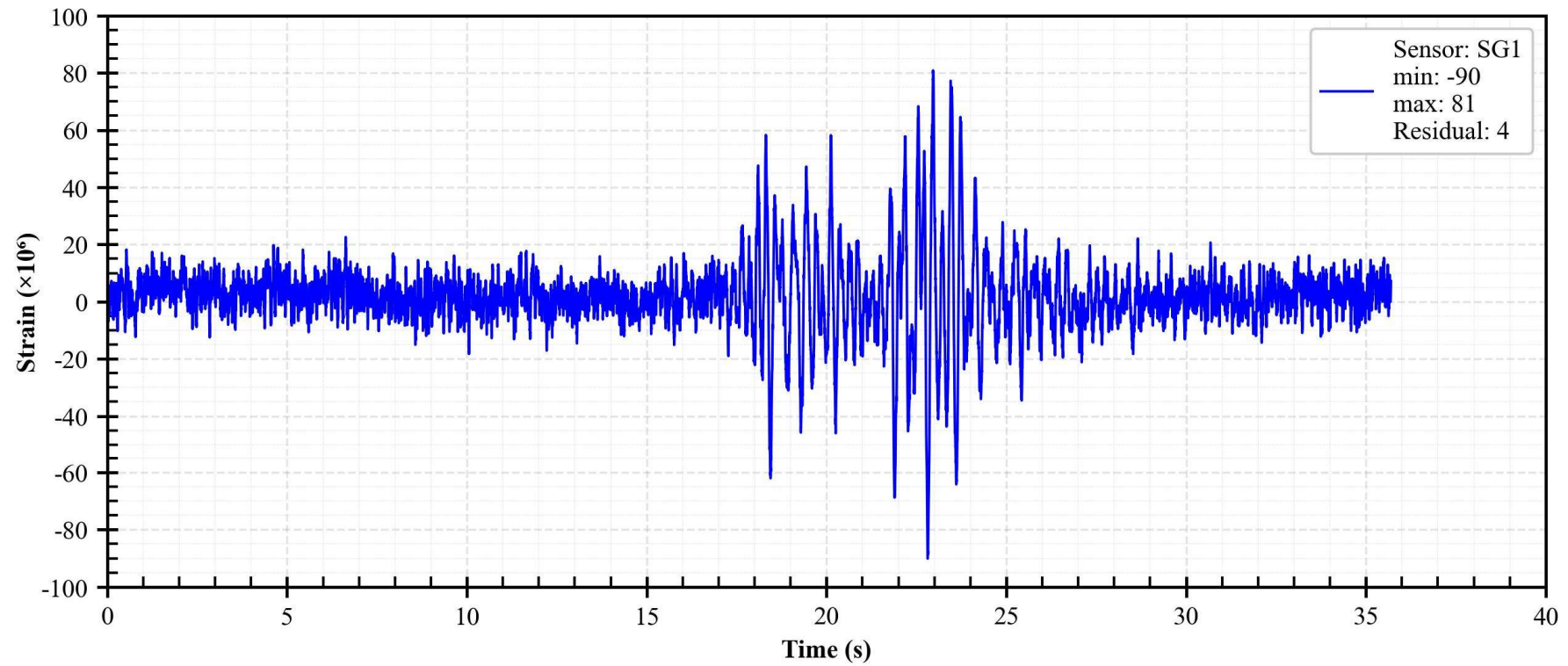


Figure 3.4.18 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 1

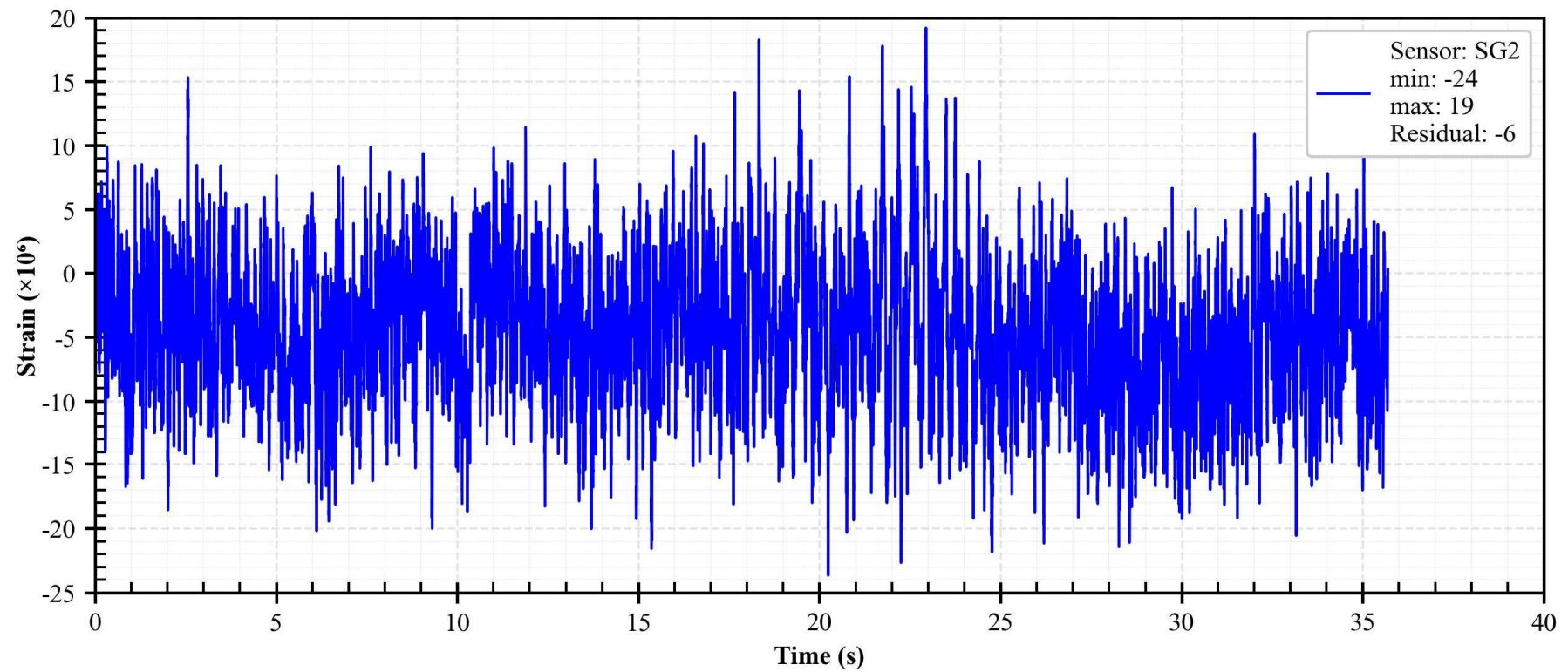


Figure 3.4.19 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 2

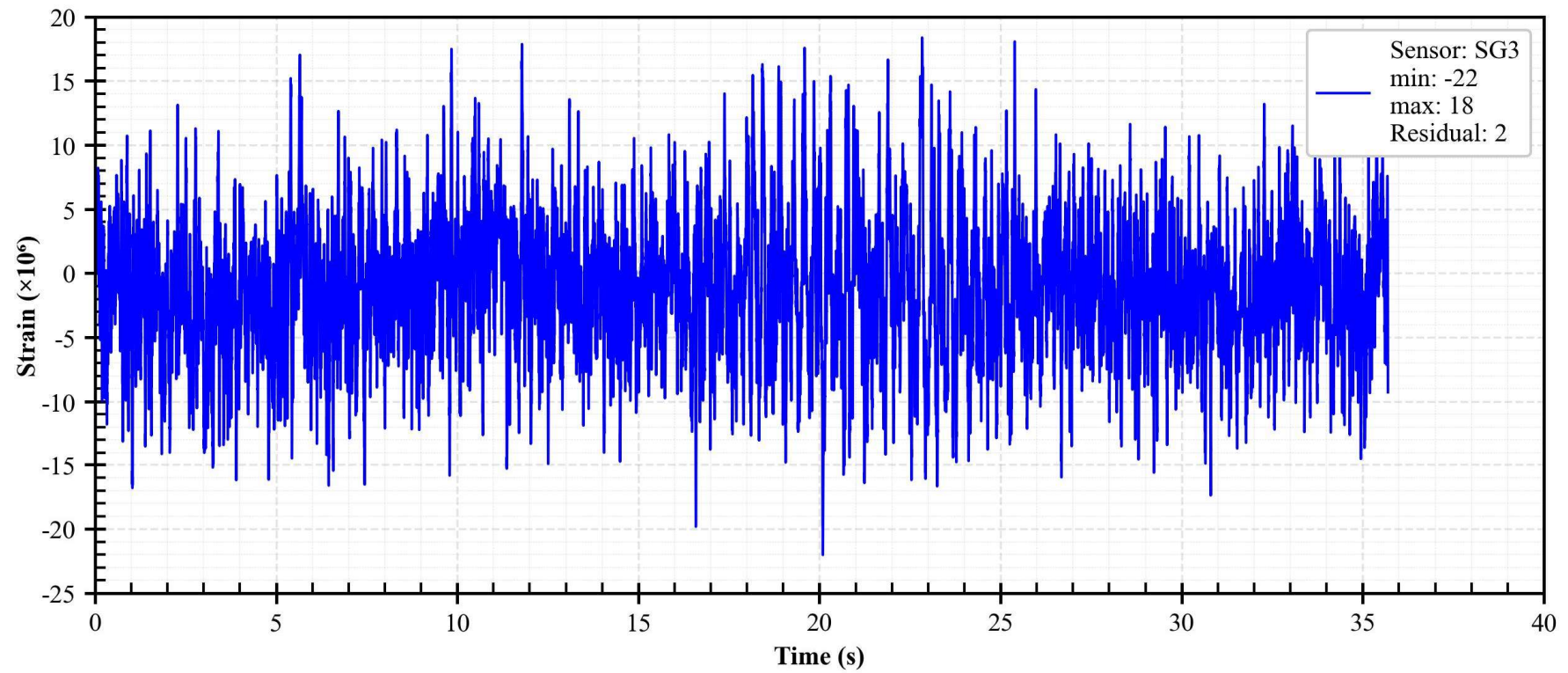


Figure 3.4.20 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 3

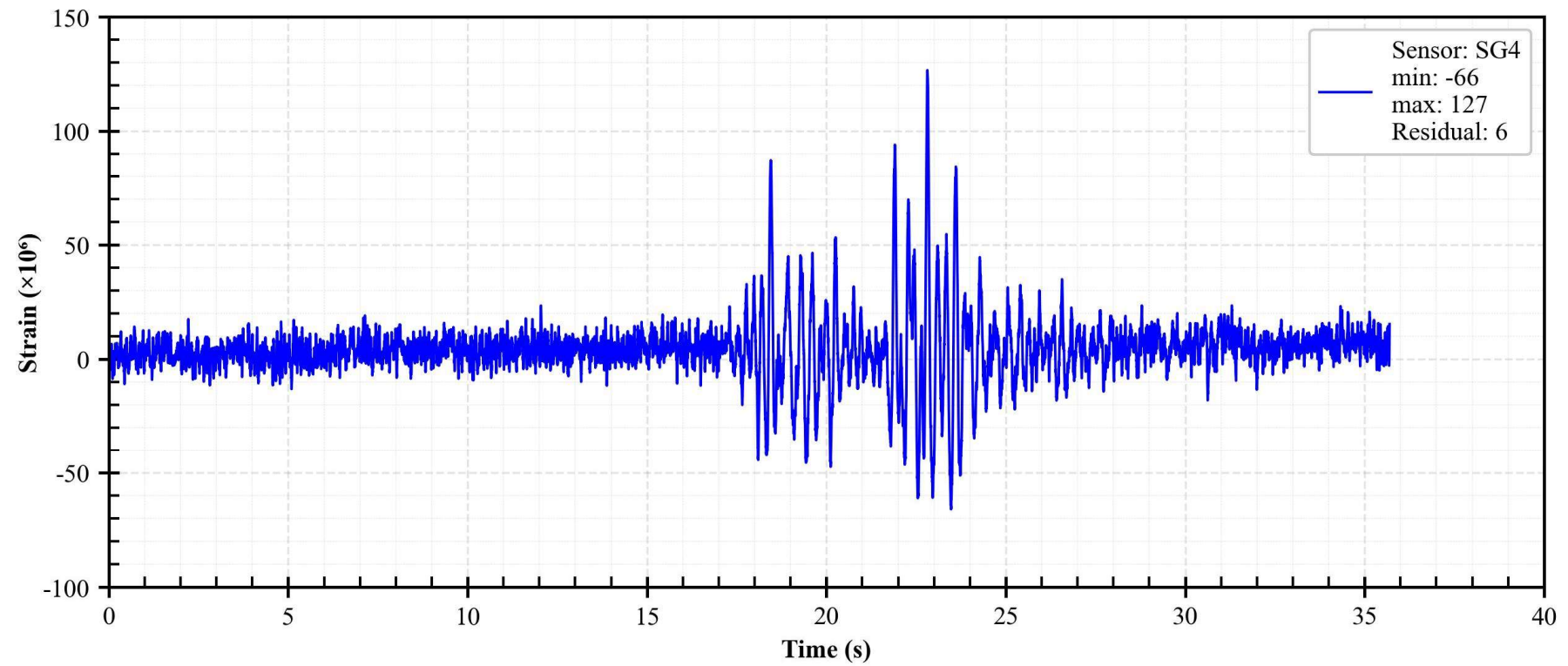


Figure 3.4.21 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 4

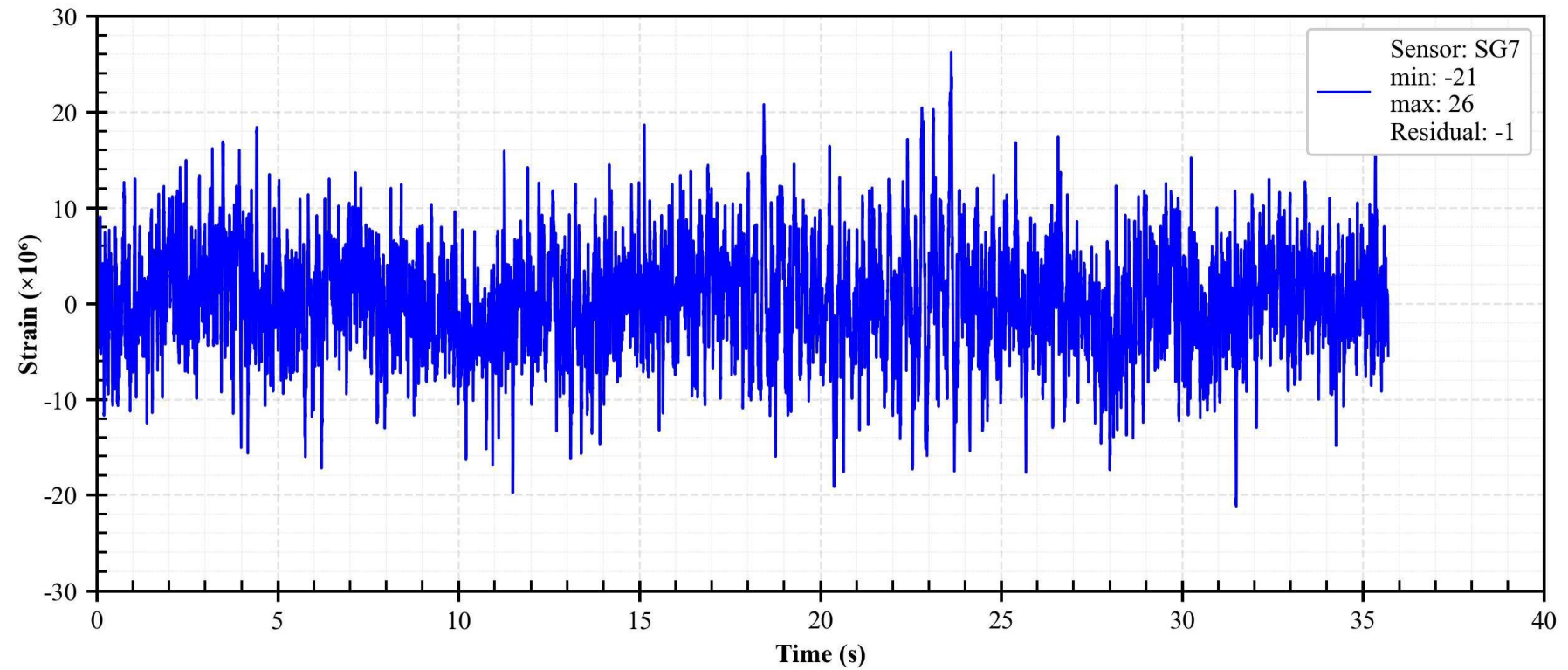


Figure 3.4.22 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 7

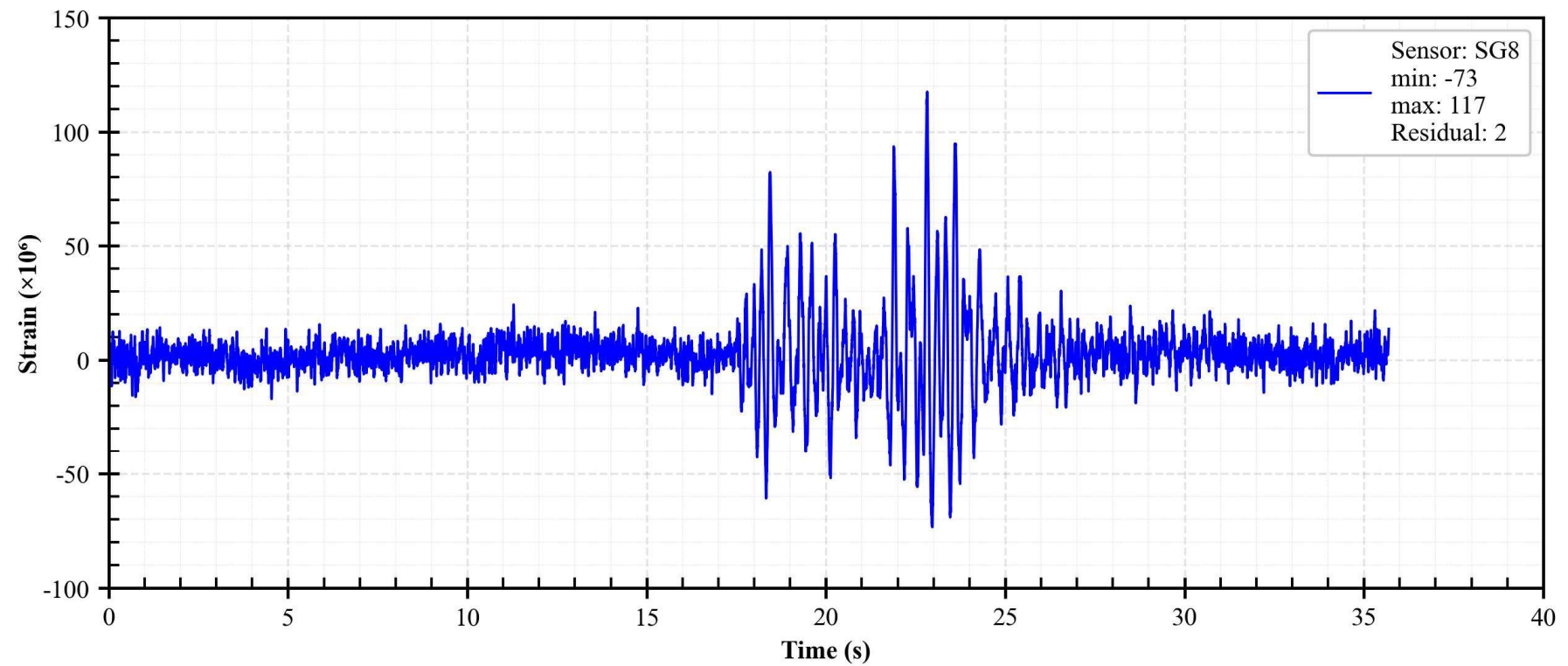


Figure 3.4.23 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 8

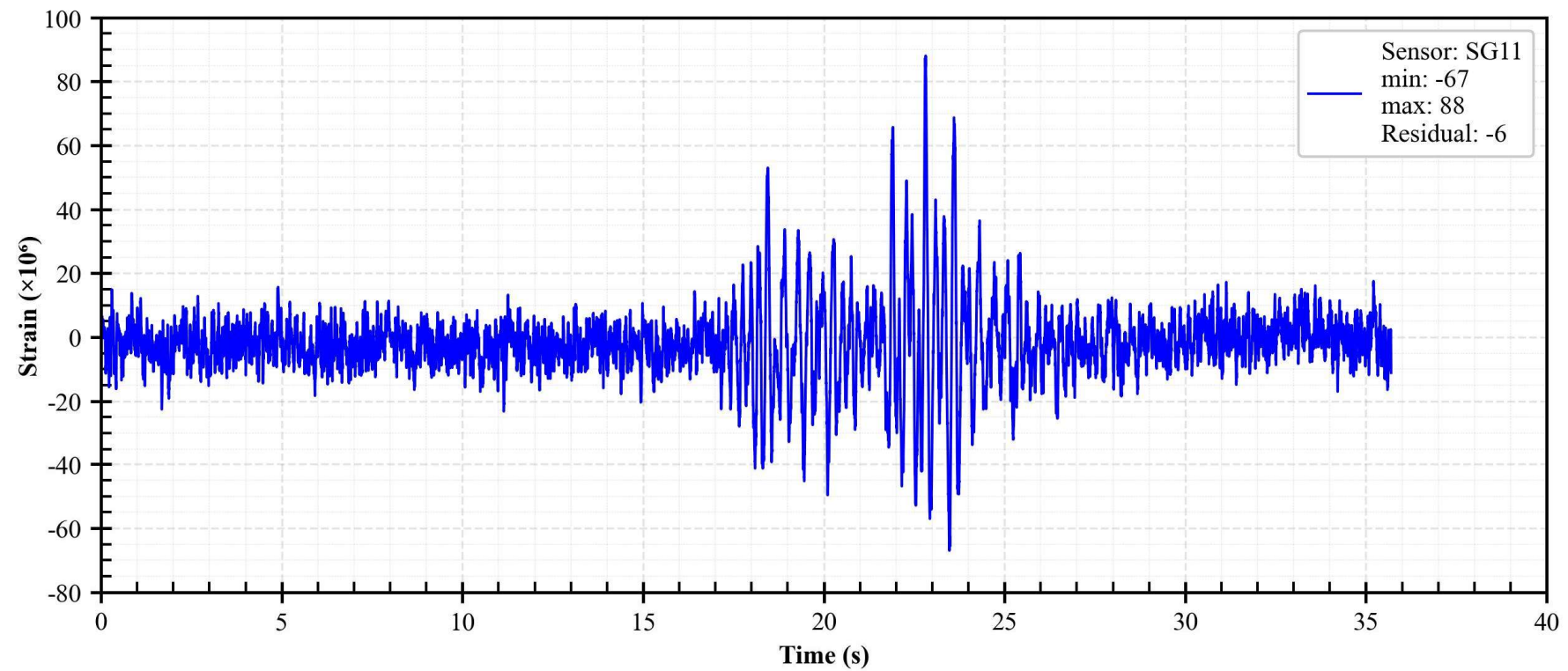


Figure 3.4.24 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 11

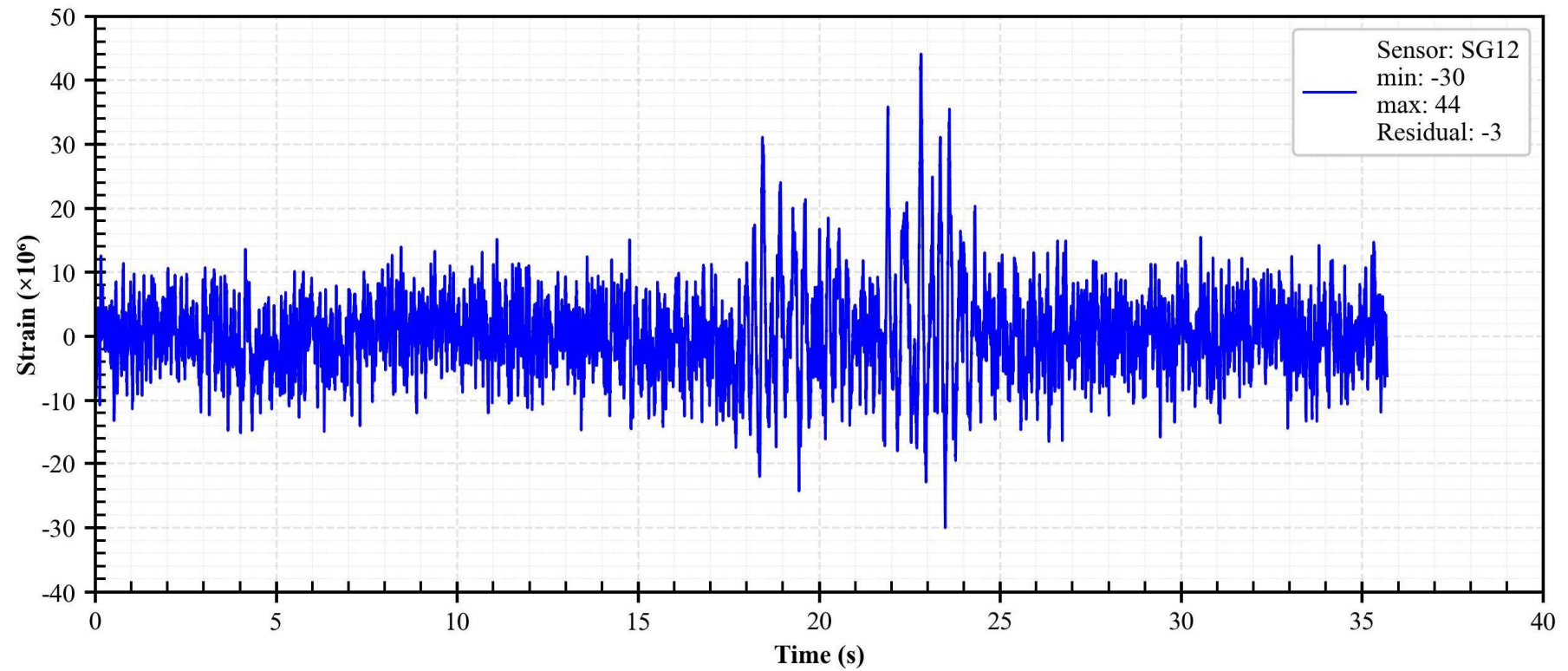


Figure 3.4.25 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 12

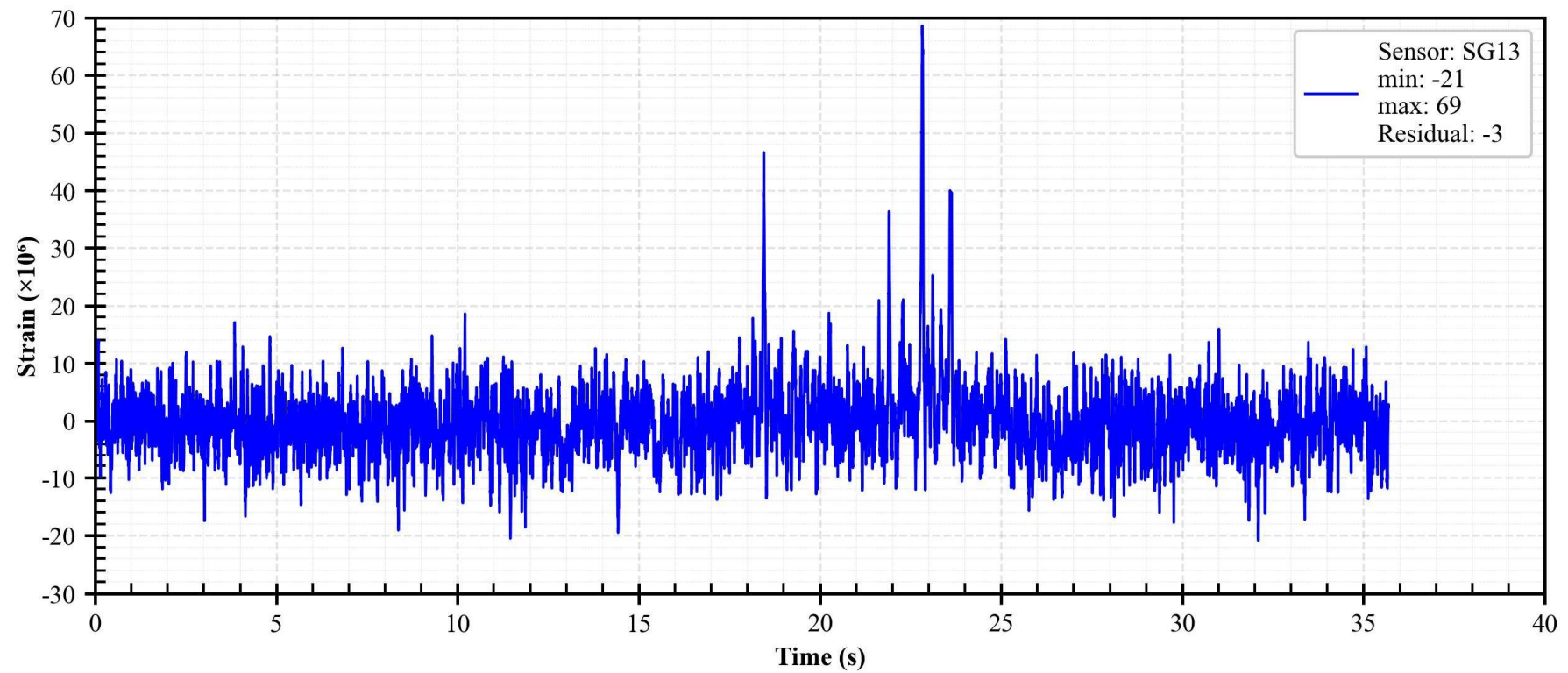


Figure 3.4.26 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 13

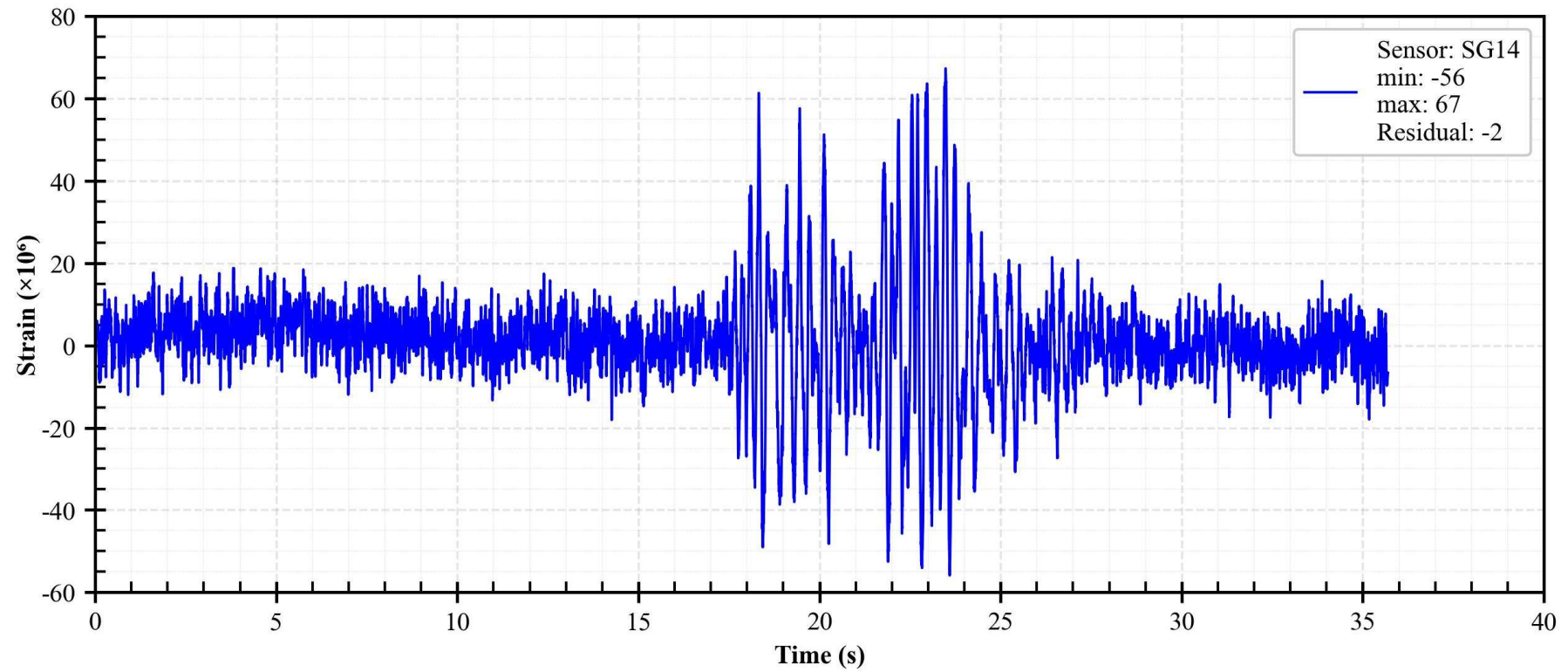


Figure 3.4.27 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 14

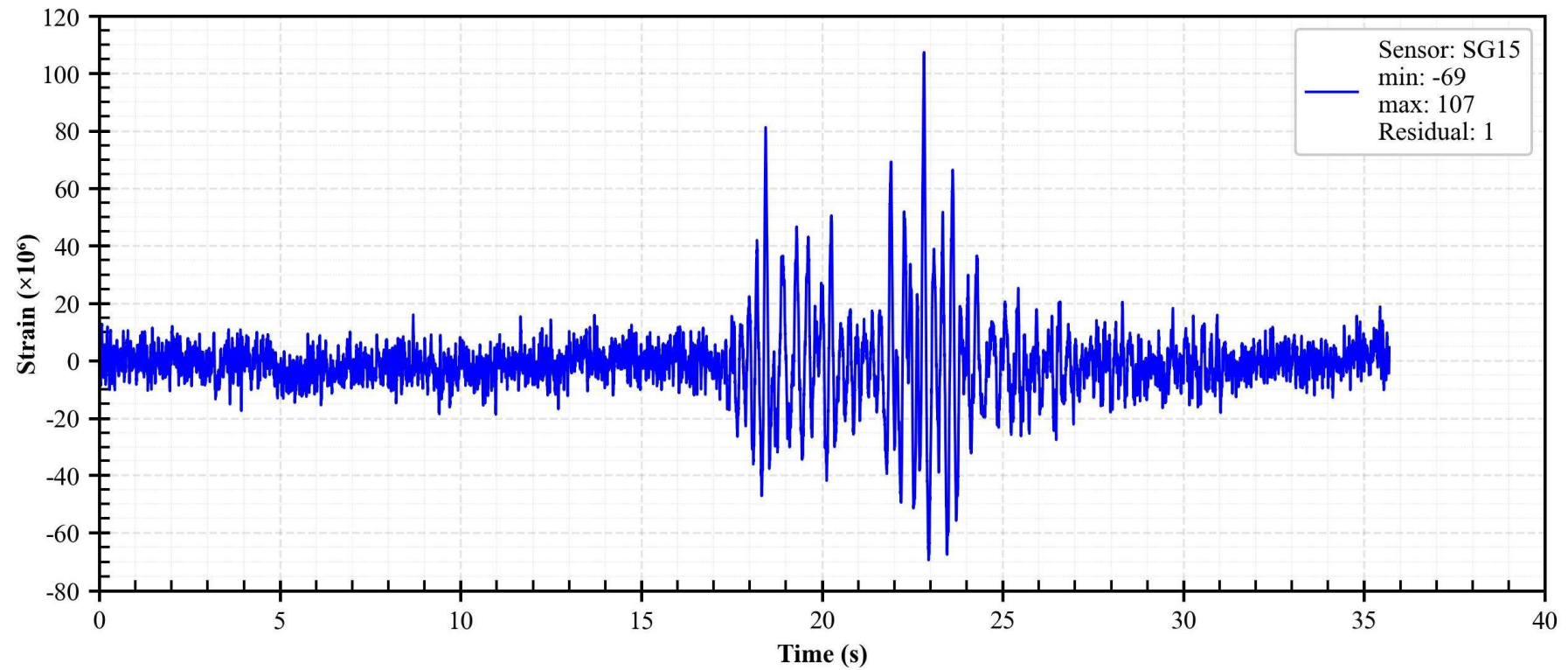


Figure 3.4.28 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 15

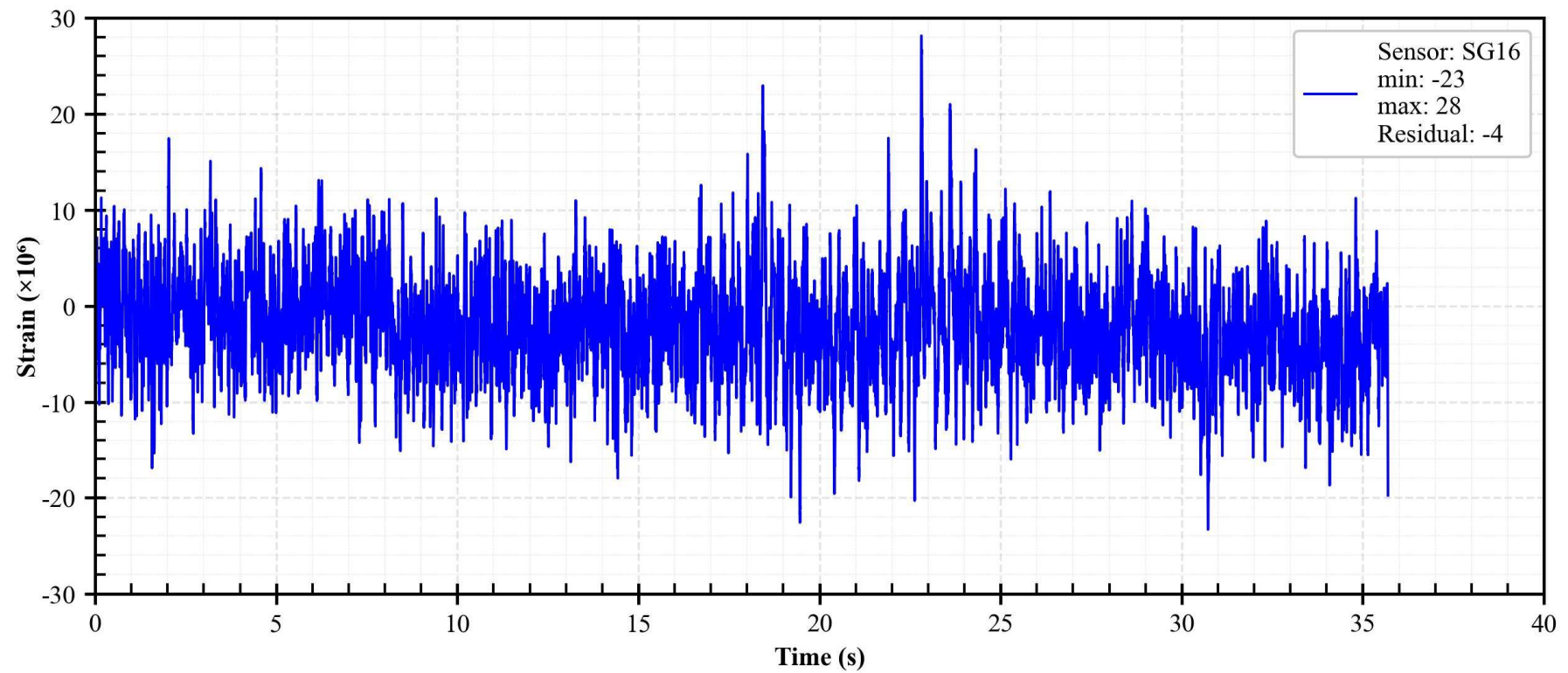


Figure 3.4.29 Characteristic results for phase B (earthquake EQ0,07g): strain gauge 16

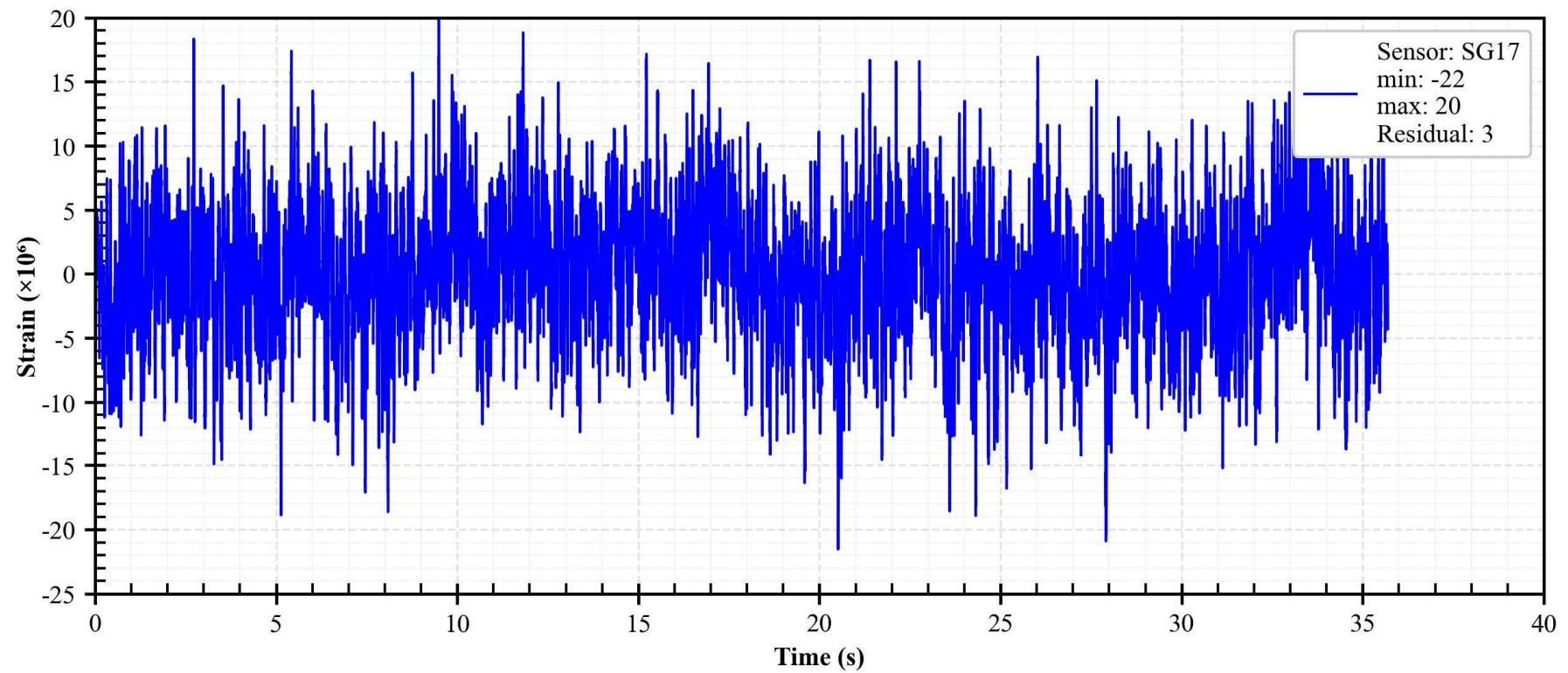


Figure 3.4.30 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 17

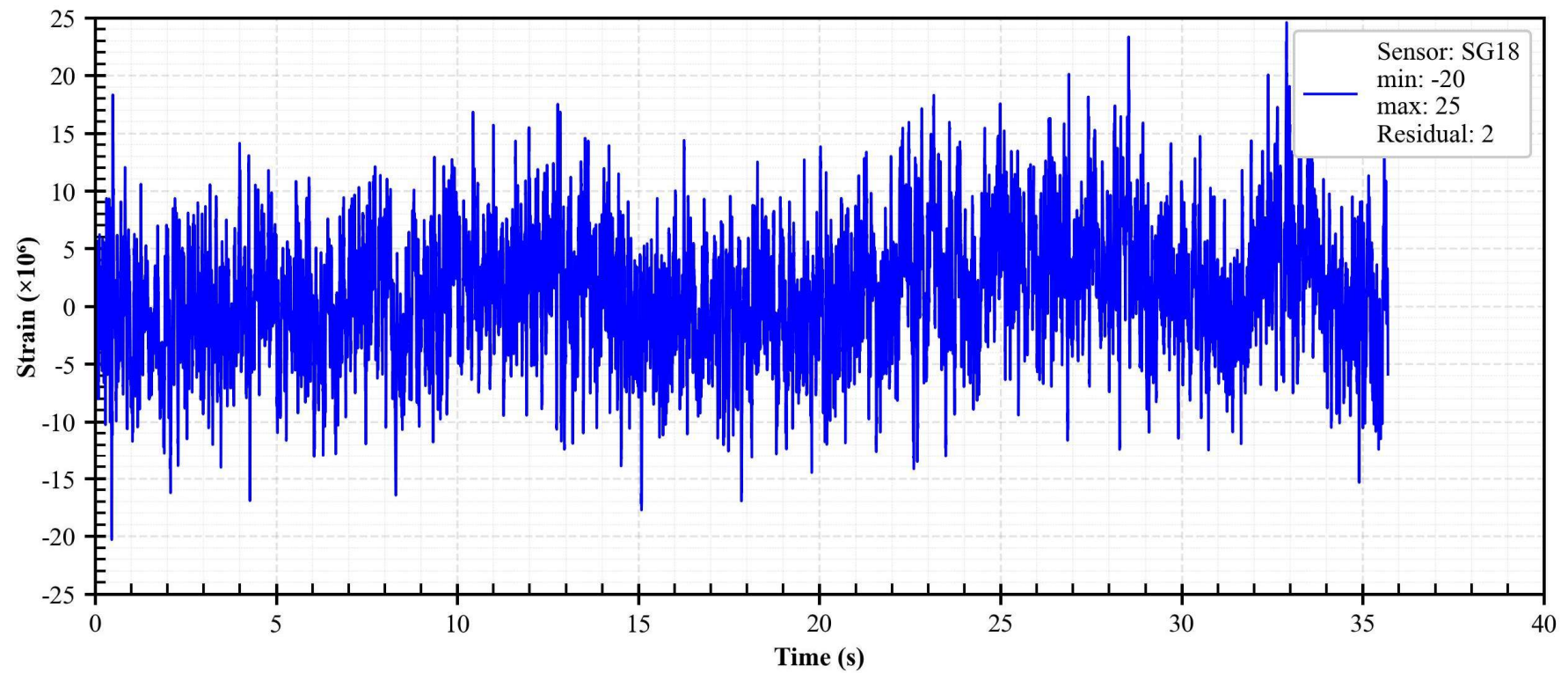


Figure 3.4.31 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 18

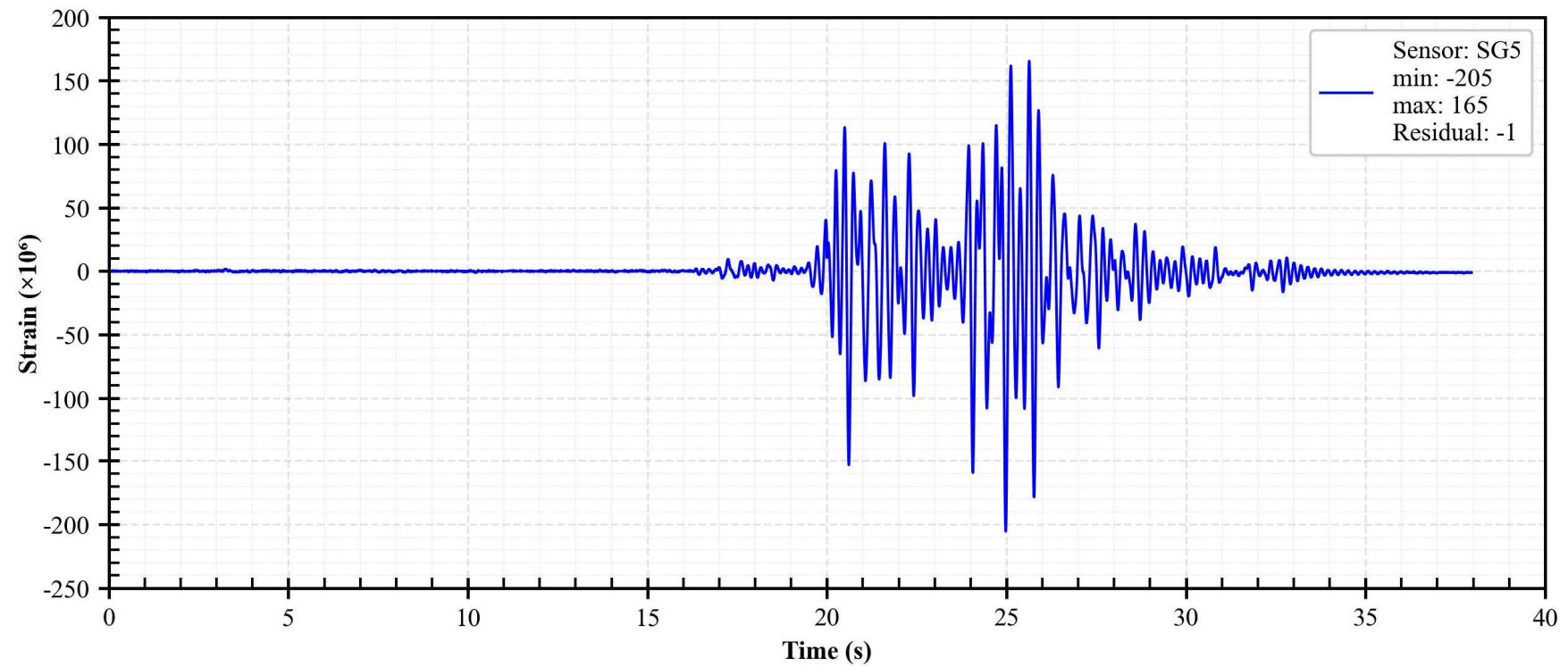


Figure 3.4.32 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 5

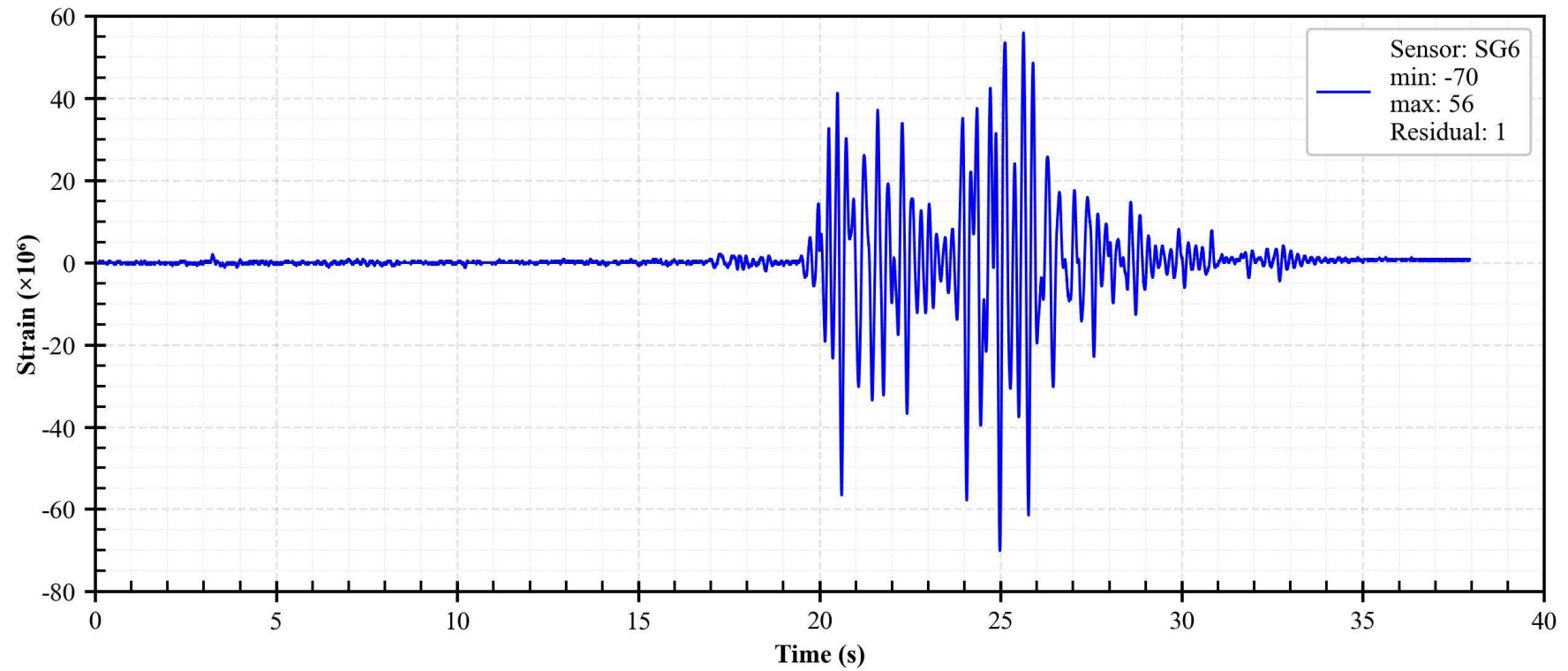


Figure 3.4.33 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 6

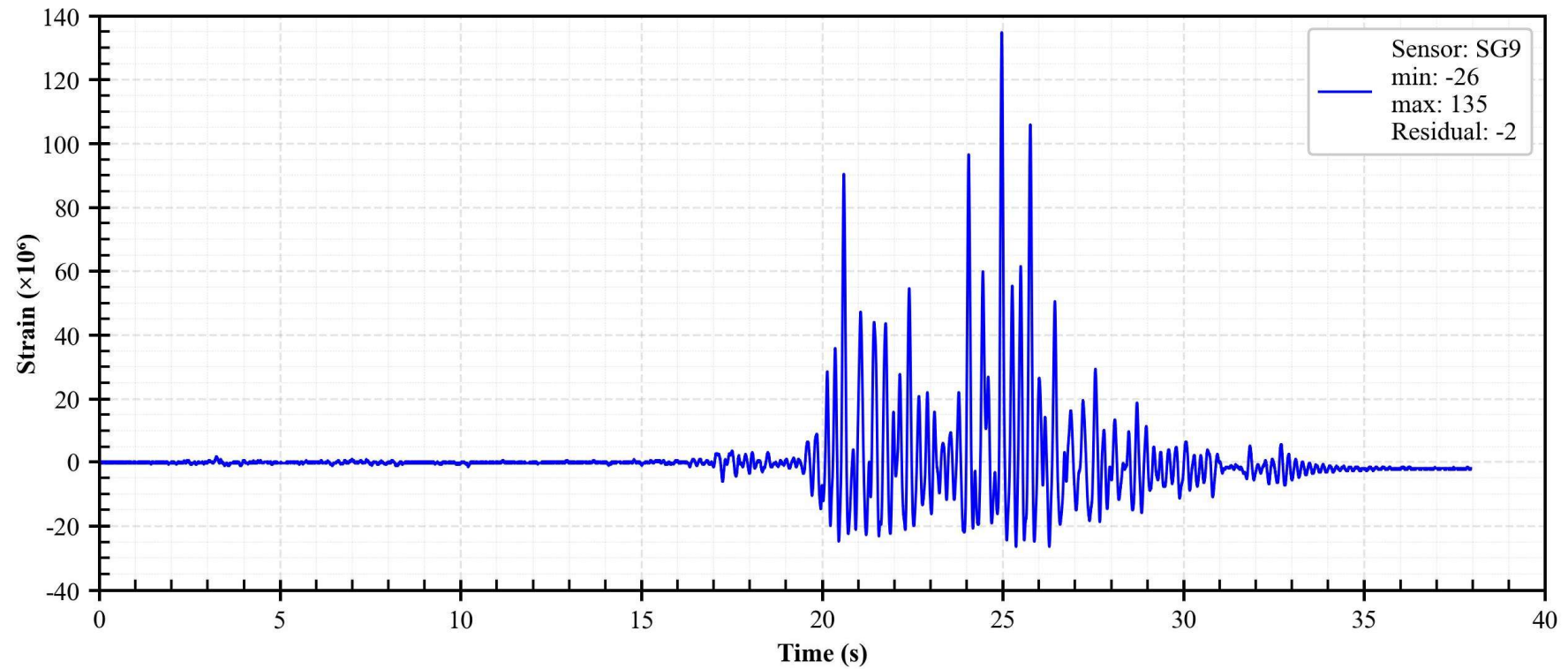


Figure 3.4.34 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 9

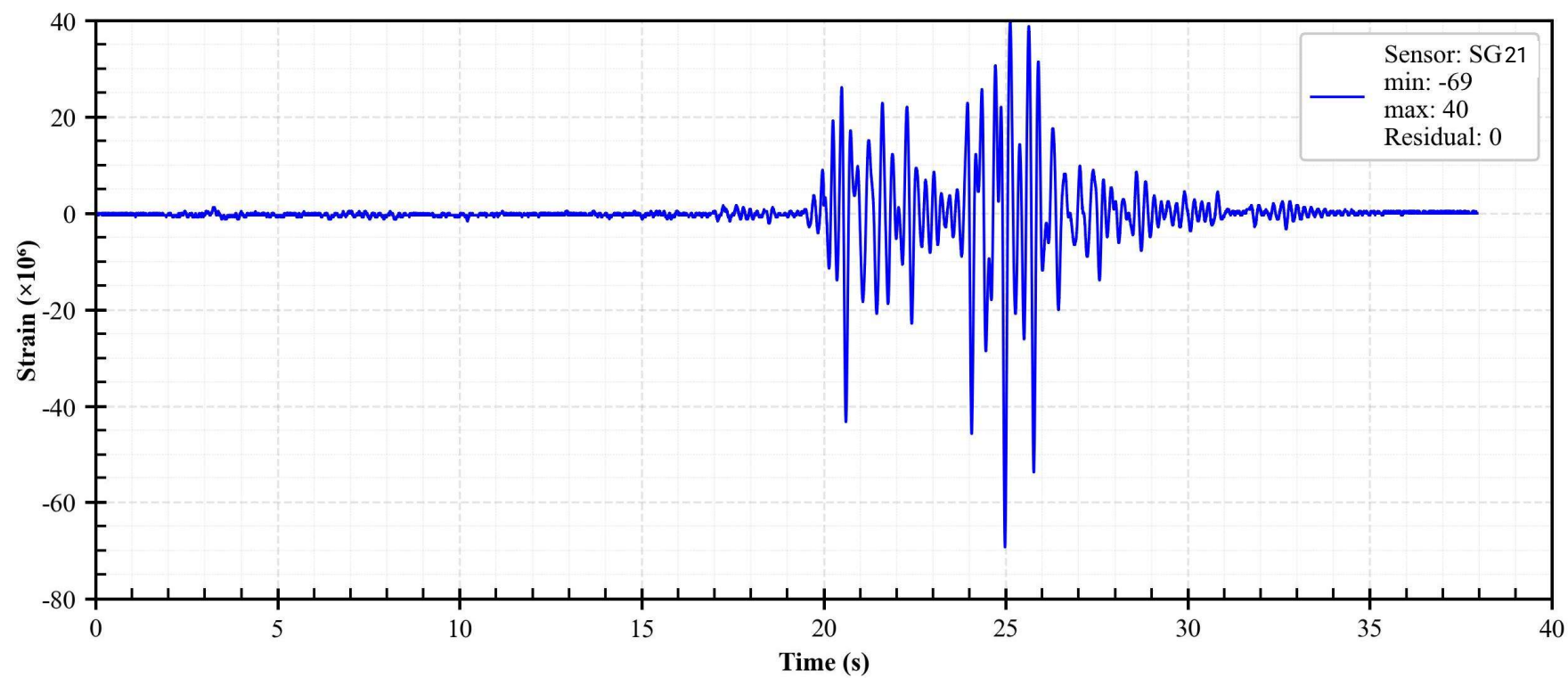


Figure 3.4.35 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 21 (PUFJ, column 1)

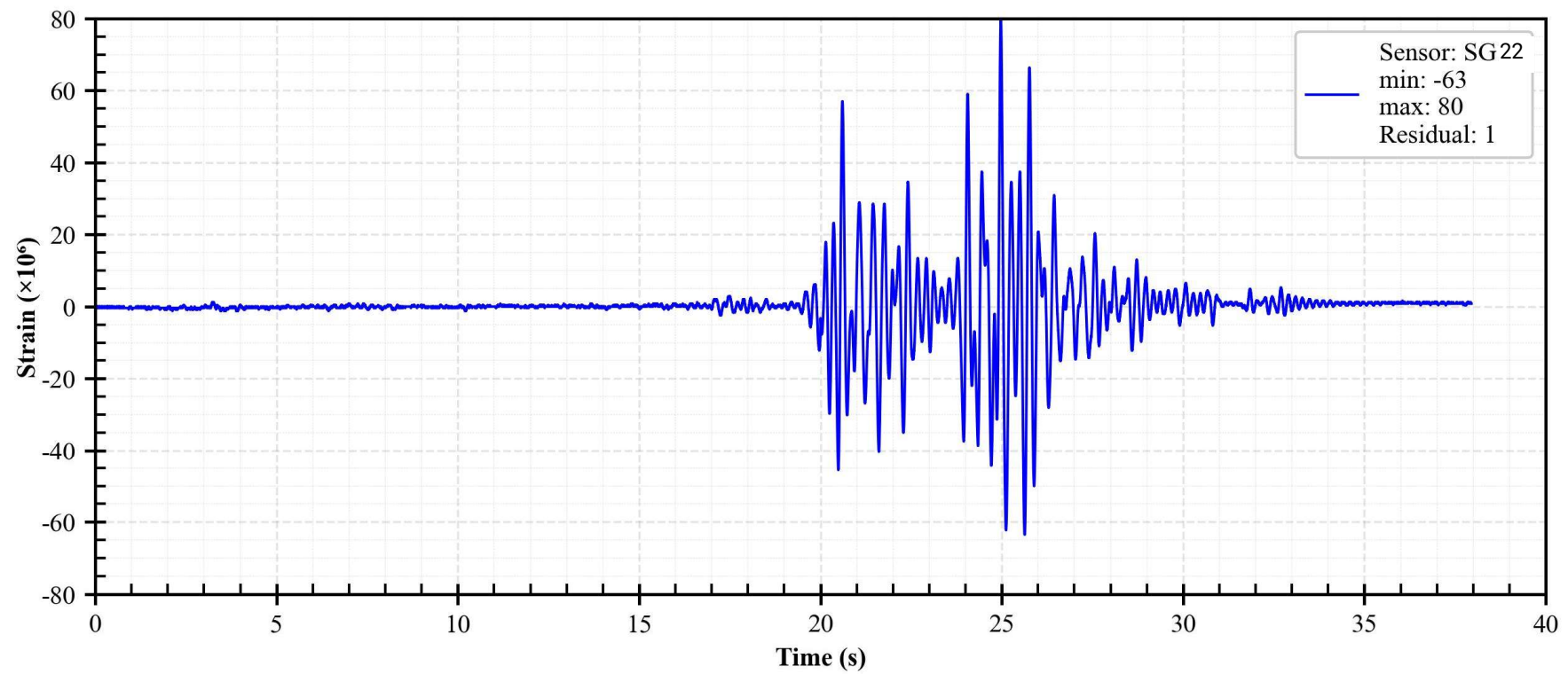


Figure 3.4.36 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 22 (PUFJ, column 2)

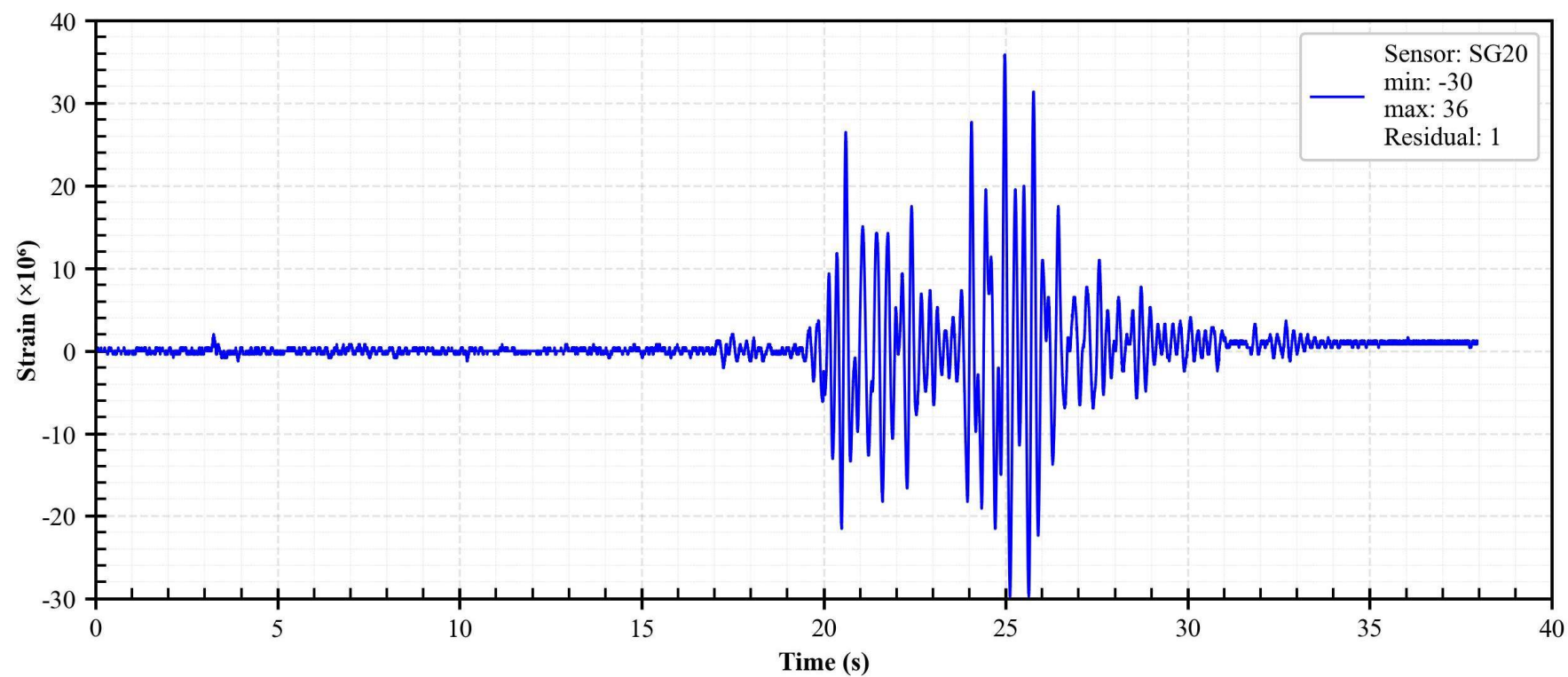


Figure 3.4.37 Characteristic results for phase B (earthquake EQ0,1g): strain gauge 20

3.5 White noise before EQ0,14g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise before test EQ0.14g. The max acceleration at the slab level on the accelerometer acc4 is 0.21g. The max acceleration at the foundation level on the accelerometer acc10 is 0.06g.

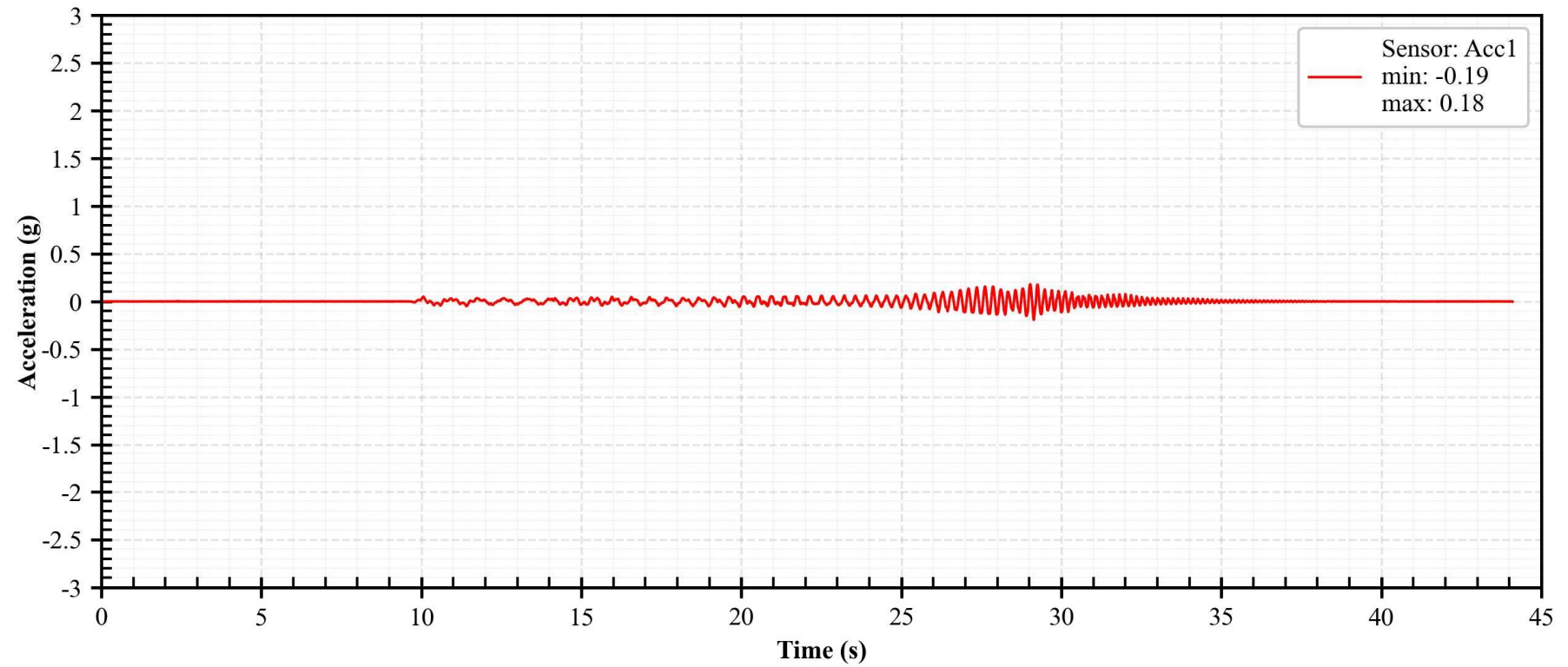


Figure 3.5.1 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 1

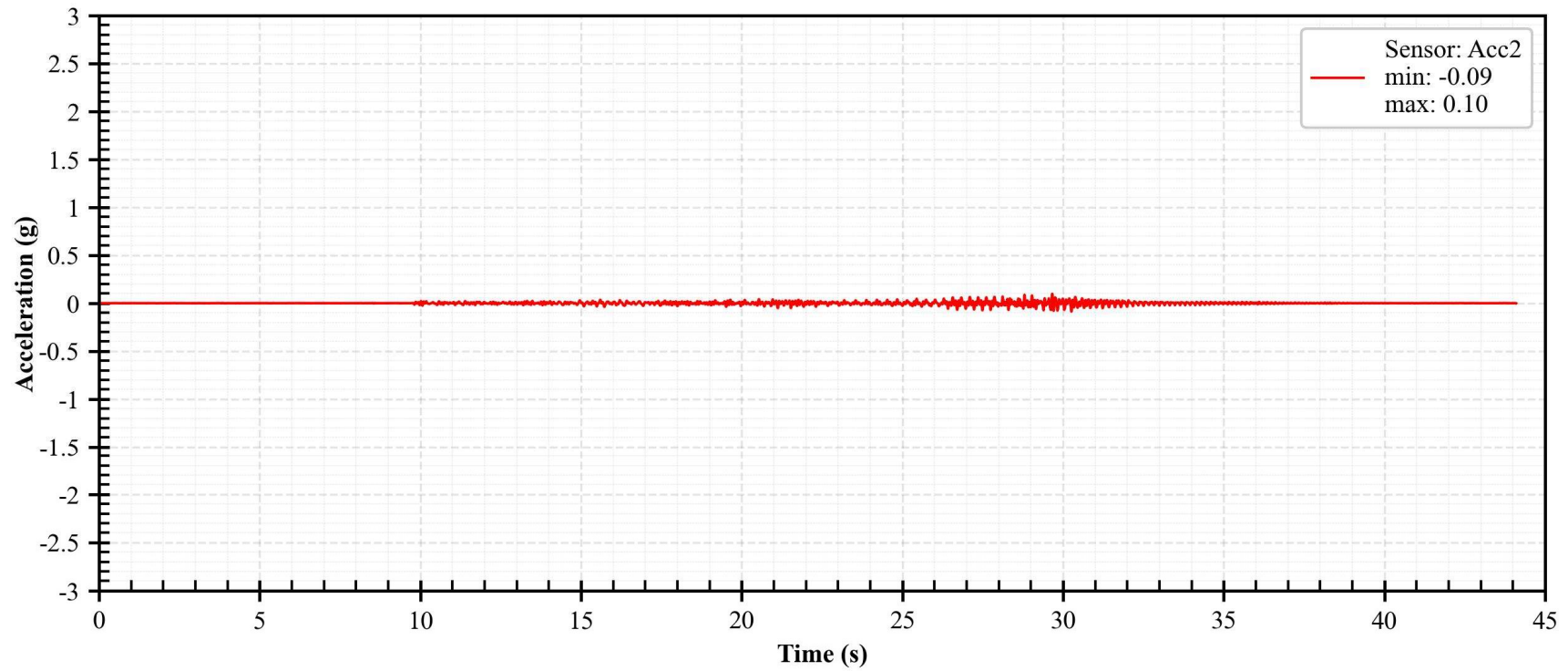


Figure 3.5.2 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 2

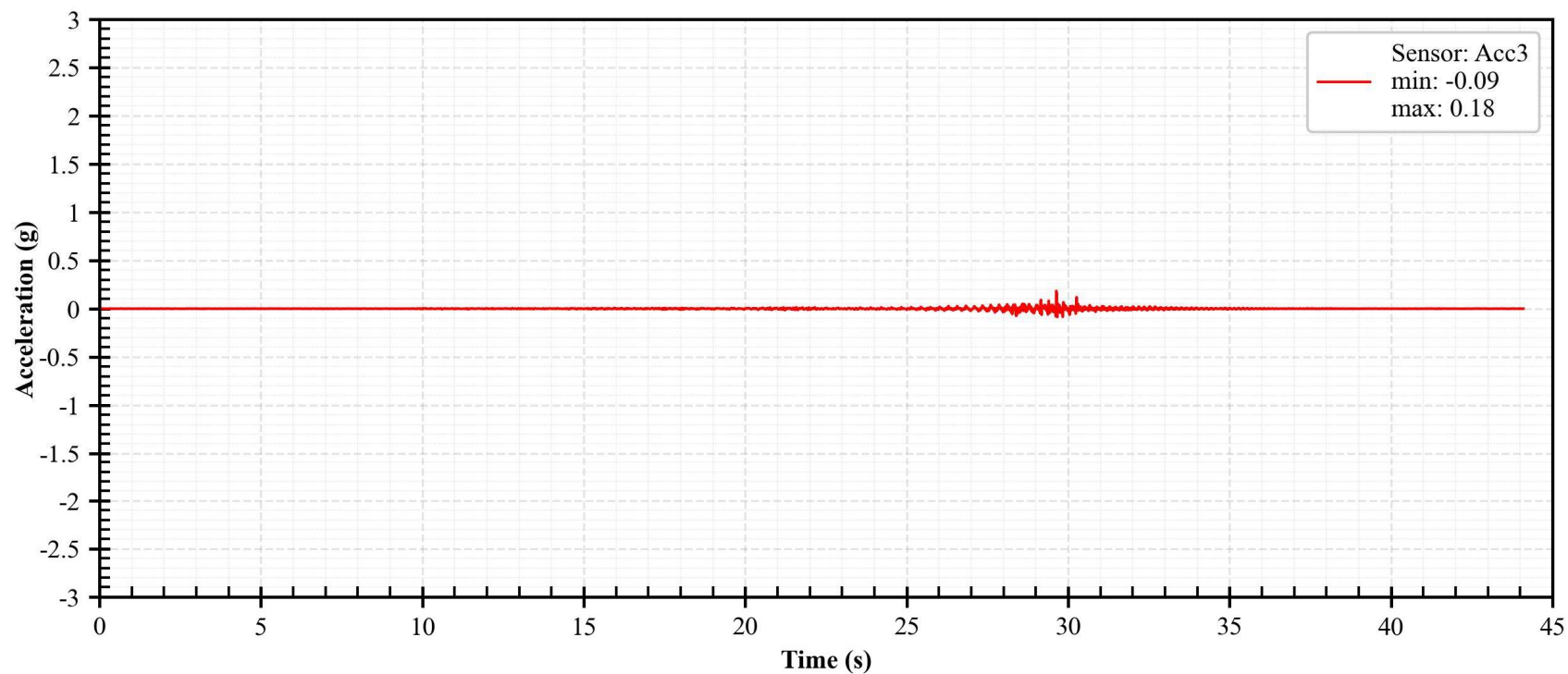


Figure 3.5.3 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 3

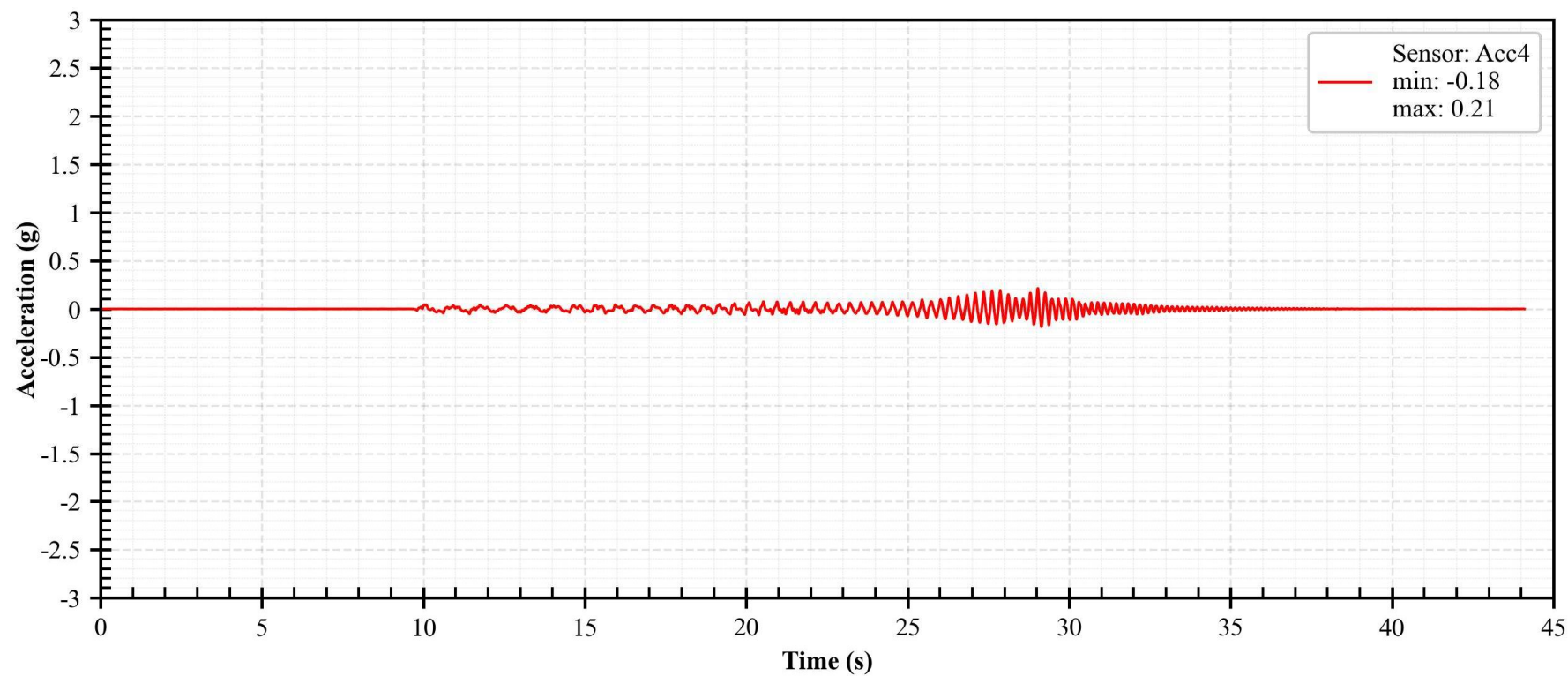


Figure 3.5.4 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 4

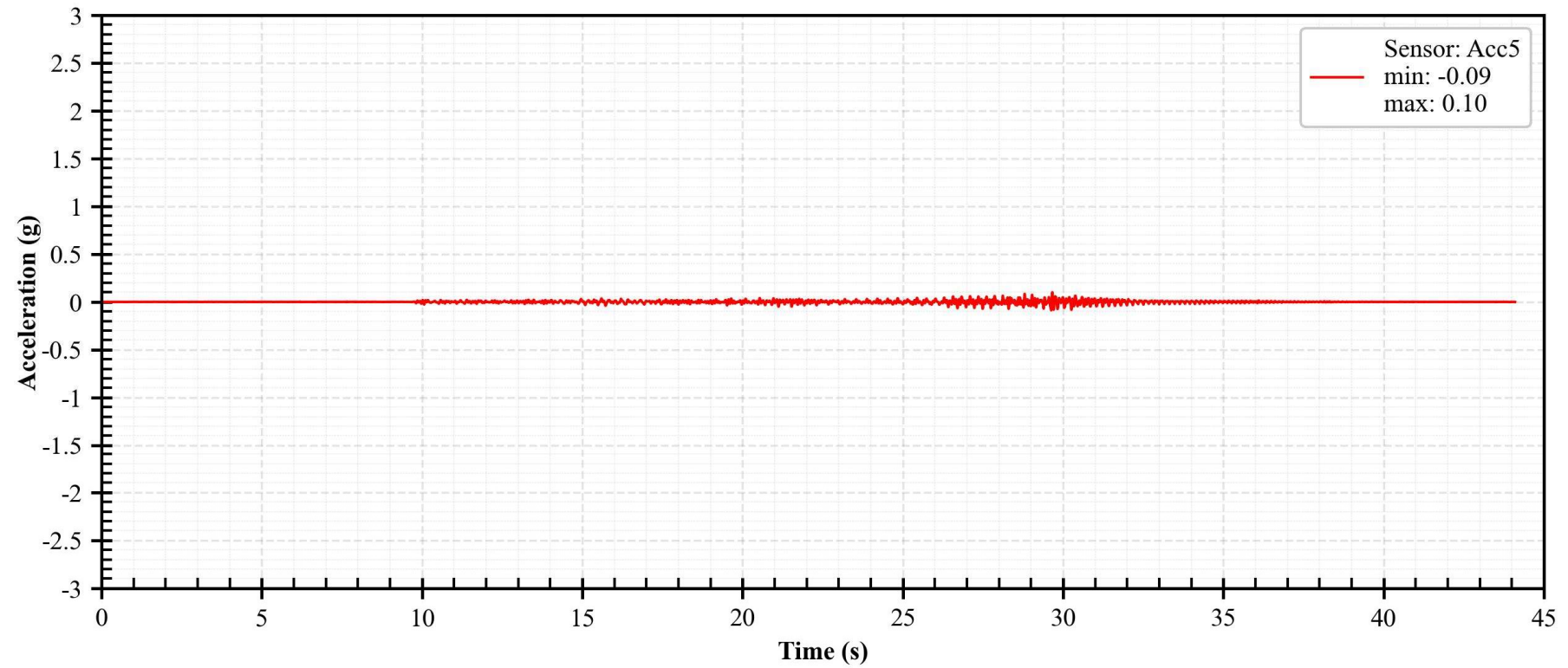


Figure 3.5.5 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 5

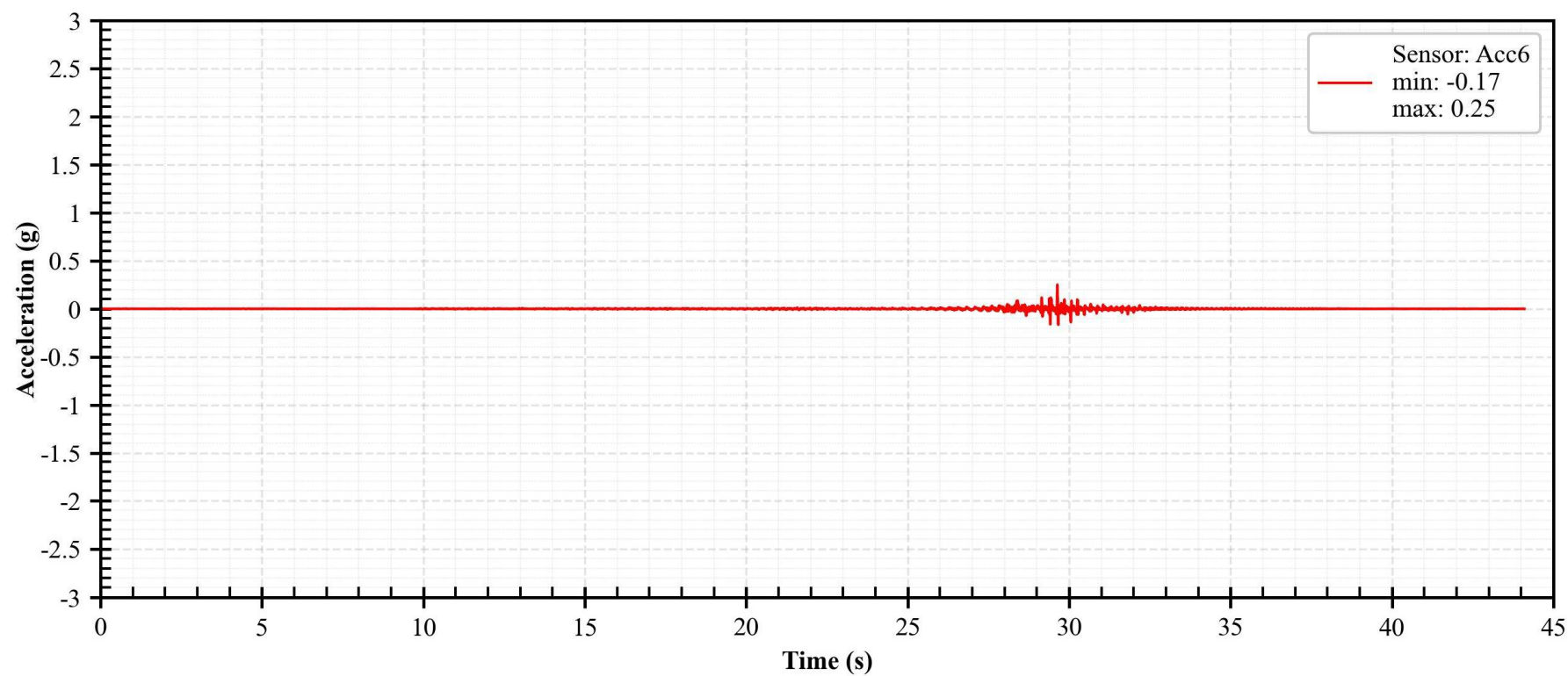


Figure 3.5.6 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 6

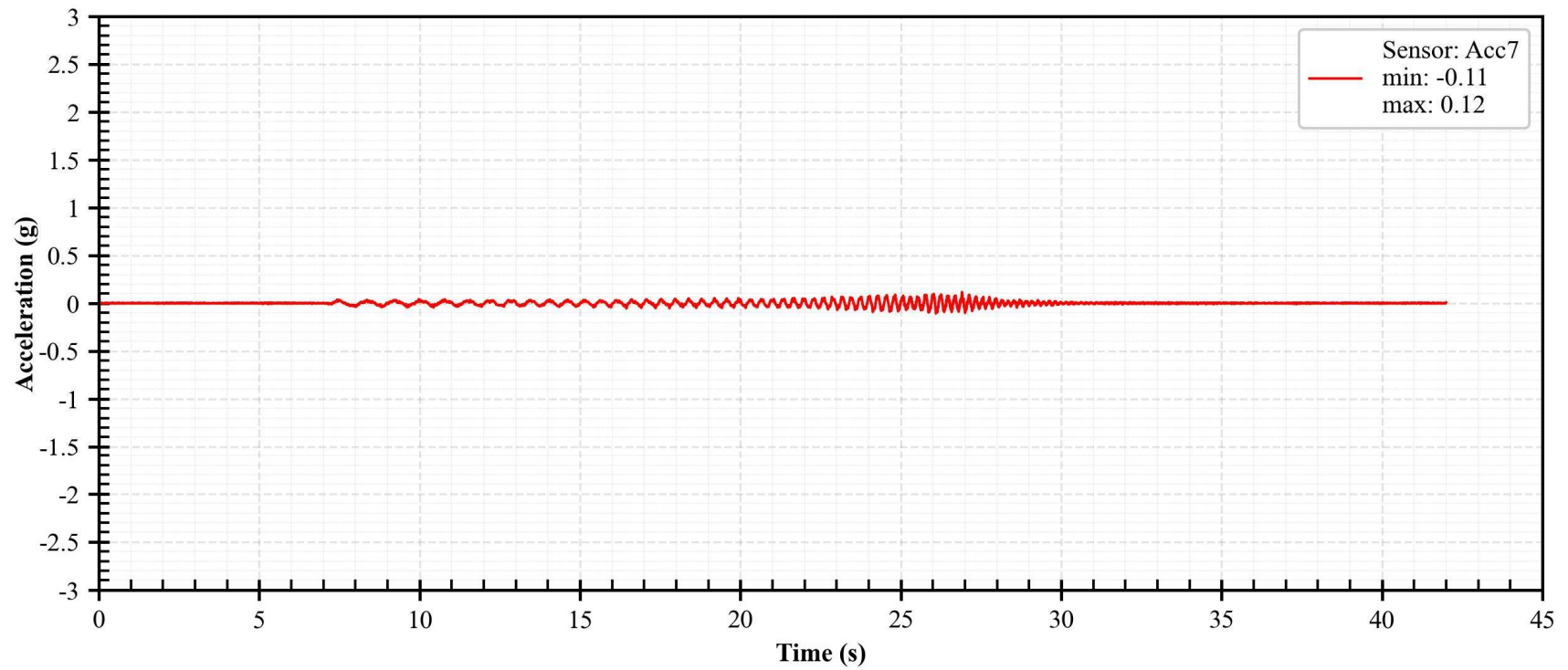


Figure 3.5.7 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 7

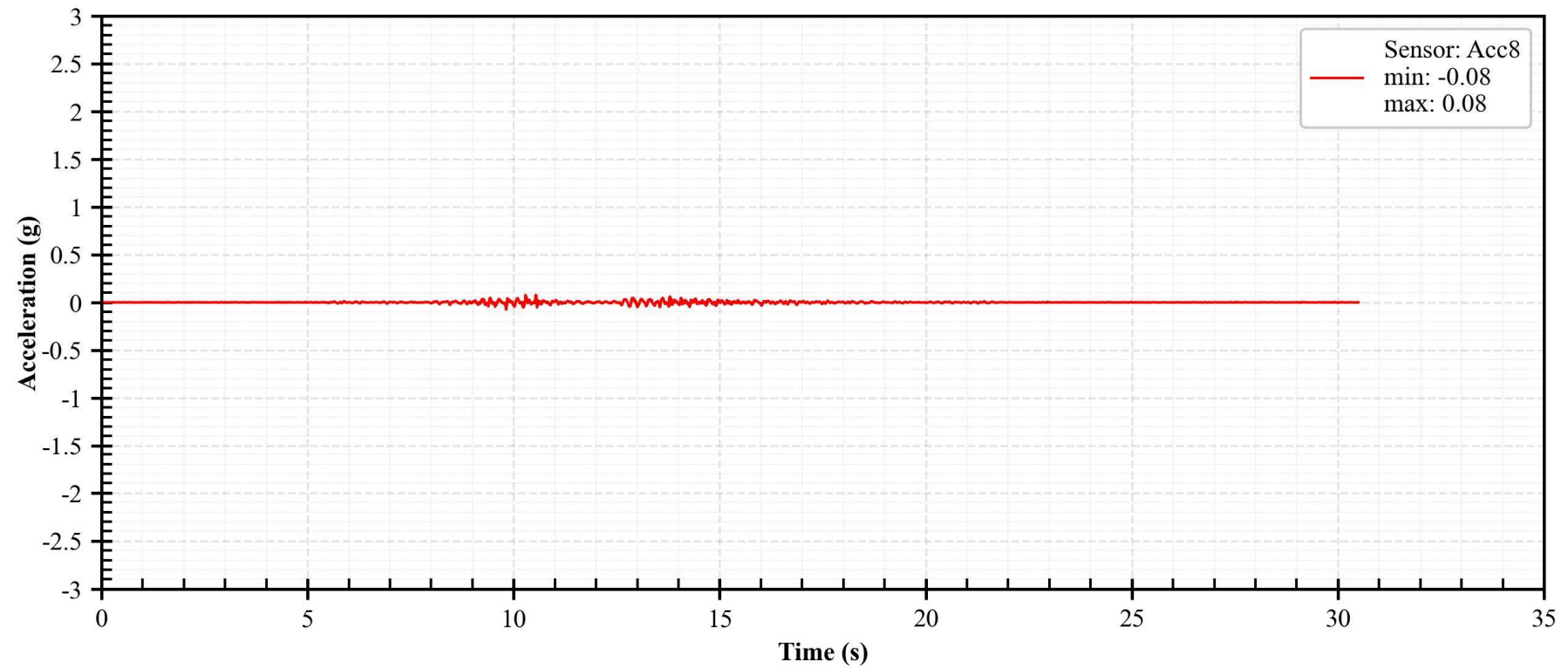


Figure 3.5.8 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 8

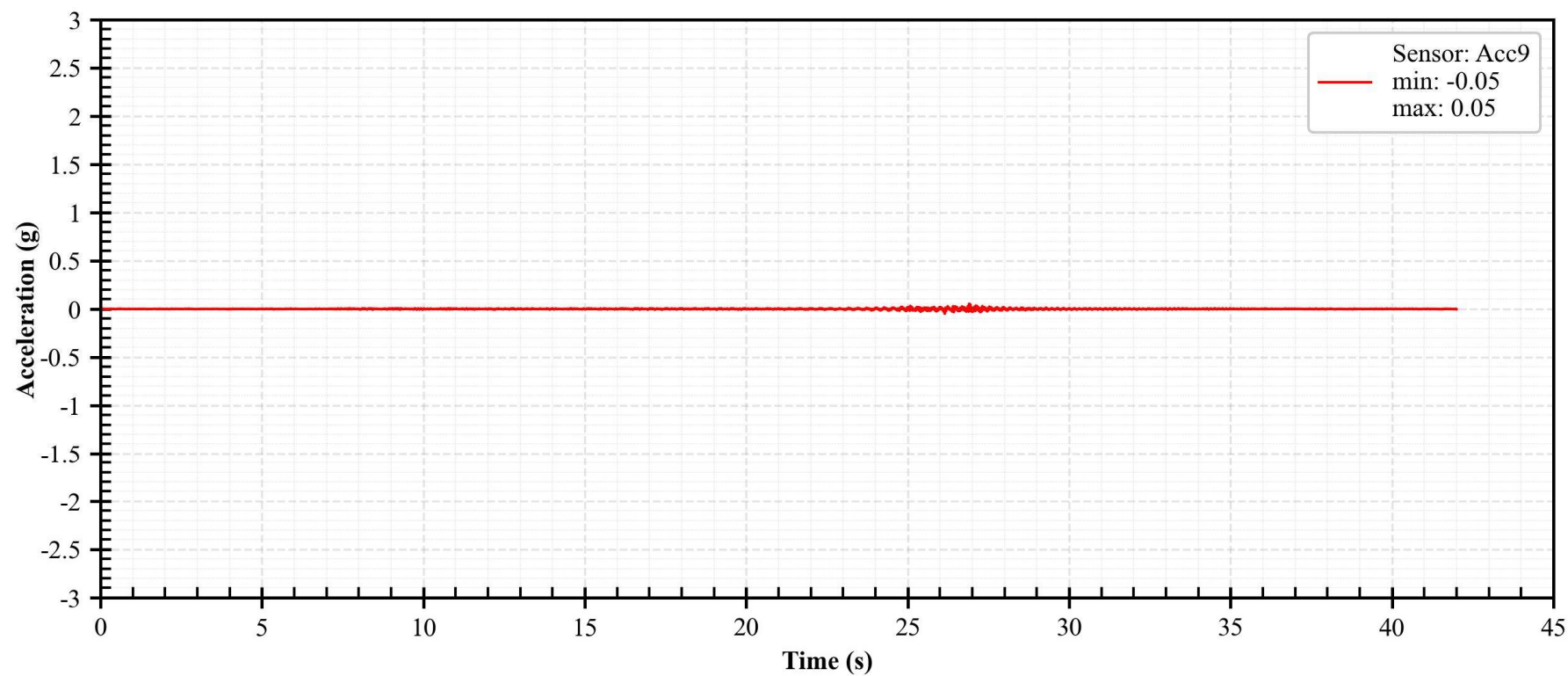


Figure 3.5.9 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 9

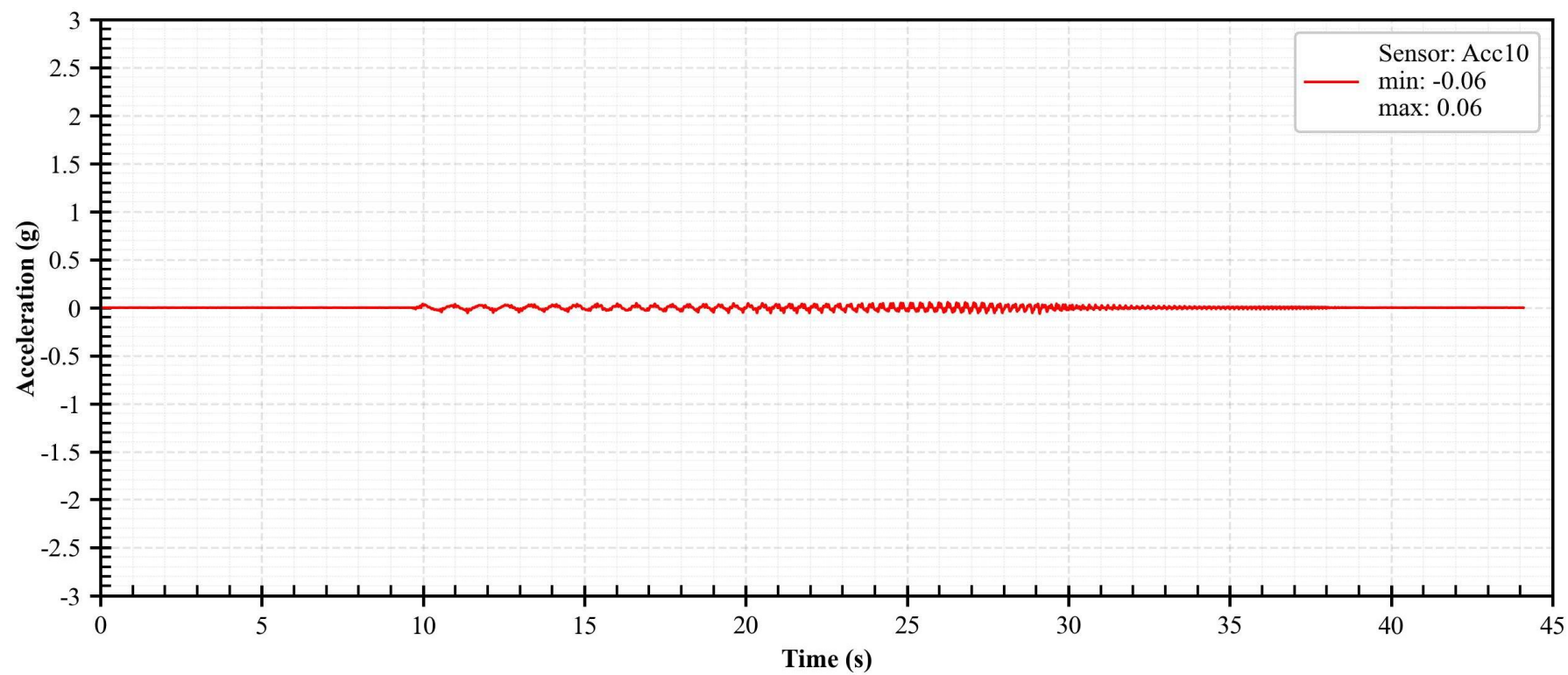


Figure 3.5.10 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 10

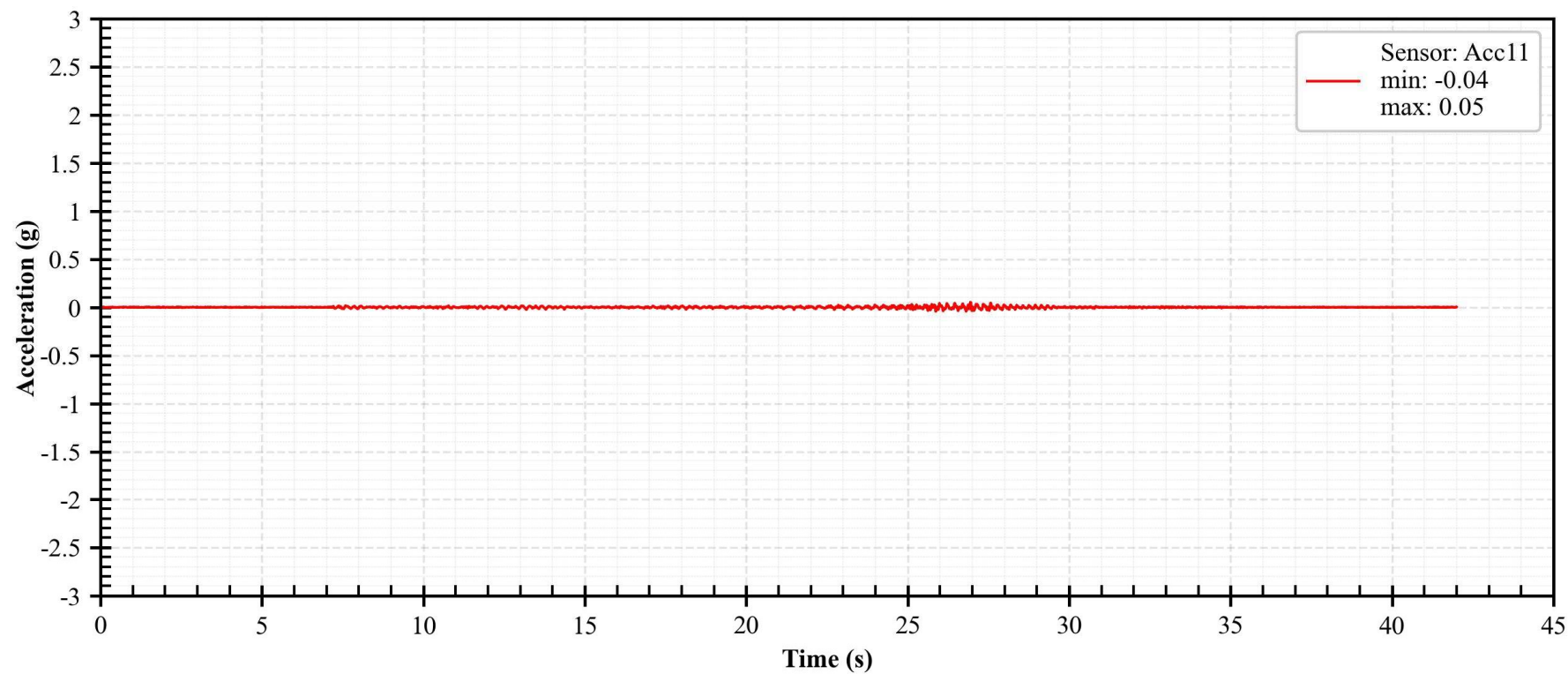


Figure 3.5.11 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 11

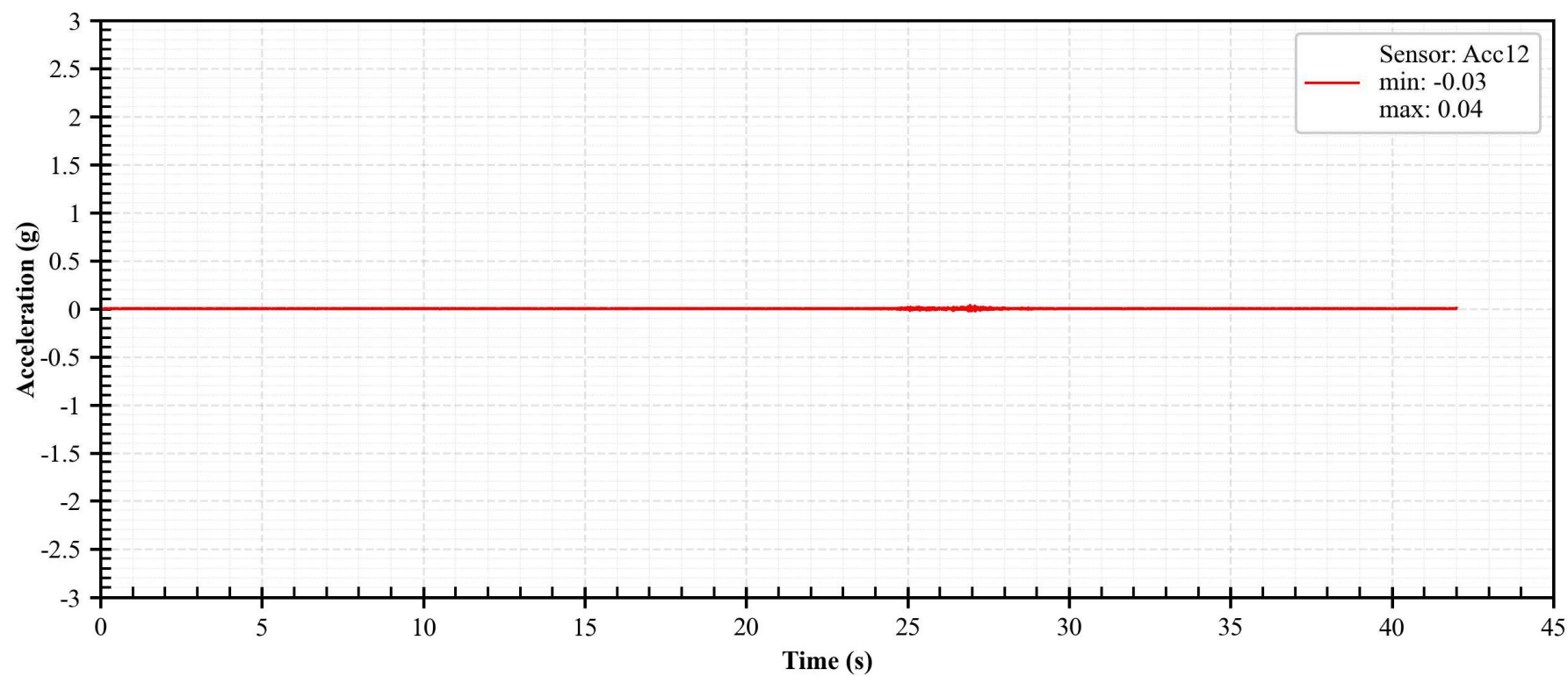


Figure 3.5.12 Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 12

Draw wire sensors

Figures 3.5.13 – 3.5.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 20.91 mm while the minimum is -16.33 mm. The maximum movement detected by draw wire sensor W2 is 21.18 mm while the minimum is -16.32 mm. The maximum movement detected by draw wire sensor W3 is 4.30 mm while the minimum is -4.13 mm. The maximum movement detected by draw wire sensor W4 is 4.68 mm while the minimum is -4.39 mm. The maximum drift is $(1.69/1.225) = 1.38 \%$ and minimum drift is $(-1.77/1.225) = -1.44 \%$.

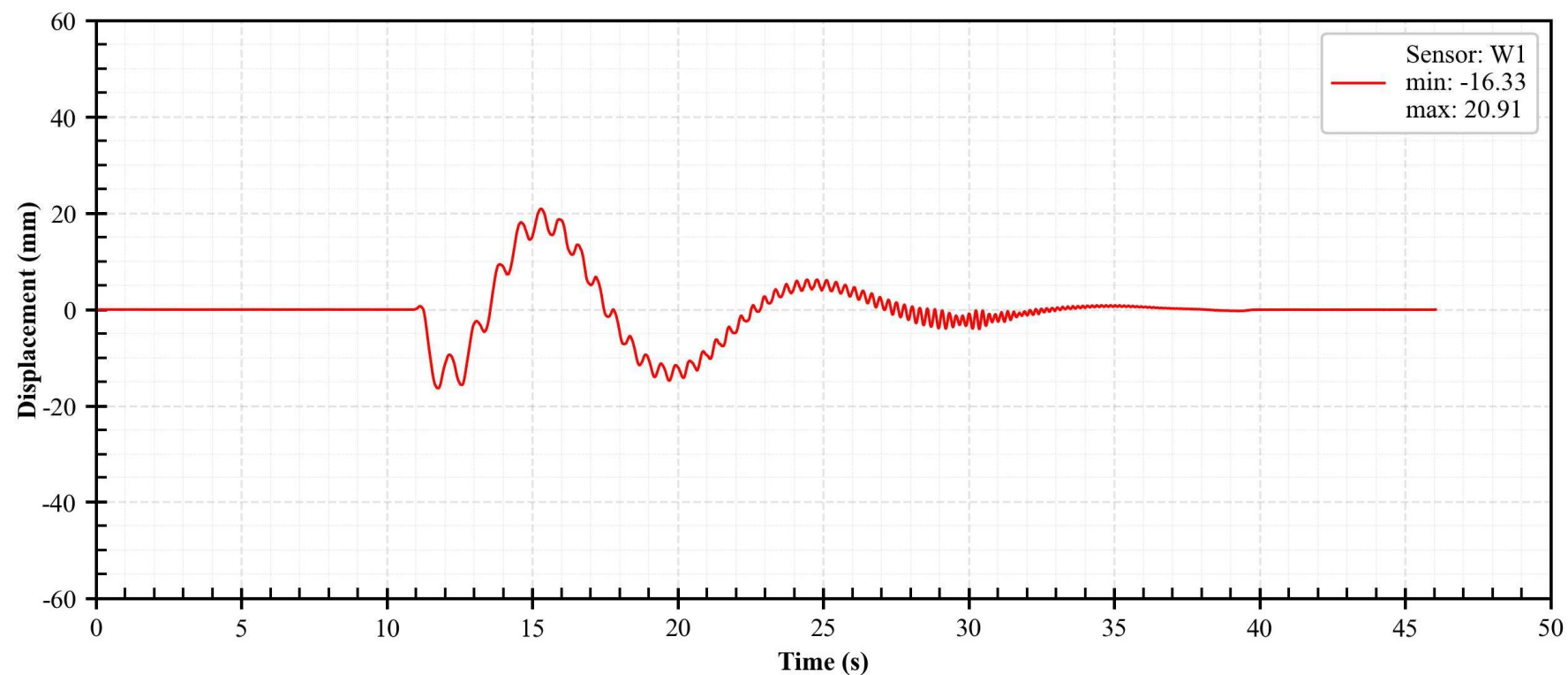


Figure 3.5.13 Characteristic results for phase B (white noise before EQ0,14g): Draw wire sensor 1

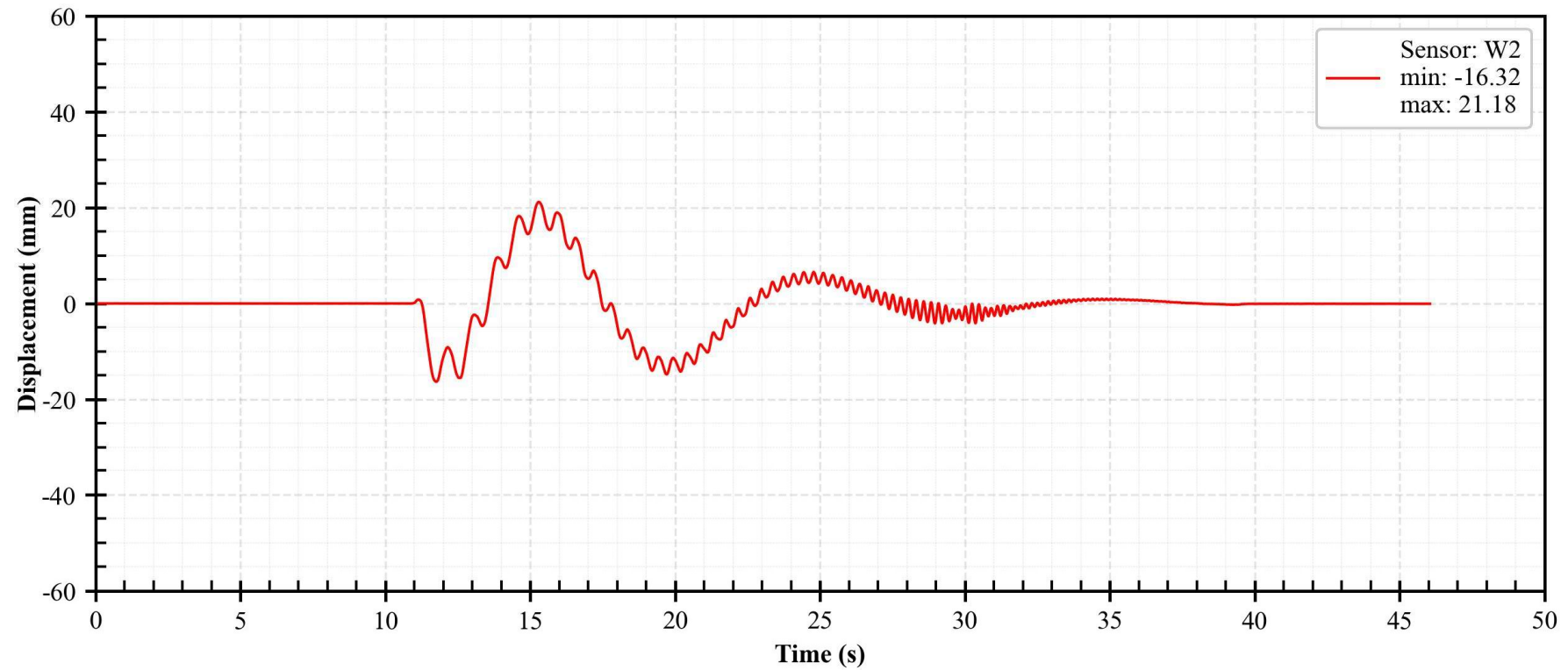


Figure 3.5.14 Characteristic results for phase B (white noise before EQ0,14g): Draw wire sensor 2

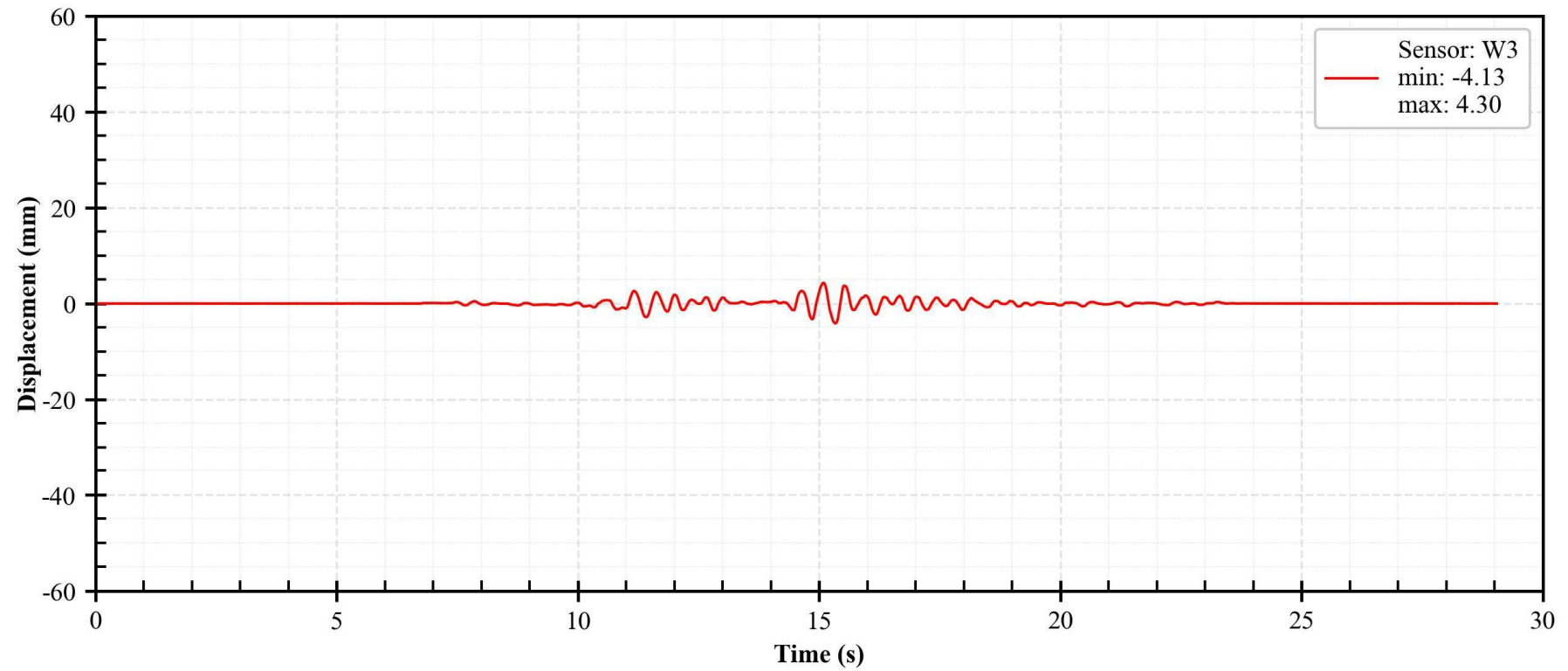


Figure 3.5.15 Characteristic results for phase B (white noise before EQ0,14g): Draw wire sensor 3

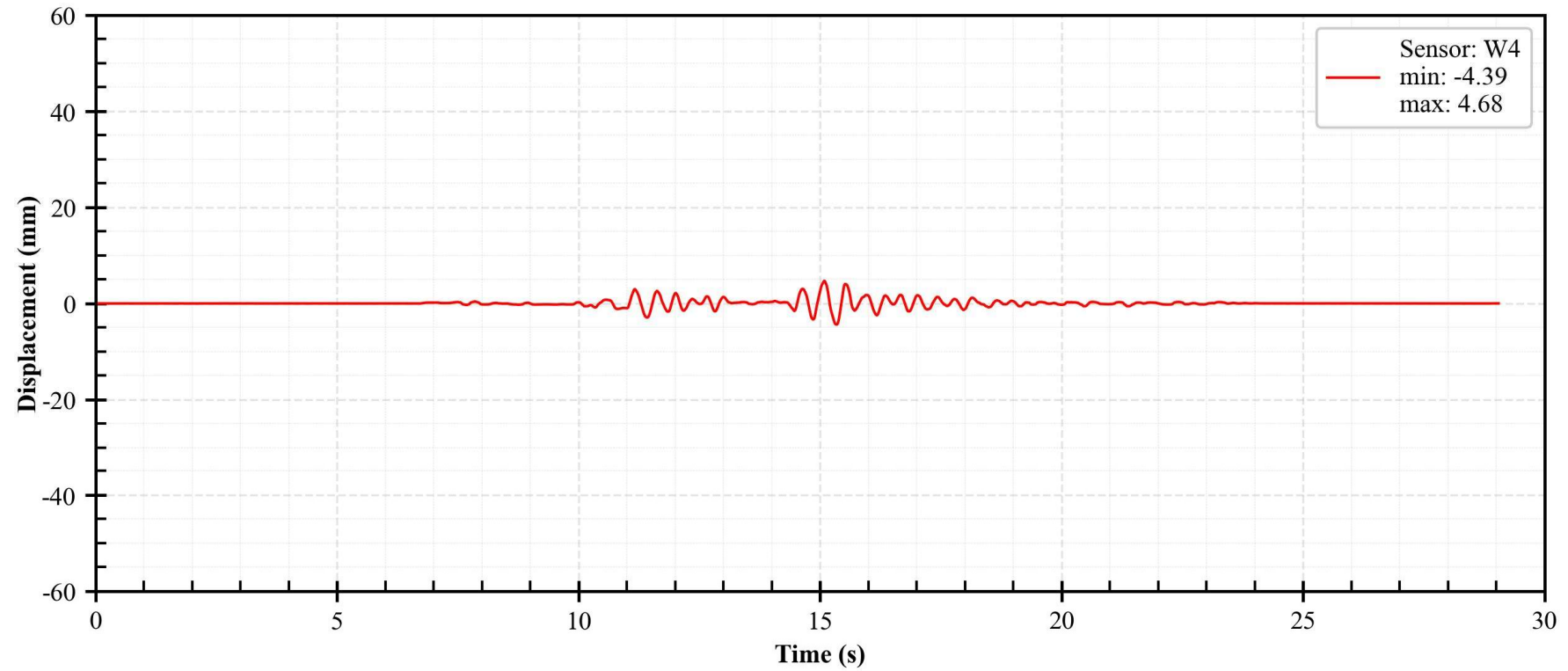


Figure 3.5.16 Characteristic results for phase B (white noise before EQ0,14g): Draw wire sensor 4

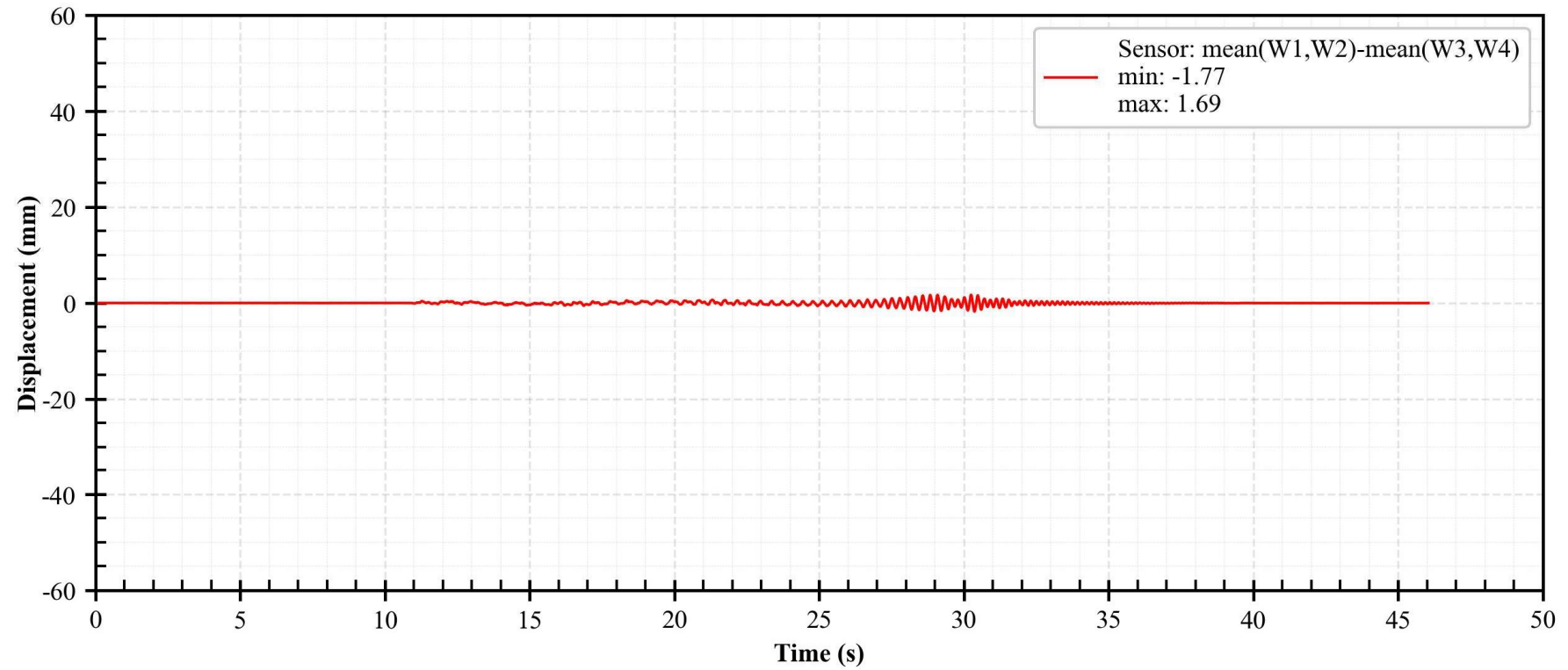


Figure 3.5.17 Characteristic results for phase B (white noise before EQ0,14g): $\text{mean}(W1,W2) - \text{mean}(W3,W4)$

Strain gauges

No notable changes are detected in the values of strain gauges.

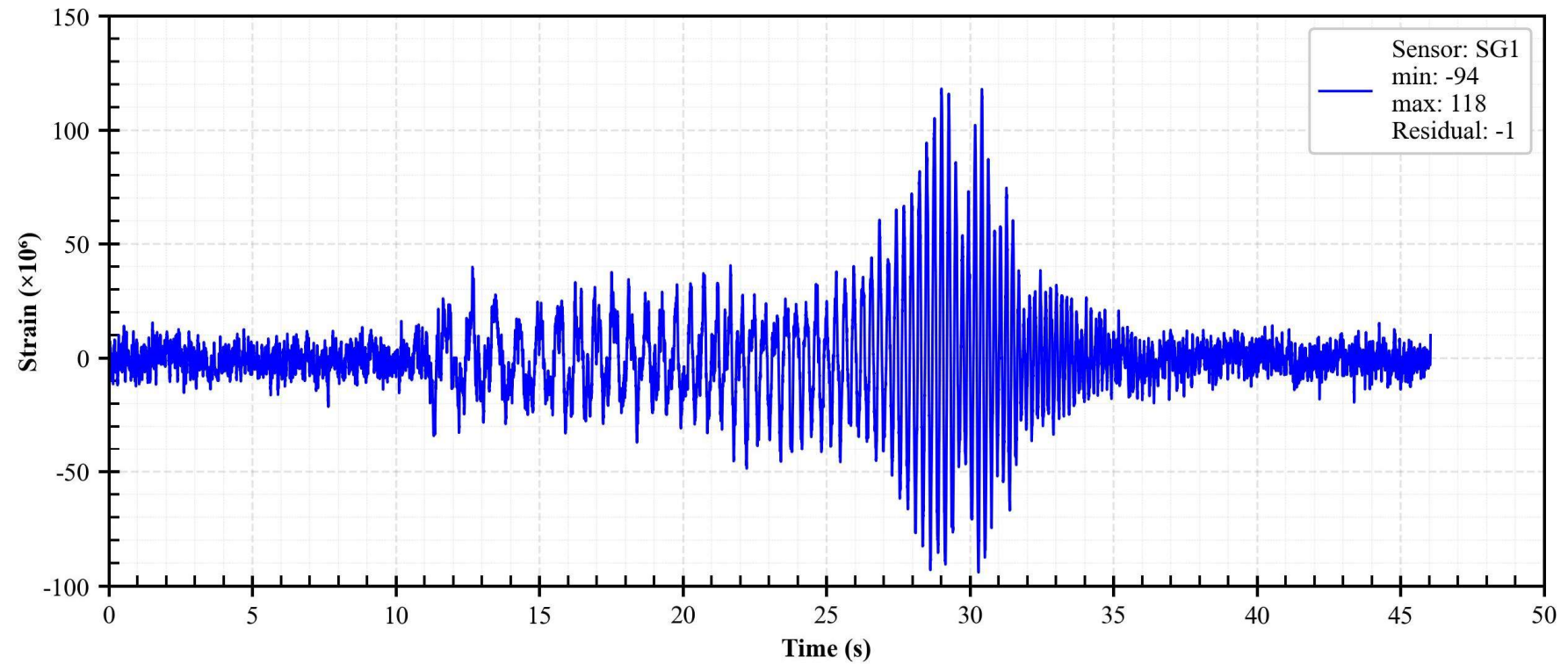


Figure 3.5.18 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 1

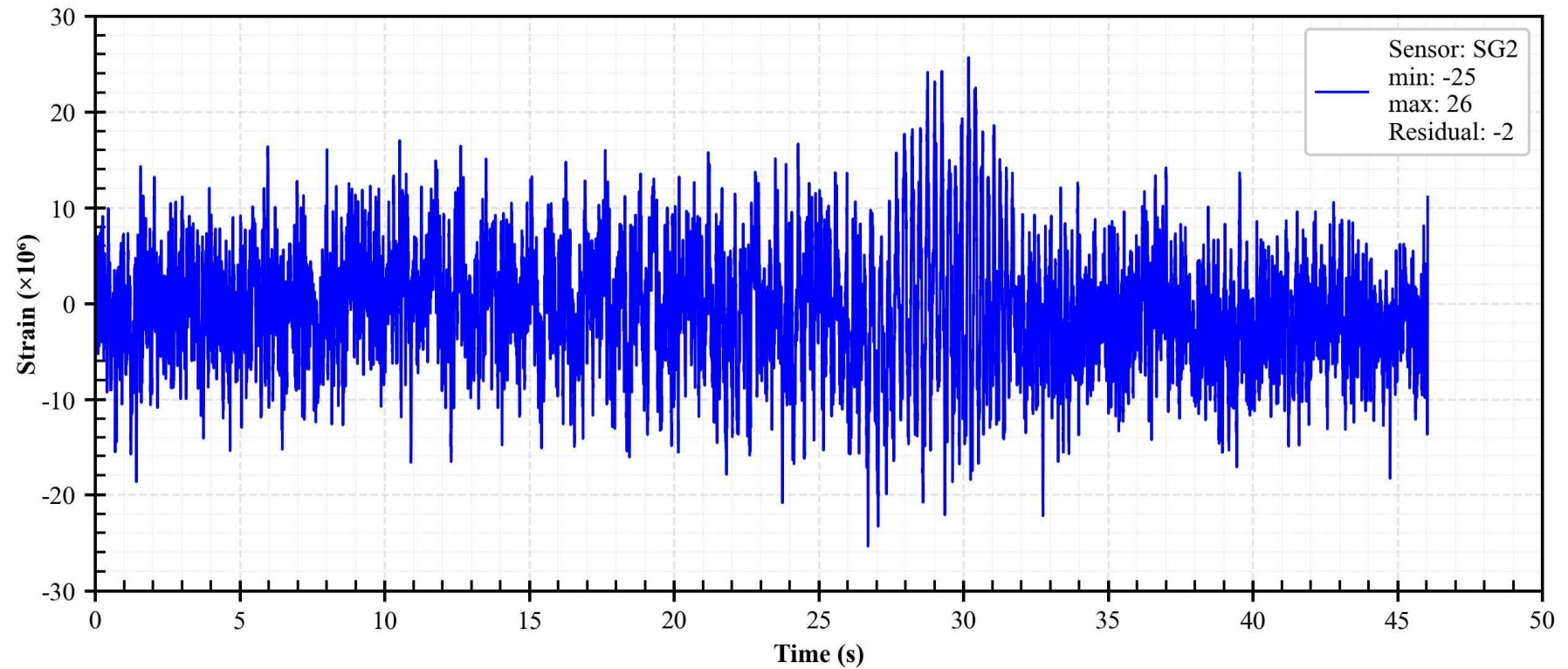


Figure 3.5.19 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 2

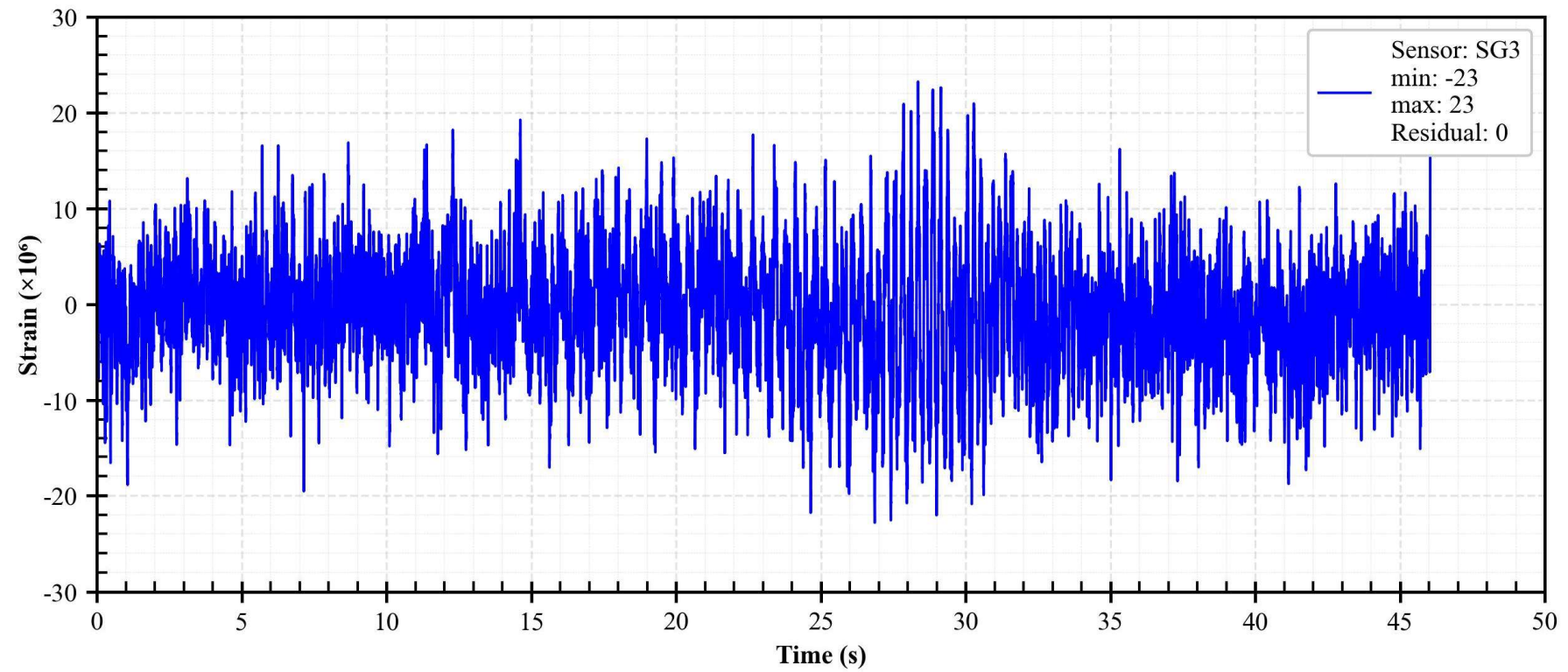


Figure 3.5.20 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 3

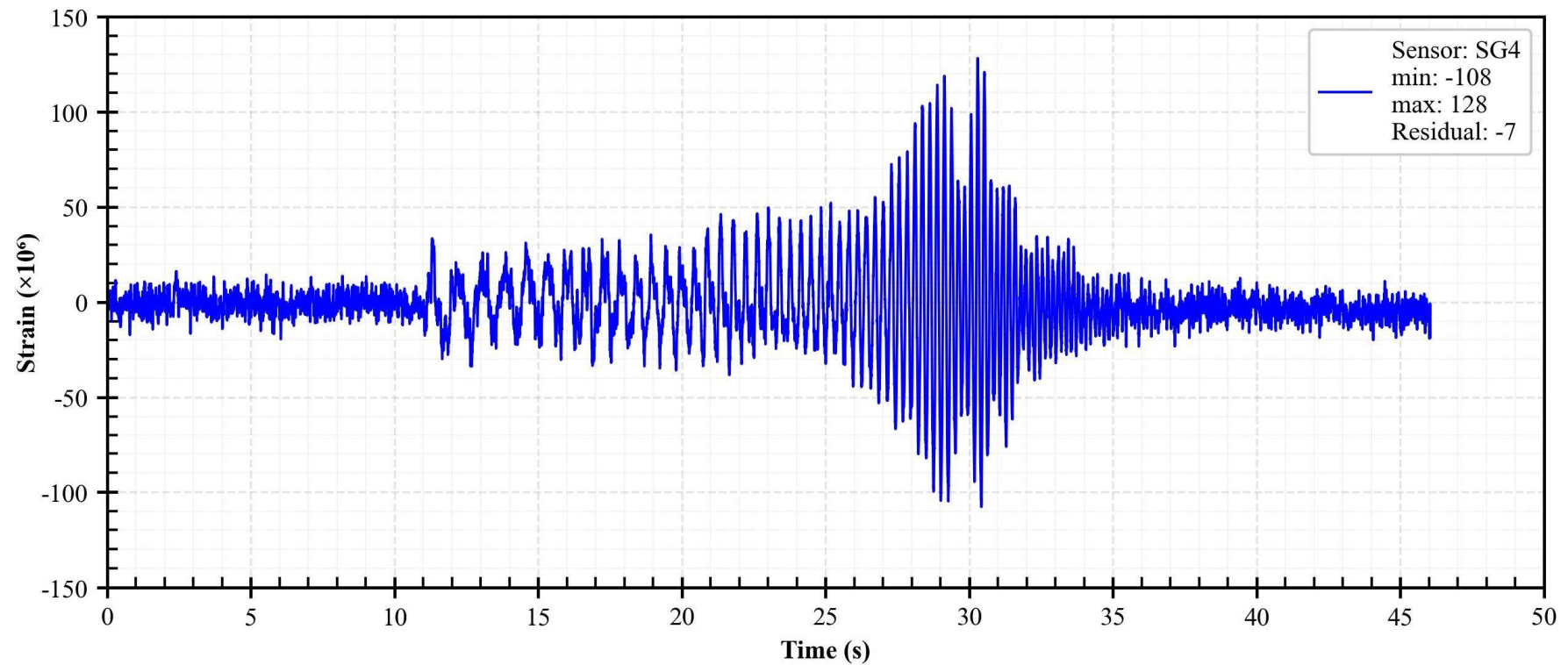


Figure 3.5.21 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 4

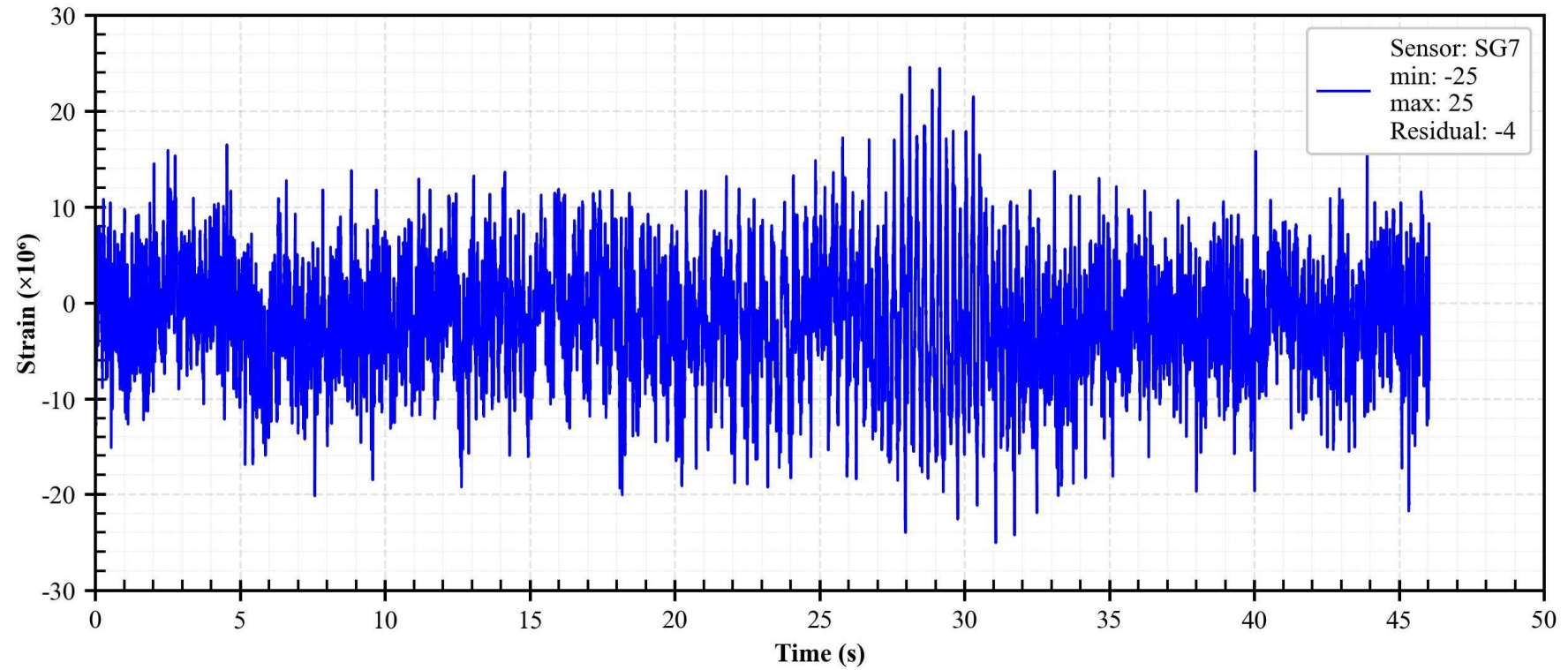


Figure 3.5.22 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 7

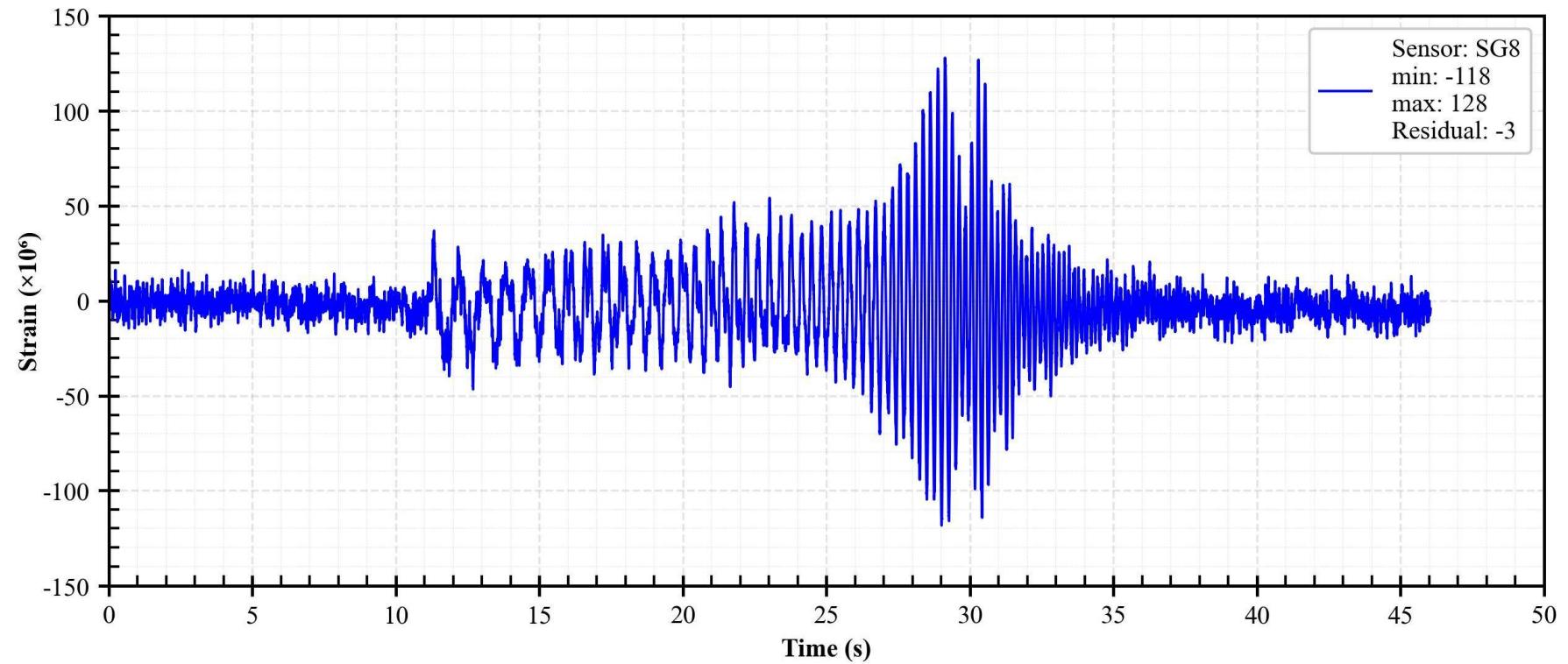


Figure 3.5.23 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 8



Figure Characteristic results for phase B (white noise before EQ0,14g): Accelerometer 1

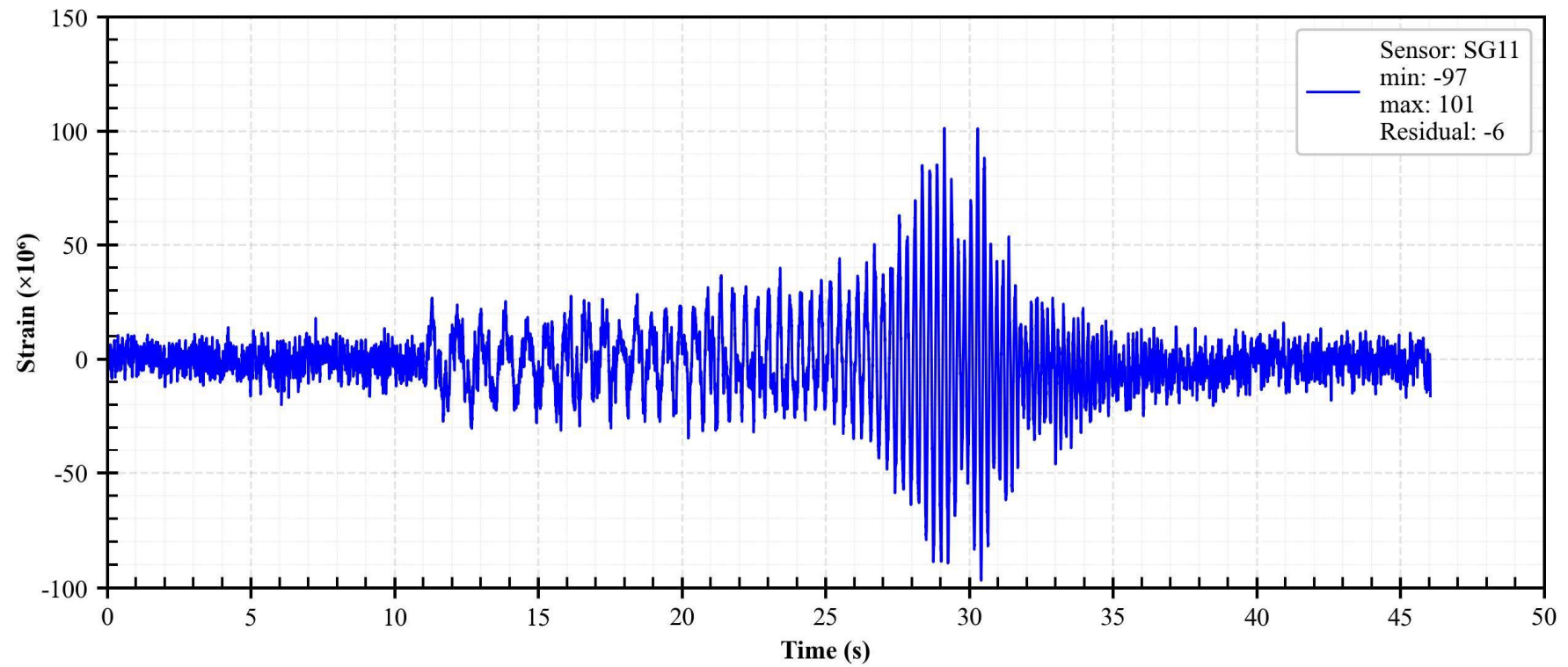


Figure 3.5.24 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 11

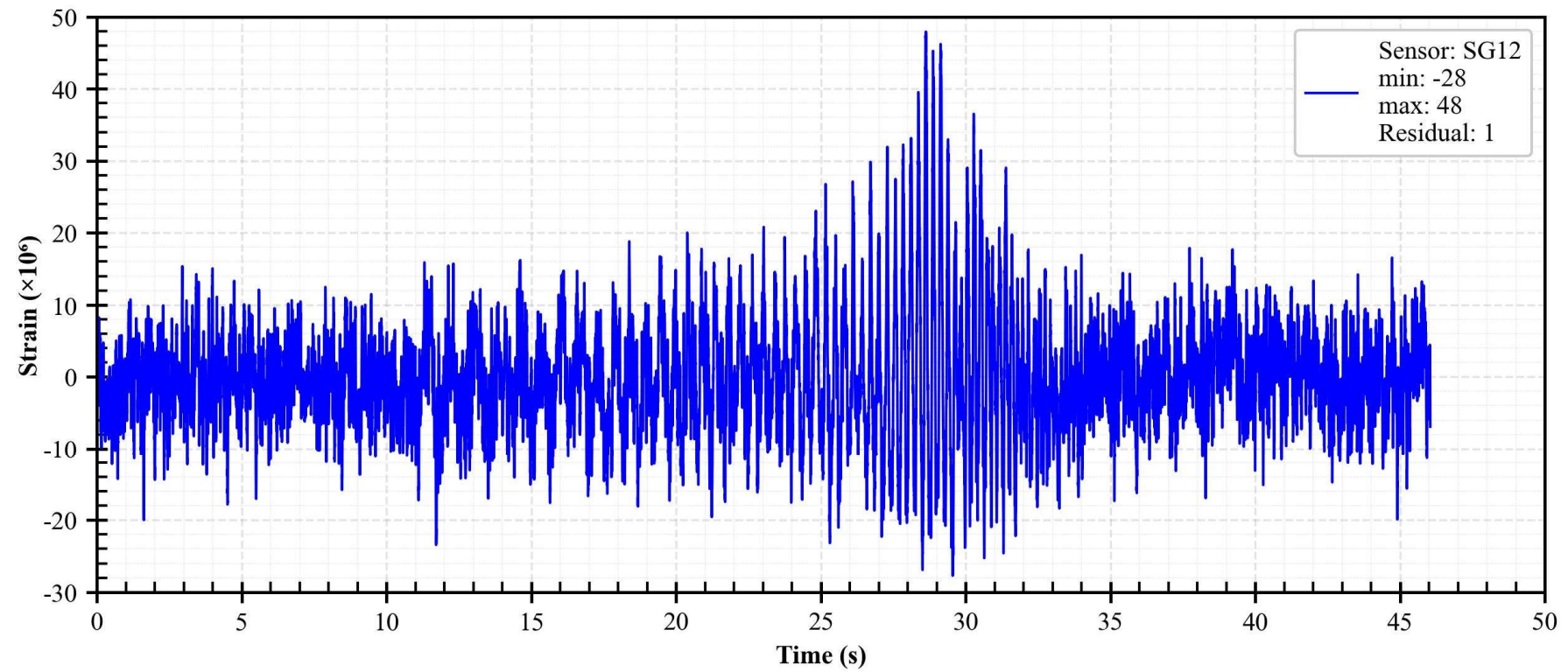


Figure 3.5.25 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 12

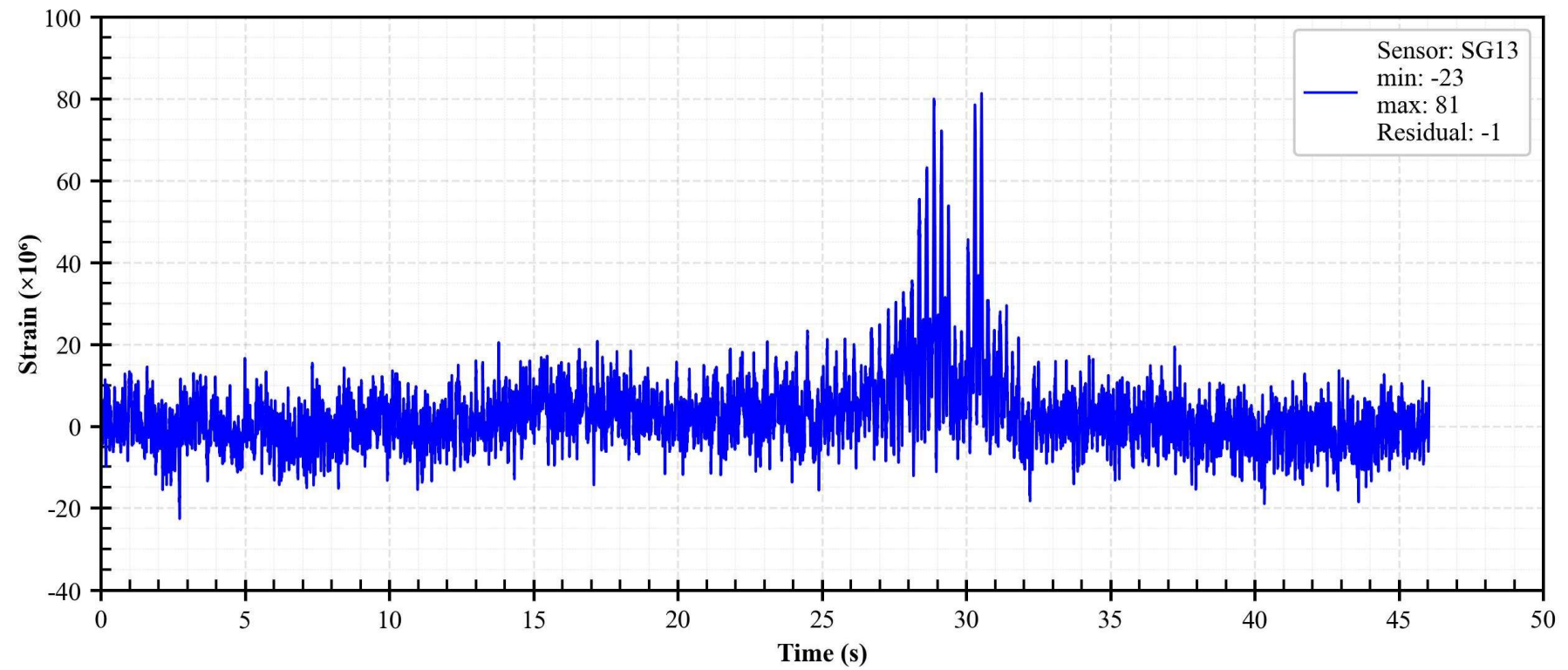


Figure 3.5.26 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 13

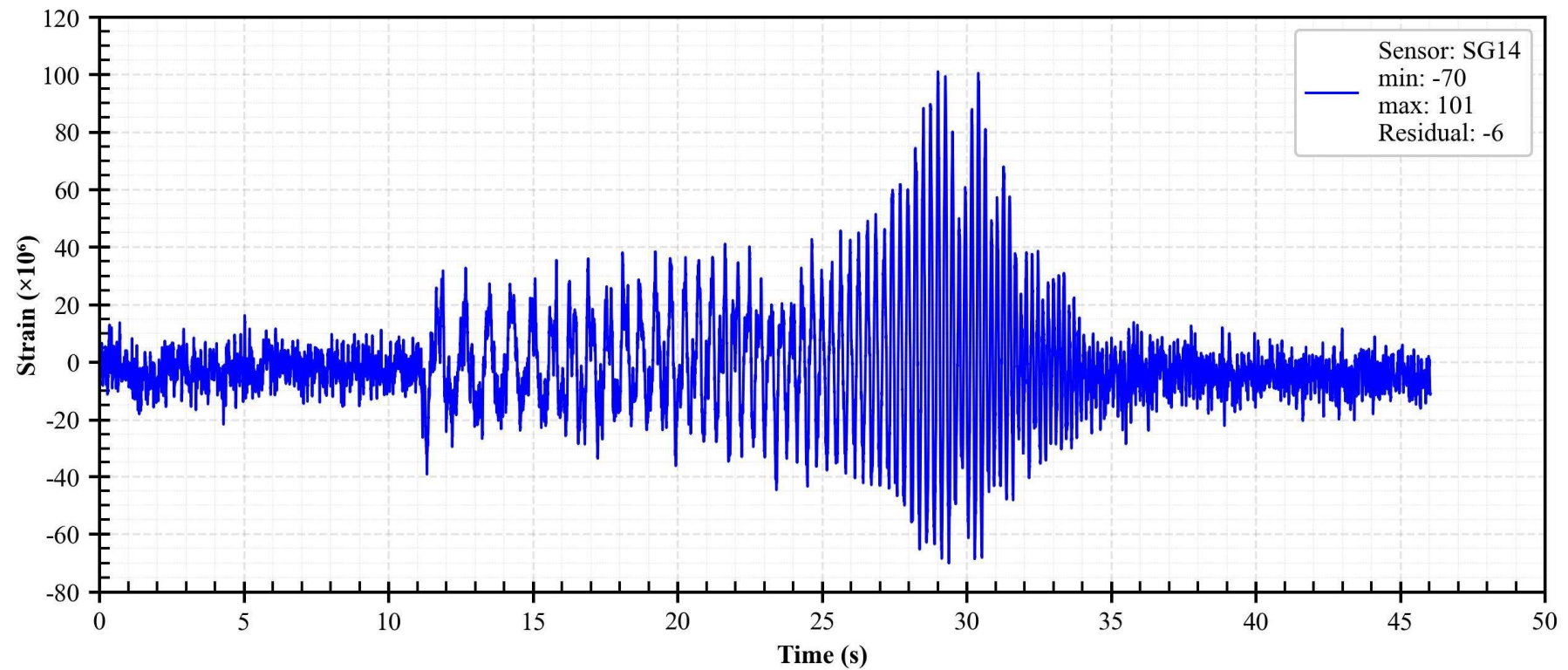


Figure 3.5.27 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 14

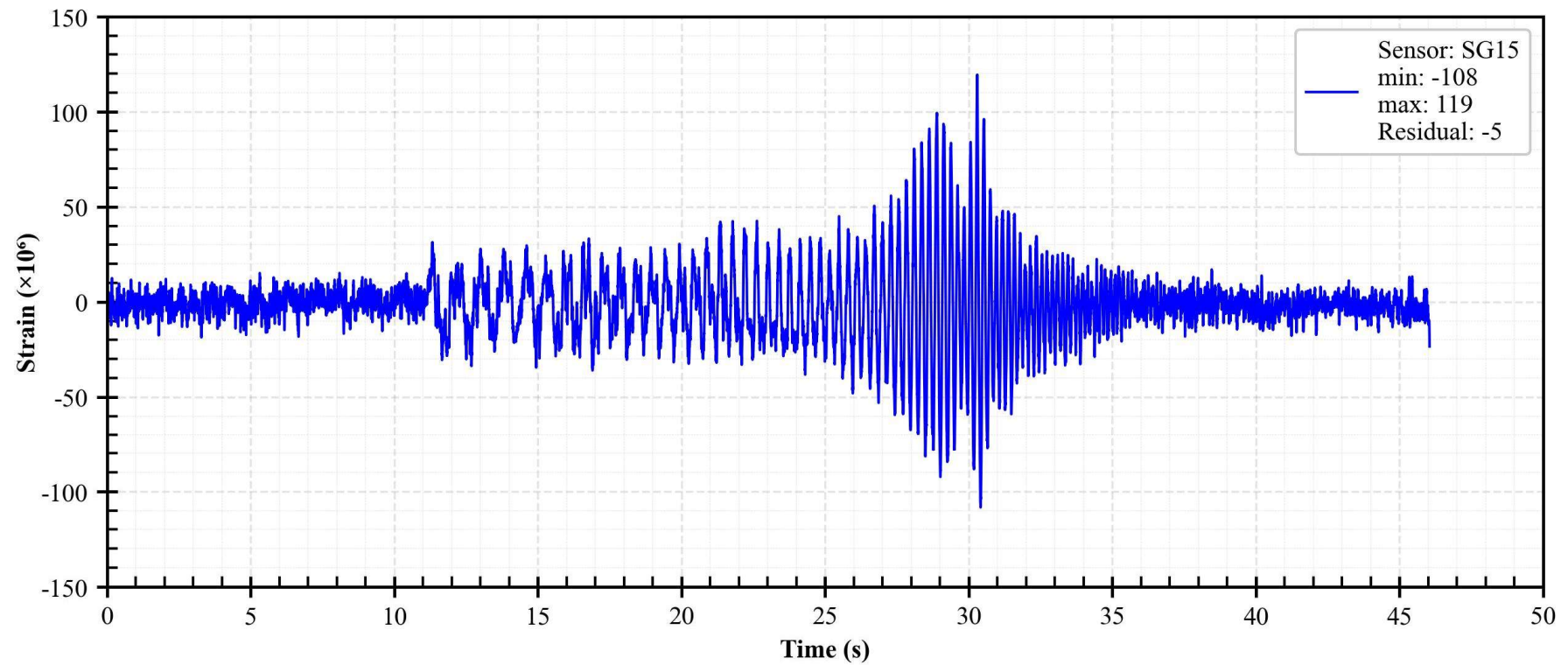


Figure 3.5.28 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 15

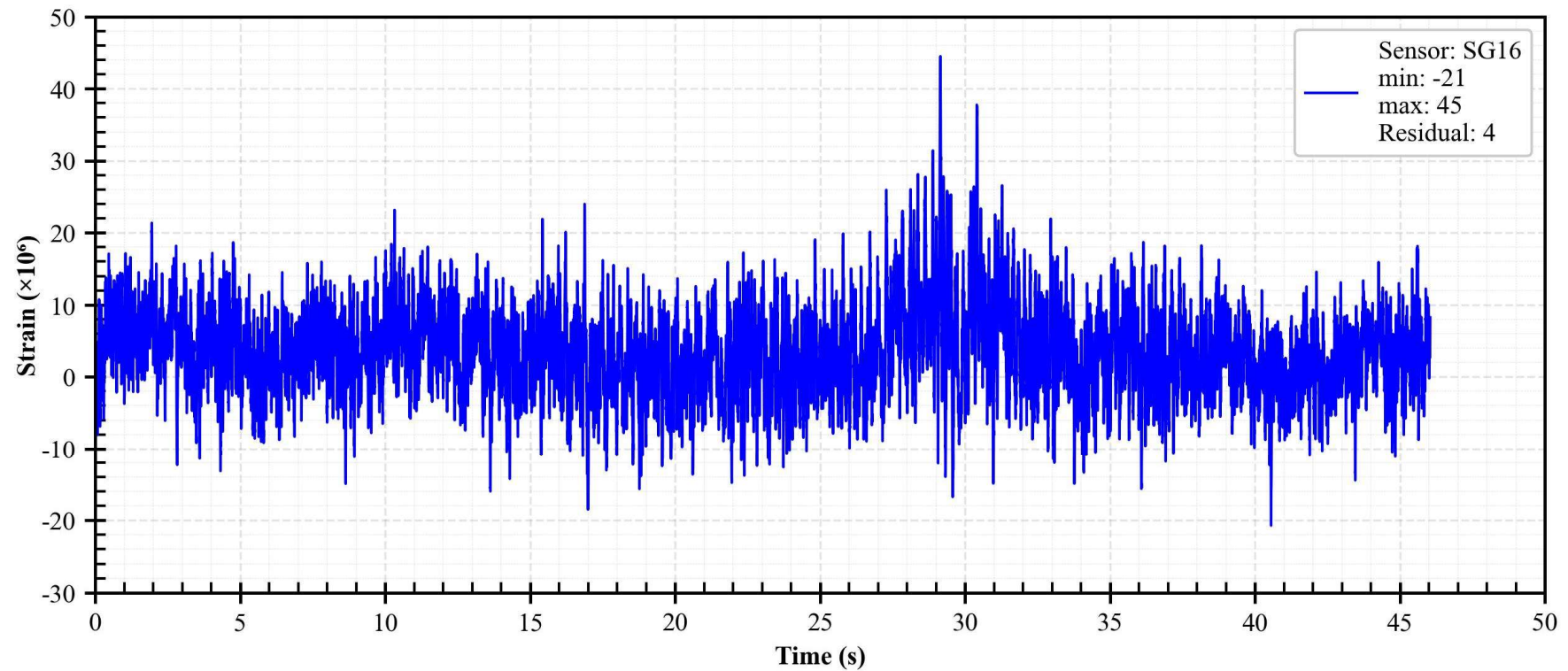


Figure 3.5.29 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 16

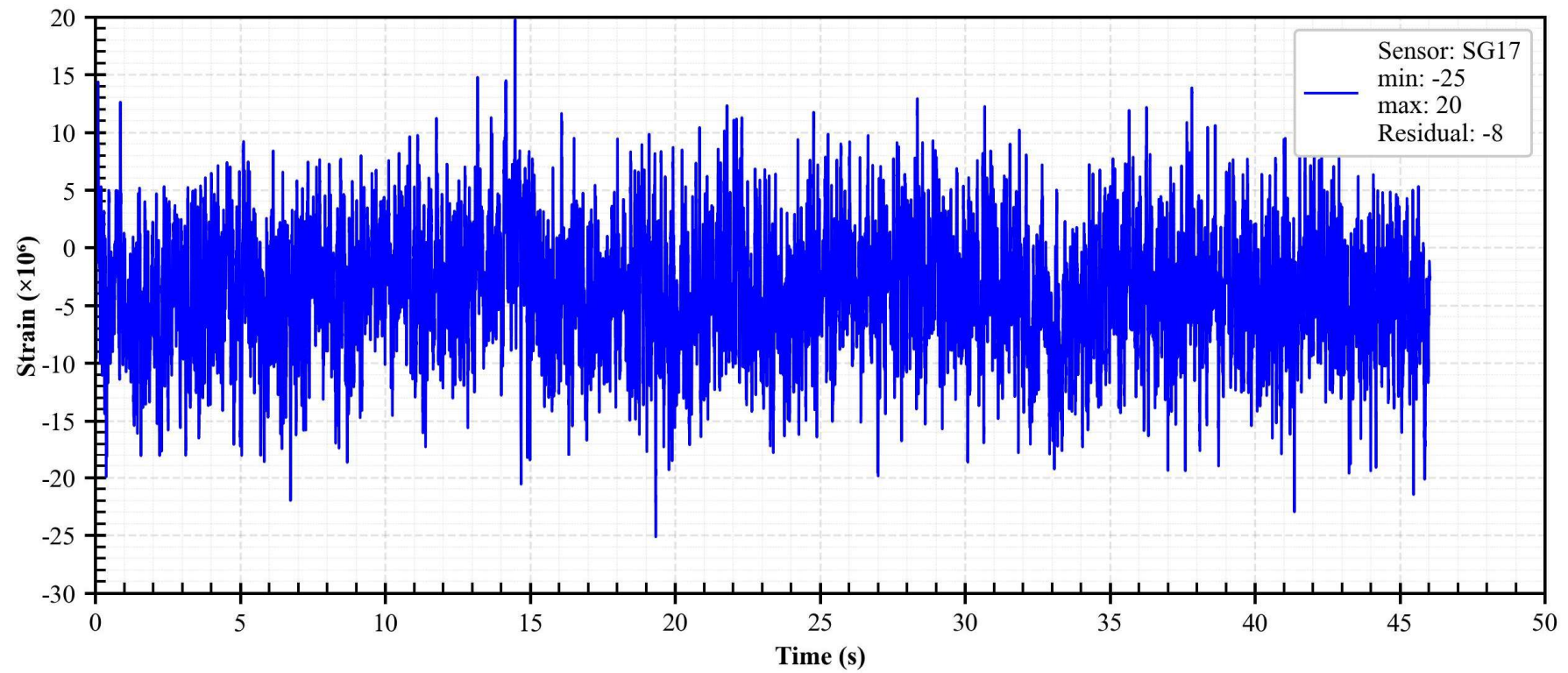


Figure 3.5.30 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 17

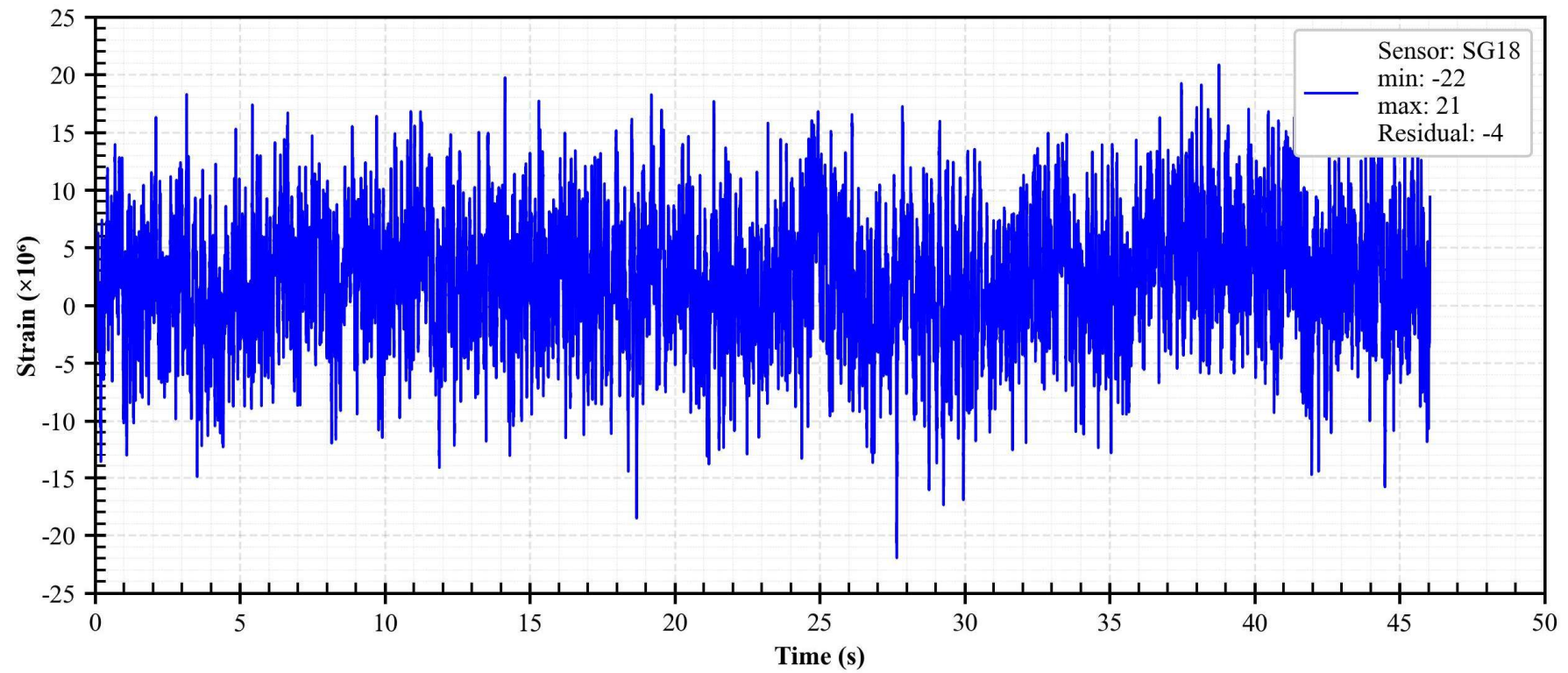


Figure 3.5.31 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 18

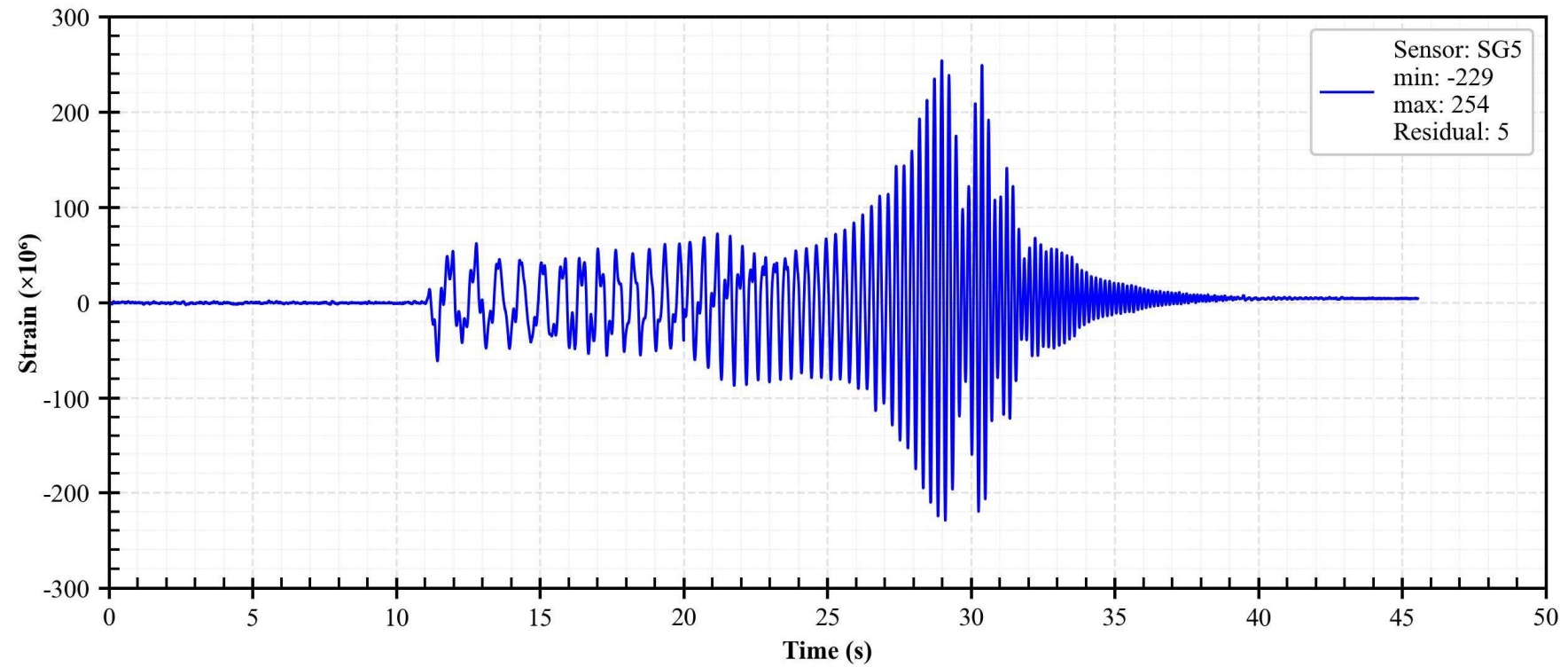


Figure 3.5.32 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 5

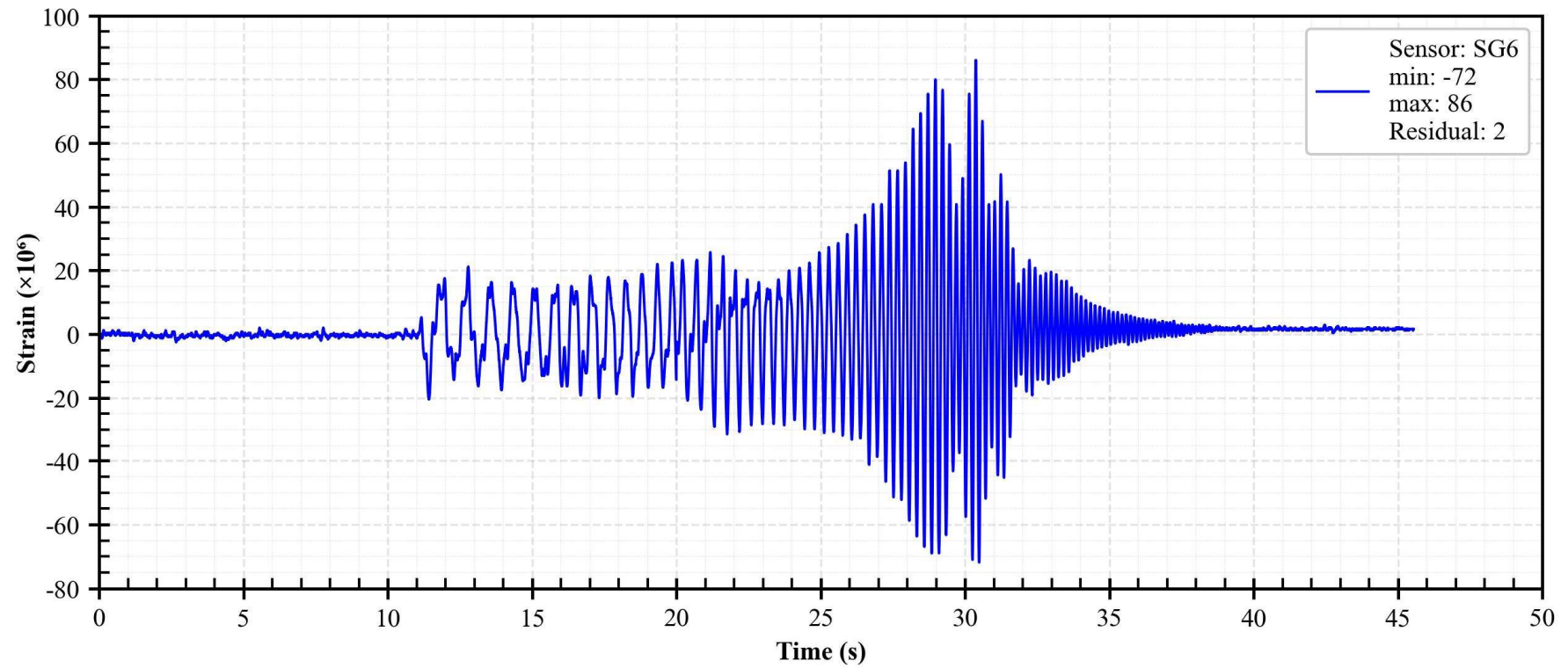


Figure 3.5.33 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 6

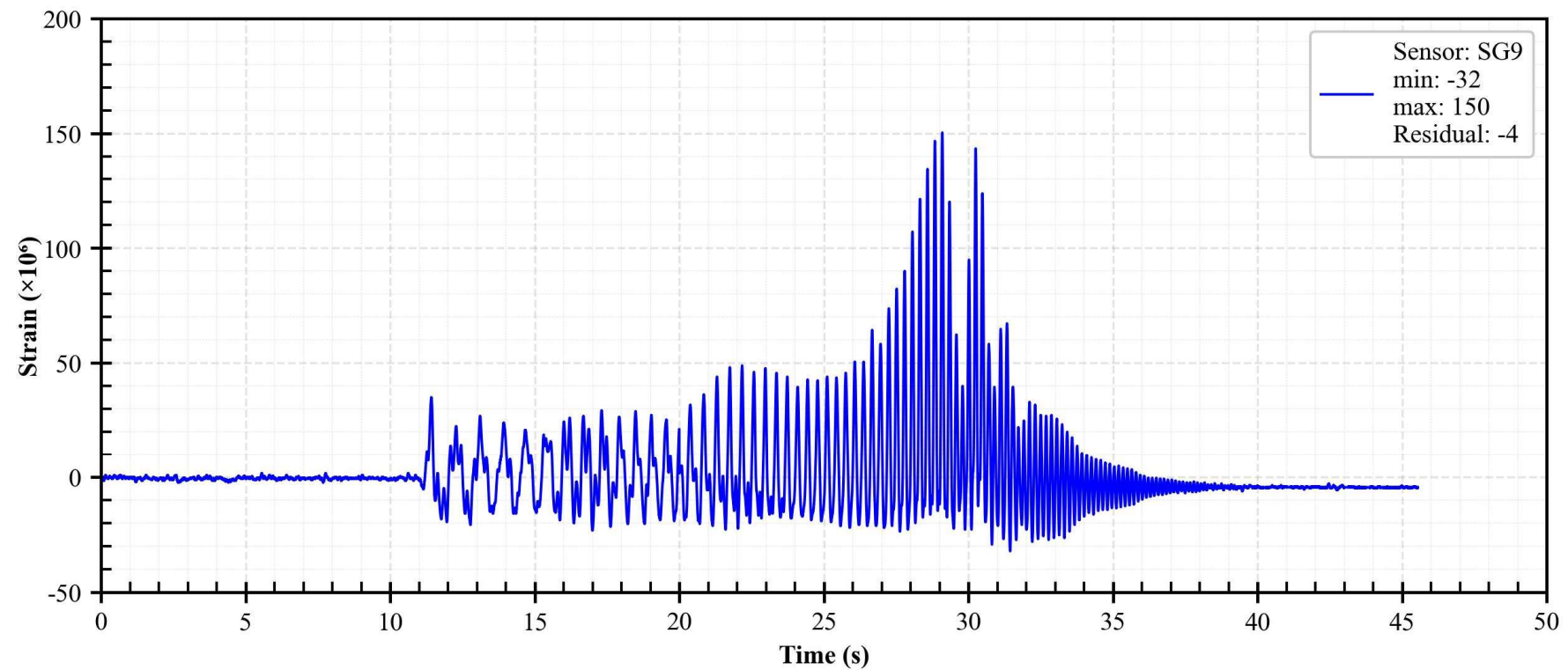


Figure 3.5.34 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 9

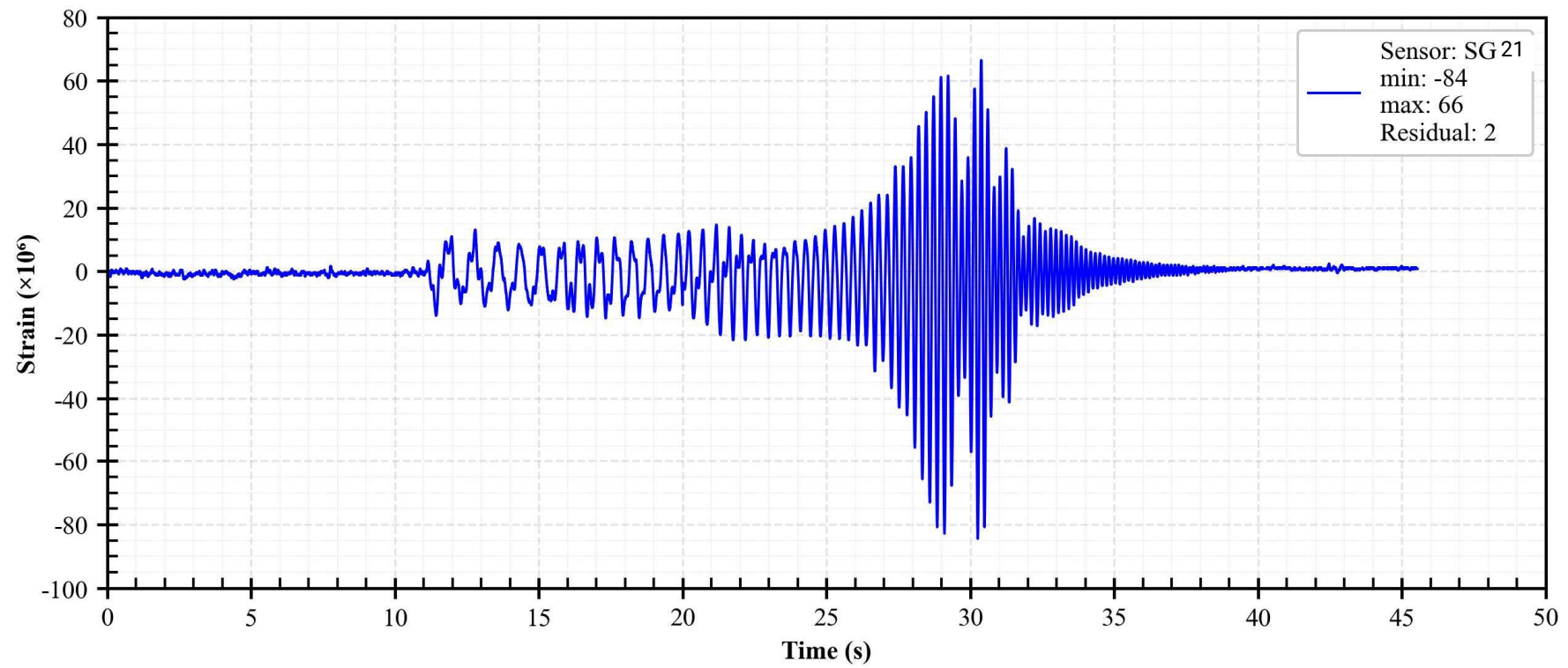


Figure 3.5.35 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 21 (PUFJ, column 1)

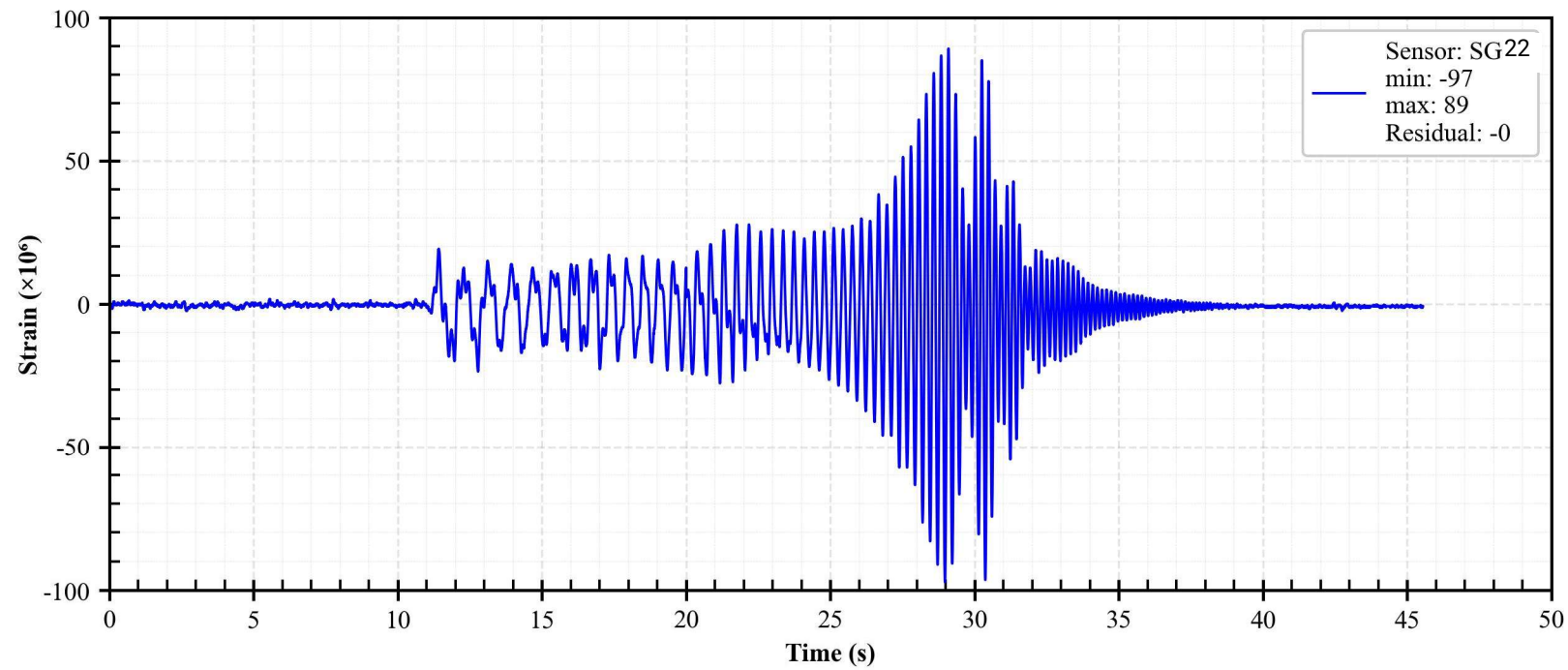


Figure 3.5.36 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 22 (PUFJ, column 2)

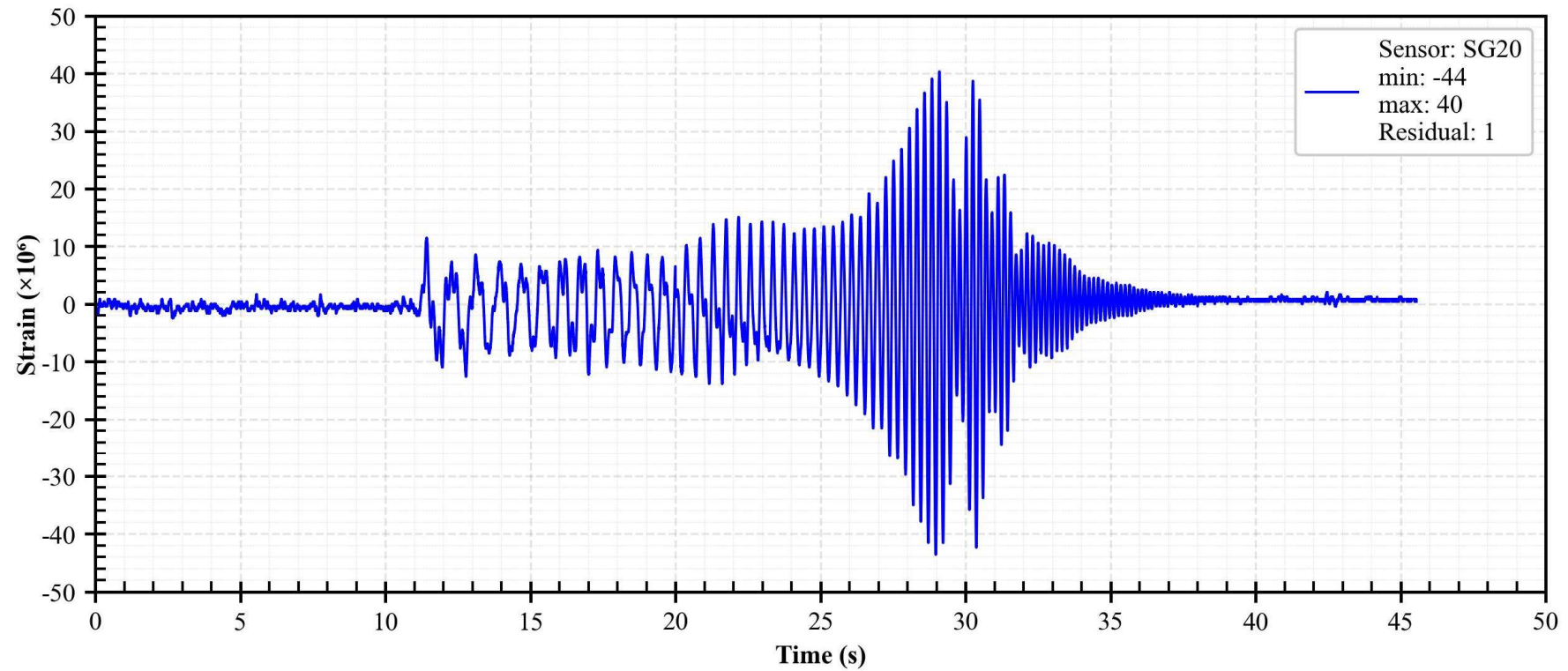


Figure 3.5.37 Characteristic results for phase B (white noise before EQ0,14g): strain gauge 20

3.6 Earthquake EQ0,14g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,14g. The max acceleration at the slab level on the accelerometer acc4 is 0,23g. The max acceleration at the foundation level on the accelerometer acc10 is 0,14g.

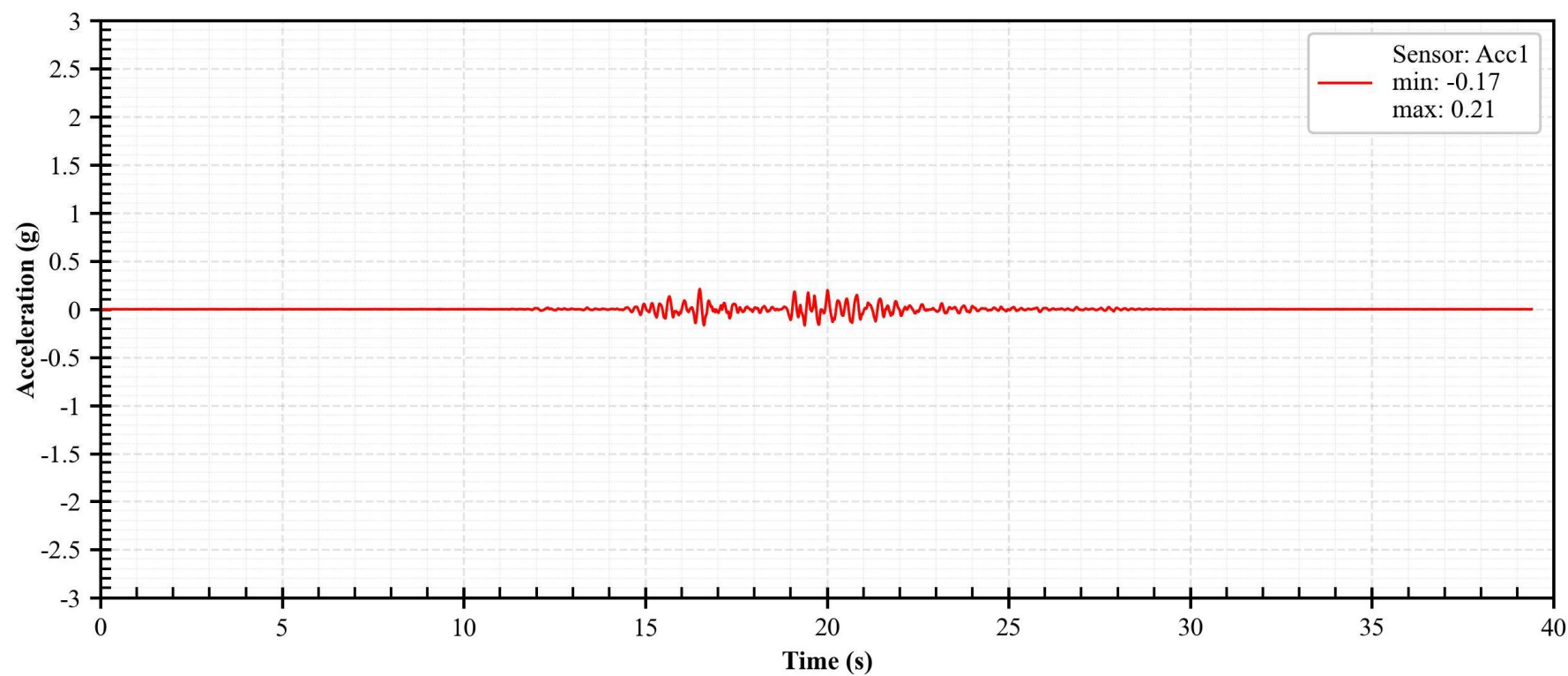


Figure 3.6.1 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 1

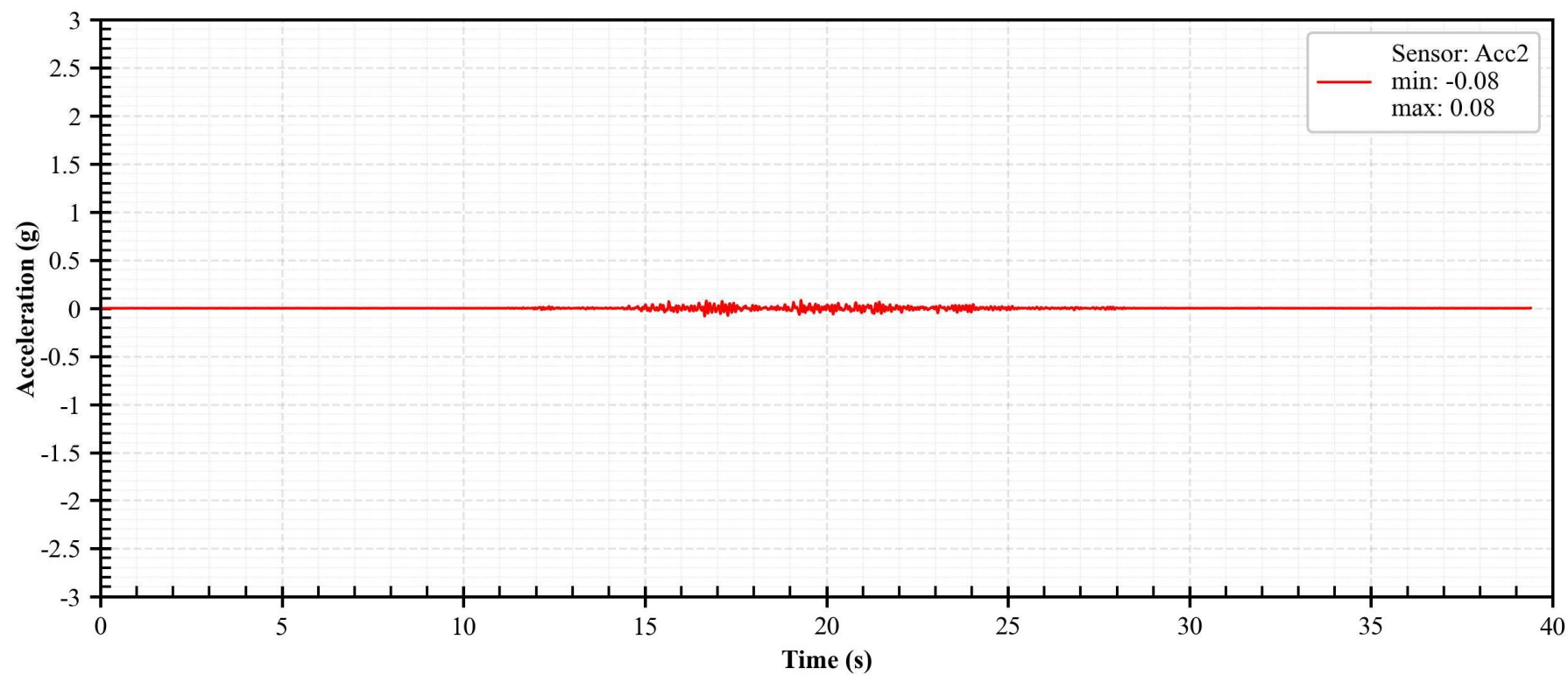


Figure 3.6.2 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 2

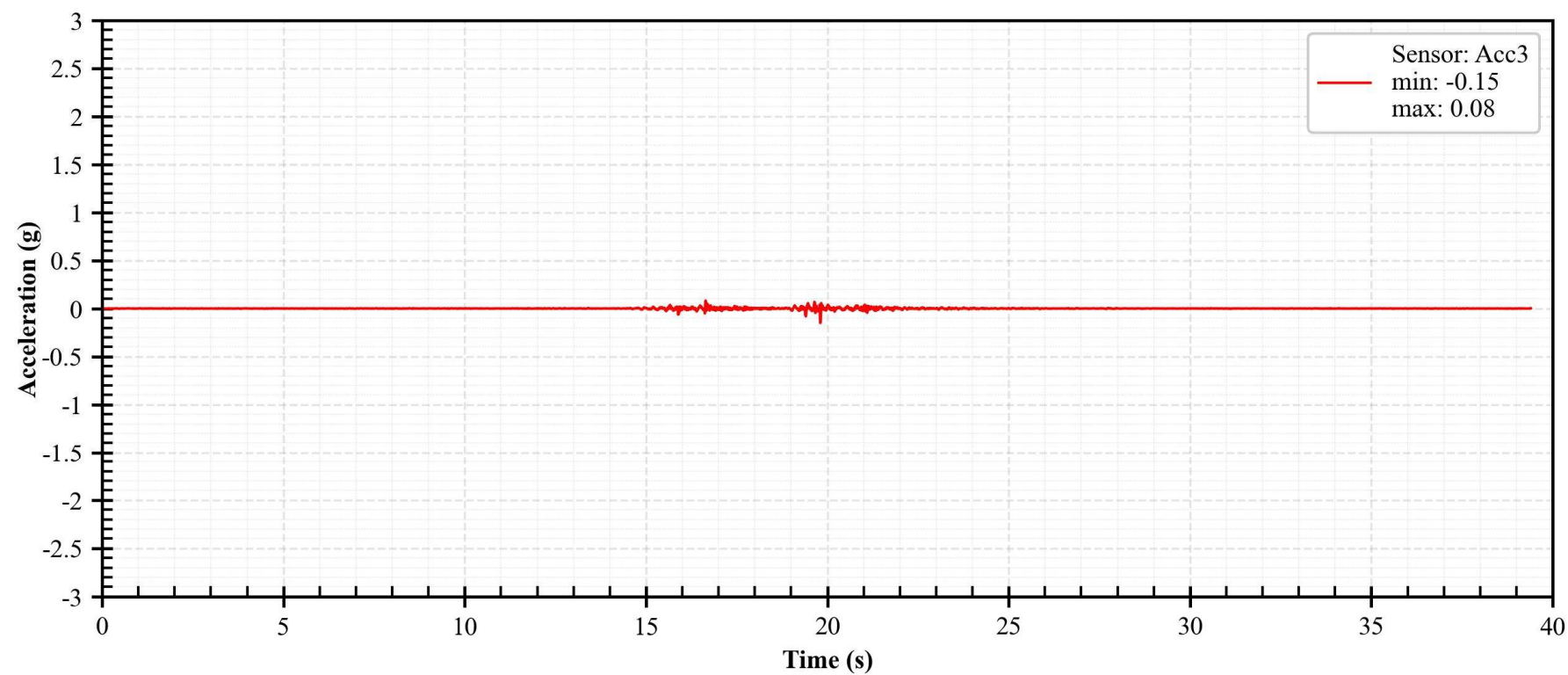


Figure 3.6.3 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 3

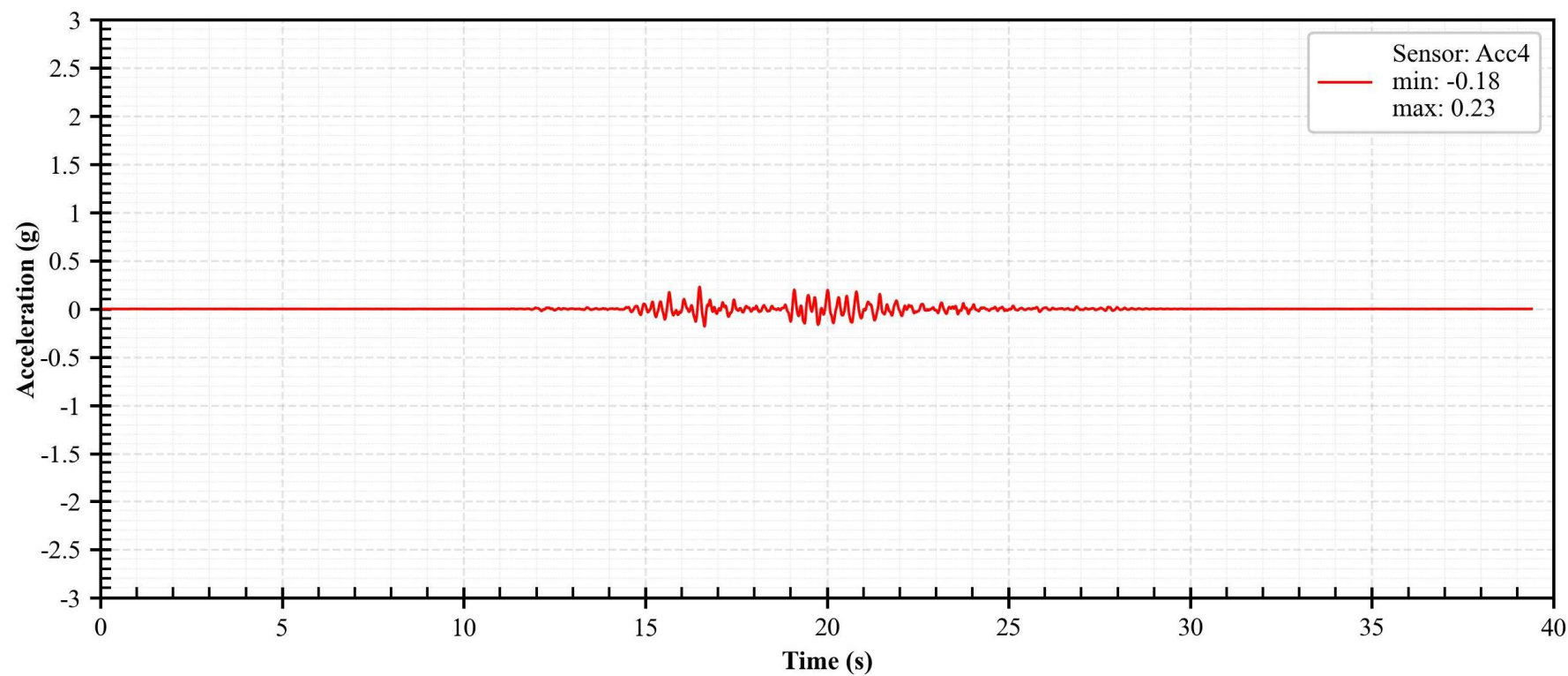


Figure 3.6.4 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 4

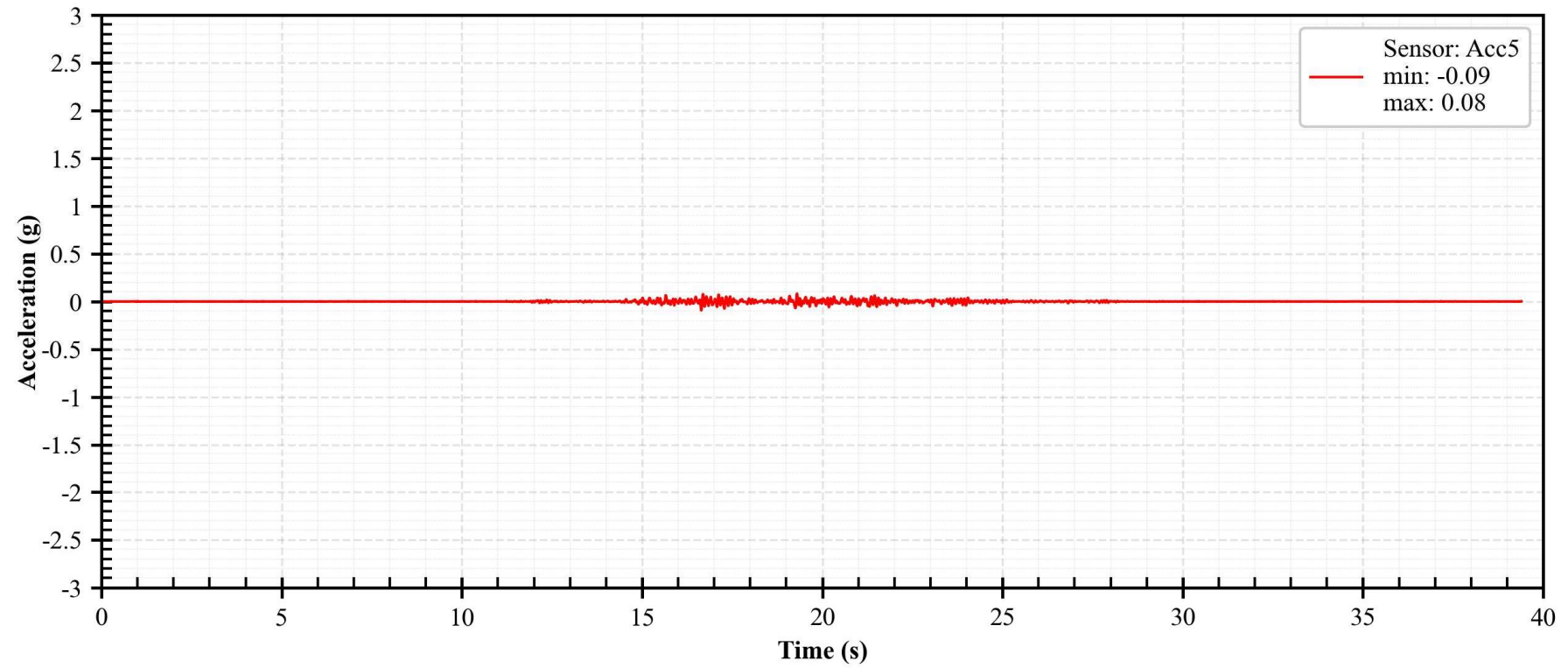


Figure 3.6.5 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 5

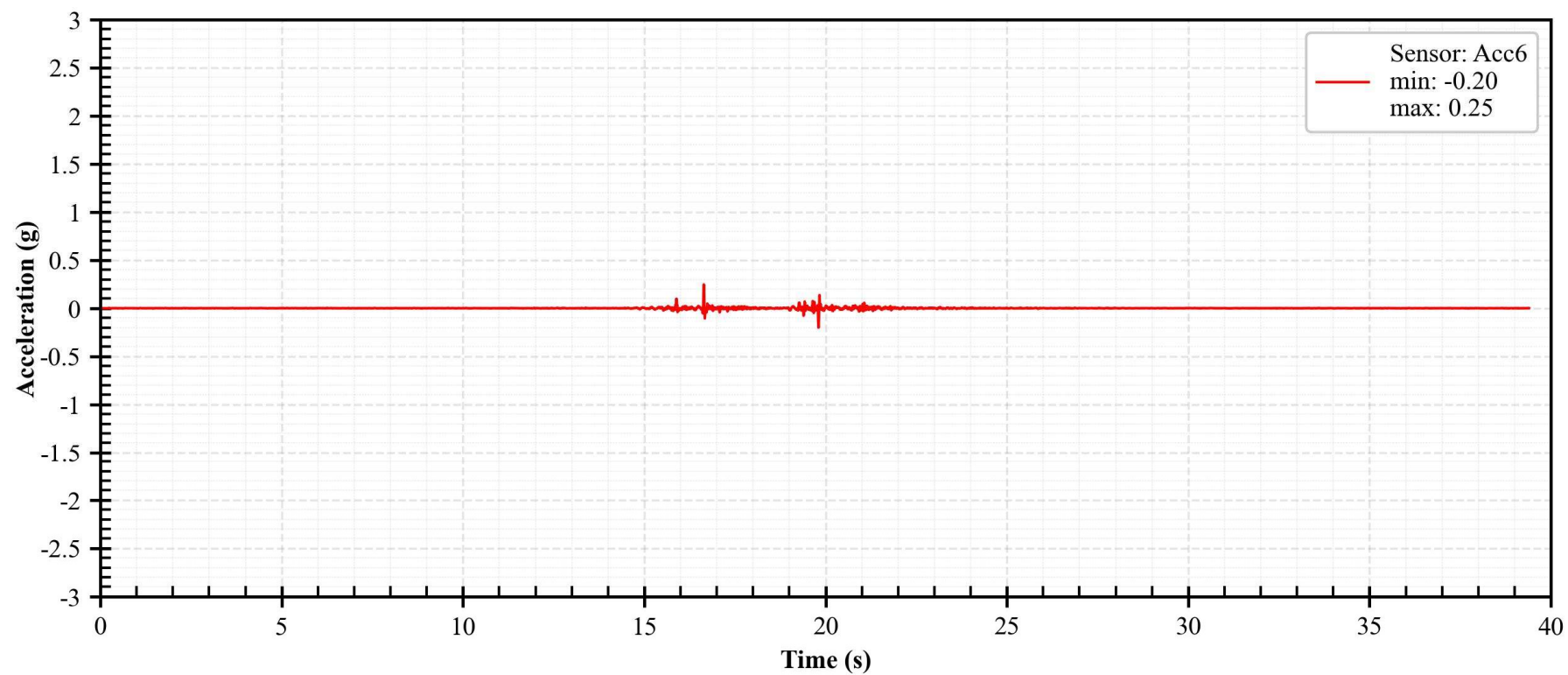


Figure 3.6.6 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 6

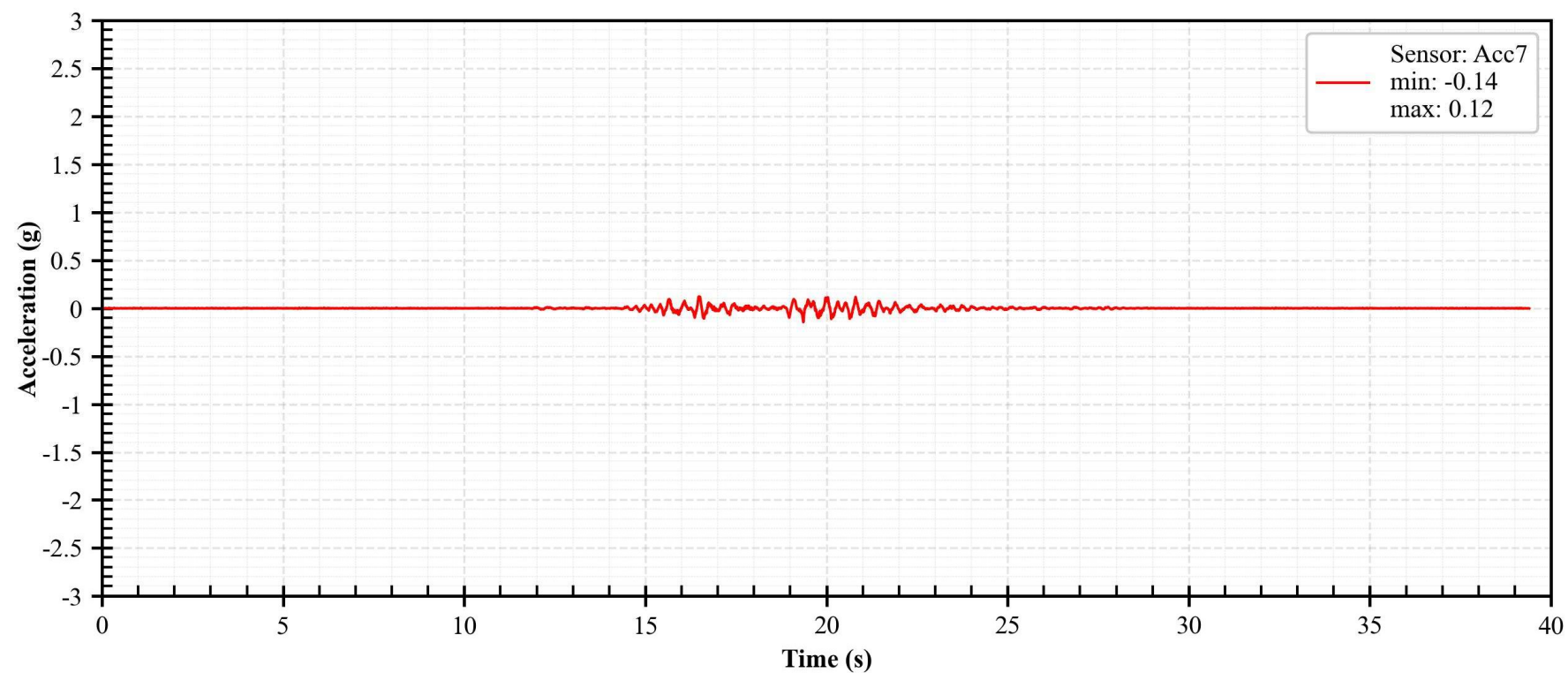


Figure 3.6.7 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 7

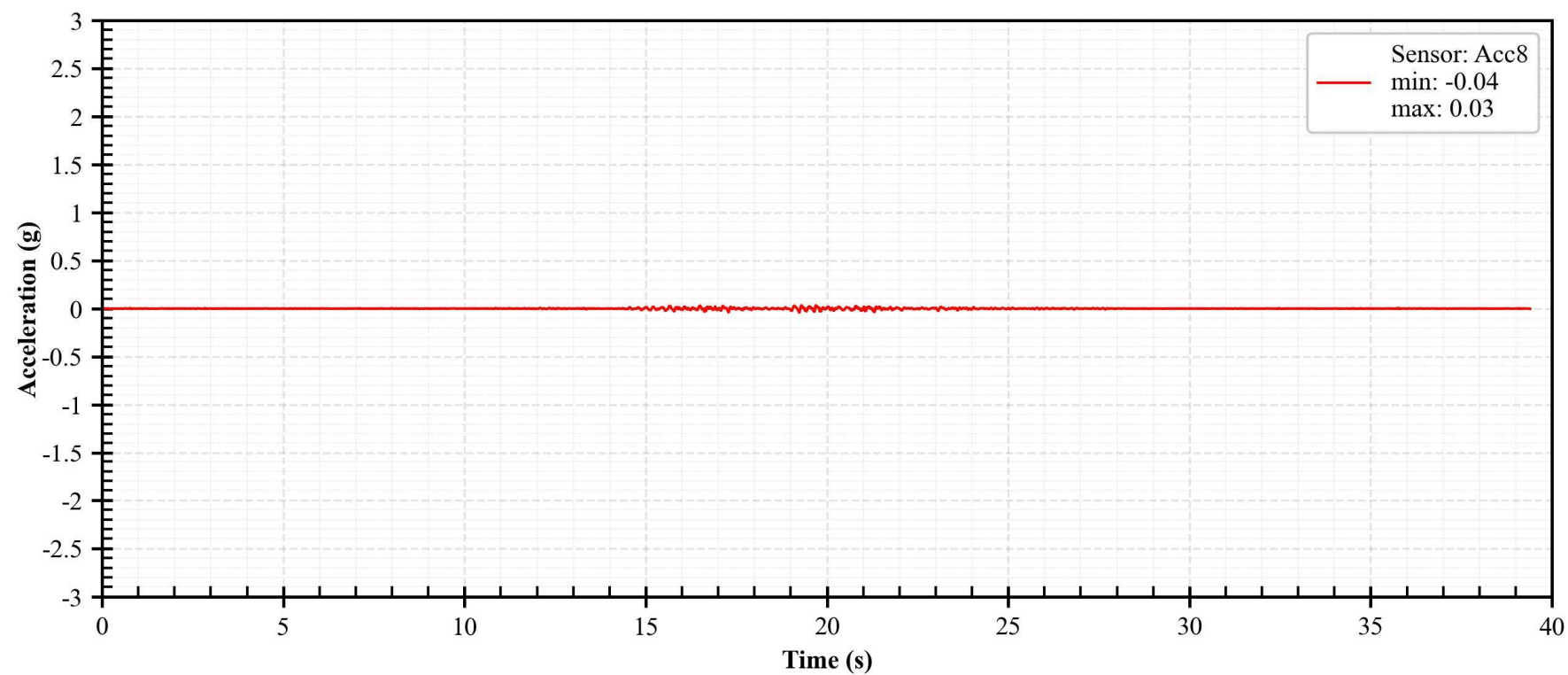


Figure 3.6.8 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 8

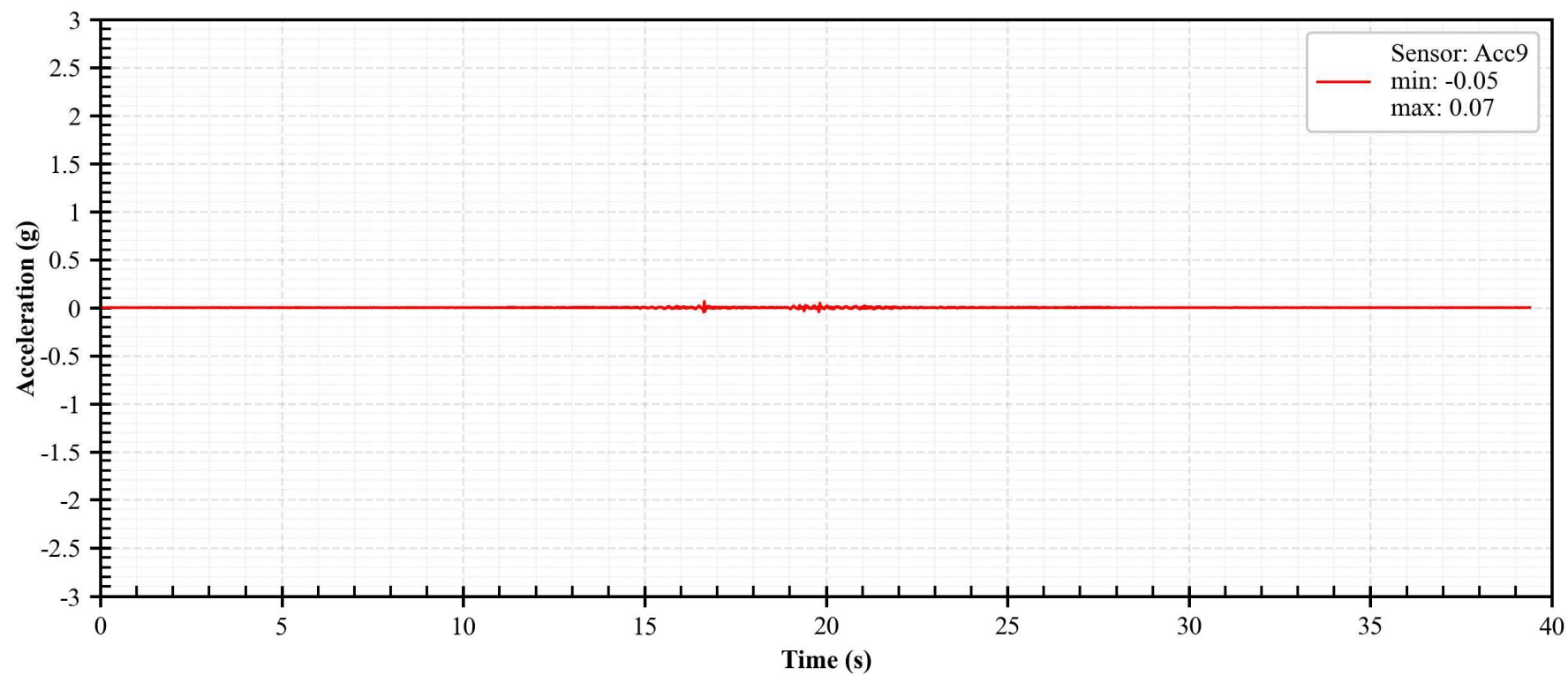


Figure 3.6.9 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 9

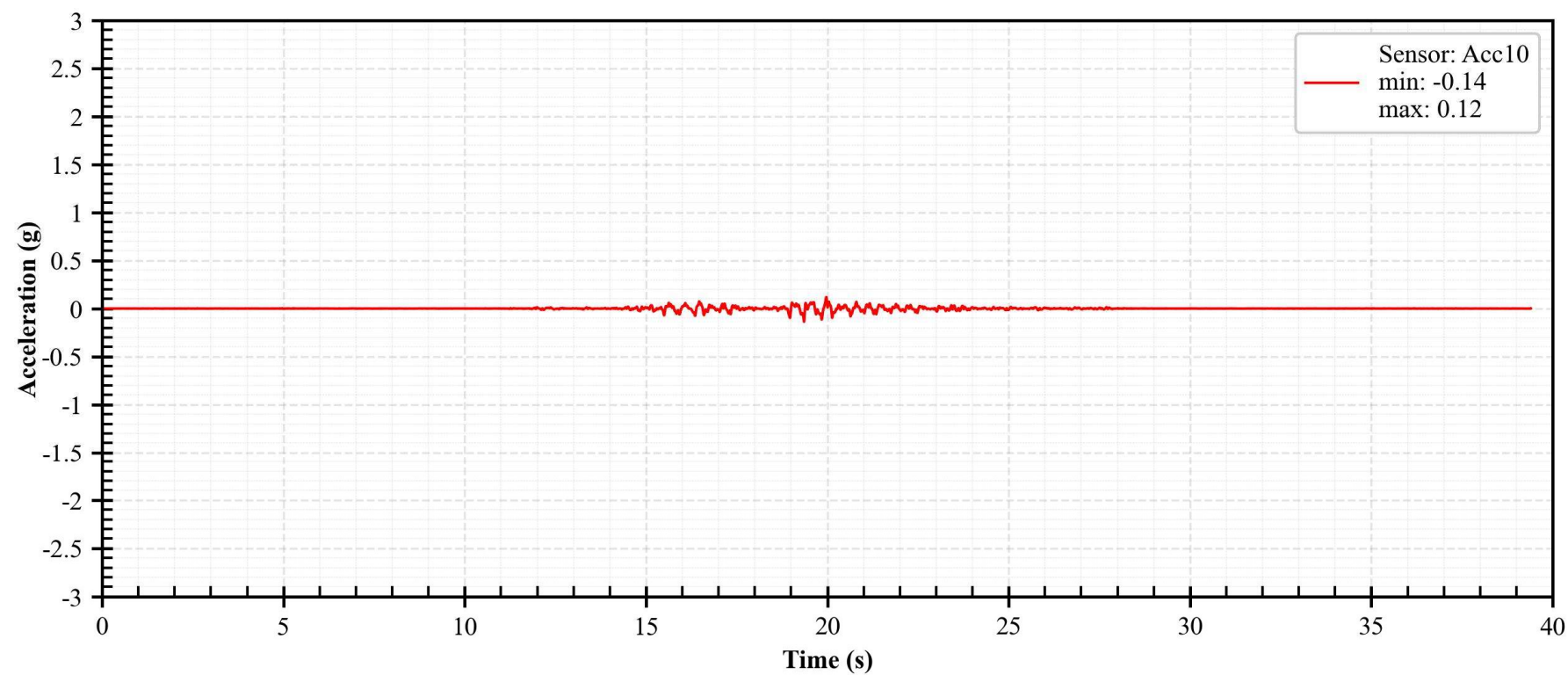


Figure 3.6.10 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 10

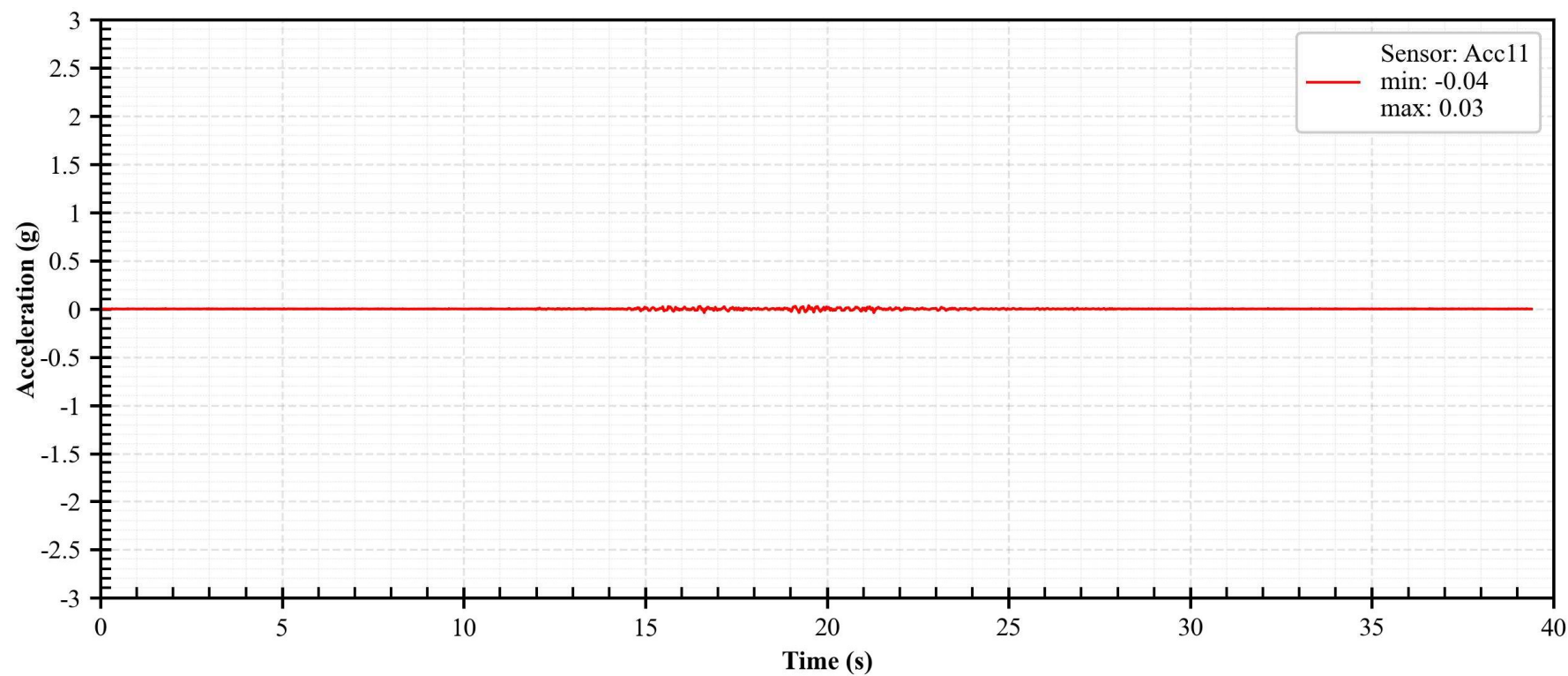


Figure 3.6.11 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 11

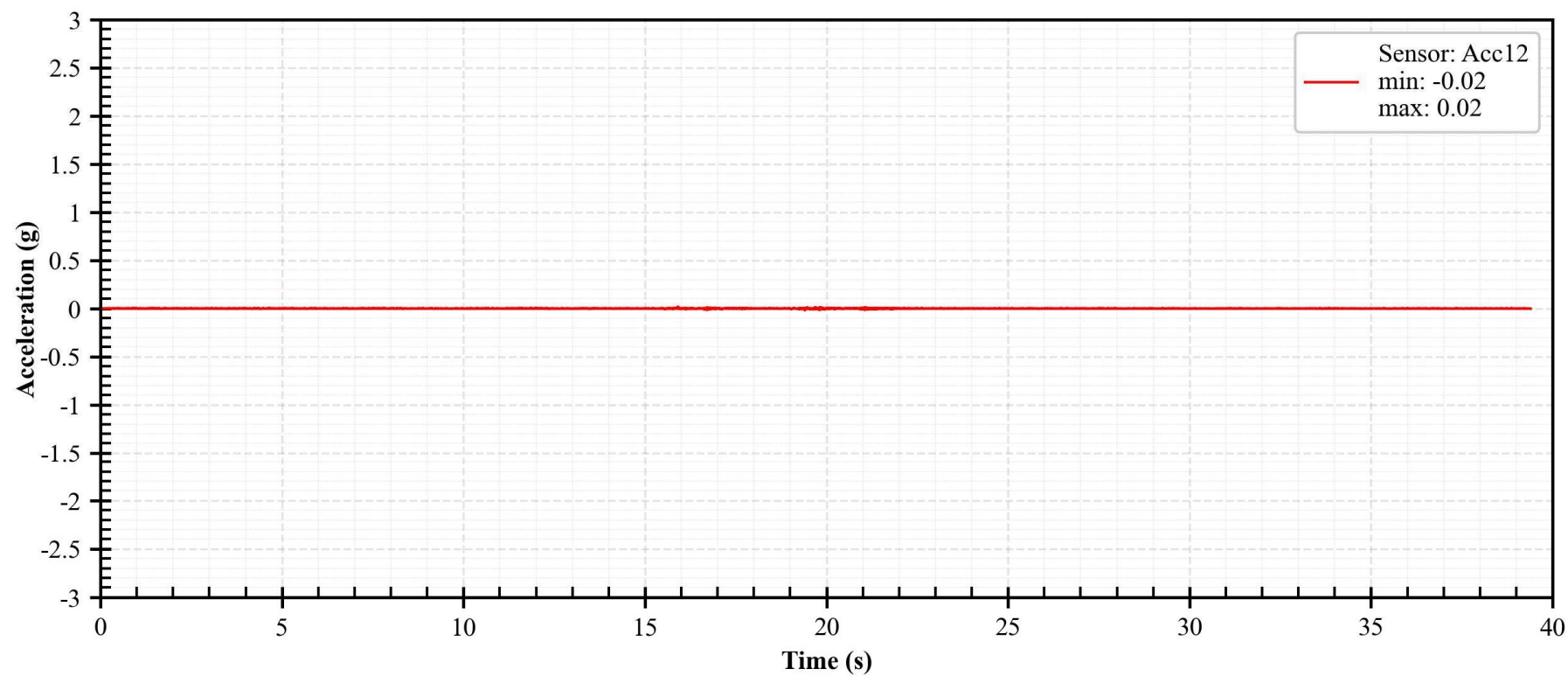


Figure 3.6.12 Characteristic results for phase B (earthquake EQ0,14g): Accelerometer 12

Draw wire sensors

Figures 3.6.13 – 3.6.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 4.05 mm while the minimum is -4.38 mm. The maximum movement detected by draw wire sensor W2 is 4.50 mm while the minimum is -4.46 mm. The maximum movement detected by draw wire sensor W3 is 2.96 mm while the minimum is -2.91 mm. The maximum movement detected by draw wire sensor W4 is 3.23 mm while the minimum is -3.09 mm. The maximum drift is $(1.85 / 1.225) = 1.51 \%$ and minimum drift is $(-1.73 / 1.225) = -1.41 \%$.

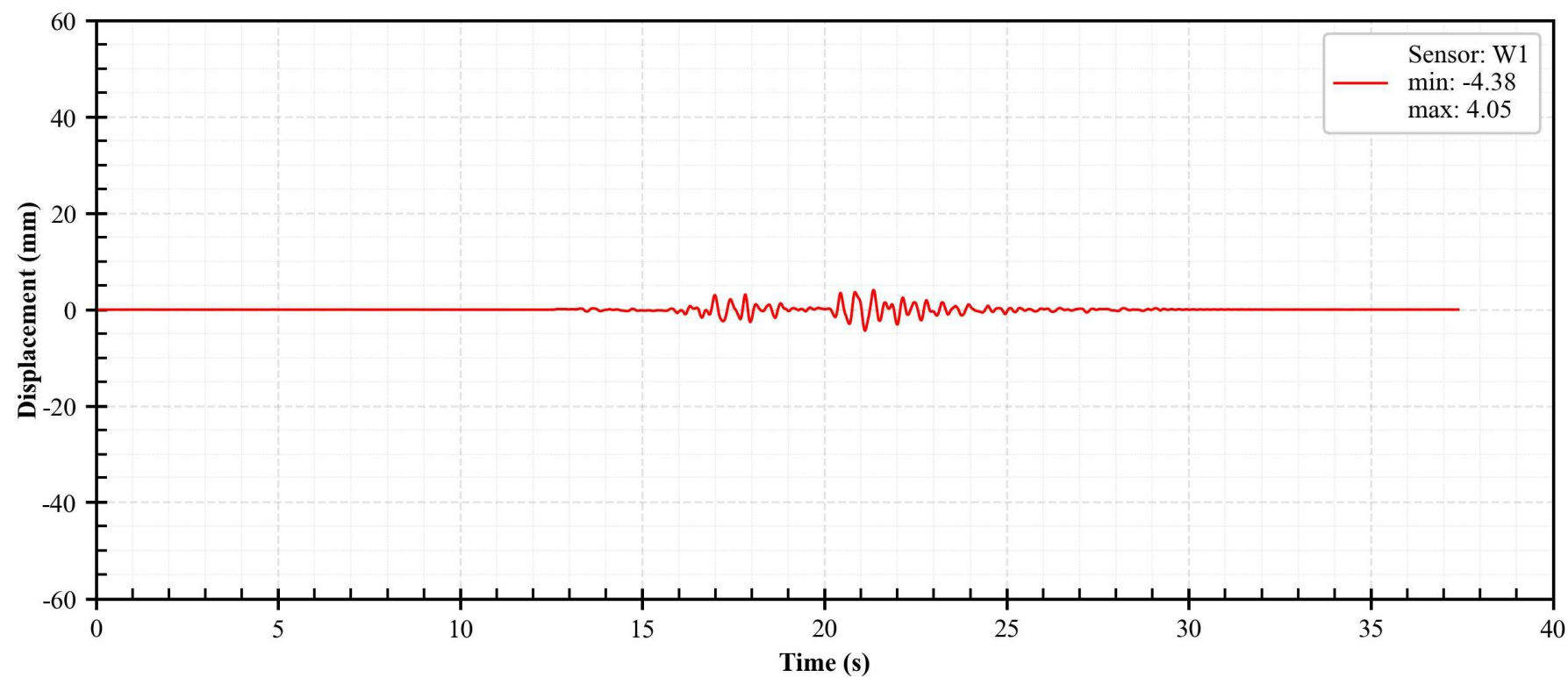


Figure 3.6.13 Characteristic results for phase B (earthquake EQ0,14g): Draw wire sensor 1

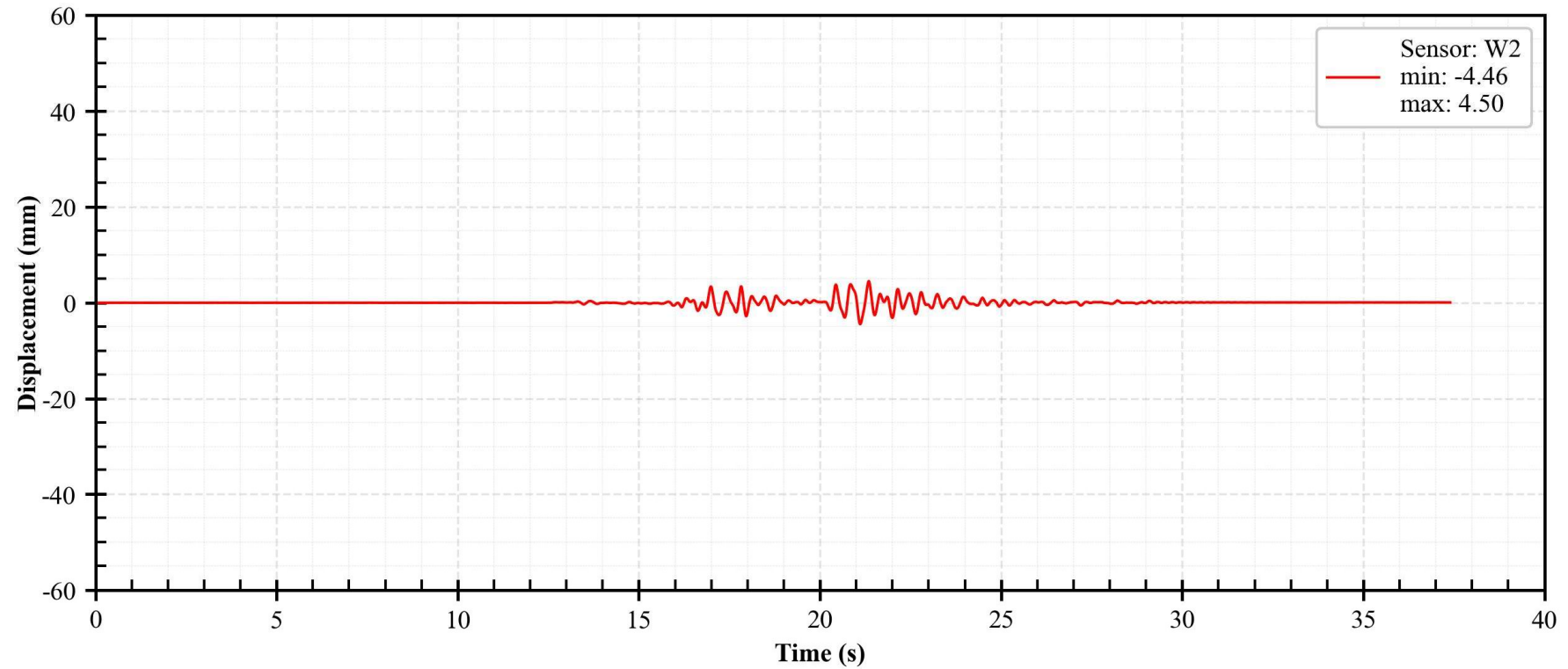


Figure 3.6.14 Characteristic results for phase B (earthquake EQ0,14g): Draw wire sensor 2

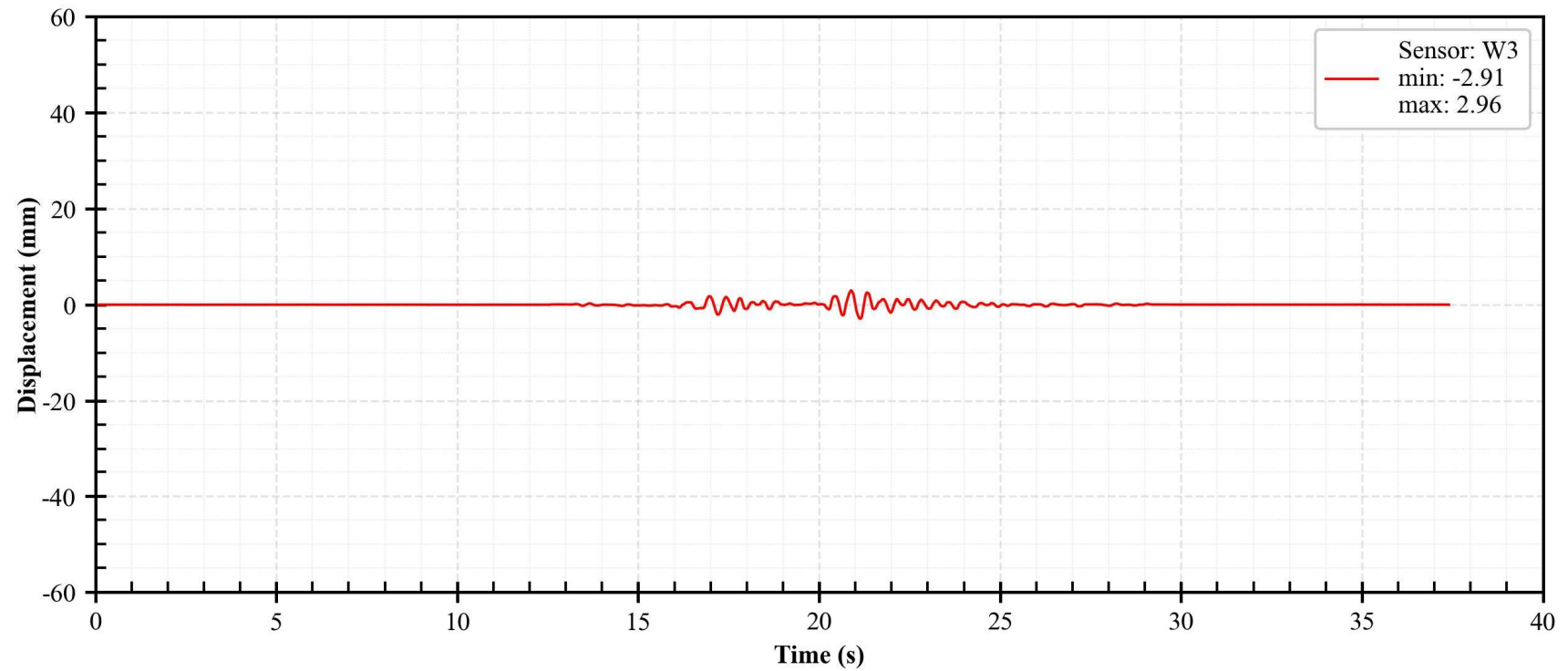


Figure 3.6.15 Characteristic results for phase B (earthquake EQ0,14g): Draw wire sensor 3

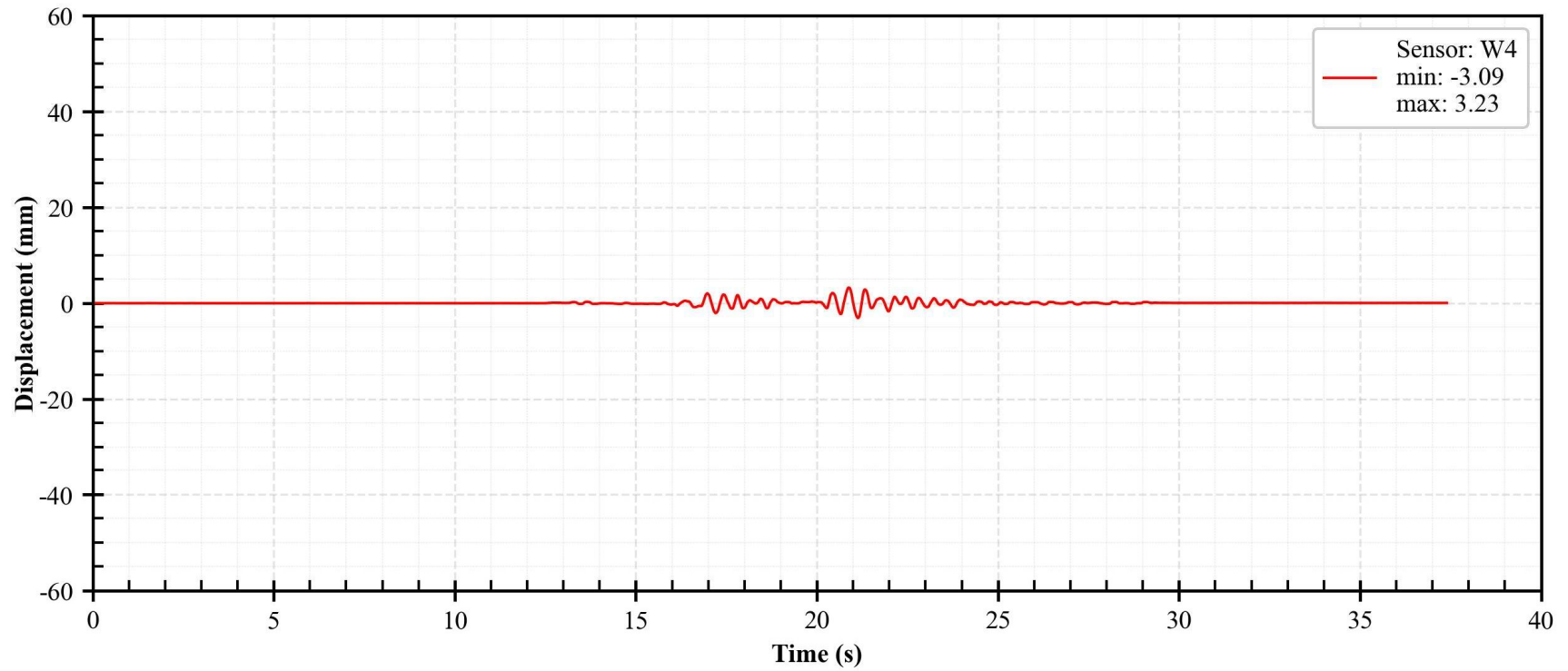


Figure 3.6.16 Characteristic results for phase B (earthquake EQ0,14g): Draw wire sensor 4

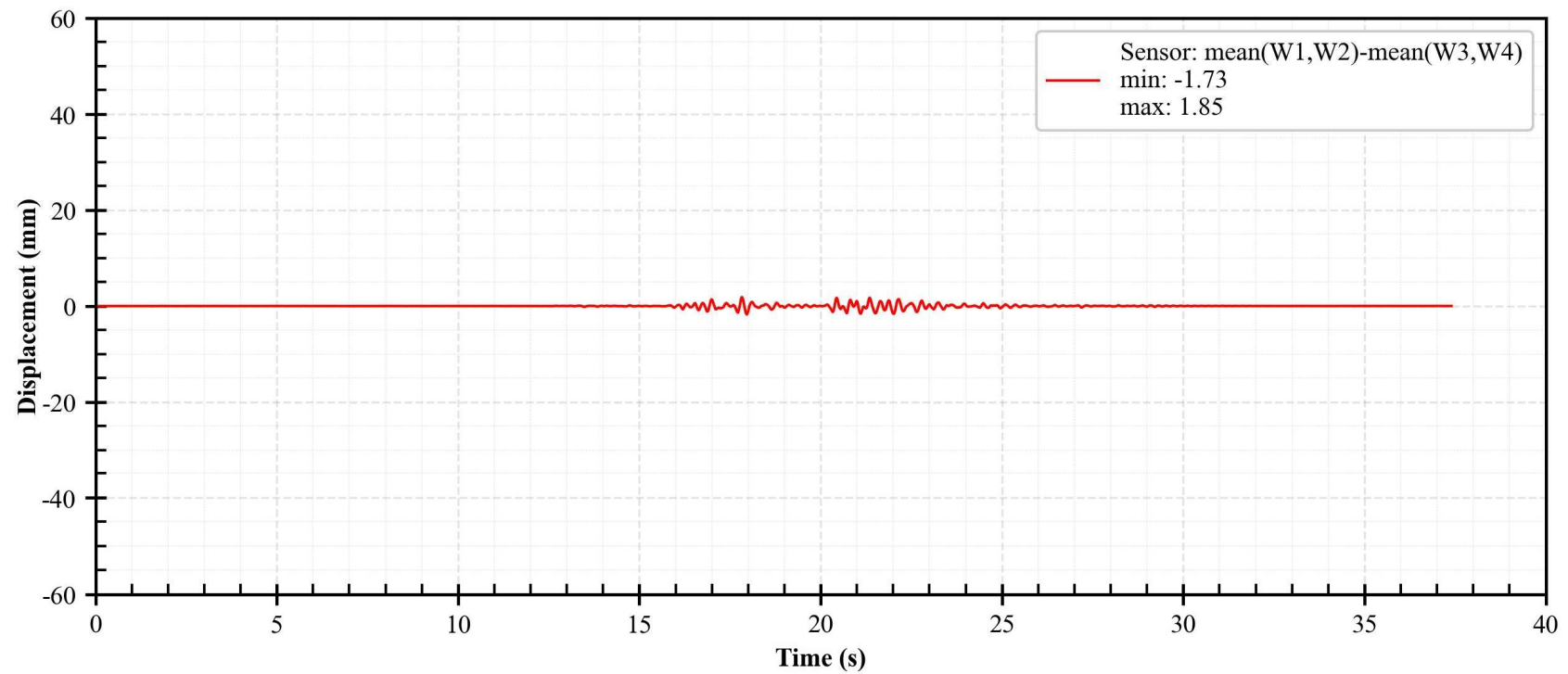


Figure 3.6.17 Characteristic results for phase B (earthquake EQ0,14g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.6.18, 3.6.19, 3.6.20, 3.6.21, 3.6.22, 3.6.23, 3.6. 32, 3.6.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.6.24, 3.6.25, 3.6.26, 3.6.27, 3.6.28, 3.6.29 and 3.6.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 248 μ strain and minimum strain -257 μ strain. The residual strain is -2 μ strain. SG21 & SG22 are located on PUFJ.

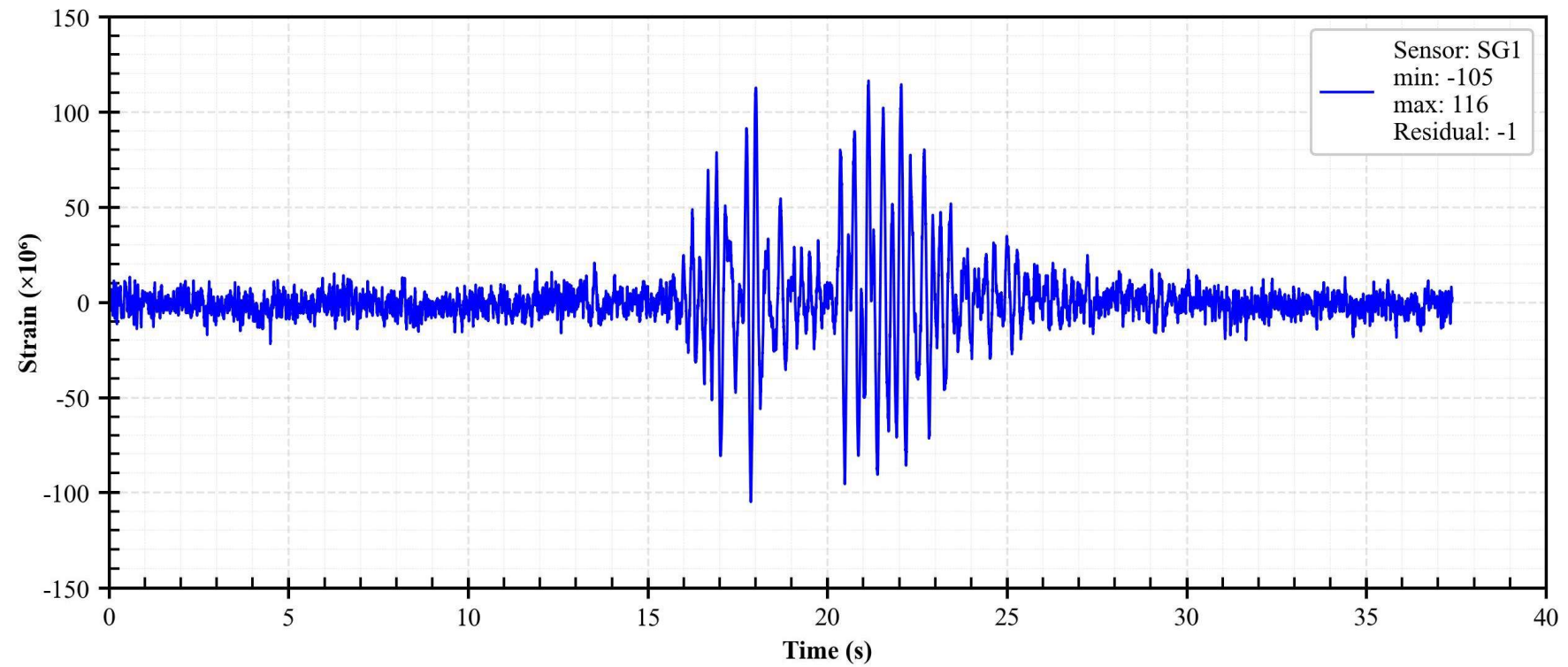


Figure 3.6.18 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 1

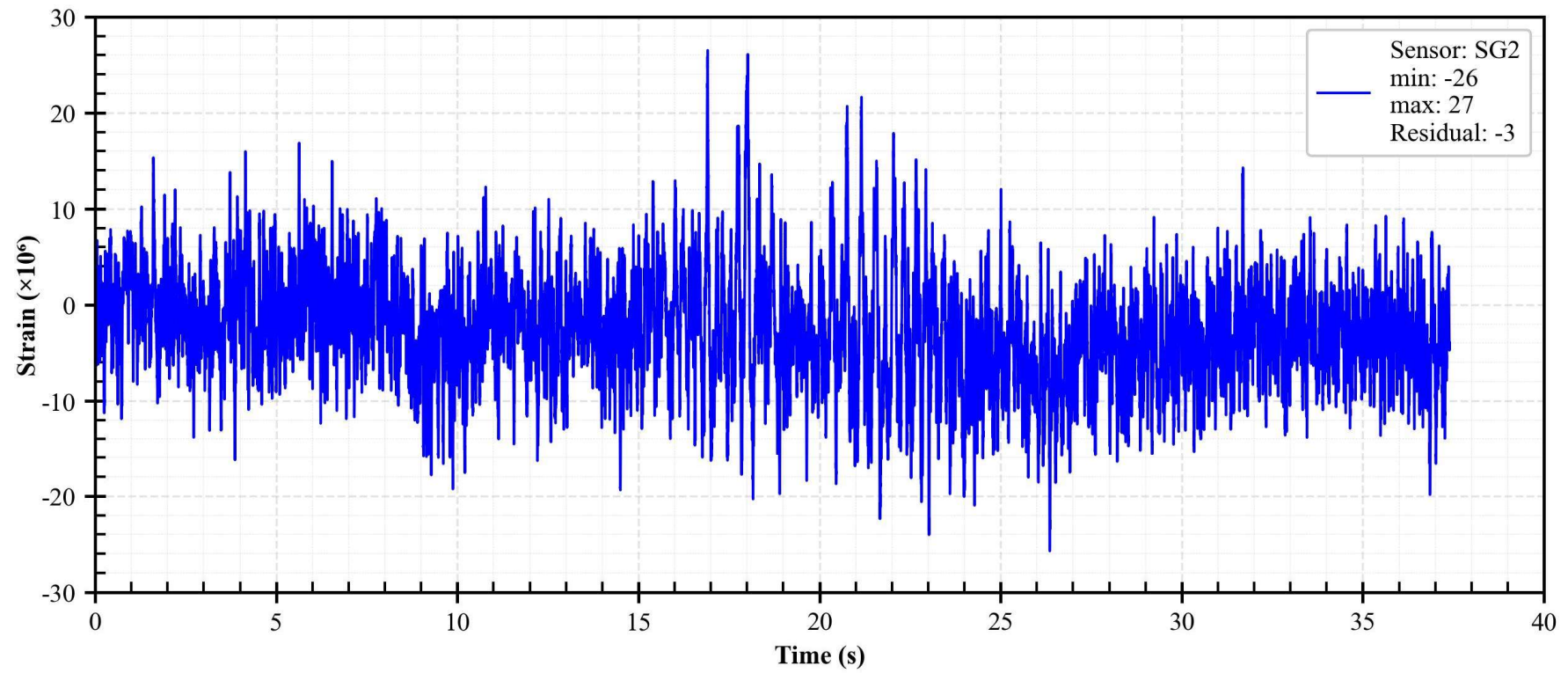


Figure 3.6.19 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 2

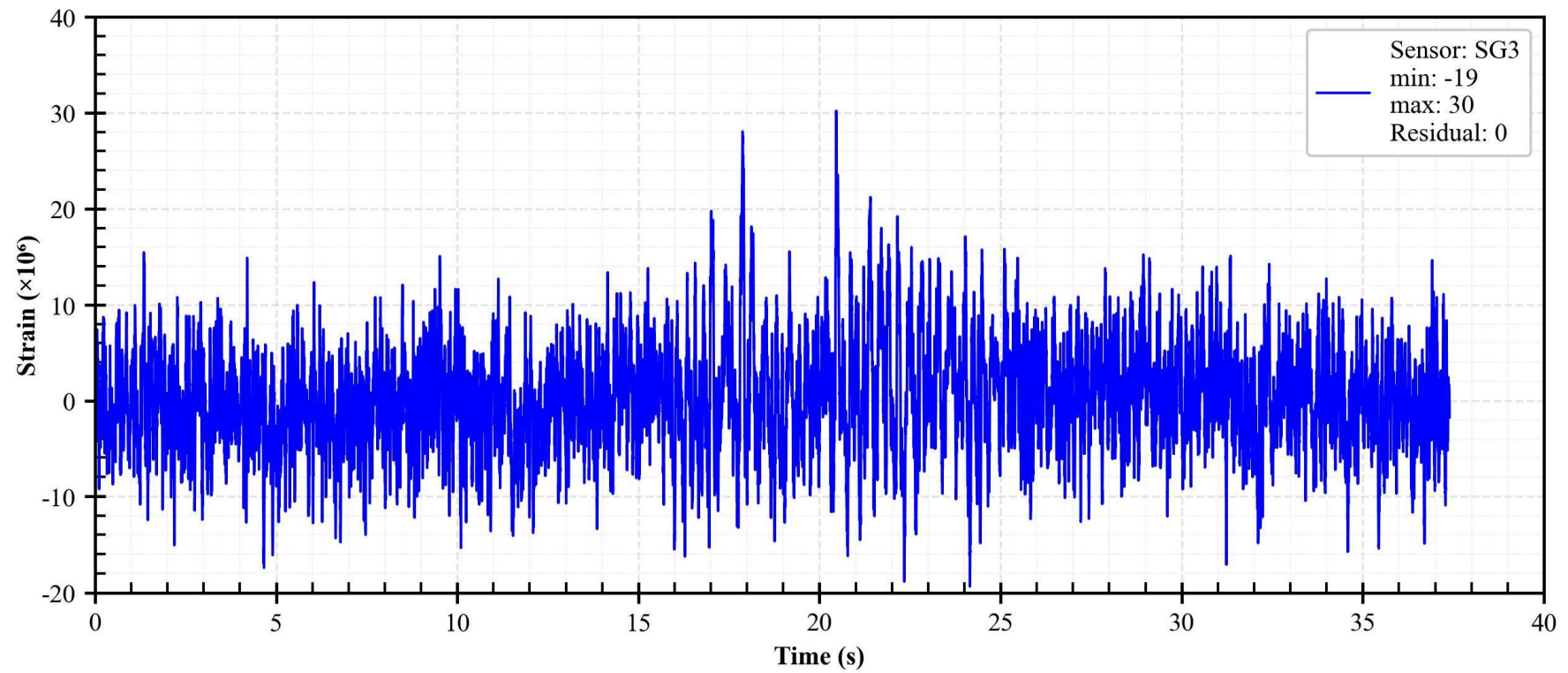


Figure 3.6.20 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 3

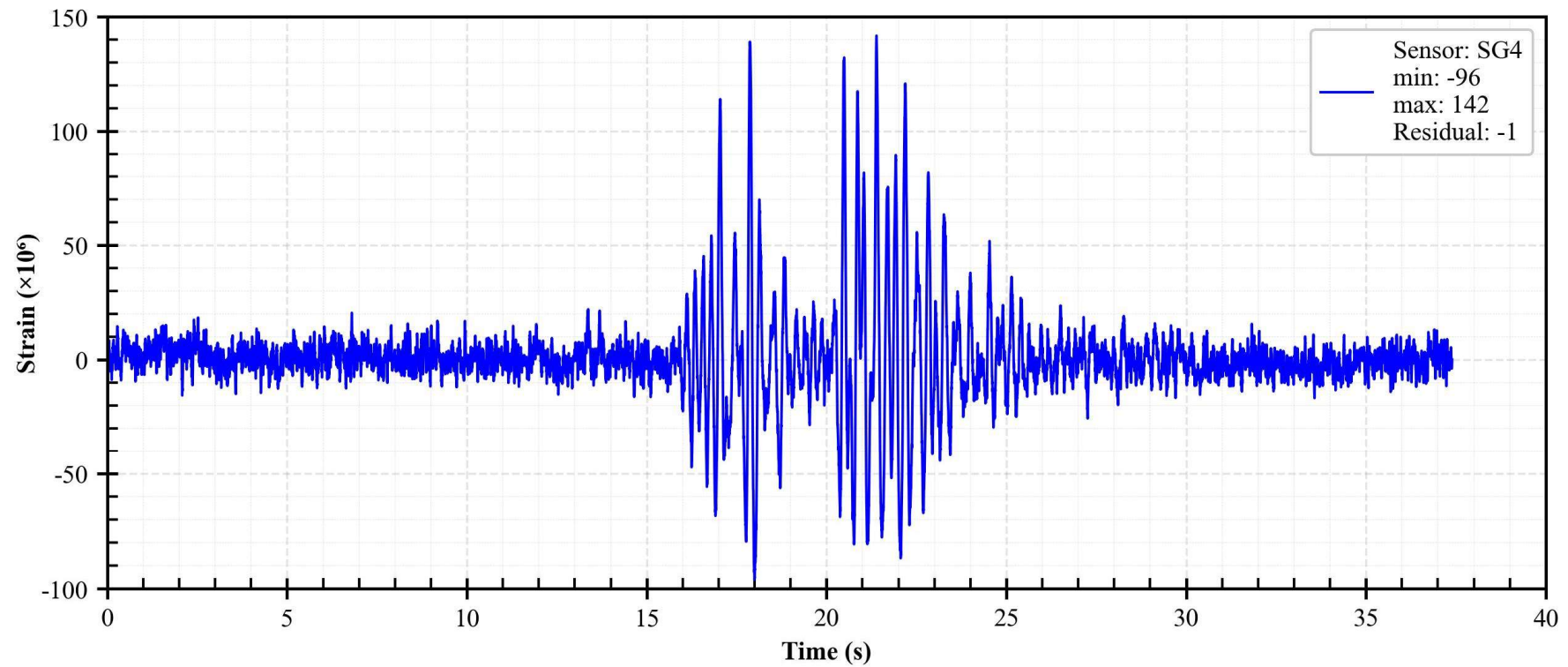


Figure 3.6.21 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 4

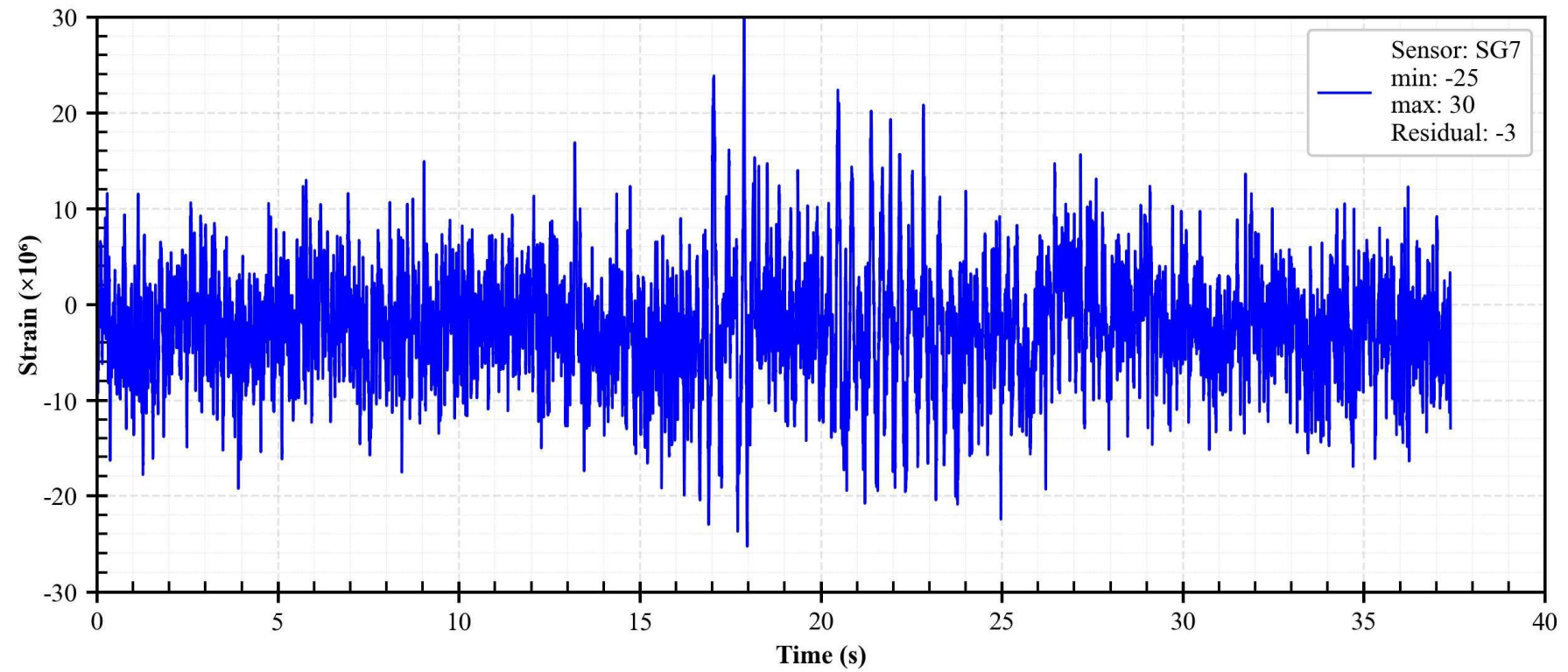


Figure 3.6.22 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 7

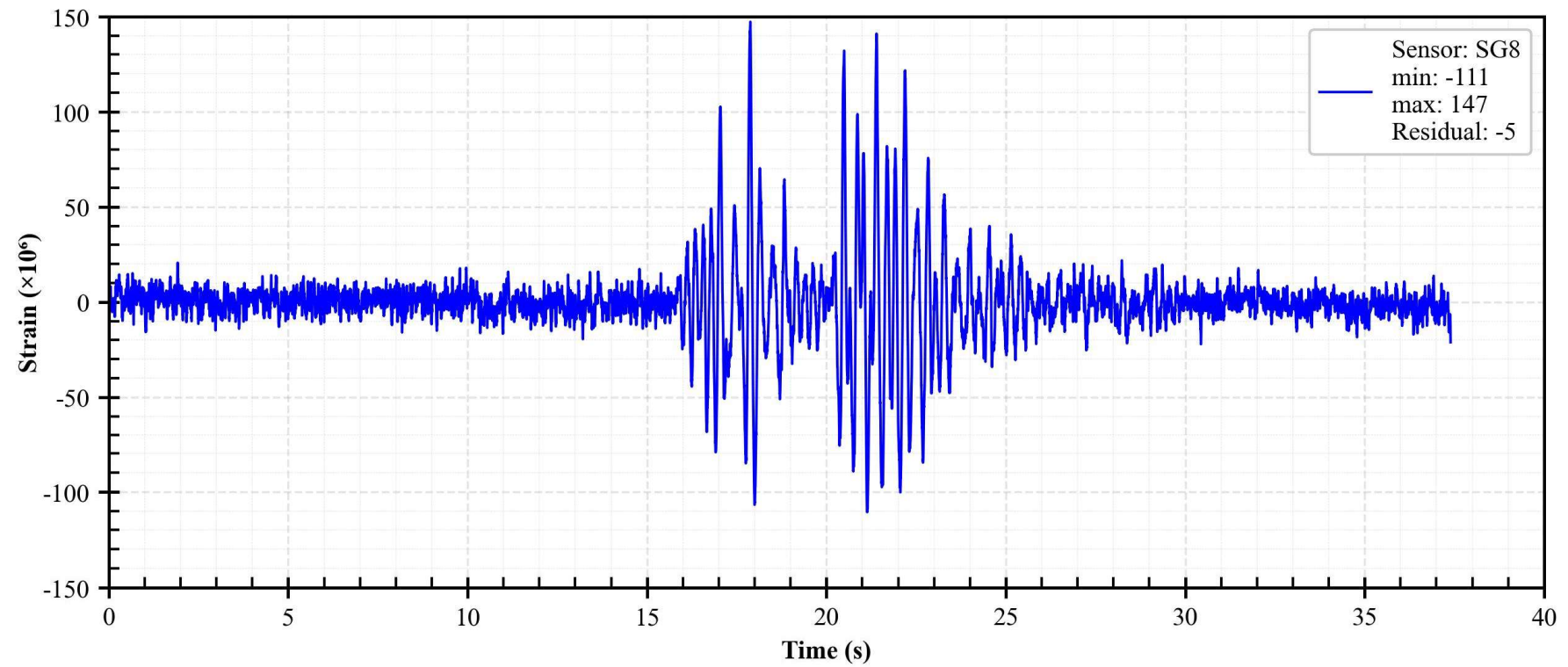


Figure 3.6.23 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 8

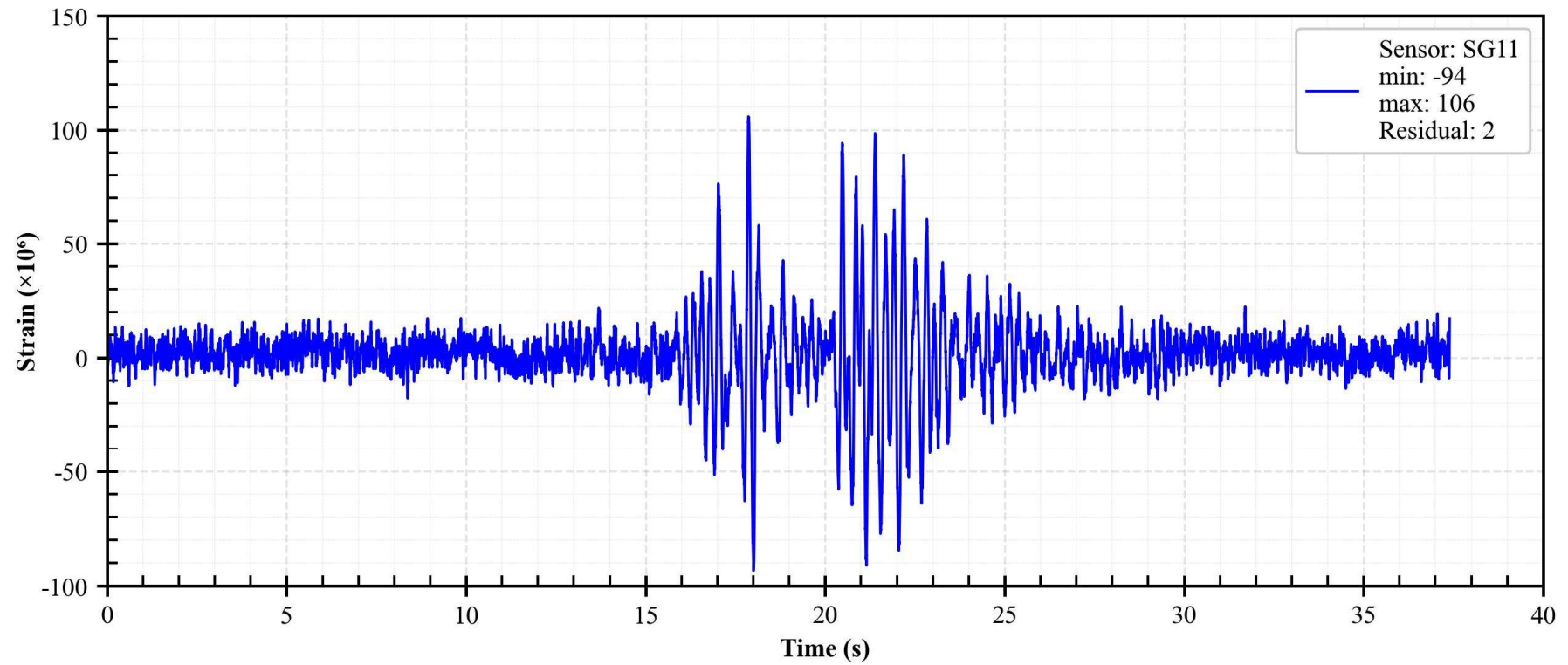


Figure 3.6.24 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 11

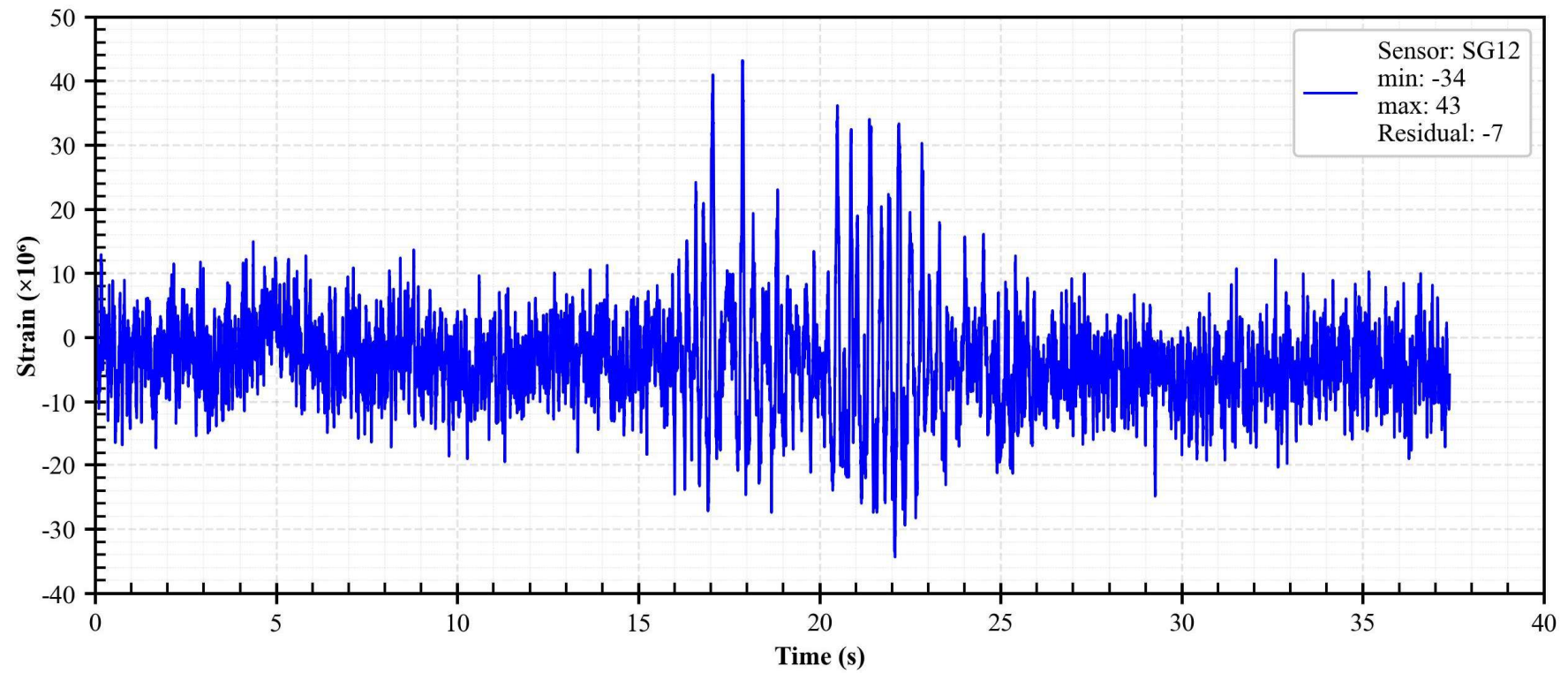


Figure3.6.25 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 12

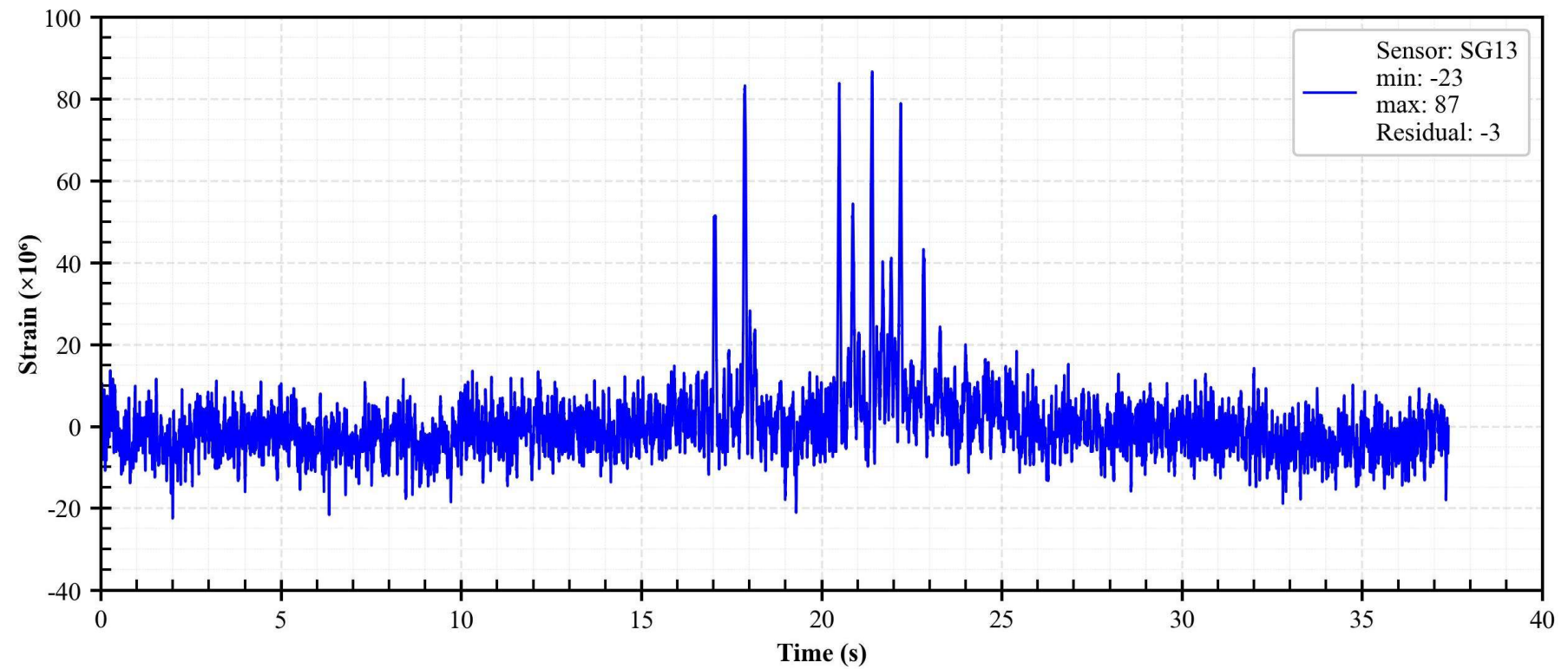


Figure 3.6.26 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 13

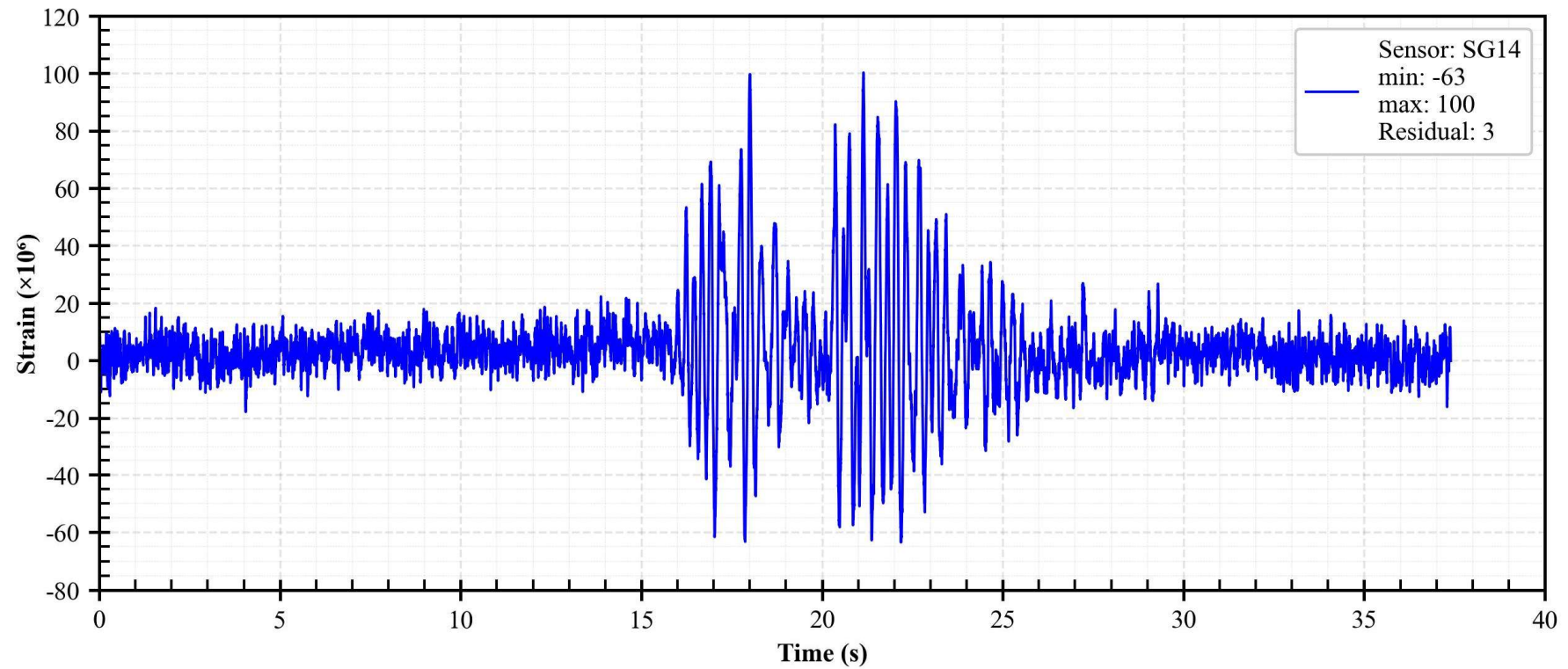


Figure 3.6.27 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 14

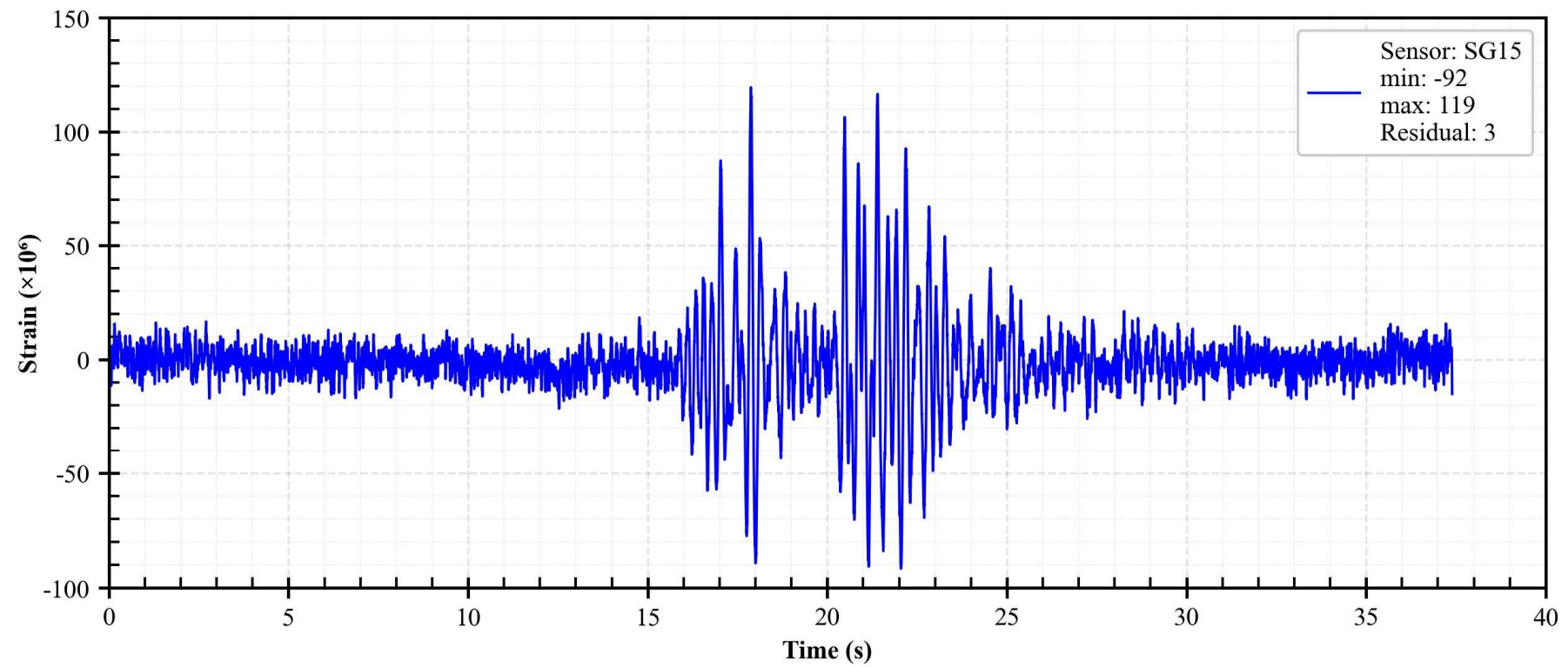


Figure 3.6.28 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 15

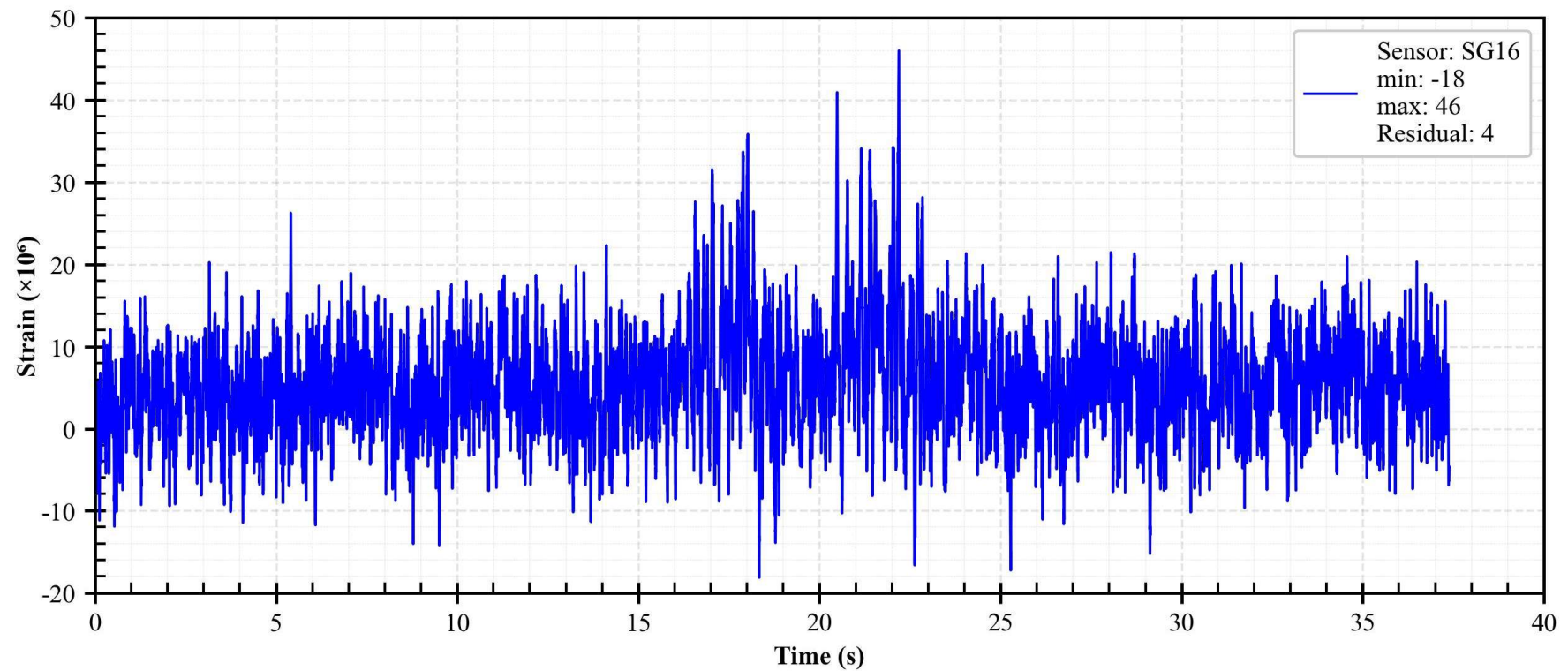


Figure 3.6.29 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 16

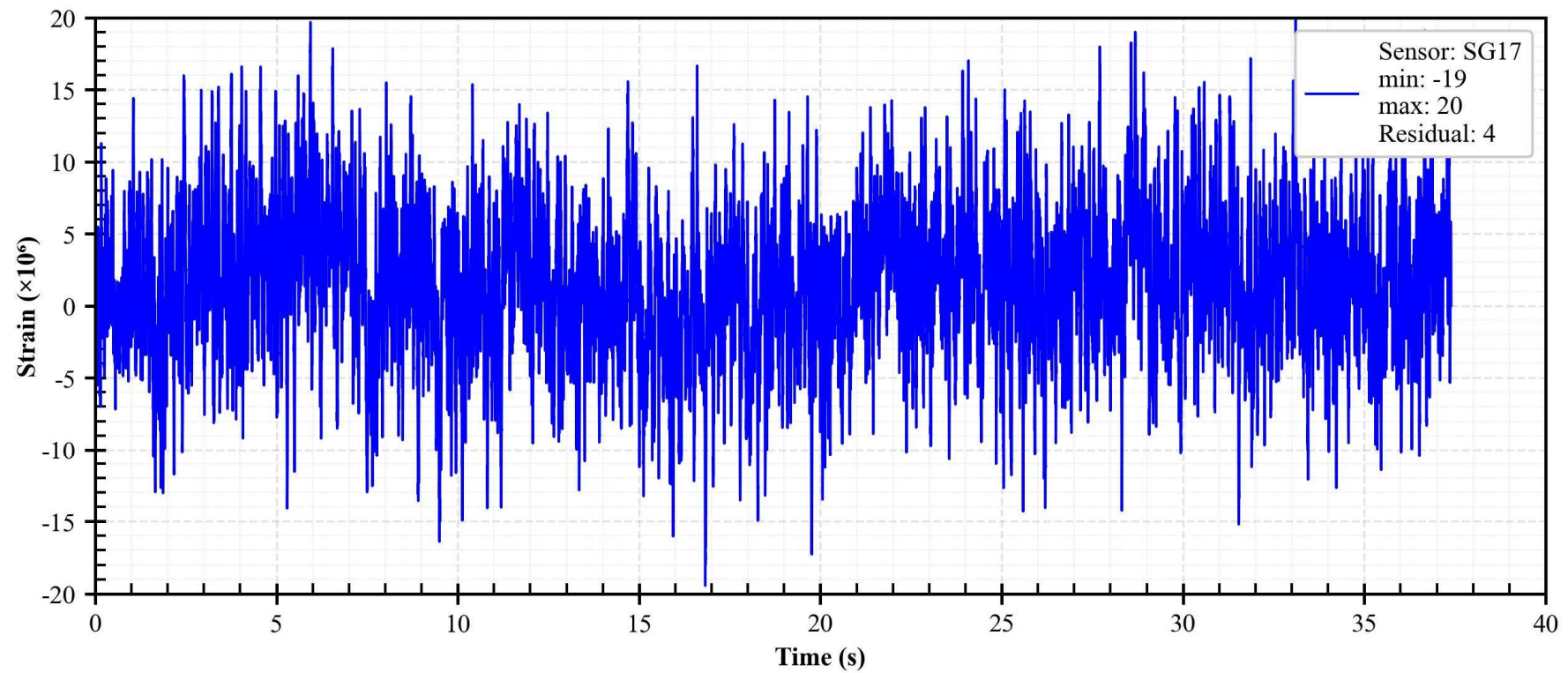


Figure 3.6.30 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 17

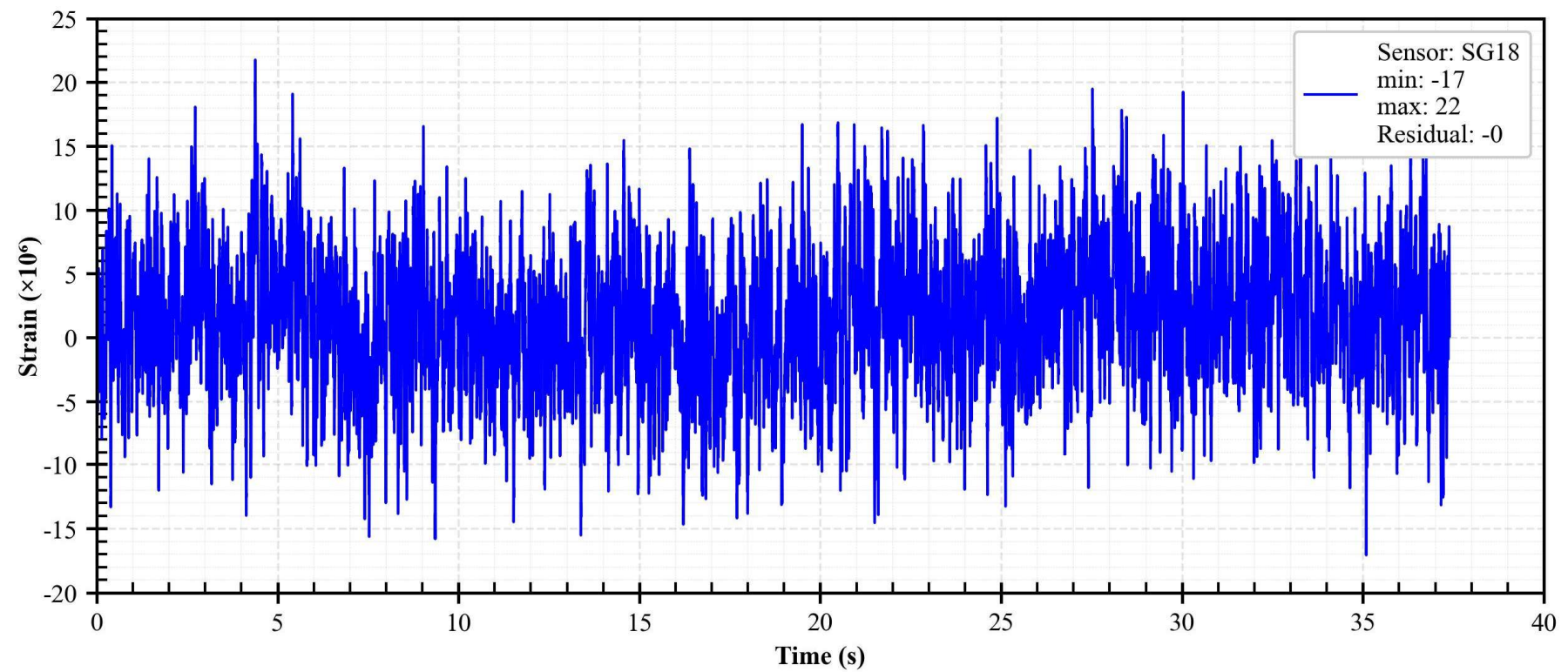


Figure 3.6.31 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 18

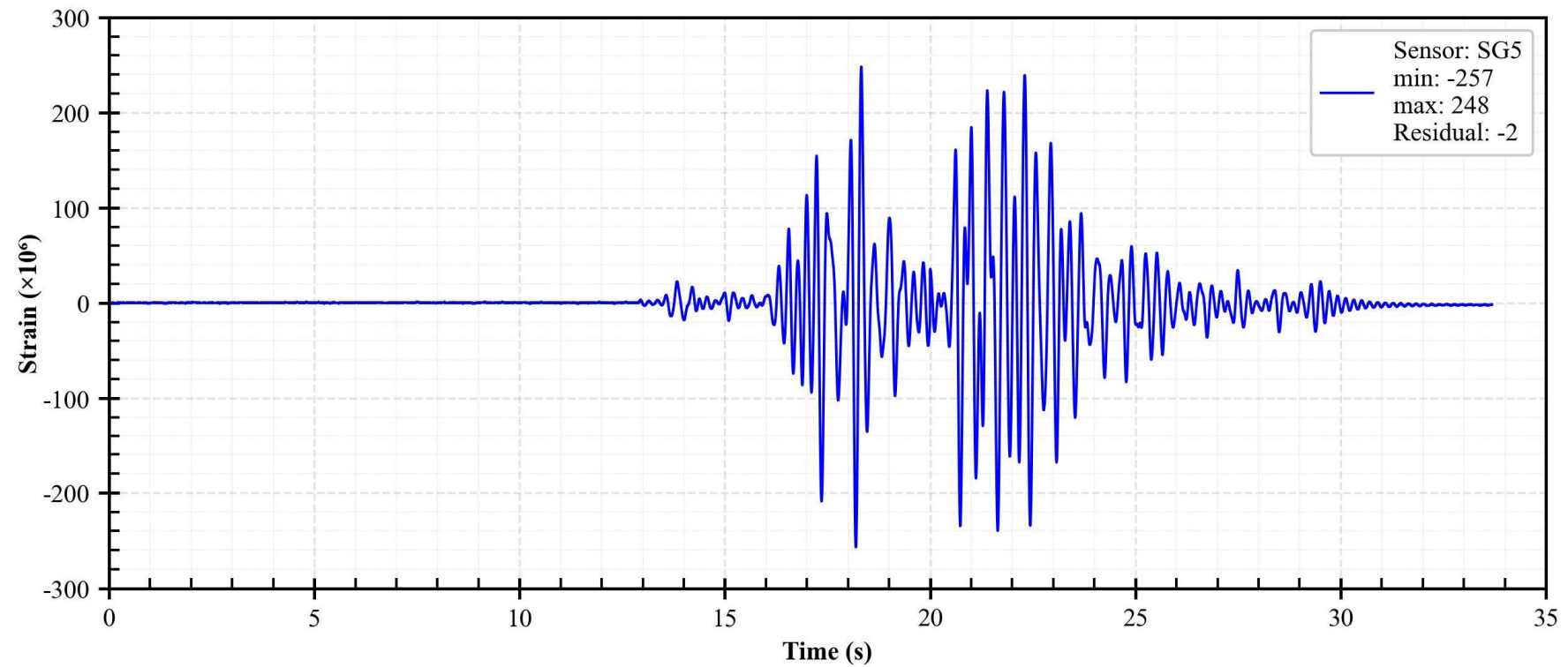


Figure 3.6.32 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 5

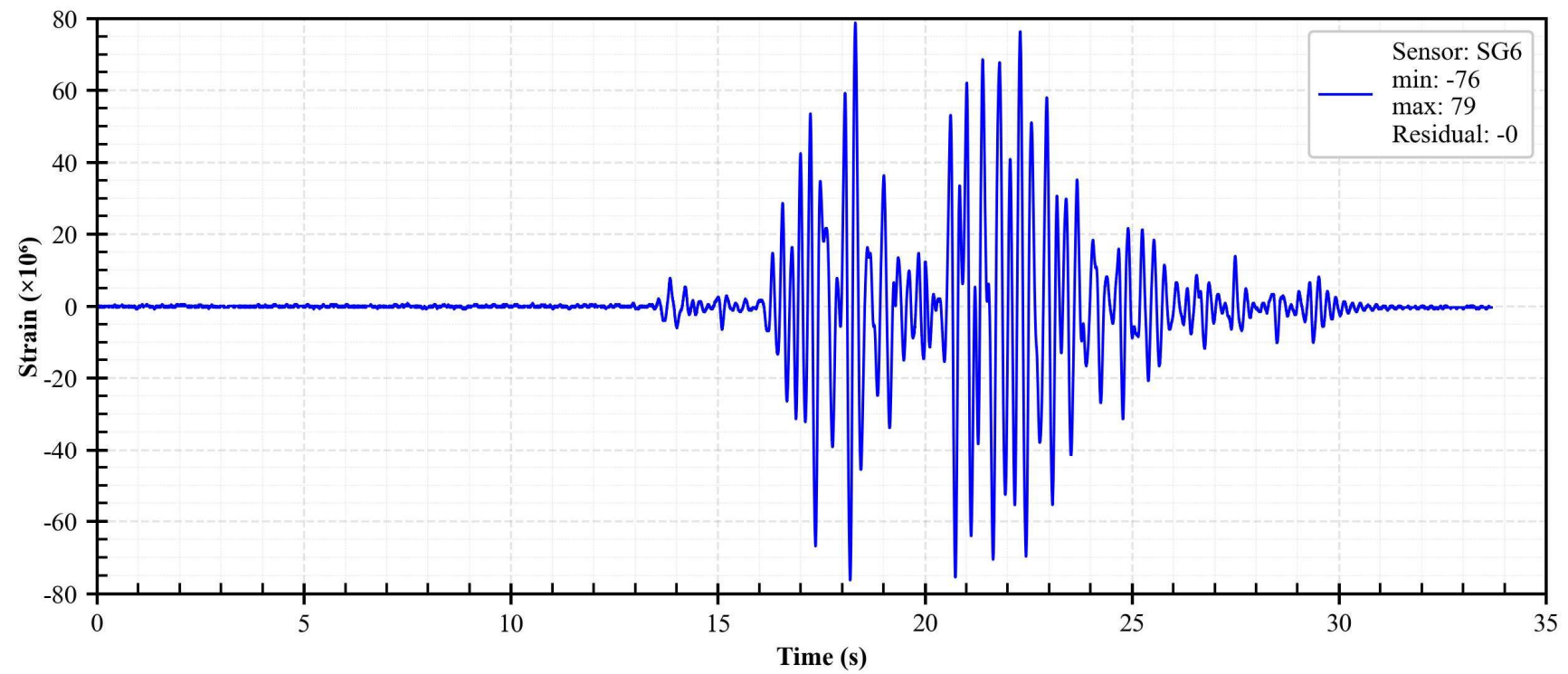


Figure 3.6.33 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 6

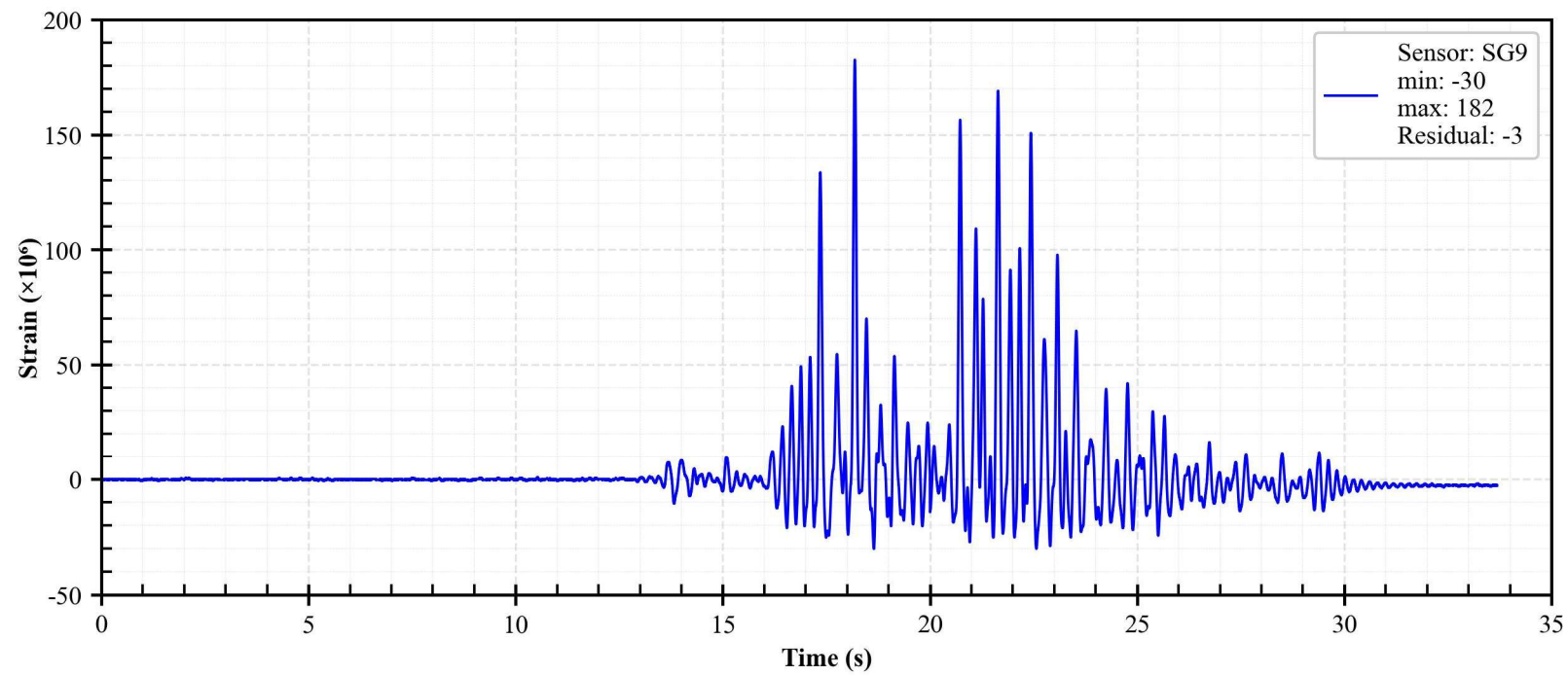


Figure 3.6.34 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 9

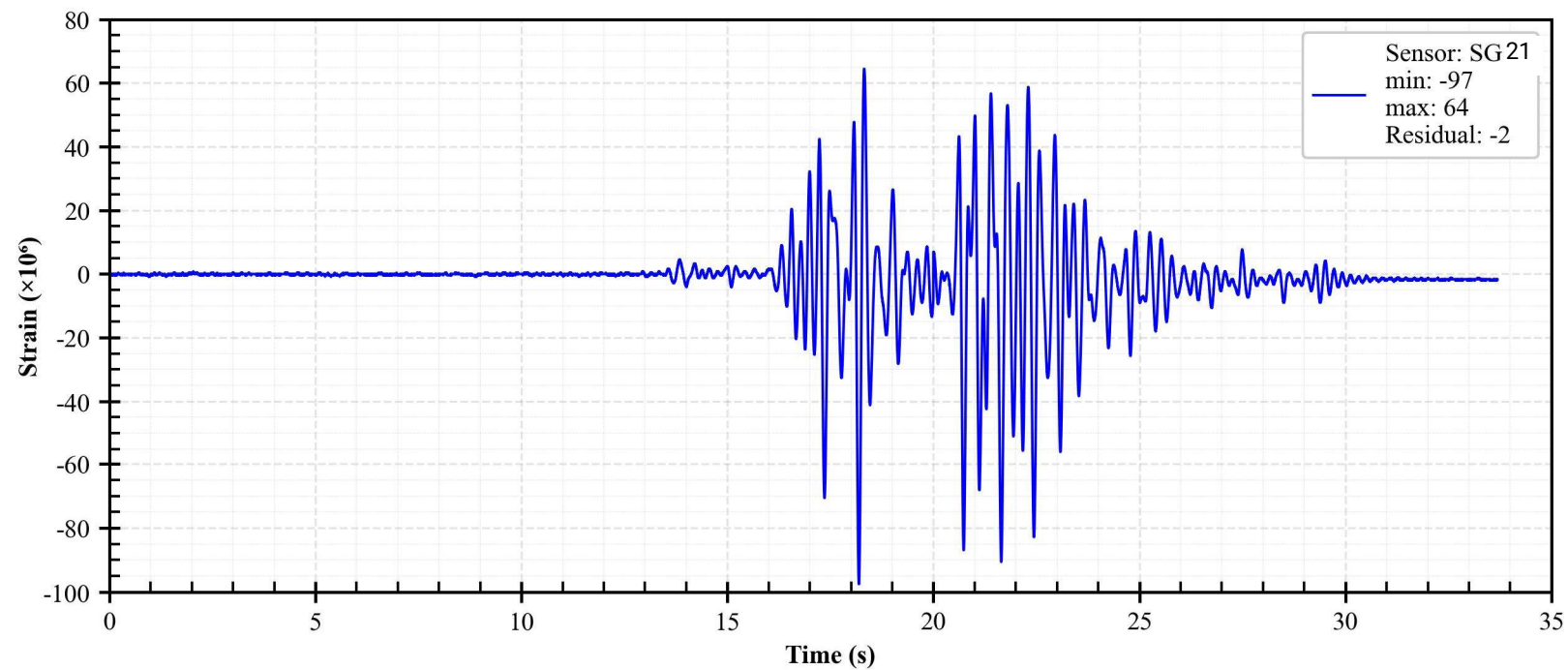


Figure 3.6.35 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 21 (PUFJ, column 1)

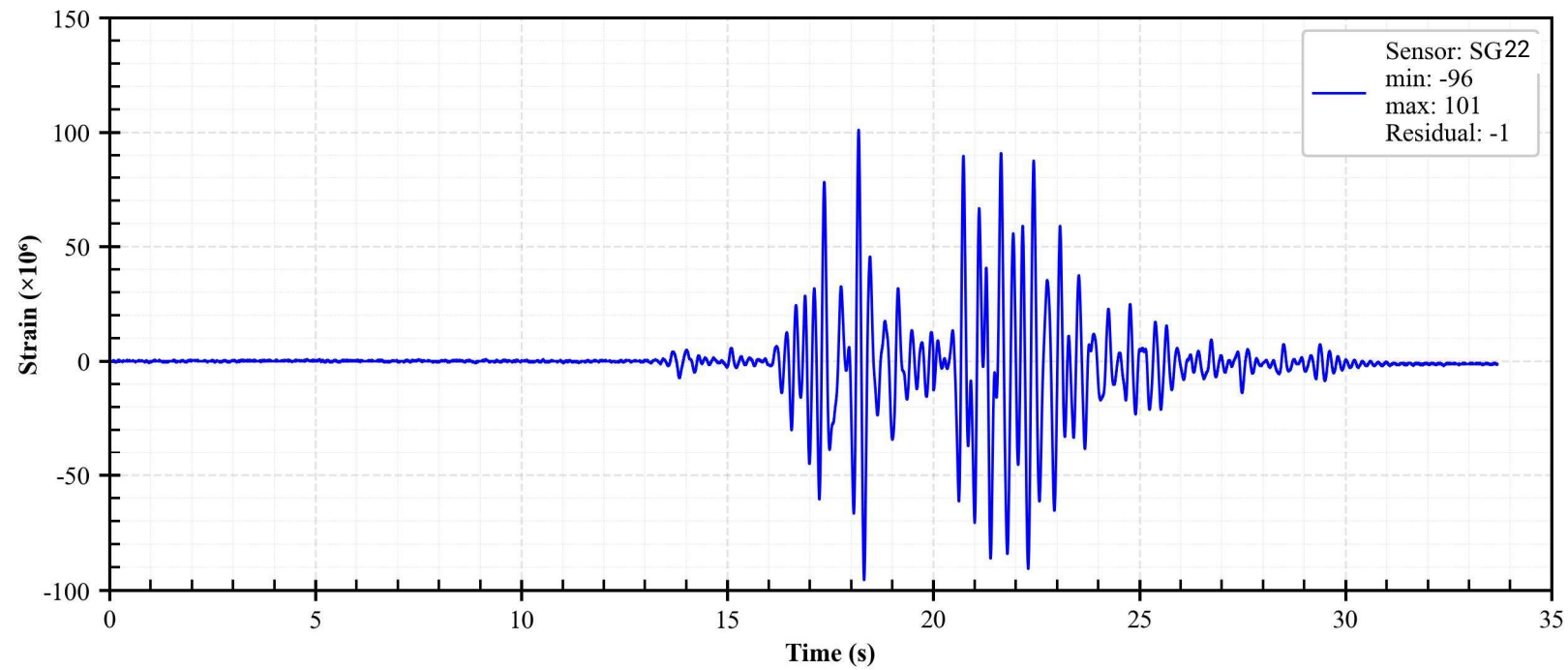


Figure 3.6.36 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 22 (PUFJ, column 2)

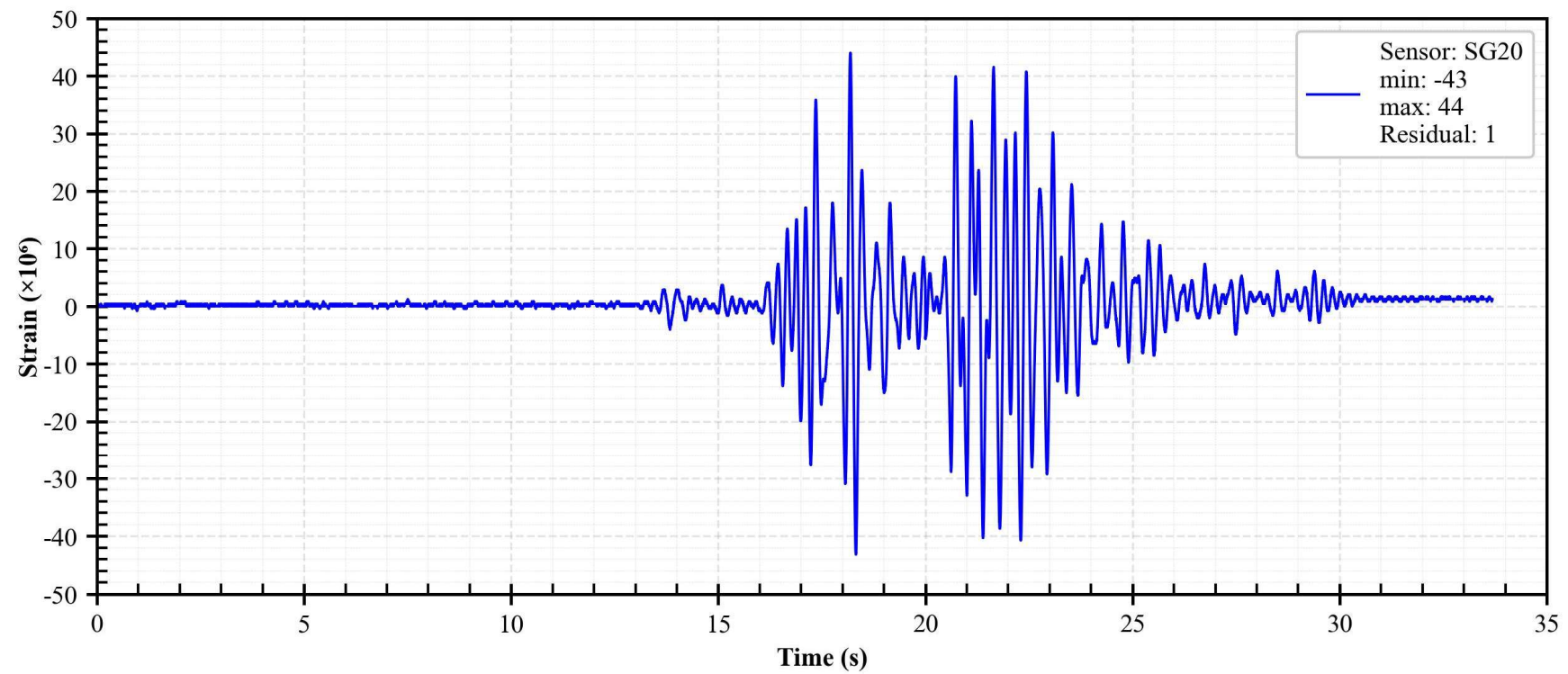


Figure 3.6.37 Characteristic results for phase B (earthquake EQ0,14g): strain gauge 20

3.7 Earthquake EQ0,2g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,2g. The max acceleration at the slab level on the accelerometer acc4 is 0.35g. The max acceleration at the foundation level on the accelerometer acc10 is 0,21g.

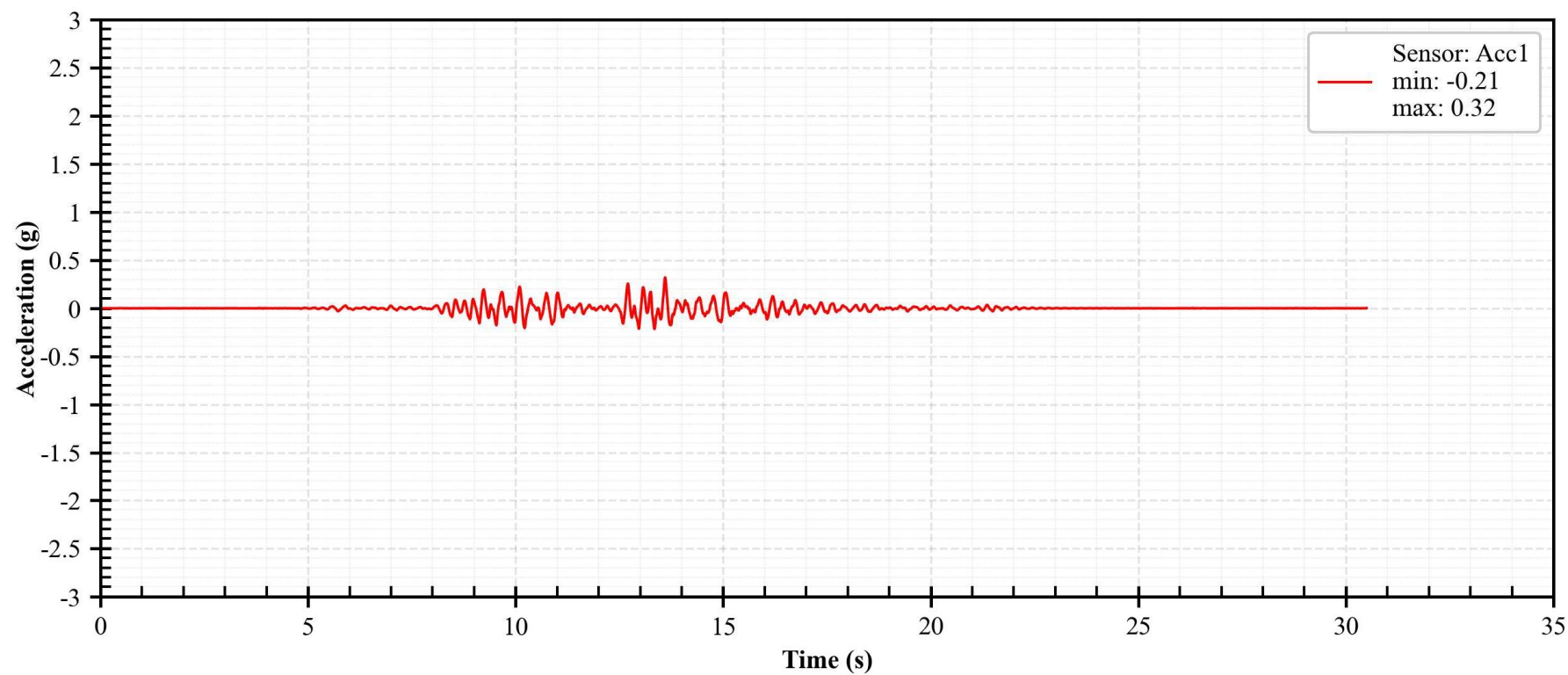


Figure 3.7.1 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 1

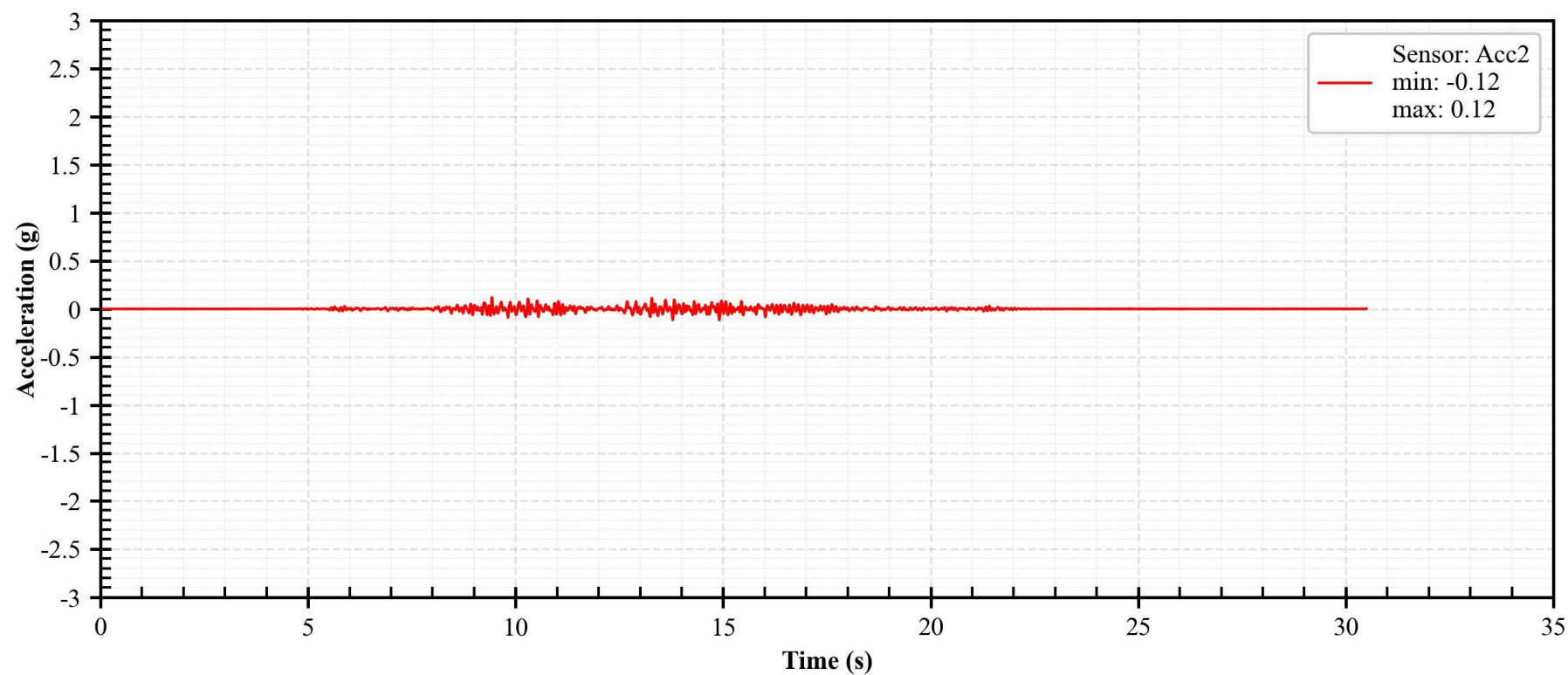


Figure 3.7.2 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 2

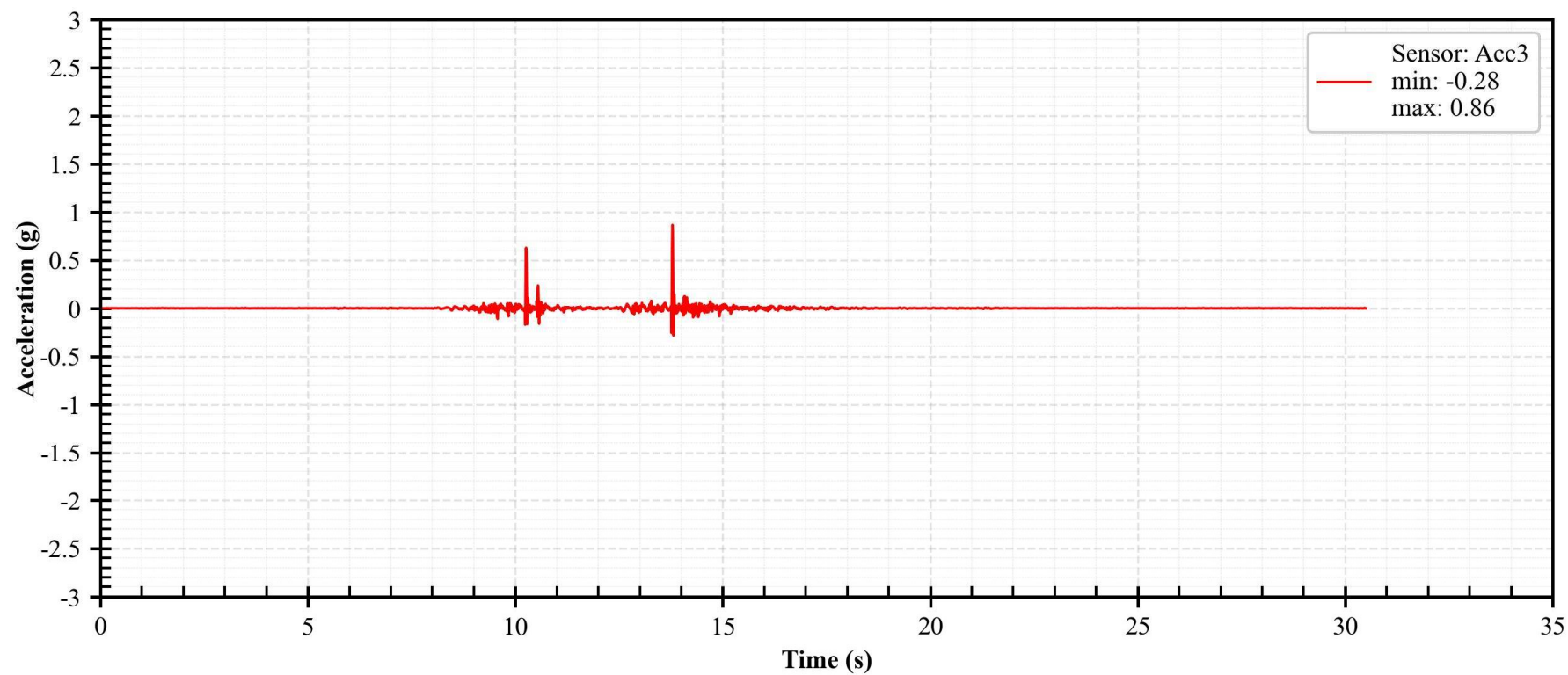


Figure 3.7.3 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 3

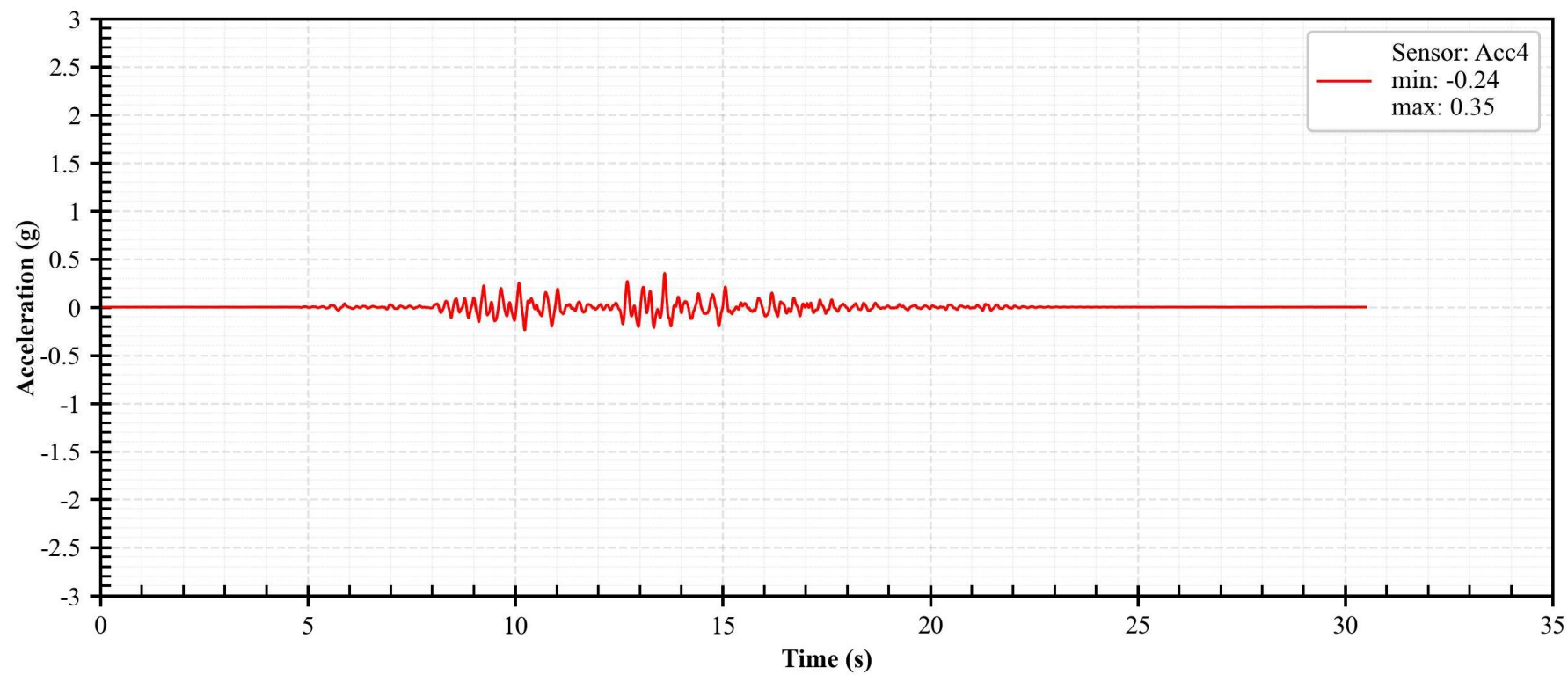


Figure 3.7.4 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 4

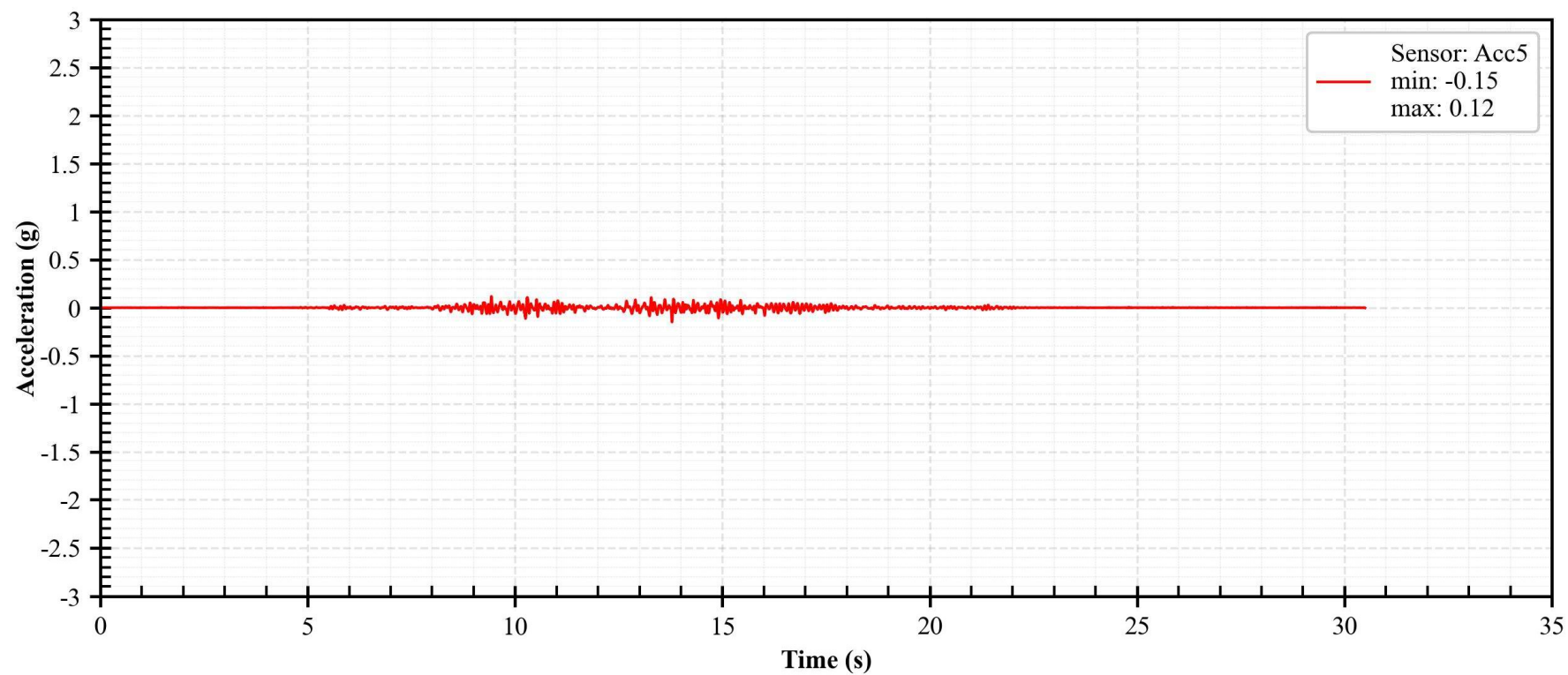


Figure 3.7.5 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 5

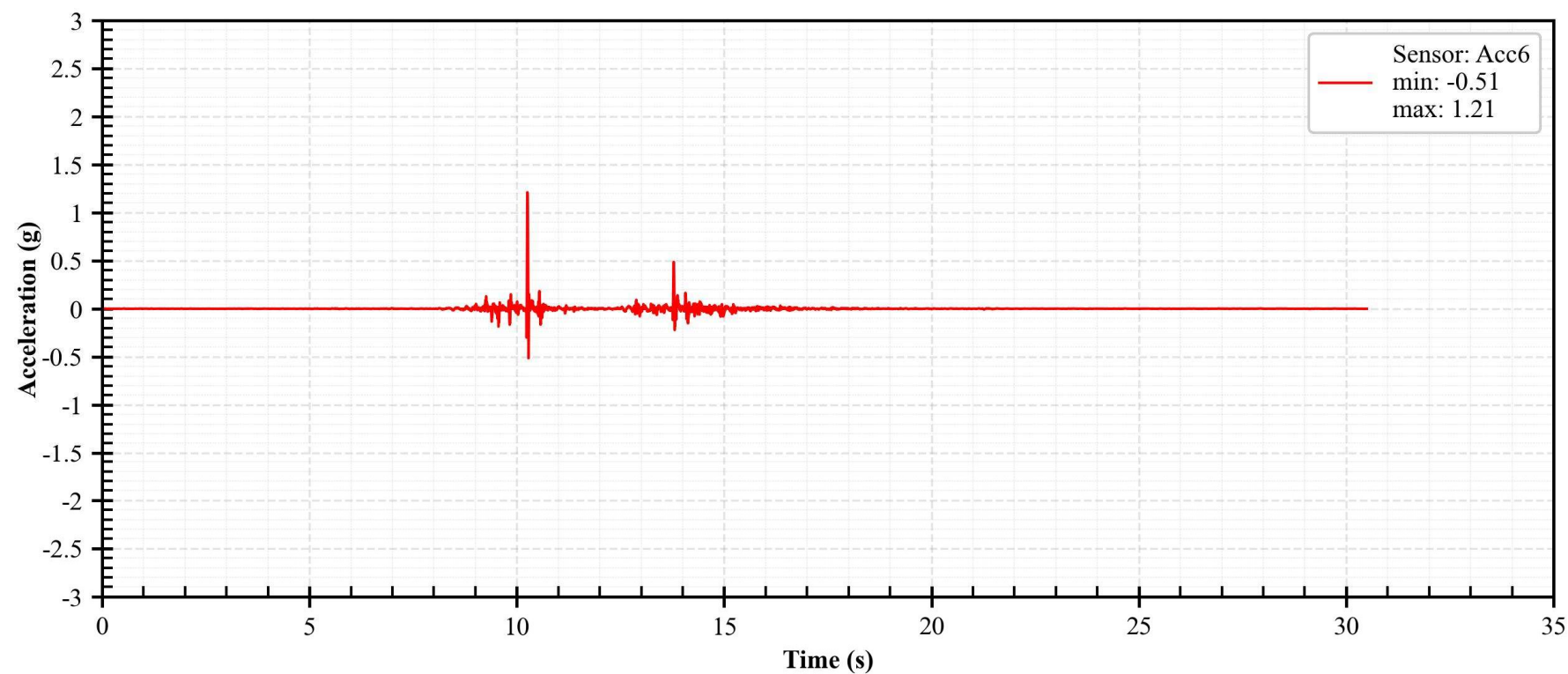


Figure 3.7.6 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 6

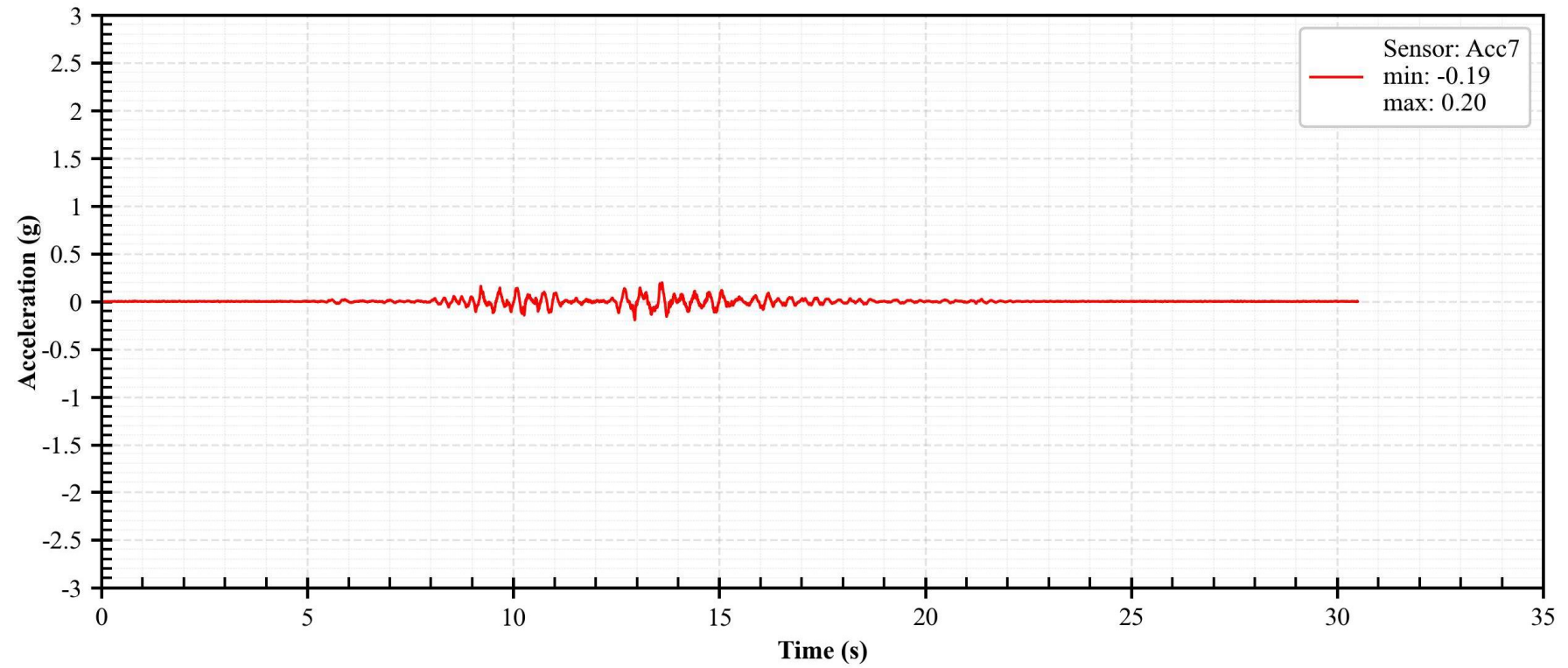


Figure 3.7.7 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 7

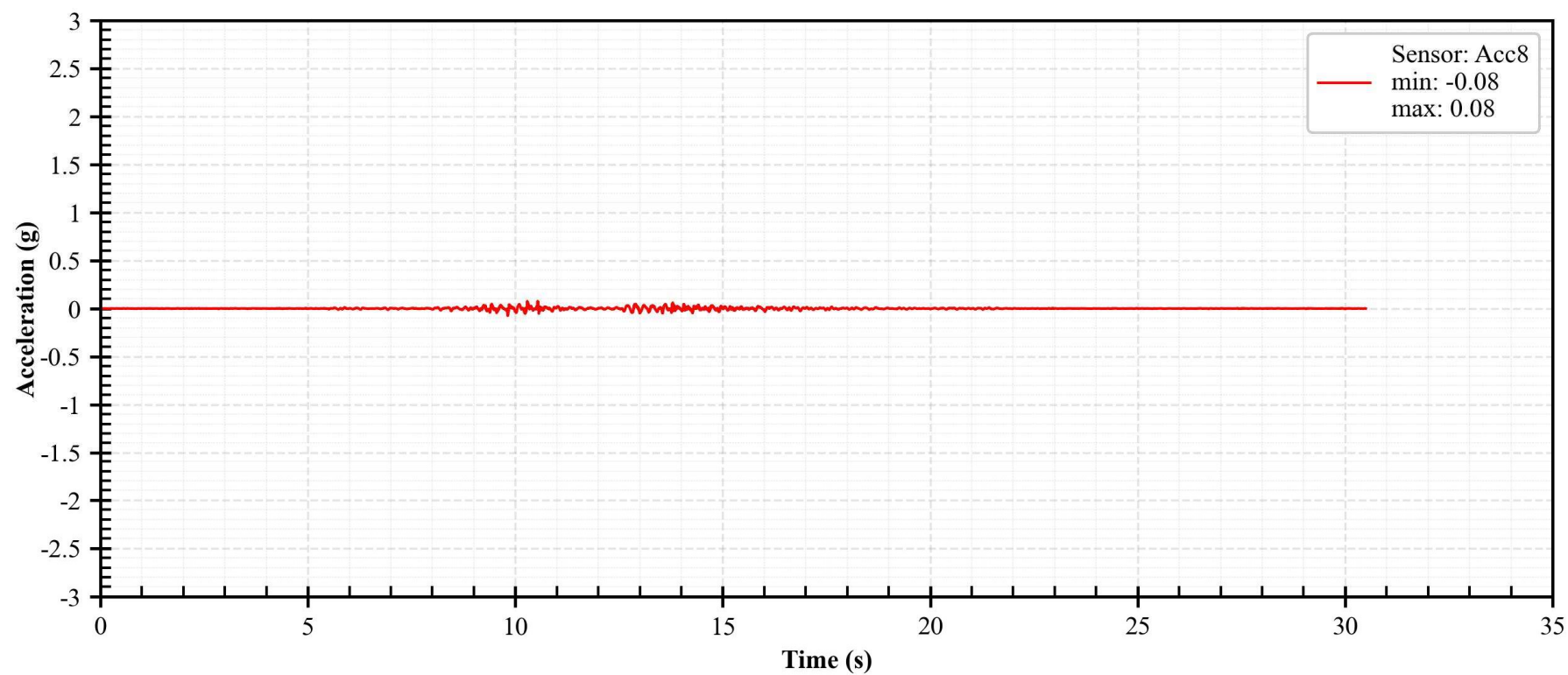


Figure 3.7.8 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 8

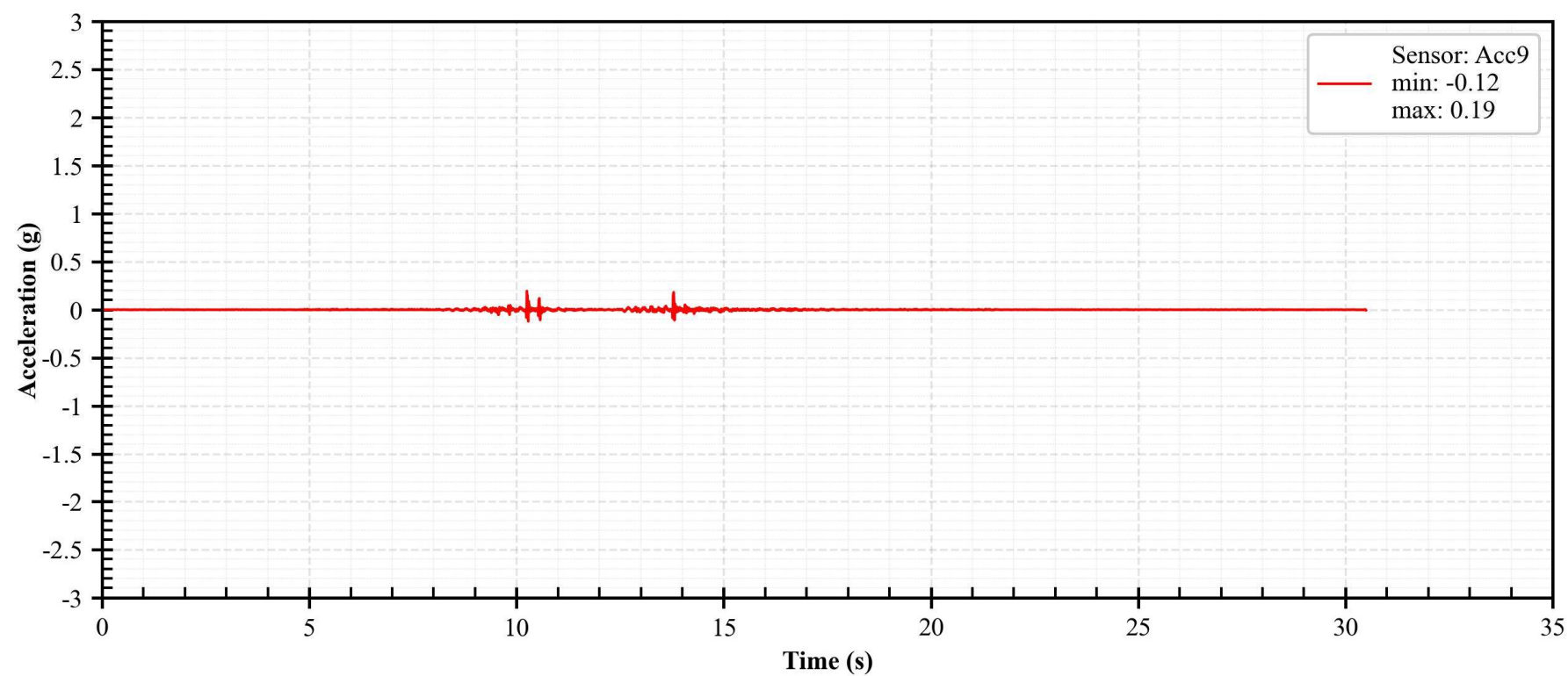


Figure 3.7.9 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 9

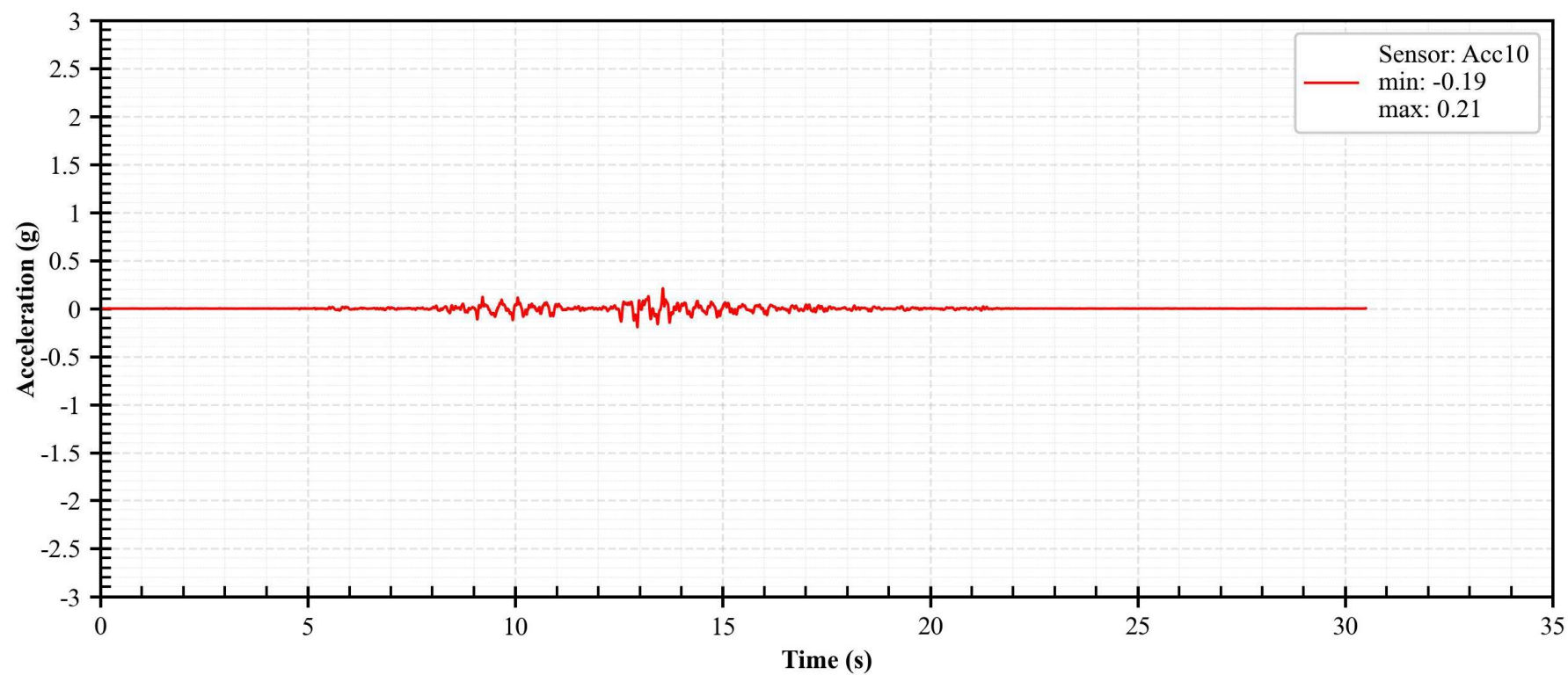


Figure 3.7.10 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 10

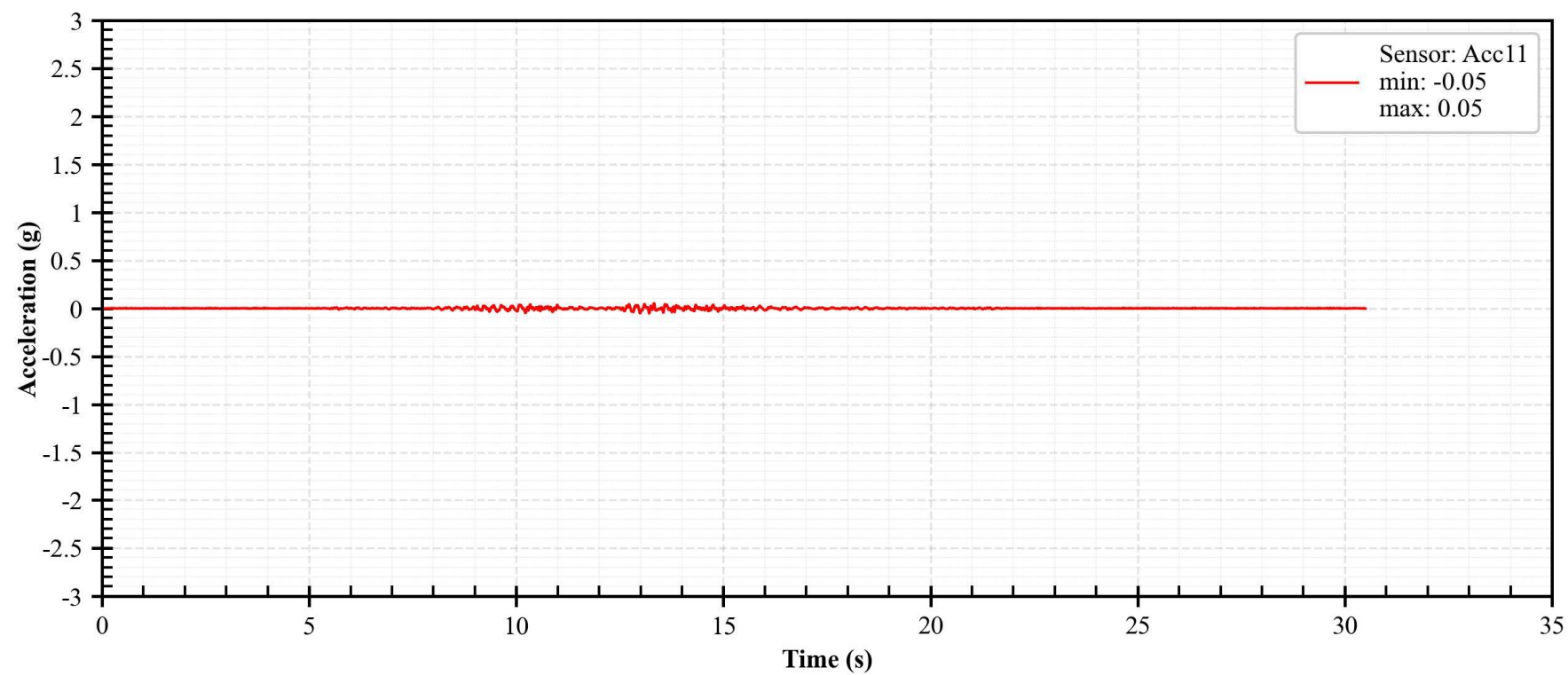


Figure 3.7.11 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 11

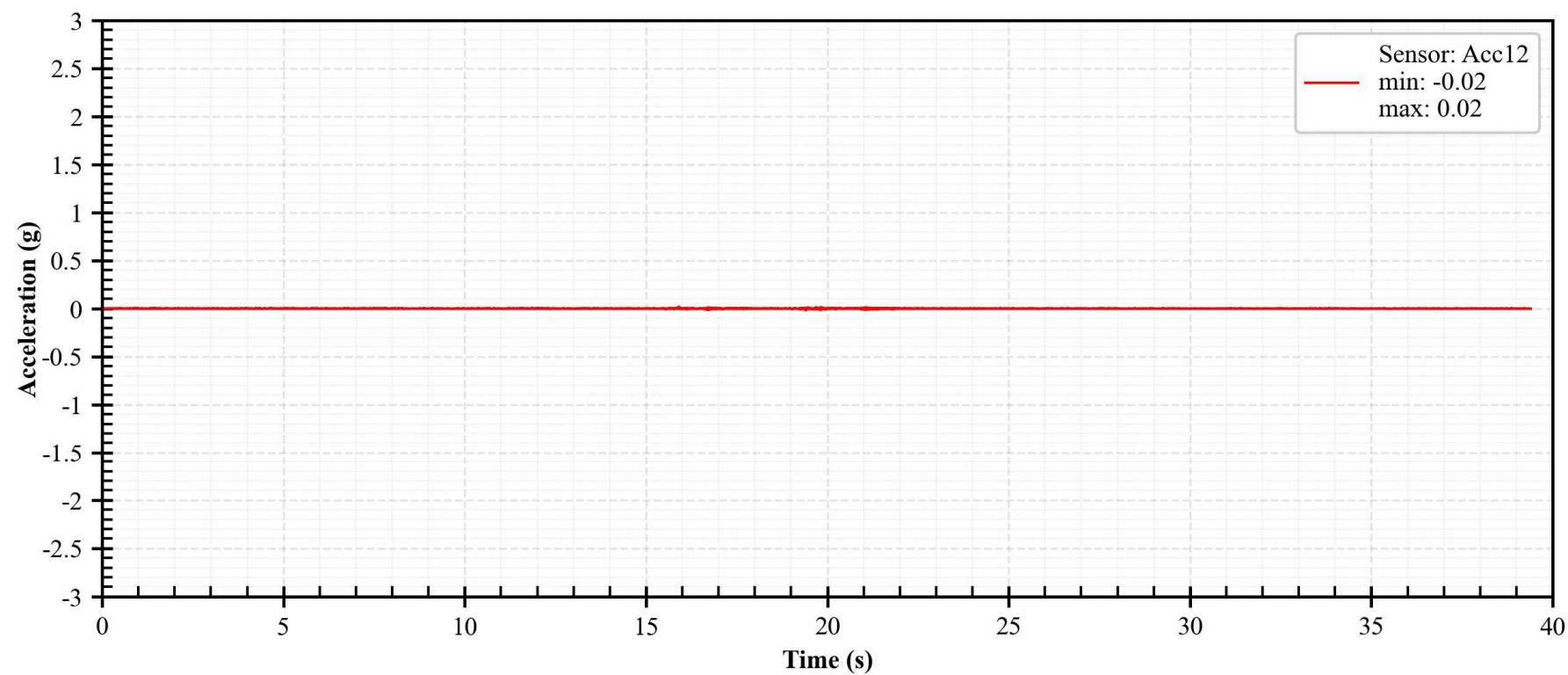


Figure 3.7.12 Characteristic results for phase B (earthquake EQ0,2g): Accelerometer 12

Draw wire sensors

Figures 3.7.13 – 3.7.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 4.05 mm while the minimum is -4.38 mm. The maximum movement detected by draw wire sensor W2 is 6.88 mm while the minimum is -5.88 mm. The maximum movement detected by draw wire sensor W3 is 4.30 mm while the minimum is -4.13 mm. The maximum movement detected by draw wire sensor W4 is 4.68 mm while the minimum is -4.39 mm. The maximum drift is $(2.83 / 1.225) = 2.31 \%$ and minimum drift is $(-2.08 / 1.225) = -1.70 \%$.

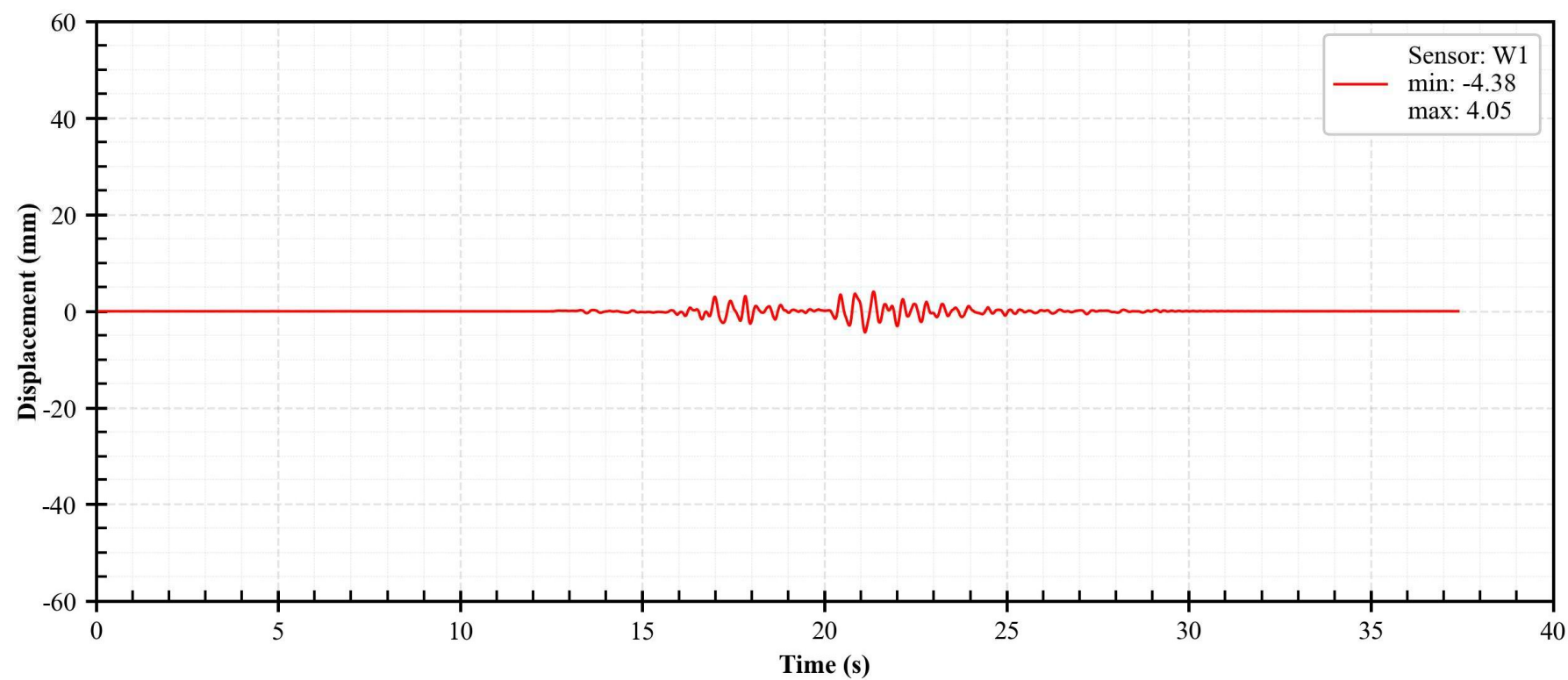


Figure 3.7.13 Characteristic results for phase B (earthquake EQ0,2g): Draw wire sensor 1

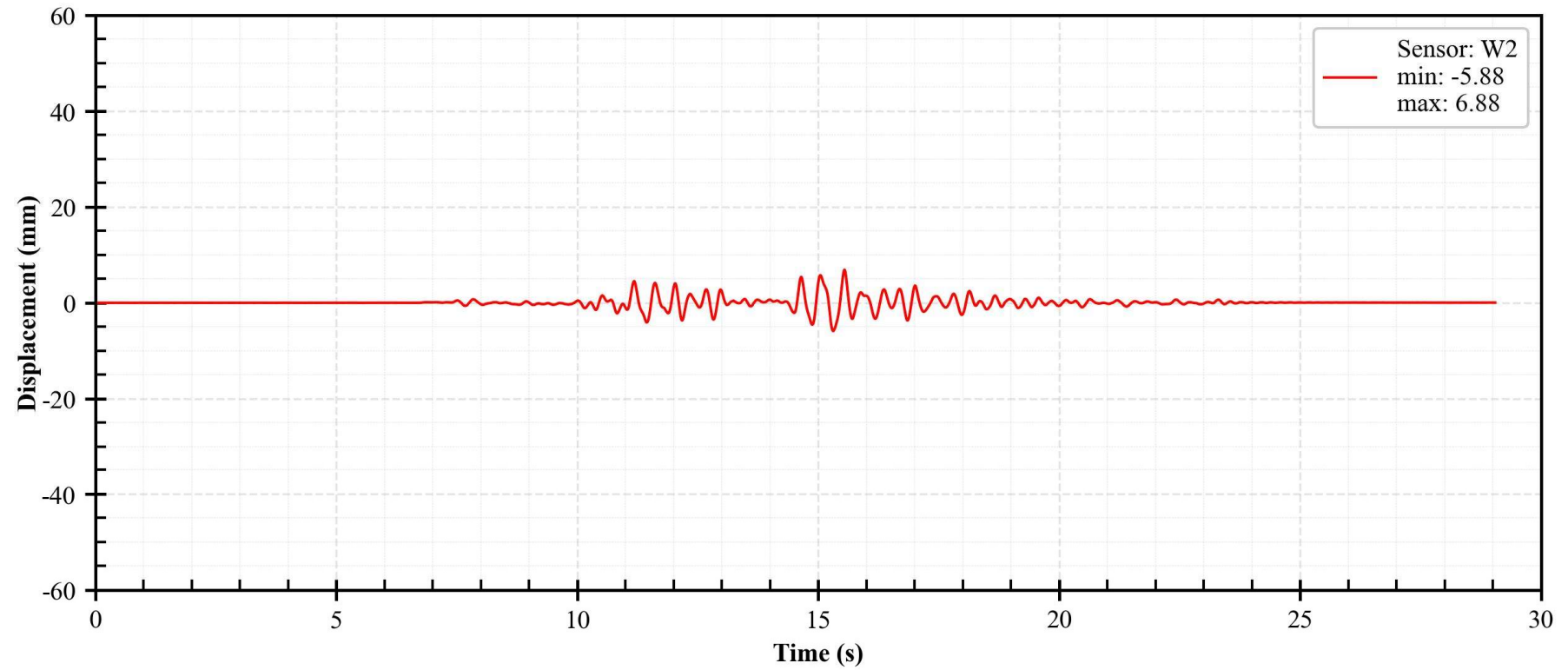


Figure 3.7.14 Characteristic results for phase B (earthquake EQ0,2g): Draw wire sensor 2

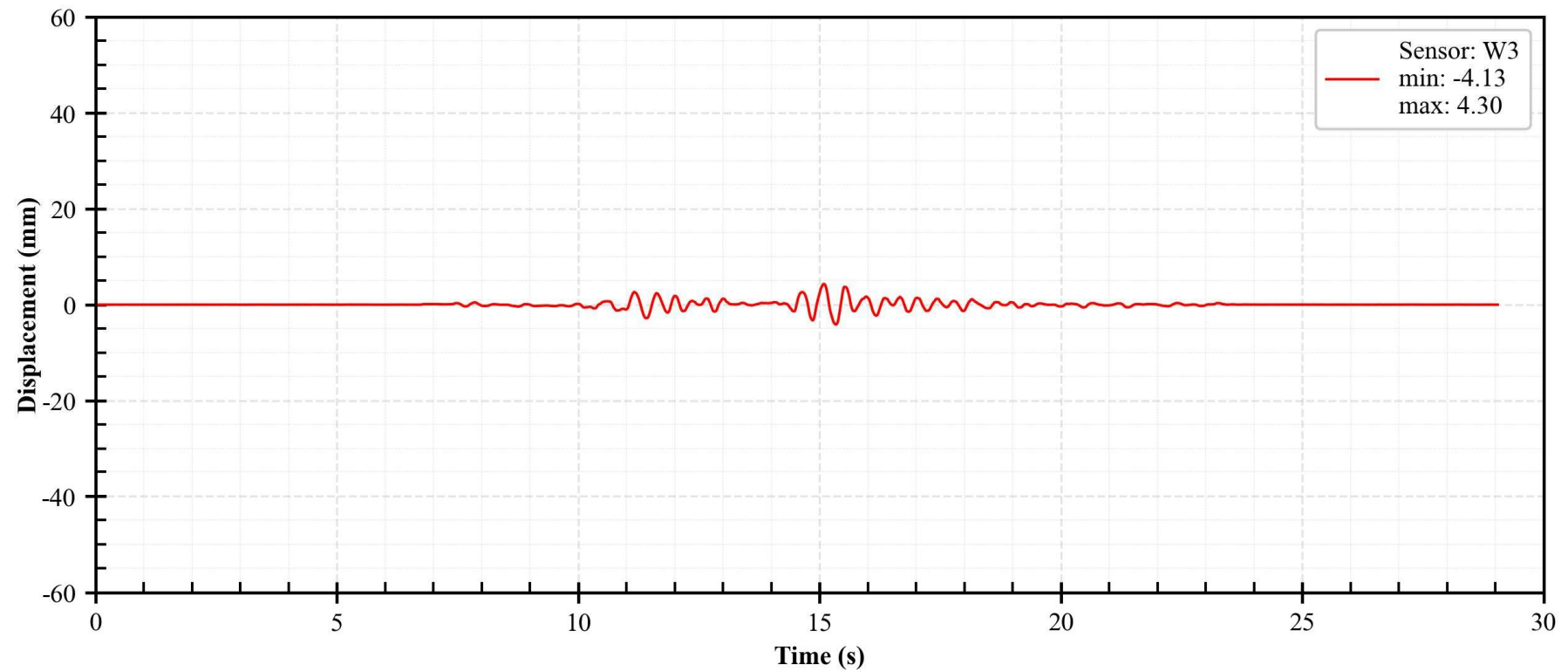


Figure 3.7.15 Characteristic results for phase B (earthquake EQ0,2g): Draw wire sensor 3

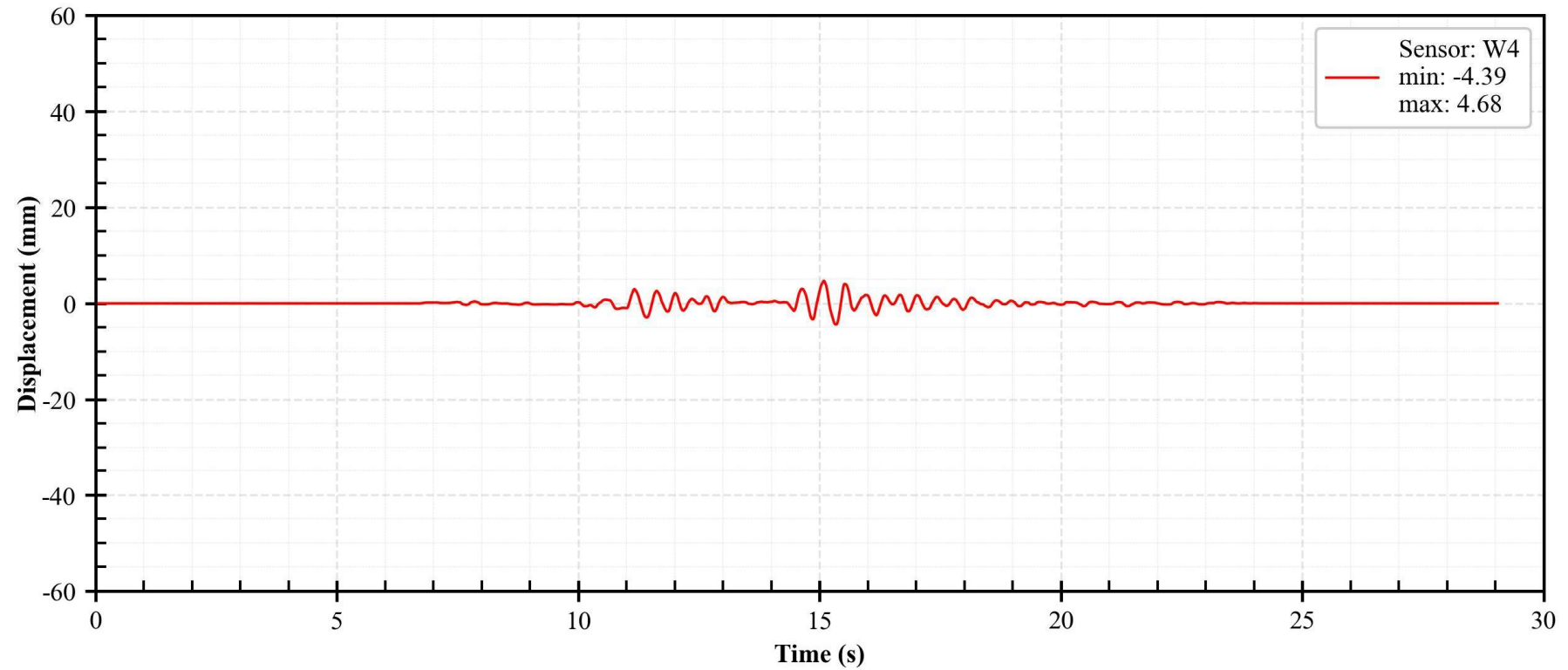


Figure 3.7.16 Characteristic results for phase B (earthquake EQ0,2g): Draw wire sensor 4

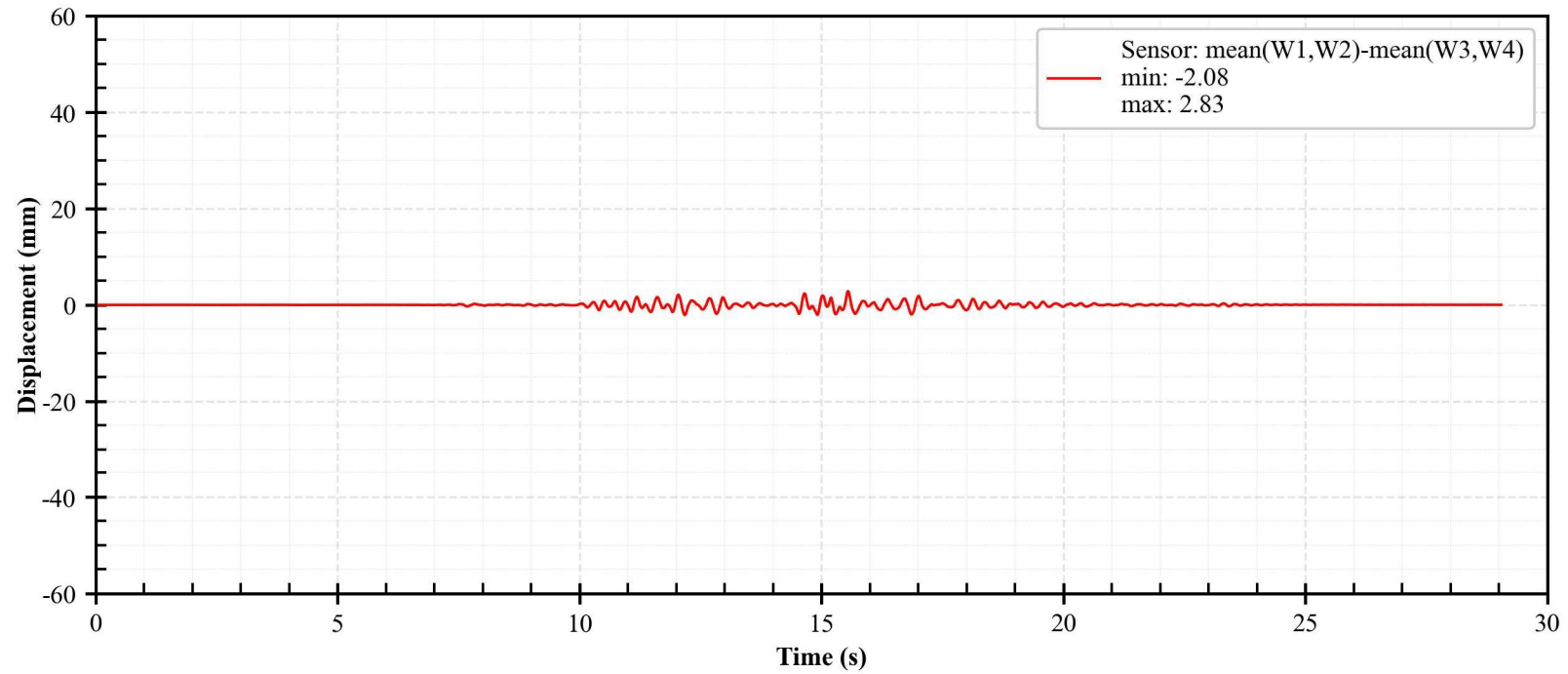


Figure 3.7.17 Characteristic results for phase B (earthquake EQ0,2g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.7.18, 3.7.19, 3.7.20, 3.7.21, 3.7.22, 3.7.23, 3.7. 32, 3.7.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.7.24, 3.7.25, 3.7.26, 3.7.27, 3.7.28, 3.7.29 and 3.7.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 318 μ strain and minimum strain -343 μ strain. The residual strain is -6 μ strain. SG21 & SG22 are located on PUFJ.

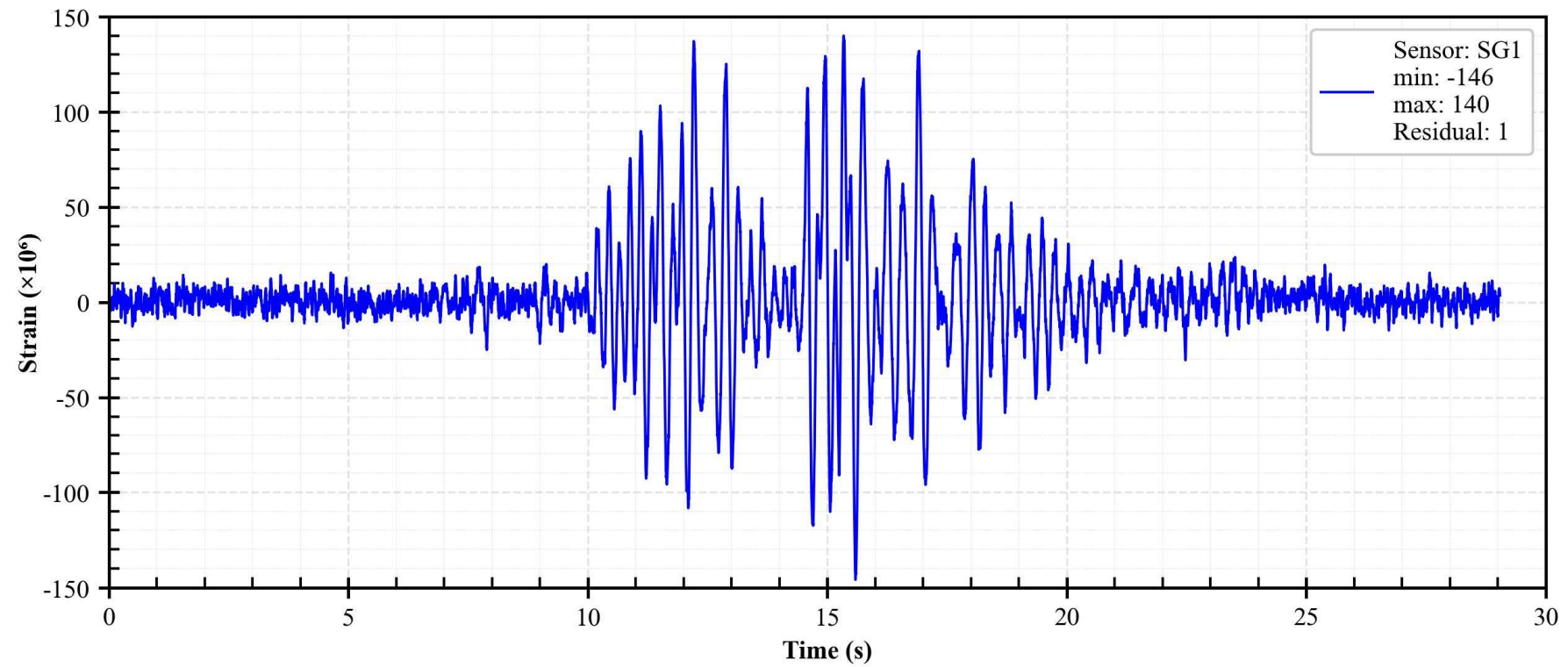


Figure 3.7.18 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 1

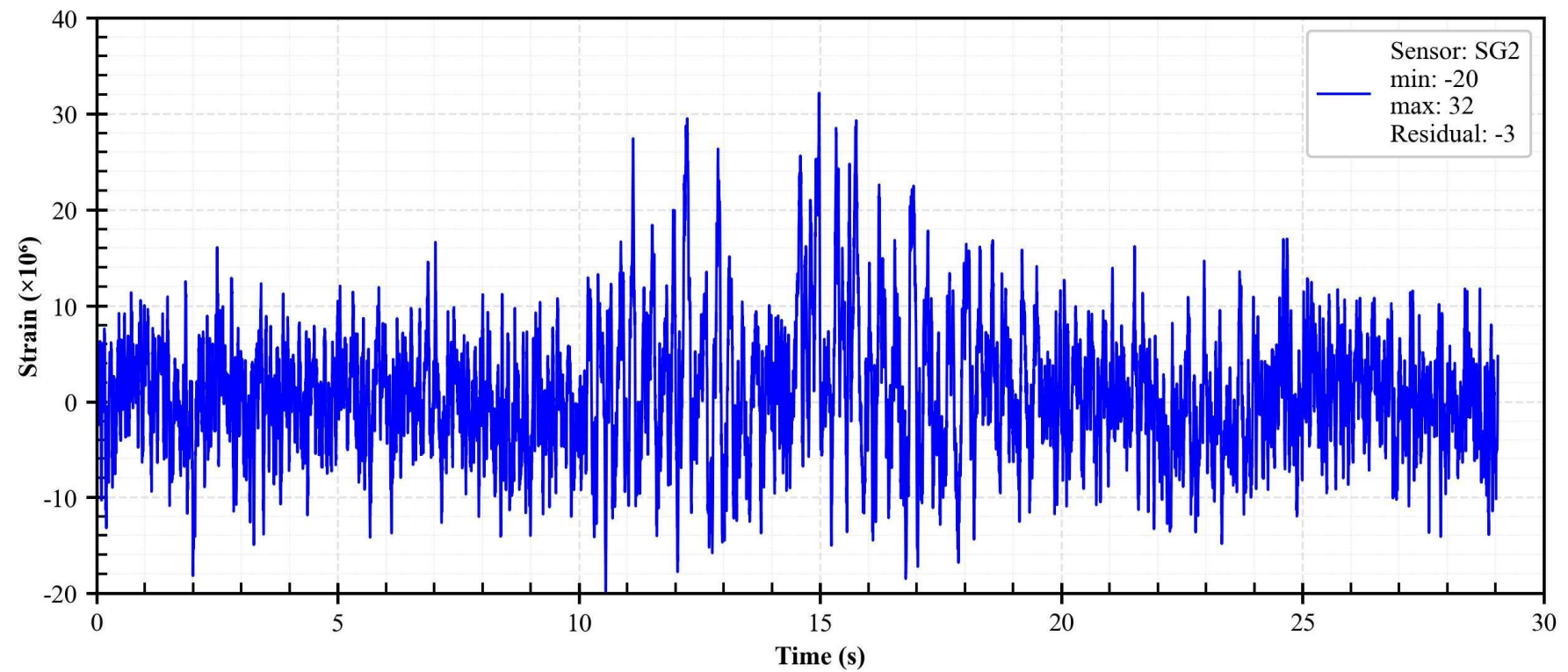


Figure 3.7.19 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 2

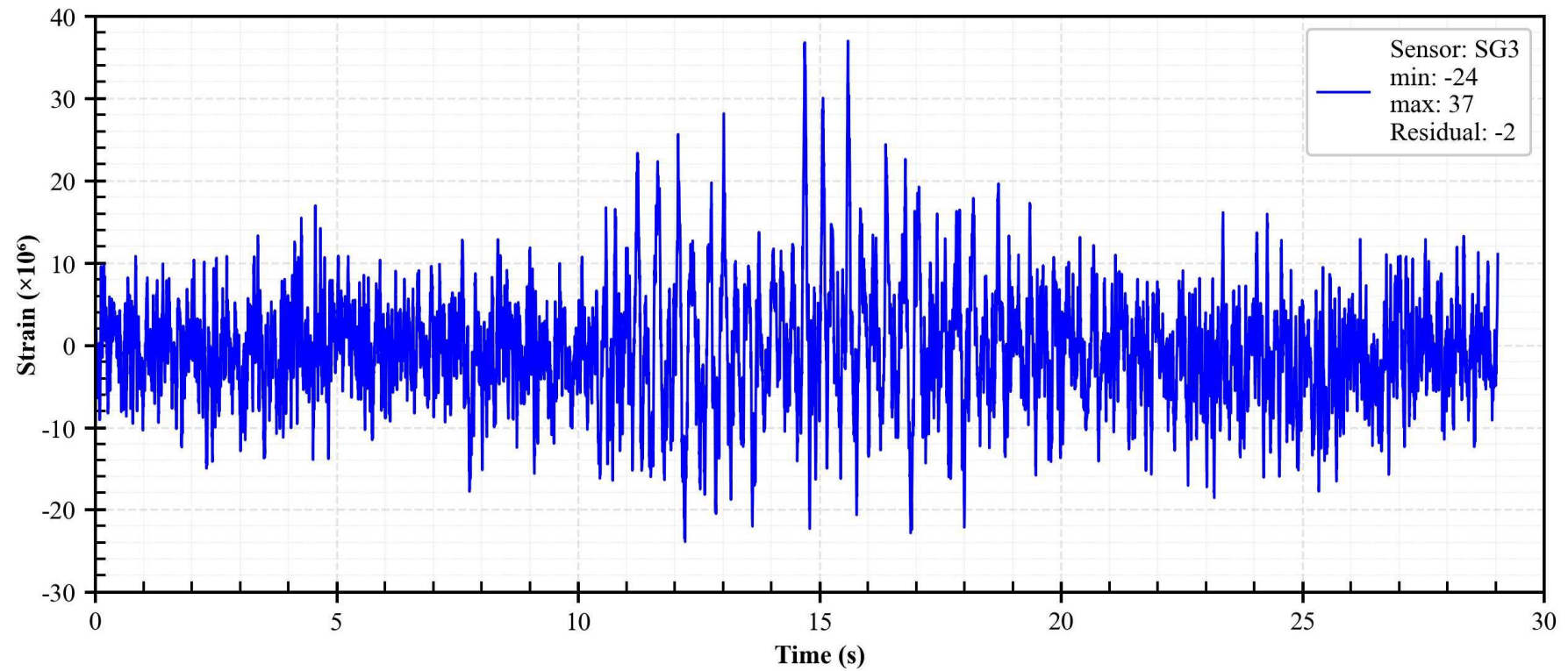


Figure 3.7.20 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 3

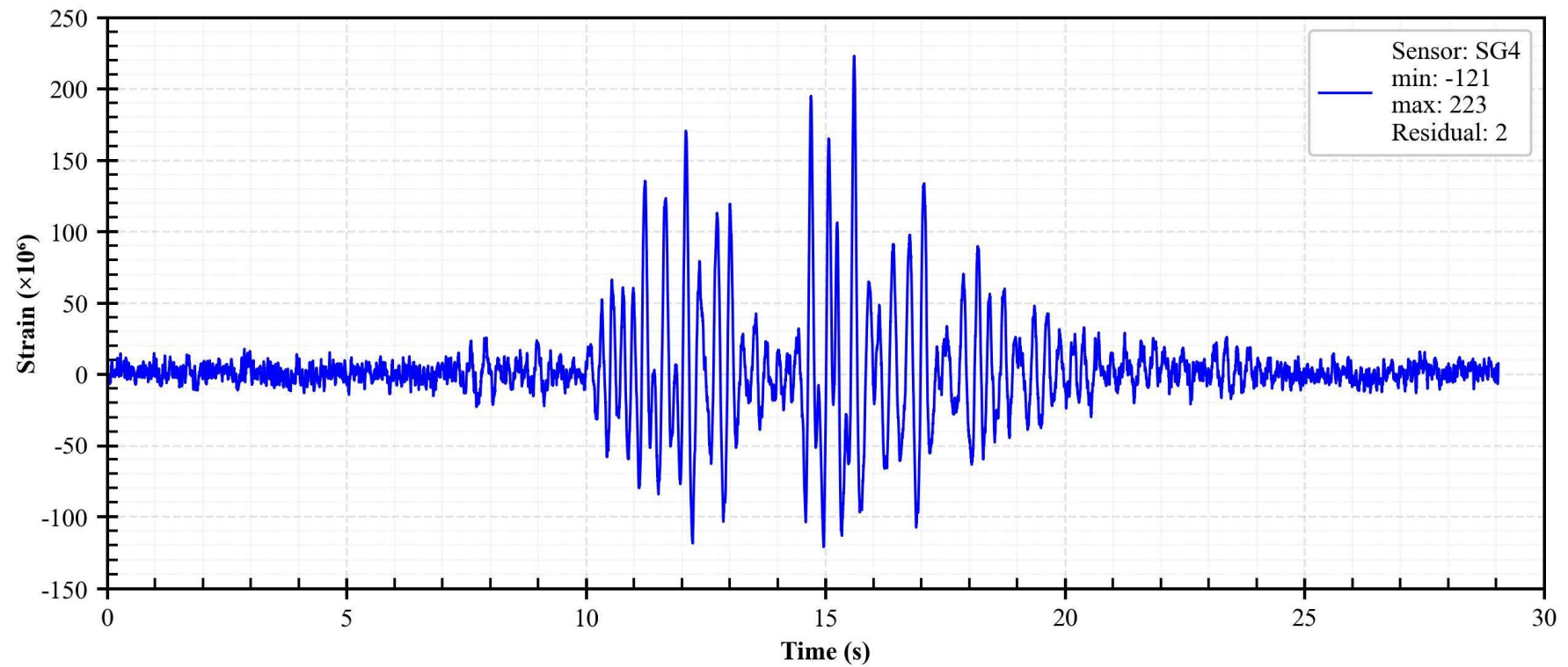


Figure 3.7.21 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 4

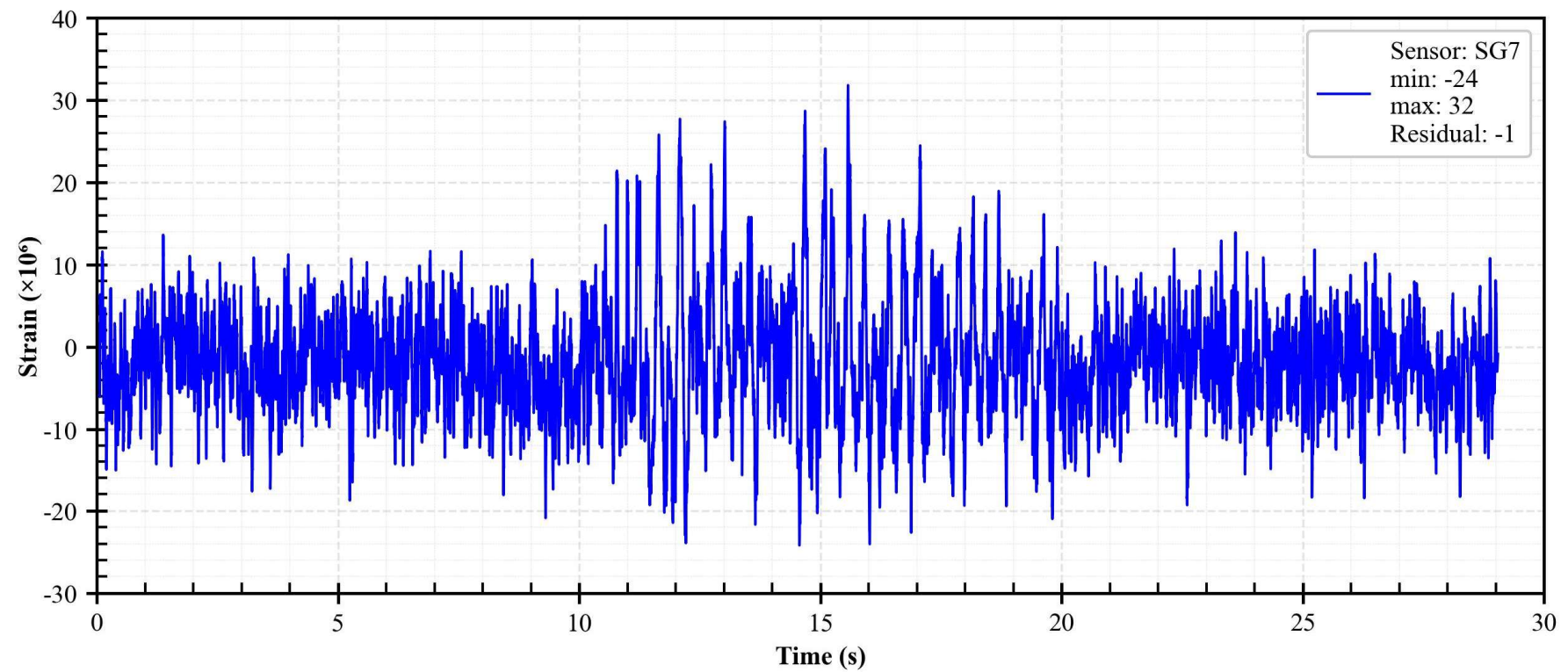


Figure 3.7.22 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 7

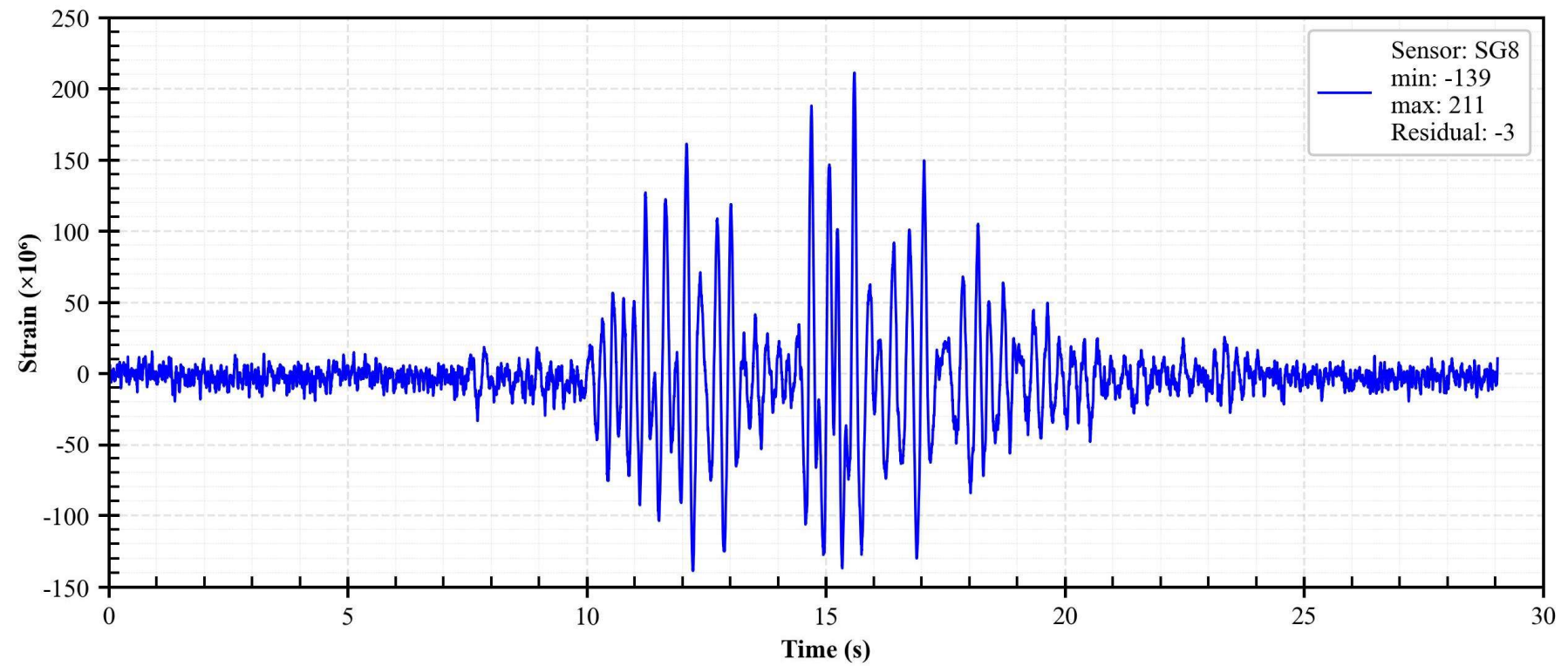


Figure 3.7.23 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 8

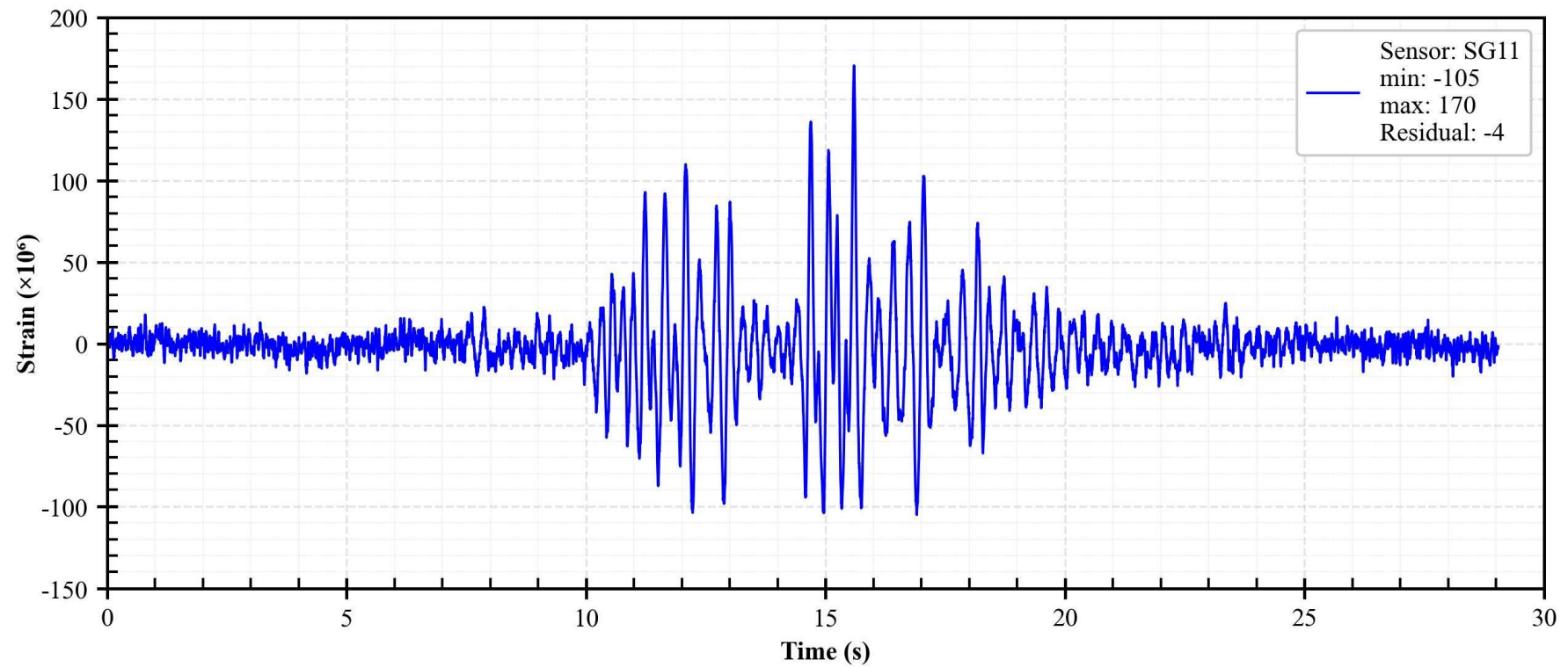


Figure 3.7.24 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 11

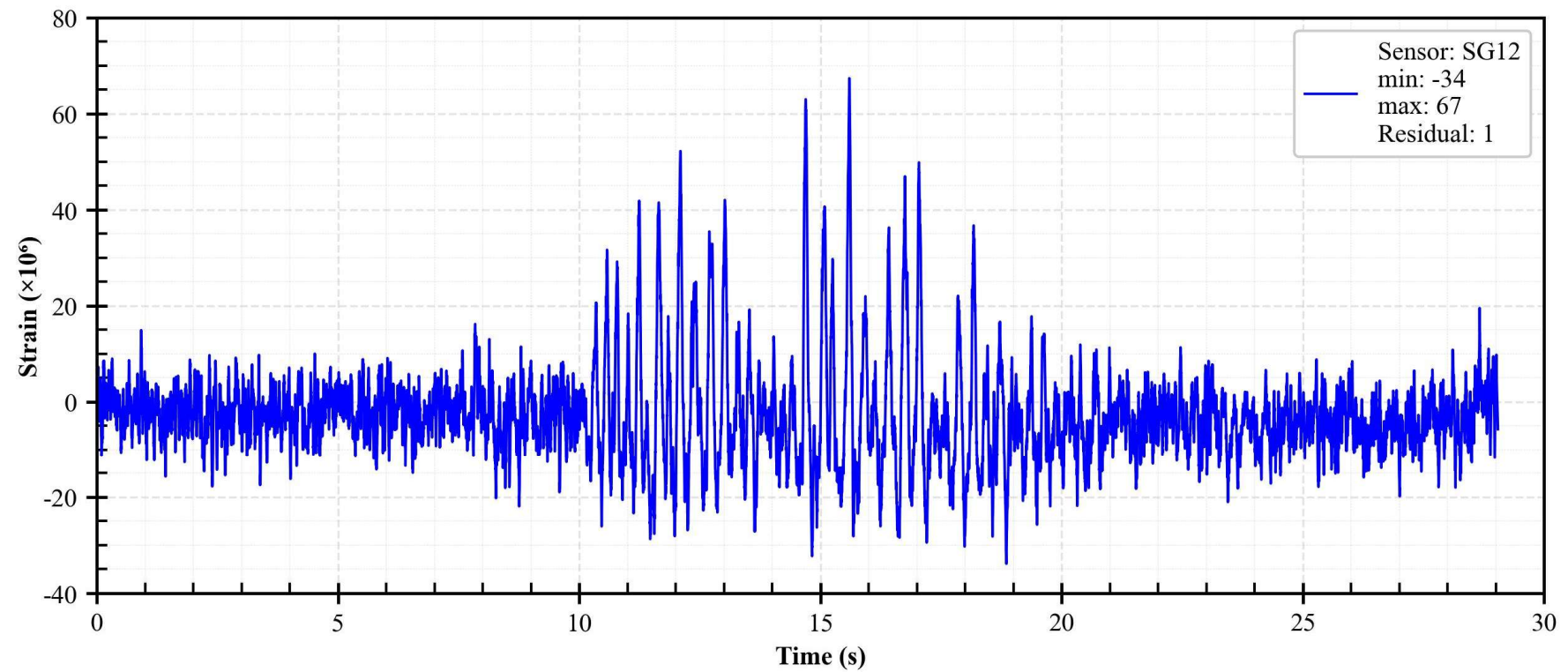


Figure 3.7.25 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 12

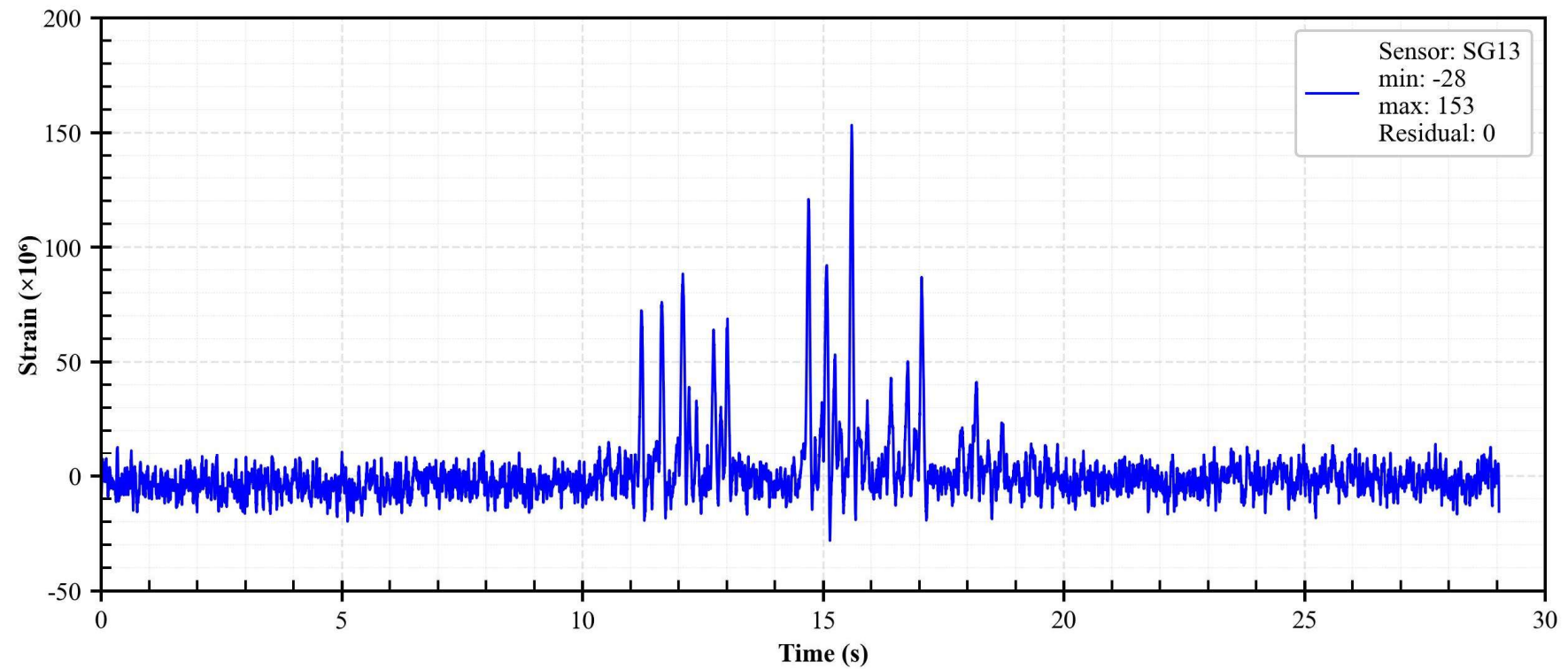


Figure 3.7.26 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 13

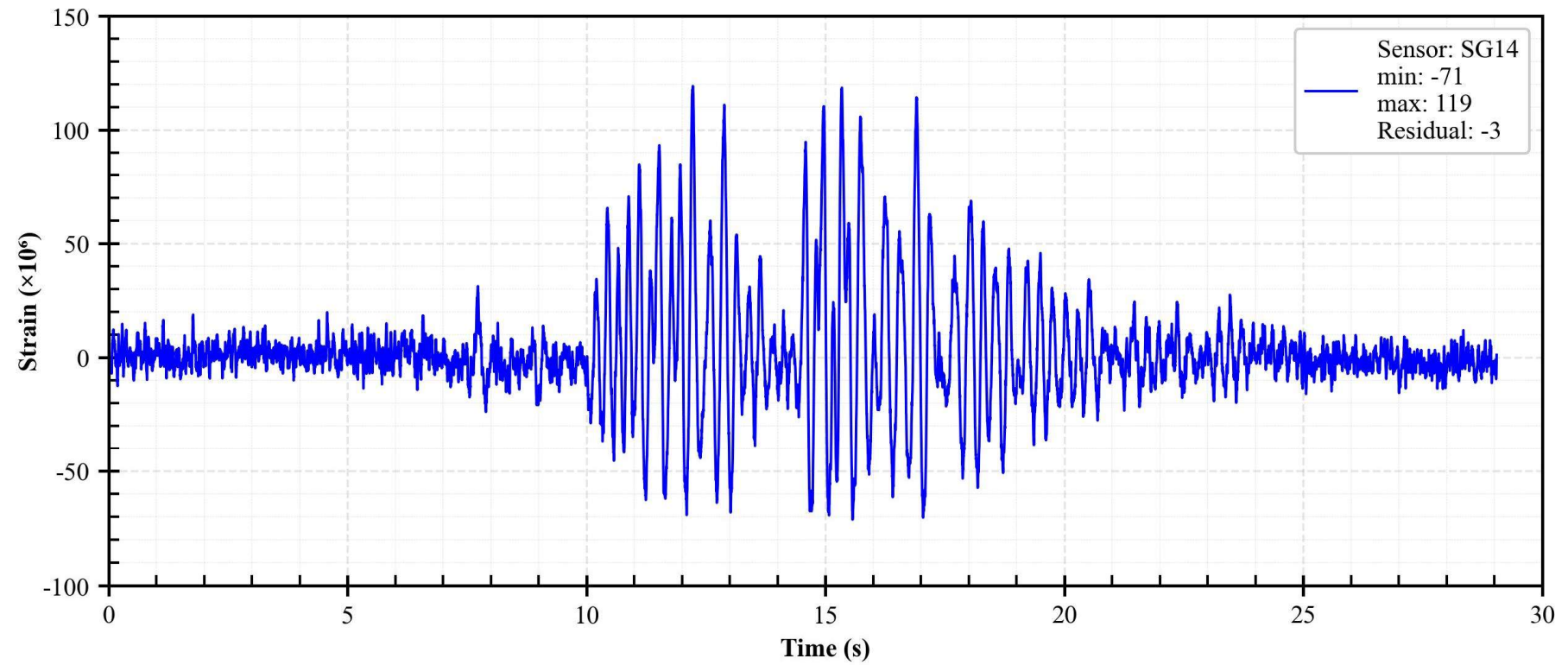


Figure 3.7.27 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 14

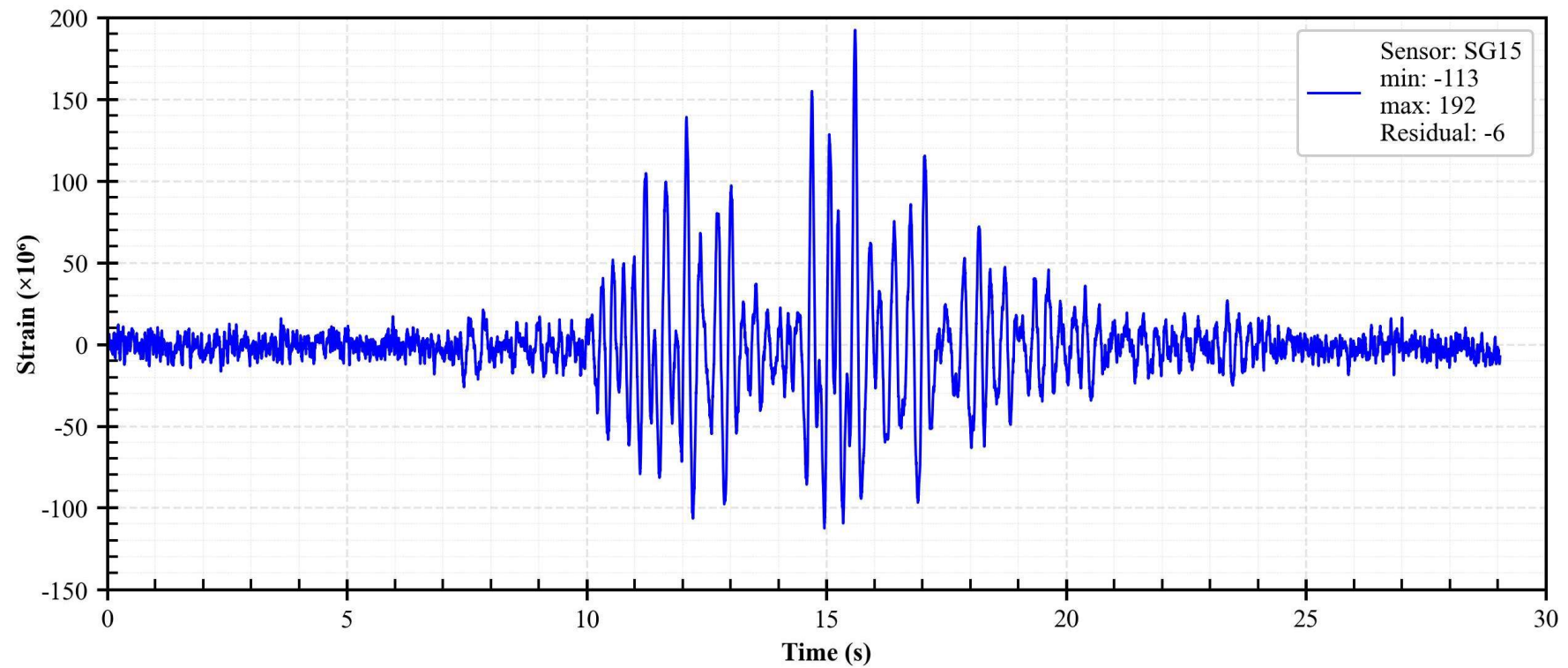


Figure 3.7.28 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 15

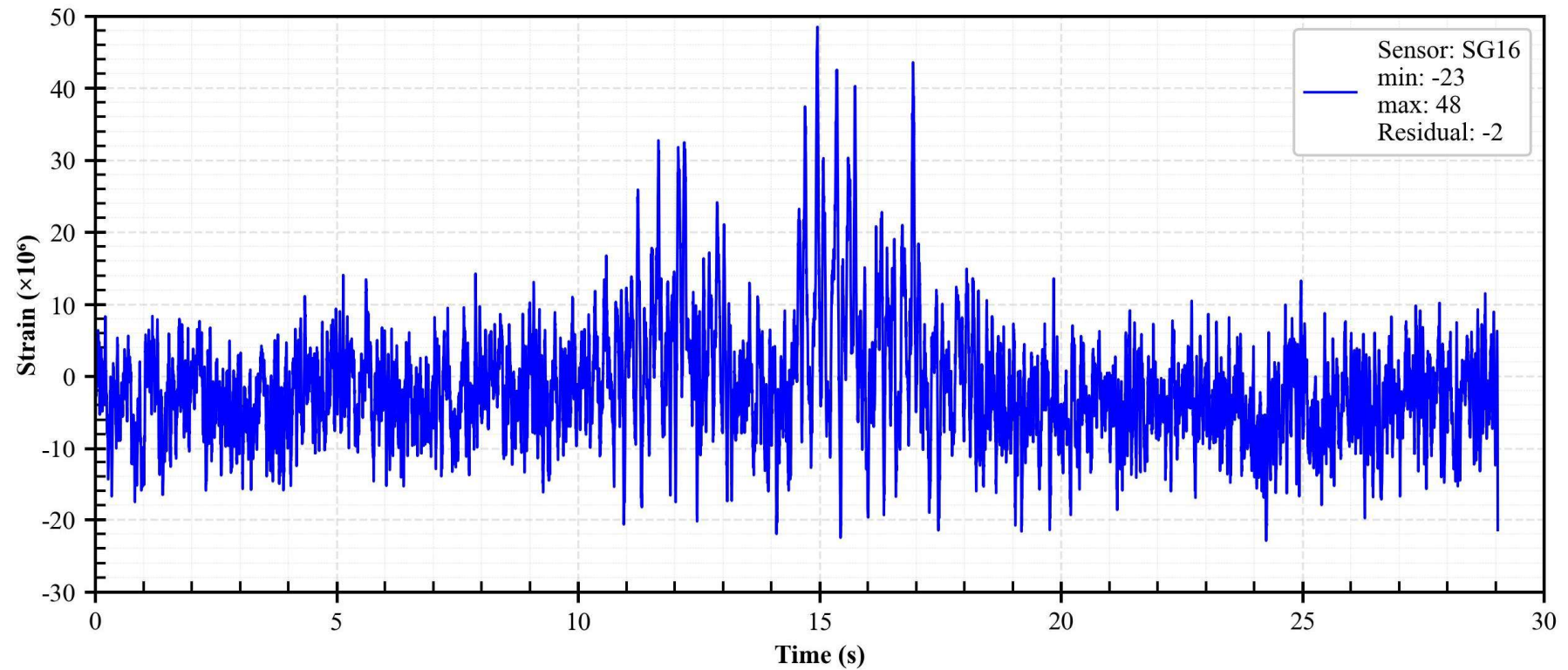


Figure 3.7.29 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 16

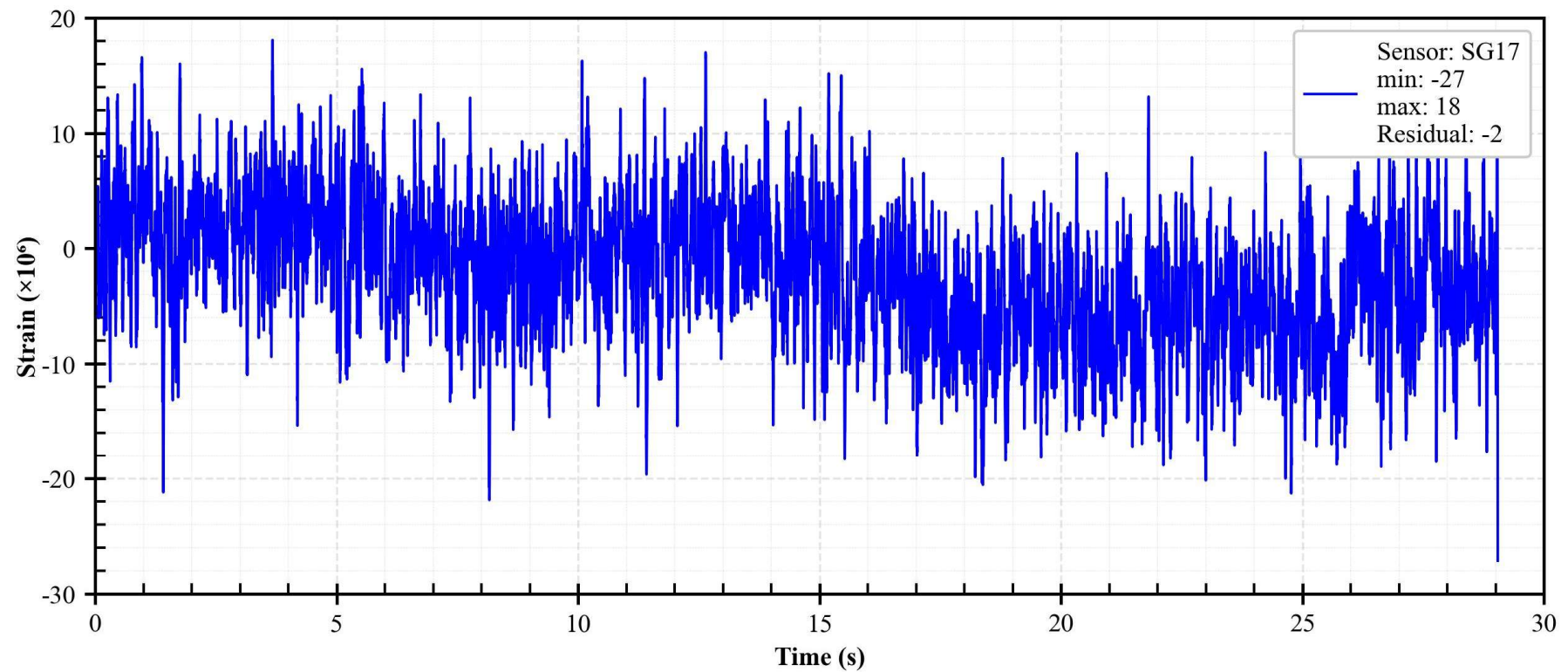


Figure 3.7.30 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 17

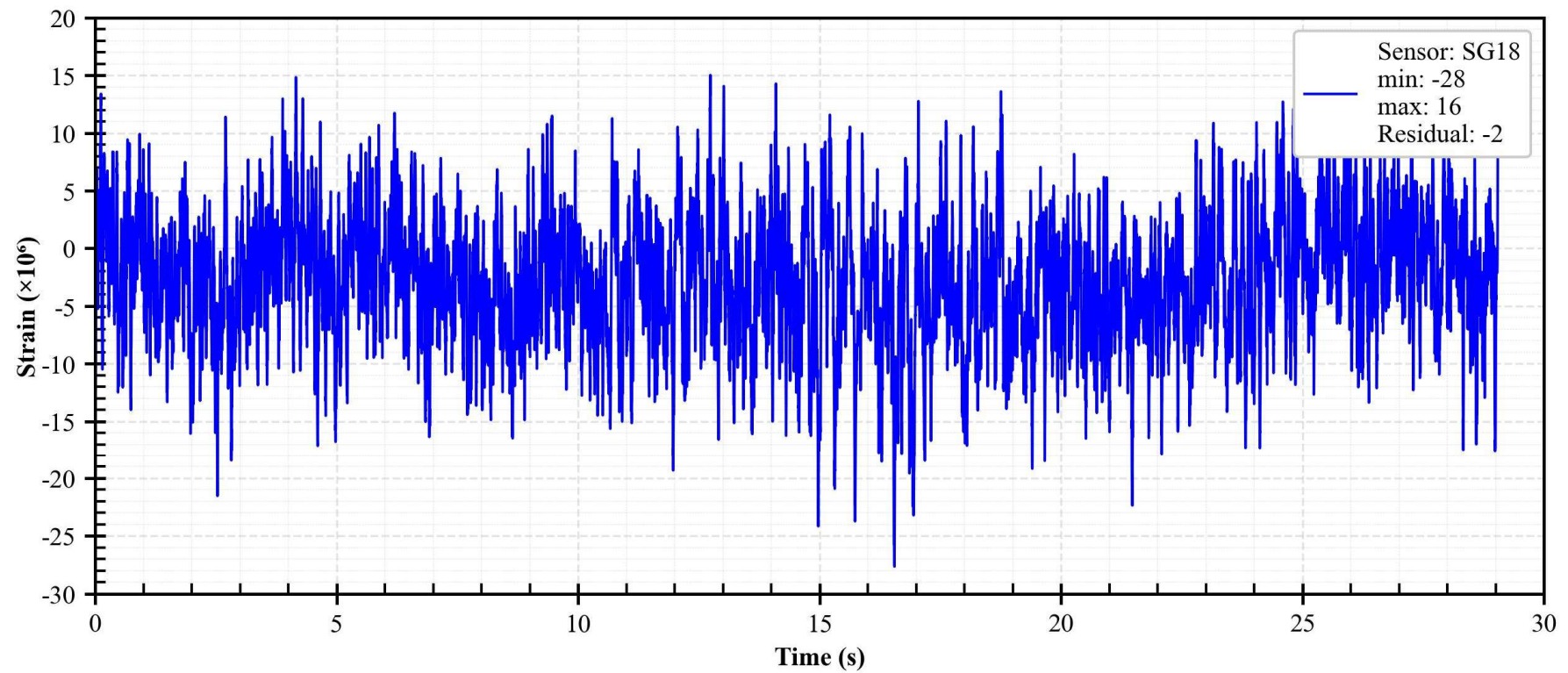


Figure 3.7.31 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 18

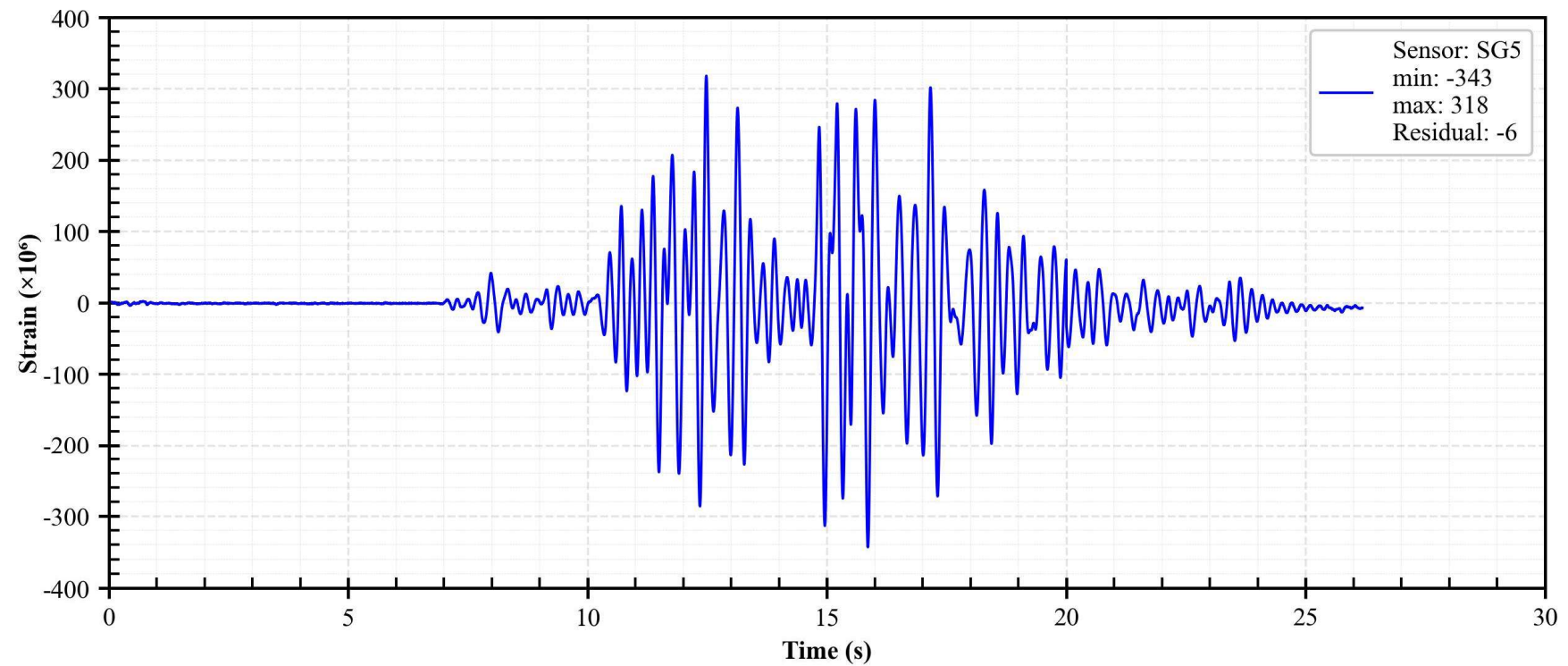


Figure 3.7.32 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 5

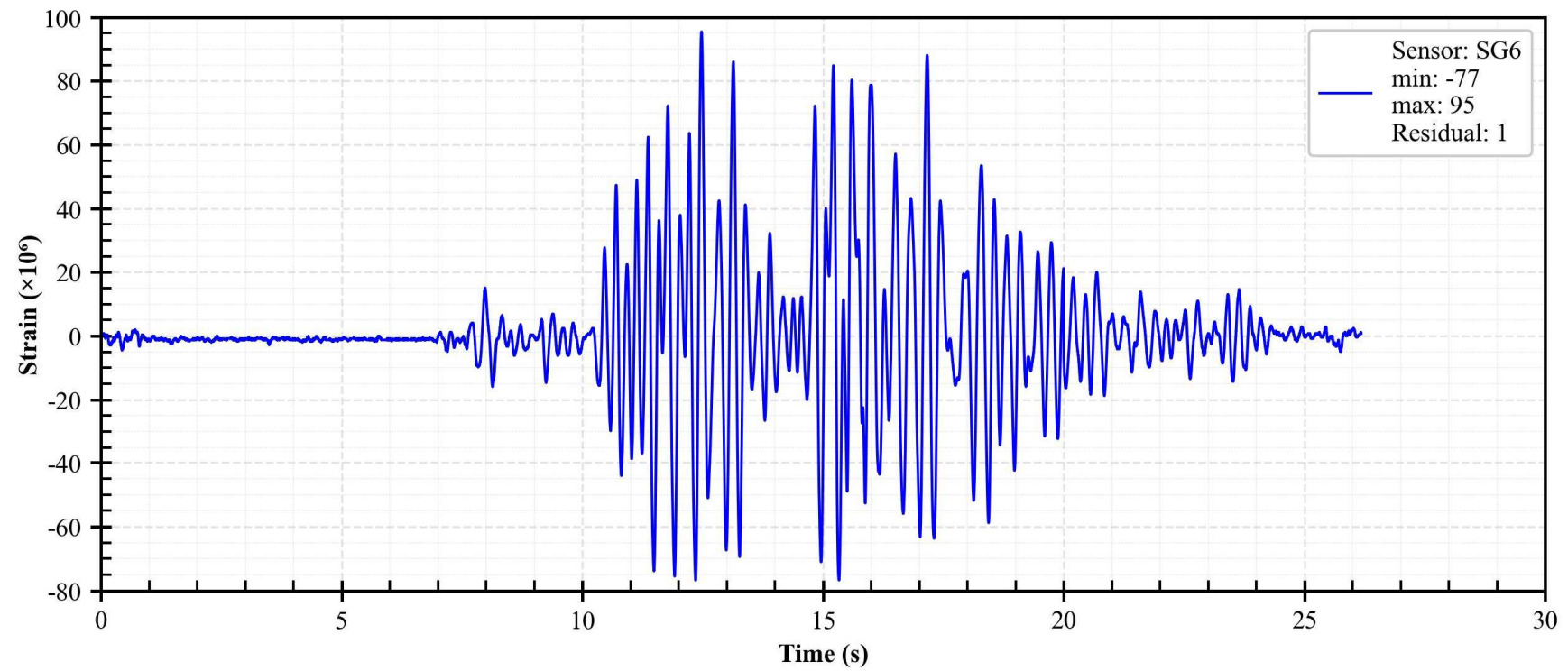


Figure 3.7.33 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 6

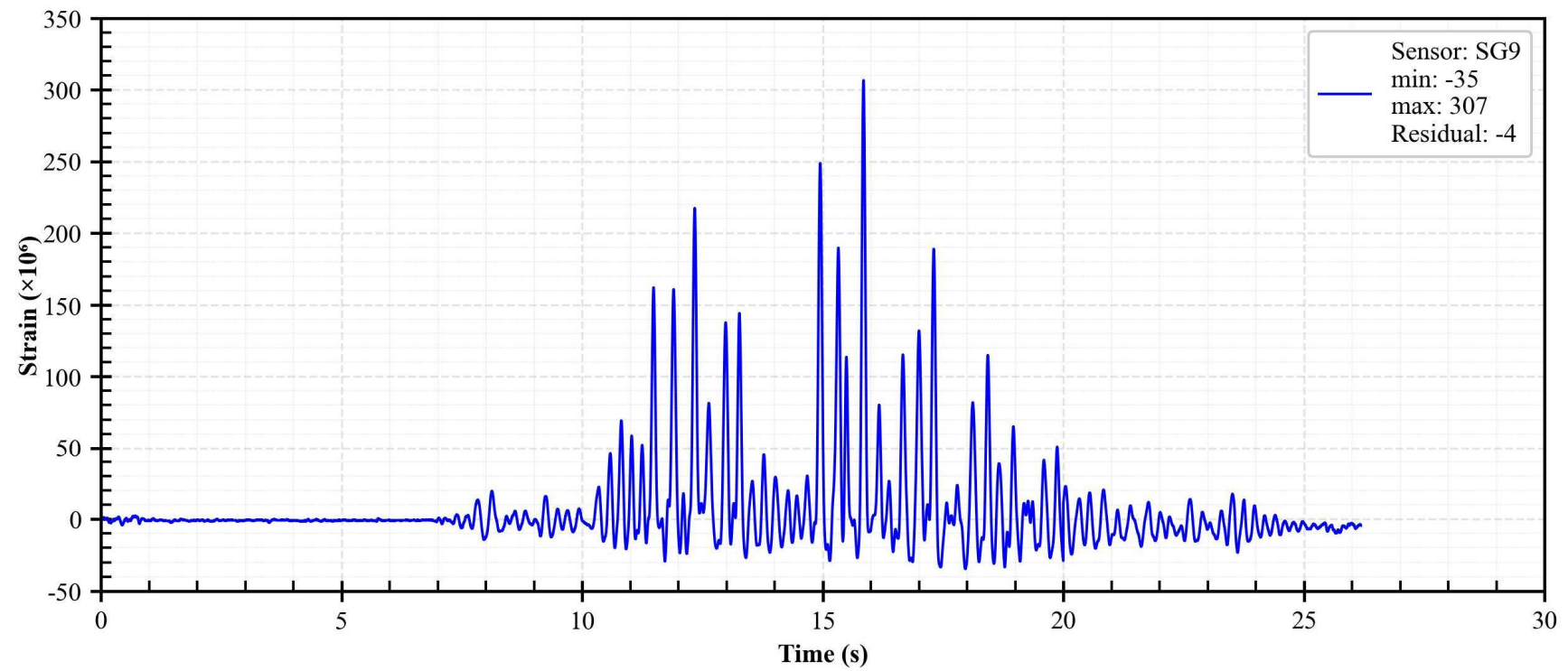


Figure 3.7.34 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 9

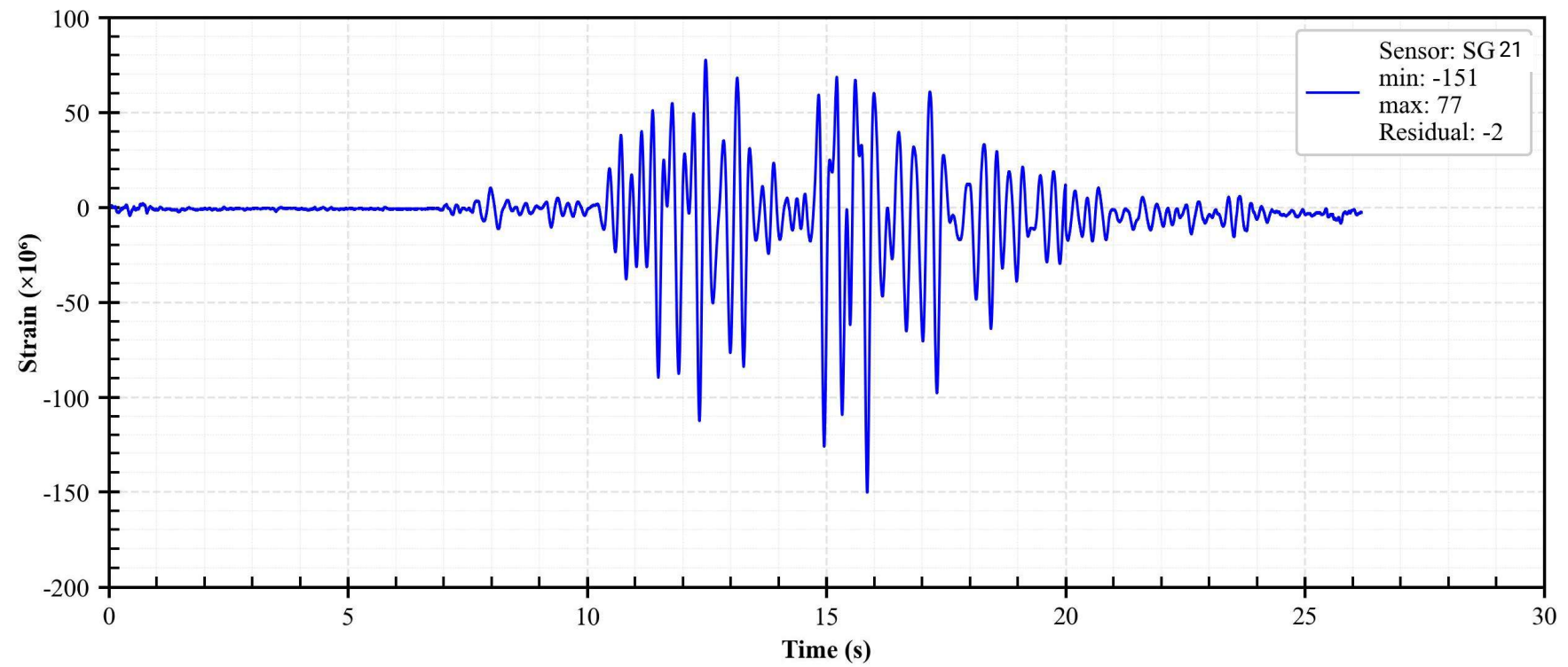


Figure 3.7.35 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 21 (PUFJ, column 1)

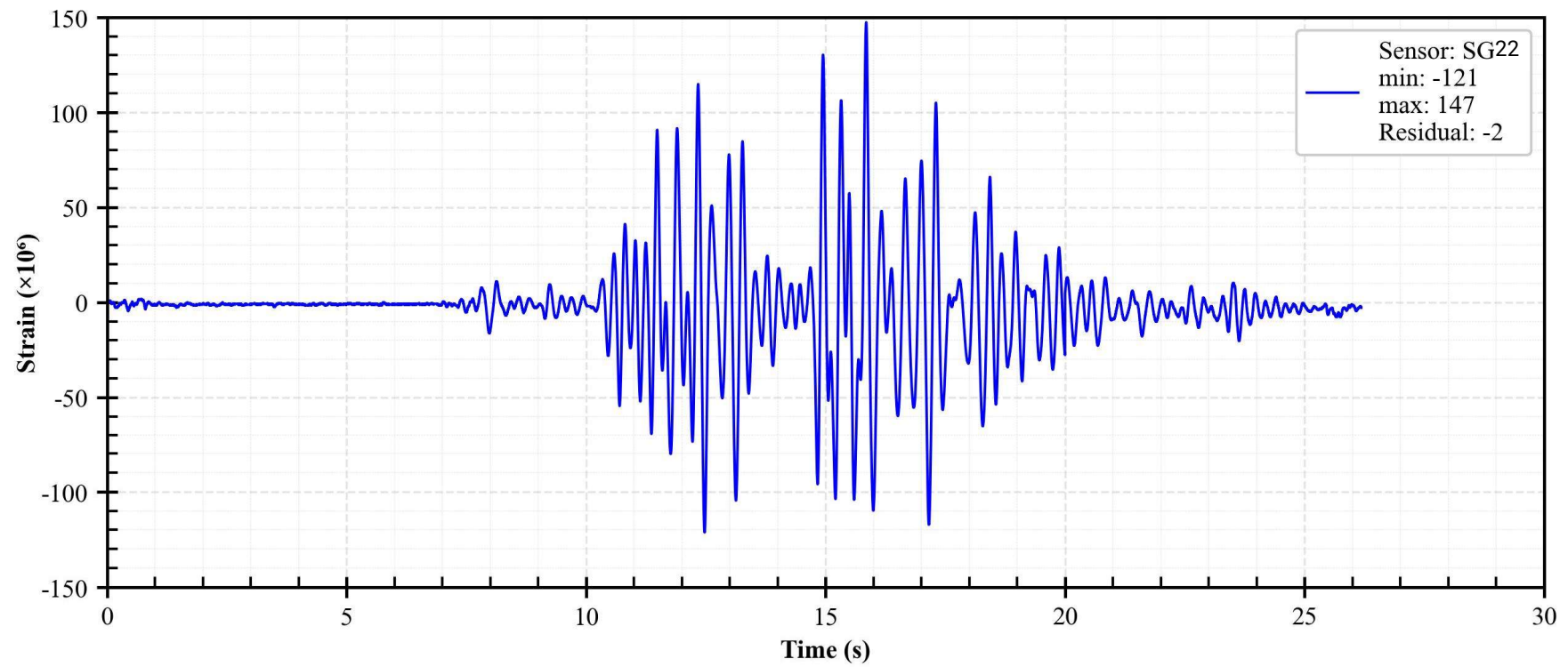


Figure 3.7.36 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 22 (PUFJ, column 2)

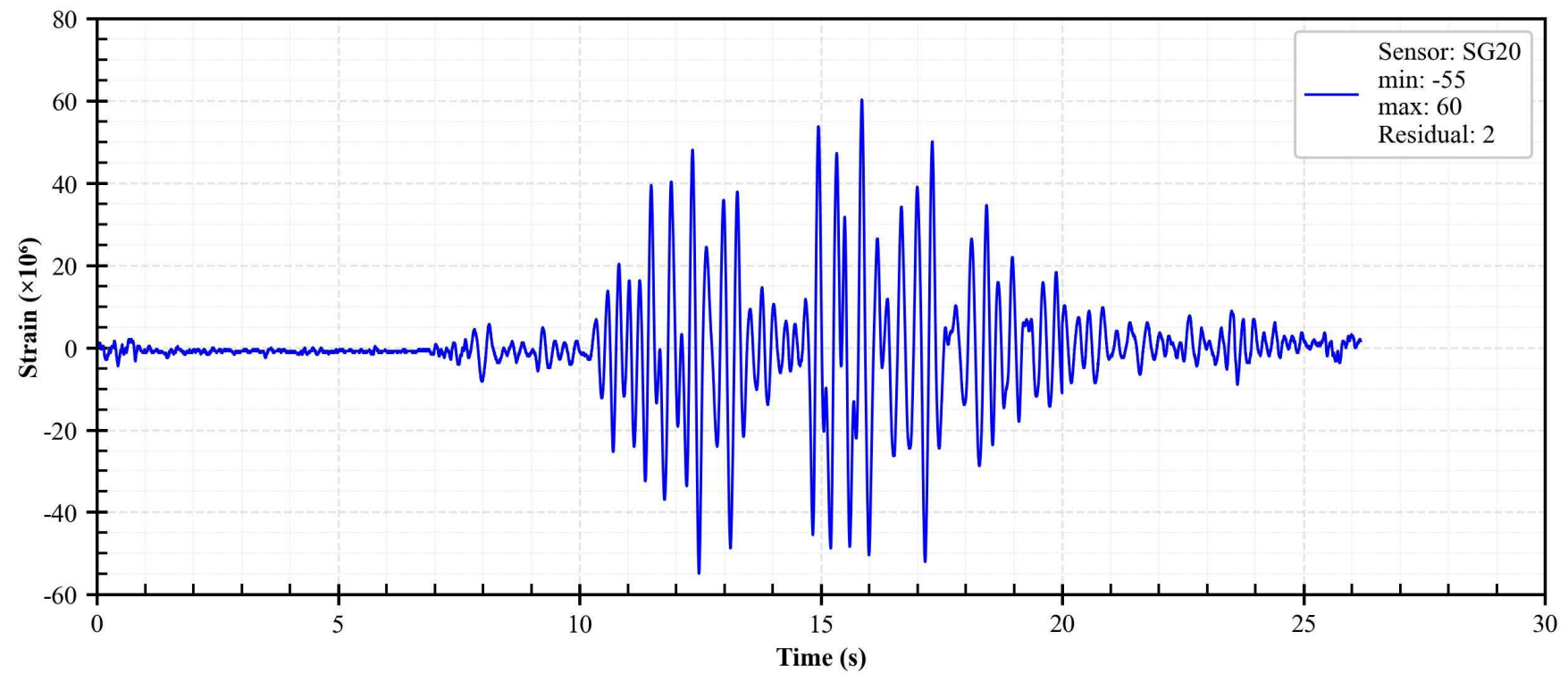


Figure 3.7.37 Characteristic results for phase B (earthquake EQ0,2g): strain gauge 20

3.8 White noise before EQ0,34g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,34g. The max acceleration at the slab level on the accelerometer acc4 is 0.19g. The max acceleration at the foundation level on the accelerometer acc10 is 0,08g.

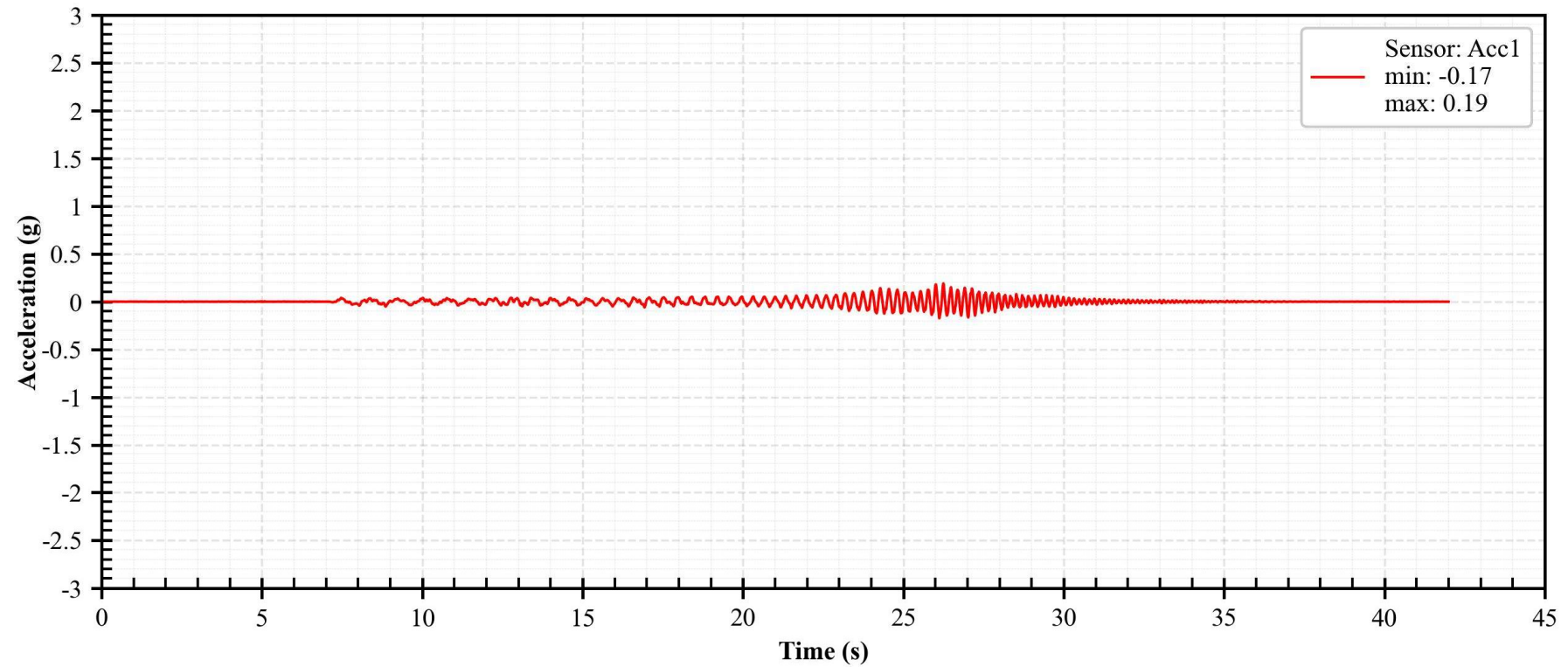


Figure 3.8.1 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 1

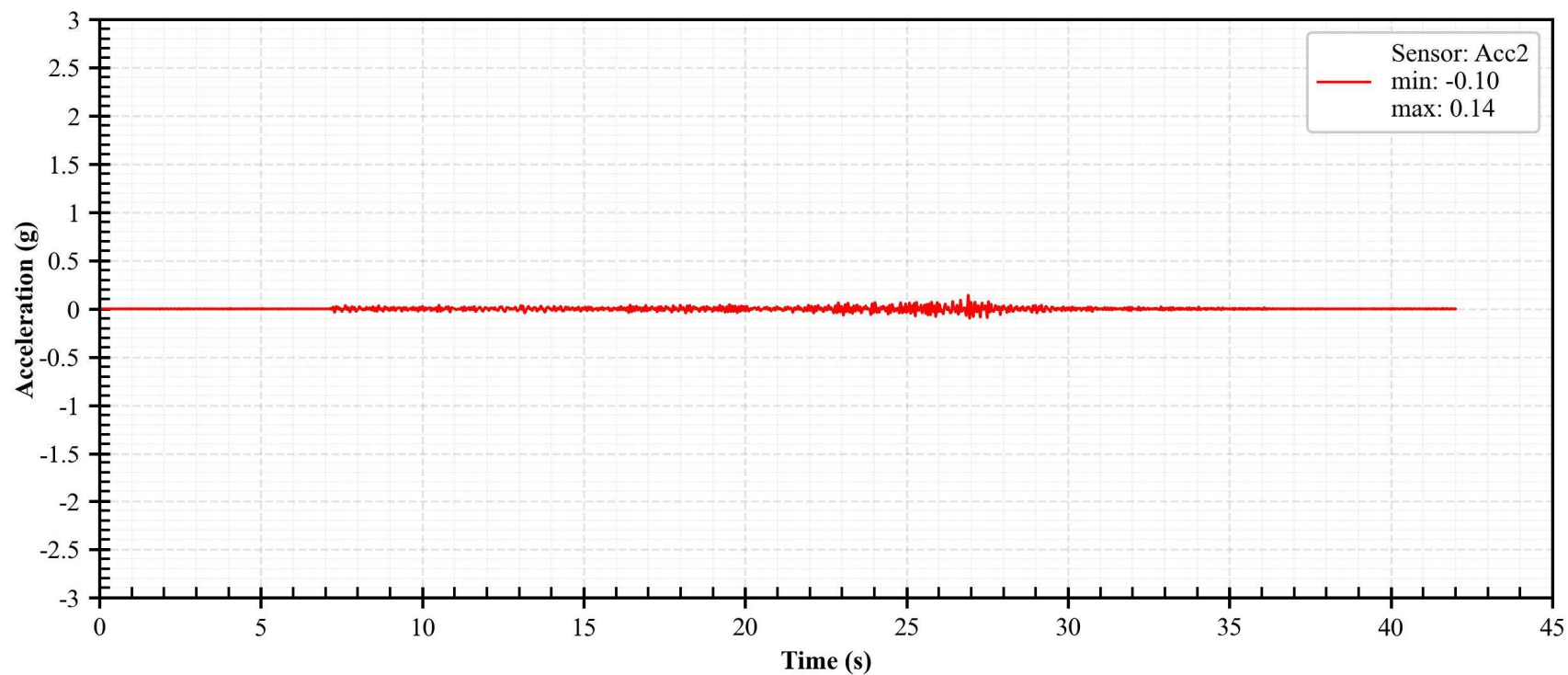


Figure 3.8.2 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 2

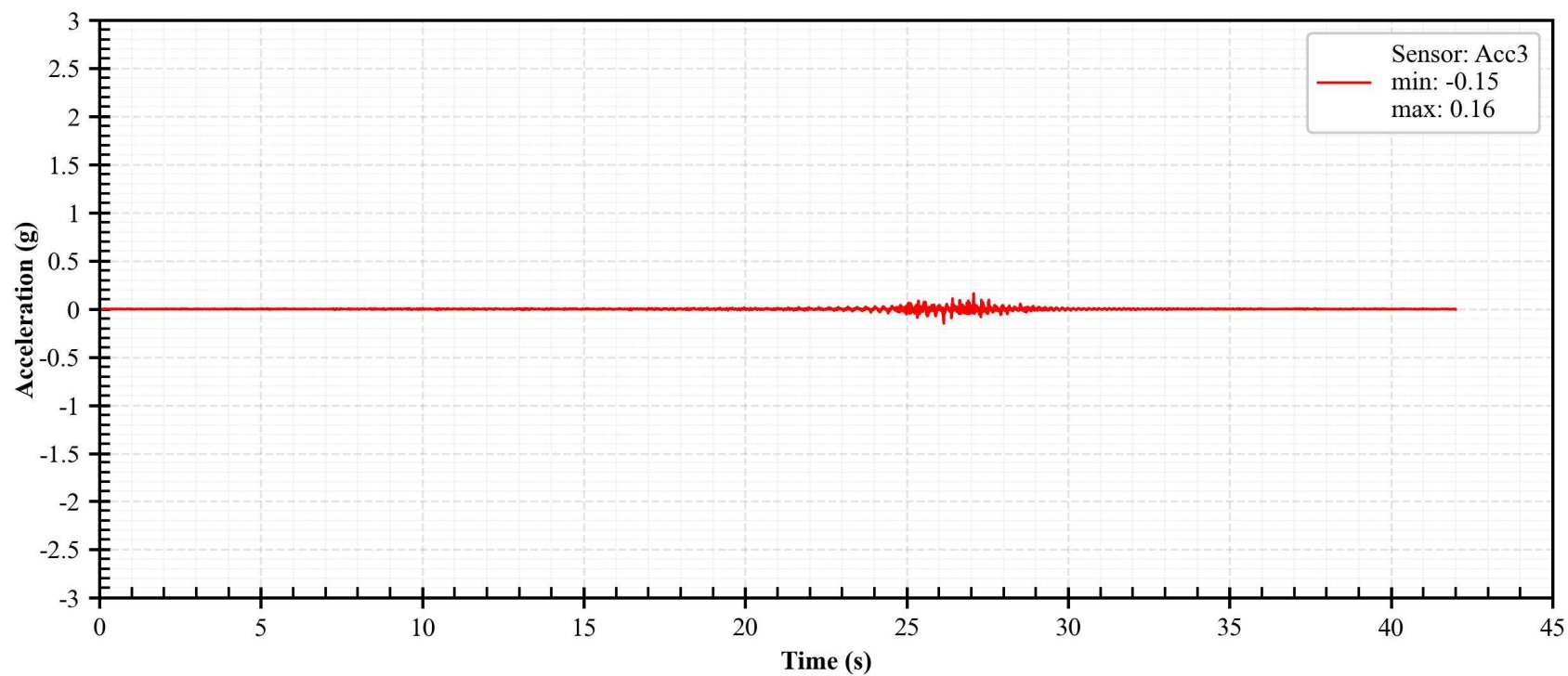


Figure 3.8.3 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 3

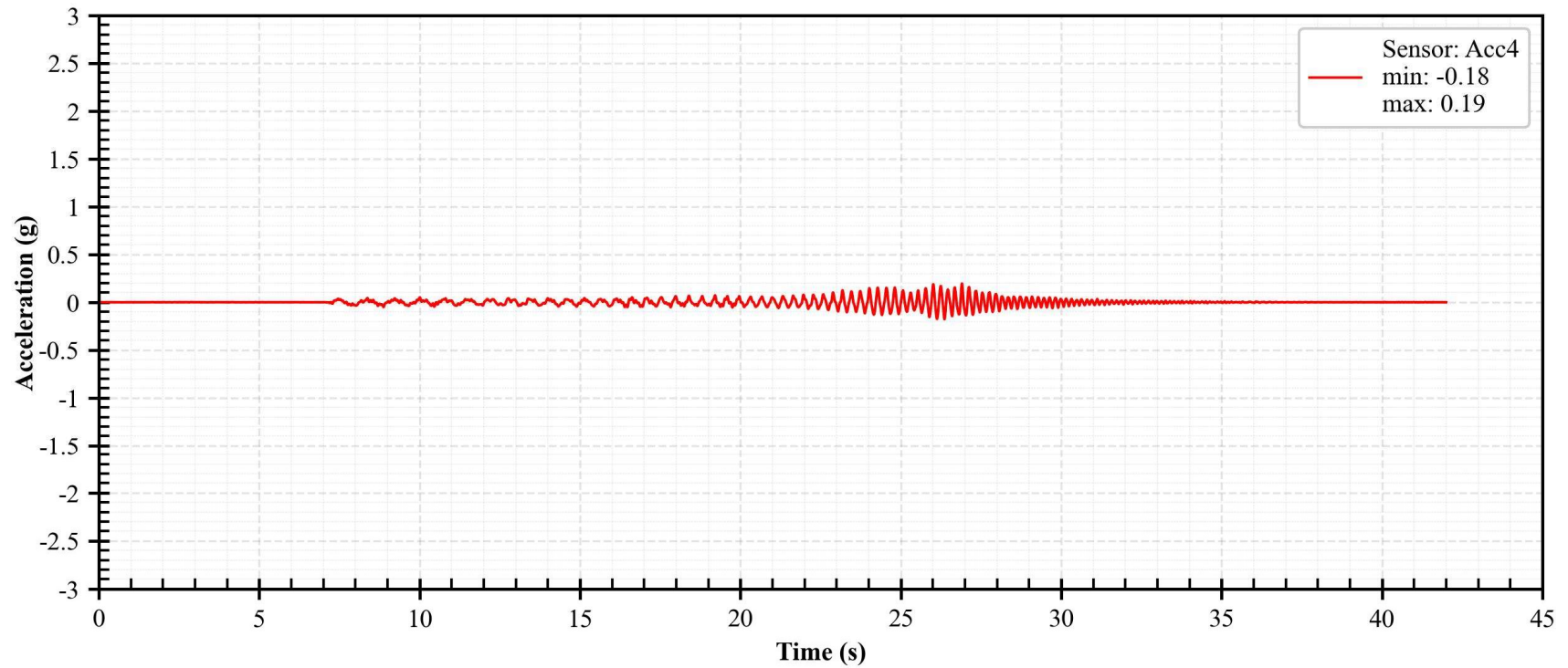


Figure 3.8.4 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 4

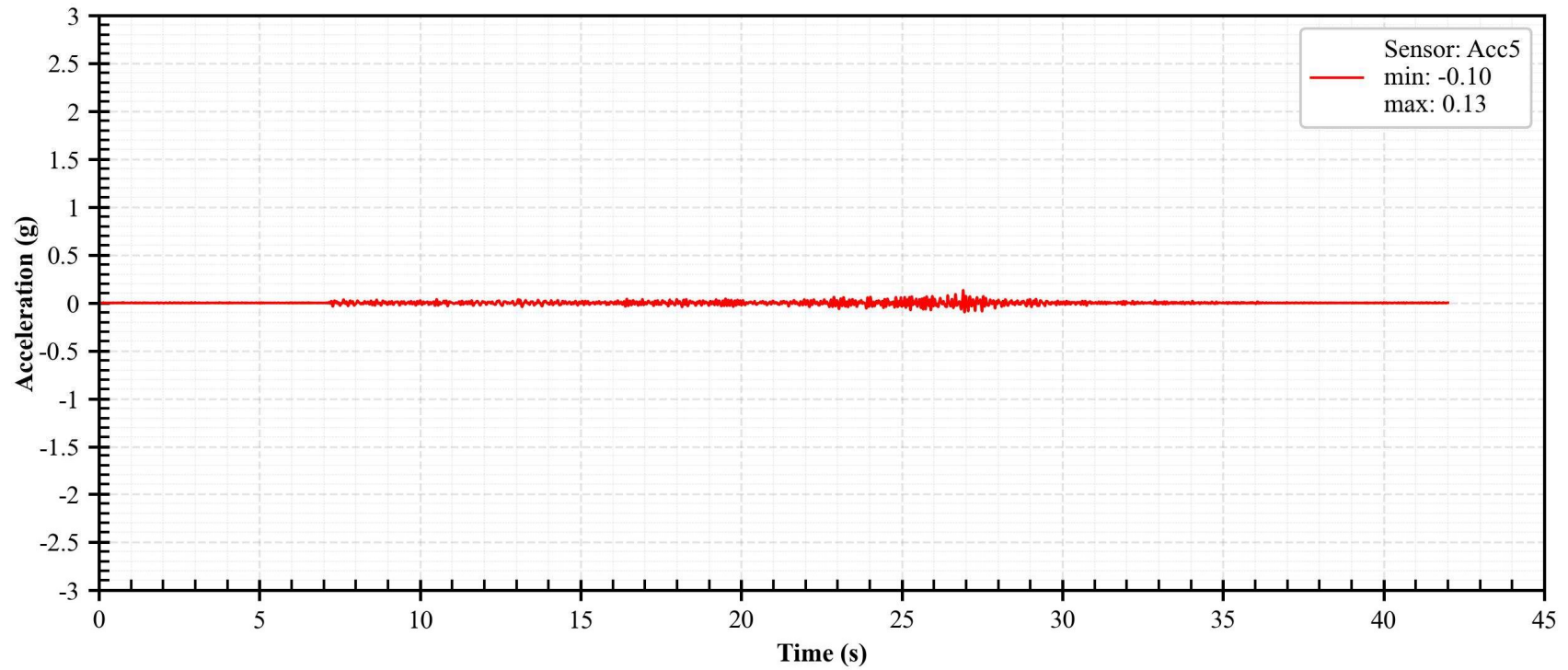


Figure 3.8.5 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 5

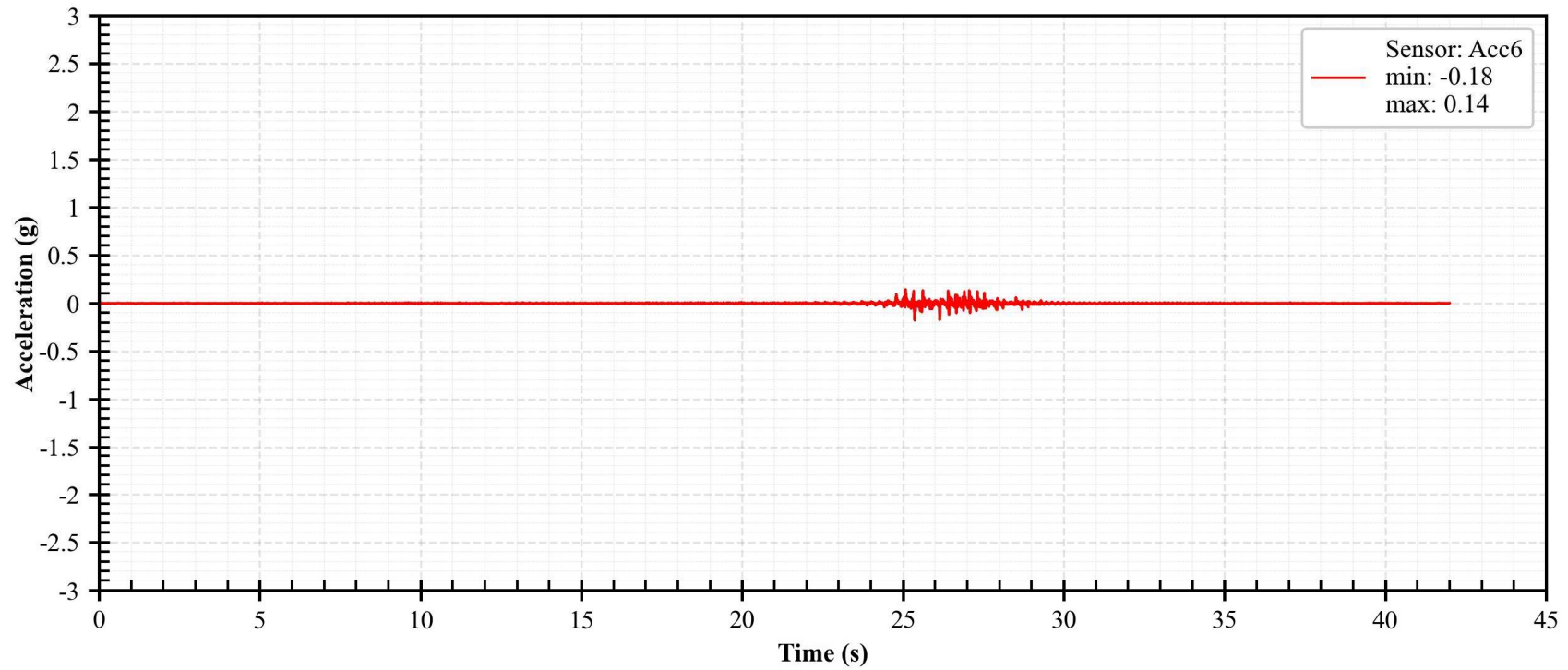


Figure 3.8.6 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 6

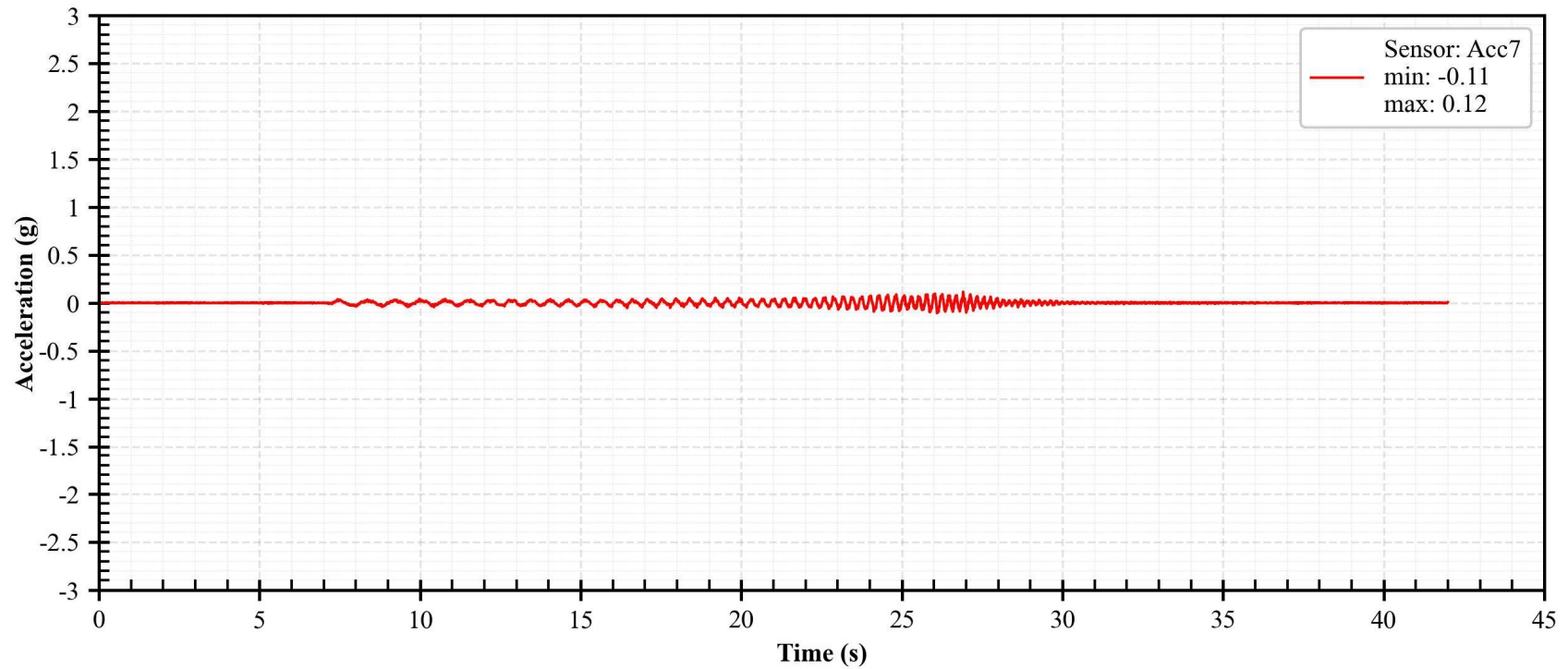


Figure 3.8.7 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 7

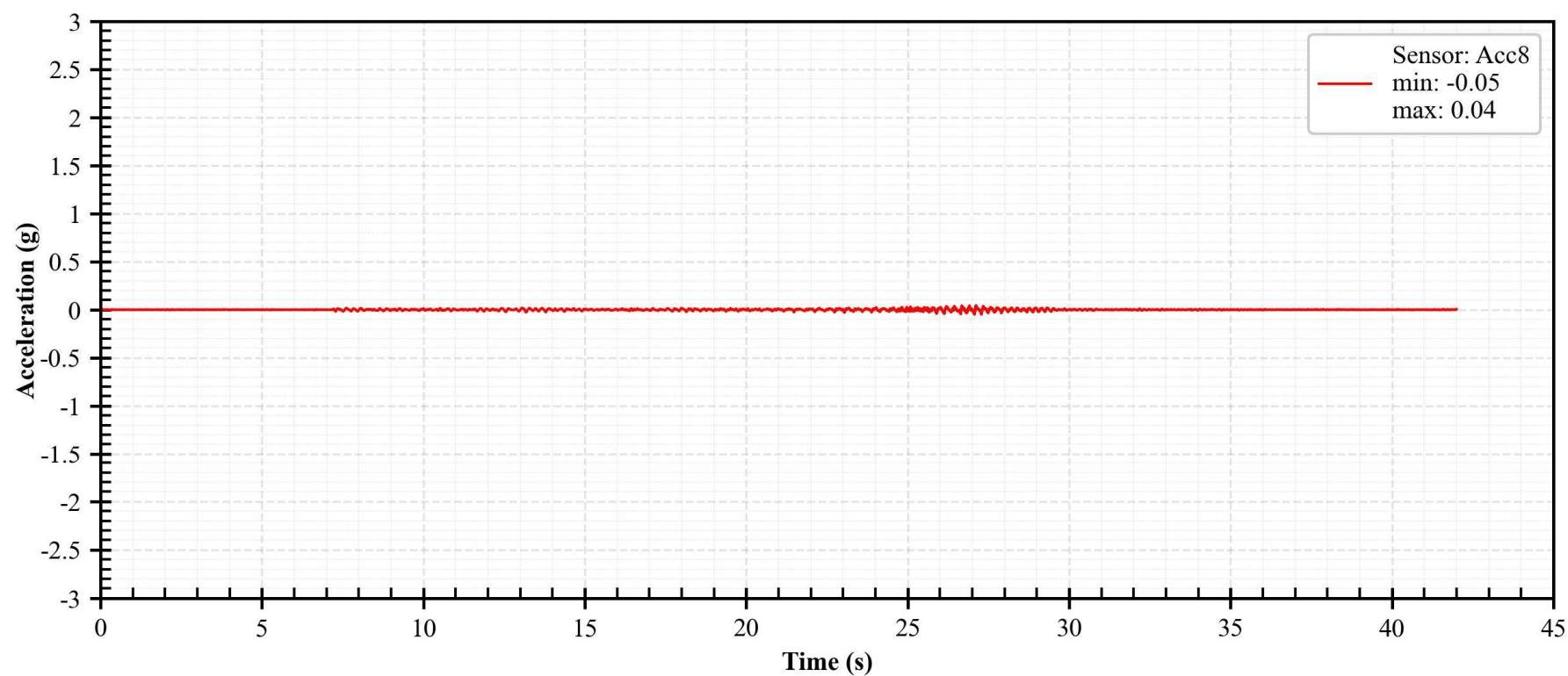


Figure 3.8.8 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 8

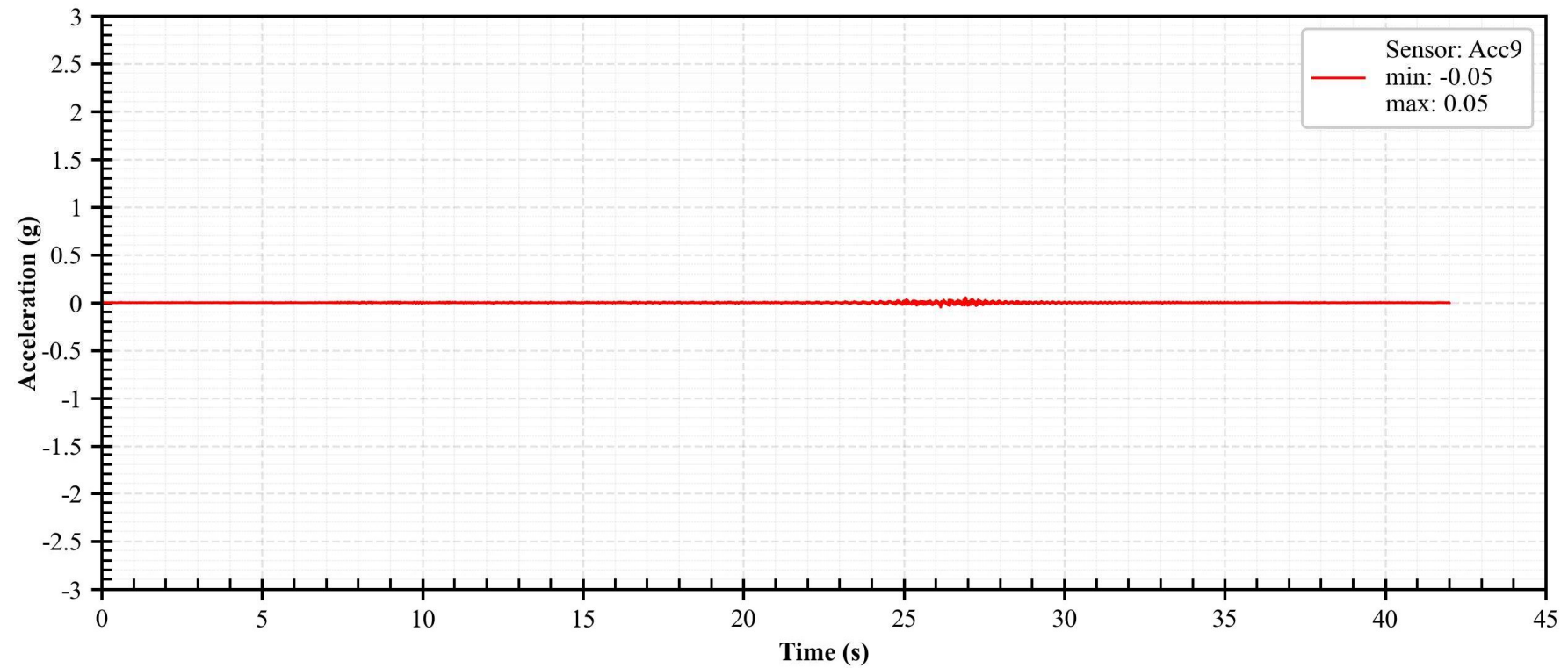


Figure 3.8.9 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 9

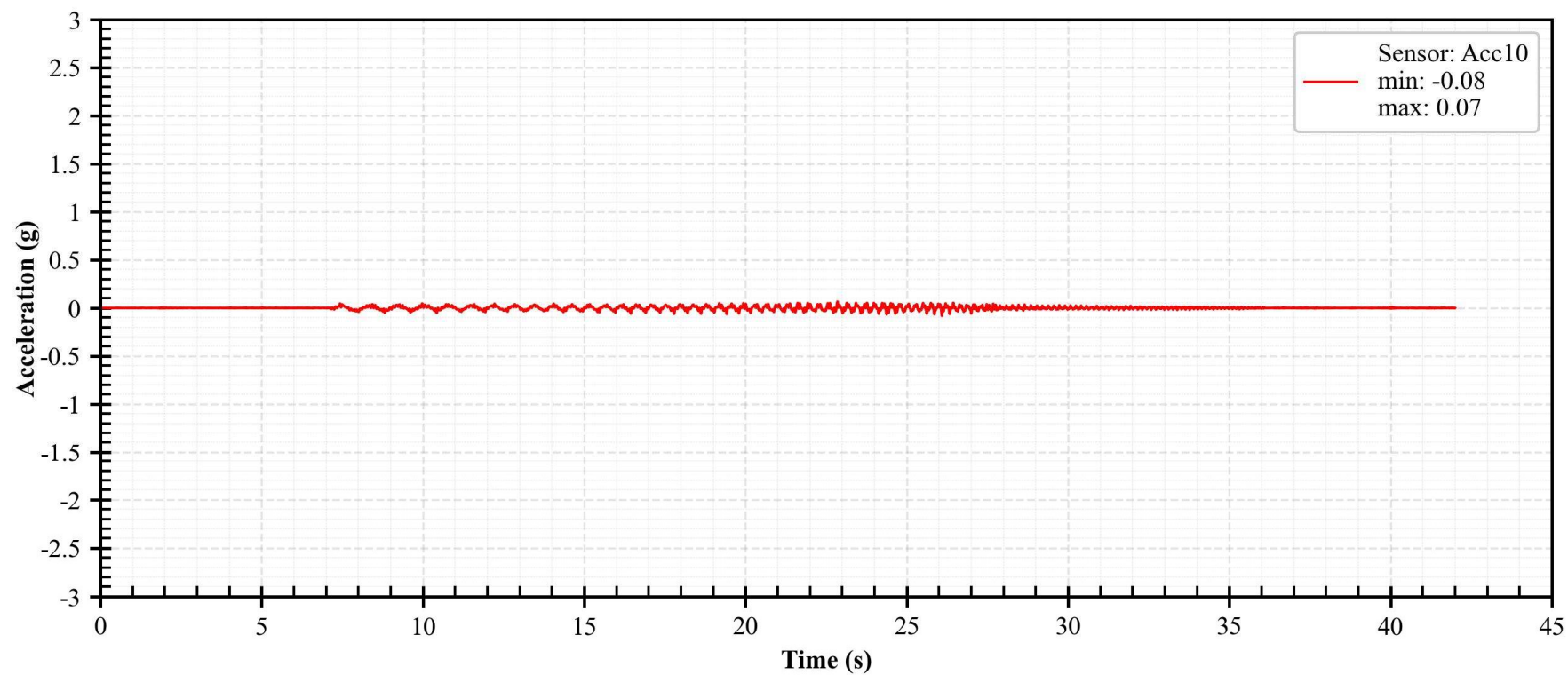


Figure 3.8.10 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 10

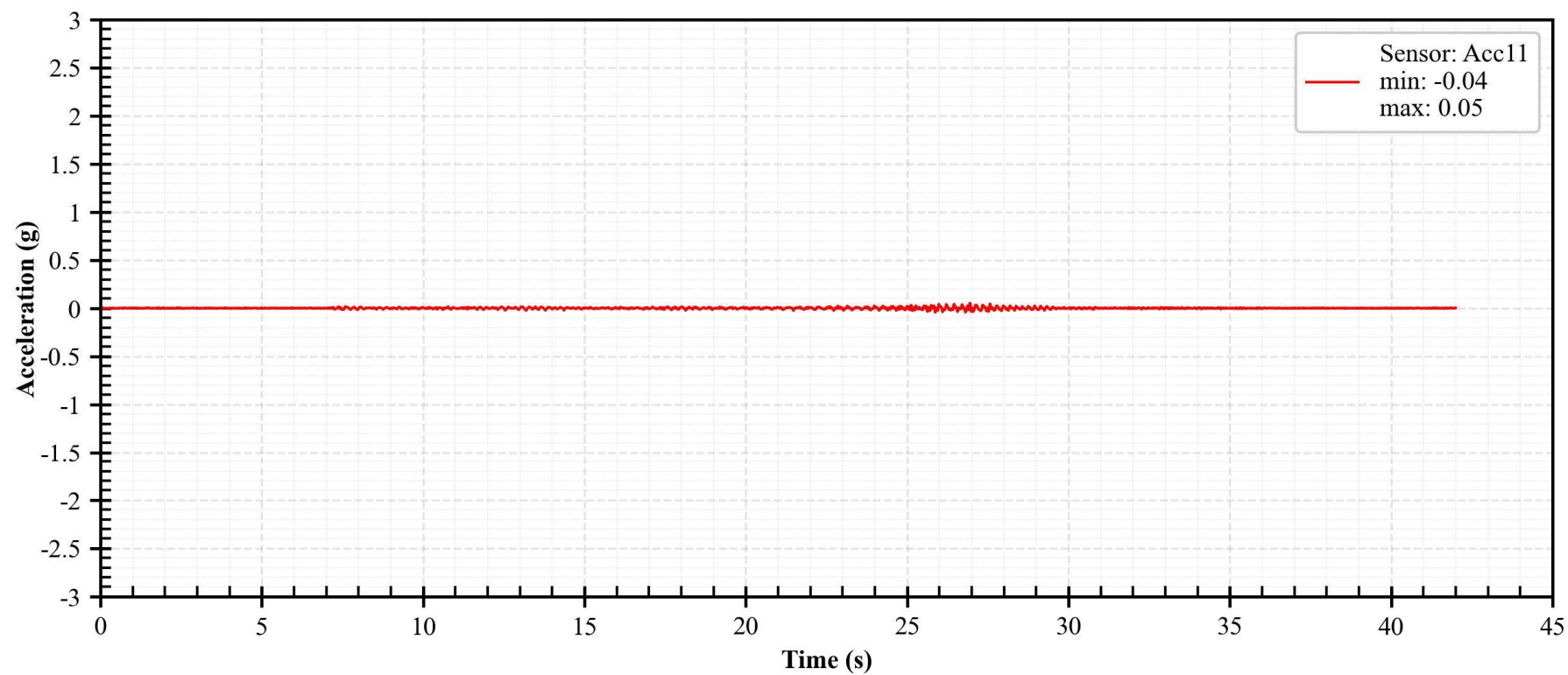


Figure 3.8.11 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 11

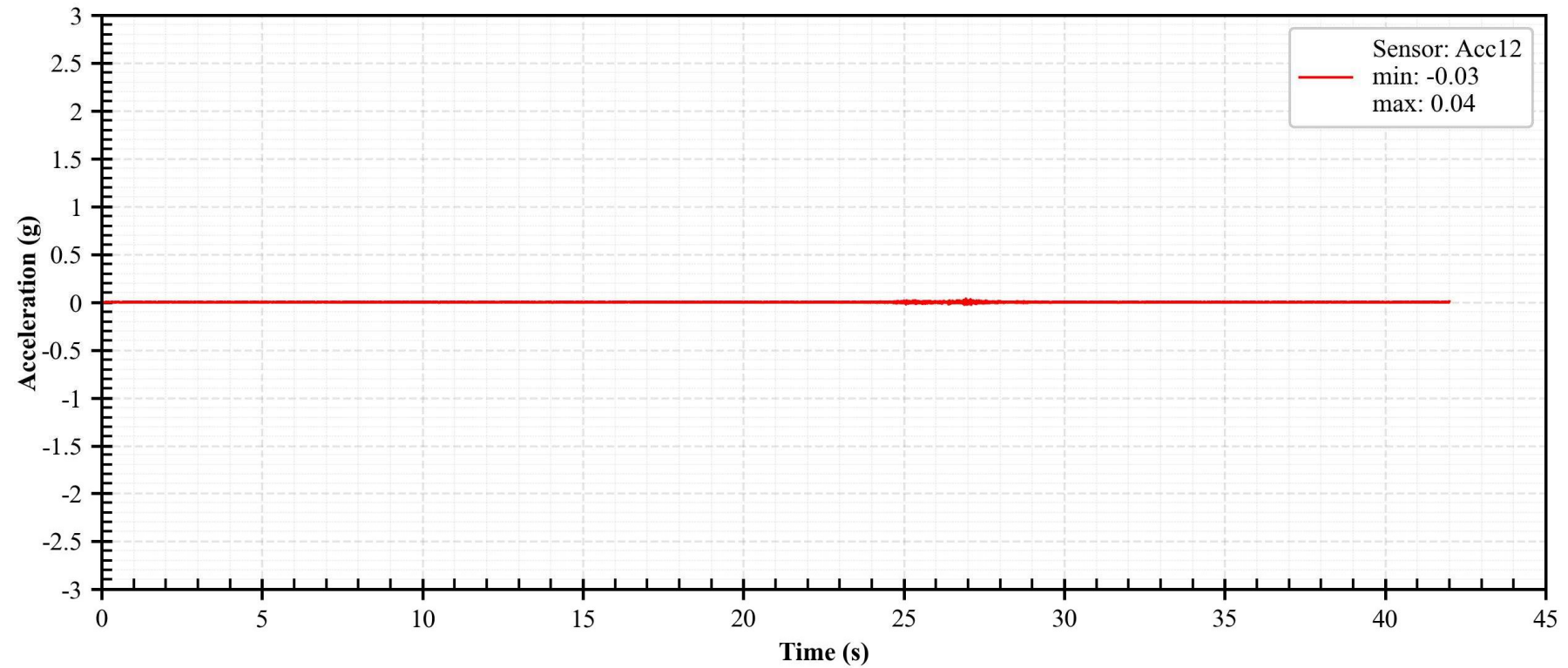


Figure 3.8.12 Characteristic results for phase B (white noise before EQ0,34g): Accelerometer 12

Draw wire sensors

Figures 3.8.13 – 3.8.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 20.95 mm while the minimum is -16.36 mm. The maximum movement detected by draw wire sensor W2 is 21.18 mm while the minimum is -16.45 mm. The maximum movement detected by draw wire sensor W3 is 21.16 mm while the minimum is -16.35 mm. The maximum movement detected by draw wire sensor W4 is 21.21 mm while the minimum is -16.32 mm. The maximum drift is $(1.63 / 1.225) = 1.33 \text{ ‰}$ and minimum drift is $(-1.72 / 1.225) = -1.40 \text{ ‰}$.

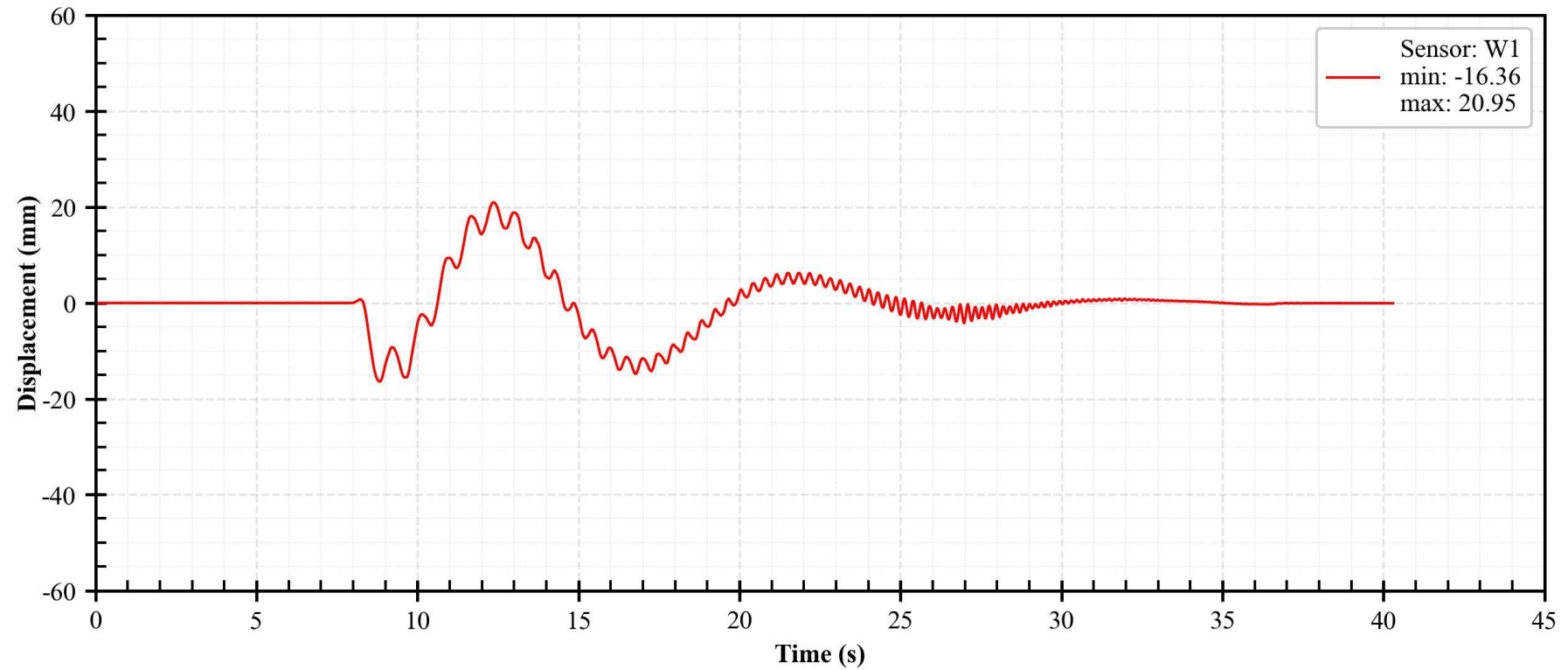


Figure 3.8.13 Characteristic results for phase B (white noise before EQ0,34g): Draw wire sensor 1

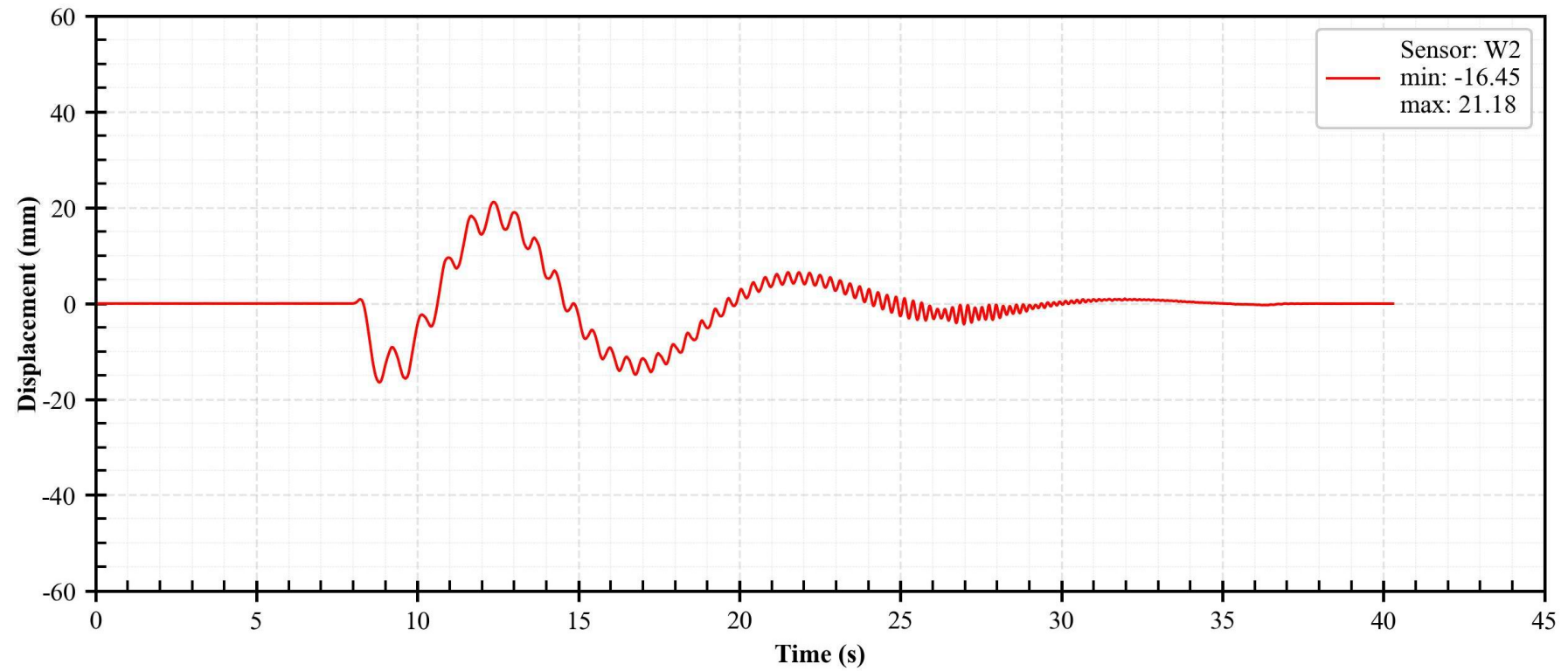


Figure 3.8.14 Characteristic results for phase B (white noise before EQ0,34g): Draw wire sensor 2

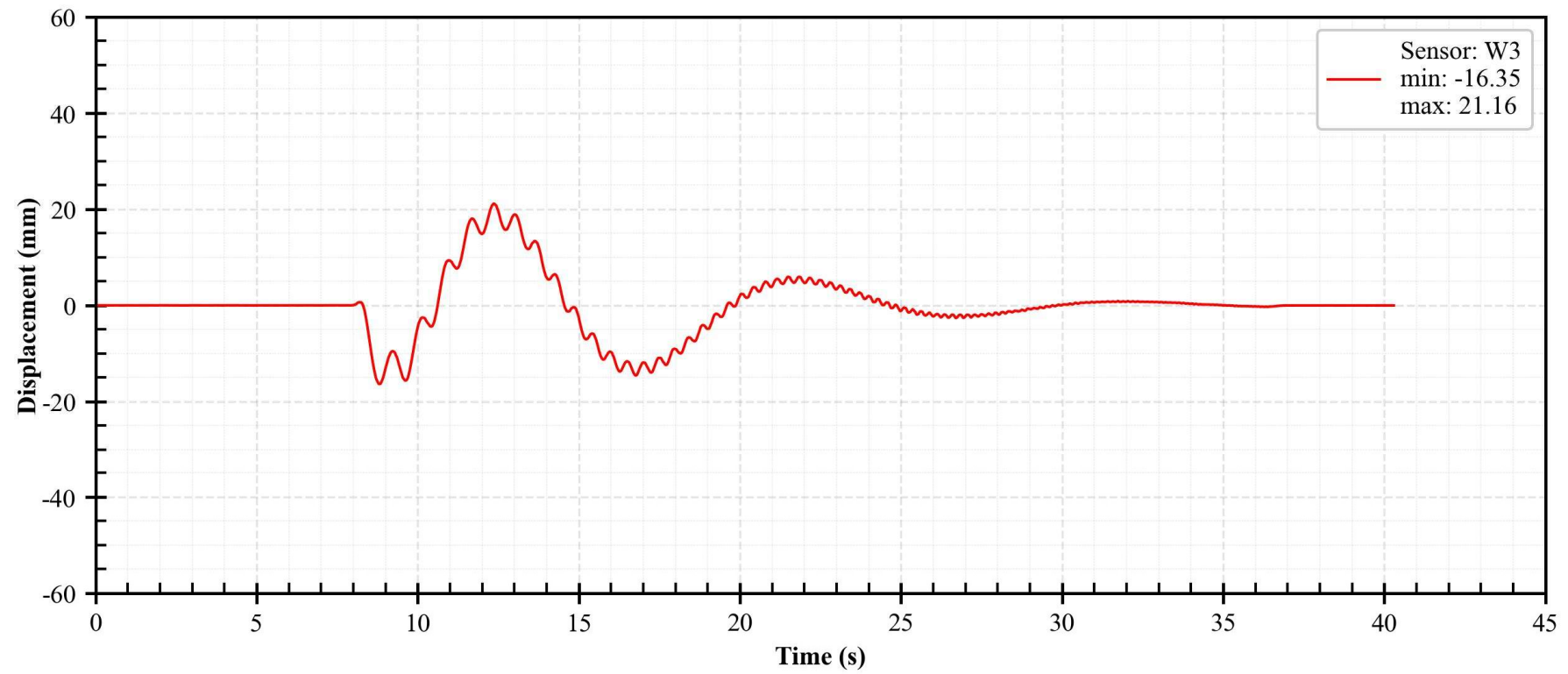


Figure 3.8.15 Characteristic results for phase B (white noise before EQ0,34g): Draw wire sensor 3

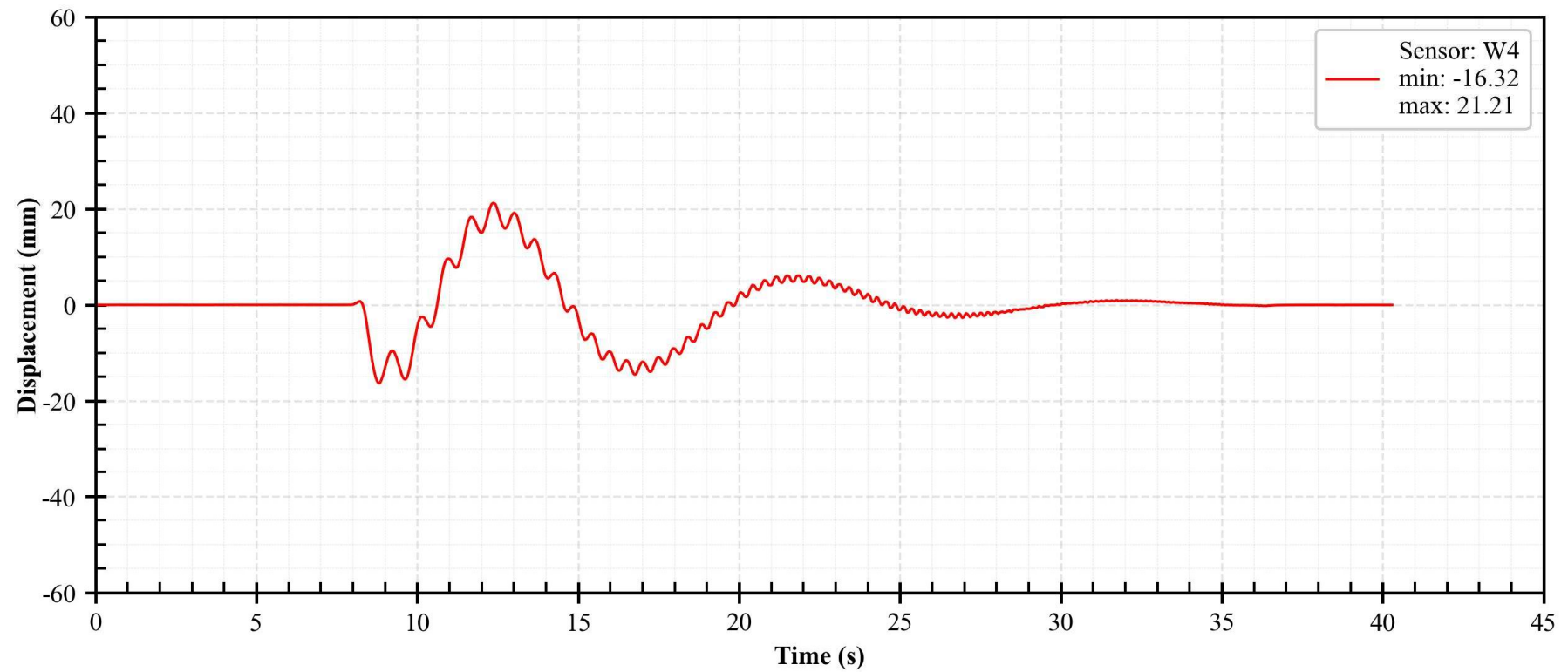


Figure 3.8.16 Characteristic results for phase B (white noise before EQ0,34g): Draw wire sensor 4

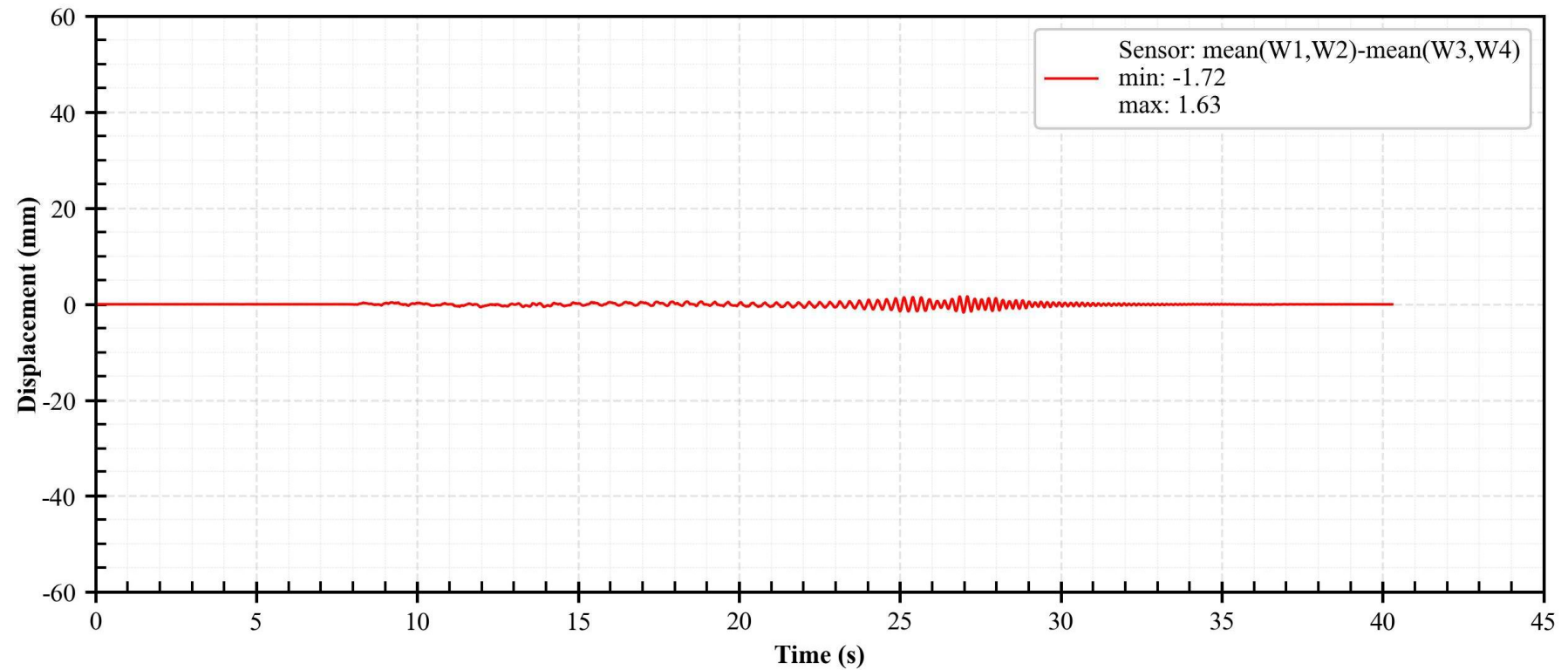


Figure 3.8.17 Characteristic results for phase B (white noise before EQ0,34g): mean (W1,W2) – mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

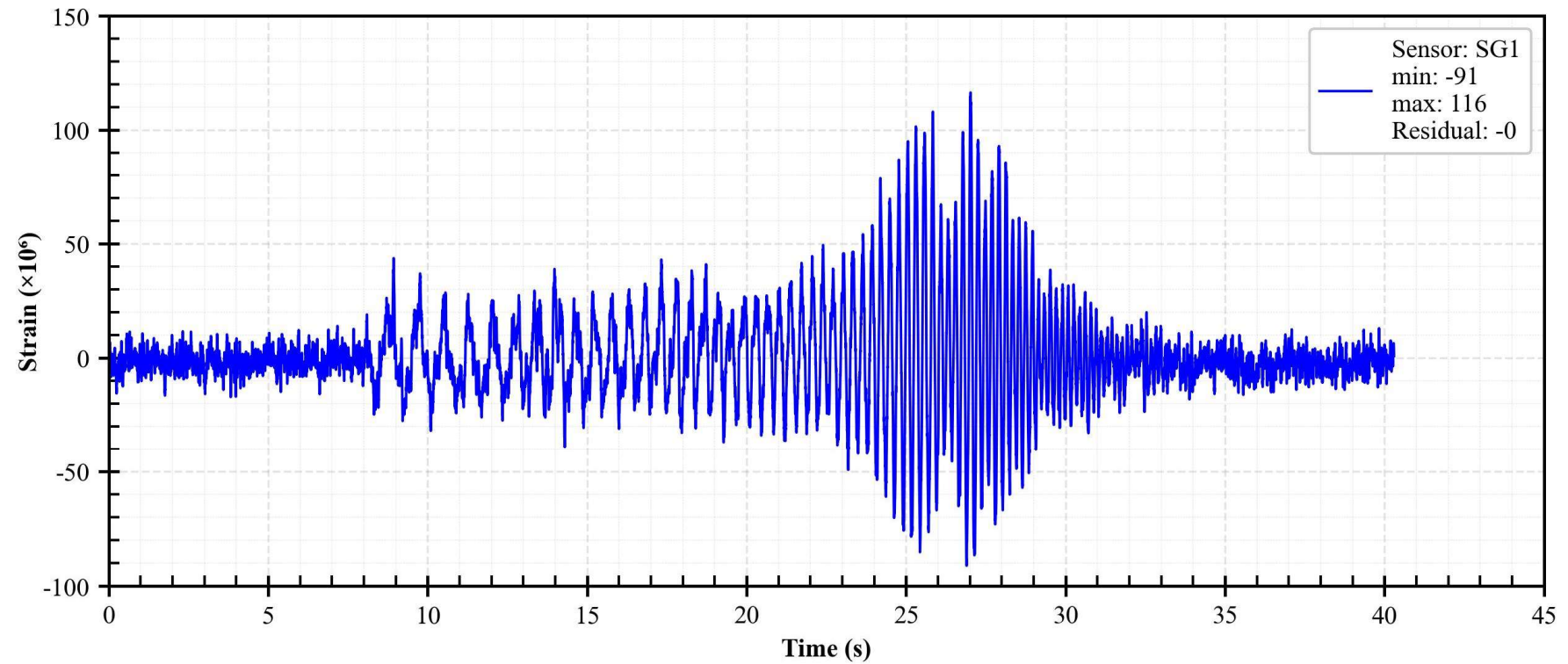


Figure3.8.18 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 1

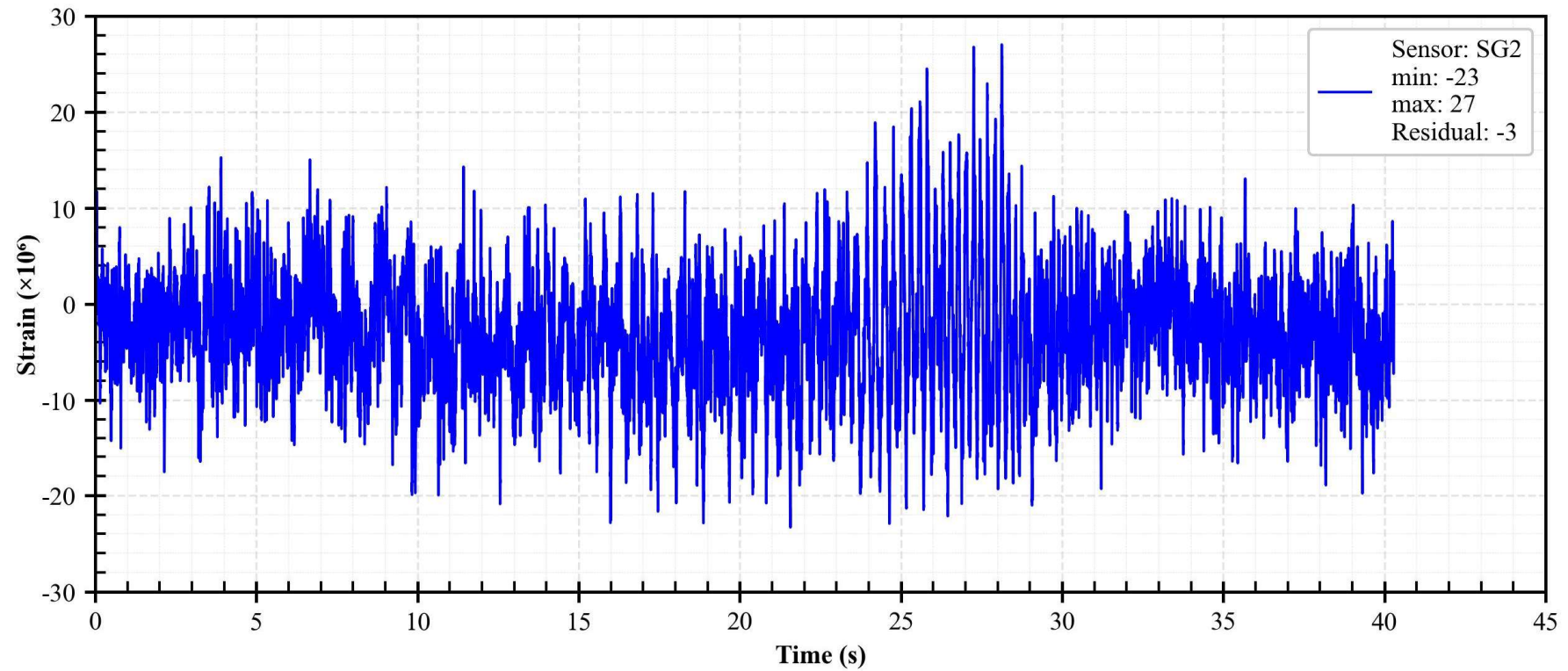


Figure 3.8.19 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 2

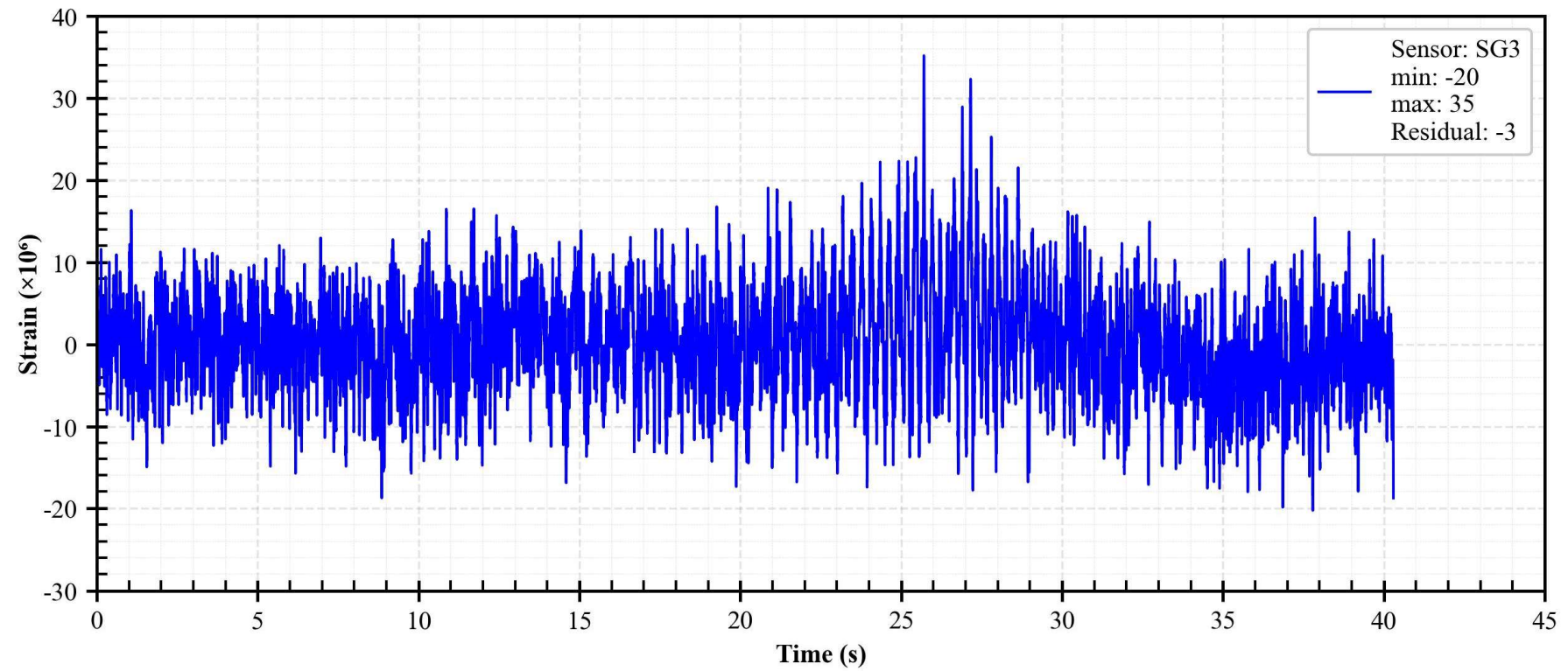


Figure 3.8.20 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 3

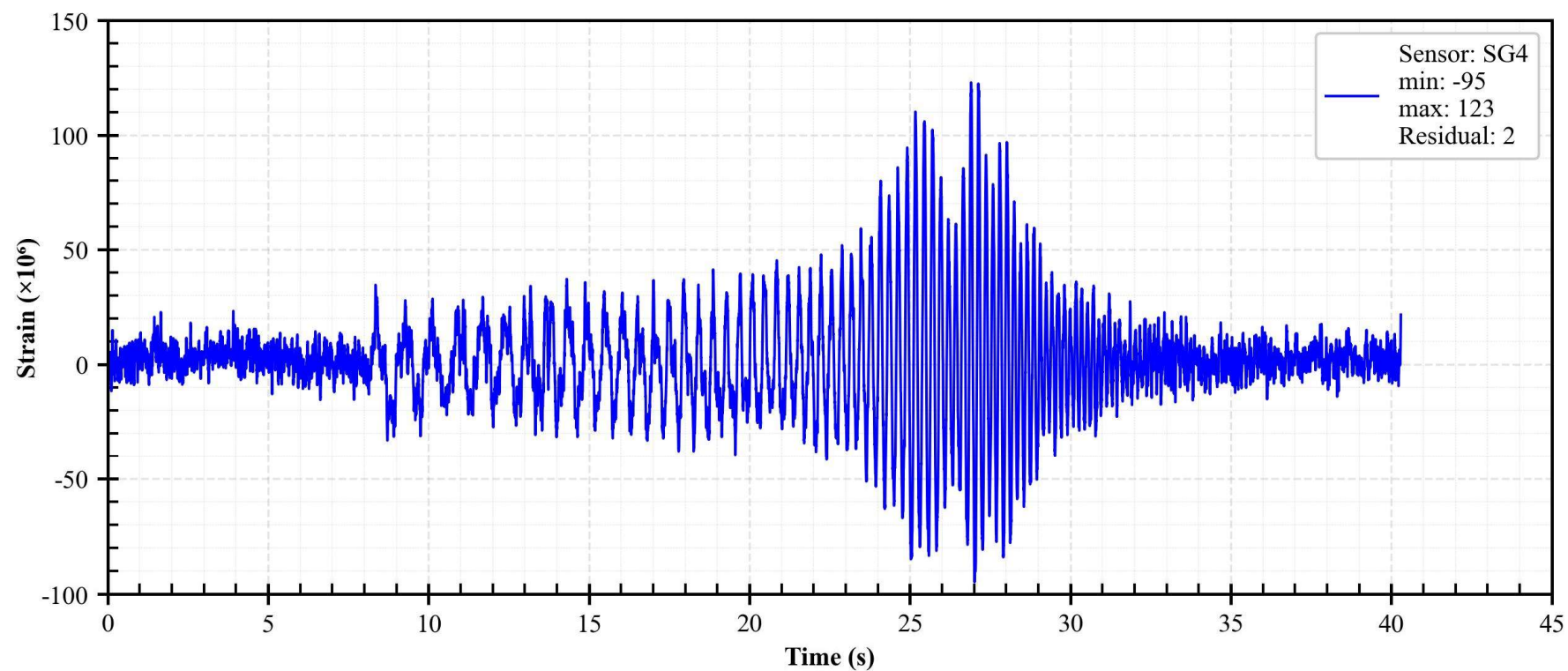


Figure 3.8.21 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 4

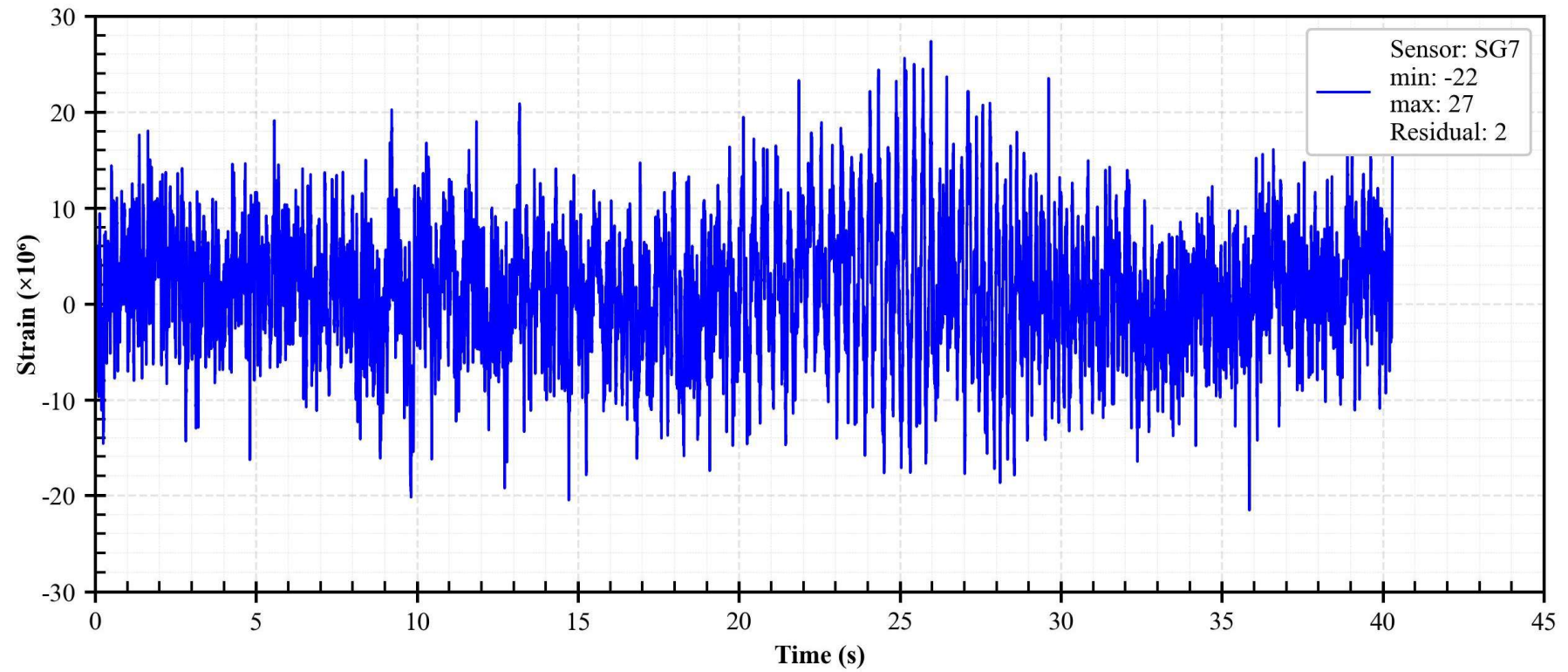


Figure 3.8.22 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 7

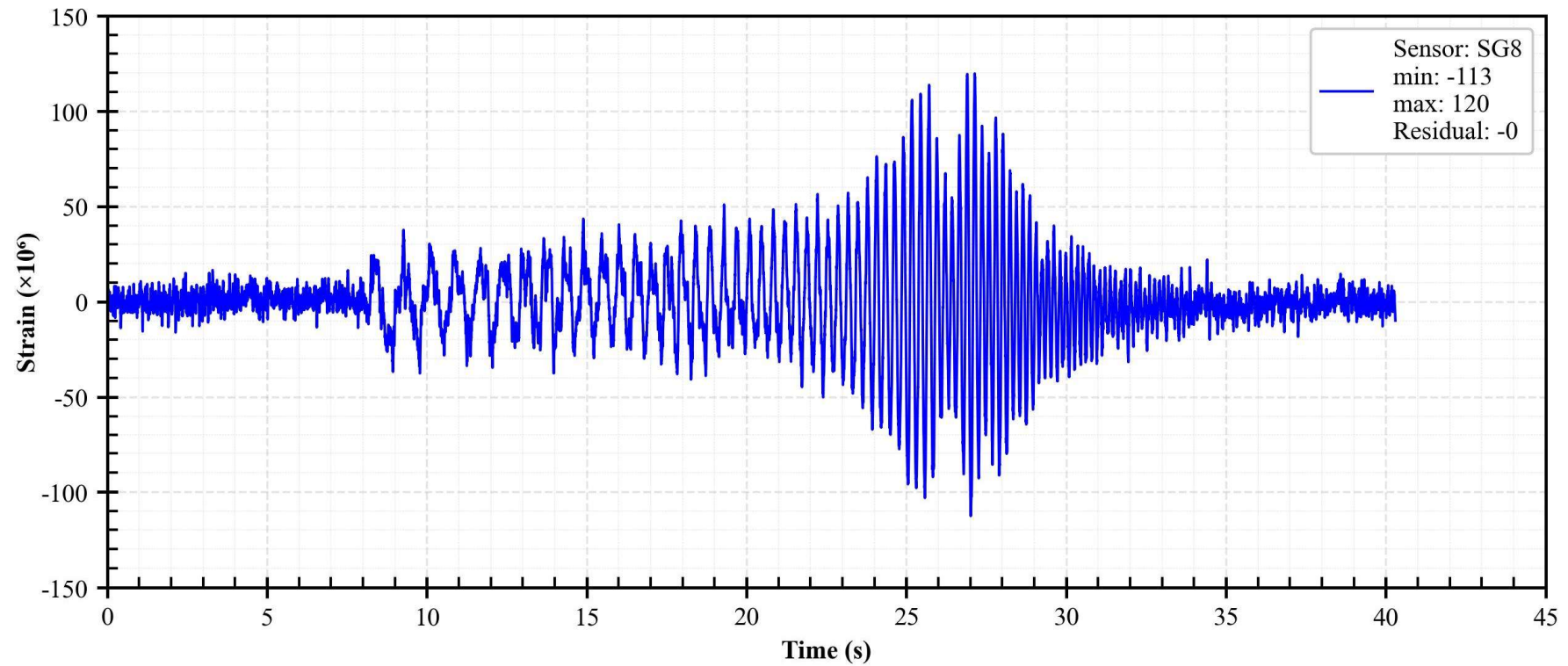


Figure 3.8.23 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 8

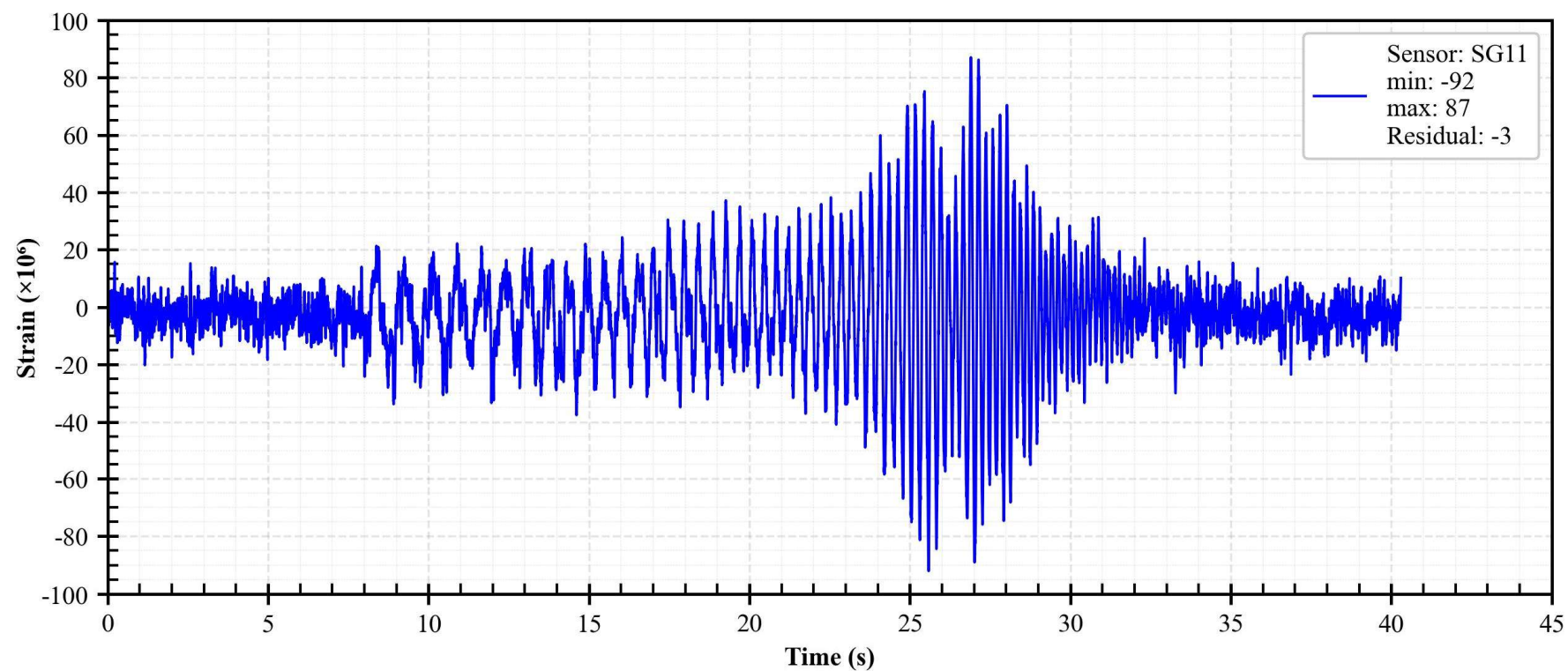


Figure 3.8.24 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 11

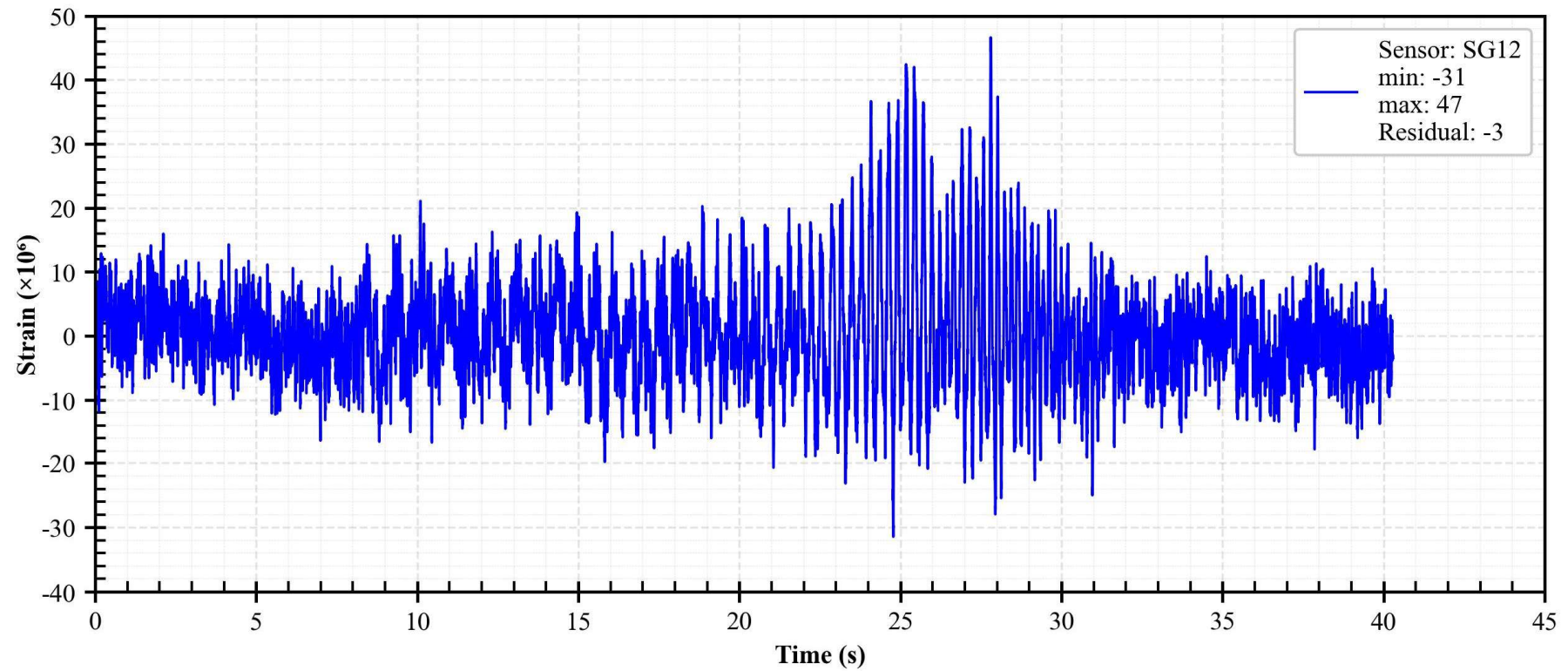


Figure 3.8.25 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 12

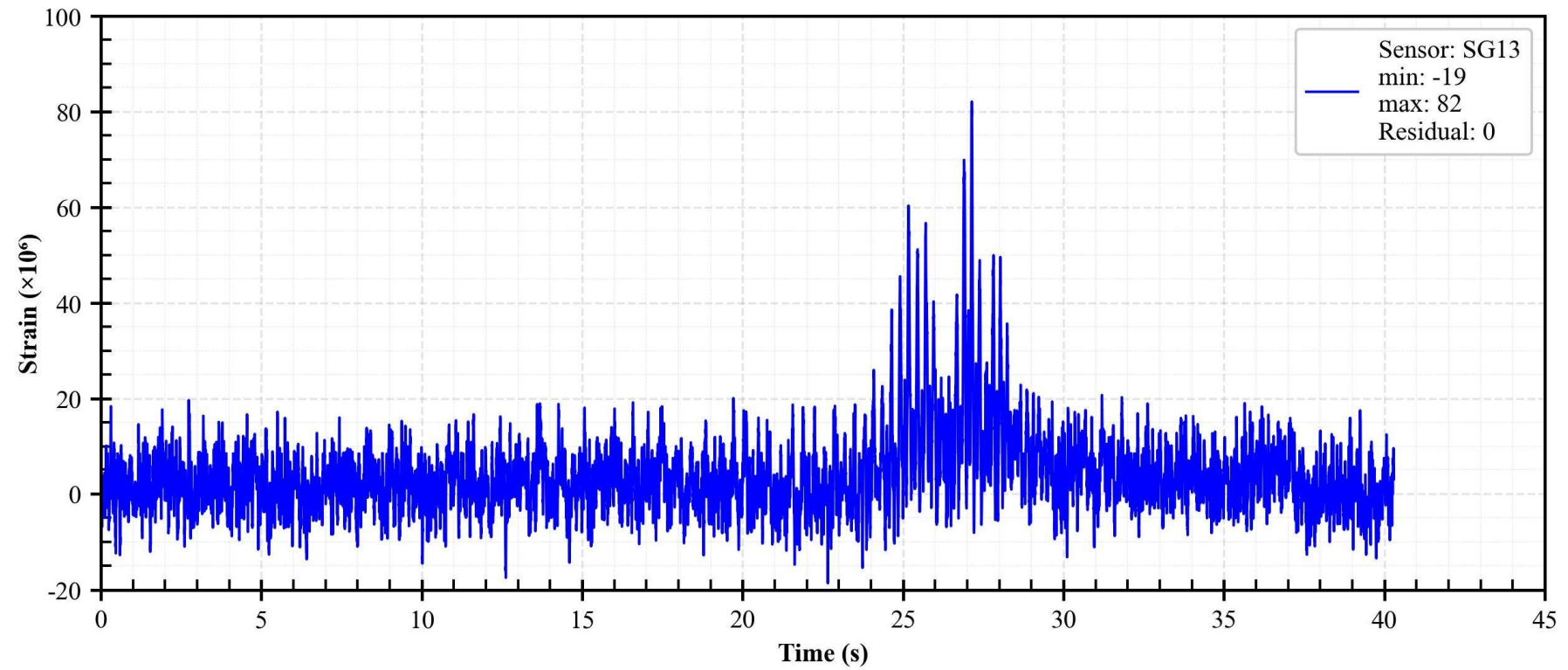


Figure 3.8.26 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 13

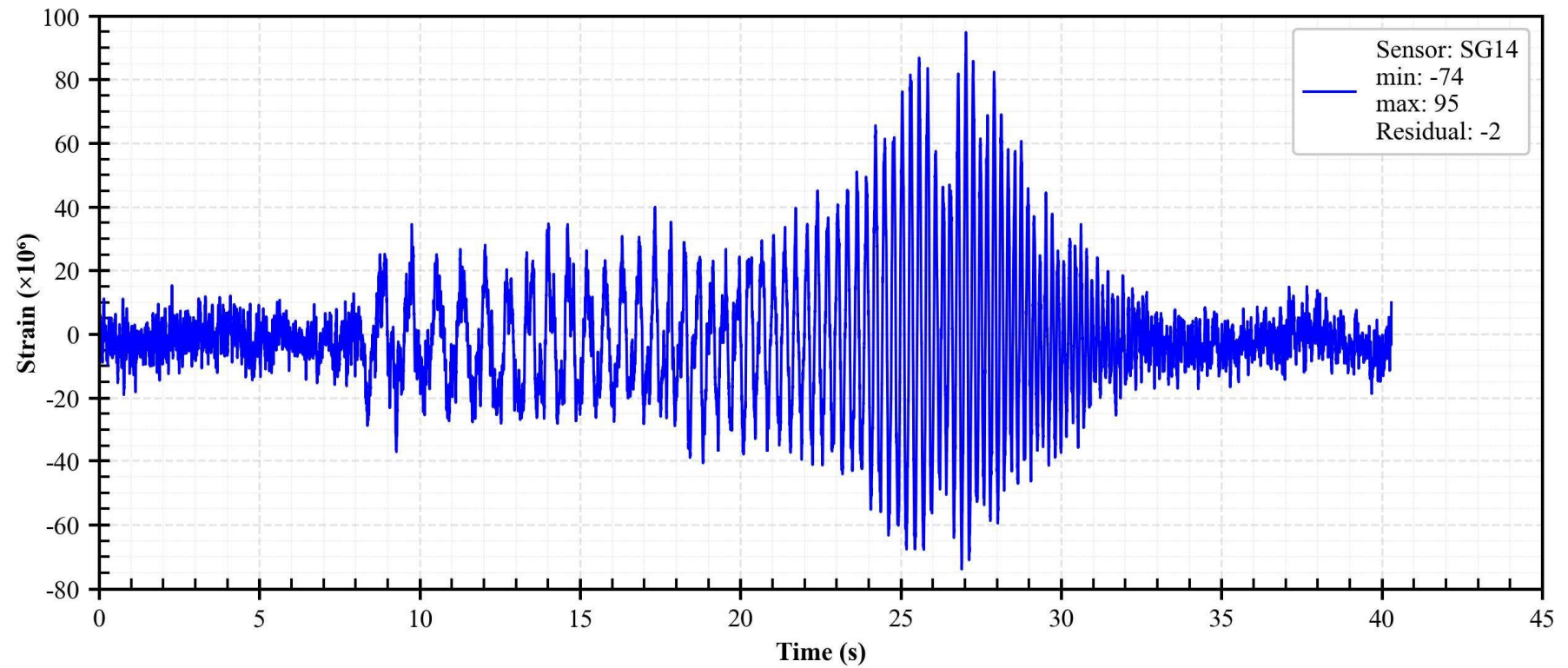


Figure 3.8.27 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 14

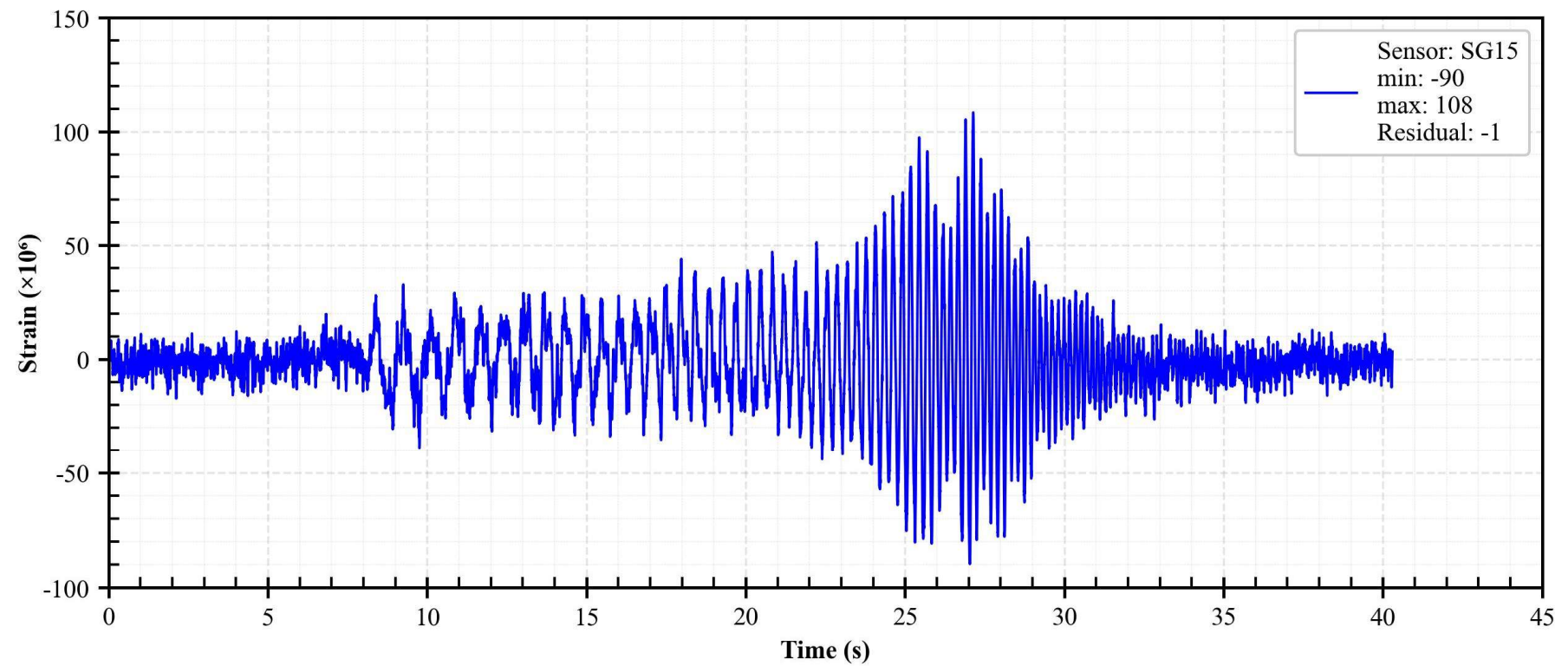


Figure 3.8.28 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 15

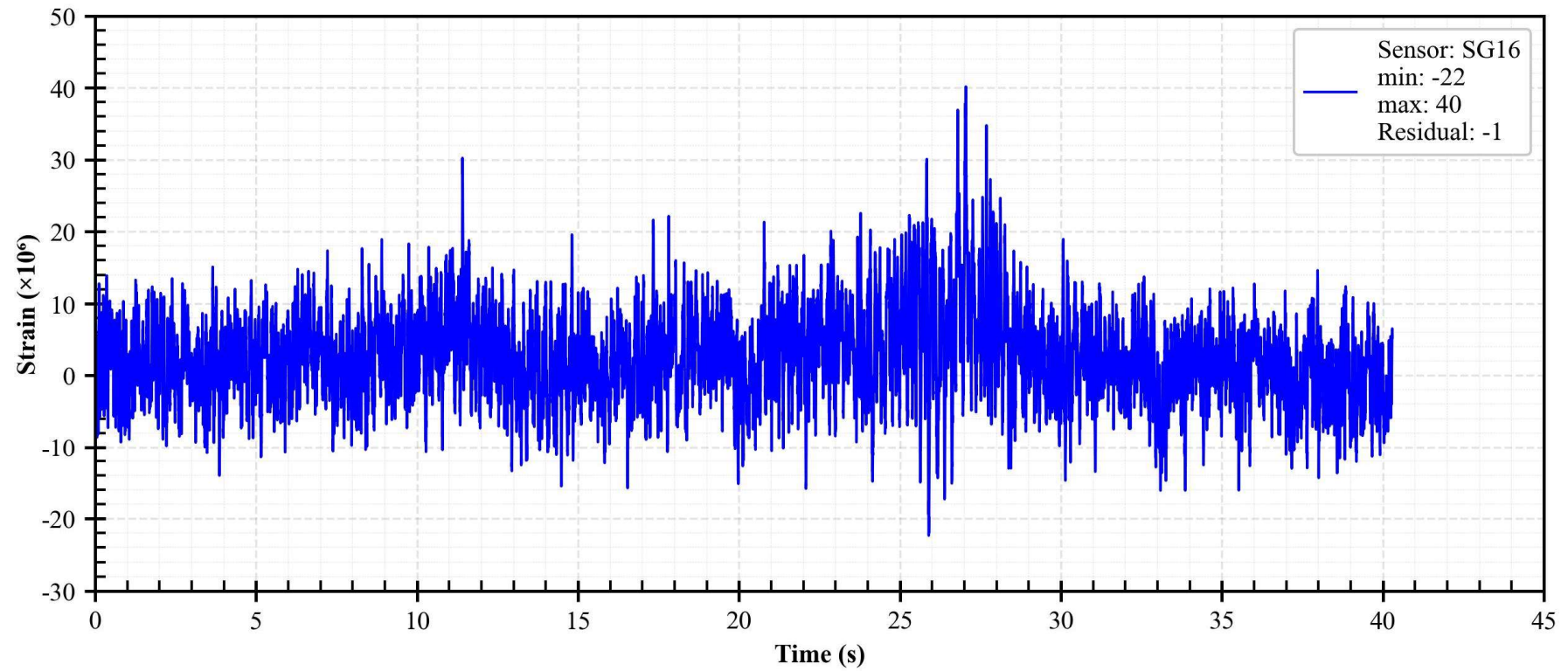


Figure 3.8.29 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 16

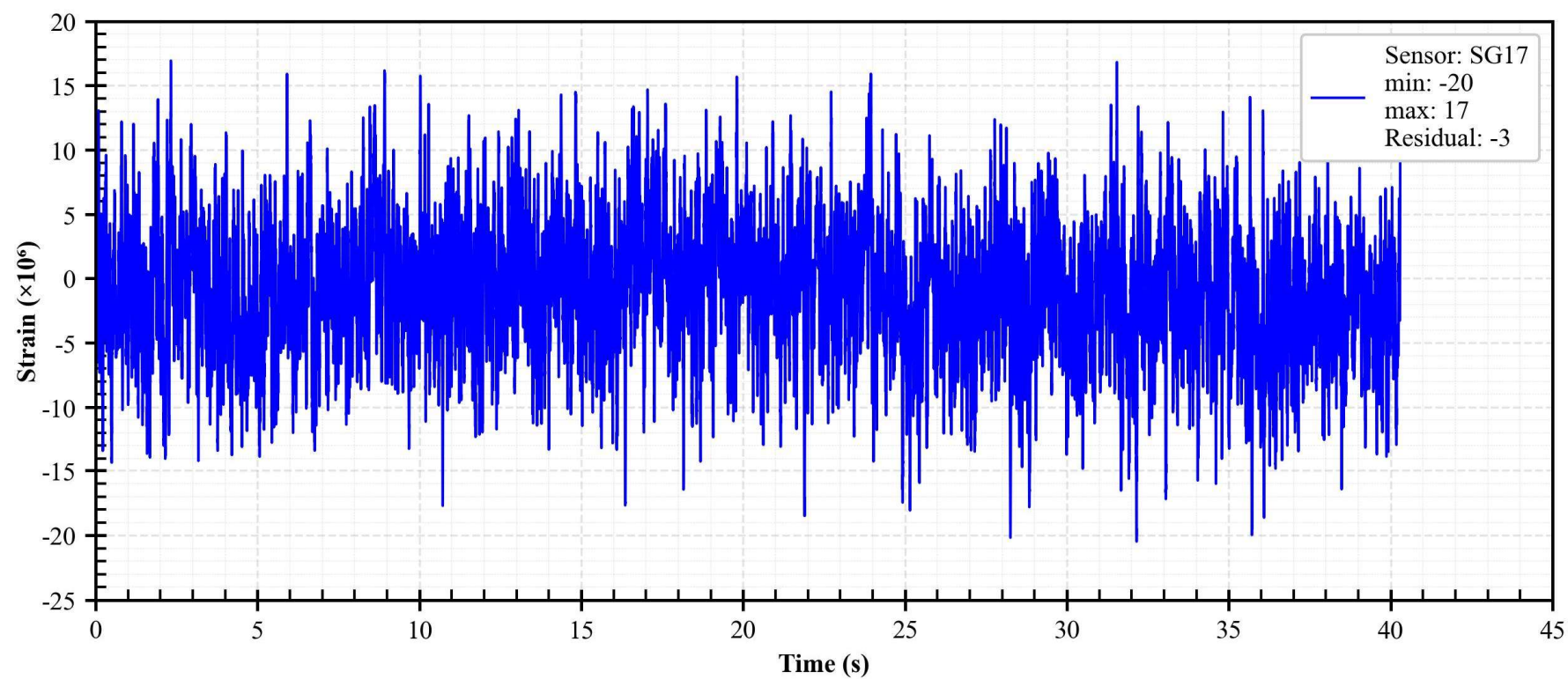


Figure 3.8.30 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 17

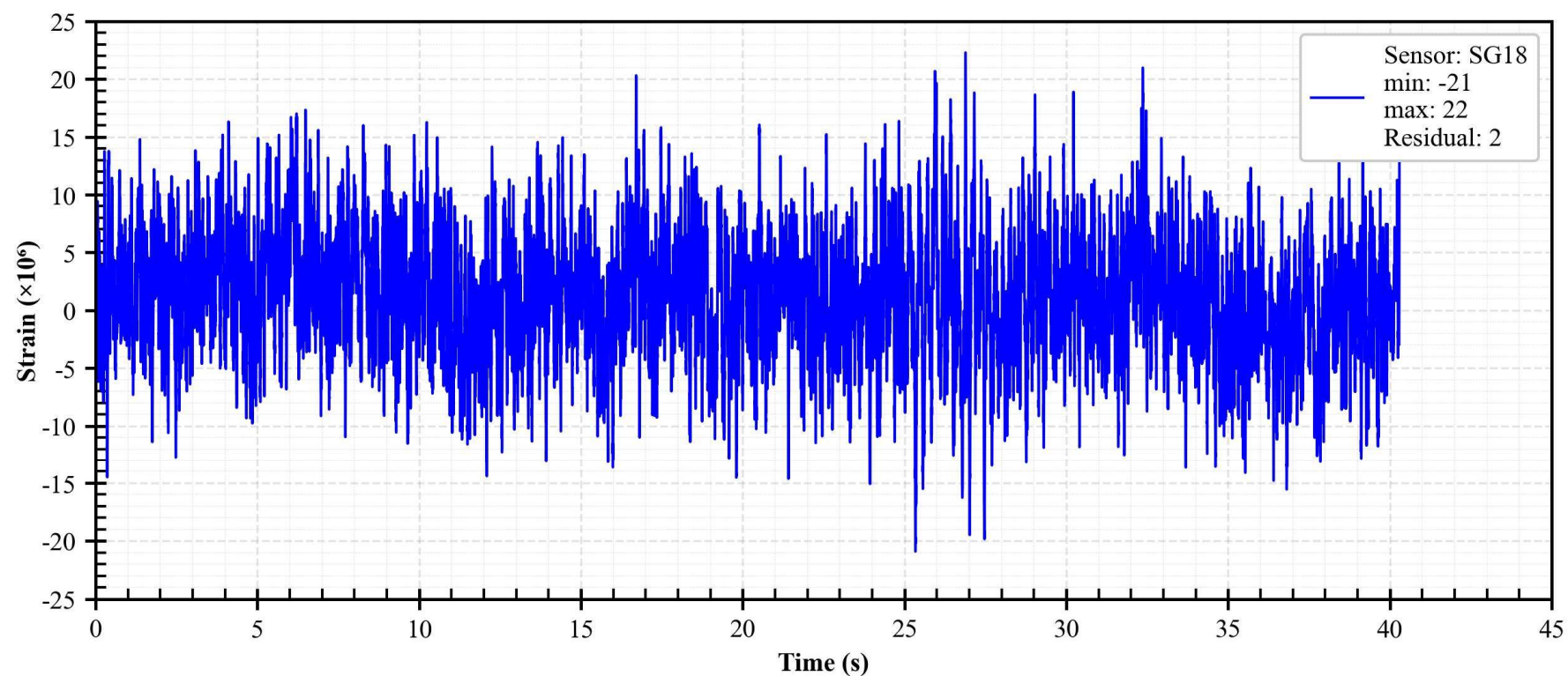


Figure 3.8.31 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 18

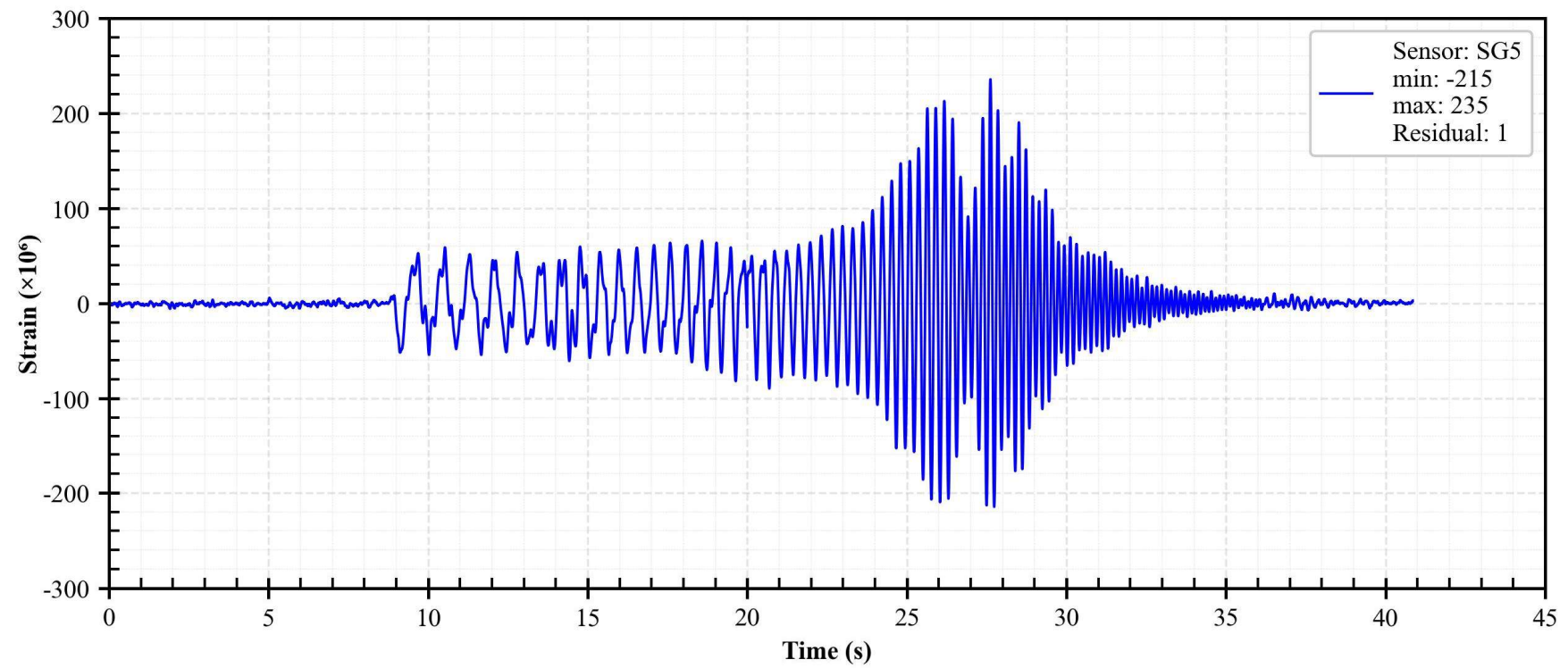


Figure 3.8.32 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 5

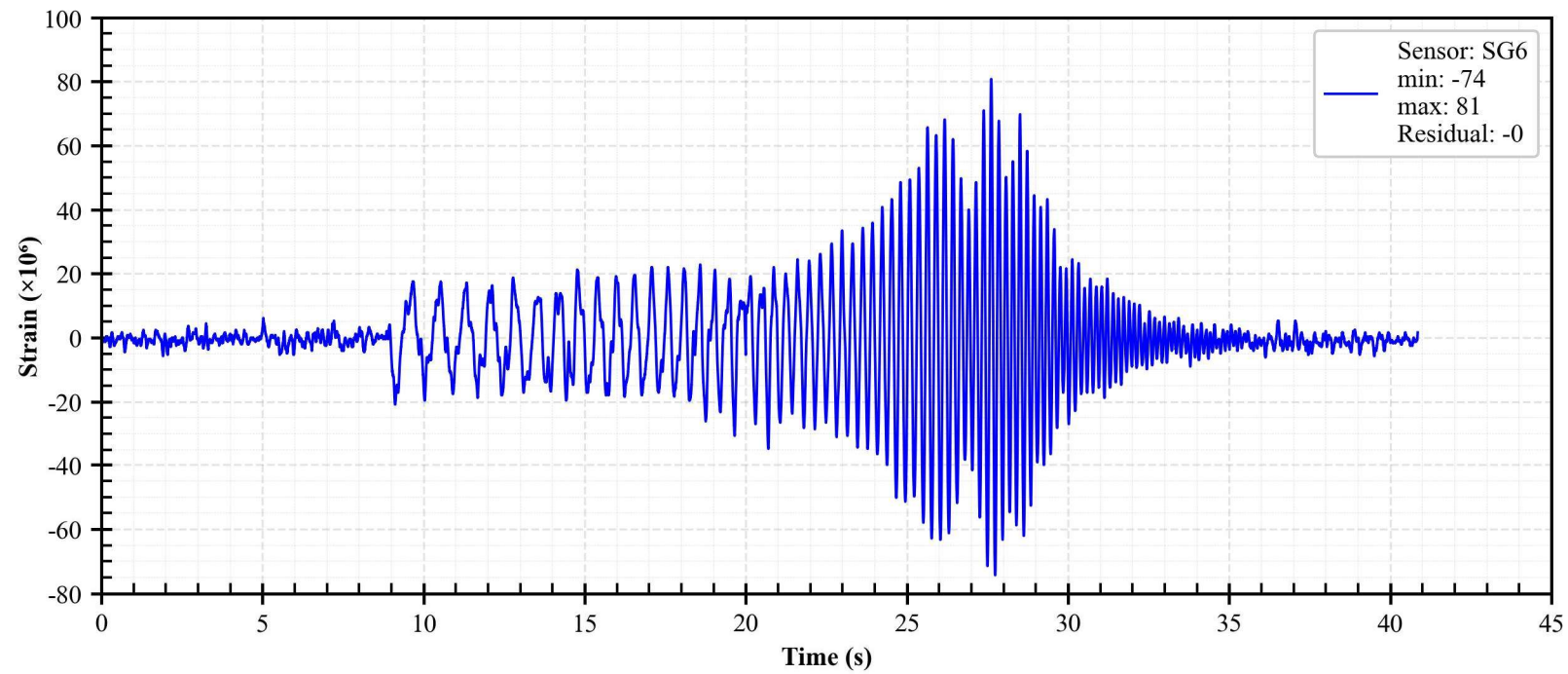


Figure 3.8.33 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 6

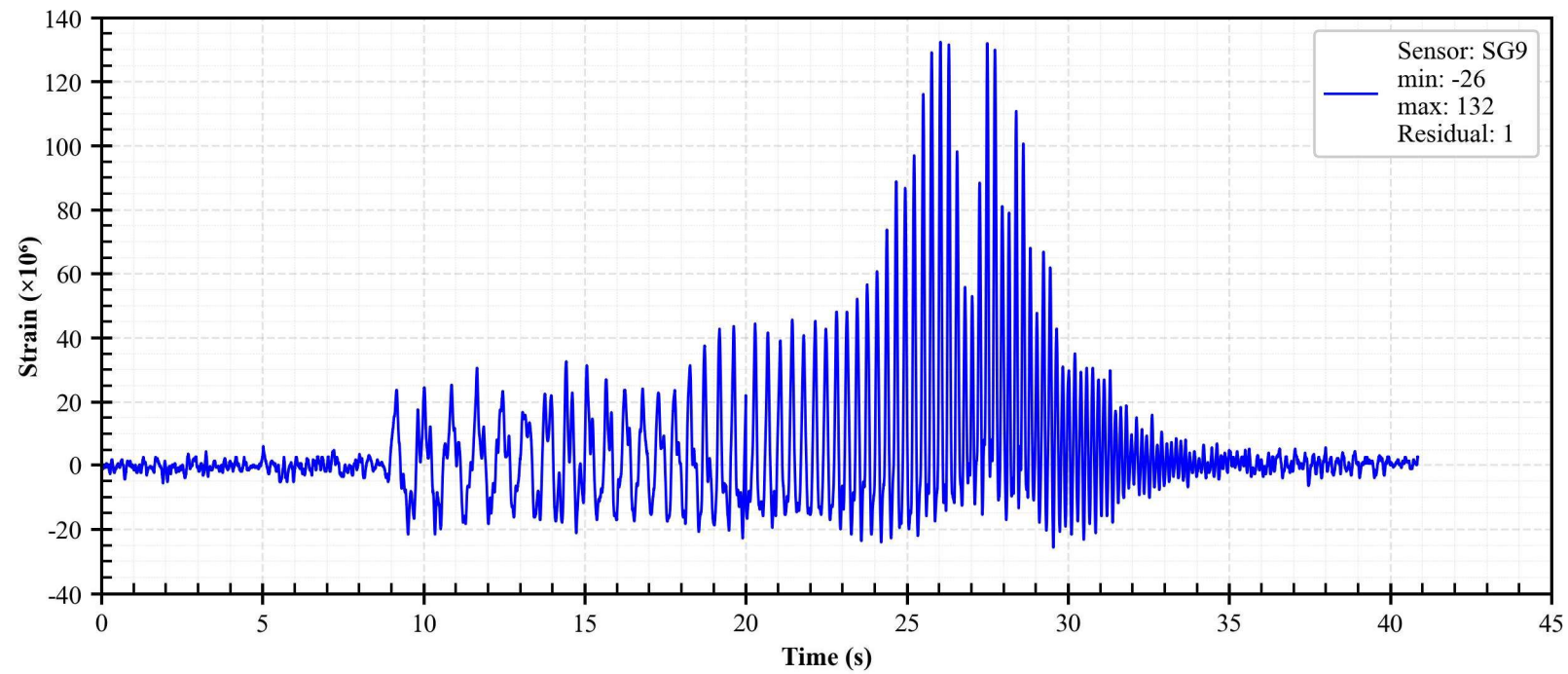


Figure 3.8.34 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 9

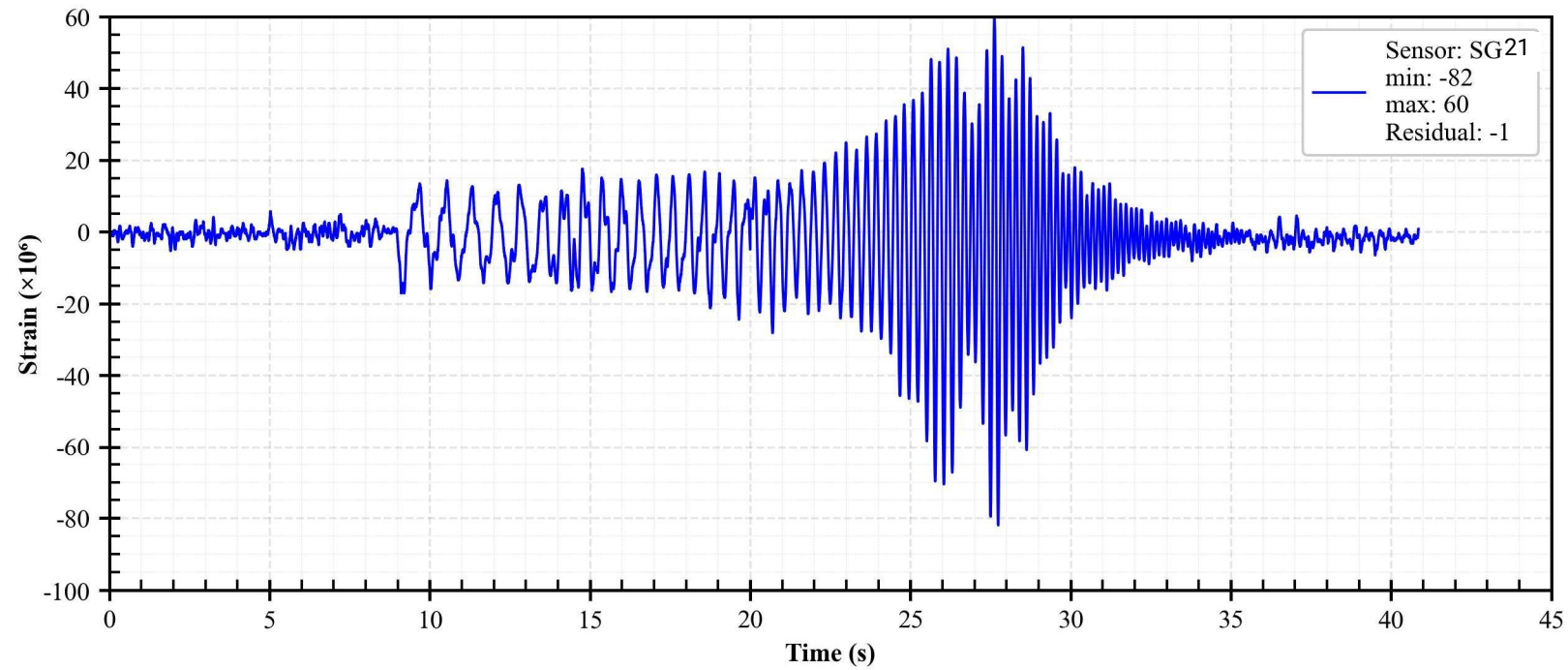


Figure 3.8.35 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 21 (PUFJ, column 1)

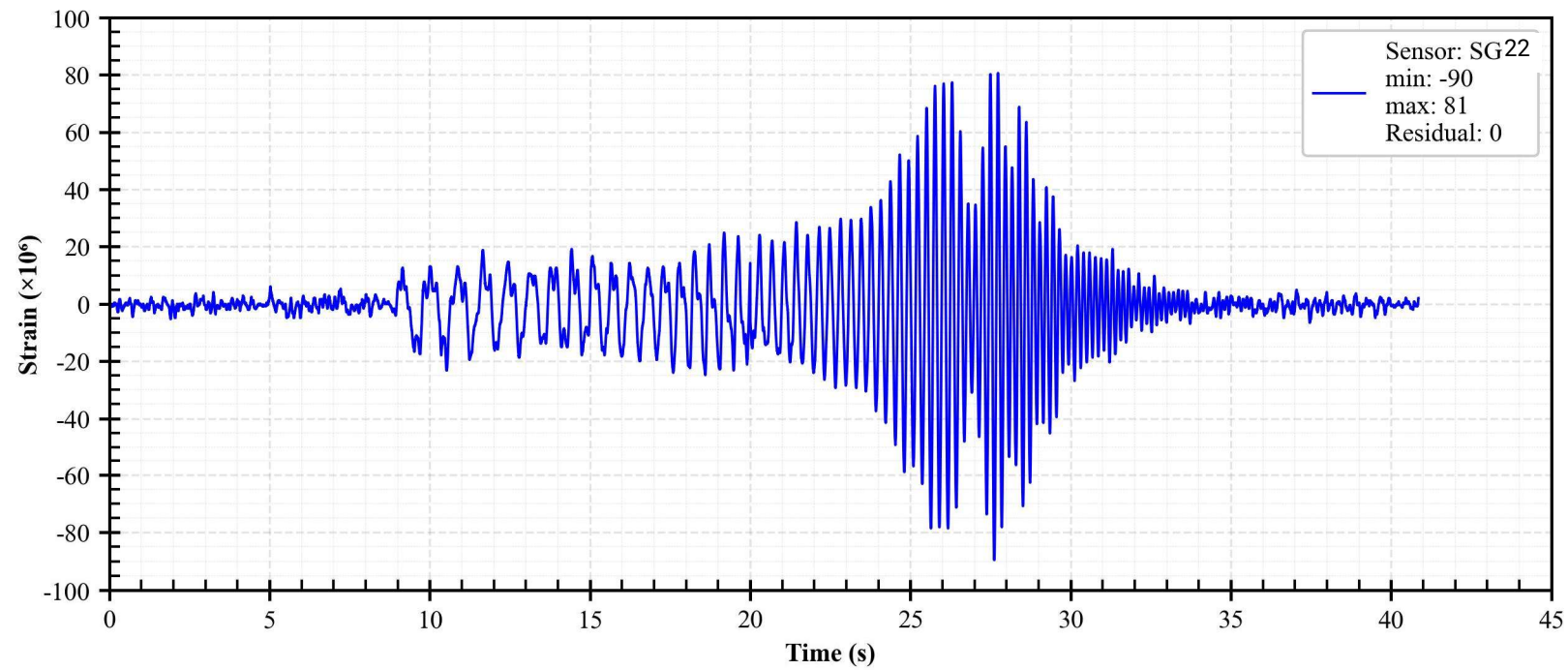


Figure 3.8.36 Characteristic results for phase B (white noise before EQ0,34g): strain gauge 22 (PUFJ, column 2)

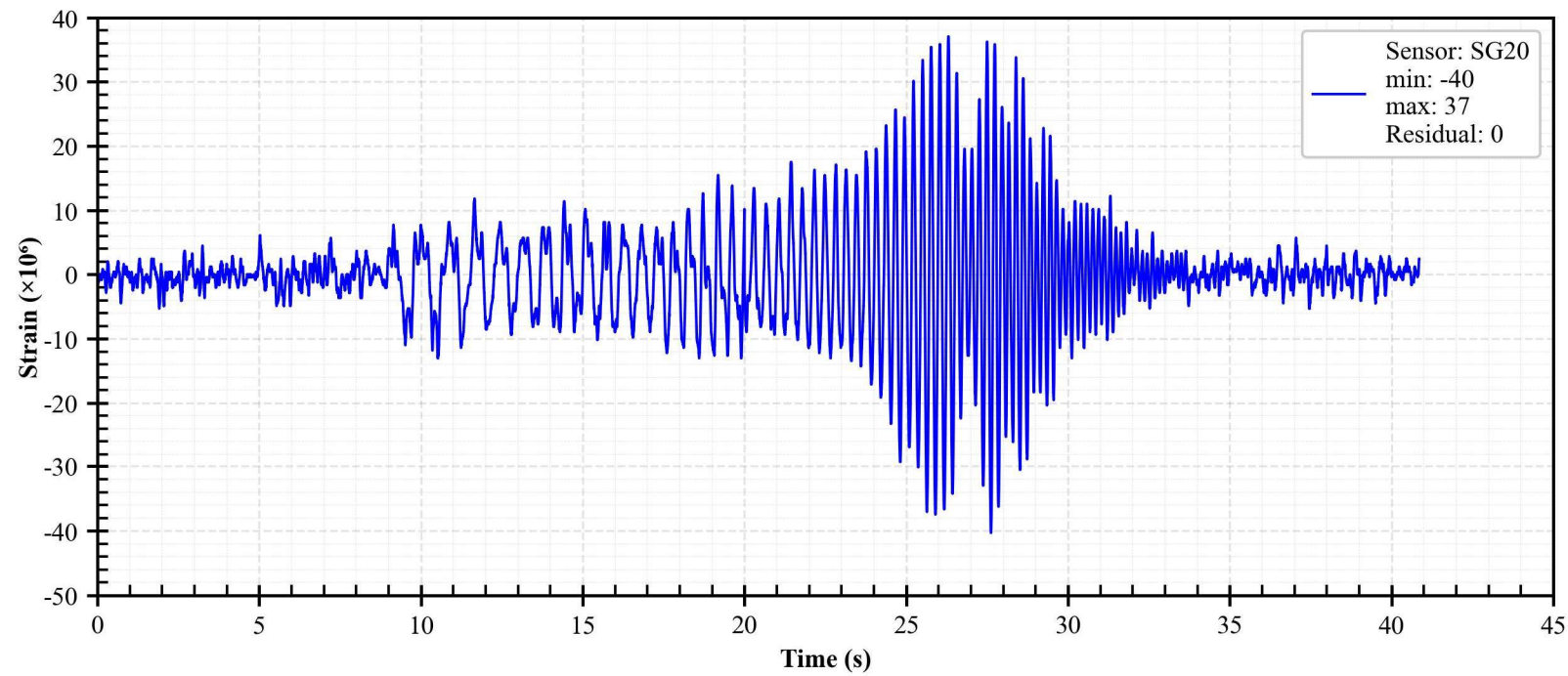


Figure 3.8.37 Characteristic results for phase B (white noise before EQ0,34g): strain gauge

3.9 Earthquake EQ0,34g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,34g. The max acceleration at the slab level on the accelerometer acc4 is 0.53g. The max acceleration at the foundation level on the accelerometer acc10 is 0,36g.

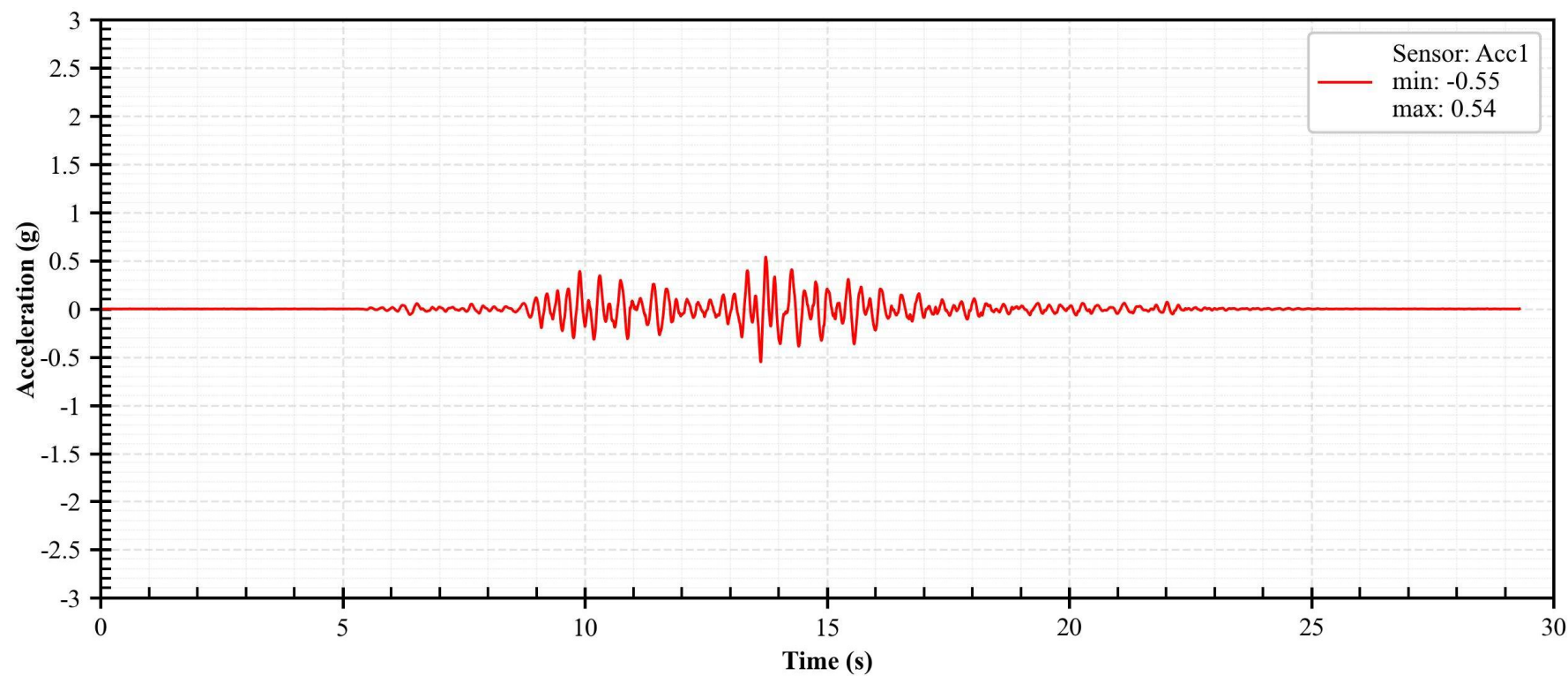


Figure 3.9.1 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 1

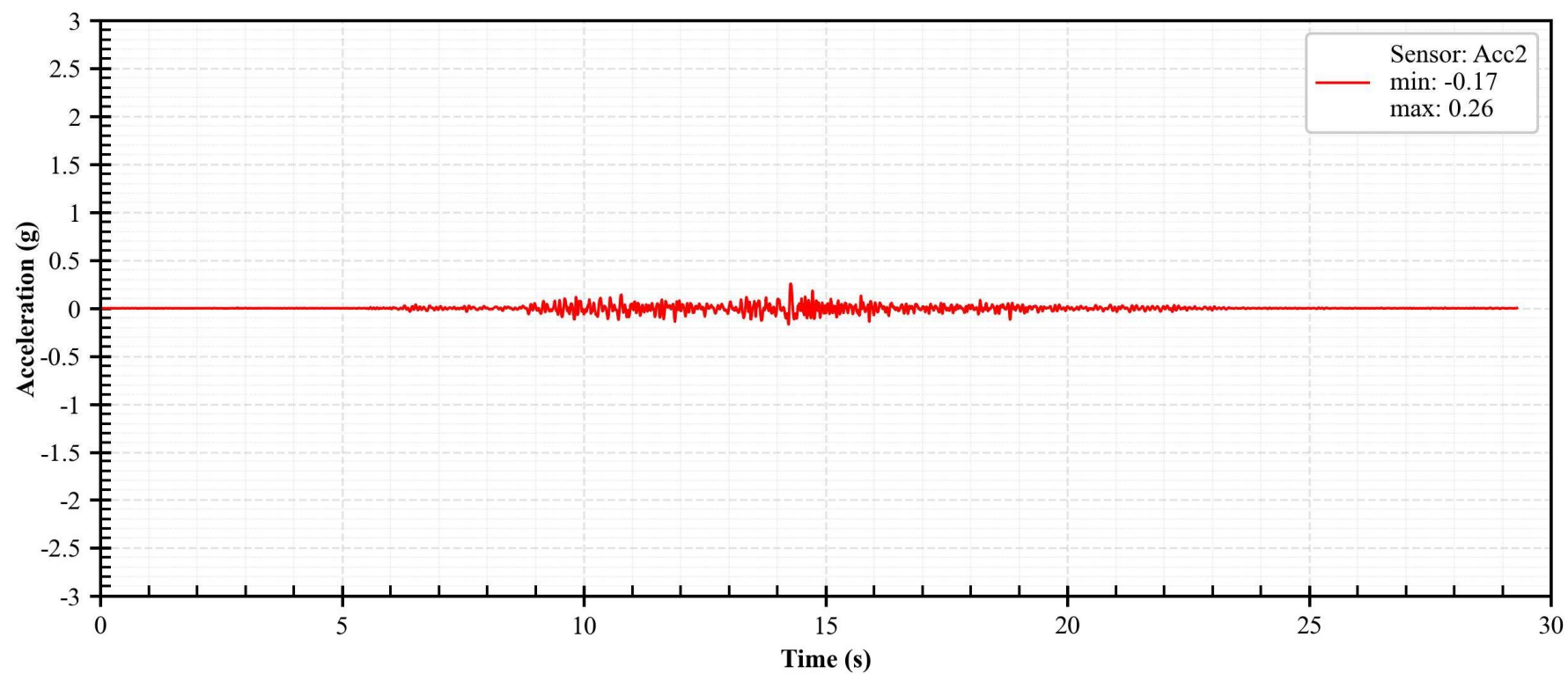


Figure 3.9.2 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 2

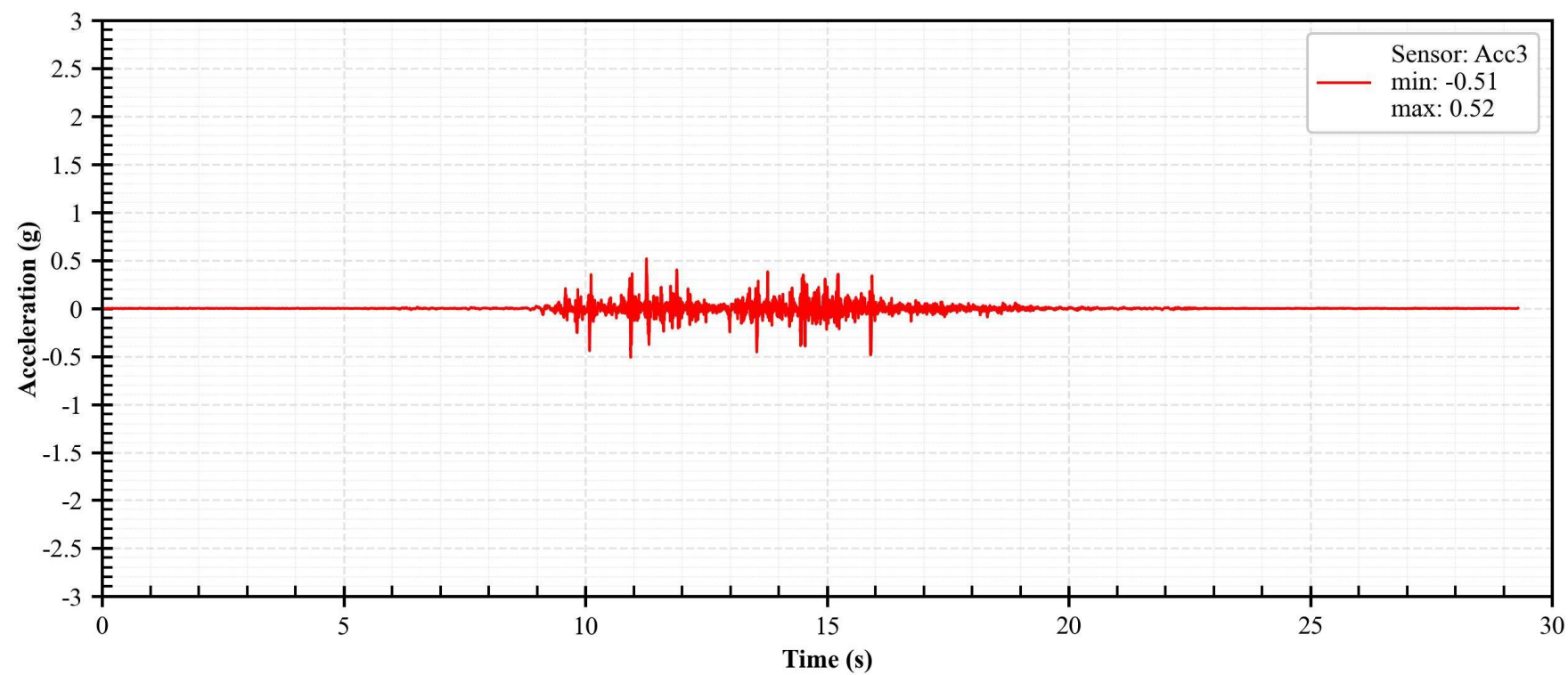


Figure 3.9.3 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 3

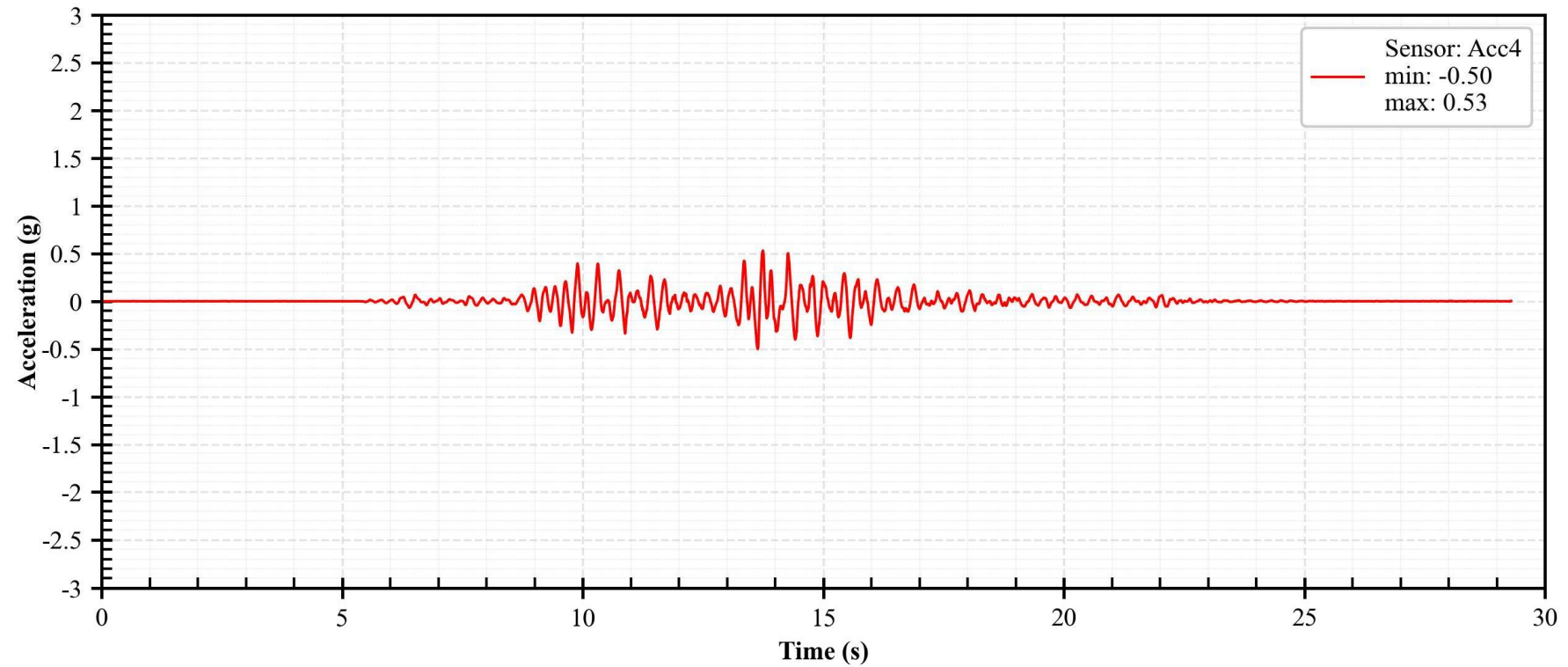


Figure 3.9.4 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 4

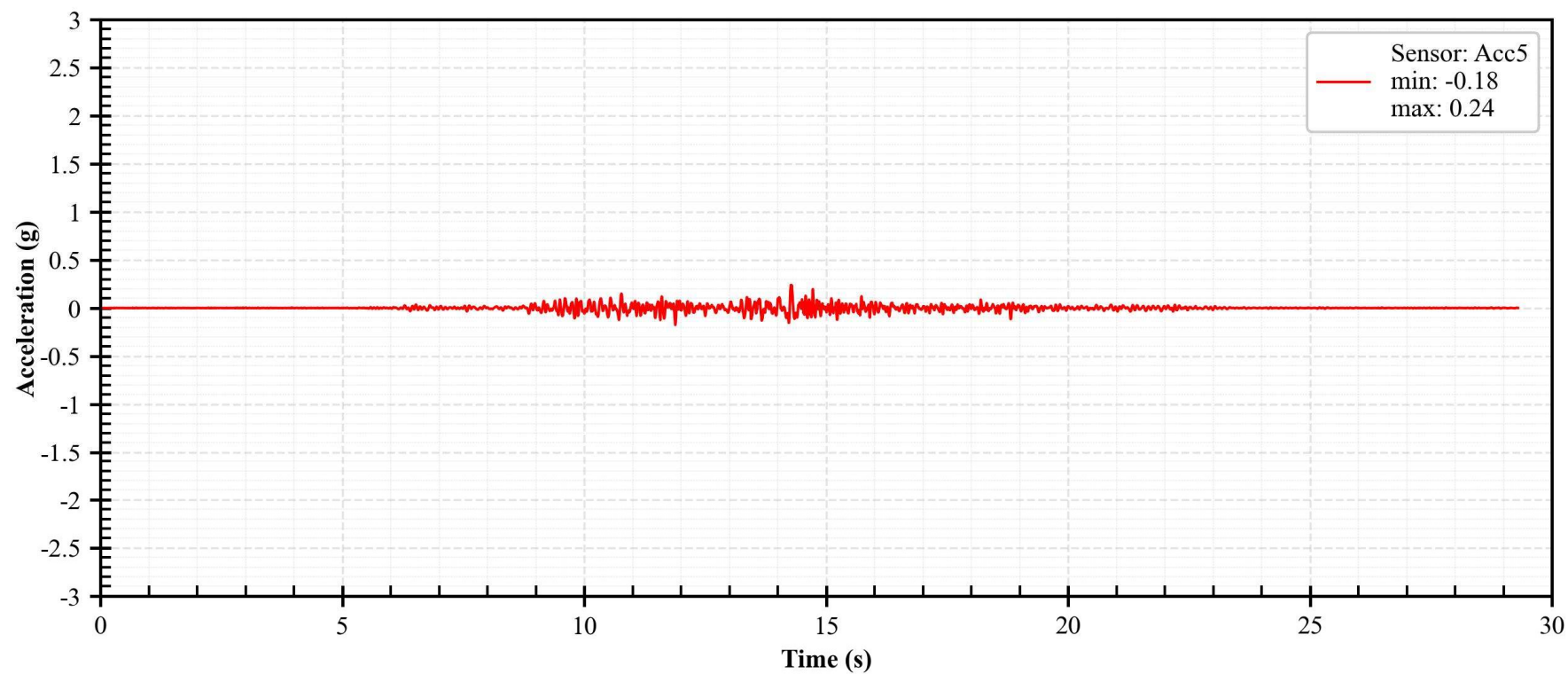


Figure 3.9.5 Characteristic results for phase B (earthquake EQ034g): Accelerometer 5

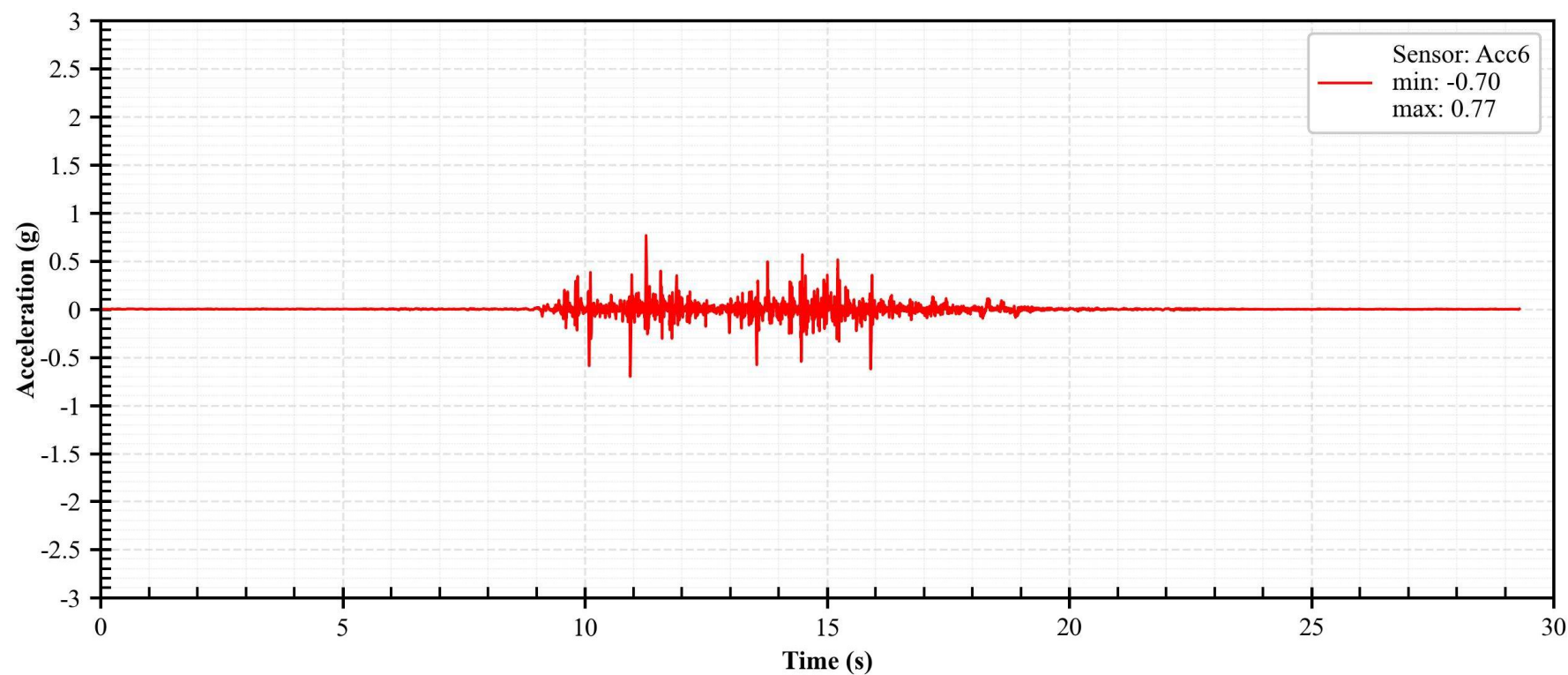


Figure 3.9.6 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 6

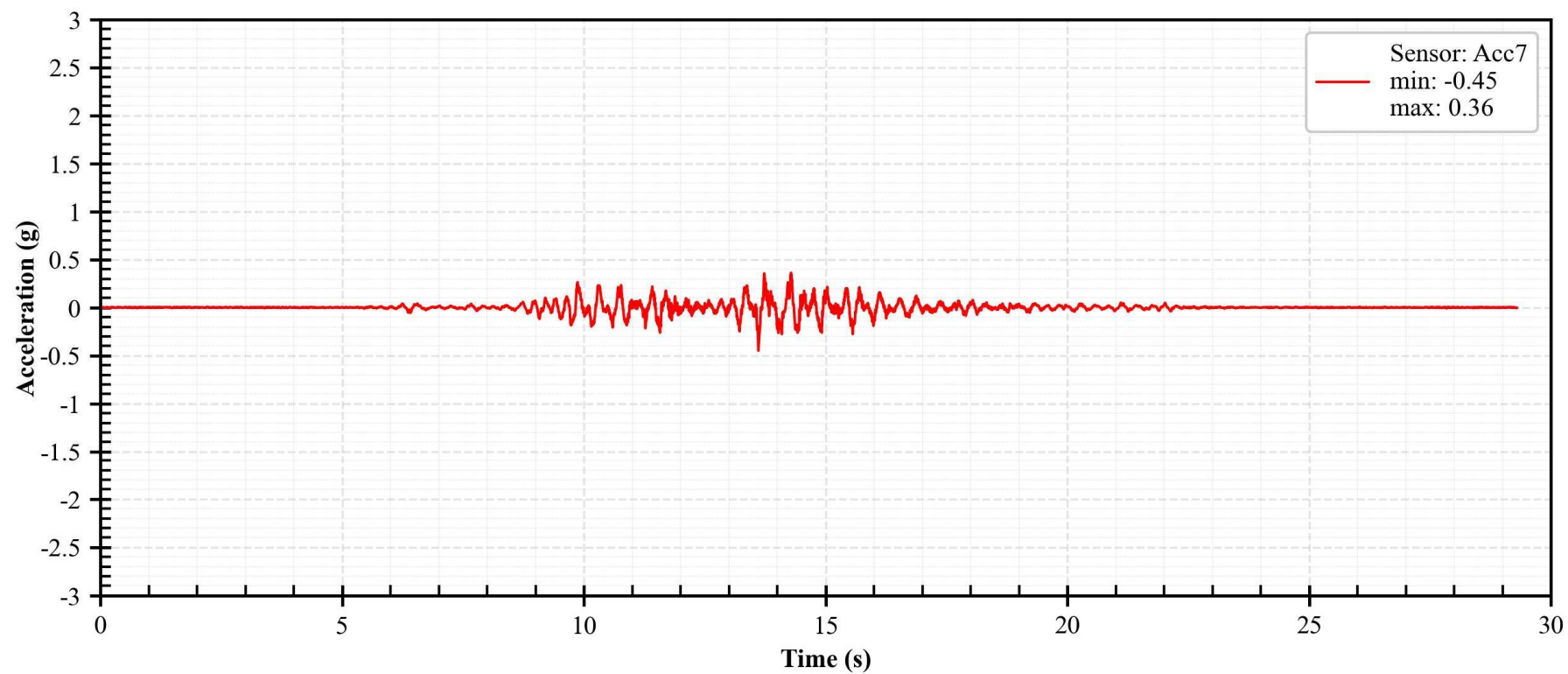


Figure 3.9.7 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 7

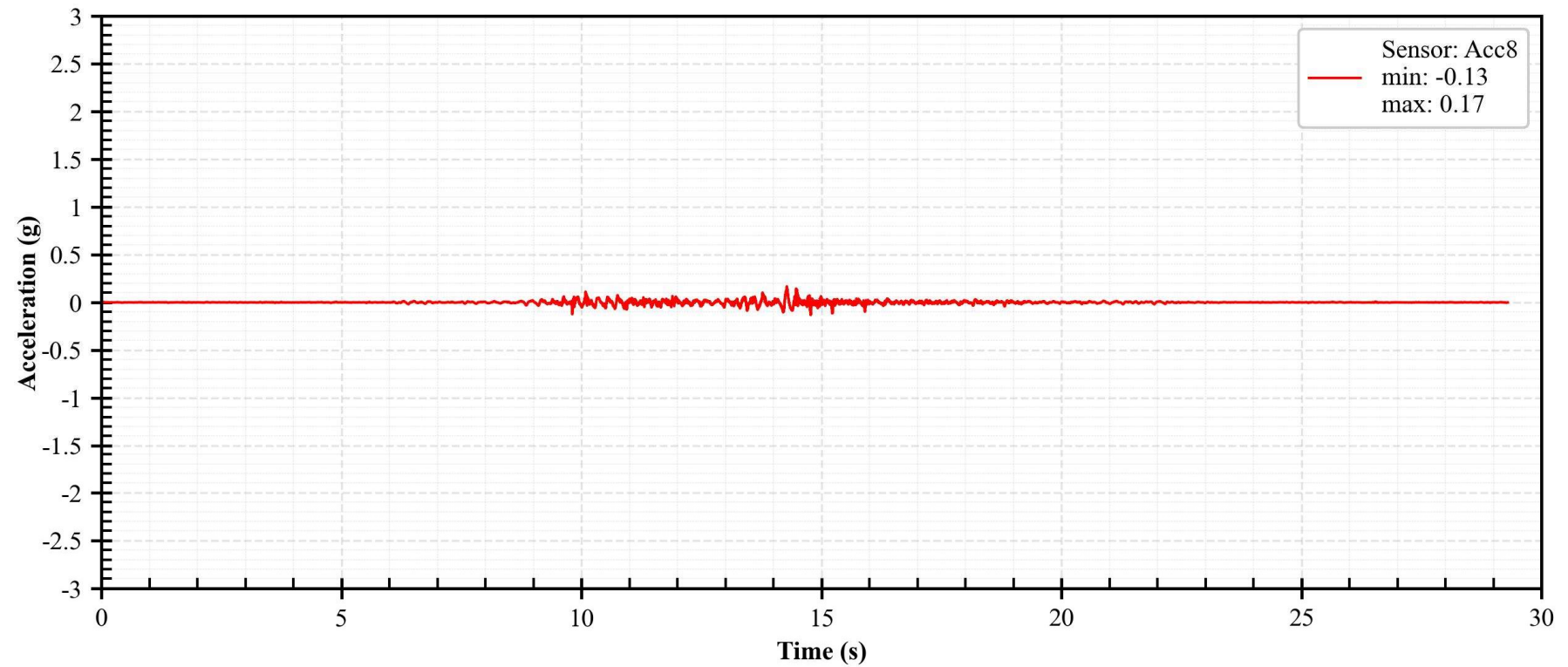


Figure 3.9.8 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 8

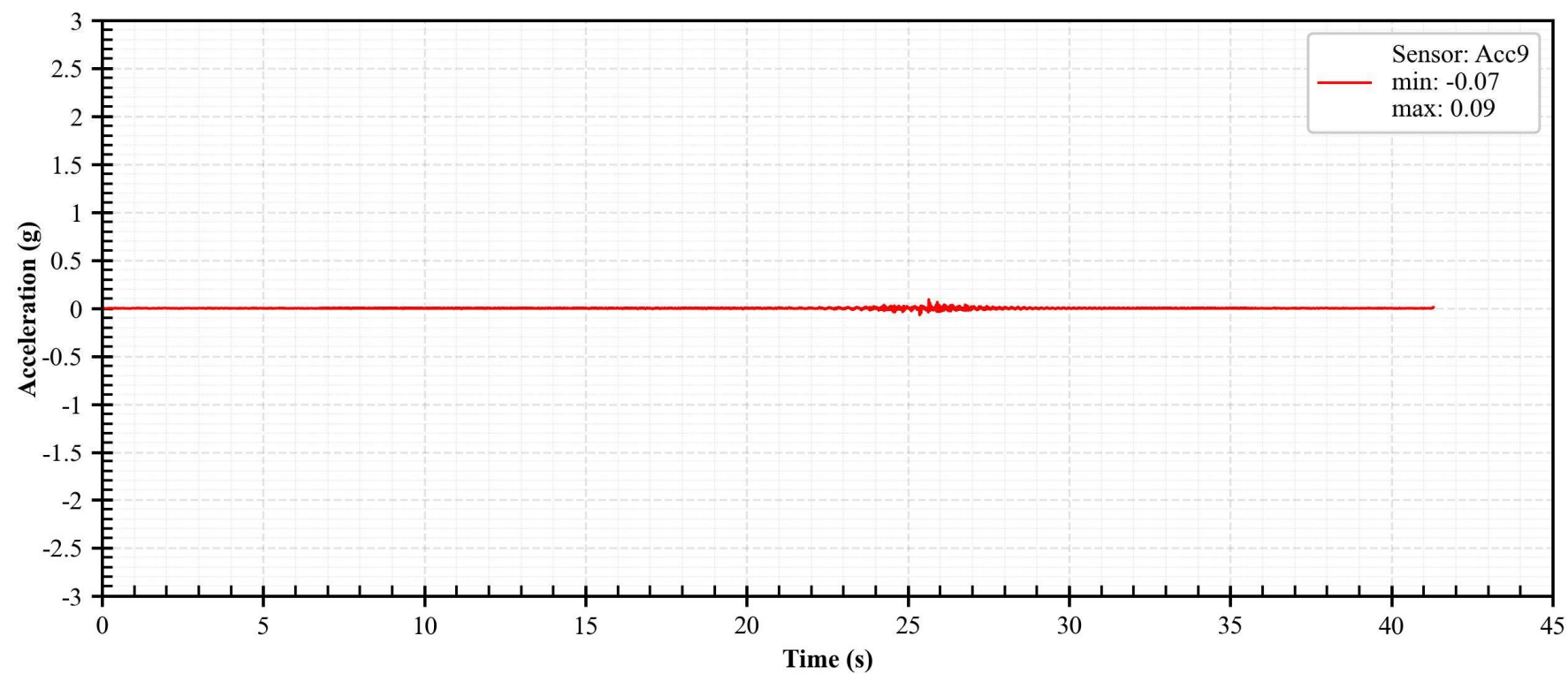


Figure 3.9.9 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 9

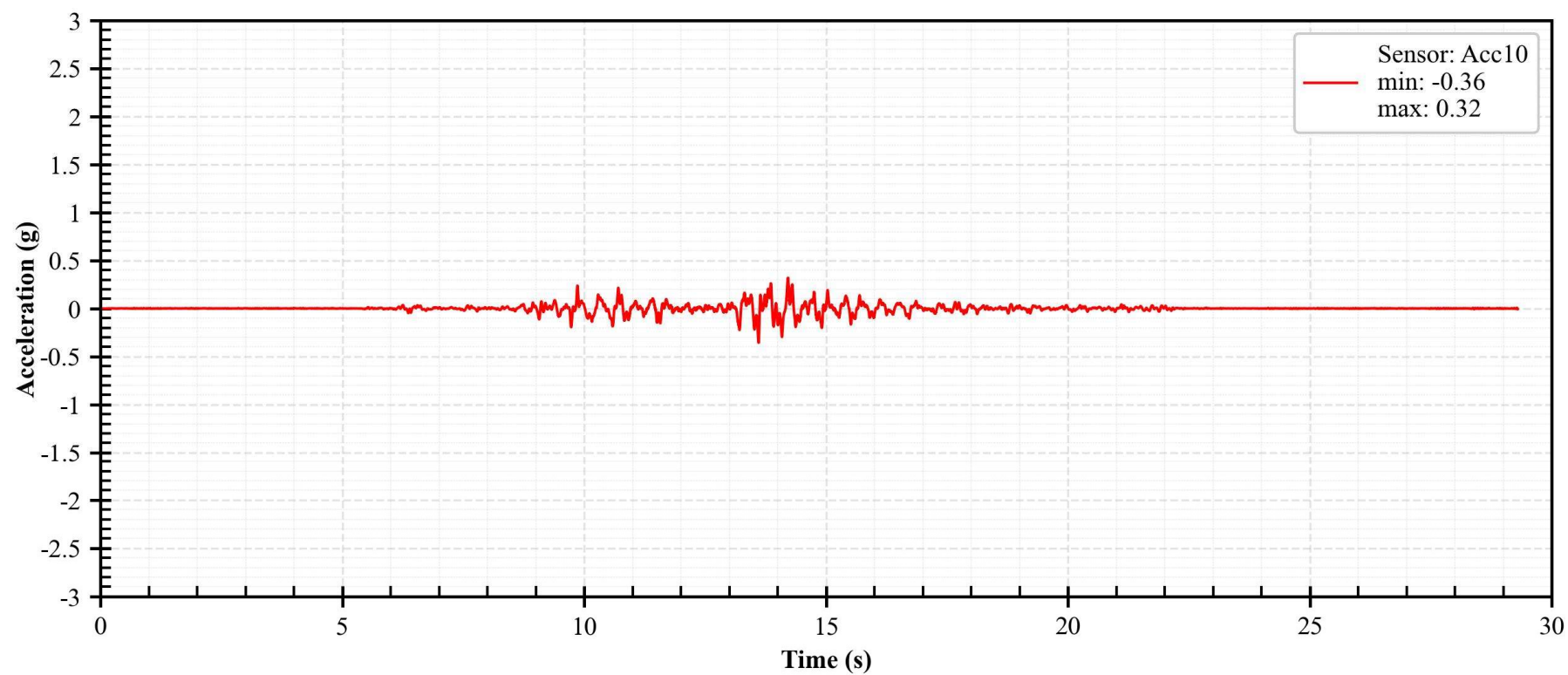


Figure 3.9.10 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 10

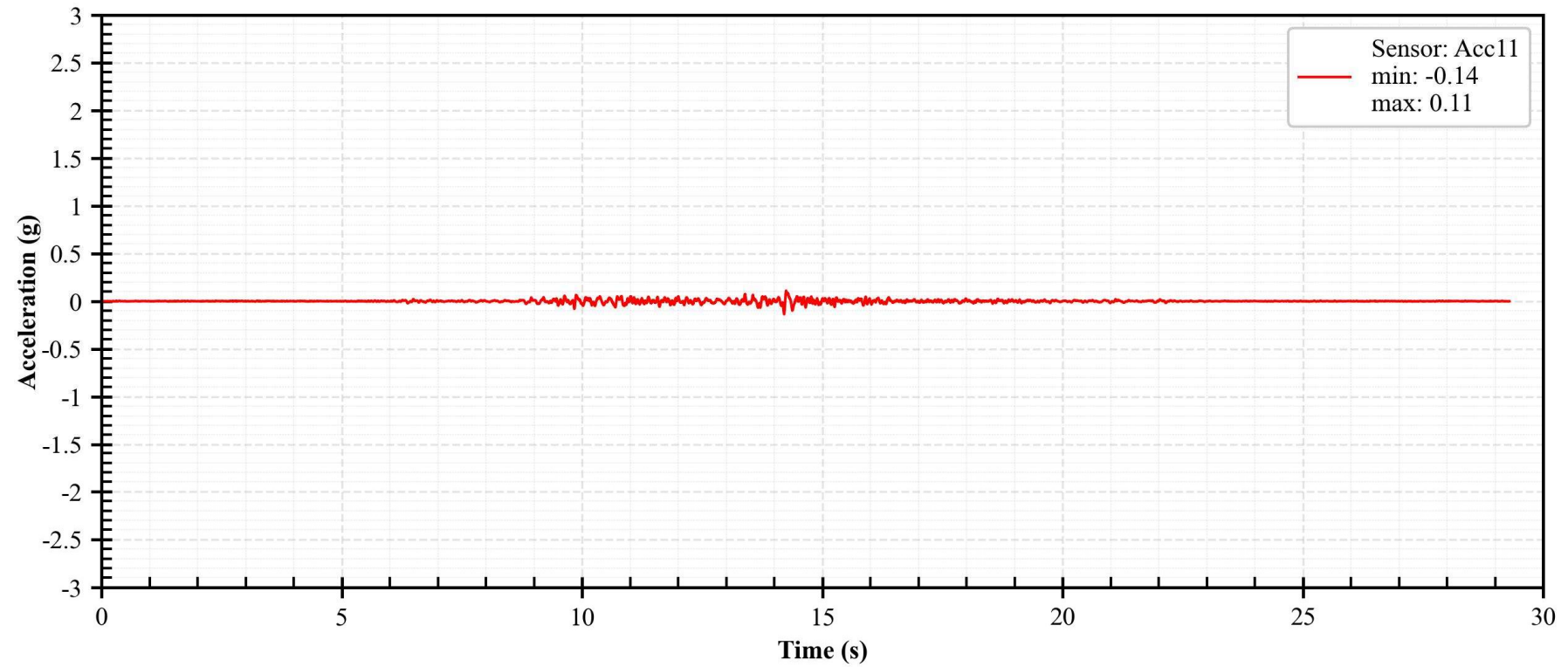


Figure 3.9.11 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 11

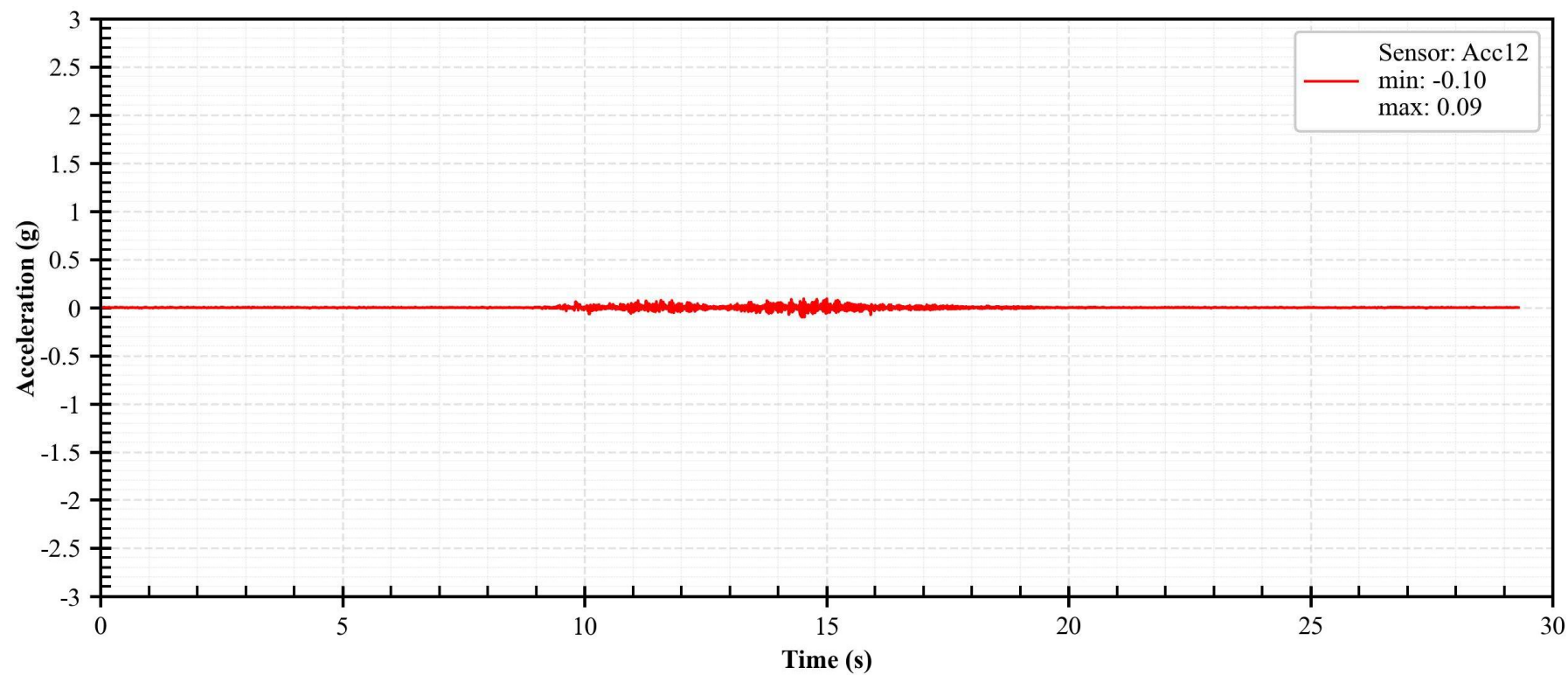


Figure 3.9.12 Characteristic results for phase B (earthquake EQ0,34g): Accelerometer 12

Draw wire sensors

Figures 3.9.13 – 3.9.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 10.66 mm while the minimum is -11.39 mm. The maximum movement detected by draw wire sensor W2 is 10.95 mm while the minimum is -11.07 mm. The maximum movement detected by draw wire sensor W3 is 7.45 mm while the minimum is -7.22 mm. The maximum movement detected by draw wire sensor W4 is 7.78 mm while the minimum is -7.48 mm. The maximum drift is $(4.64 / 1.225) = 3.79 \%$ and minimum drift is $(-5.63 / 1.225) = -4.60 \%$.

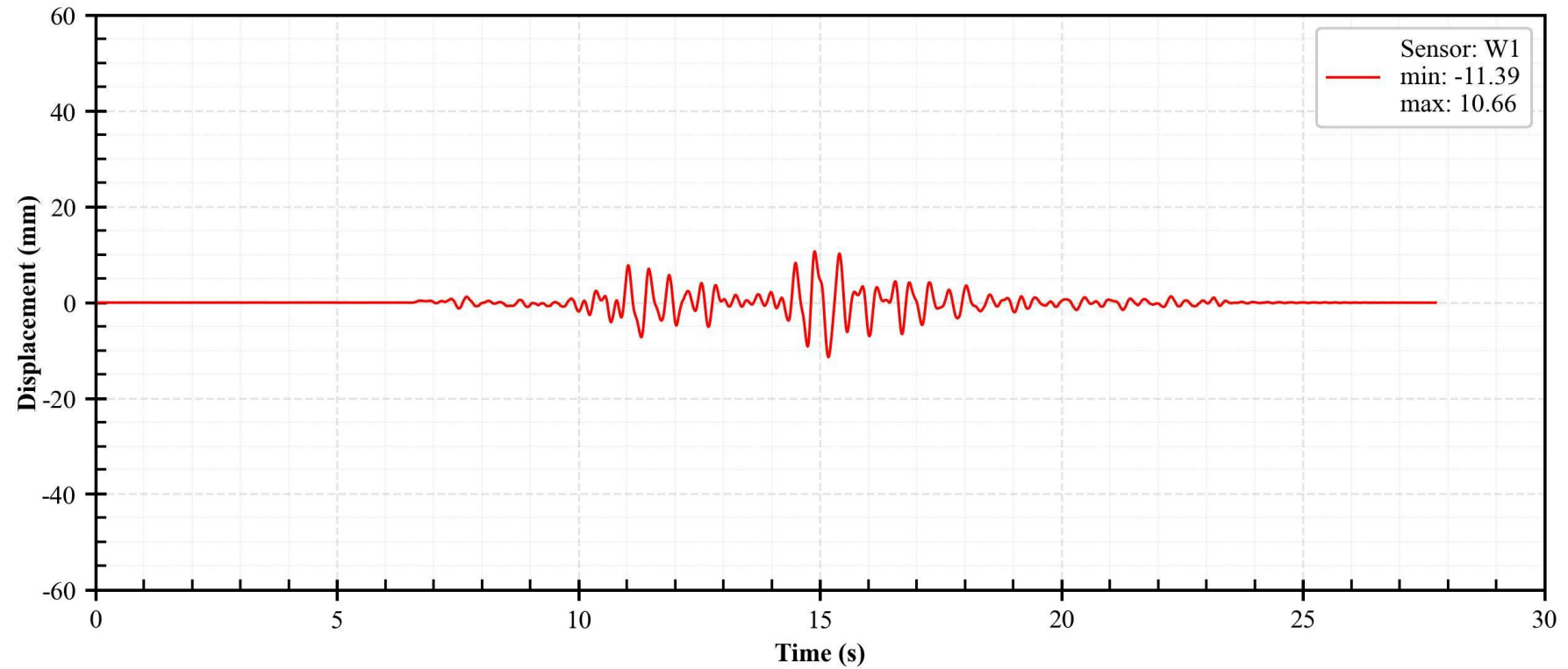


Figure 3.9.13 Characteristic results for phase B (earthquake EQ0,34g): Draw wire sensor 1

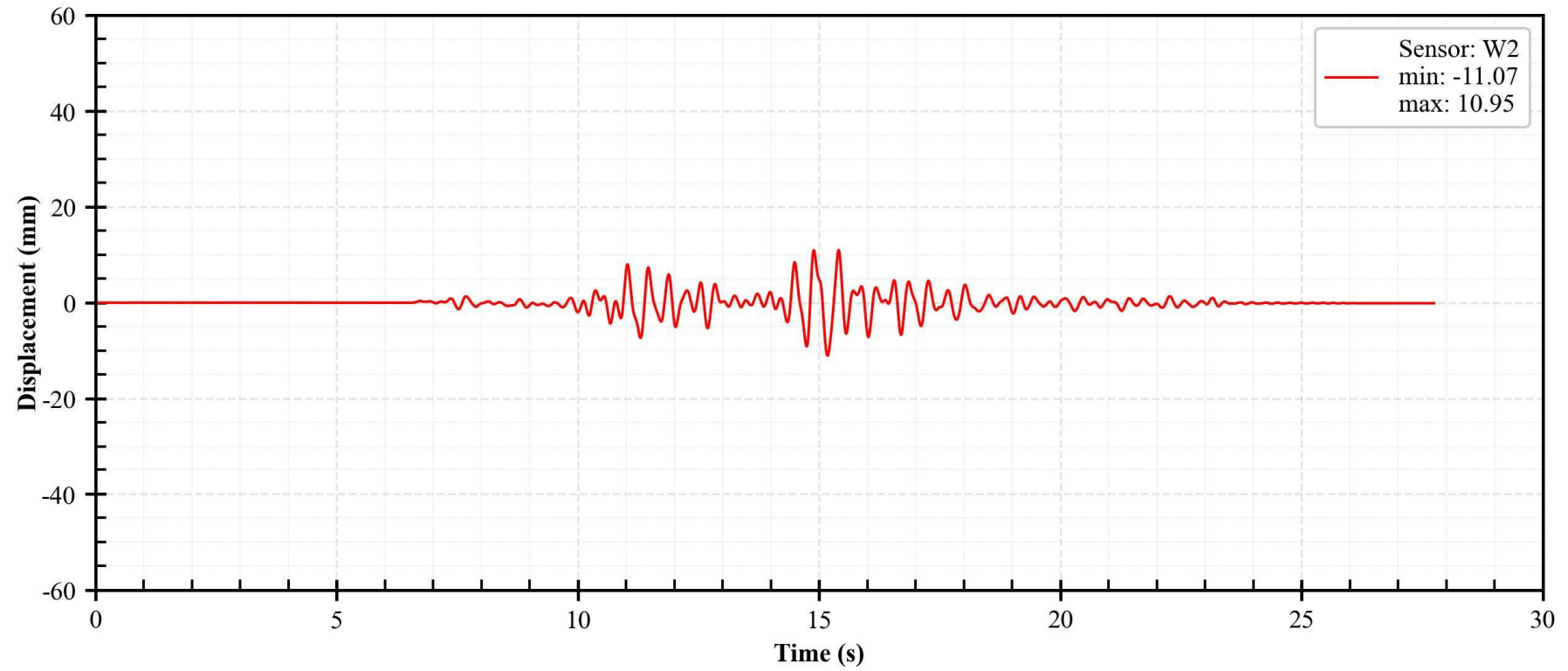


Figure 3.9.14 Characteristic results for phase B (earthquake EQ0,34g): Draw wire sensor 2

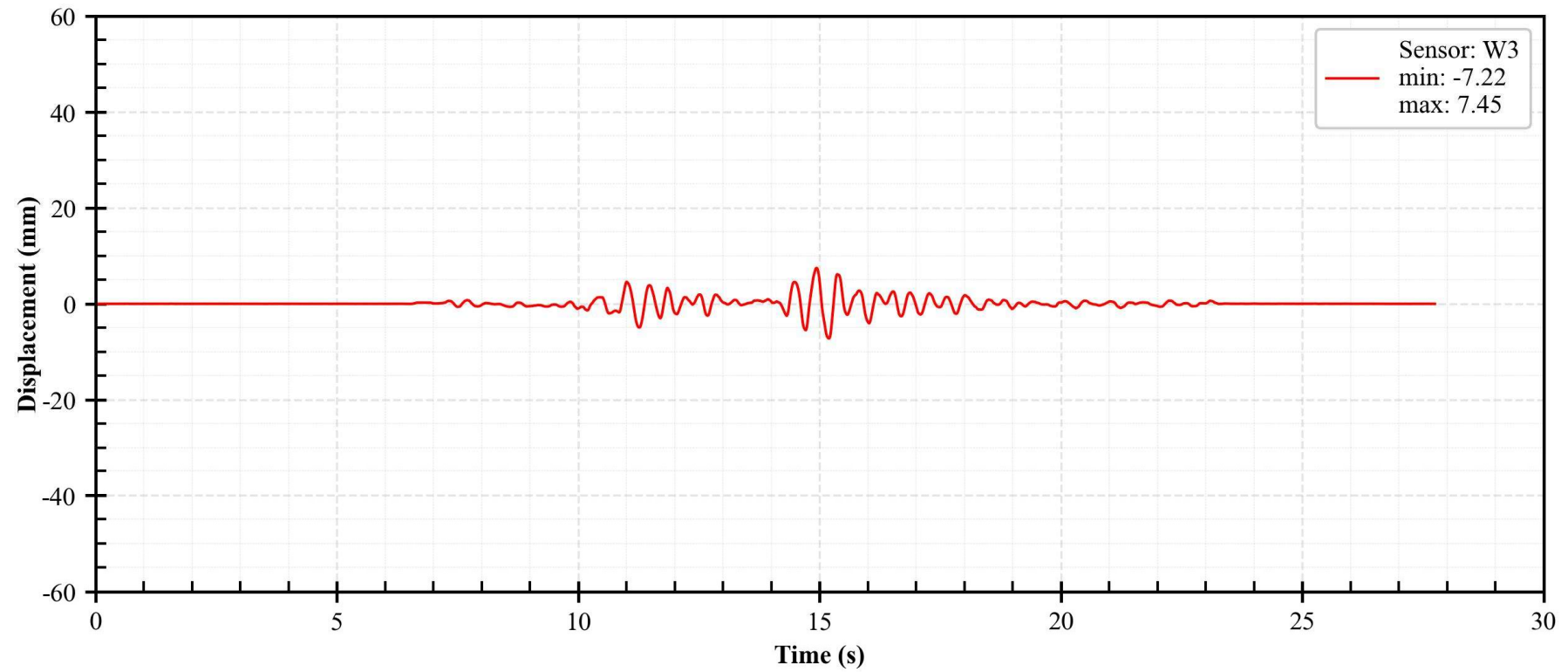


Figure 3.9.15 Characteristic results for phase B (earthquake EQ0,34g): Draw wire sensor 3

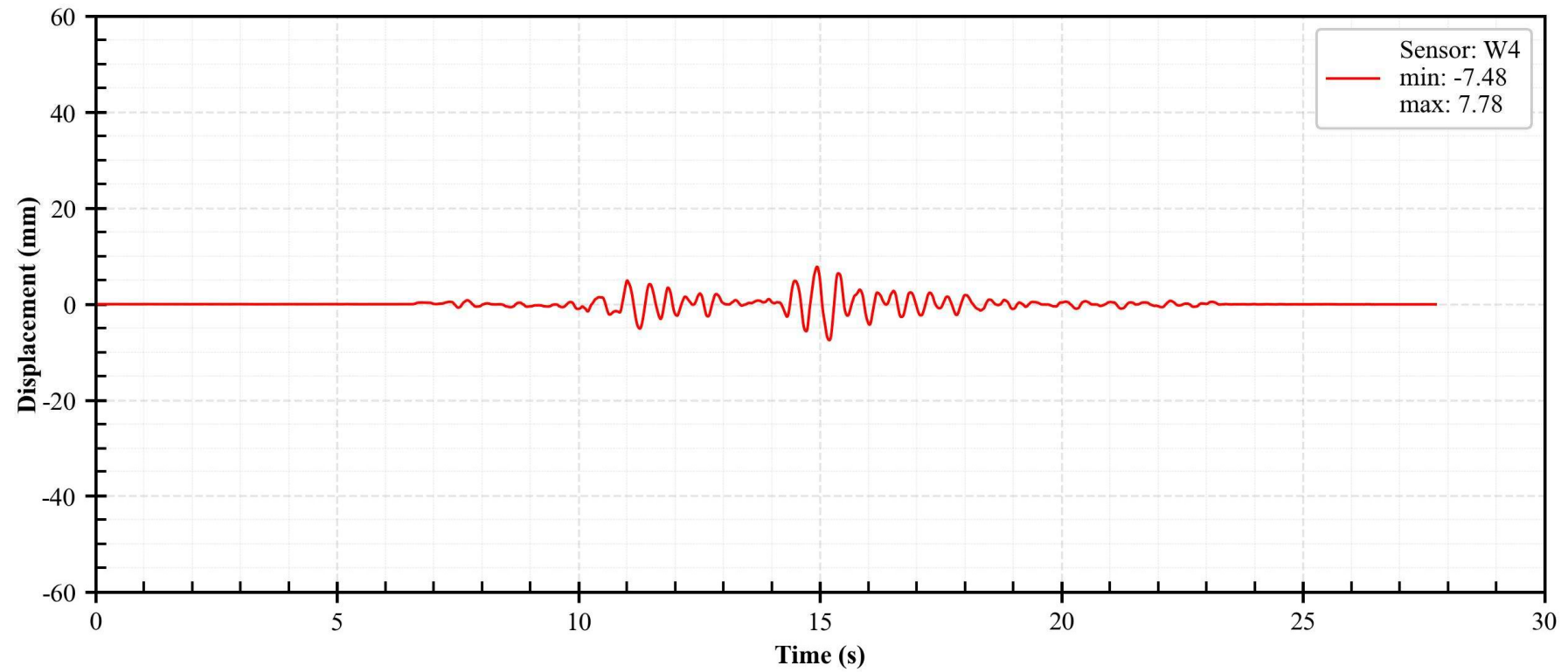


Figure 3.9.16 Characteristic results for phase B (earthquake EQ0,34g): Draw wire sensor 4

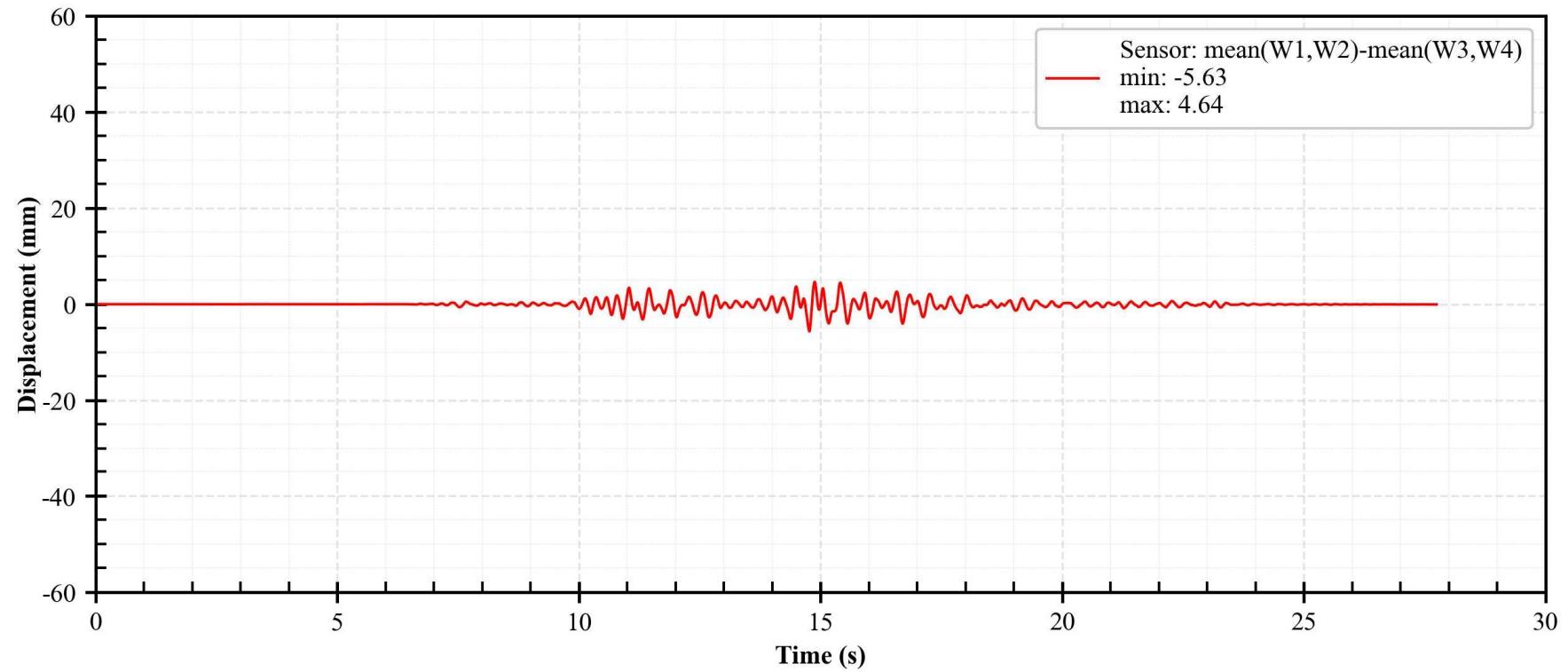


Figure 3.9.17 Characteristic results for phase B (earthquake EQ0,34g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.8.18, 3.8.19, 3.8.20, 3.8.21, 3.8.22, 3.8.23, 3.8.32, 3.8.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.9.24, 3.9.25, 3.9.26, 3.9.27, 3.9.28, 3.9.29 and 3.9.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 857 μstrain and minimum strain -481 μstrain . The residual strain is 3 μstrain . SG21 & SG22 are located on PUFJ.

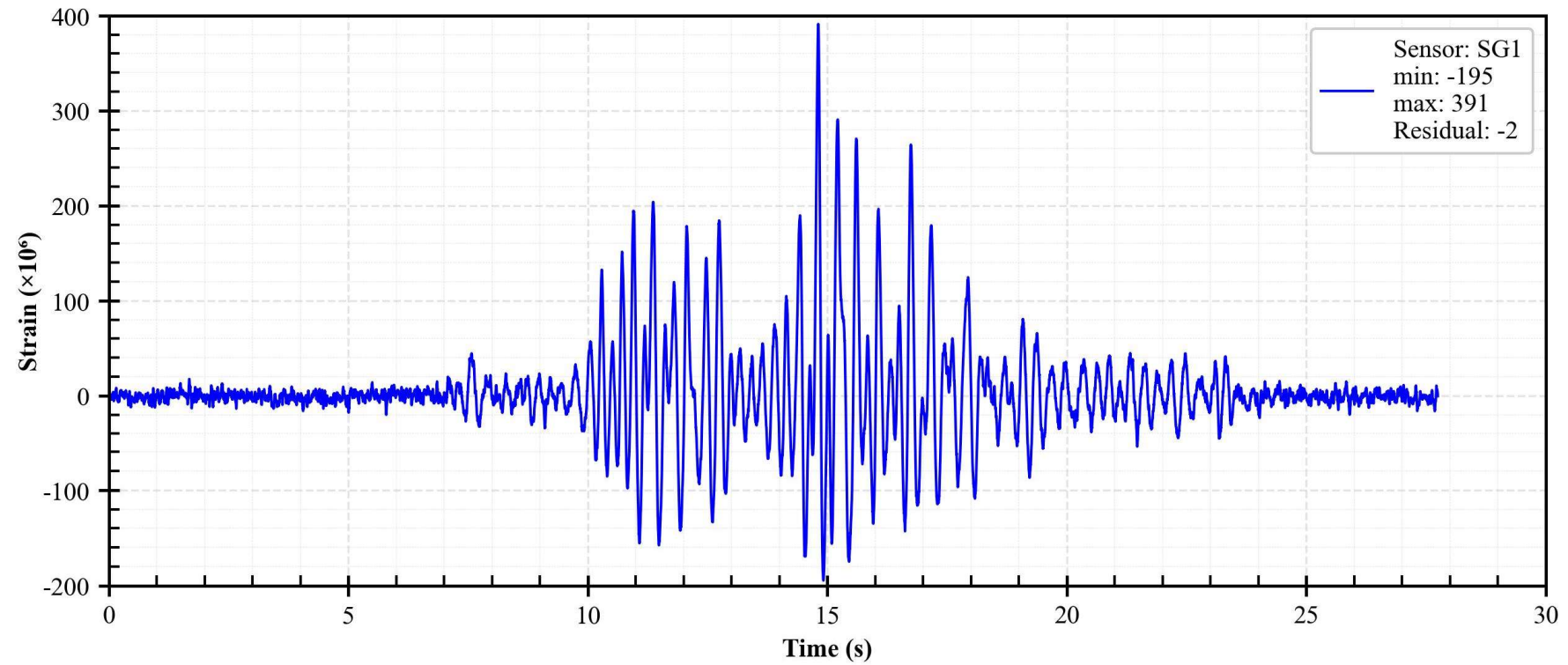


Figure 3.9.18 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 1

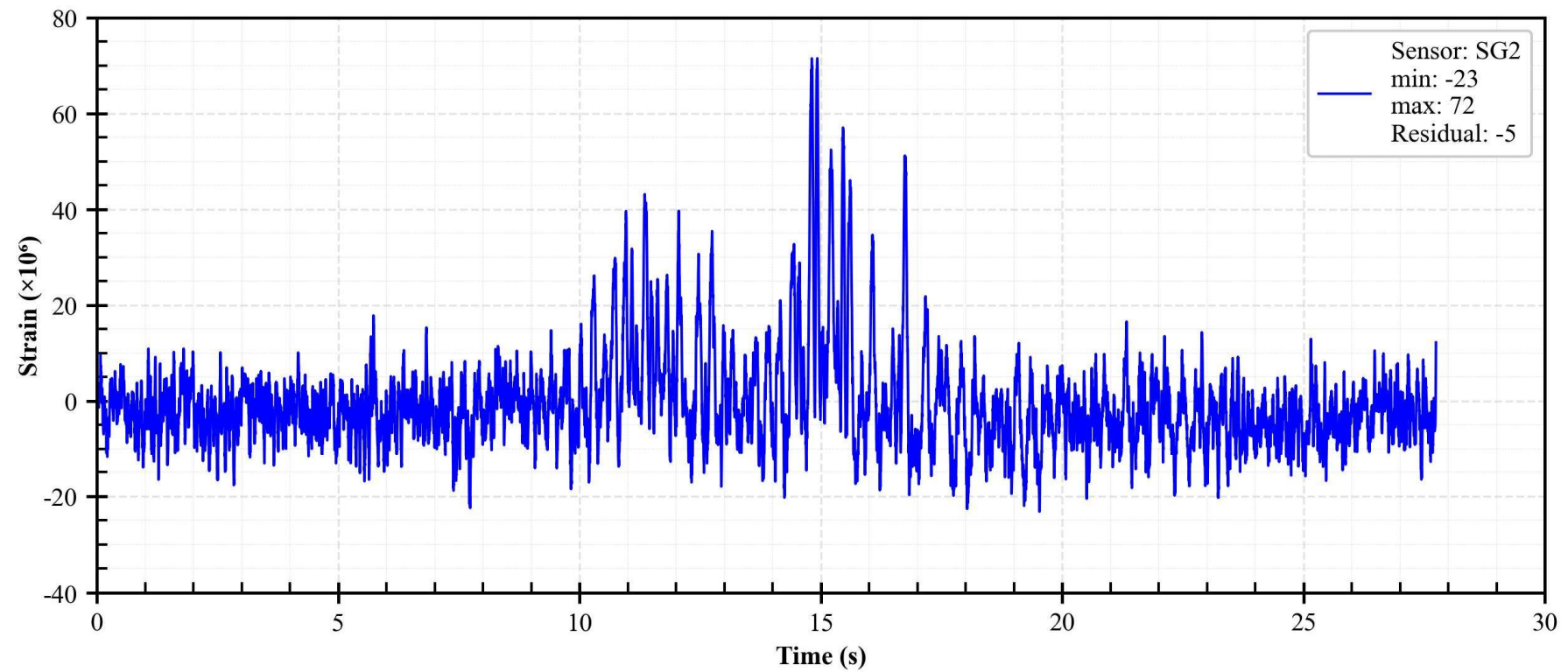


Figure 3.9.19 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 2

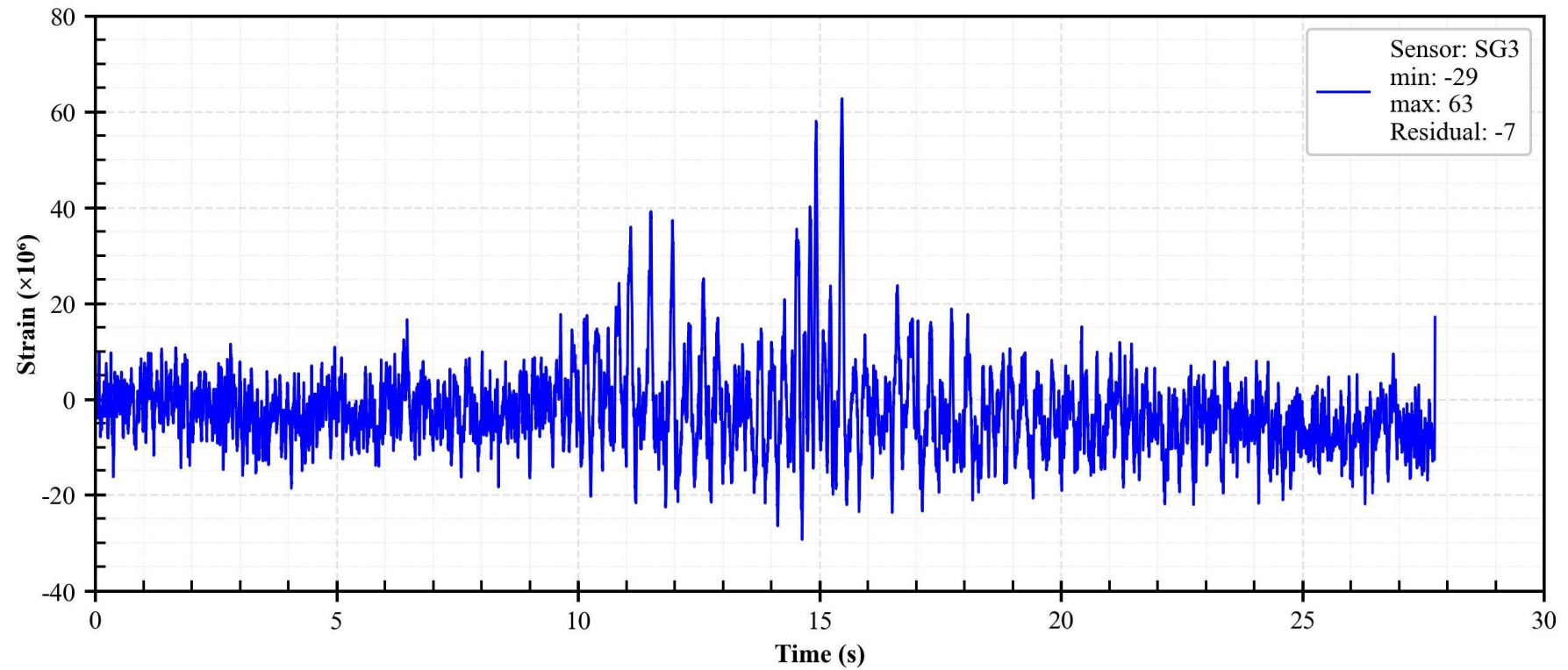


Figure 3.9.20 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 3

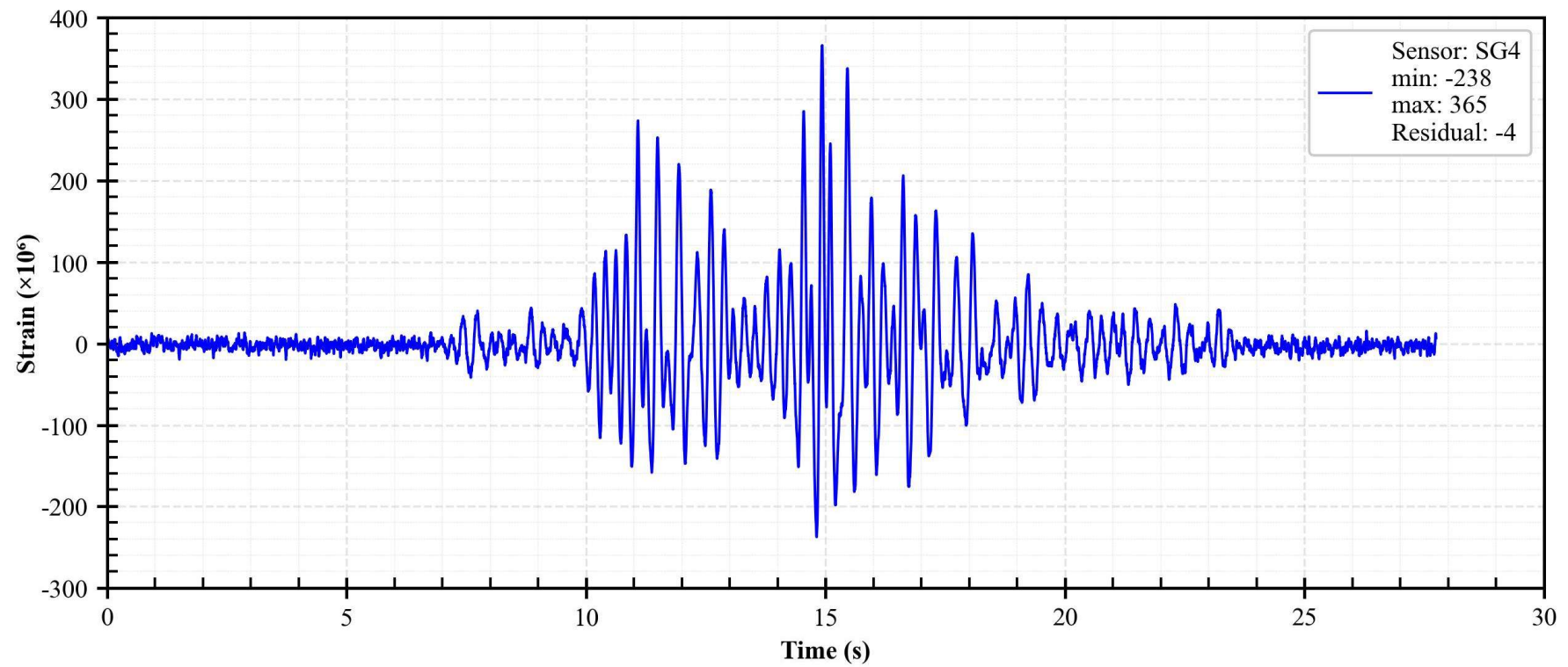


Figure 3.9.21 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 4

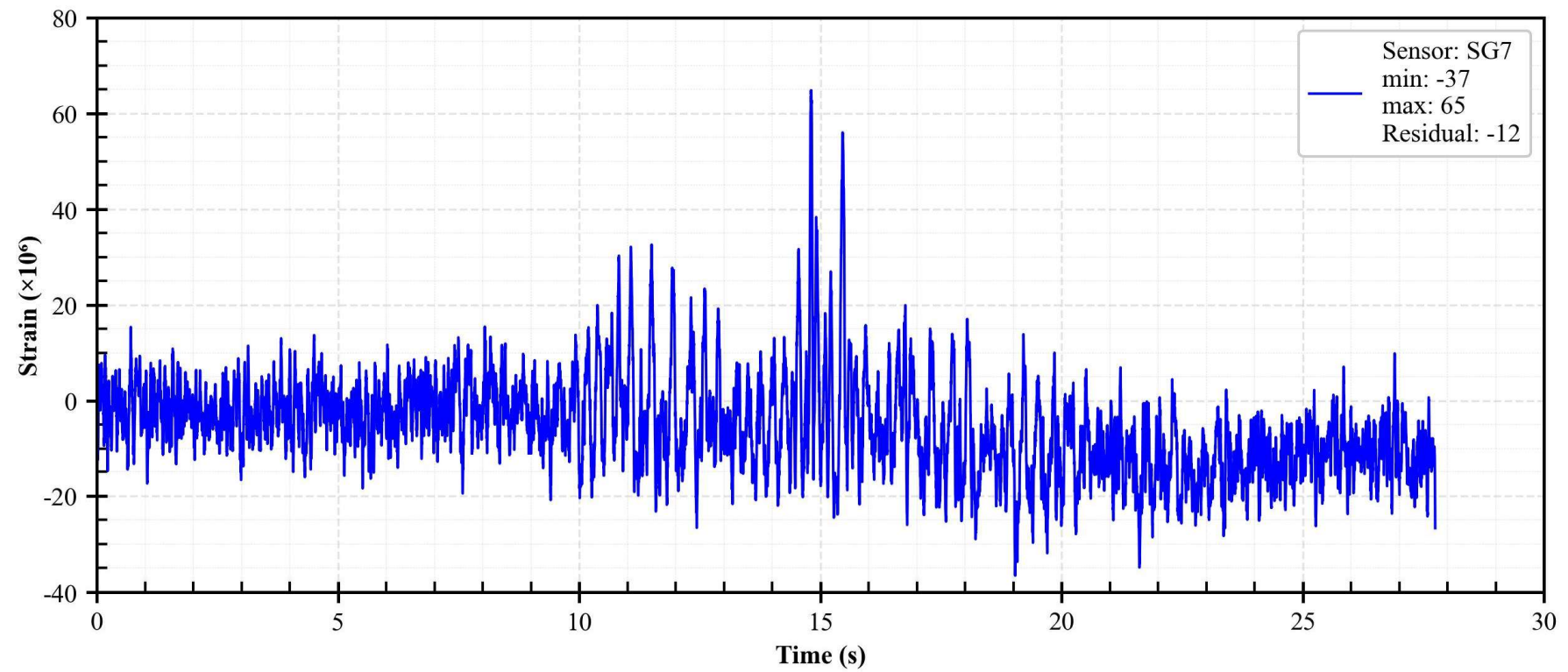


Figure 3.9.22 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 7

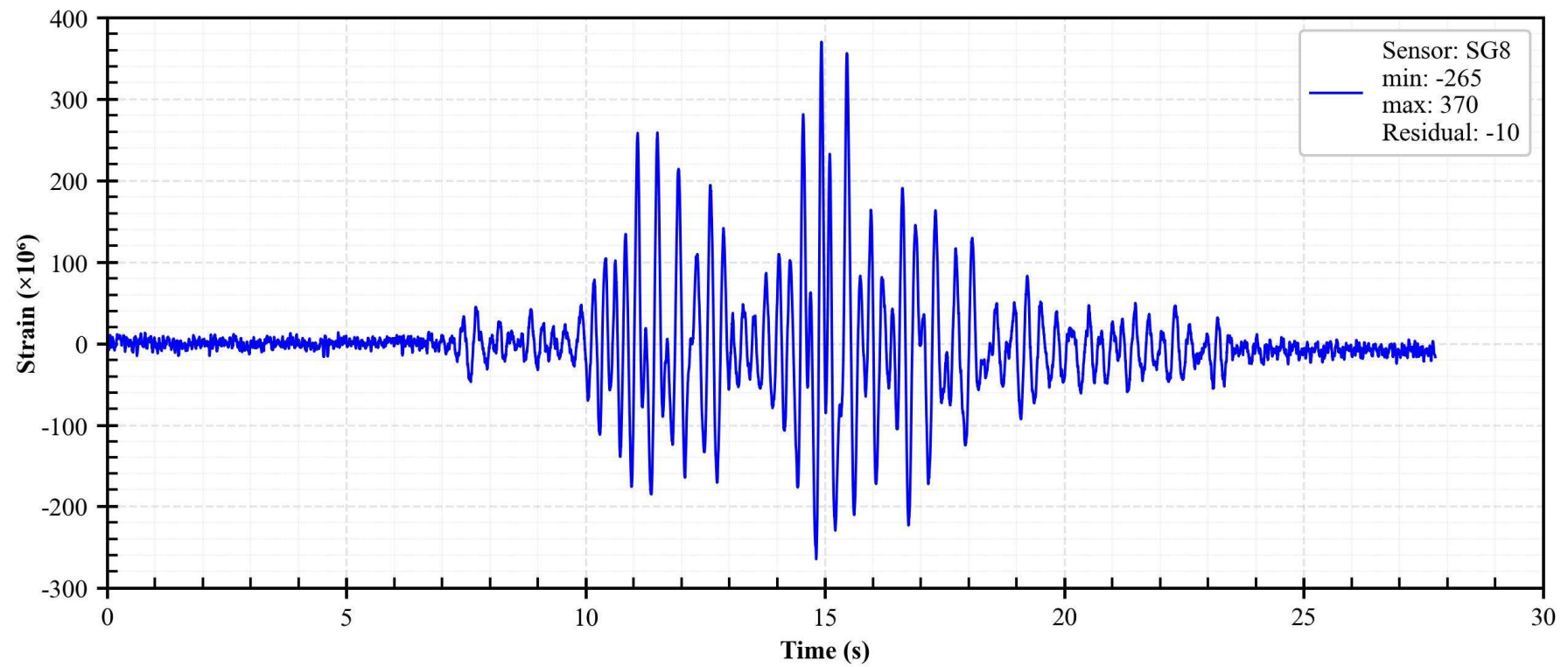


Figure 3.9.23 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 8

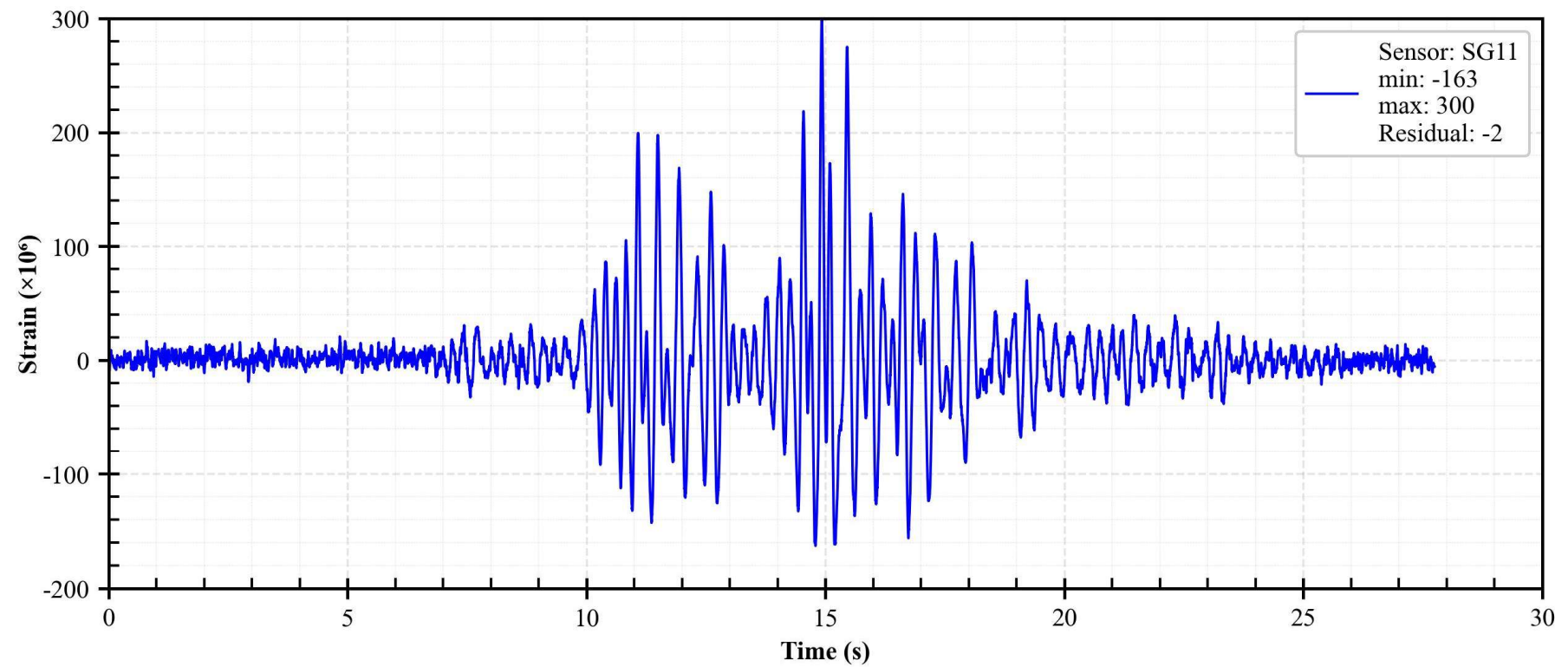


Figure 3.9.24 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 11

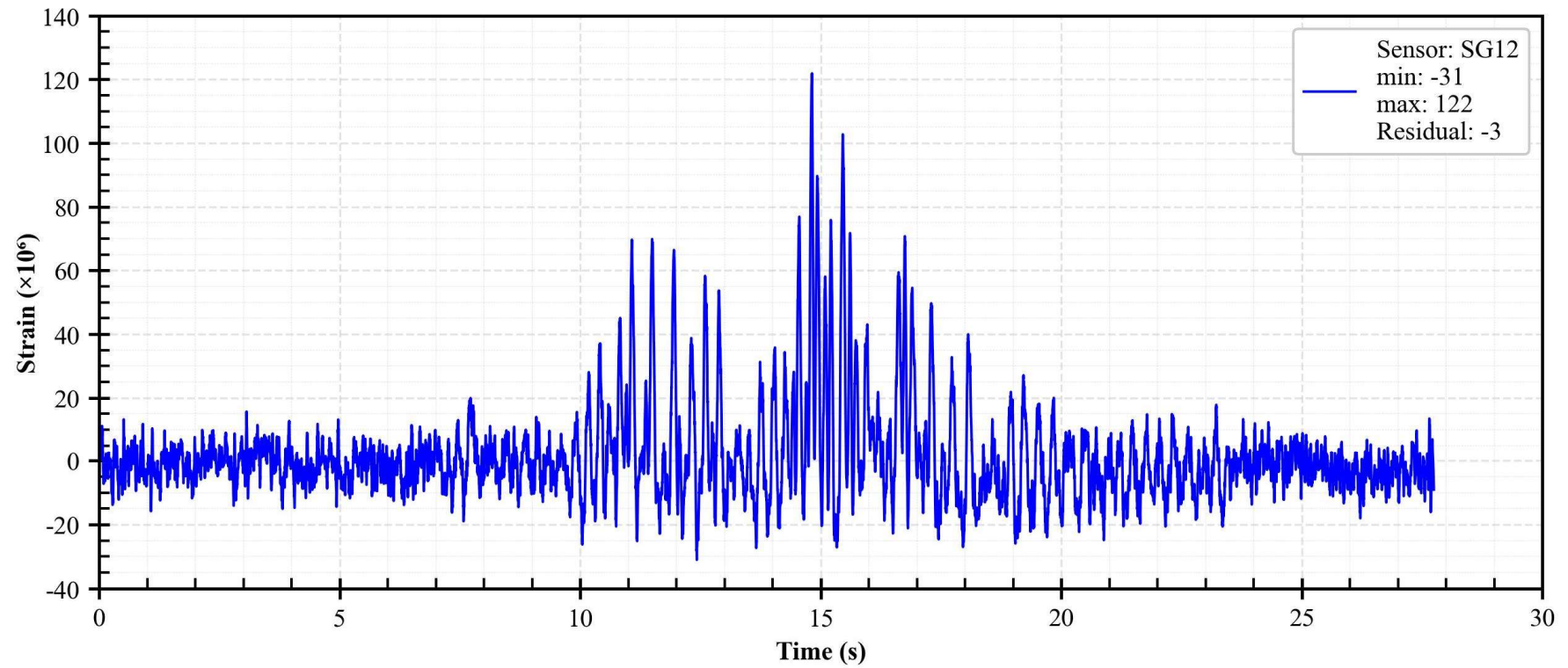


Figure 3.9.25 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 12

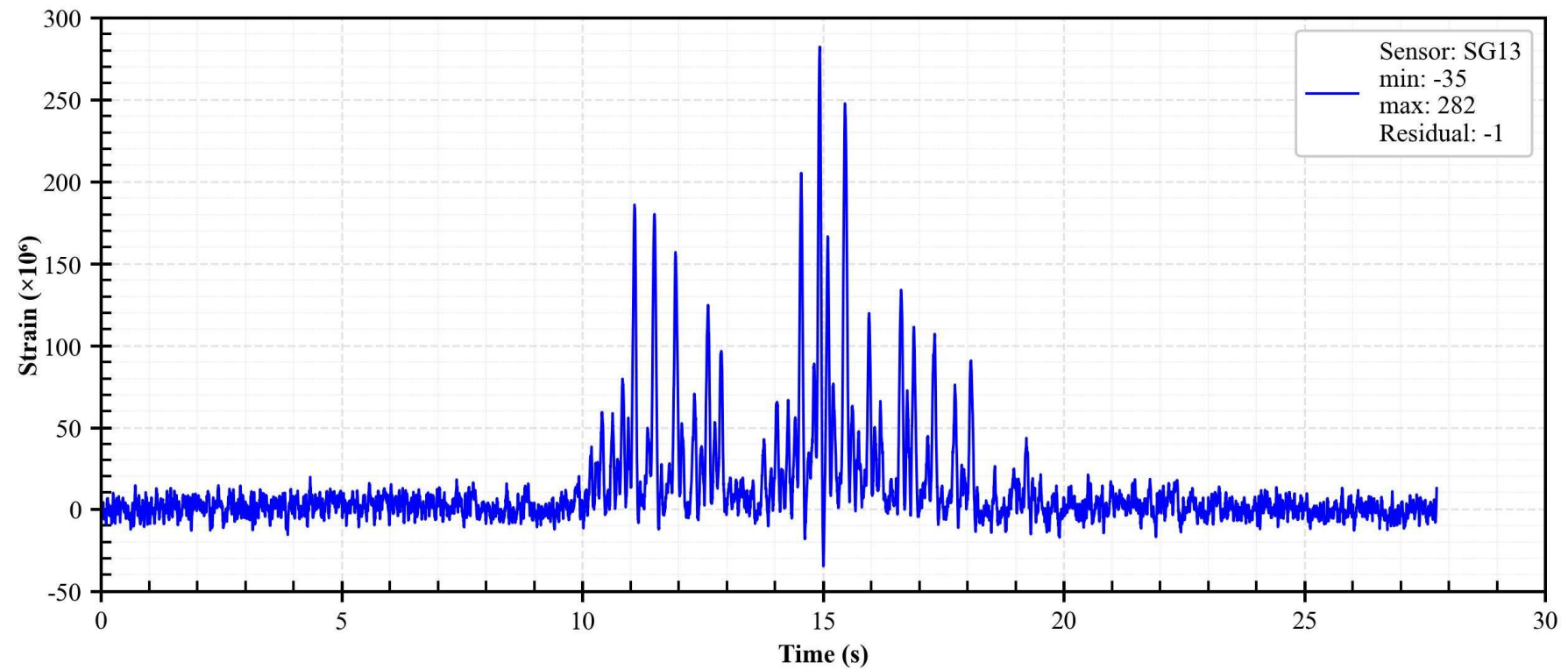


Figure 3.9.26 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 13

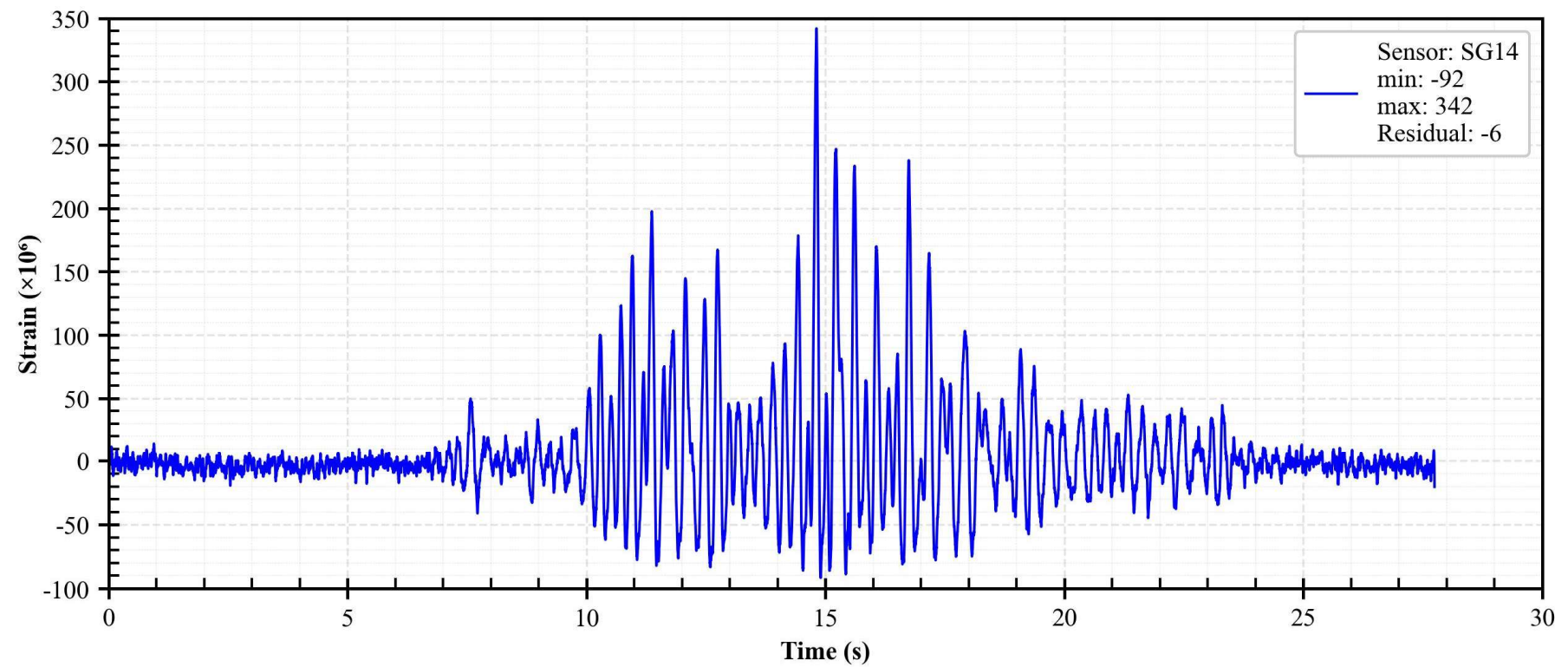


Figure 3.9.27 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 14

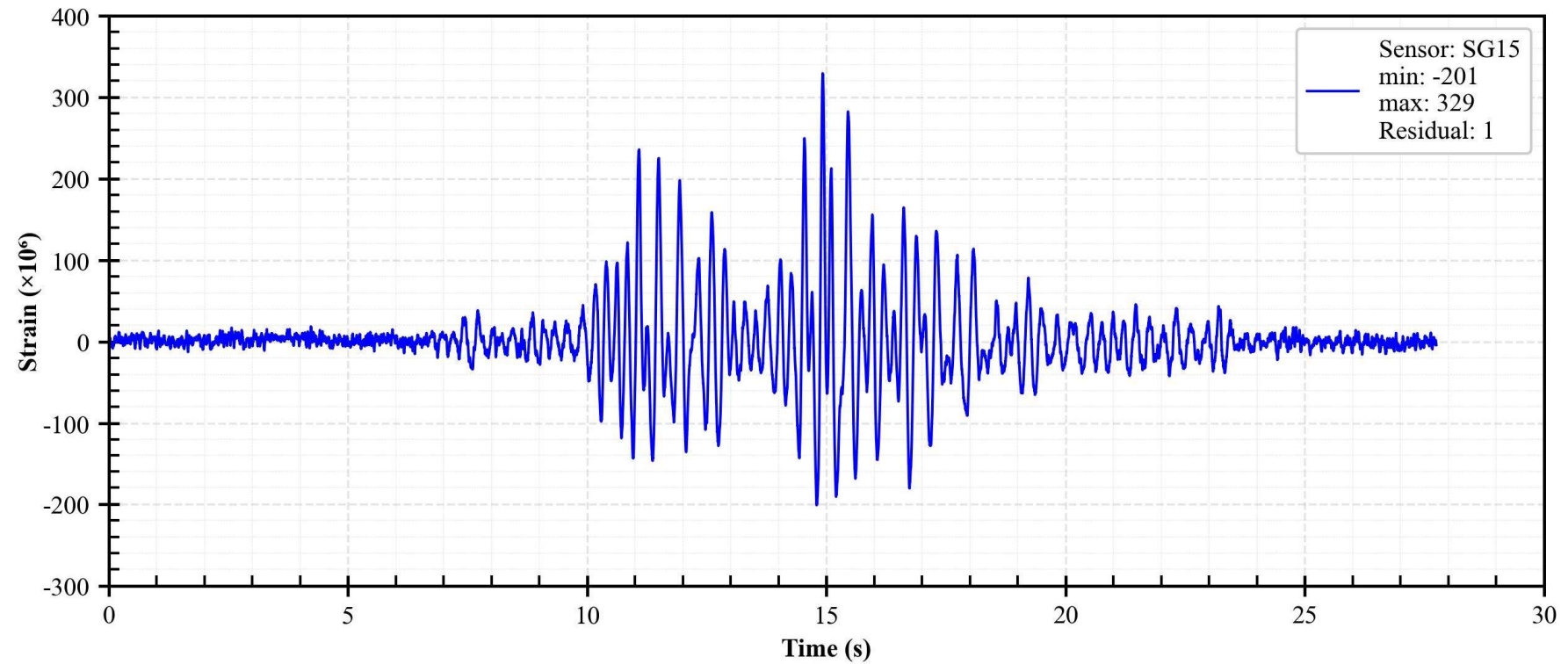


Figure 3.9.28 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 15

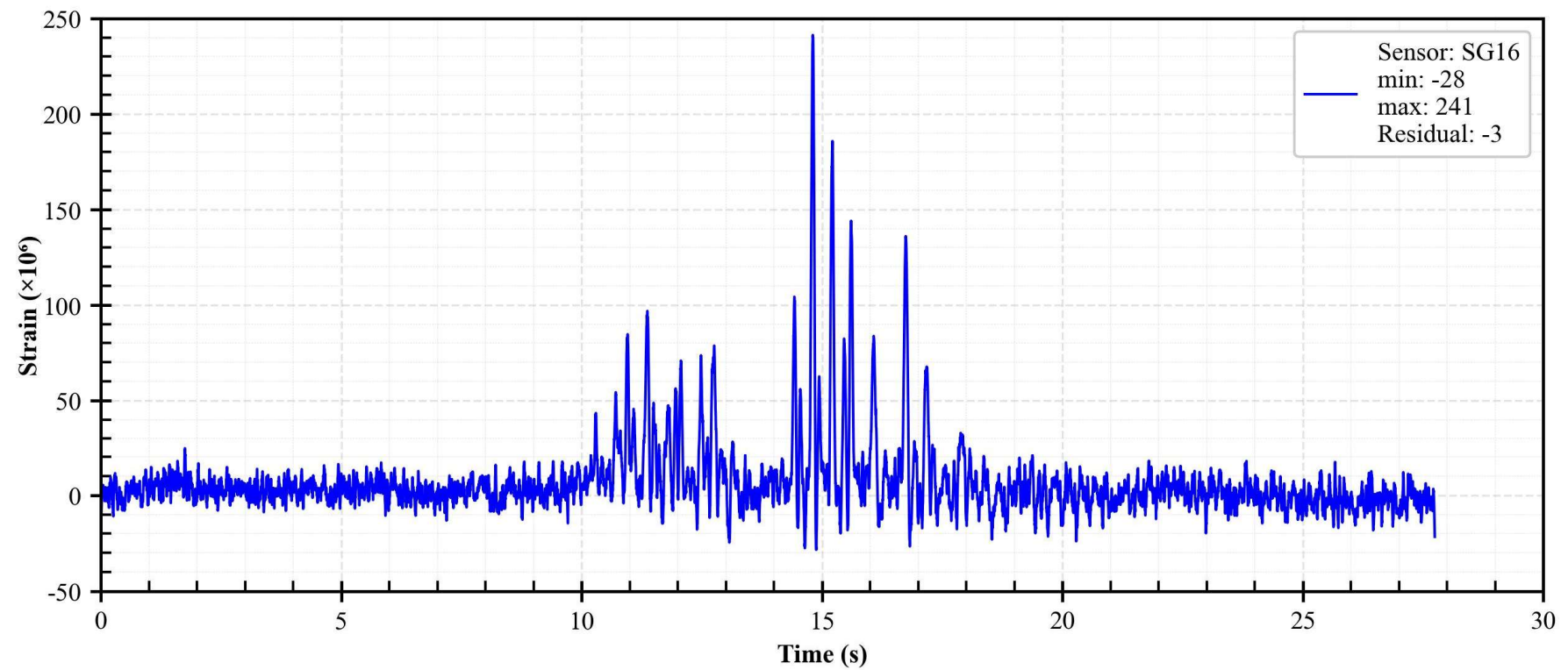


Figure 3.9.29 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 16

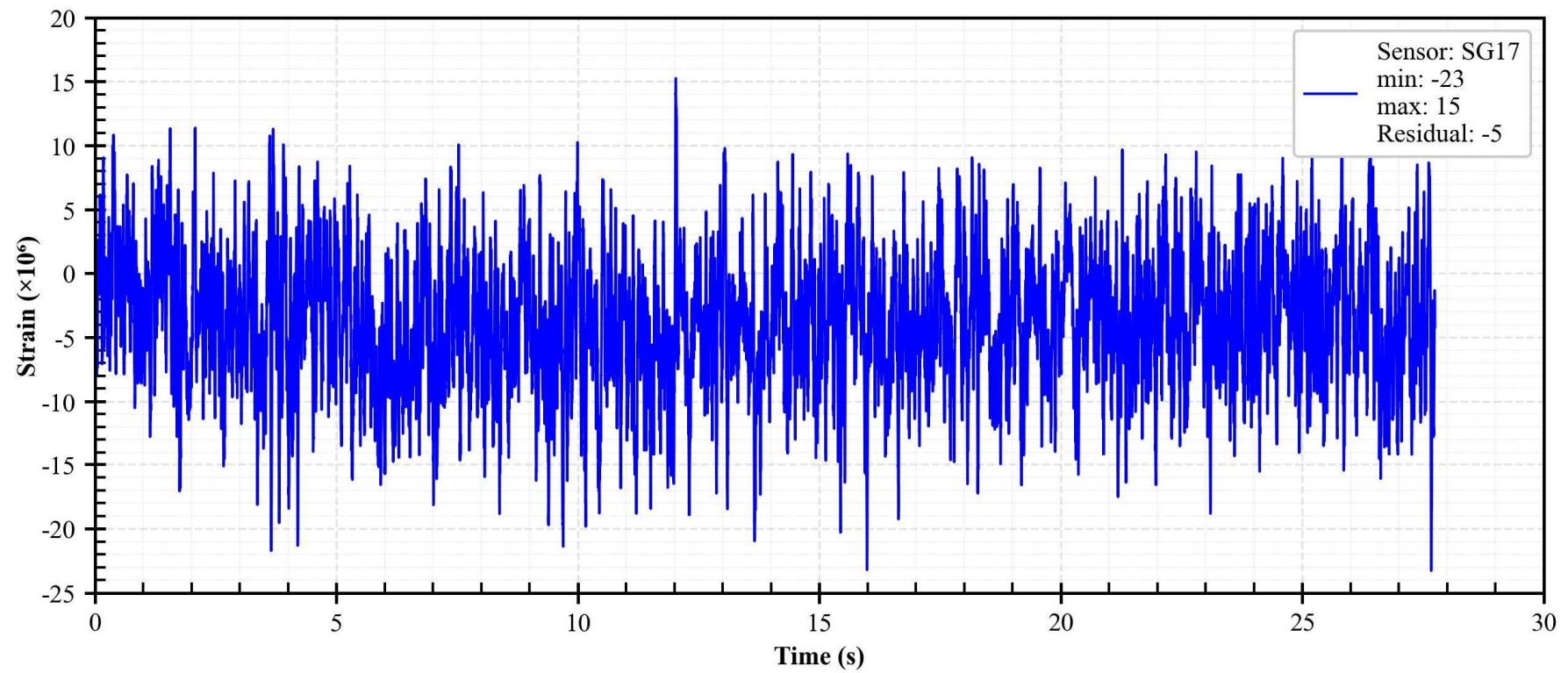


Figure 3.9.30 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 17

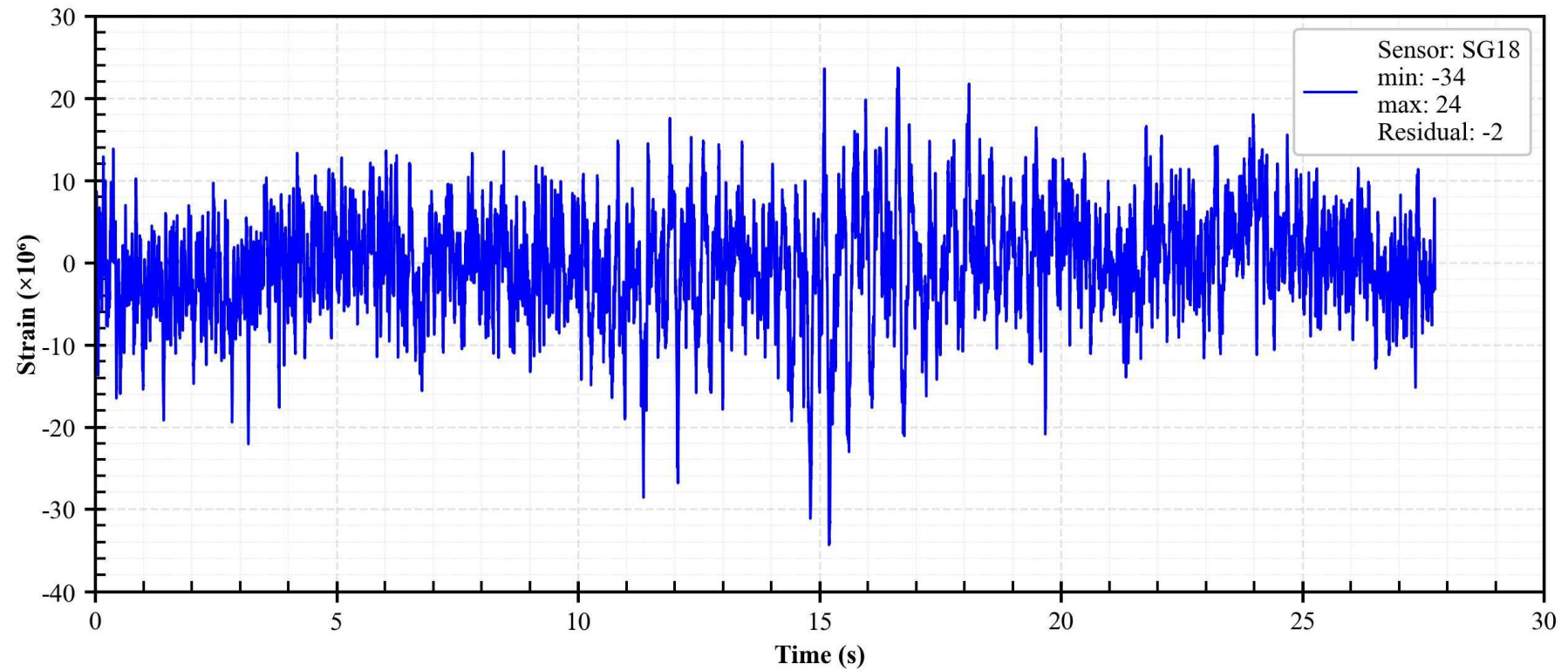


Figure 3.9.31 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 18

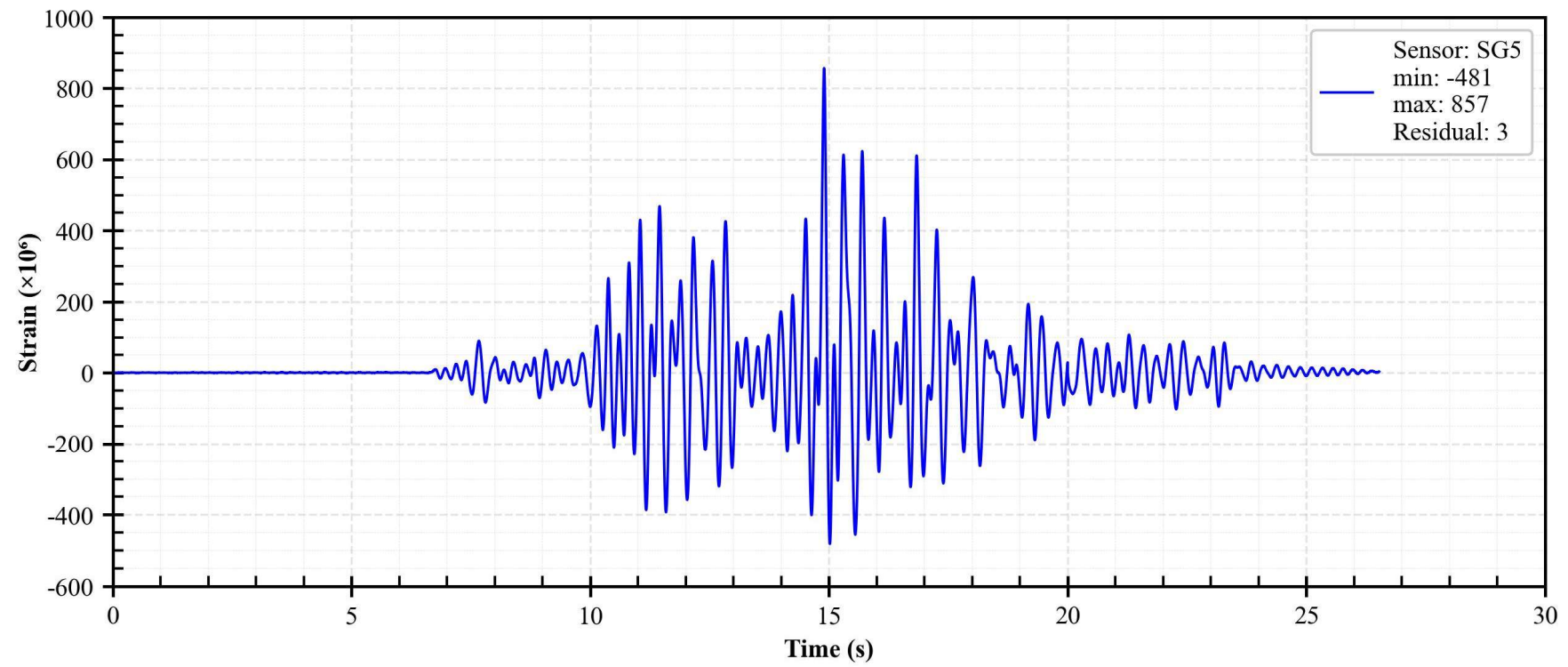


Figure 3.9.32 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 5

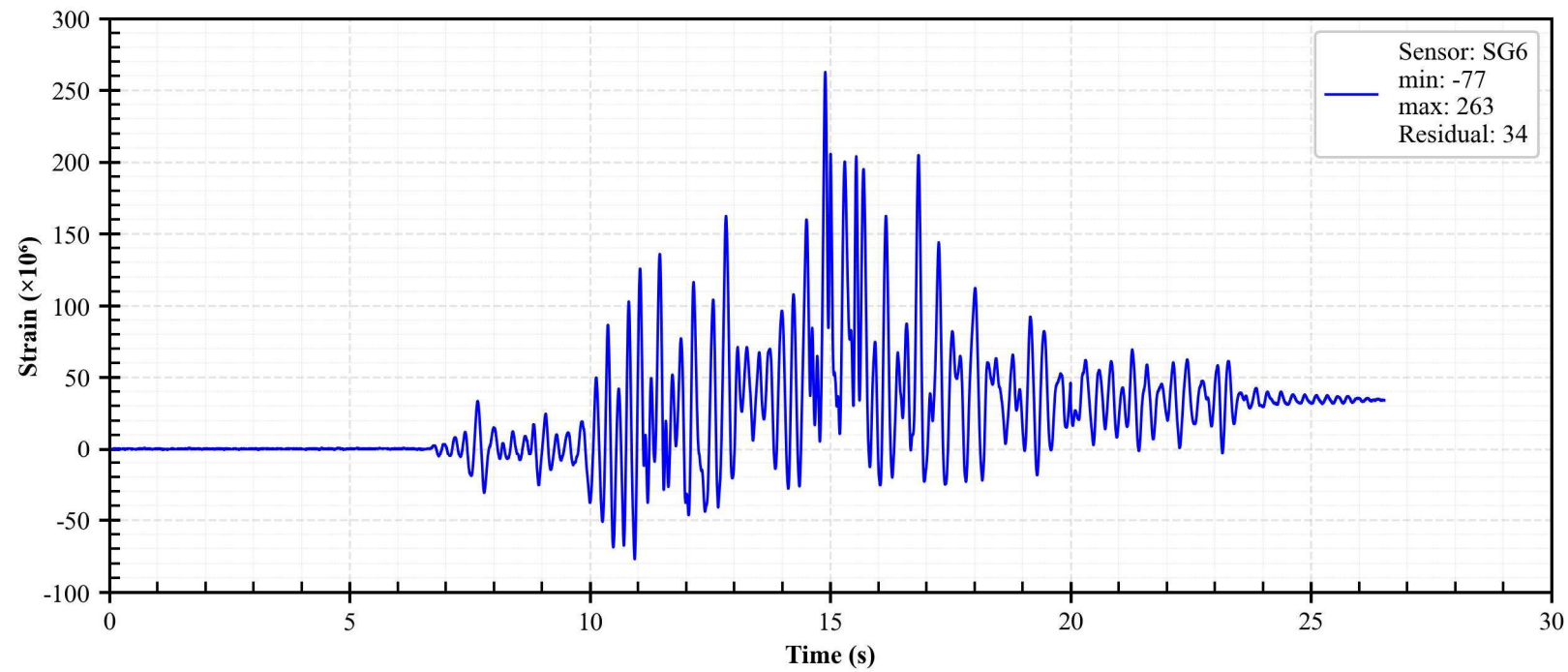


Figure 3.9.33 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 6

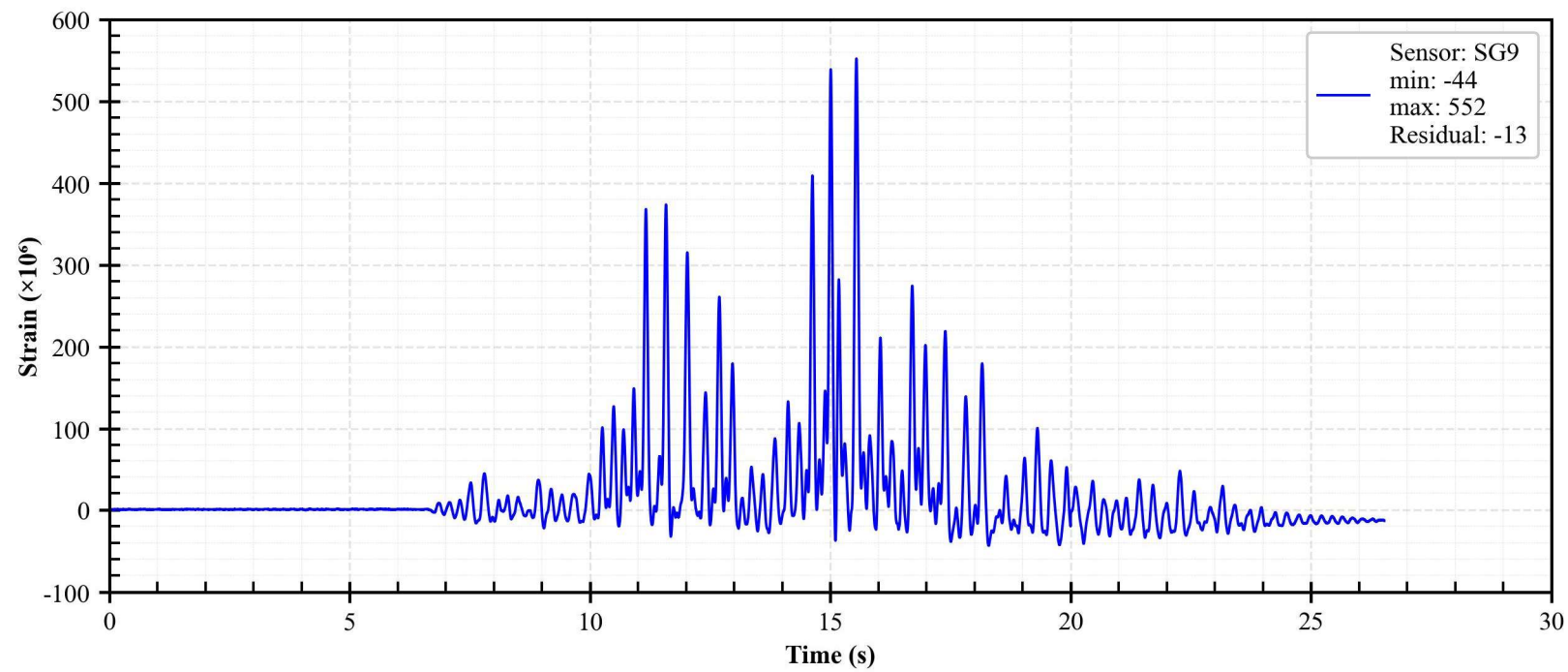


Figure 3.9.34 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 9

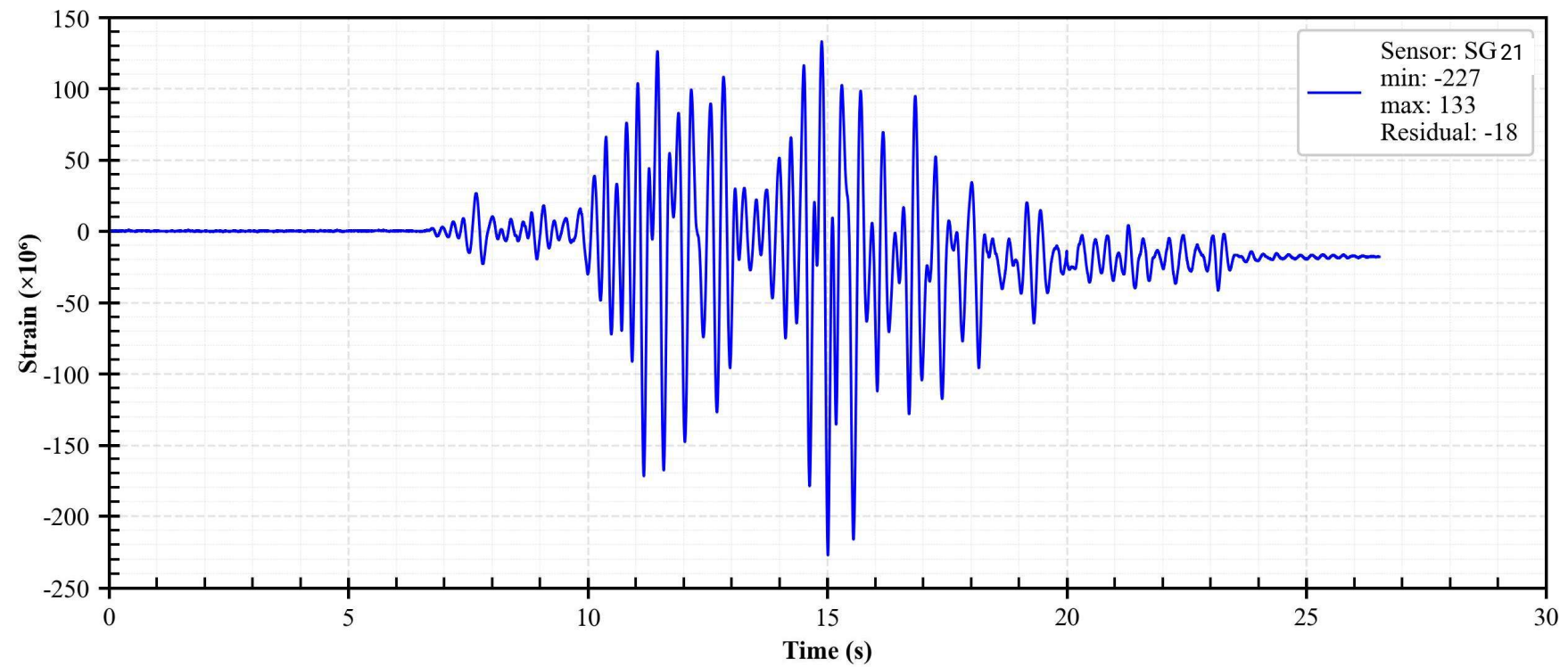


Figure 3.9.35 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 21 (PUFJ, column 2)

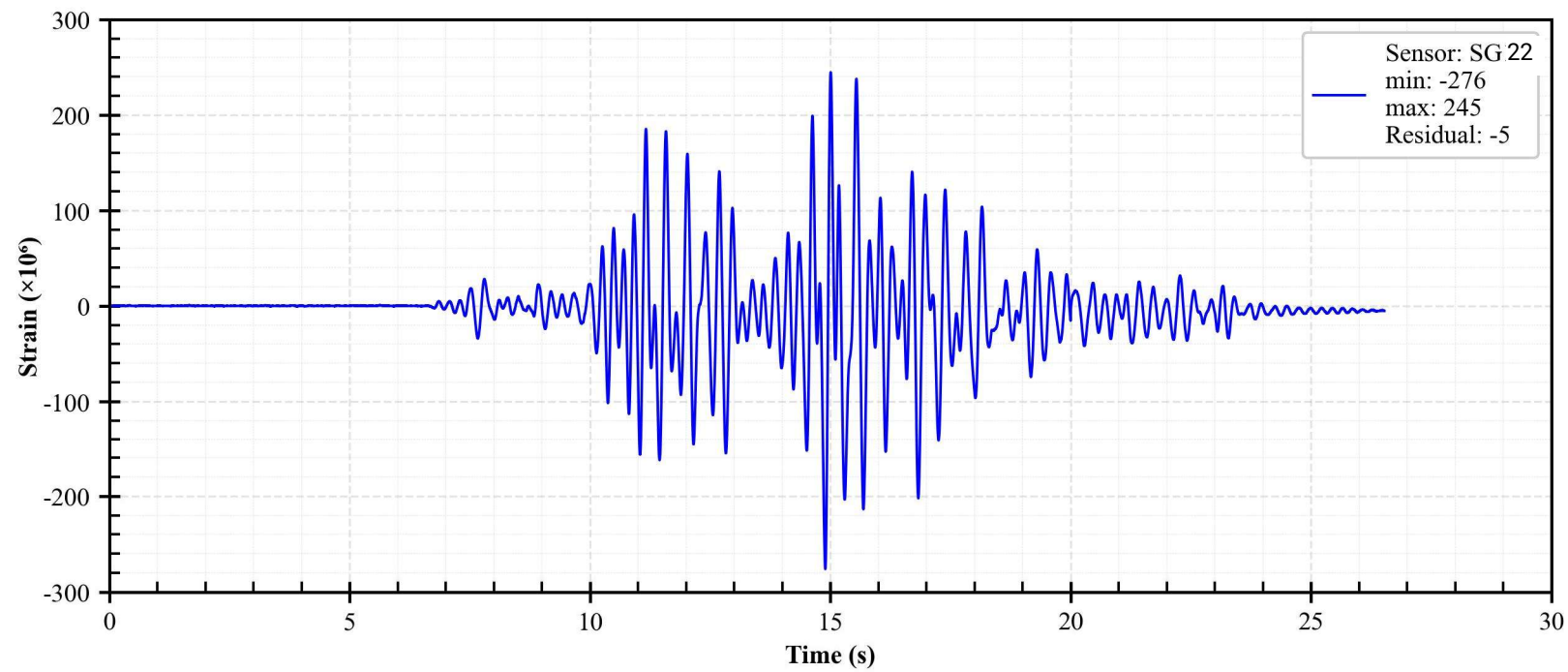


Figure 3.9.36 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 22 (PUFJ, column 2)

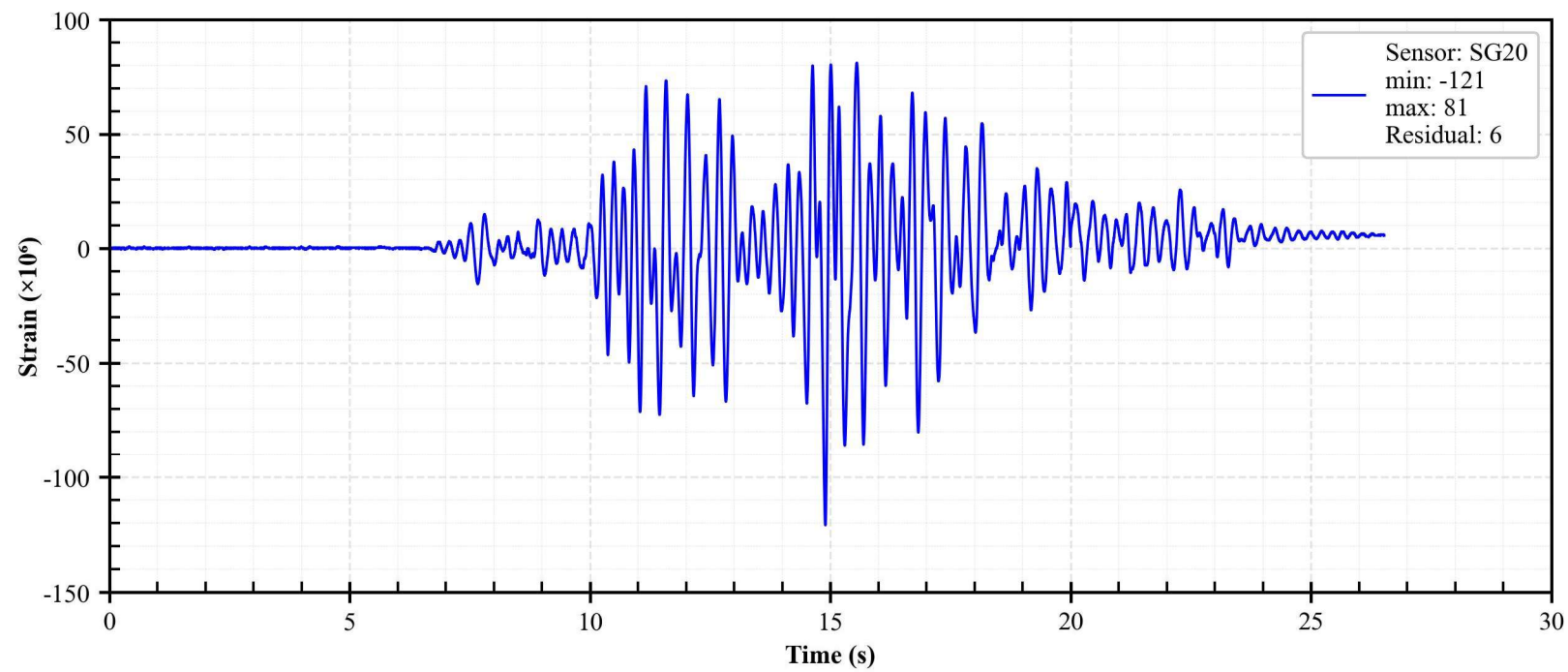


Figure 3.9.37 Characteristic results for phase B (earthquake EQ0,34g): strain gauge 20

3.10 White noise before EQ0,5g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,5g. The max acceleration at the slab level on the accelerometer acc4 is 0.17g. The max acceleration at the foundation level on the accelerometer acc10 is 0,08g.

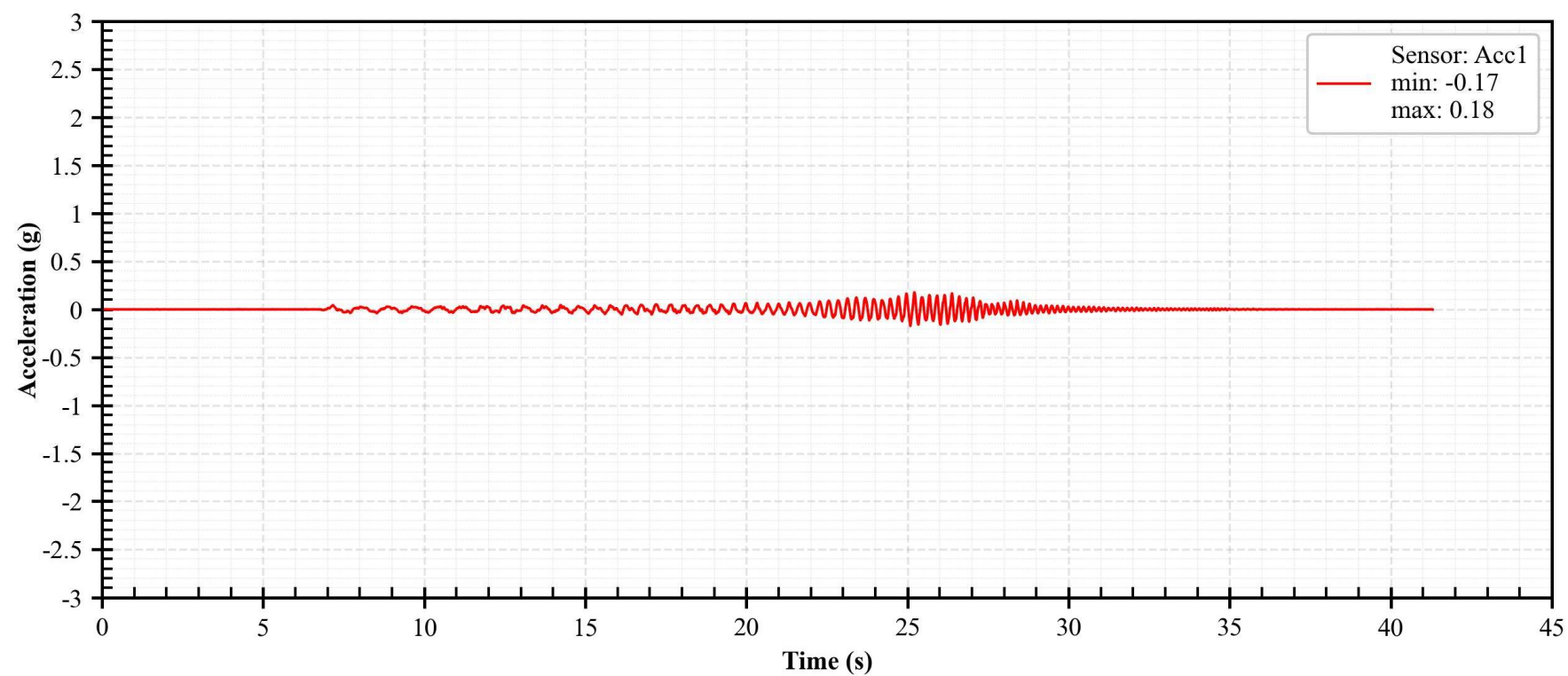


Figure 3.10.1 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 1

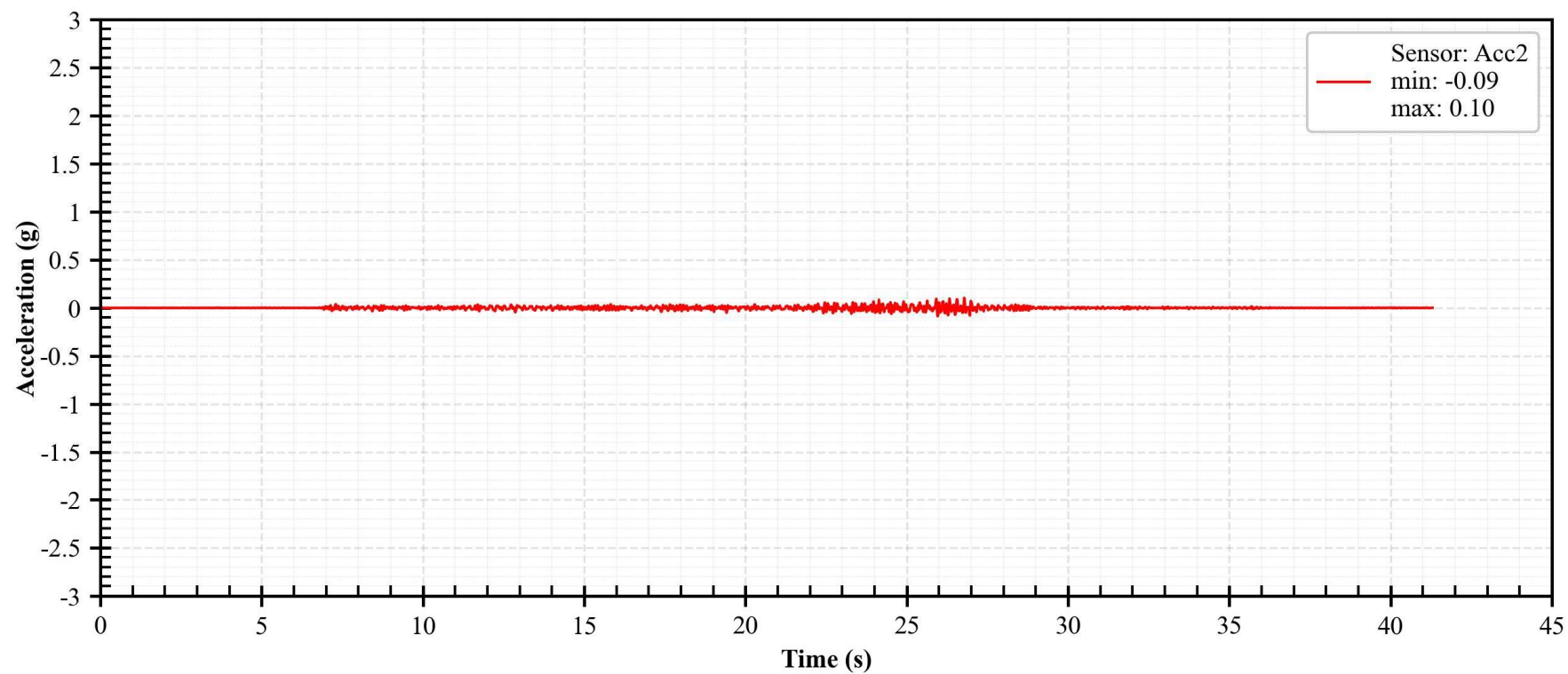


Figure 3.10.2 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 2

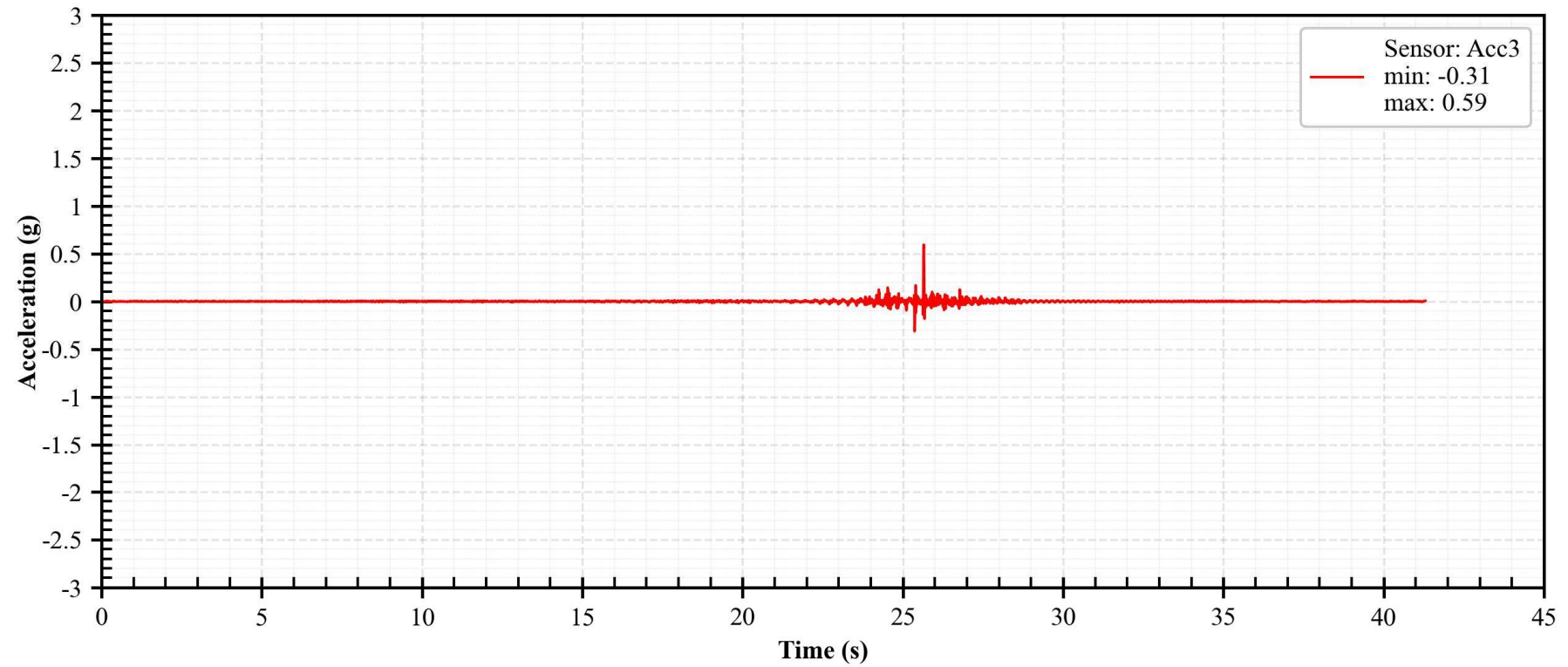


Figure 3.10.3 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 3

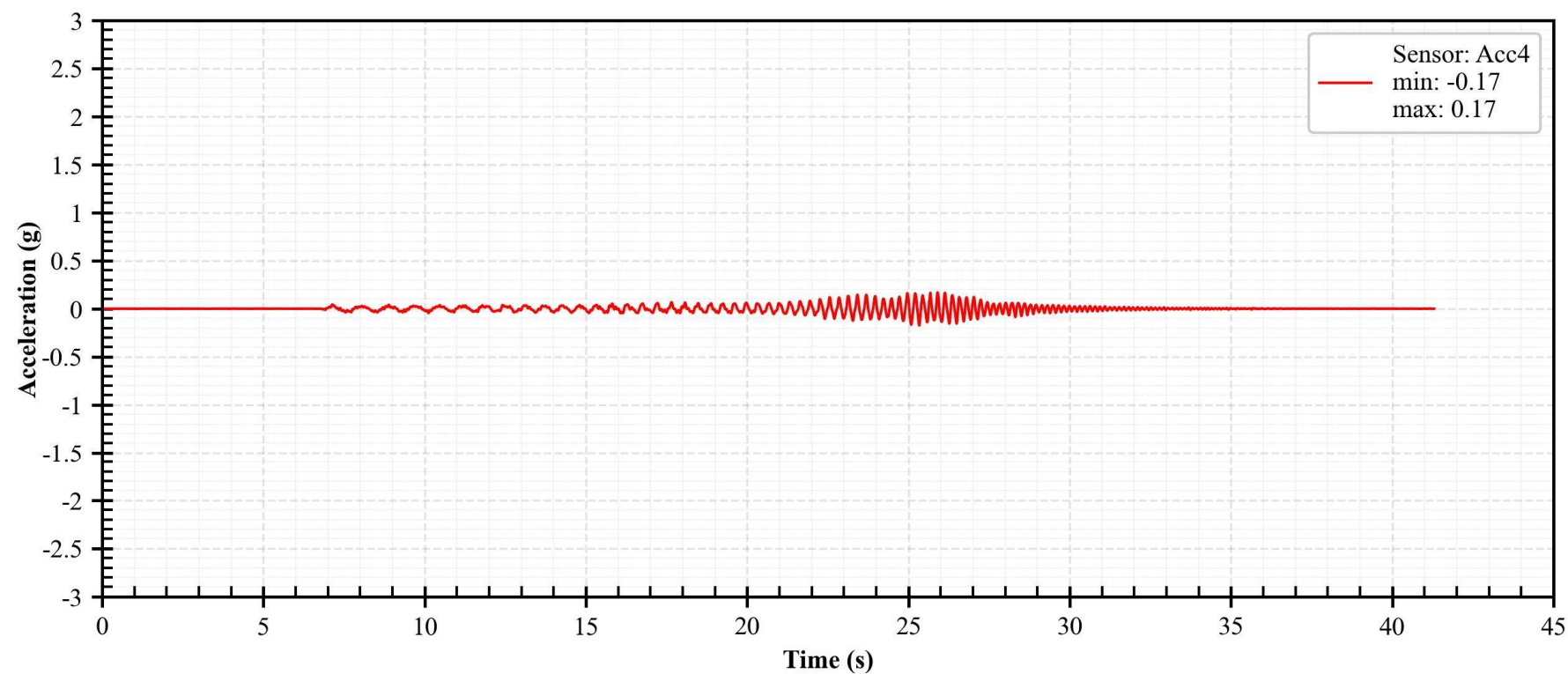


Figure 3.10.4 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 4

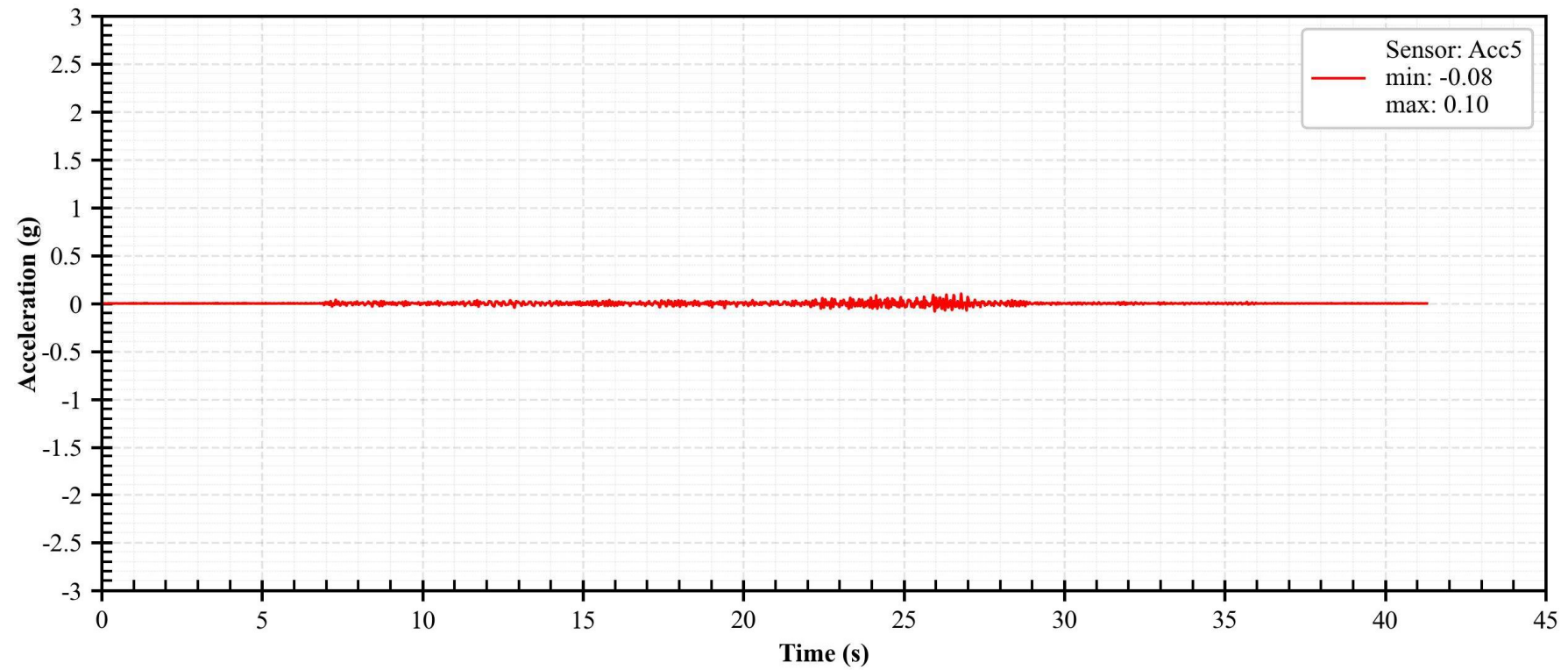


Figure 3.10.5 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 5

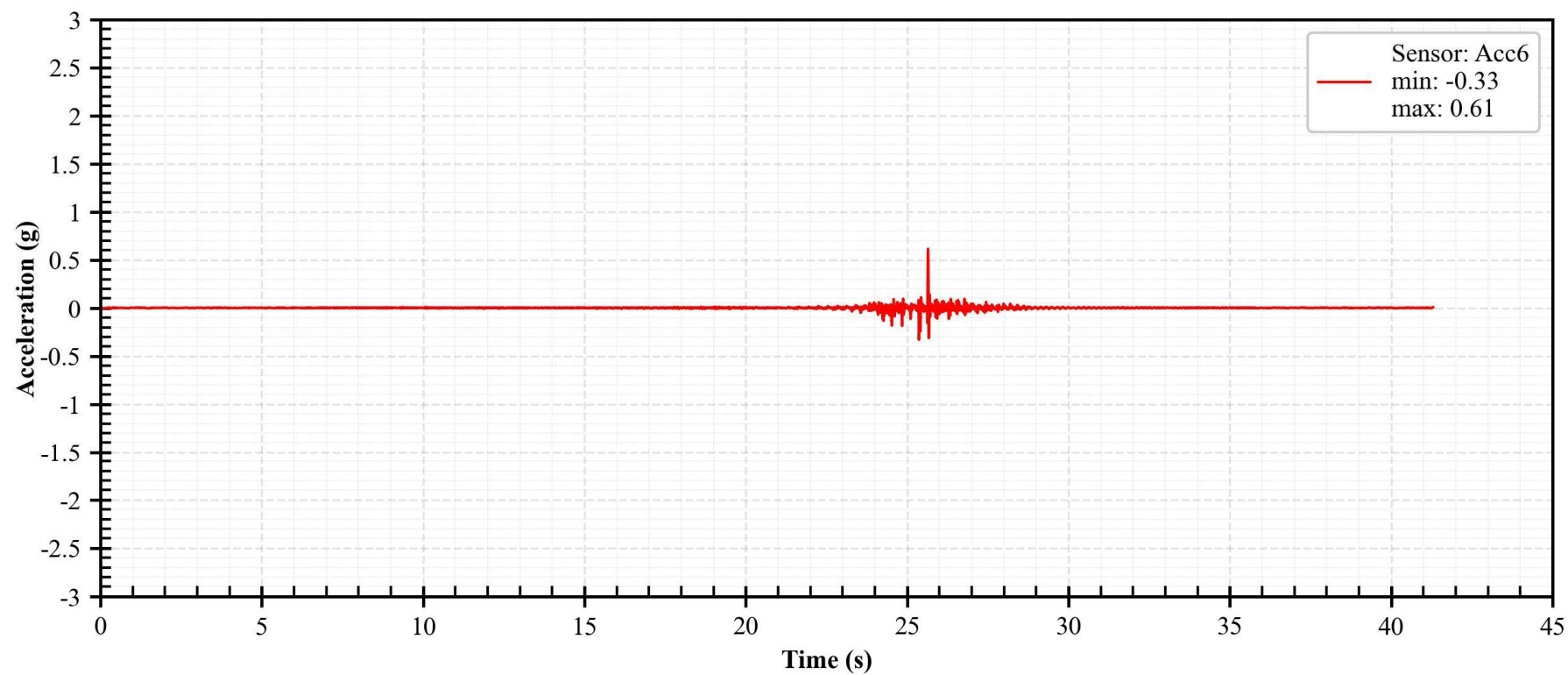


Figure 3.10.6 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 6

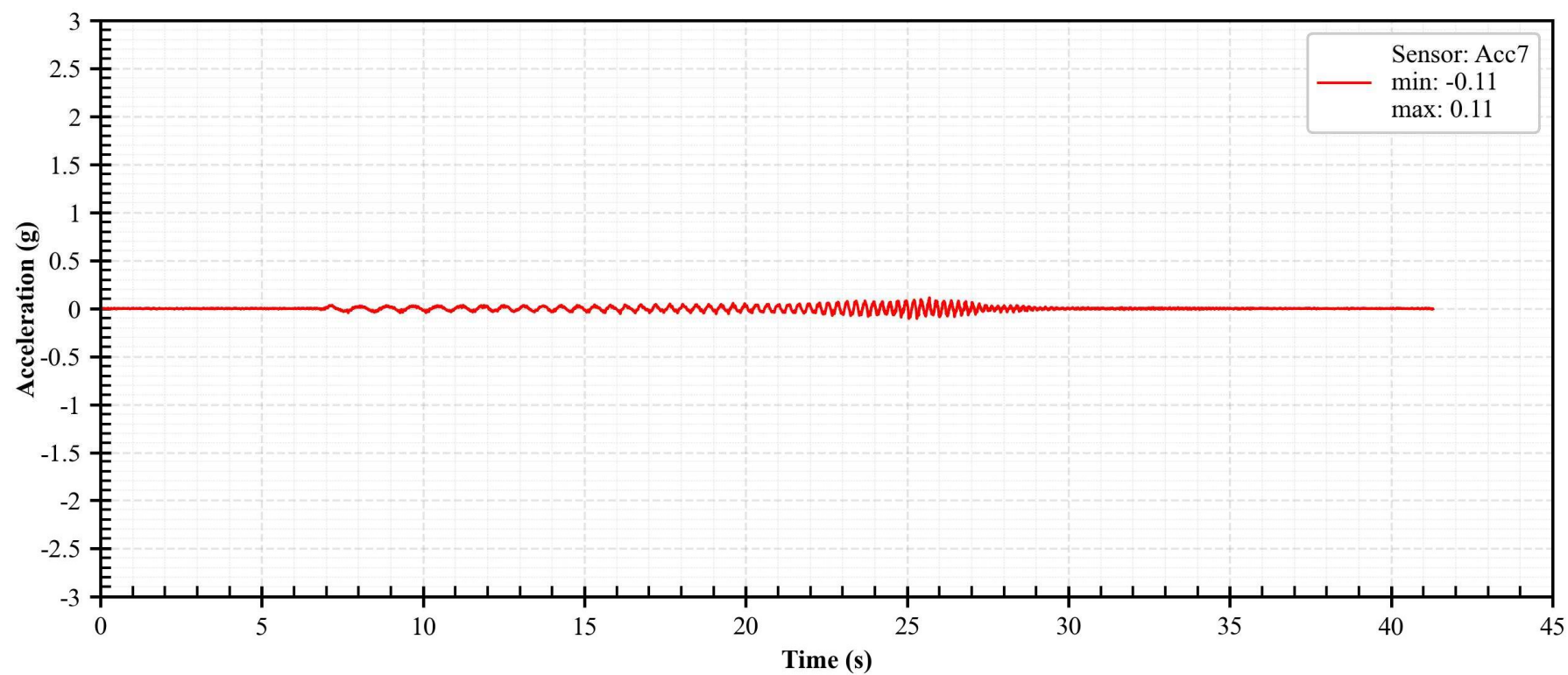


Figure 3.10.7 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 7

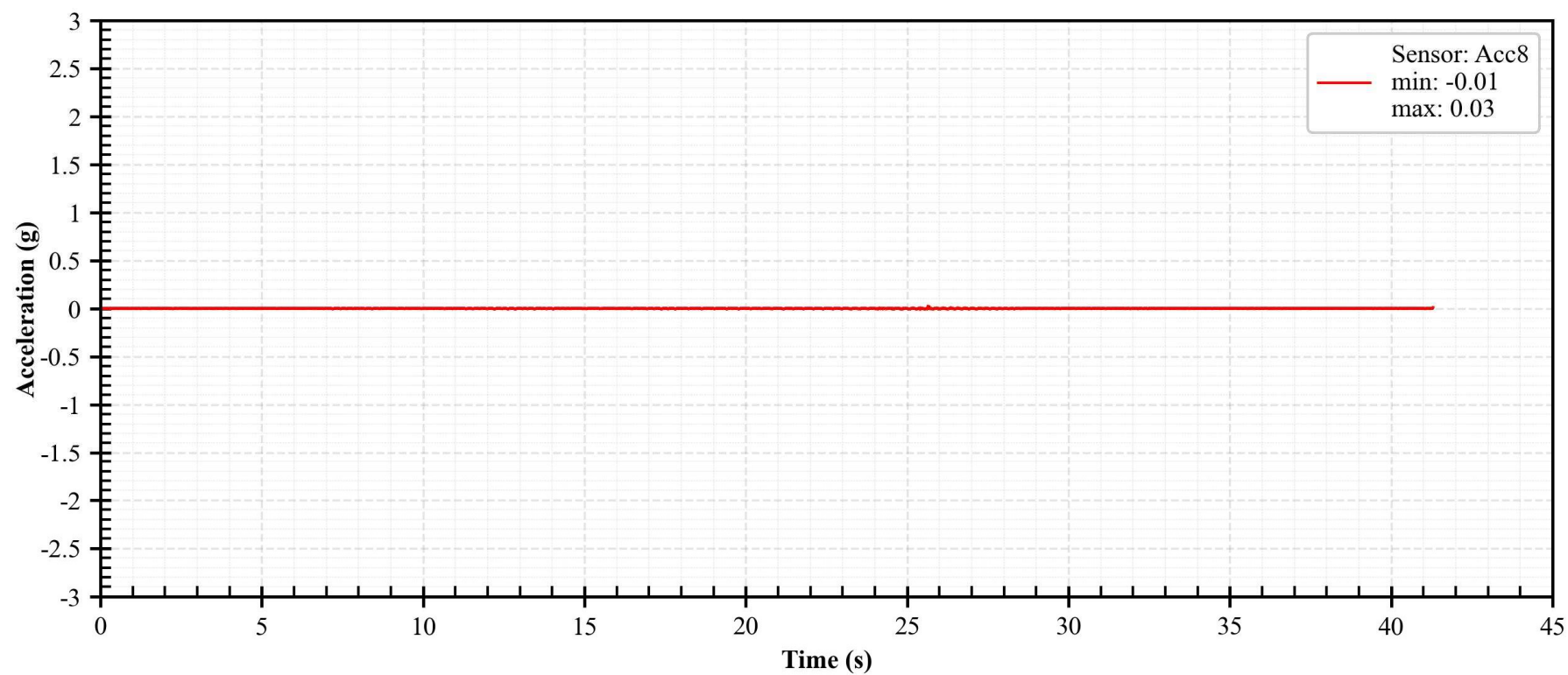


Figure 3.10.8 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 8

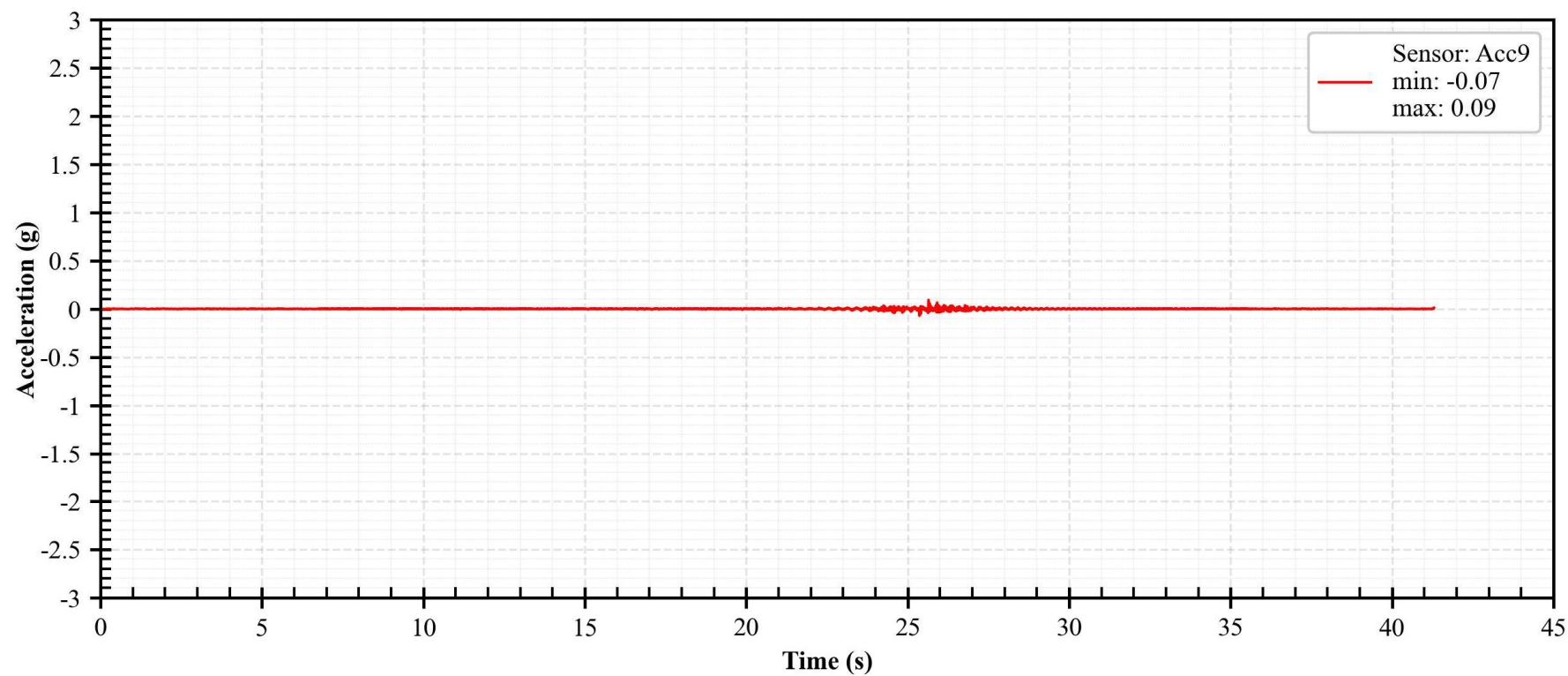


Figure 3.10.9 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 9

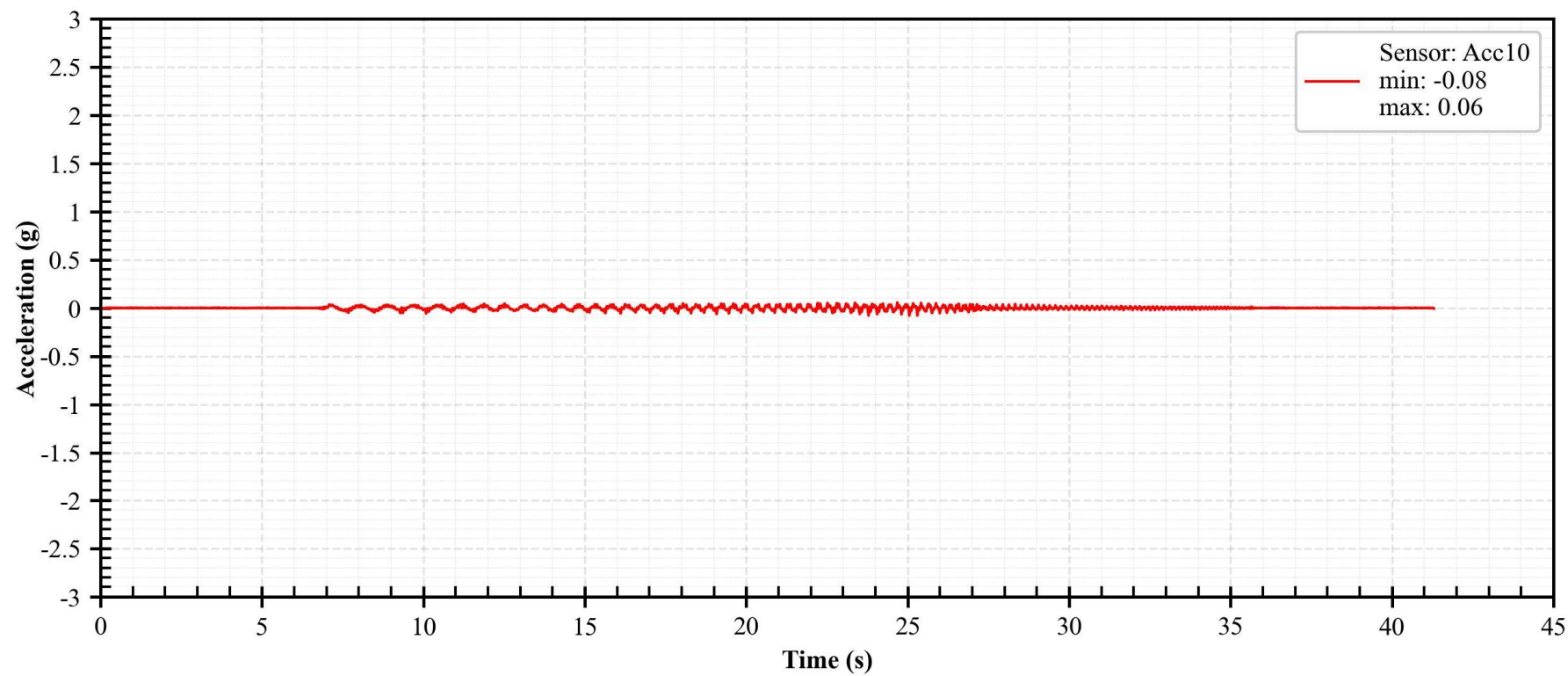


Figure 3.10.10 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 10

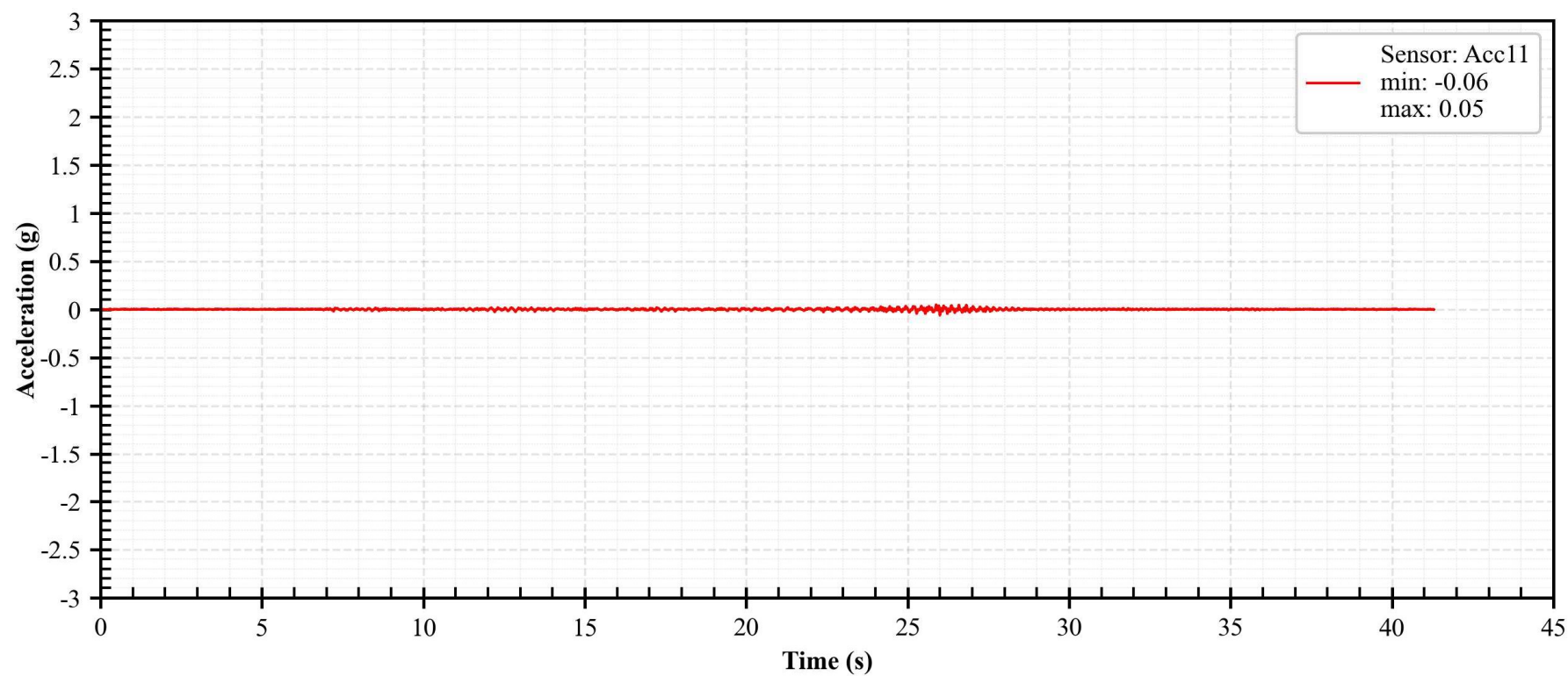


Figure 3.10.11 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 11

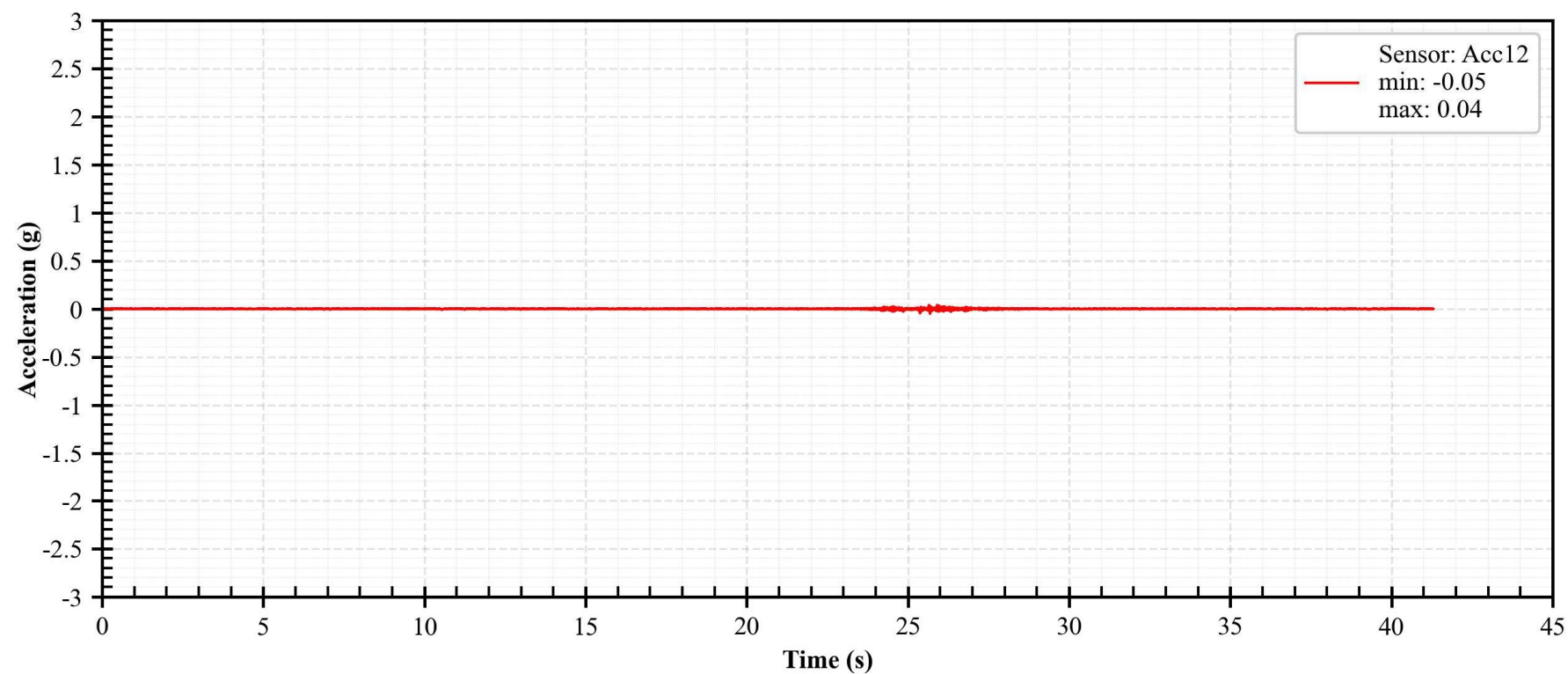


Figure 3.10.12 Characteristic results for phase B (white noise before EQ0,5g): Accelerometer 12

Draw wire sensors

Figures 3.10.13 – 3.10.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.03 mm while the minimum is -16.31 mm. The maximum movement detected by draw wire sensor W2 is 21.24 mm while the minimum is -16.42 mm. The maximum movement detected by draw wire sensor W3 is 21.05 mm while the minimum is -16.33 mm. The maximum movement detected by draw wire sensor W4 is 21.16 mm while the minimum is -16.28 mm. The maximum drift is $(1.67/1.225) = 1.36 \text{ ‰}$ and minimum drift is $(-1.71/1.225) = -1.40 \text{ ‰}$.

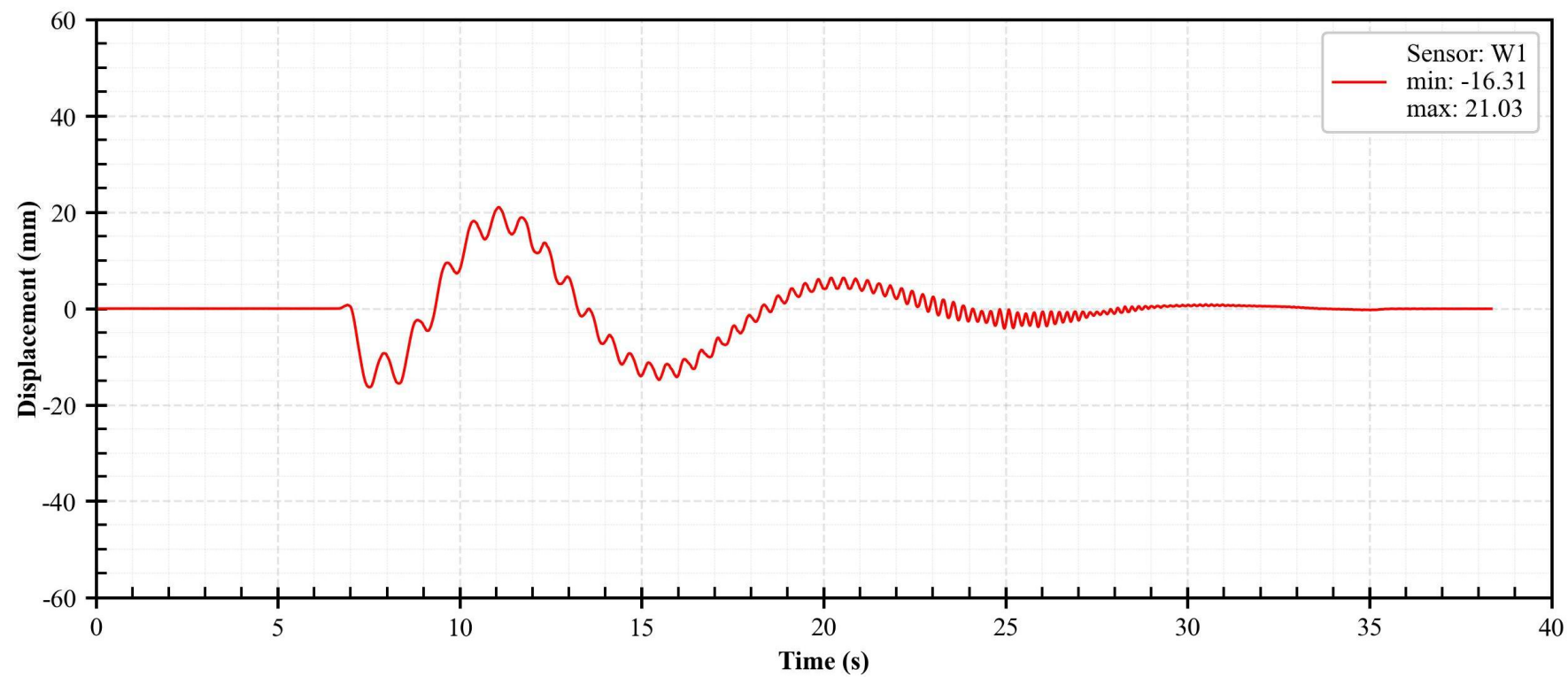


Figure 3.10.13 Characteristic results for phase B (white noise before EQ0,5g): Draw wire sensor 1

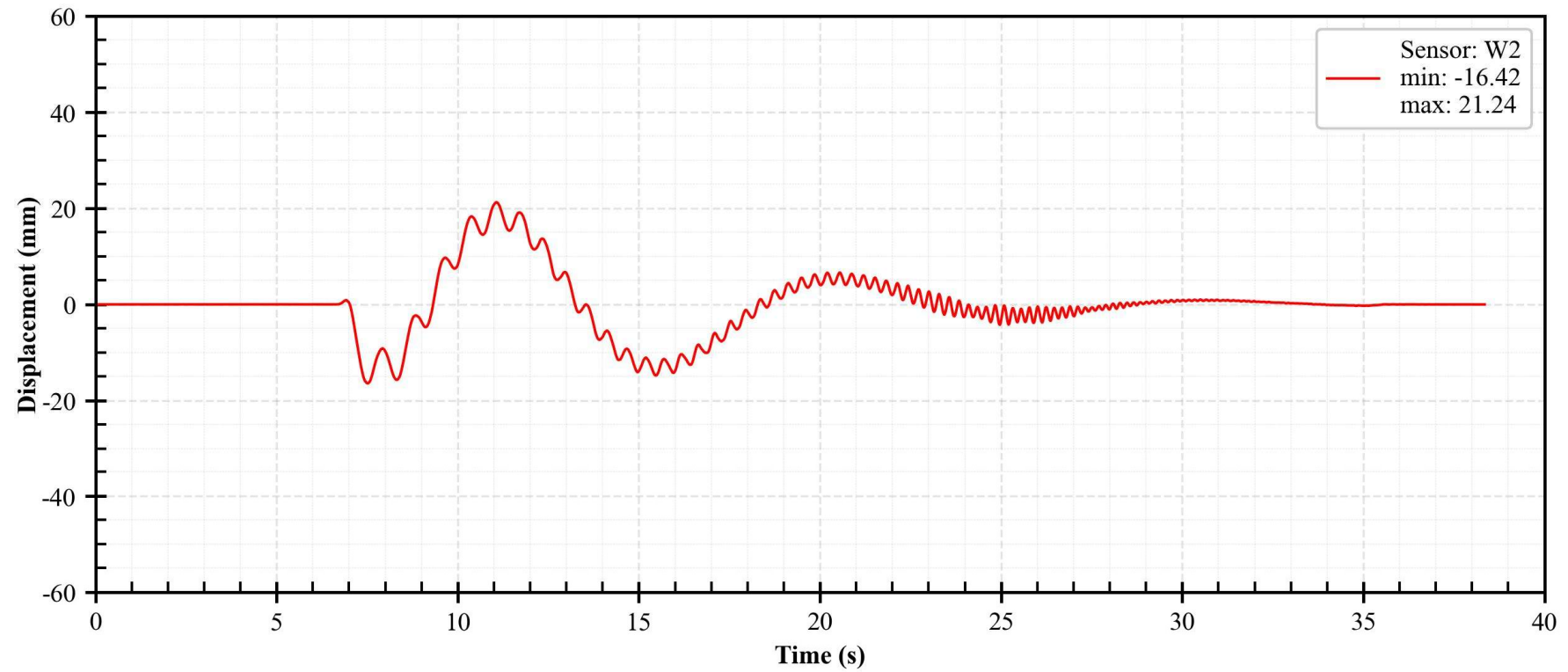


Figure 3.10.14 Characteristic results for phase B (white noise before EQ0,5g): Draw wire sensor 2

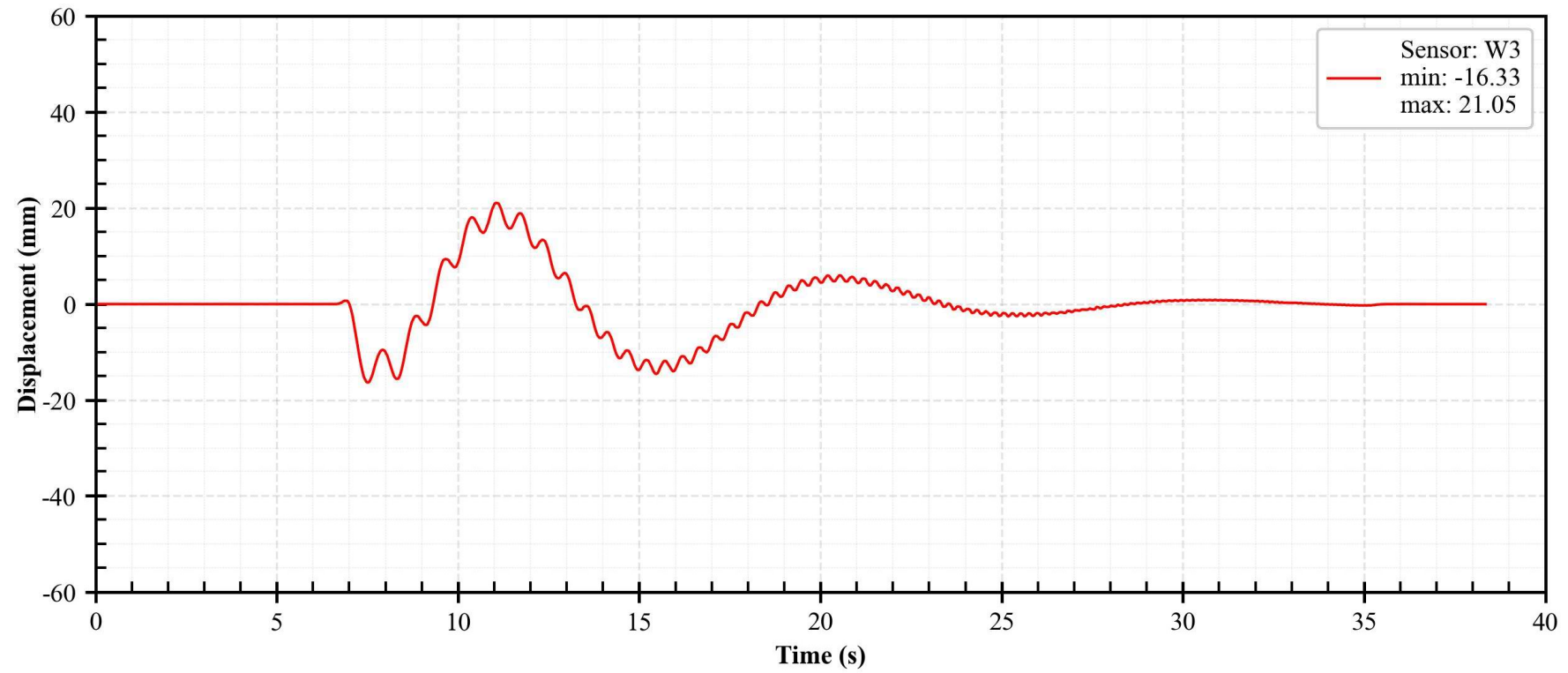


Figure3.10.15 Characteristic results for phase B (white noise before EQ0,5g): Draw wire sensor 3

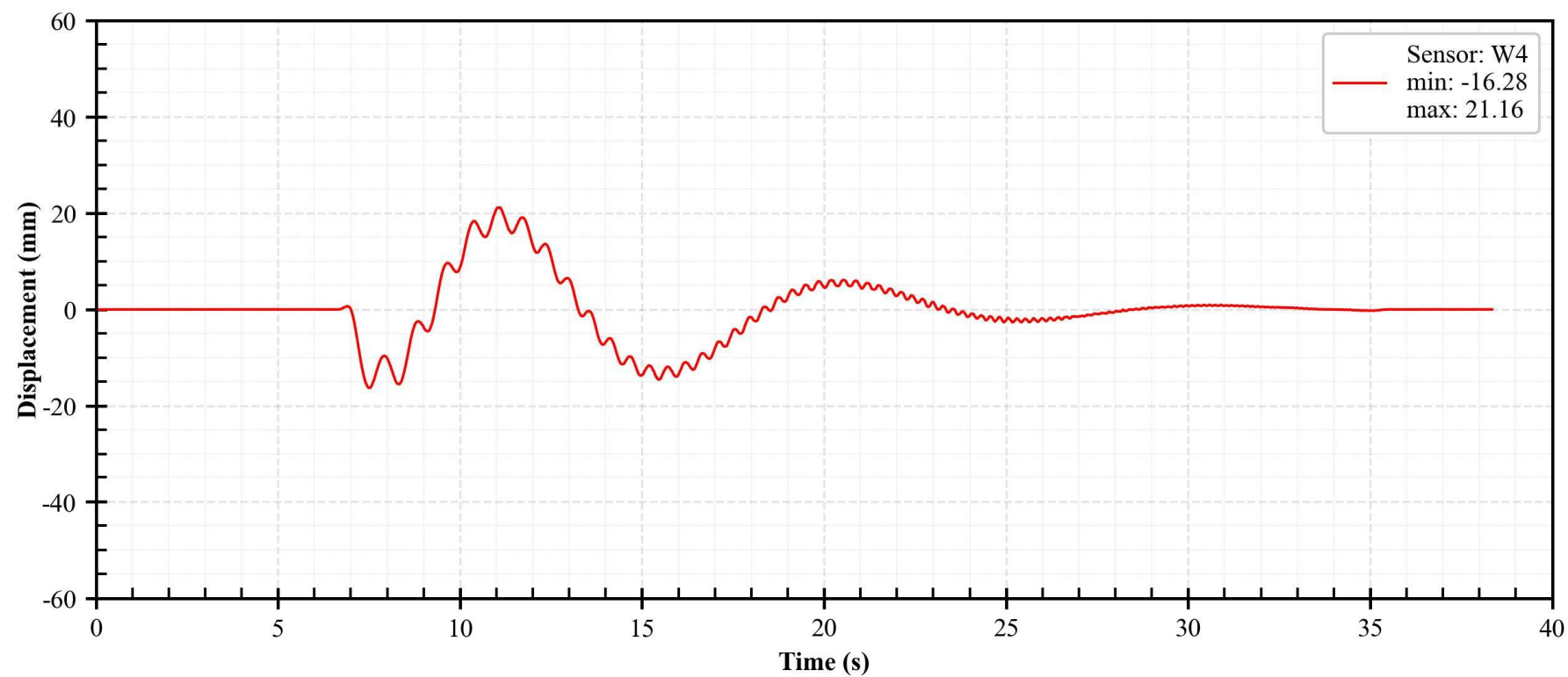


Figure 3.10.16 Characteristic results for phase B (white noise before EQ0,5g): Draw wire sensor 4

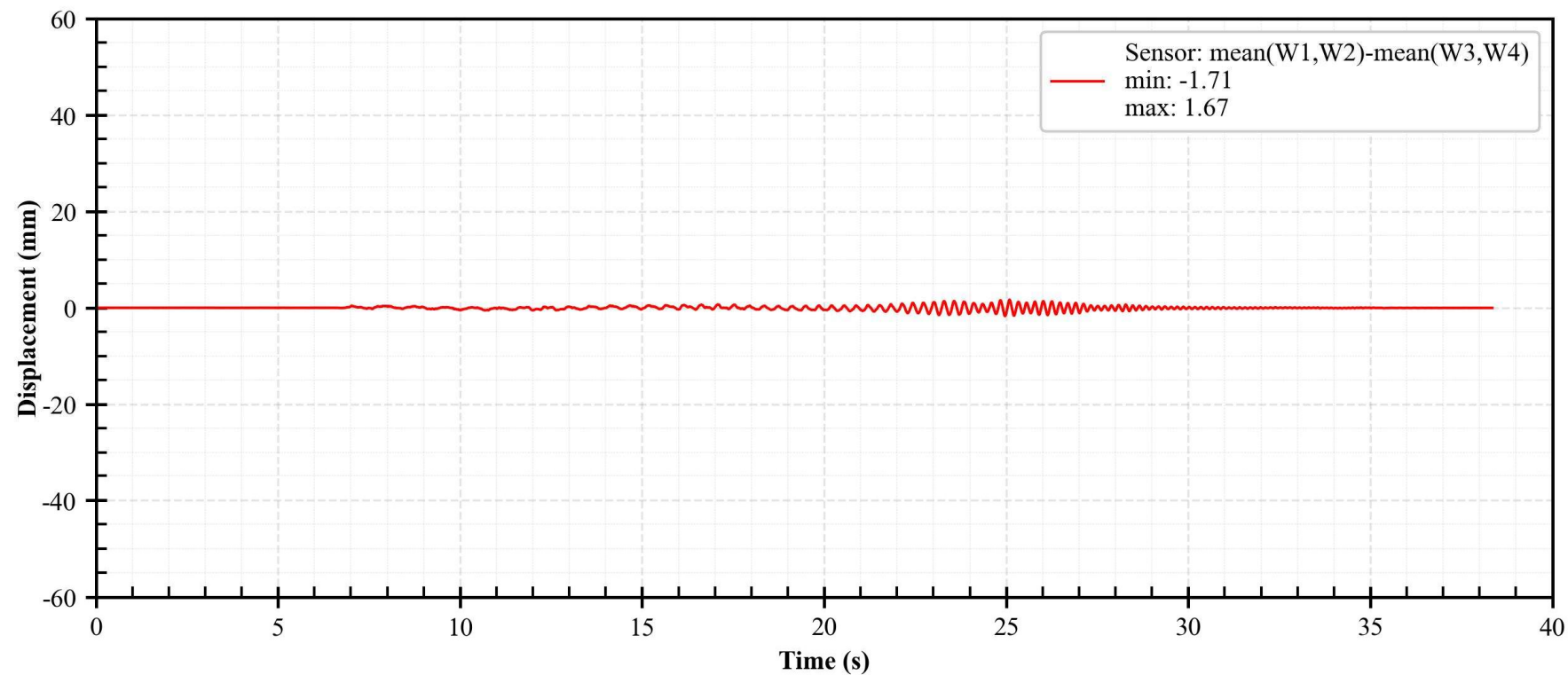


Figure 3.10.17 Characteristic results for phase B (white noise before EQ0,5g): $\text{mean}(W1, W2) - \text{mean}(W3, W4)$

Strain gauges

No notable changes are detected in the values of strain gauges.

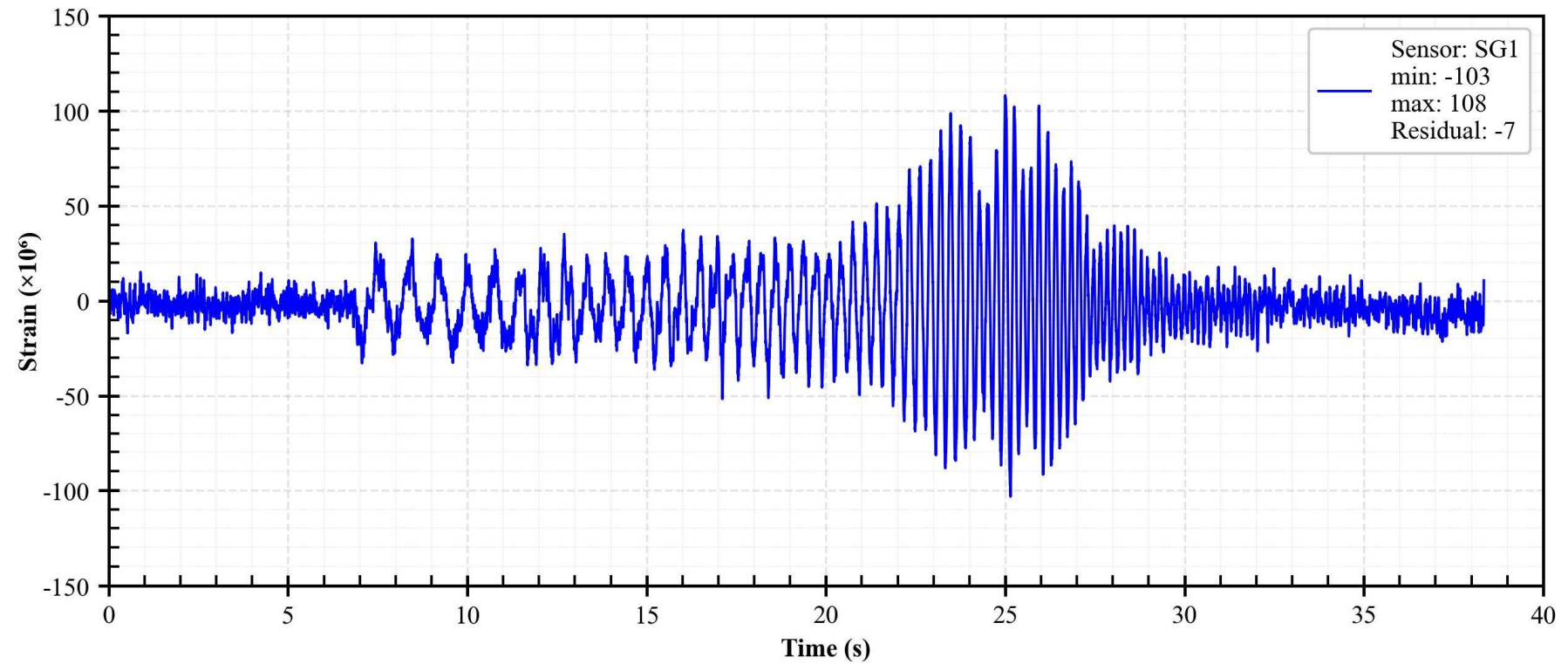


Figure 3.10. 18 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 1

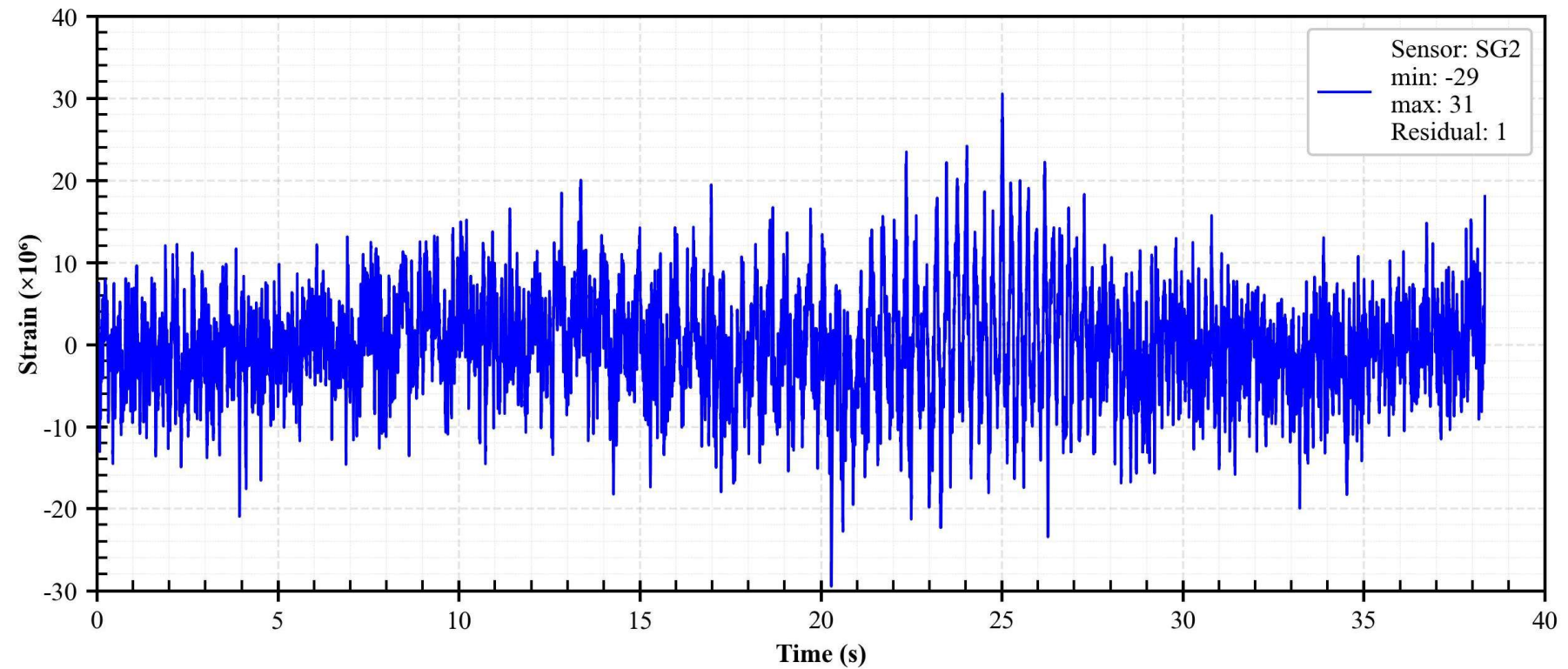


Figure 3.10.19 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 2

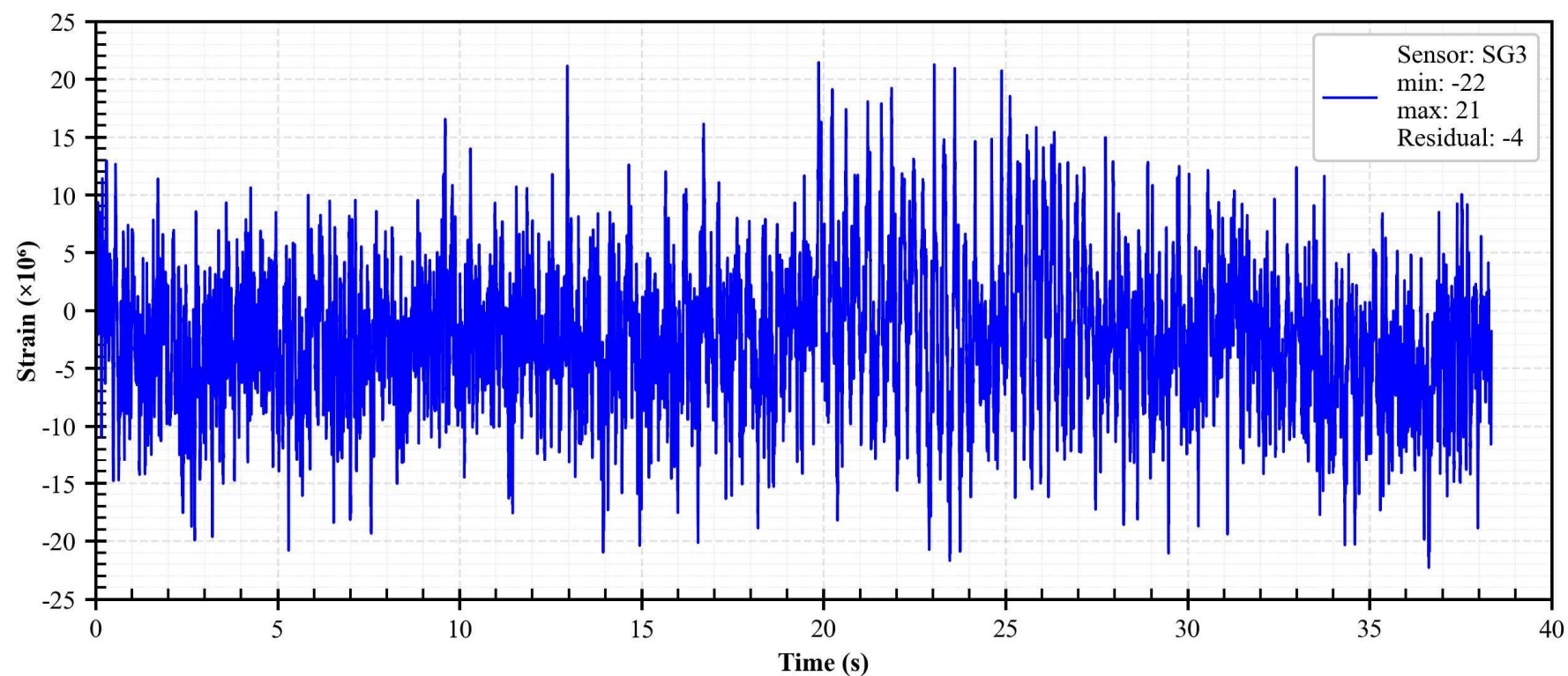


Figure 3.10.20 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 3

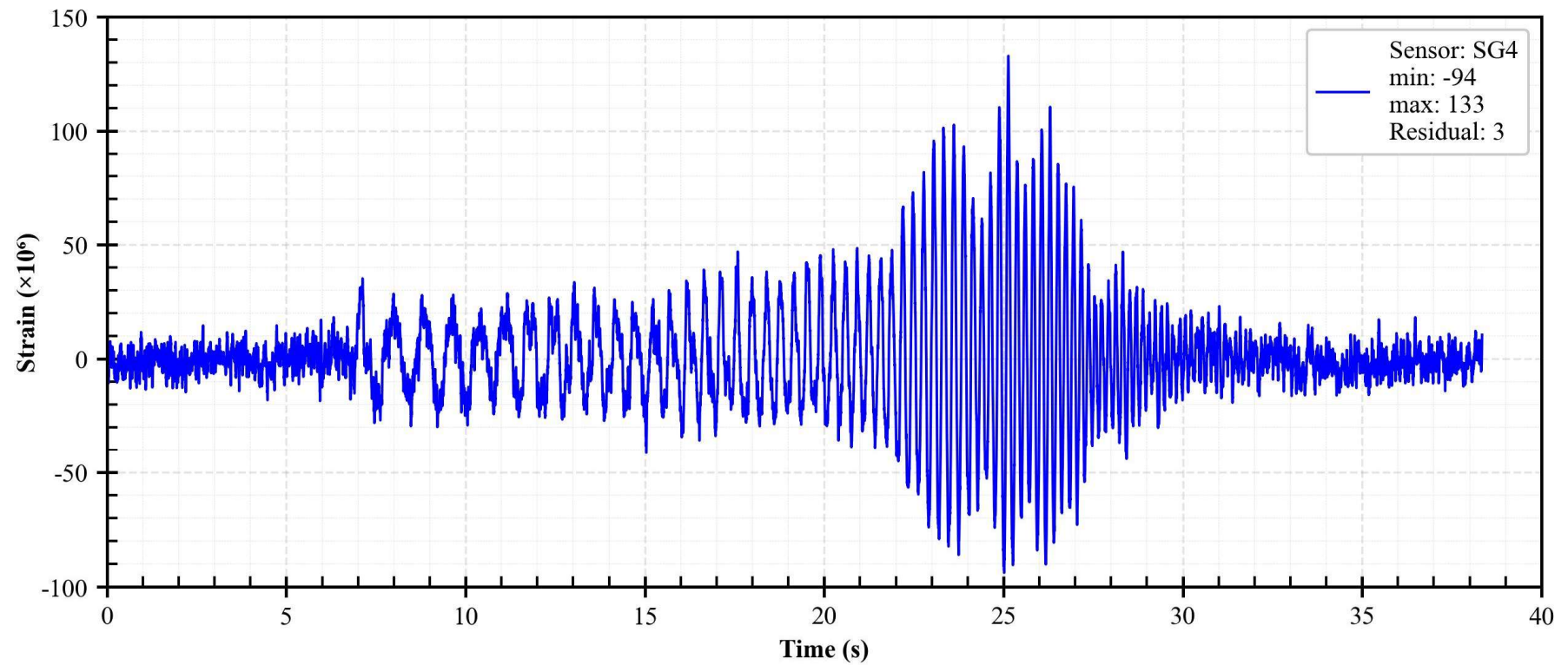


Figure 3.10.21 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 4

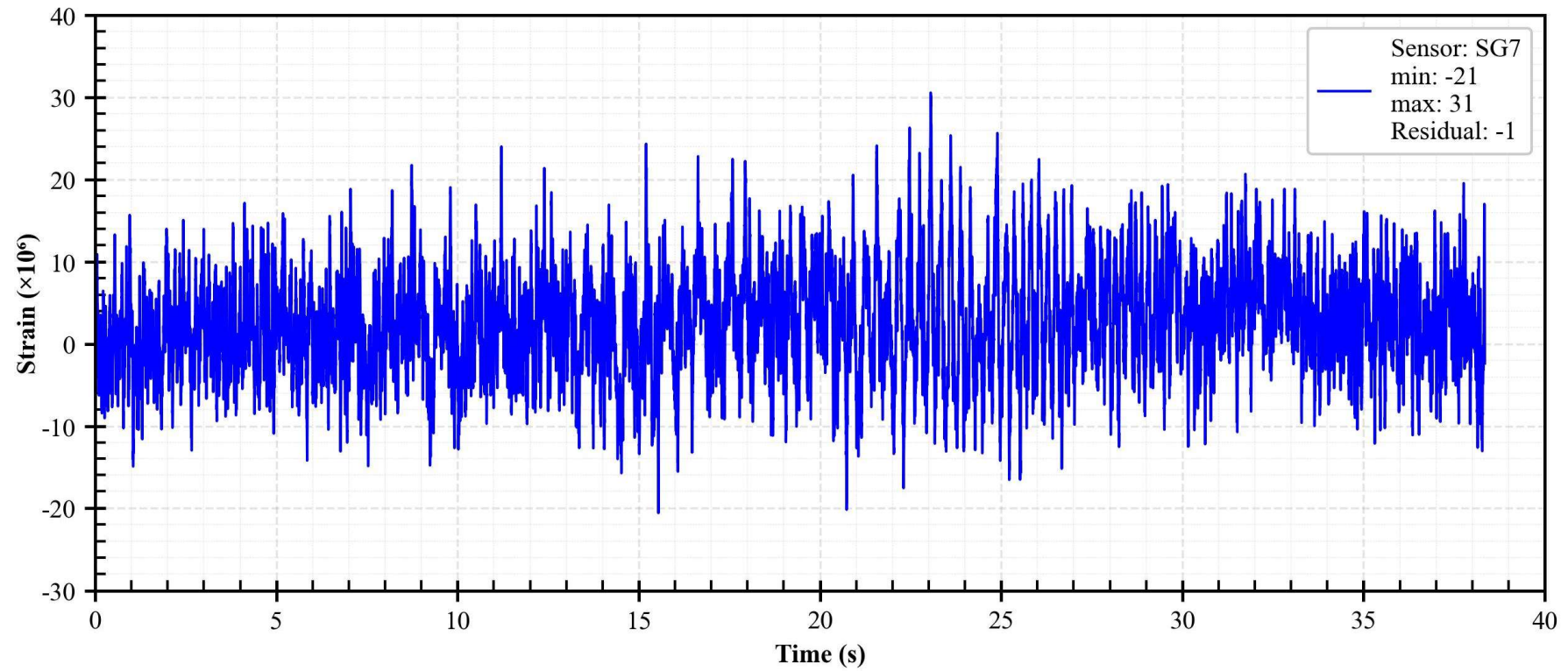


Figure 3.10.22 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 7

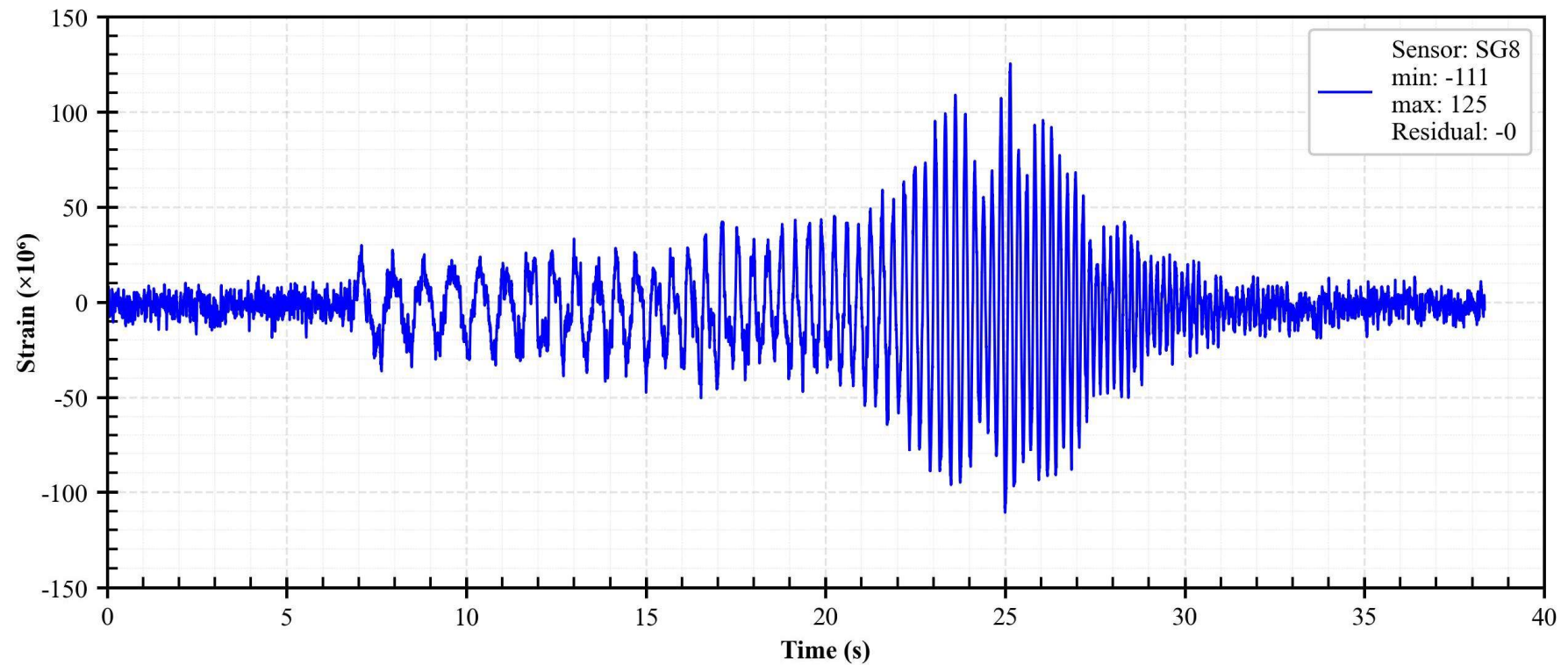


Figure 3.10.23 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 8

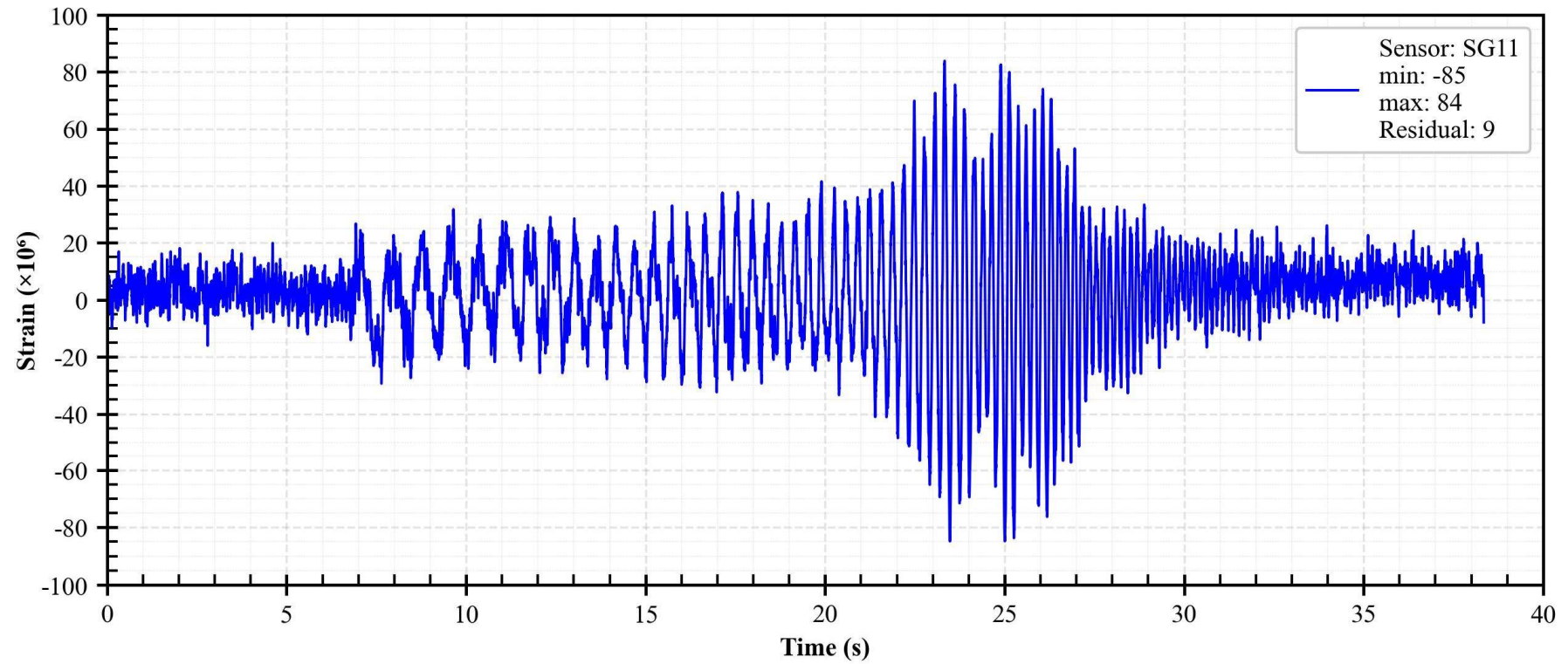


Figure 3.10.24 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 11

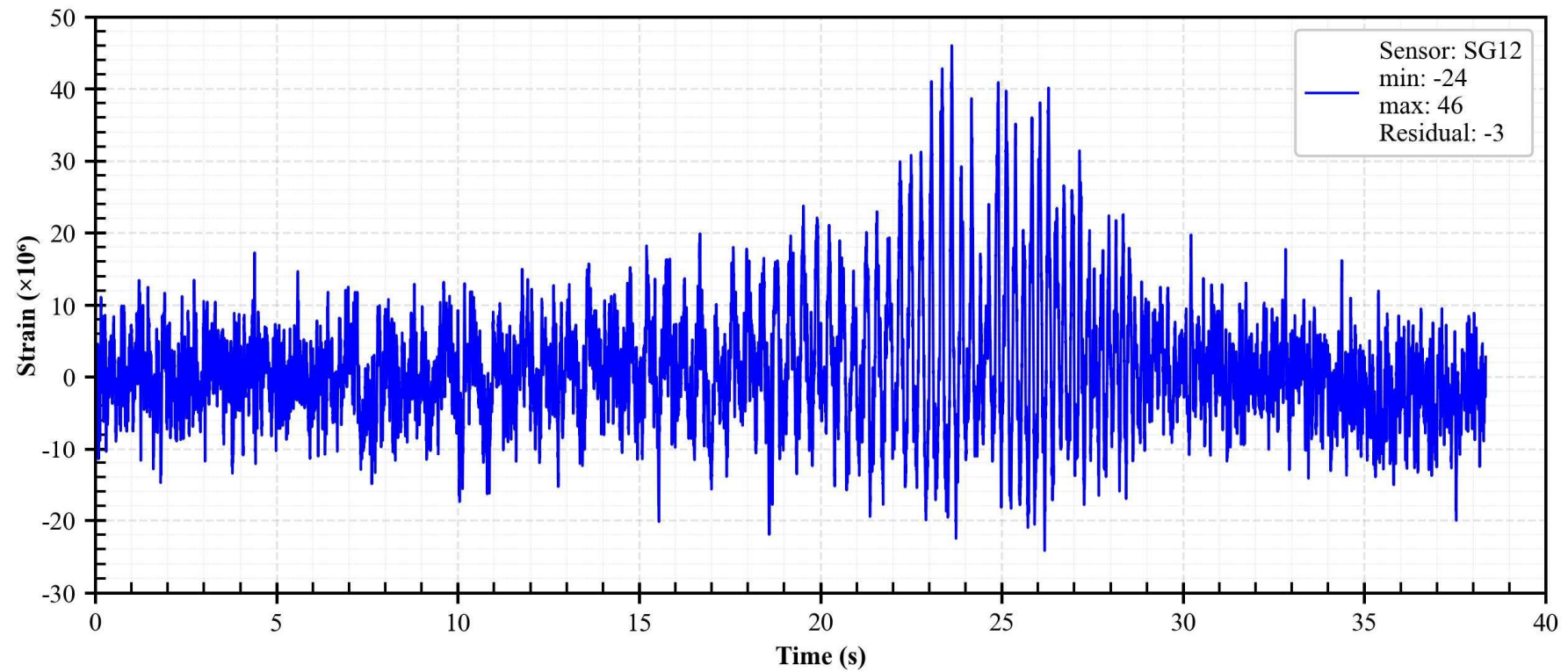


Figure 3.10.25 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 12

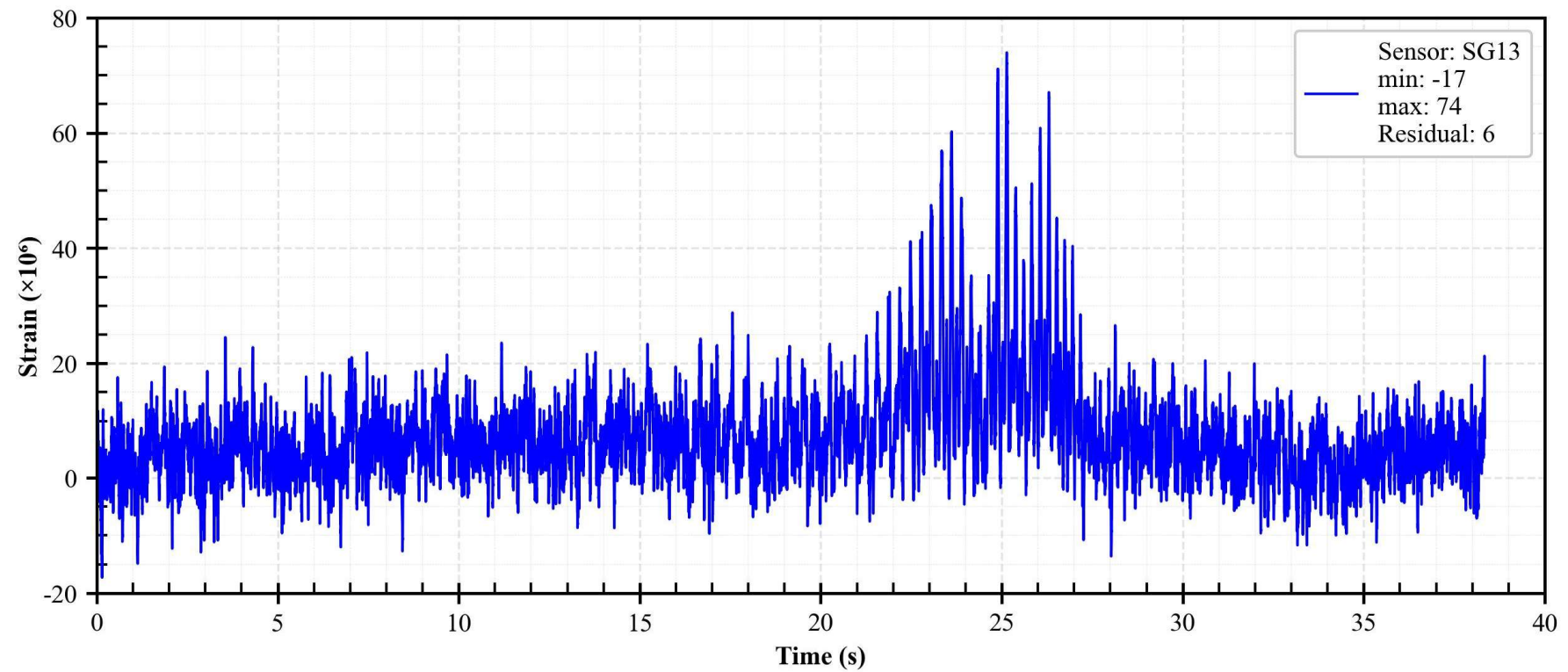


Figure 3.10.26 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 13

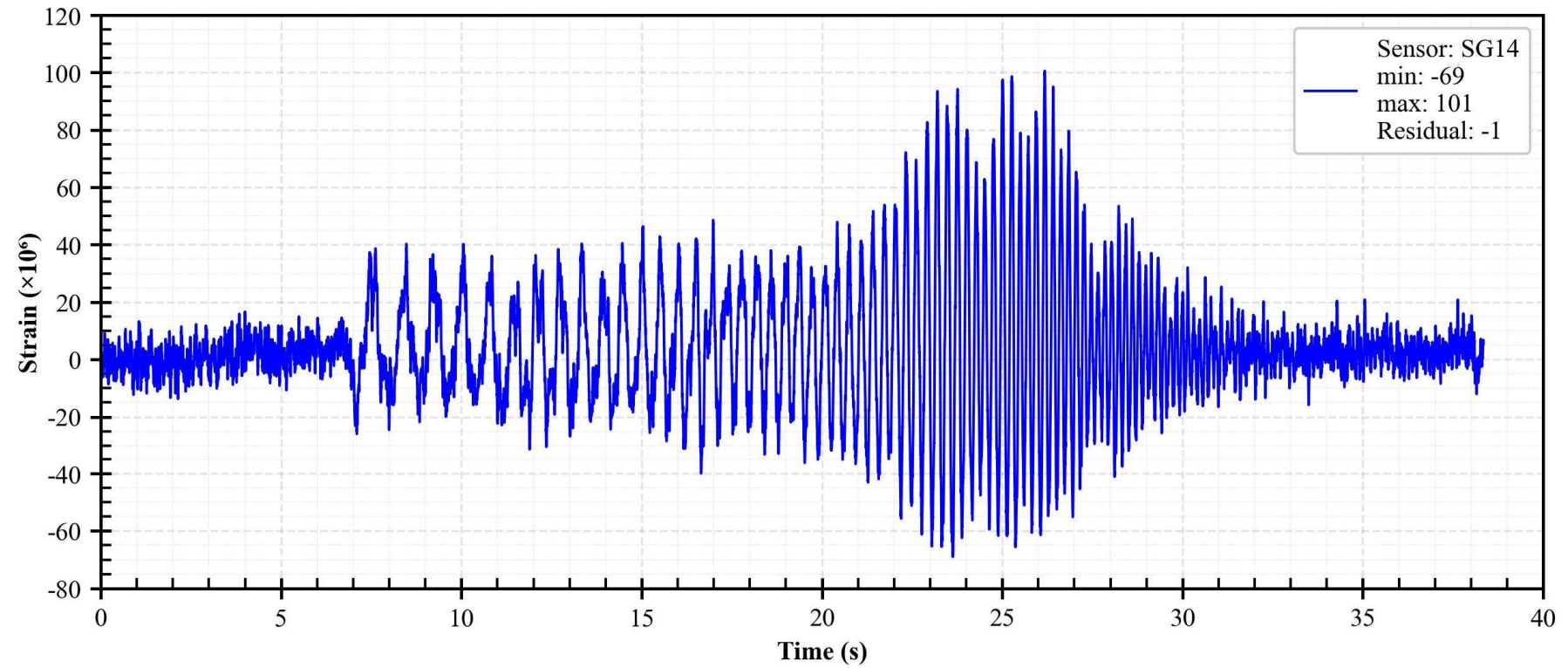


Figure 3.10.27 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 14

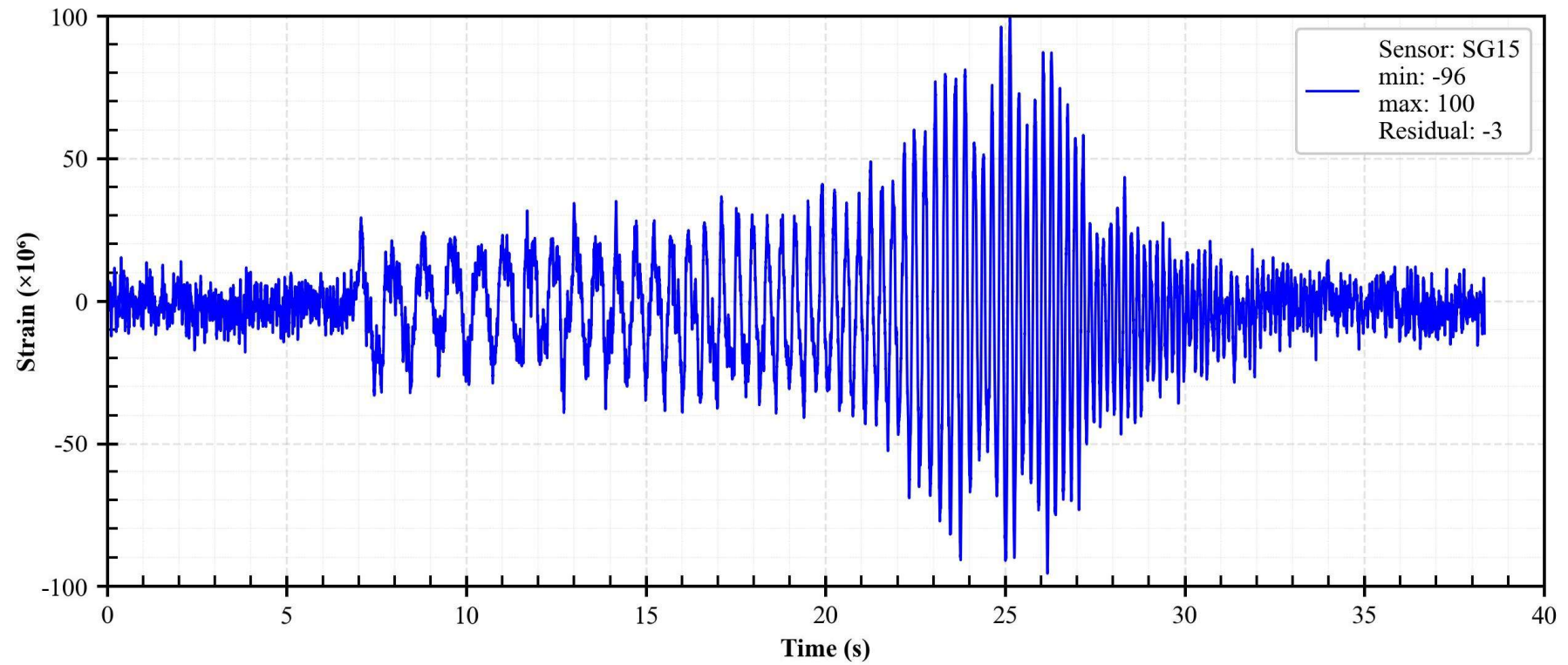


Figure 3.10.28 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 15

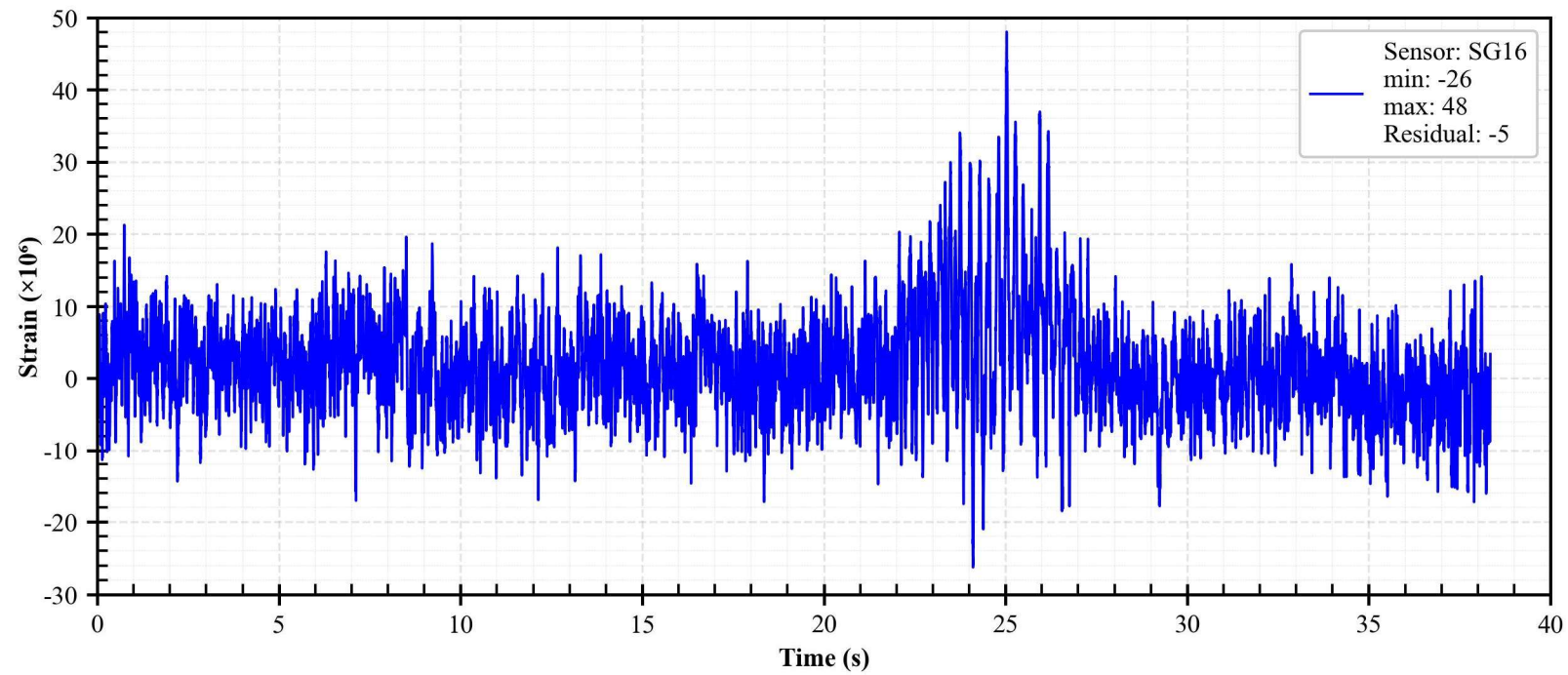


Figure 3.10.29 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 16

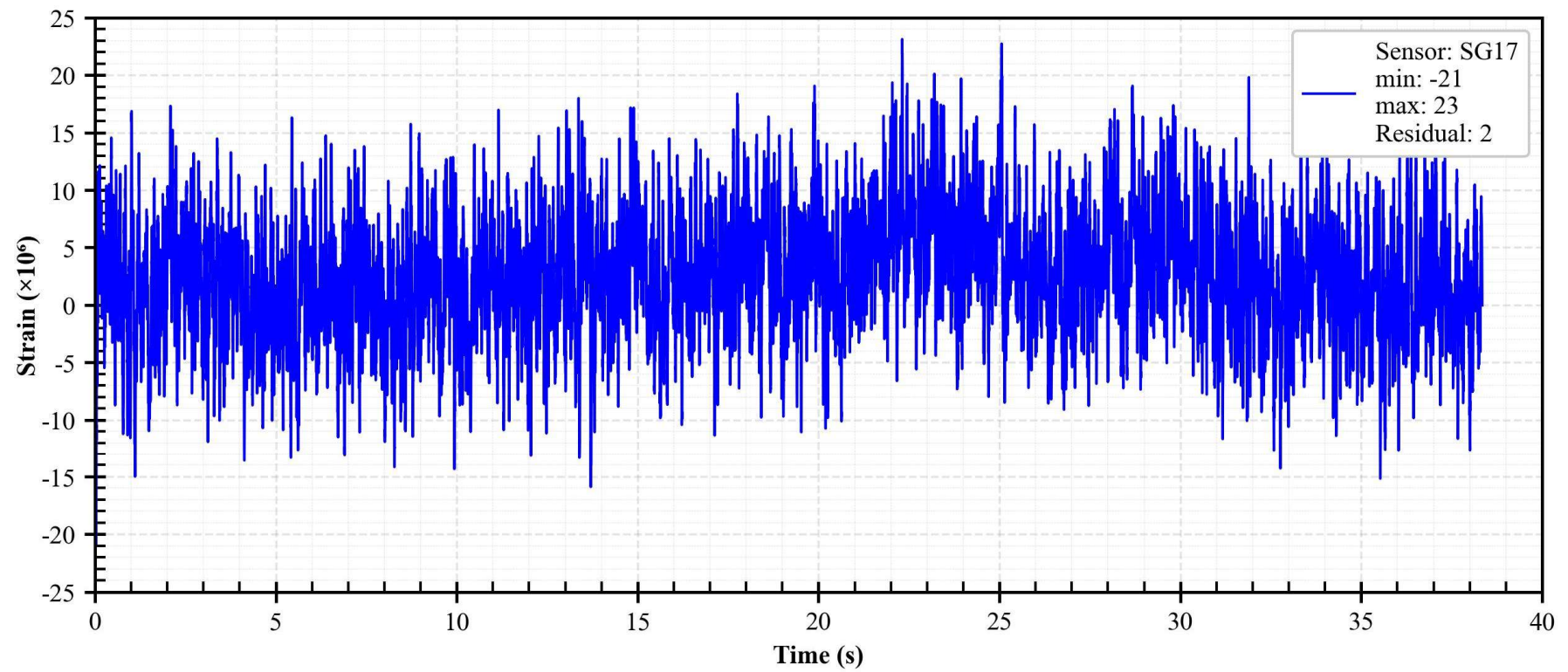


Figure 3.10.30 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 17

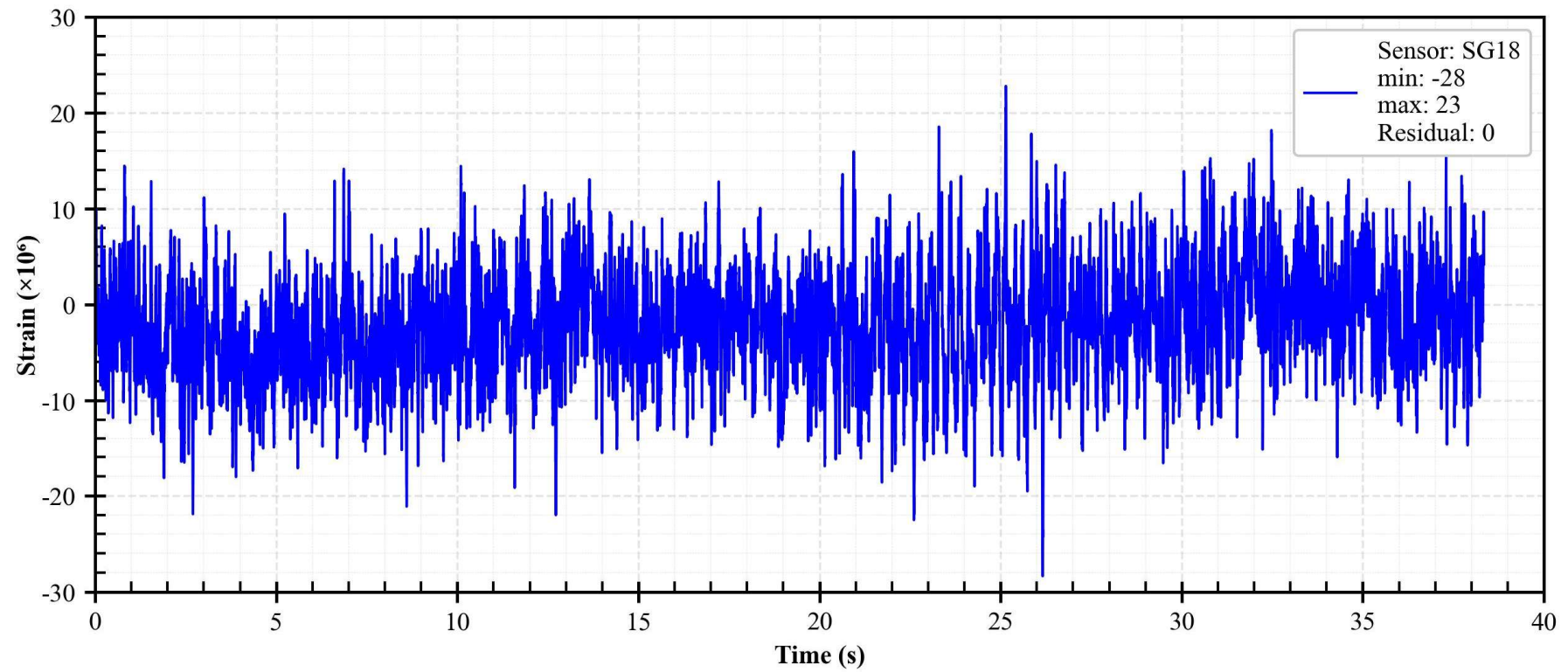


Figure 3.10.31 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 18

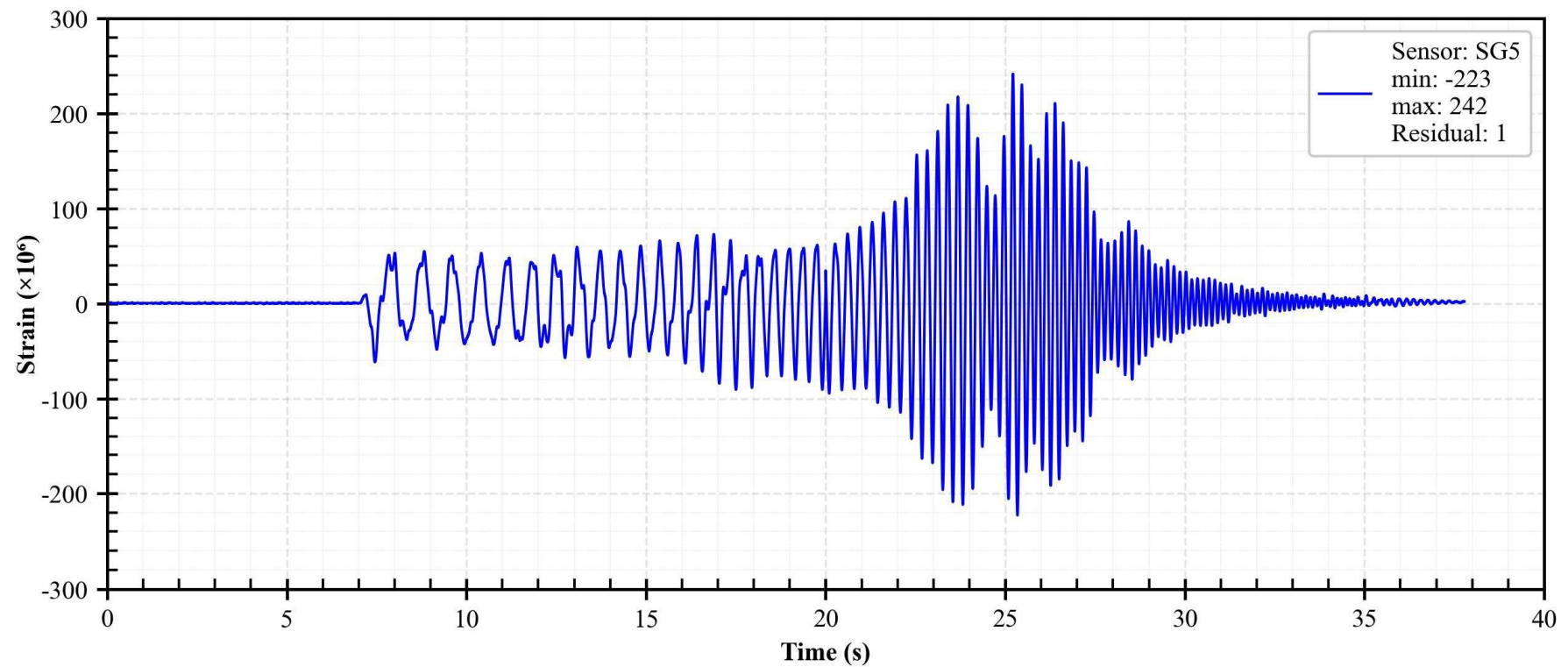


Figure 3.10.32 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 5

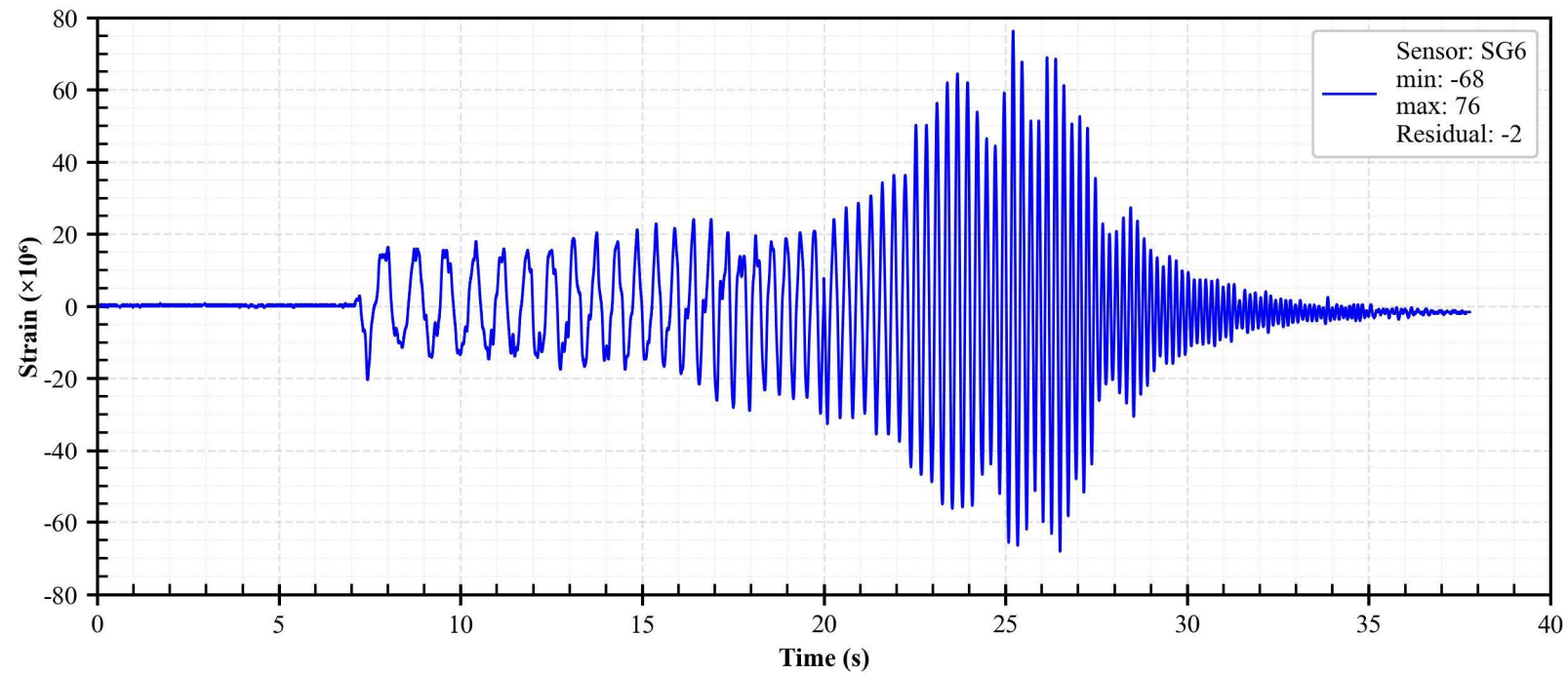


Figure 3.10.33 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 6

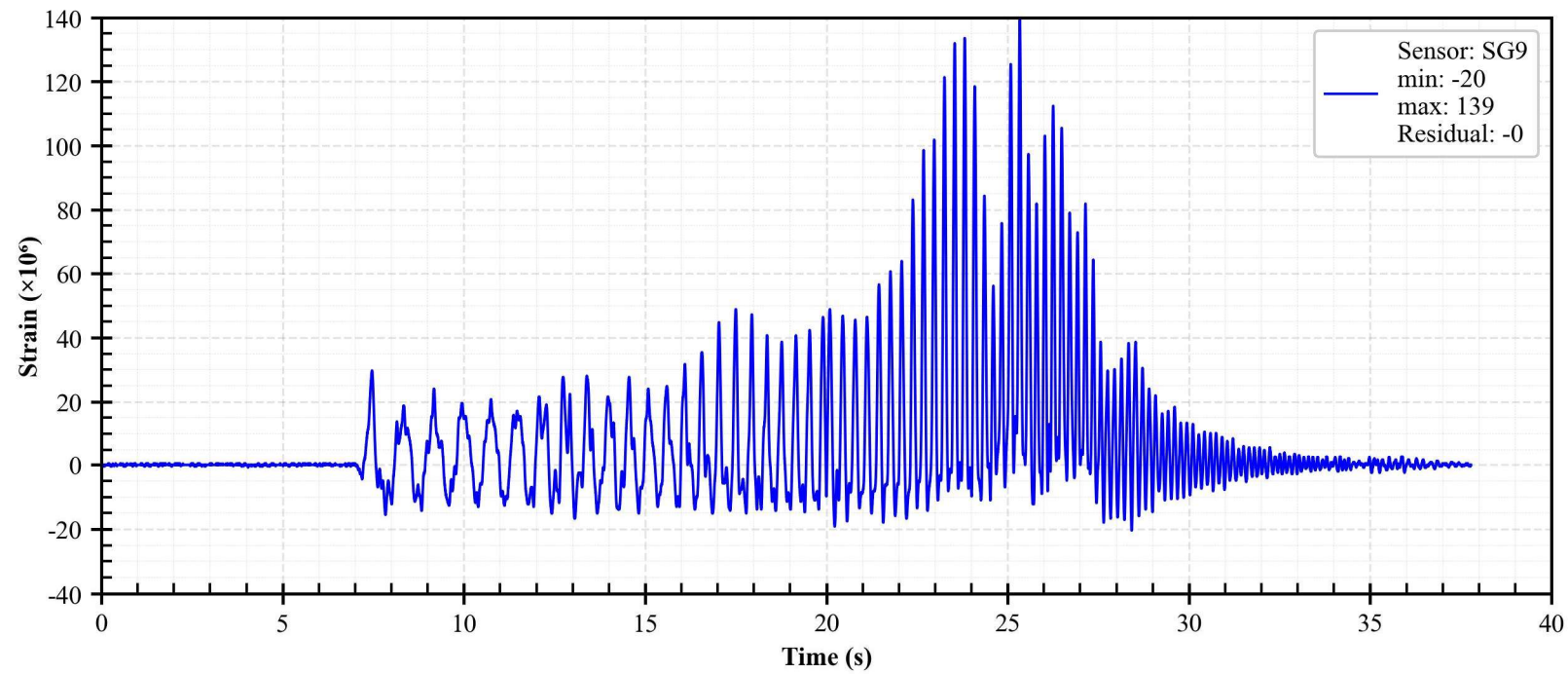


Figure 3.10.34 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 9

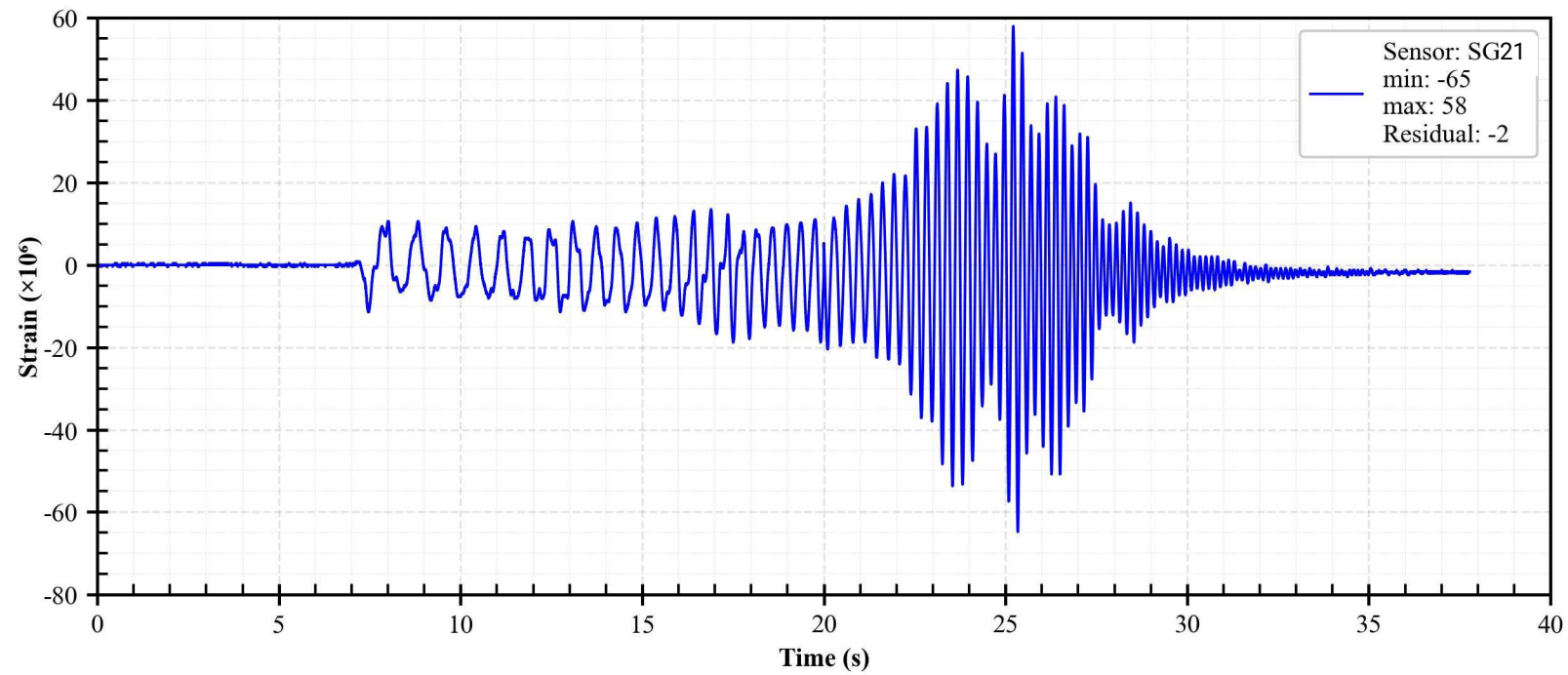


Figure 3.10.35 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 21 (PUFJ, column 1)

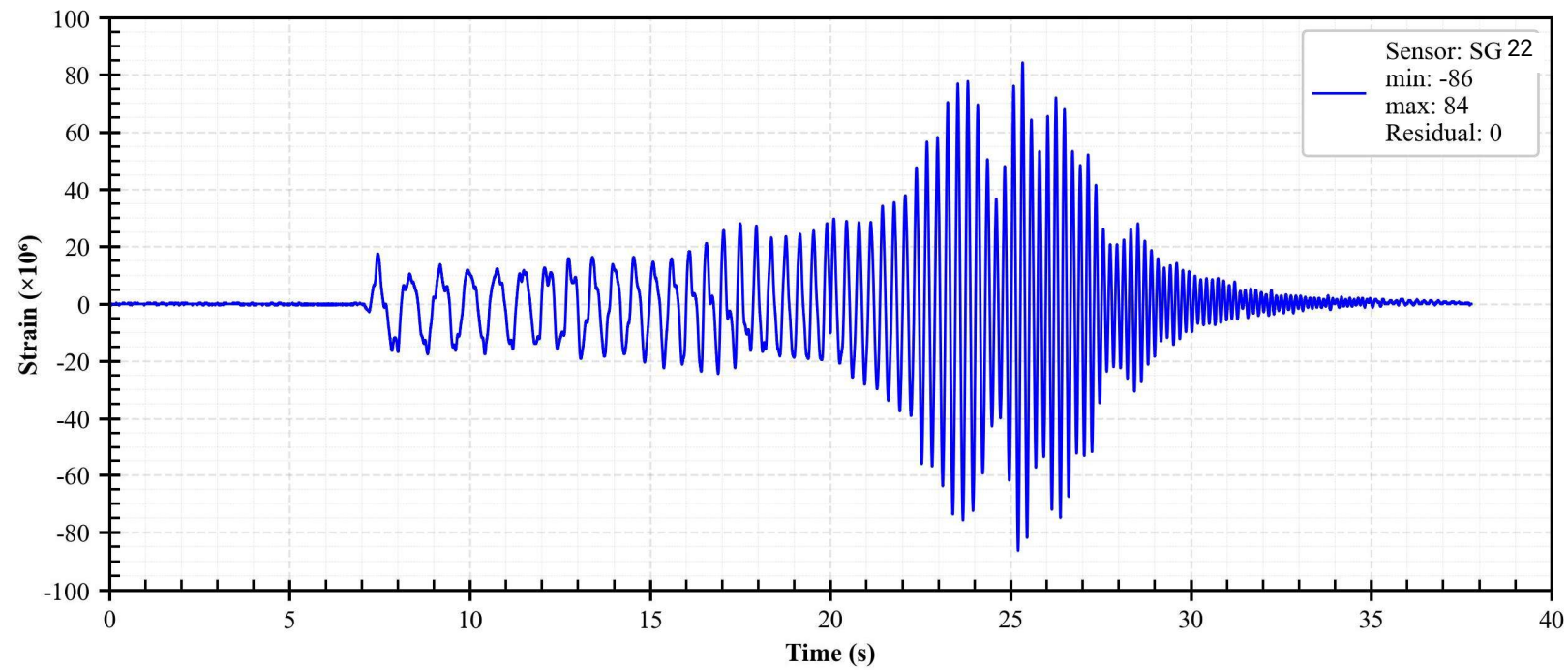


Figure 3.10.36 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 22 (PUFJ, column 2)

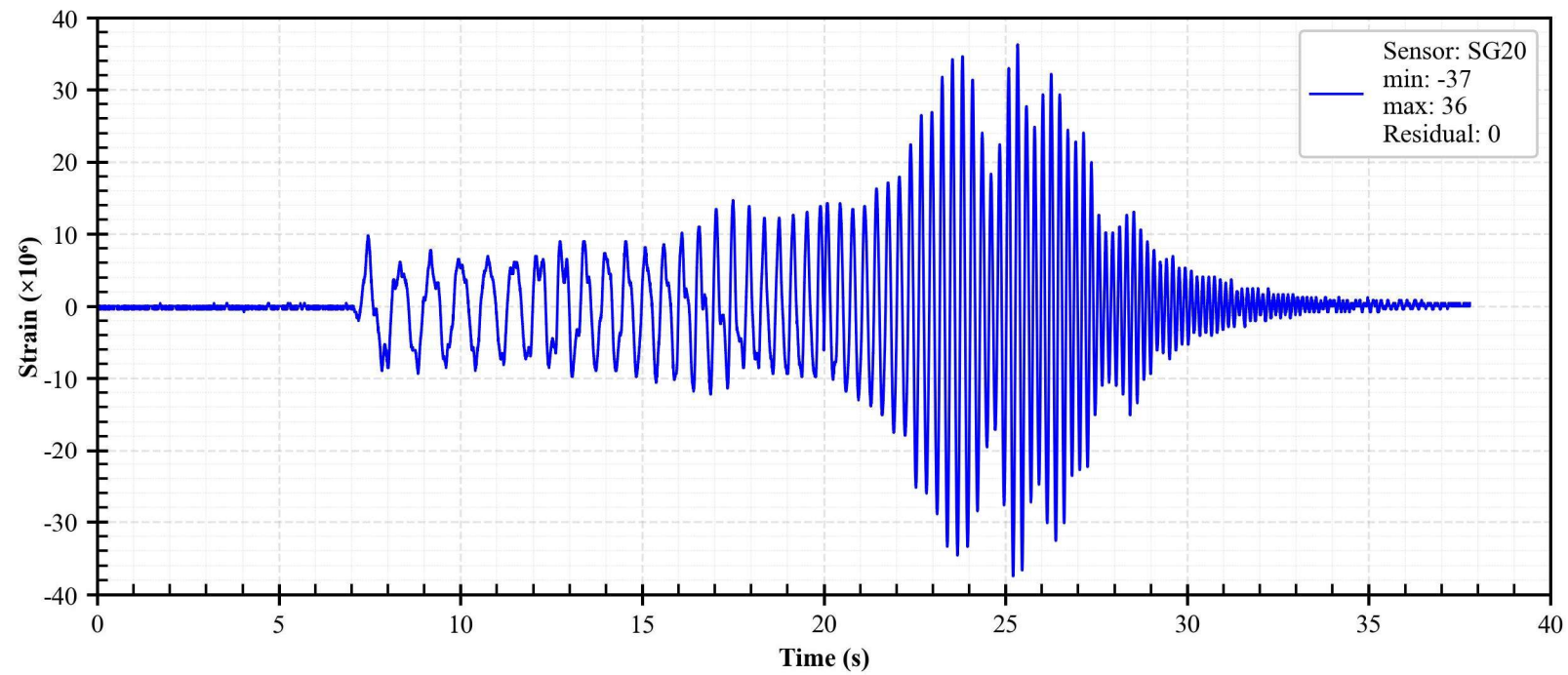


Figure 3.10.37 Characteristic results for phase B (white noise before EQ0,5g): strain gauge 20

3.11 Earthquake EQ0,5g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,5g. The max acceleration at the slab level on the accelerometer acc4 is 0.80g. The max acceleration at the foundation level on the accelerometer acc10 is 0,58g.

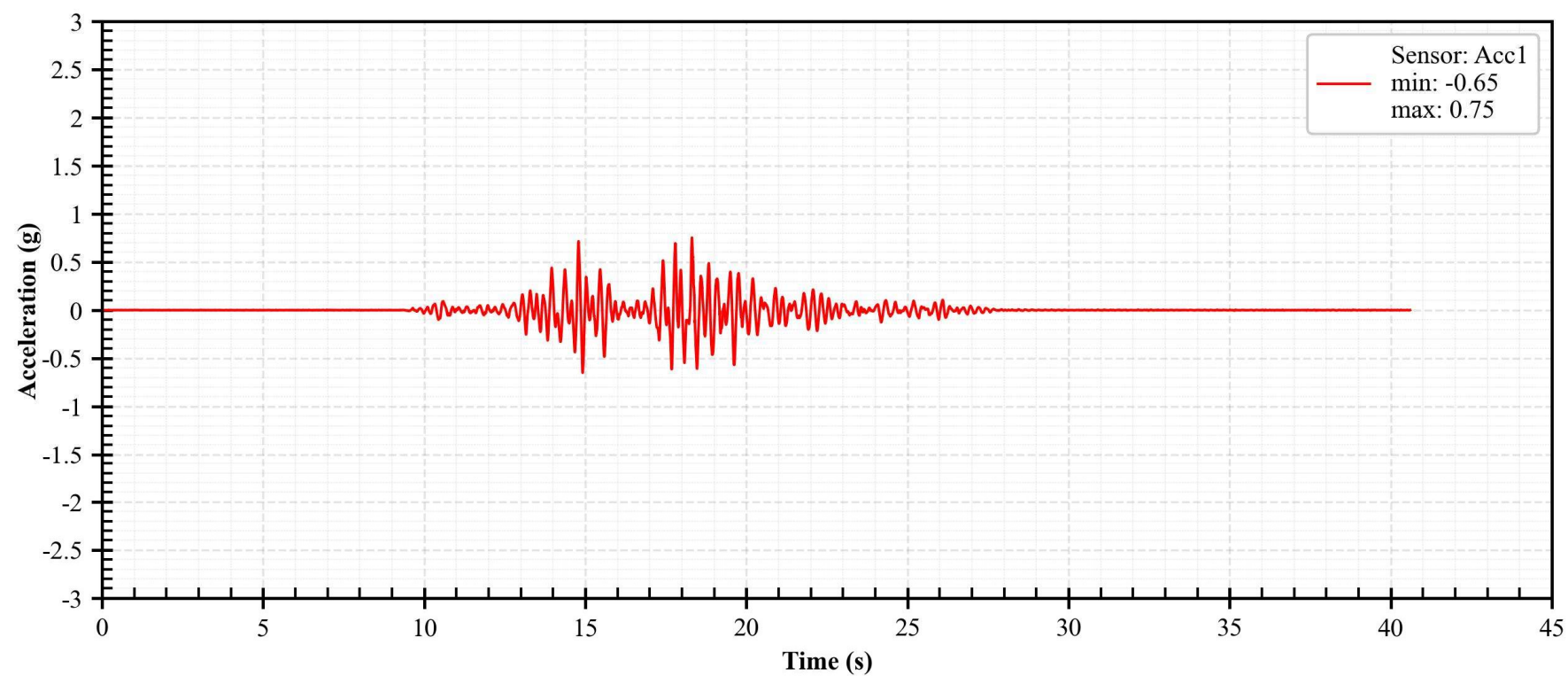


Figure 3.11.1 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 1

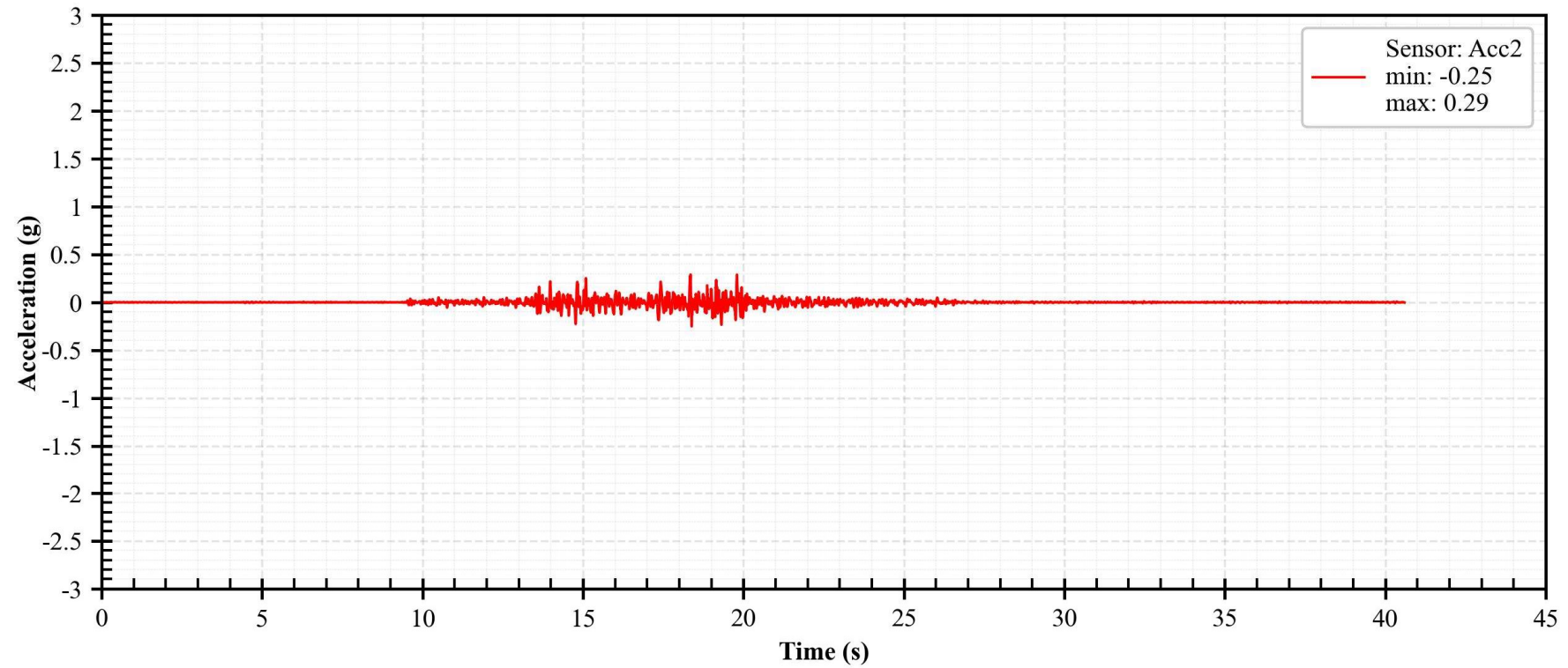


Figure 3.11.2 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 2

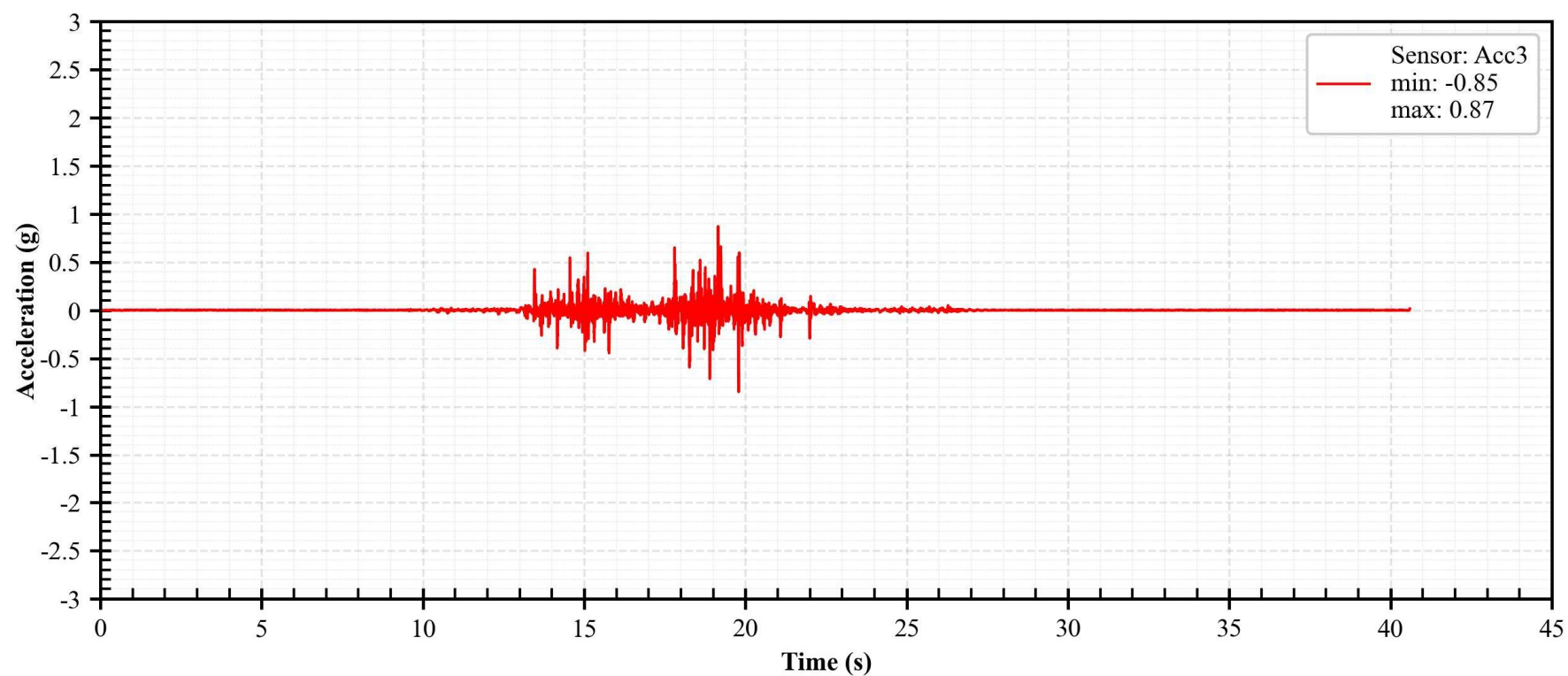


Figure 3.11.3 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 3

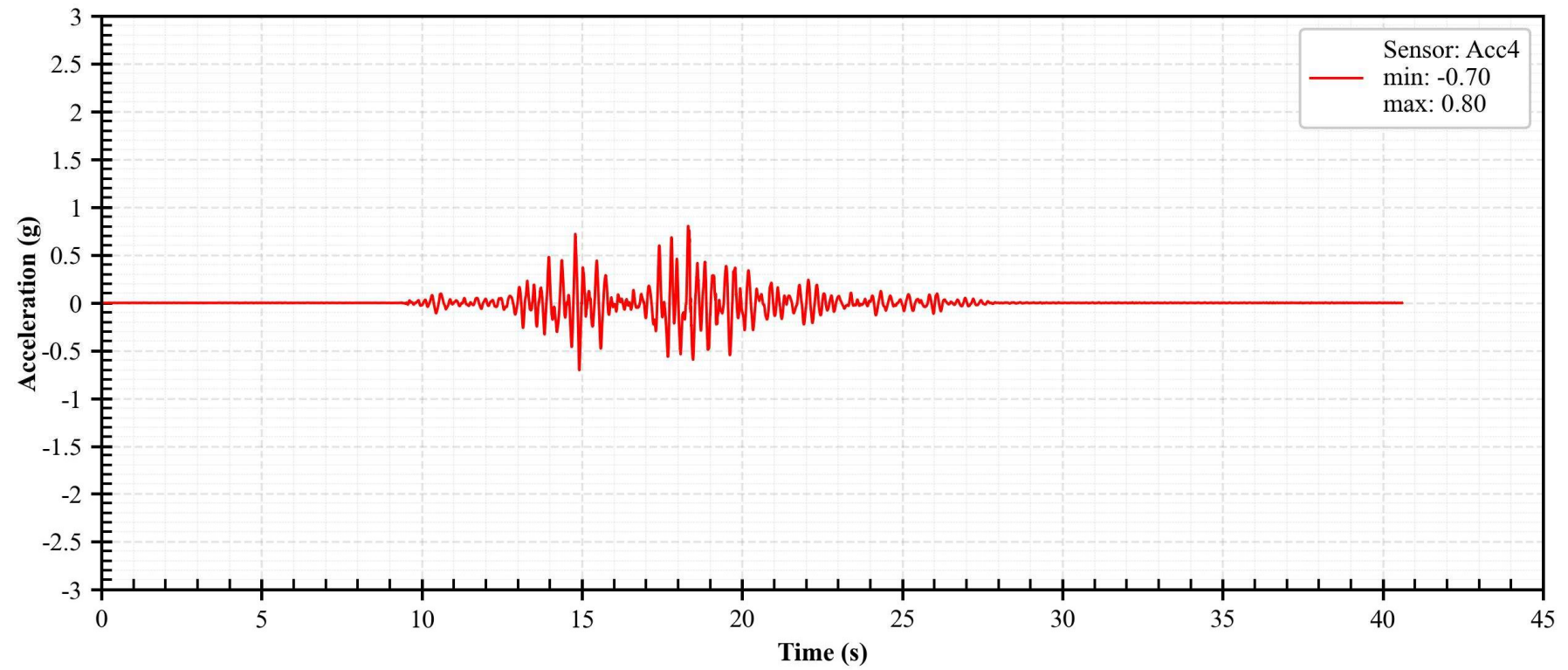


Figure 3.11.4 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 4

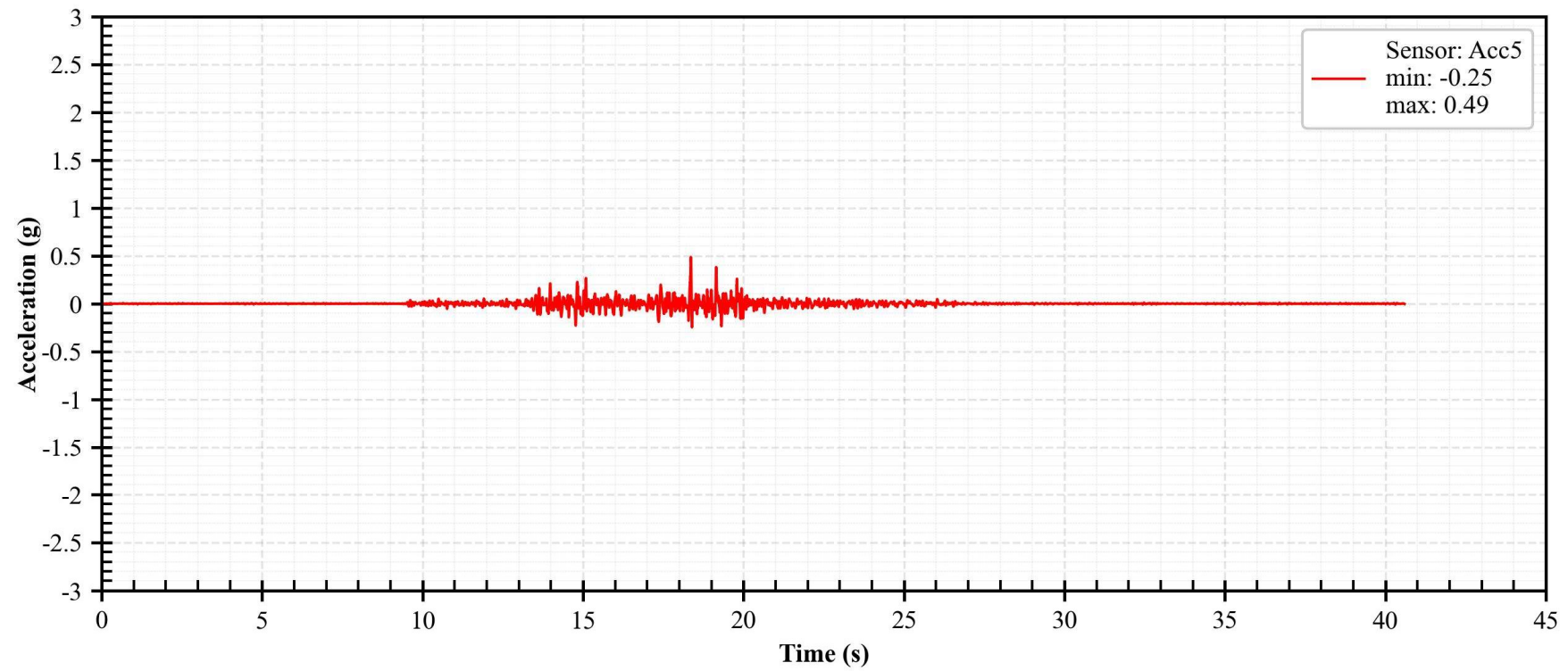


Figure 3.11.5 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 5

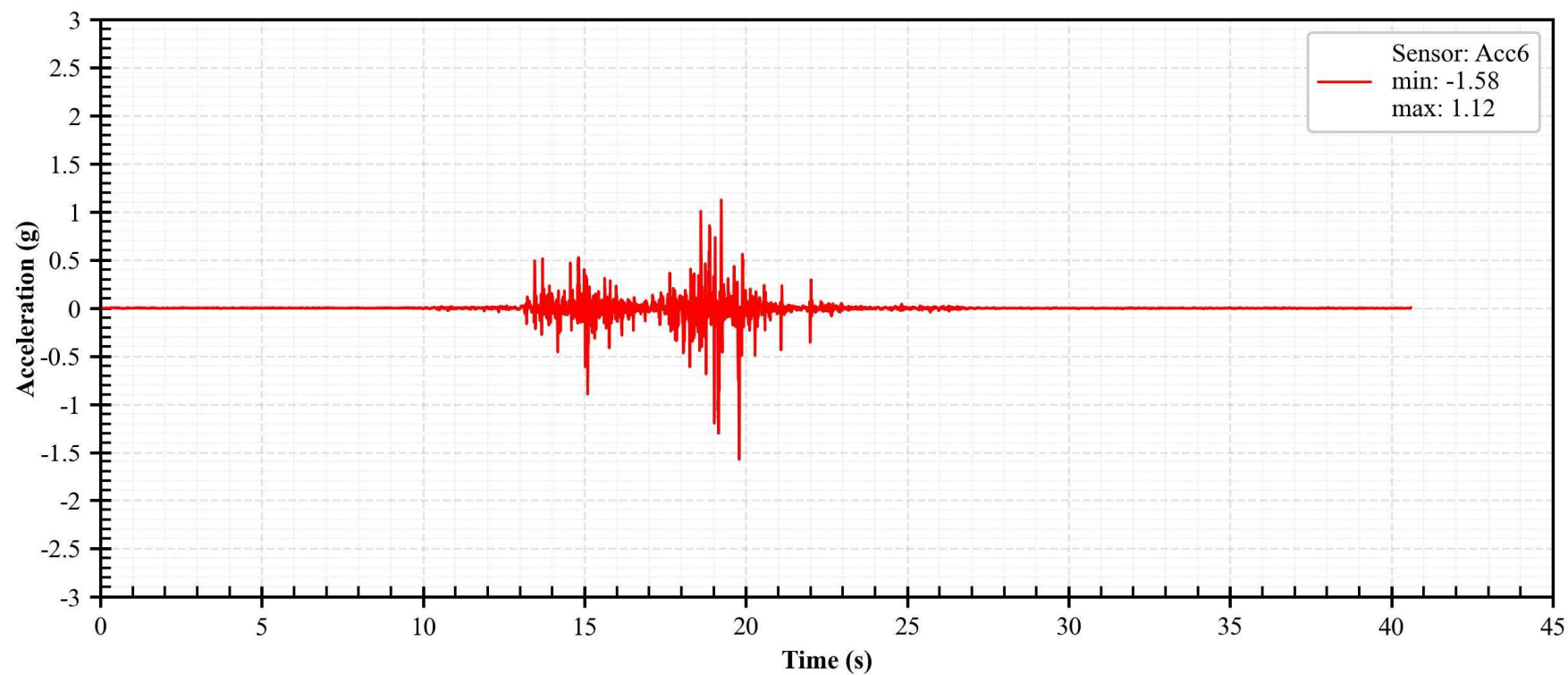


Figure 3.11.6 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 6

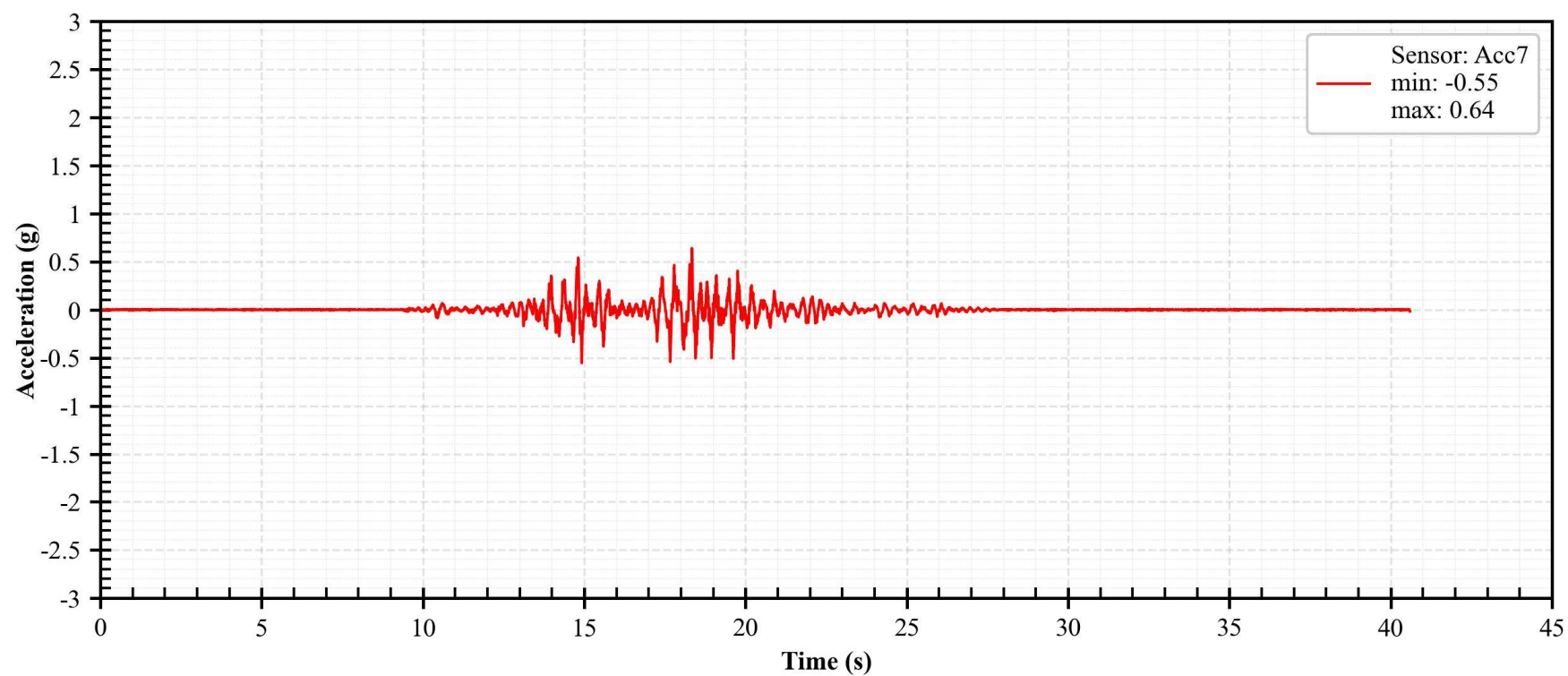


Figure 3.11.7 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 7

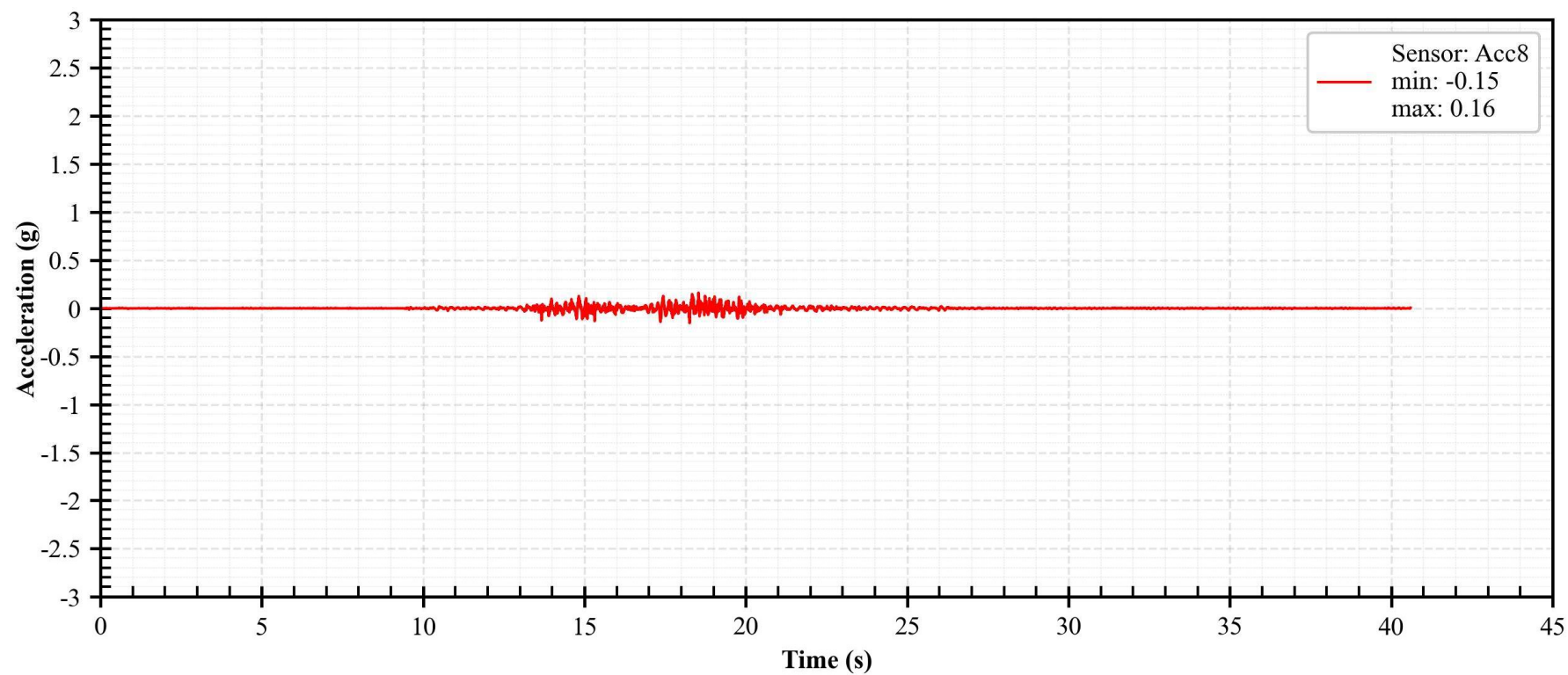


Figure 3.11.8 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 8

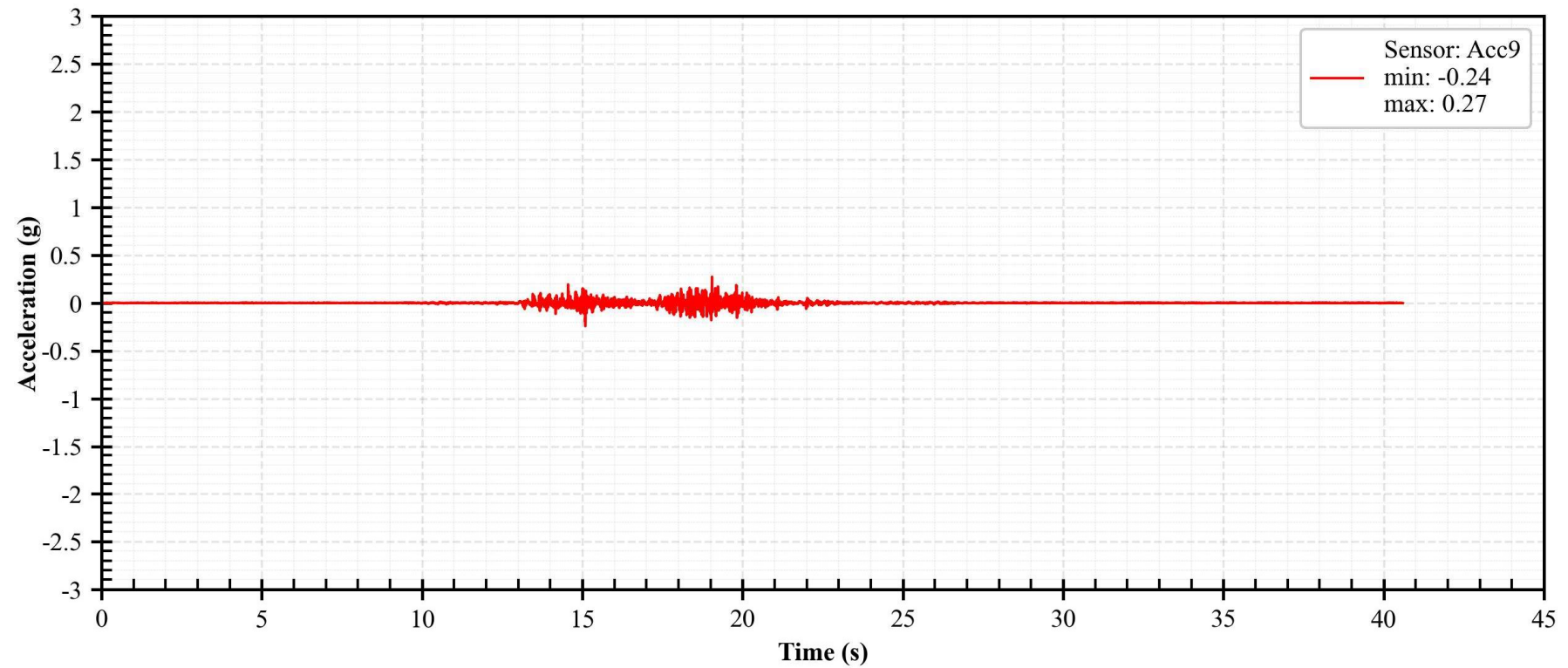


Figure 3.11.9 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 9

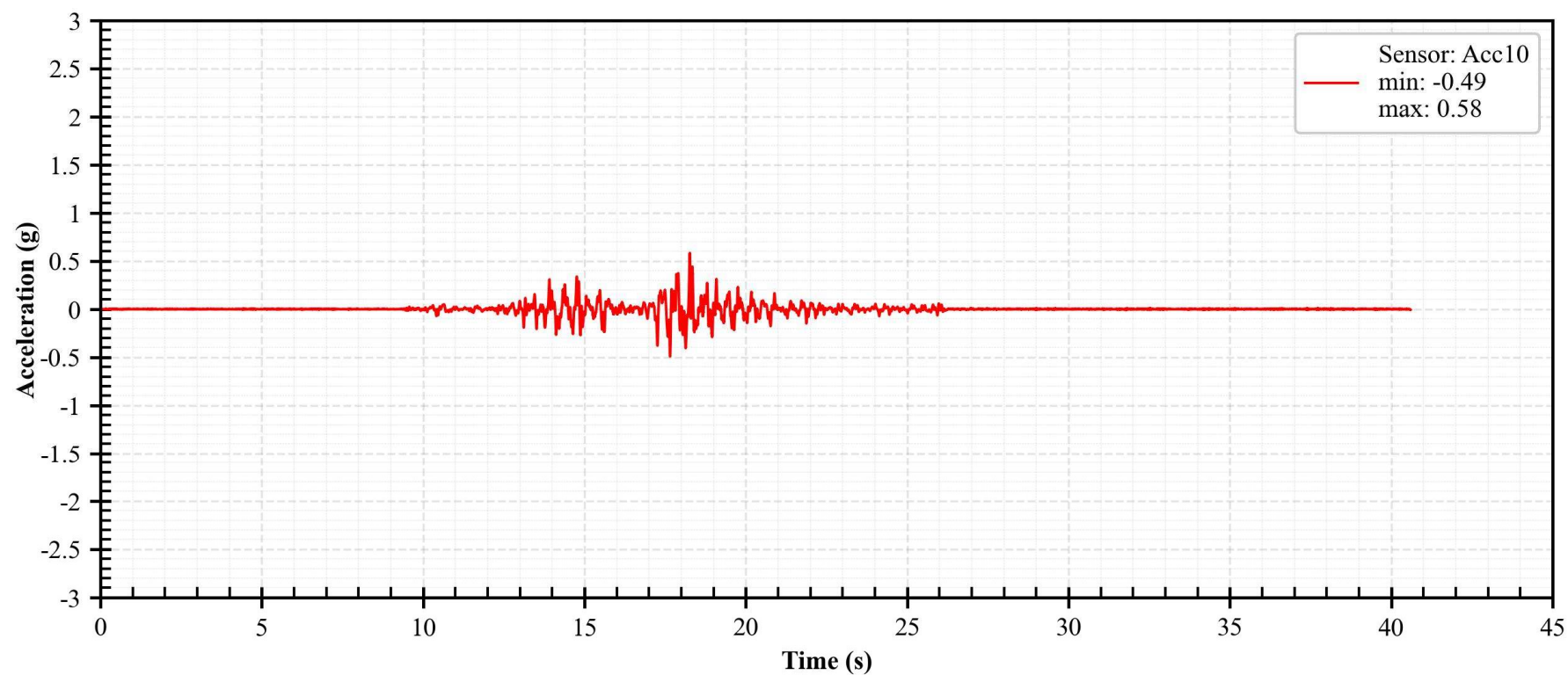


Figure 3.11.10 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 10

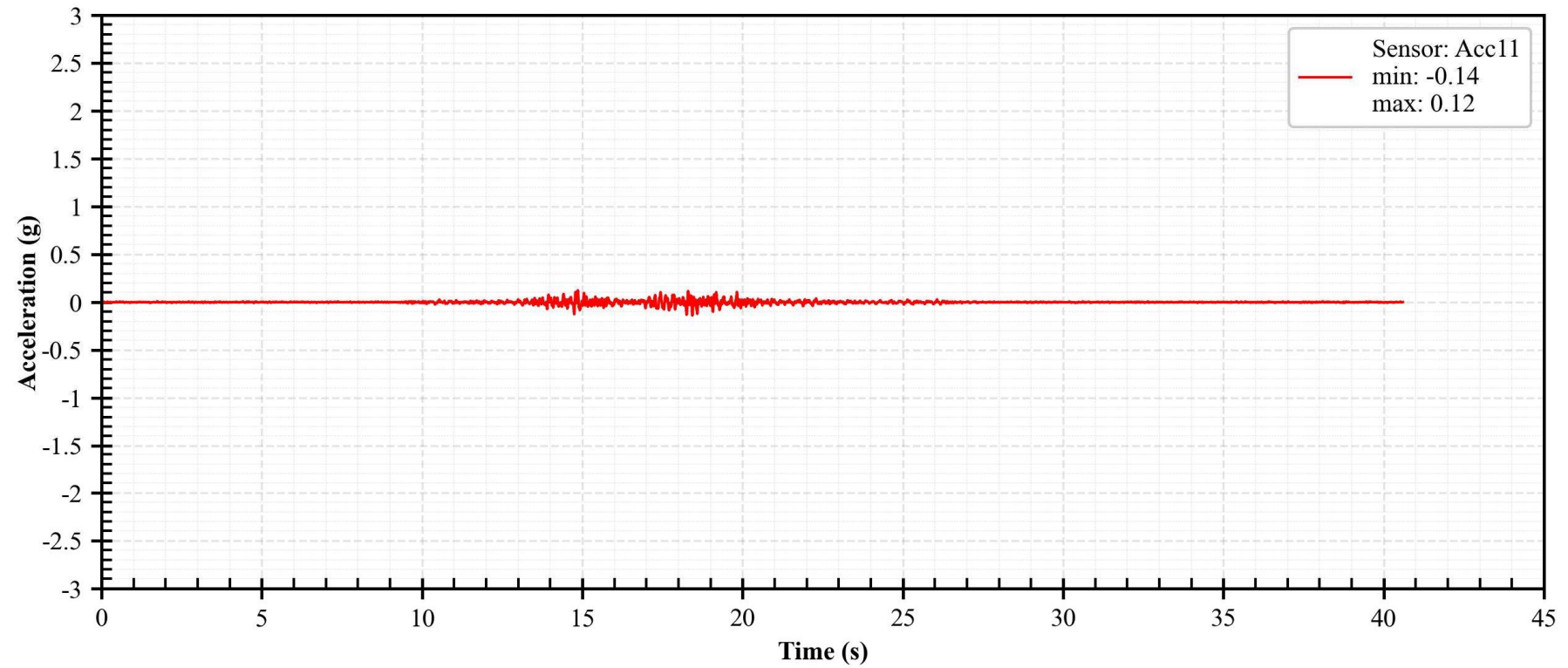


Figure 3.11.11 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 11

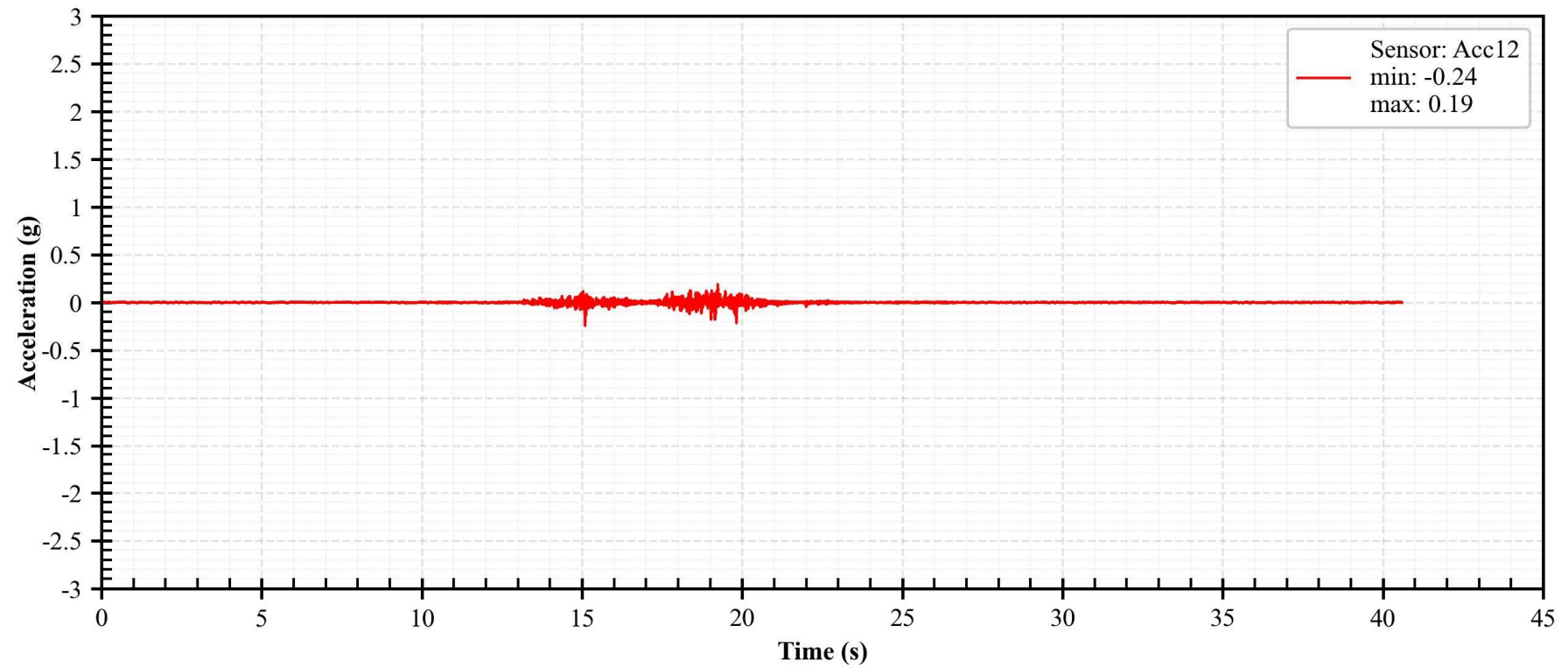


Figure 3.11.12 Characteristic results for phase B (earthquake EQ0,5g): Accelerometer 12

Draw wire sensors

Figures 3.11.13 – 3.11.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 15.68 mm while the minimum is -16.01 mm. The maximum movement detected by draw wire sensor W2 is 15.99 mm while the minimum is -15.80 mm. The maximum movement detected by draw wire sensor W3 is 11.15 mm while the minimum is -10.49 mm. The maximum movement detected by draw wire sensor W4 is 11.49 mm while the minimum is -10.73 mm. The maximum drift is $(6.83 / 1.225) = 5.58 \text{ ‰}$ and minimum drift is $(-6.48 / 1.225) = -5.29 \text{ ‰}$.

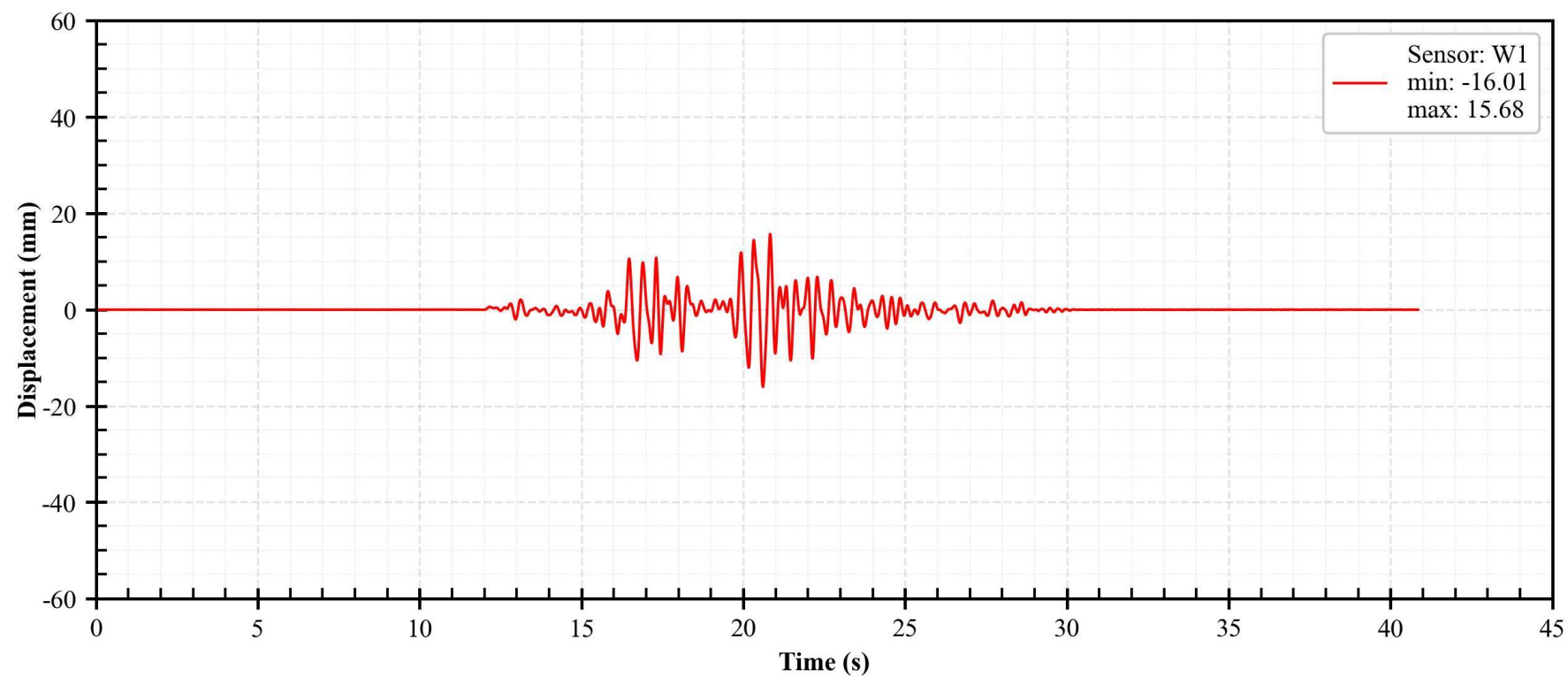


Figure3.11.13 Characteristic results for phase B (earthquake EQ0,5g): Draw wire sensor 1

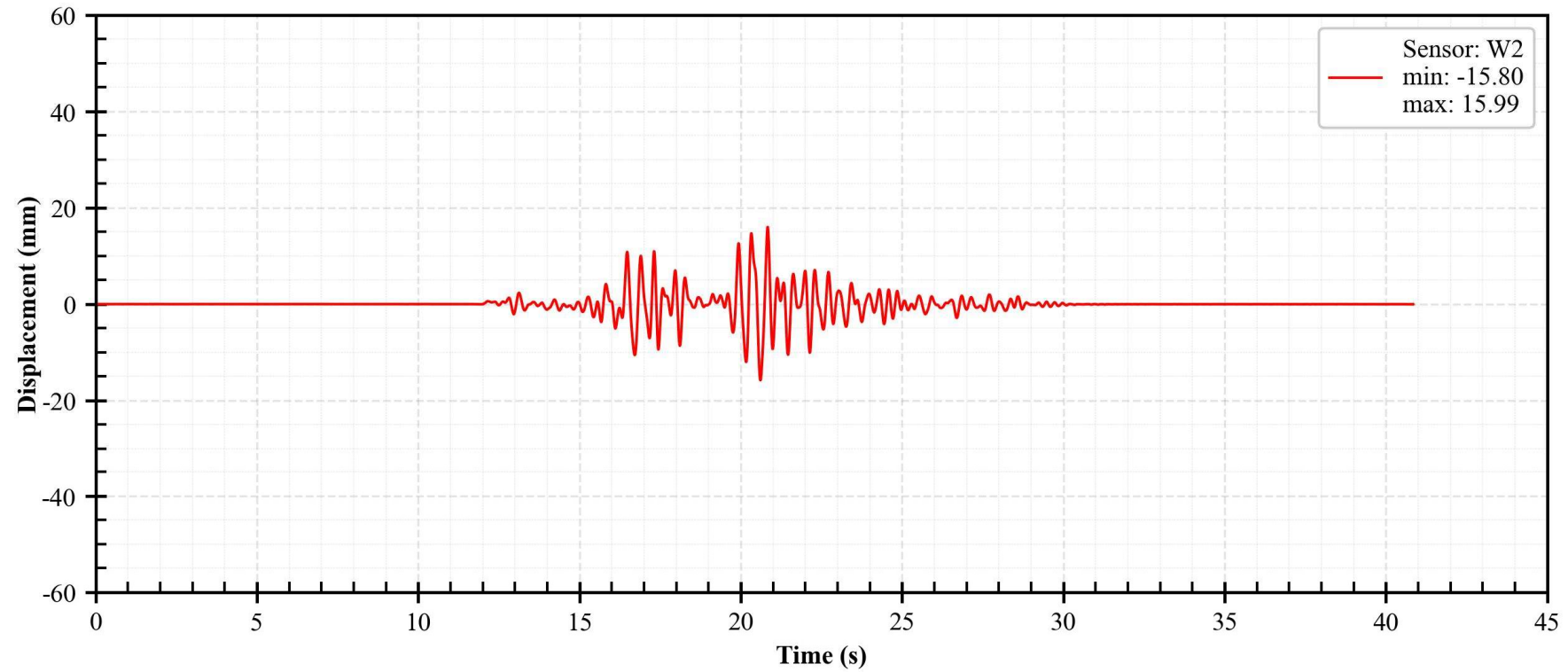


Figure3.11.14 Characteristic results for phase B (earthquake EQ0,5g): Draw wire sensor 2

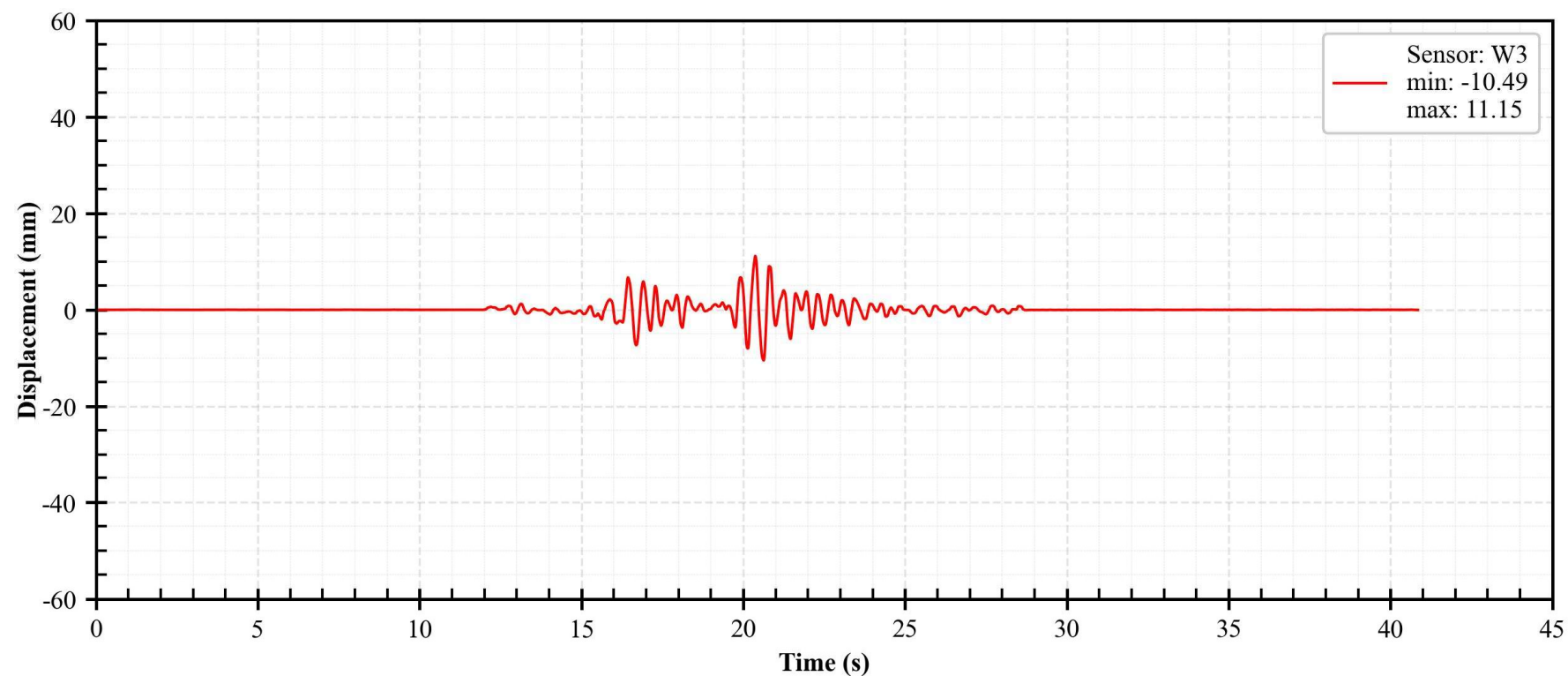


Figure3.11.15 Characteristic results for phase B (earthquake EQ0,5g): Draw wire sensor 3

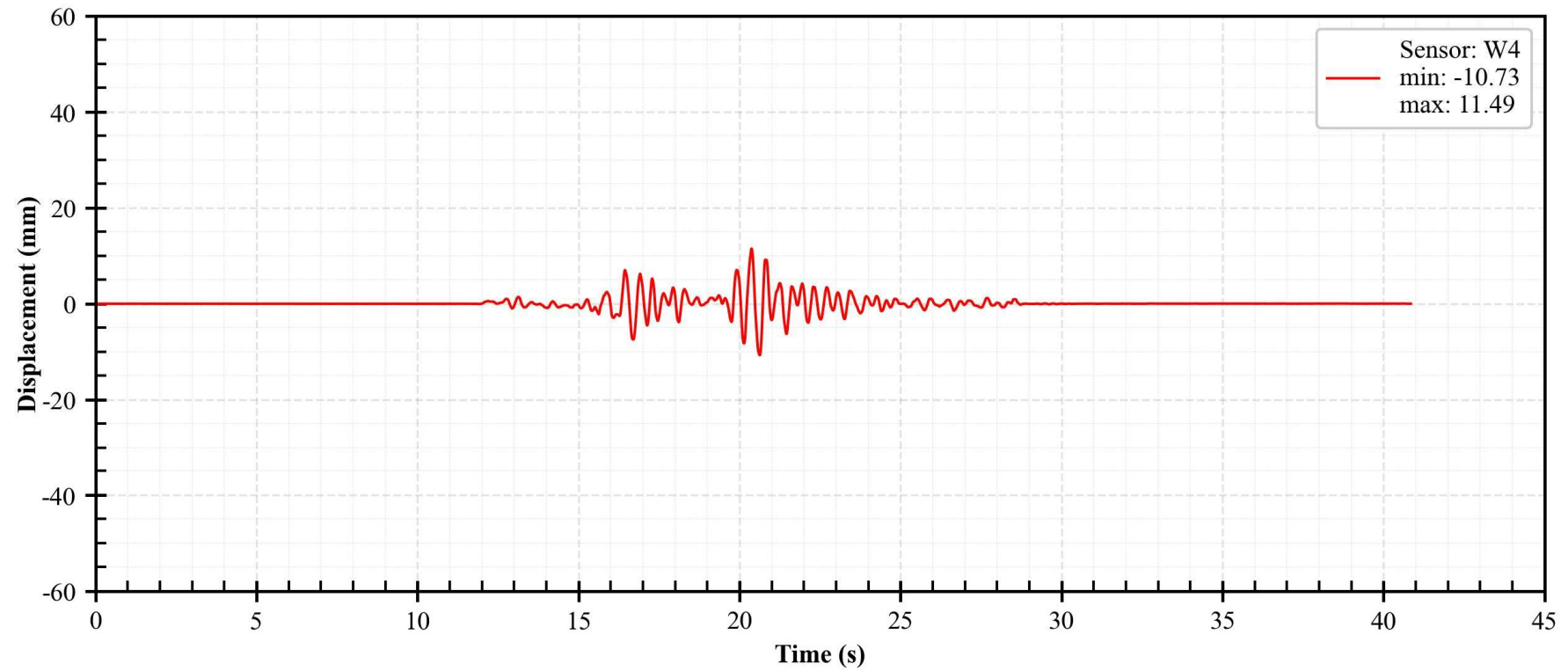


Figure 3.11.16 Characteristic results for phase B (earthquake EQ0,5g): Draw wire sensor 4

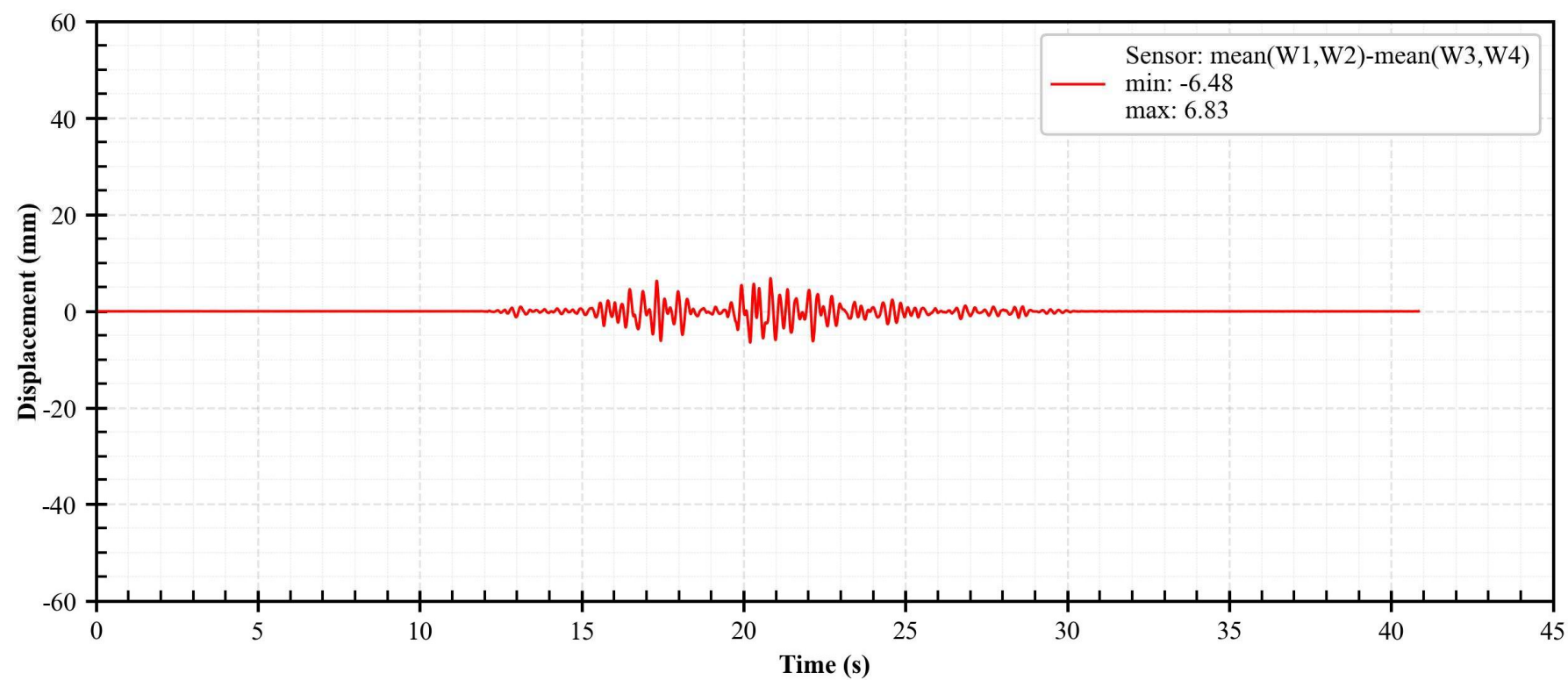


Figure 3.11.17 Characteristic results for phase B (earthquake EQ0,5g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.11.18, 3.11.19, 3.11.20, 3.11.21, 3.11.22, 3.11.23, 3.11. 32, 3.11.33 are located on the longitudinal reinforcement, at the bottom of the column. The strain gauges shown in the figures 3.11.24, 3.11.25, 3.11.26, 3.11.27, 3.11.28, 3.11.29 and 3.11.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 1026 μ strain and minimum strain -503 μ strain. The residual strain is 1 μ strain. SG21 & SG22 are located on PUFJ.

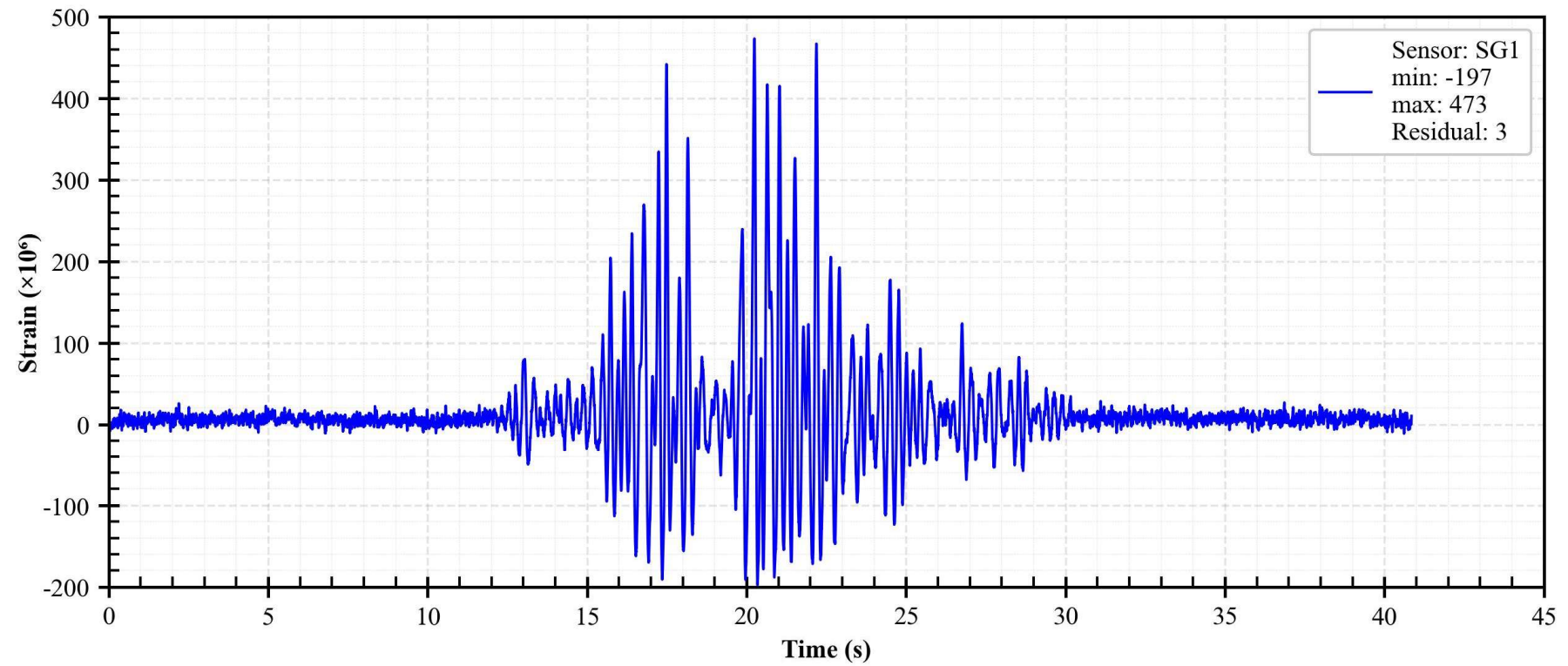


Figure 3.11.18 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 1

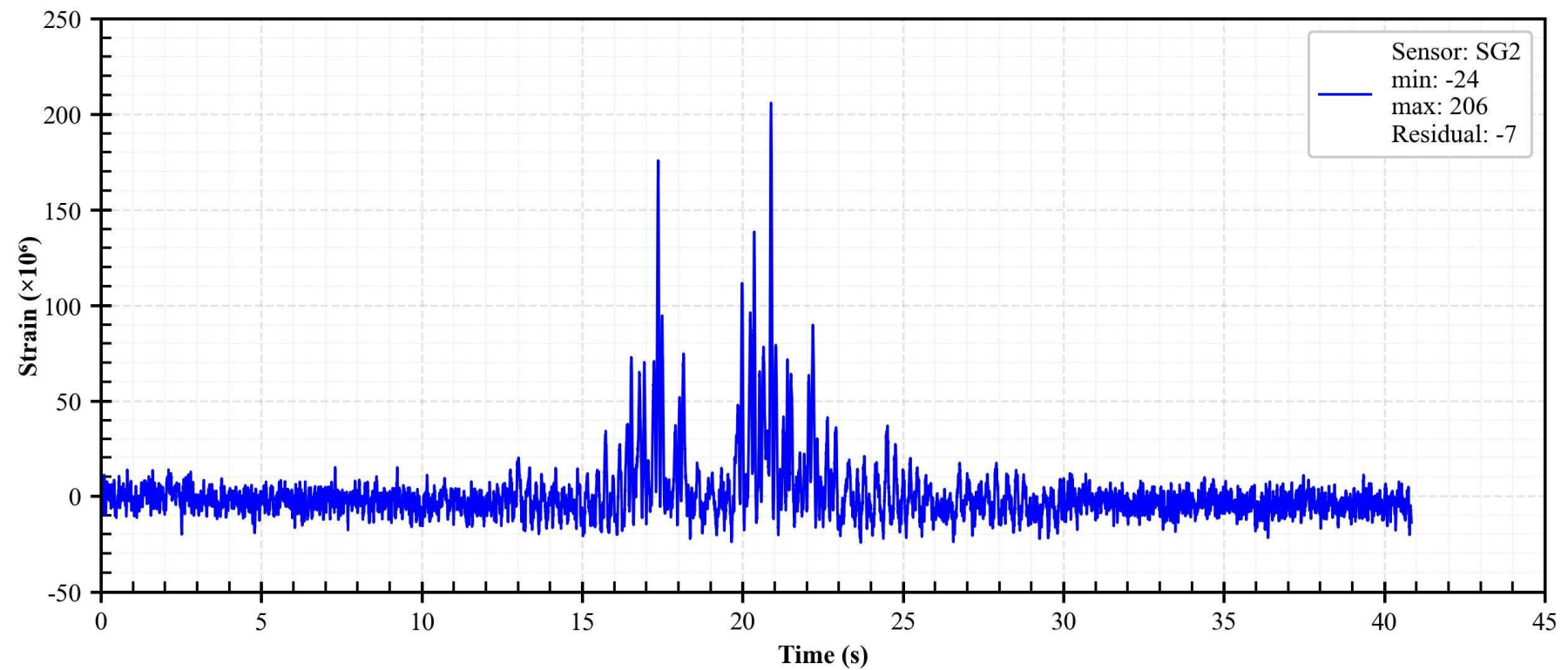


Figure 3.11.19 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 2

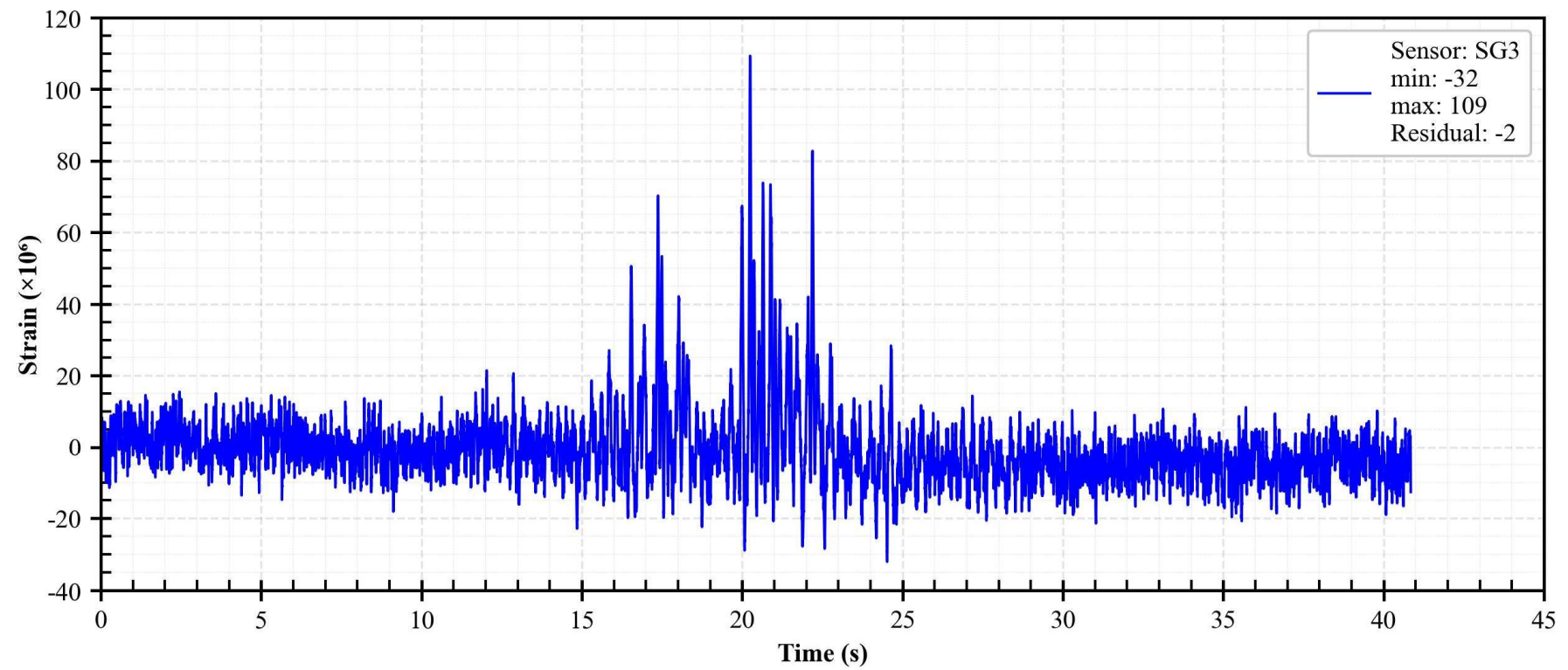


Figure 3.11.20 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 3

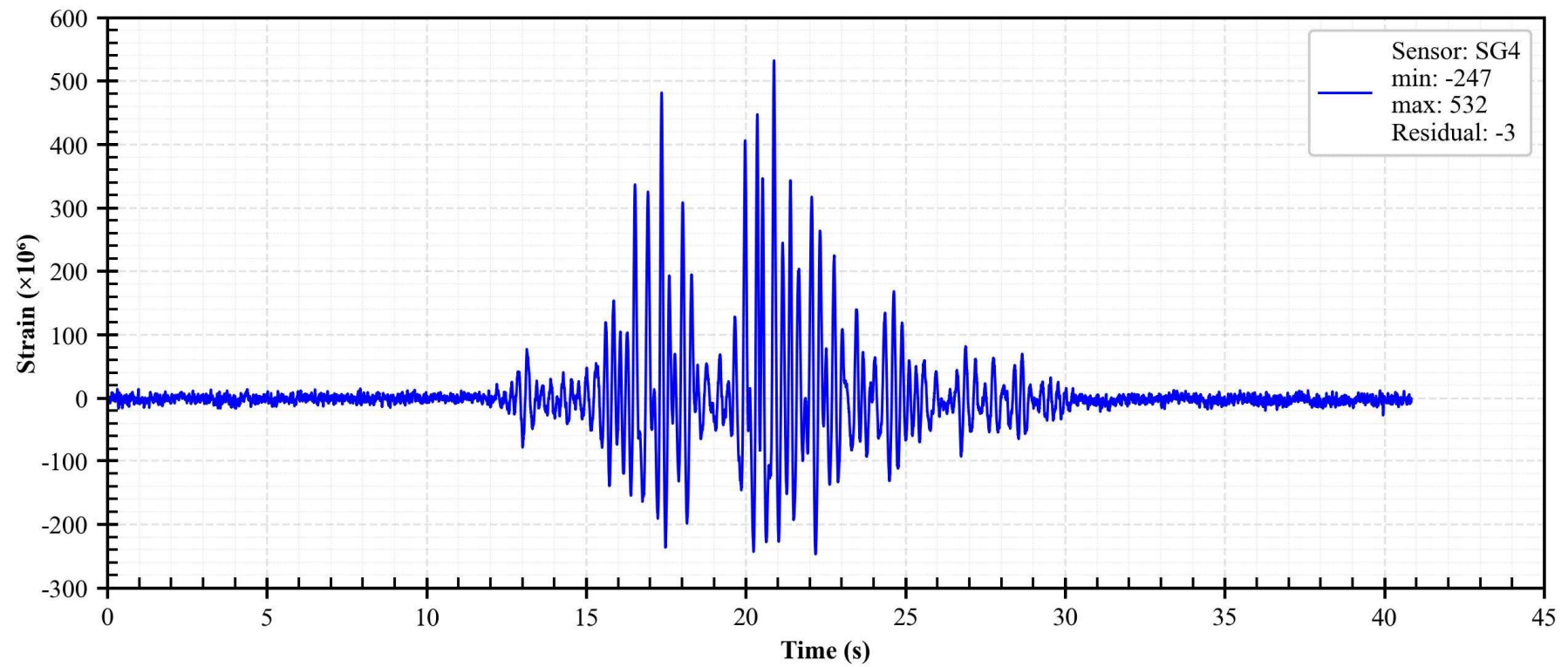


Figure 3.11.21 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 4

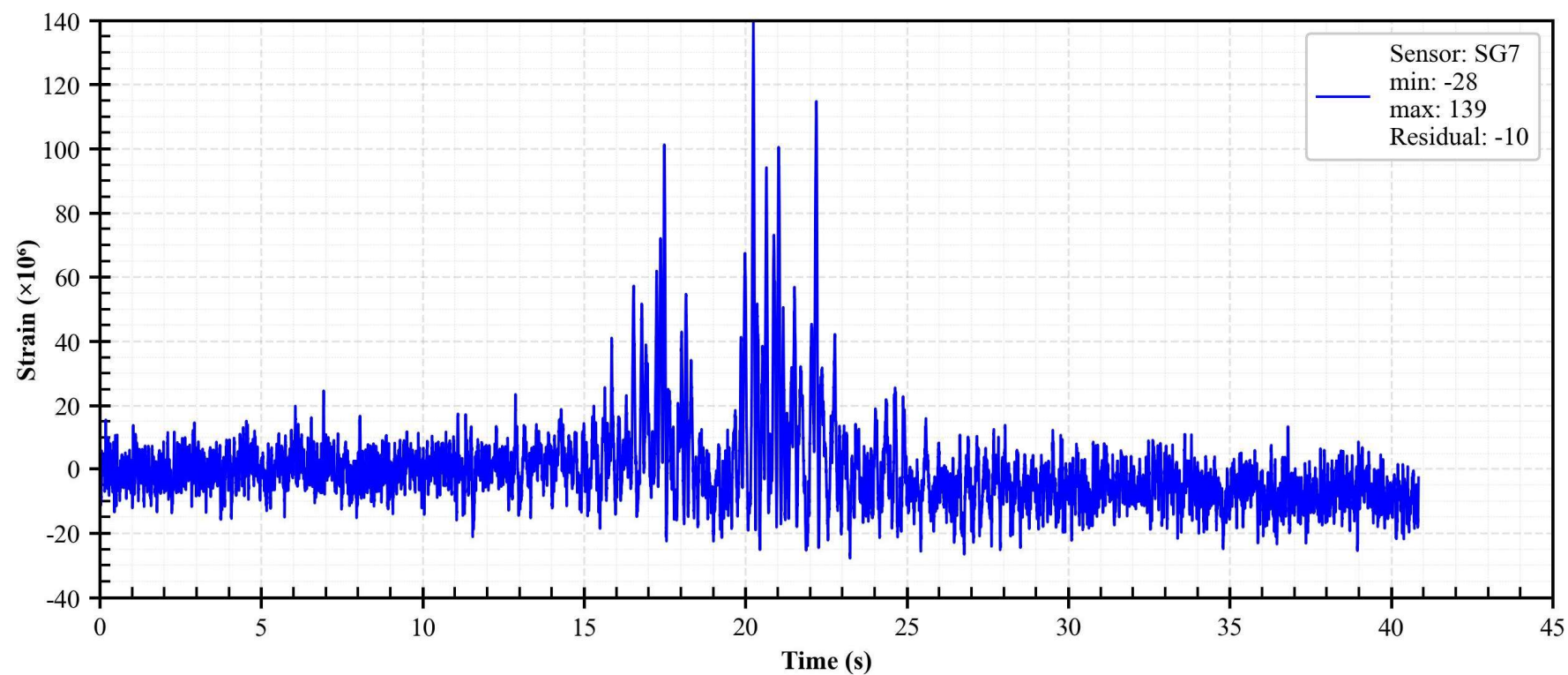


Figure 3.11.22 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 7

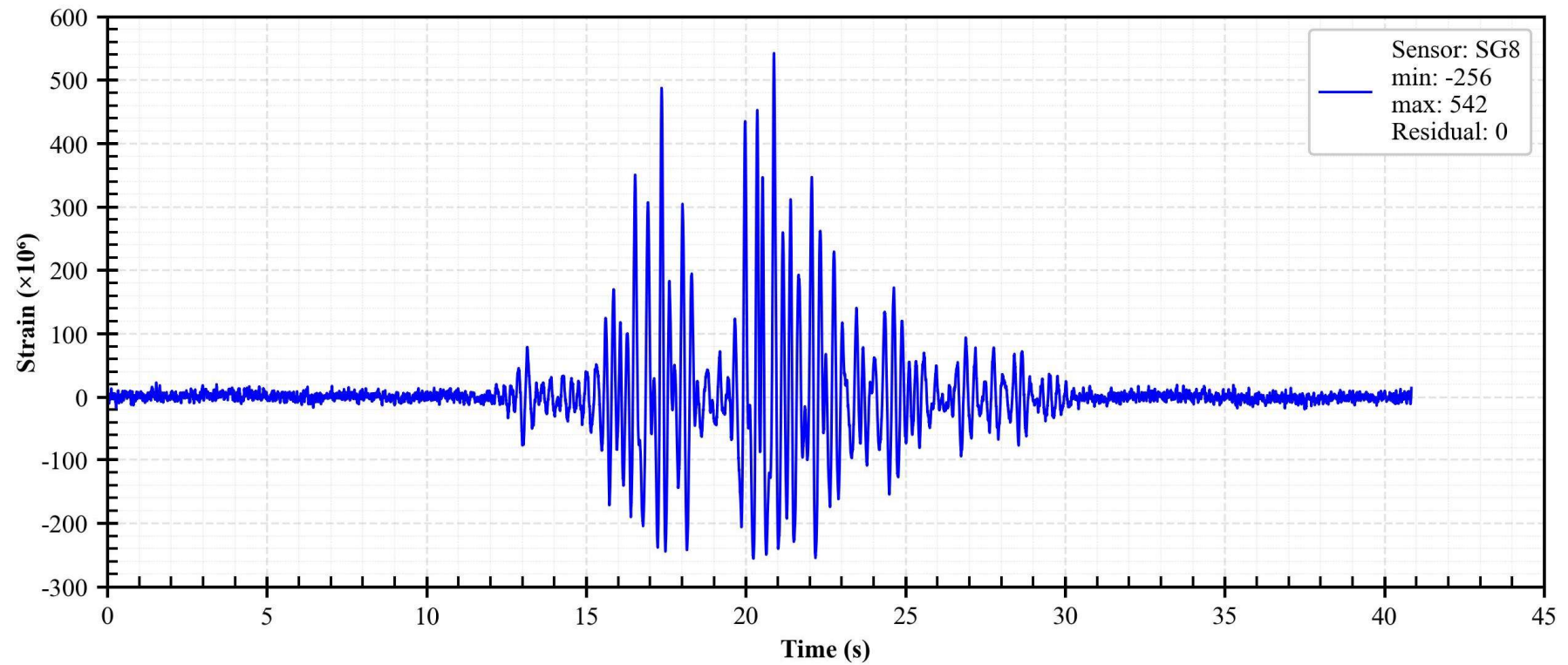


Figure 3.11.23 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 8

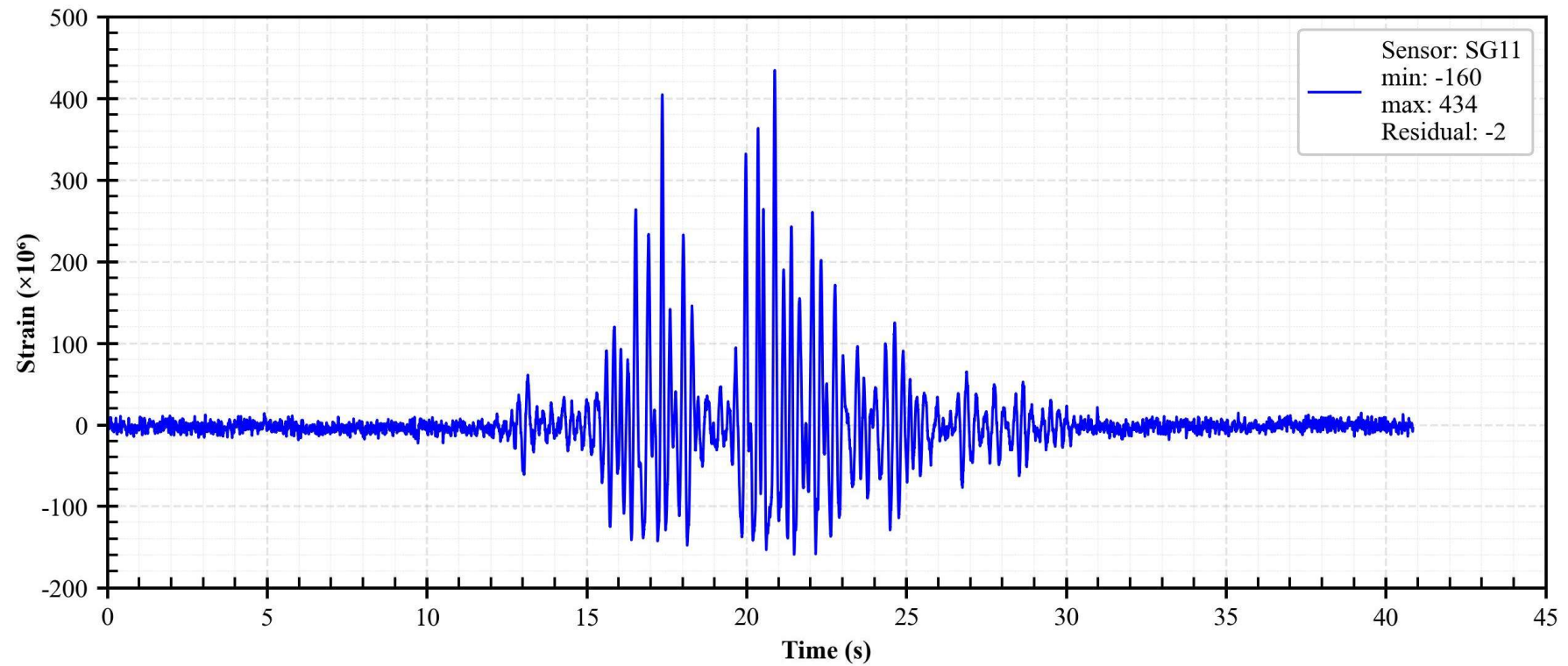


Figure 3.11.24 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 11

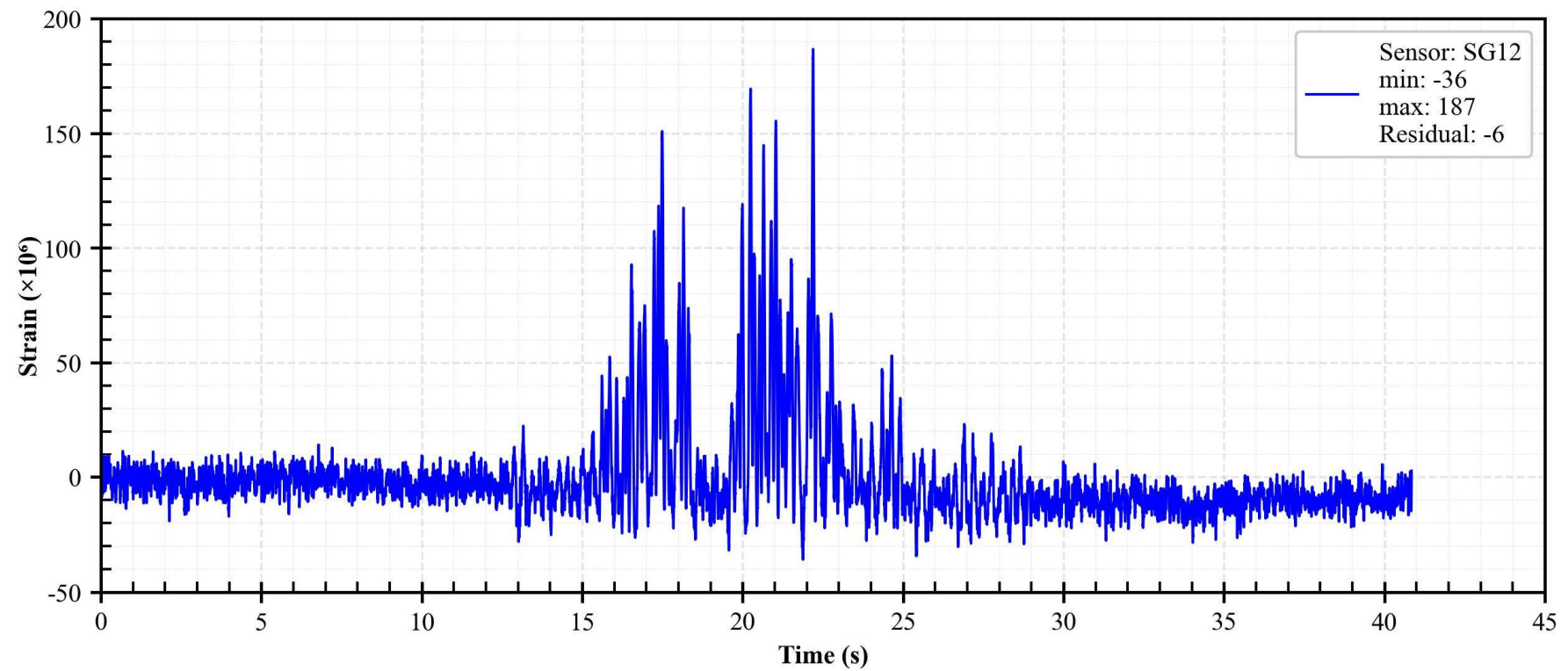


Figure 3.11.25 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 12

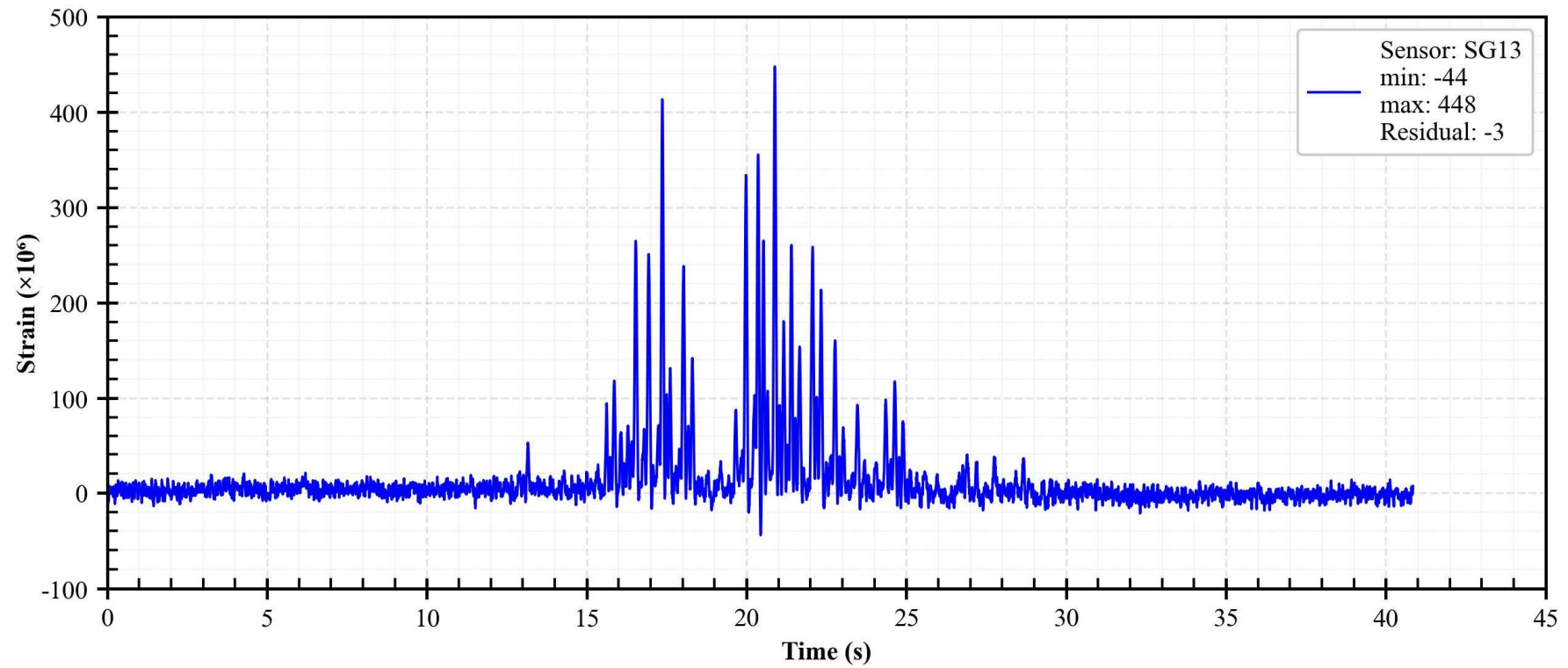


Figure 3.11.26 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 13

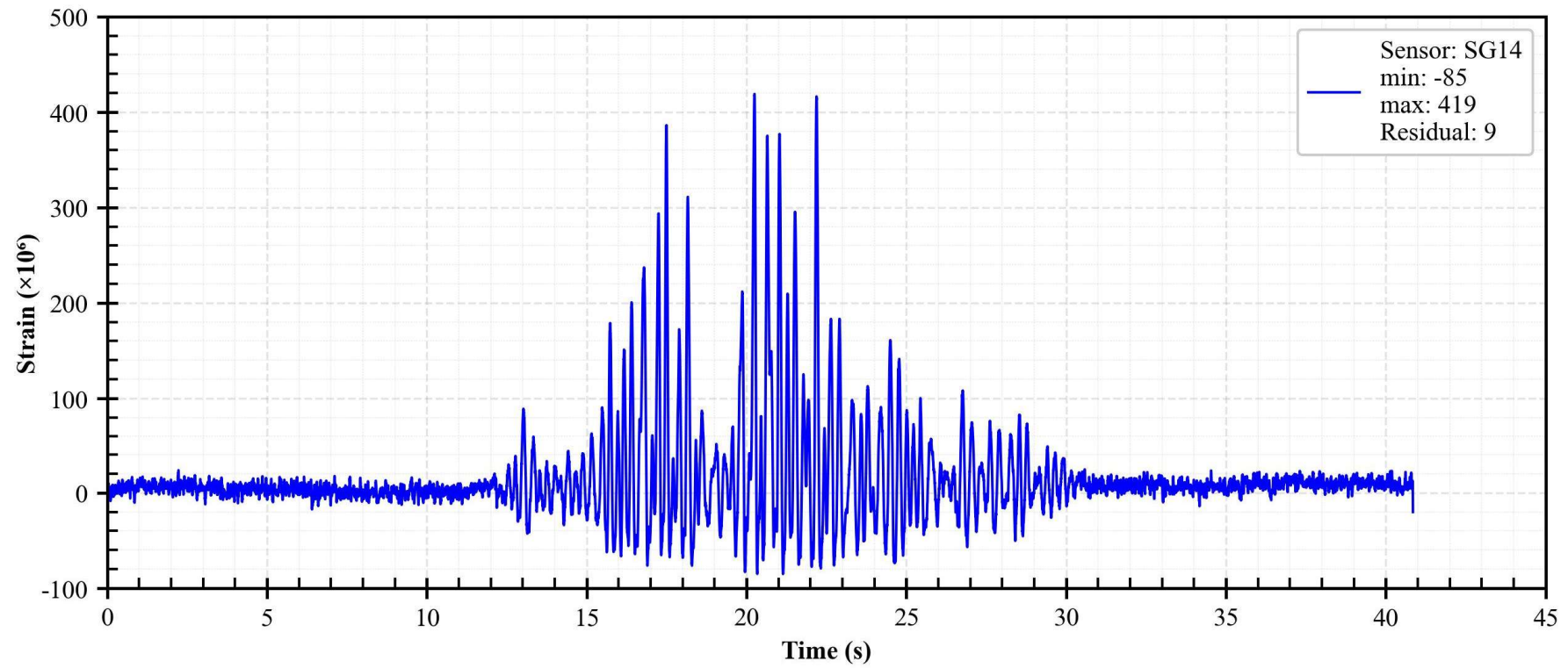


Figure 3.11.27 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 14

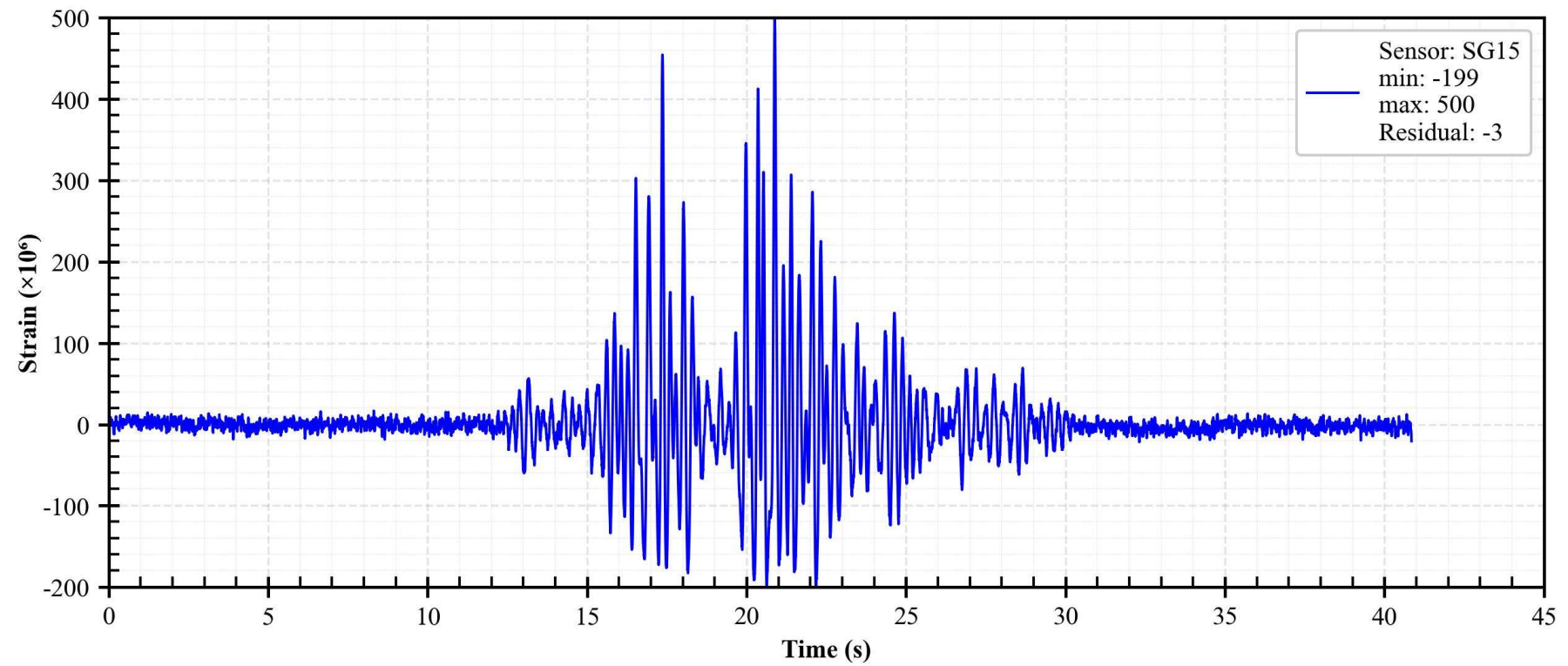


Figure 3.11.28 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 15

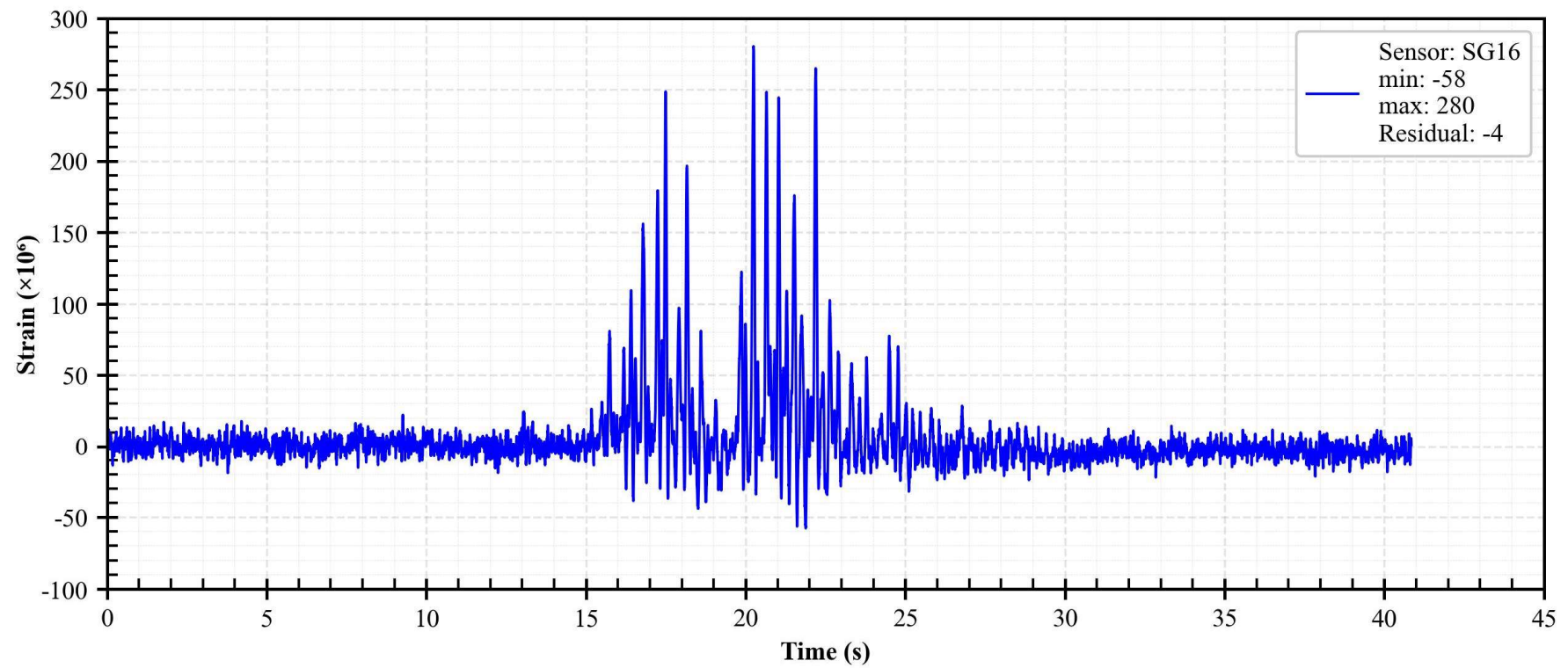


Figure 3.11.29 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 16

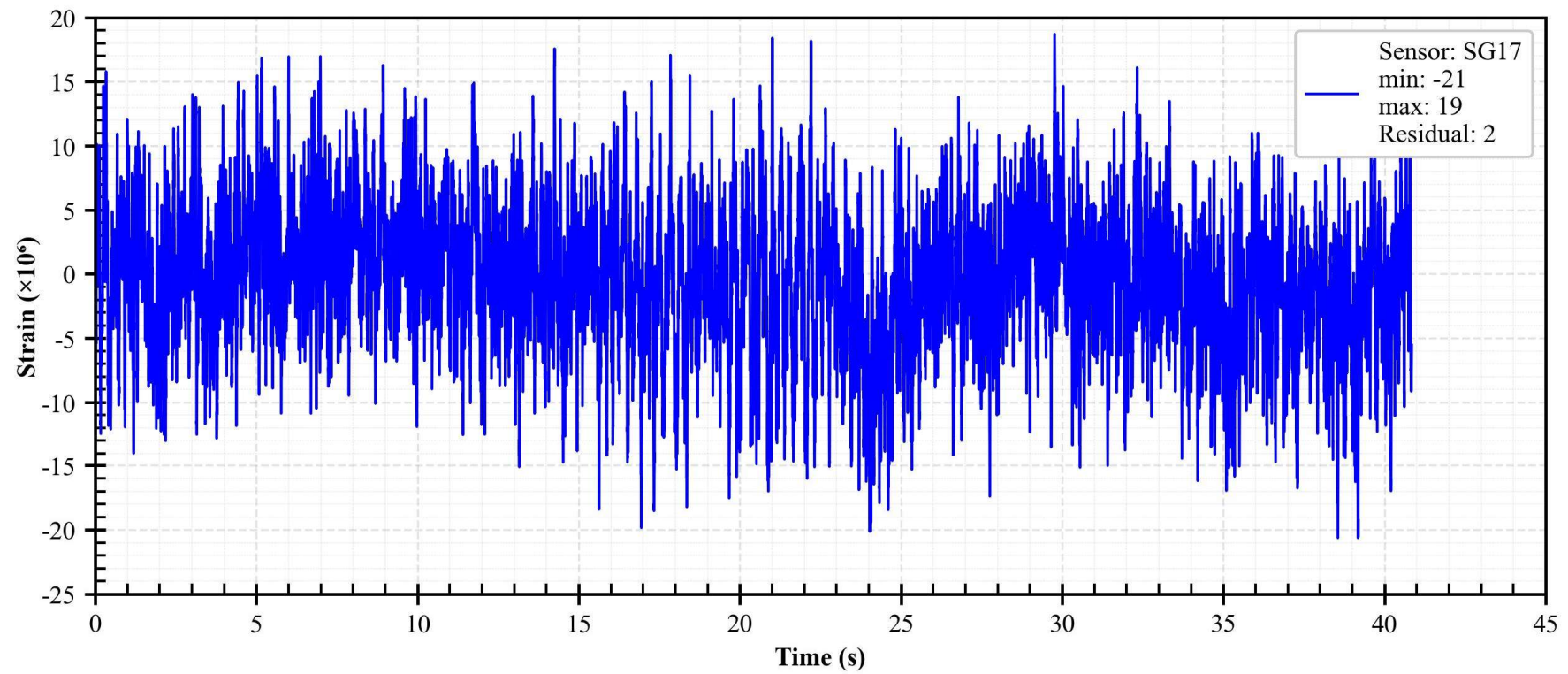


Figure 3.11.30 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 17

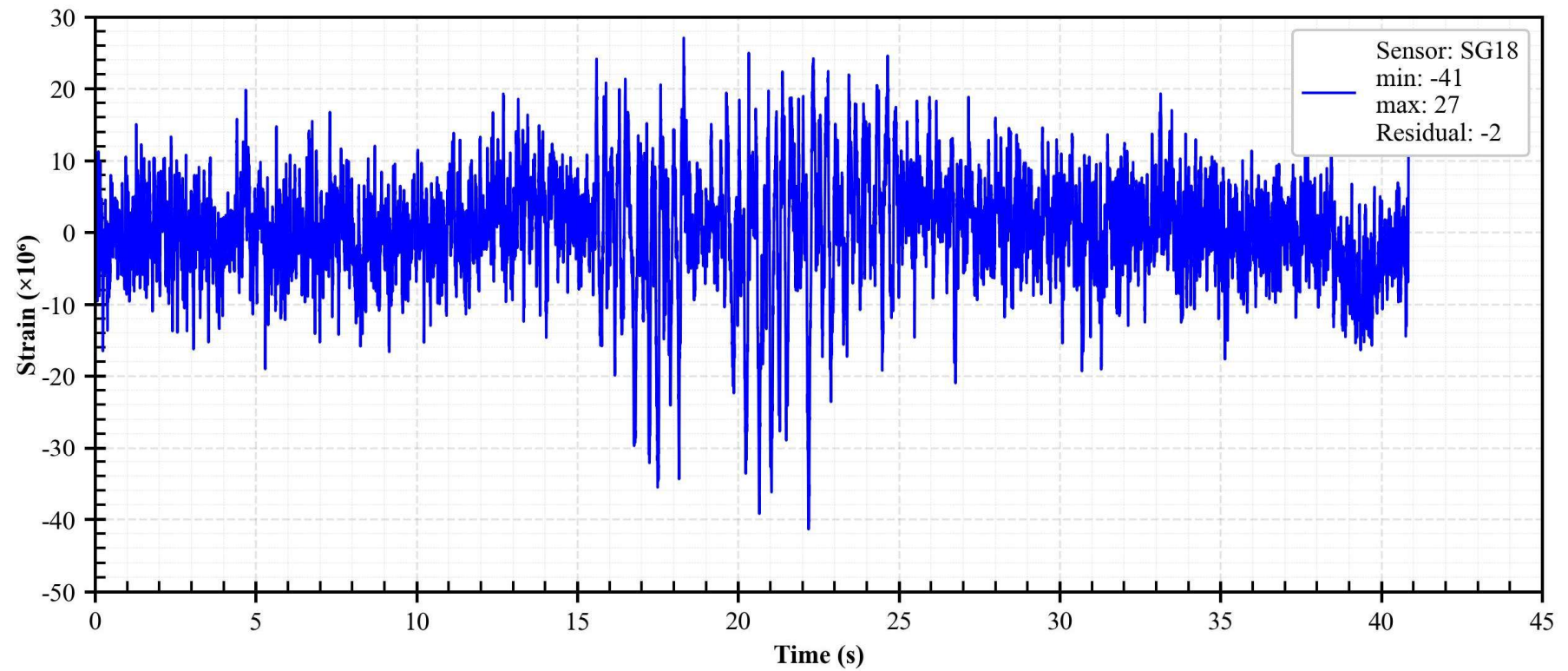


Figure 3.11.31 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 18

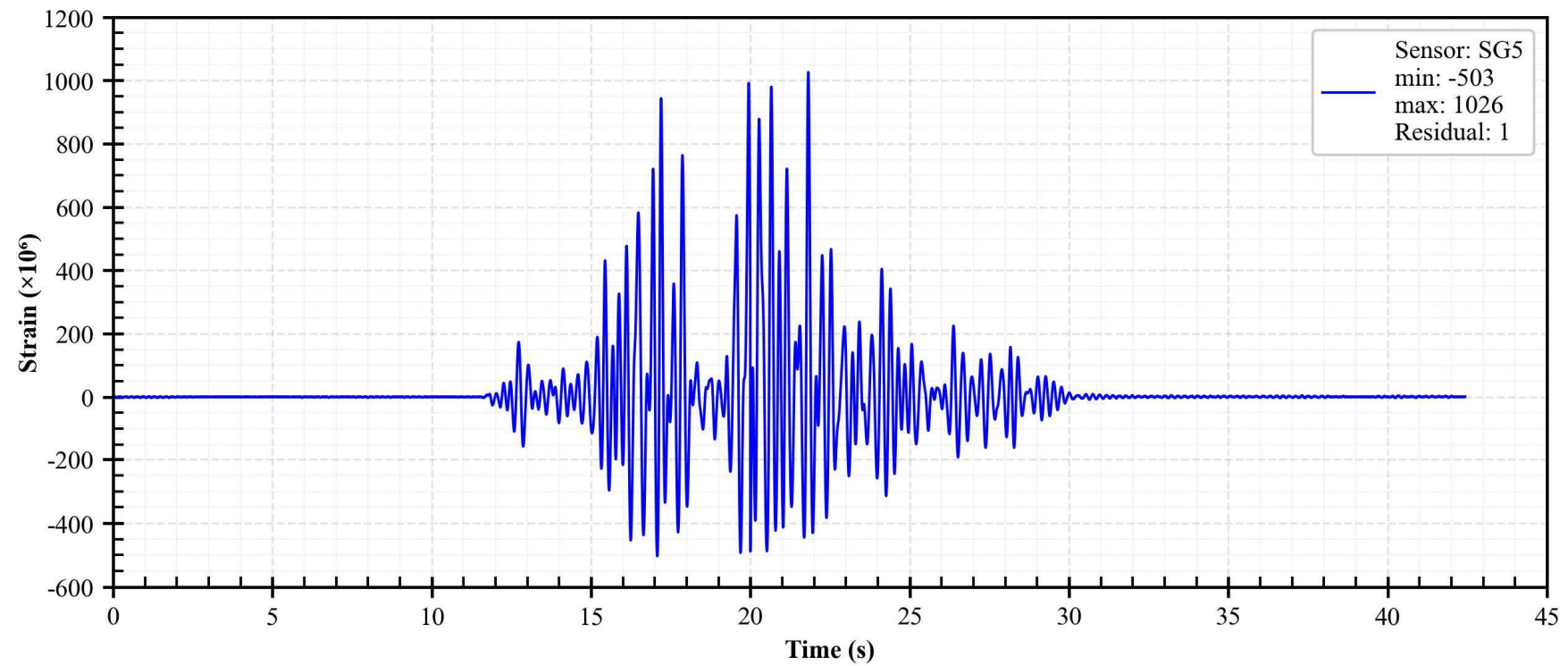


Figure 3.11.32 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 5

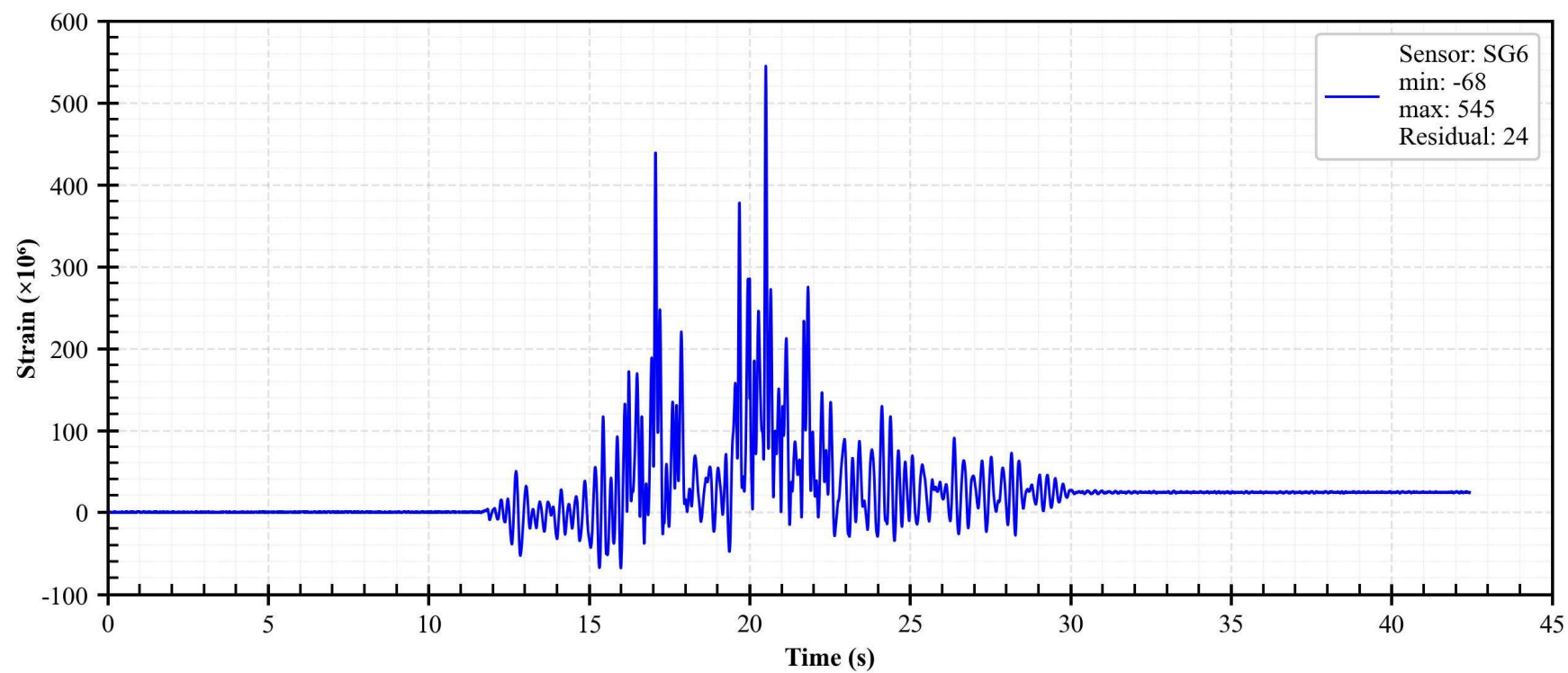


Figure 3.11.33 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 6

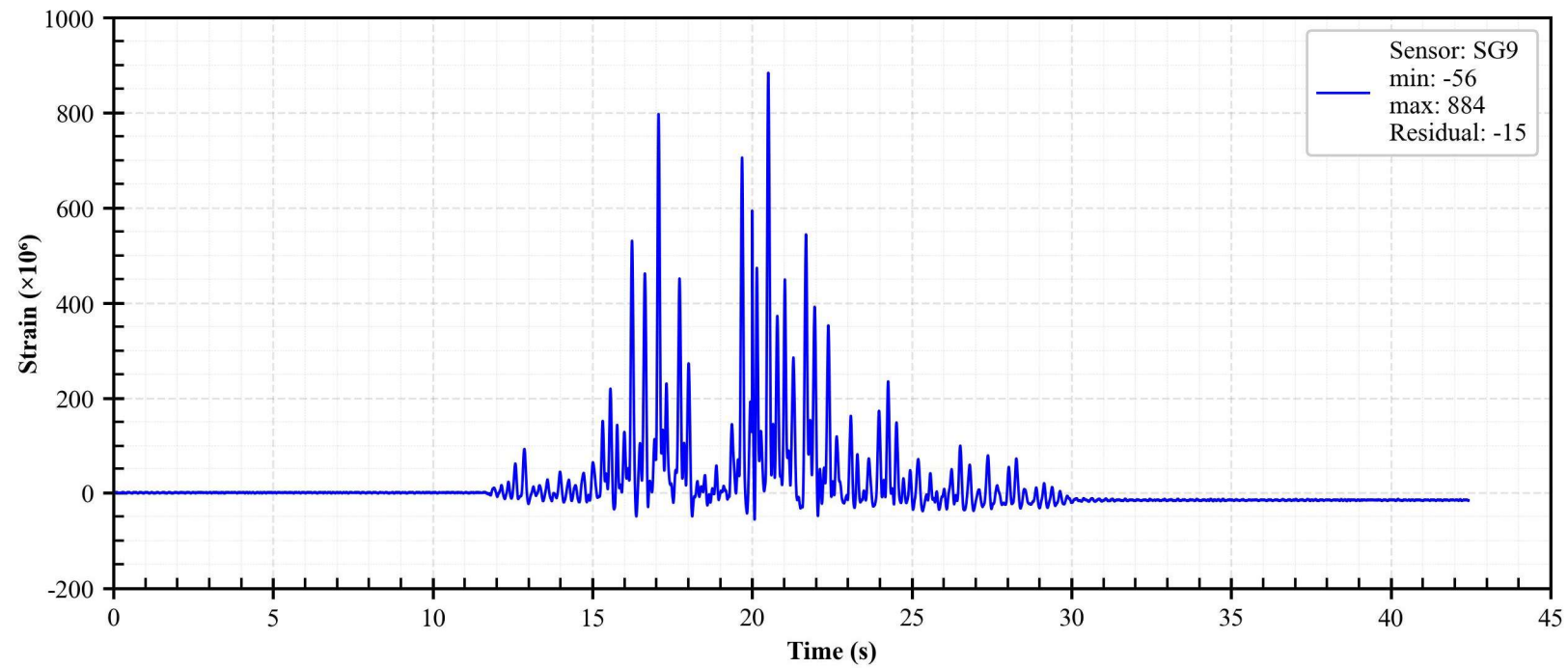


Figure 3.11.34 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 9

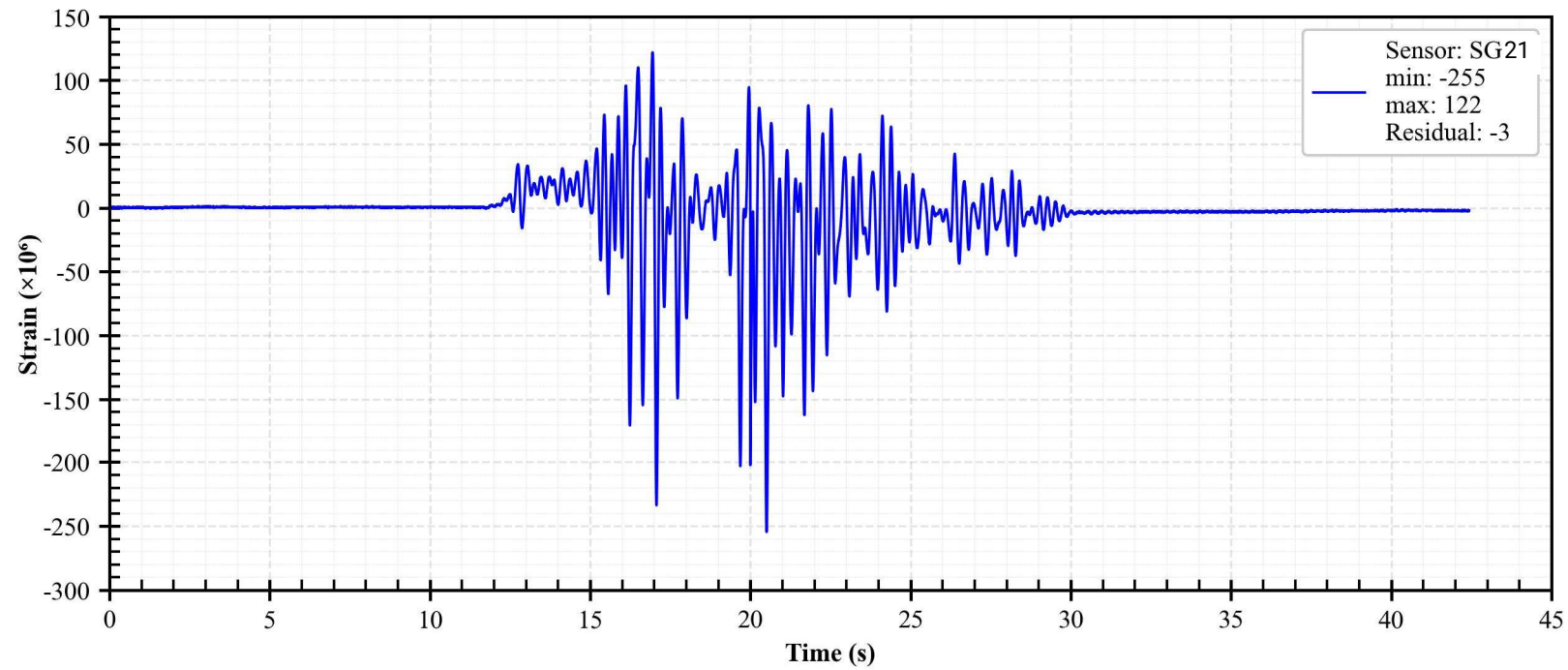


Figure 3.11.35 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 21 (PUFJ, column 1)

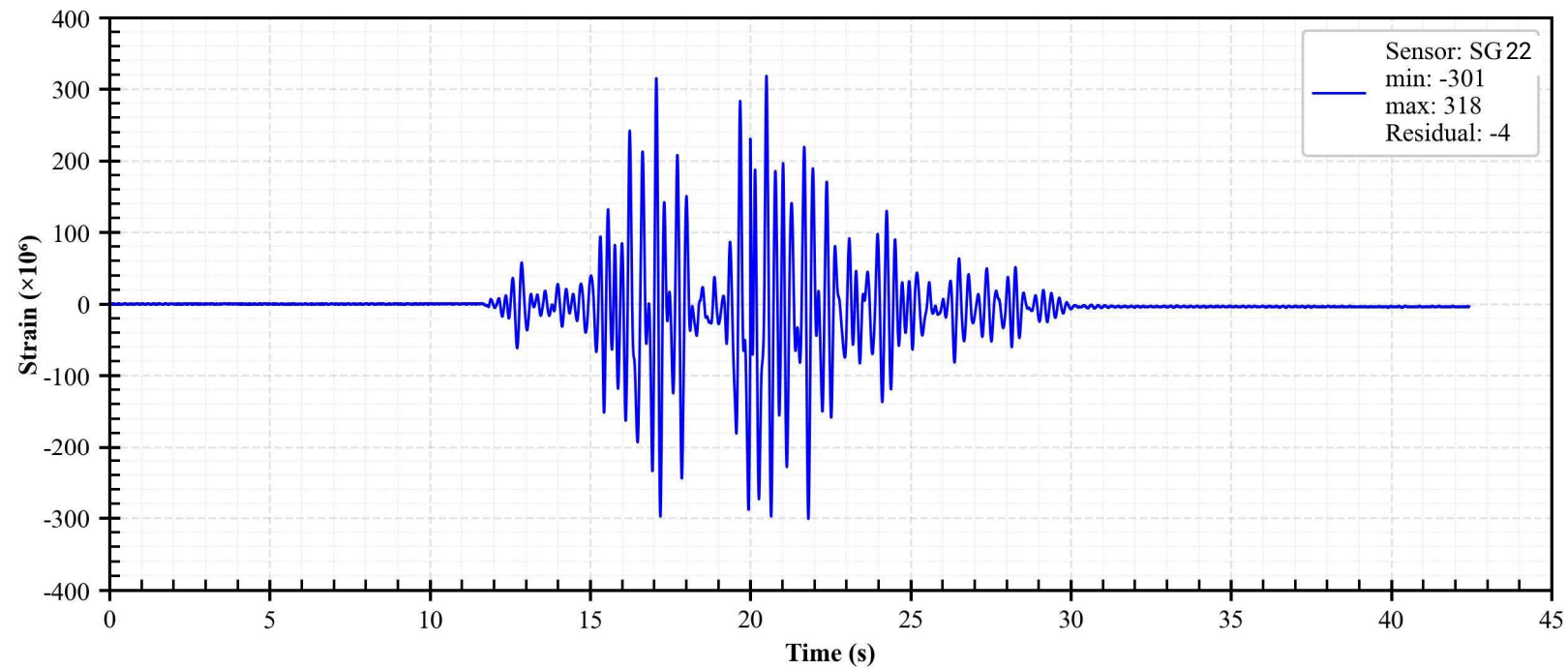


Figure 3.11.36 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 22 (PUFJ, column 2)

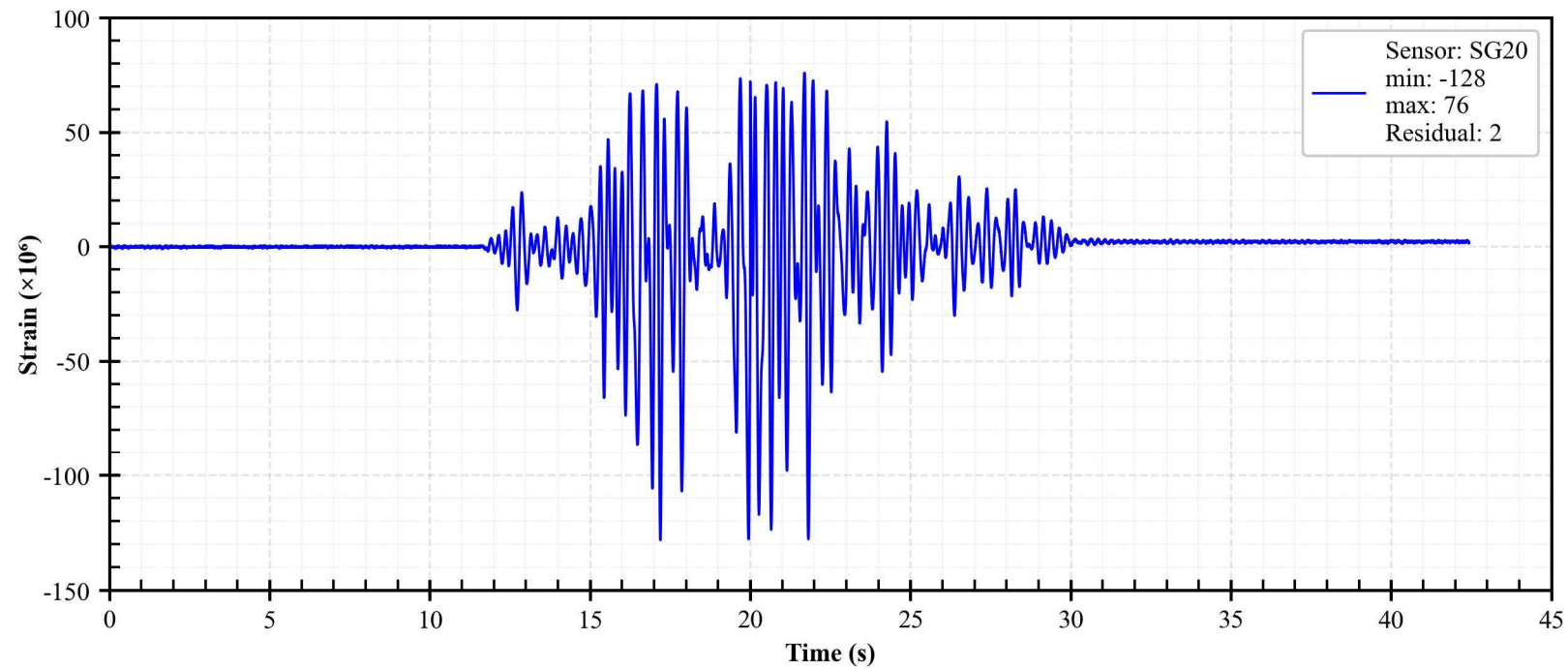


Figure 3.11.37 Characteristic results for phase B (earthquake EQ0,5g): strain gauge 20

3.12 White noise before EQ0,55g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,55g. The max acceleration at the slab level on the accelerometer acc4 is 0.18g. The max acceleration at the foundation level on the accelerometer acc10 is 0.07g.

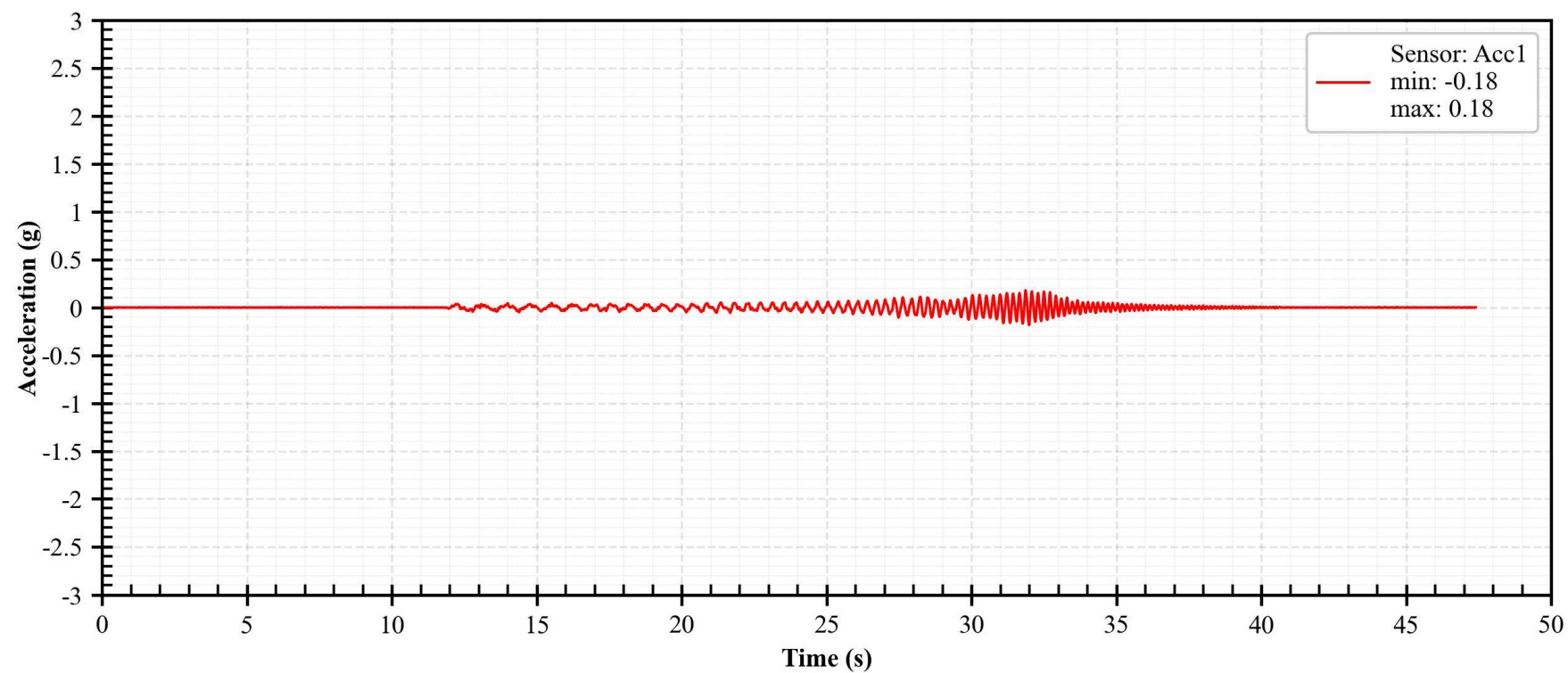


Figure 3.12.1 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 1

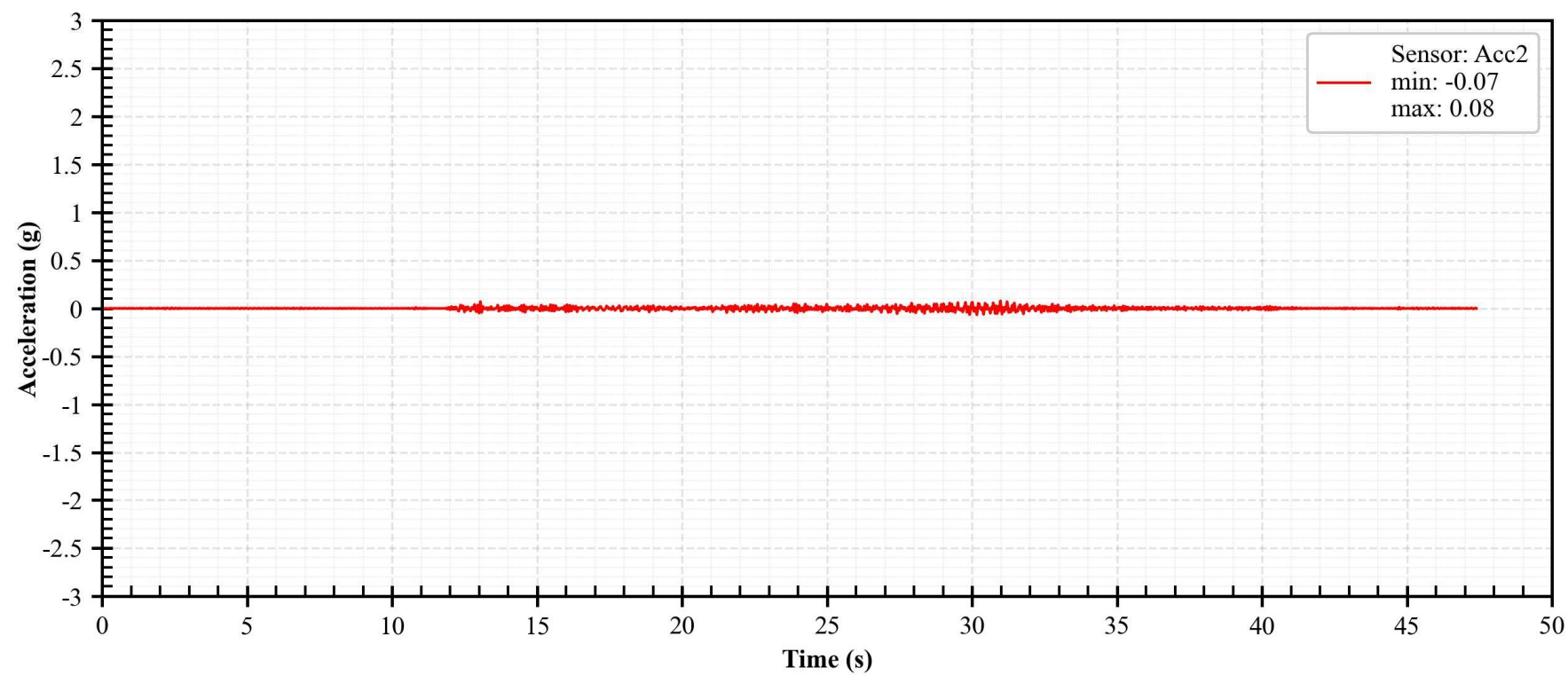


Figure 3.12.2 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 2

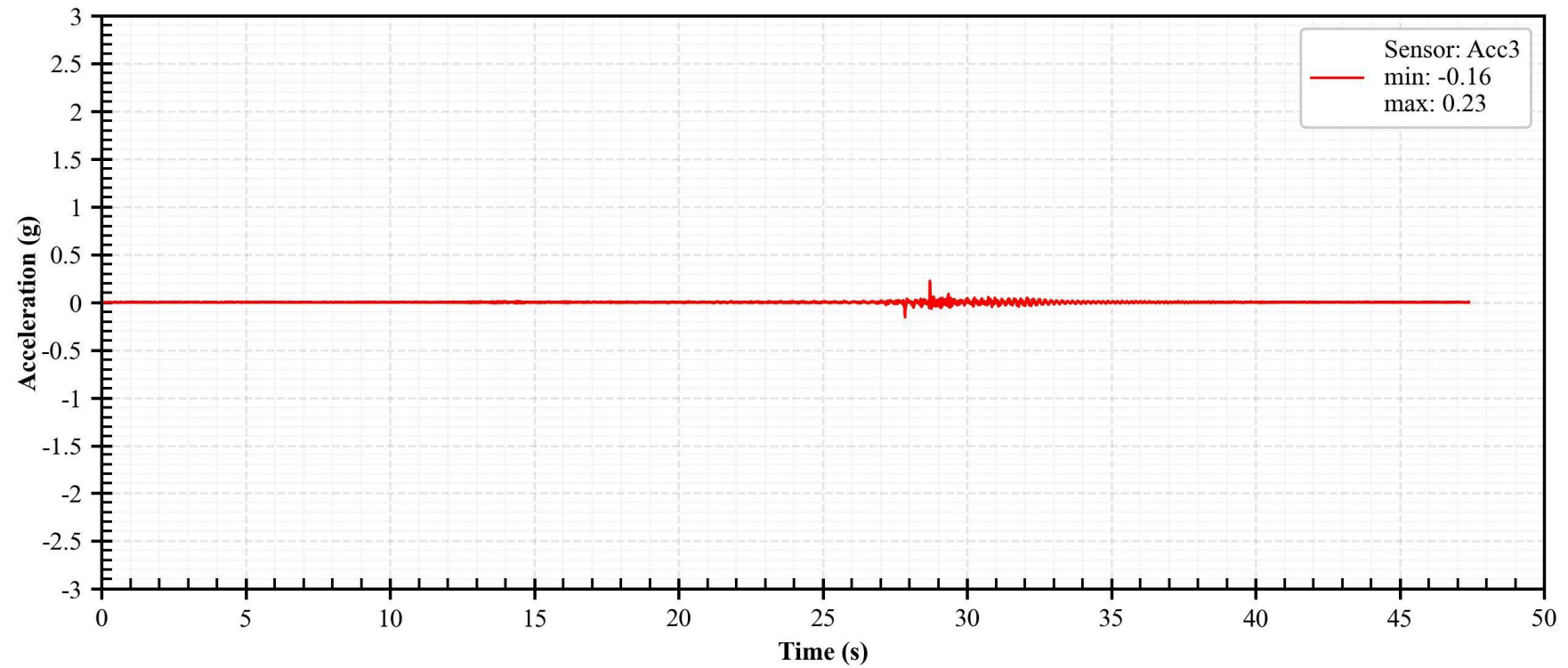


Figure 3.12.3 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 3

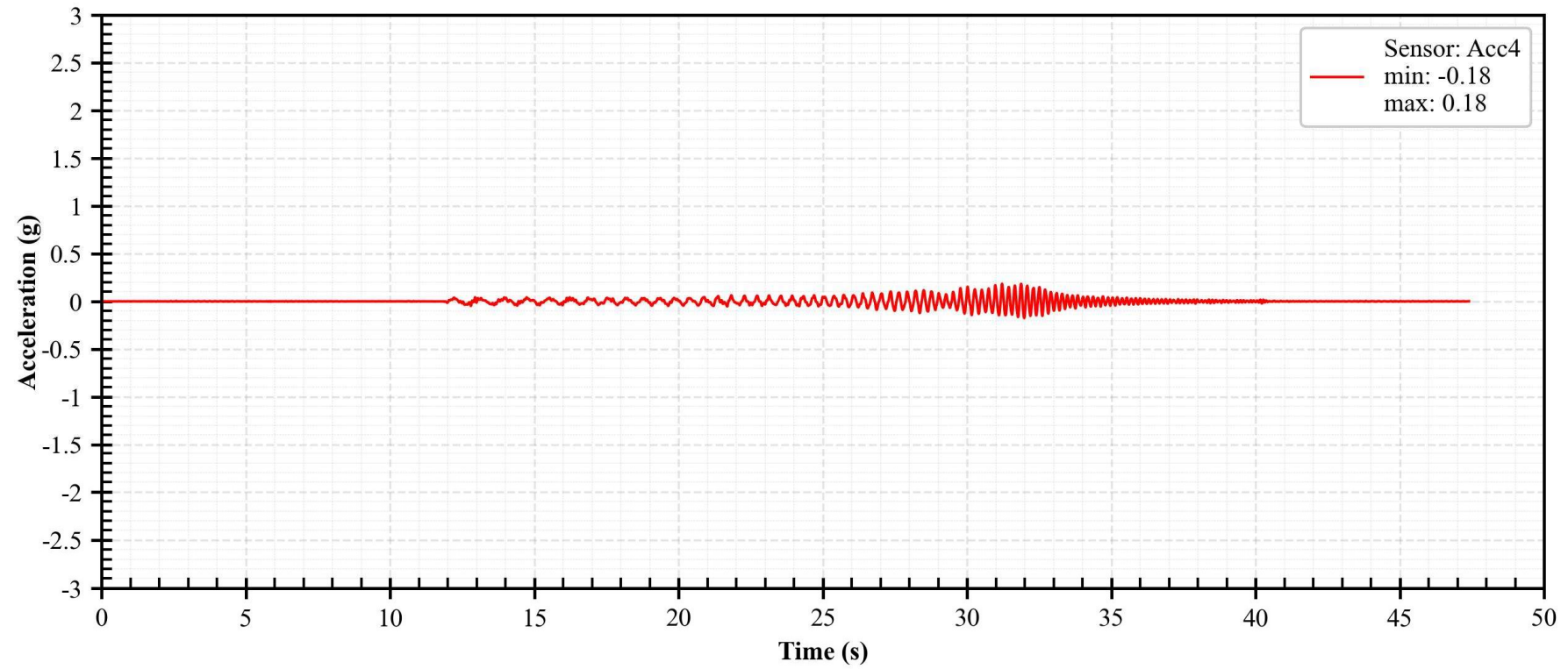


Figure 3.12.4 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 4

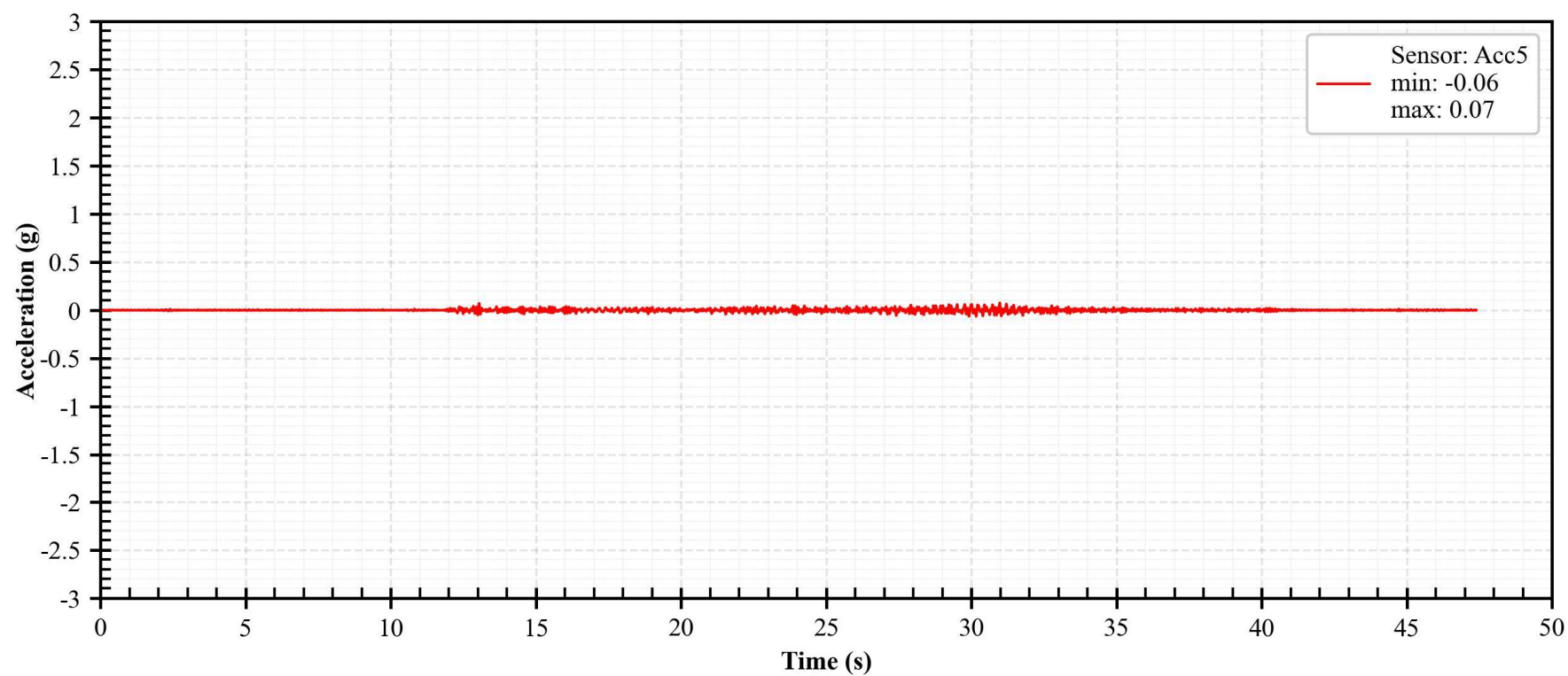


Figure 3.12.5 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 5

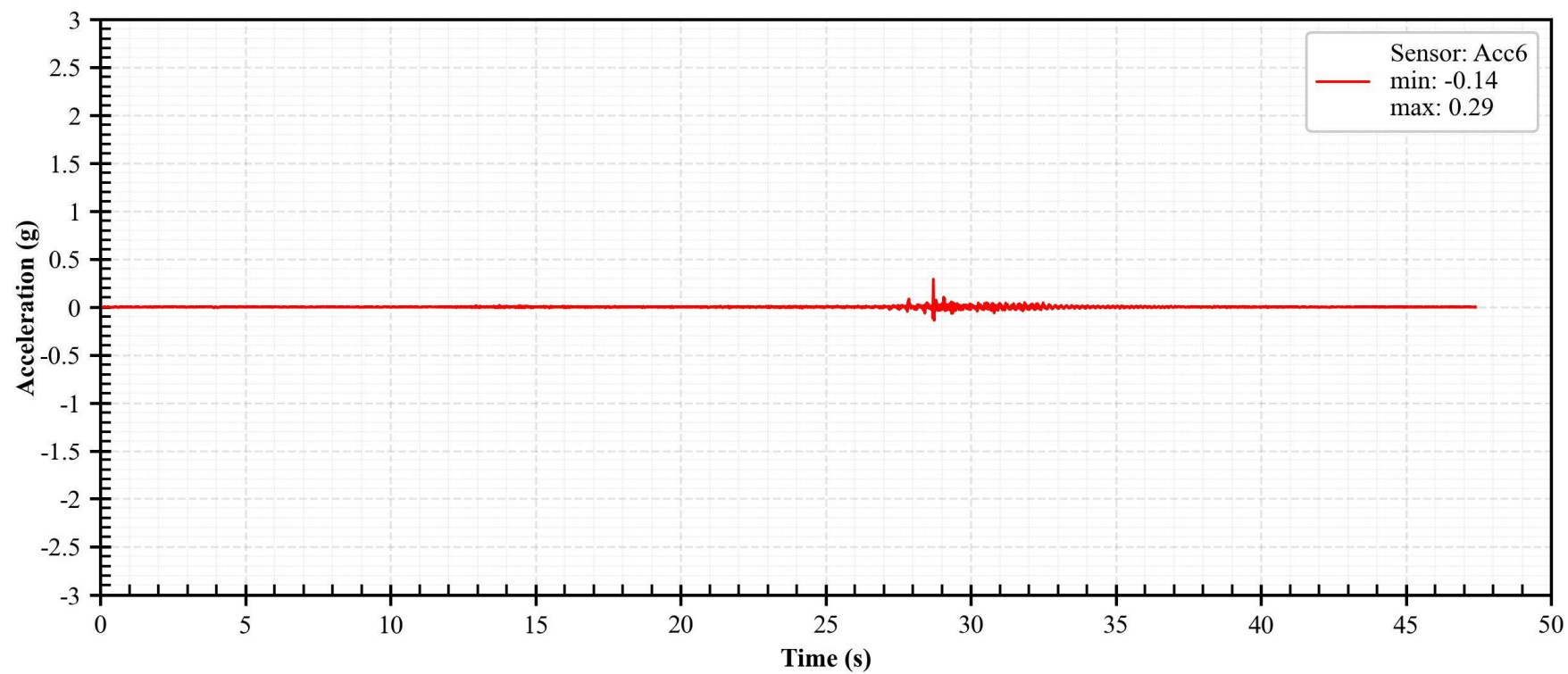


Figure 3.12.6 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 6

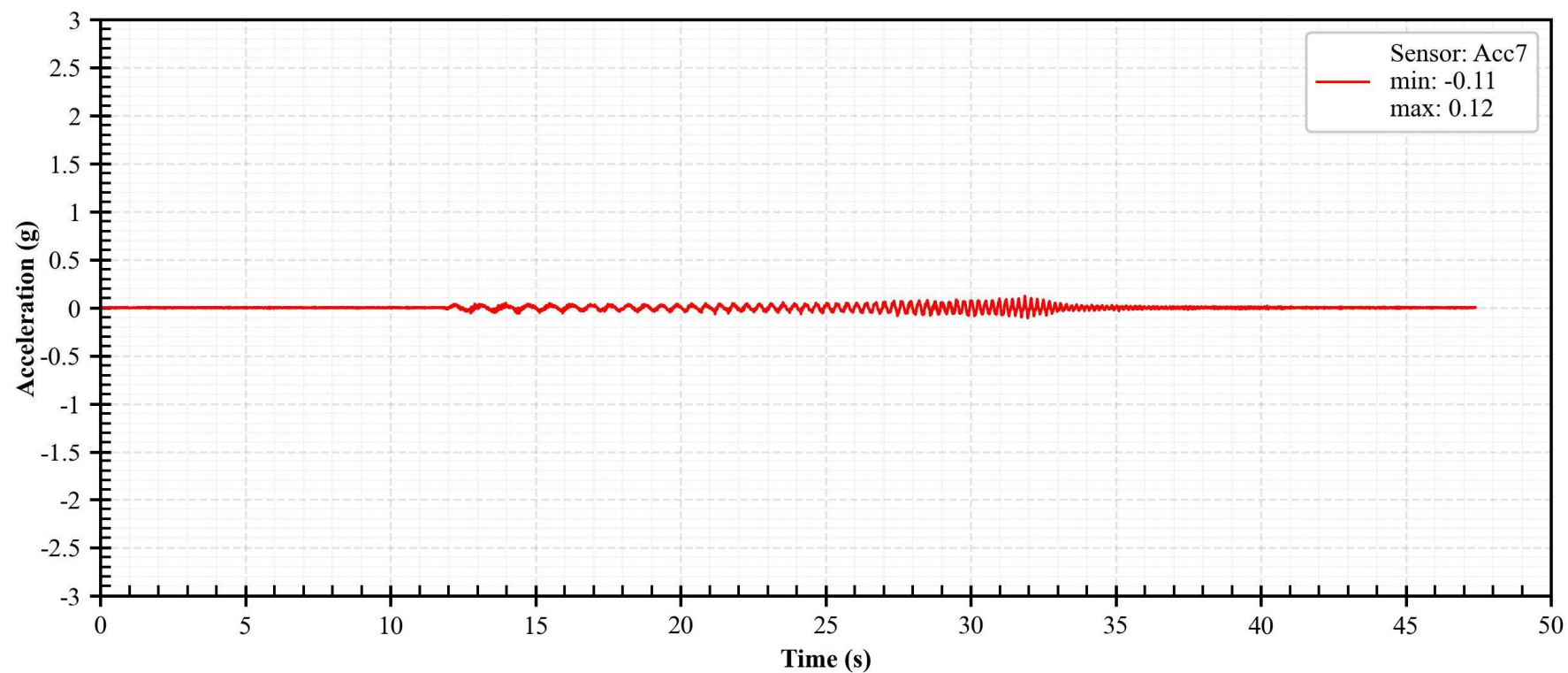


Figure 3.12.7 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 7

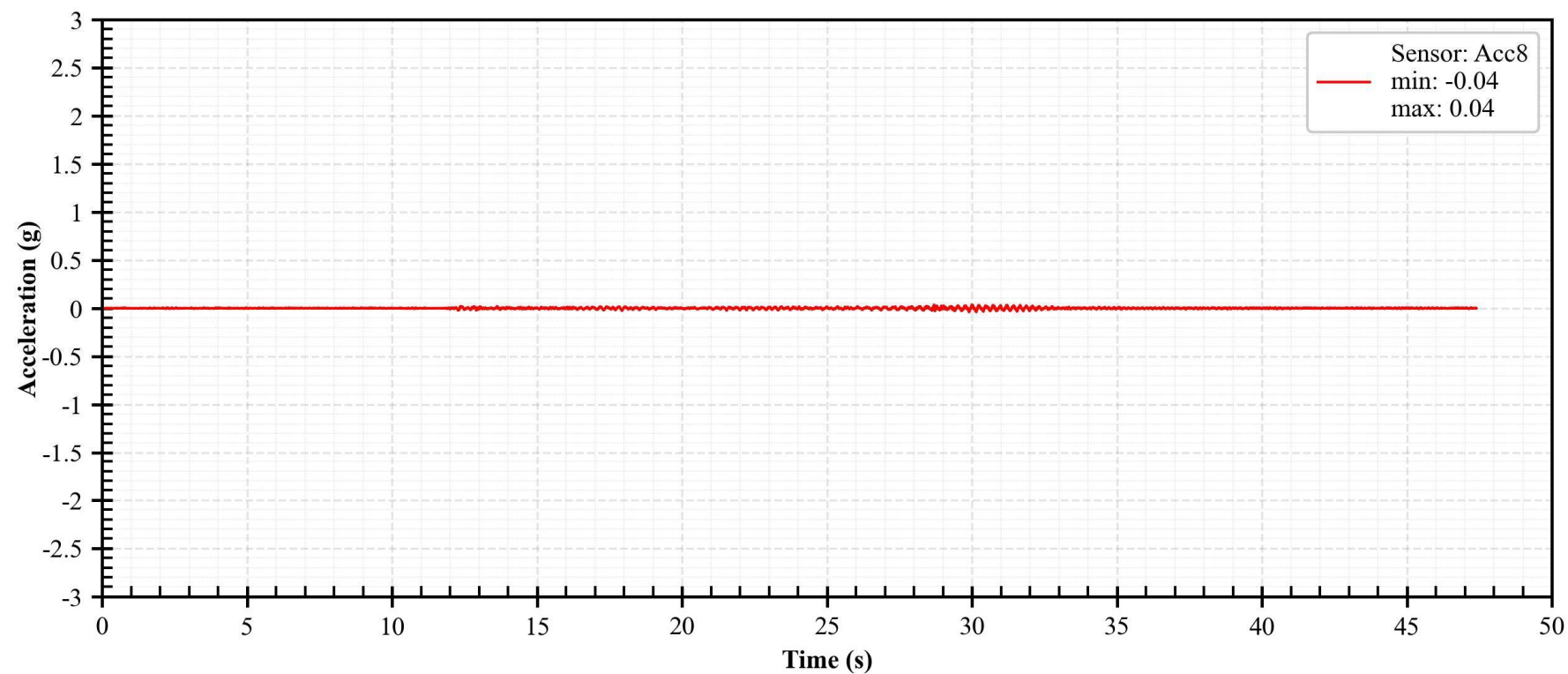


Figure 3.12.8 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 8

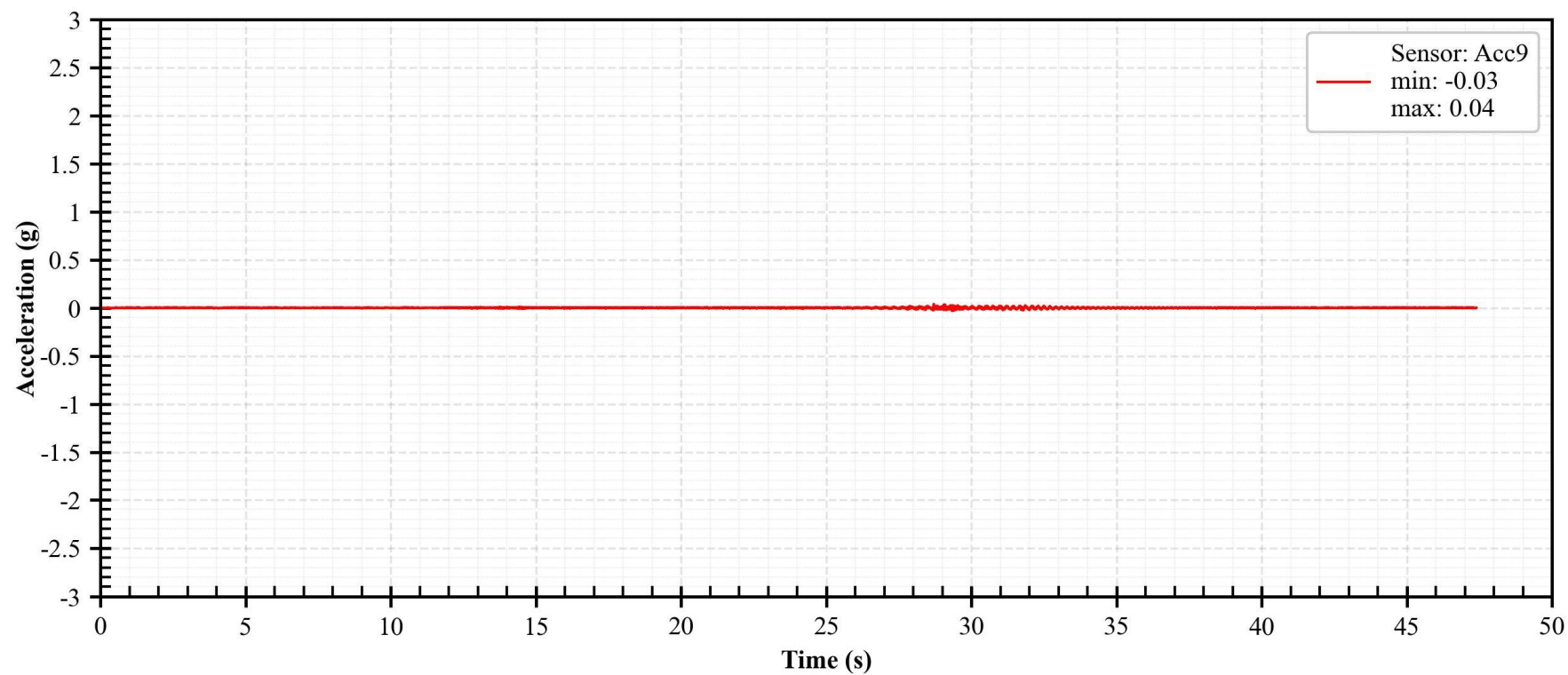


Figure 3.12.9 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 9

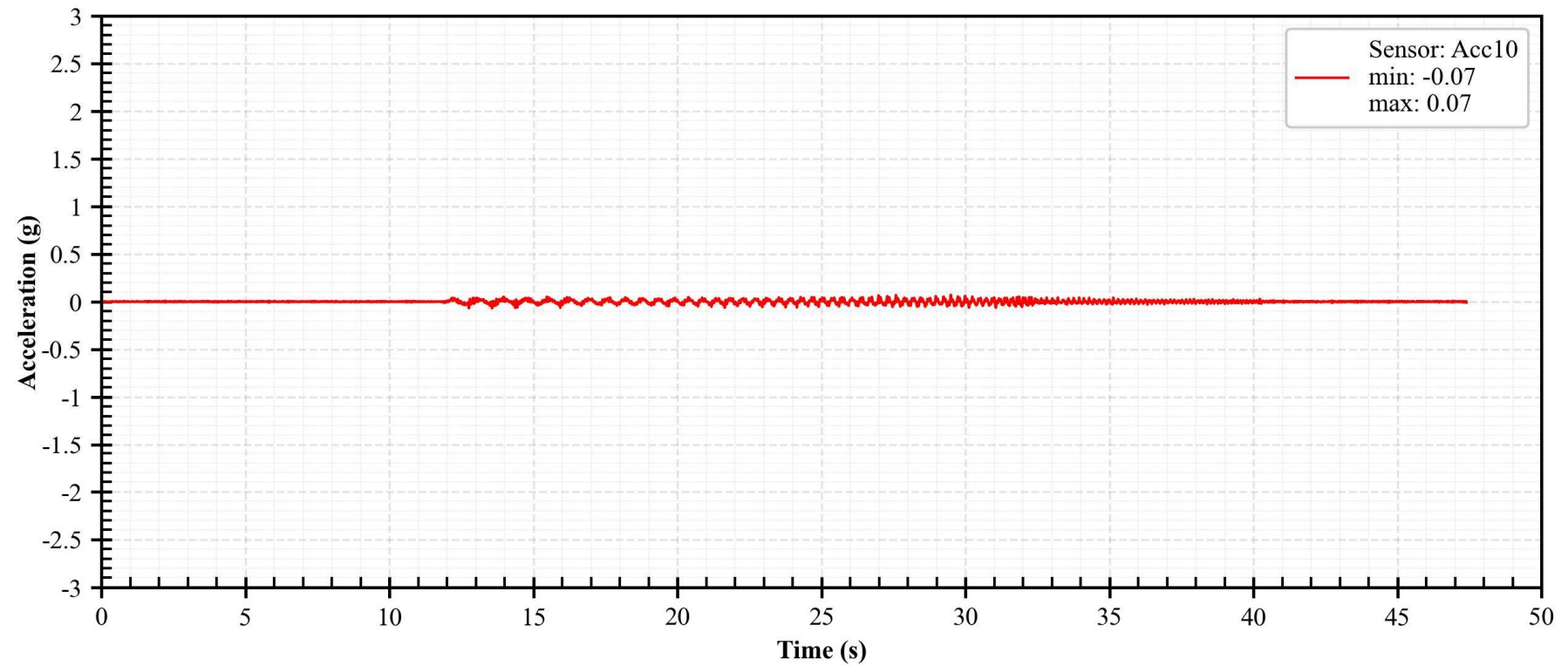


Figure 3.12.10 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 10

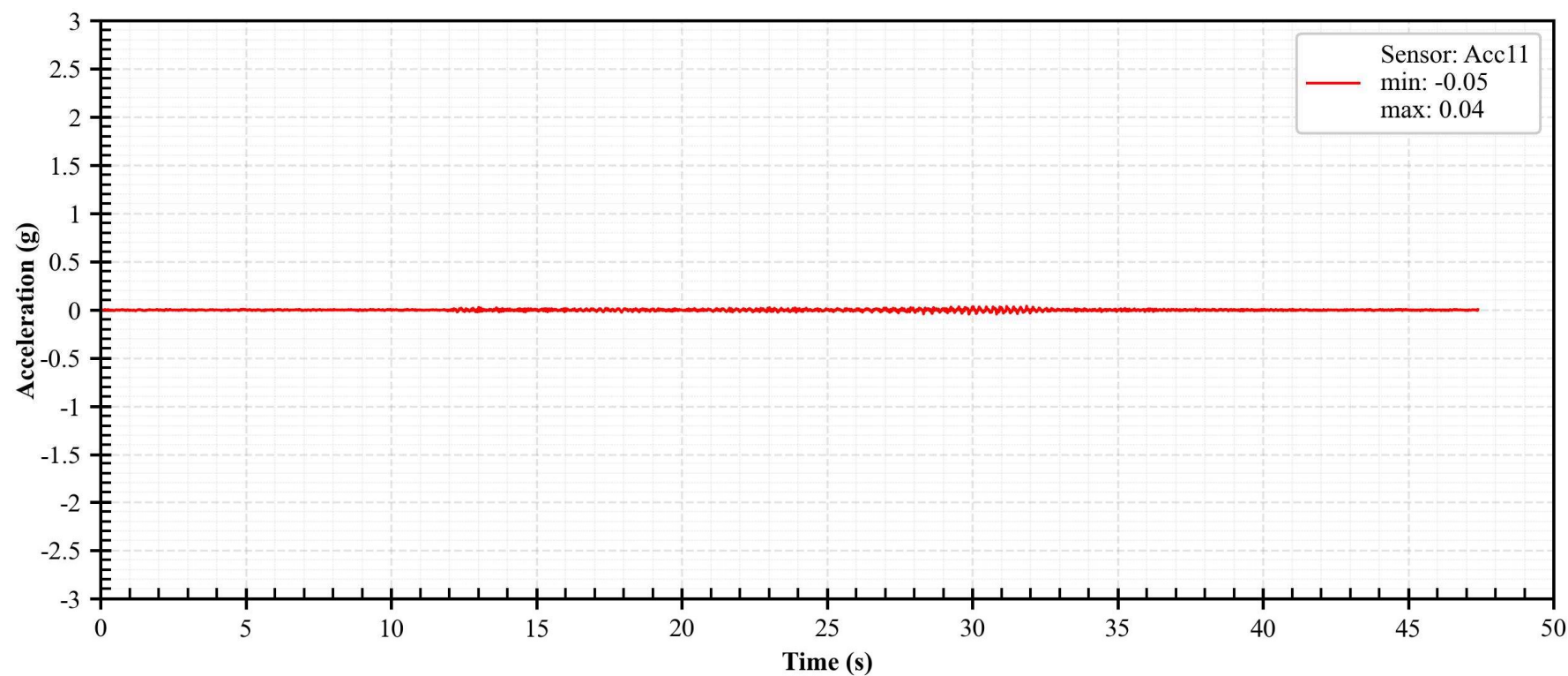


Figure 3.12.11 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 11

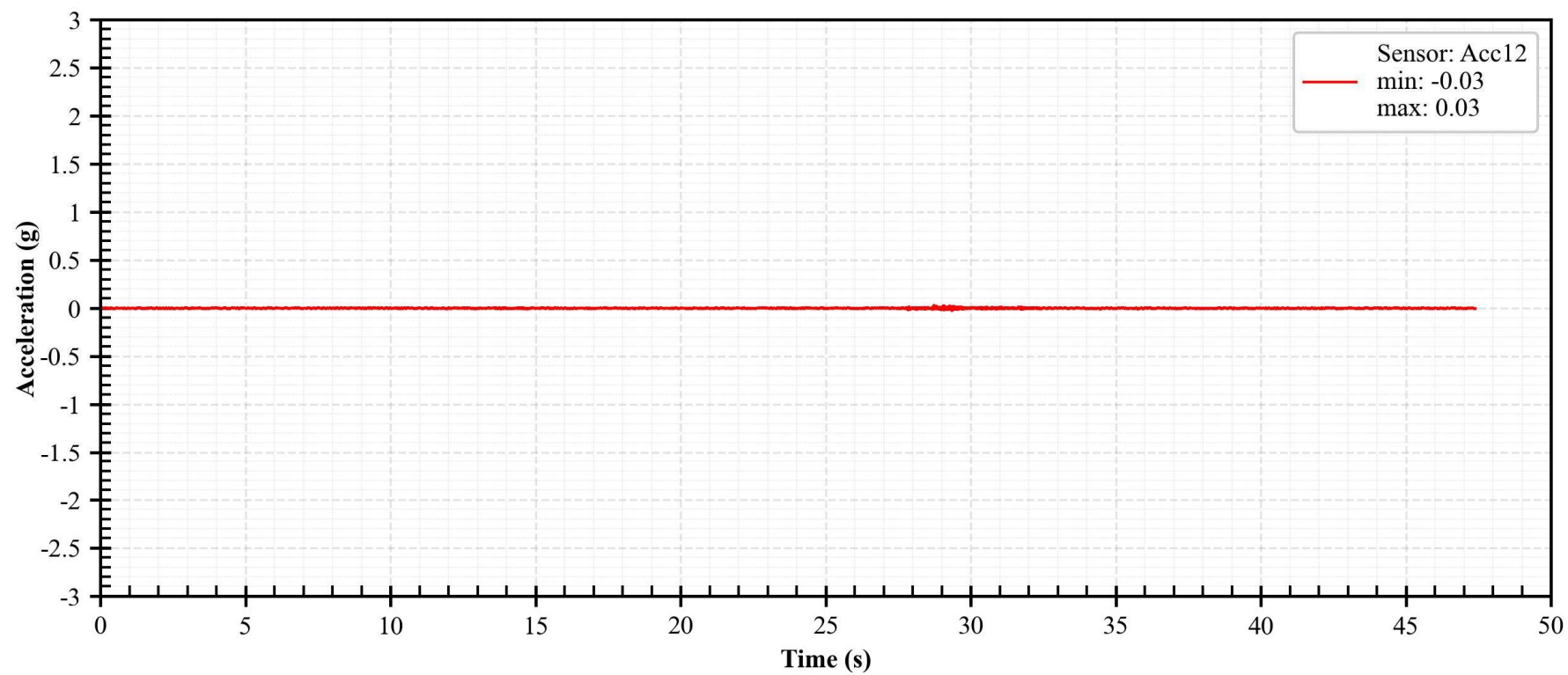


Figure 3.12.12 Characteristic results for phase B (white noise before EQ0,55g): Accelerometer 12

Draw wire sensor

Figures 3.12.13 – 3.12.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 15.68 mm while the minimum is -16.01 mm. The maximum movement detected by draw wire sensor W2 is 15.99 mm while the minimum is -15.80 mm. The maximum movement detected by draw wire sensor W3 is 11.15 mm while the minimum is -10.49 mm. The maximum movement detected by draw wire sensor W4 is 11.49 mm while the minimum is -10.73 mm. The maximum drift is $(1.59/1.225) = 1.30 \text{ ‰}$ and minimum drift is $(-1.74/1.225) = -1.42 \text{ ‰}$.

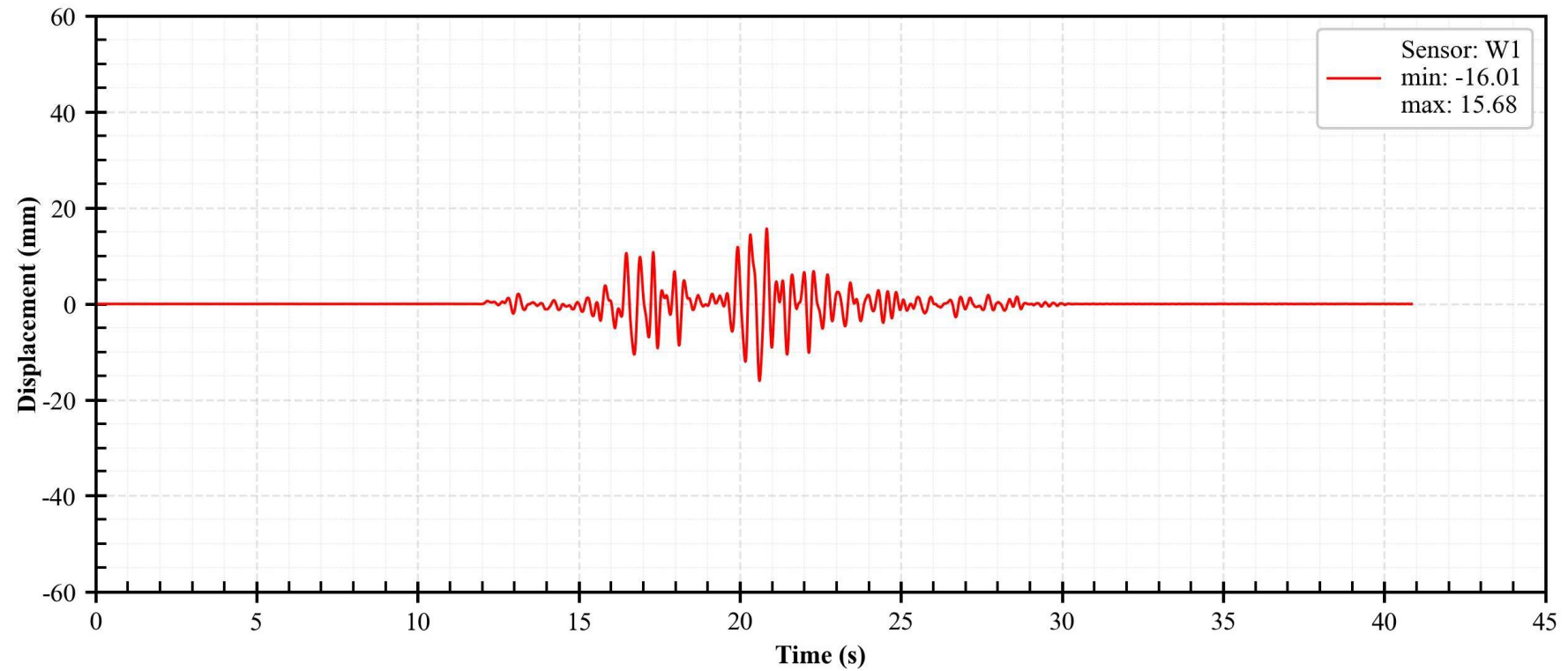


Figure 3.12.13 Characteristic results for phase B (white noise before EQ0,55g): Draw wire sensor 1

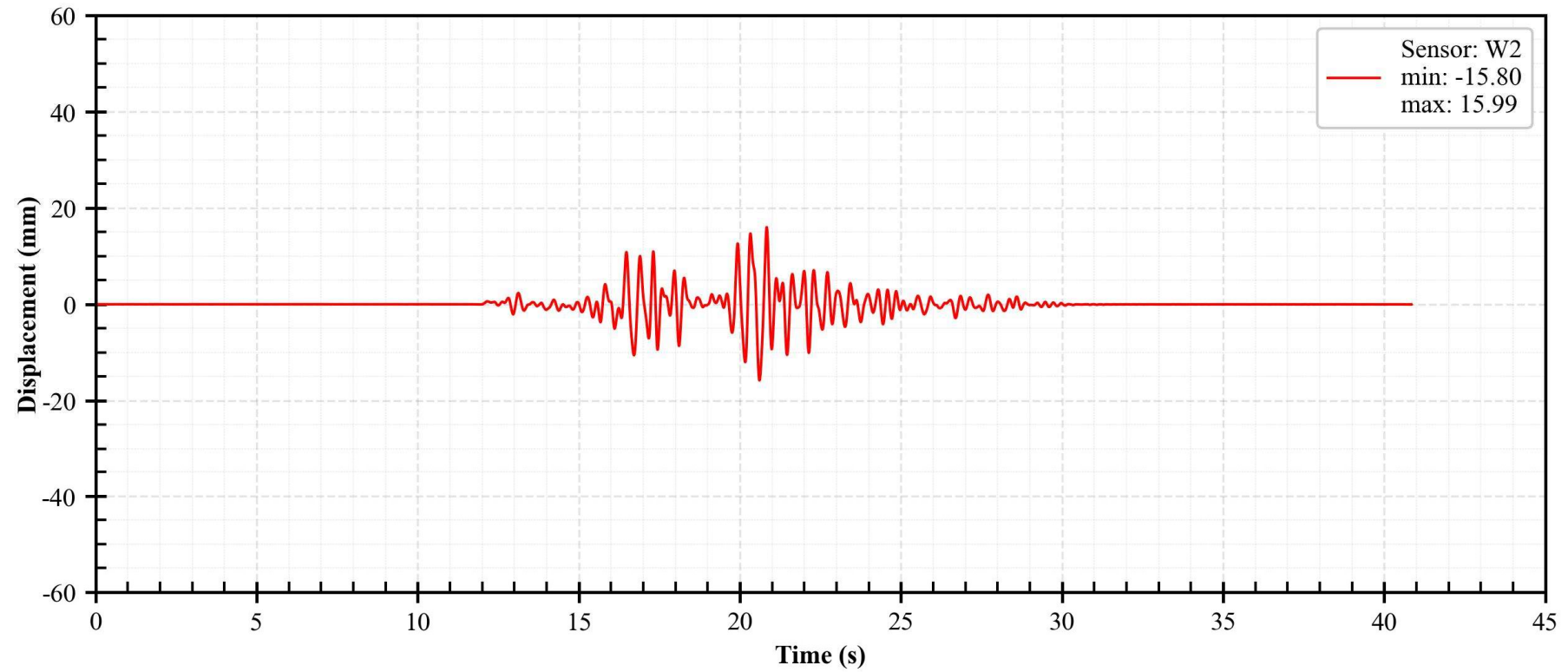


Figure 3.12.14 Characteristic results for phase B (white noise before EQ0,55g): Draw wire sensor 2

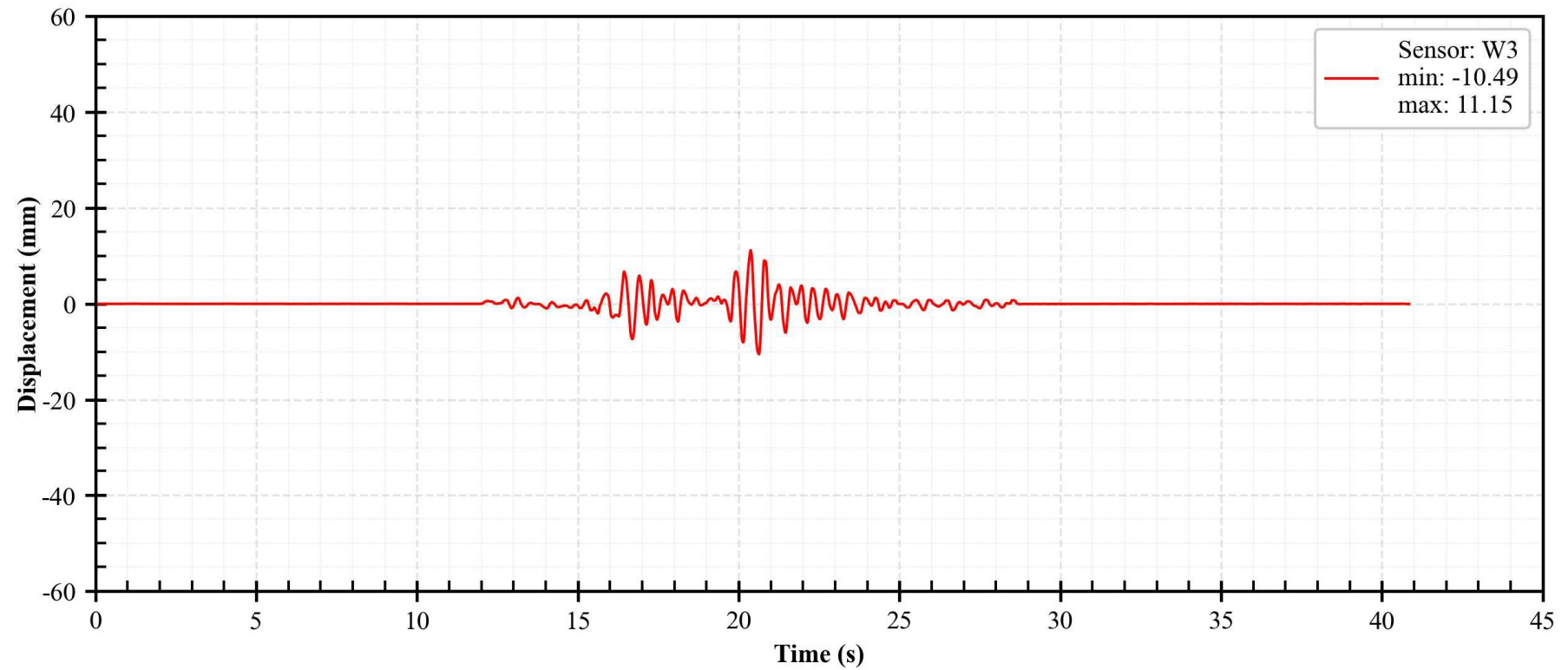


Figure 3.12.15 Characteristic results for phase B (white noise before EQ0,55g): Draw wire sensor 3

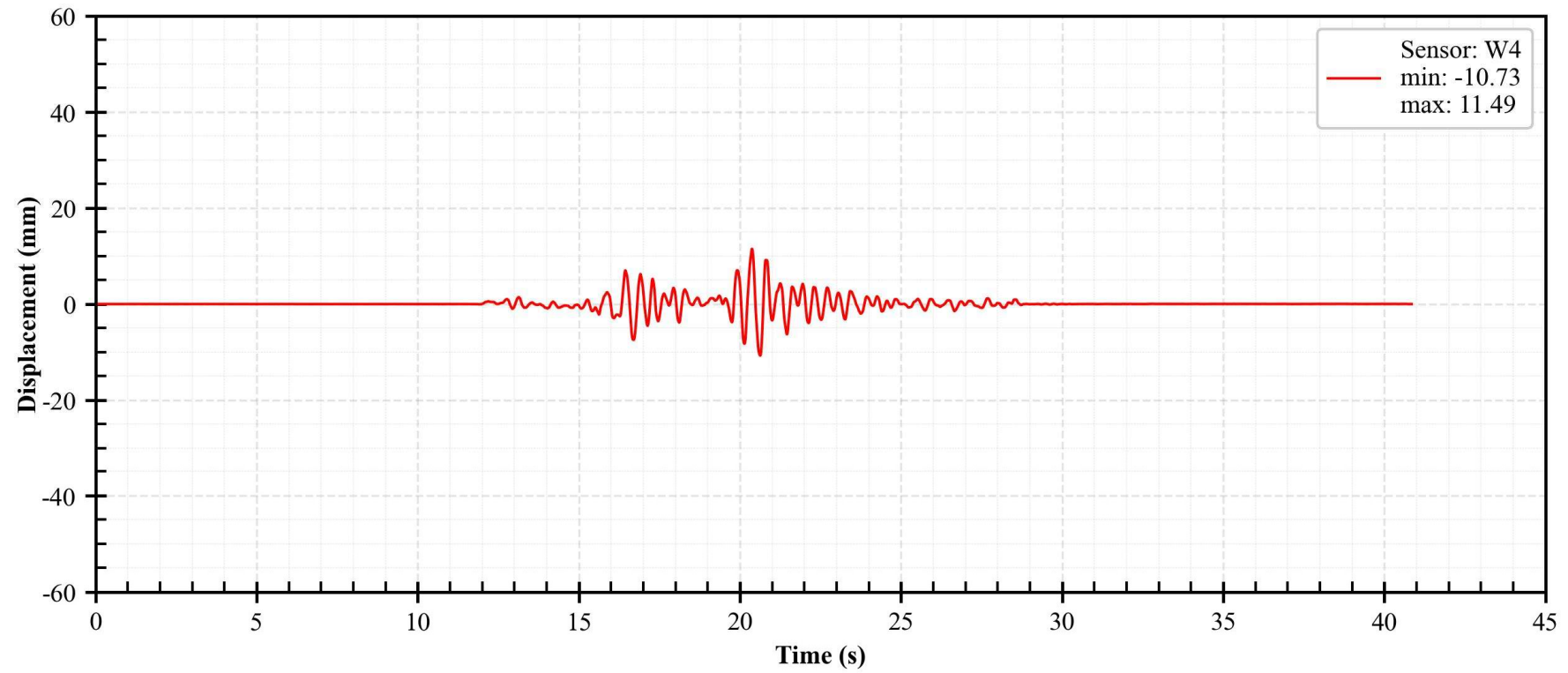


Figure 3.12.16 Characteristic results for phase B (white noise before EQ0,55g): Draw wire sensor 4

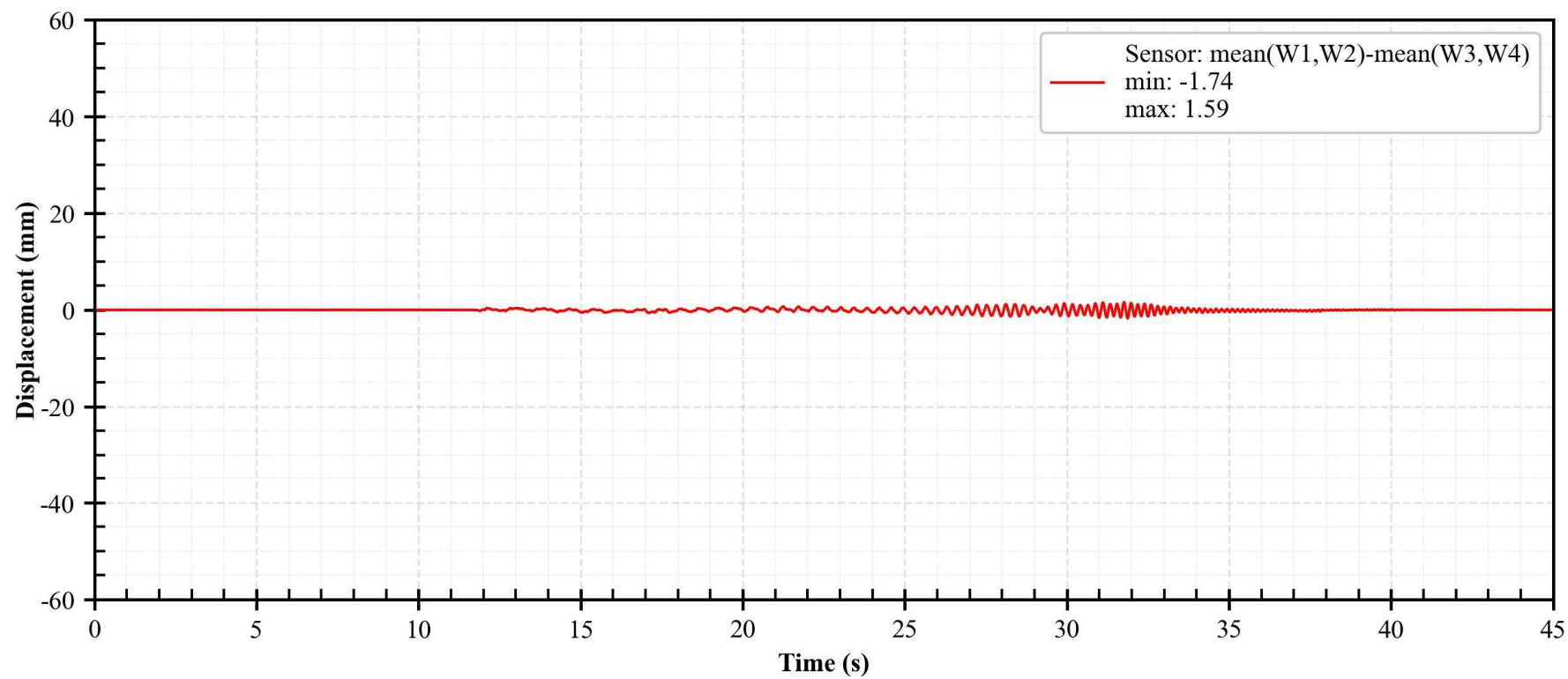


Figure 3.12.17 Characteristic results for phase B (white noise before EQ0,55g): mean (W1,W2) – mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

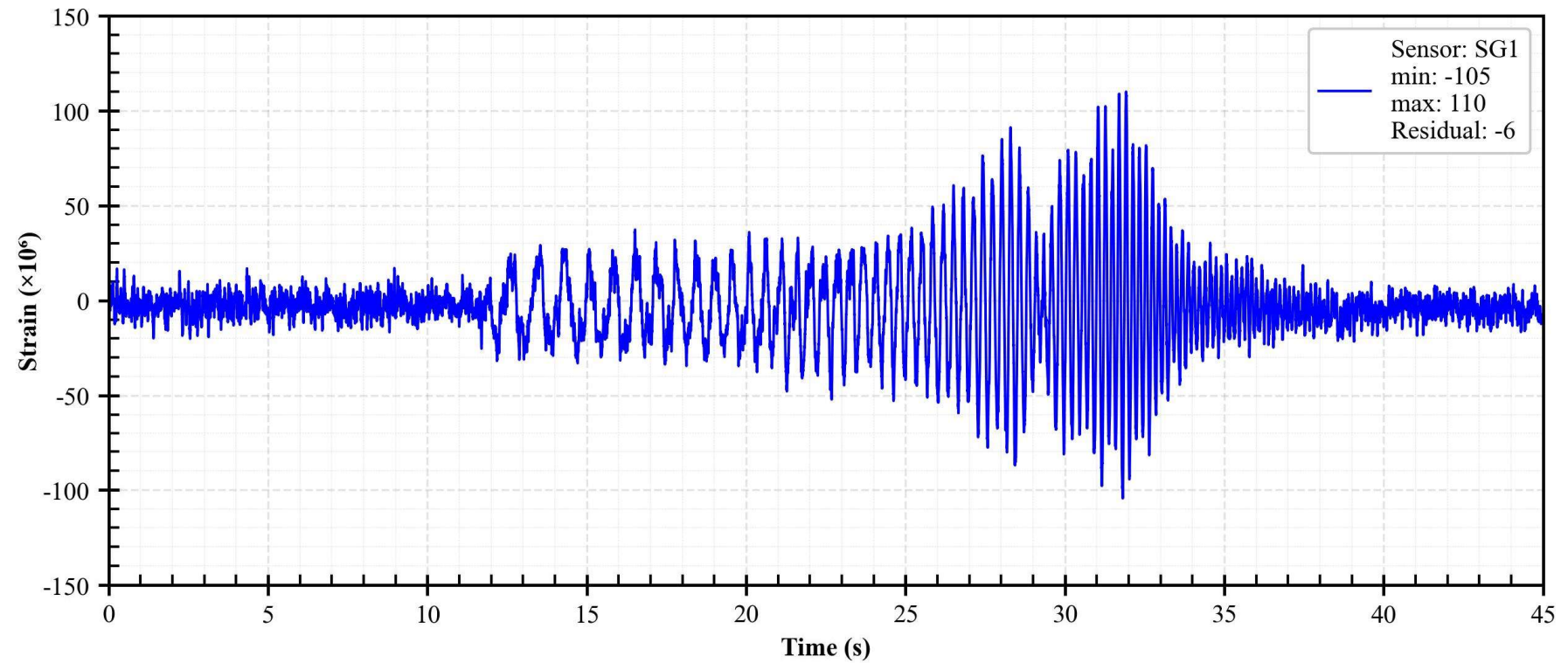


Figure 3.12.18 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 1

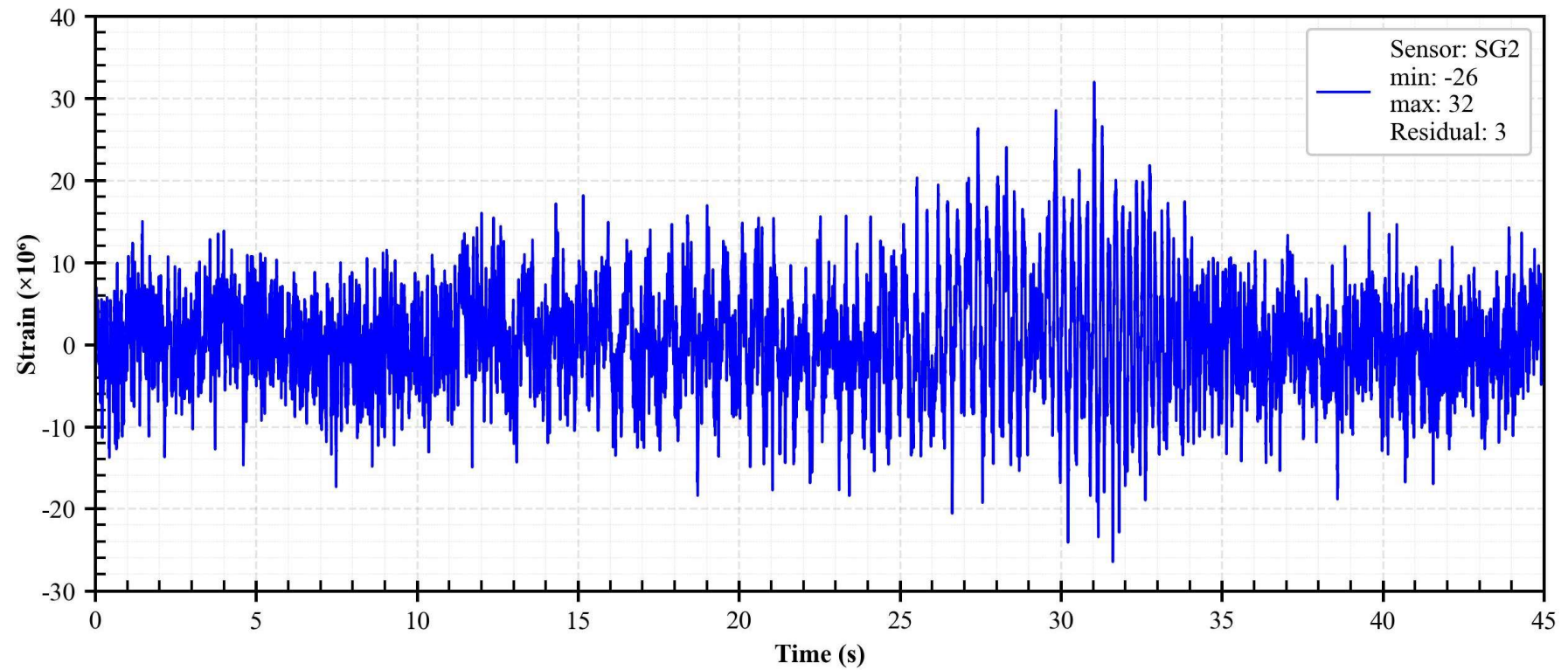


Figure 3.12.19 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 2

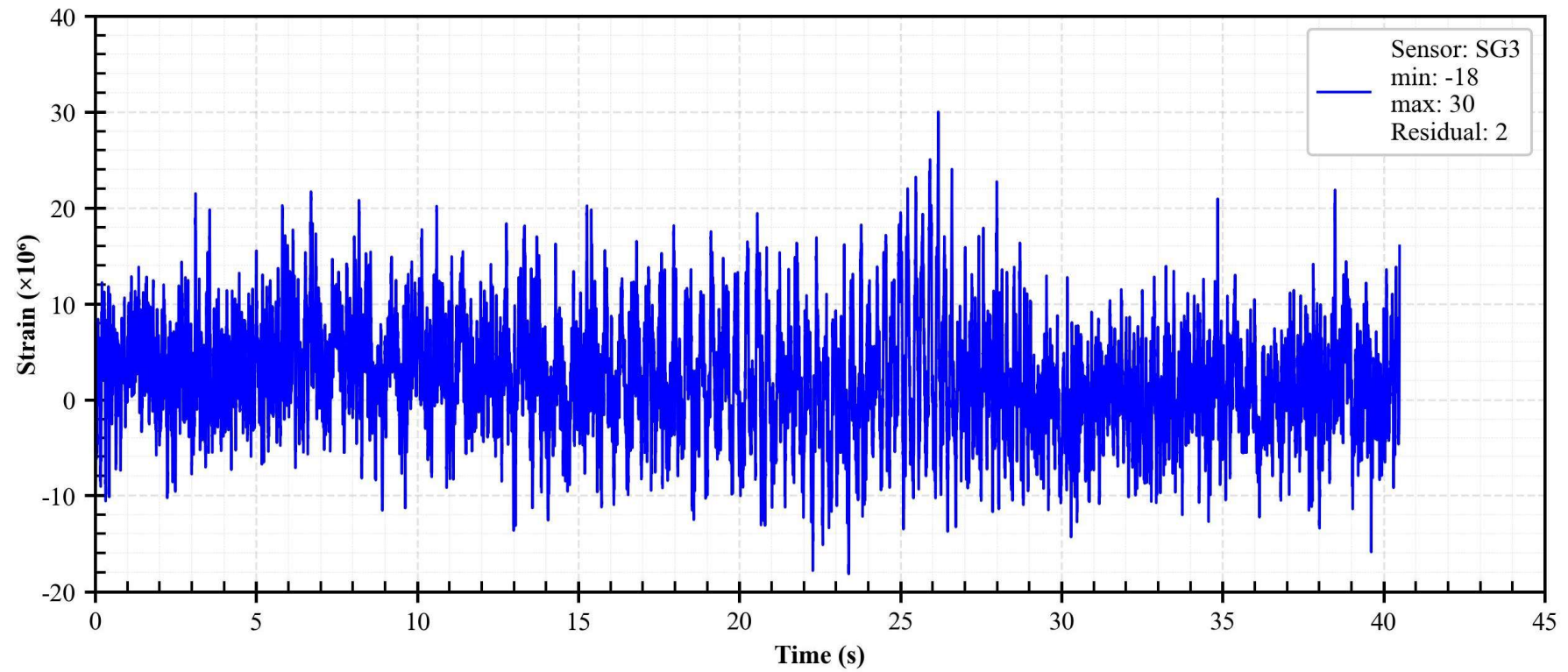


Figure 3.12.20 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 3

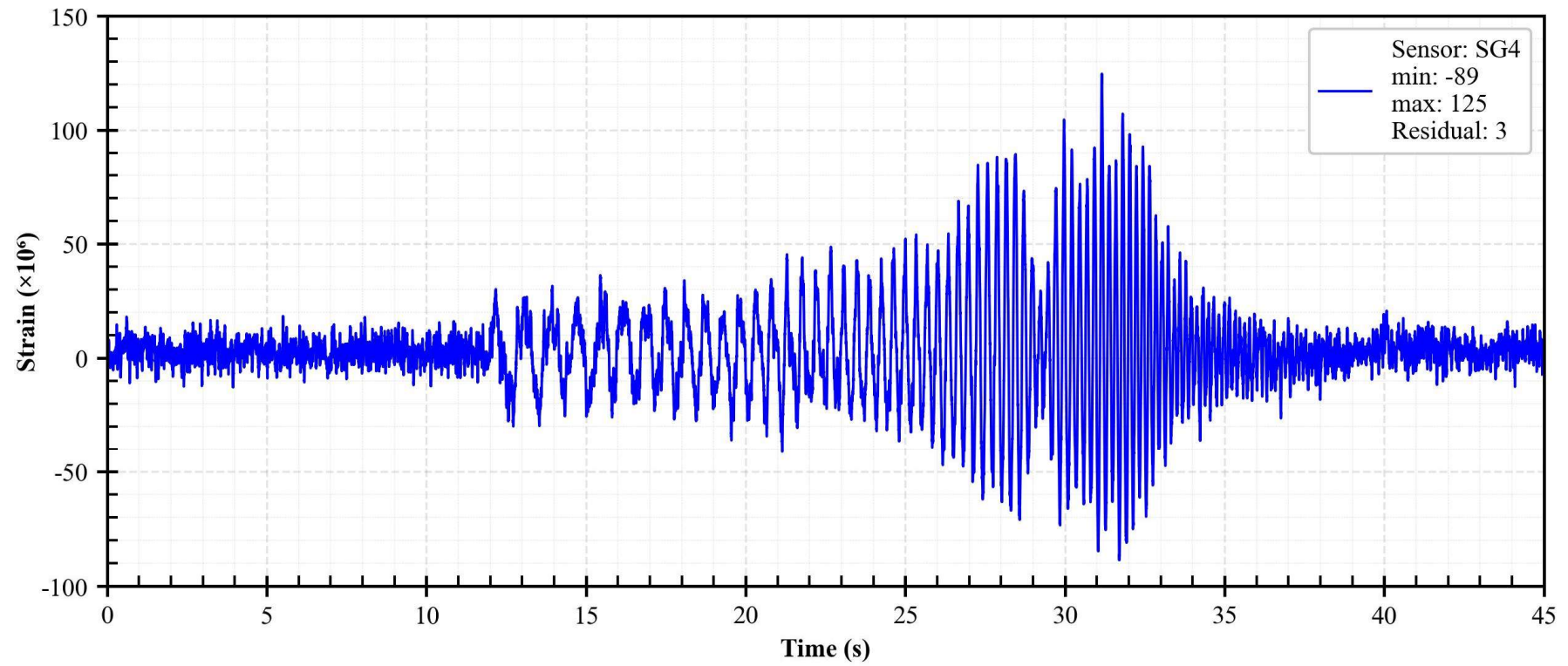


Figure 3.12.21 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 4

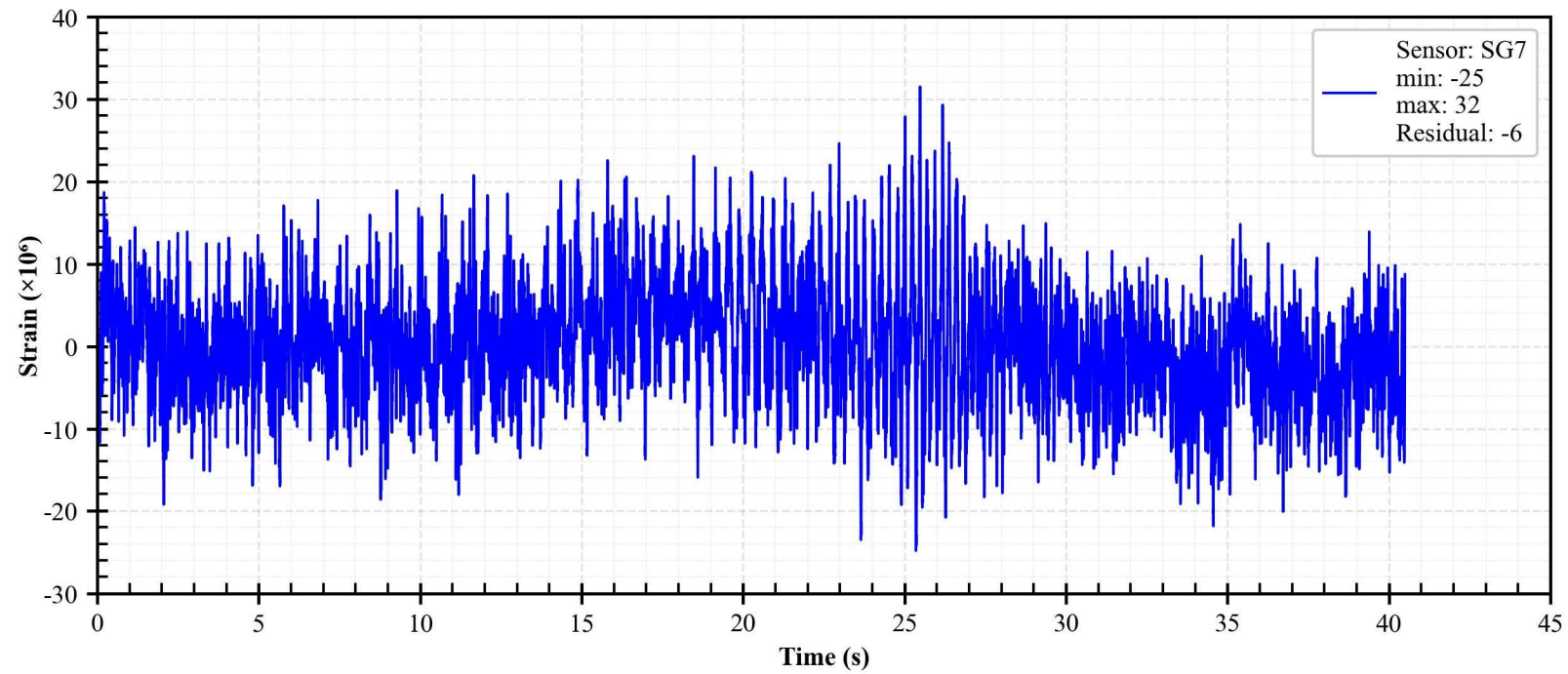


Figure 3.12.22 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 7

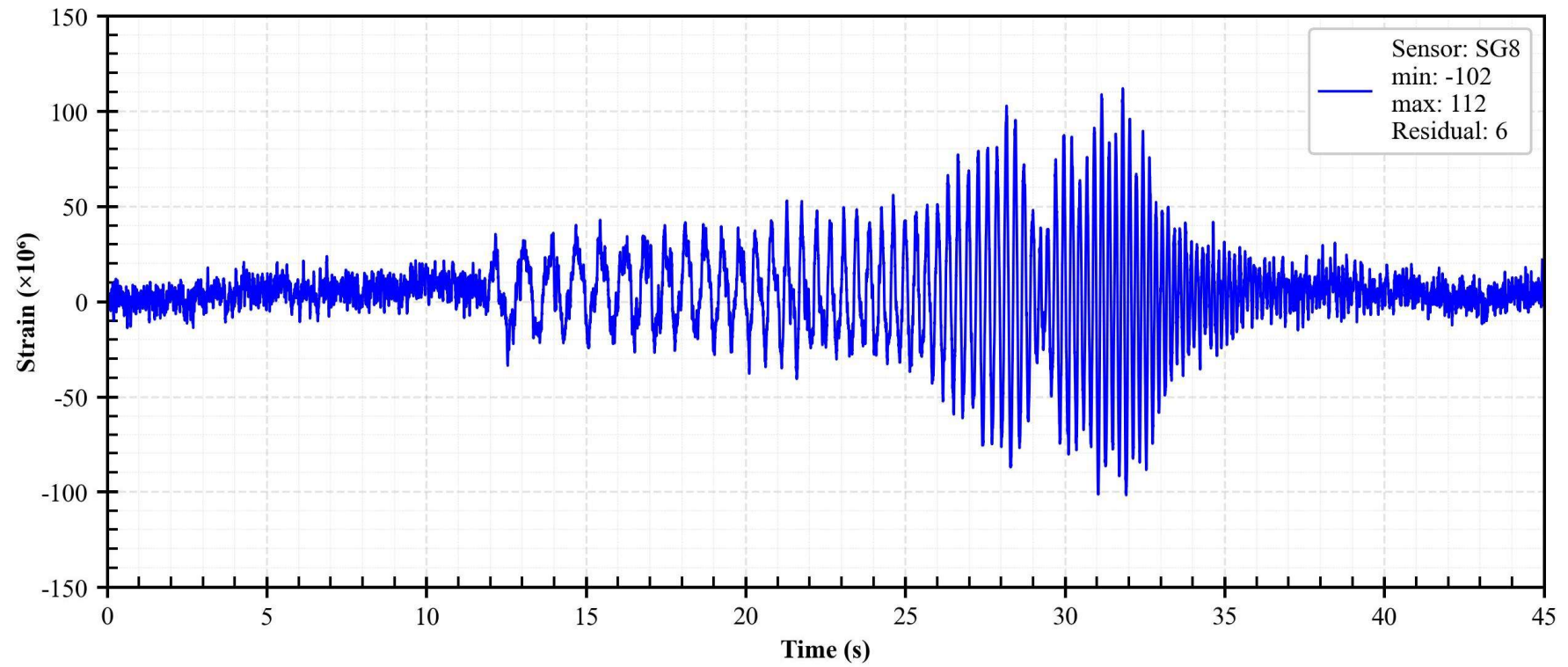


Figure 3.12.23 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 8

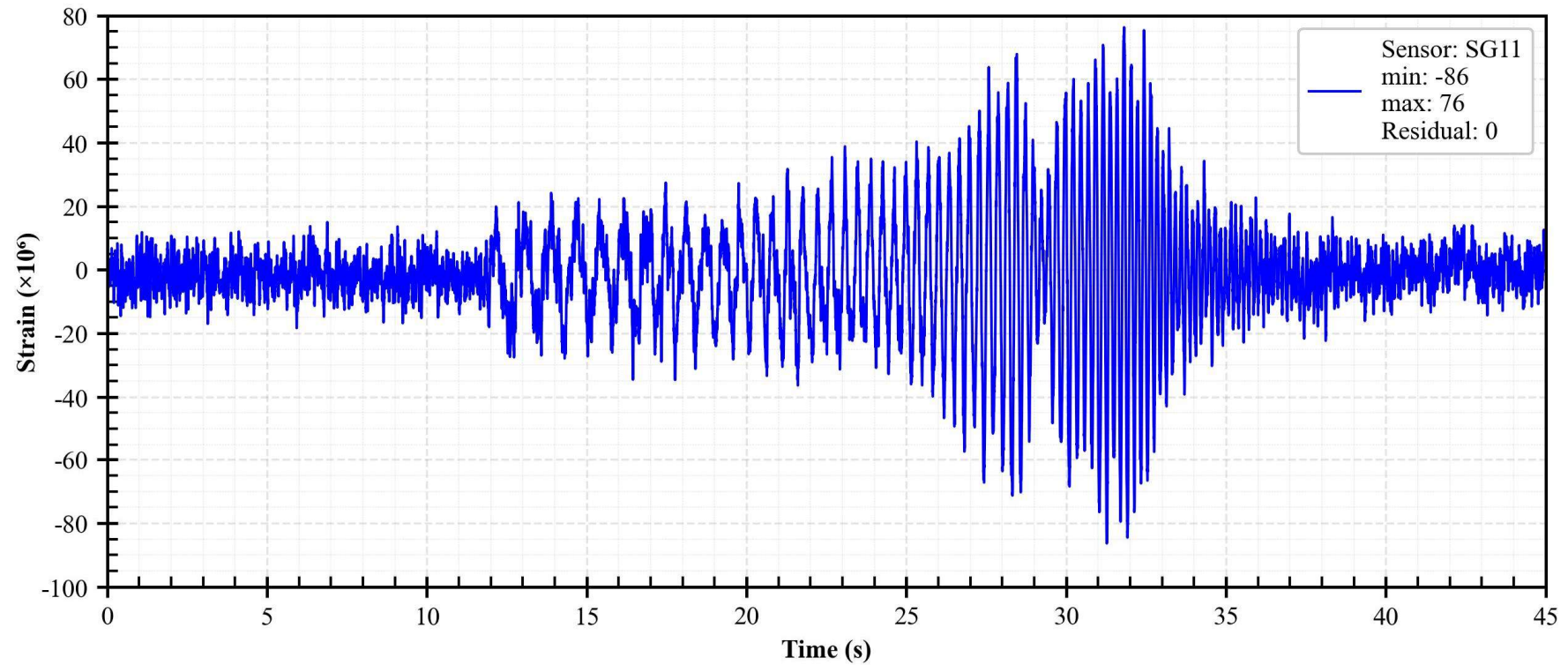


Figure 3.12.24 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 11

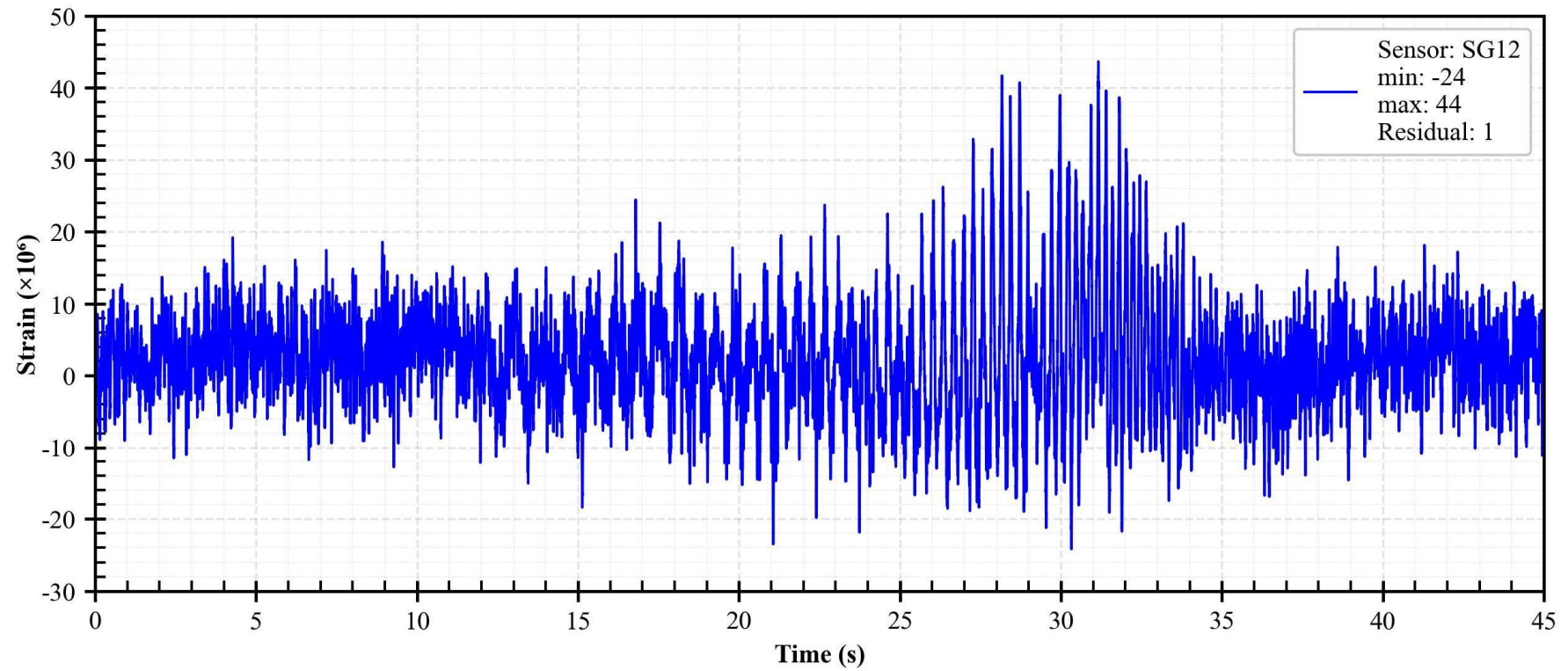


Figure 3.12.25 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 12

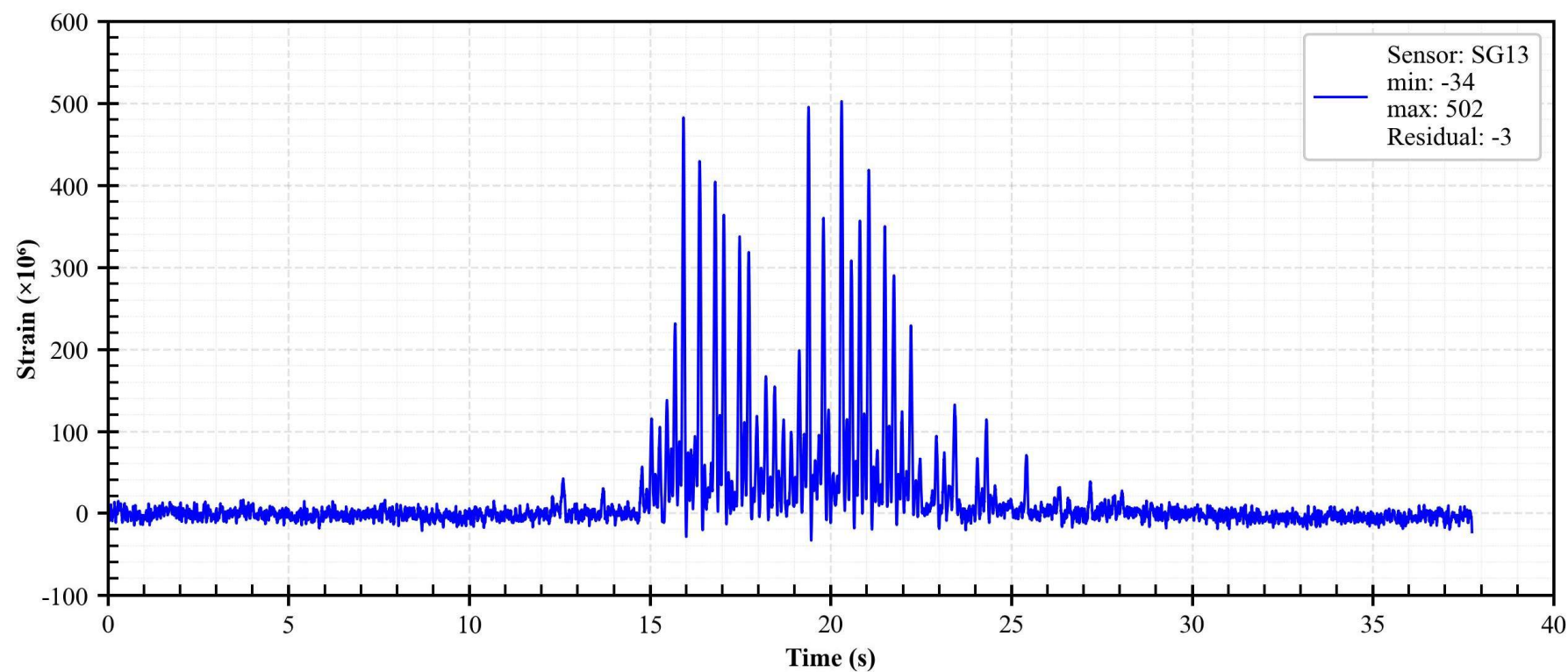


Figure 3.12.26 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 13

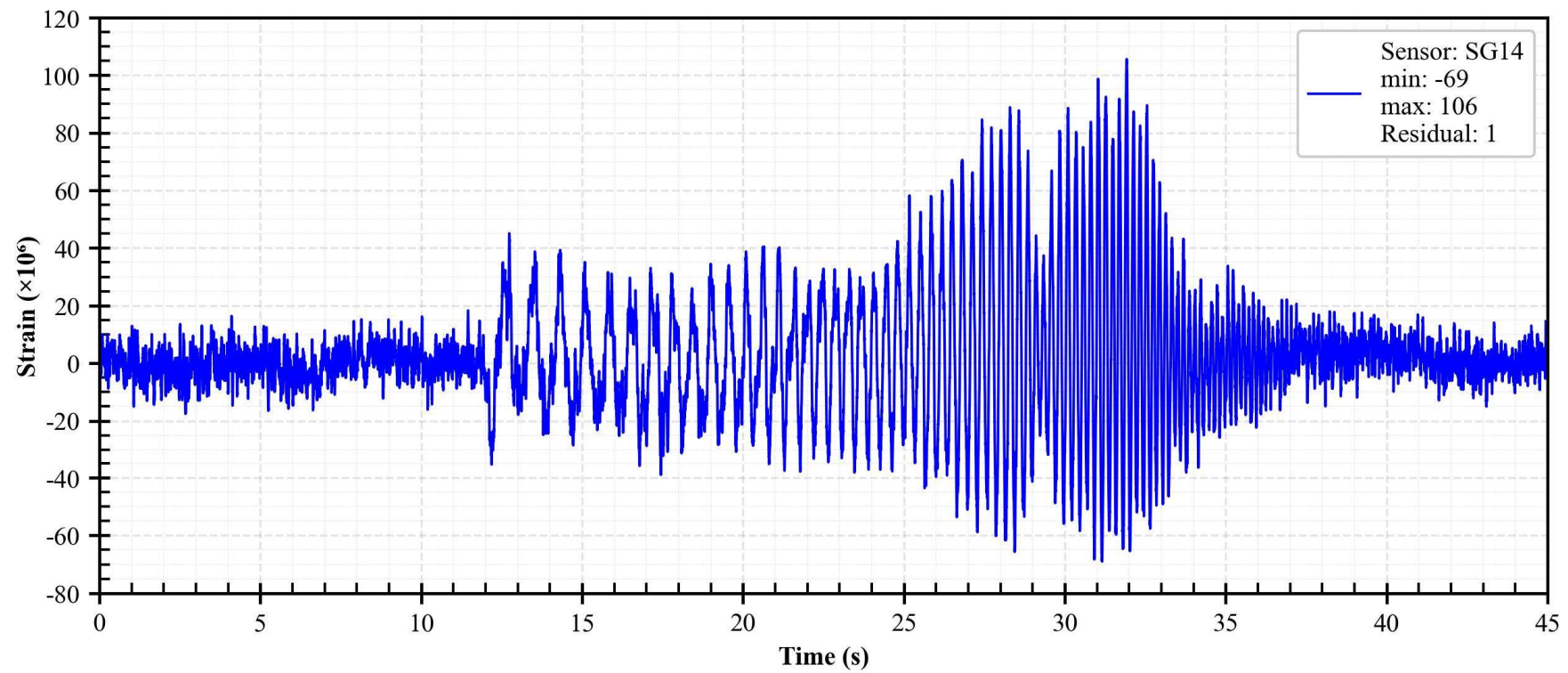


Figure 3.12.27 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 14

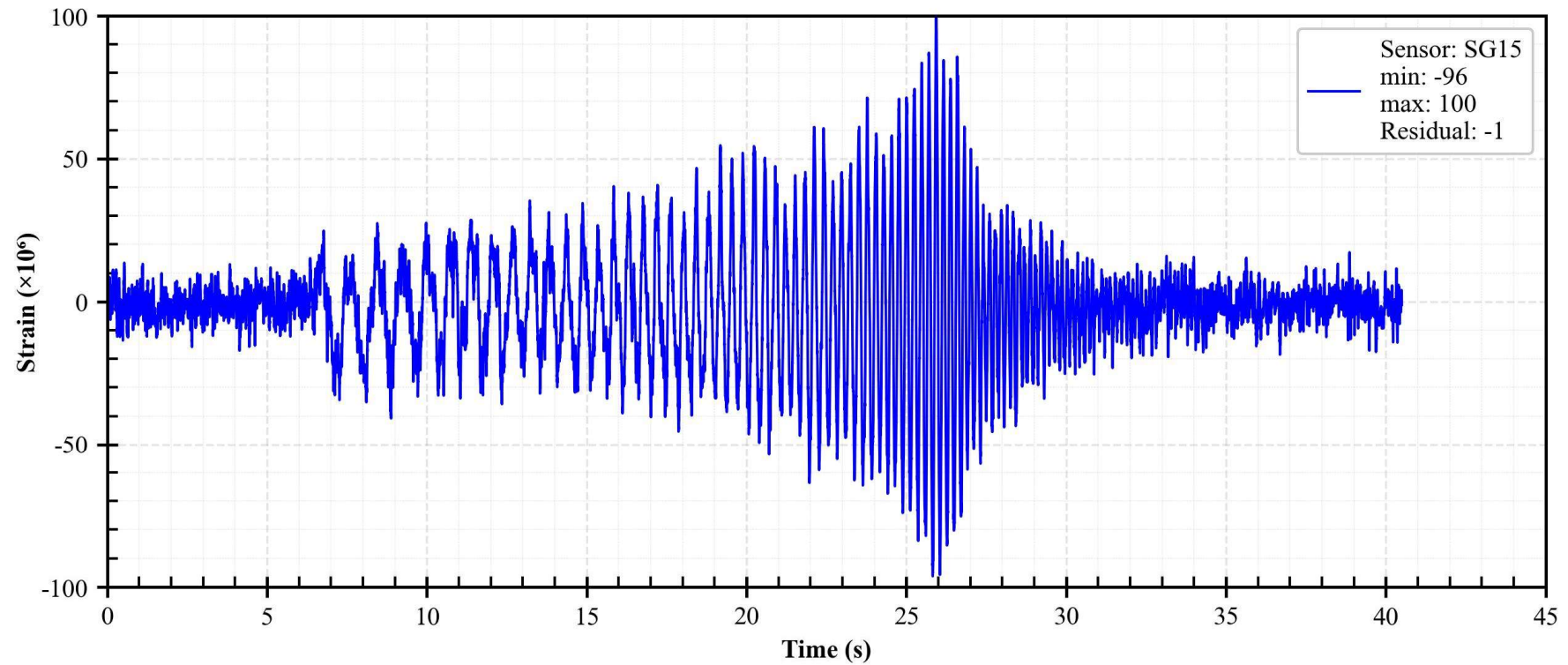


Figure 3.12.28 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 15

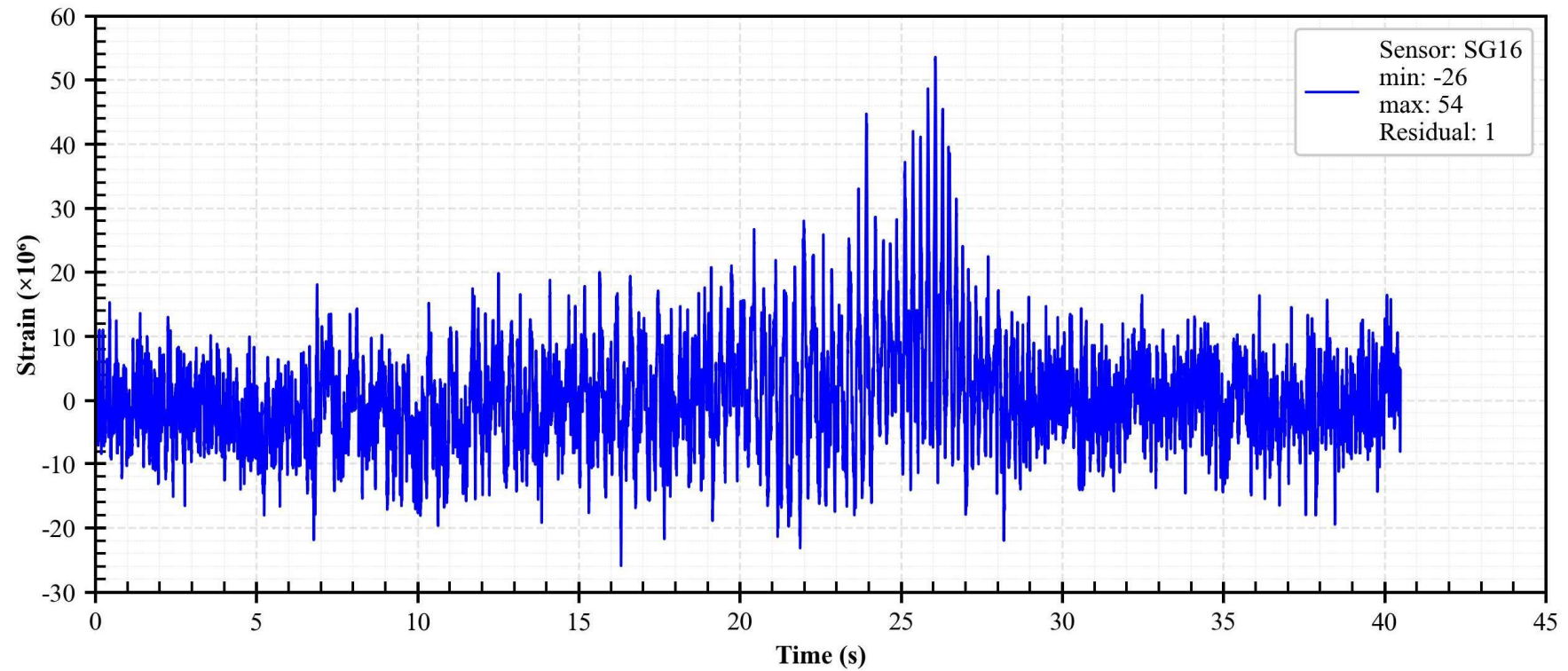


Figure 3.12.29 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 16

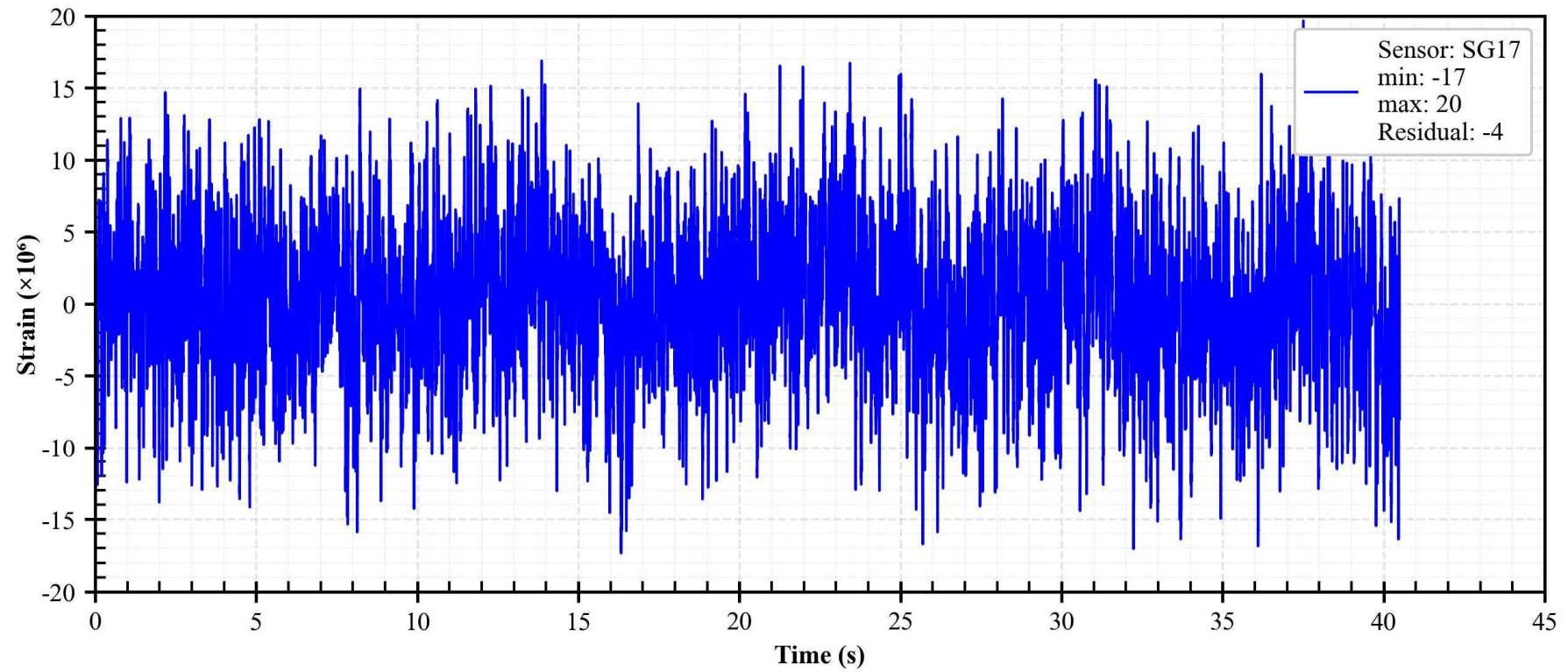


Figure 3.12.30 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 17

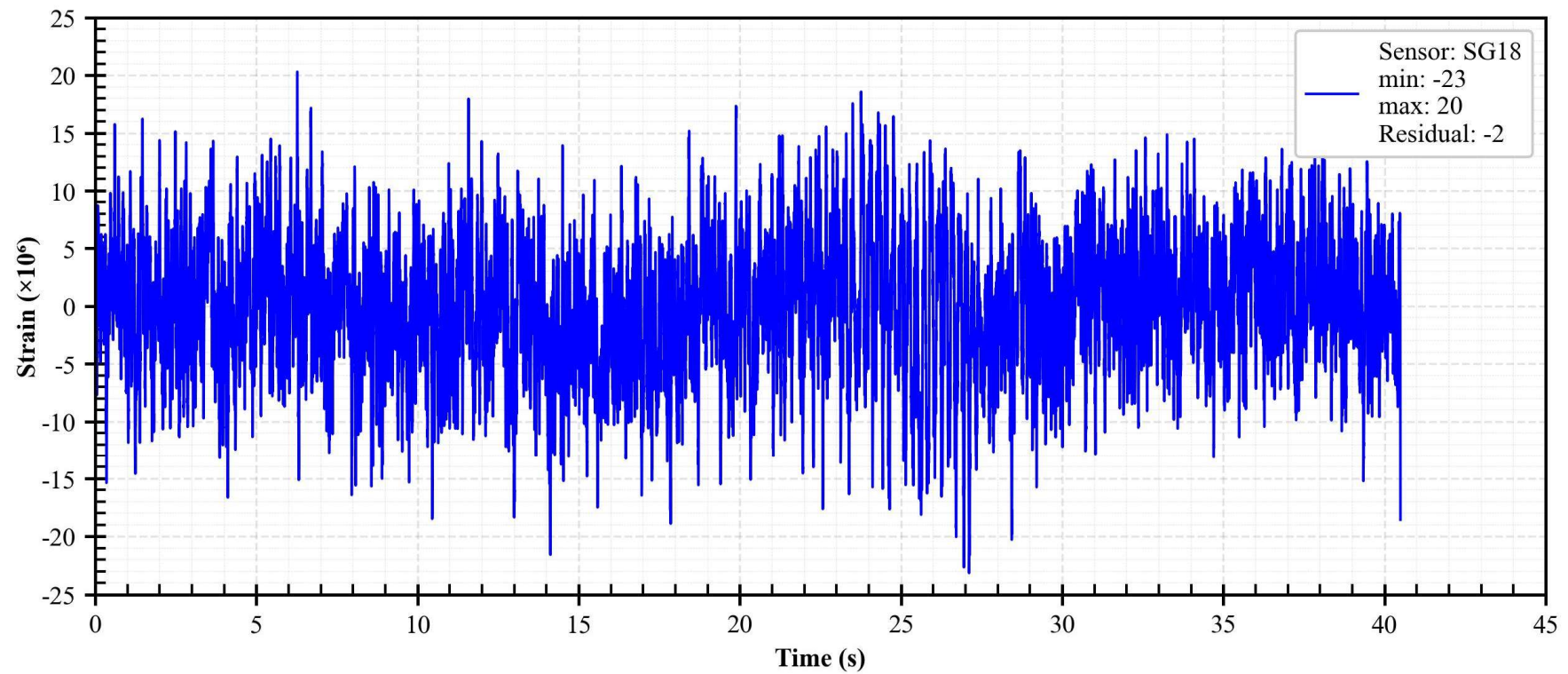


Figure 3.12.31 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 18

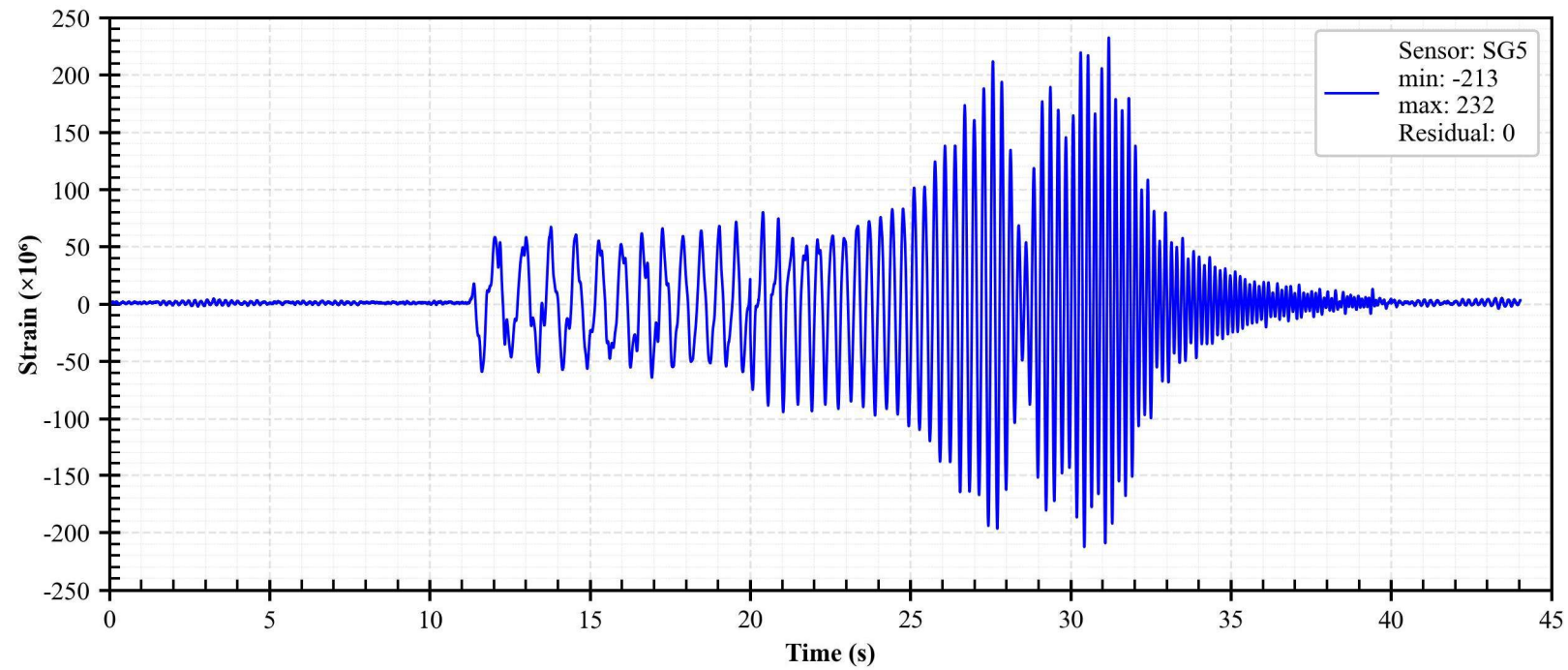


Figure 3.12.32 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 5

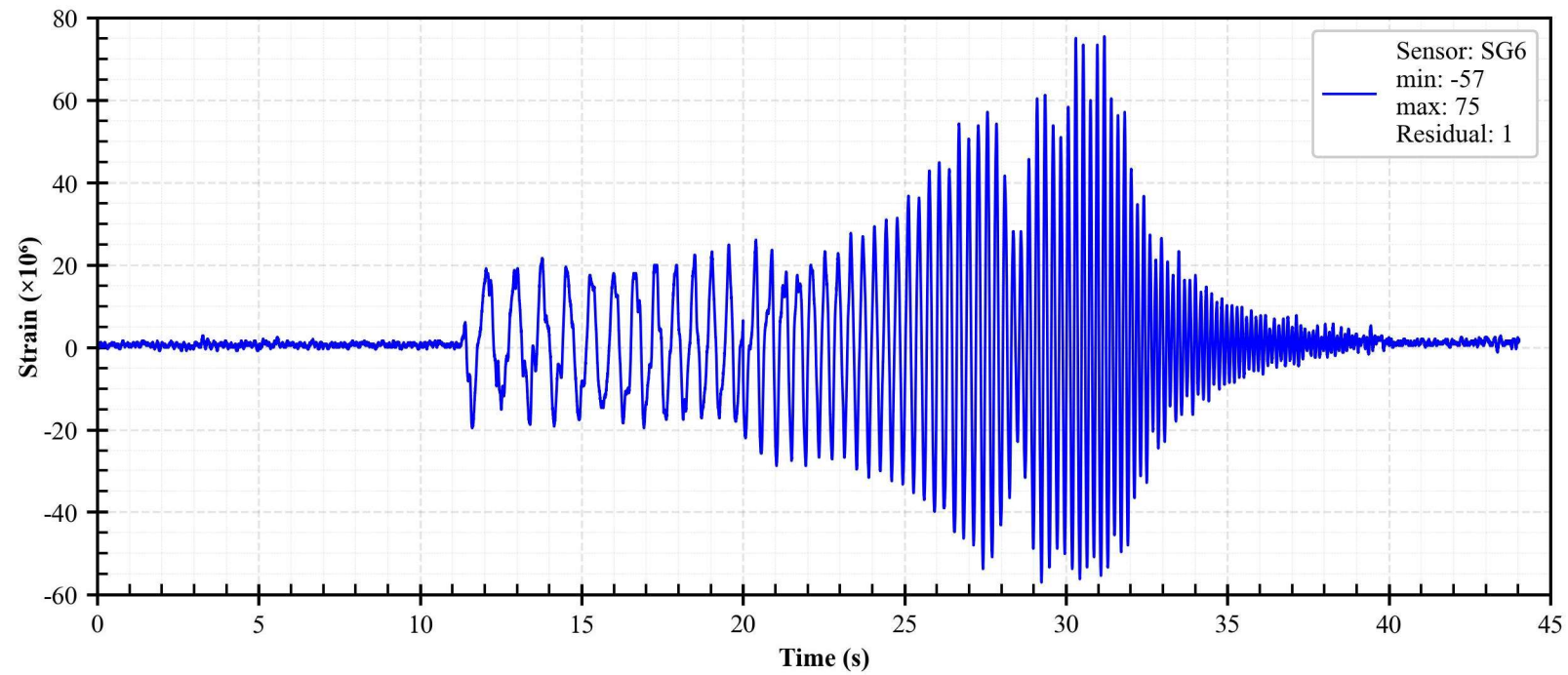


Figure 3.12.33 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 6

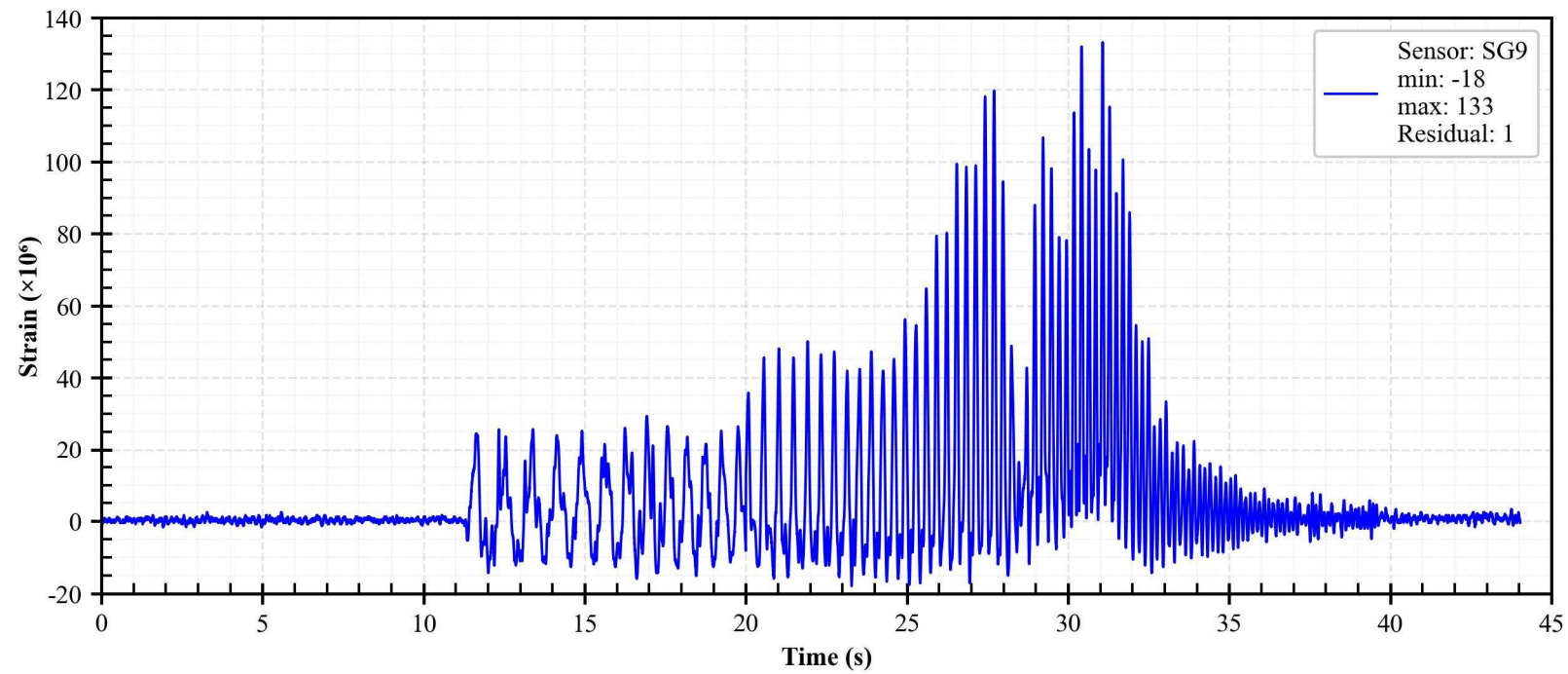


Figure 3.12.34 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 9

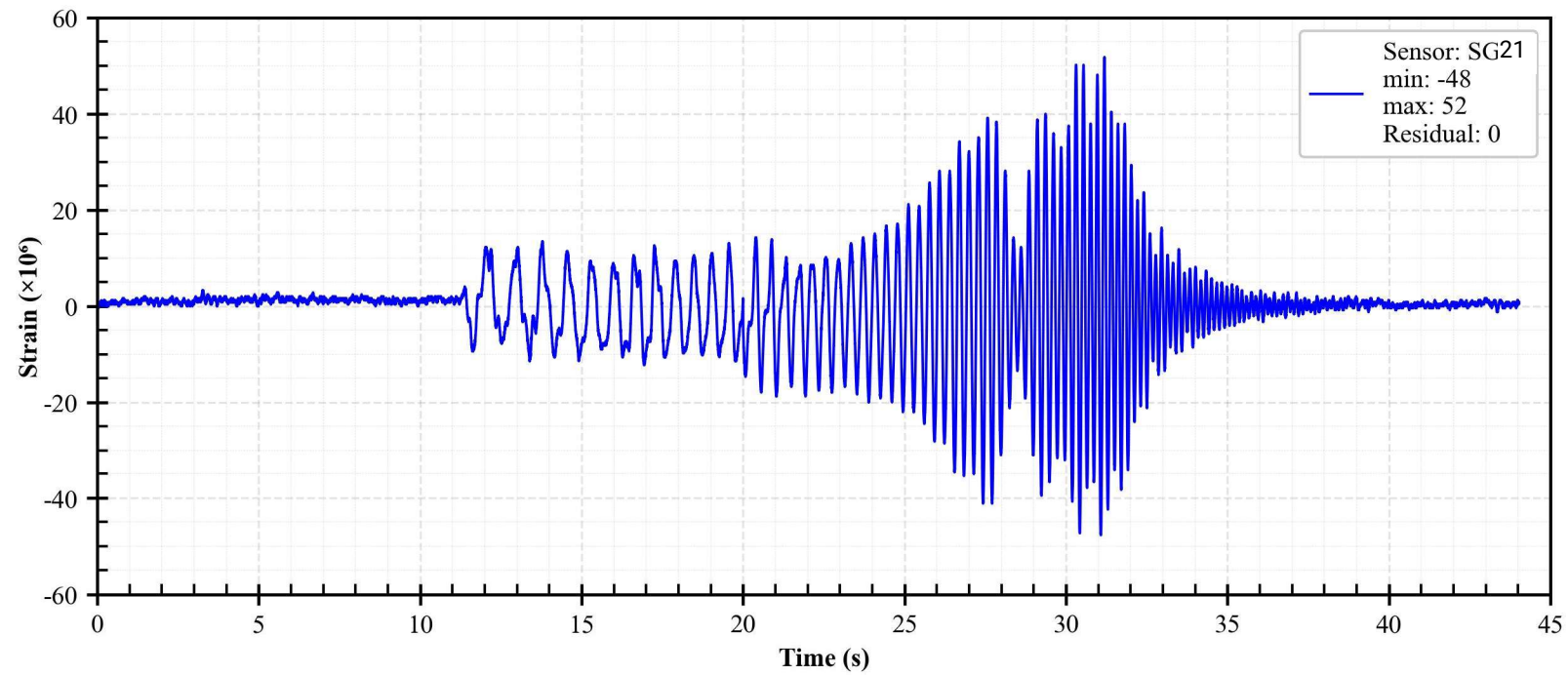


Figure 3.12.35 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 21 (PUFJ, column 1)

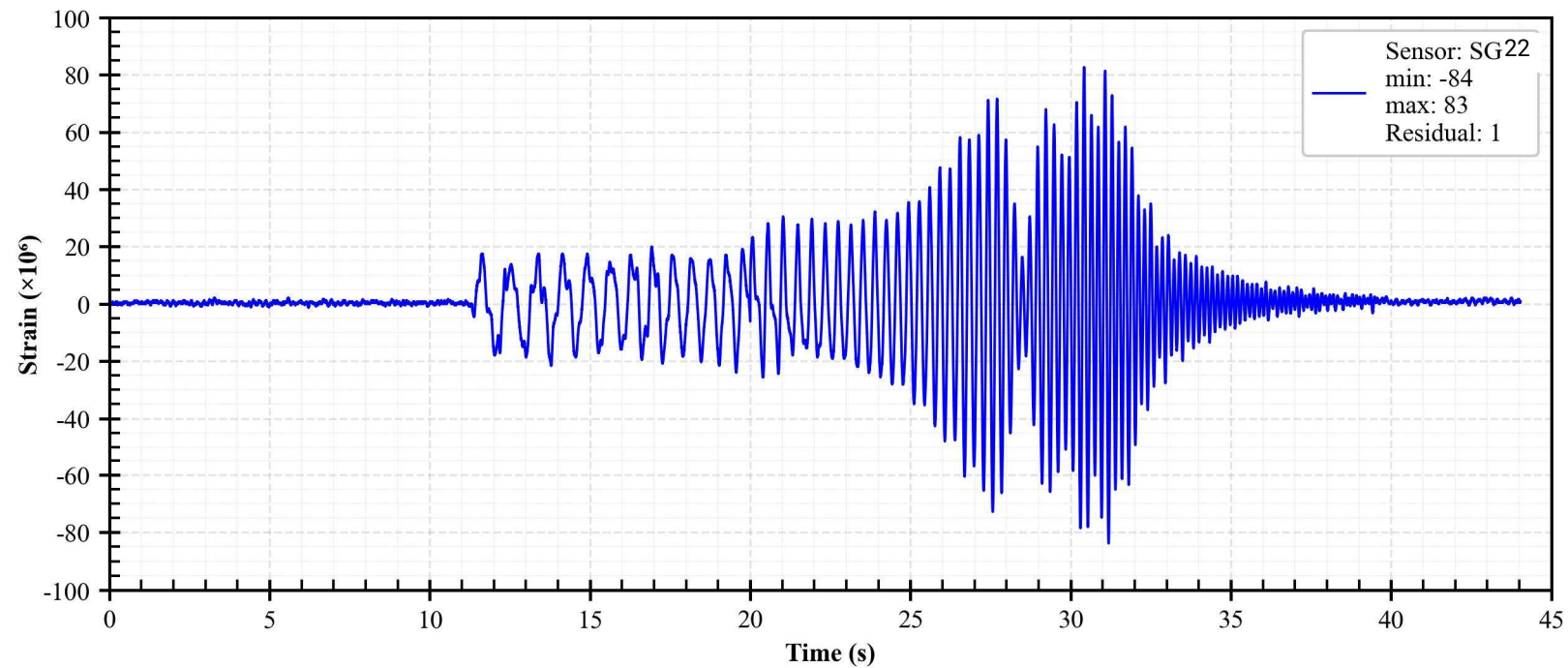


Figure 3.12.36 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 22 (PUFJ, column 2)

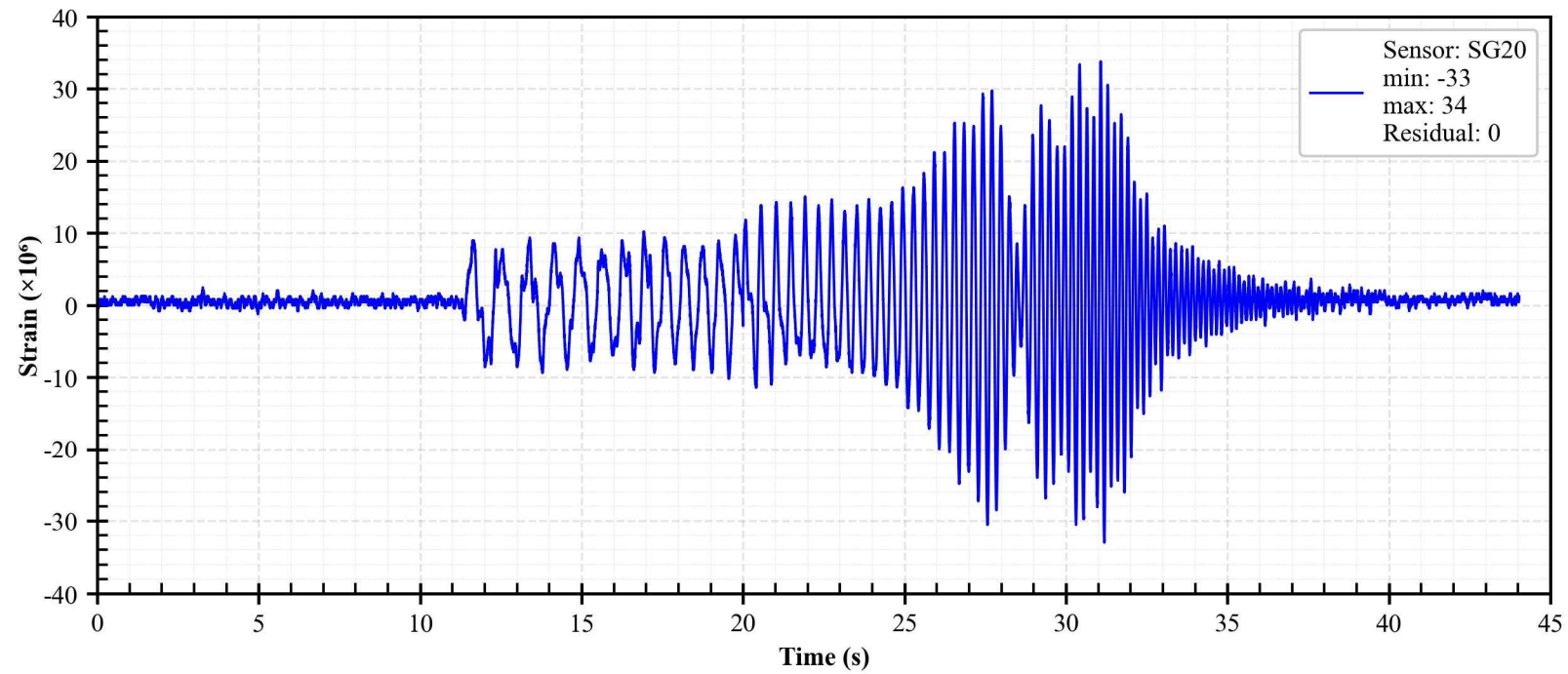


Figure 3.12.37 Characteristic results for phase B (white noise before EQ0,55g): strain gauge 20

3.13 Earthquake EQ0,55g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,55g. The max acceleration at the slab level on the accelerometer acc4 is 0.93g. The max acceleration at the foundation level on the accelerometer acc10 is 0.63g.

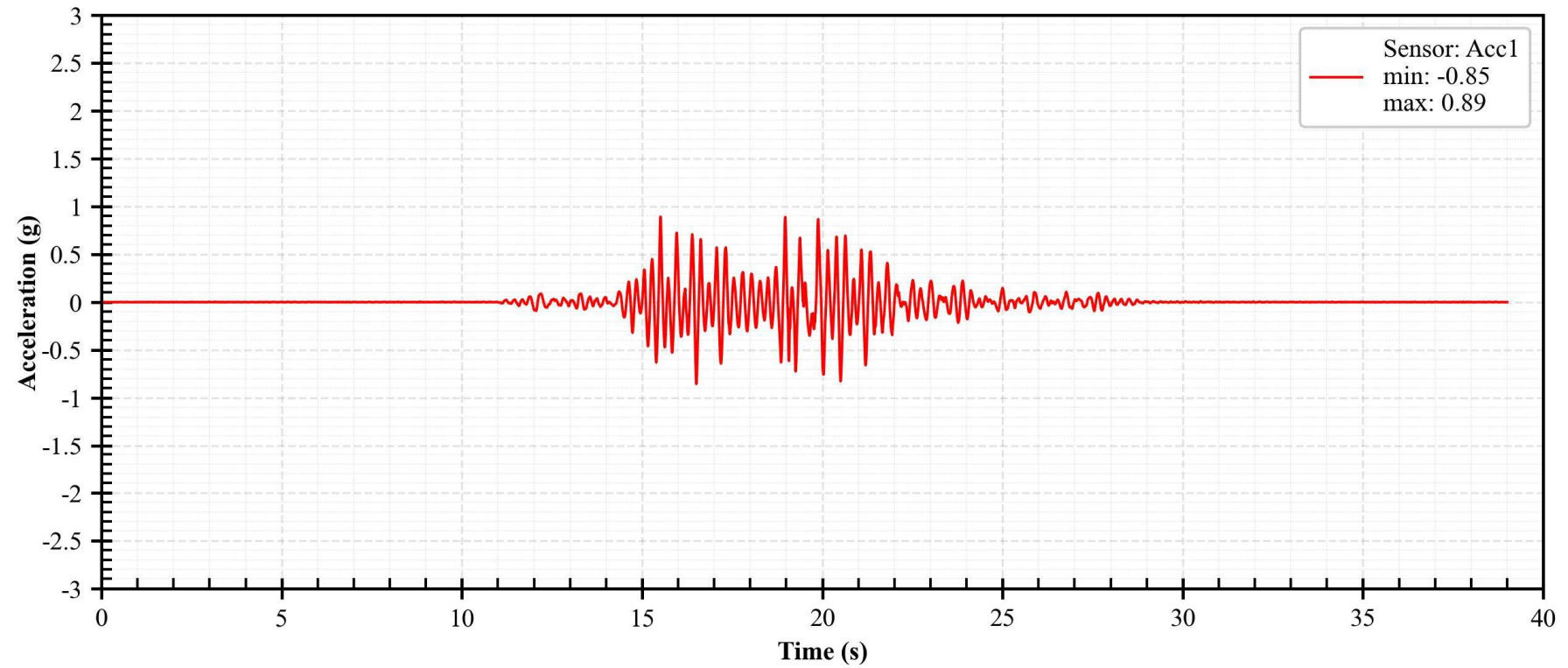


Figure 3.13.1 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 1

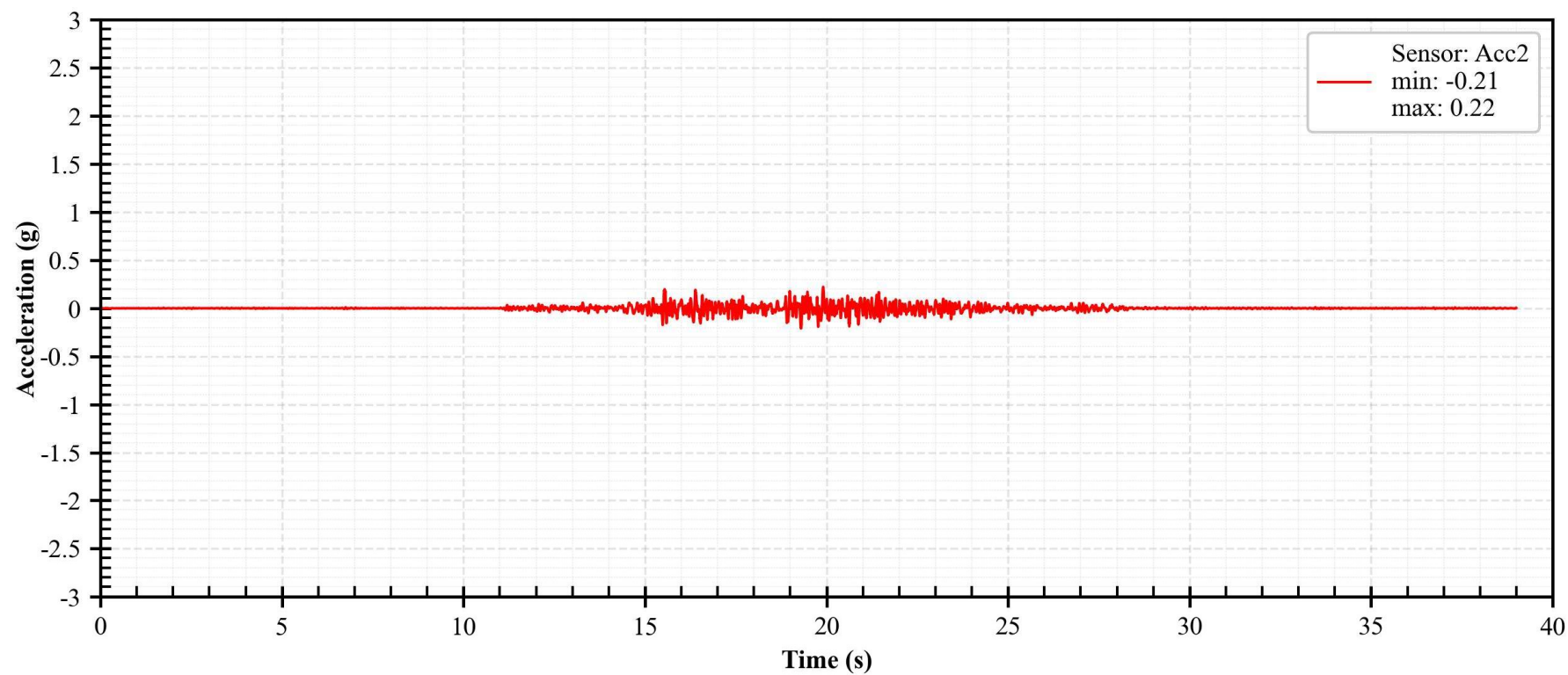


Figure 3.13.2 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 2

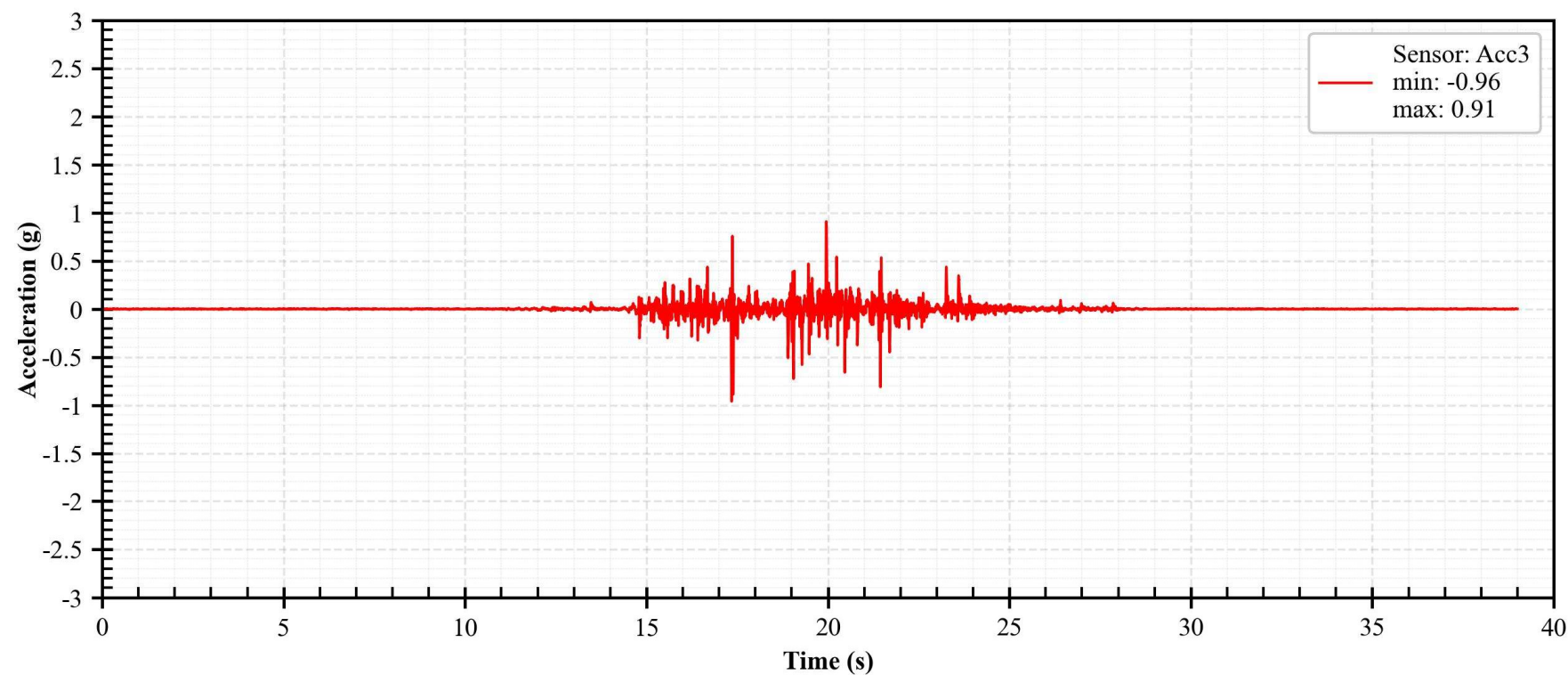


Figure 3.13.3 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 3

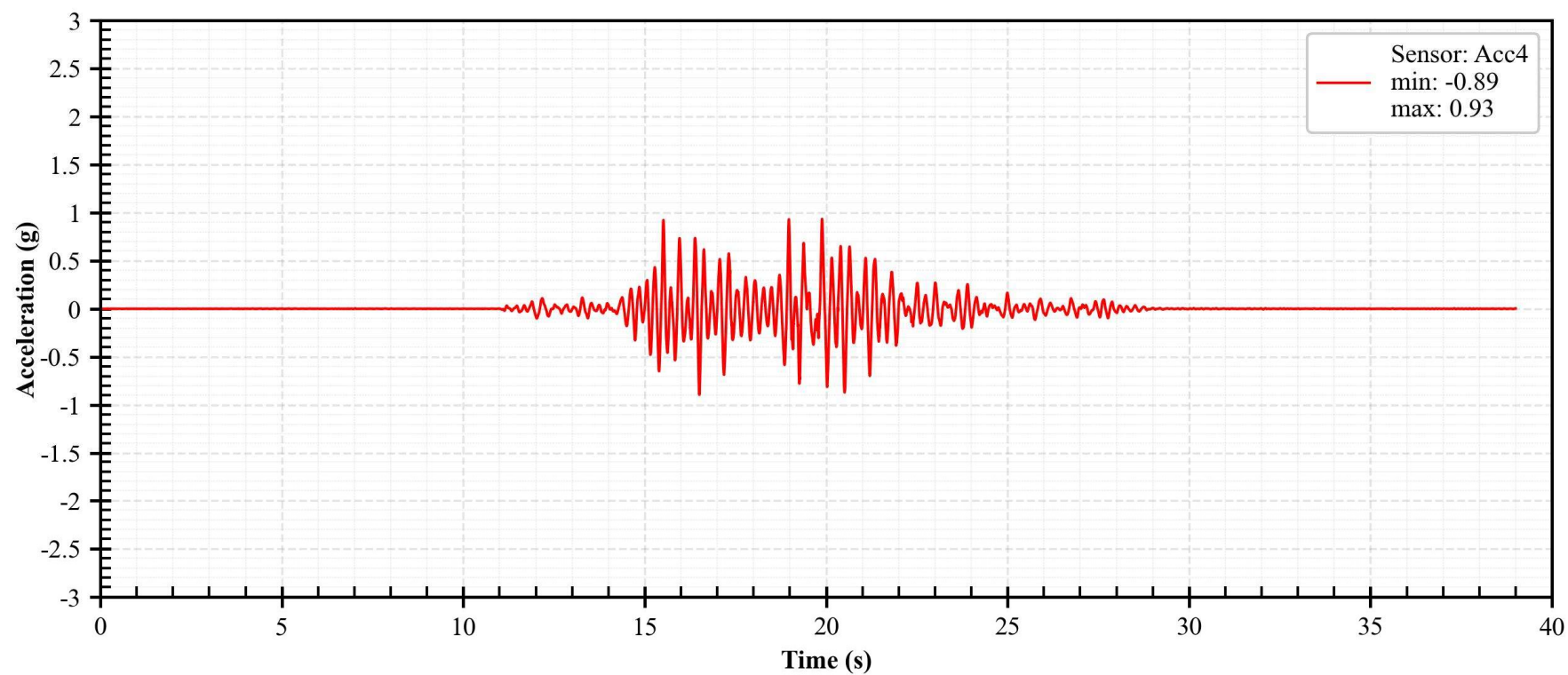


Figure 3.13.4 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 4

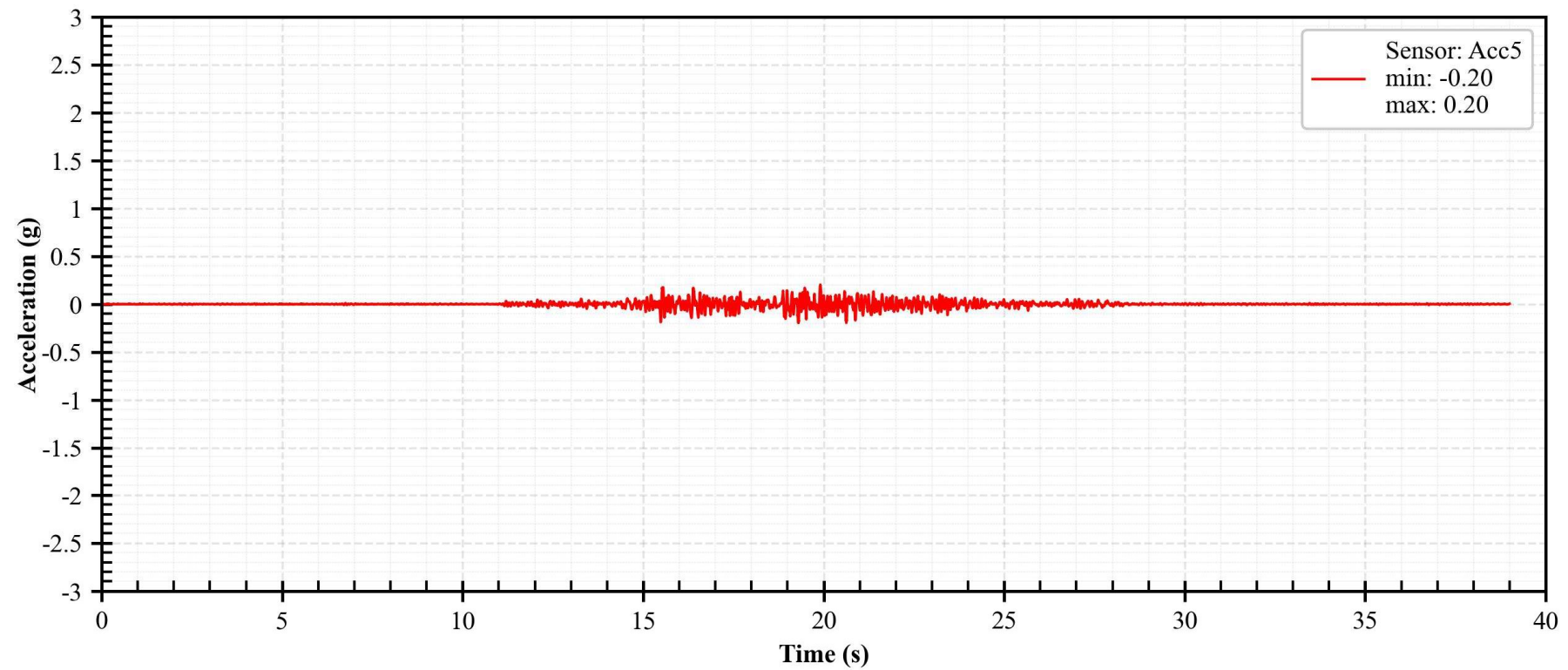


Figure 3.13.5 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 5

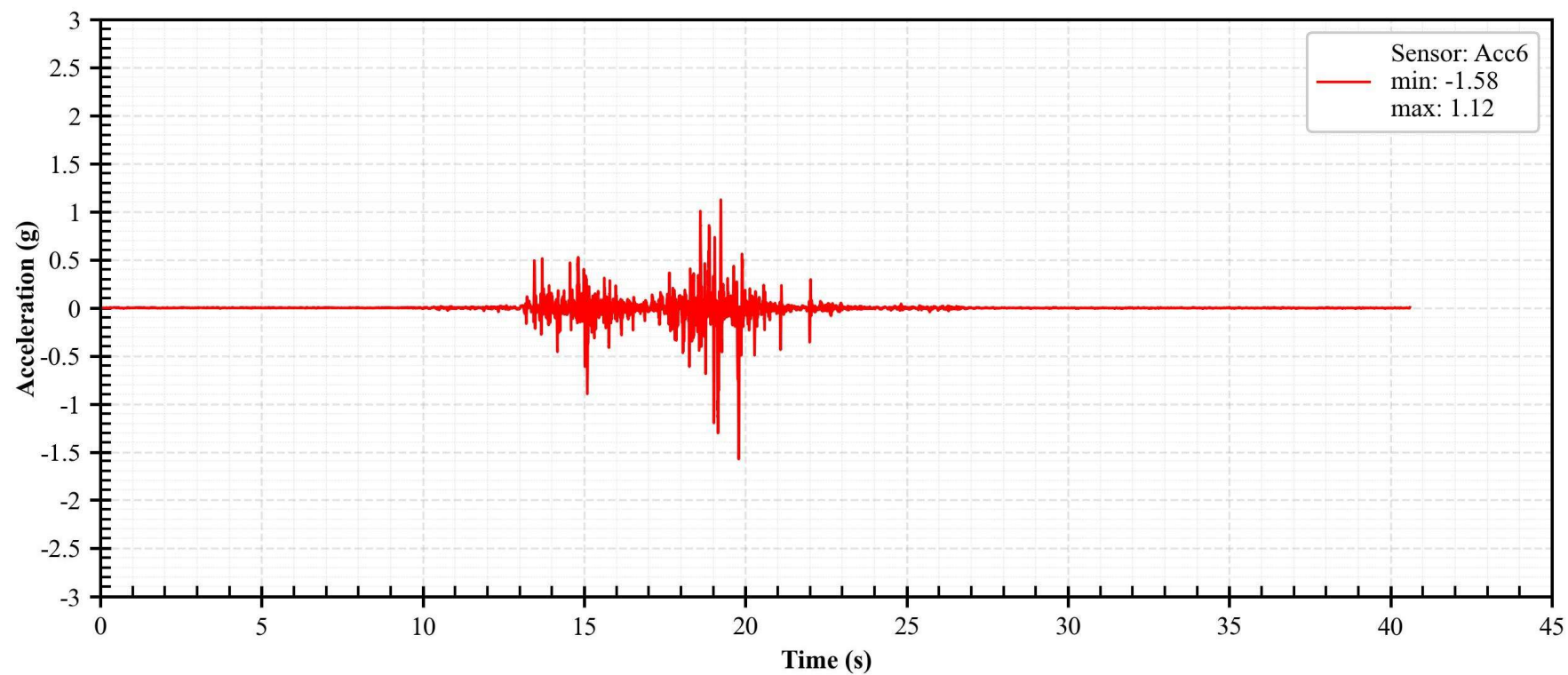


Figure 3.13.6 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 6

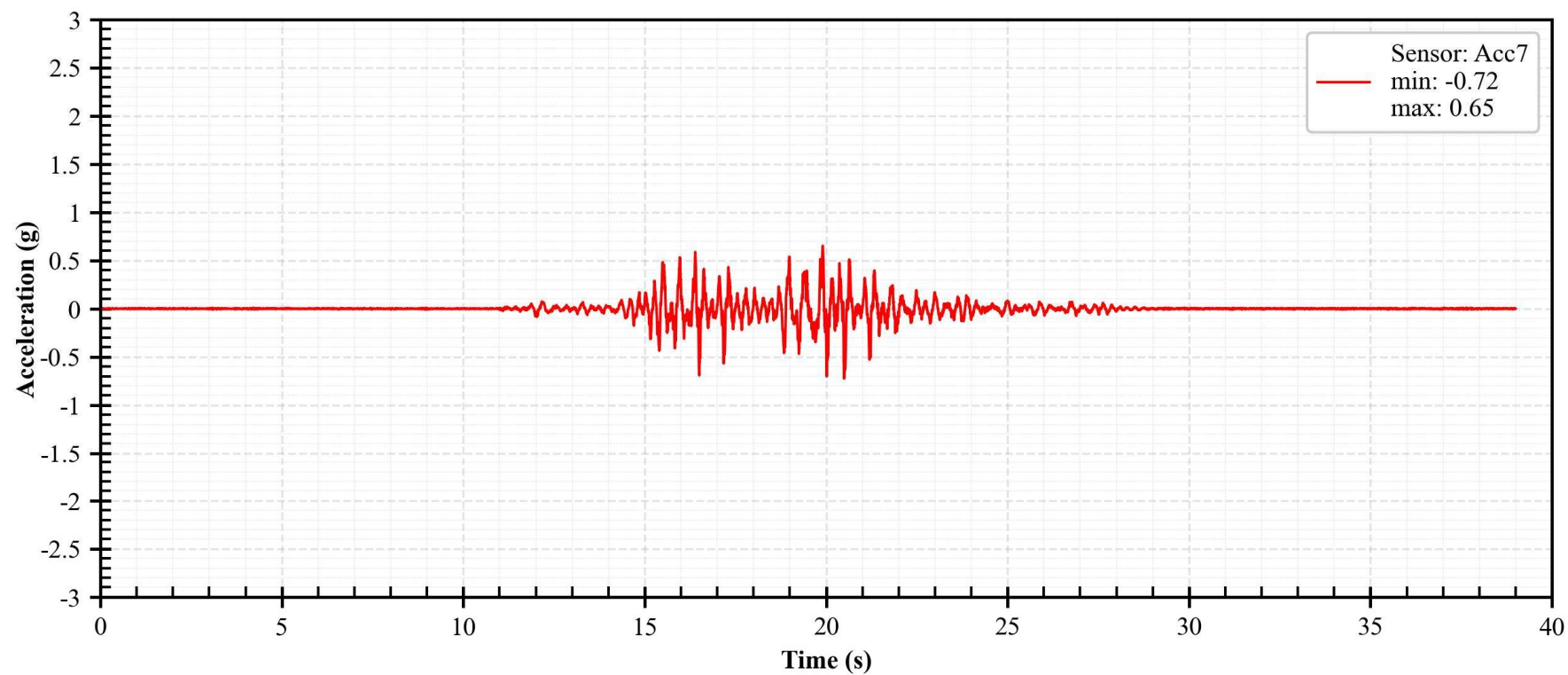


Figure 3.13.7 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 7

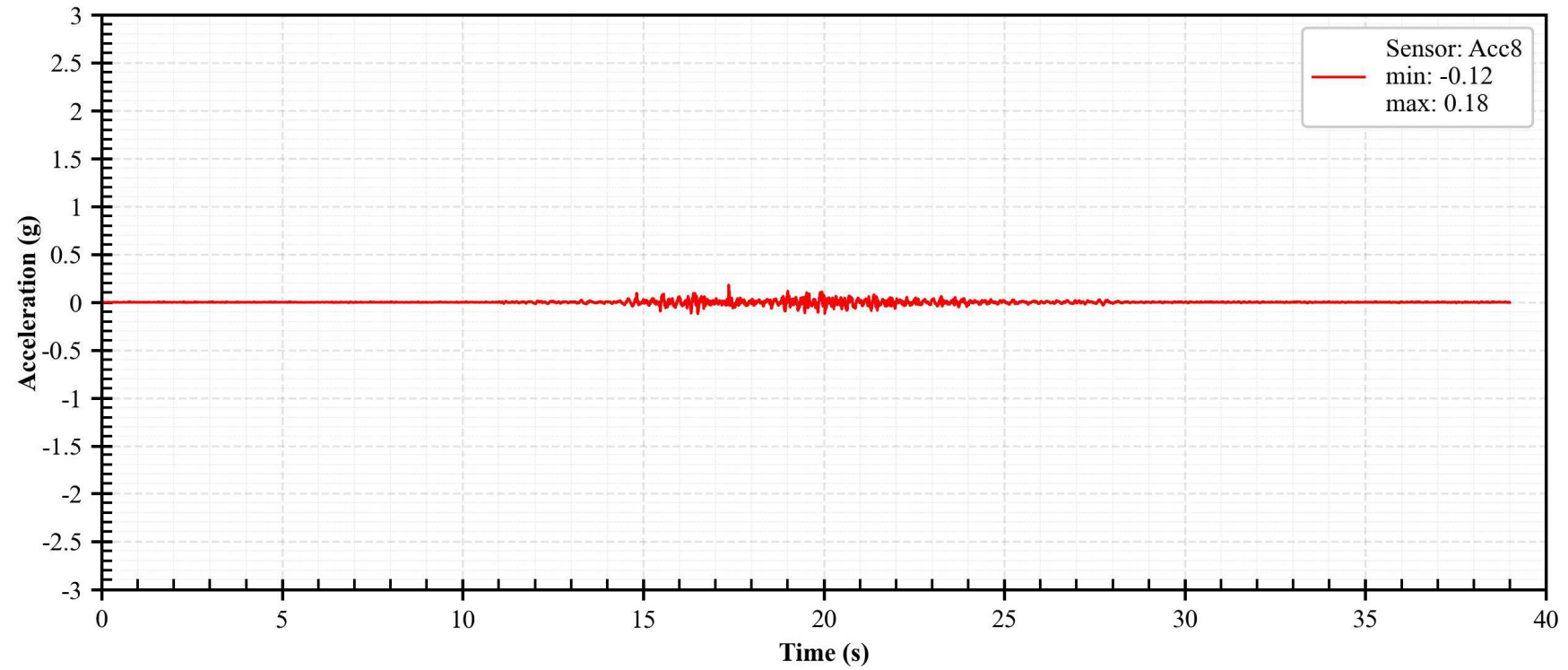


Figure 3.13.8 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 8

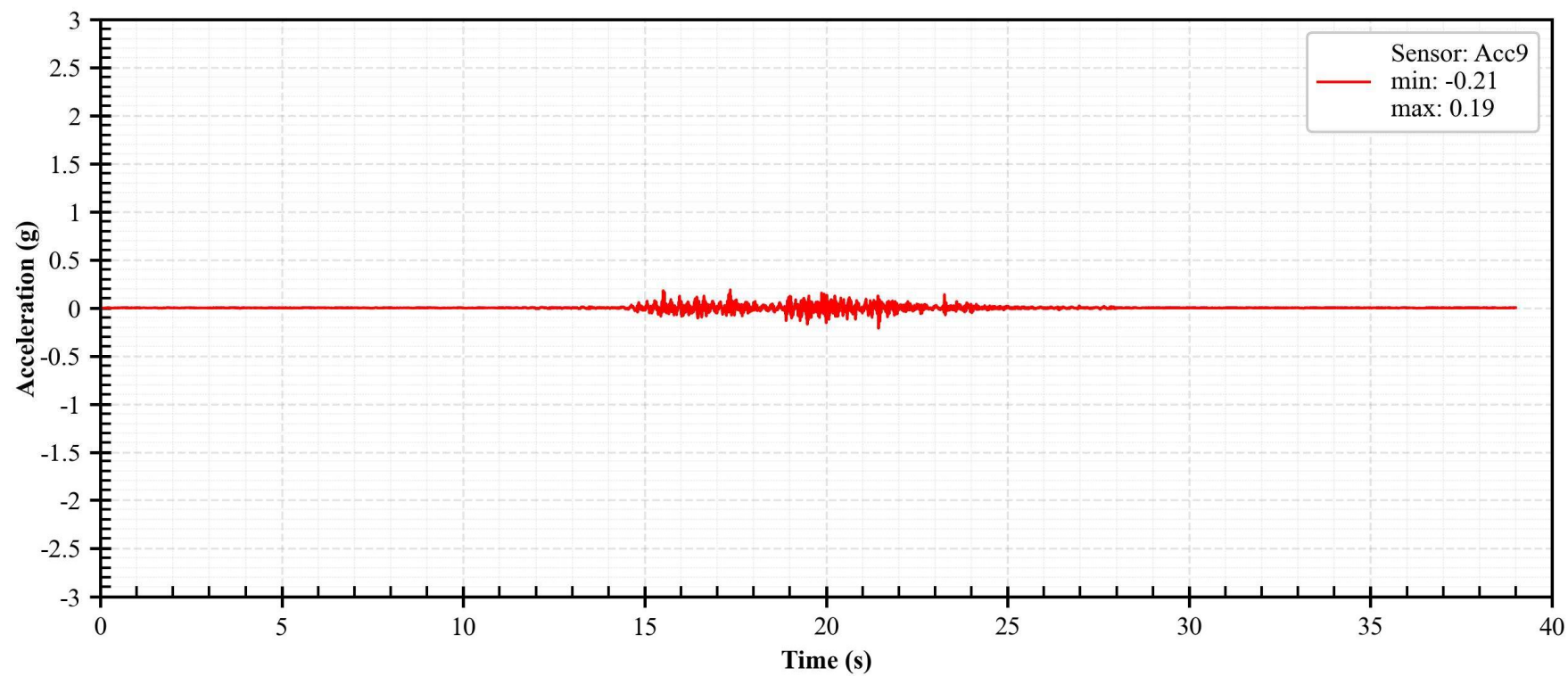


Figure 3.13.9 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 9

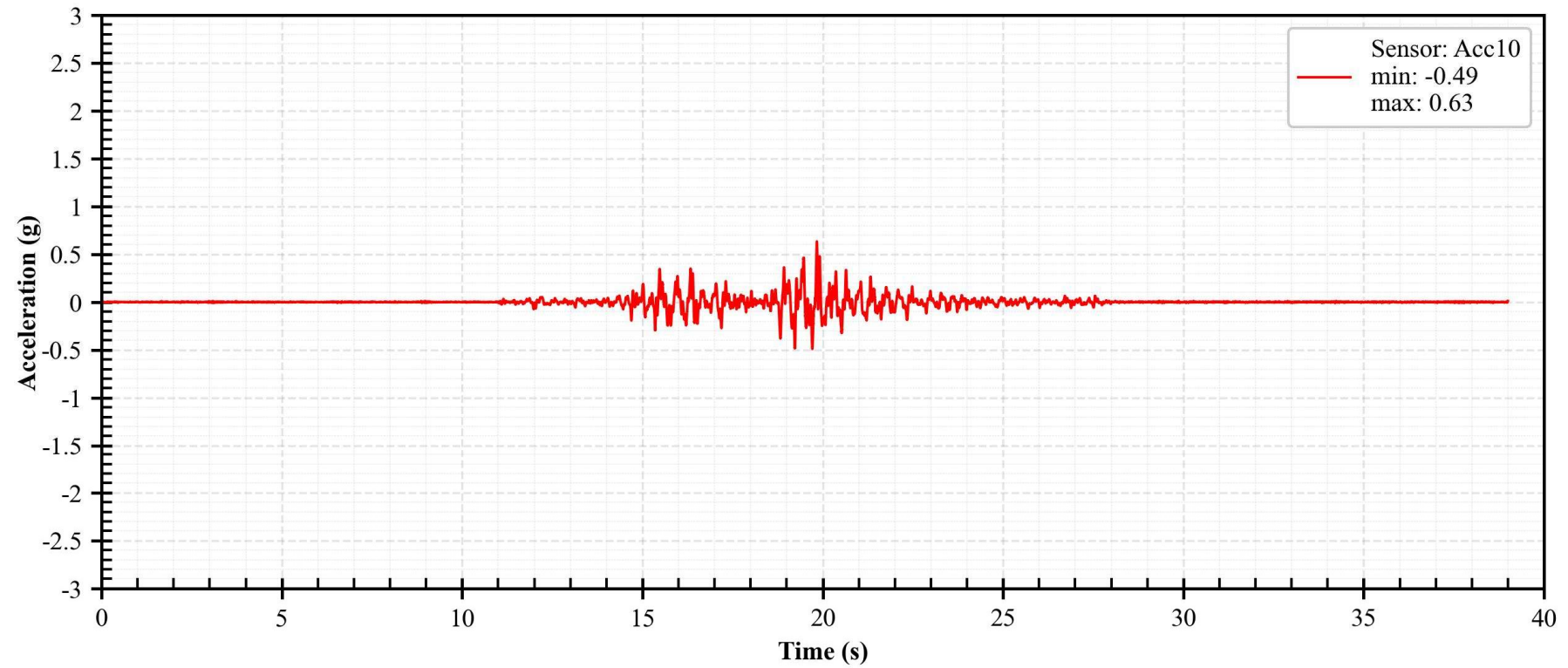


Figure 3.13.10 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 10

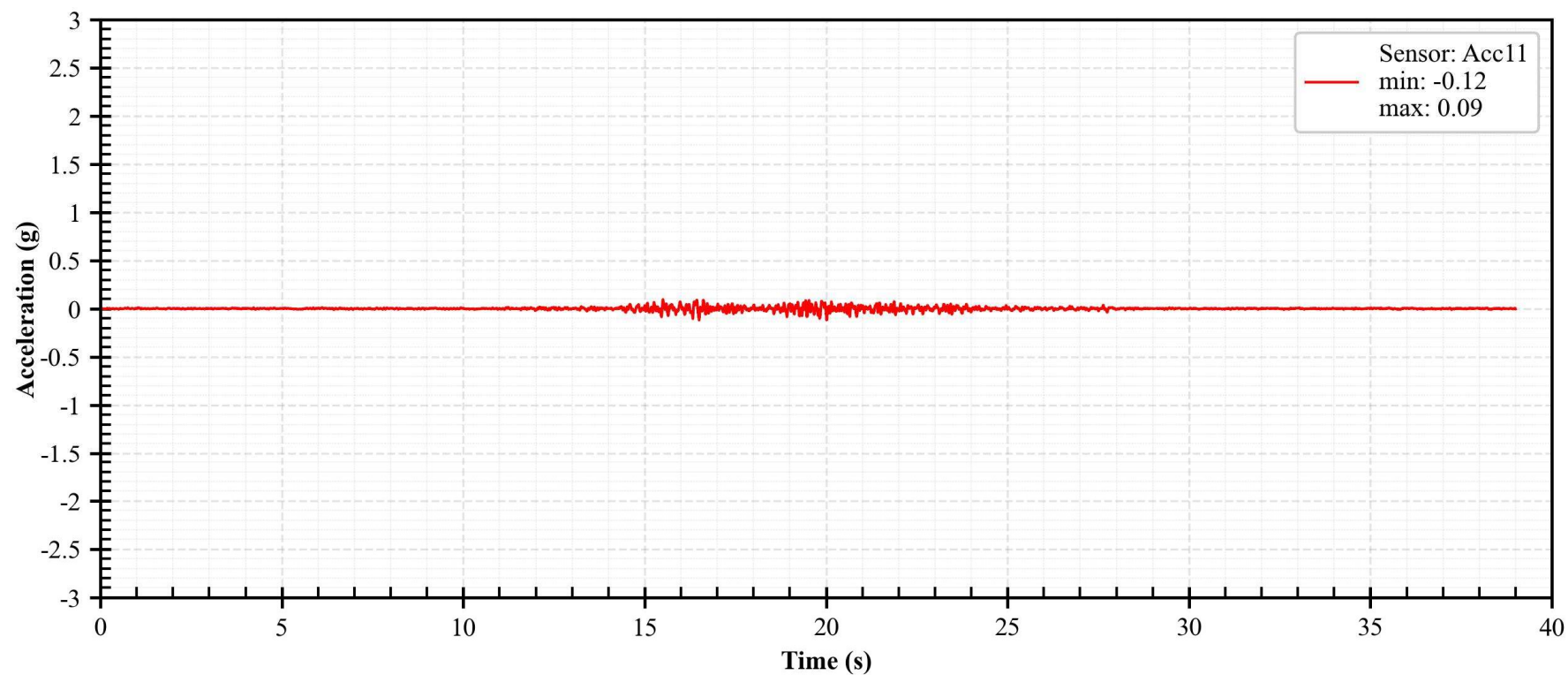


Figure 3.13.11 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 11

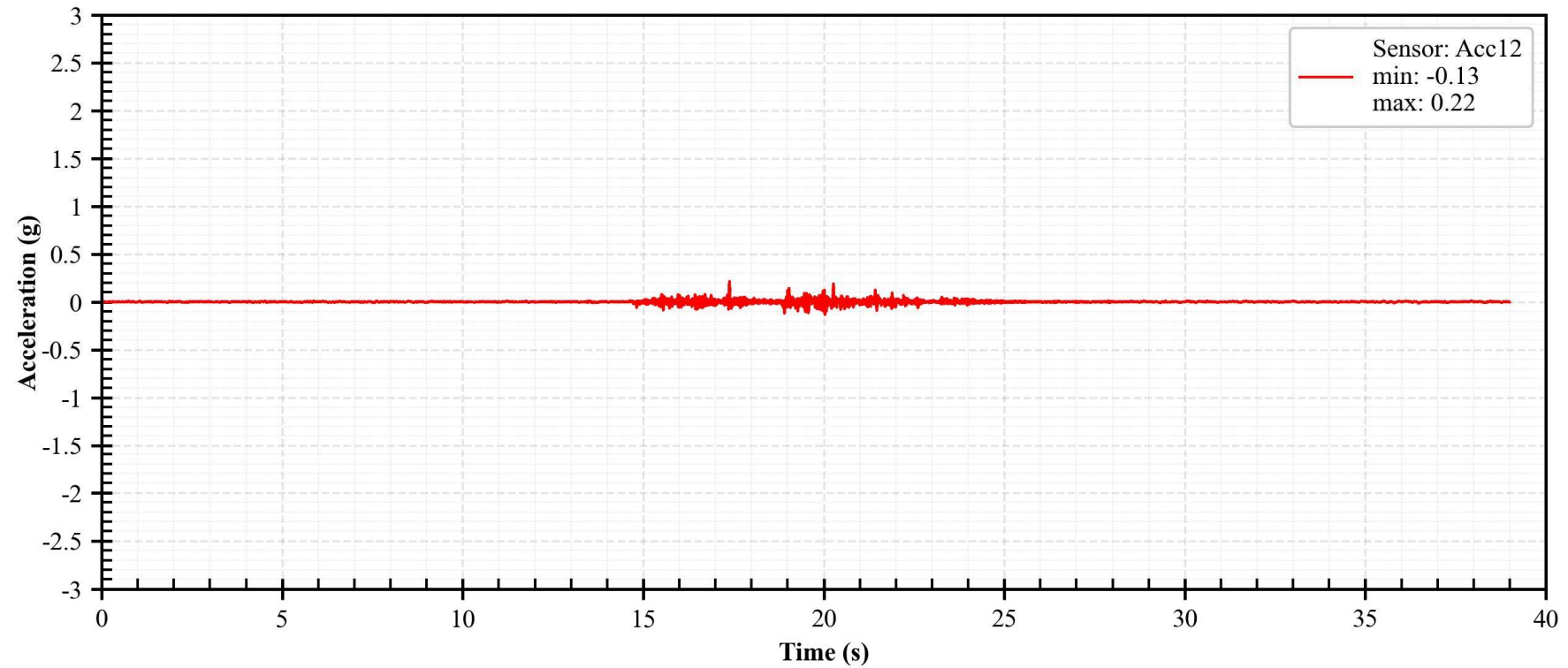


Figure 3.13.12 Characteristic results for phase B (earthquake EQ0,55g): Accelerometer 12

Draw wire sensors

Figures 3.13.13 – 3.13.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 17.28 mm while the minimum is -15.13 mm. The maximum movement detected by draw wire sensor W2 is 17.96 mm while the minimum is -15.68 mm. The maximum movement detected by draw wire sensor W3 is 12.39 mm while the minimum is -11.32 mm. The maximum movement detected by draw wire sensor W4 is 12.71 mm while the minimum is -11.63 mm. The maximum drift is $(7.61/1.225) = 6.21 \text{ ‰}$ and minimum drift is $(-8.43/1.225) = -6.88 \text{ ‰}$.

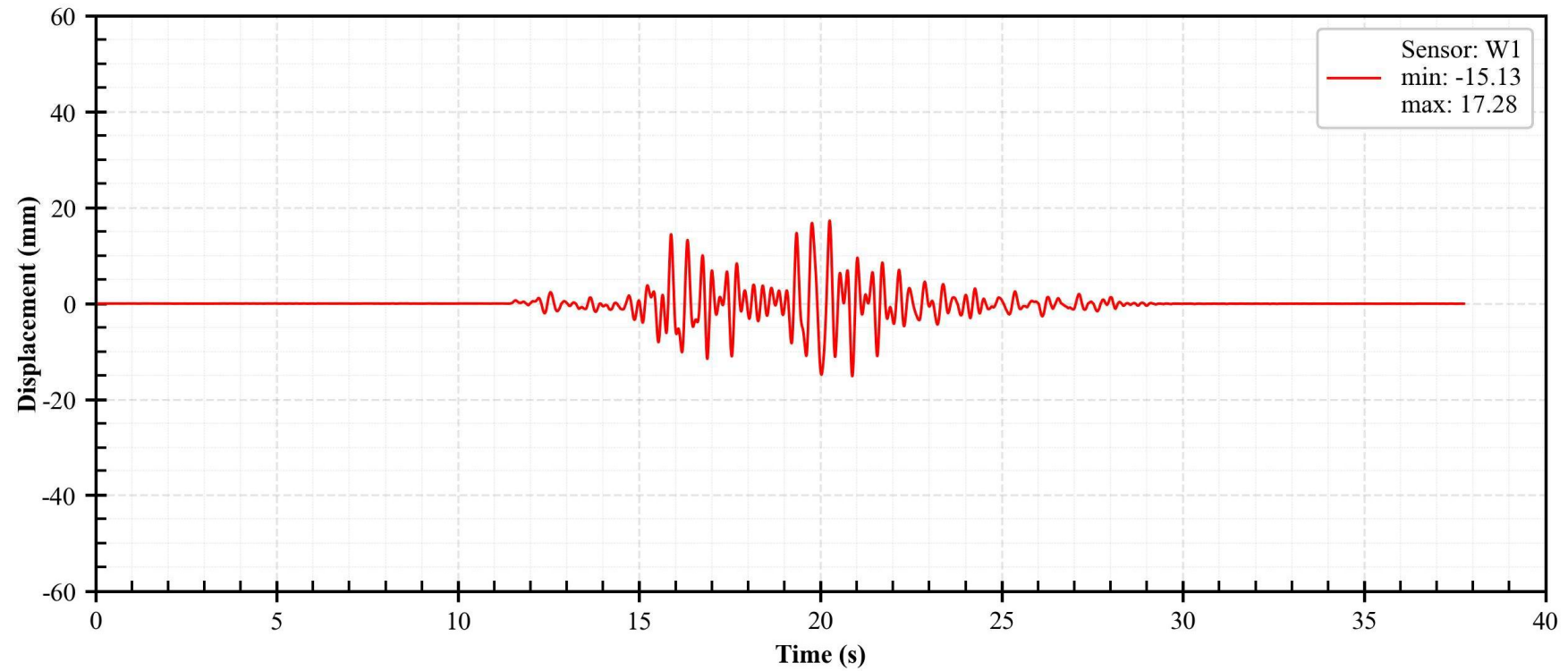


Figure 3.13.13 Characteristic results for phase B (earthquake EQ0,55g): Draw wire sensor 1

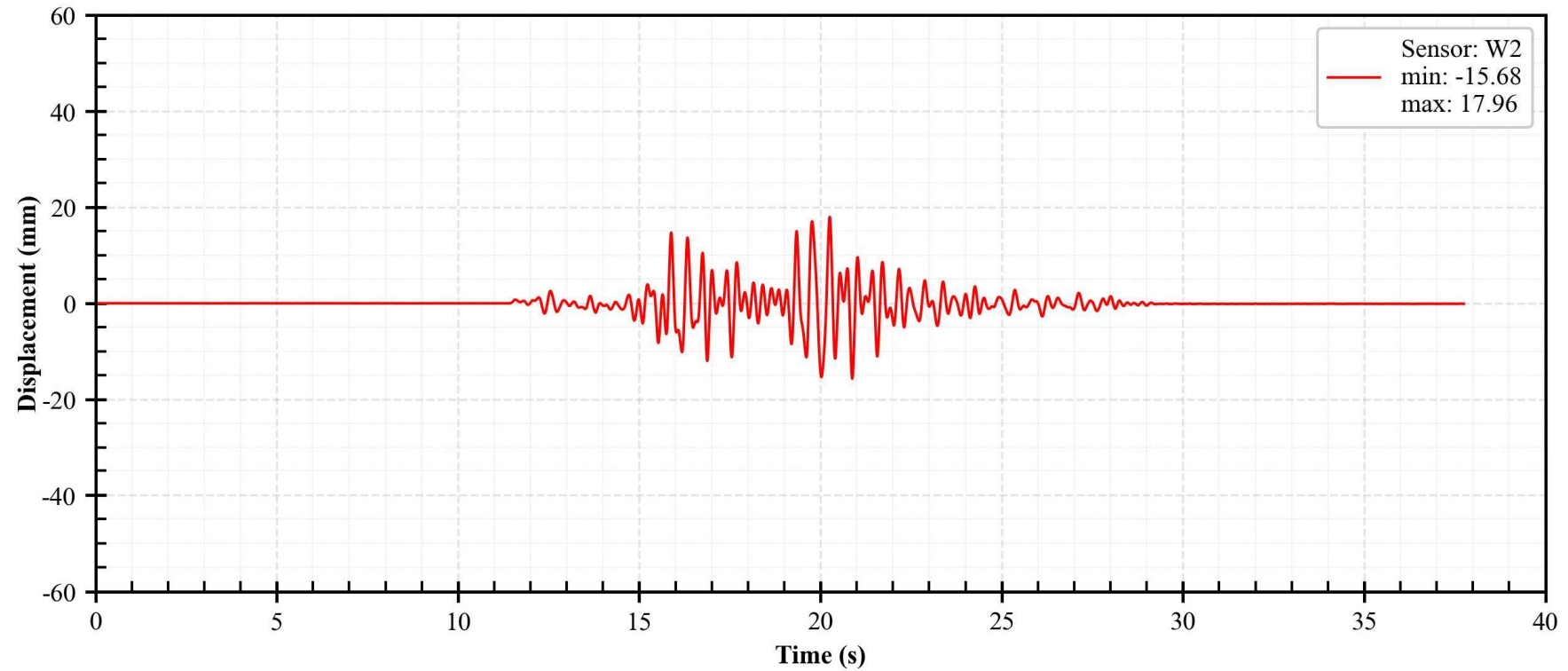


Figure 3.13.14 Characteristic results for phase B (earthquake EQ0,55g): Draw wire sensor 2

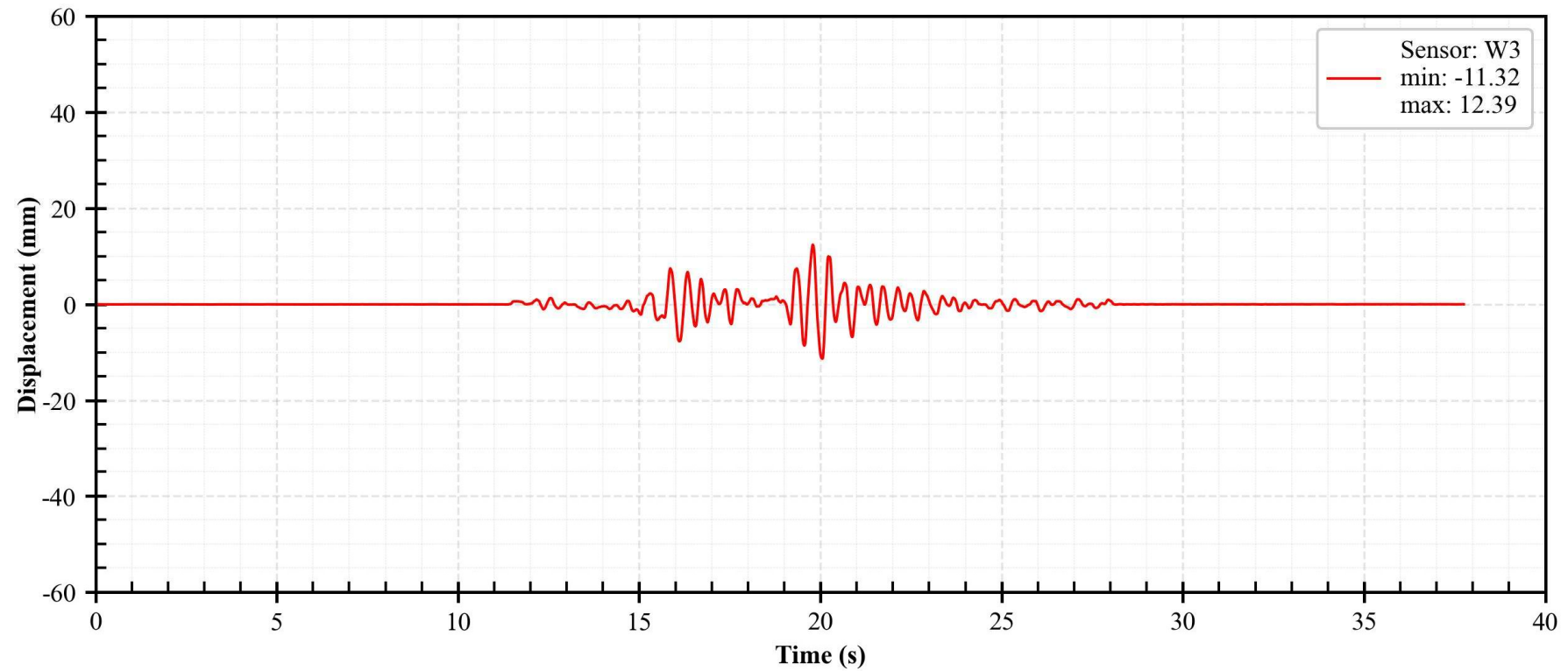


Figure 3.13.15 Characteristic results for phase B (earthquake EQ0,55g): Draw wire sensor 3

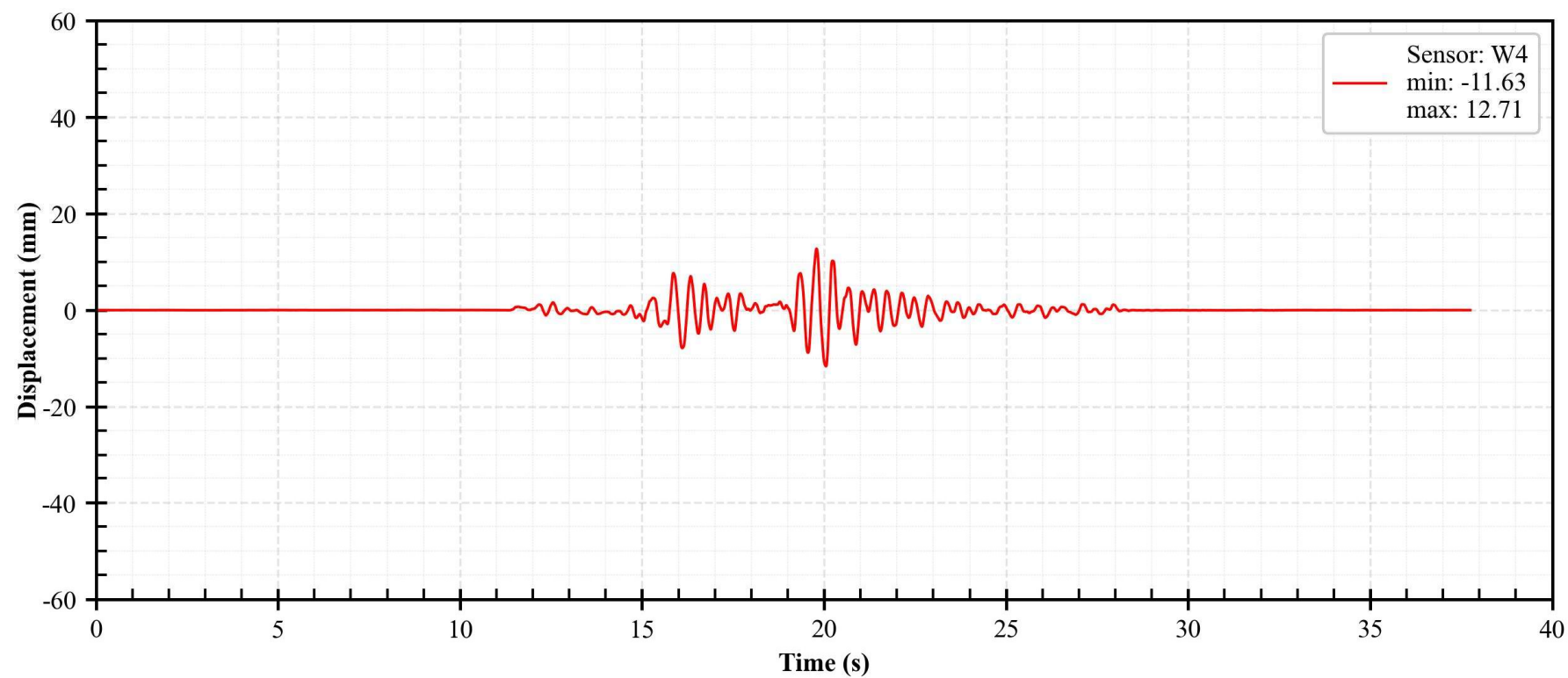


Figure 3.13.16 Characteristic results for phase B (earthquake EQ0,55g): Draw wire sensor 4

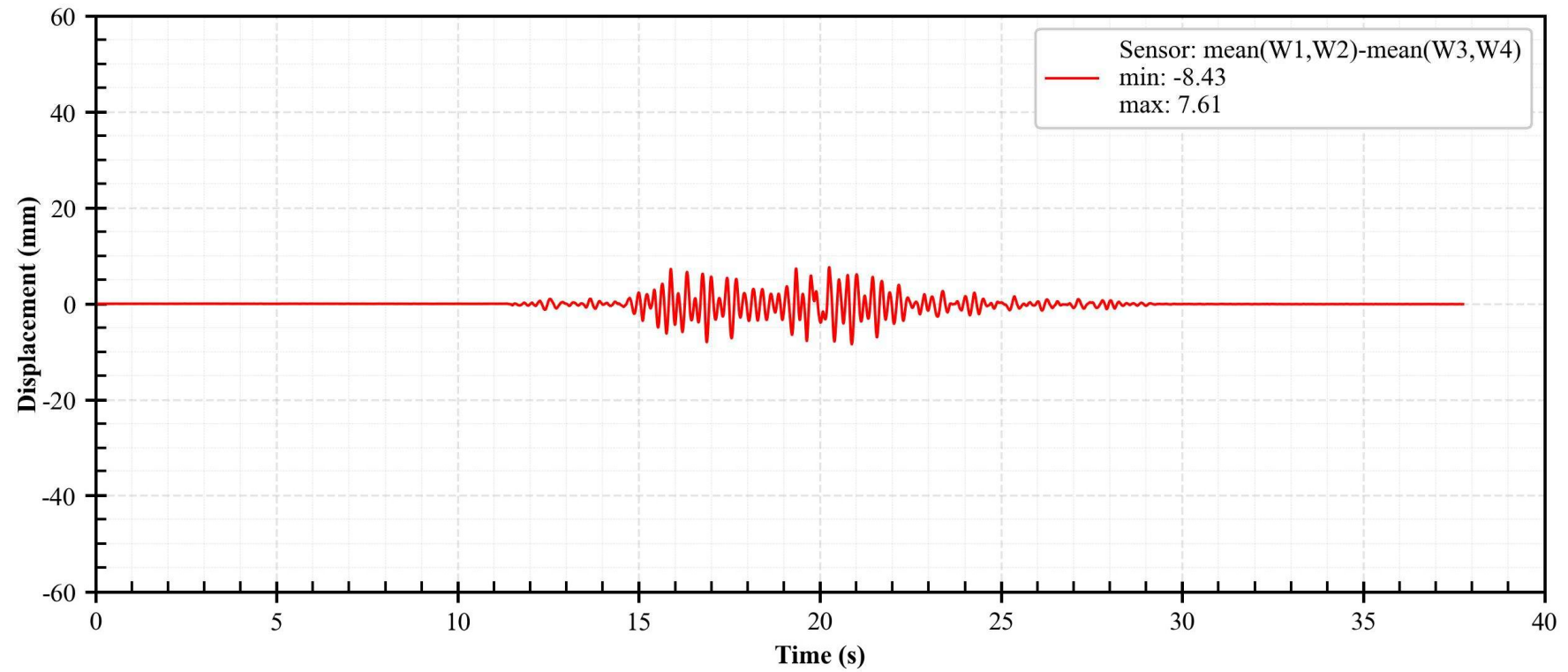


Figure 3.13.17 Characteristic results for phase B (earthquake EQ0,55g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.13.18, 3.13.19, 3.13.20, 3.13.21, 3.13.22, 3.13.23, 3.13.32, 3.13.33 are located on the longitudinal reinforcement, at the bottom of the column. Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. The strain gauges shown in the figures 3.13.24, 3.13.25, 3.13.26, 3.13.27, 3.13.28, 3.13.29 and 3.13.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 1507 μ strain and minimum strain -556 μ strain. The residual strain is 10 μ strain. SG21 & SG22 are located on PUFJ.

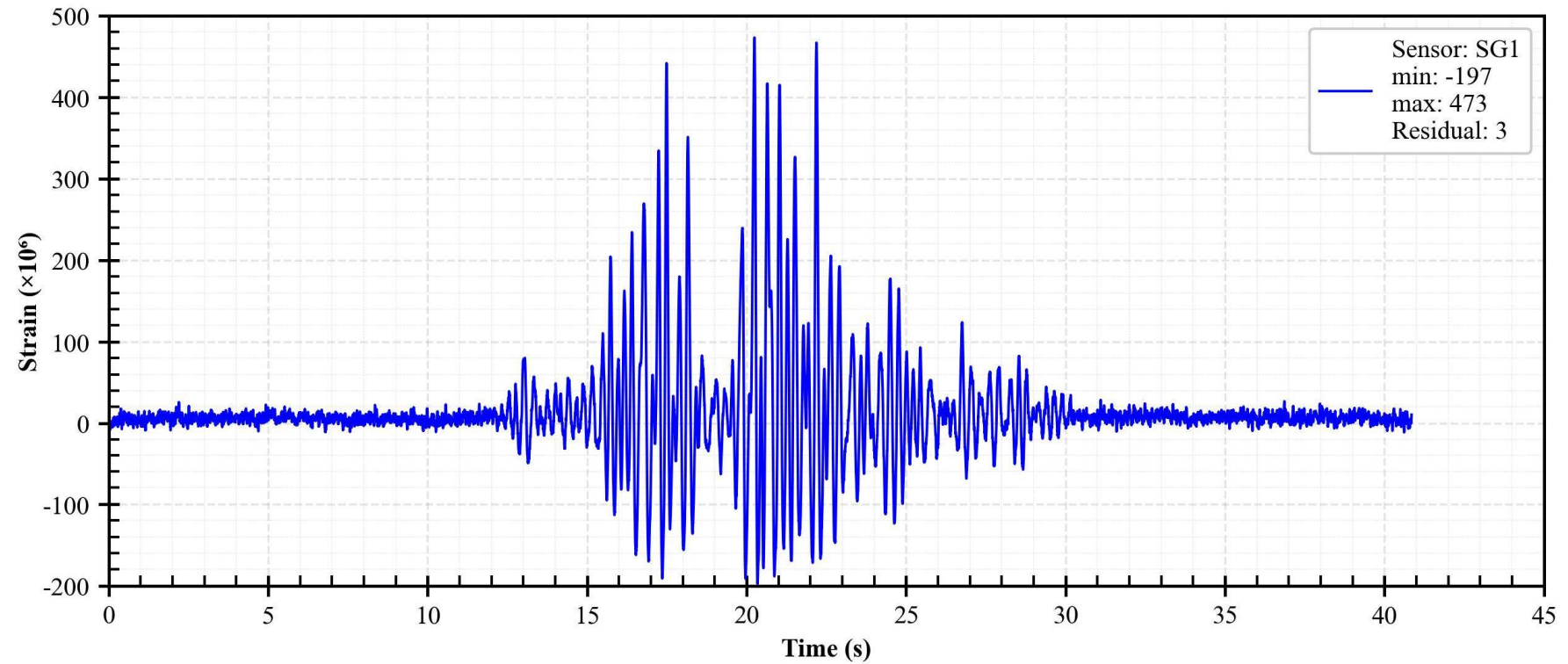


Figure 3.13.18 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 1

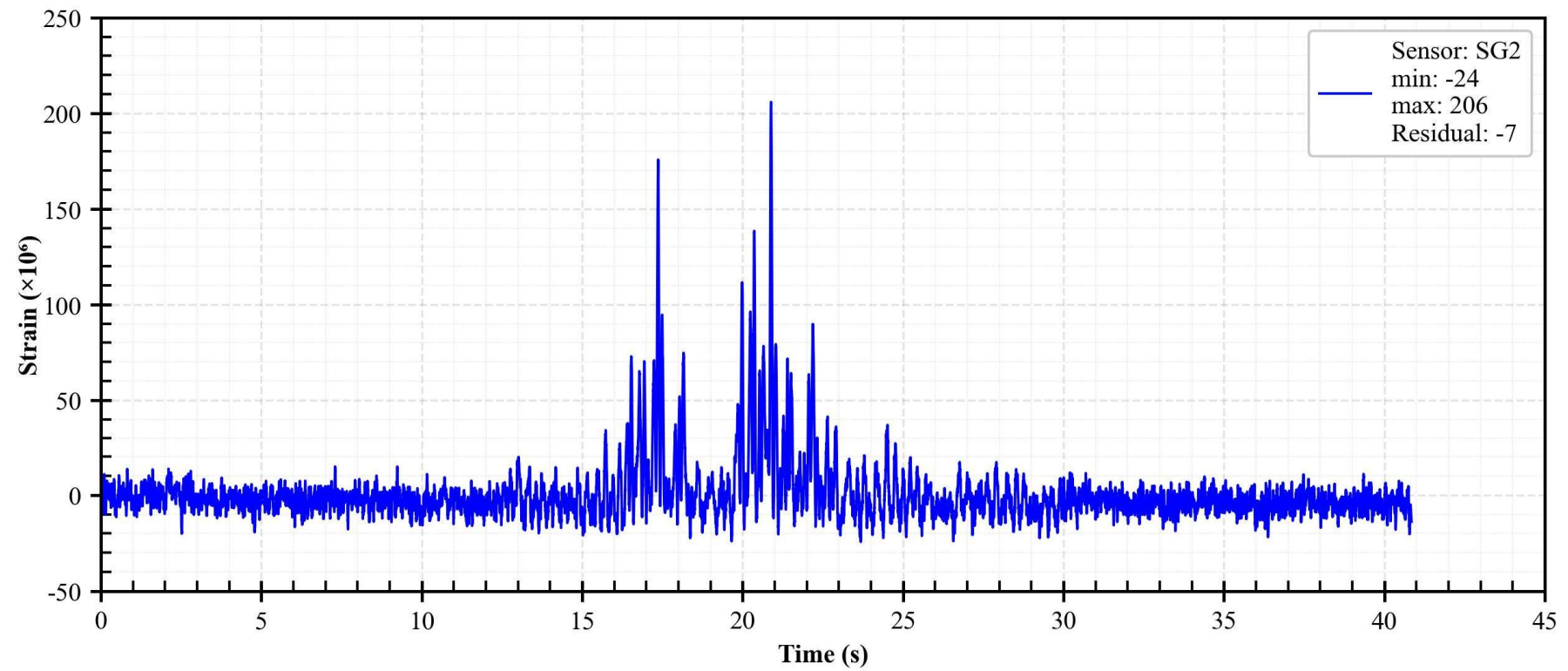


Figure 3.13.19 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 2

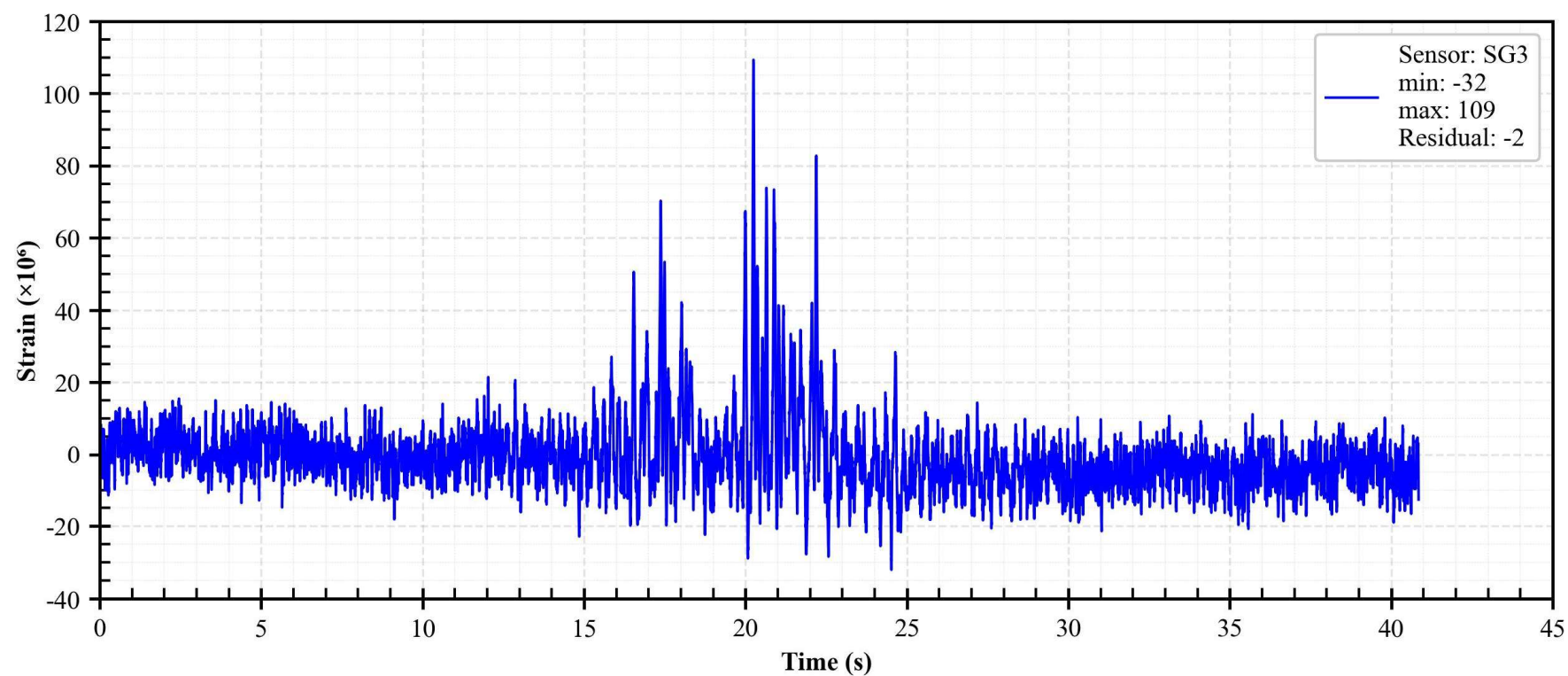


Figure 3.13.20 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 3

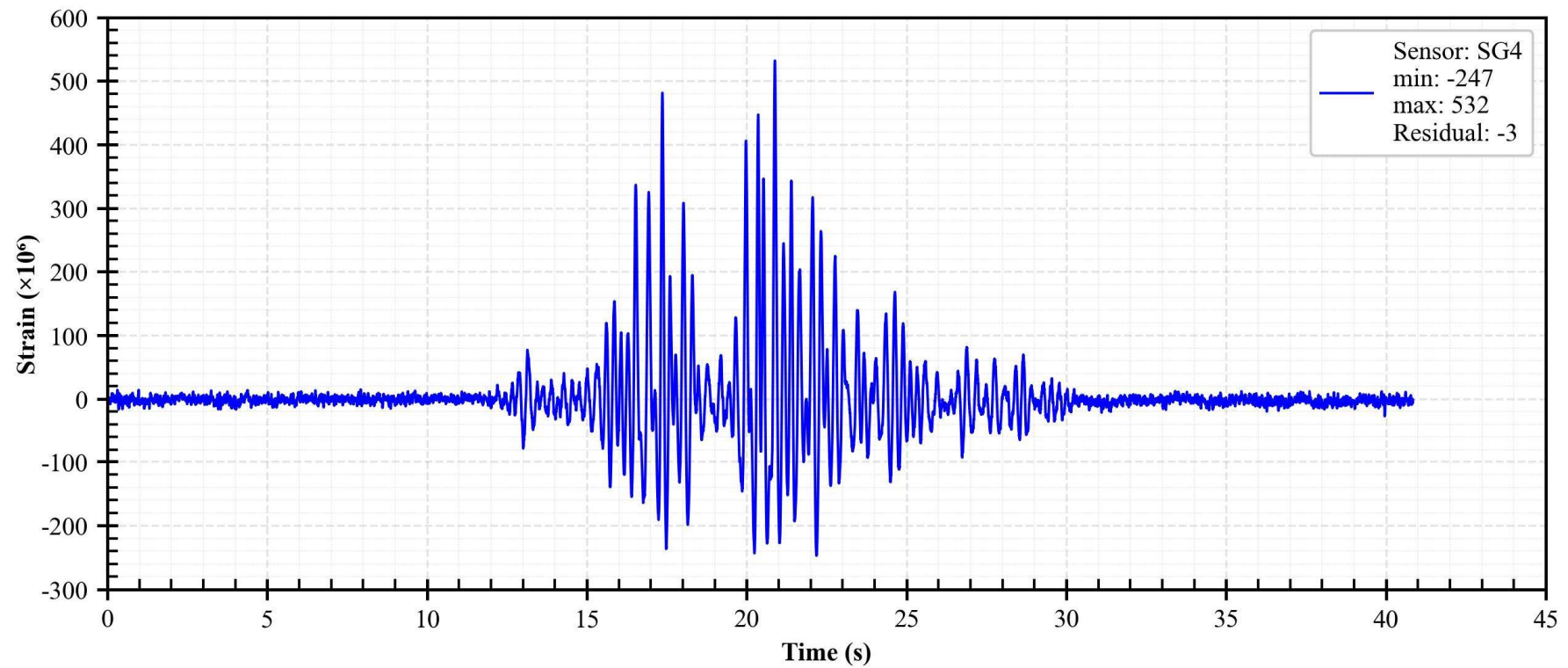


Figure 3.13.21 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 4

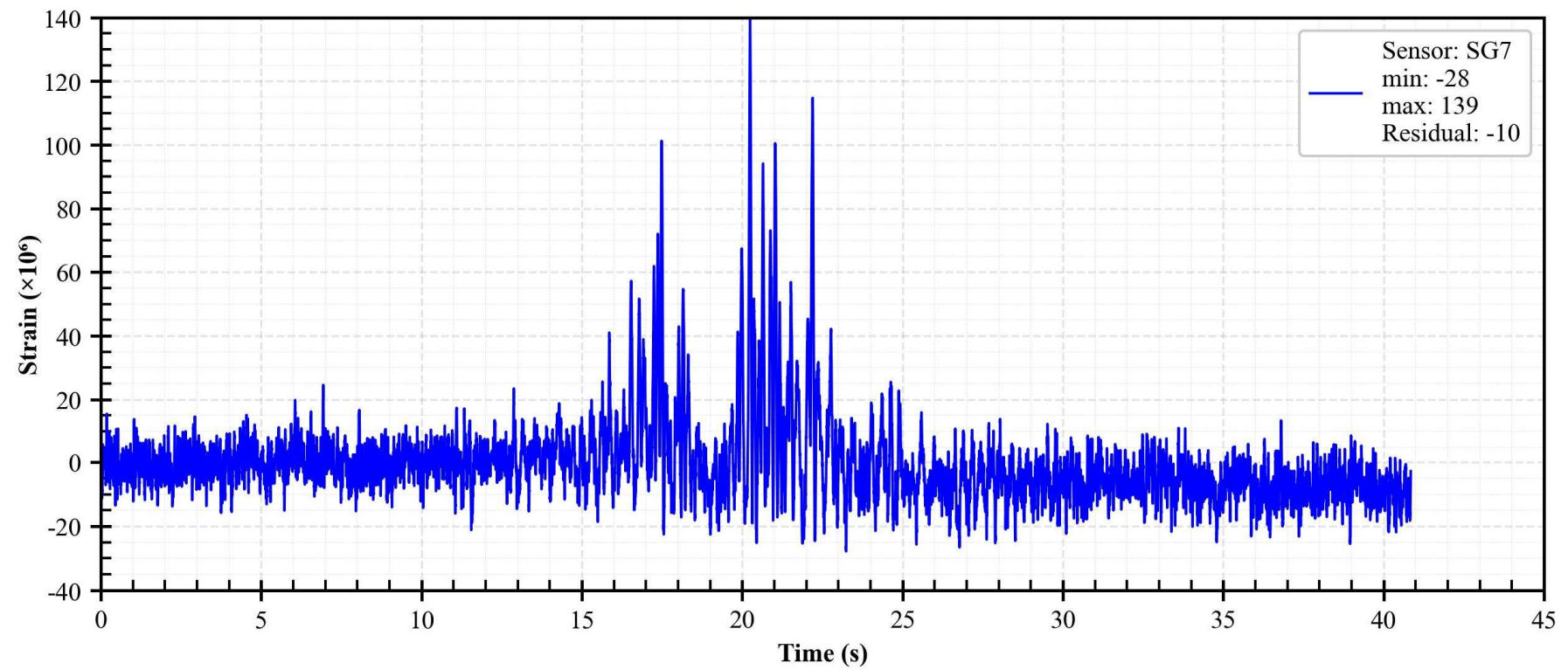


Figure 3.13.22 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 7

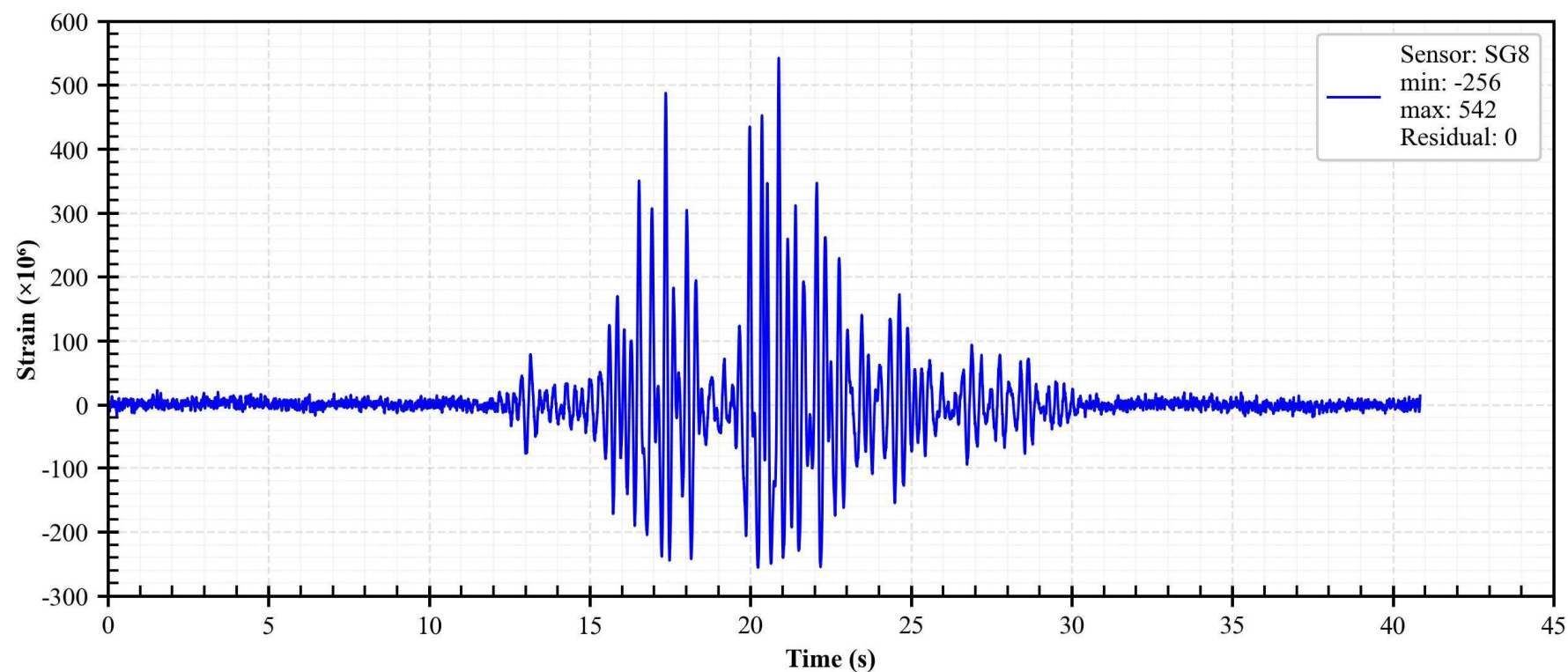


Figure 3.13.23 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 8

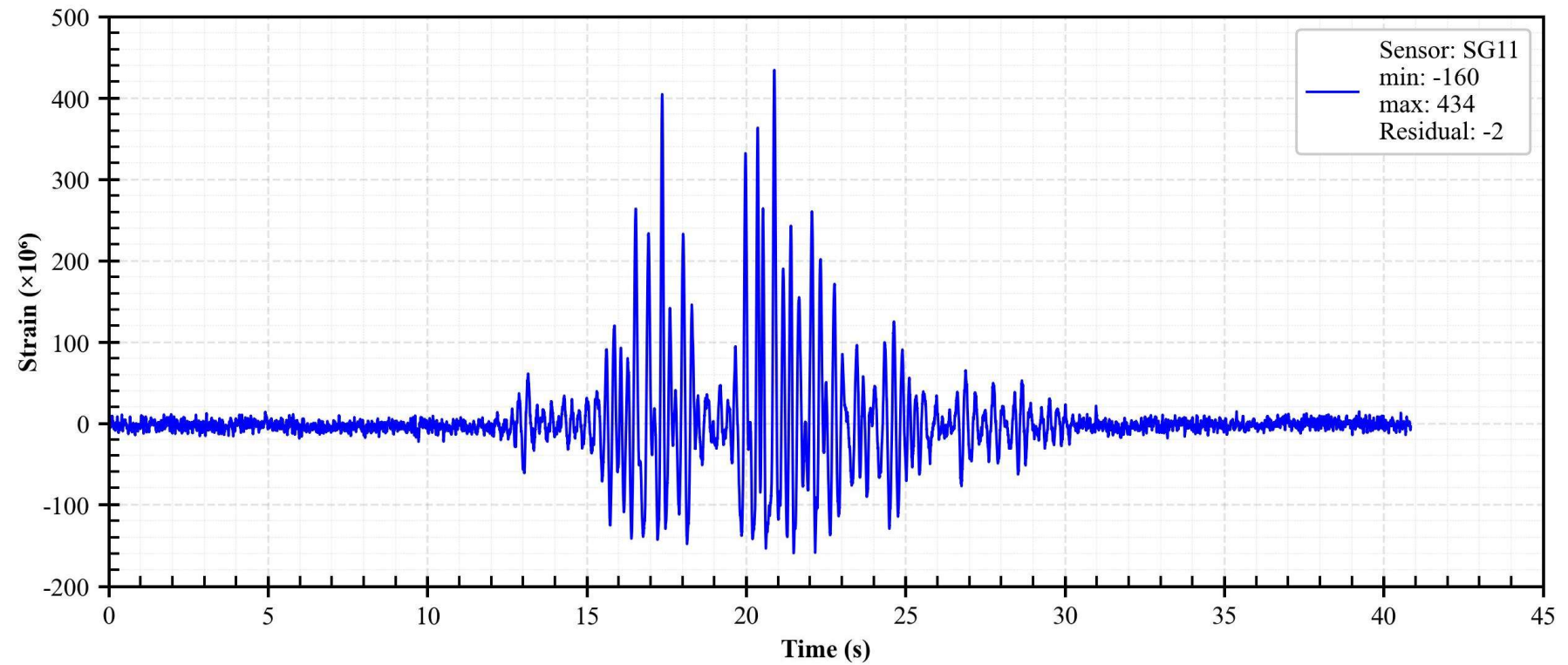


Figure 3.13.24 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 11

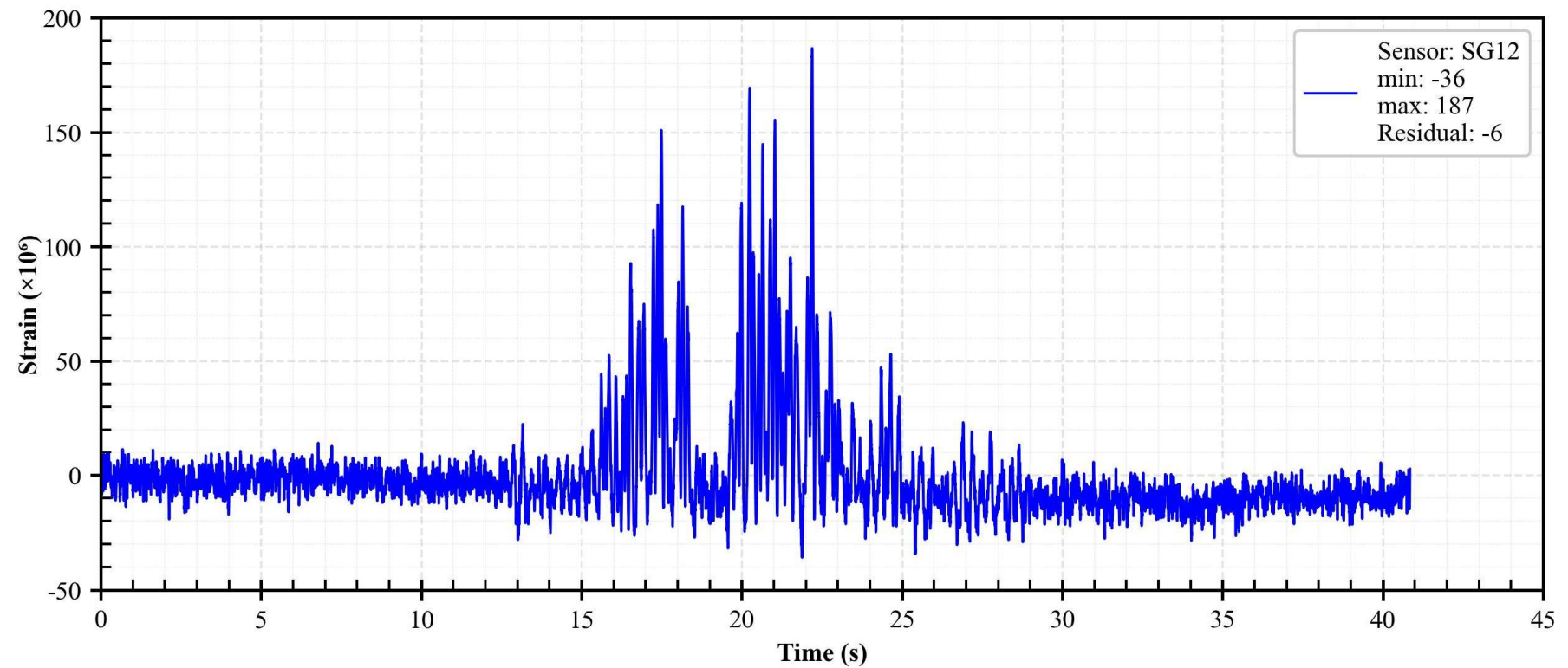


Figure 3.13.25 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 12

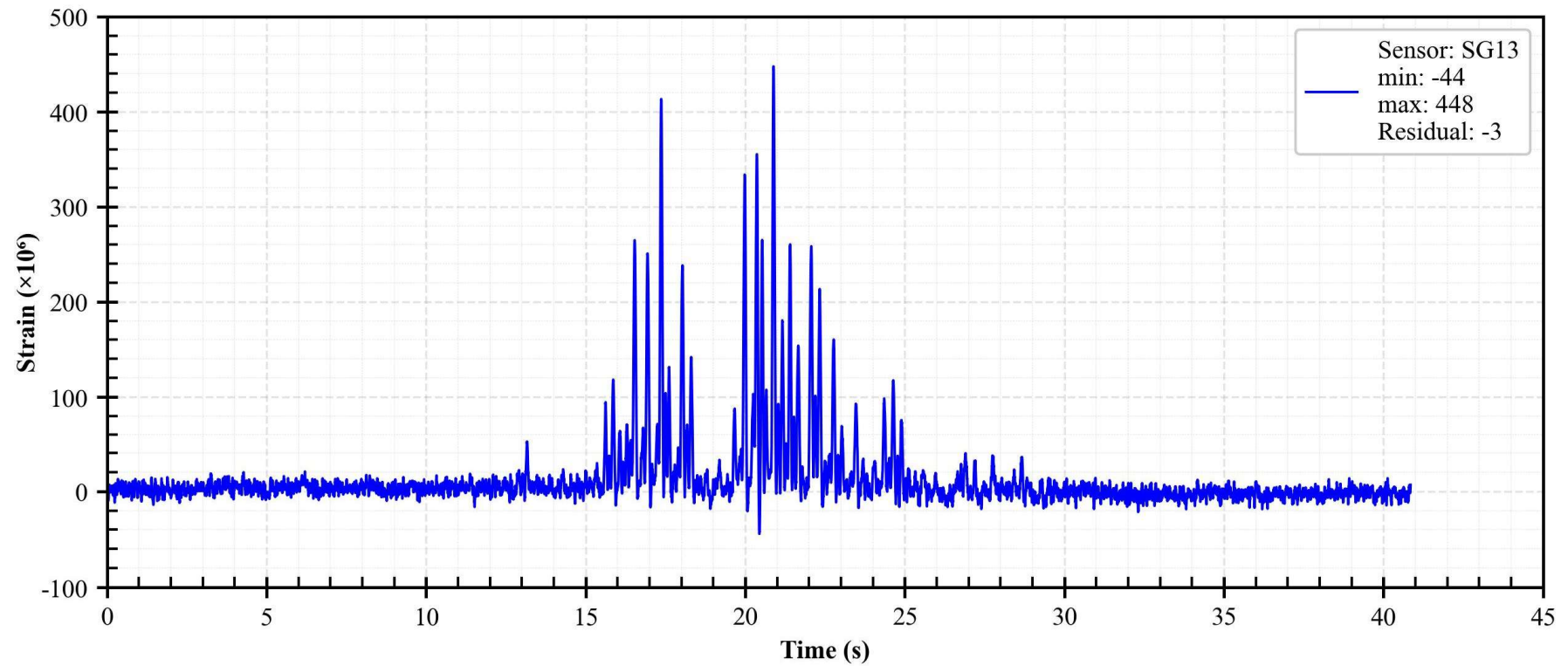


Figure 3.13.26 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 13

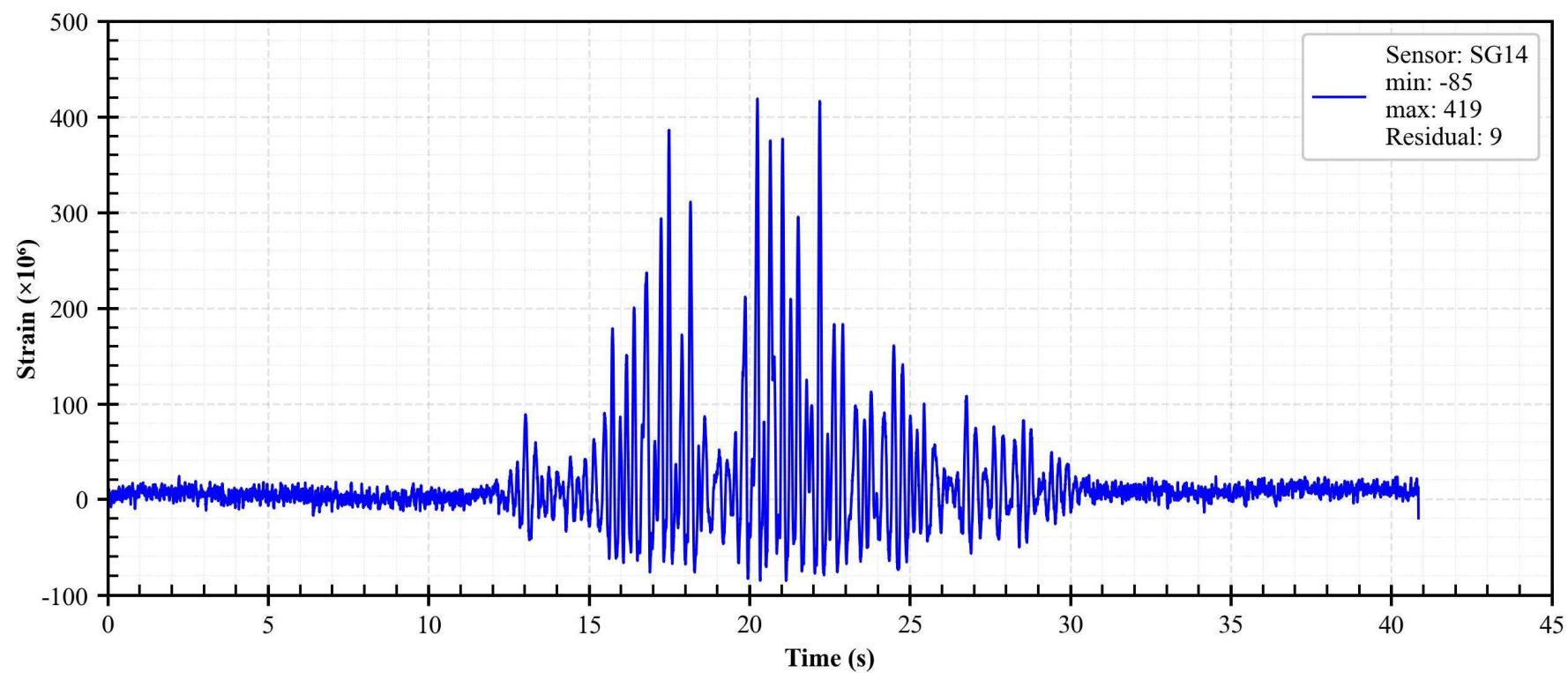


Figure 3.13.27 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 14

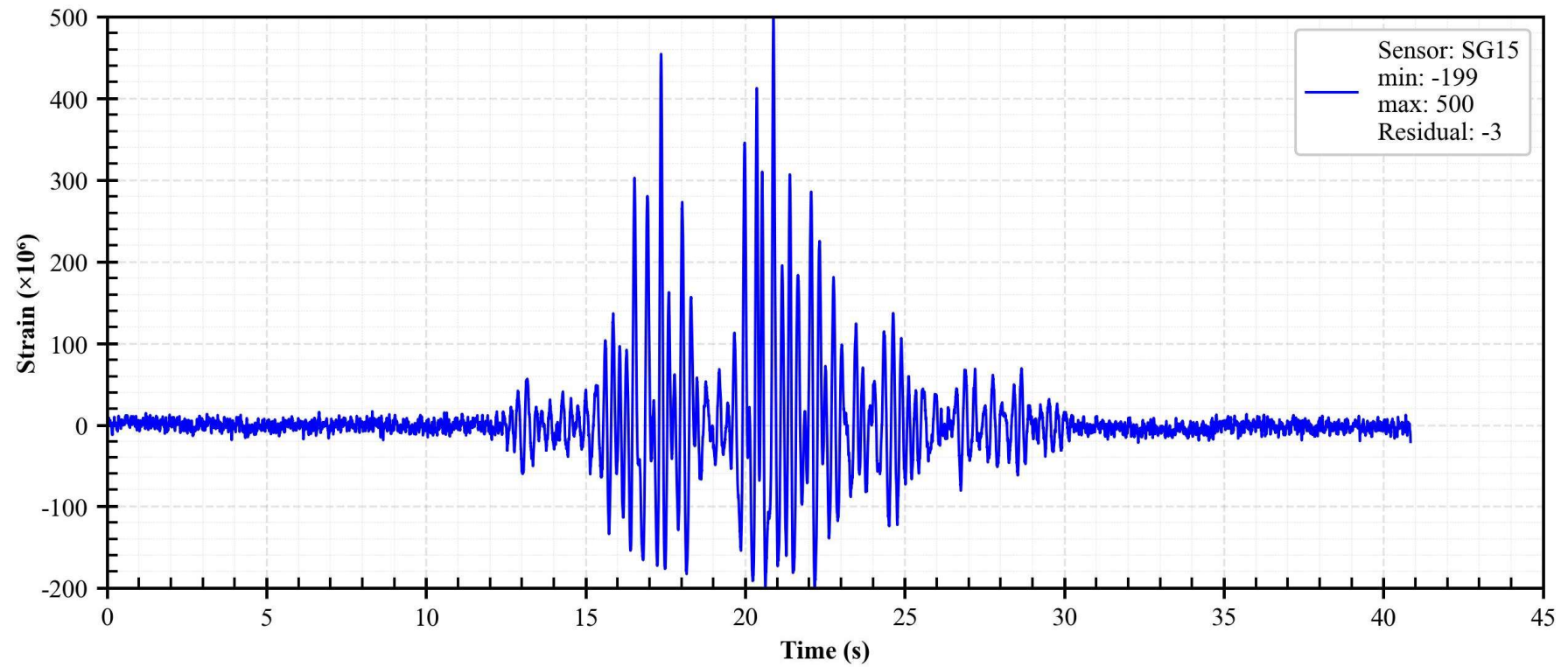


Figure 3.13.28 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 15

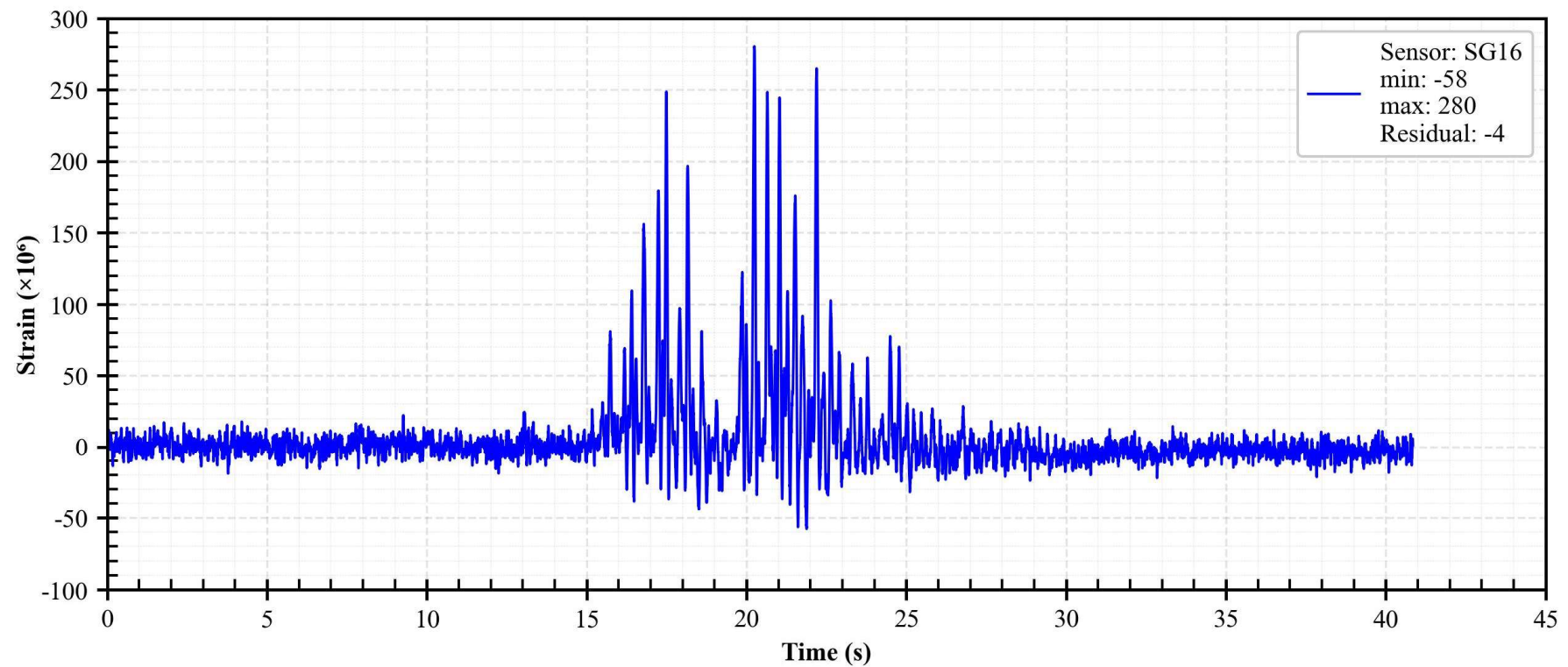


Figure 3.13.29 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 16

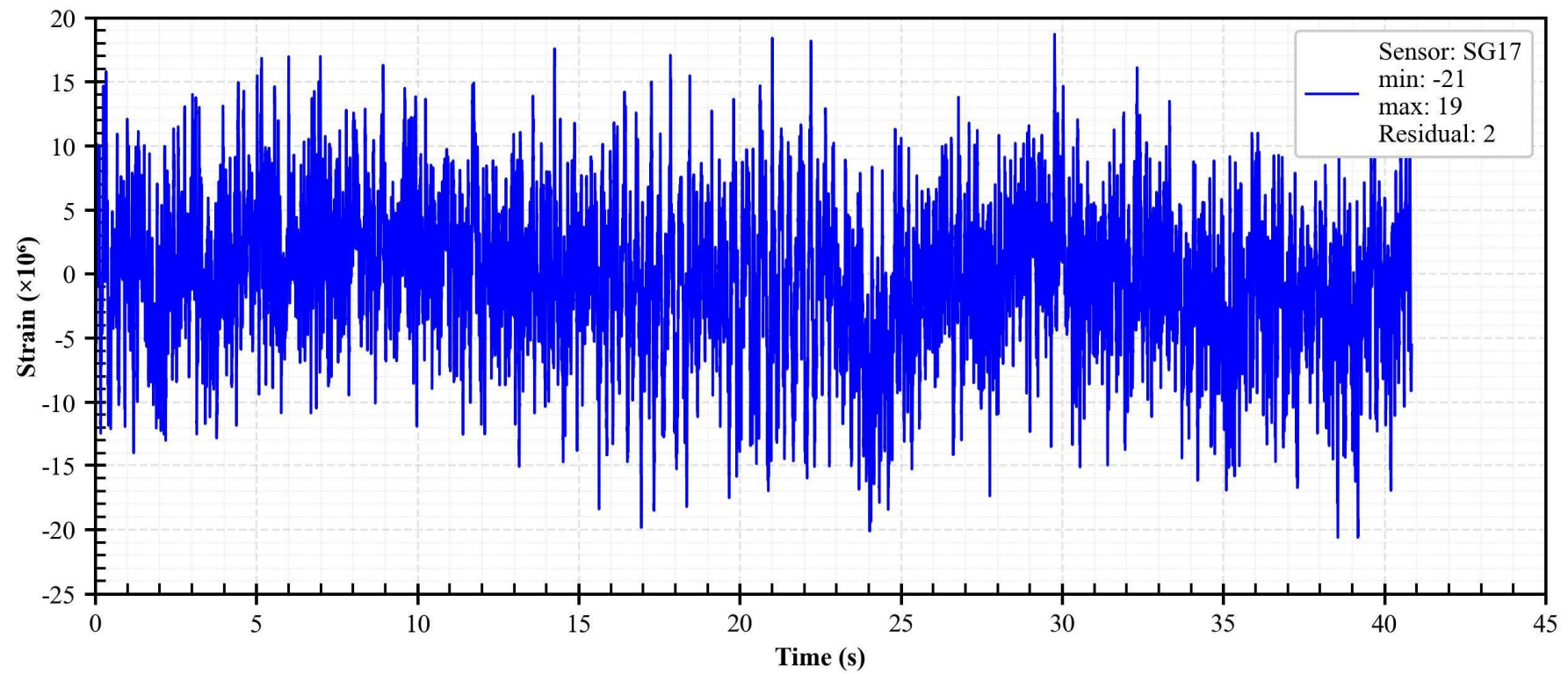


Figure 3.13.30 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 17

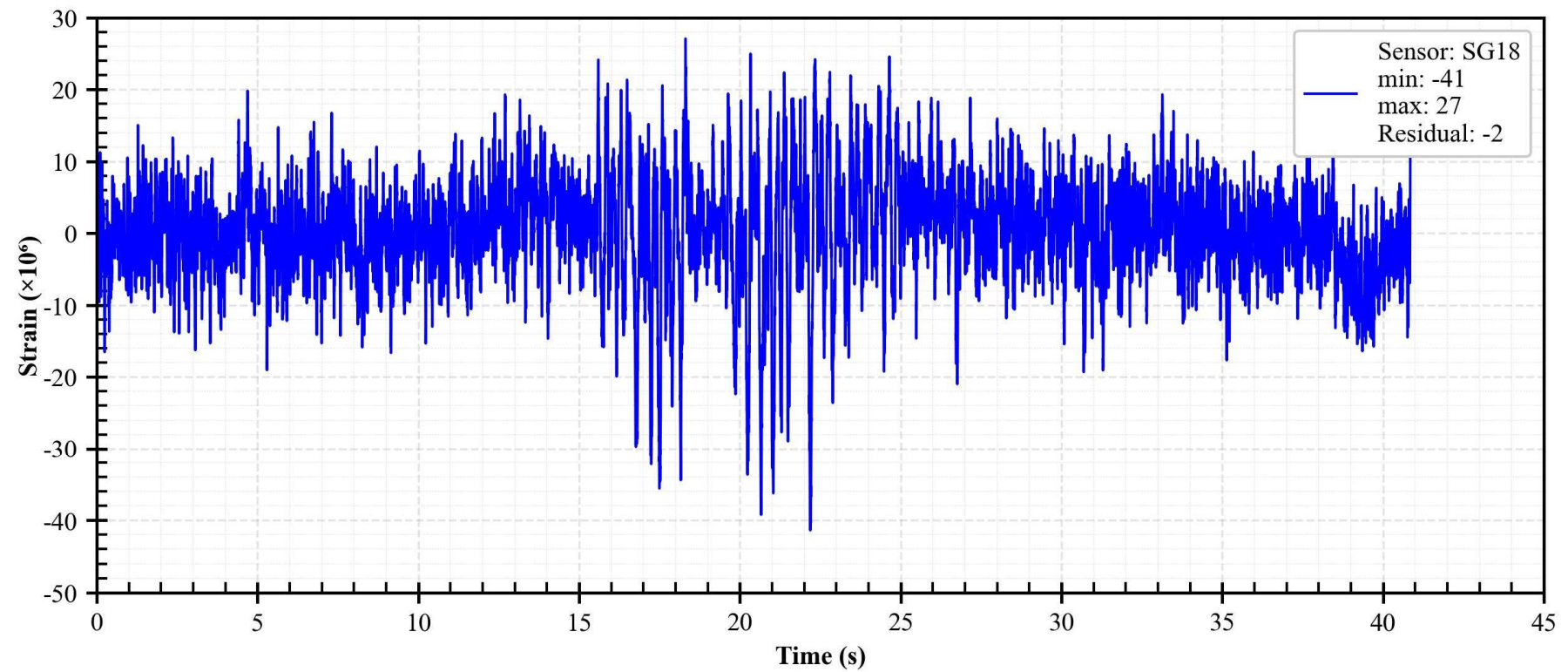


Figure 3.13.31 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 18

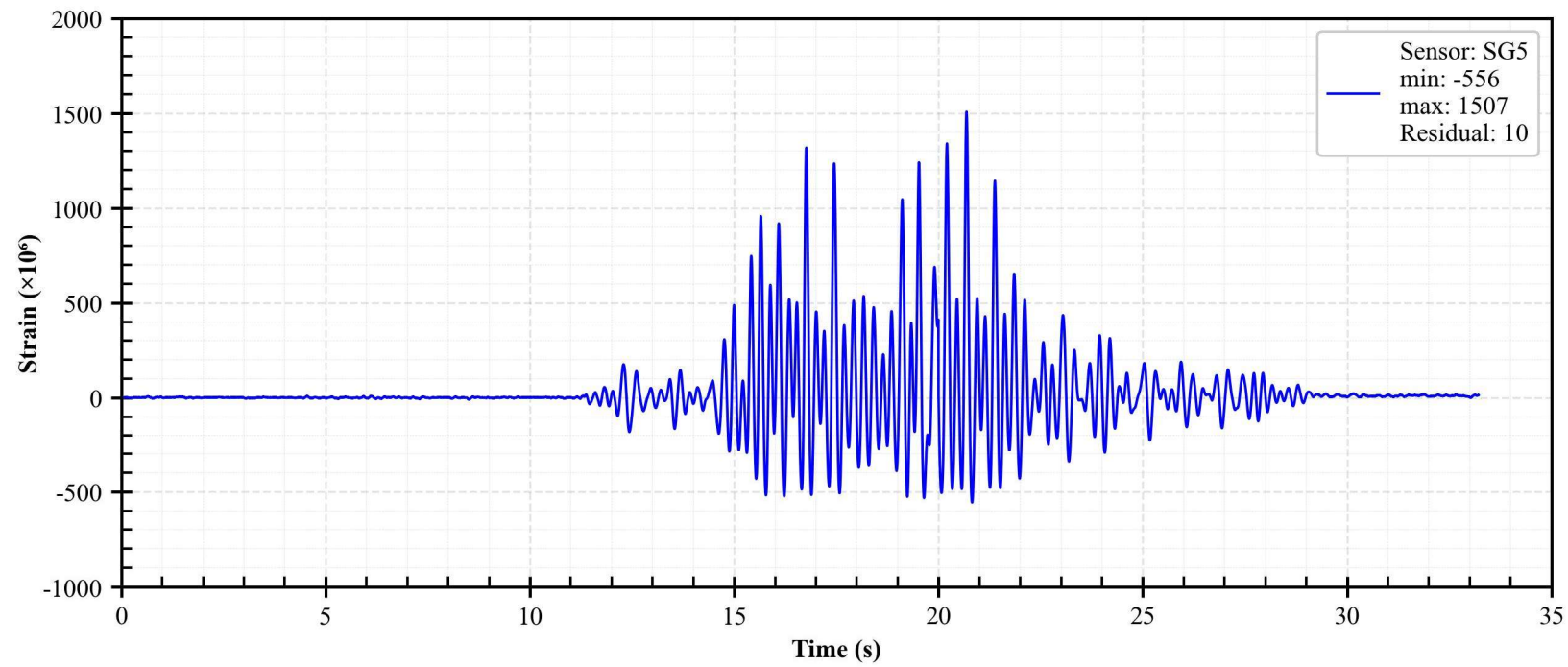


Figure 3.13.32 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 5

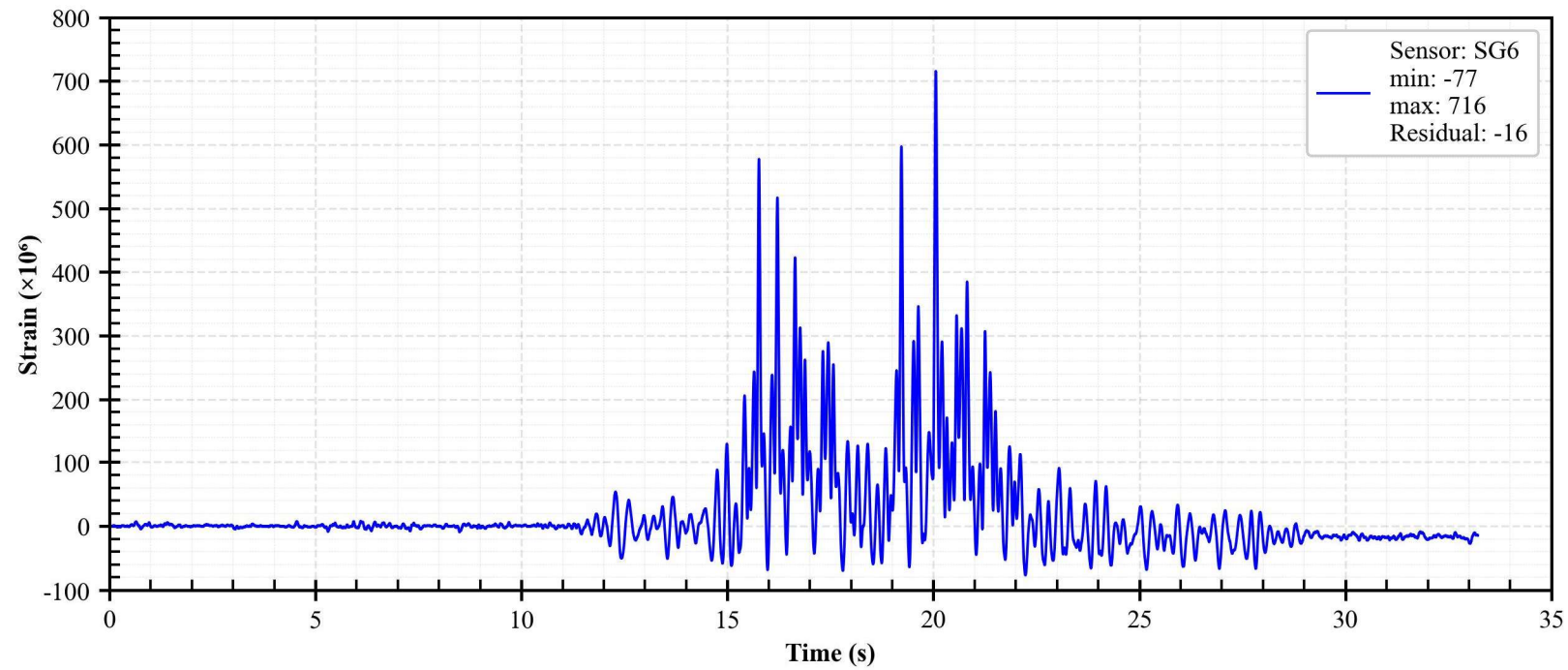


Figure 3.13.33 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 6

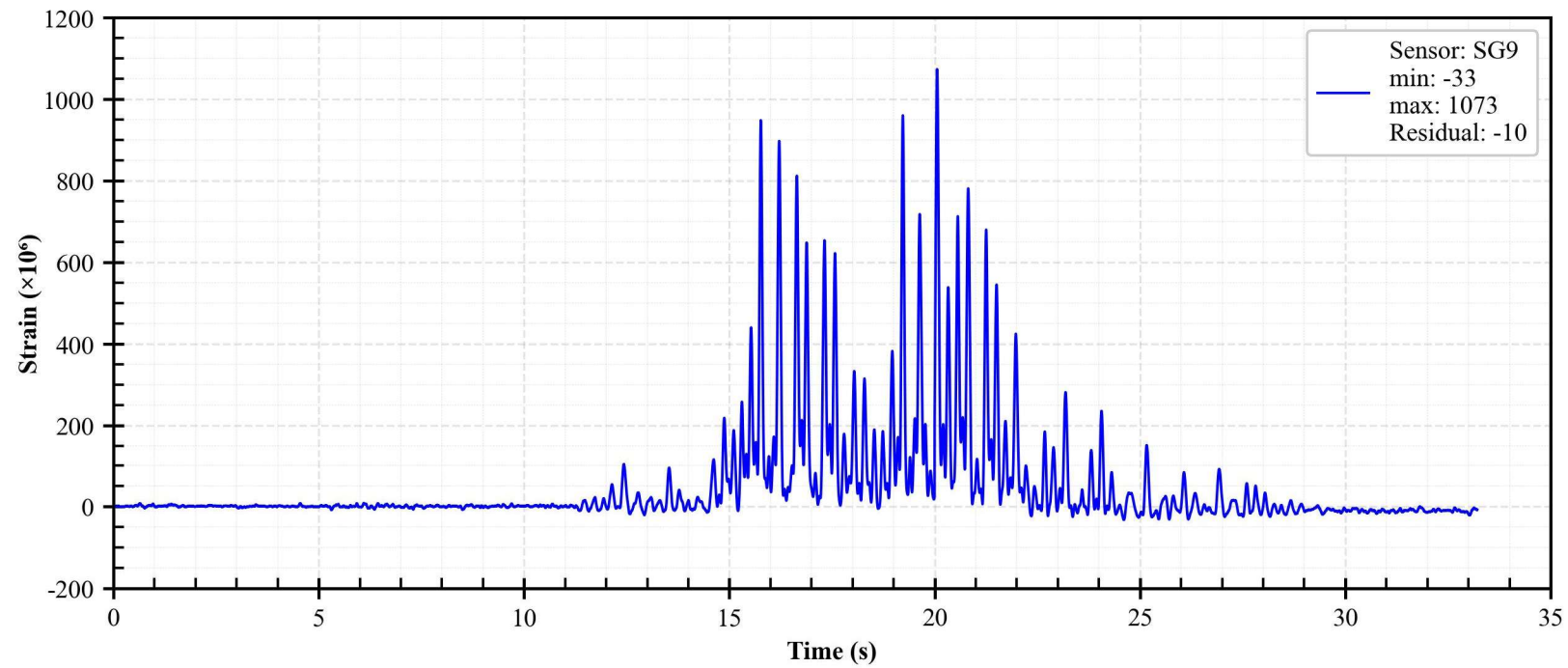


Figure 3.13.34 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 9

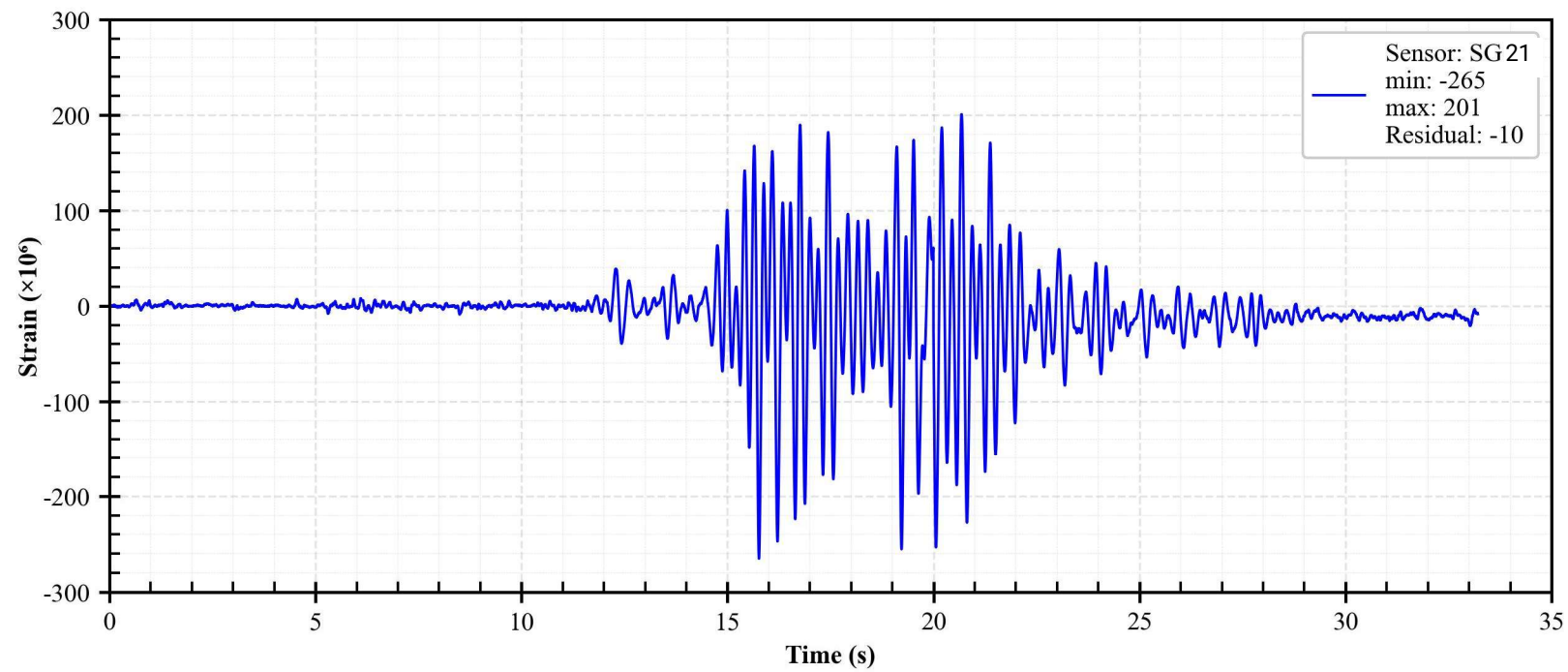


Figure 3.13.35 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 21 (PUFJ, column 1)

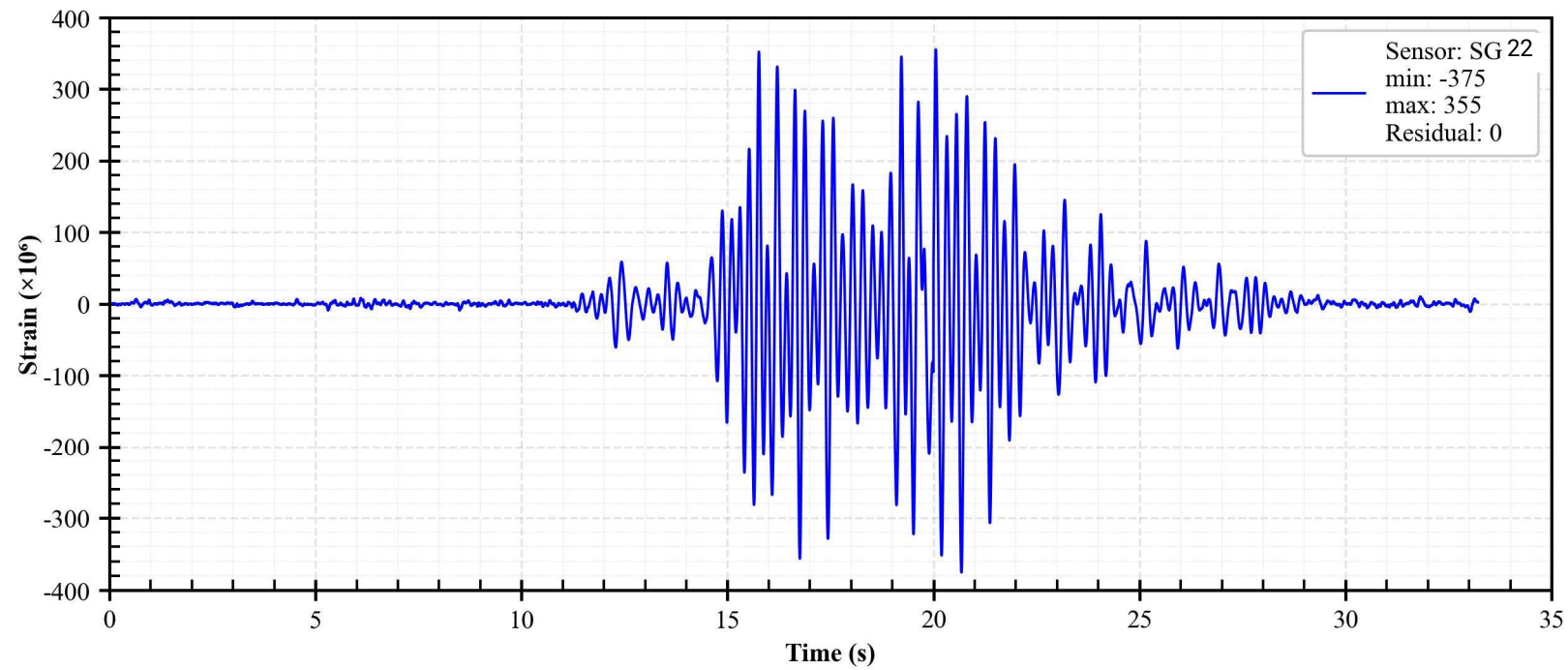


Figure 3.13.36 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 22 (PUFJ, column 2)

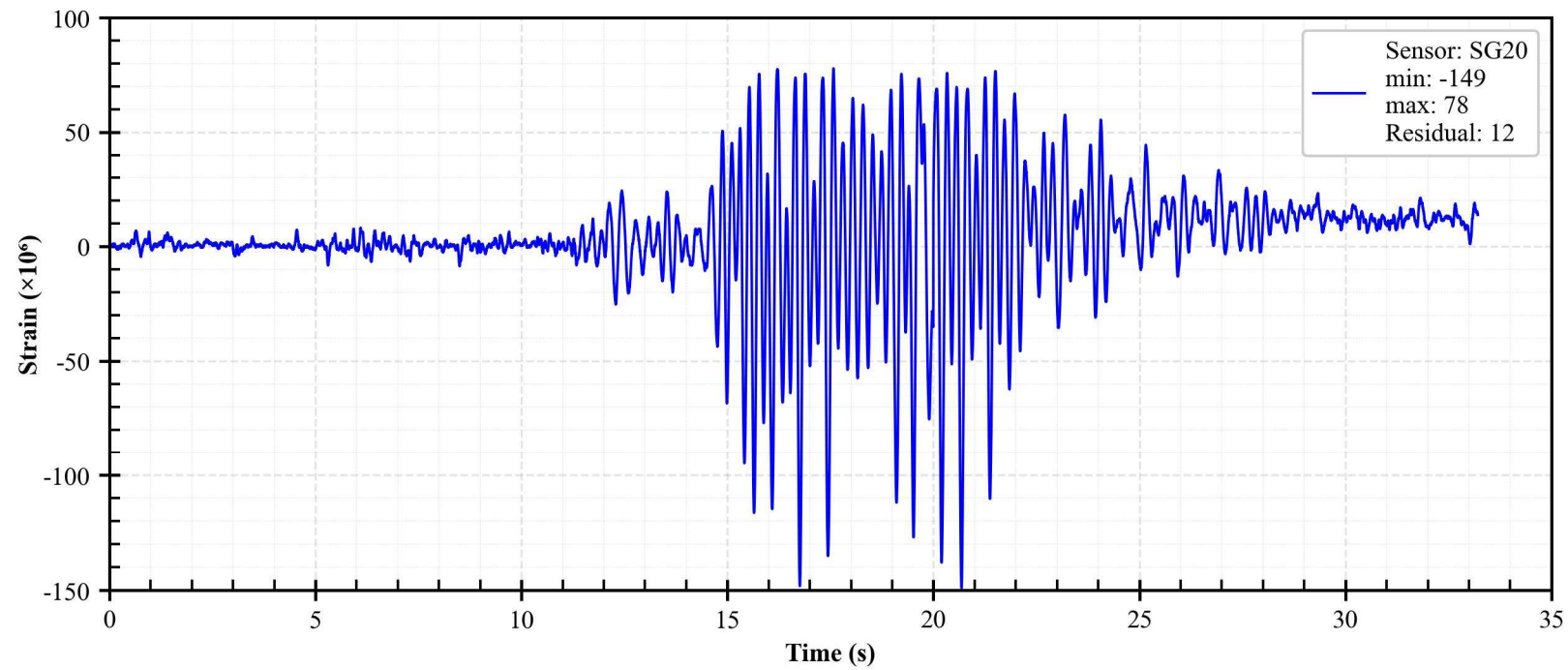


Figure 3.13.37 Characteristic results for phase B (earthquake EQ0,55g): strain gauge 20

3.14 White noise before EQ0,74g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,74g. The max acceleration at the slab level on the accelerometer acc4 is 0.20g. The max acceleration at the foundation level on the accelerometer acc10 is 0.07g.

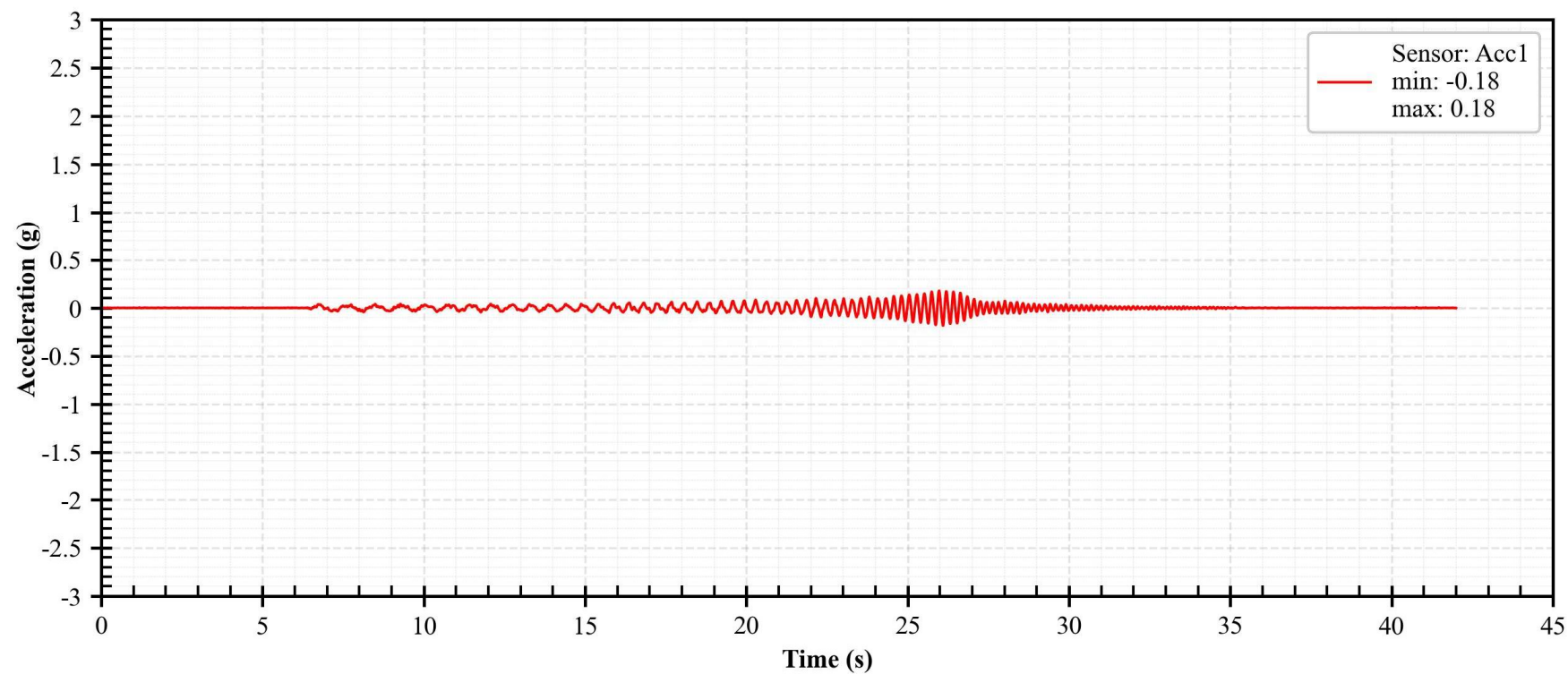


Figure 3.14.1 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 1

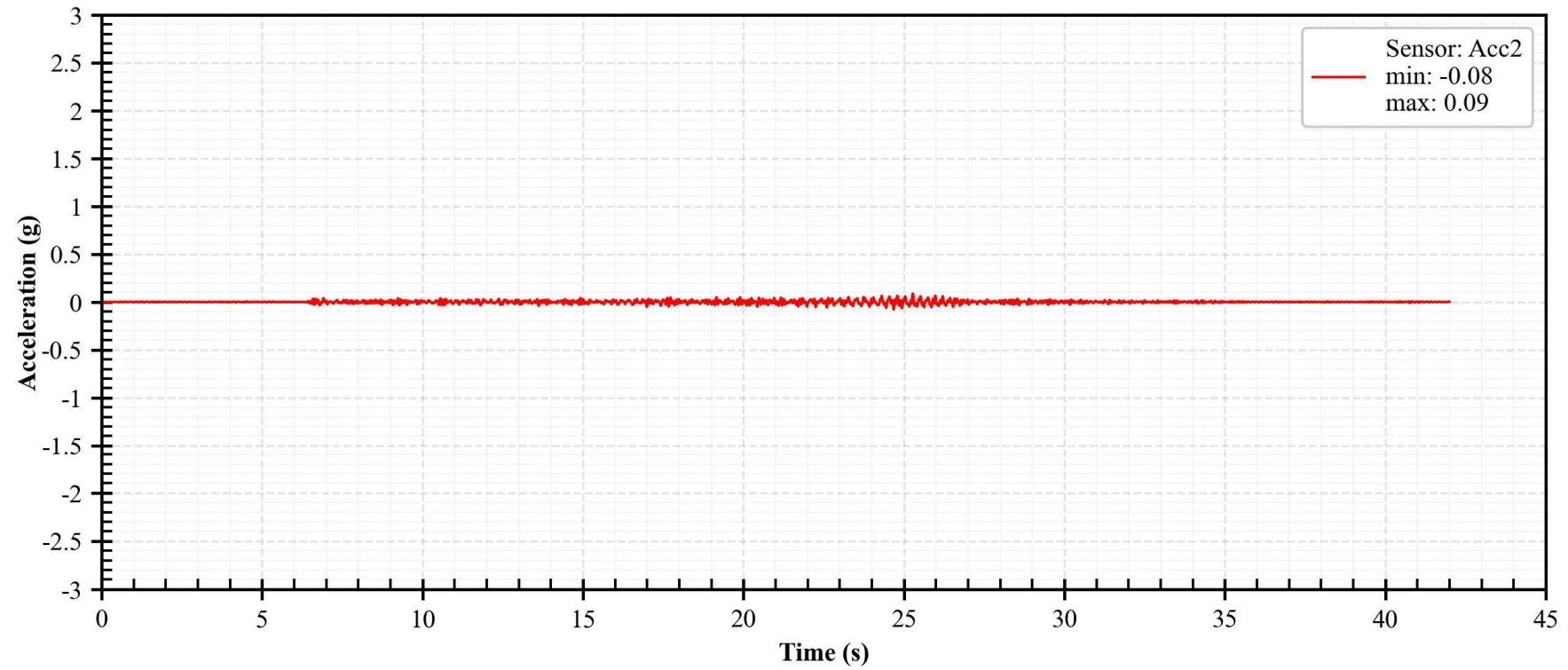


Figure 3.14.2 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 2

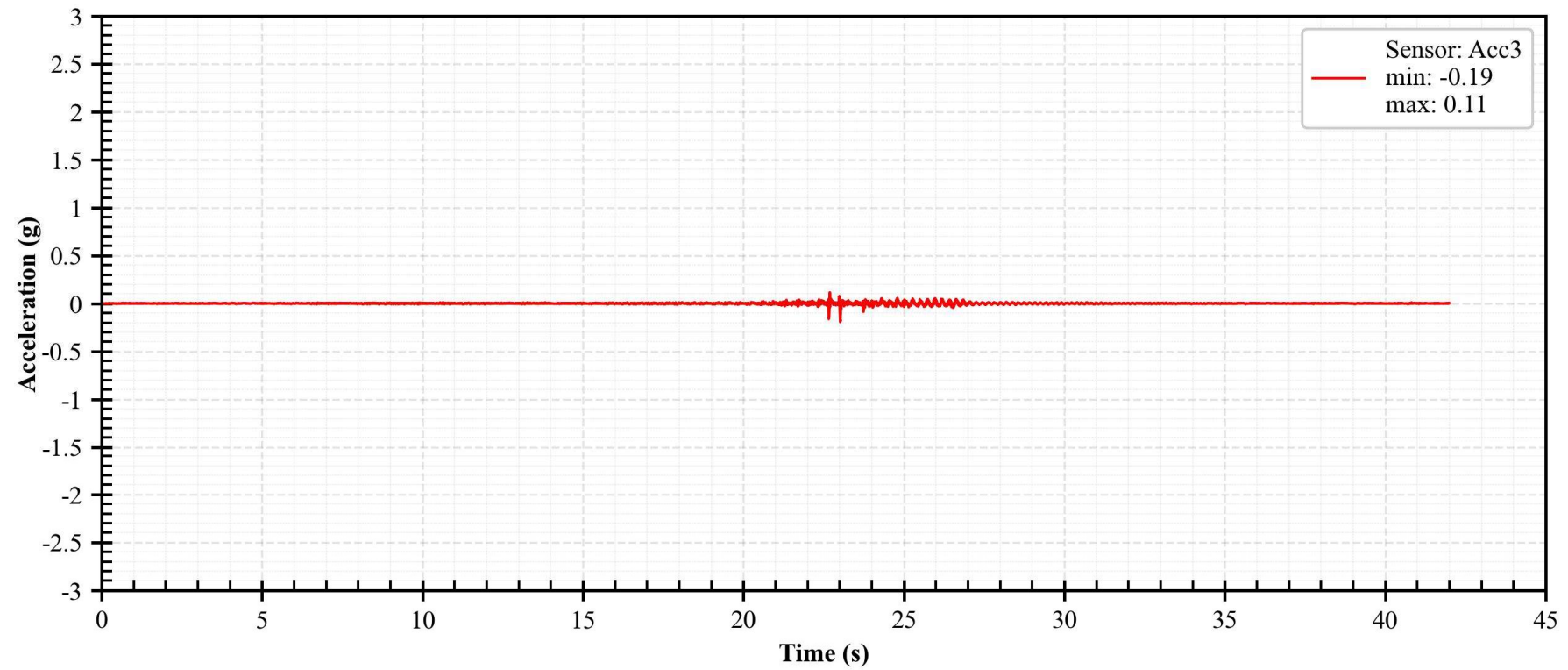


Figure 3.14.3 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 3

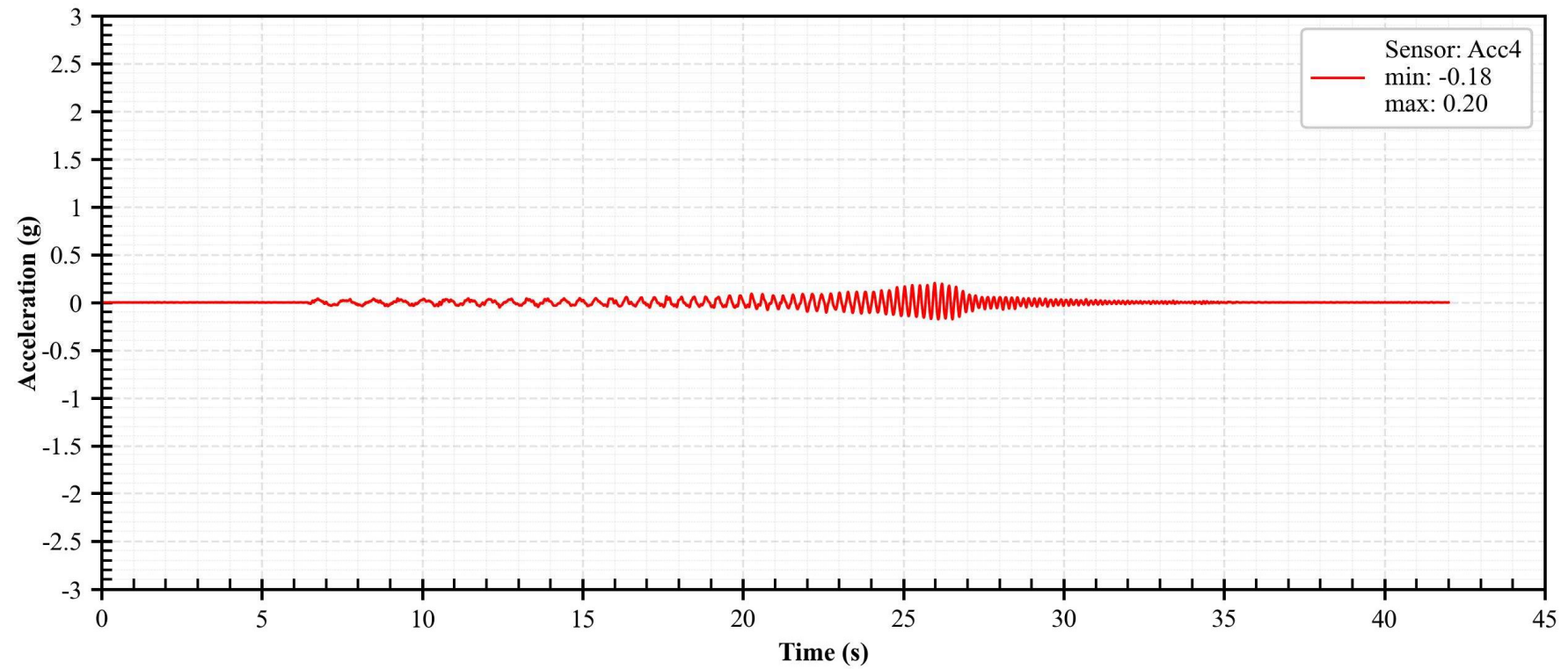


Figure 3.14.4 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 4

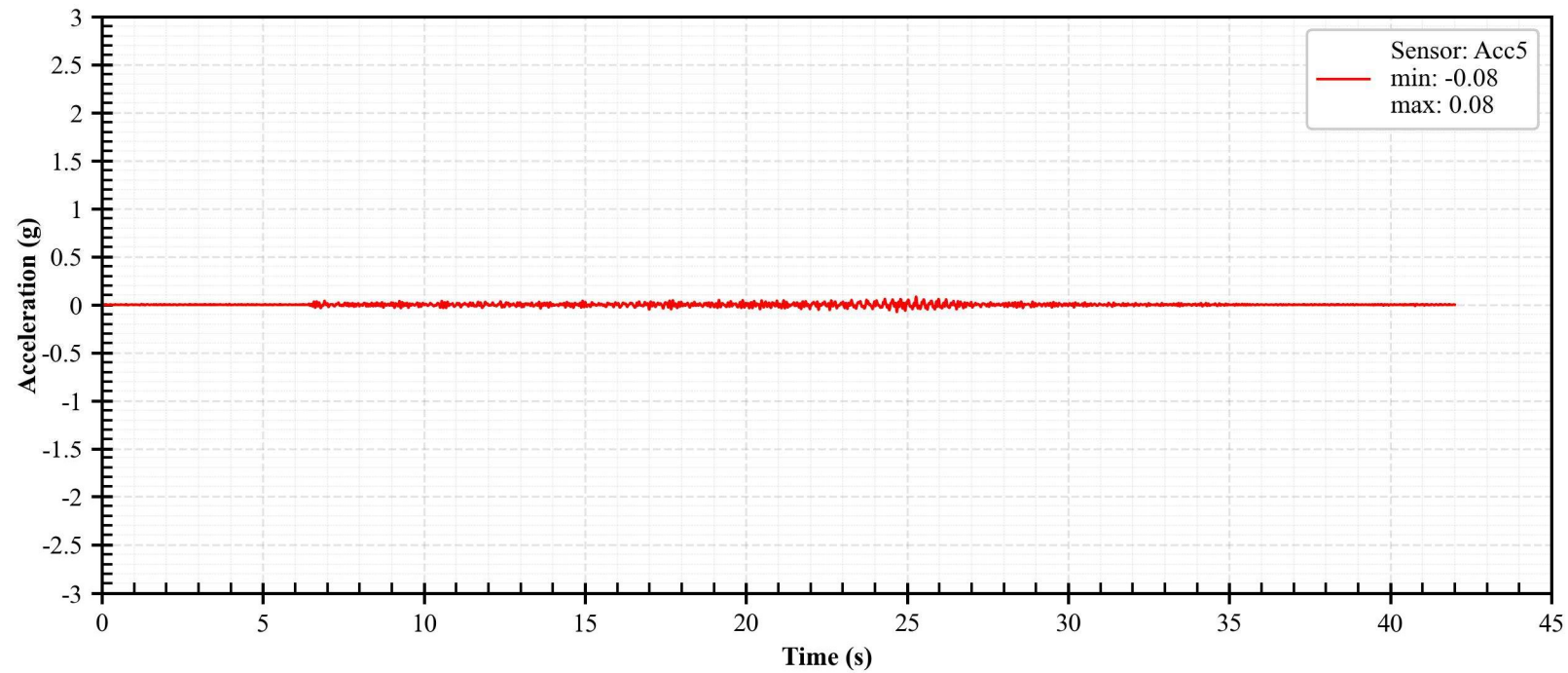


Figure 3.14.5 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 5

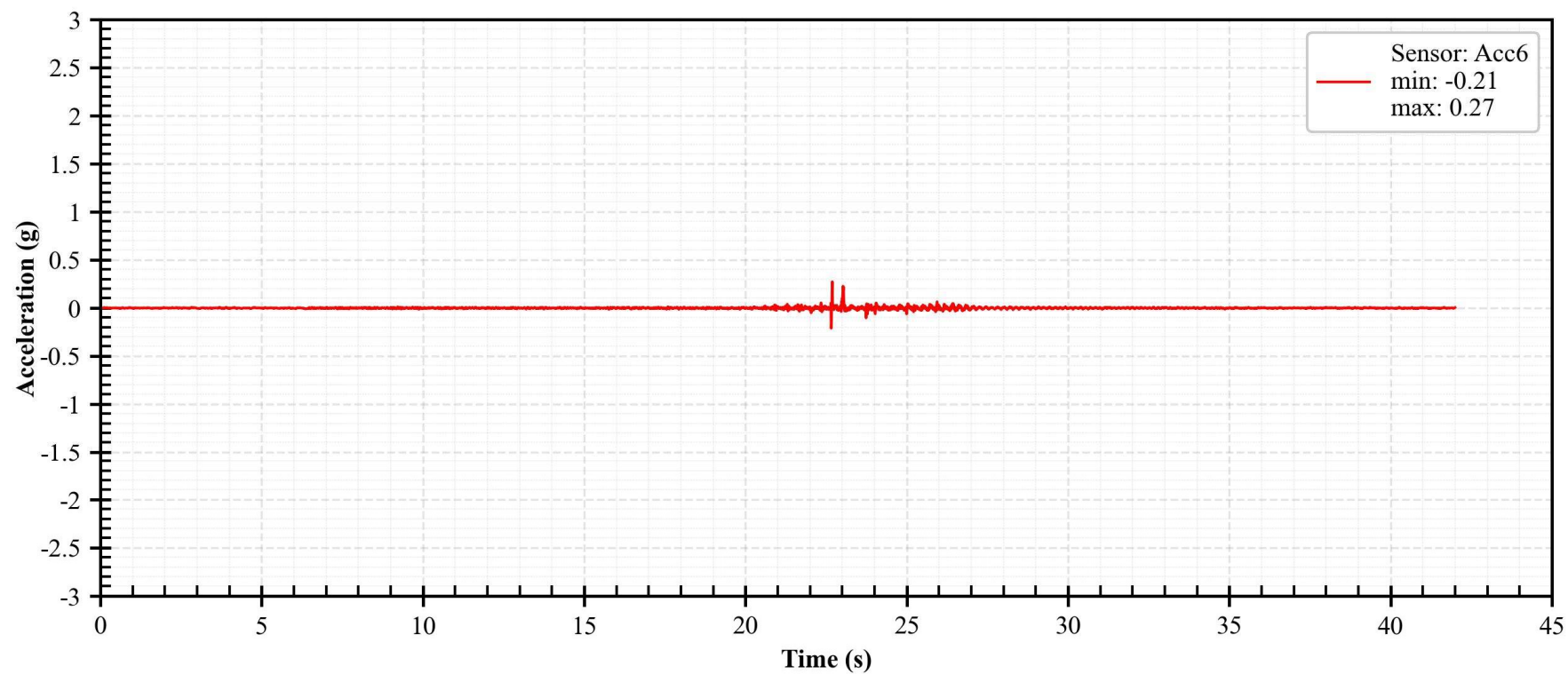


Figure 3.14.6 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 6

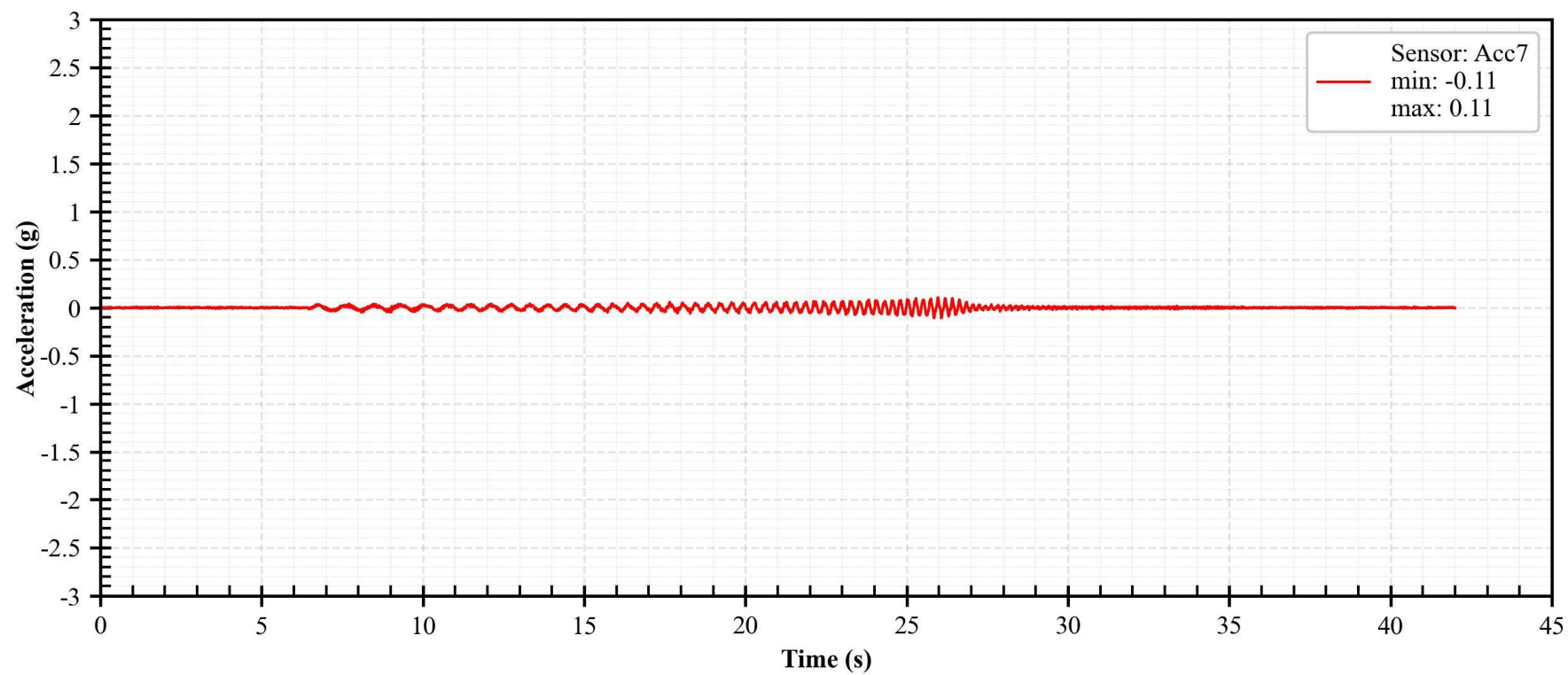


Figure 3.14.7 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 7

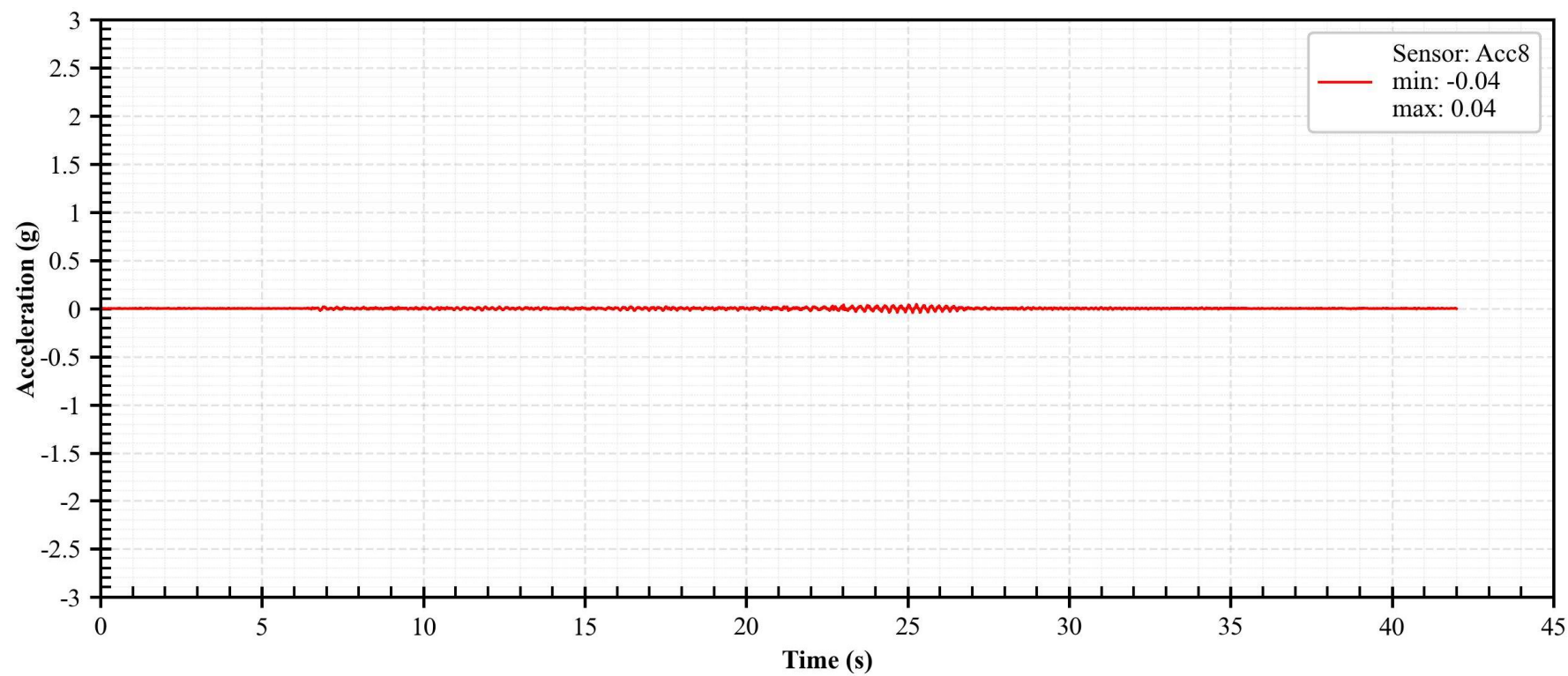


Figure 3.14.8 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 8

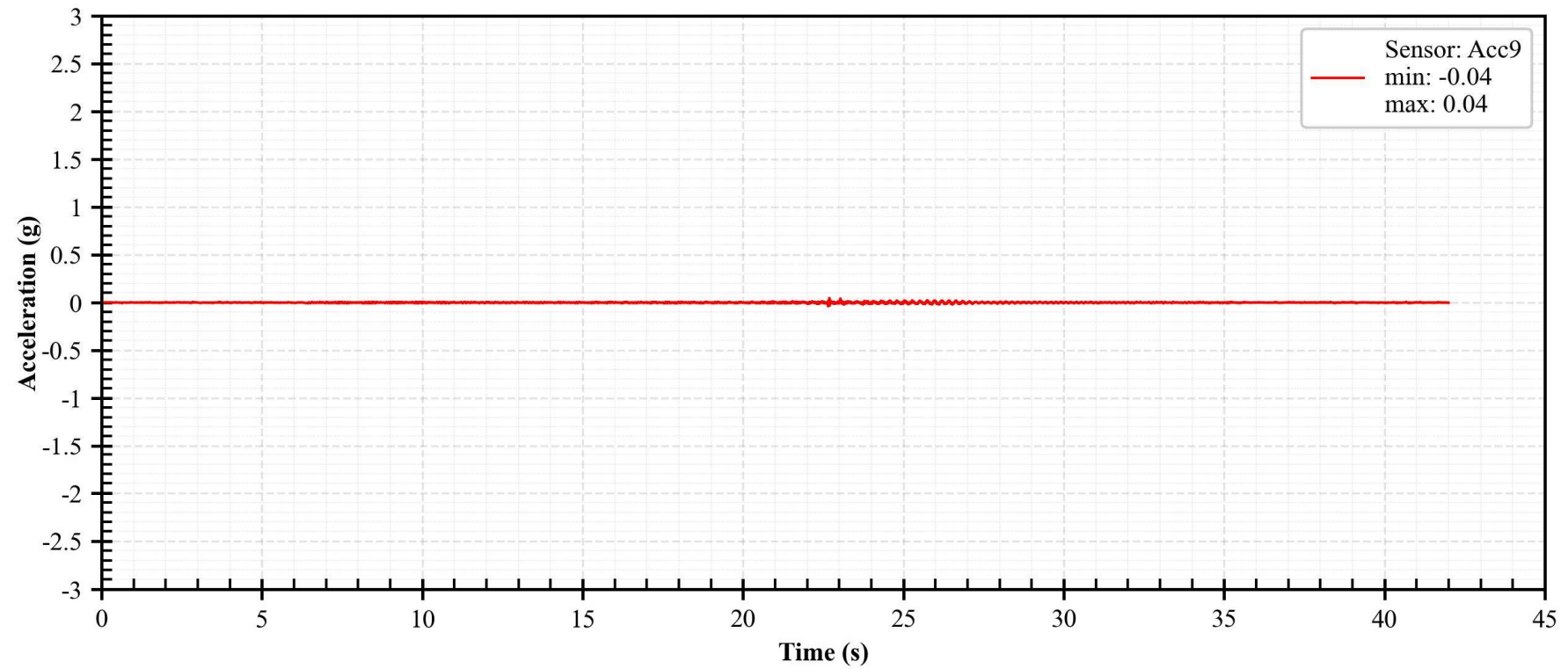


Figure 3.14.9 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 9

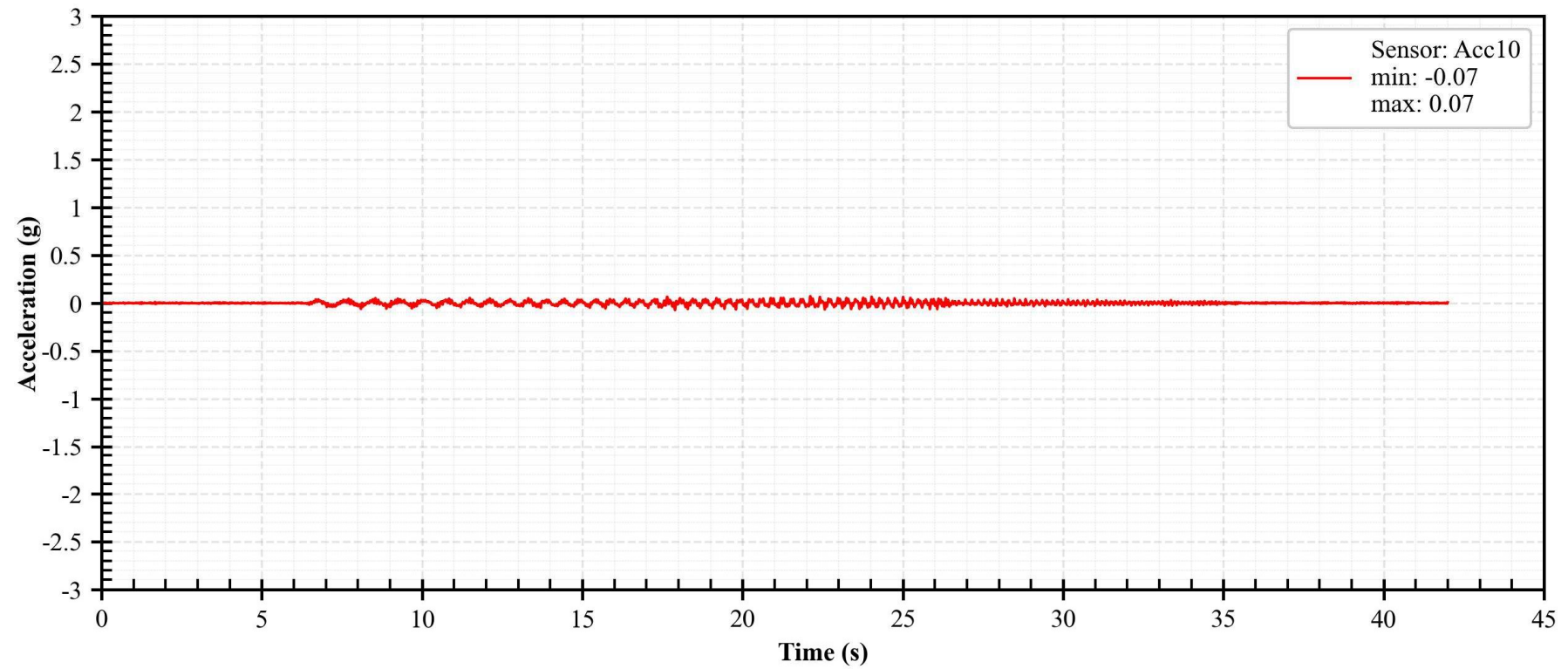


Figure 3.14.10 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 10

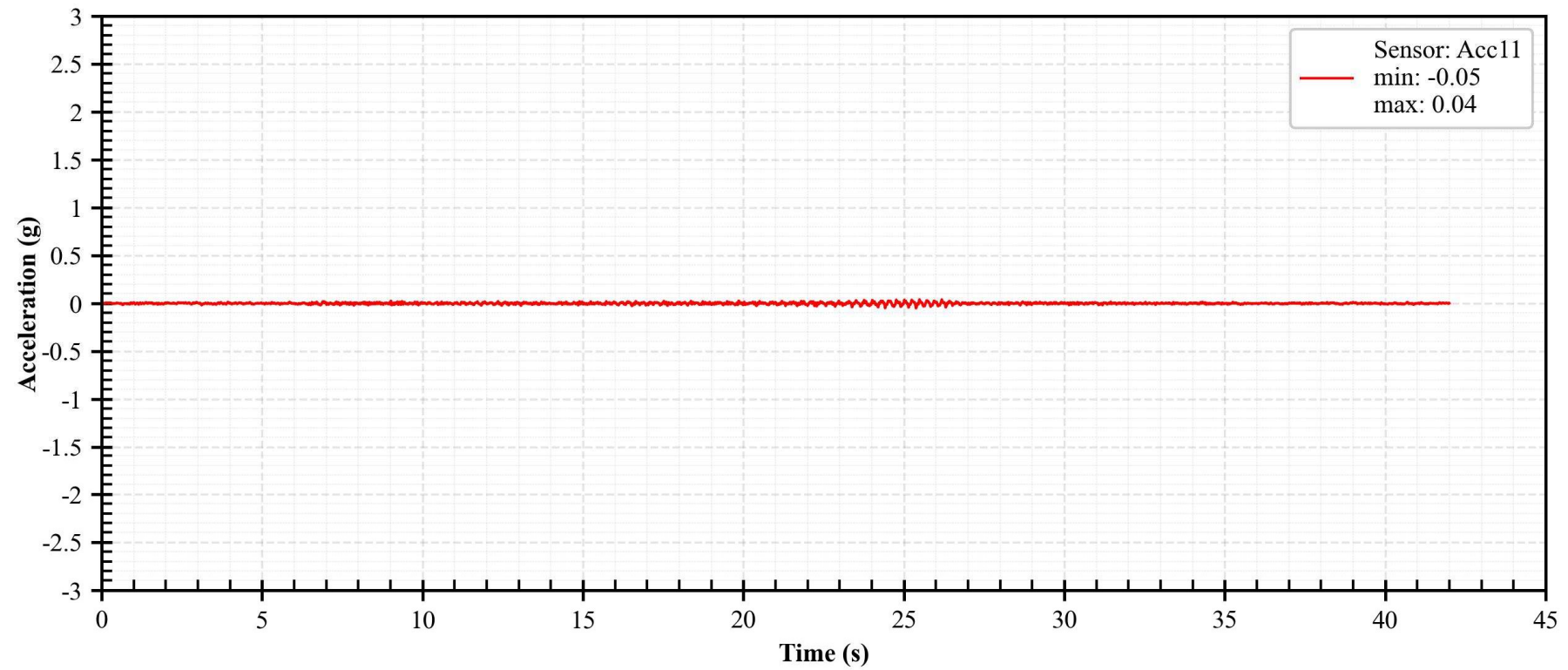


Figure 3.14.11 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 11

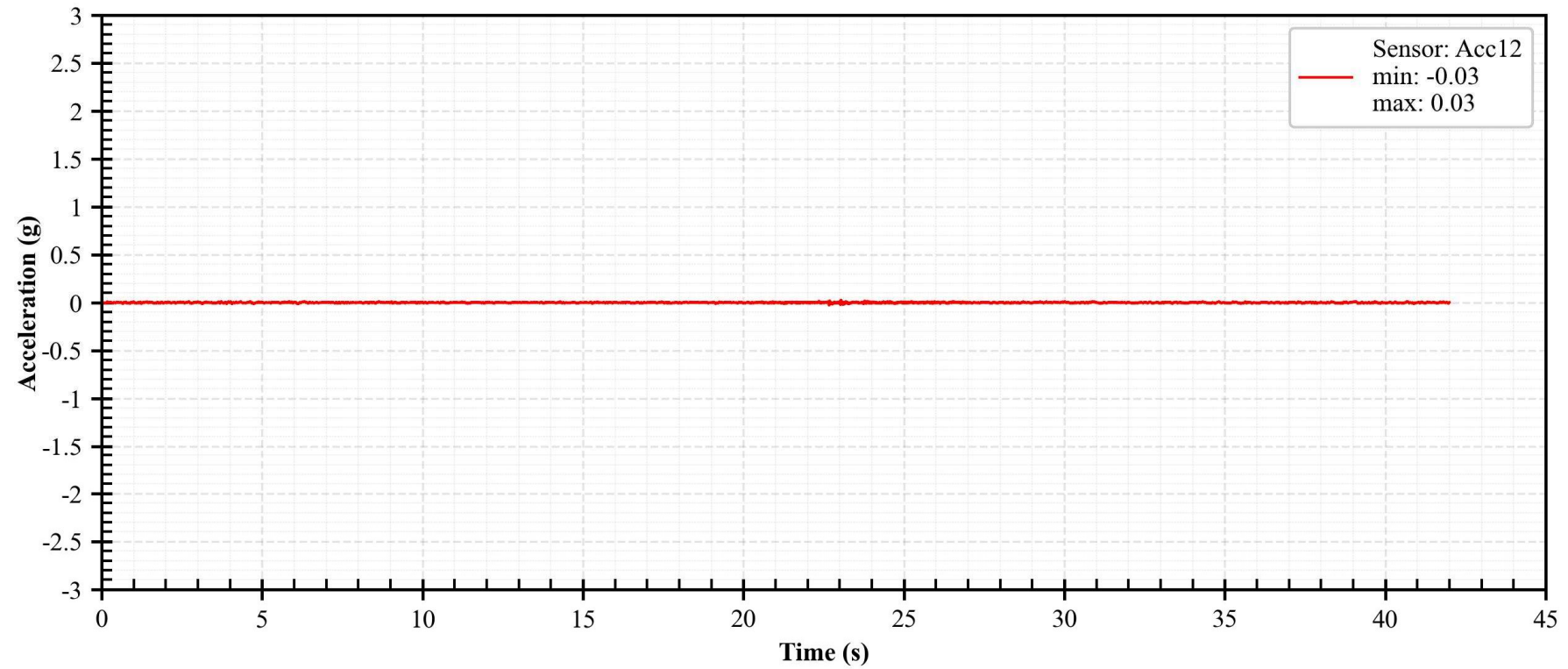


Figure 3.14.12 Characteristic results for phase B (white noise before EQ0,74g): Accelerometer 12

Draw wire sensors

Figures 3.14.13 – 3.14.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.02 mm while the minimum is -16.39 mm. The maximum movement detected by draw wire sensor W2 is 21.24 mm while the minimum is -16.43 mm. The maximum movement detected by draw wire sensor W3 is 21.13 mm while the minimum is -16.27 mm. The maximum movement detected by draw wire sensor W4 is 21.29 mm while the minimum is -16.24 mm. The maximum drift is $(1.73/1.225) = 1.41 \text{ ‰}$ and minimum drift is $(-1.92/1.225) = -1.57 \text{ ‰}$.

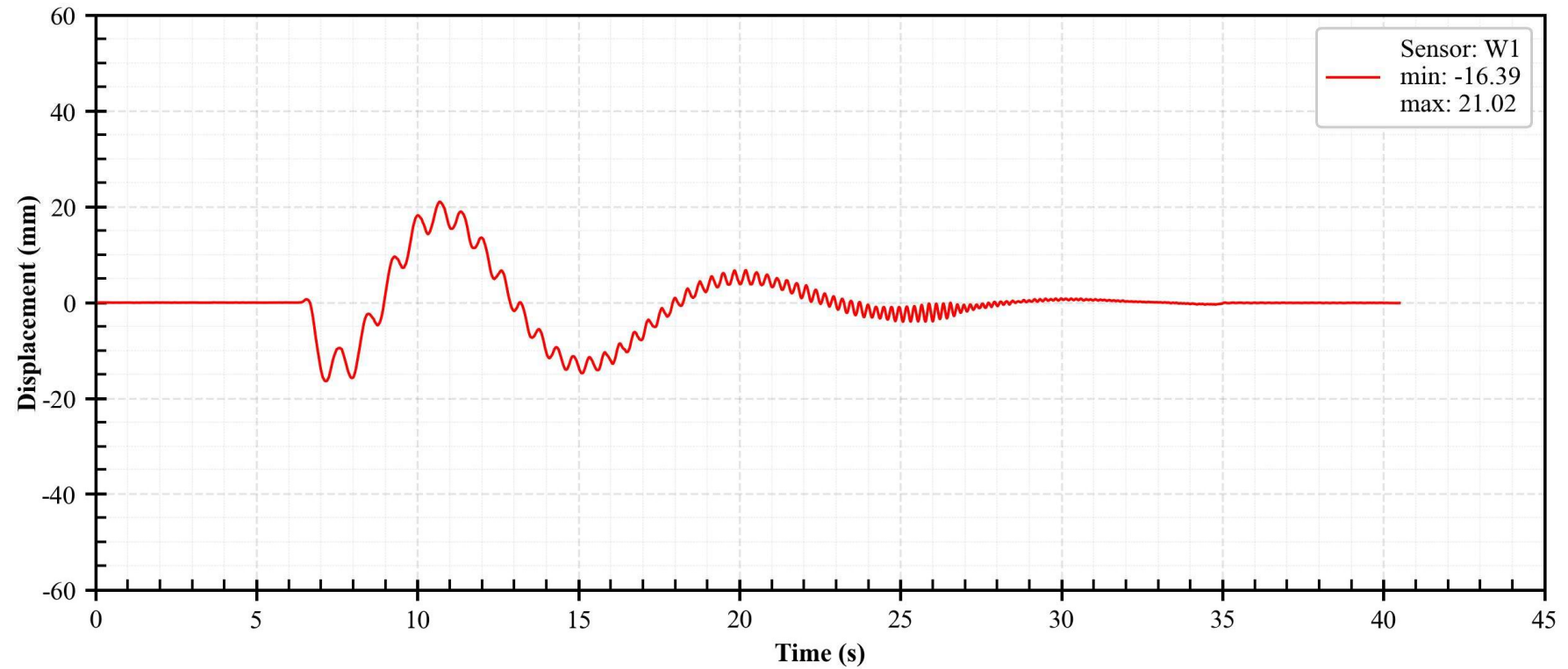


Figure 3.14.13 Characteristic results for phase B (white noise before EQ0,74g): Draw wire sensor 1

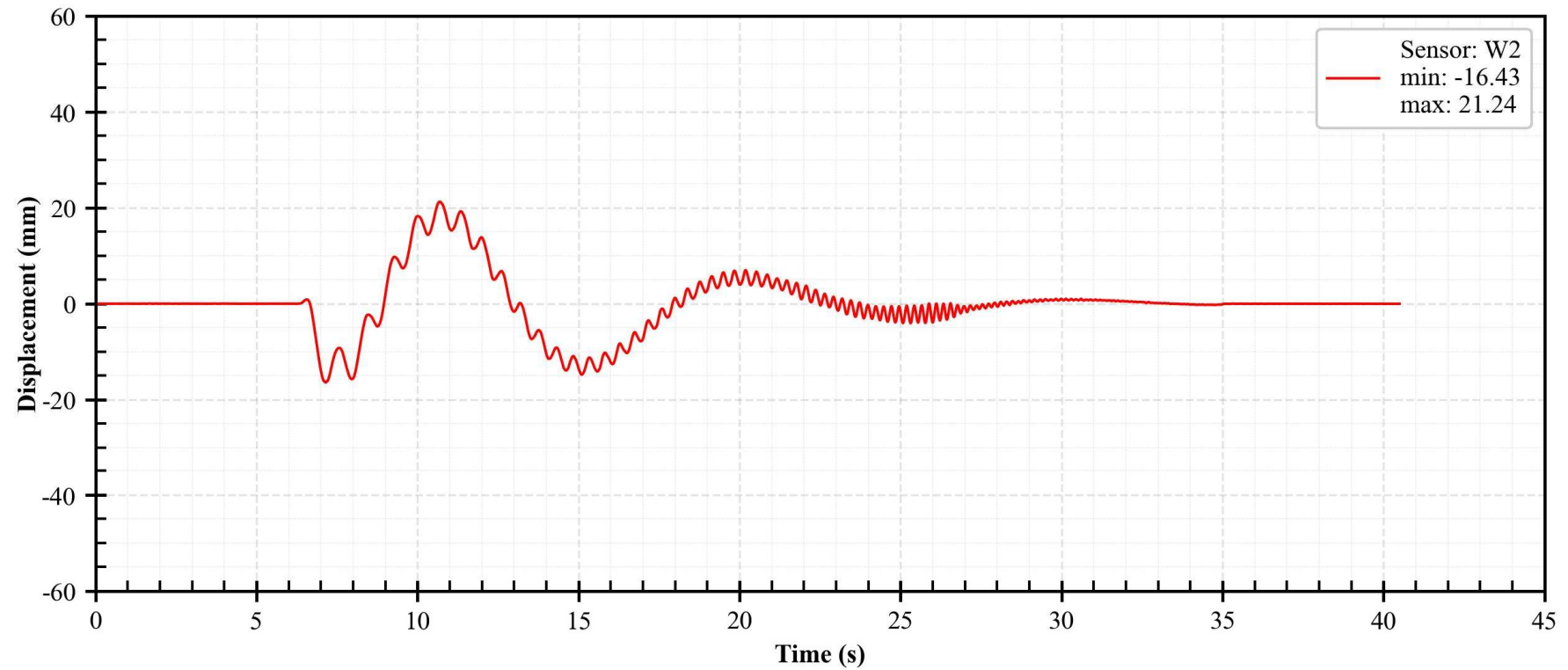


Figure 3.14.14 Characteristic results for phase B (white noise before EQ0,74g): Draw wire sensor 2

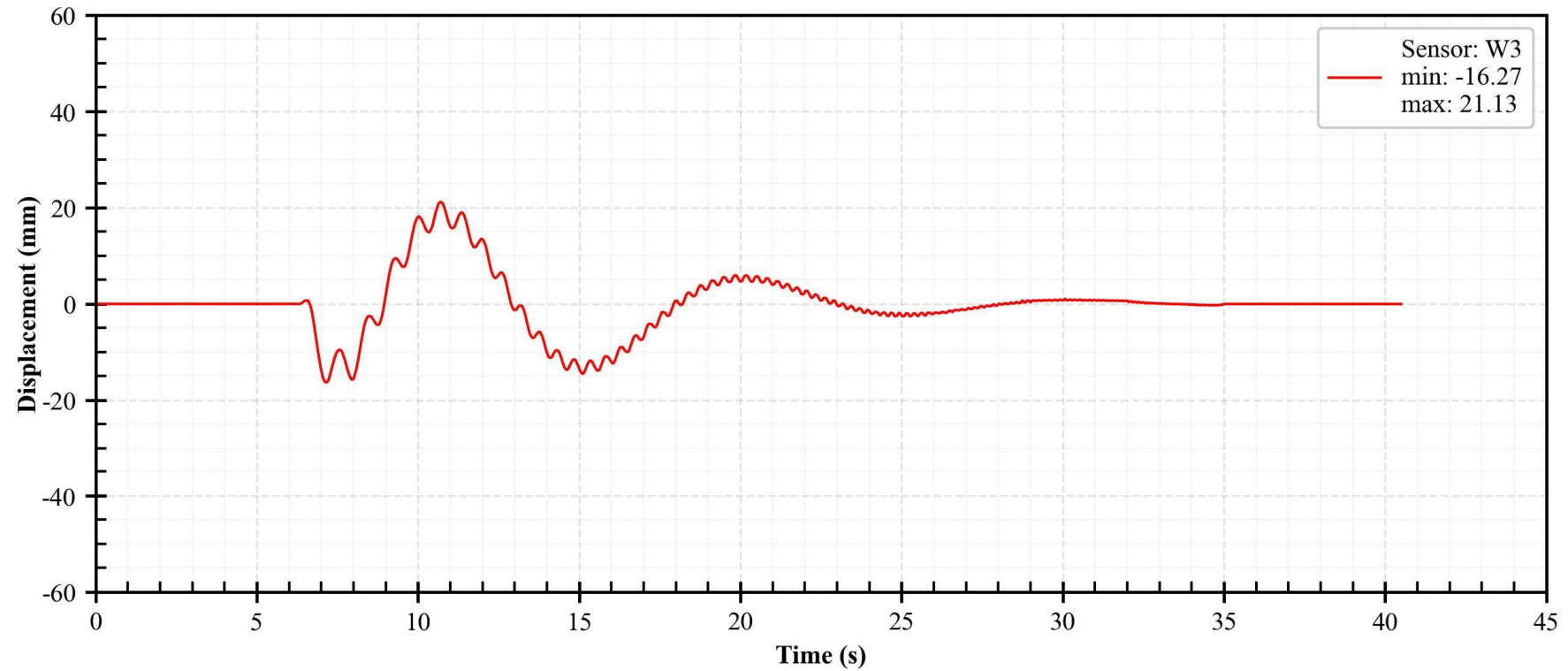


Figure 3.14.15 Characteristic results for phase B (white noise before EQ0,74g): Draw wire sensor 3

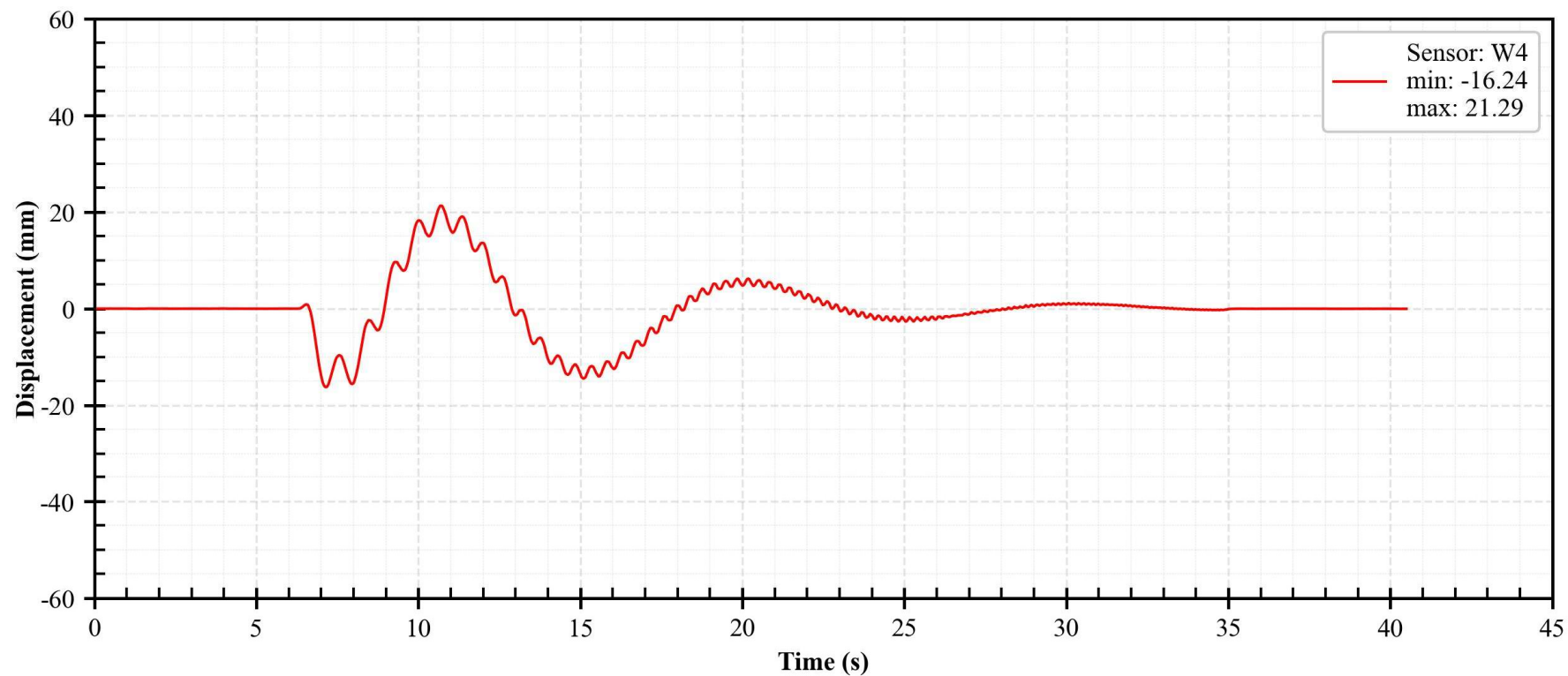


Figure 3.14.16 Characteristic results for phase B (white noise before EQ0,74g): Draw wire sensor 4

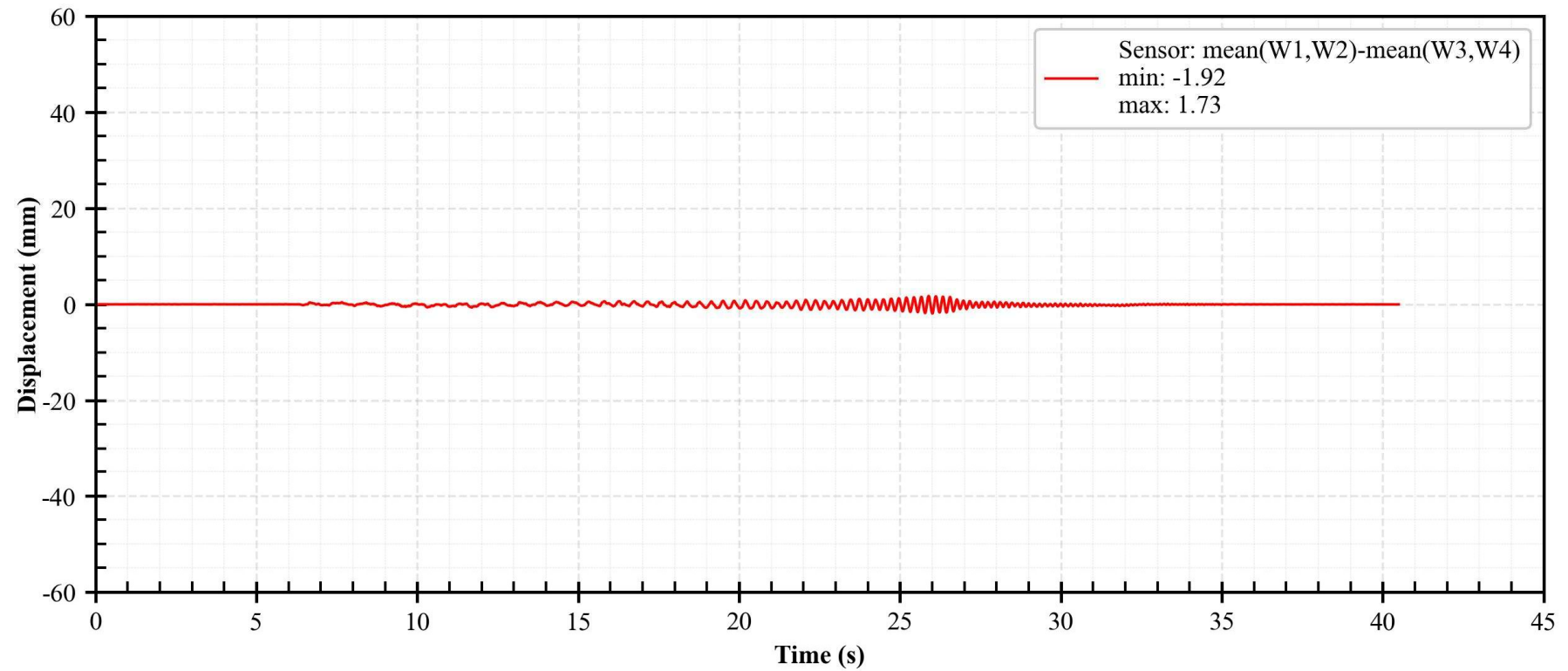


Figure 3.14.17 Characteristic results for phase B (white noise before EQ0,74g): mean (W1,W2) – mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

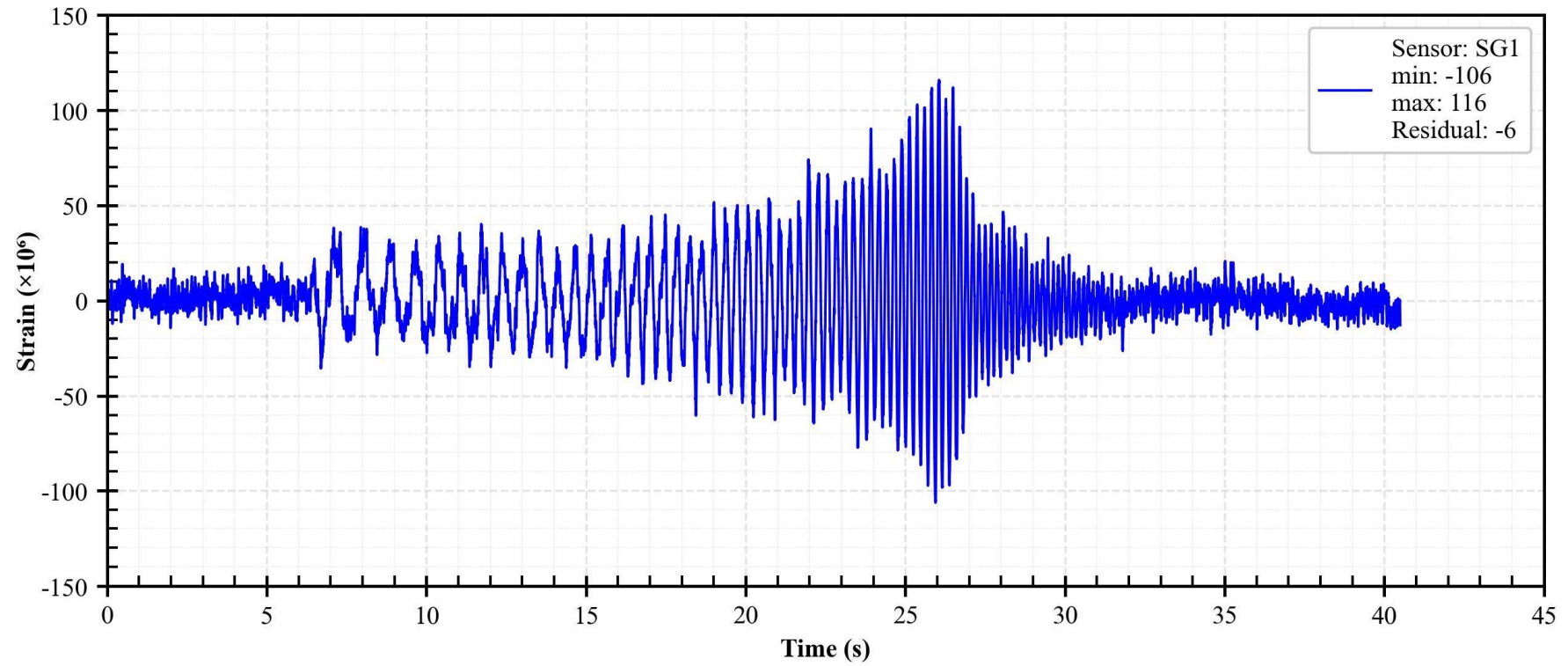


Figure 3.14.18 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 1

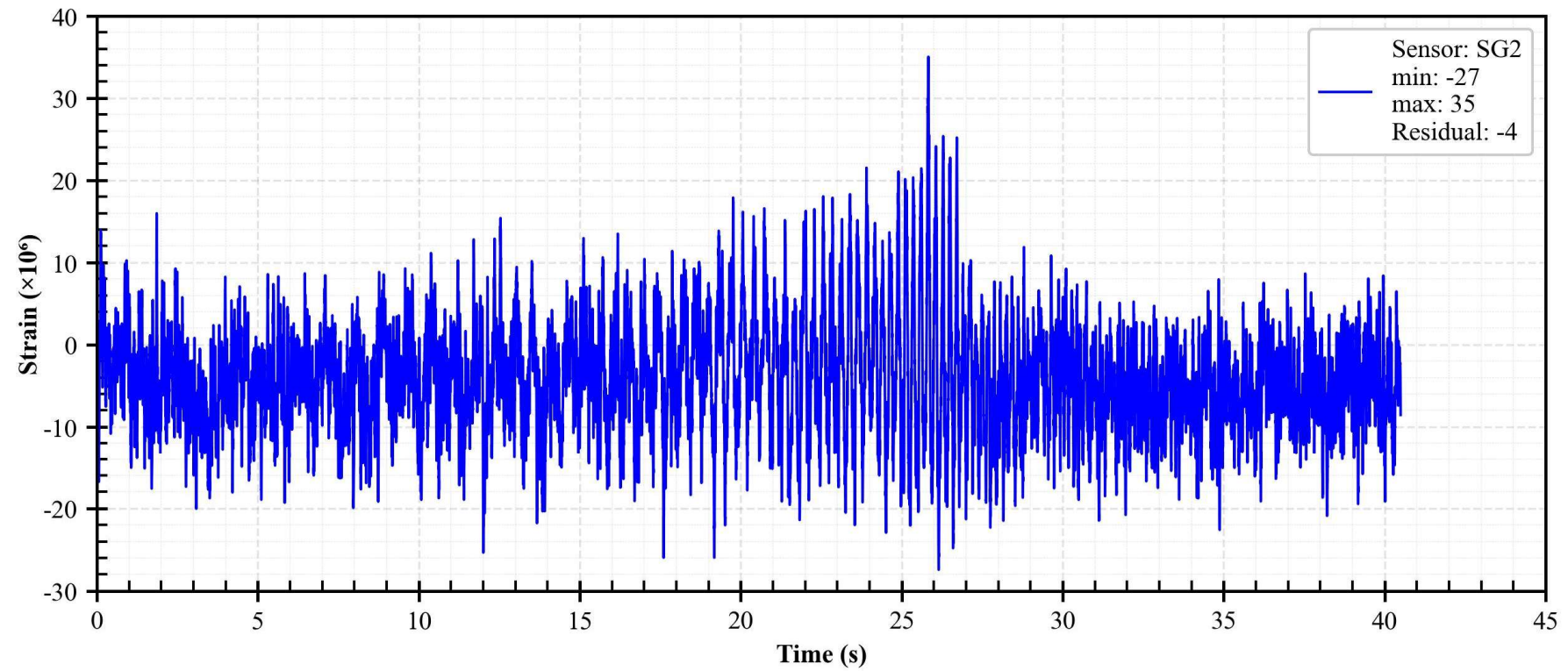


Figure 3.14.19 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 2

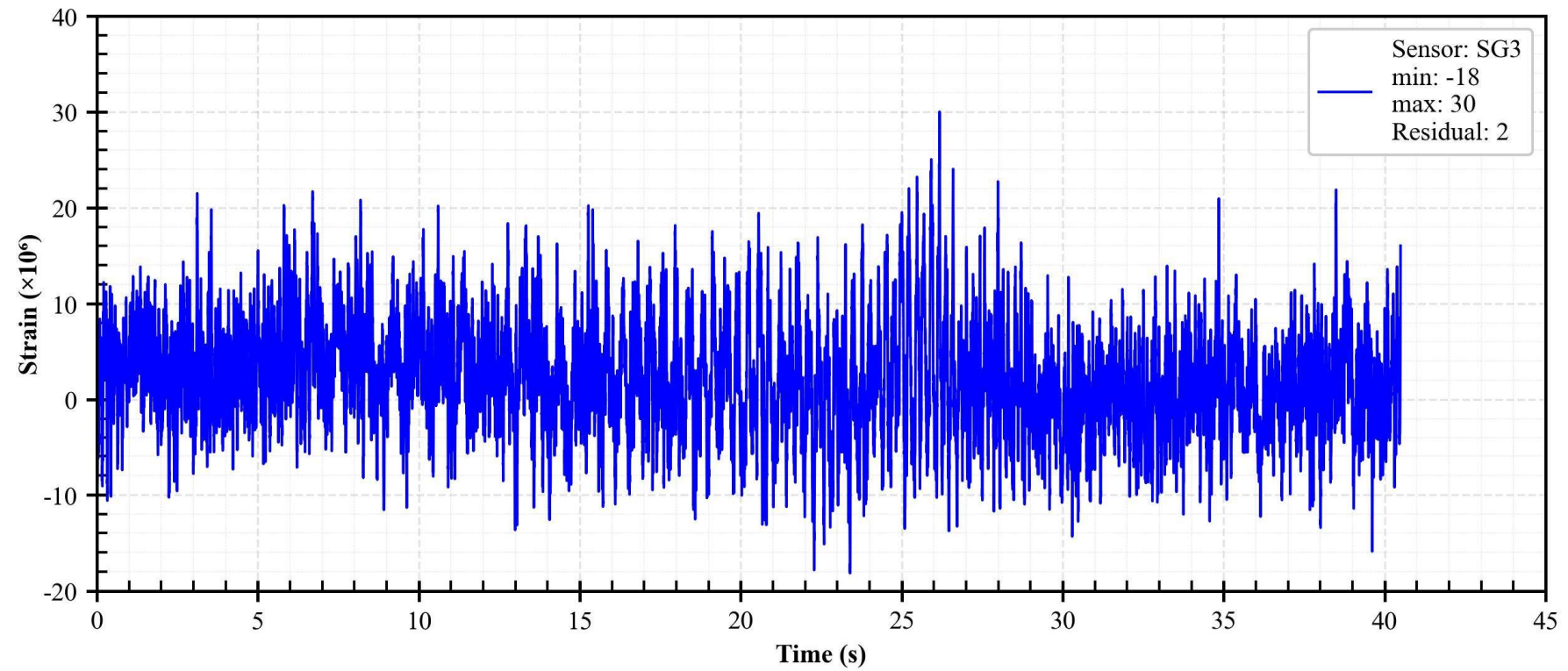


Figure 3.14.20 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 3

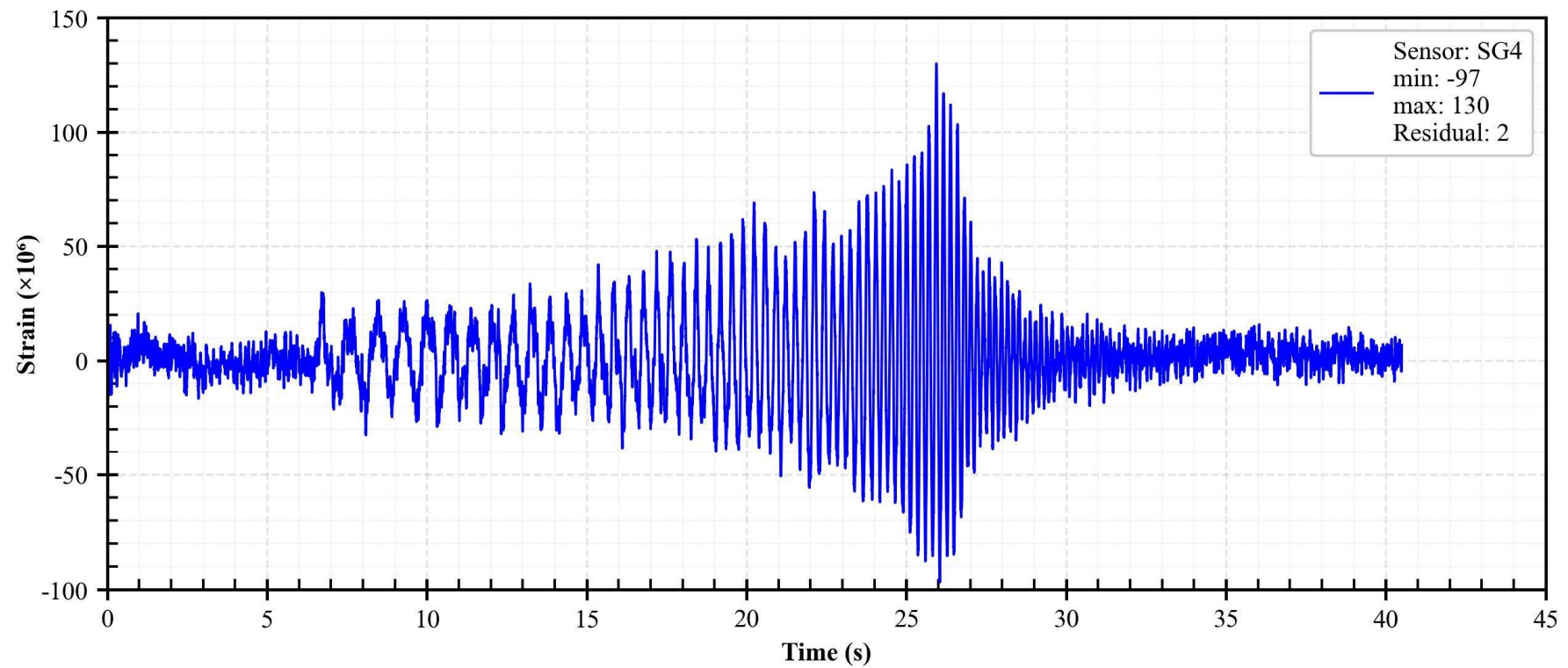


Figure 3.14.21 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 4

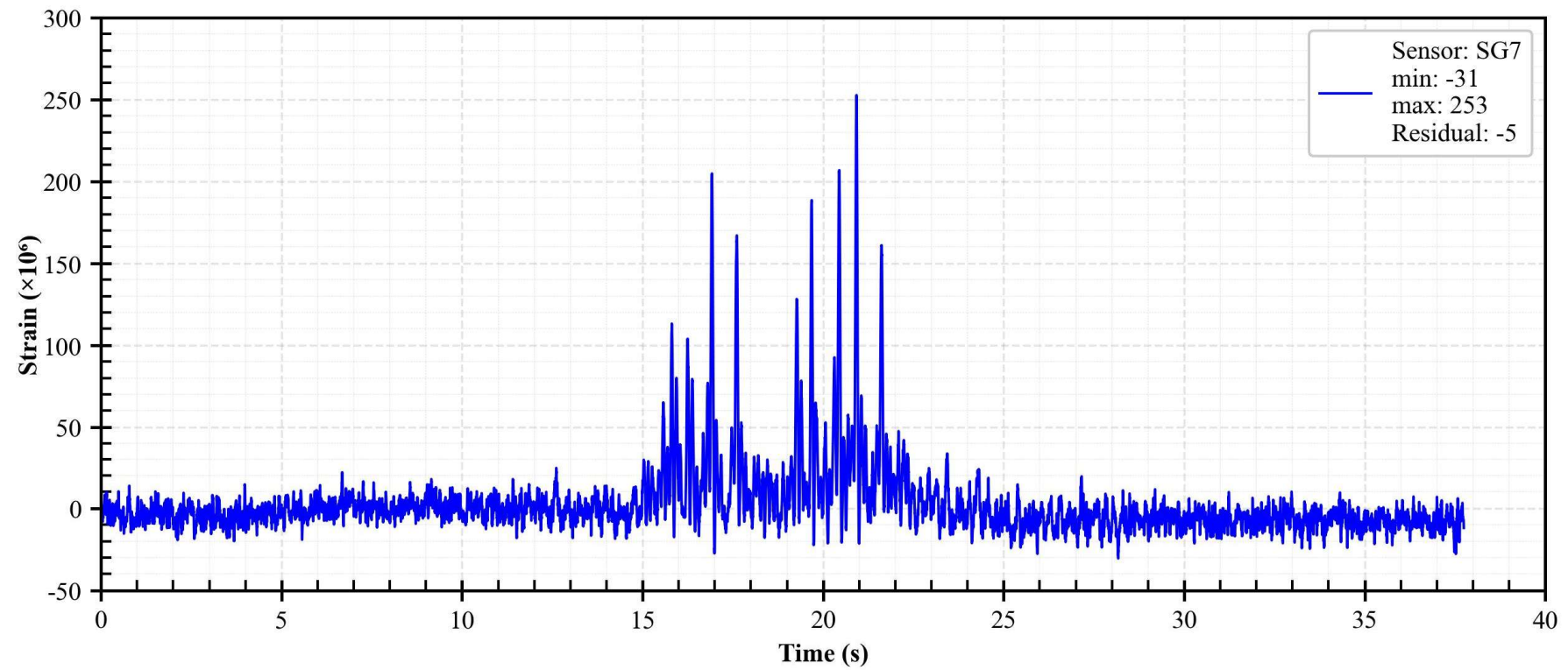


Figure 3.14.22 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 7

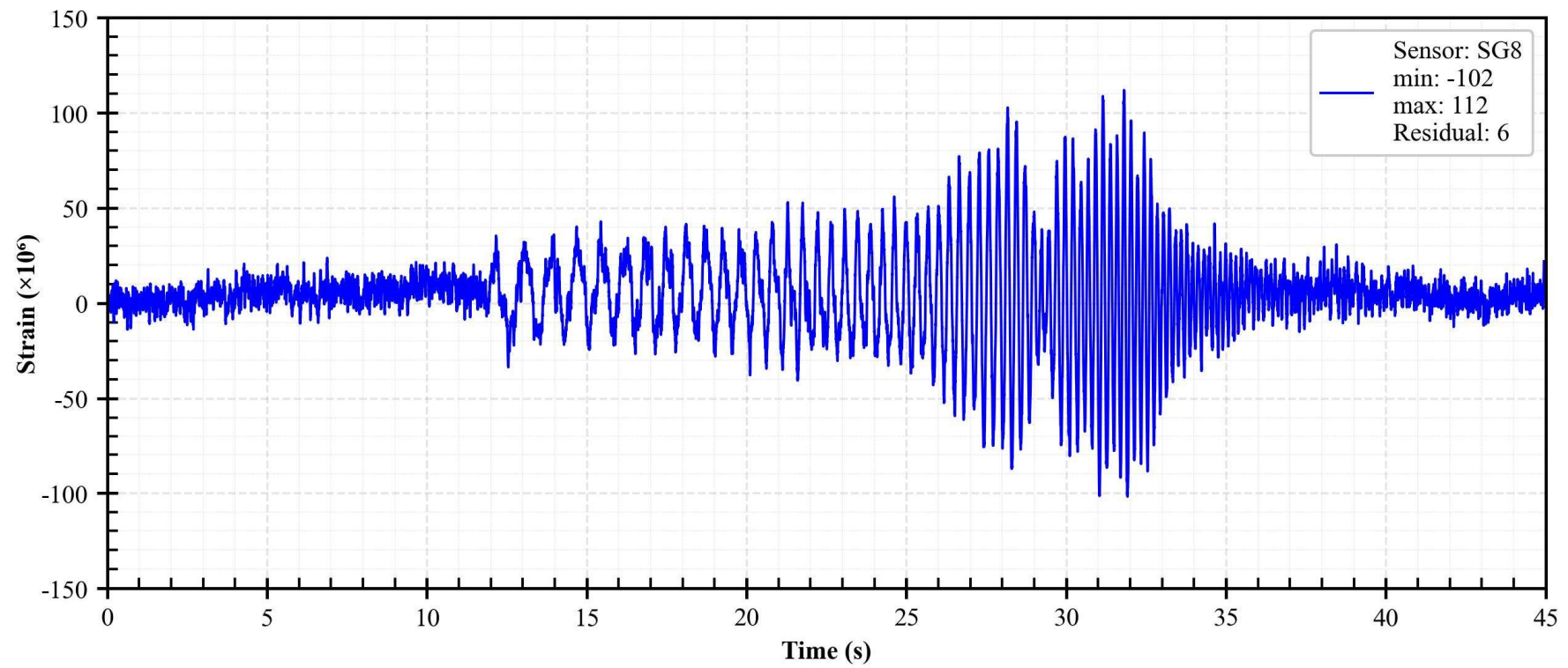


Figure 3.14.23 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 8

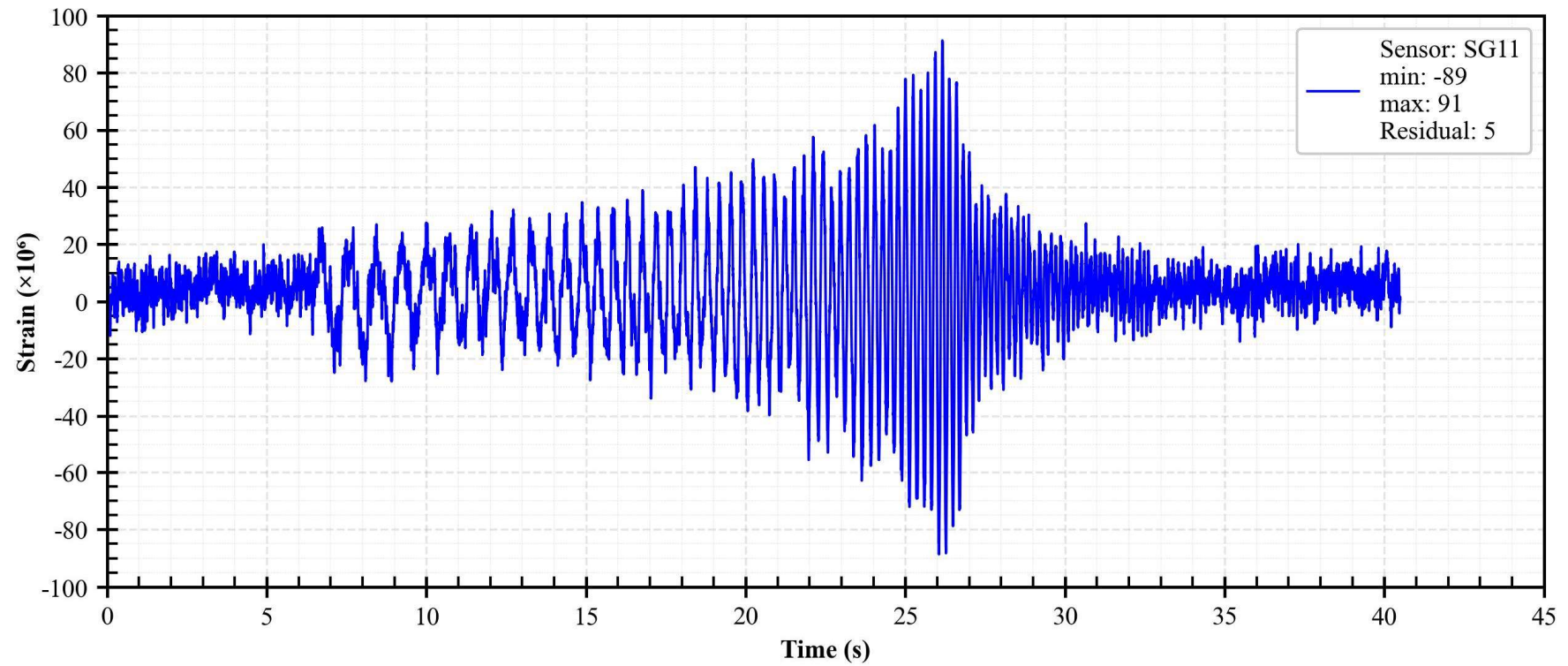


Figure 3.14.24 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 11

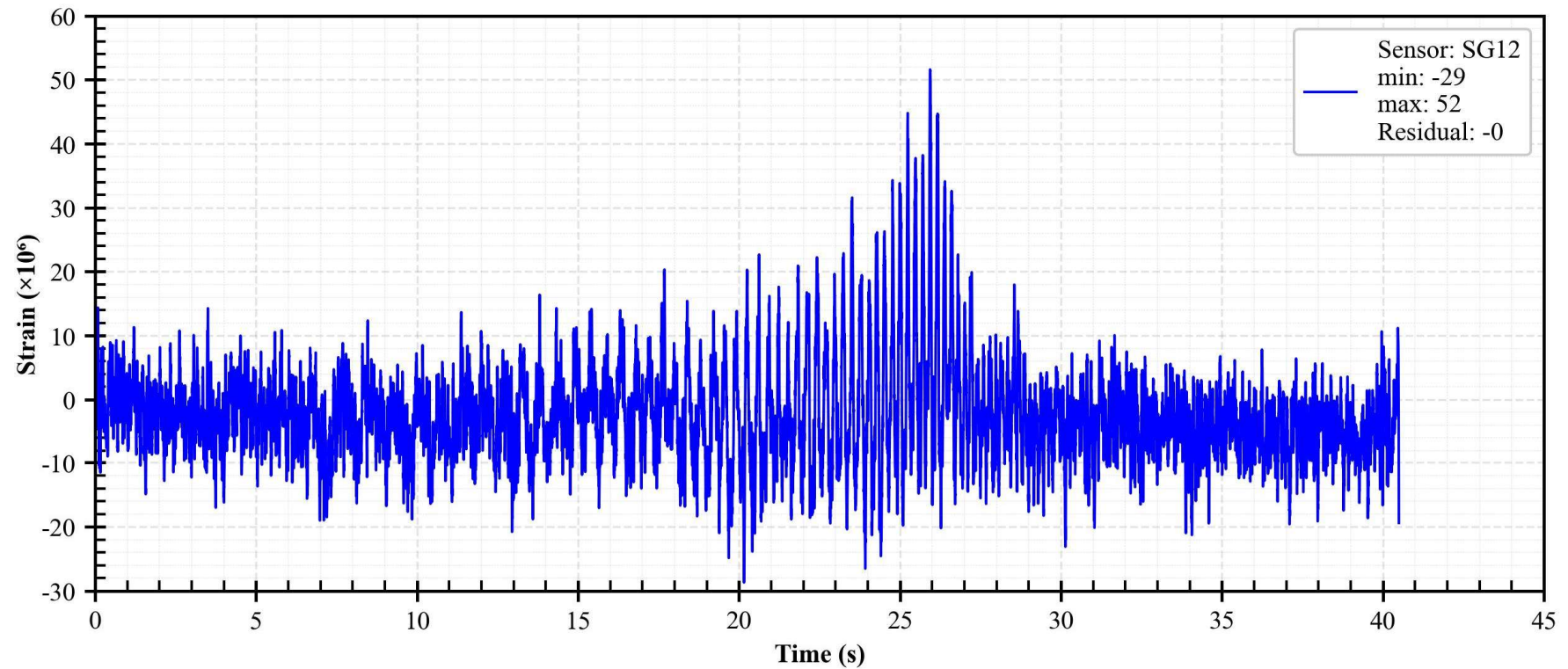


Figure 3.14.25 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 12

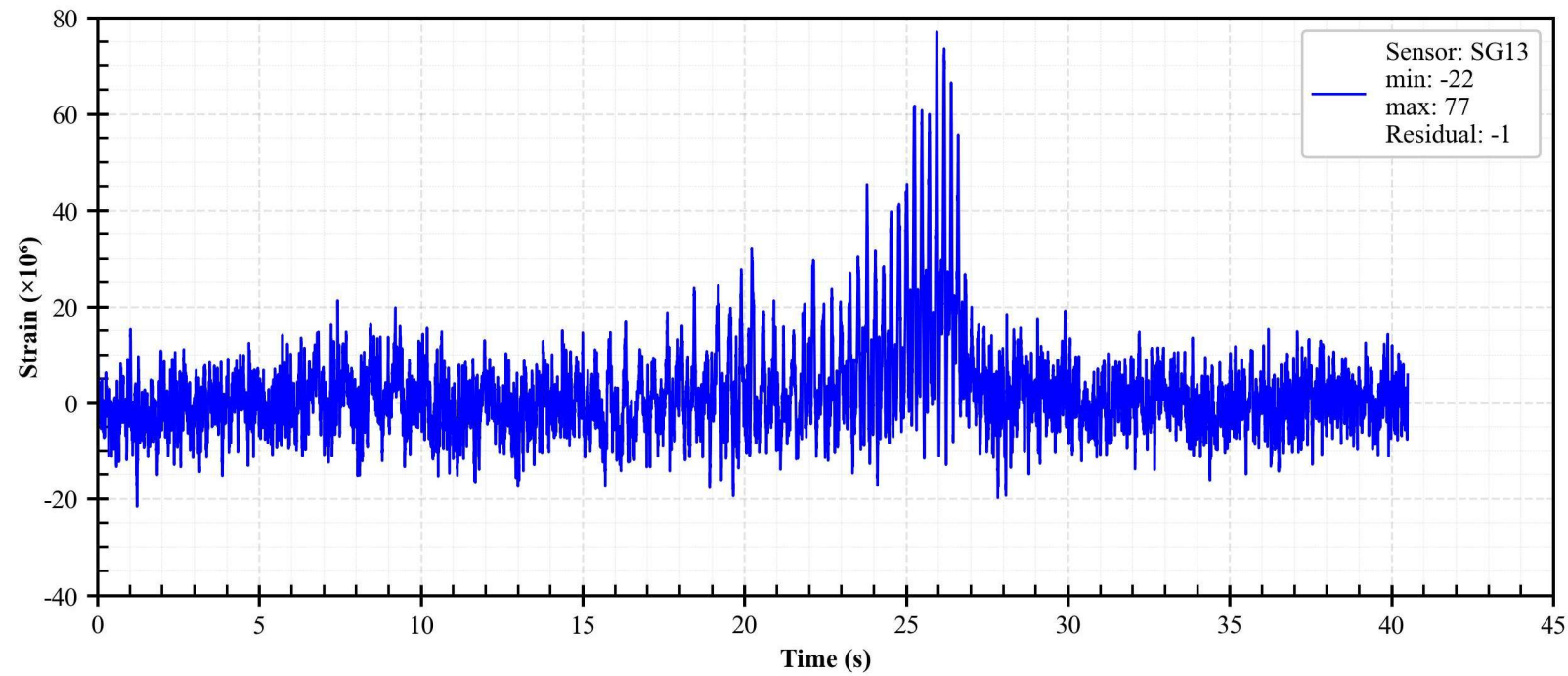


Figure 3.14.26 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 13

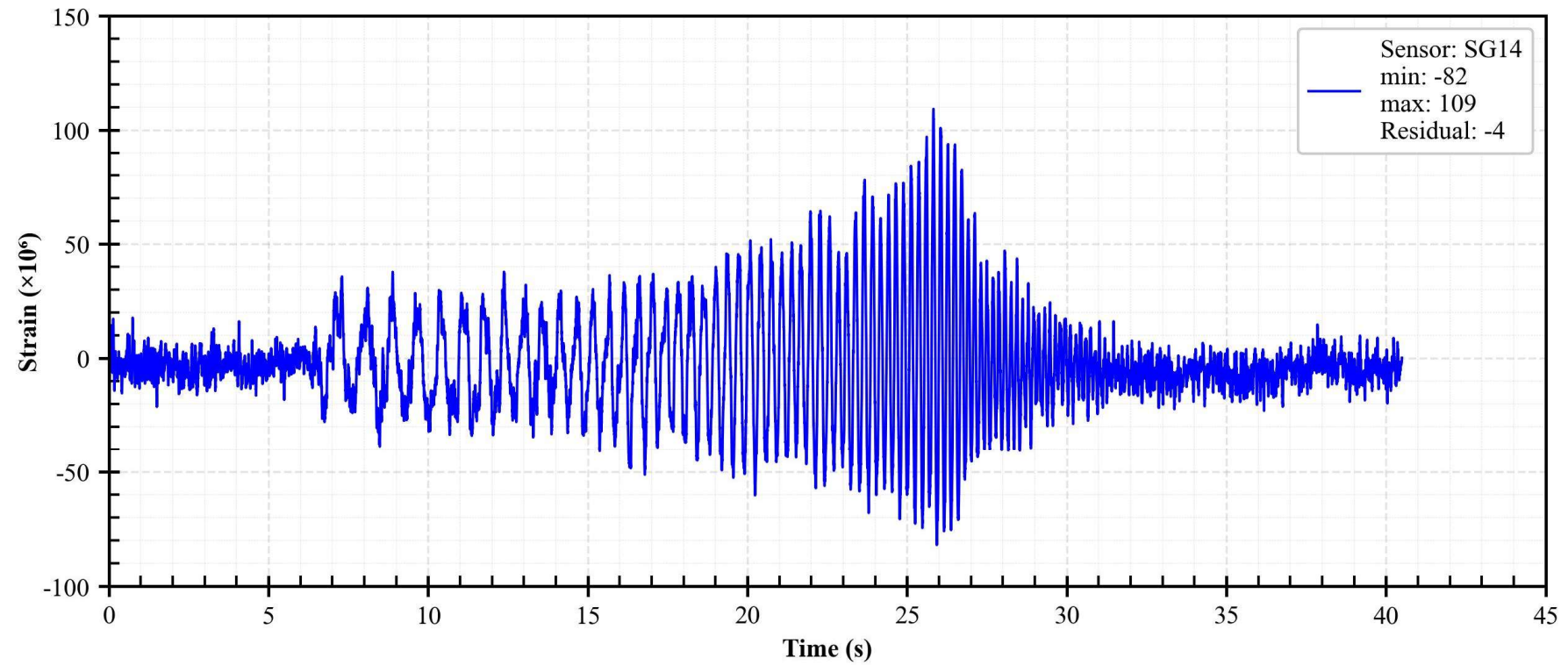


Figure 3.14.27 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 14

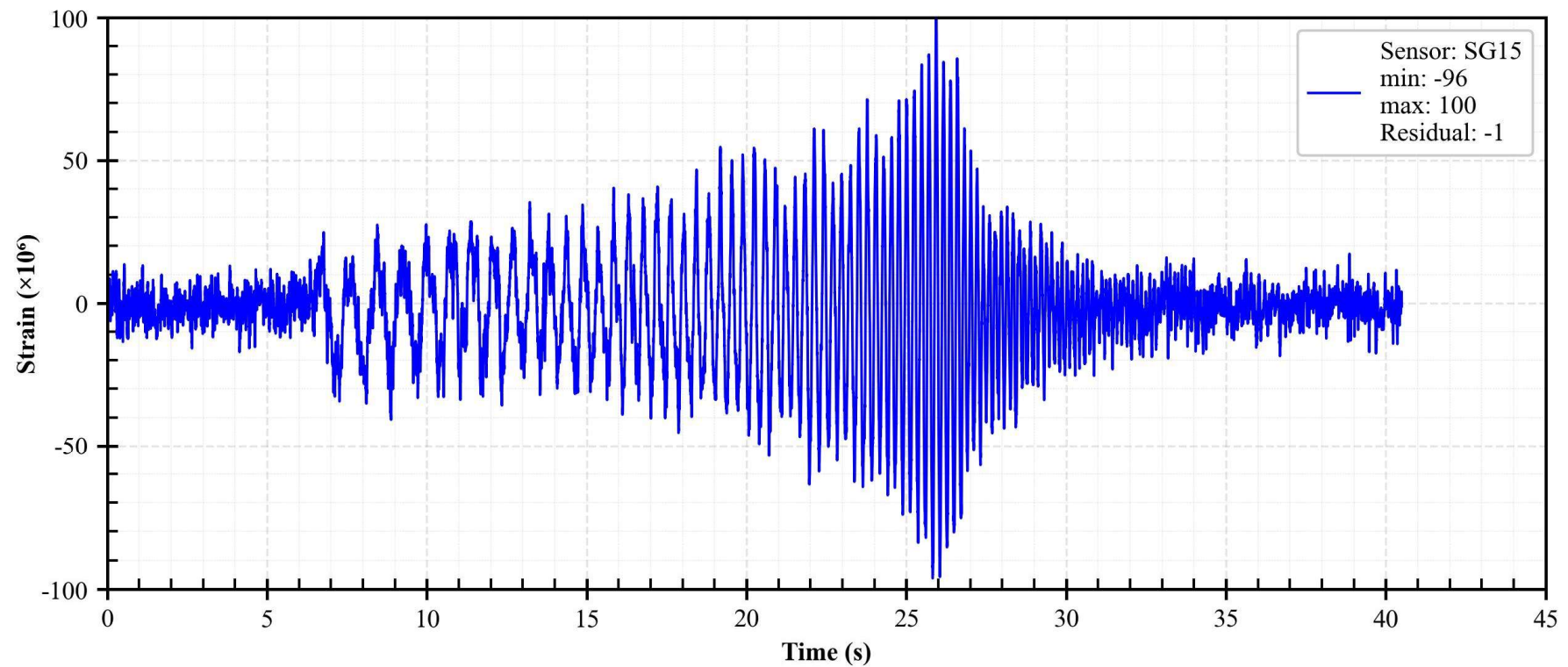


Figure 3.14.28 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 15

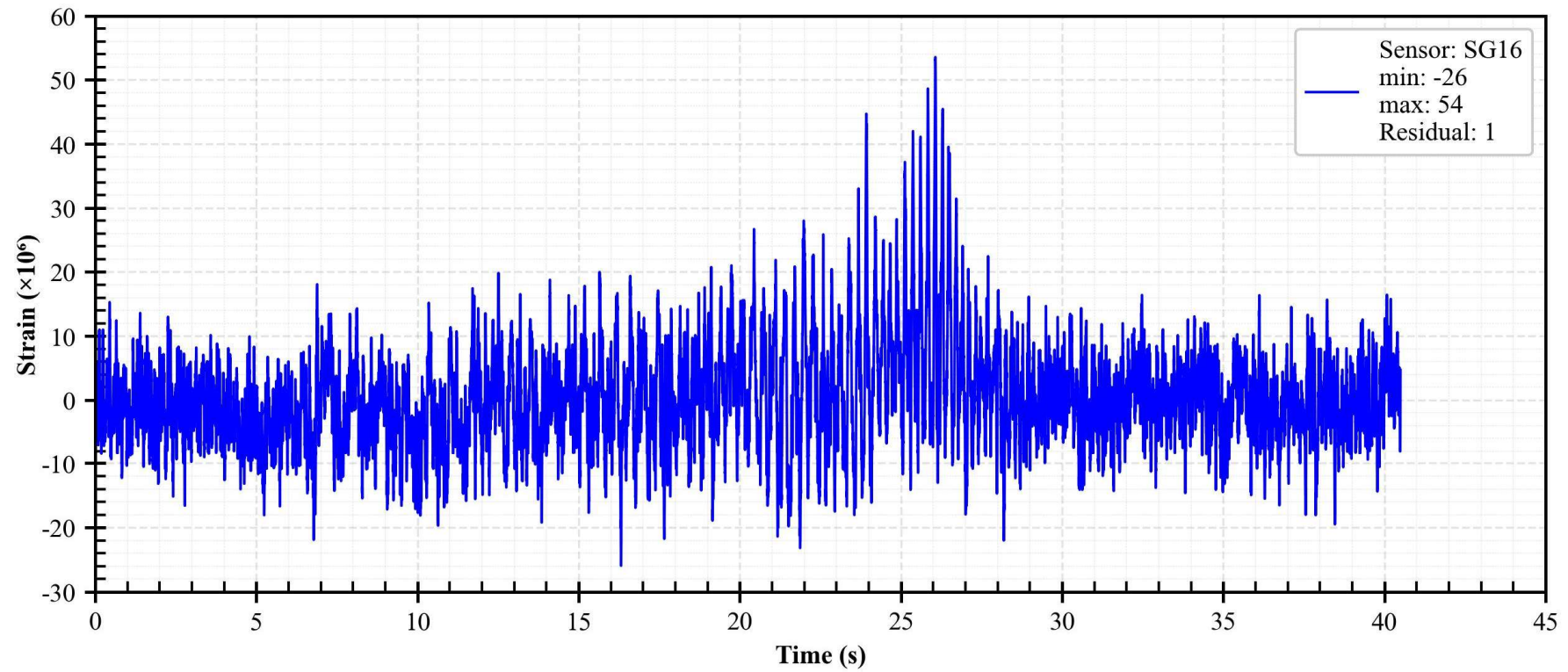


Figure 3.14.29 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 16

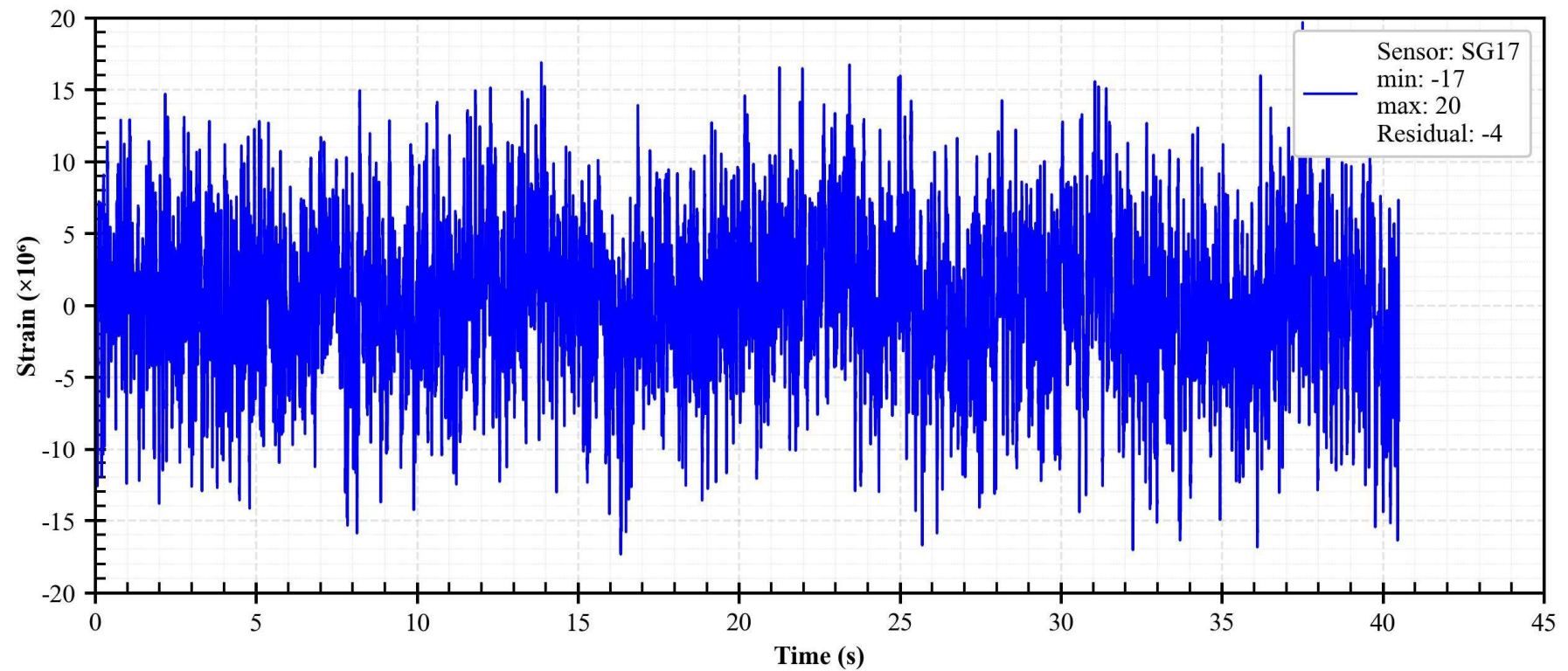


Figure 3.14.30 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 17

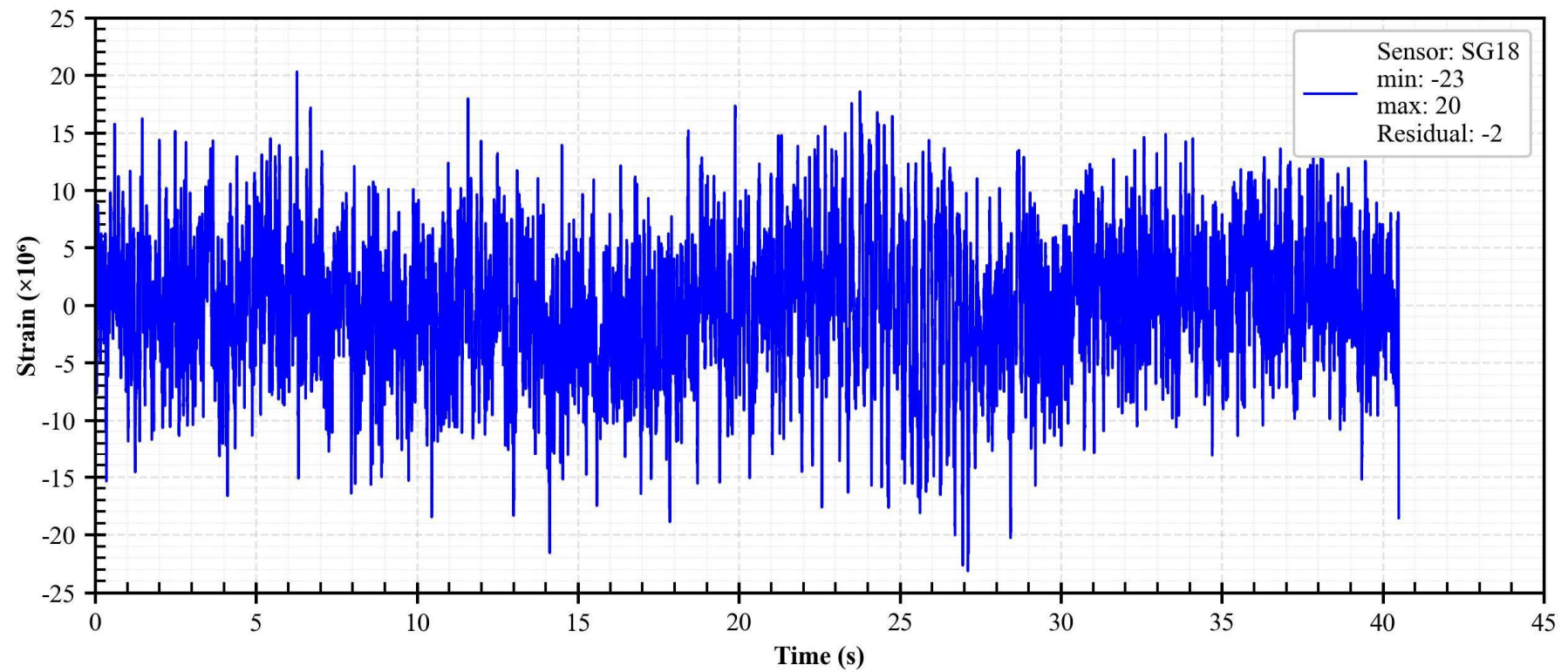


Figure 3.14.31 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 18

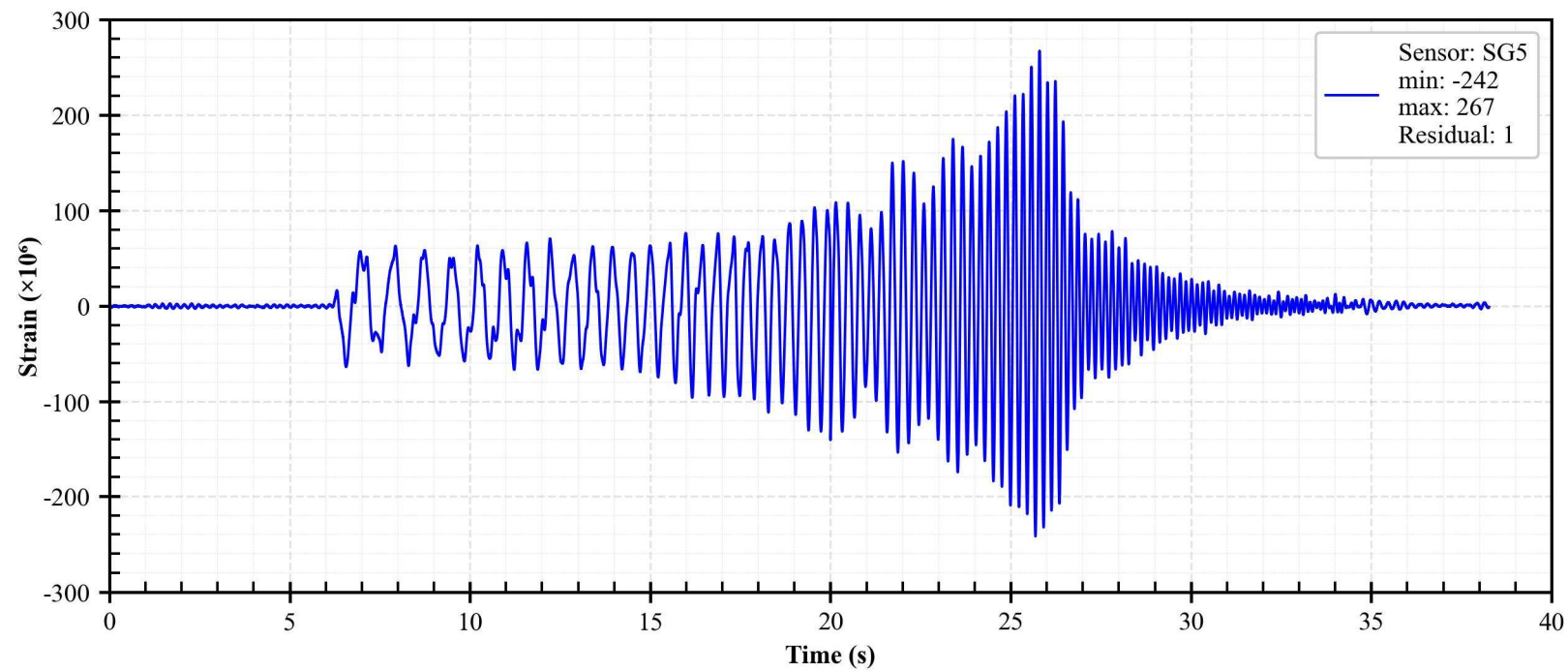


Figure 3.14.32 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 5

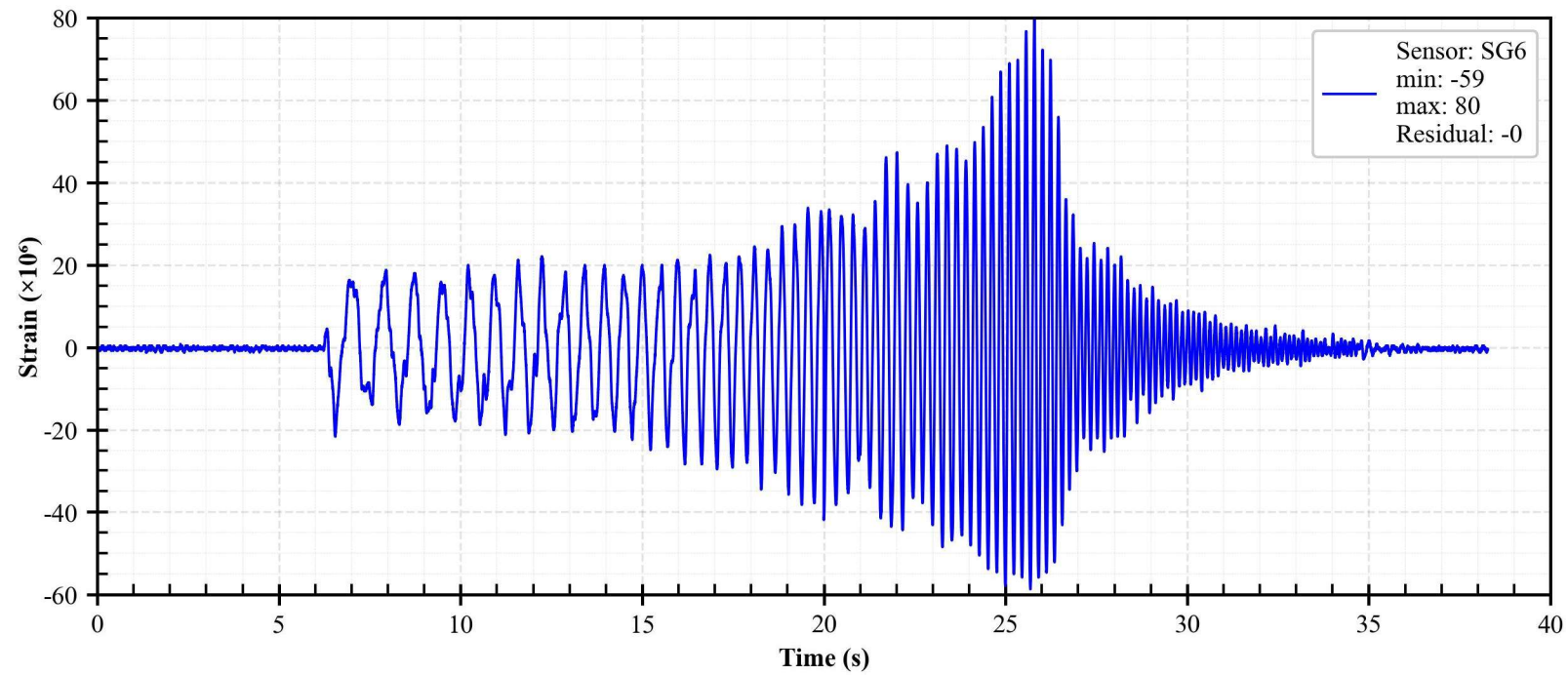


Figure 3.14.33 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 6

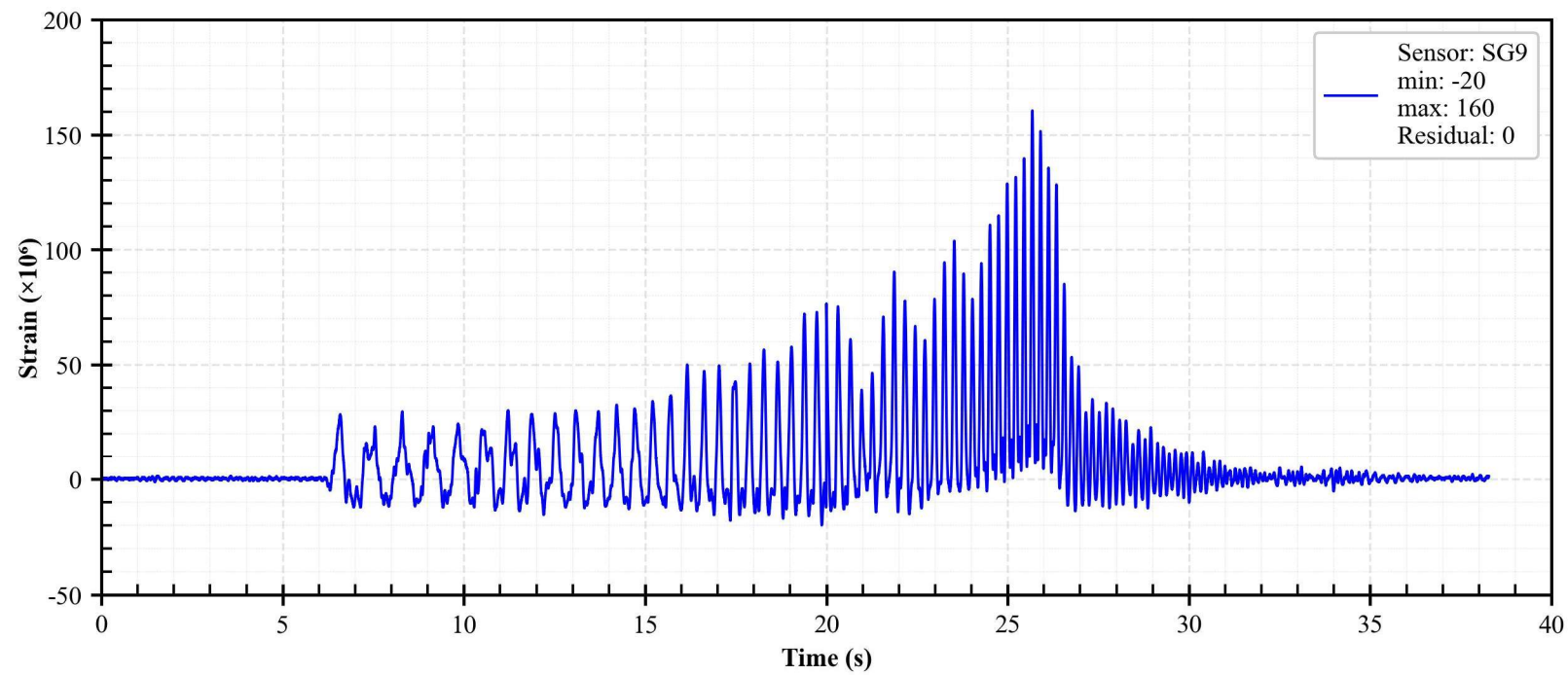


Figure 3.14.34 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 9

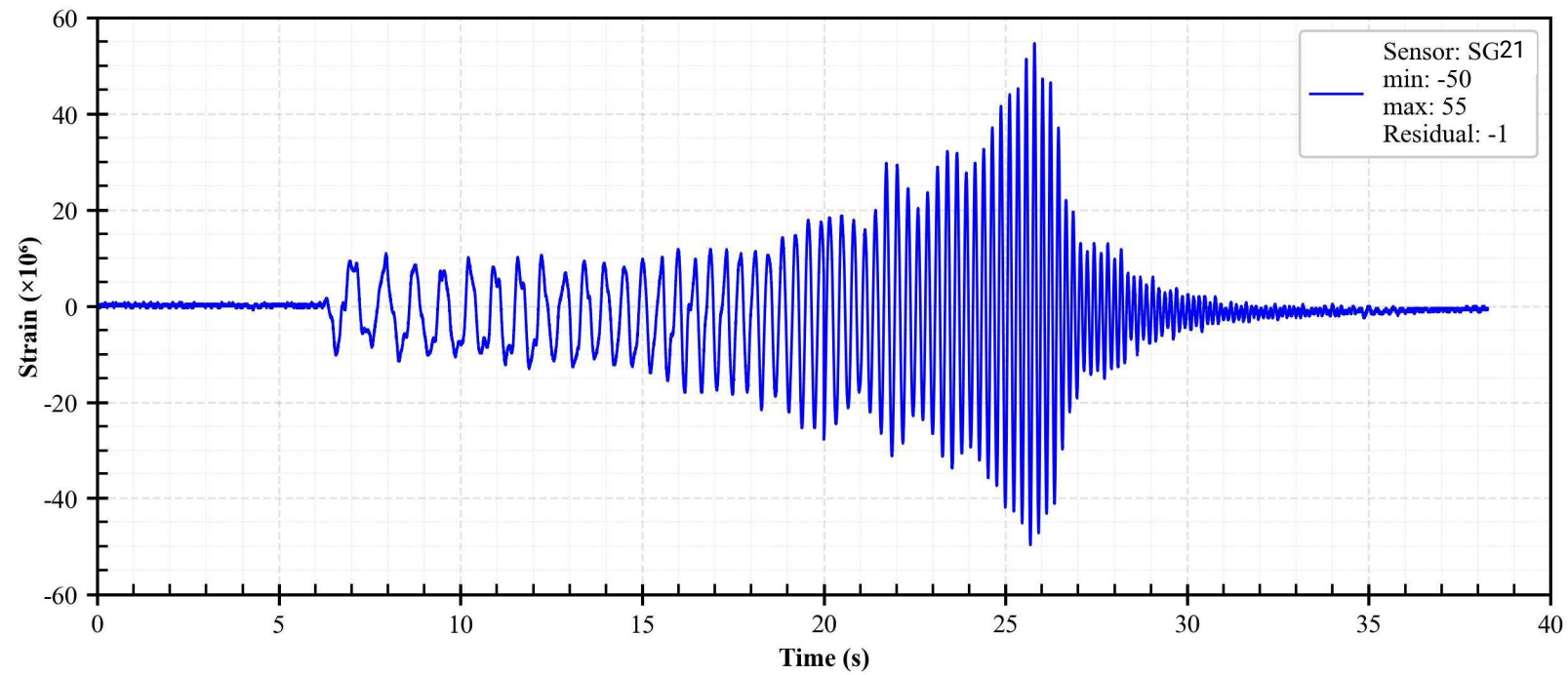


Figure 3.14.35 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 21 (PUFJ, column 1)

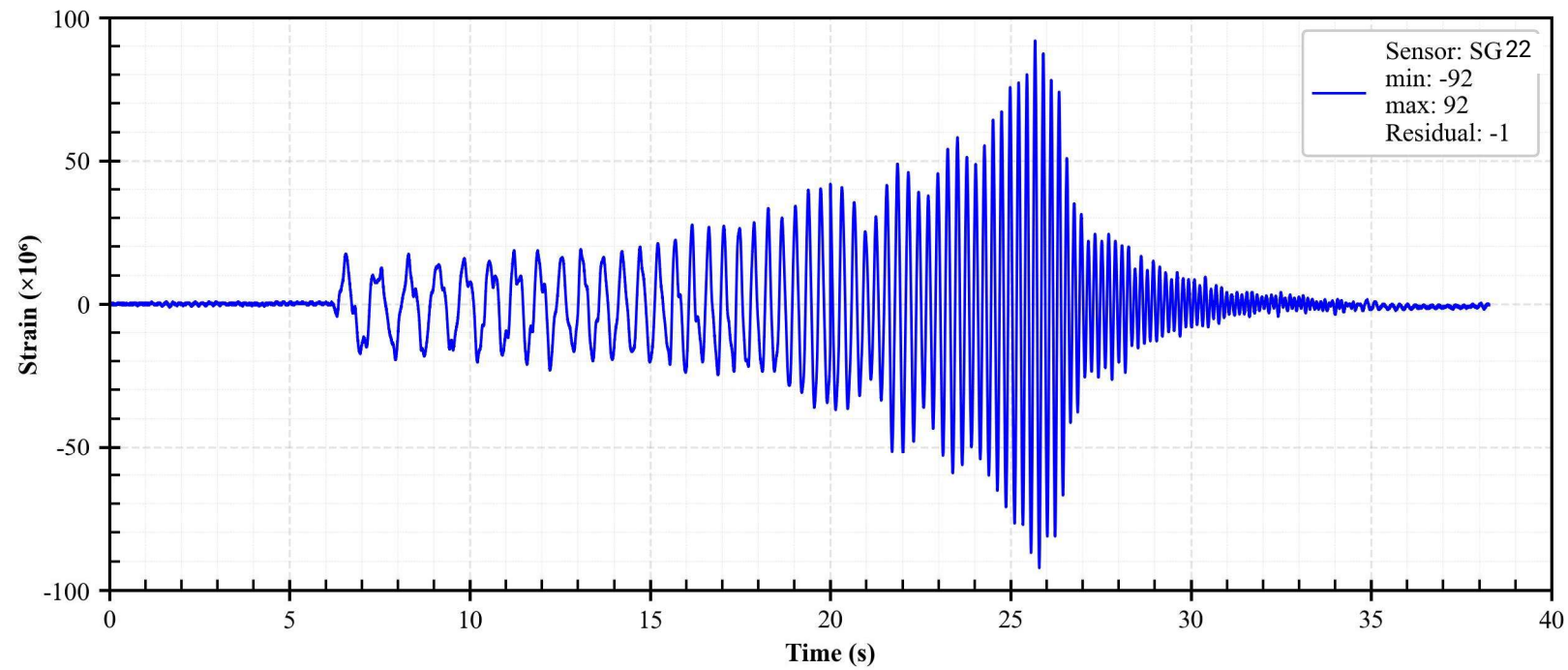


Figure 3.14.36 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 22 (PUFJ, column 2)

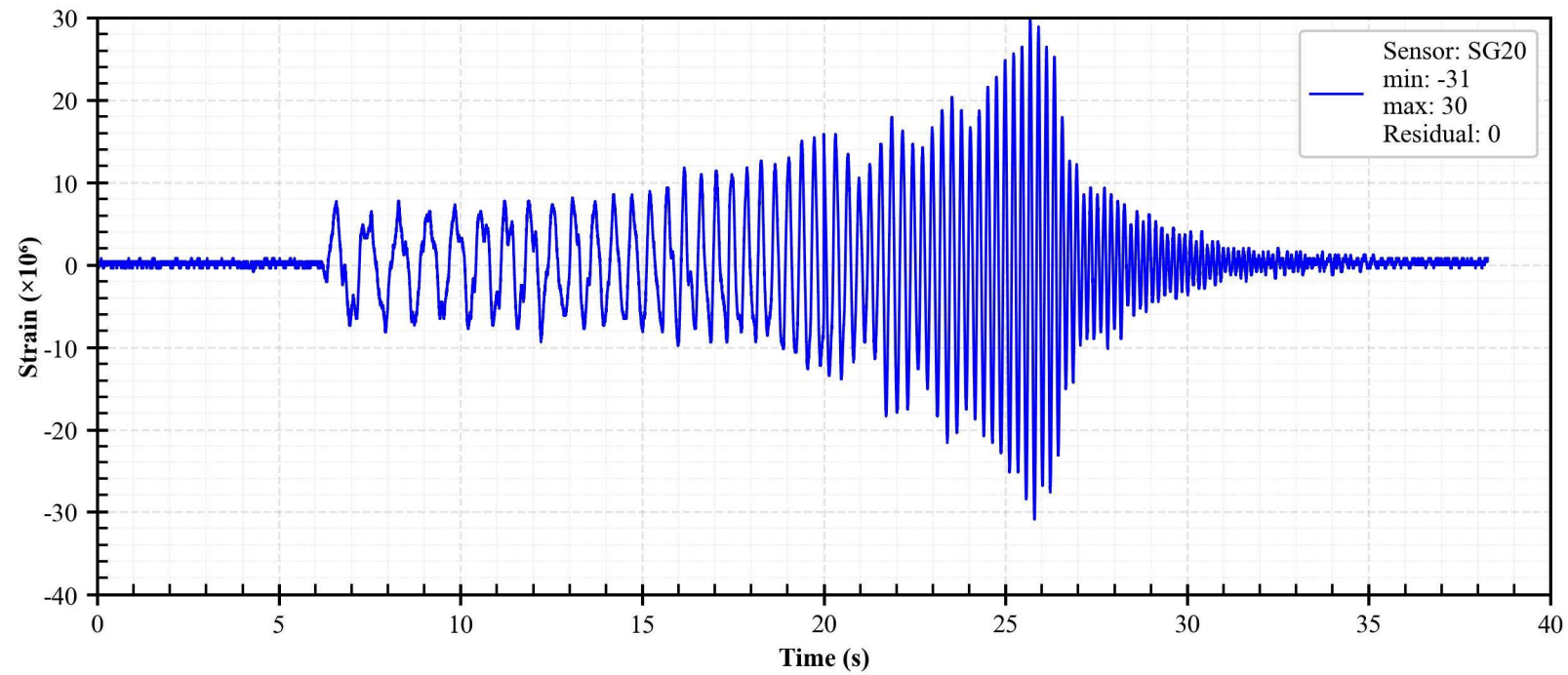


Figure 3.14.37 Characteristic results for phase B (white noise before EQ0,74g): strain gauge 20

3.15 Earthquake EQ0,74g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,74g. The max acceleration at the slab level on the accelerometer acc4 is 1.37g. The max acceleration at the foundation level on the accelerometer acc10 is 0.72g.

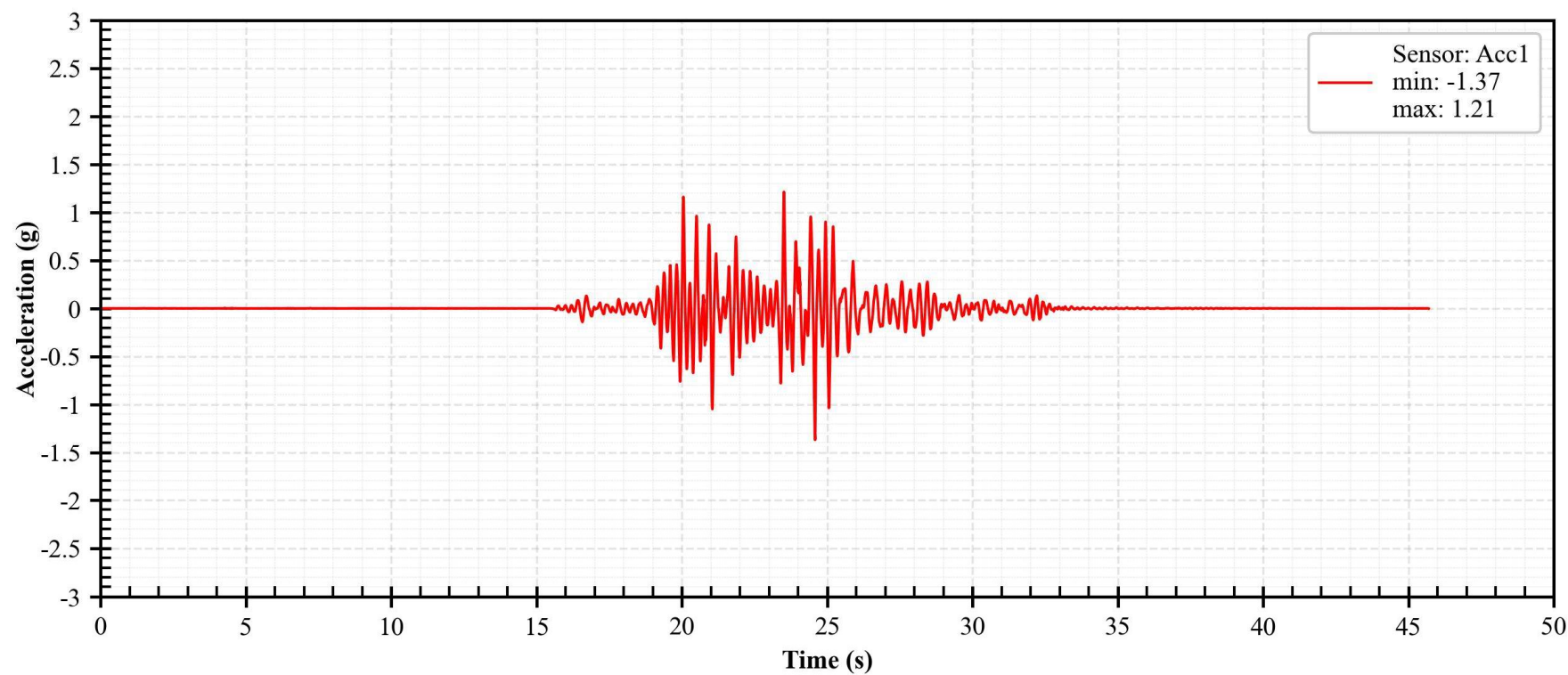


Figure 3.15.1 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 1

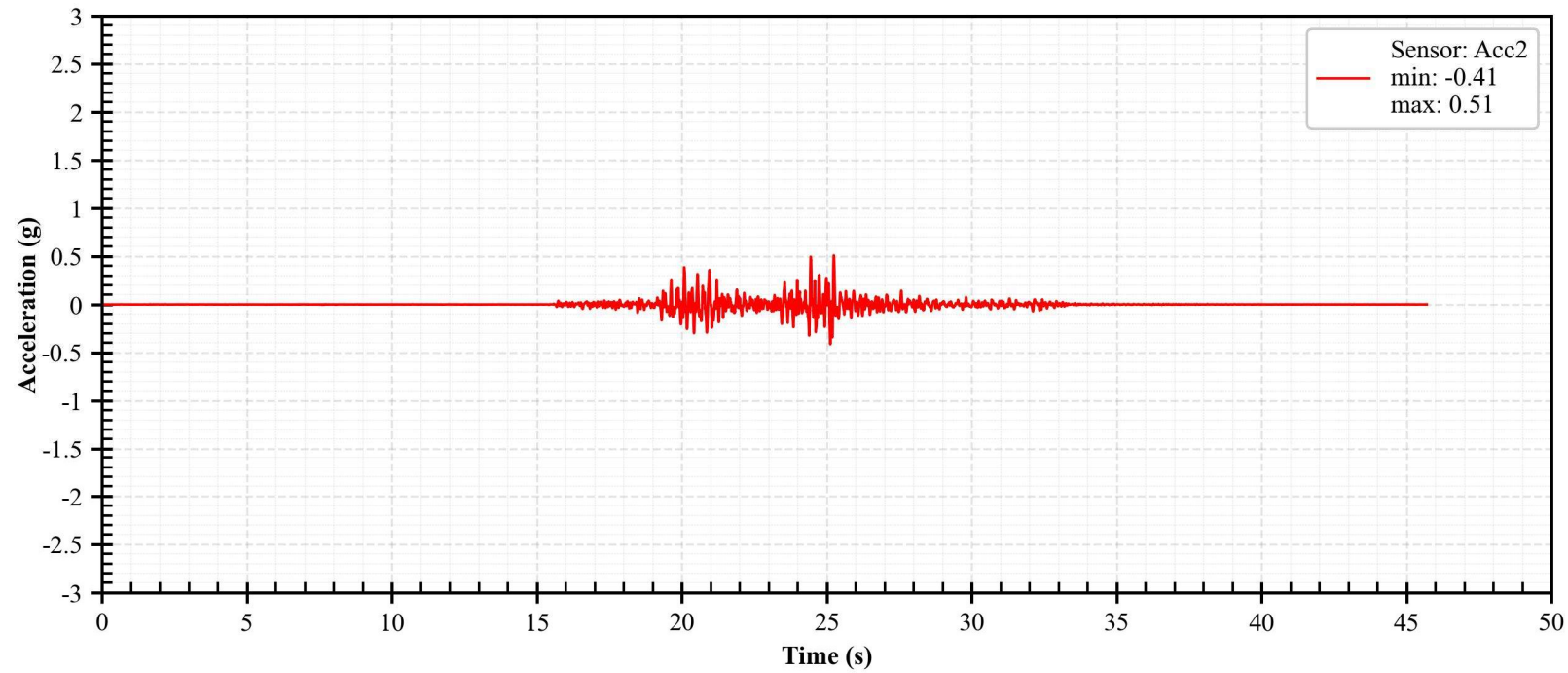


Figure 3.15.2 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 2

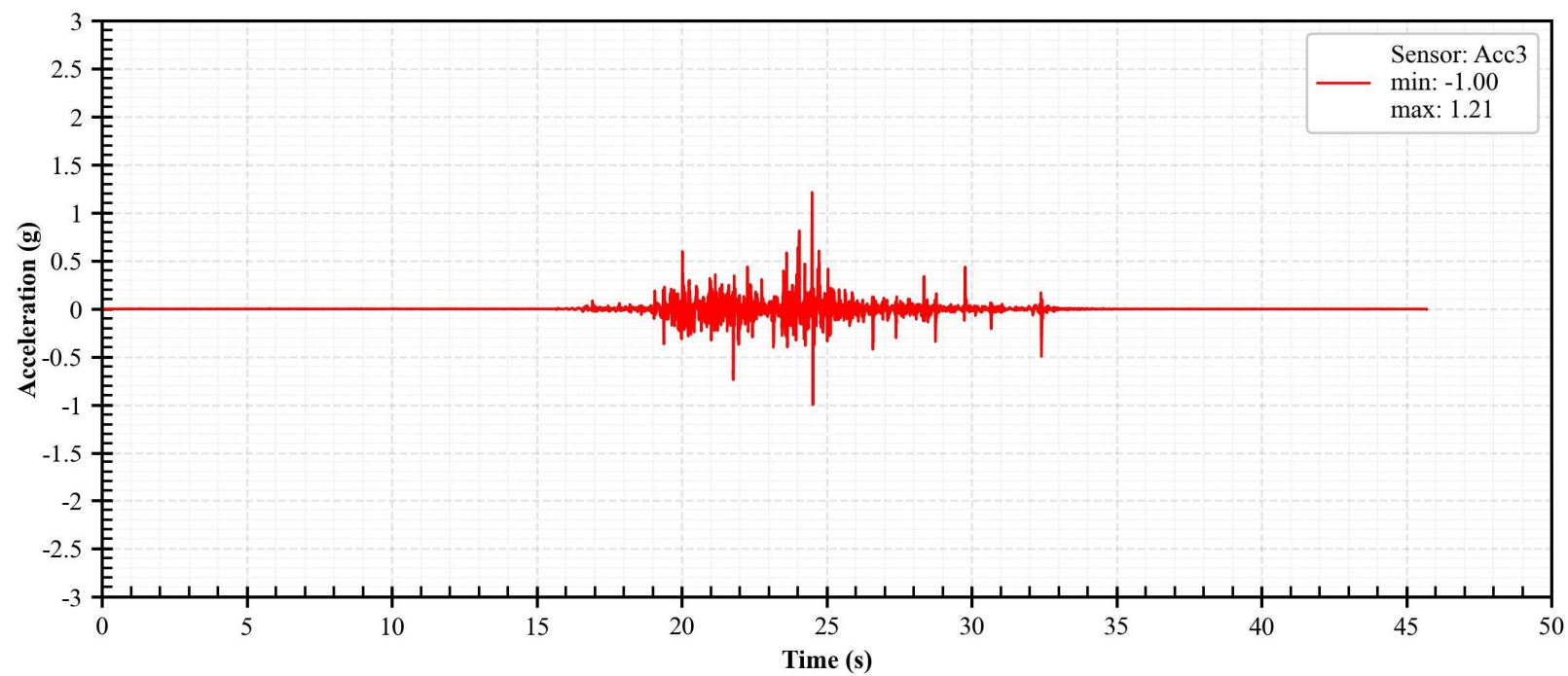


Figure 3.15.3 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 3

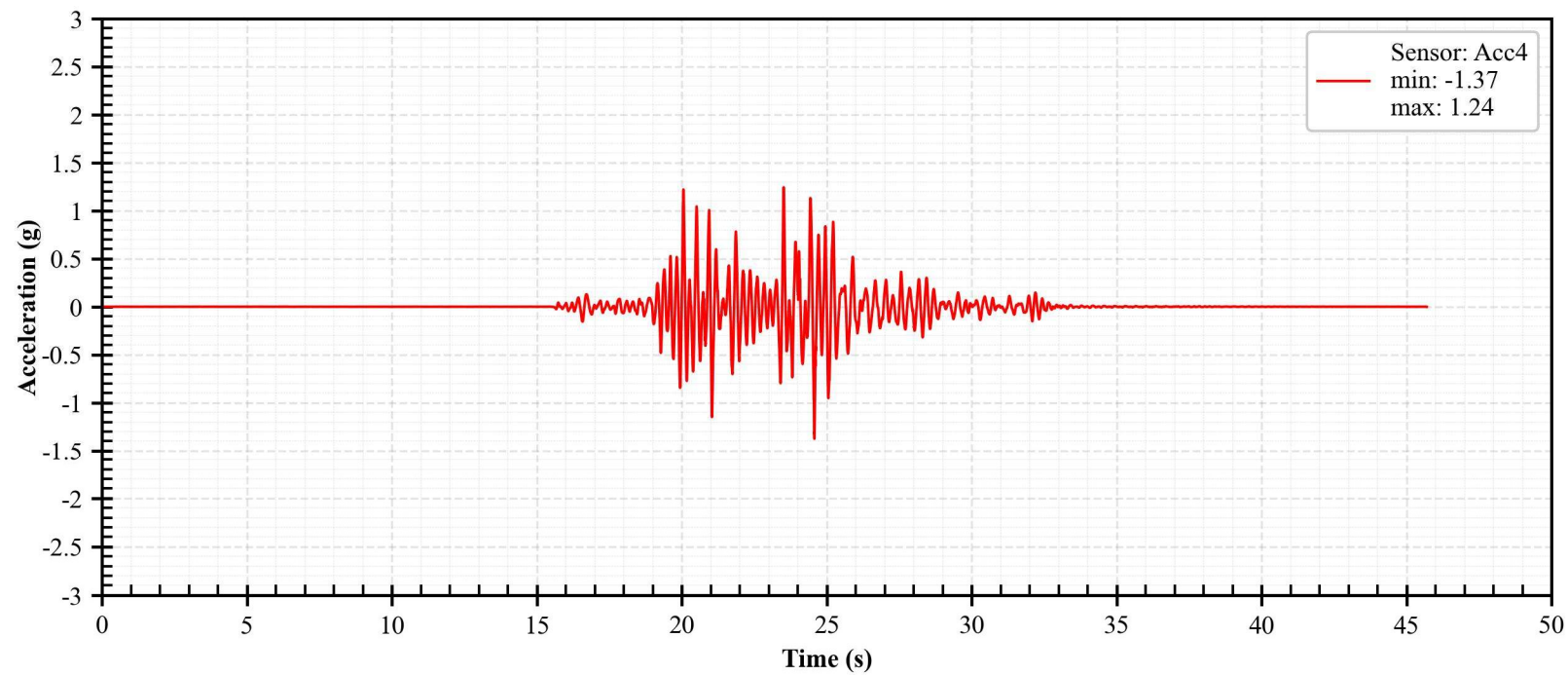


Figure 3.15.4 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 4

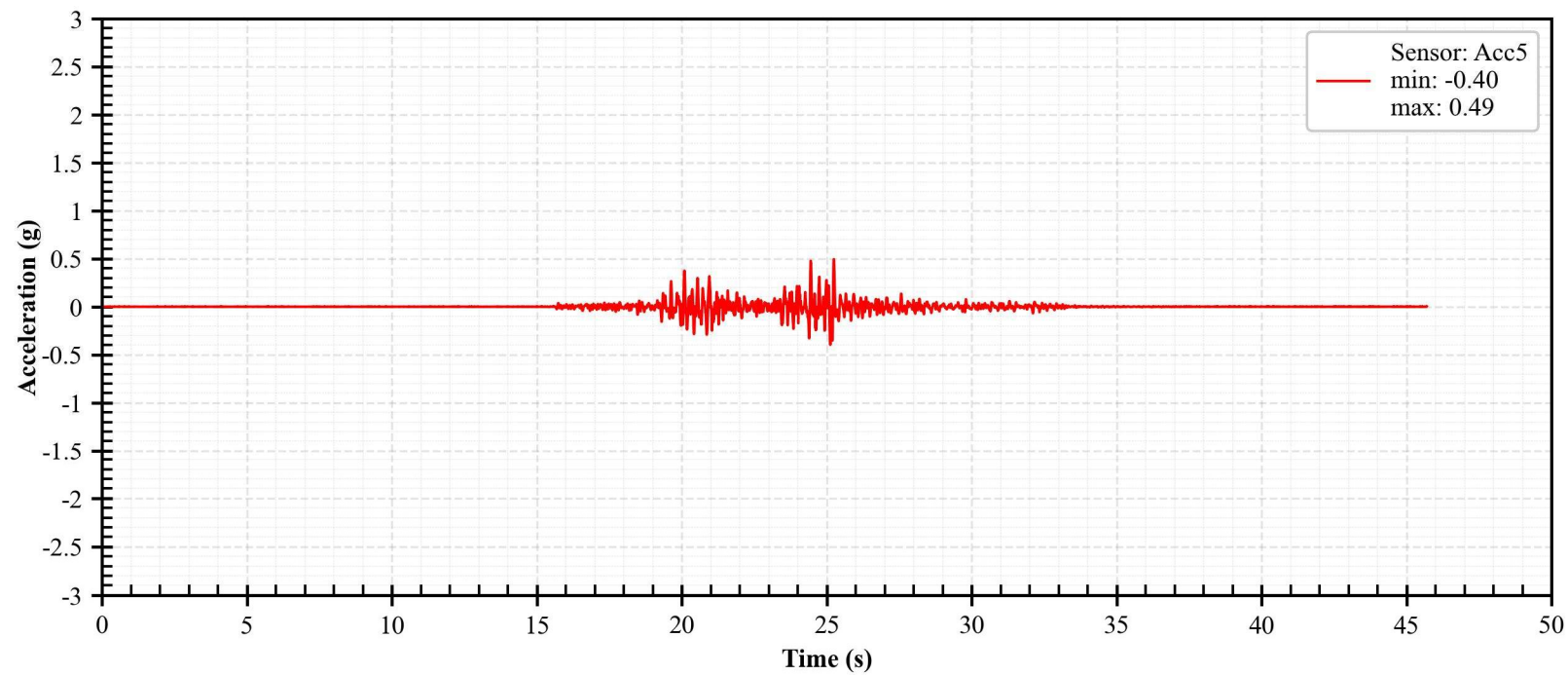


Figure 3.15.5 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 5

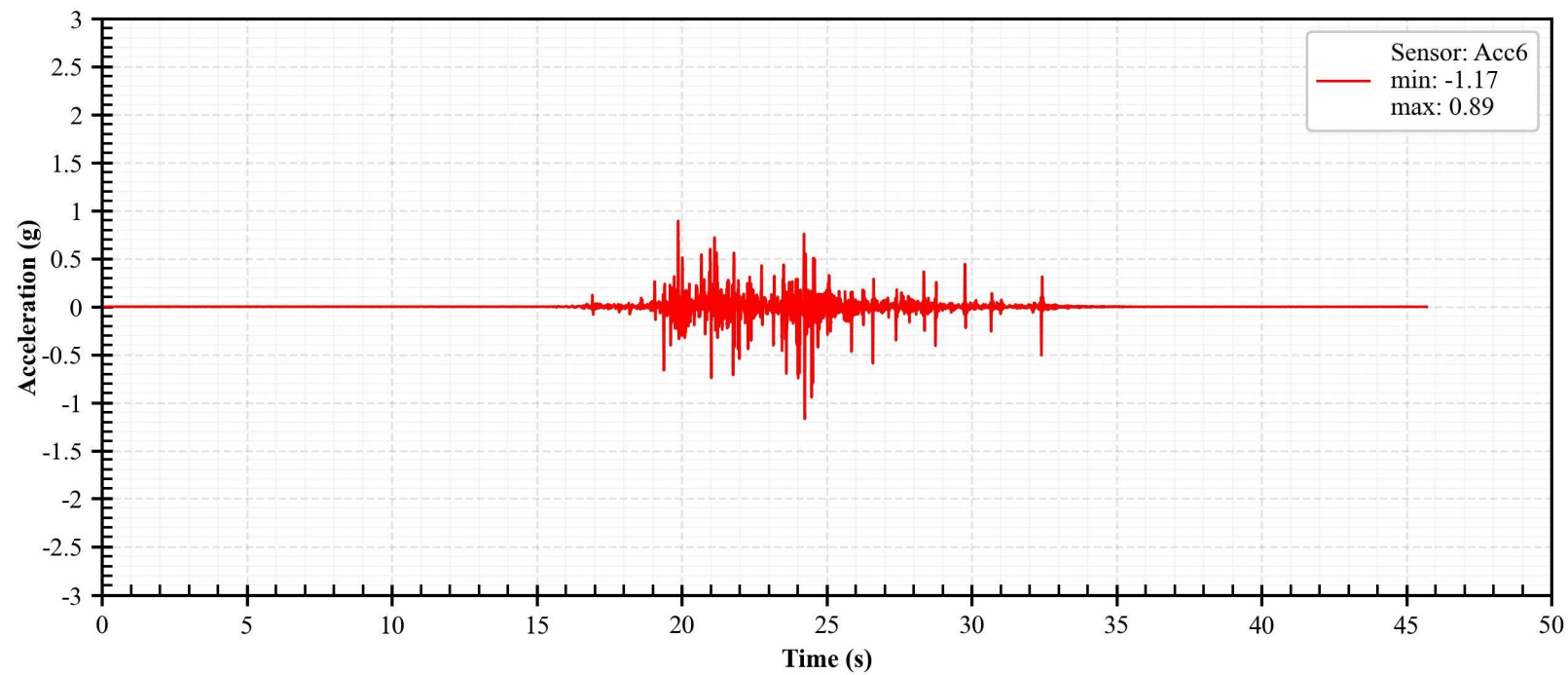


Figure 3.15.6 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 6

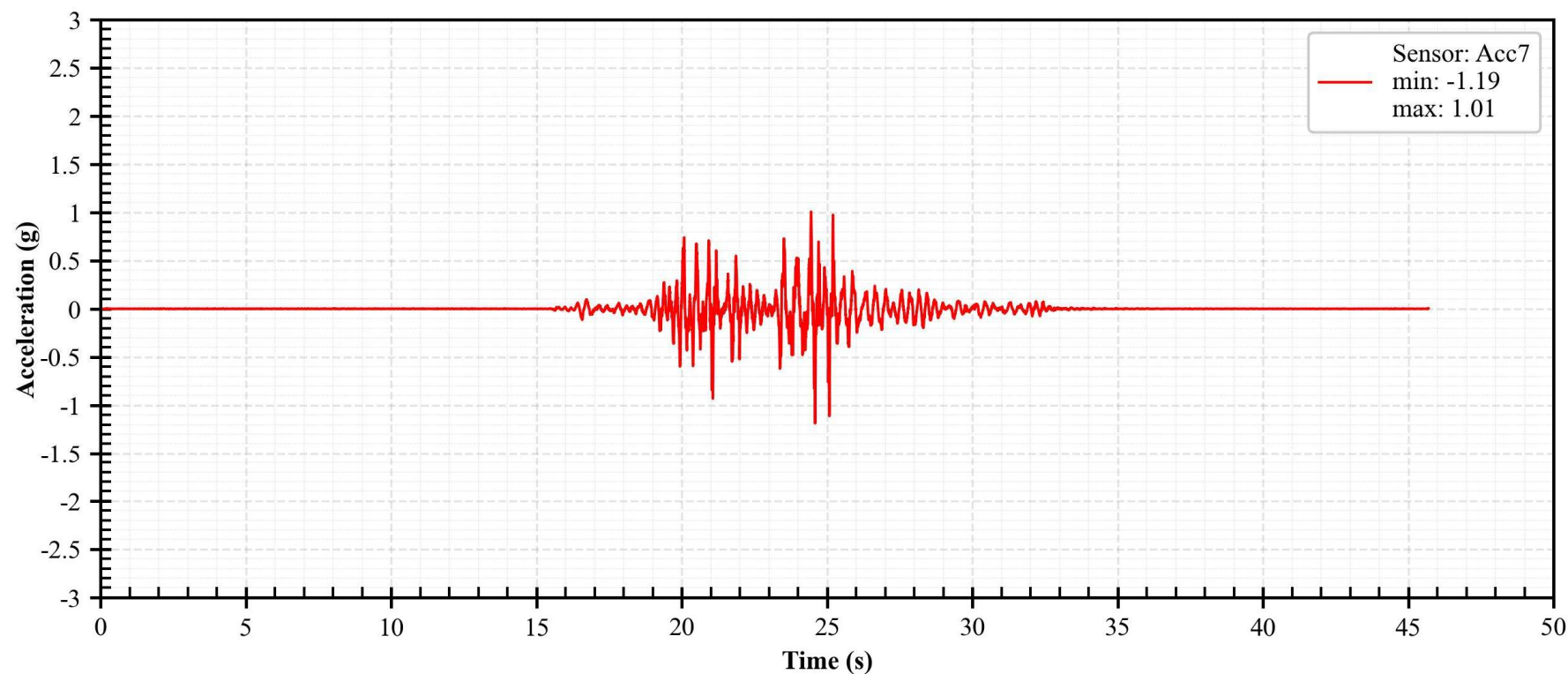


Figure 3.15.7 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 7

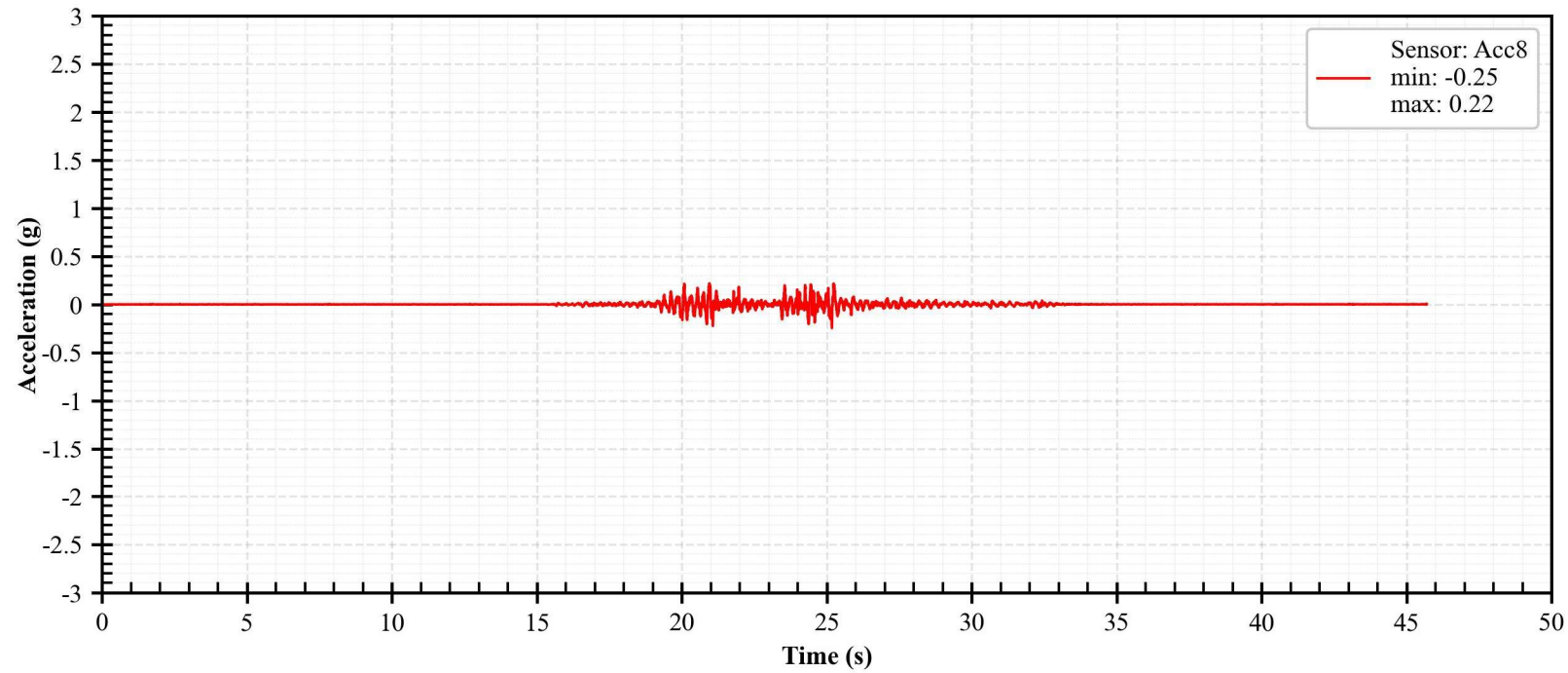


Figure 3.15.8 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 8

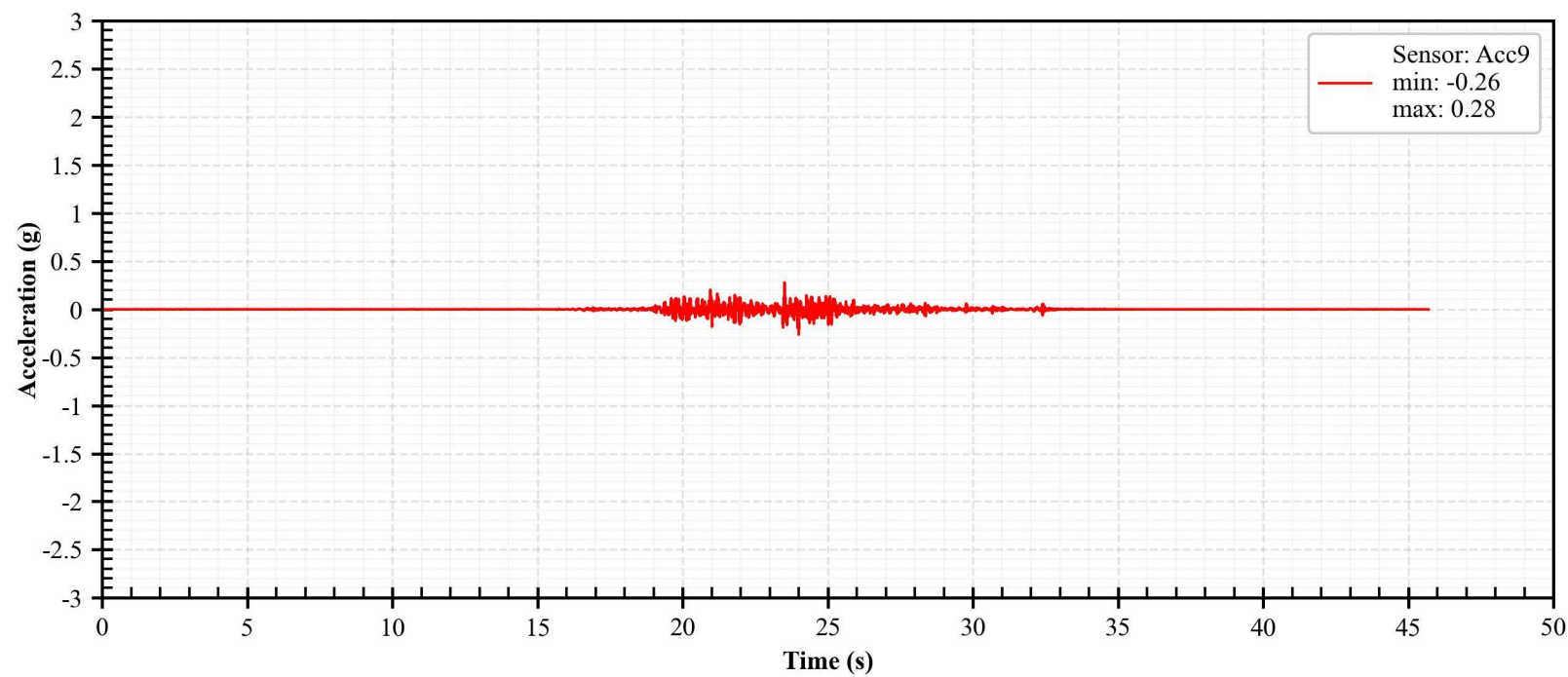


Figure 3.15.9 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 9

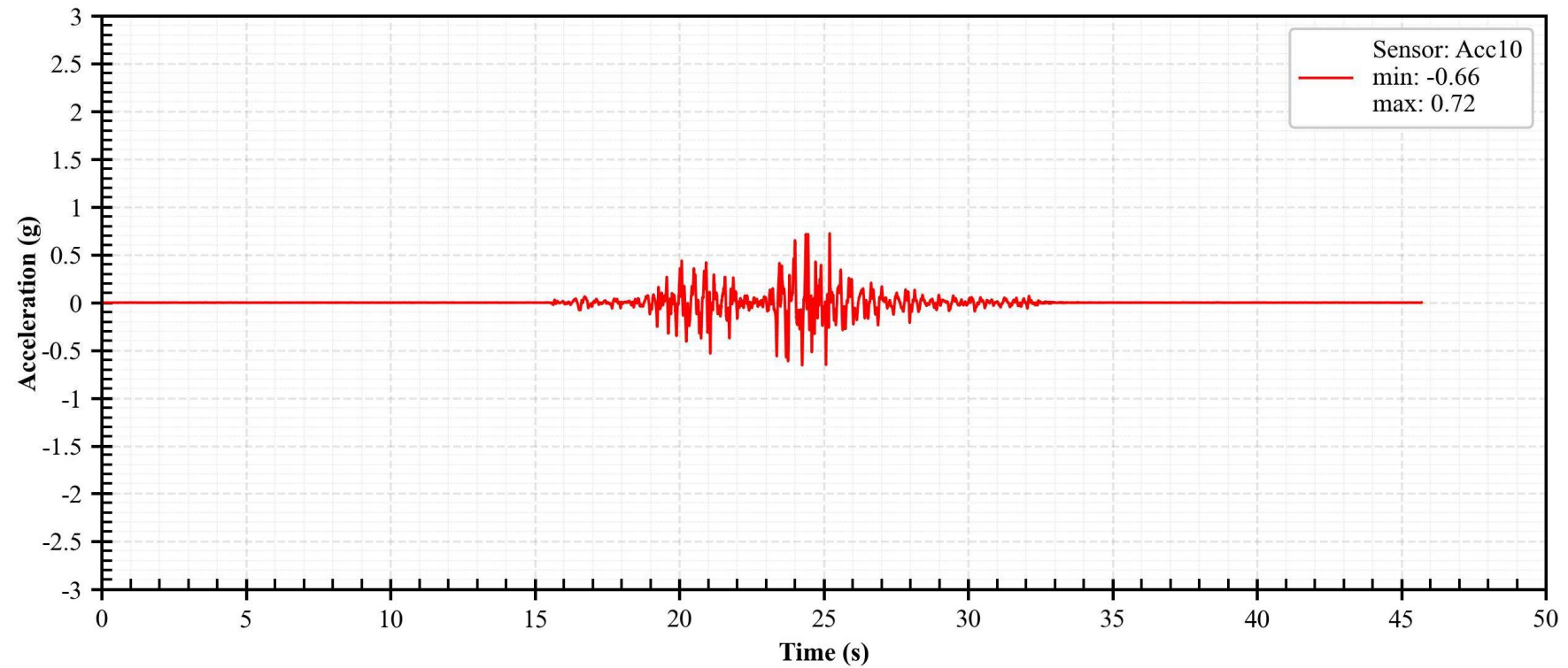


Figure 3.15.10 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 10

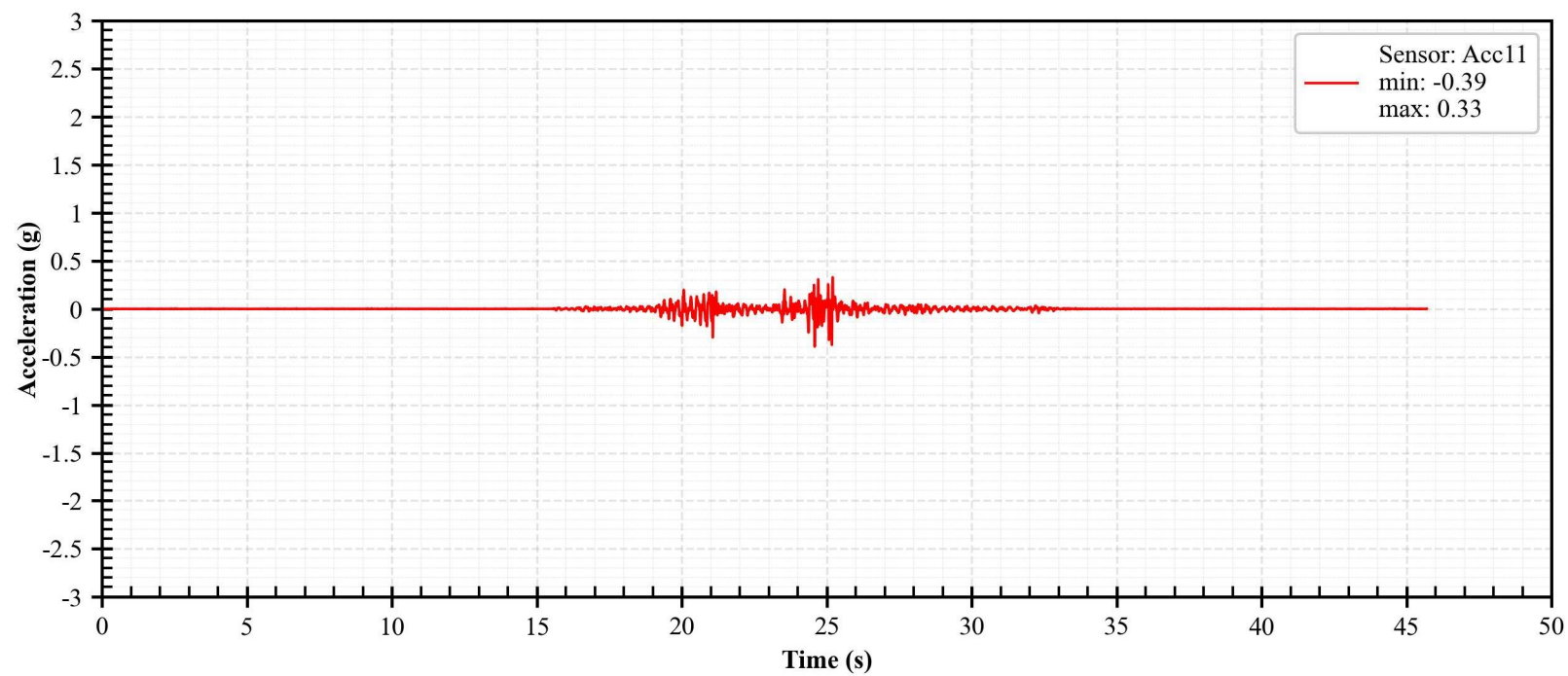


Figure 3.15.11 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 11

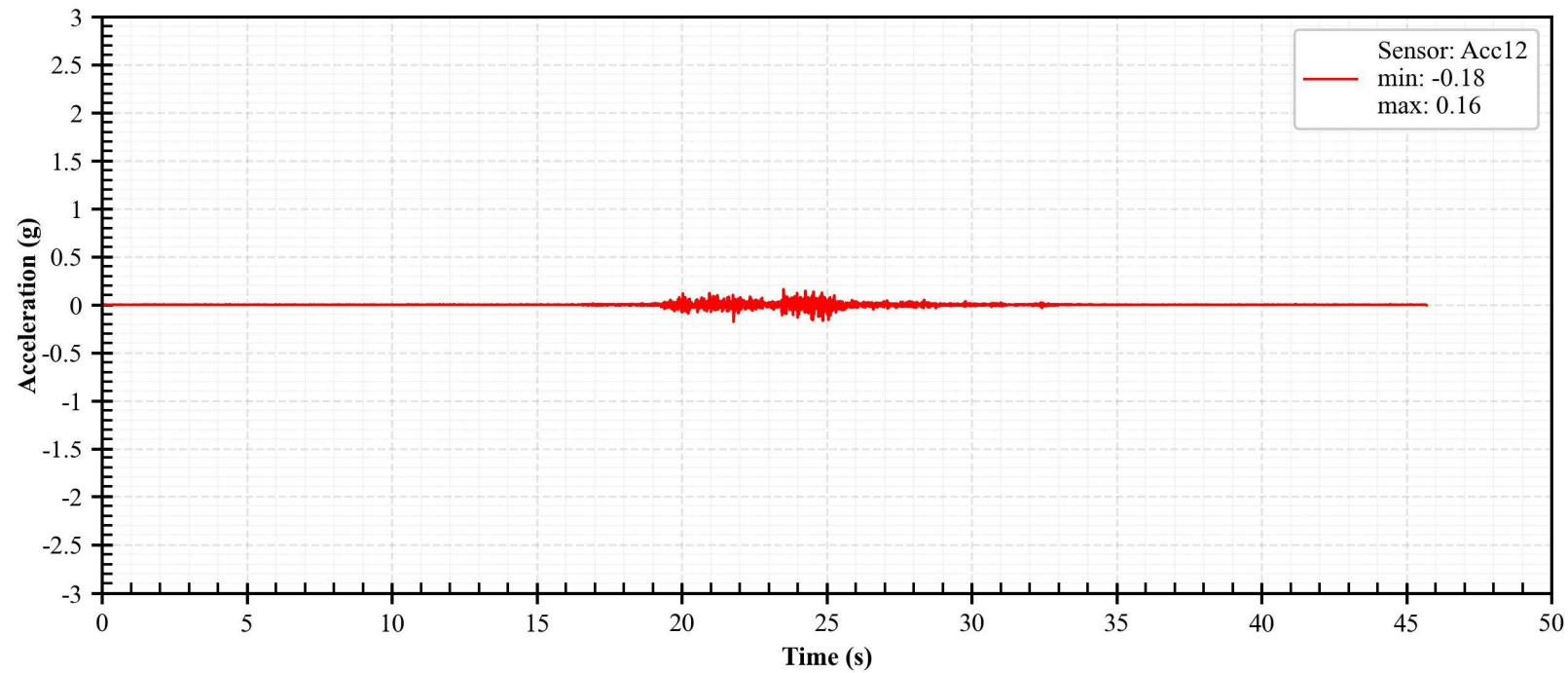


Figure 3.15.12 Characteristic results for phase B (earthquake EQ0,74g): Accelerometer 12

Draw wire sensors

Figures 3.15.13 – 3.15.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.66 mm while the minimum is -20.24 mm. The maximum movement detected by draw wire sensor W2 is 23.21 mm while the minimum is -20.30 mm. The maximum movement detected by draw wire sensor W3 is 16.69 mm while the minimum is -15.40 mm. The maximum movement detected by draw wire sensor W4 is 17.97 mm while the minimum is -14.62 mm. The maximum drift is $(10.27/1.225) = 8.55 \text{ ‰}$ and minimum drift is $(-10.48/1.225) = -8.35 \text{ ‰}$.

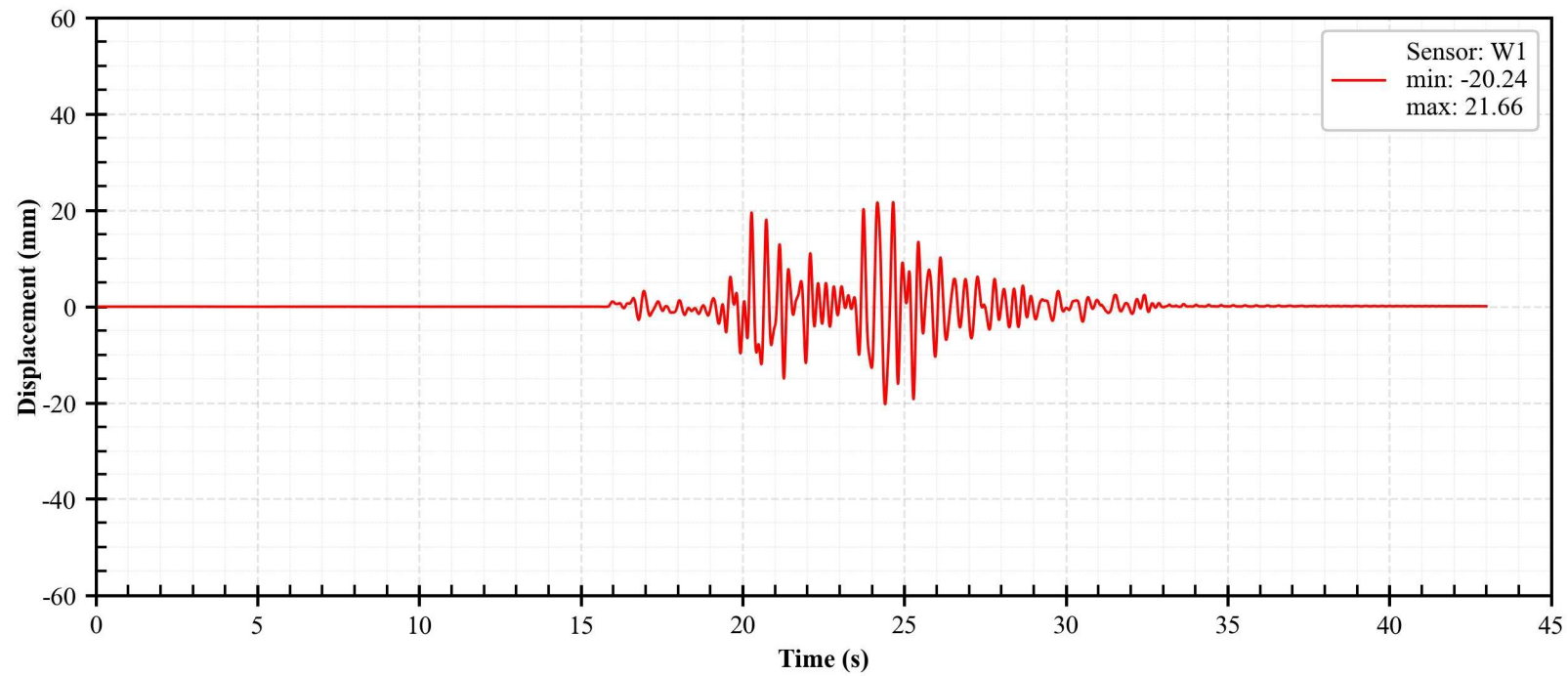


Figure 3.15.13 Characteristic results for phase B (earthquake EQ0,74g): Draw wire sensor 1

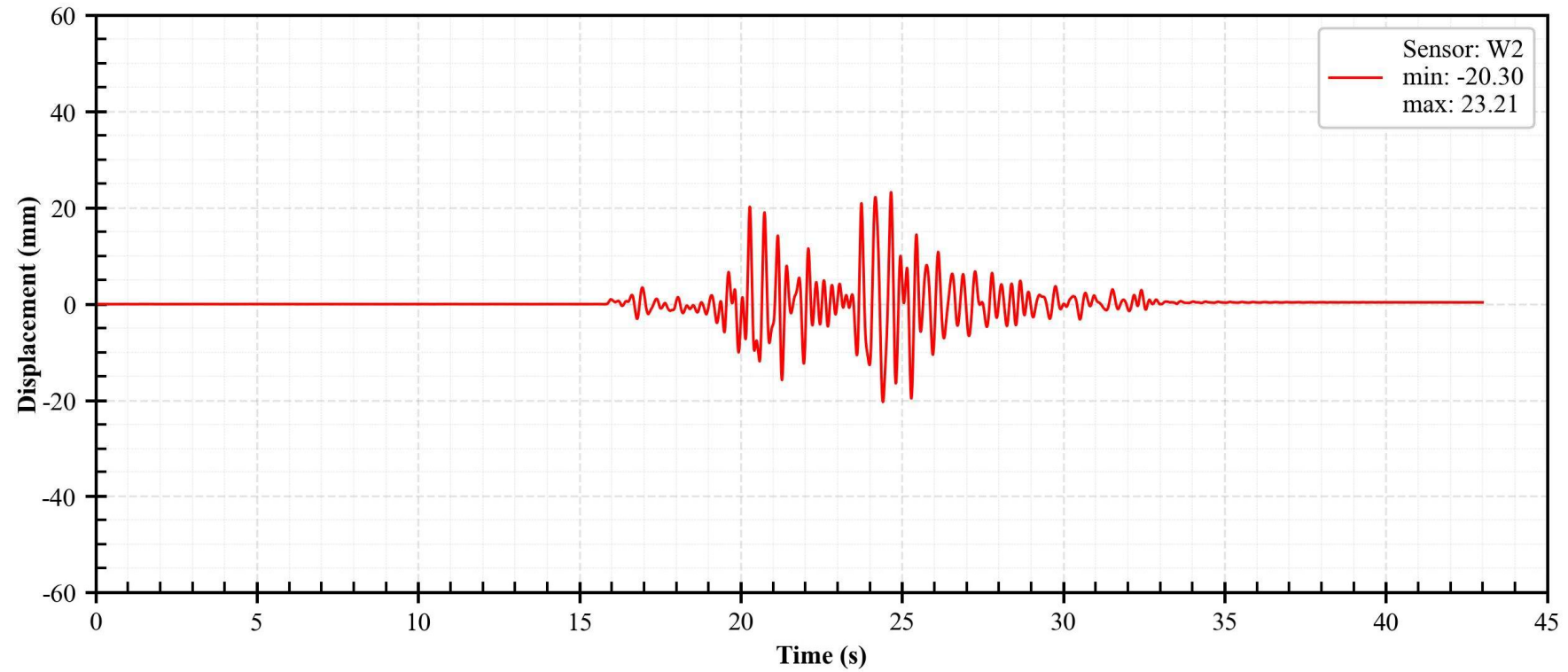


Figure 3.15.14 Characteristic results for phase B (earthquake EQ0,74g): Draw wire sensor 2

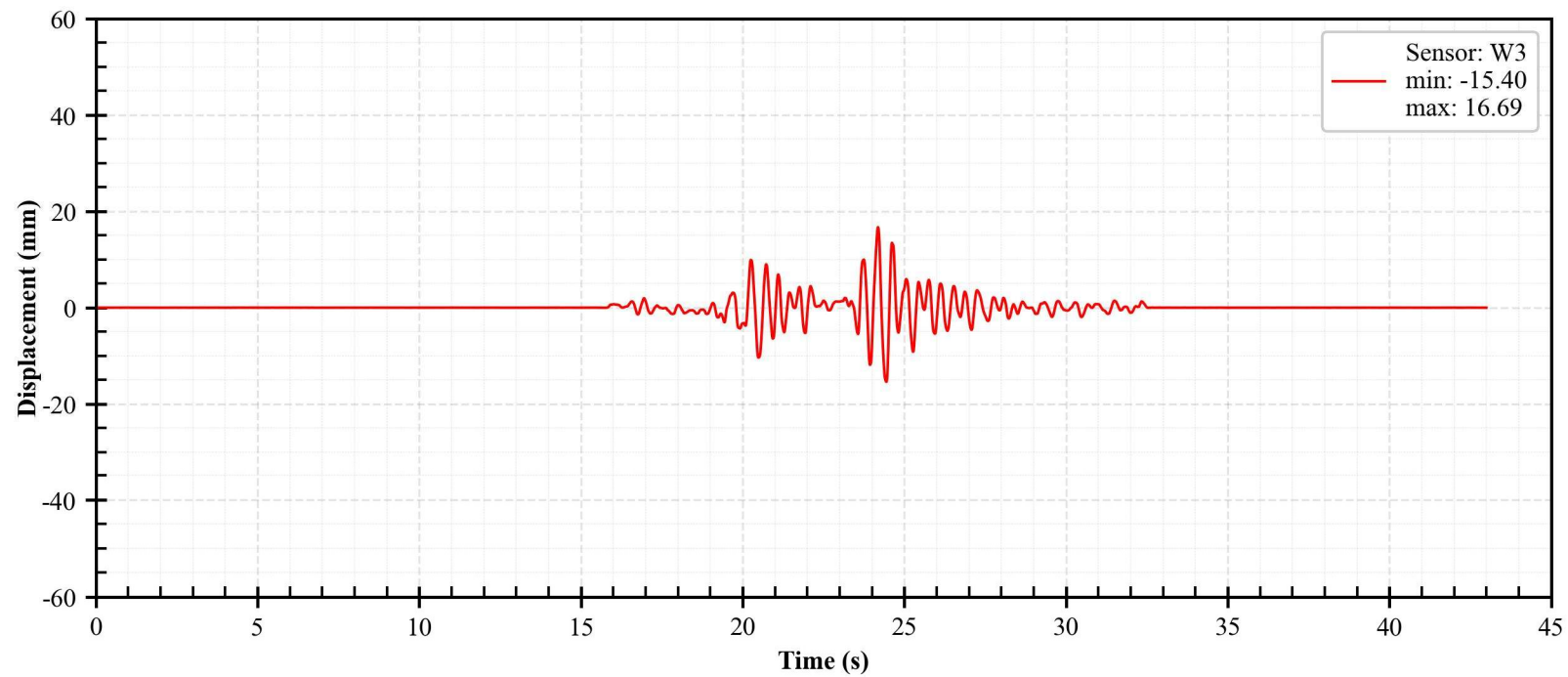


Figure 3.15.15 Characteristic results for phase B (earthquake EQ0,74g): Draw wire sensor 3

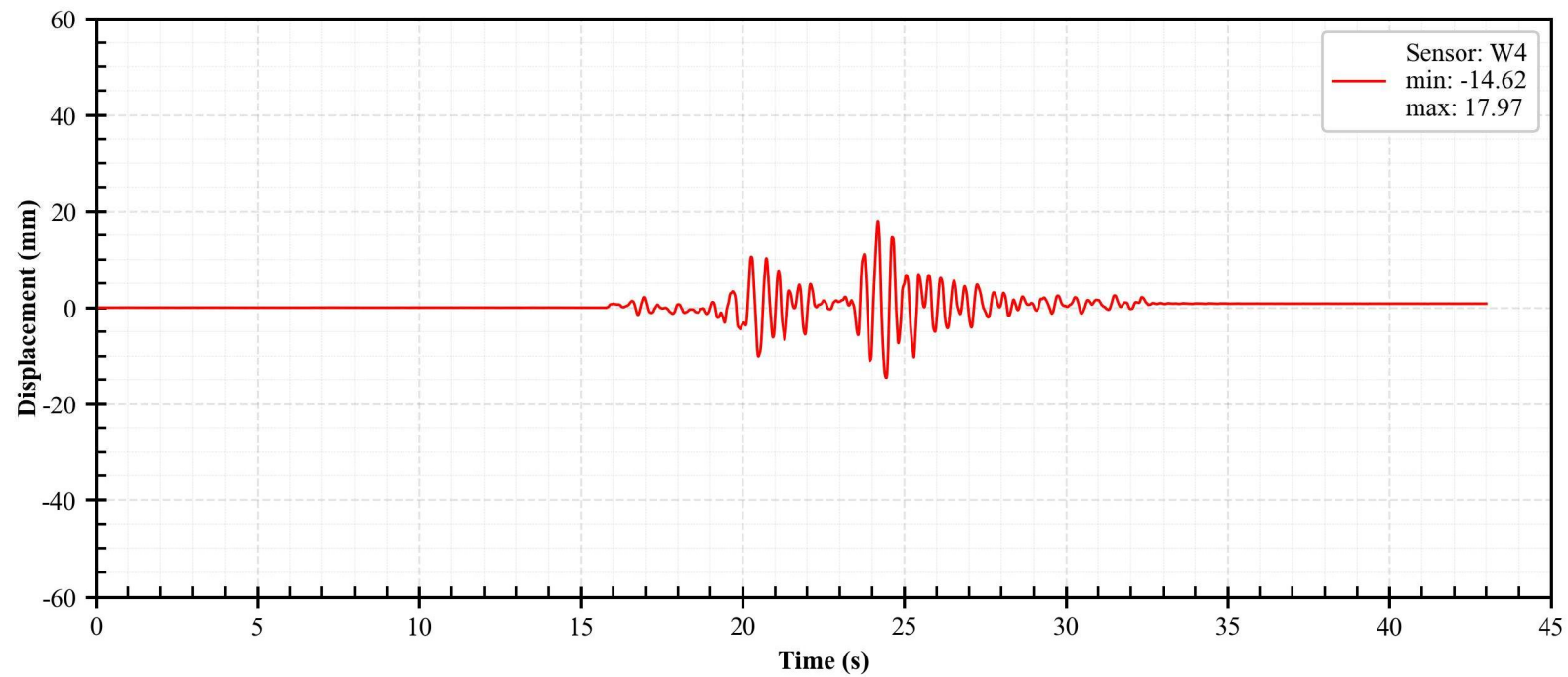


Figure 3.15.16 Characteristic results for phase B (earthquake EQ0,74g): Draw wire sensor 4

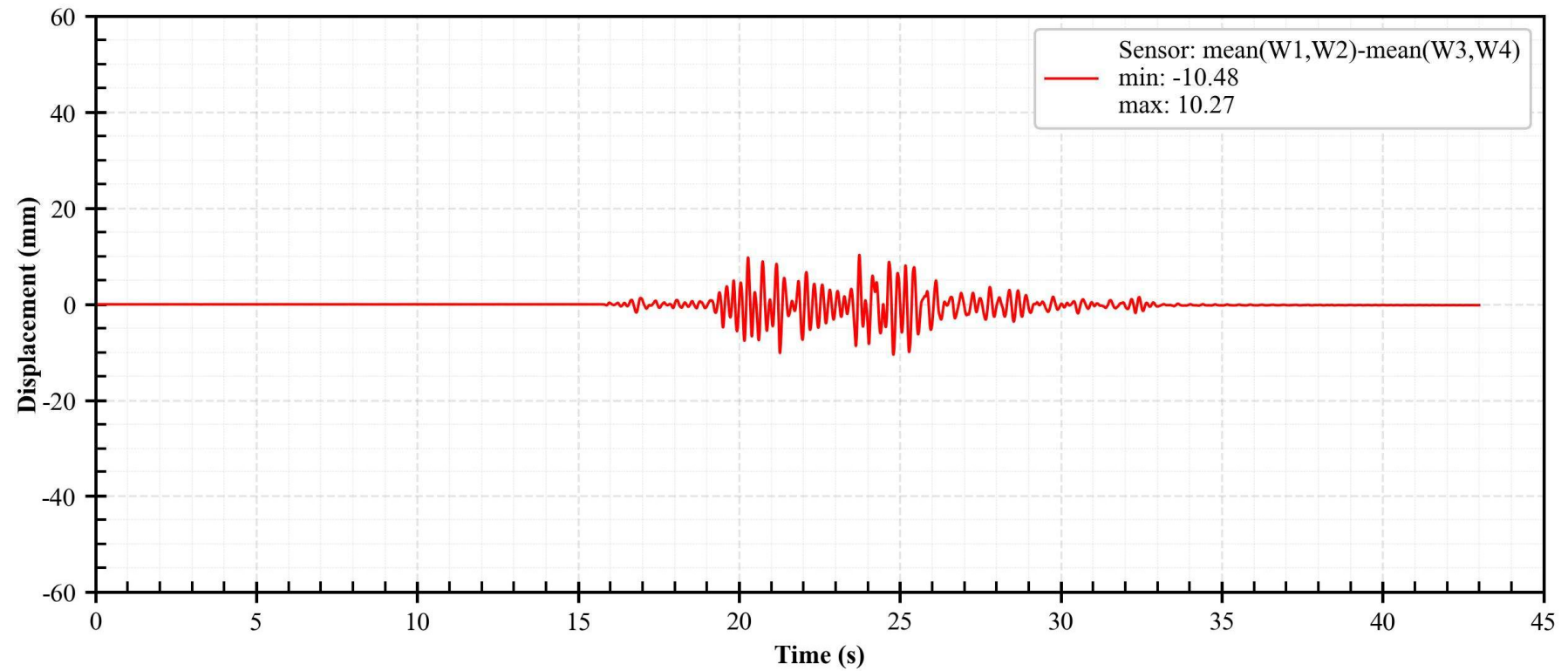


Figure 3.15.17 Characteristic results for phase B (earthquake EQ0,74g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.15.18, 3.15.19, 3.15.20, 3.15.21, 3.15.22, 3.15.23, 3.15. 32, 3.15.33 are located on the longitudinal reinforcement, at the bottom of the column. Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. The strain gauges shown in the figures 3.15.24, 3.15.25, 3.15.26, 3.15.27, 3.15.28, 3.15.29 and 3.15.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 1773 μ strain and minimum strain -639 μ strain. The residual strain is 24 μ strain. SG21 & SG22 are located on PUFJ.

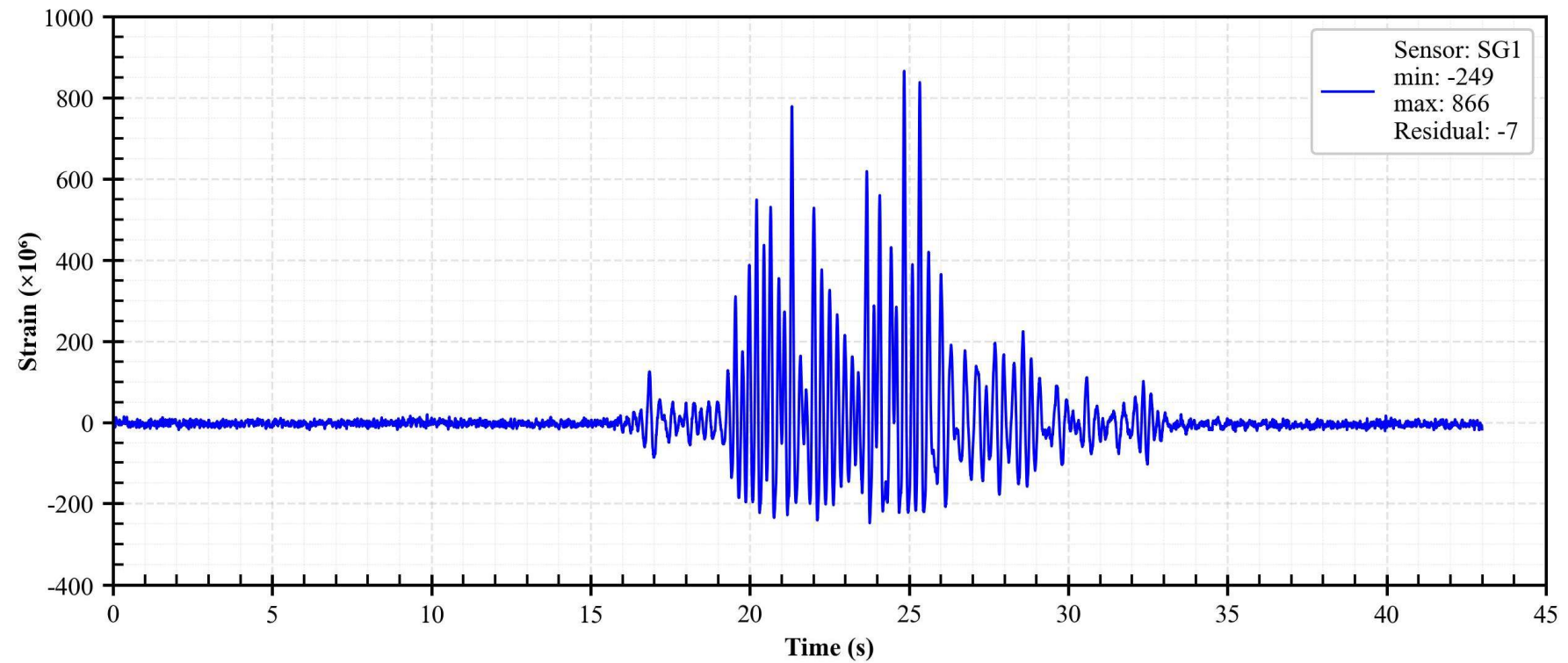


Figure 3.15.18 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 1

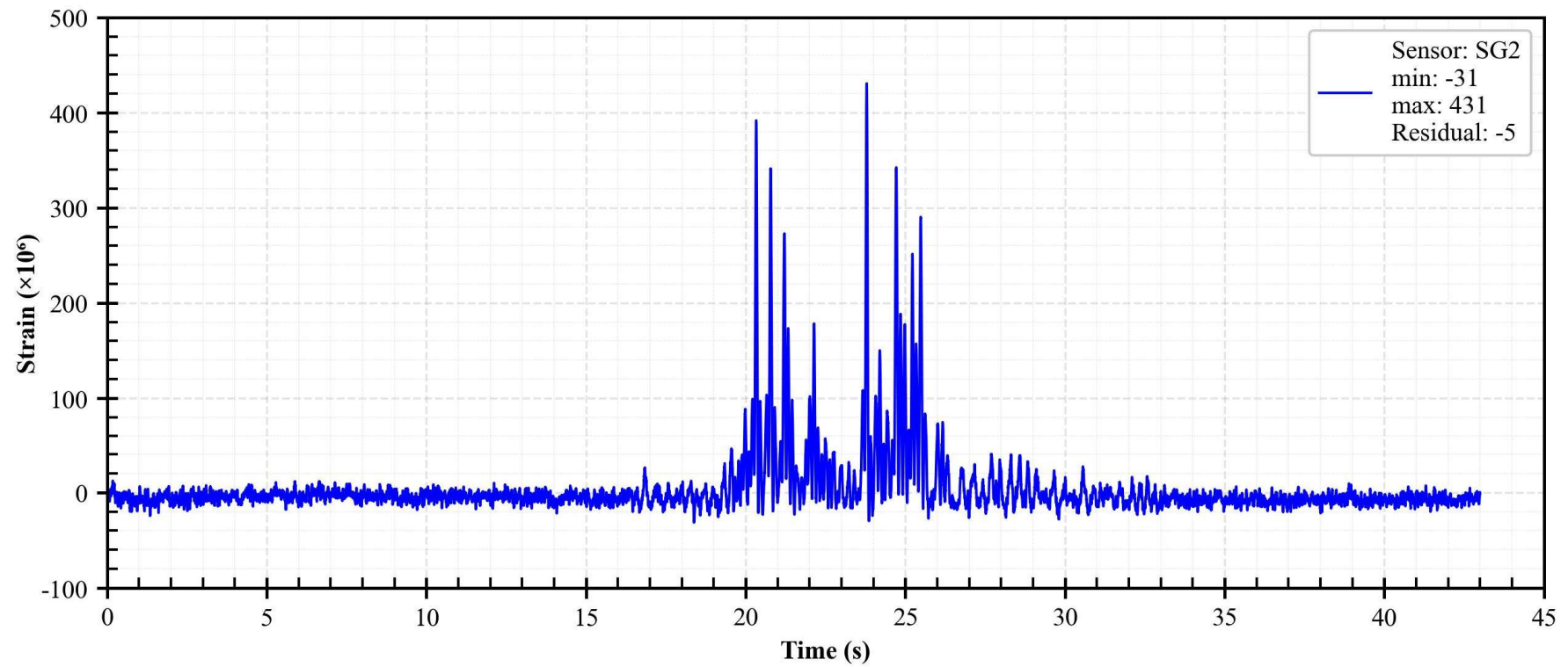


Figure 3.15.19 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 2

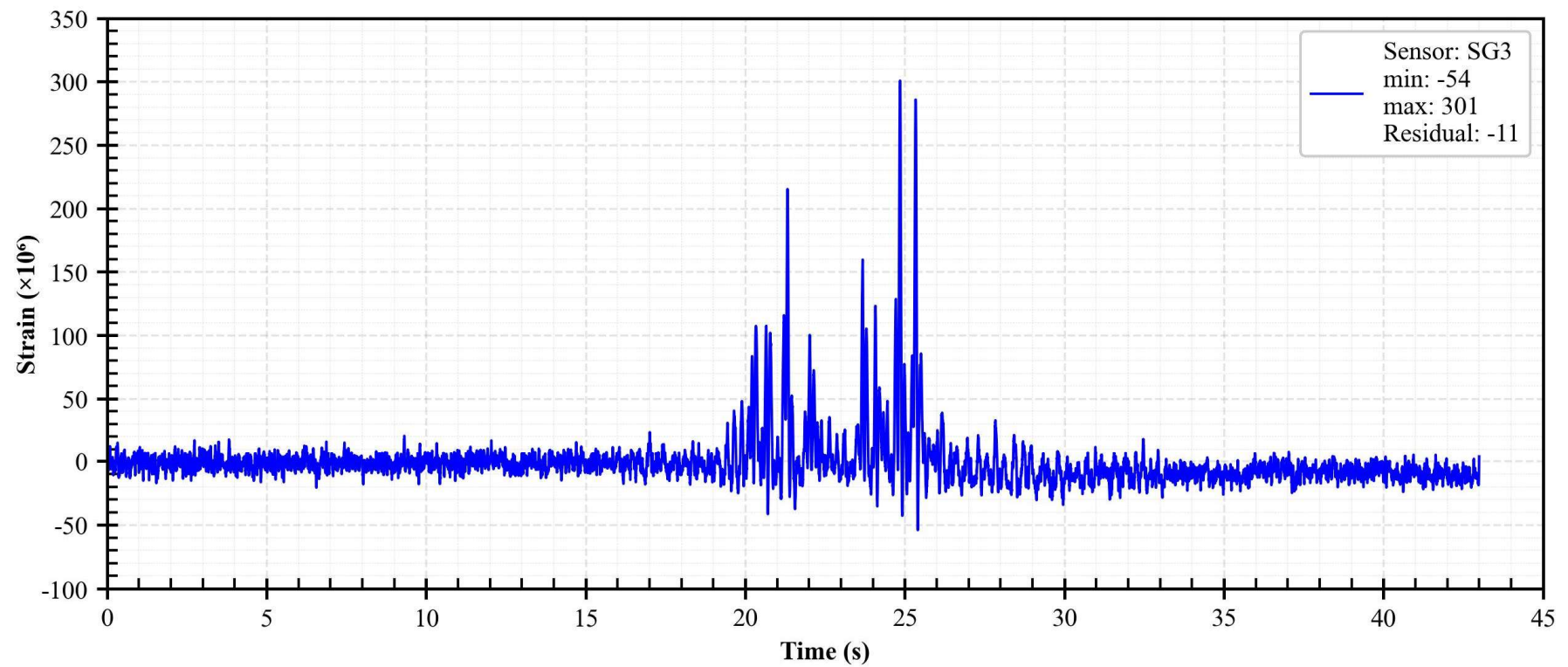


Figure 3.15.20 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 3

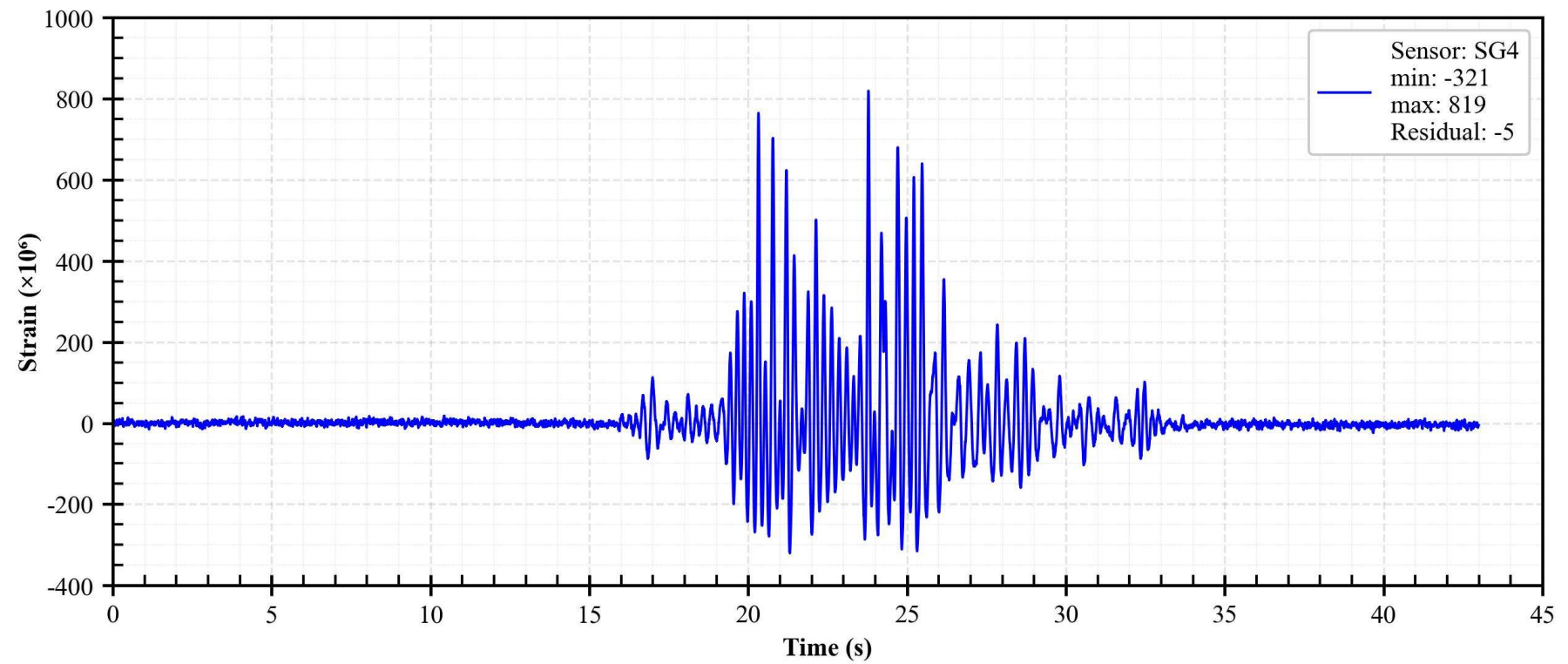


Figure 3.15.21 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 4

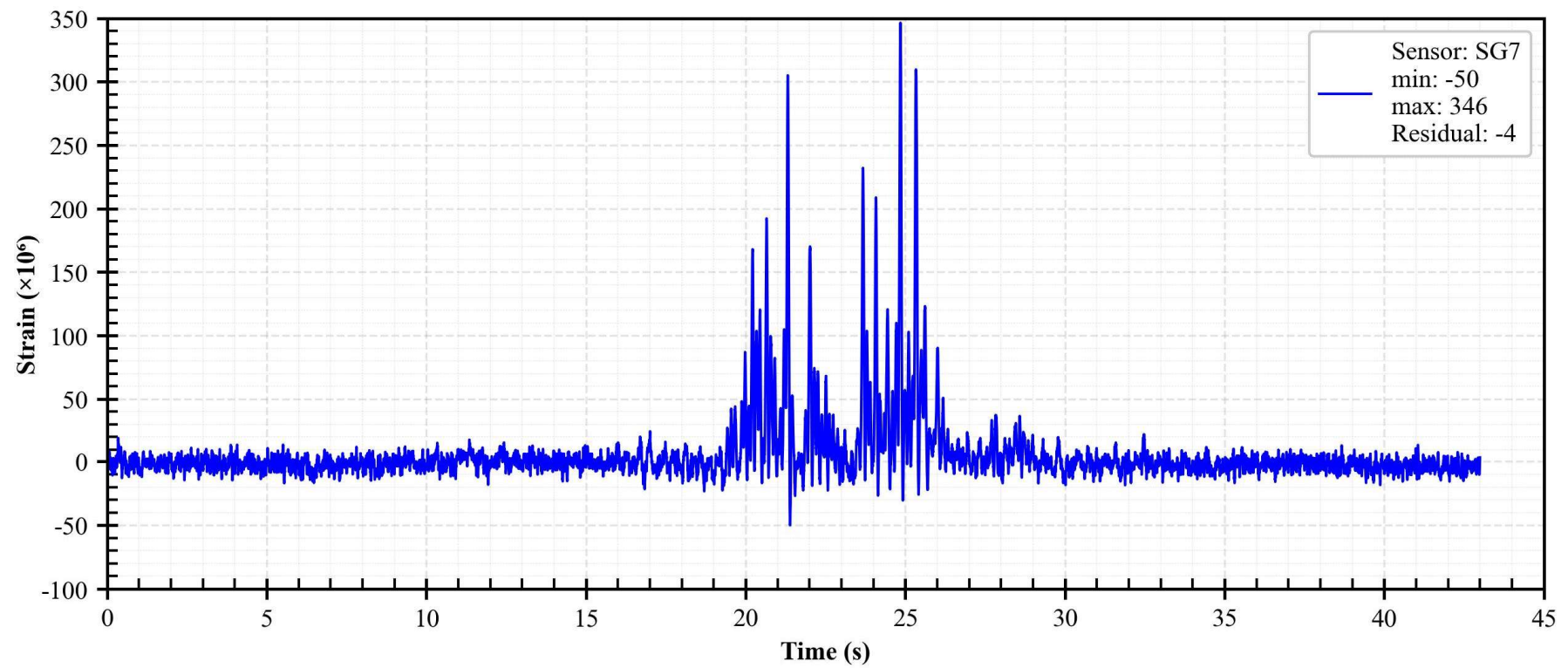


Figure 3.15.22 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 7

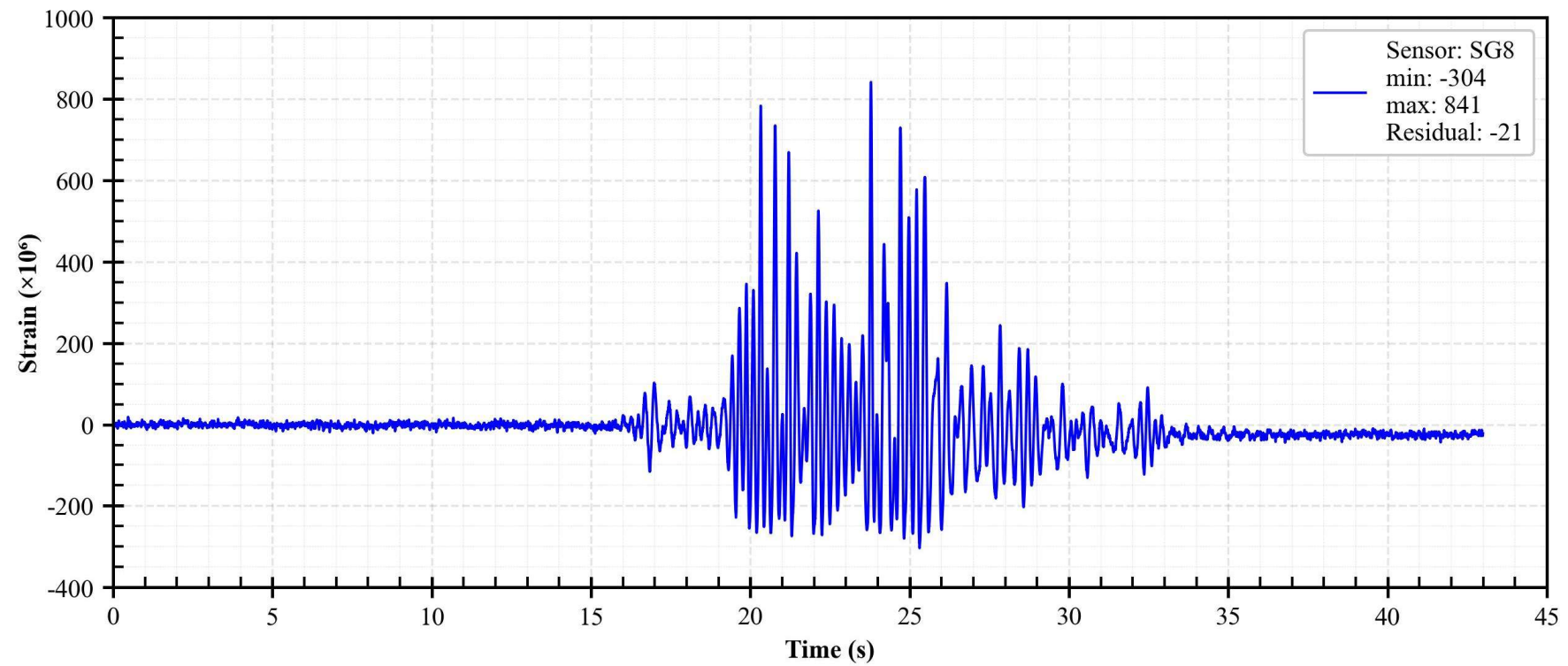


Figure 3.15.23 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 8

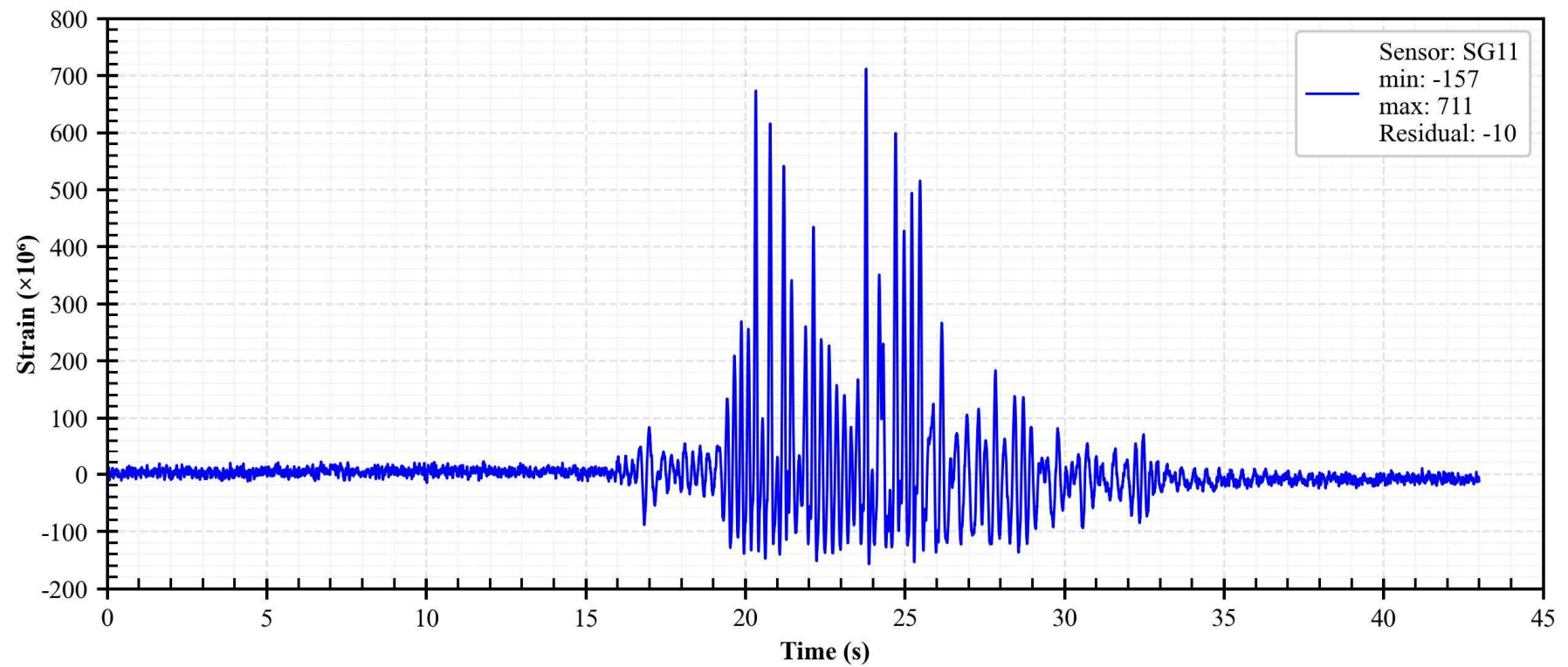


Figure 3.15.24 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 11

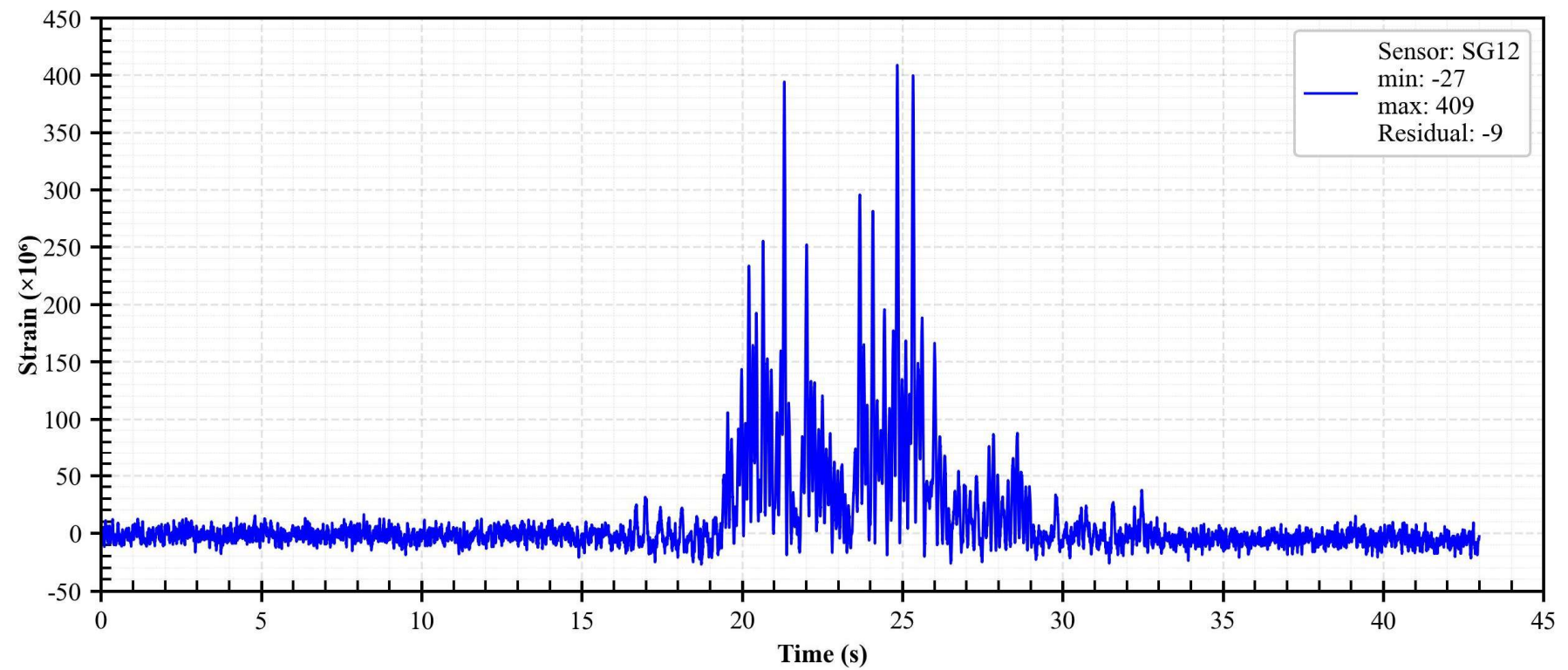


Figure 3.15.25 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 12

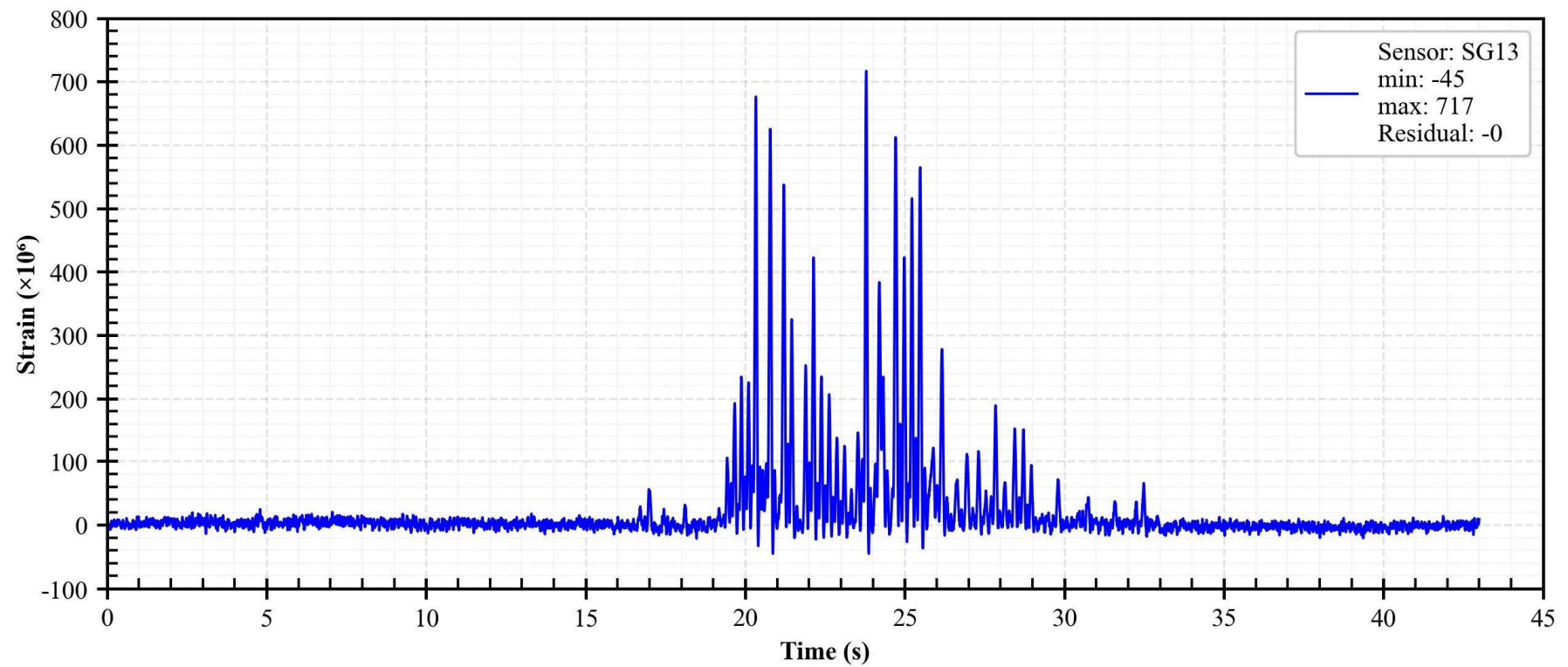


Figure 3.15.26 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 13

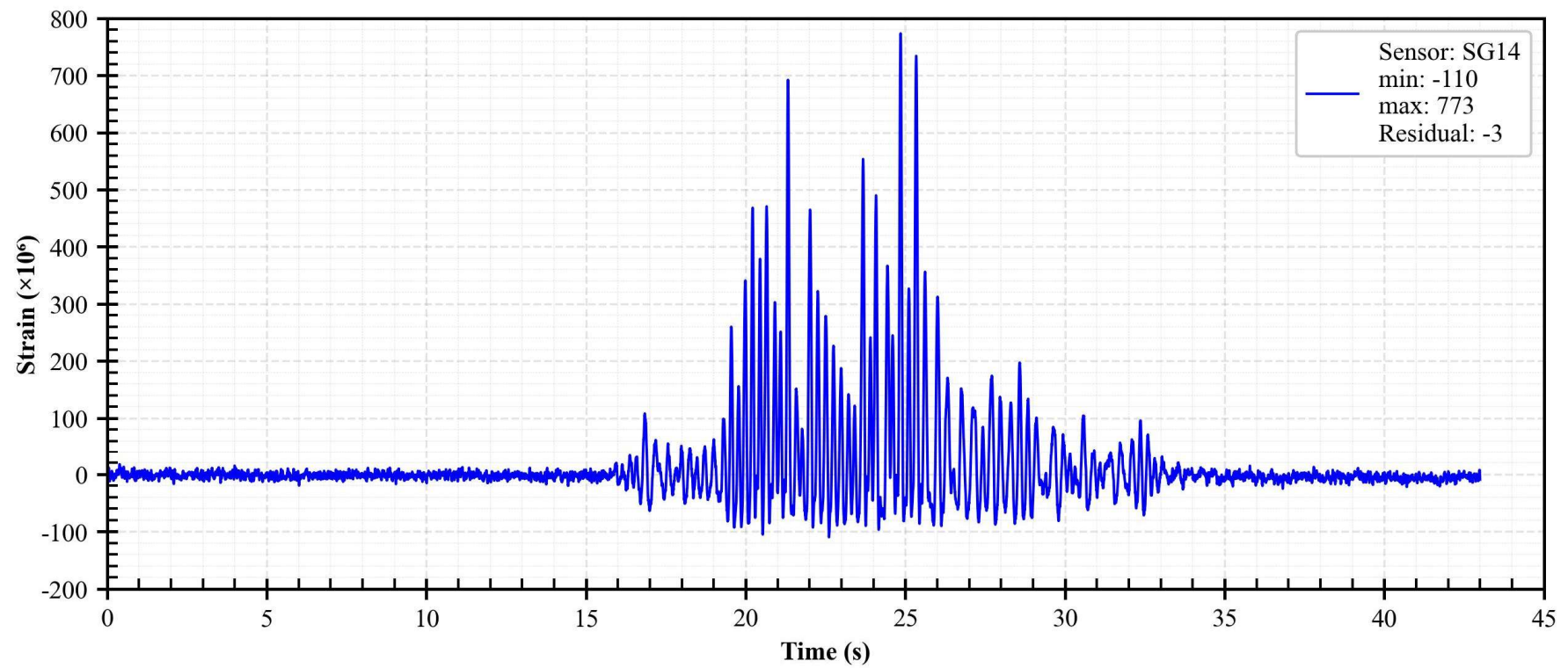


Figure 3.15.27 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 14

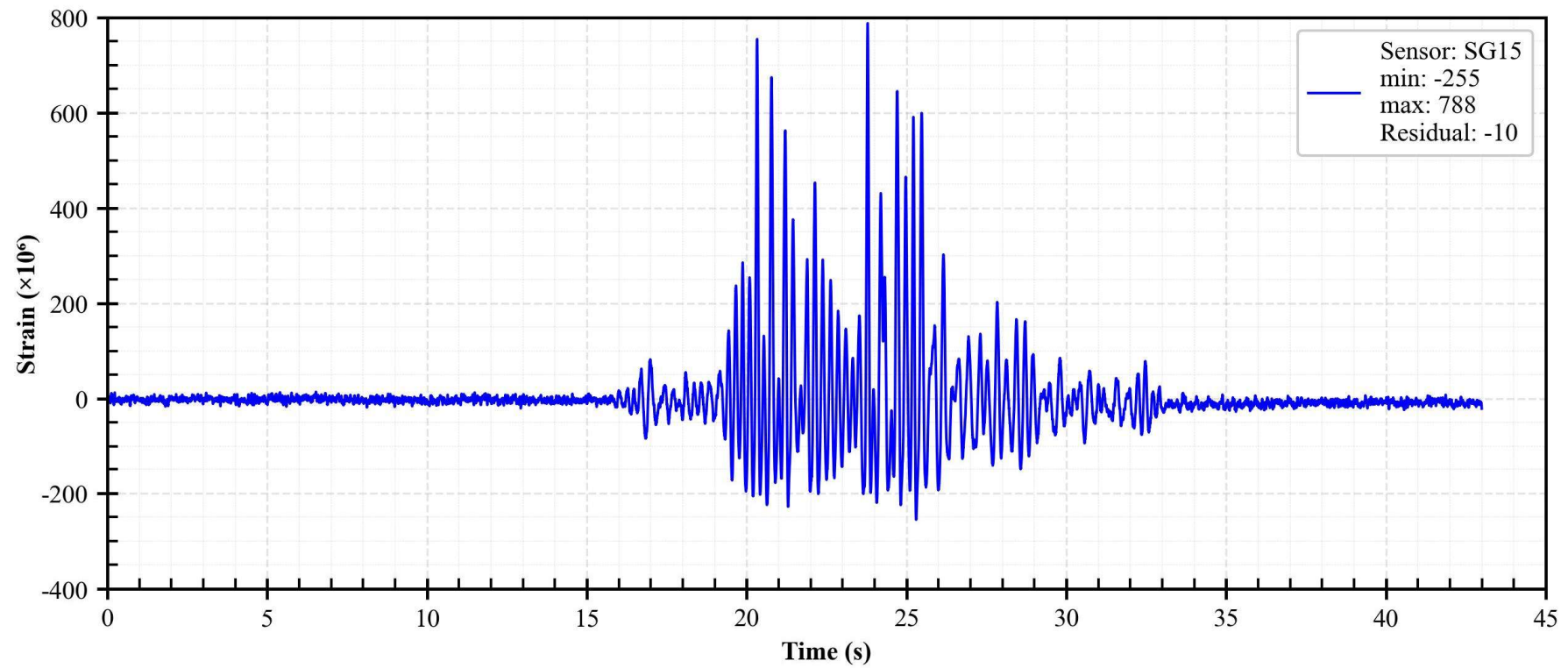


Figure 3.15.28 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 15

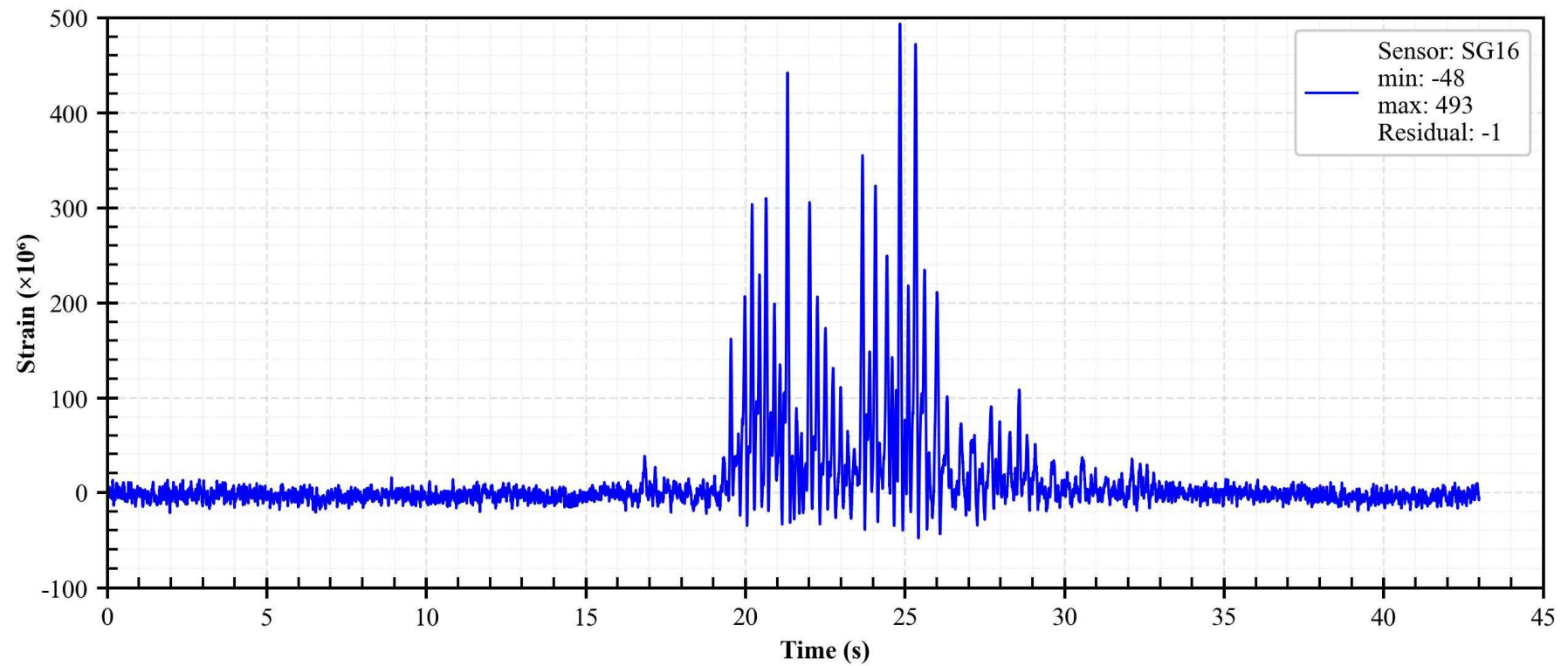


Figure 3.15.29 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 16

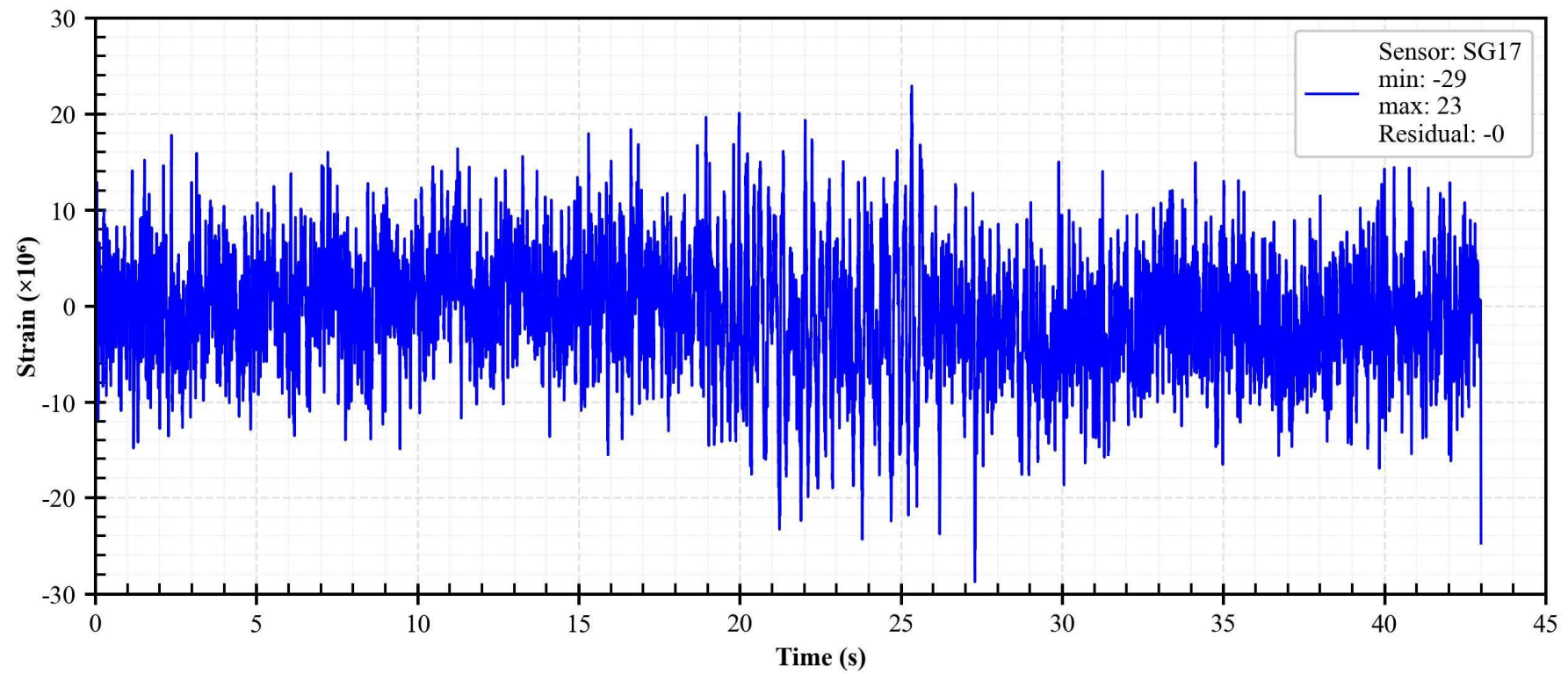


Figure 3.15.30 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 17

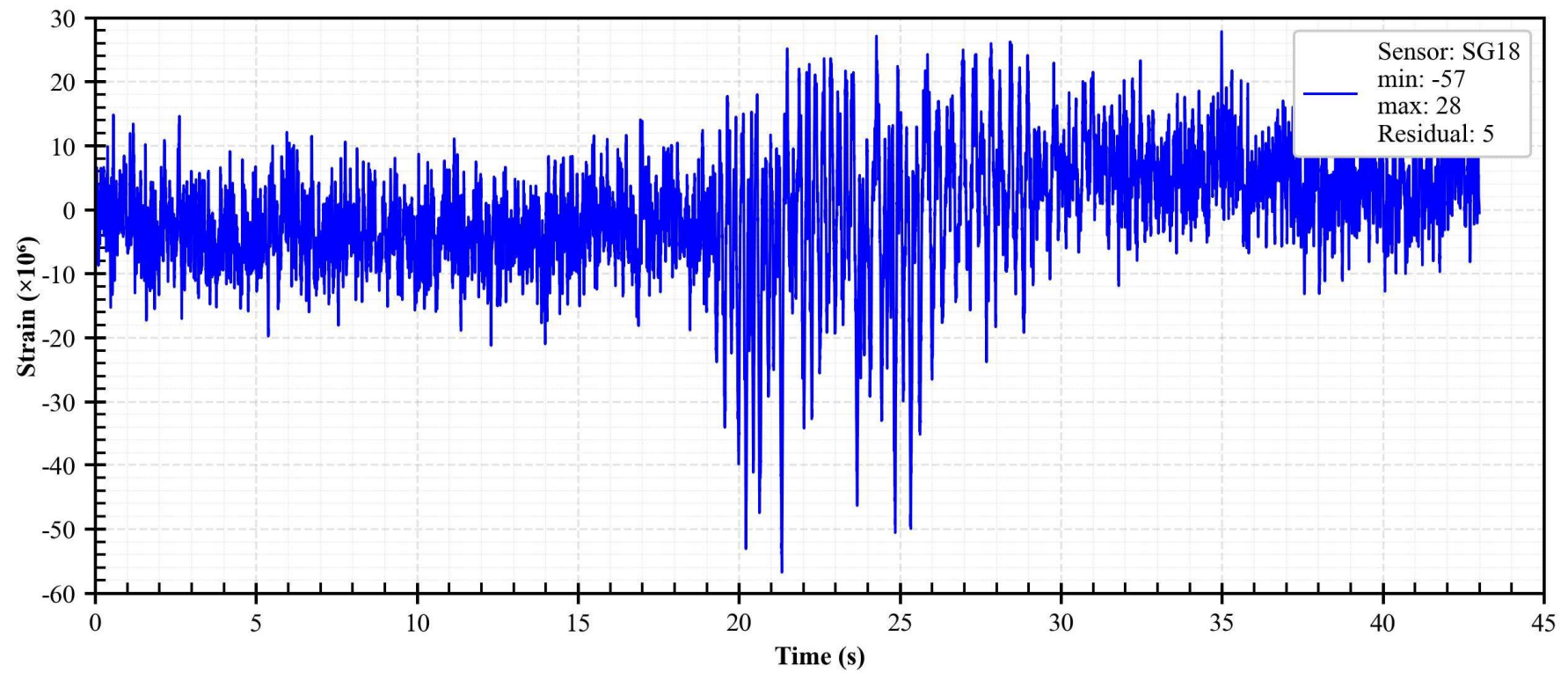


Figure 3.15.31 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 18

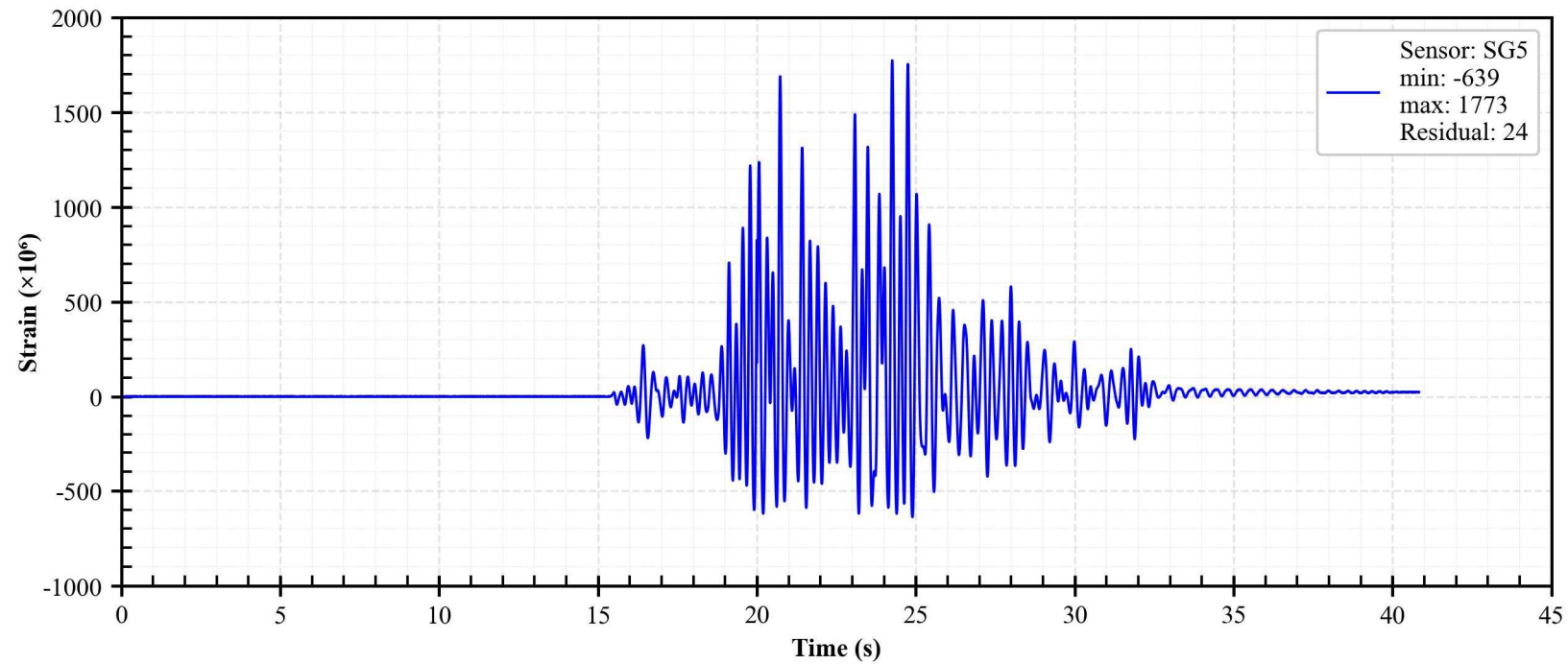


Figure 3.15.32 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 5

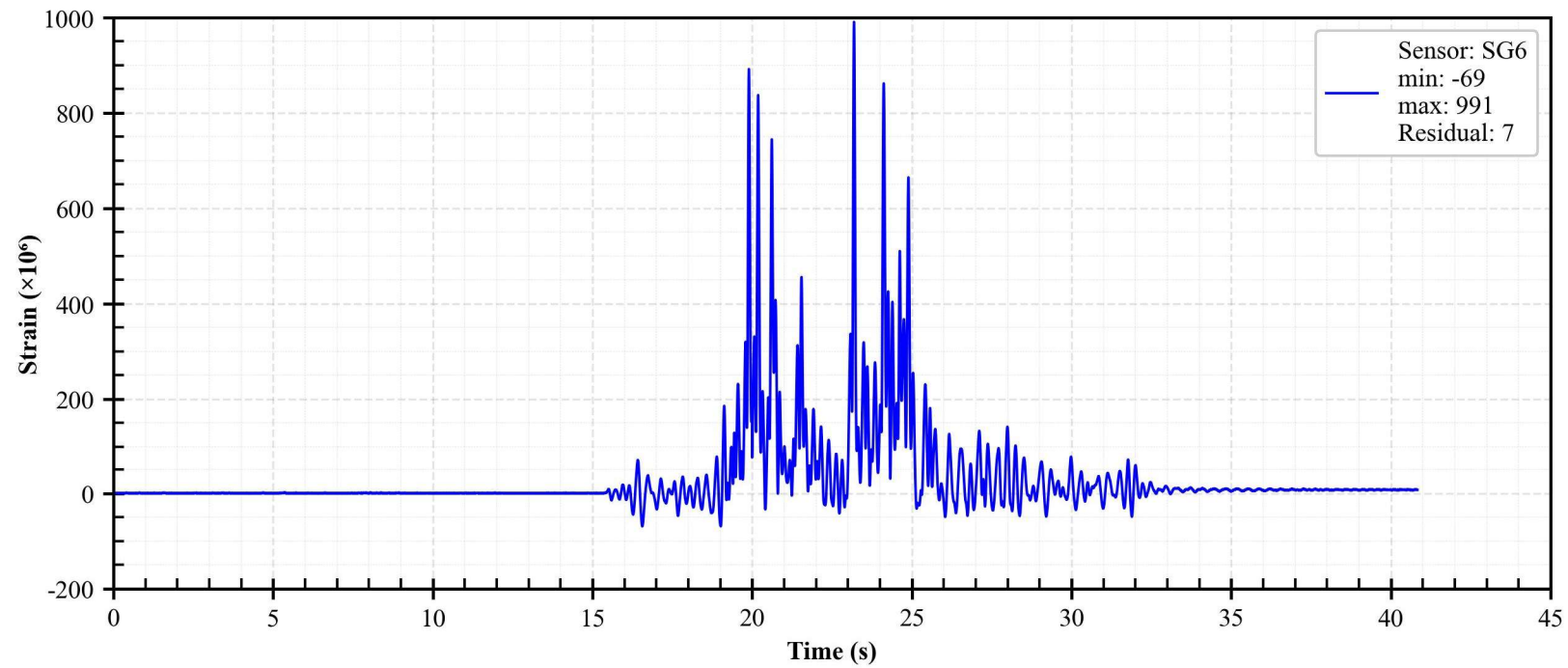


Figure 3.15.33 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 6

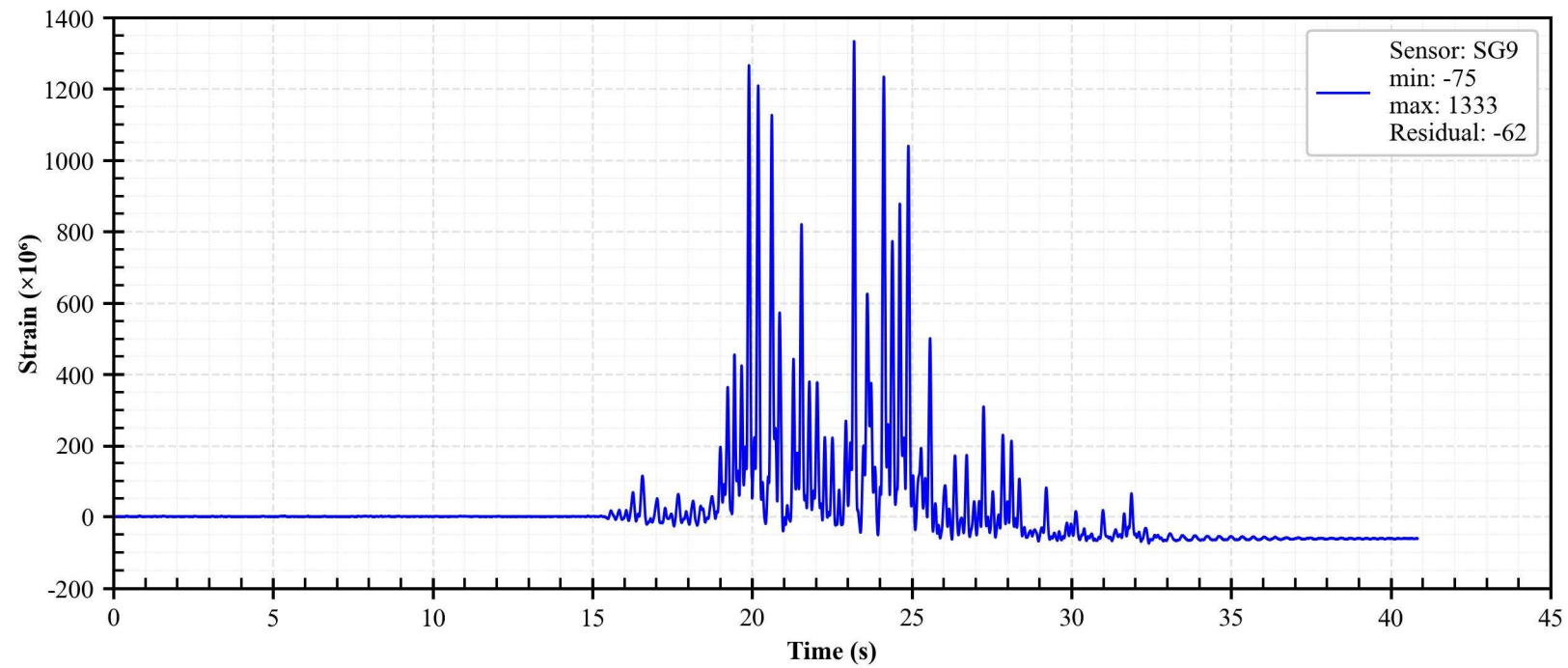


Figure 3.15.34 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 9

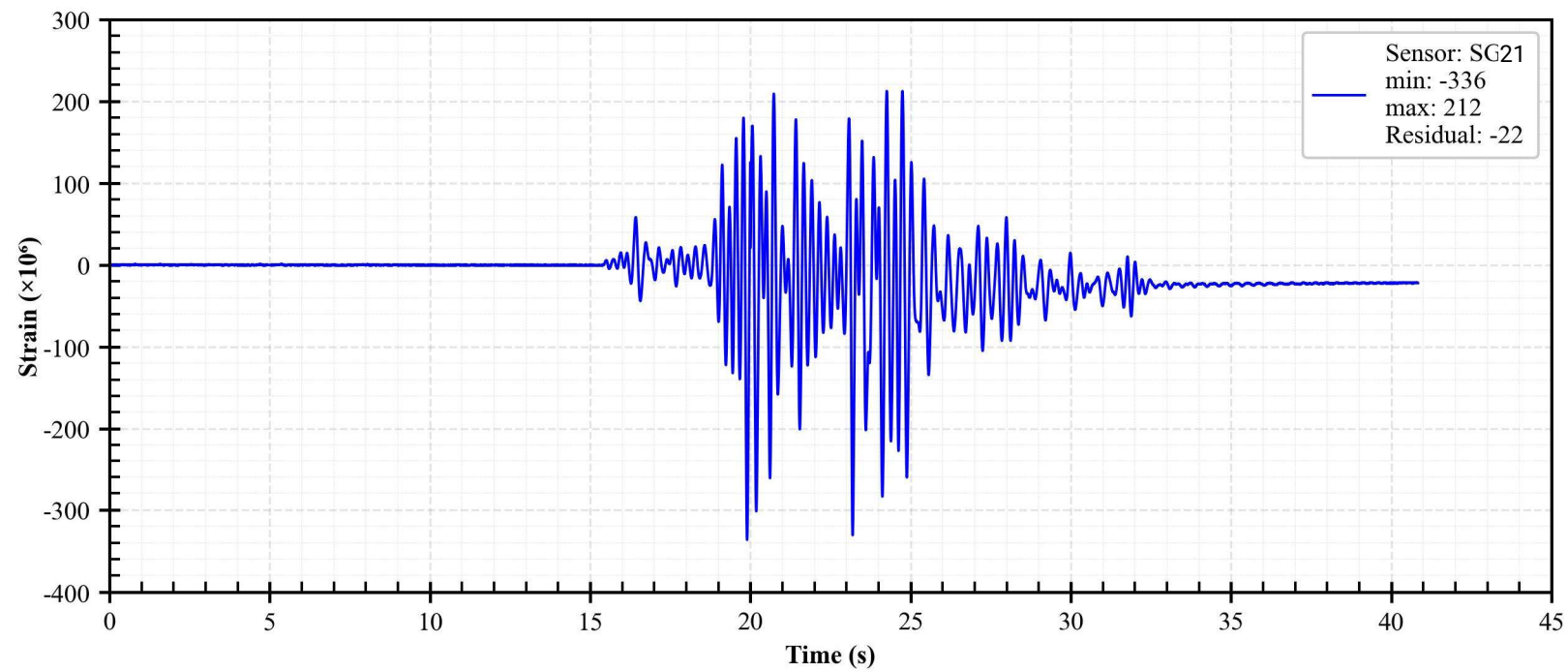


Figure 3.15.35 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 21 (PUFJ, column 1)

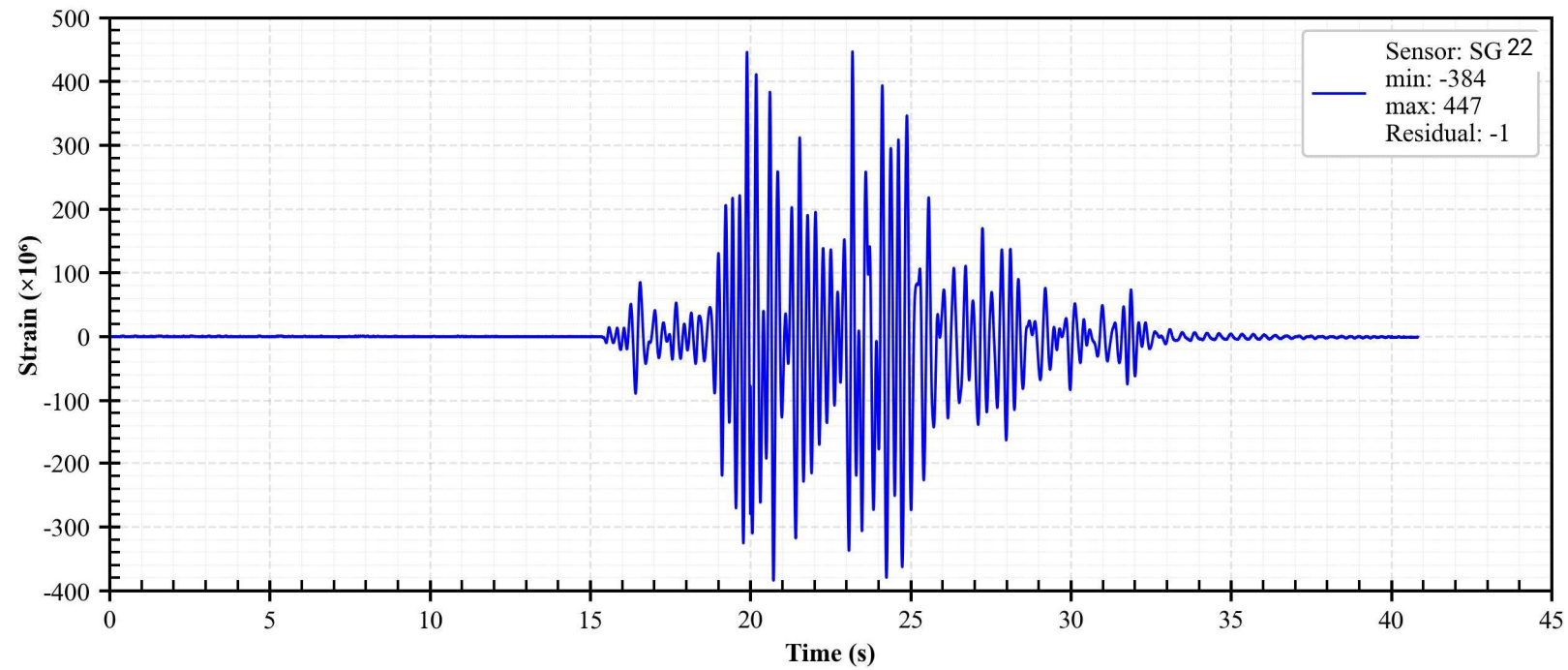


Figure 3.15.36 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 22 (PUFJ, column 2)

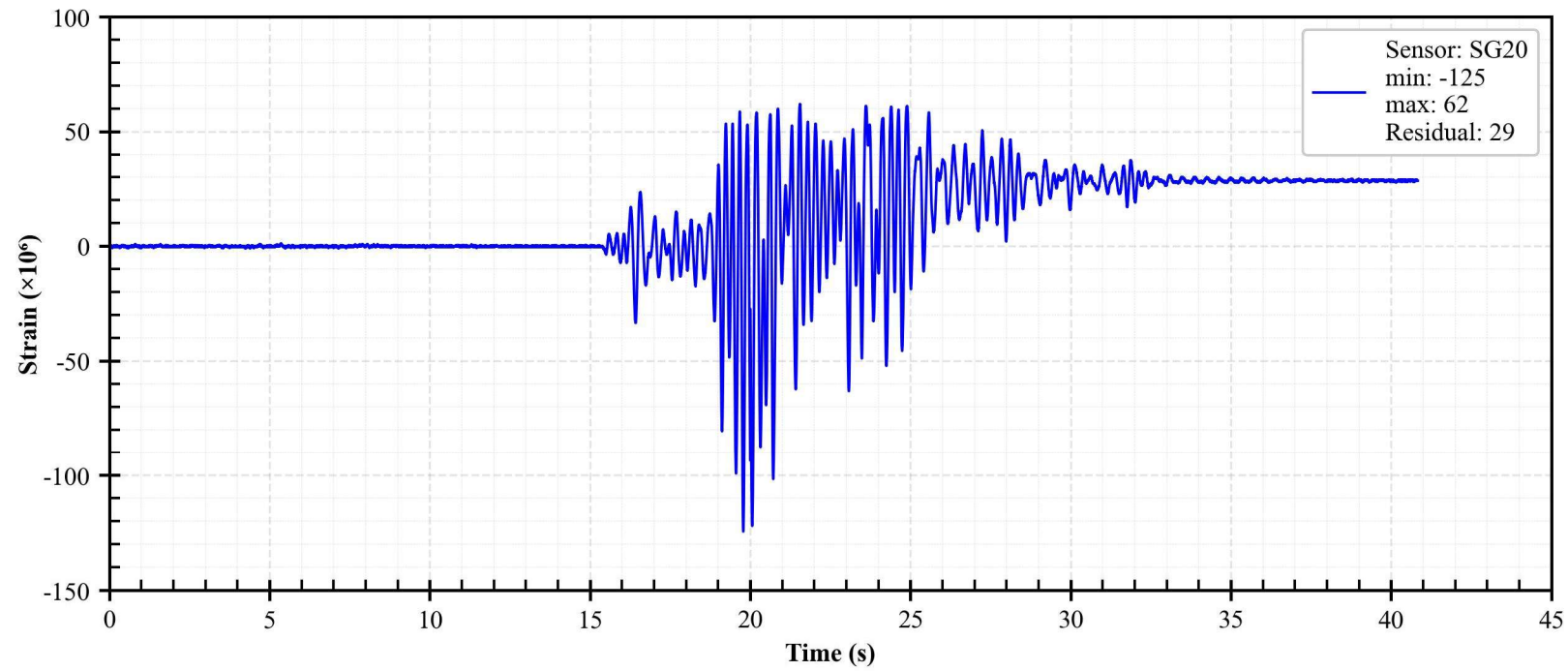


Figure 3.15.37 Characteristic results for phase B (earthquake EQ0,74g): strain gauge 20

3.16 White noise before EQ0,8g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ0,8g. The max acceleration at the slab level on the accelerometer acc4 is 0.17g. The max acceleration at the foundation level on the accelerometer acc10 is 0.07g.

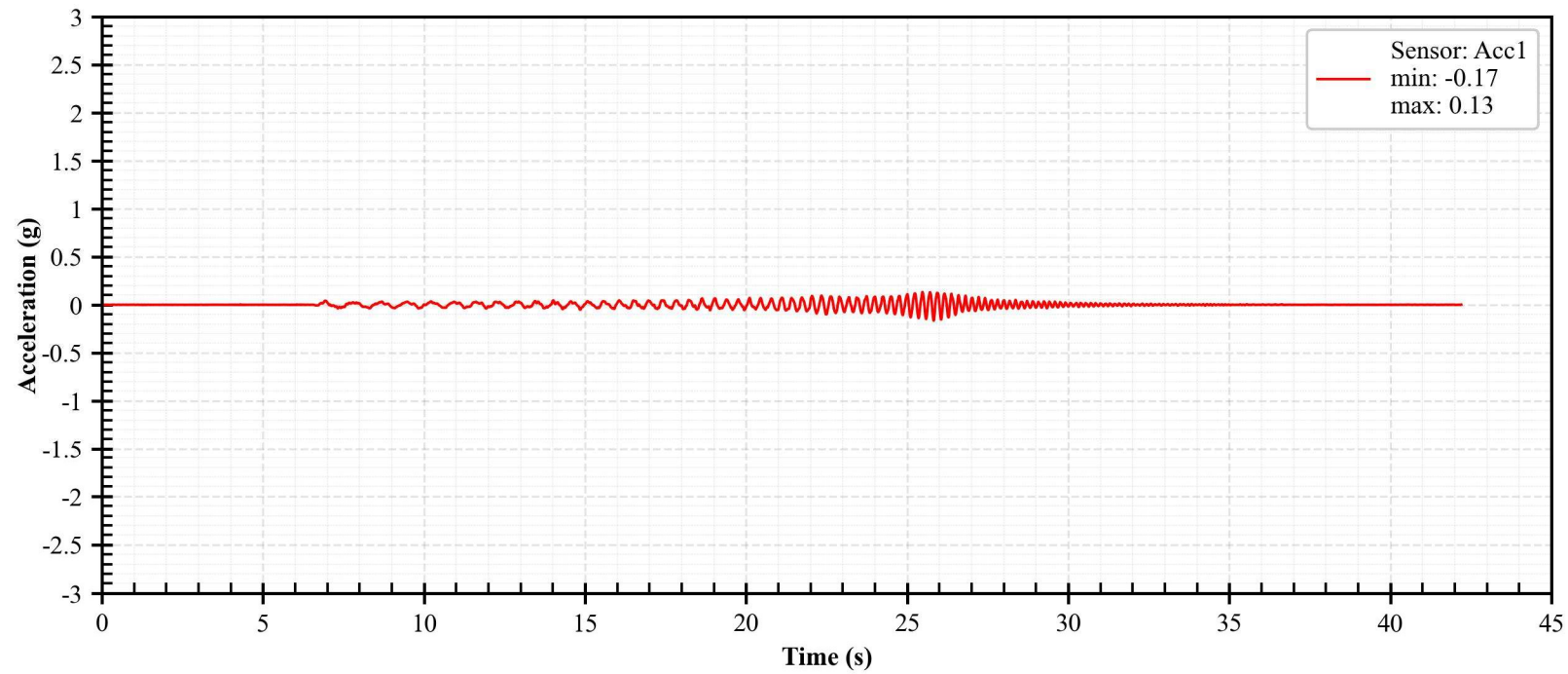


Figure 3.16.1 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 1

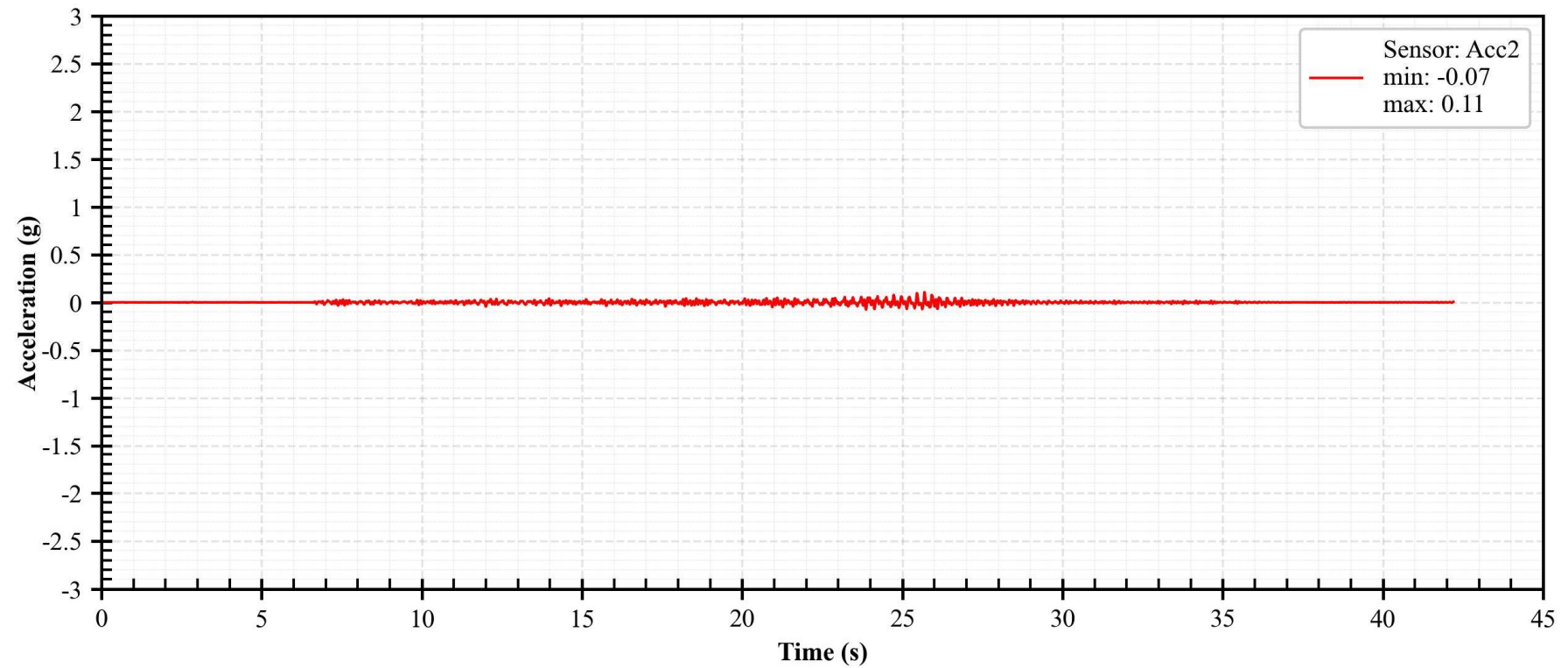


Figure 3.16.2 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 2

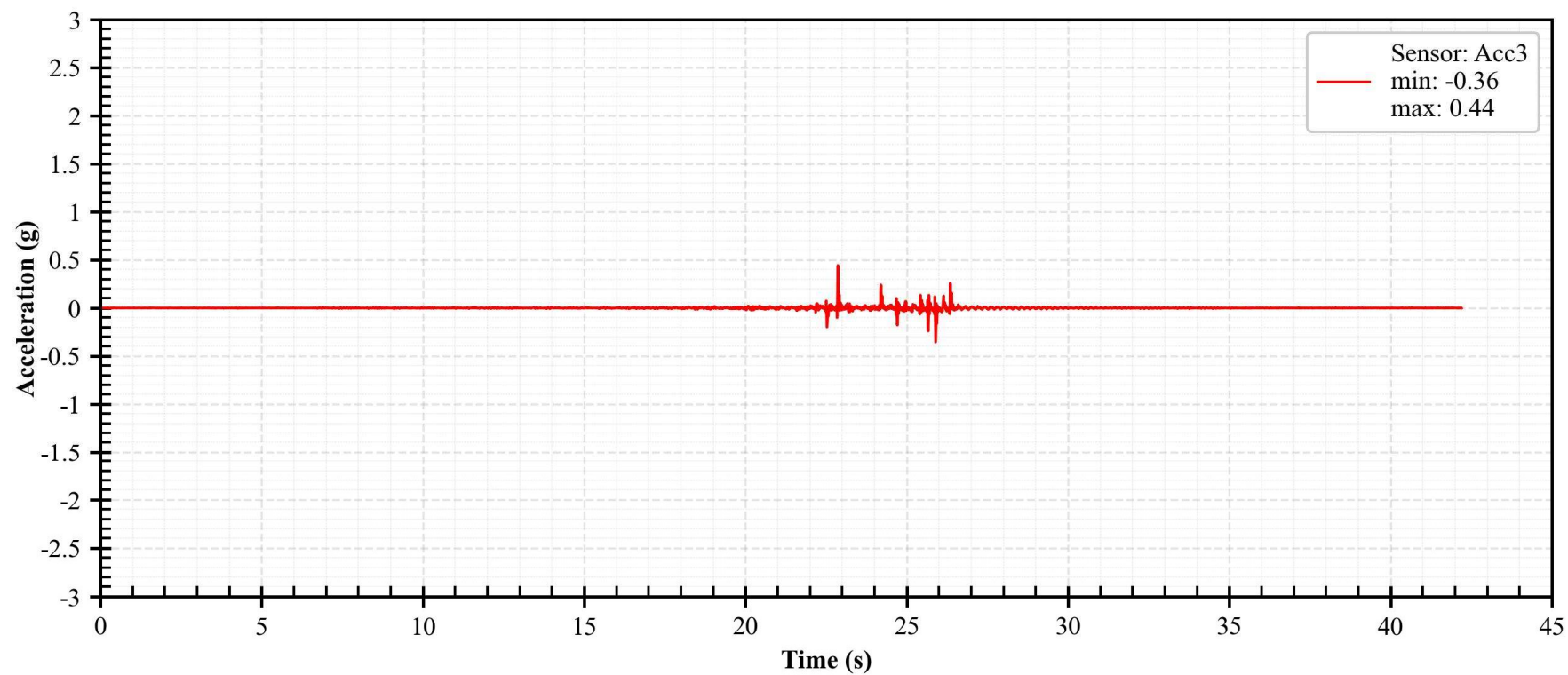


Figure 3.16.3 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 3

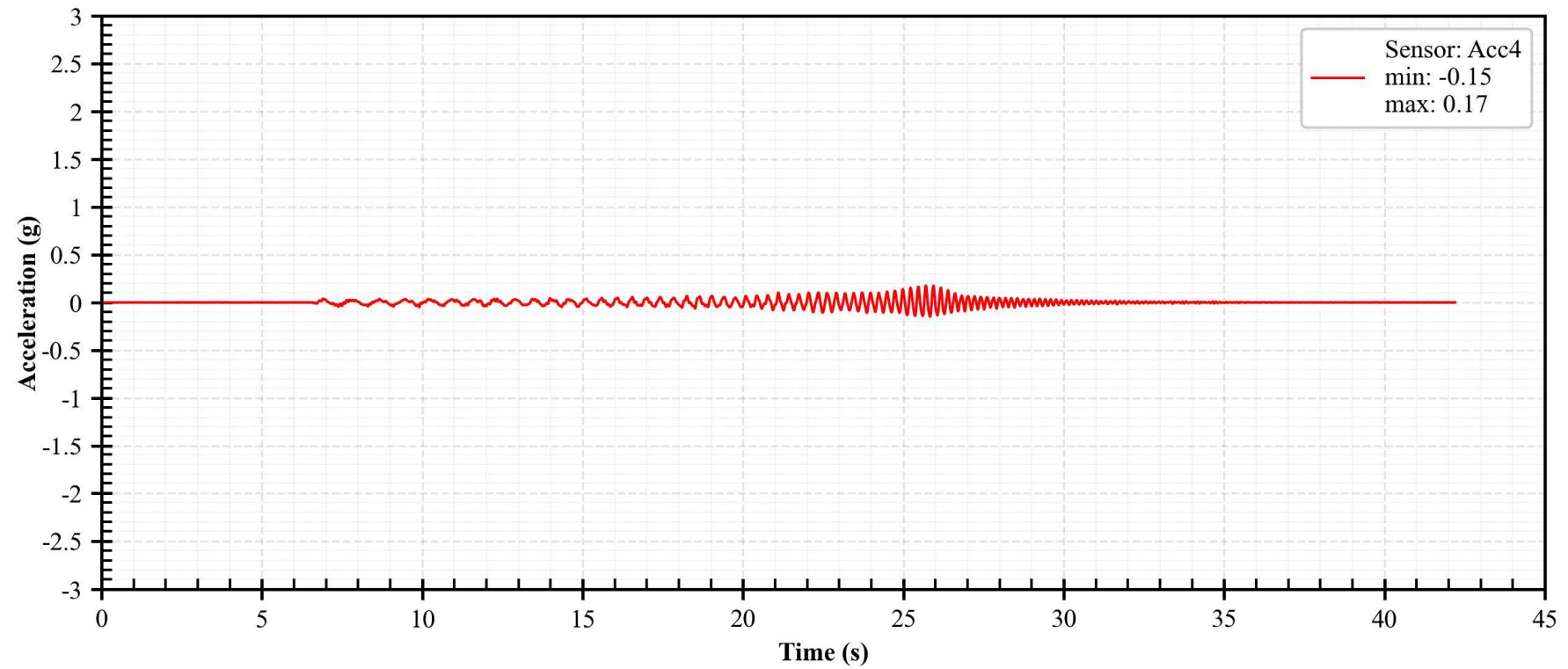


Figure 3.16.4 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 4

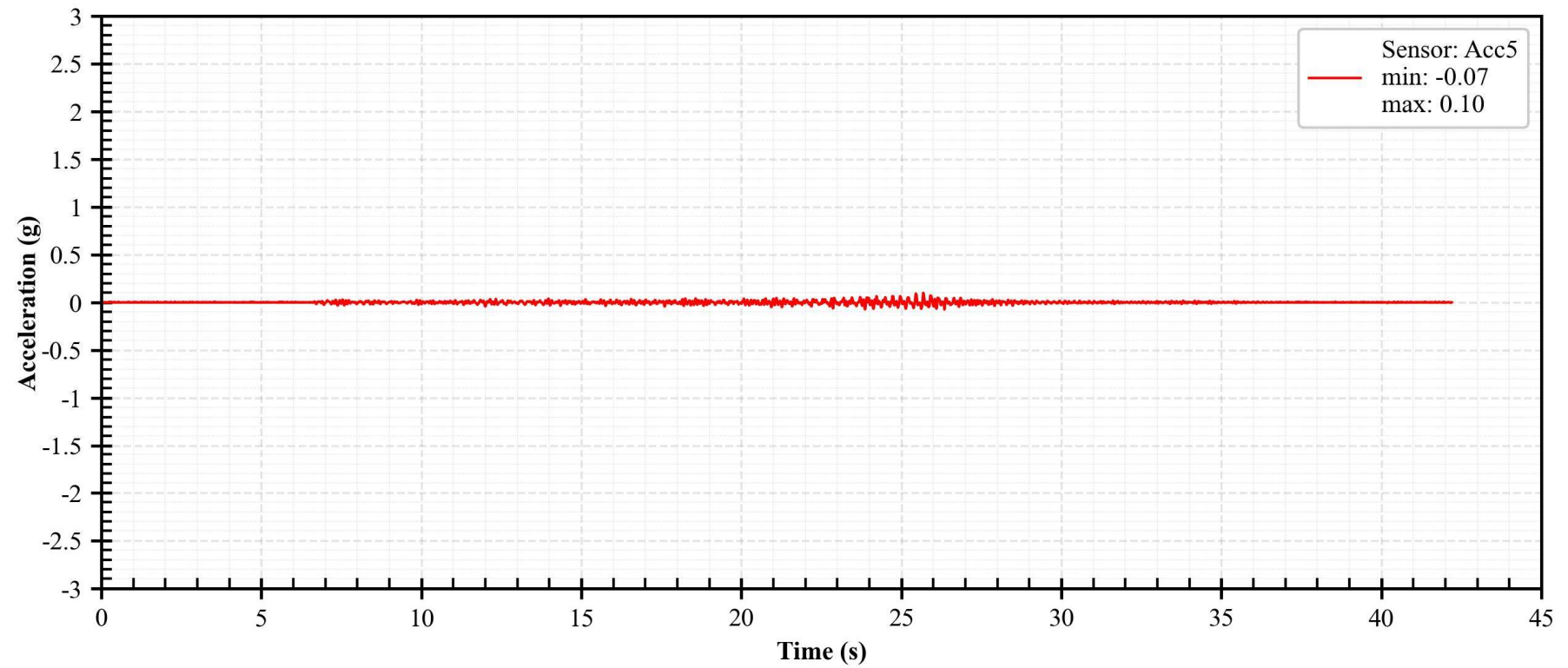


Figure 3.16.5 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 5

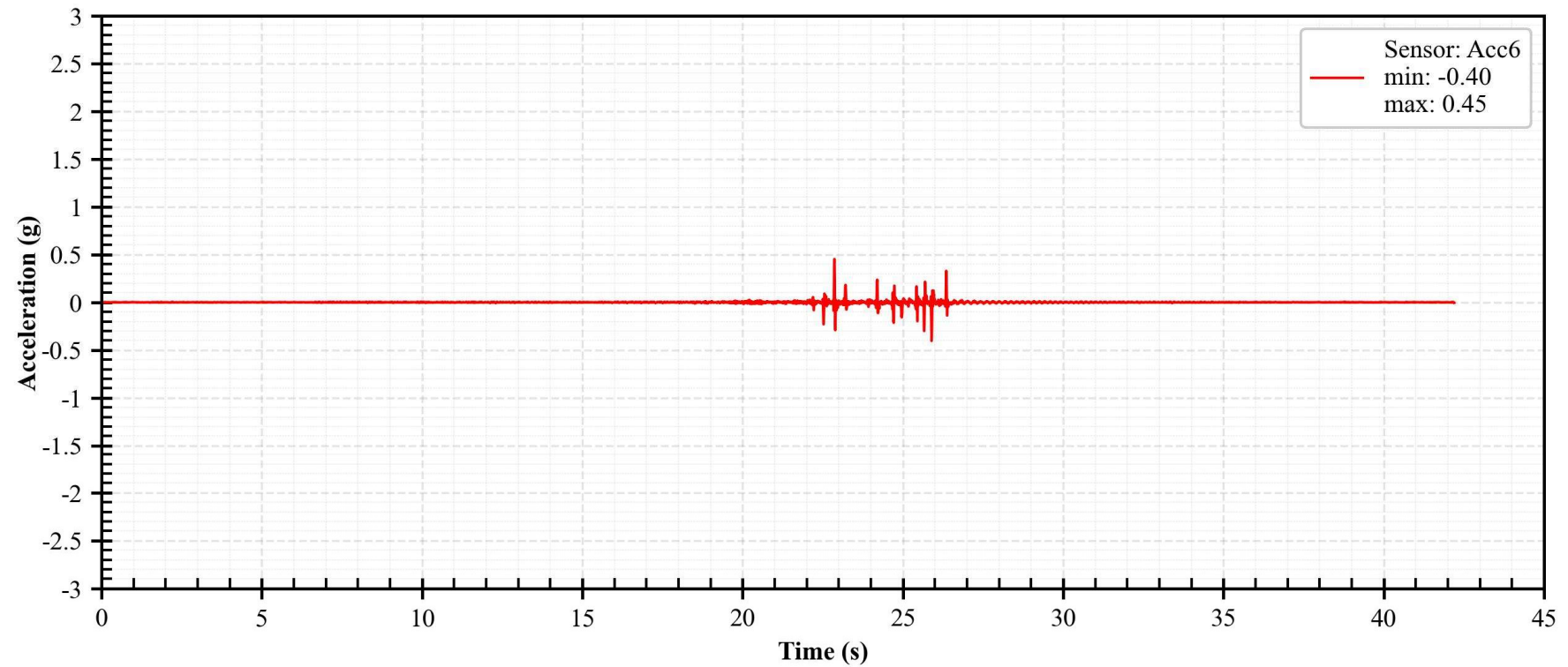


Figure 3.16.6 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 6

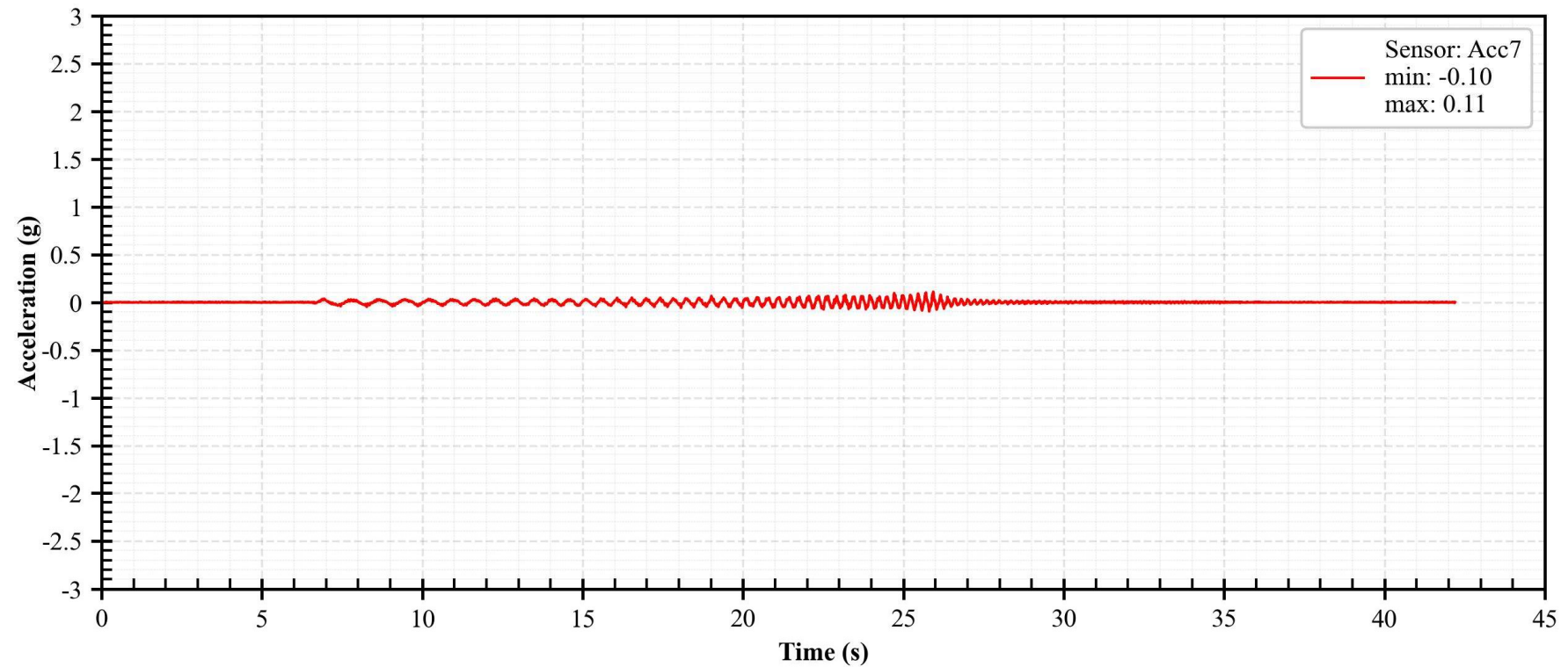


Figure 3.16.7 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 7

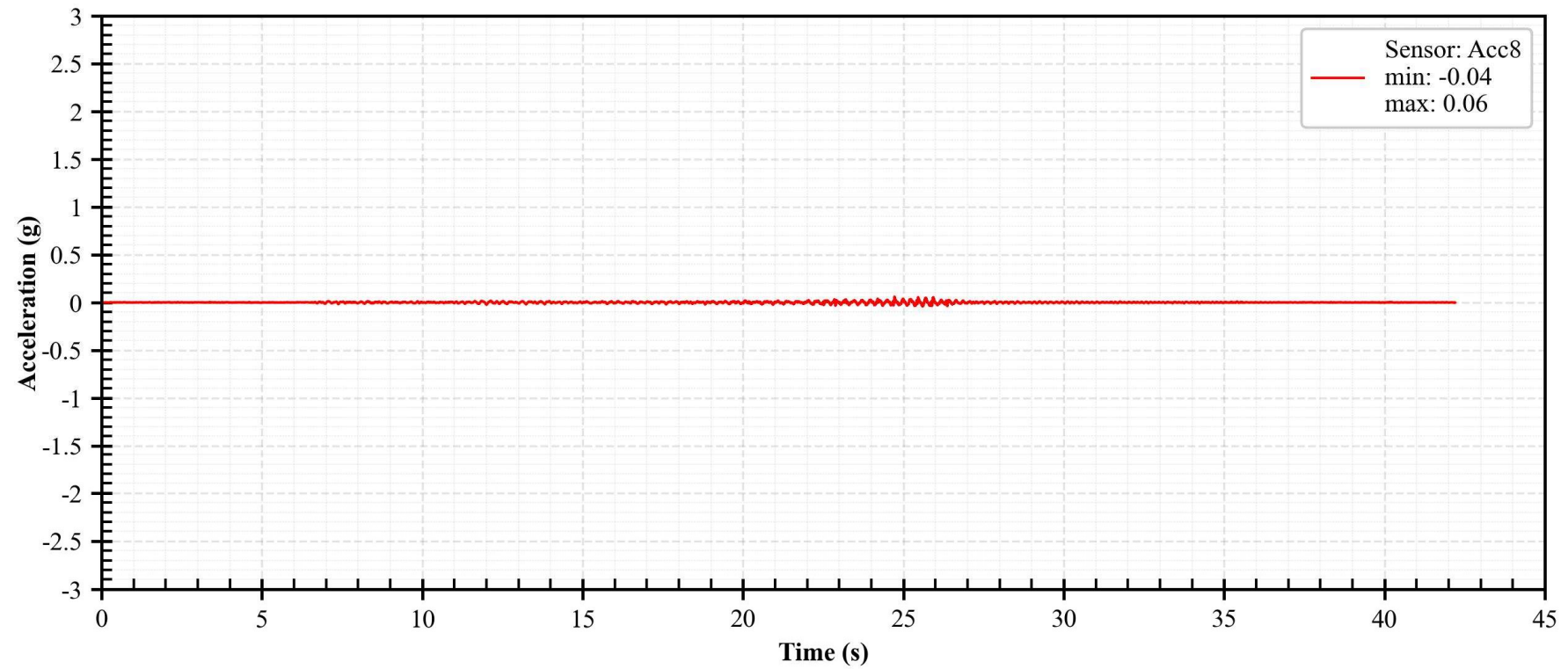


Figure 3.16.8 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 8

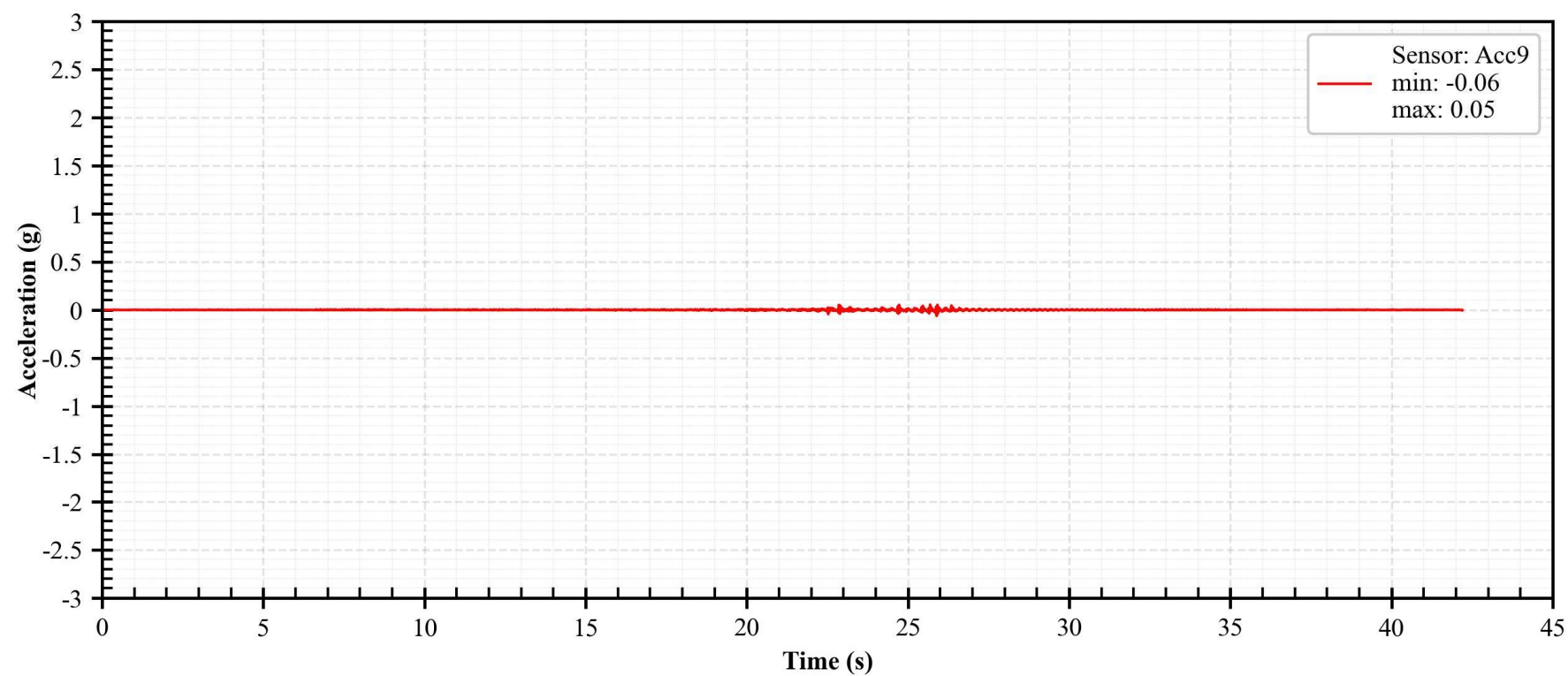


Figure 3.16.9 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 9

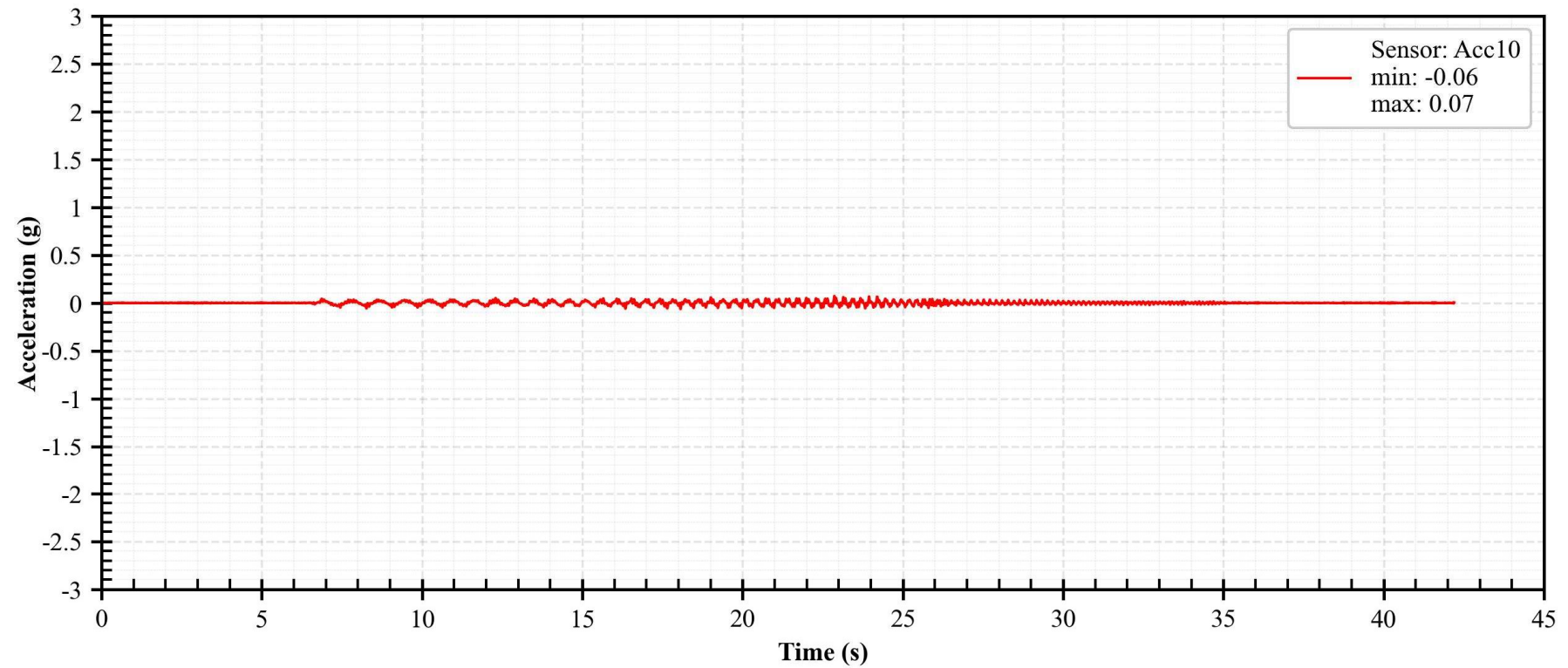


Figure 3.16.10 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 10

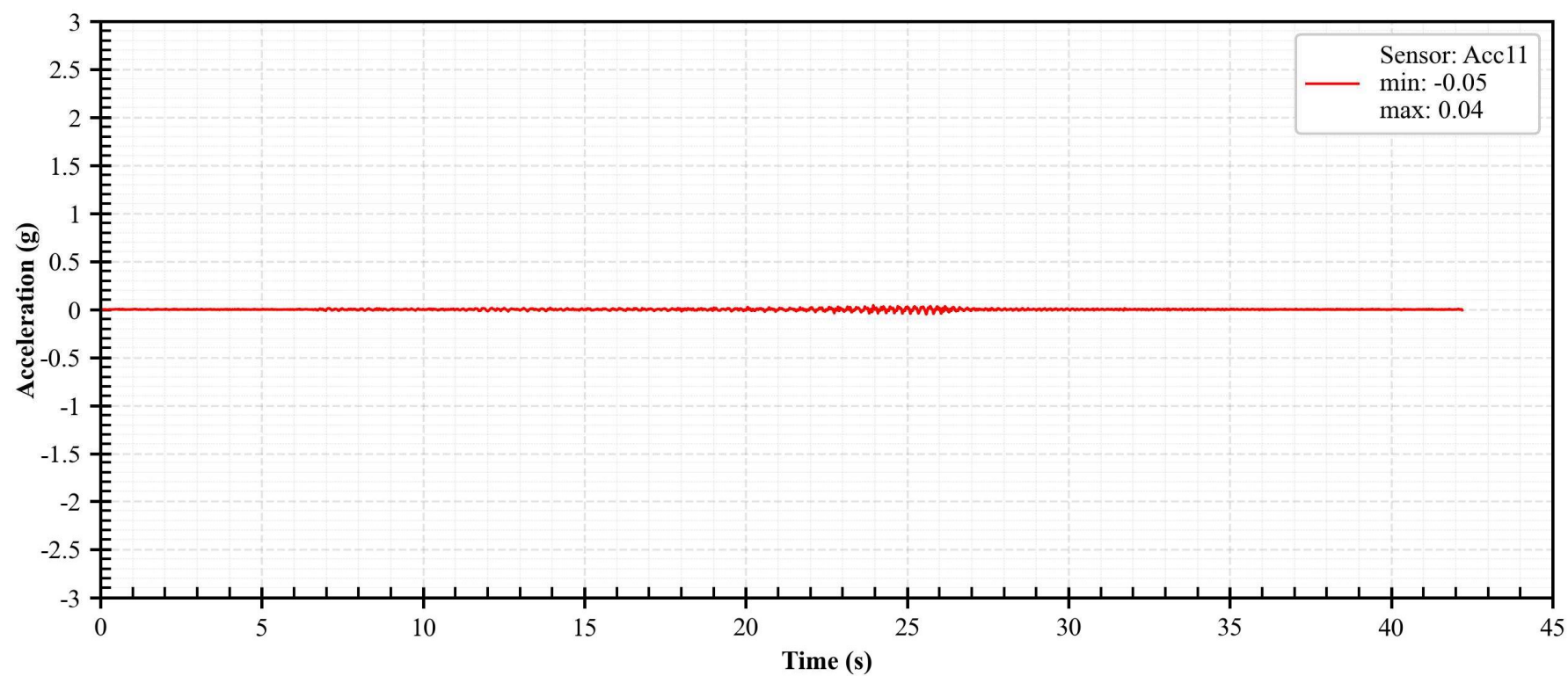


Figure 3.16.11 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 11

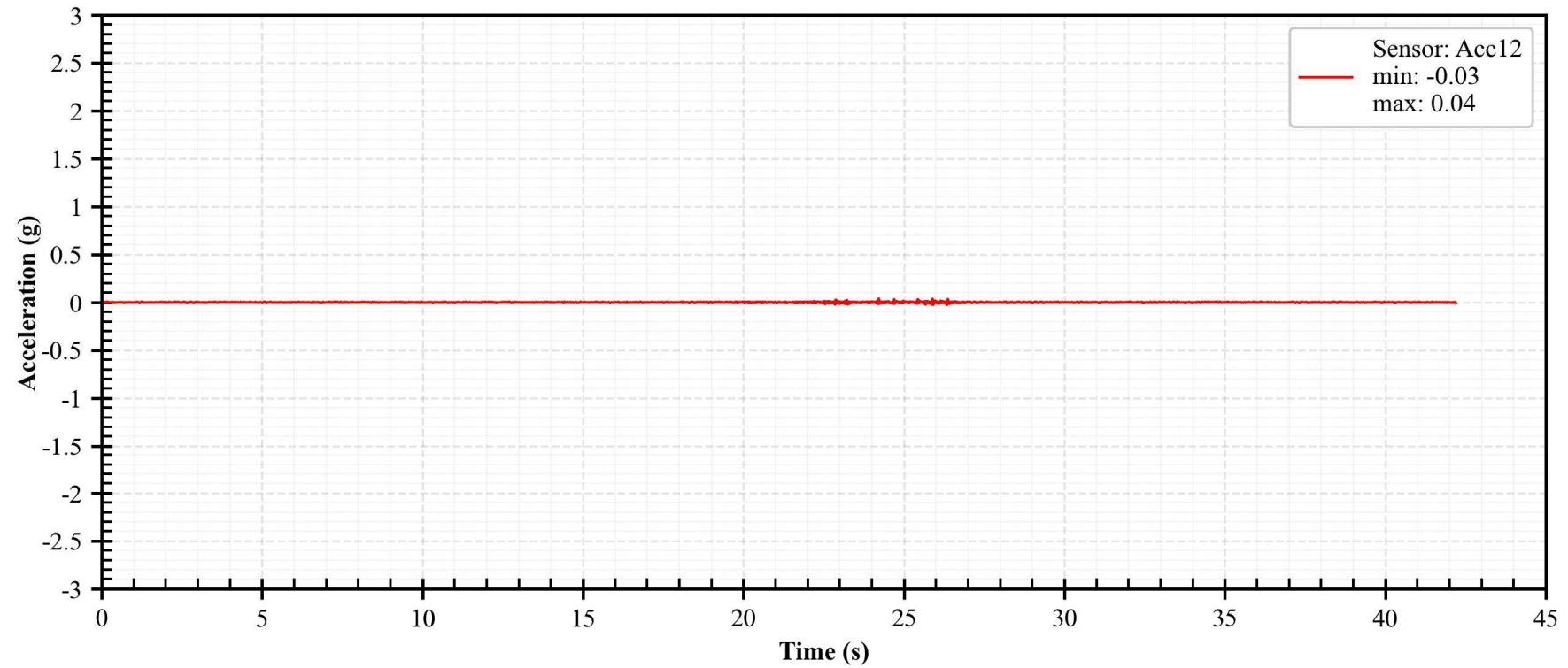


Figure 3.16.12 Characteristic results for phase B (white noise before EQ0,8g): Accelerometer 12

Draw wire sensors

Figures 3.16.13 – 3.16.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.09 mm while the minimum is -16.35 mm. The maximum movement detected by draw wire sensor W2 is 21.31 mm while the minimum is -16.52 mm. The maximum movement detected by draw wire sensor W3 is 21.11 mm while the minimum is -16.28 mm. The maximum movement detected by draw wire sensor W4 is 21.13 mm while the minimum is -16.30 mm. The maximum drift is $(1.61/1.225) = 1.31 \text{ ‰}$ and minimum drift is $(-1.71/1.225) = -1.40 \text{ ‰}$.

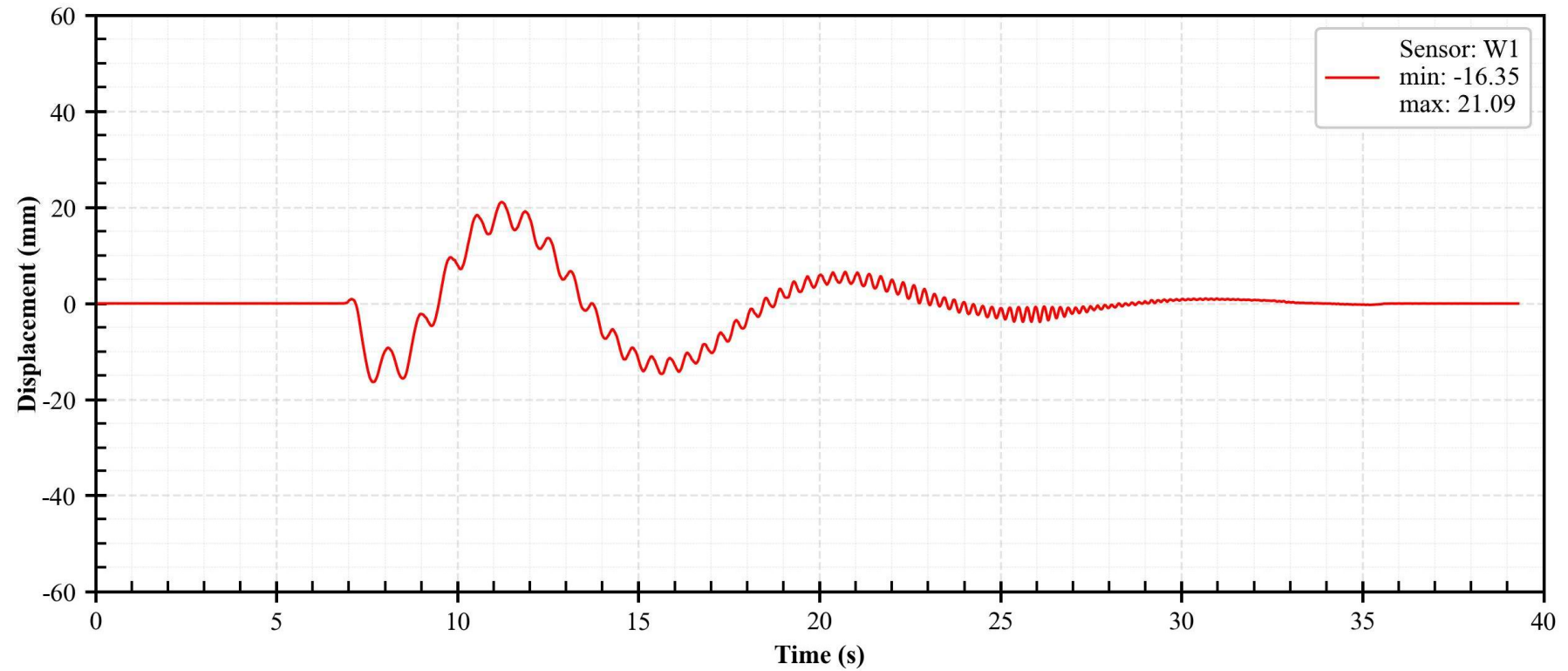


Figure 3.16.13 Characteristic results for phase B (white noise before EQ0,8g): Draw wire sensor 1

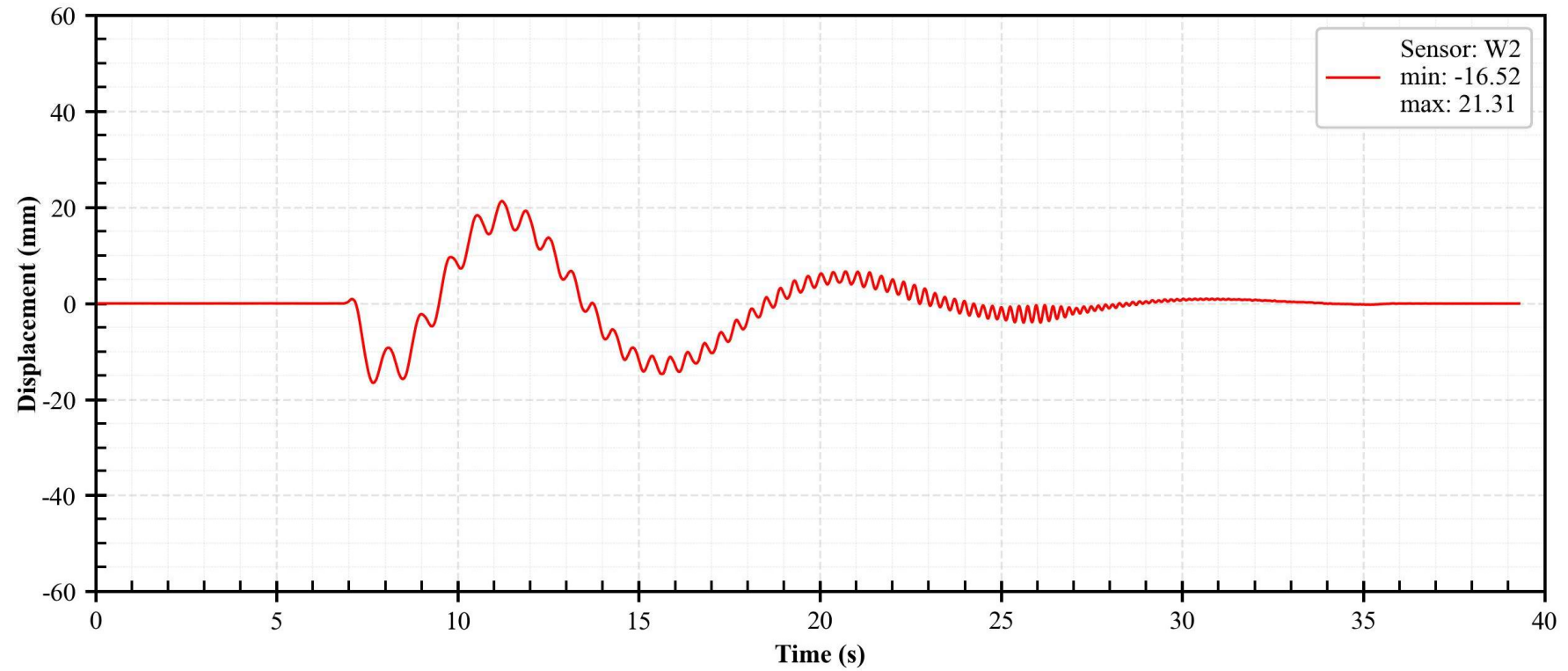


Figure 3.16.14 Characteristic results for phase B (white noise before EQ0,8g): Draw wire sensor 2

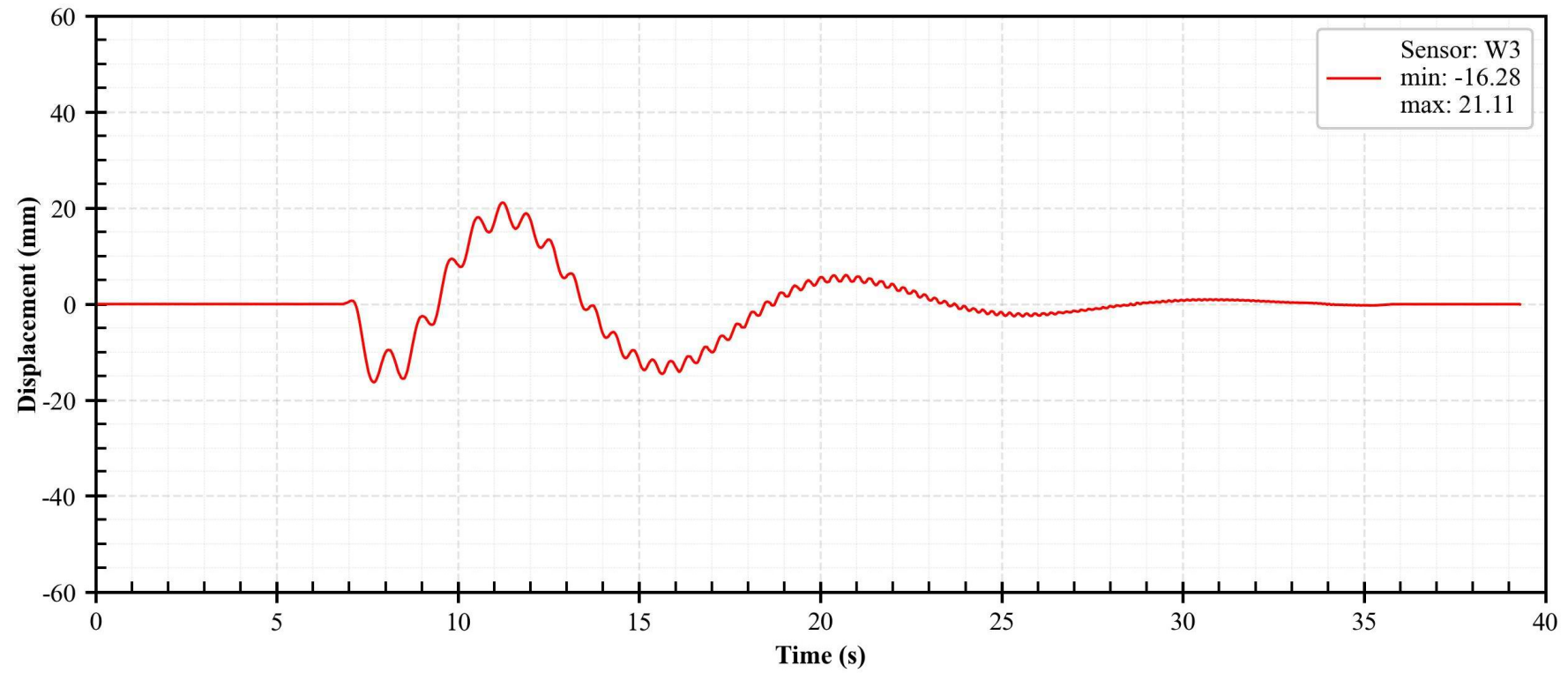


Figure 3.16.15 Characteristic results for phase B (white noise before EQ0,8g): Draw wire sensor 3

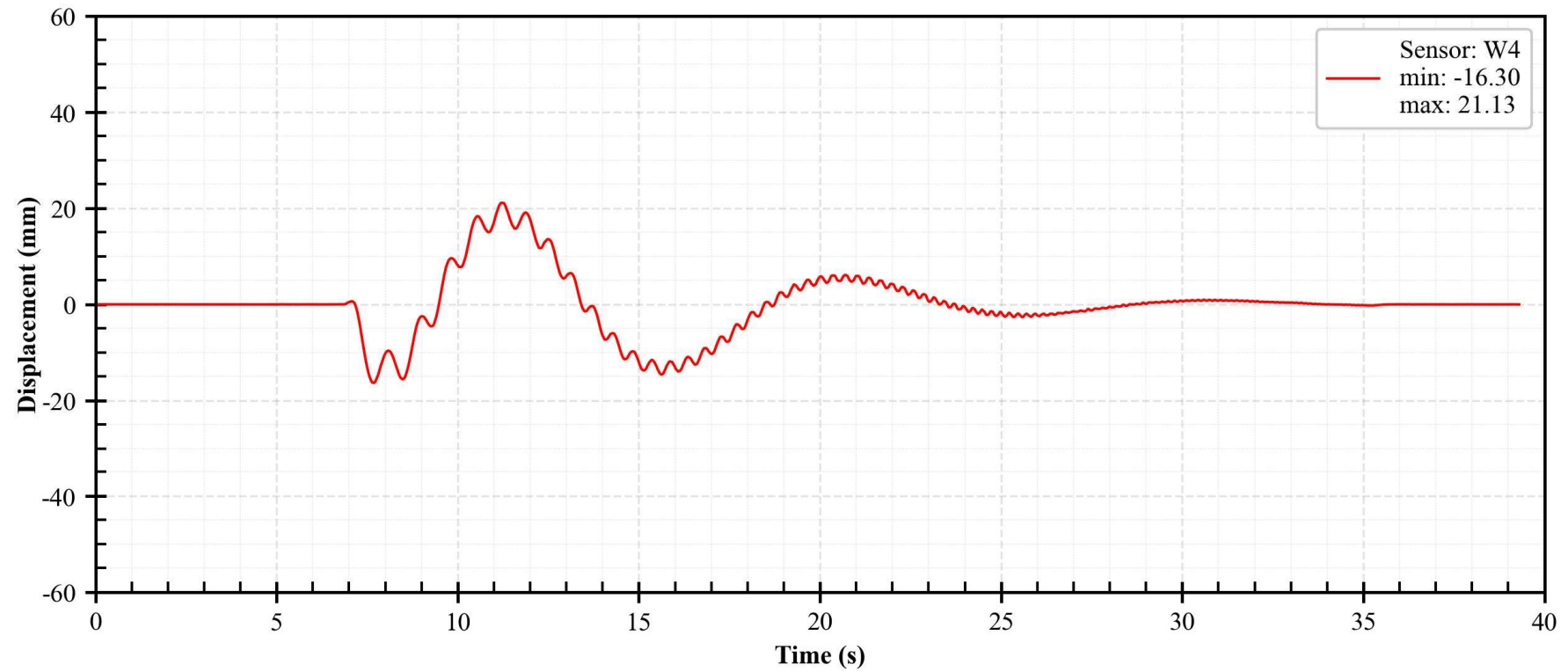


Figure 3.16.16 Characteristic results for phase B (white noise before EQ0,8g): Draw wire sensor 4

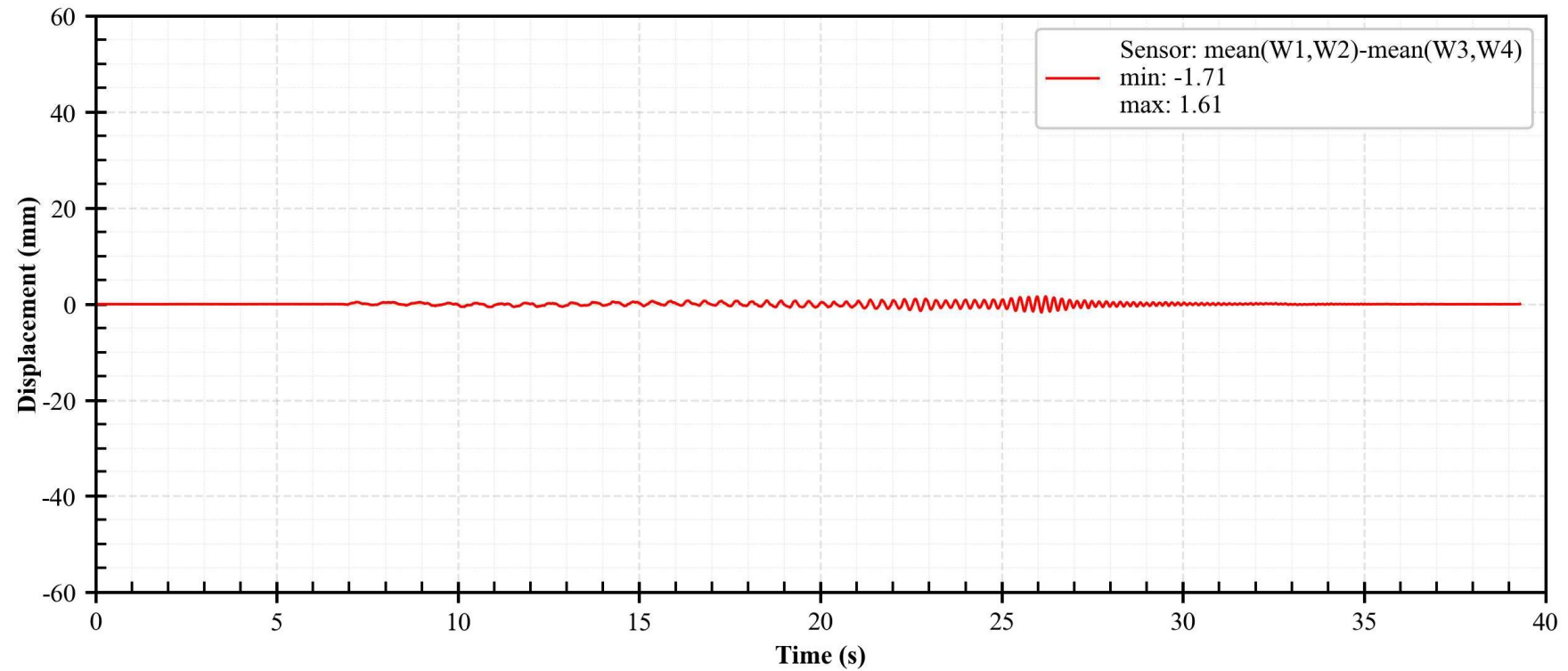


Figure 3.16.17 Characteristic results for phase B (white noise before EQ0,8g): $\text{mean}(W1,W2) - \text{mean}(W3,W4)$

Strain gauges

No notable changes are detected in the values of strain gauges

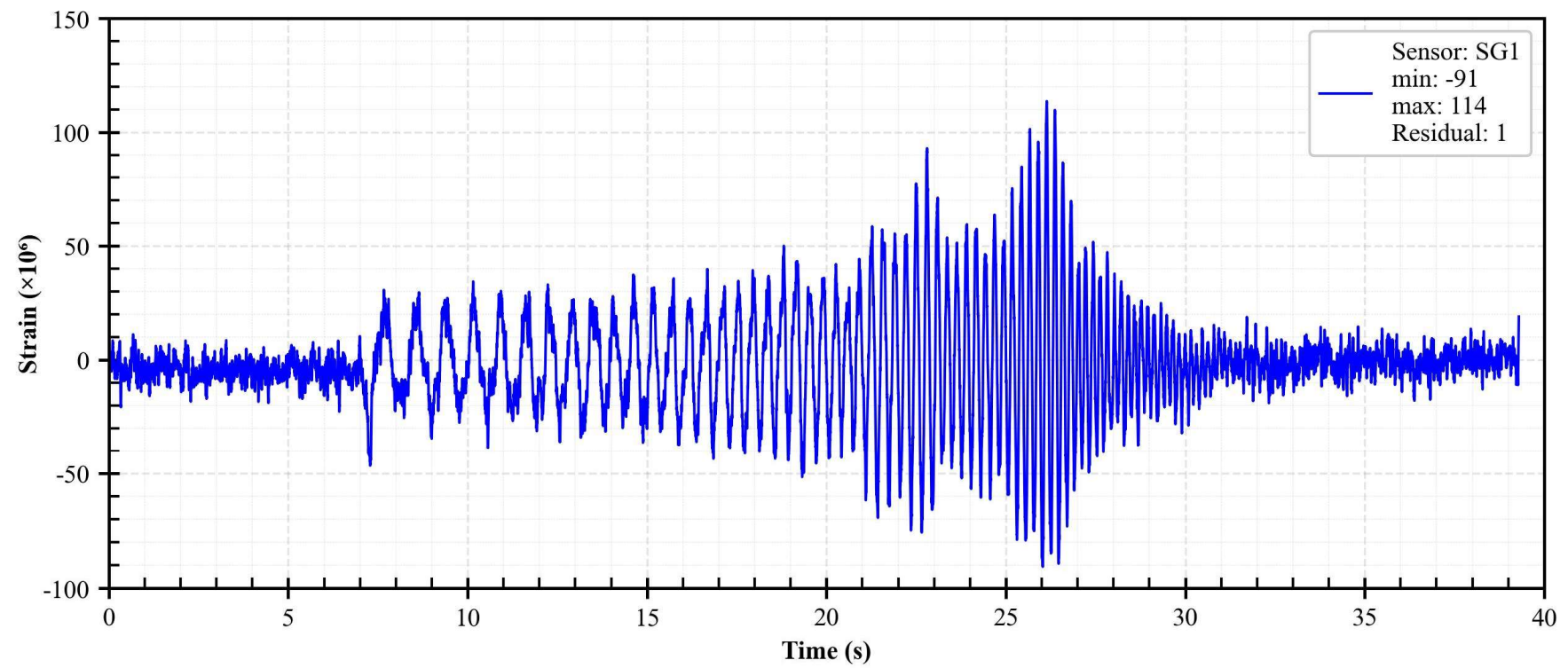


Figure 3.16.18 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 1

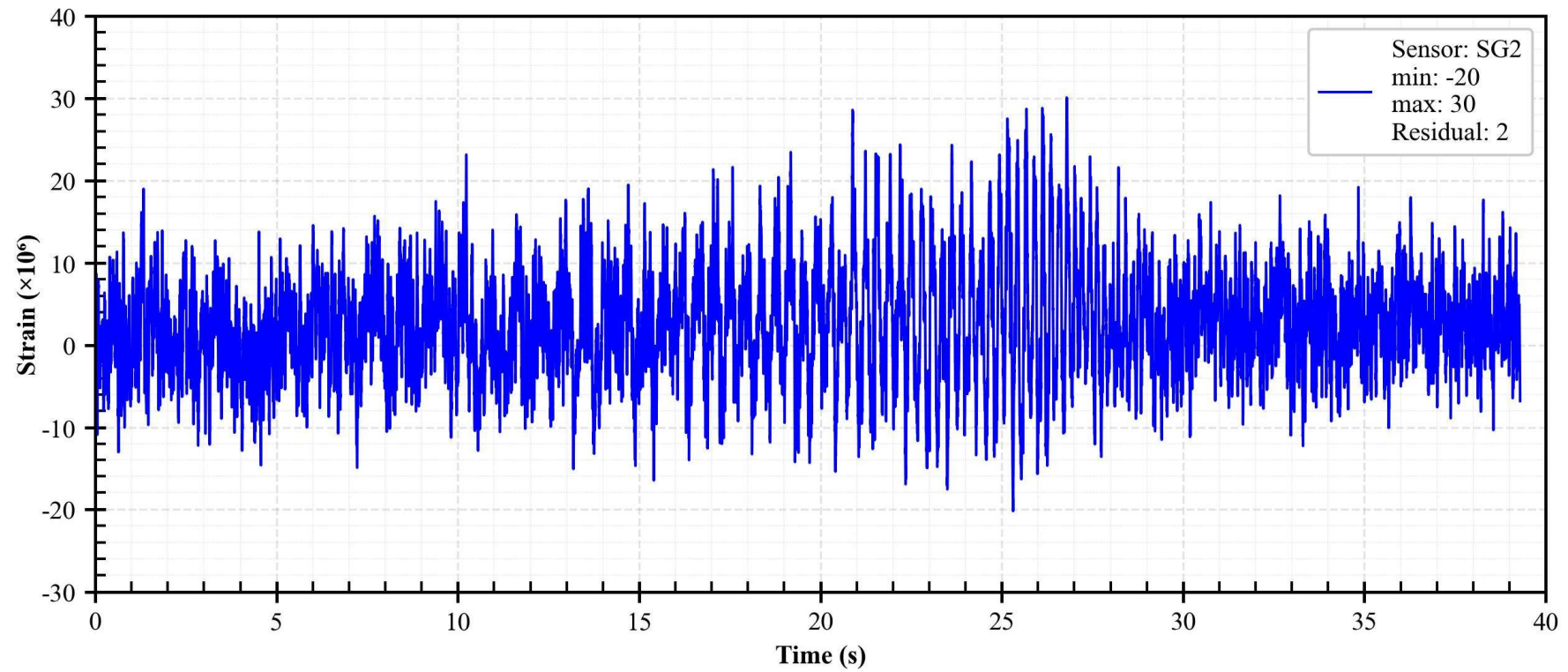


Figure 3.16.19 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 2

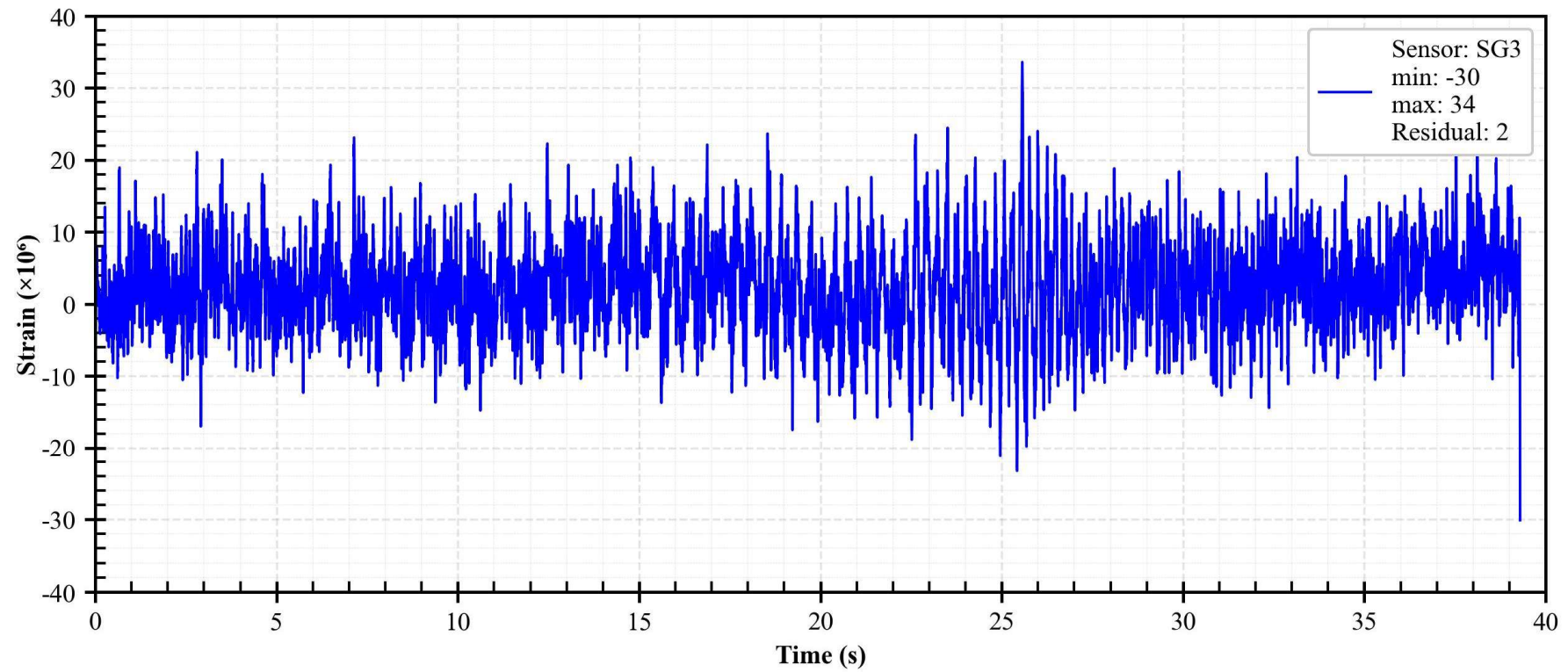


Figure 3.16.20 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 3

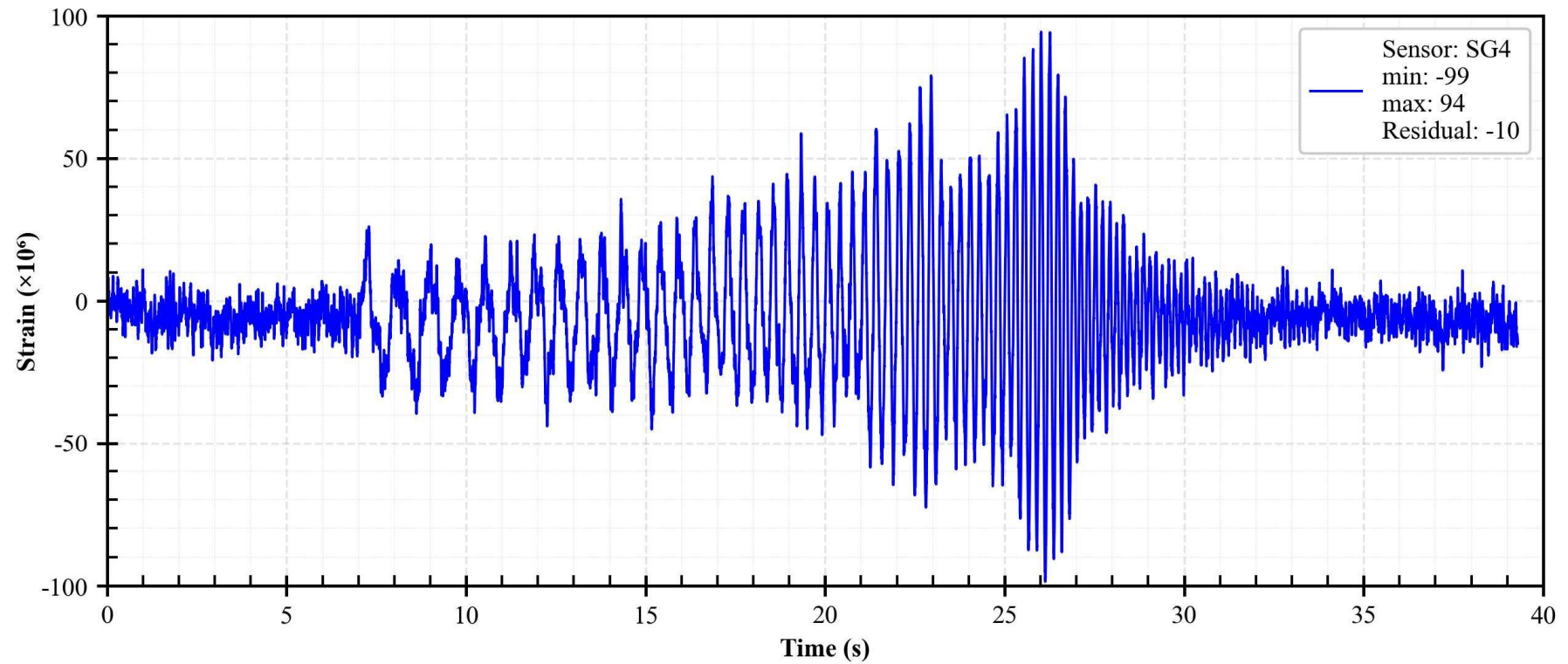


Figure 3.16.21 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 4

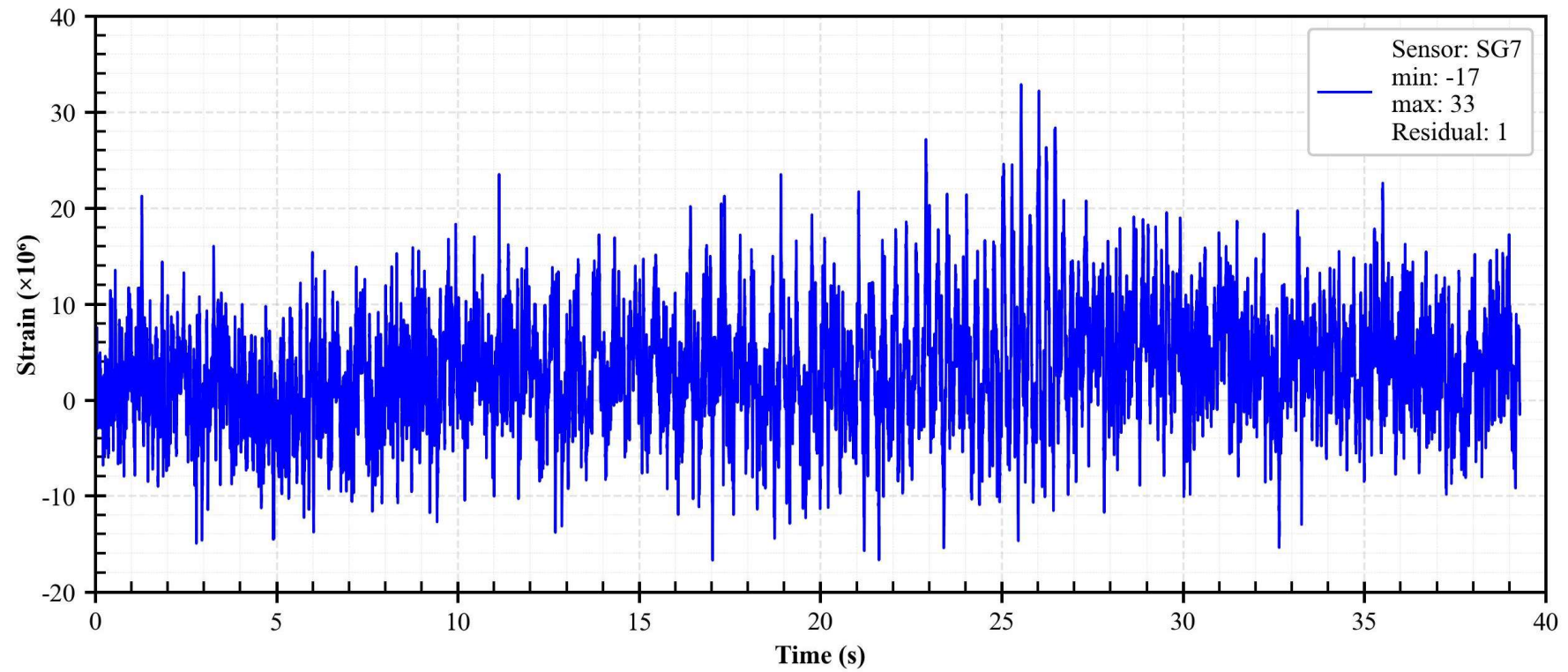


Figure 3.16.22 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 7

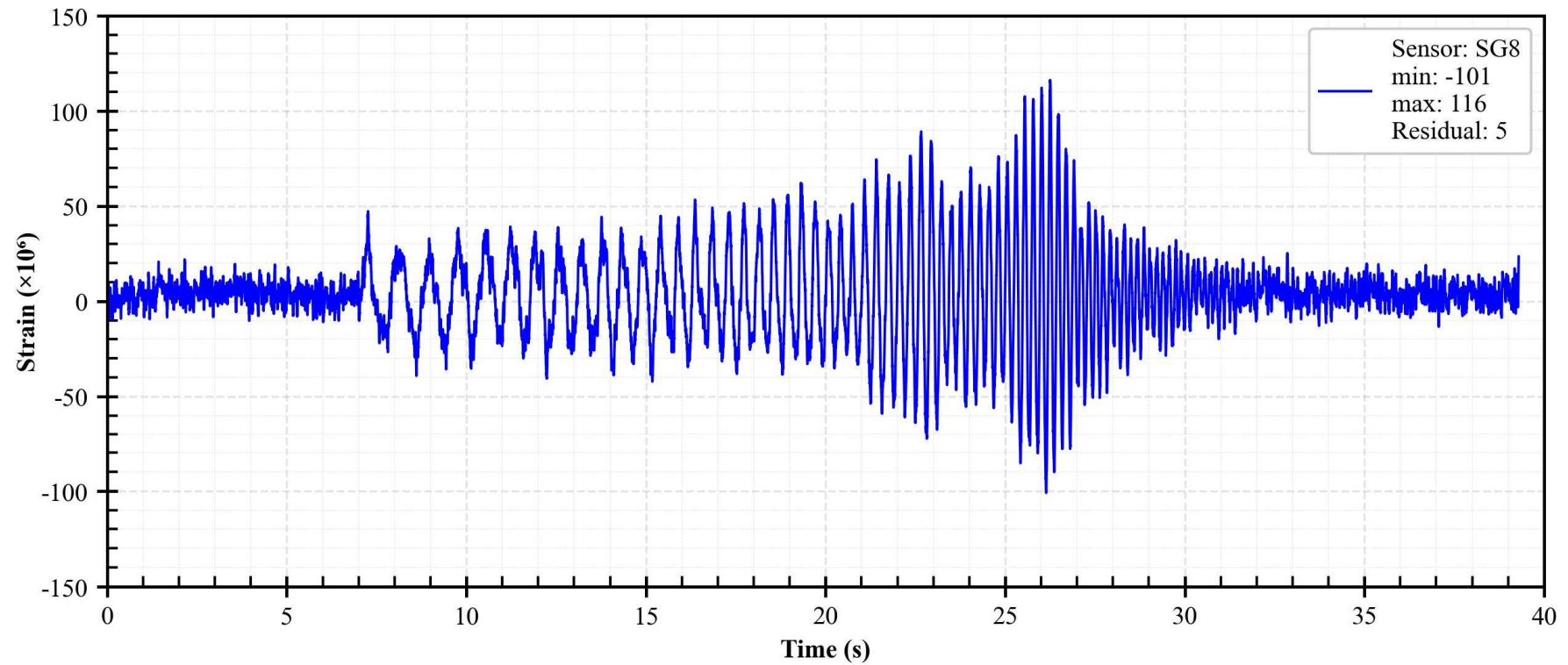


Figure 3.16.23 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 8

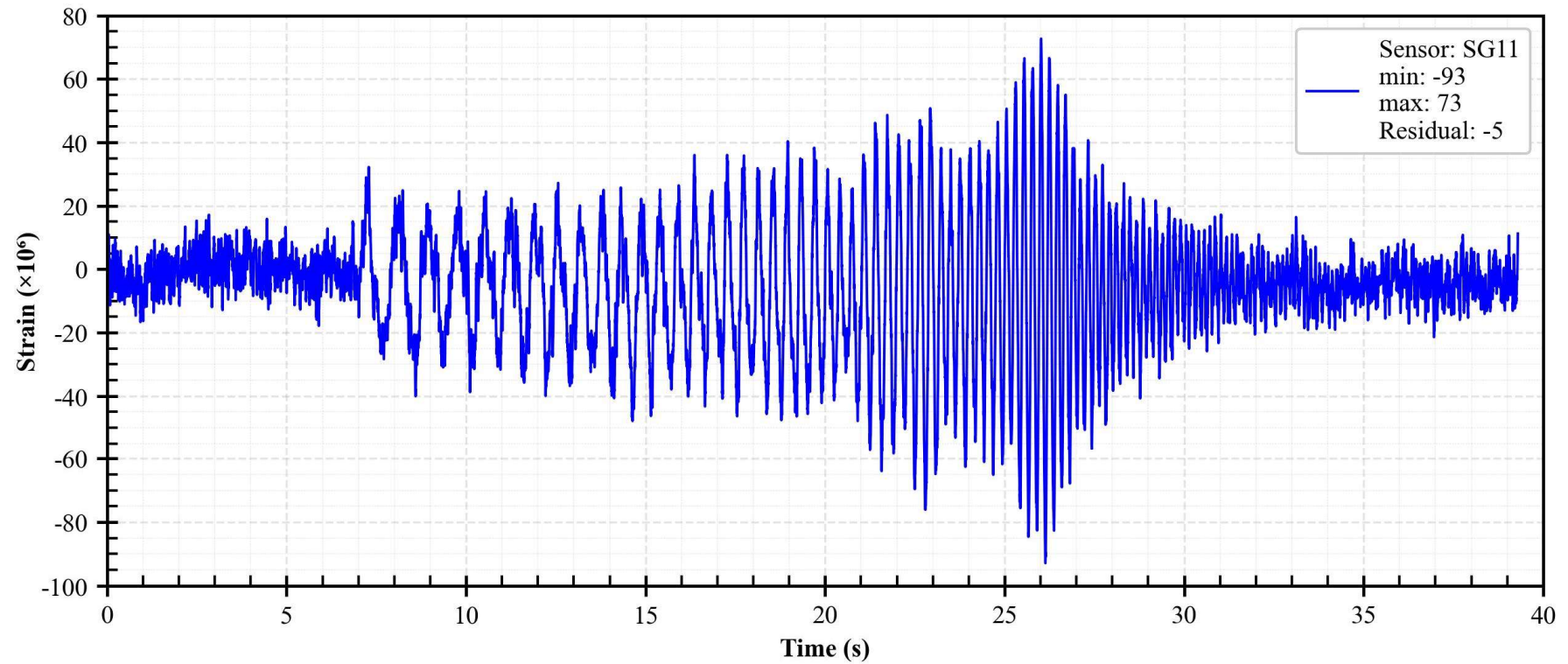


Figure 3.16.24 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 11

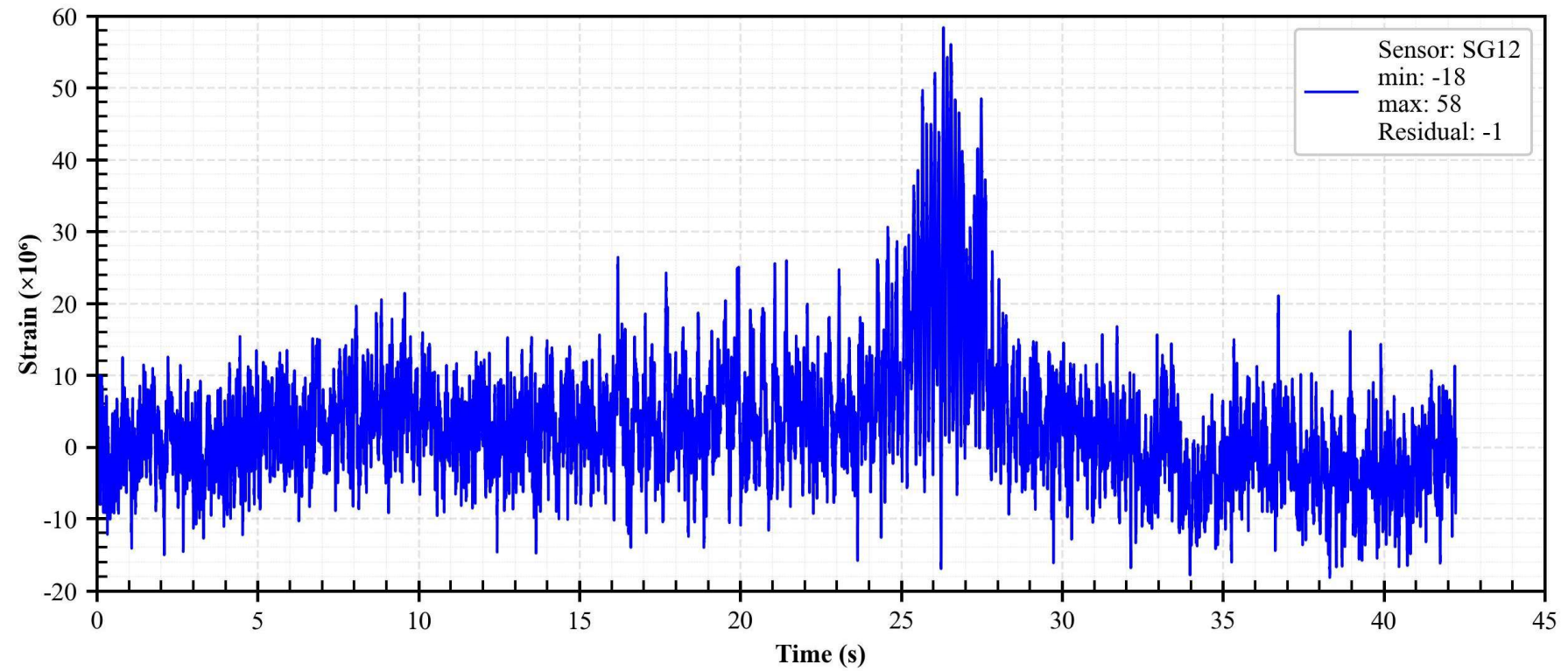


Figure 3.16.25 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 12

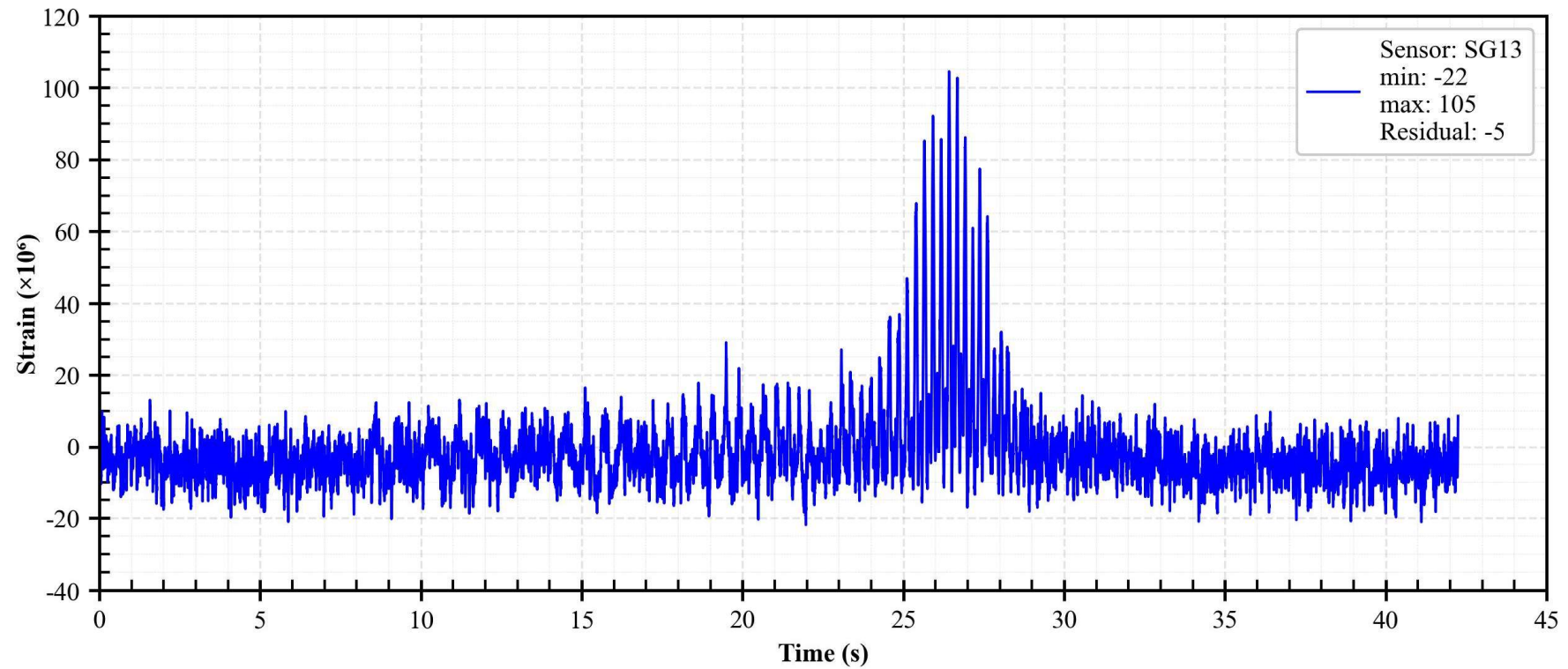


Figure 3.16.26 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 13

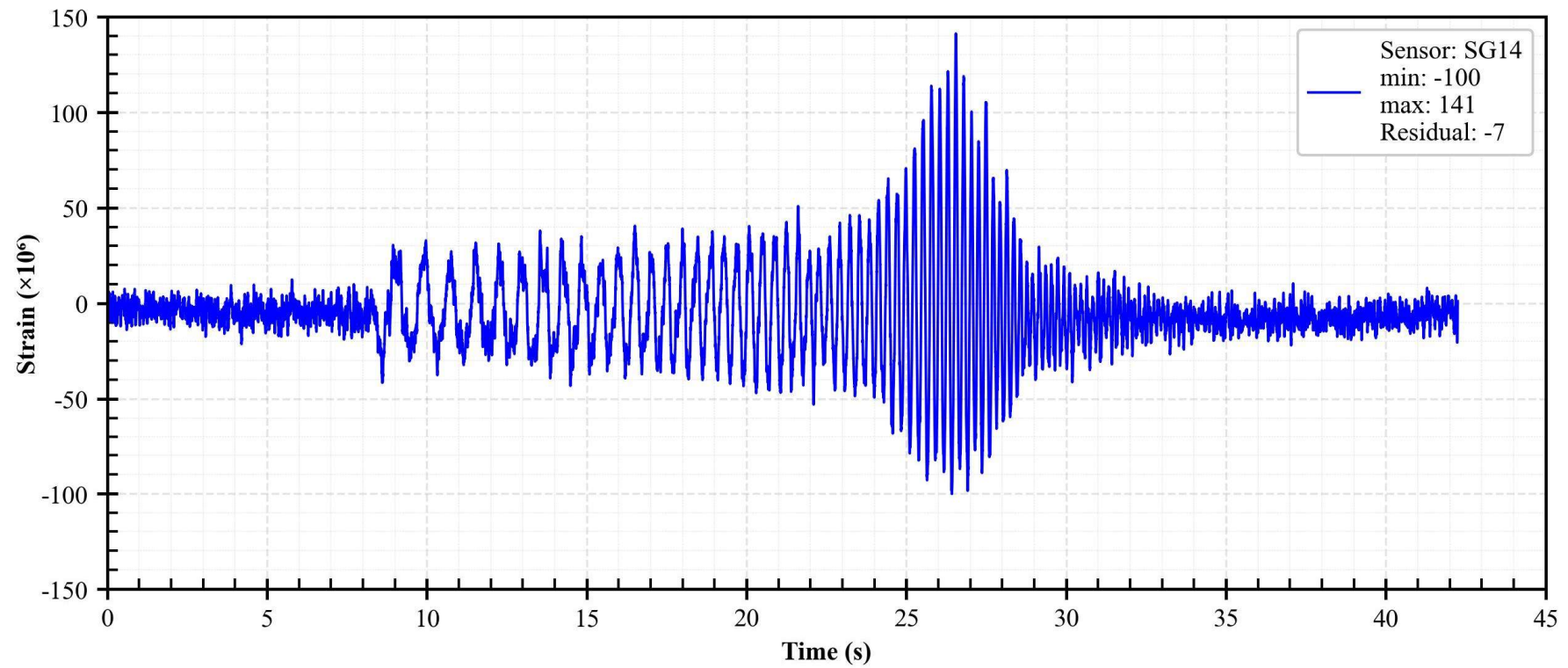


Figure 3.16.27 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 14

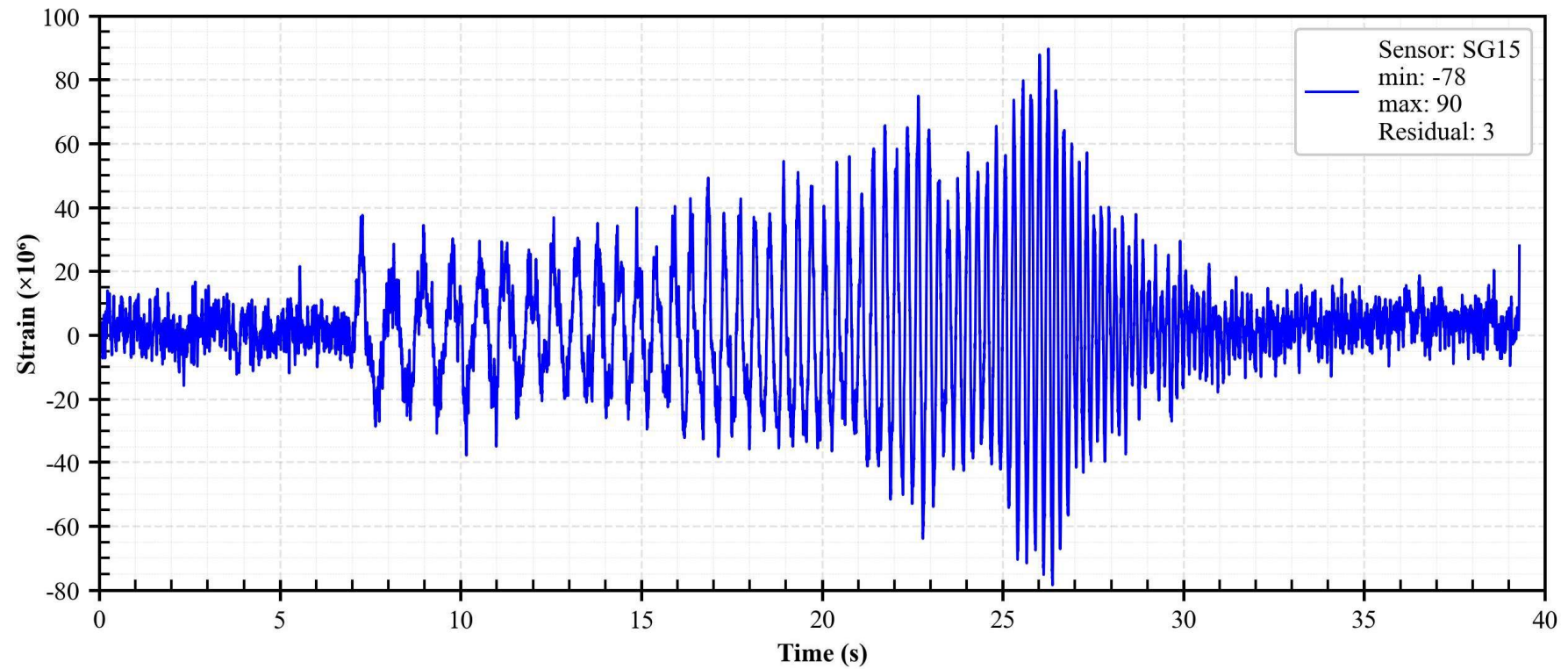


Figure 3.16.28 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 15

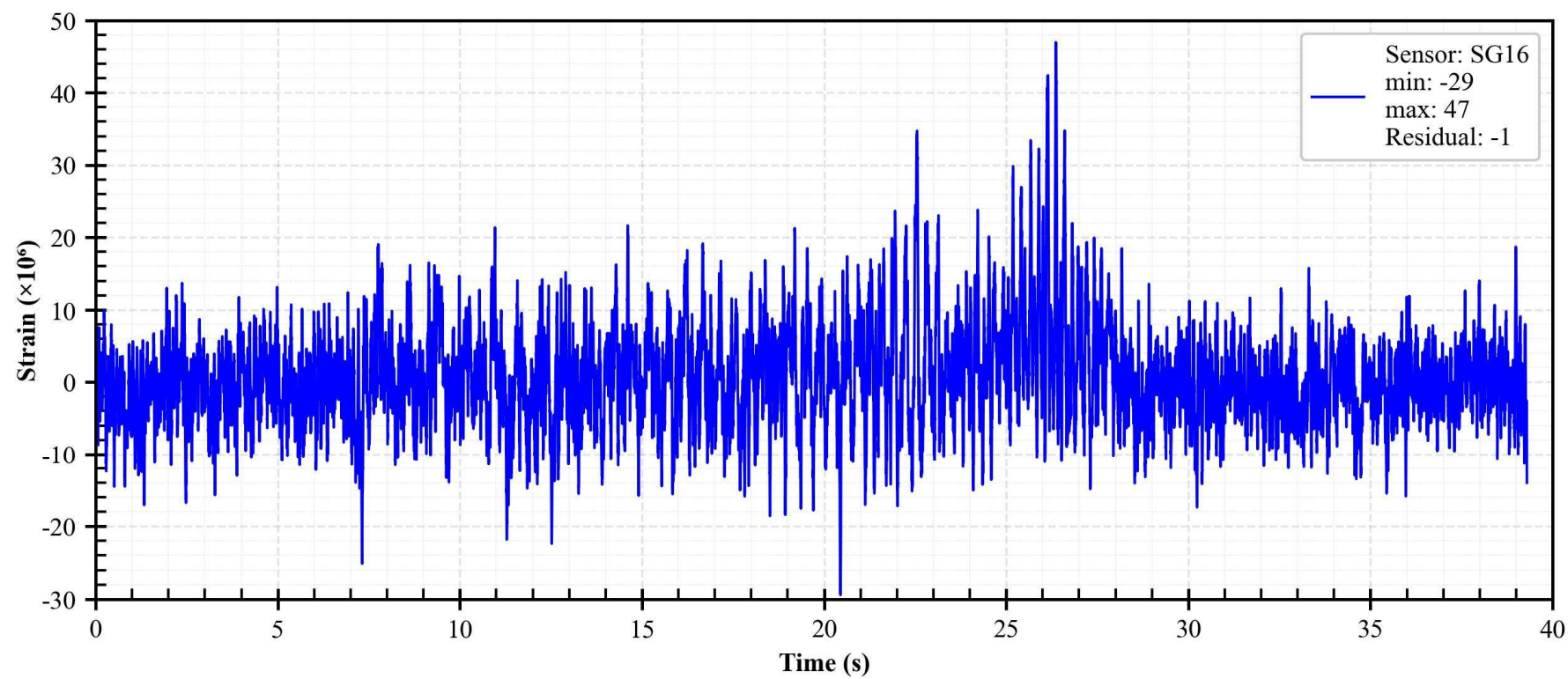


Figure 3.16.29 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 16

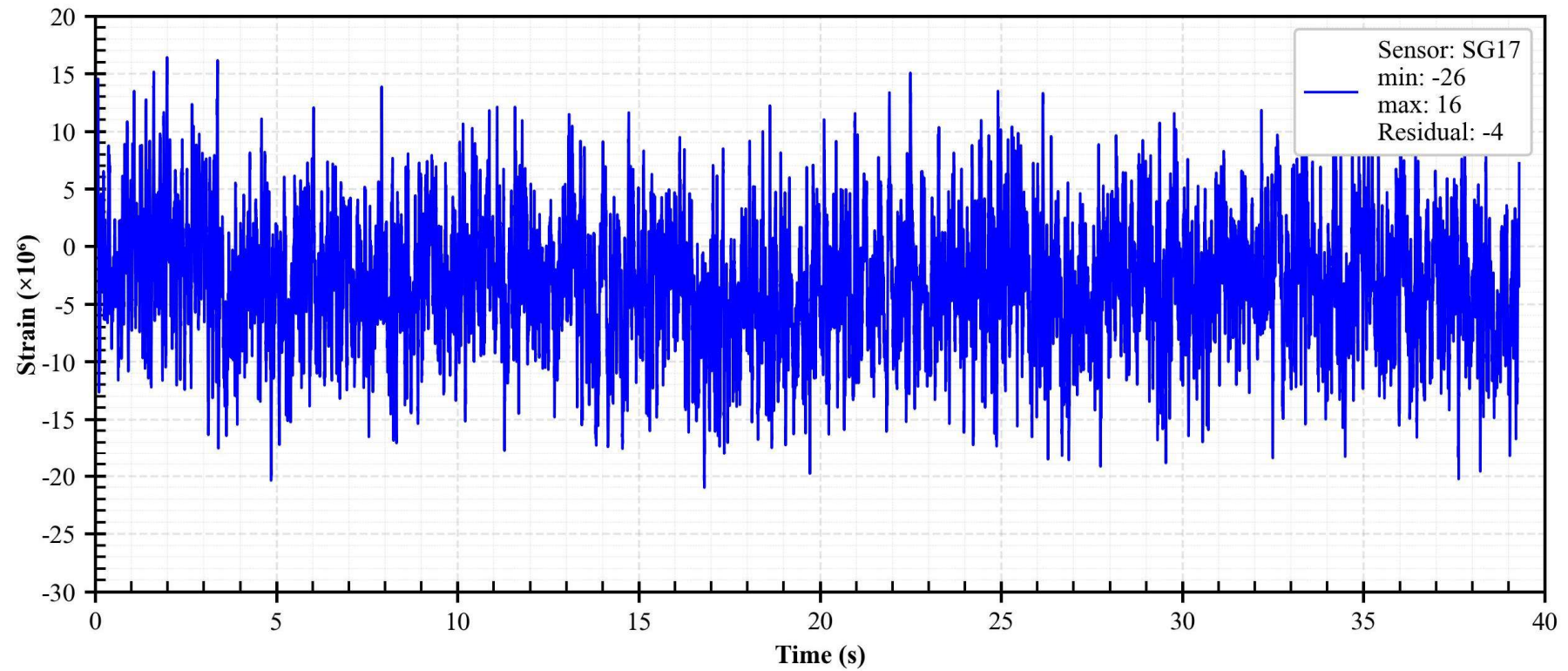


Figure 3.16.30 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 17

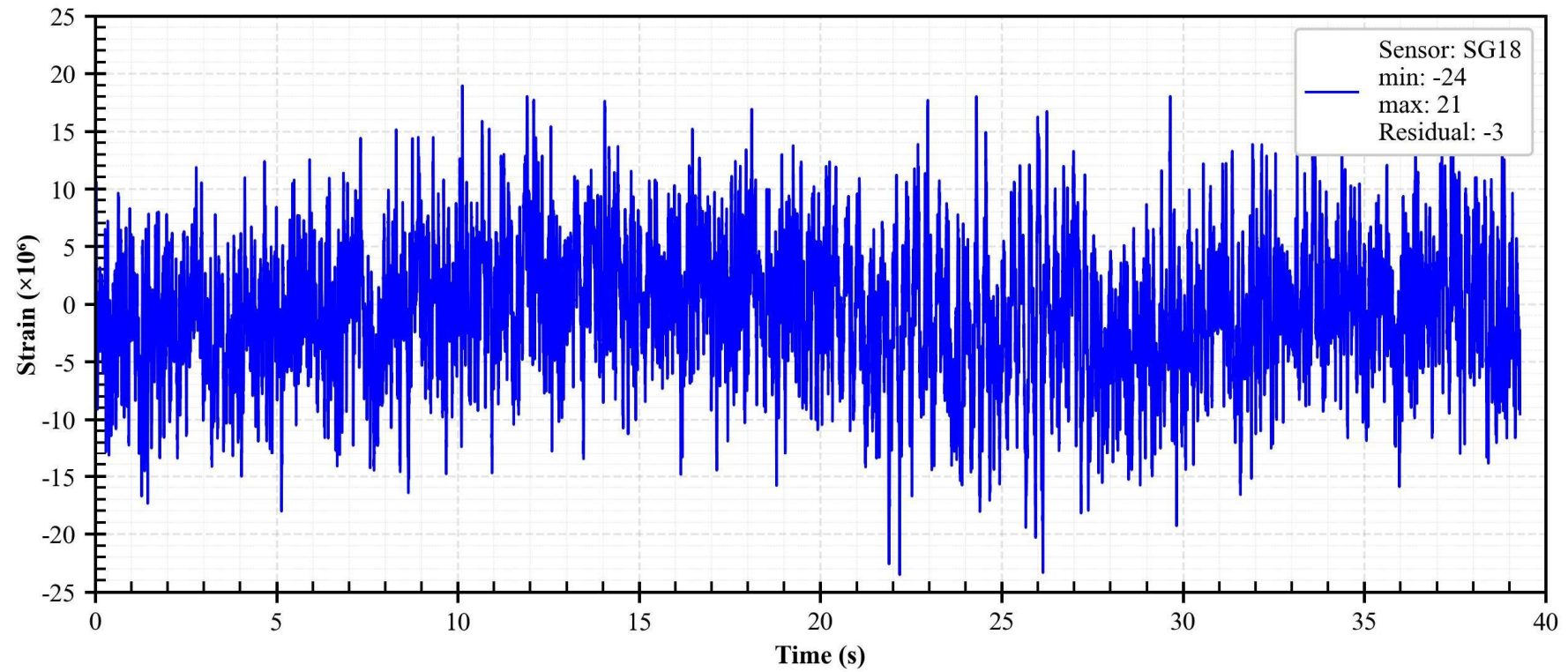


Figure 3.16.31 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 18

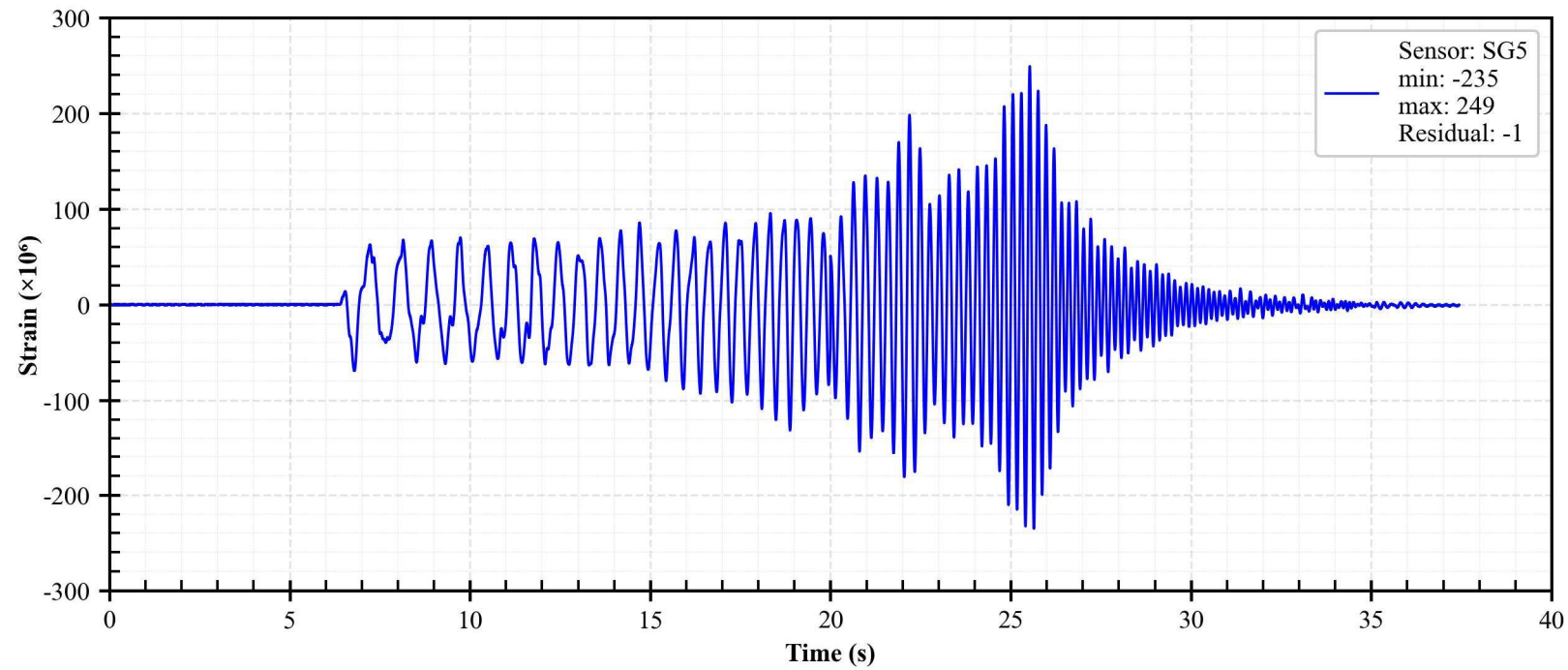


Figure 3.16.32 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 5

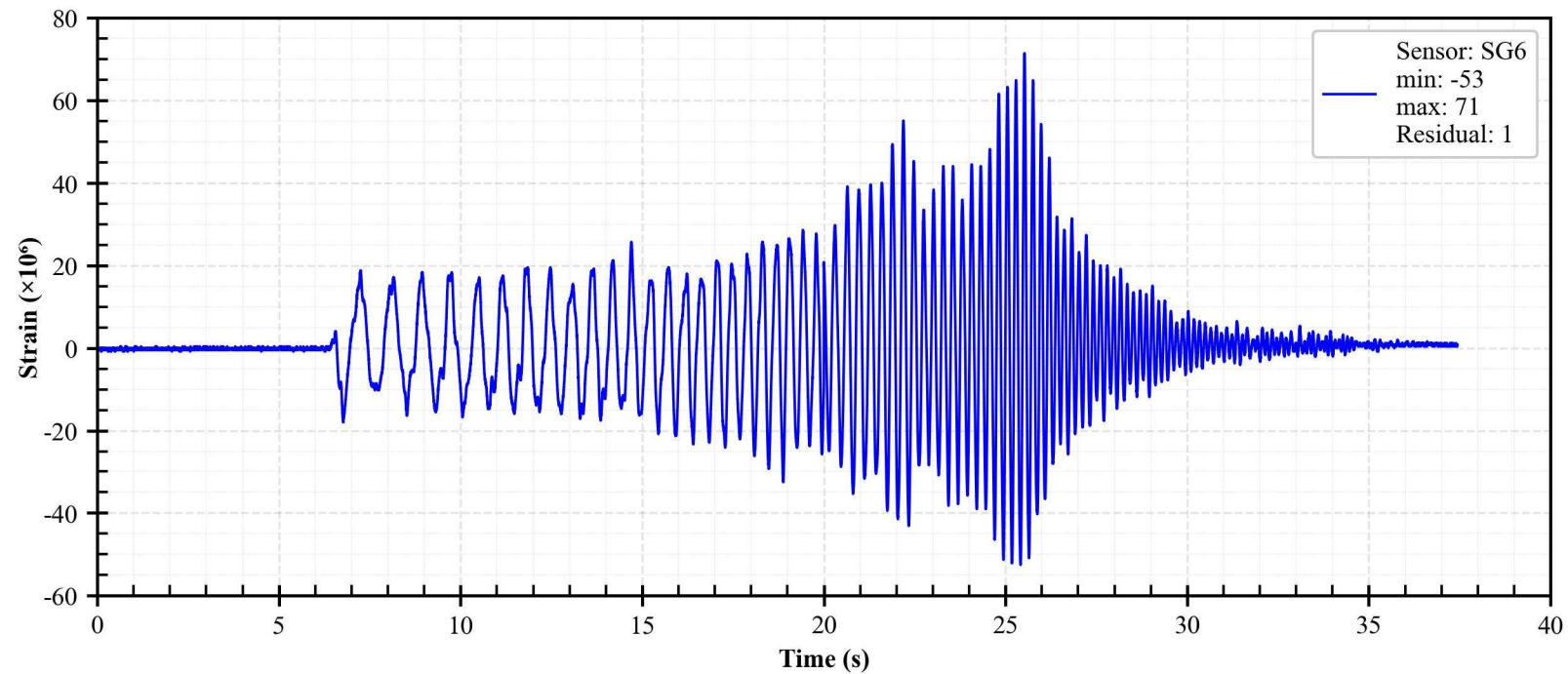


Figure 3.16.33 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 6

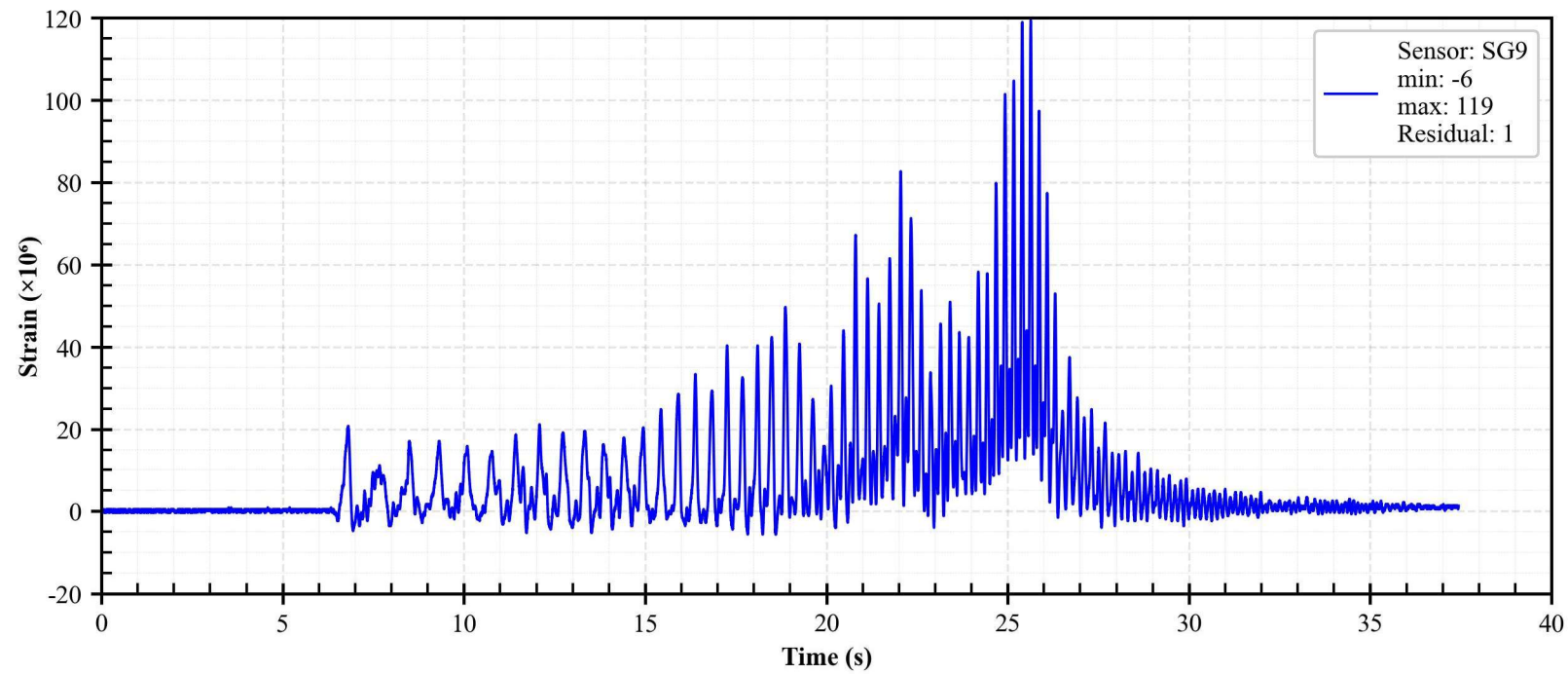


Figure 3.16.34 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 9

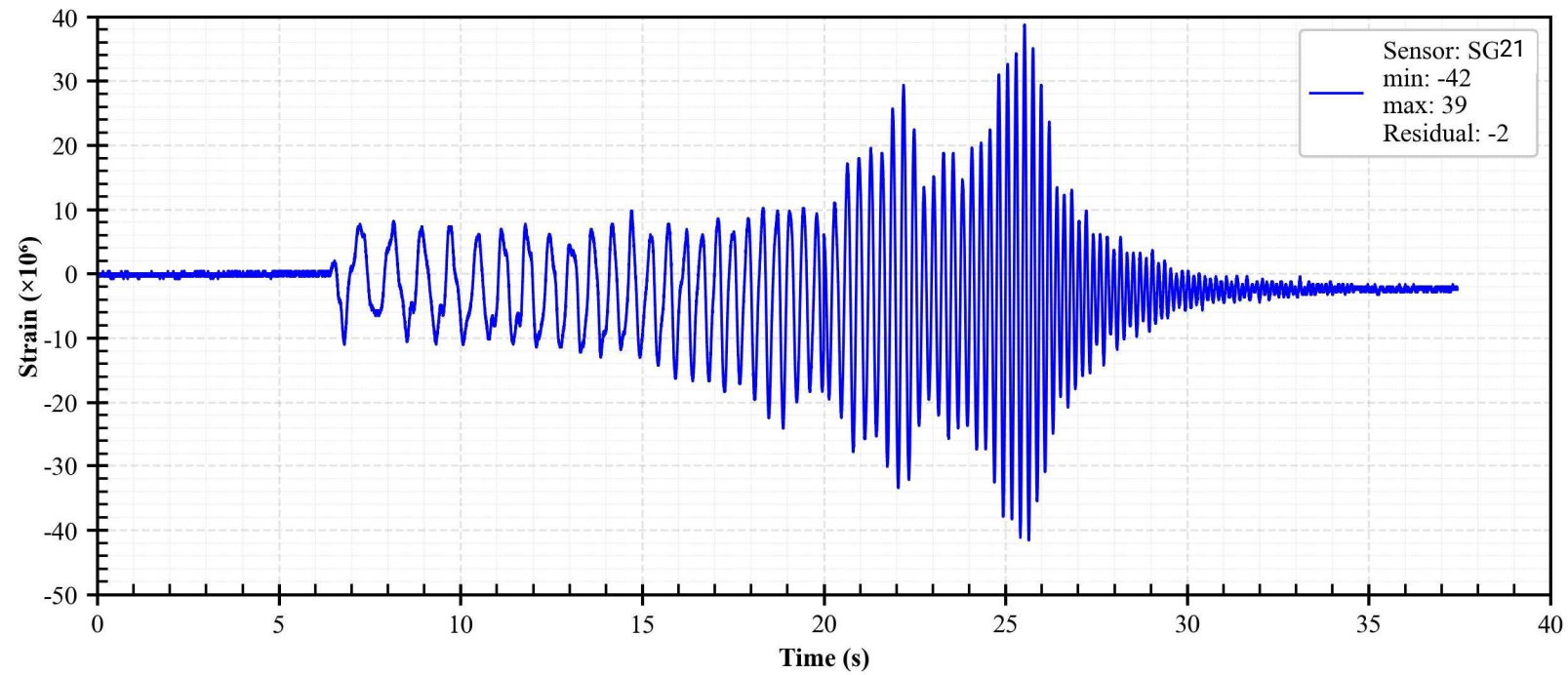


Figure 3.16.35 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 21 (PUFJ, column 1)

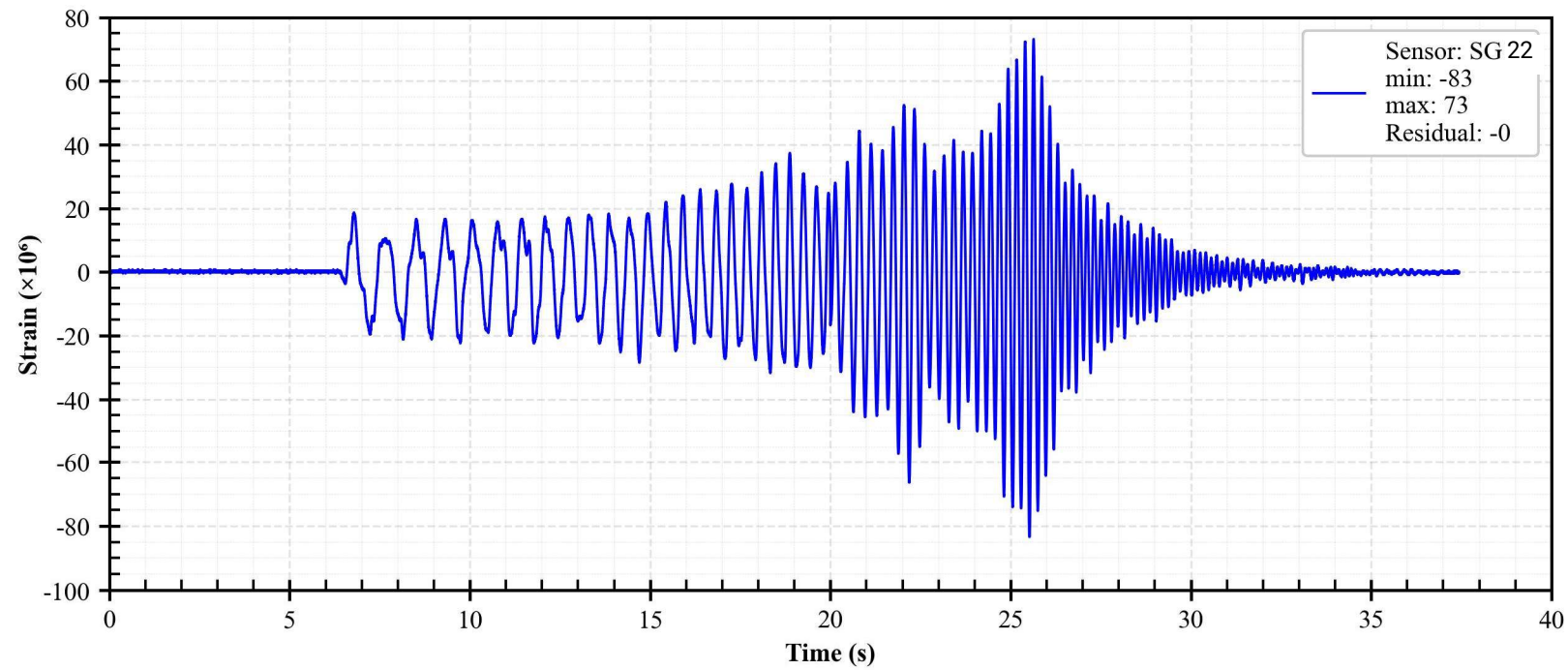


Figure 3.16.36 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 22 (PUFJ, column 2)

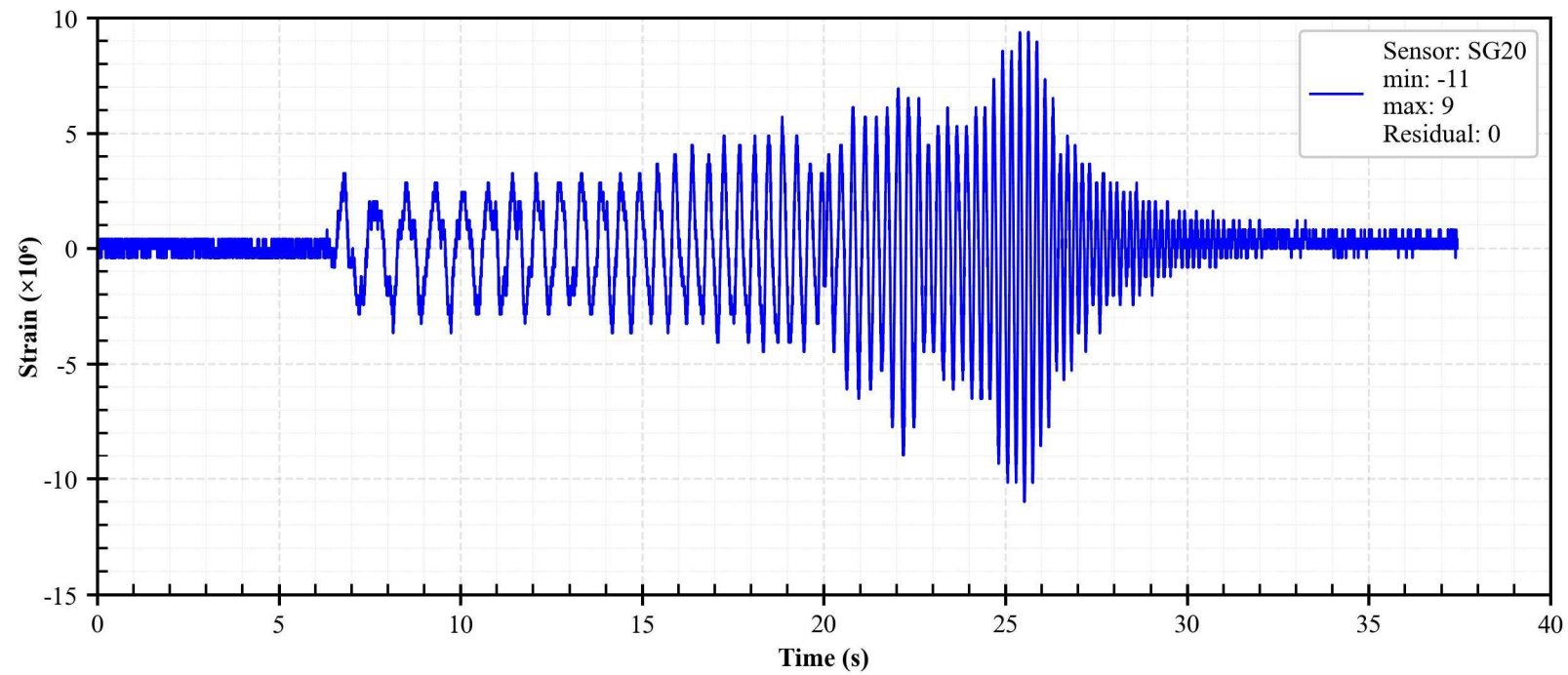


Figure 3.16.37 Characteristic results for phase B (white noise before EQ0,8g): strain gauge 20

3.17 Earthquake EQ0,8g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ0,8g. The max acceleration at the slab level on the accelerometer acc4 is 1.44g. The max acceleration at the foundation level on the accelerometer acc10 is 0.88g.

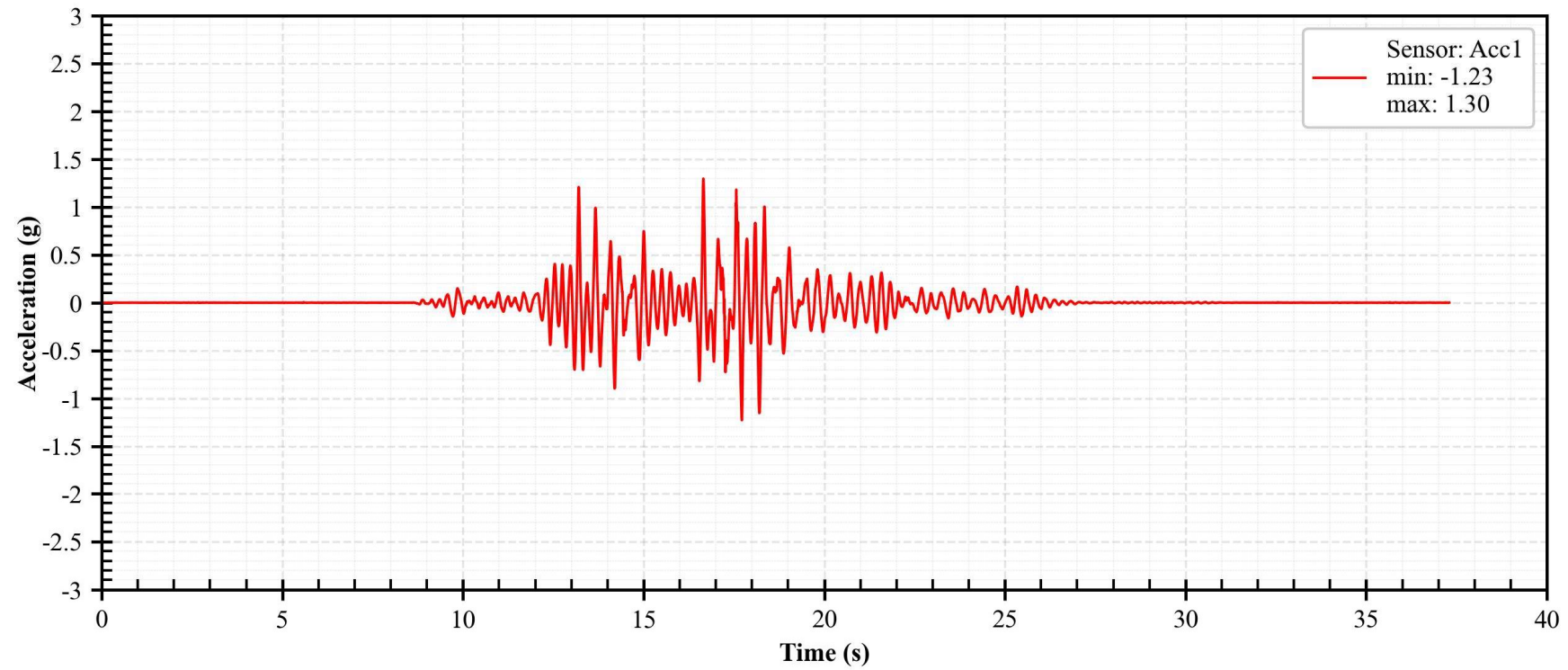


Figure 3.17.1 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 1

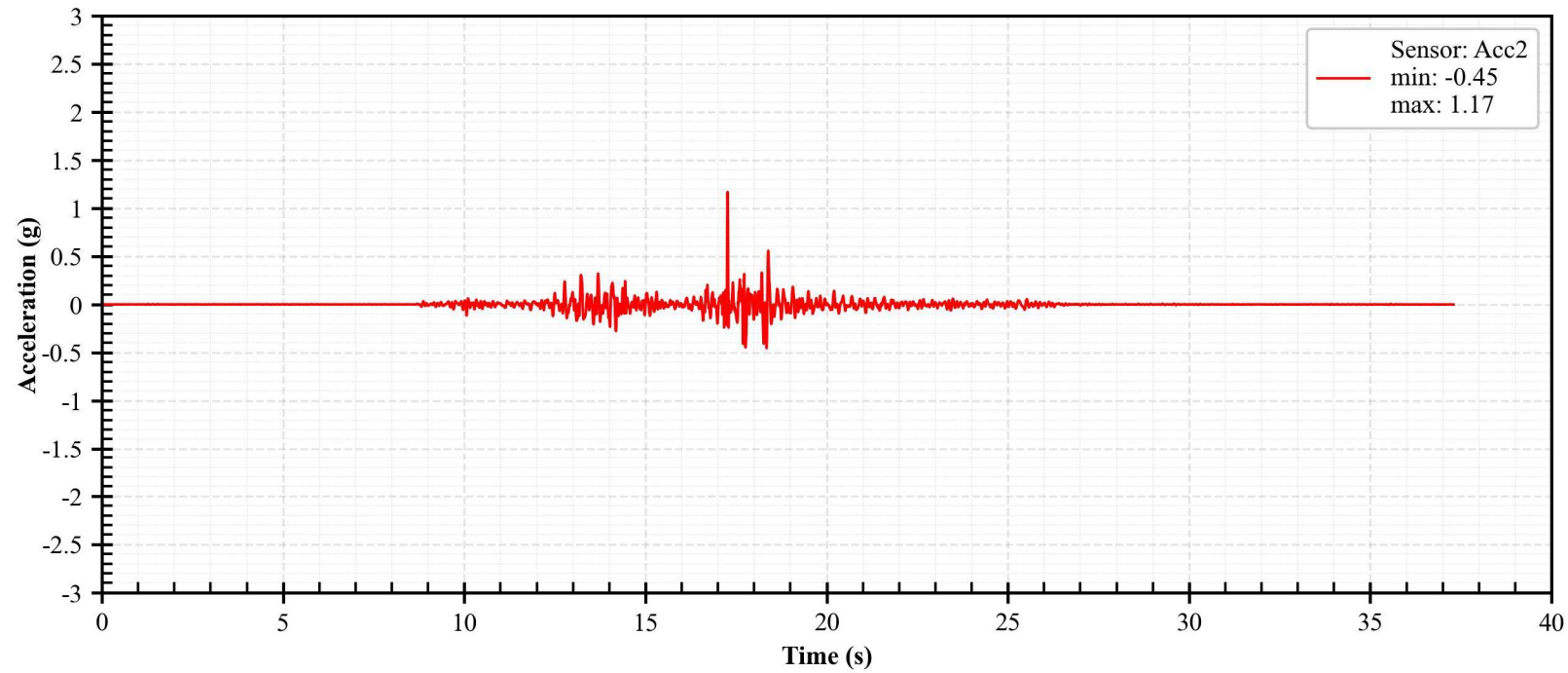


Figure 3.17.2 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 2

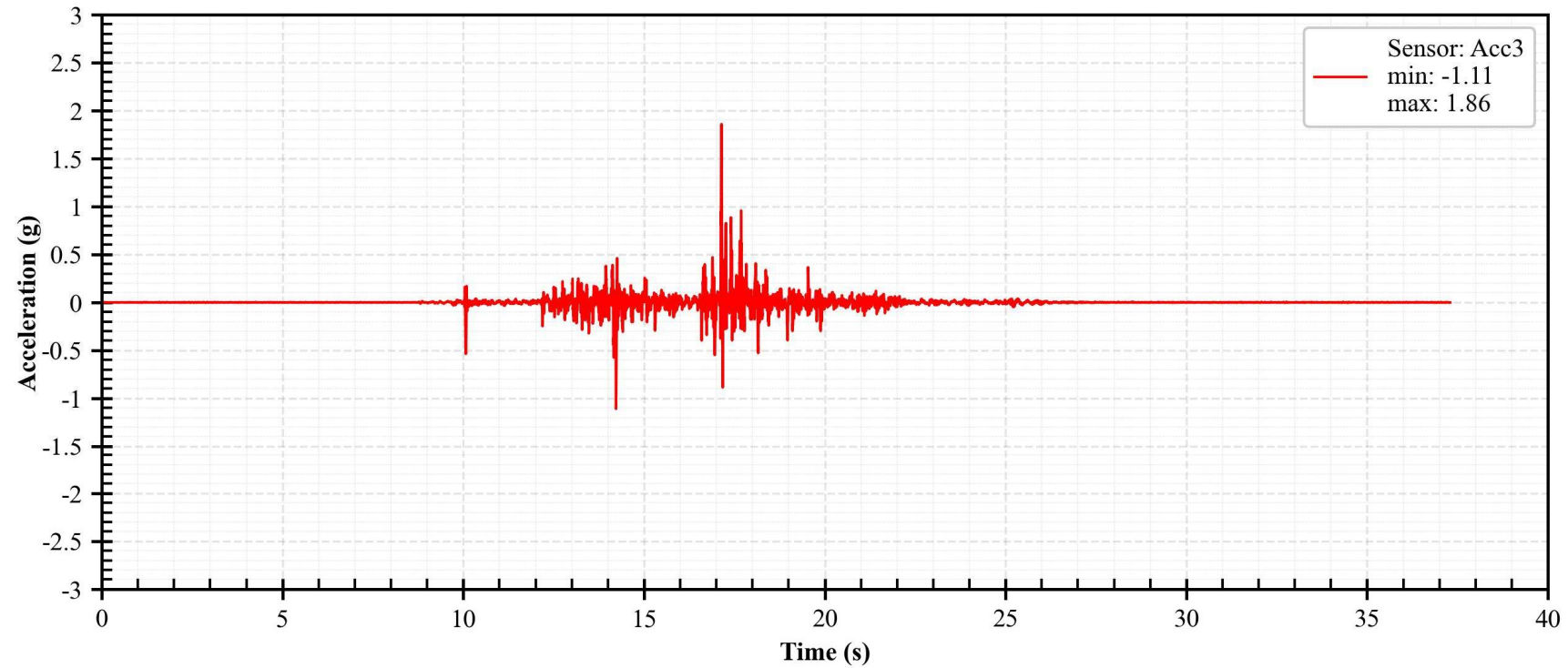


Figure 3.17.3 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 3

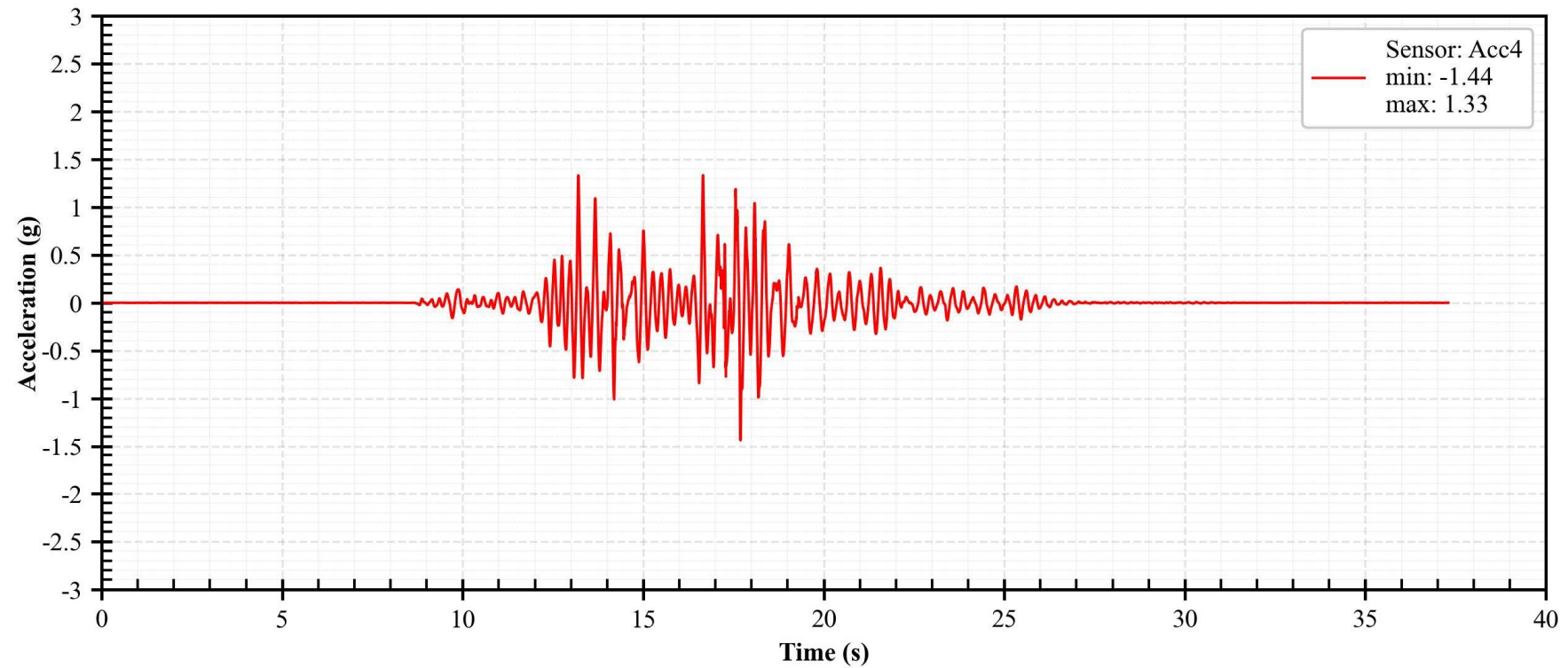


Figure 3.17.4 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 4

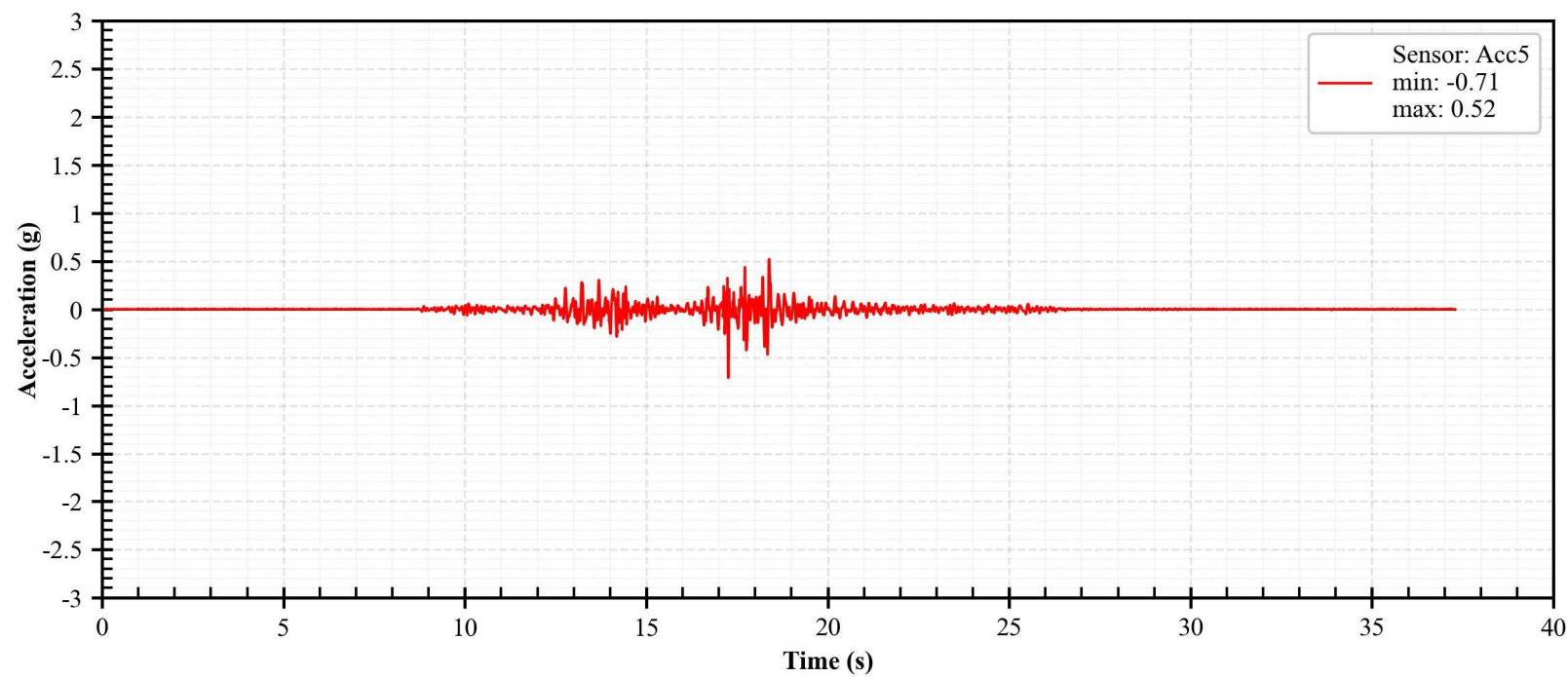


Figure 3.17.5 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 5

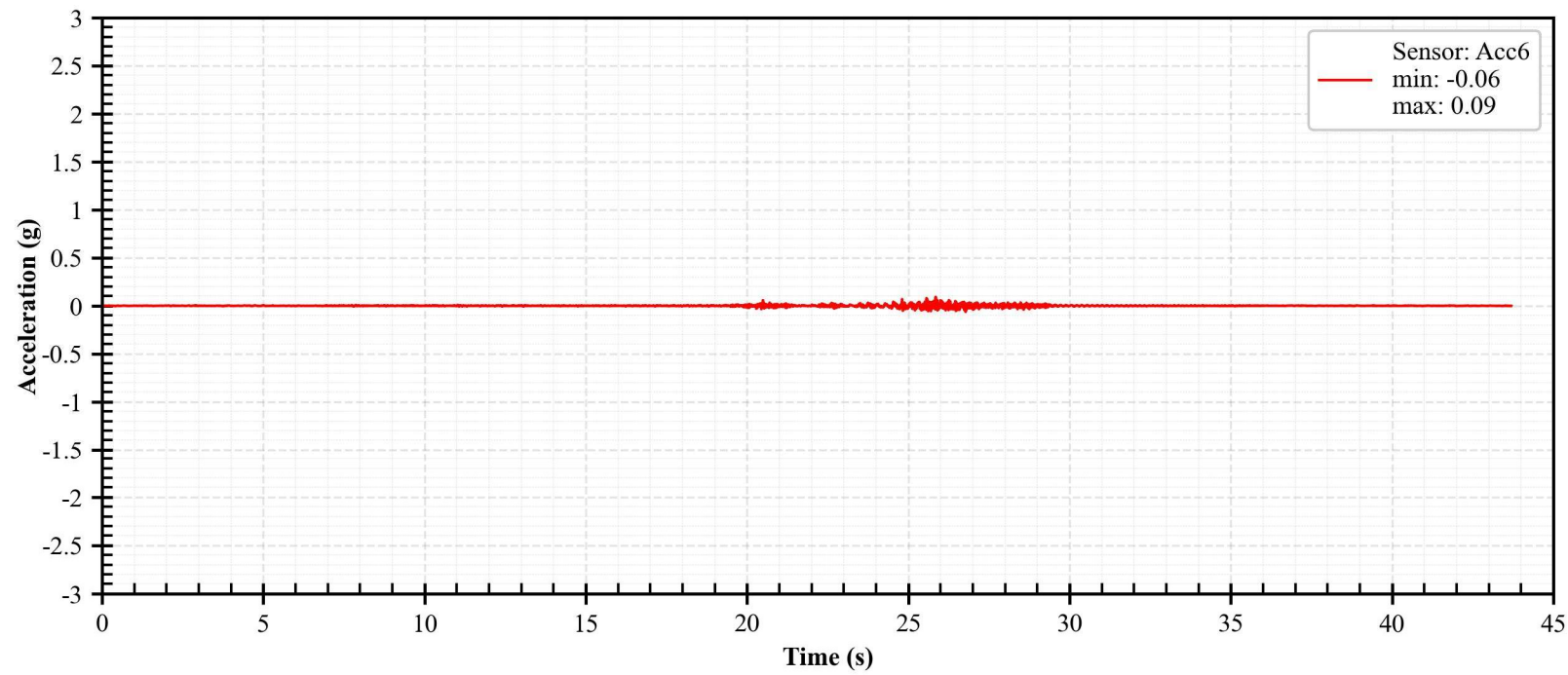


Figure 3.17.6 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 6

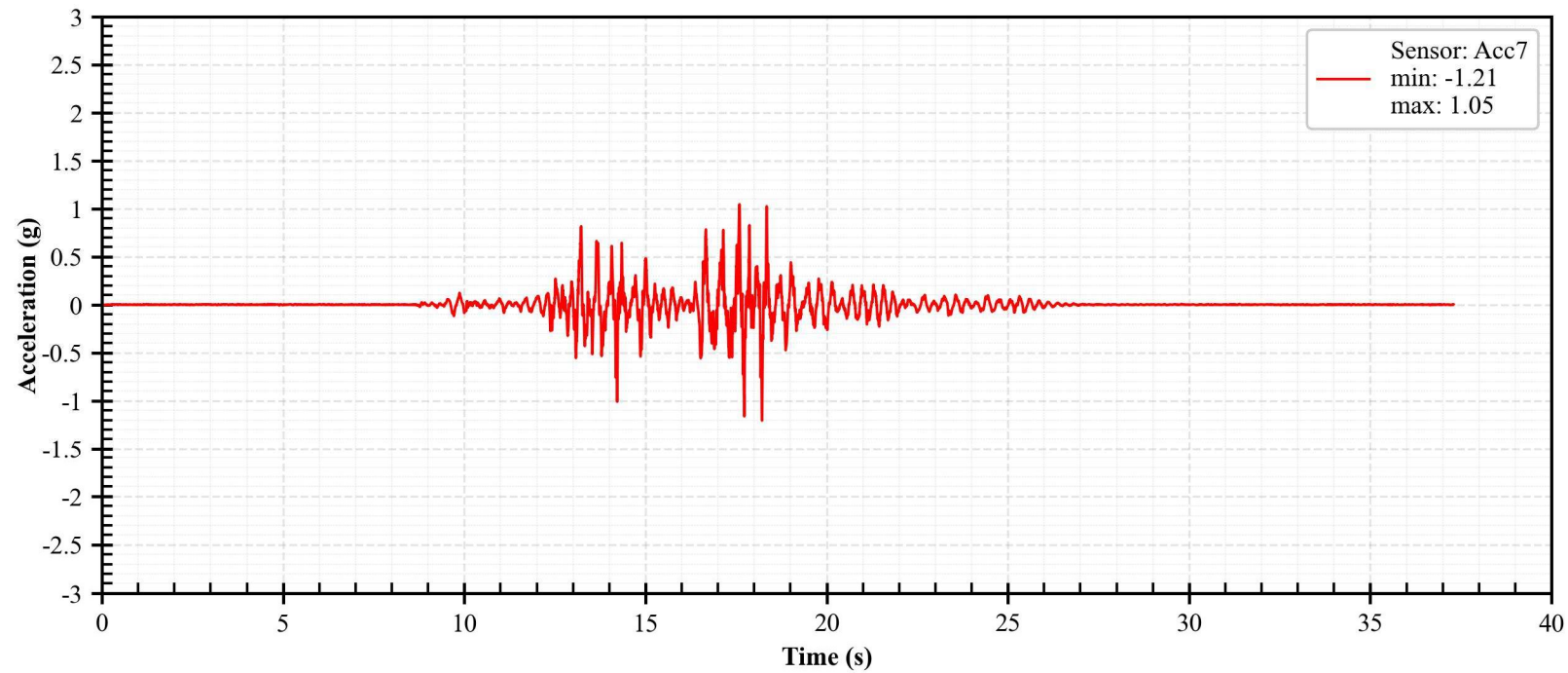


Figure 3.17.7 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 7

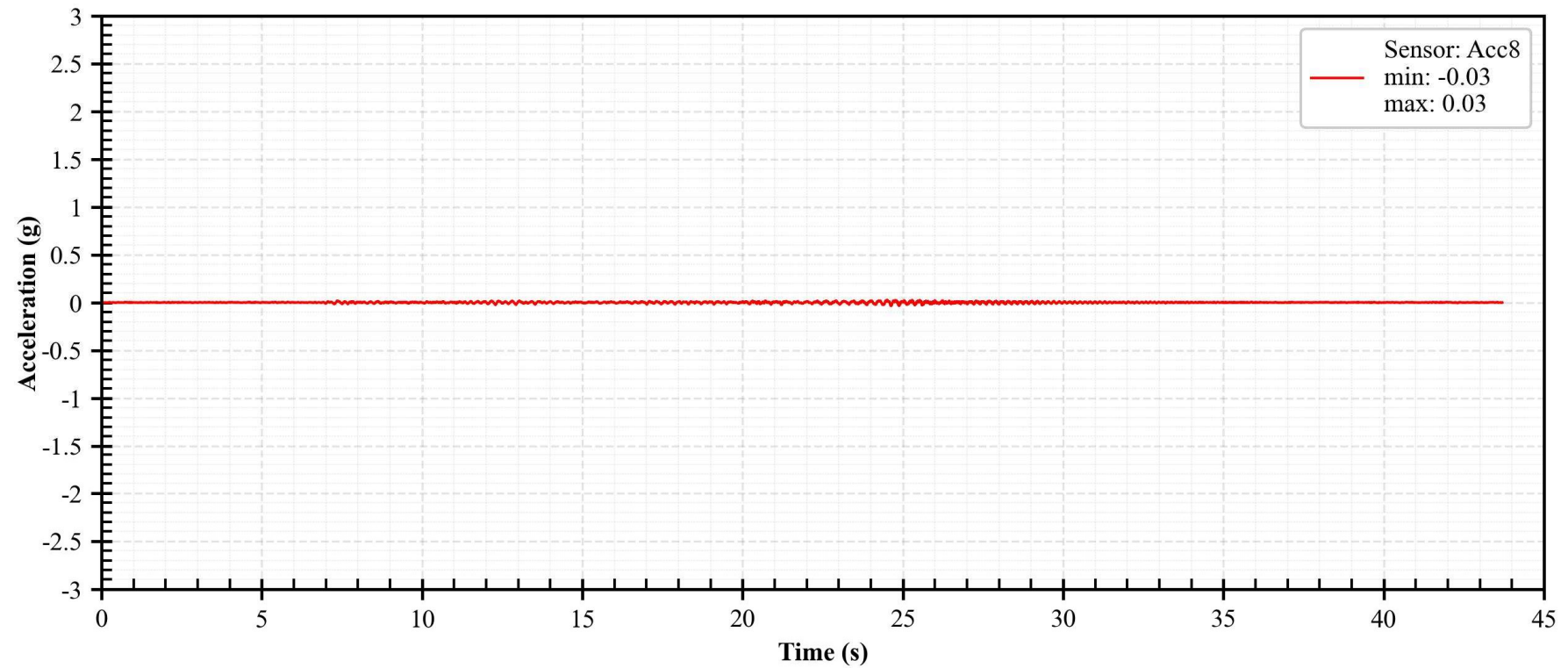


Figure 3.17.8 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 8

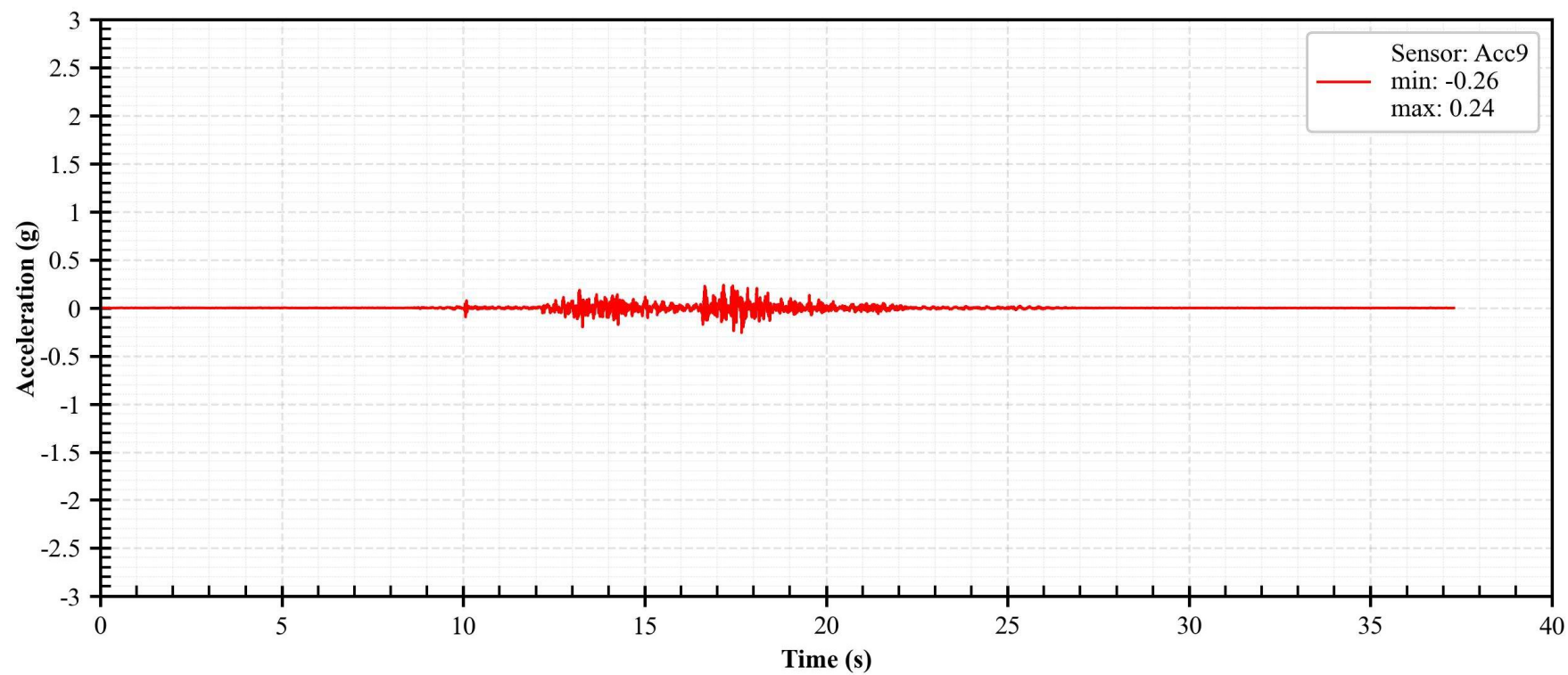


Figure 3.17.9 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 9

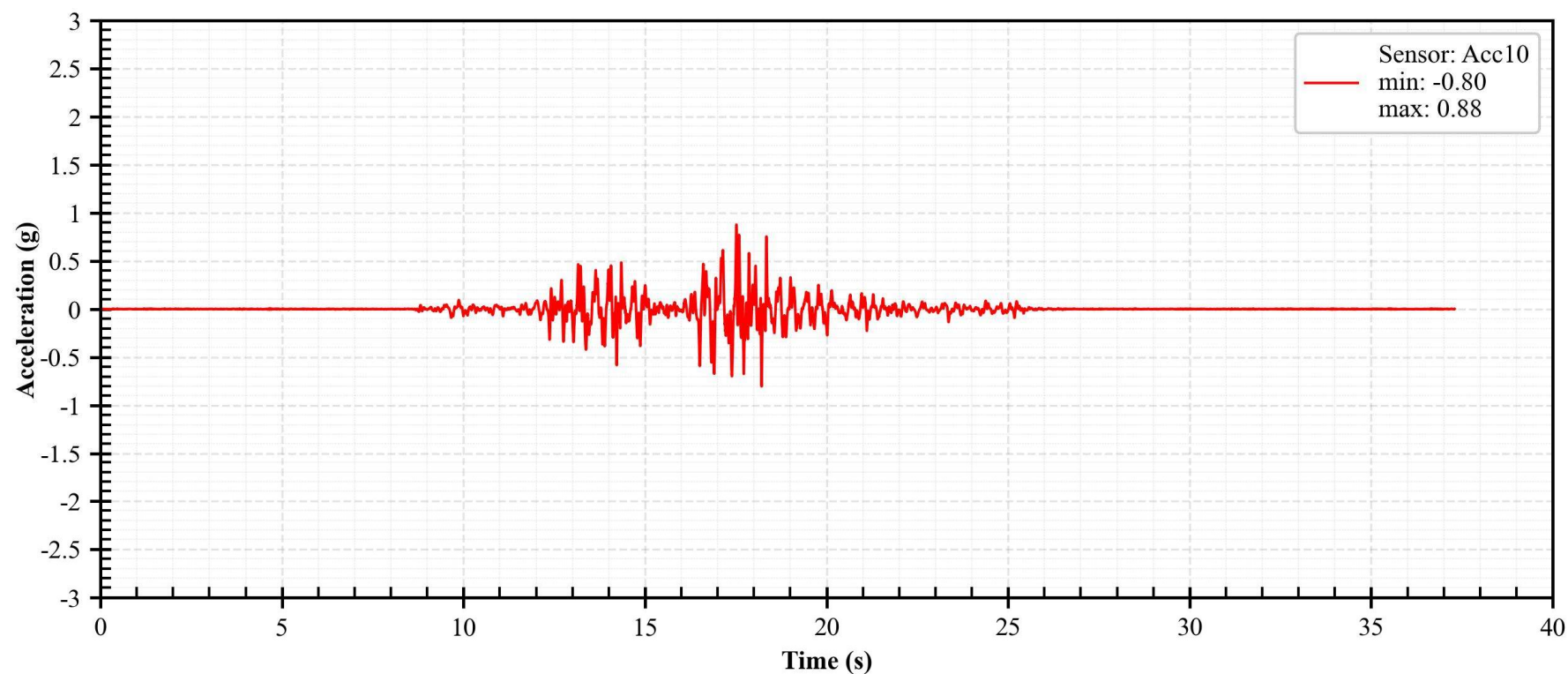


Figure 3.17.10 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 10

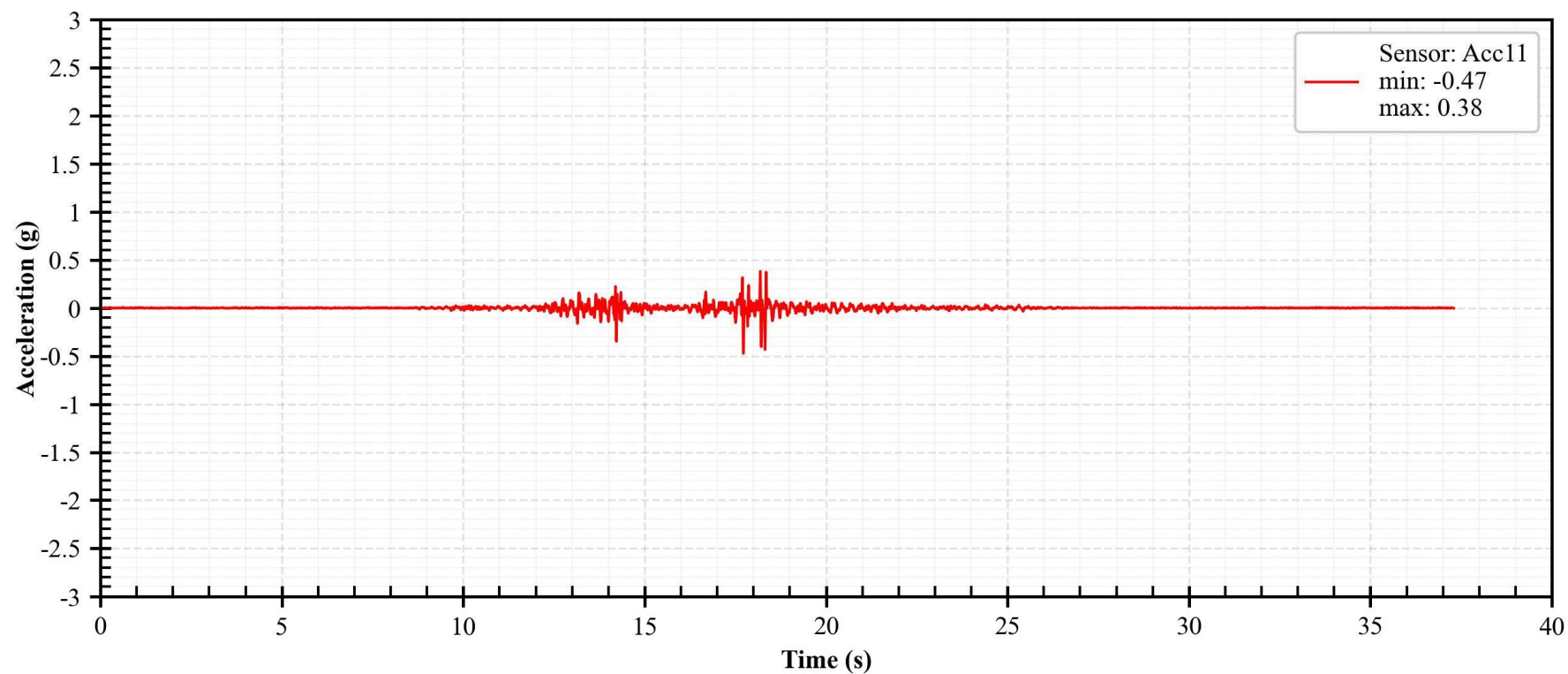


Figure 3.17.11 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 11

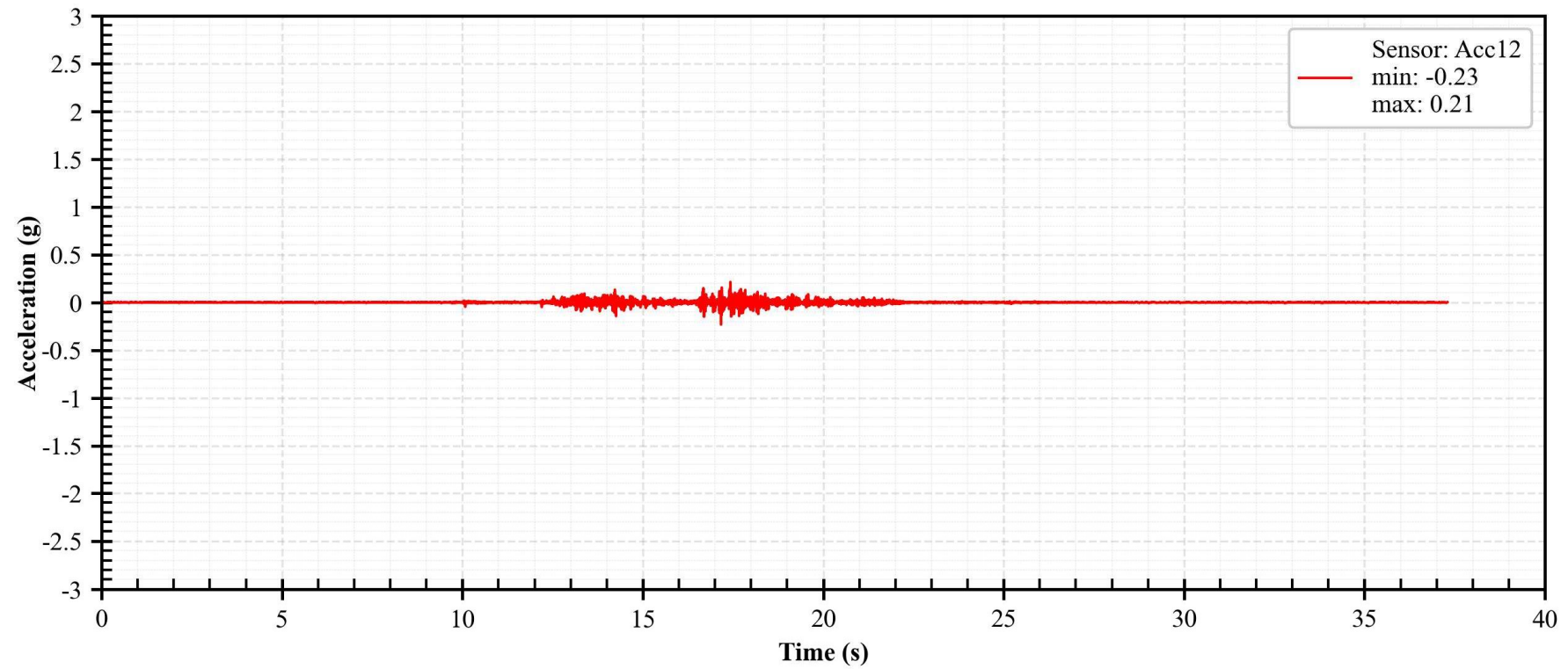


Figure 3.17.12 Characteristic results for phase B (earthquake EQ0,8g): Accelerometer 12

Draw wire sensors

Figures 3.17.13 – 3.17.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 23.65 mm while the minimum is -22.18 mm. The maximum movement detected by draw wire sensor W2 is 24.54 mm while the minimum is -23.54 mm. The maximum movement detected by draw wire sensor W3 is 18.04 mm while the minimum is -16.45 mm. The maximum movement detected by draw wire sensor W4 is 18.51 mm while the minimum is -16.40 mm. The maximum drift is $(11.23/1.225) = 9.17 \text{ ‰}$ and minimum drift is $(-10.98/1.225) = -8.96 \text{ ‰}$.

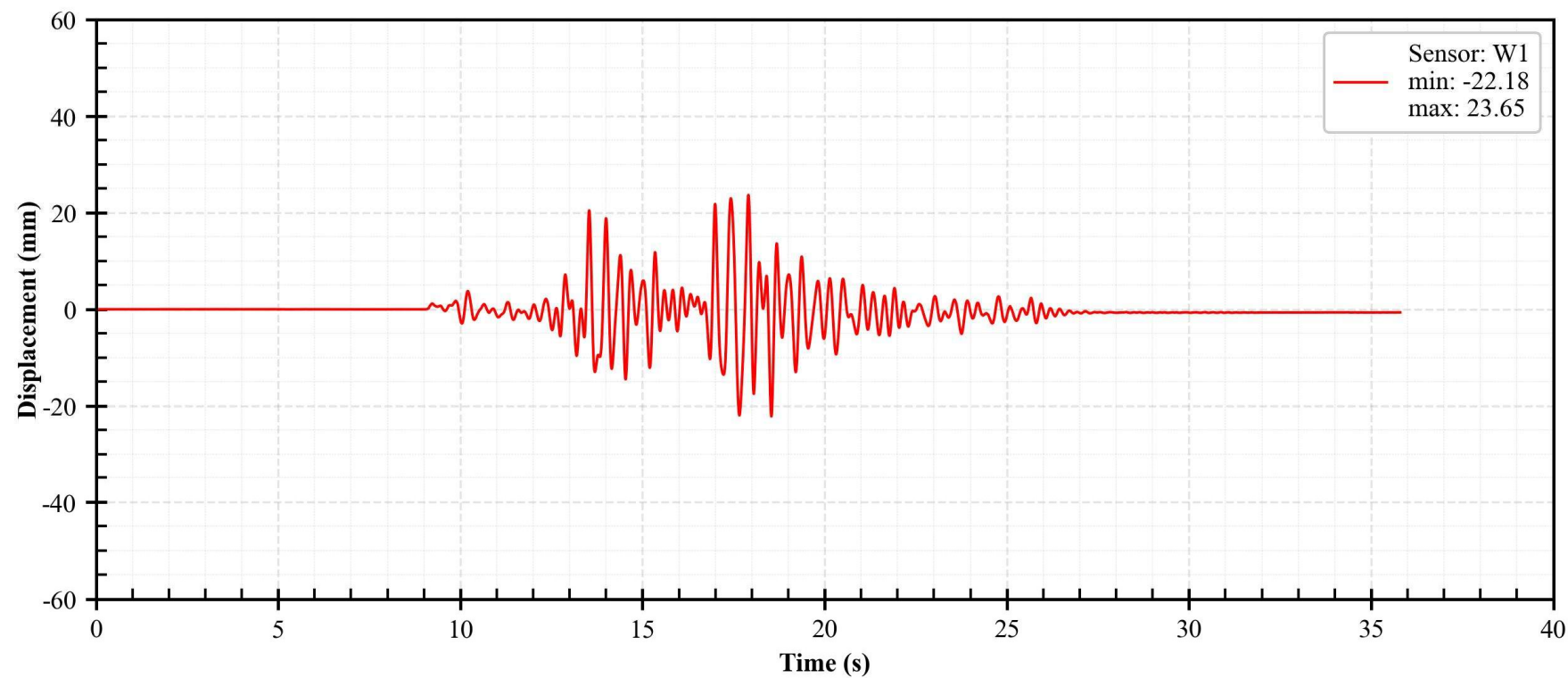


Figure 3.17.13 Characteristic results for phase B (earthquake EQ0,8g): Draw wire sensor 1

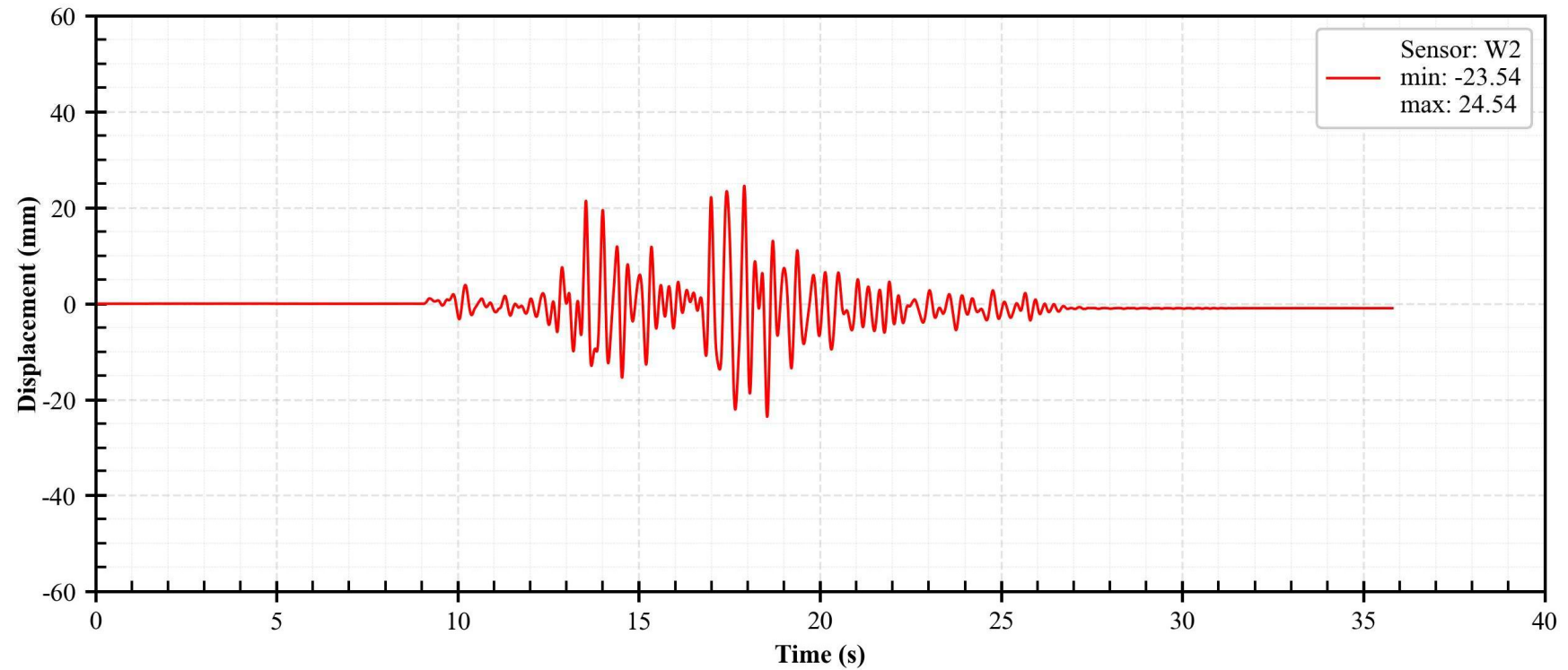


Figure 3.17.14 Characteristic results for phase B (earthquake EQ0,8g): Draw wire sensor 2

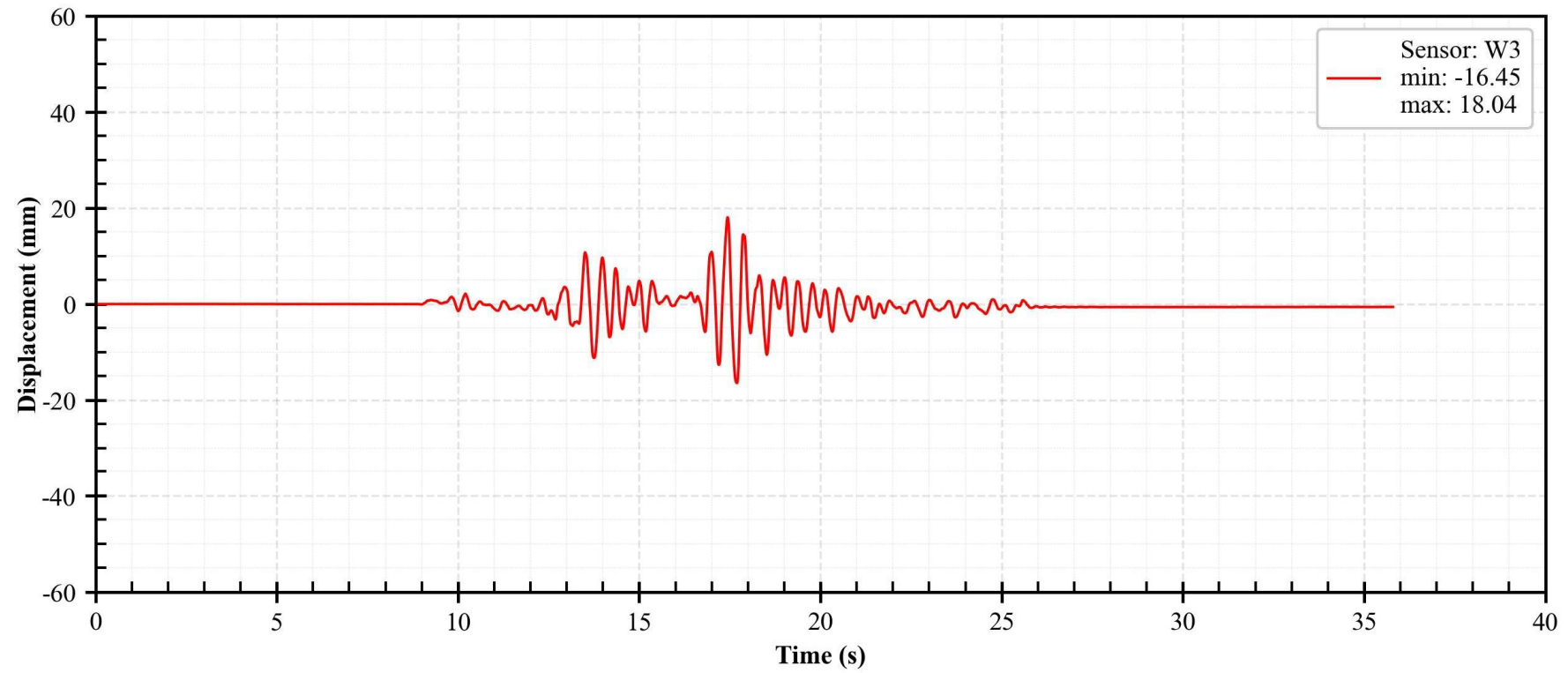


Figure 3.17.15 Characteristic results for phase B (earthquake EQ0,8g): Draw wire sensor 3

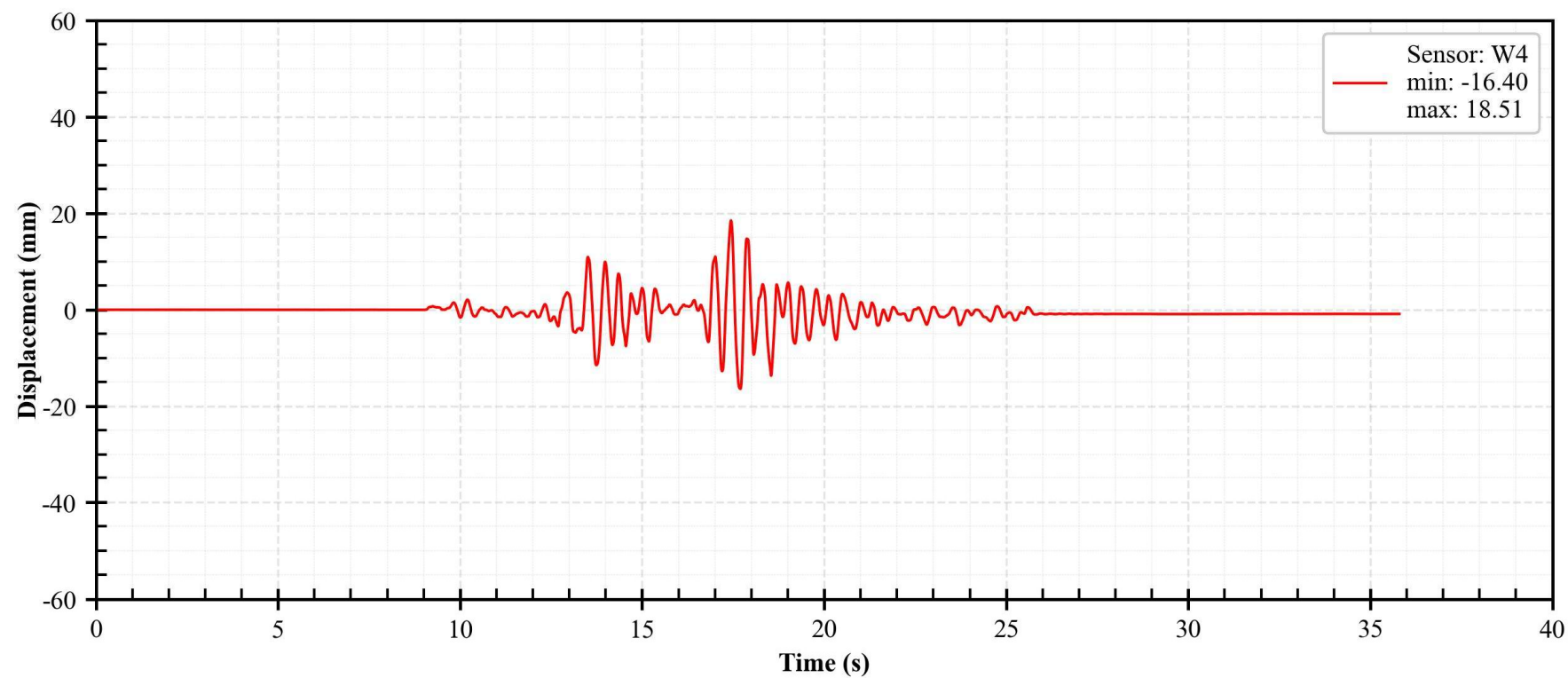


Figure 3.17.16 Characteristic results for phase B (earthquake EQ0,8g): Draw wire sensor 4

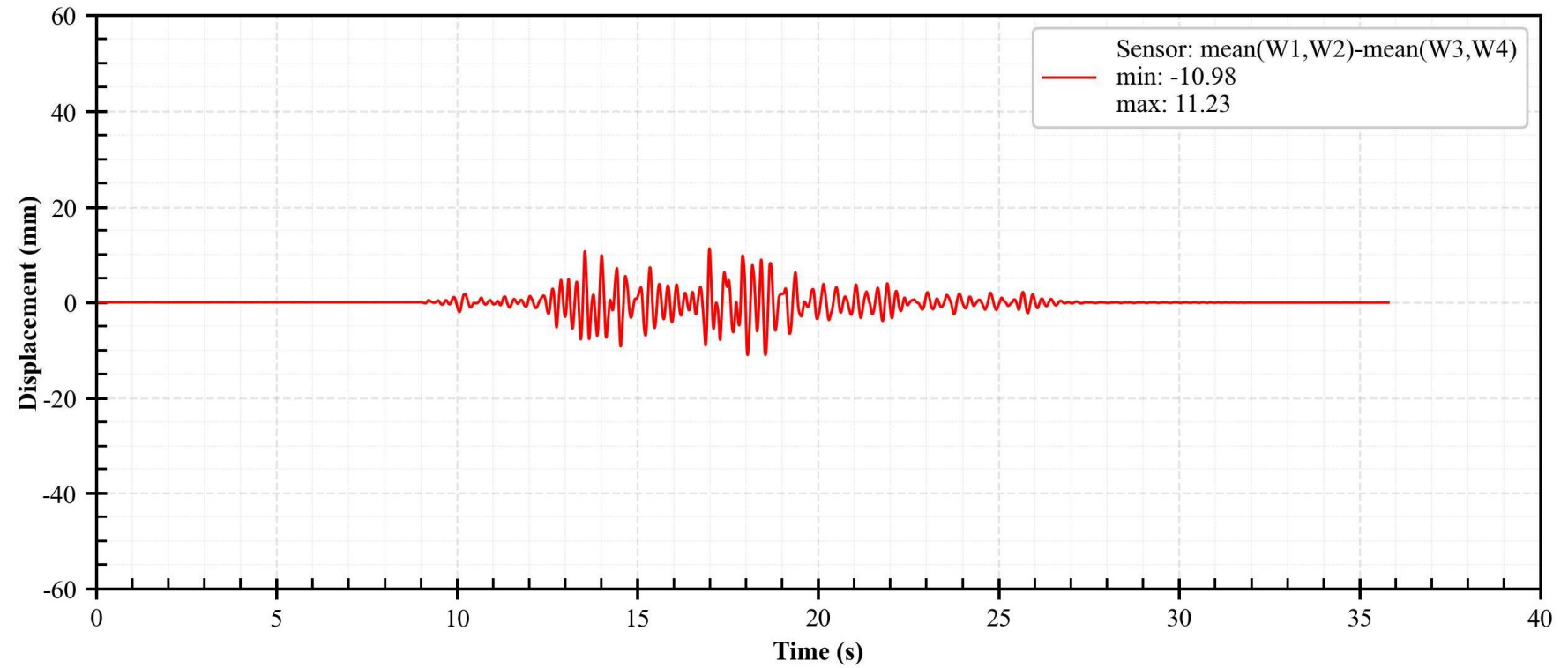


Figure 3.17.17 Characteristic results for phase B (earthquake EQ0,8g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.17.18, 3.17.19, 3.17.20, 3.17.21, 3.17.22, 3.17.23, 3.17.32, 3.17.33 are located on the longitudinal reinforcement, at the bottom of the column. Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. The strain gauges shown in the figures 3.17.24, 3.17.25, 3.17.26, 3.17.27, 3.17.28, 3.17.29 and 3.17.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 1997 μstrain and minimum strain -675 μstrain . The residual strain is 6 μstrain . SG21 & SG22 are located on PUFJ.

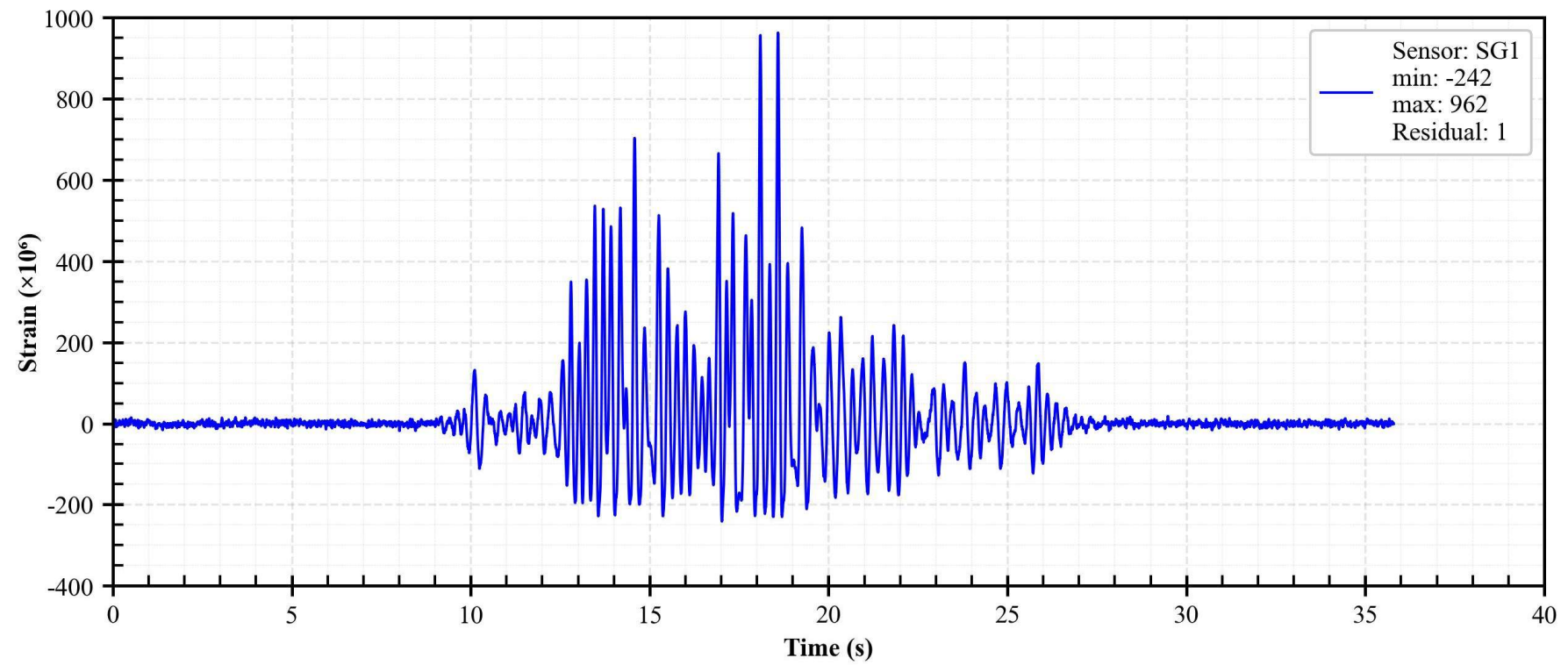


Figure 3.17.18 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 1

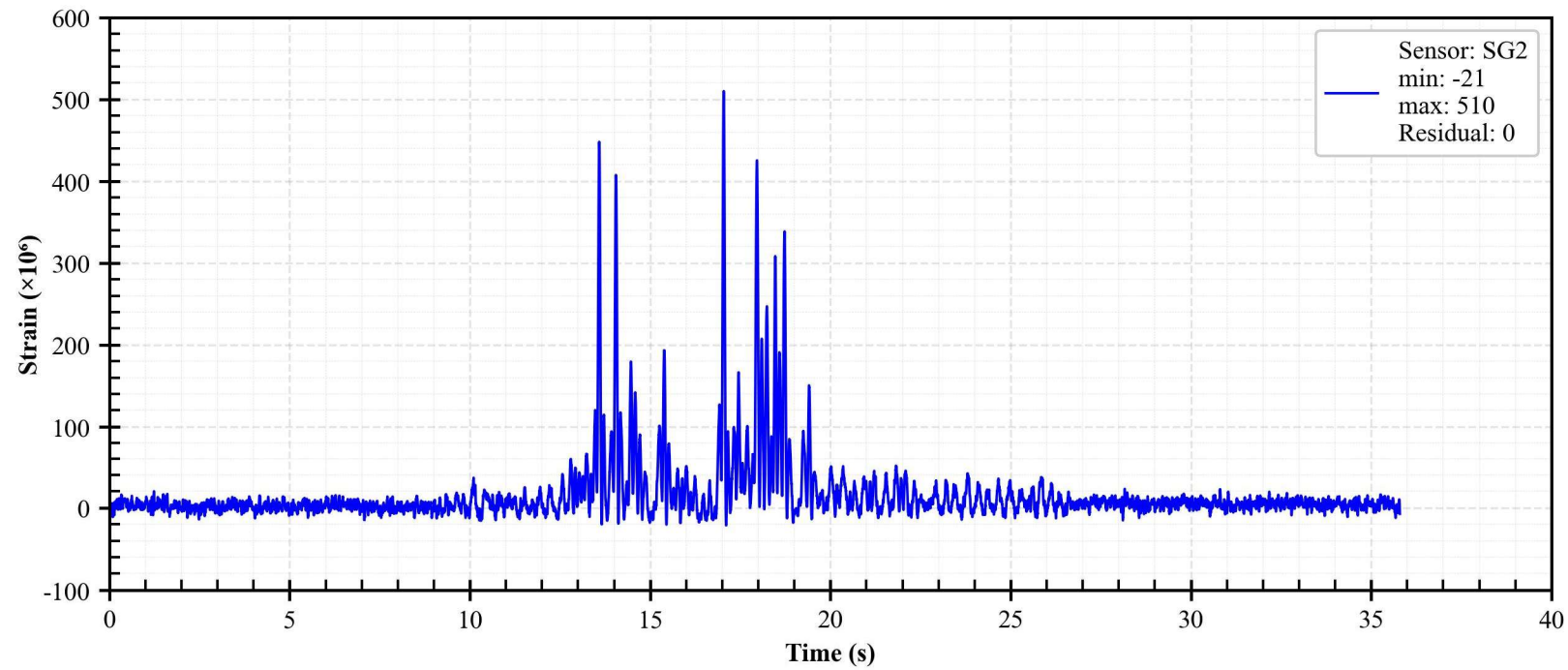


Figure 3.17.19 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 2

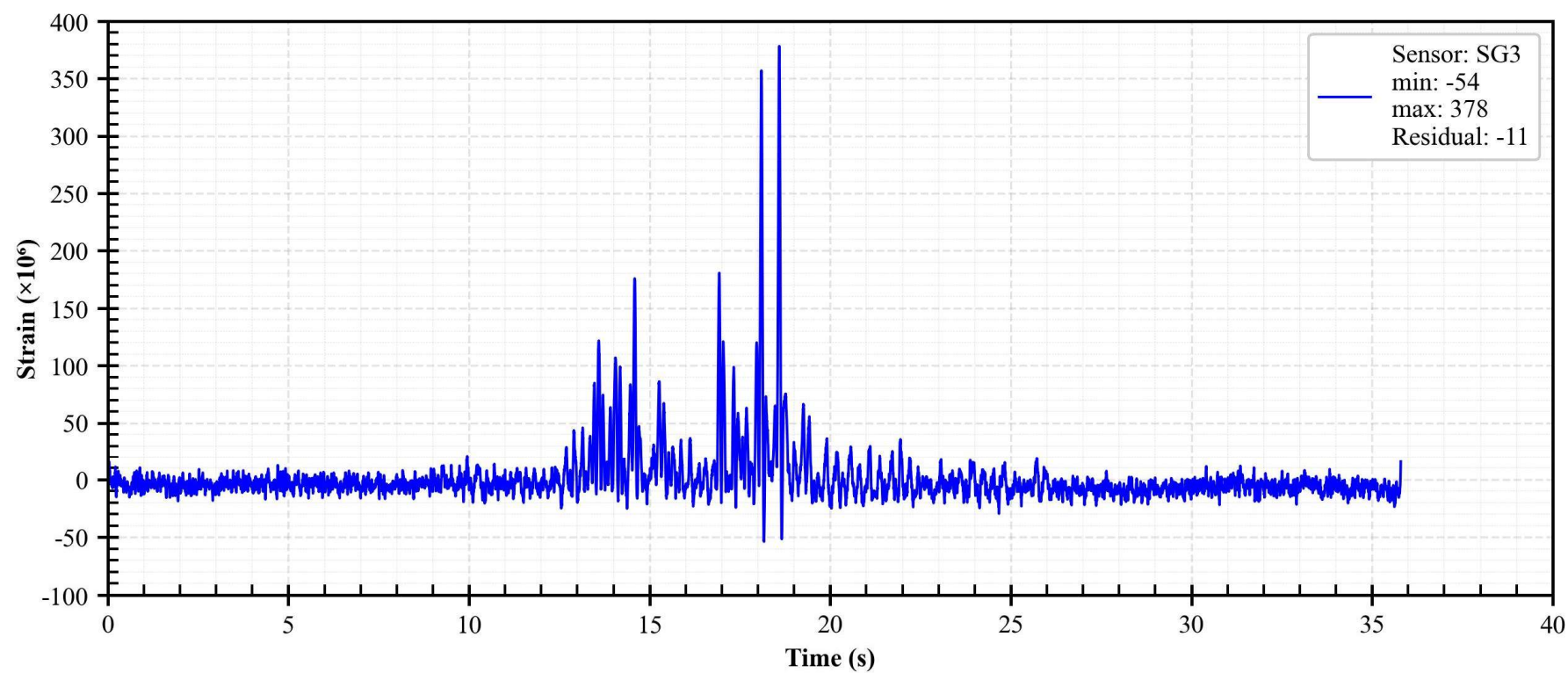


Figure 3.17.20 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 3

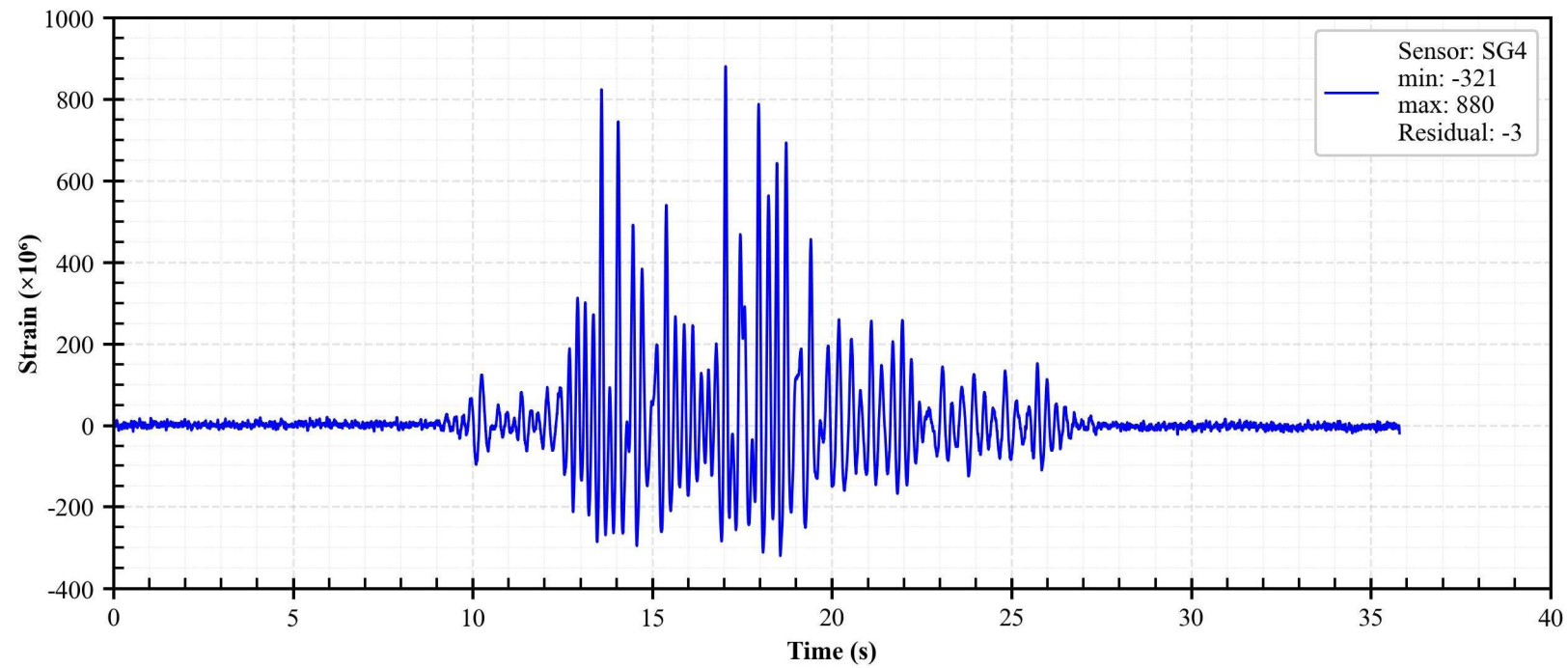


Figure 3.17.21 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 4

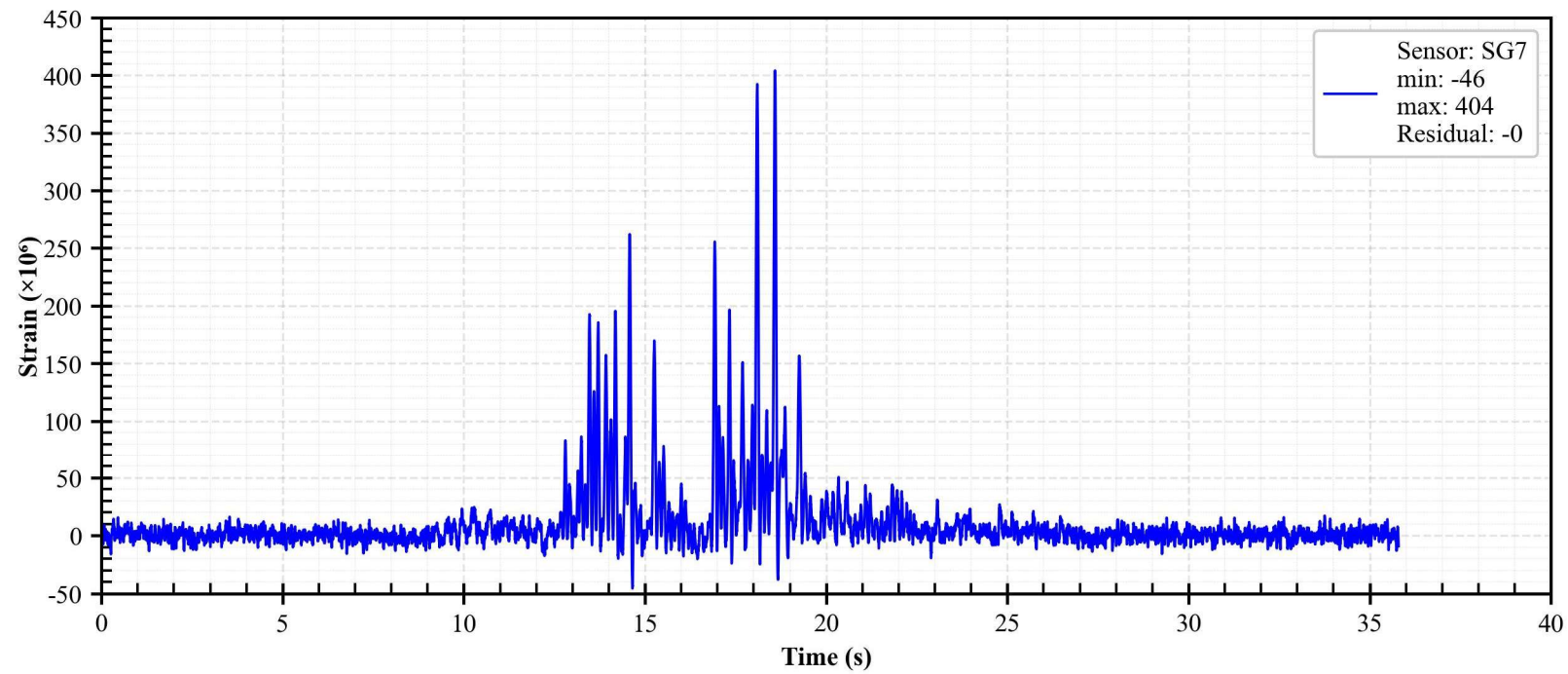


Figure 3.17.22 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 7

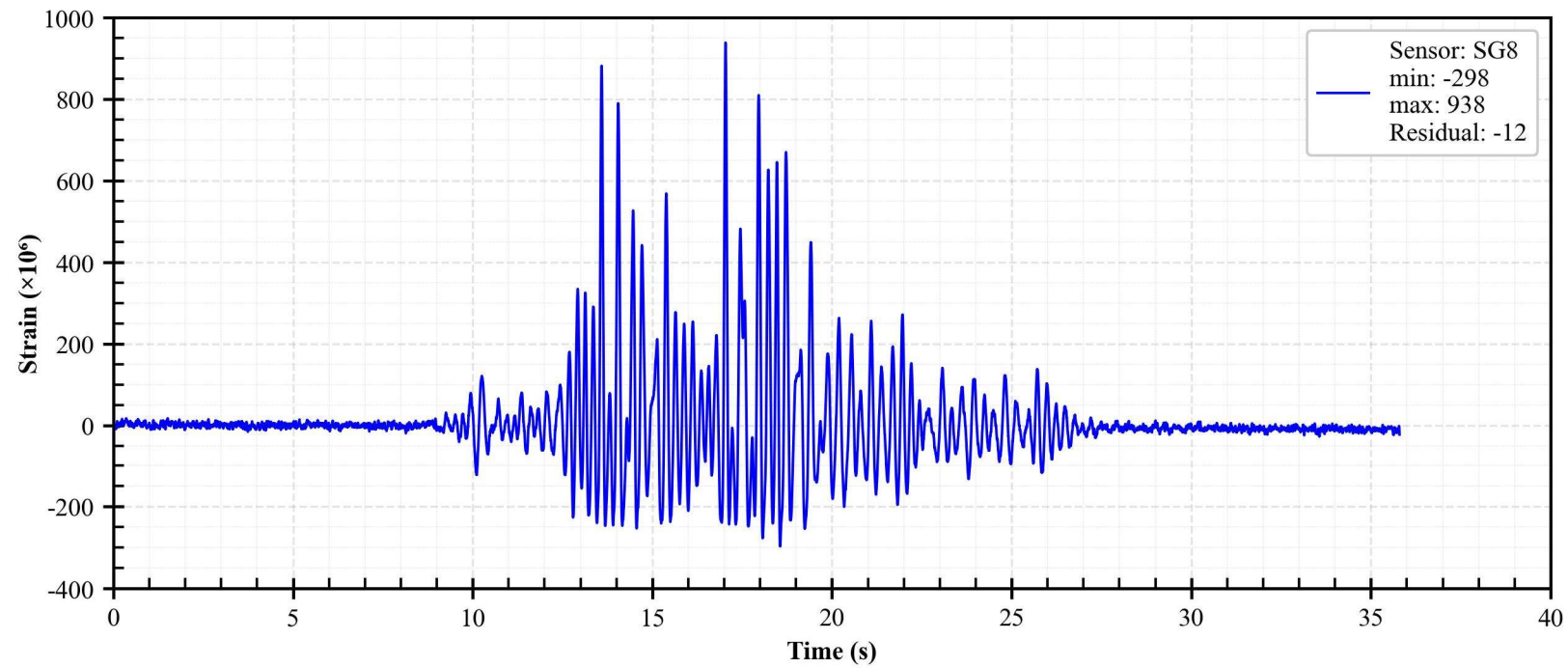


Figure 3.17.23 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 8

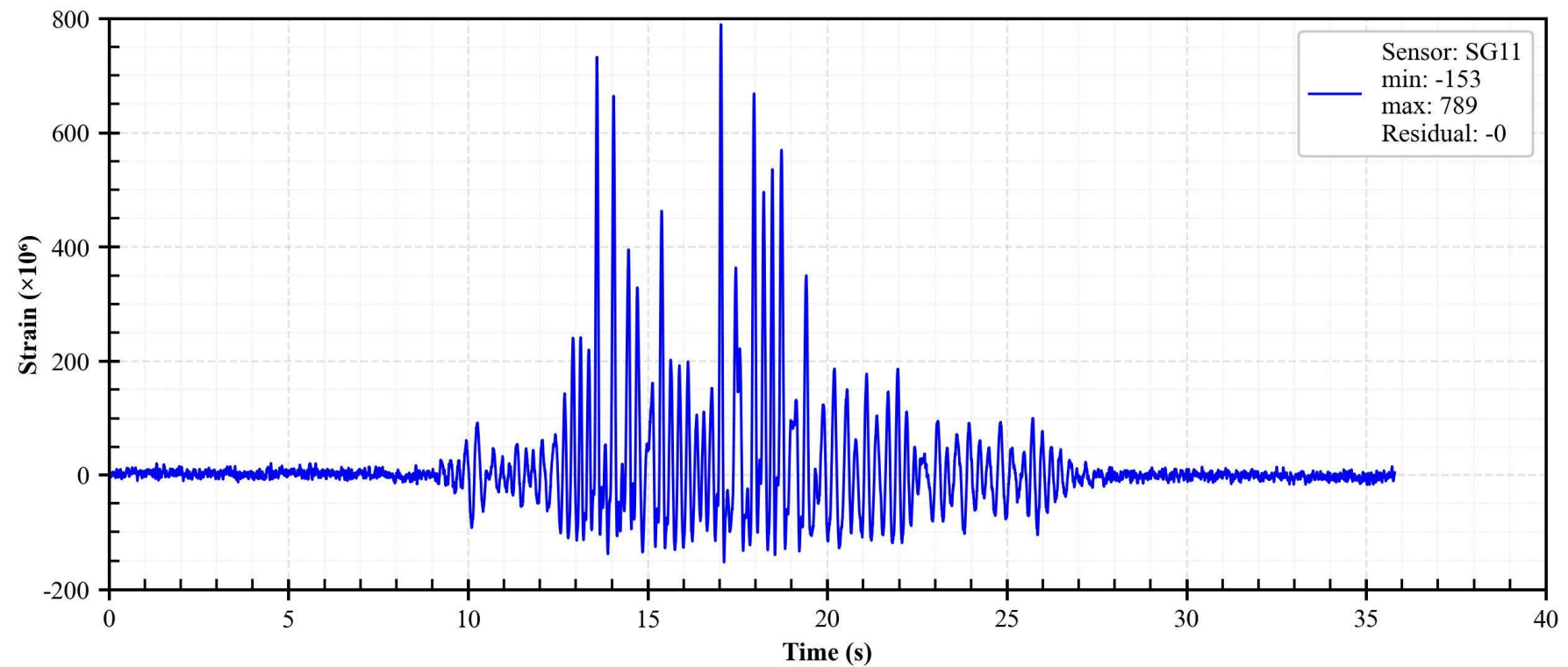


Figure 3.17.24 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 11

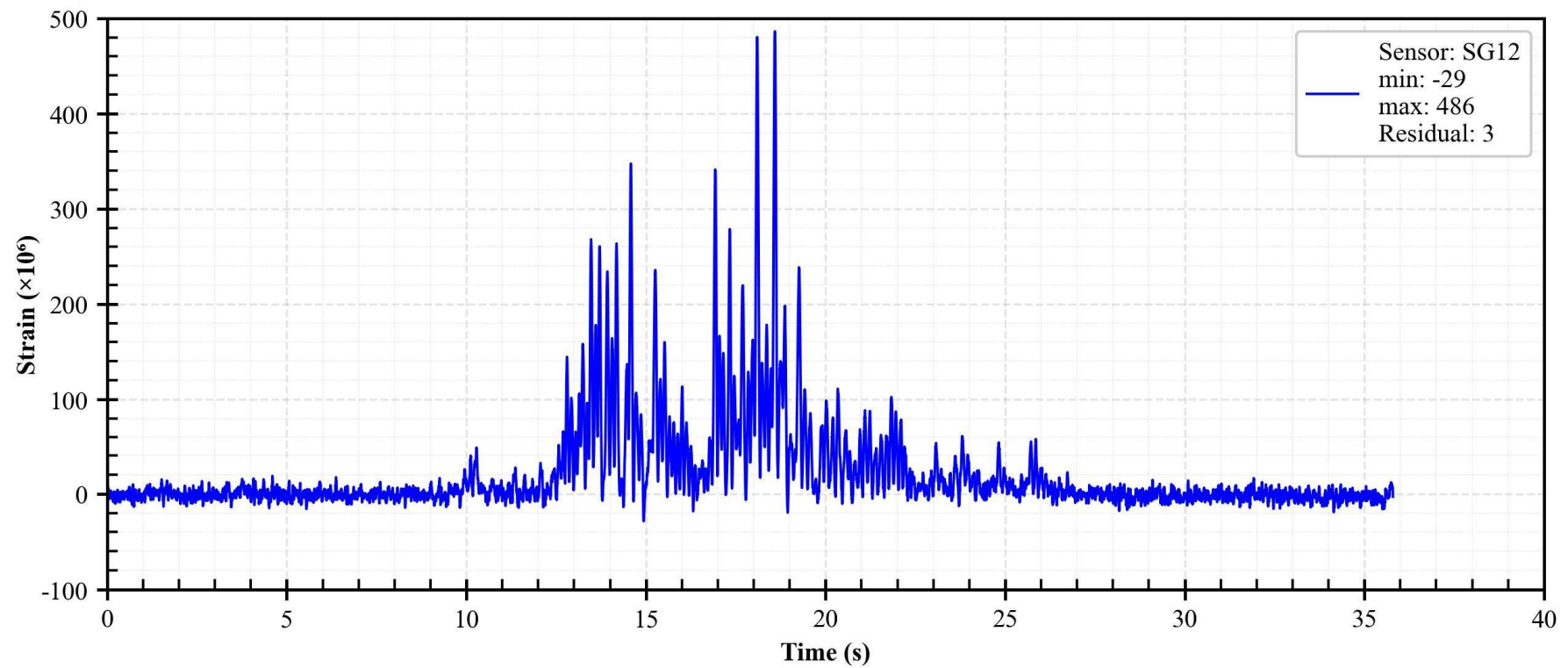


Figure 3.17.25 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 12

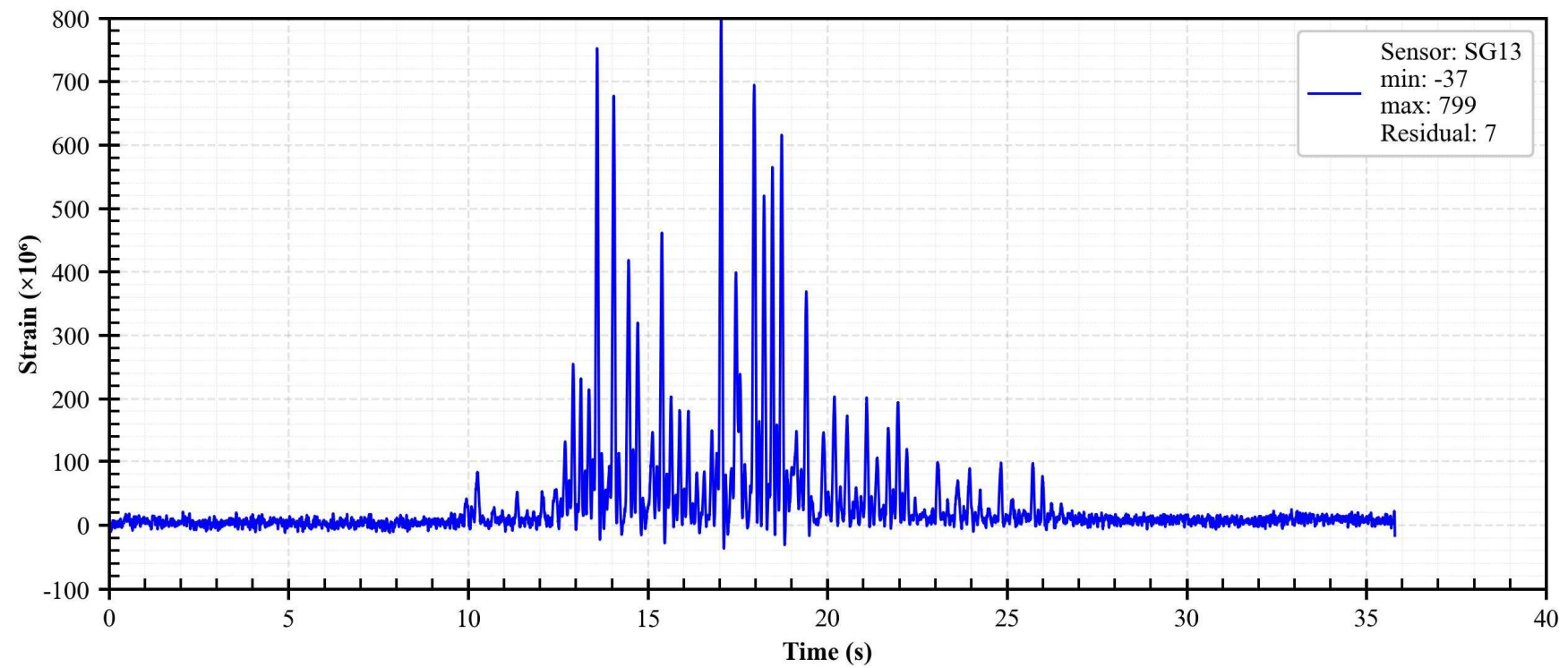


Figure 3.17.26 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 13

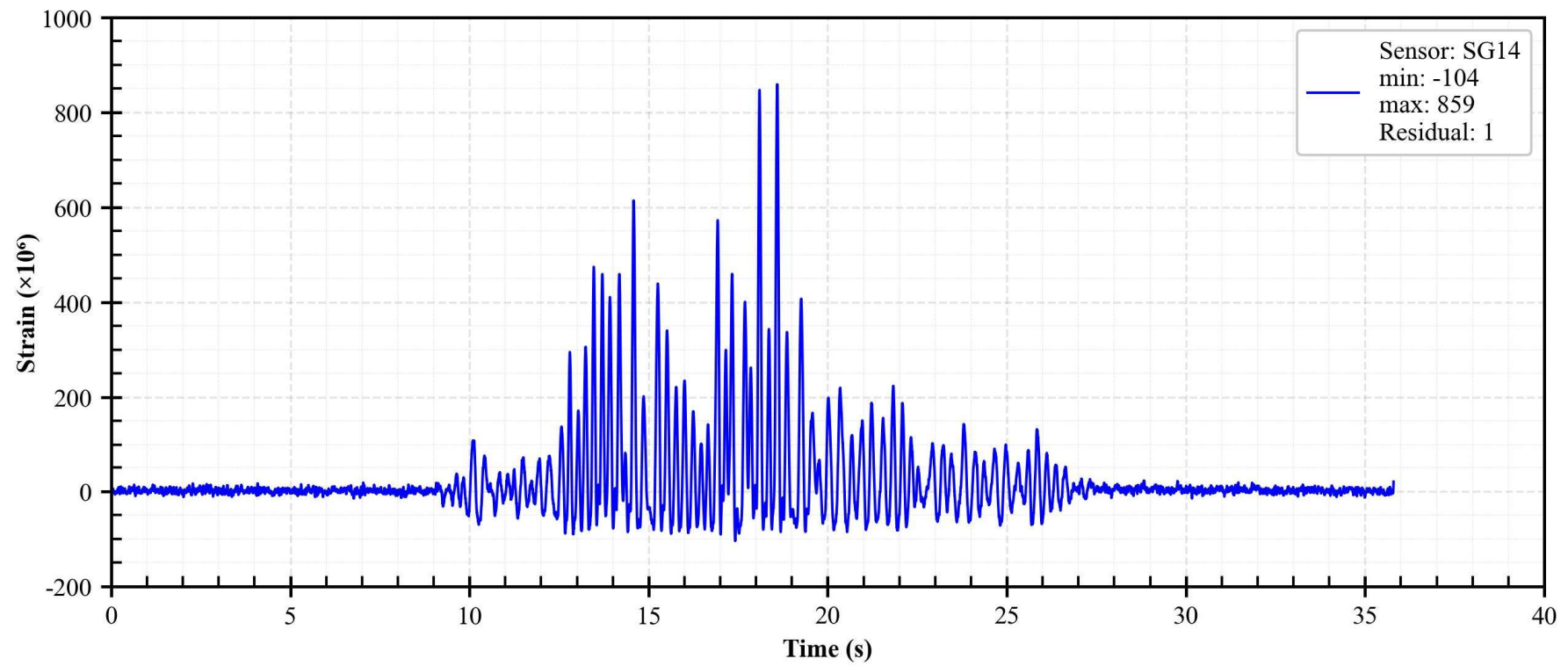


Figure 3.17.27 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 14

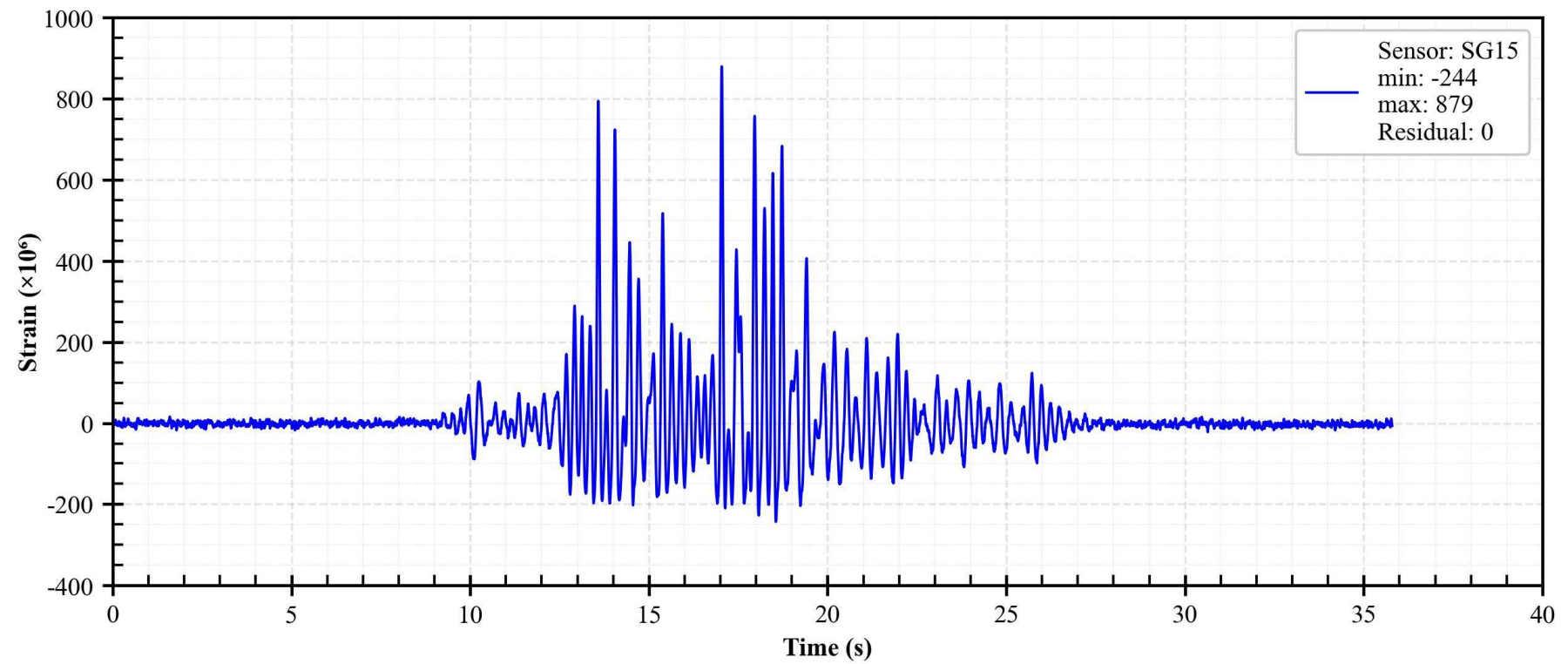


Figure 3.17.28 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 15

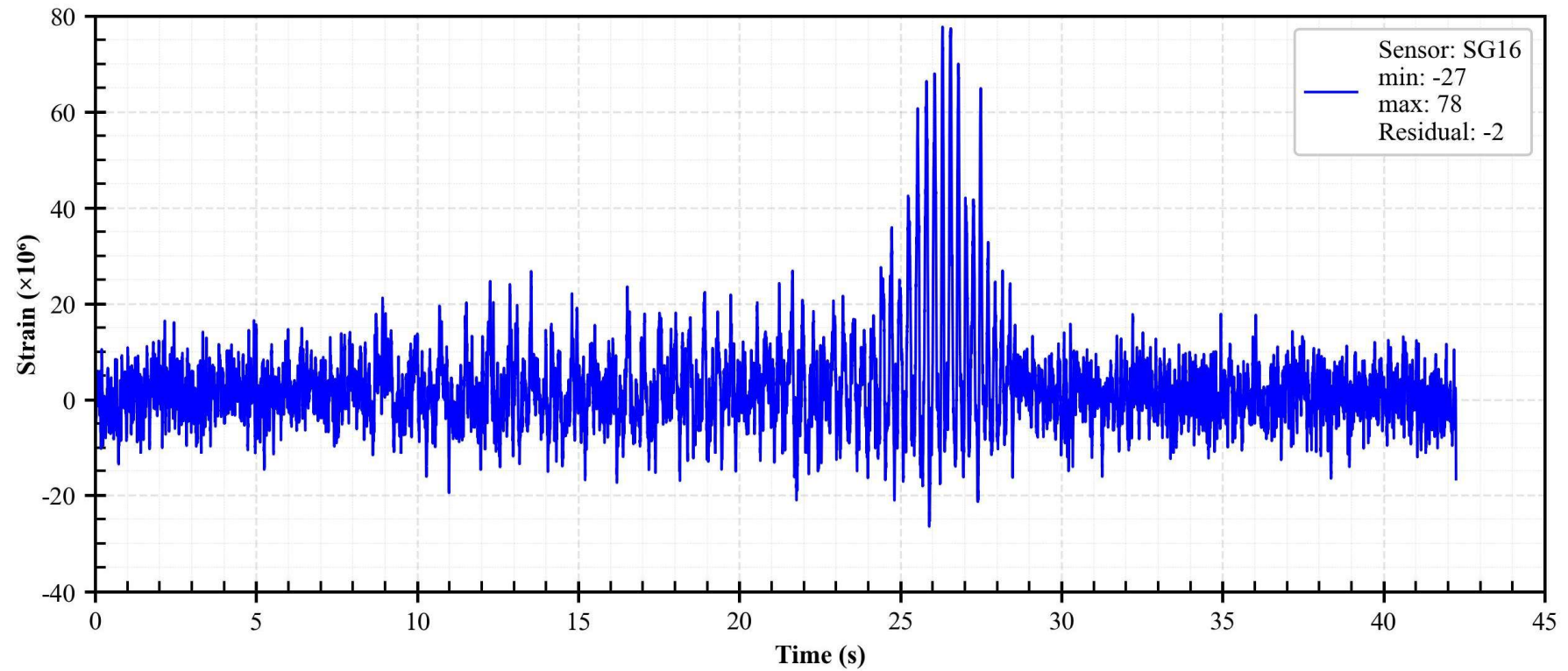


Figure 3.17.29 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 16

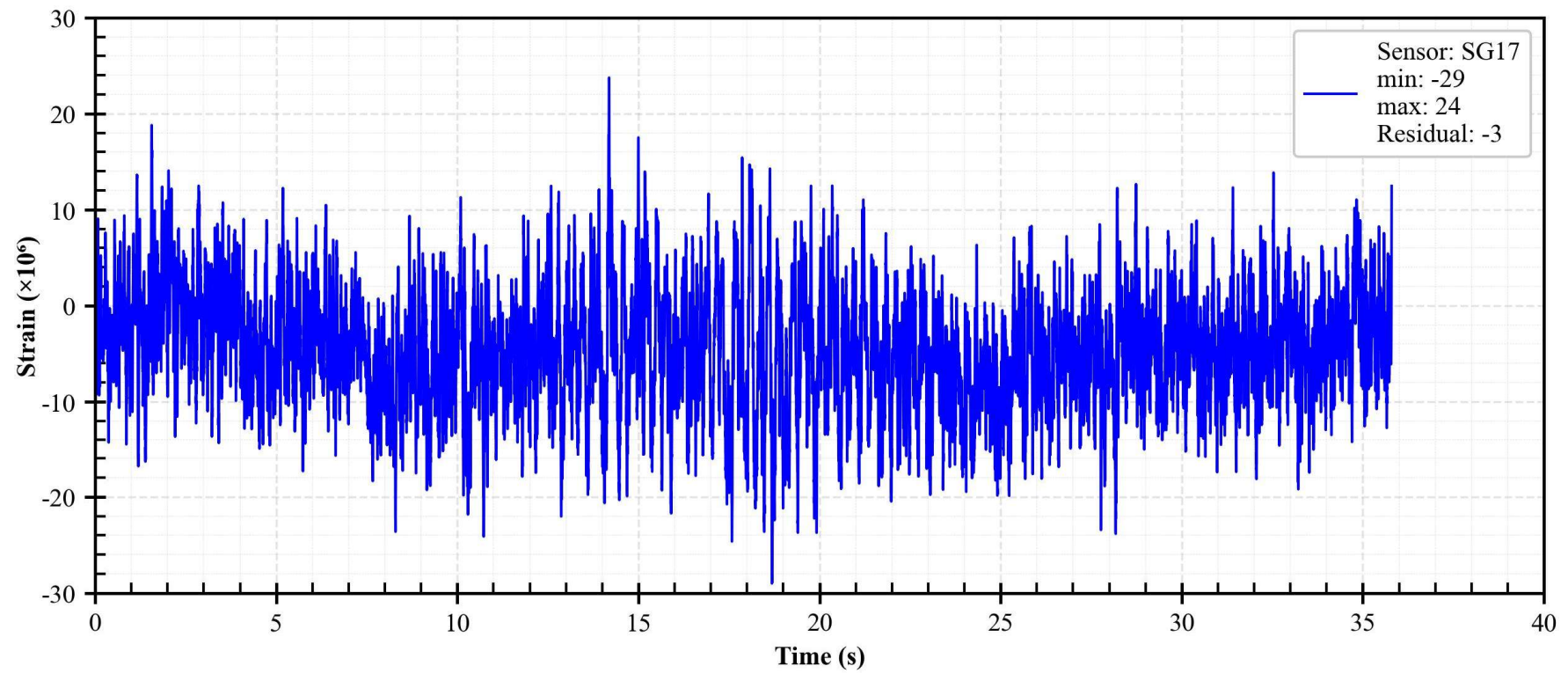


Figure 3.17.30 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 17

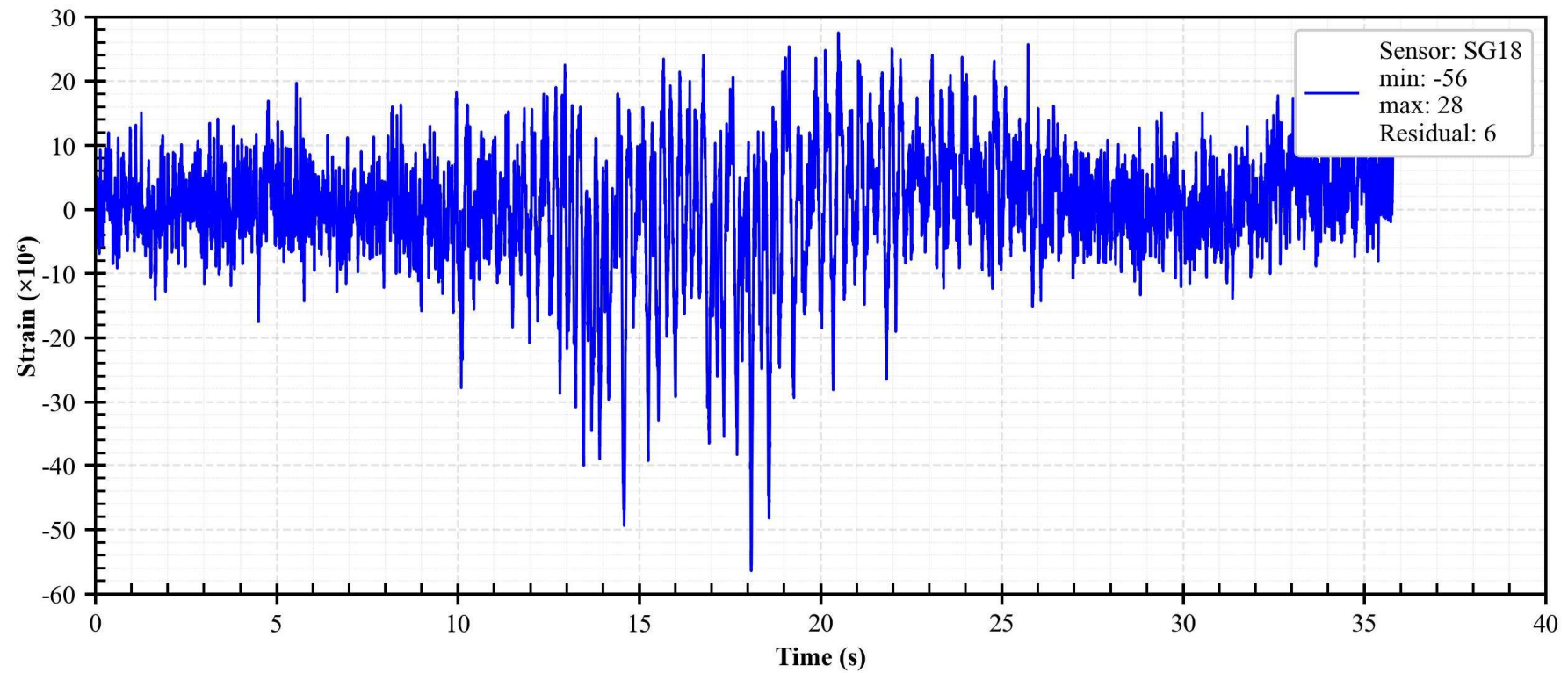


Figure 3.17.31 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 18

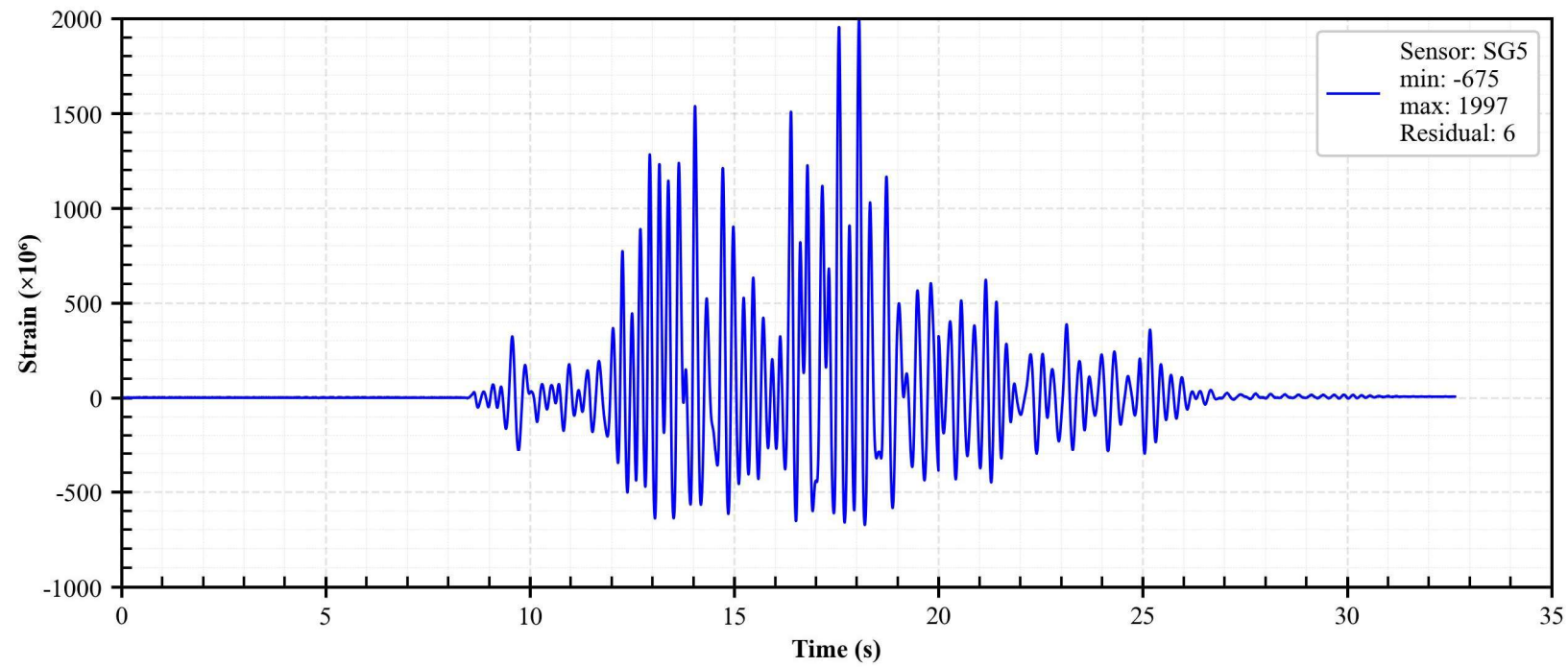


Figure 3.17.32 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 5

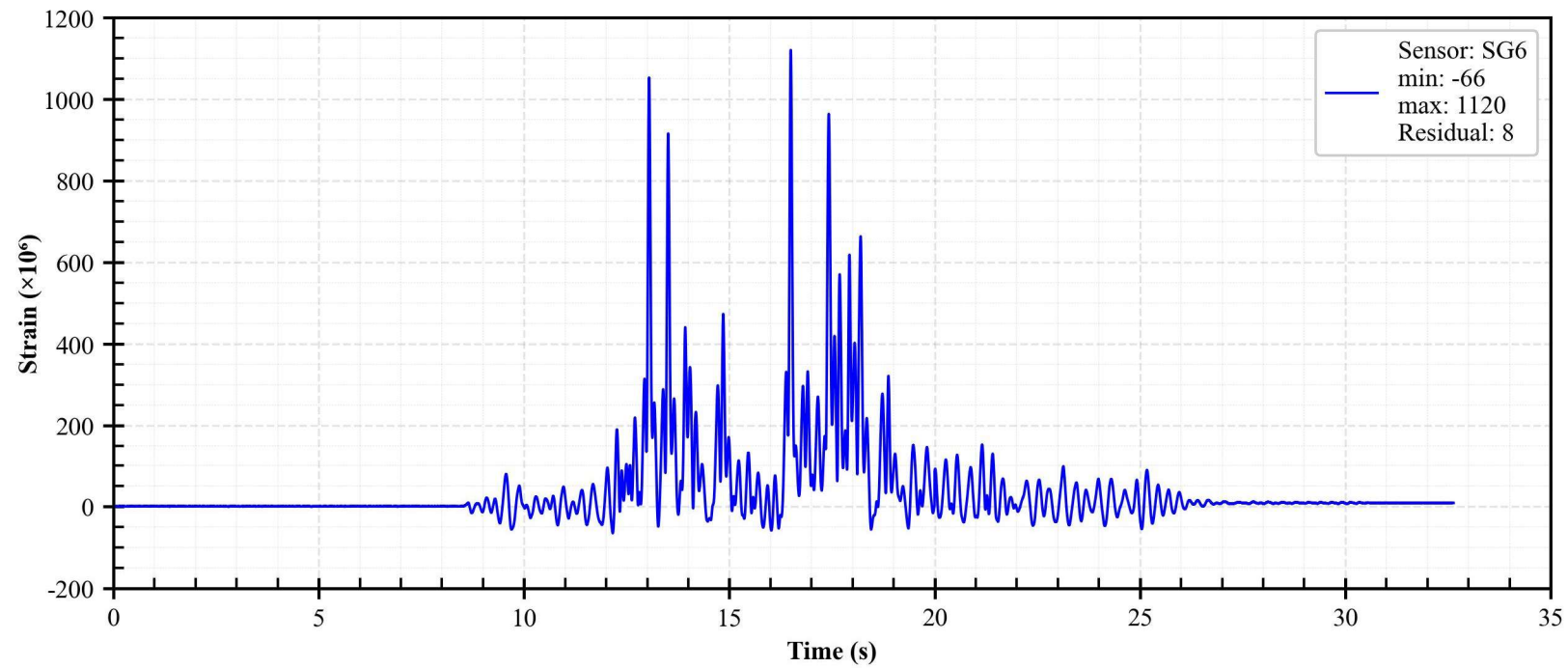


Figure 3.17.33 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 6

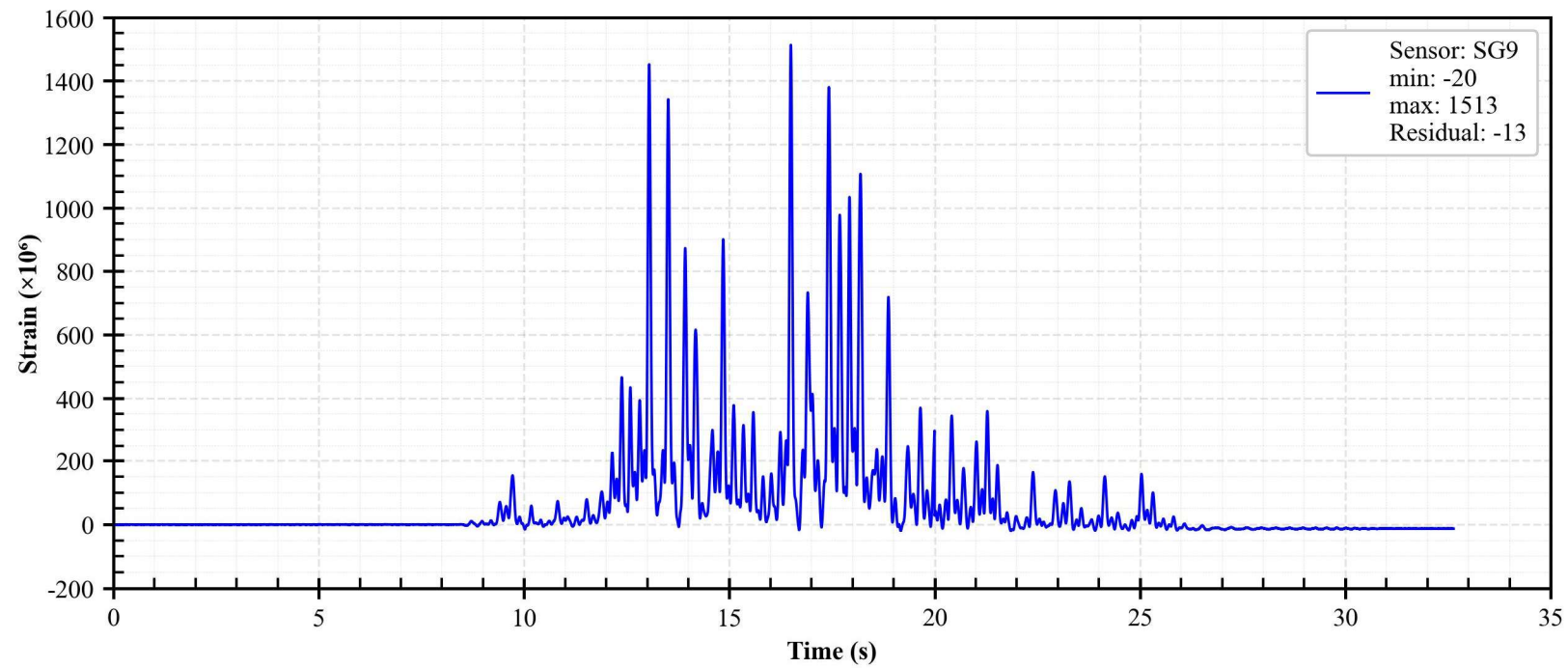


Figure 3.17.34 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 9

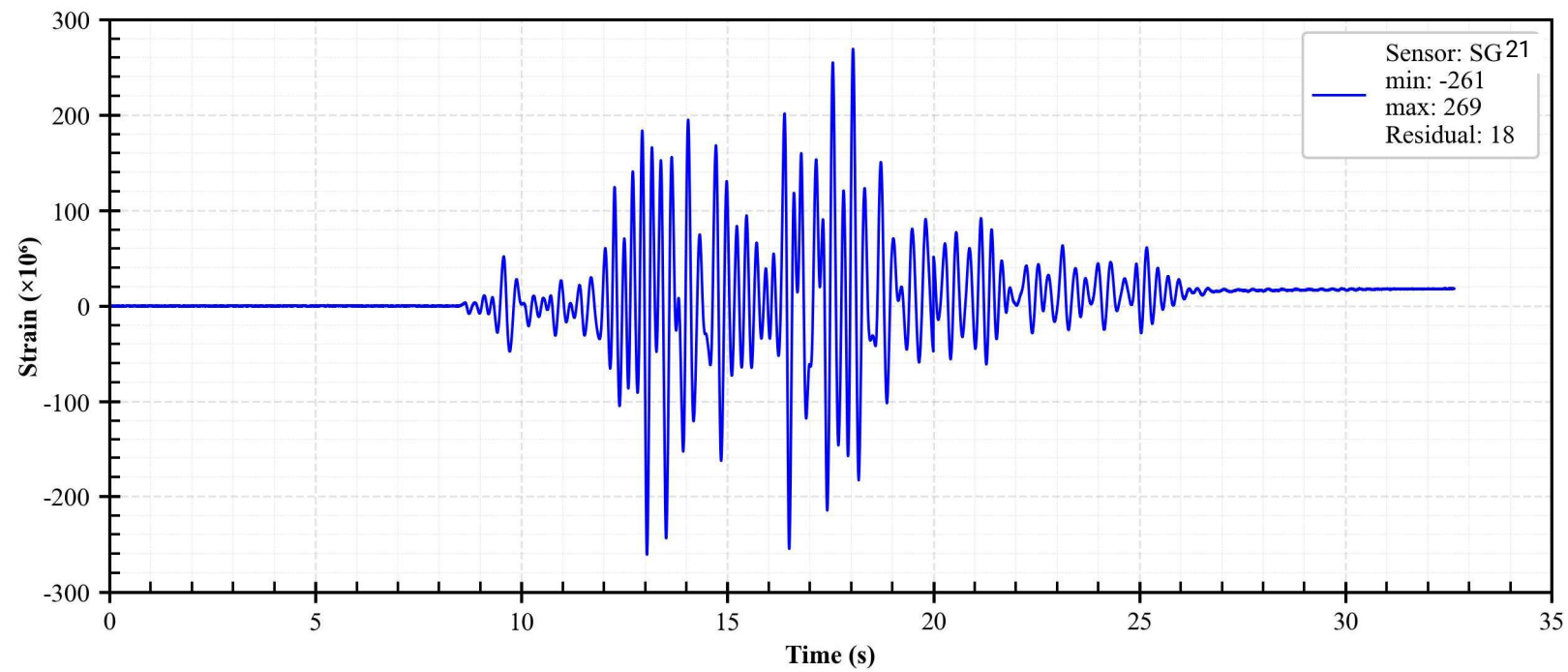


Figure 3.17.35 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 21 (PUFJ, column 1)

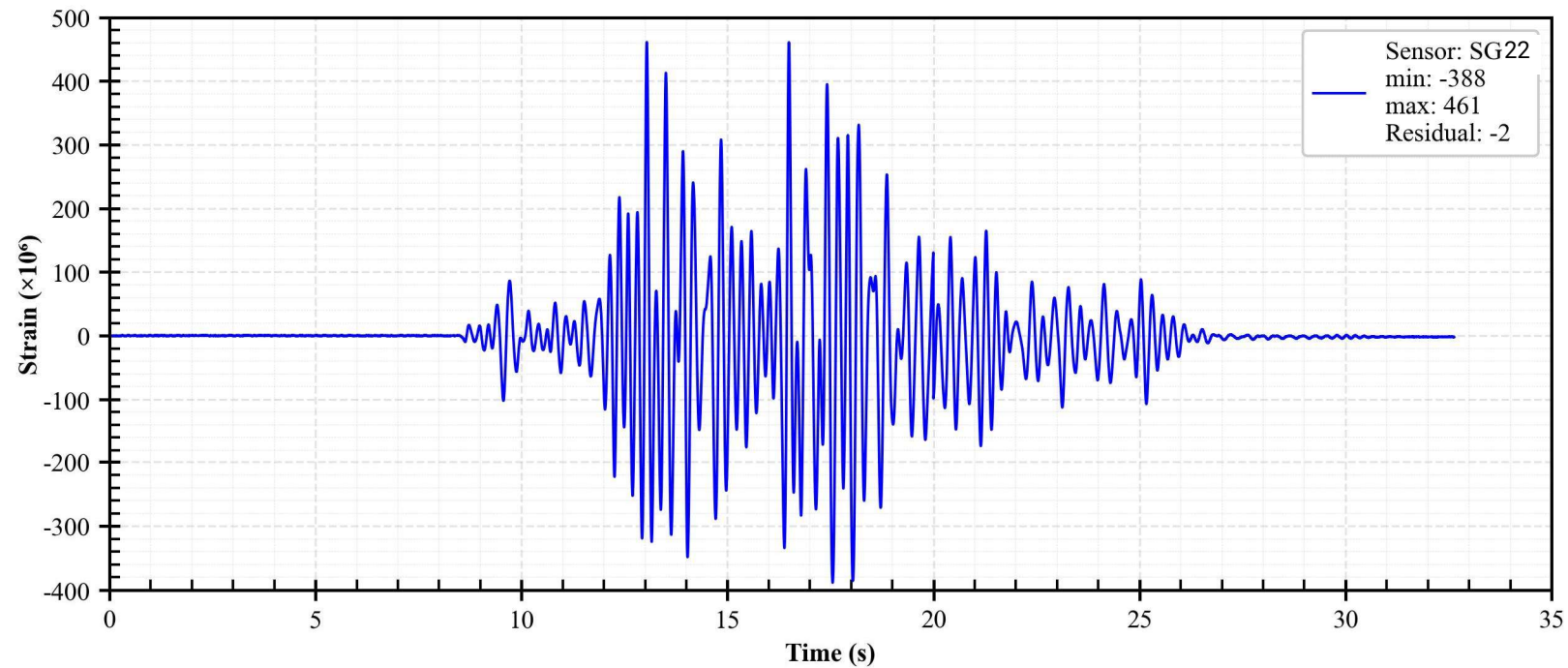


Figure 3.17.36 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 22 (PUFJ, column 2)

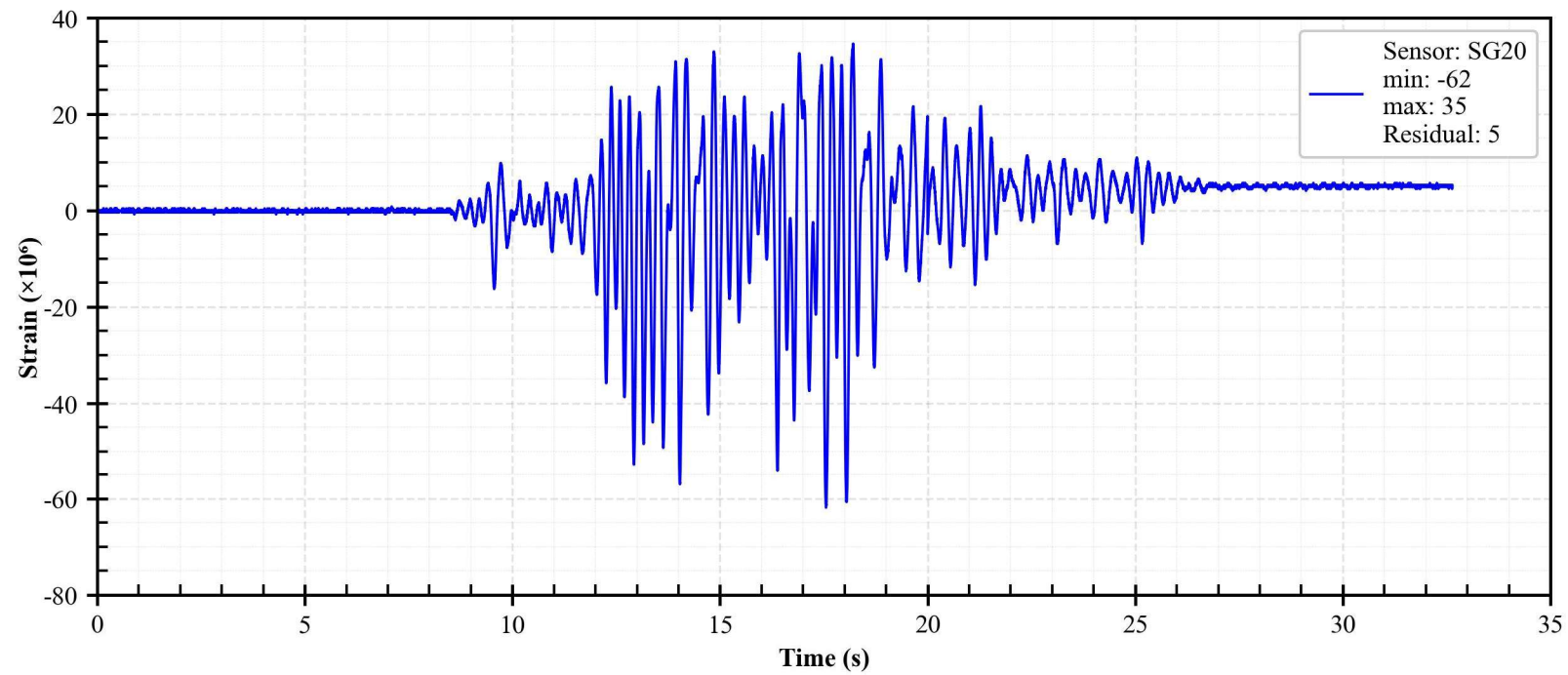


Figure 3.17.37 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 20

3.18 White noise before EQ1,1g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ1,1g. The max acceleration at the slab level on the accelerometer acc4 is 0.22g. The max acceleration at the foundation level on the accelerometer acc10 is 0.08g.

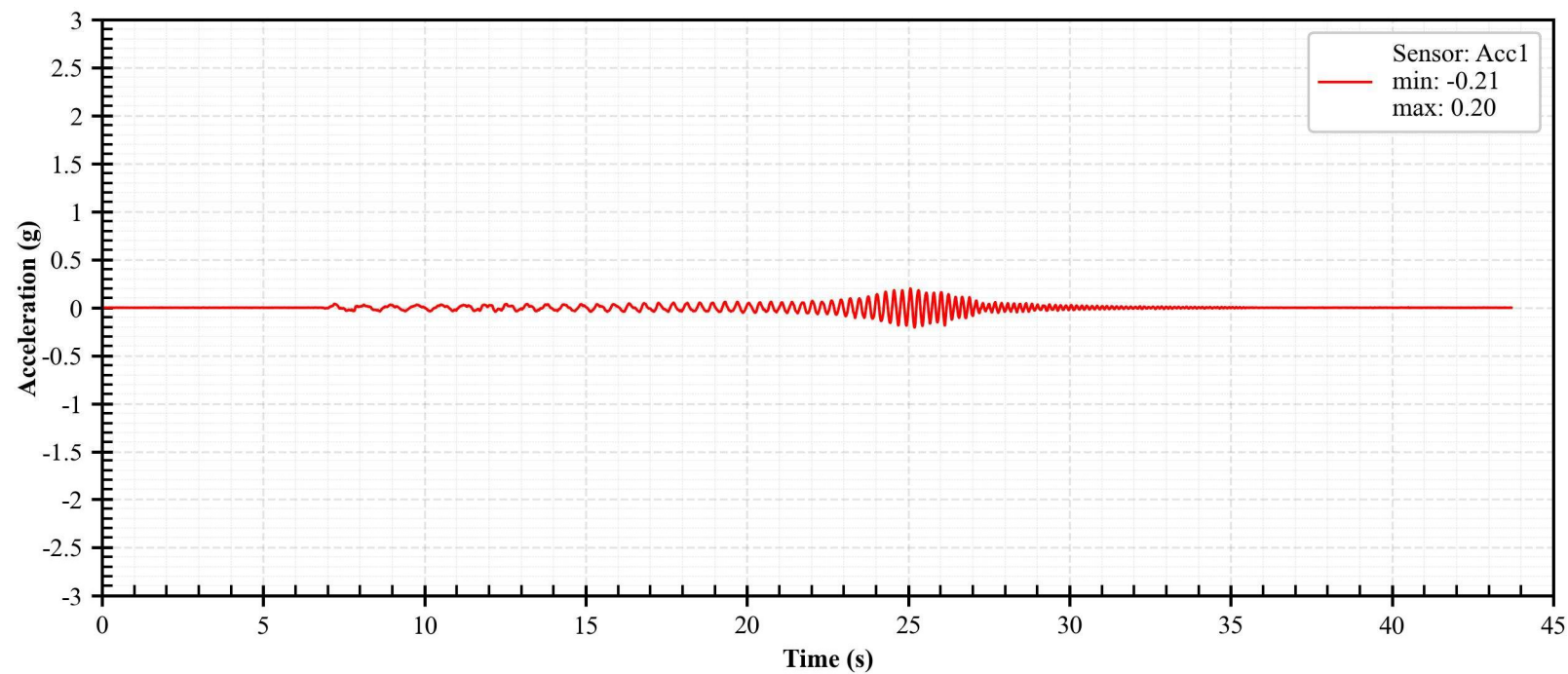


Figure 3.18.1 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 1

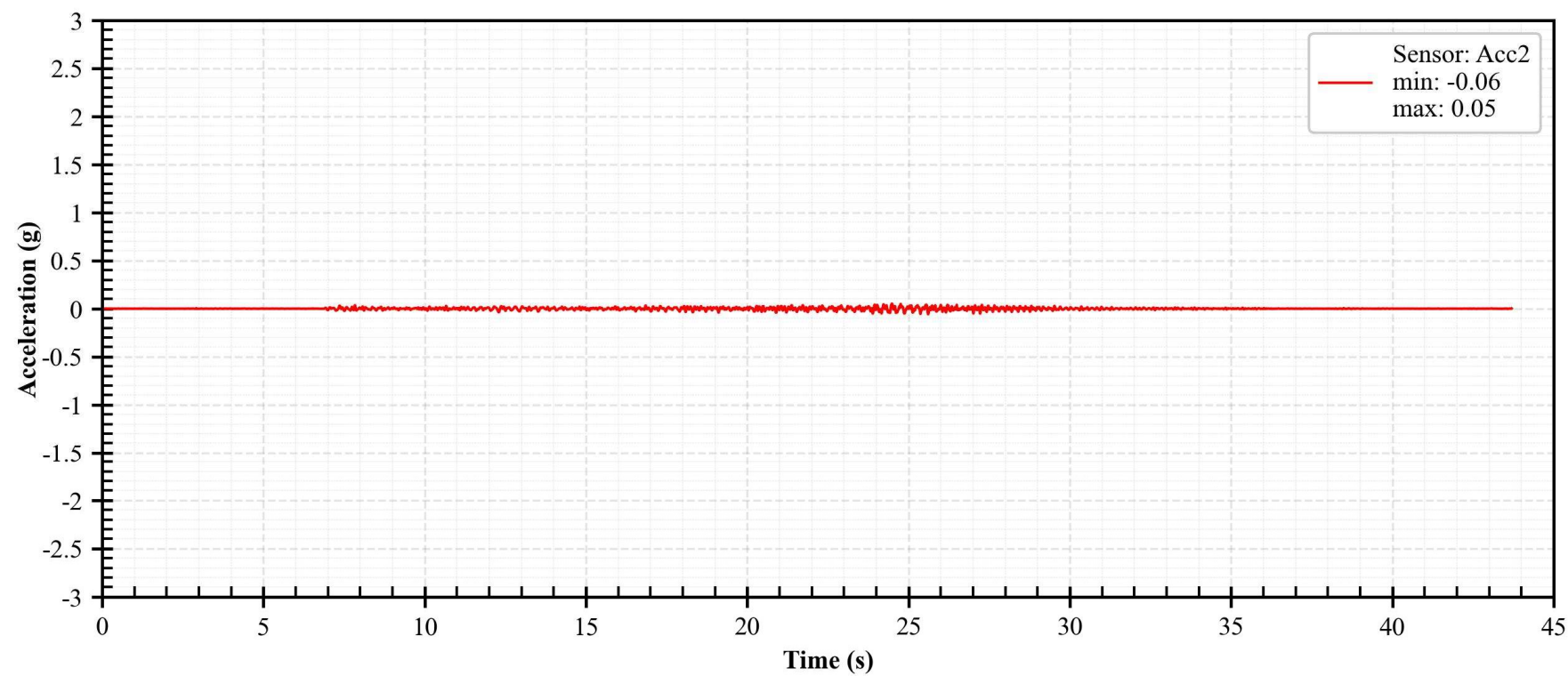


Figure 3.18.2 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 2

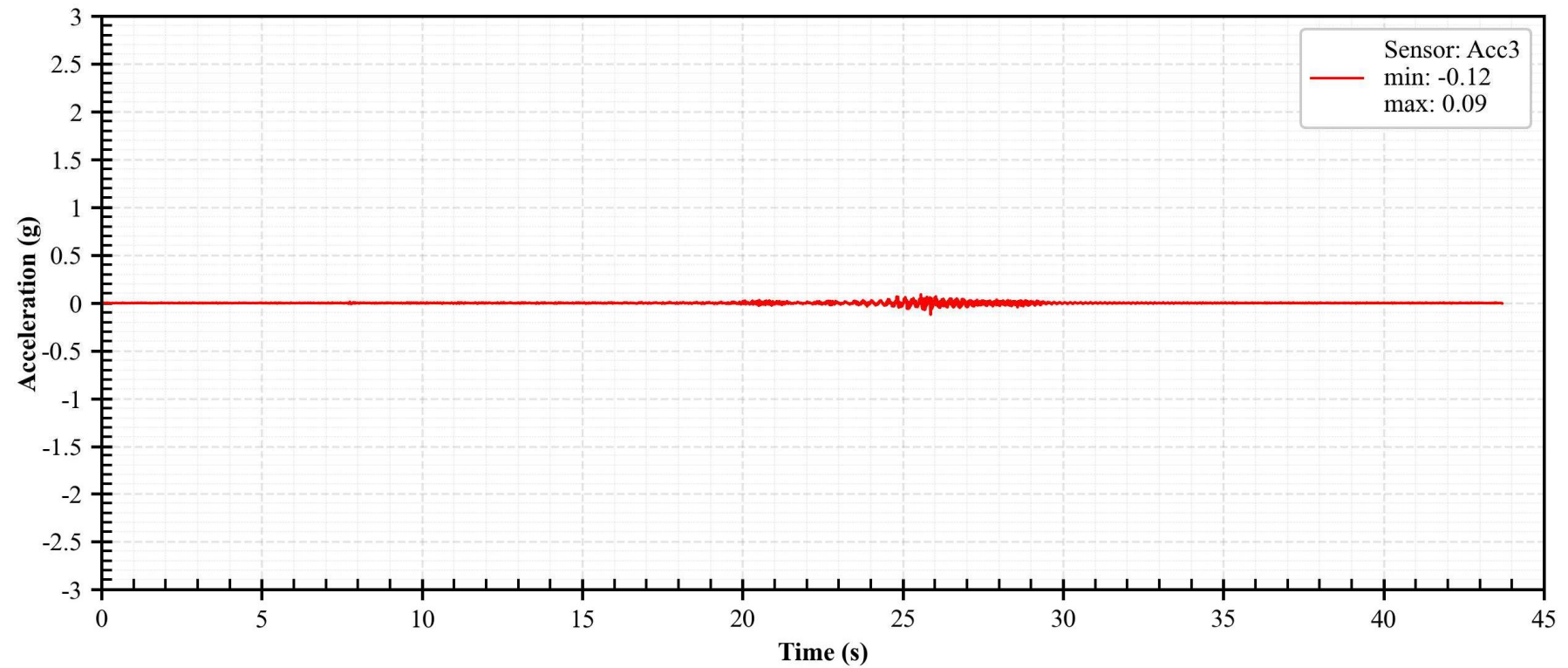


Figure 3.18.3 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 3

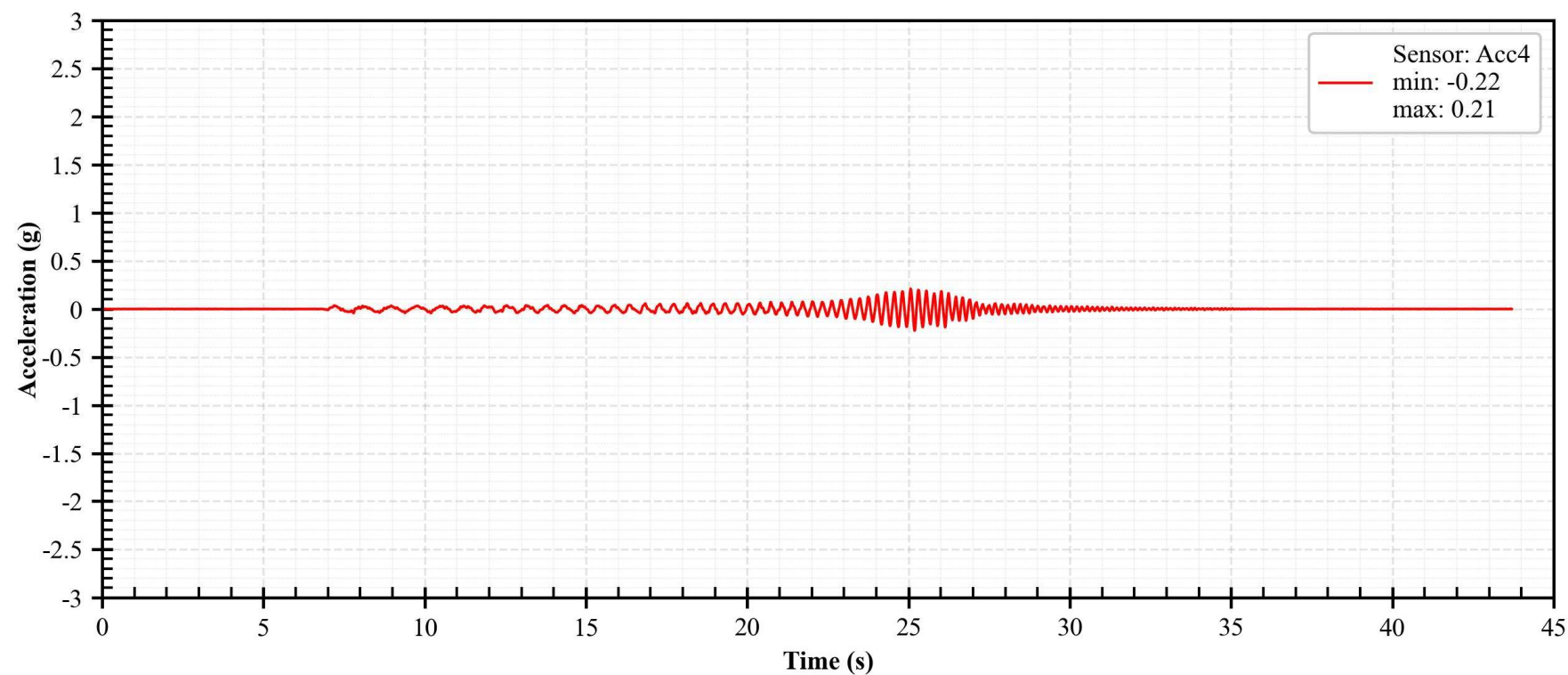


Figure 3.18.4 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 4

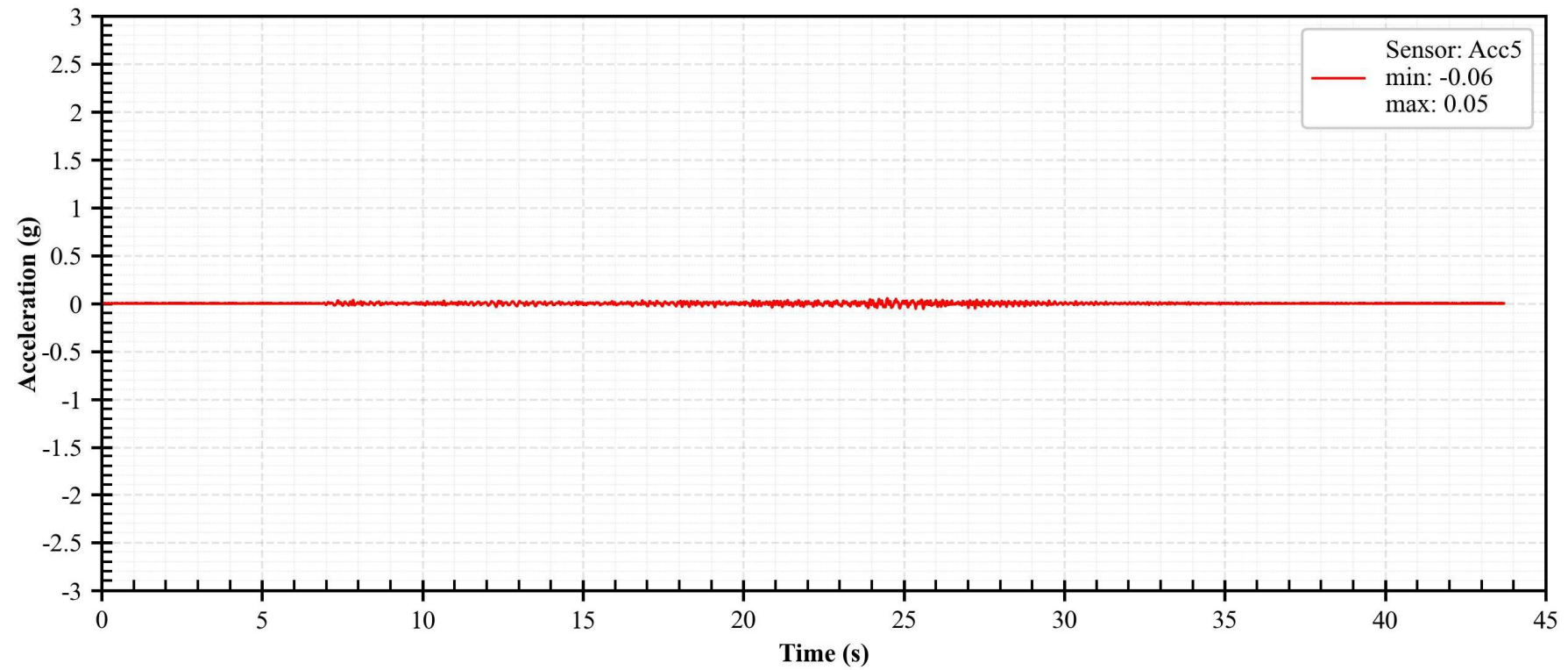


Figure 3.18.5 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 5

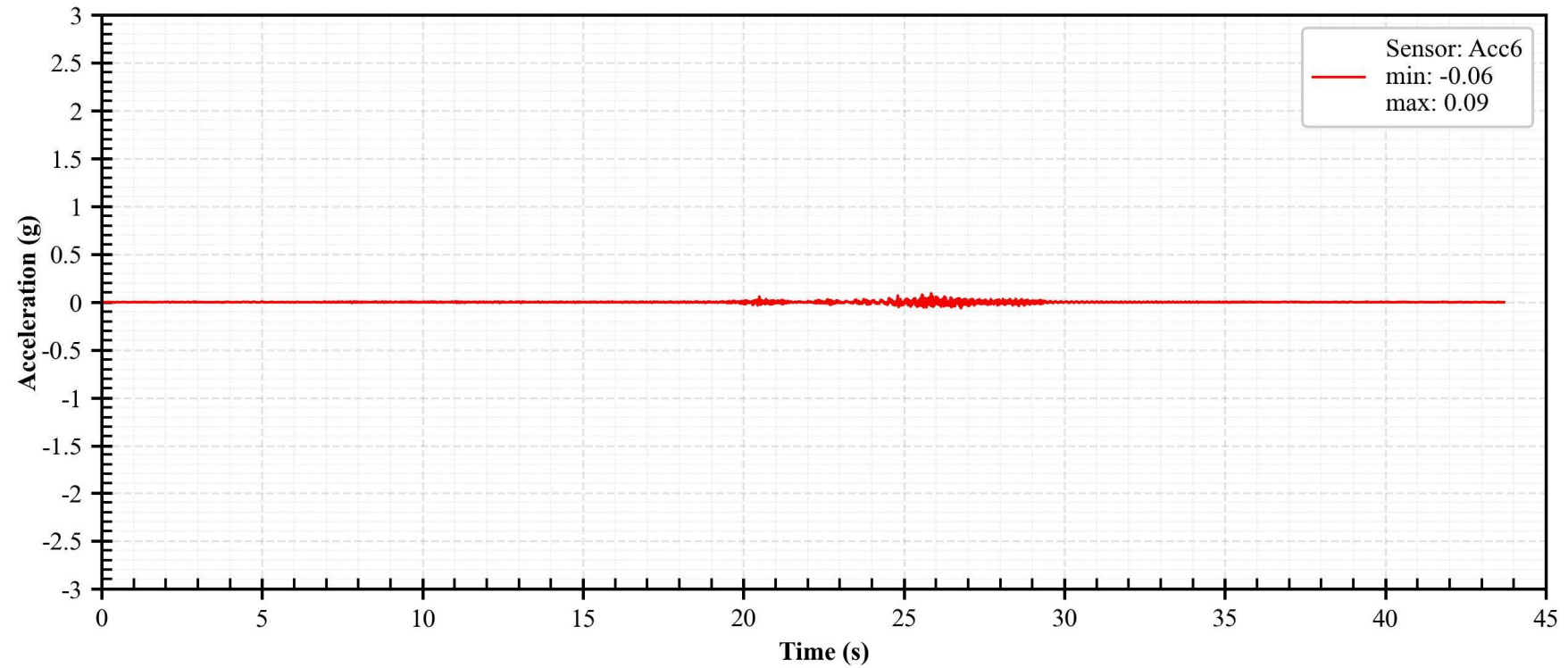


Figure 3.18.6 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 6

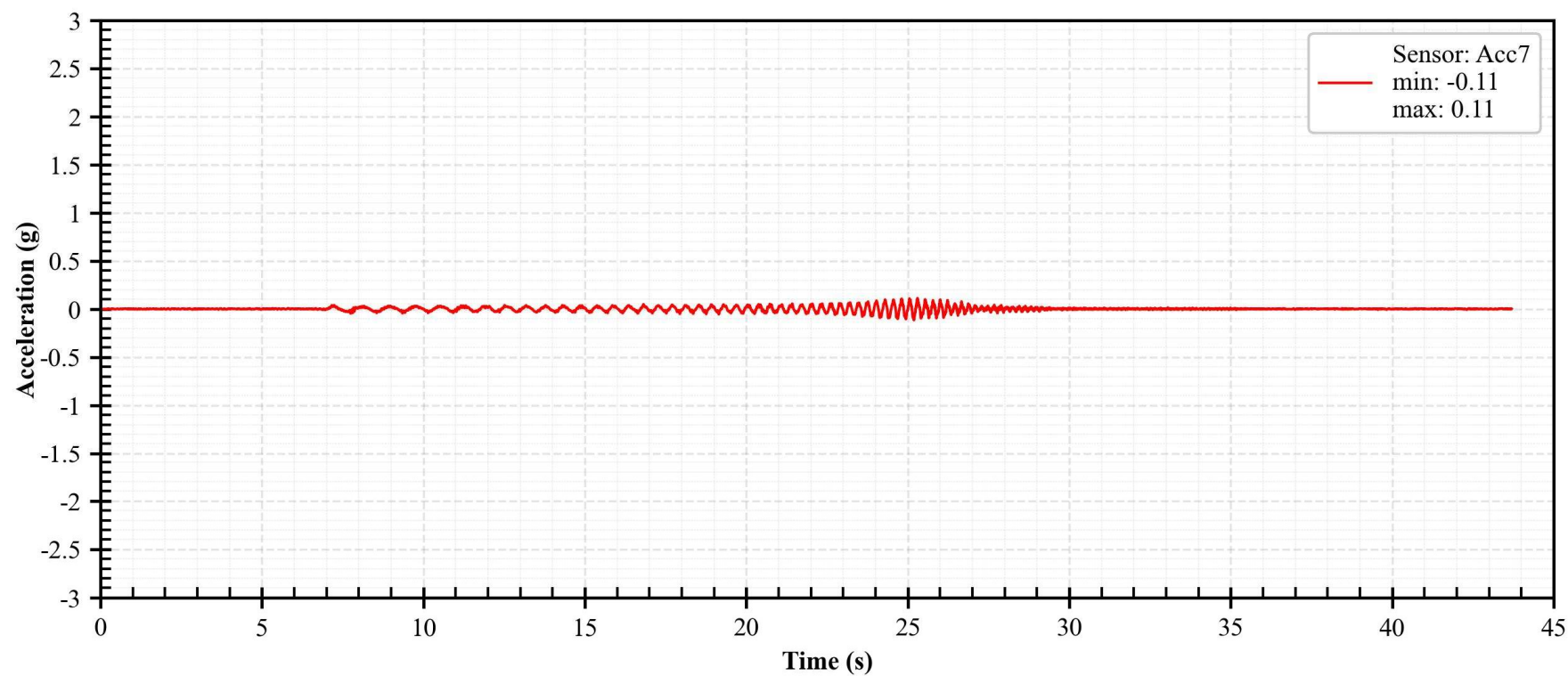


Figure 3.18.7 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 7

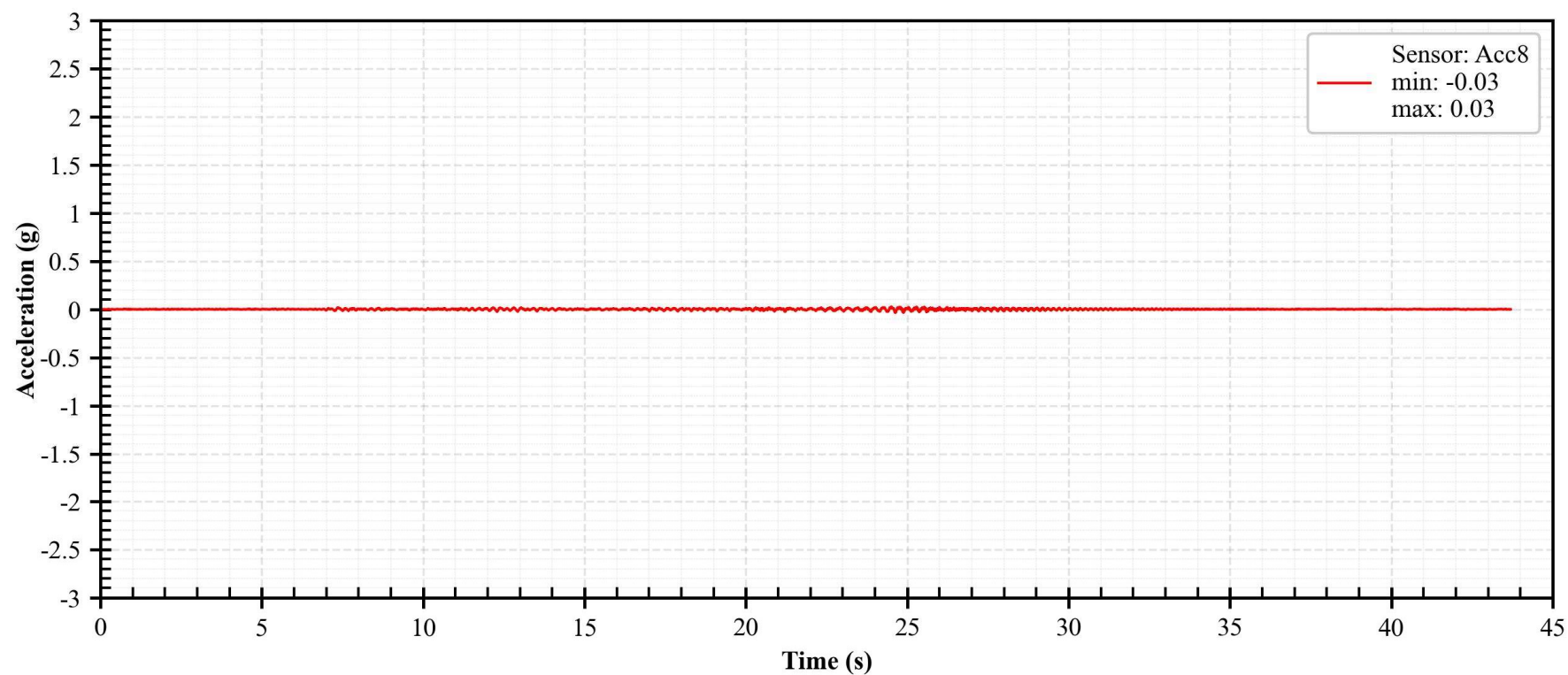


Figure 3.18.8 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 8

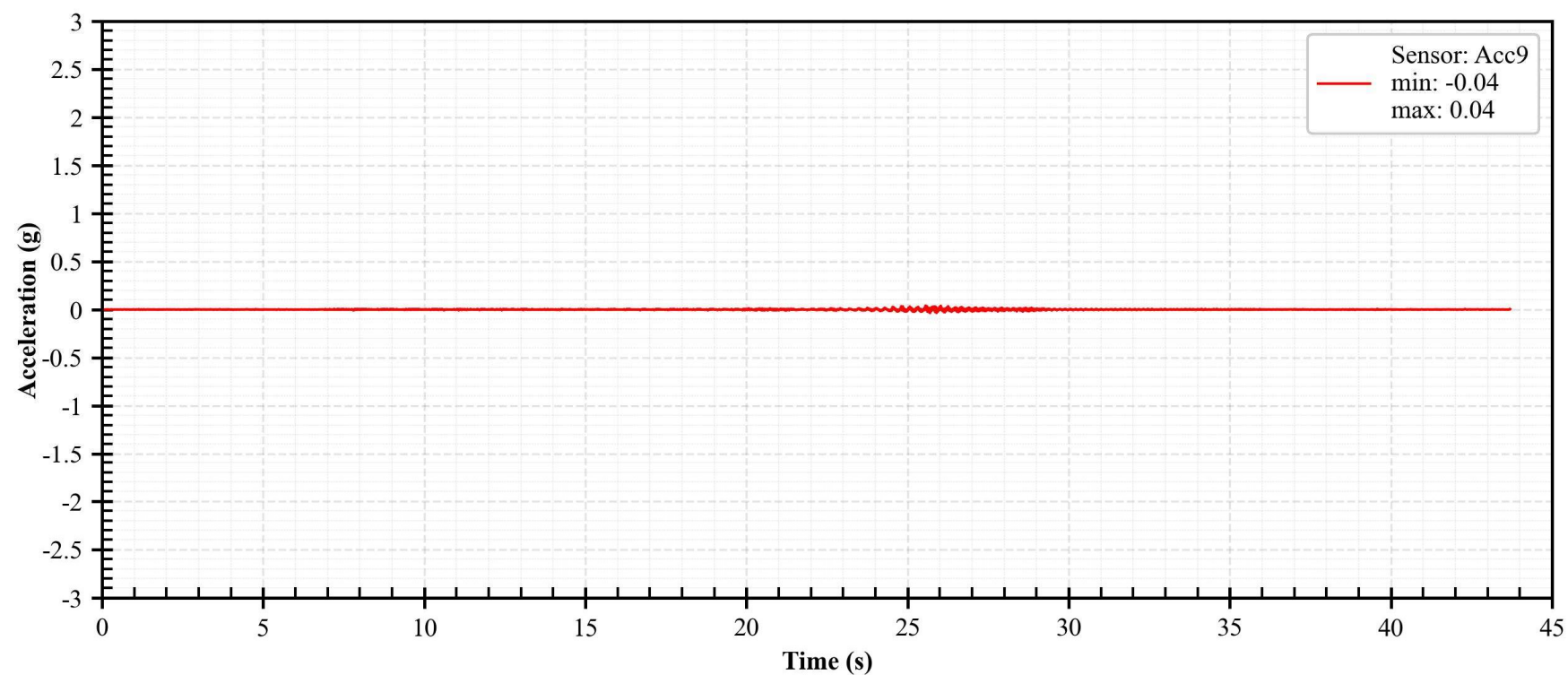


Figure 3.18.9 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 9

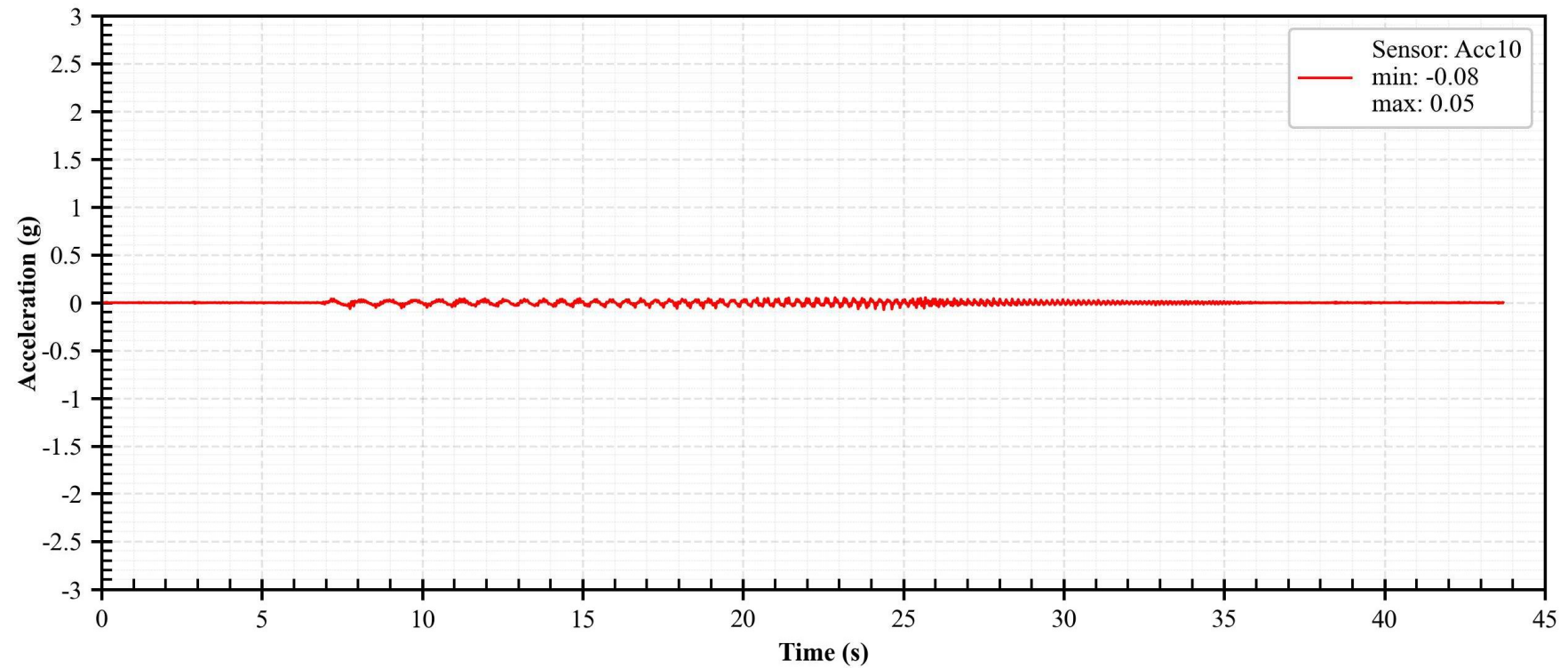


Figure 3.18.10 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 10

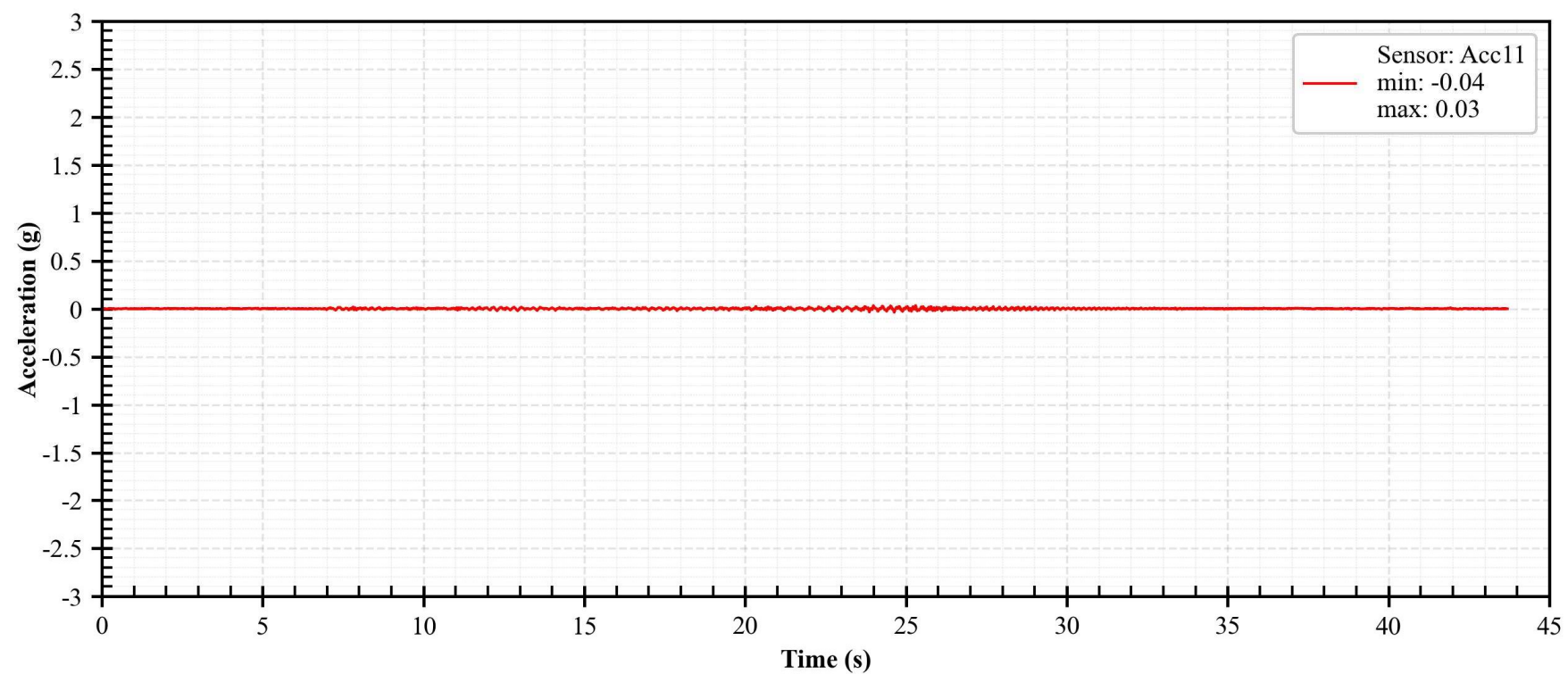


Figure 3.18.11 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 11

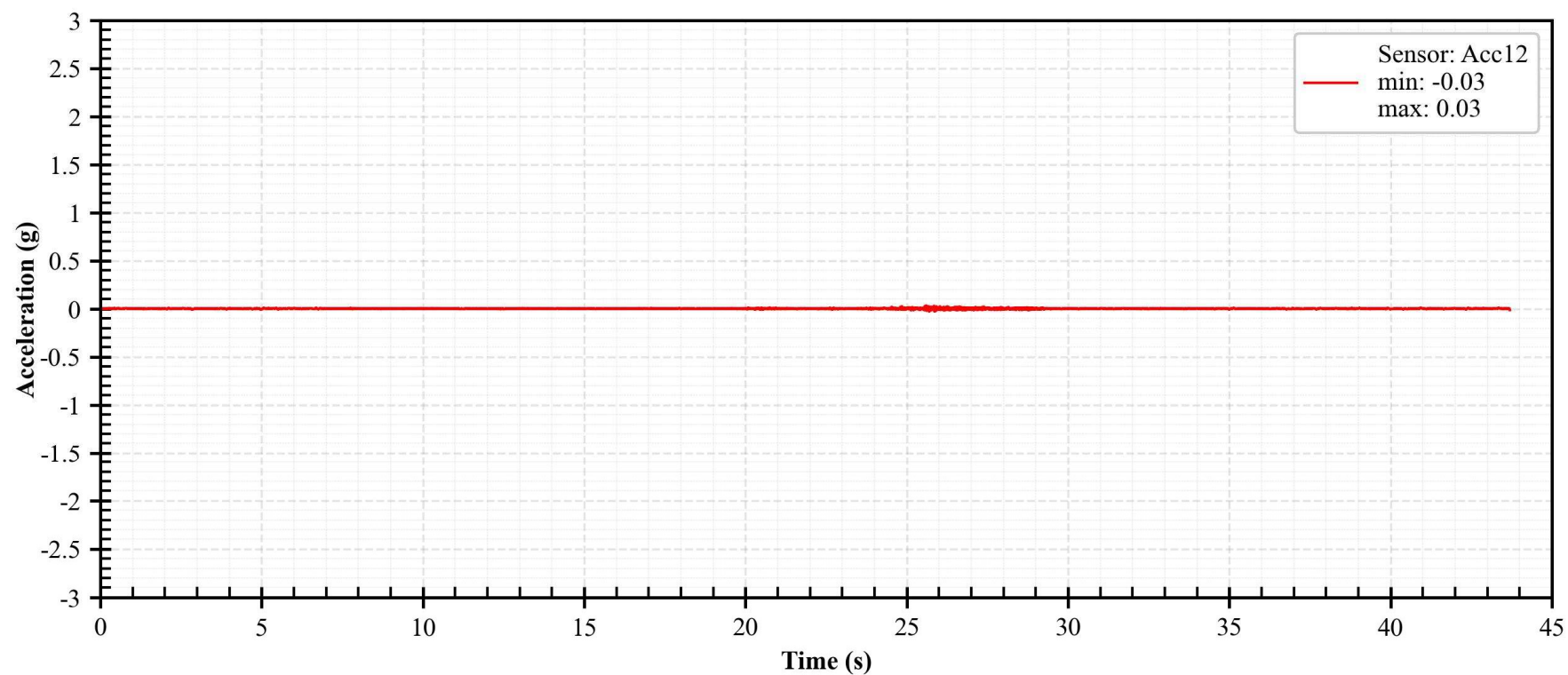


Figure 3.18.12 Characteristic results for phase B (white noise before EQ1,1g): Accelerometer 12

Draw wire sensors

Figures 3.18.13 – 3.18.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.19 mm while the minimum is -16.30 mm. The maximum movement detected by draw wire sensor W2 is 21.28 mm while the minimum is -16.47 mm. The maximum movement detected by draw wire sensor W3 is 21.07 mm while the minimum is -16.33 mm. The maximum movement detected by draw wire sensor W4 is 21.16 mm while the minimum is -16.39 mm. The maximum drift is $(2.39/1.225) = 1.95 \text{ ‰}$ and minimum drift is $(-2.57/1.225) = 2.10 \text{ ‰}$.

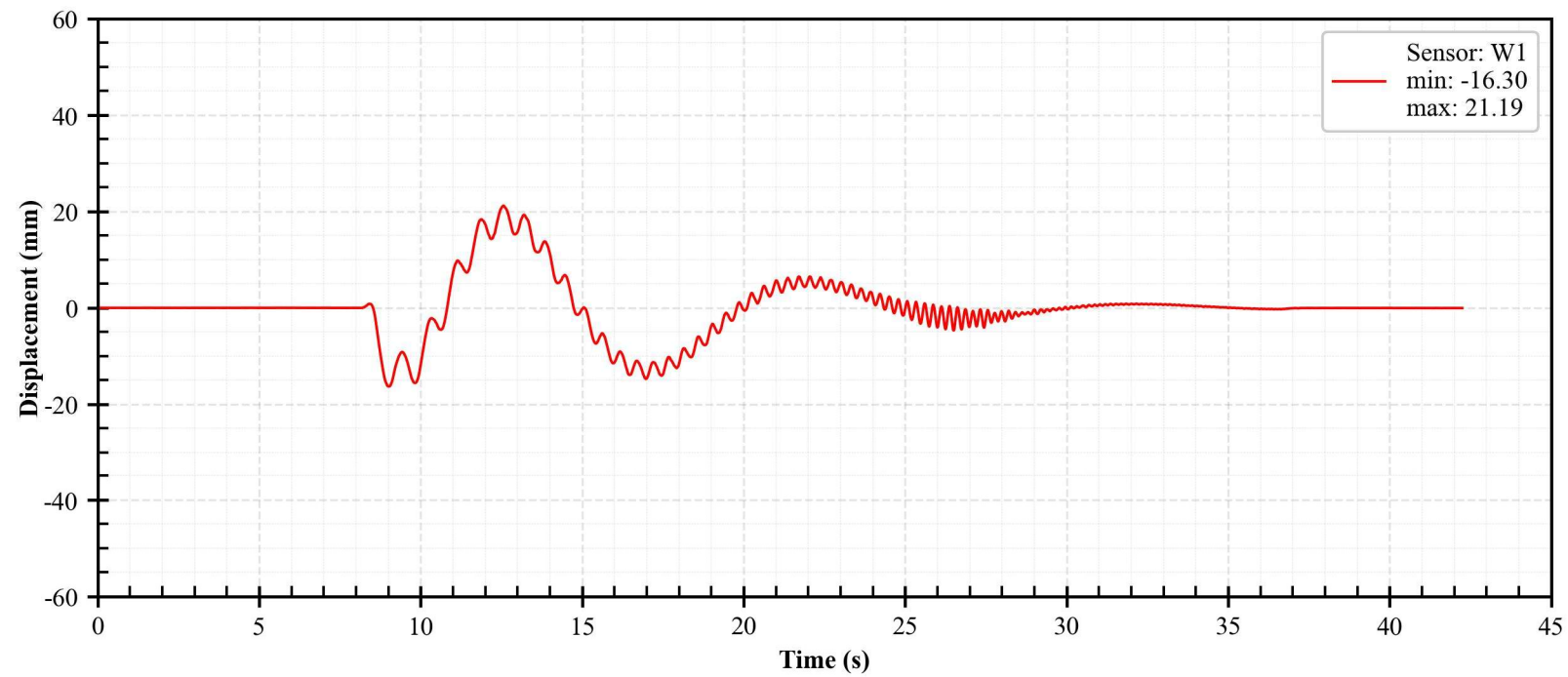


Figure 3.18.13 Characteristic results for phase B (white noise before EQ1,1g): Draw wire sensor 1

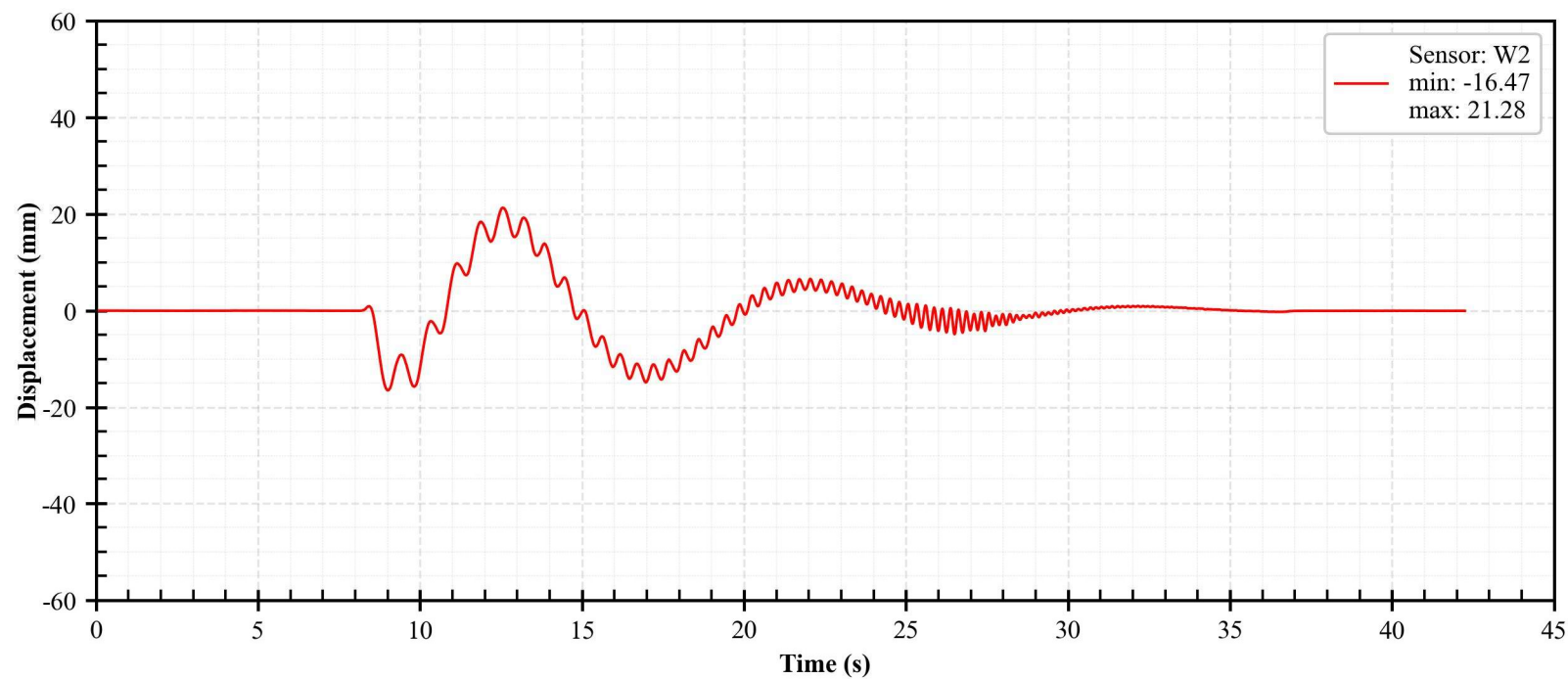


Figure 3.18.14 Characteristic results for phase B (white noise before EQ1,1g): Draw wire sensor 2

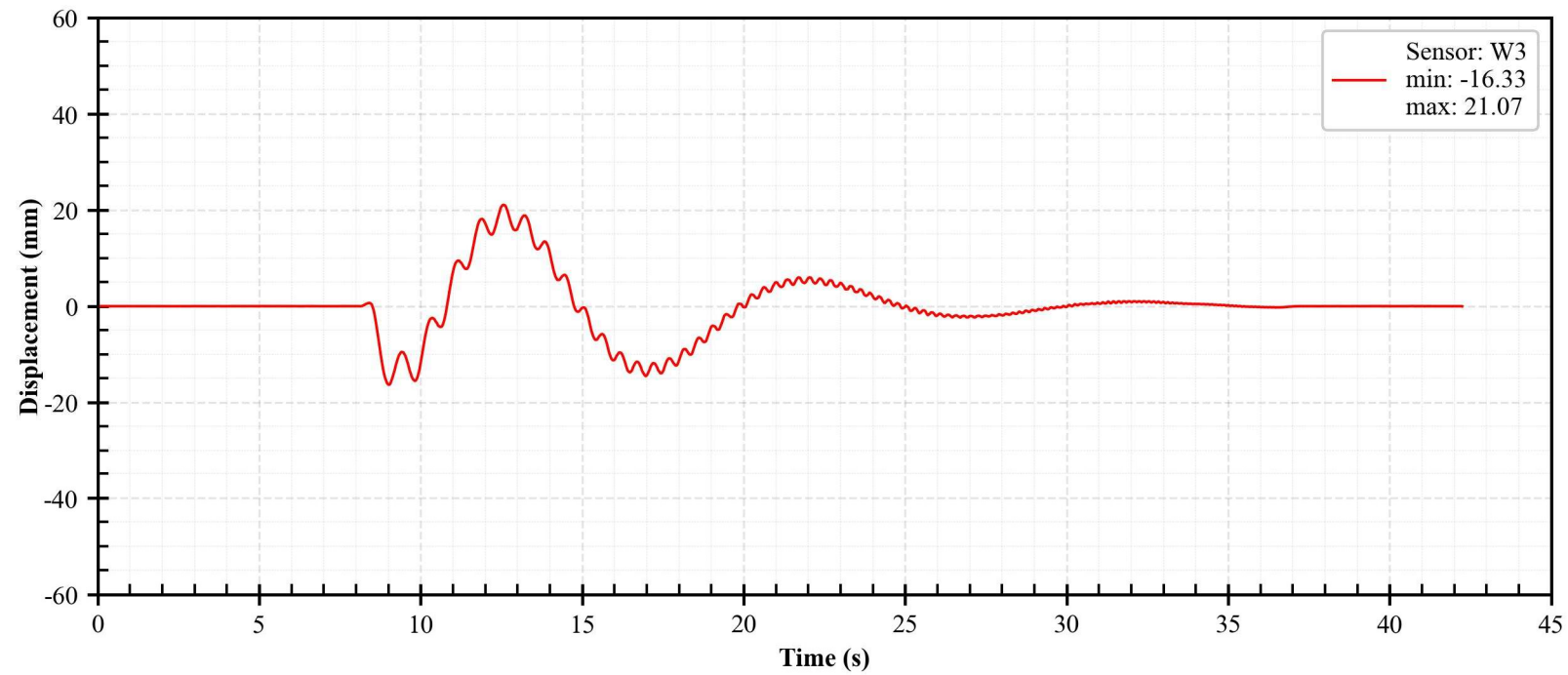


Figure 3.18.15 Characteristic results for phase B (white noise before EQ1,1g): Draw wire sensor 3

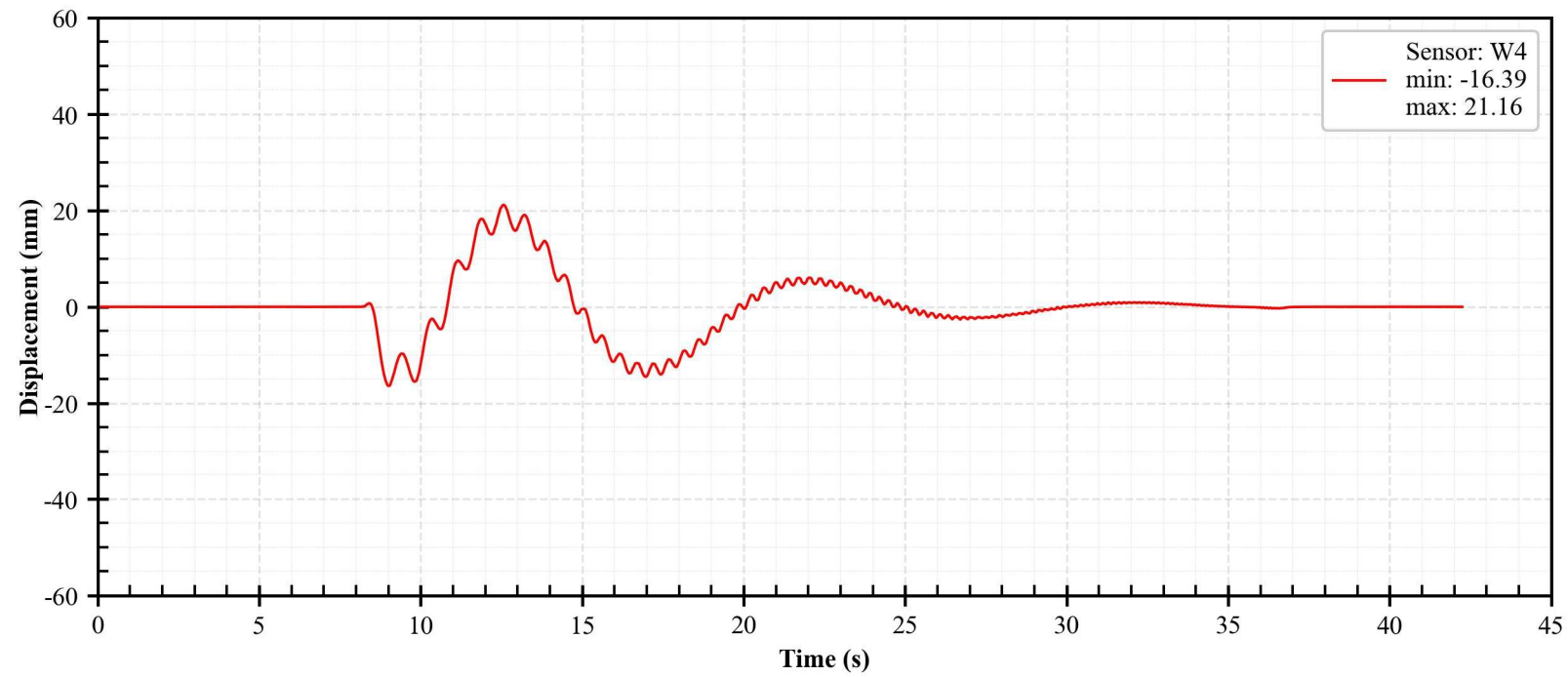


Figure 3.18.16 Characteristic results for phase B (white noise before EQ1,1g): Draw wire sensor 4

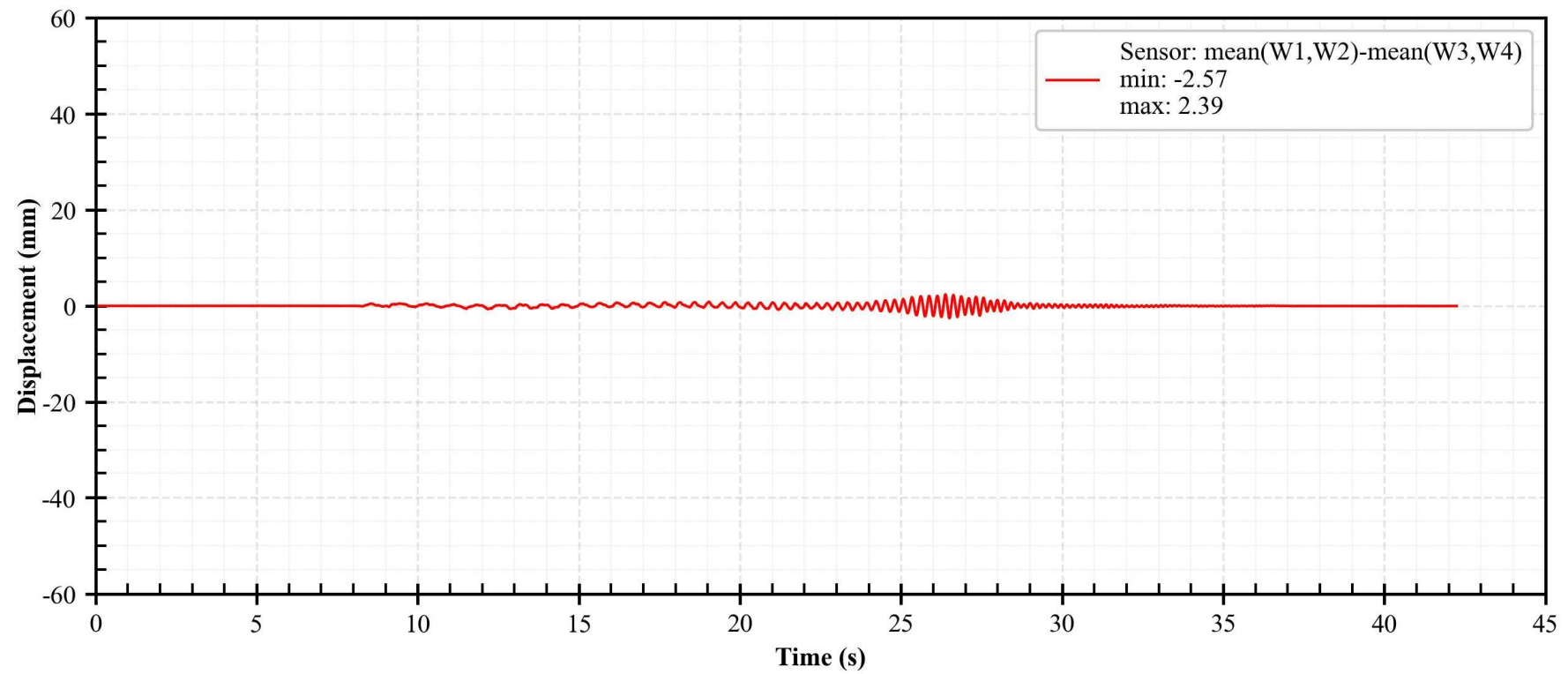


Figure 3.18.17 Characteristic results for phase B (white noise before EQ1,1g): mean (W1,W2) – mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

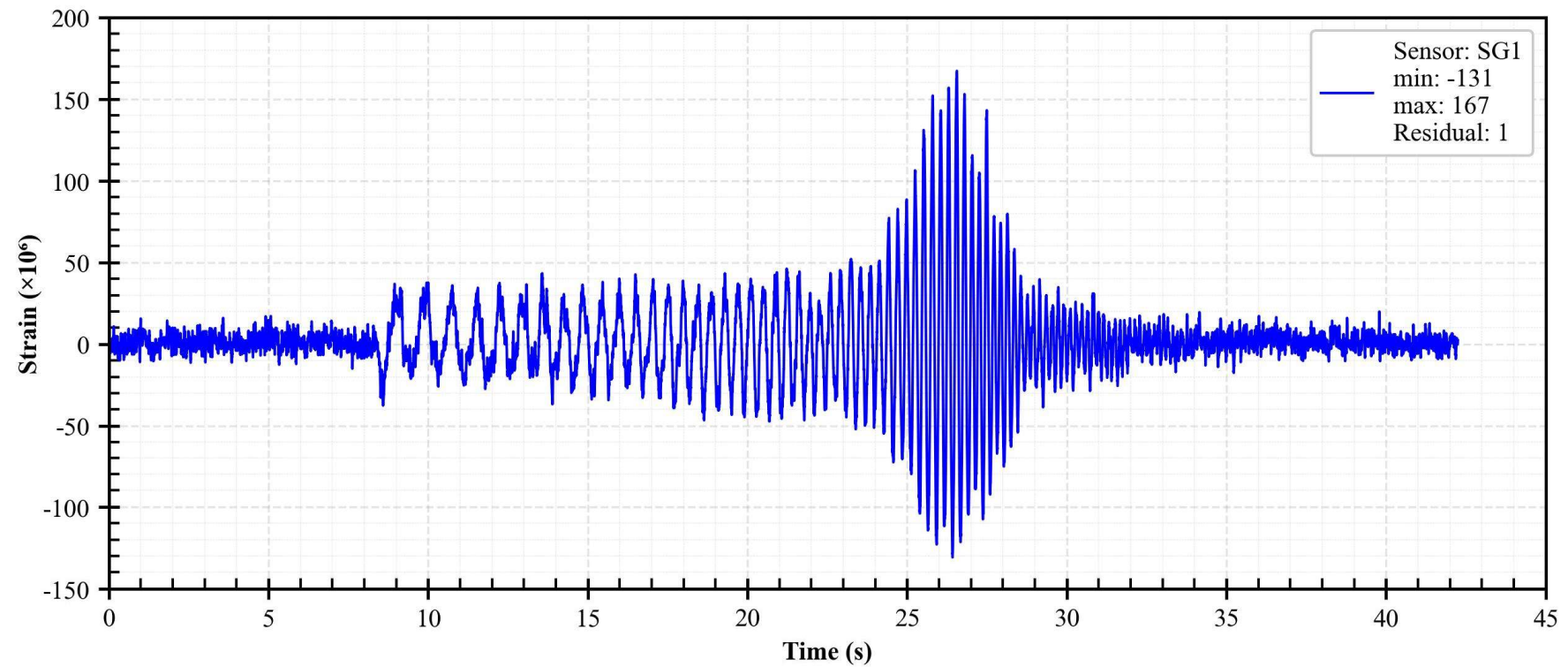


Figure 3.18.18 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 1

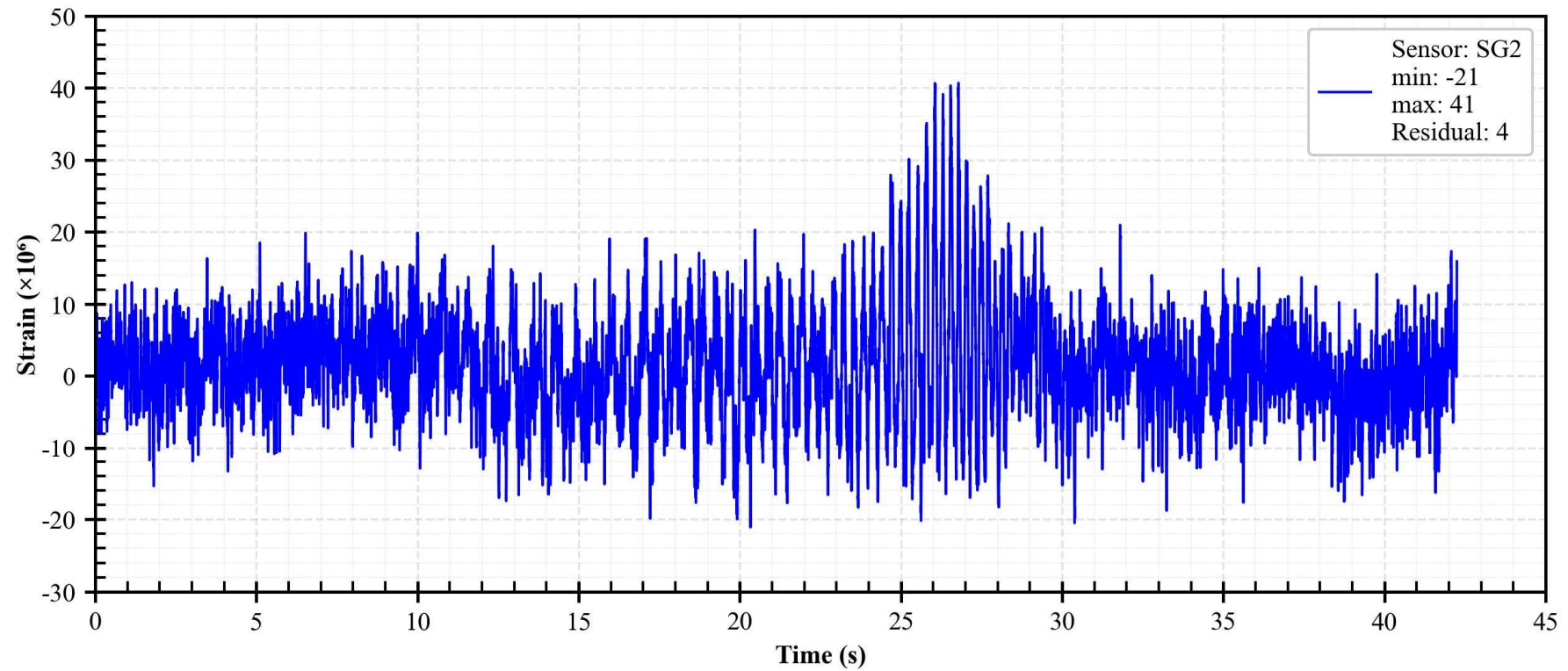


Figure 3.18.19 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 2

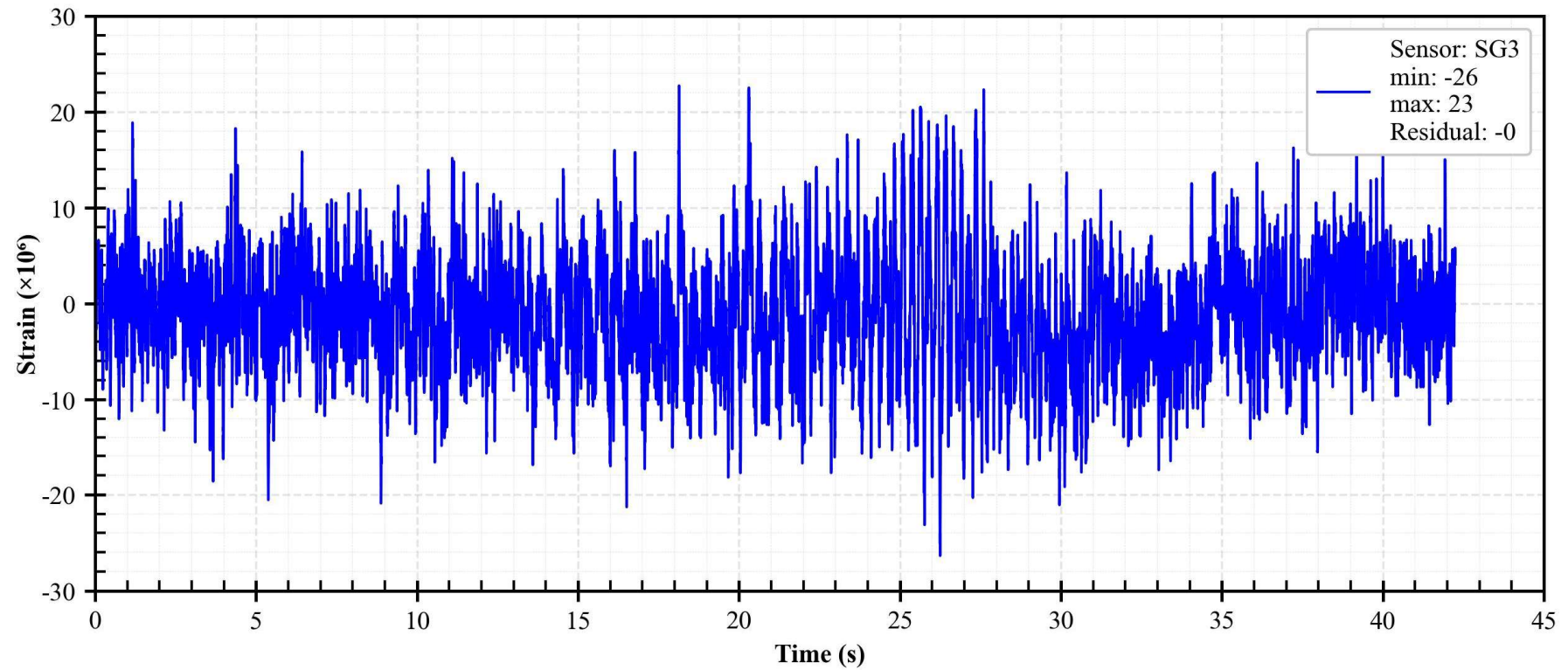


Figure 3.18.20 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 3

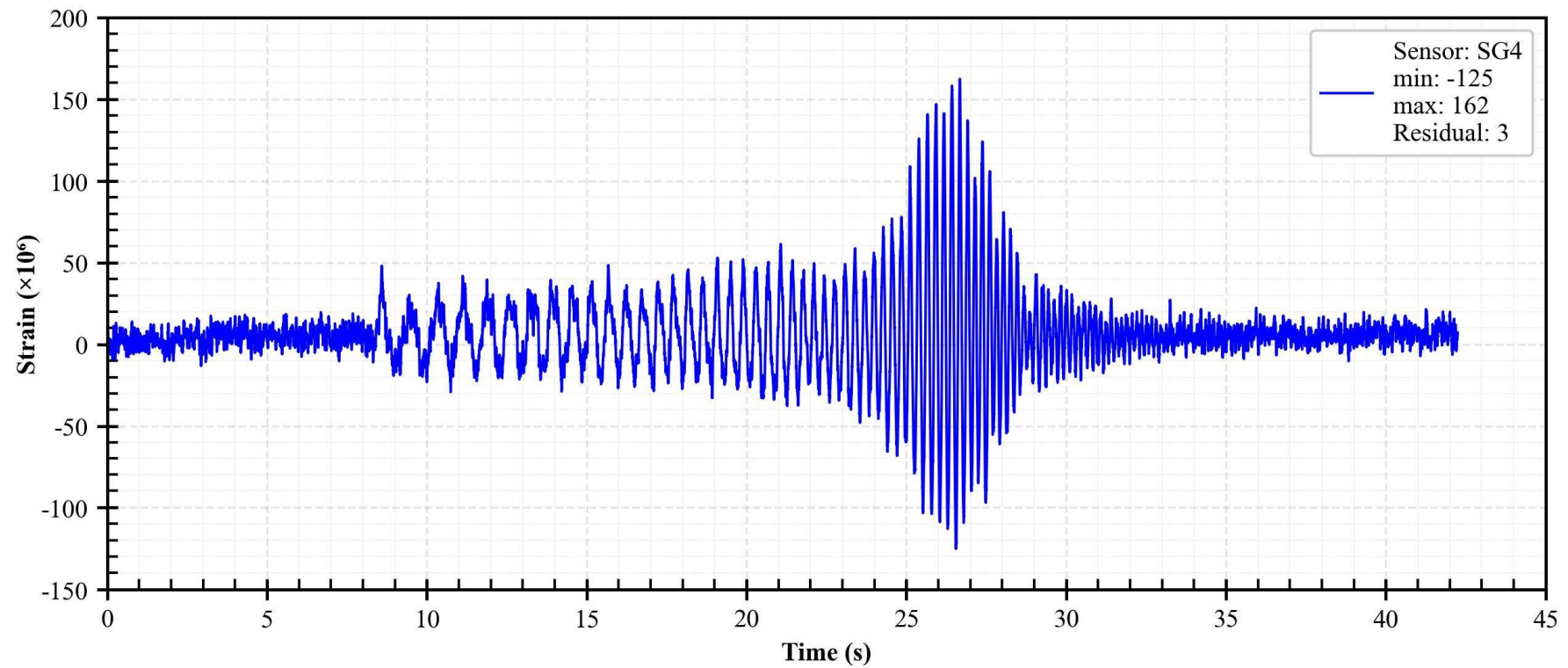


Figure 3.18.21 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 4

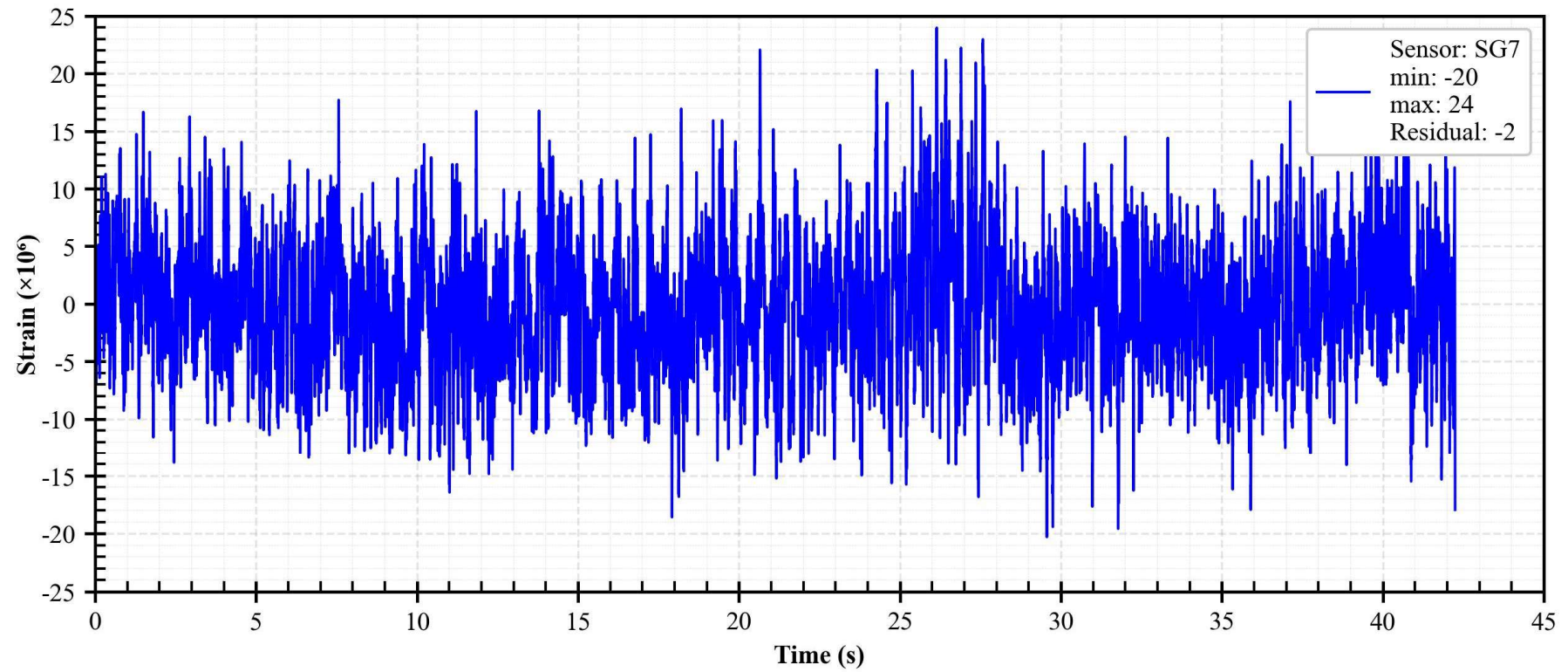


Figure 3.18.22 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 7

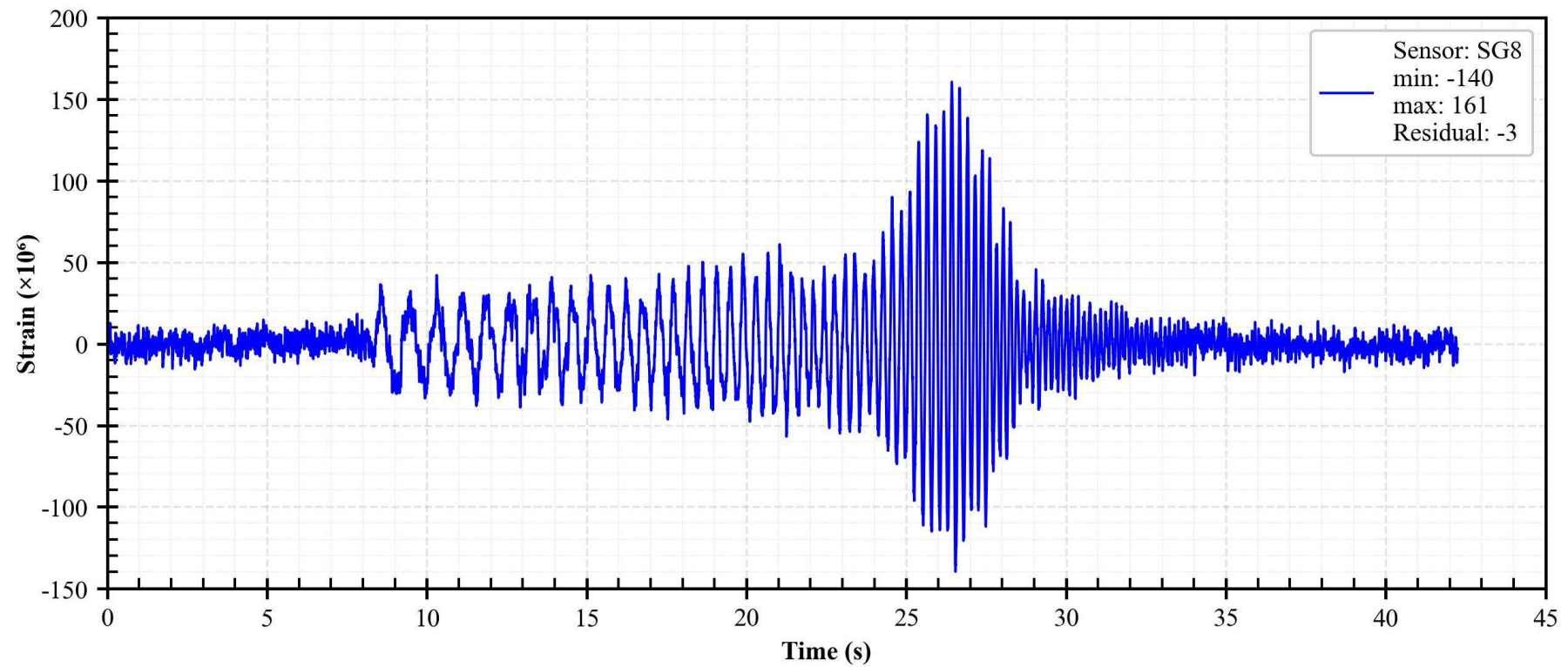


Figure 3.18.23 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 8

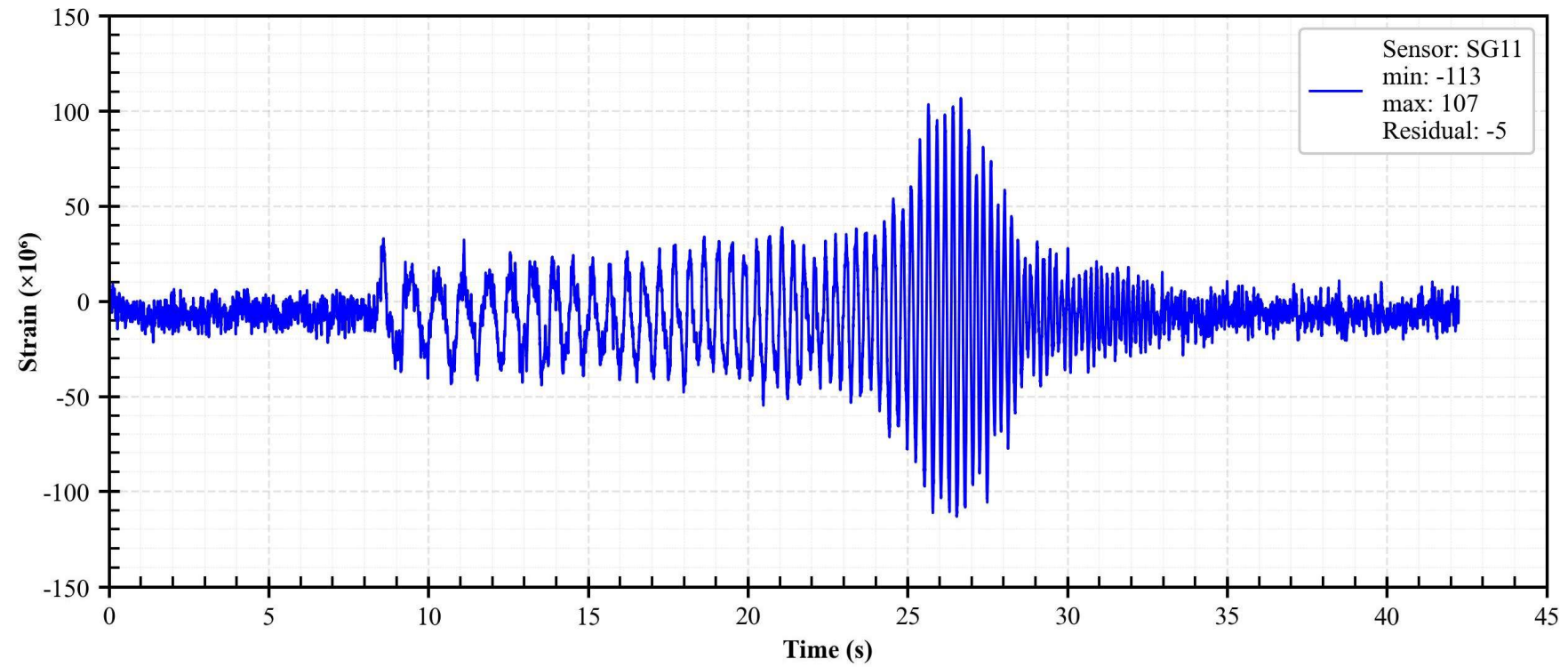


Figure 3.18.24 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 11

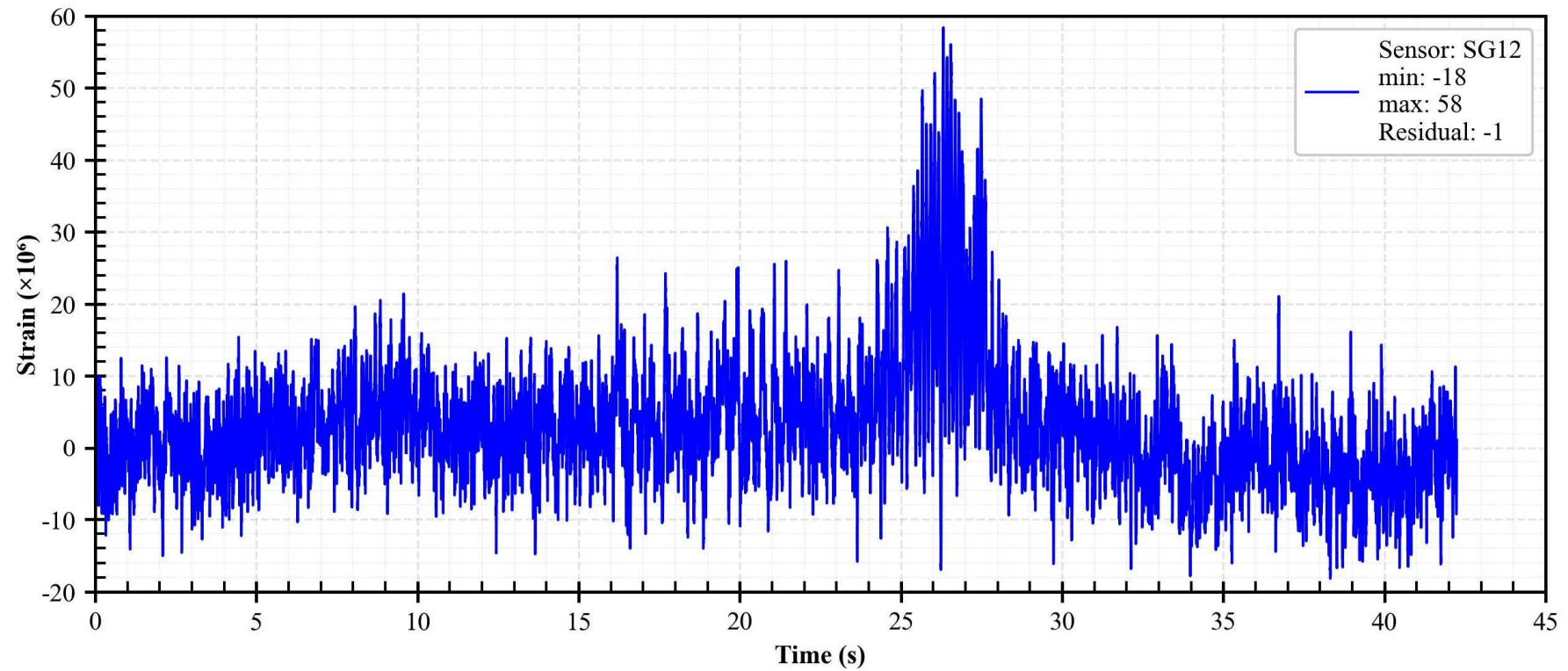


Figure 3.18.25 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 12

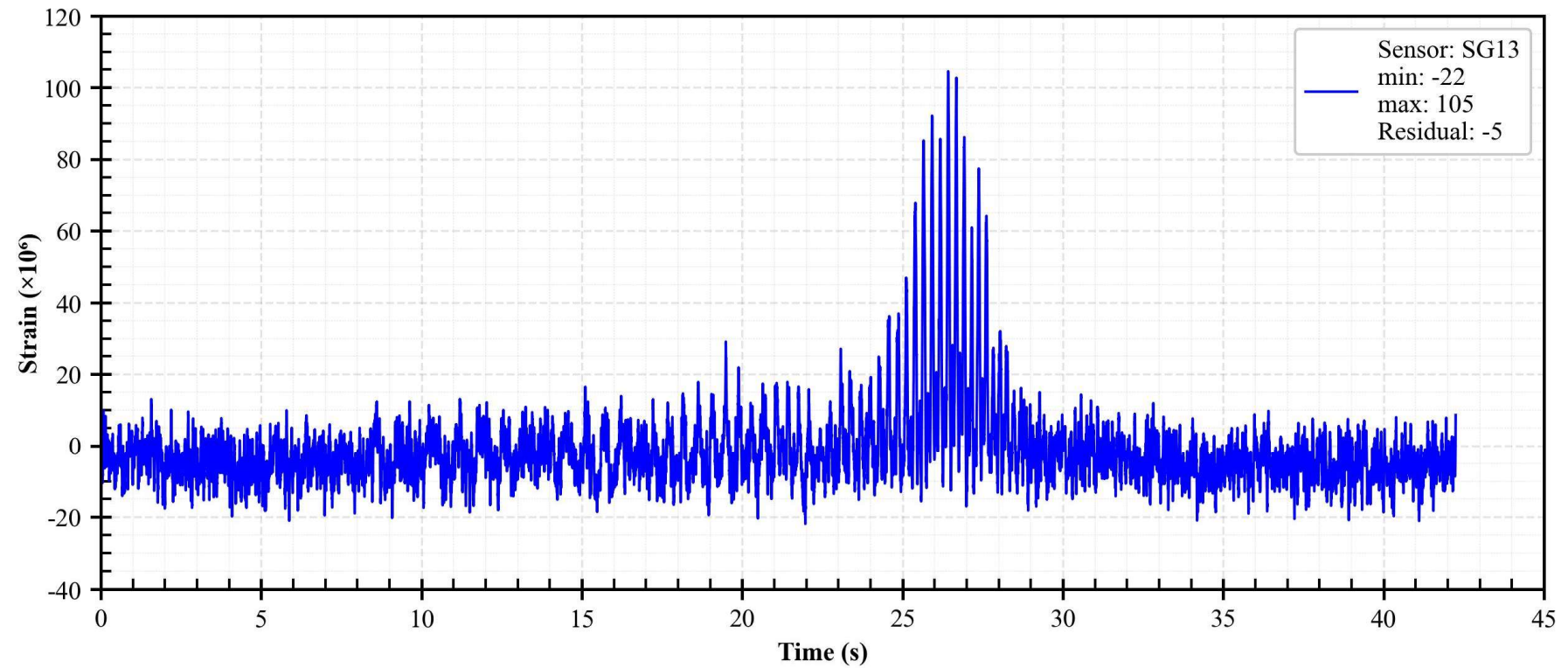


Figure 3.18.26 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 13

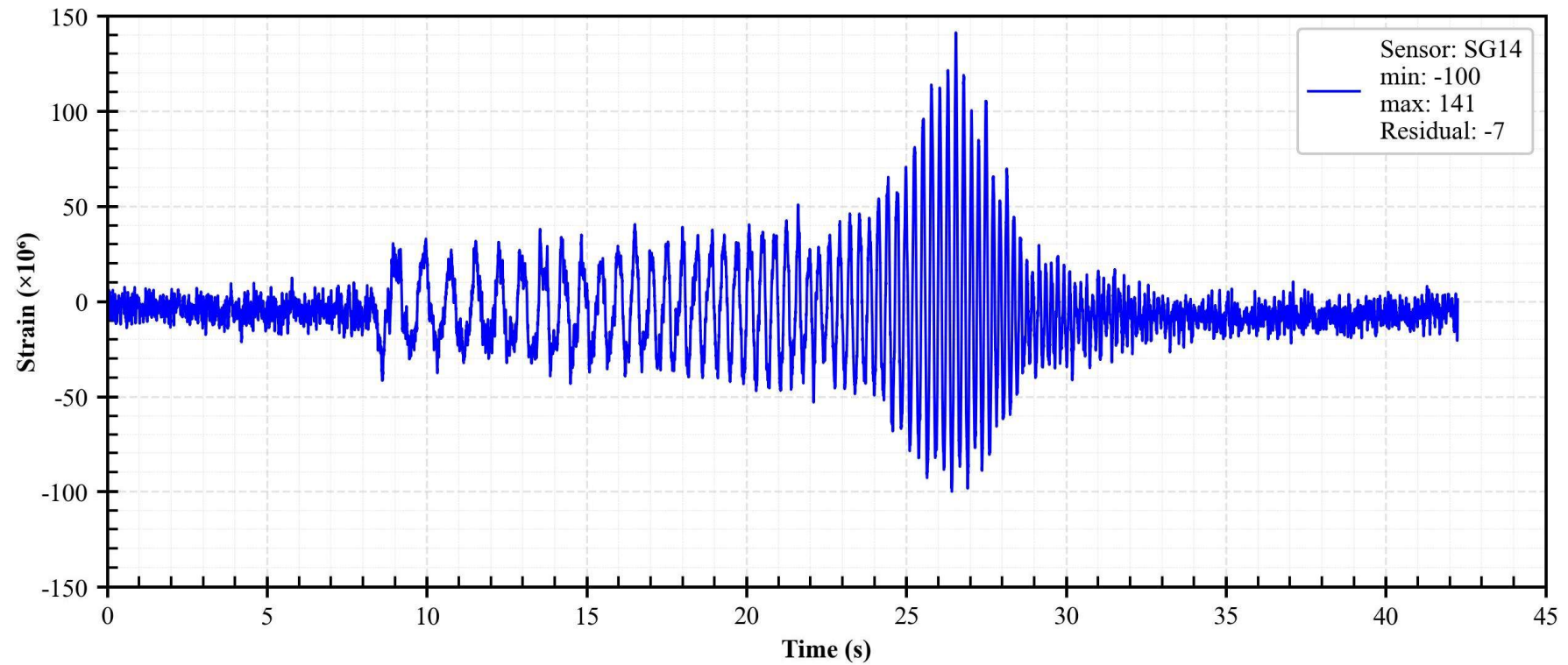


Figure 3.18.27 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 14

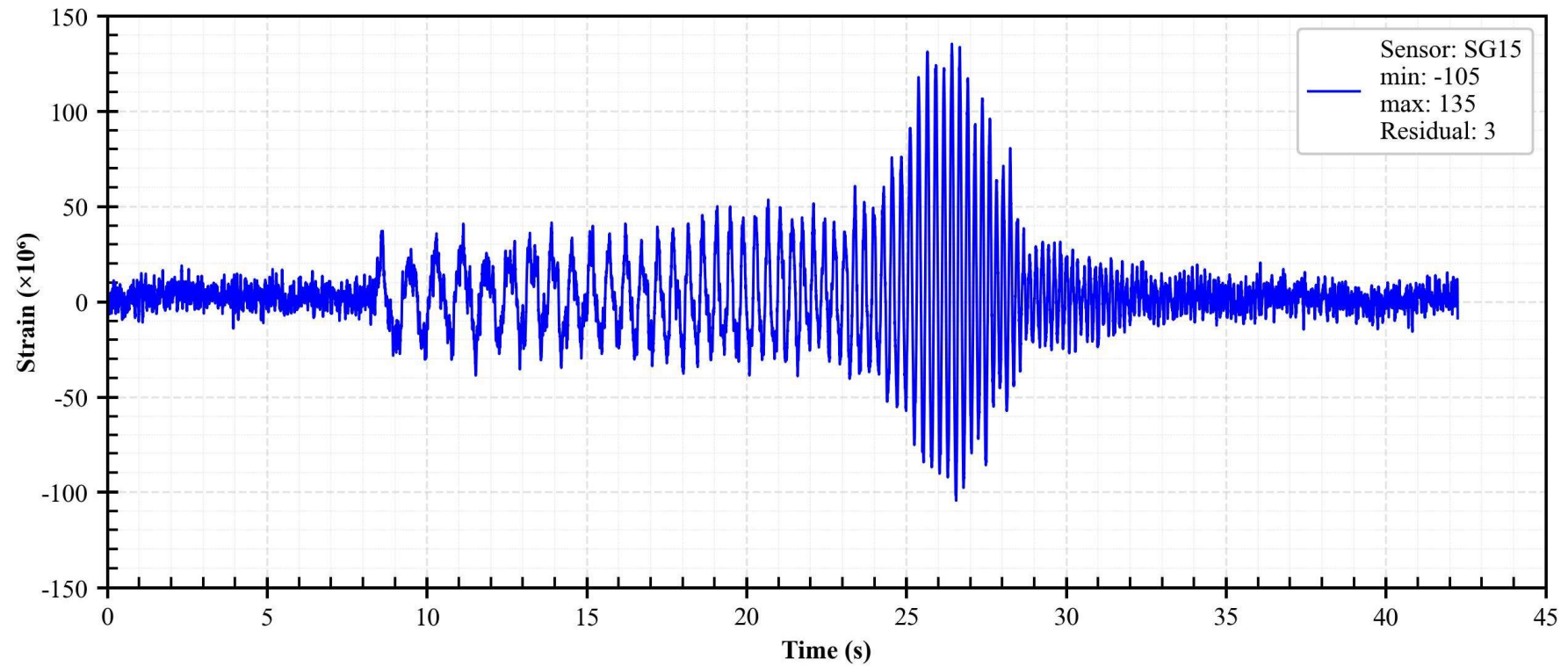


Figure 3.18.28 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 15

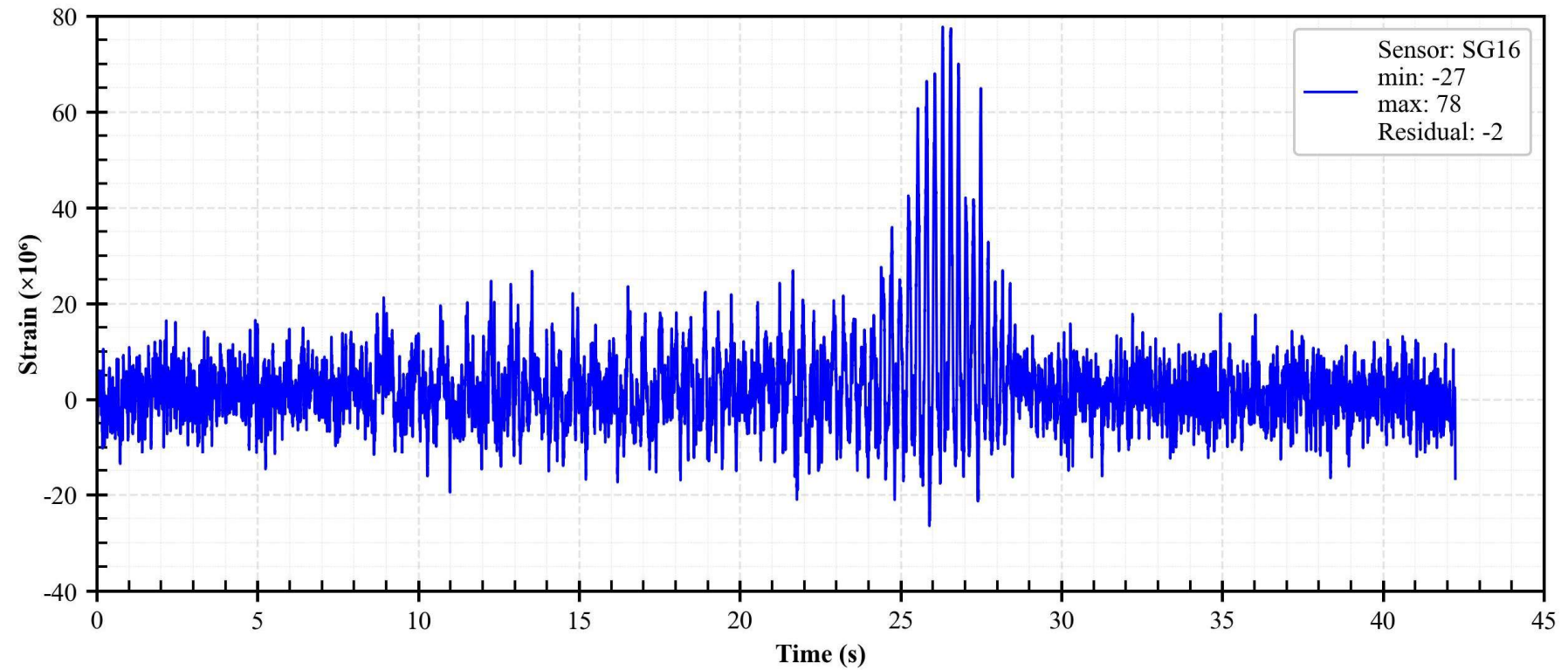


Figure 3.18.29 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 16

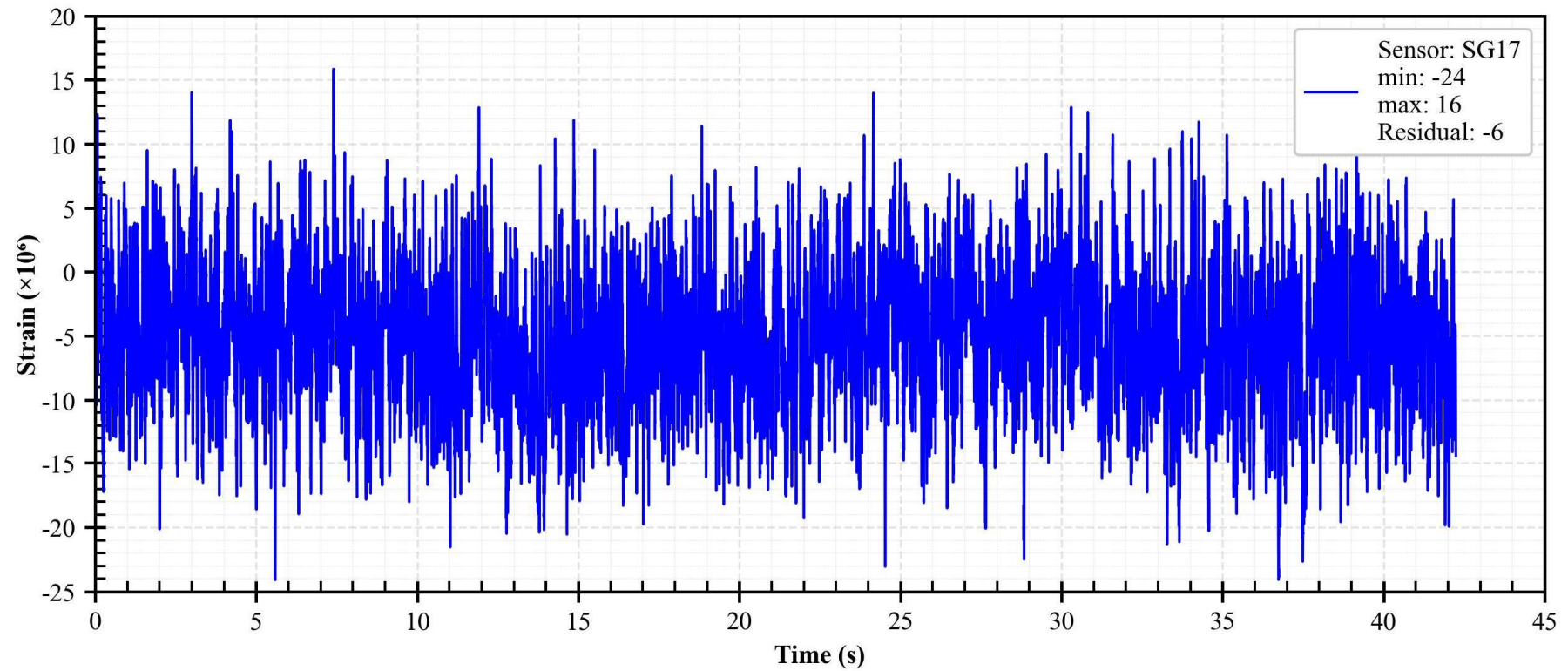


Figure 3.18.30 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 17

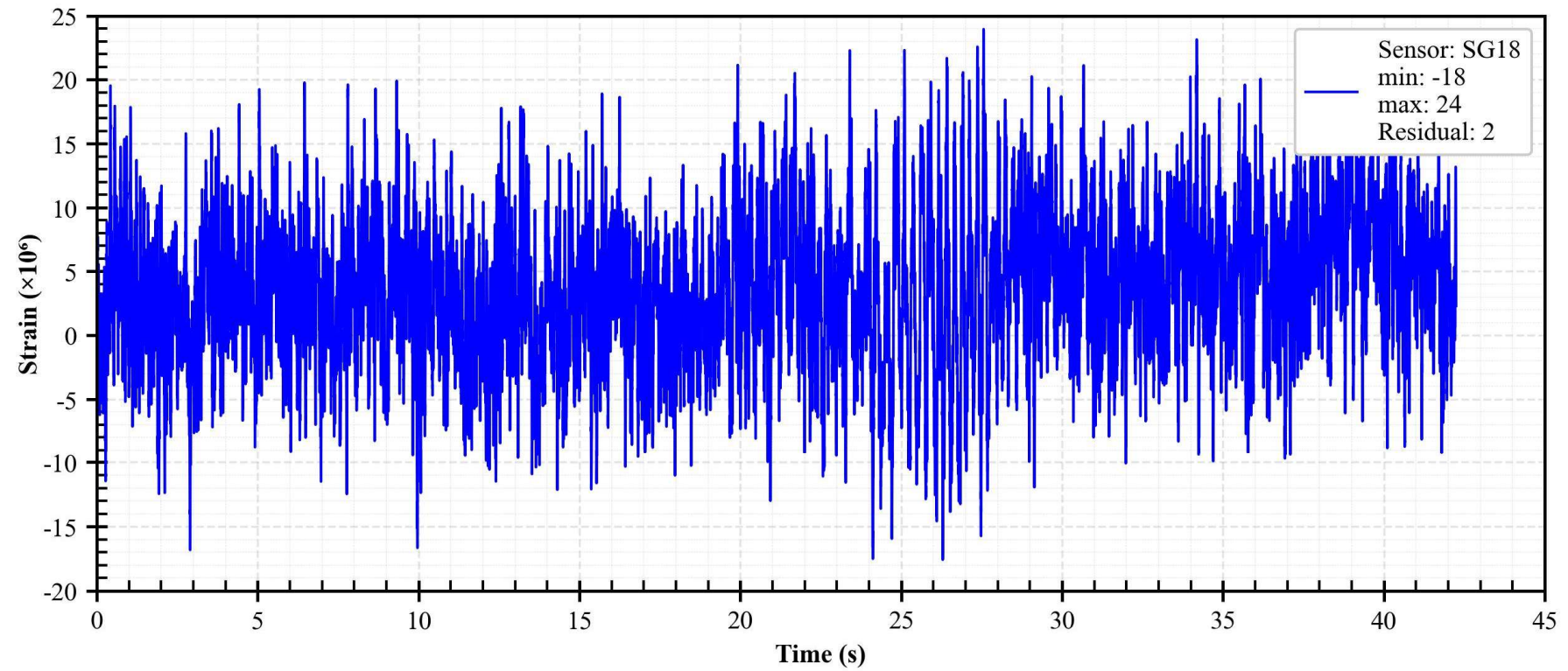


Figure 3.18.31 Characteristic results for phase B (white noise before EQ1,1g): strain gauge 18

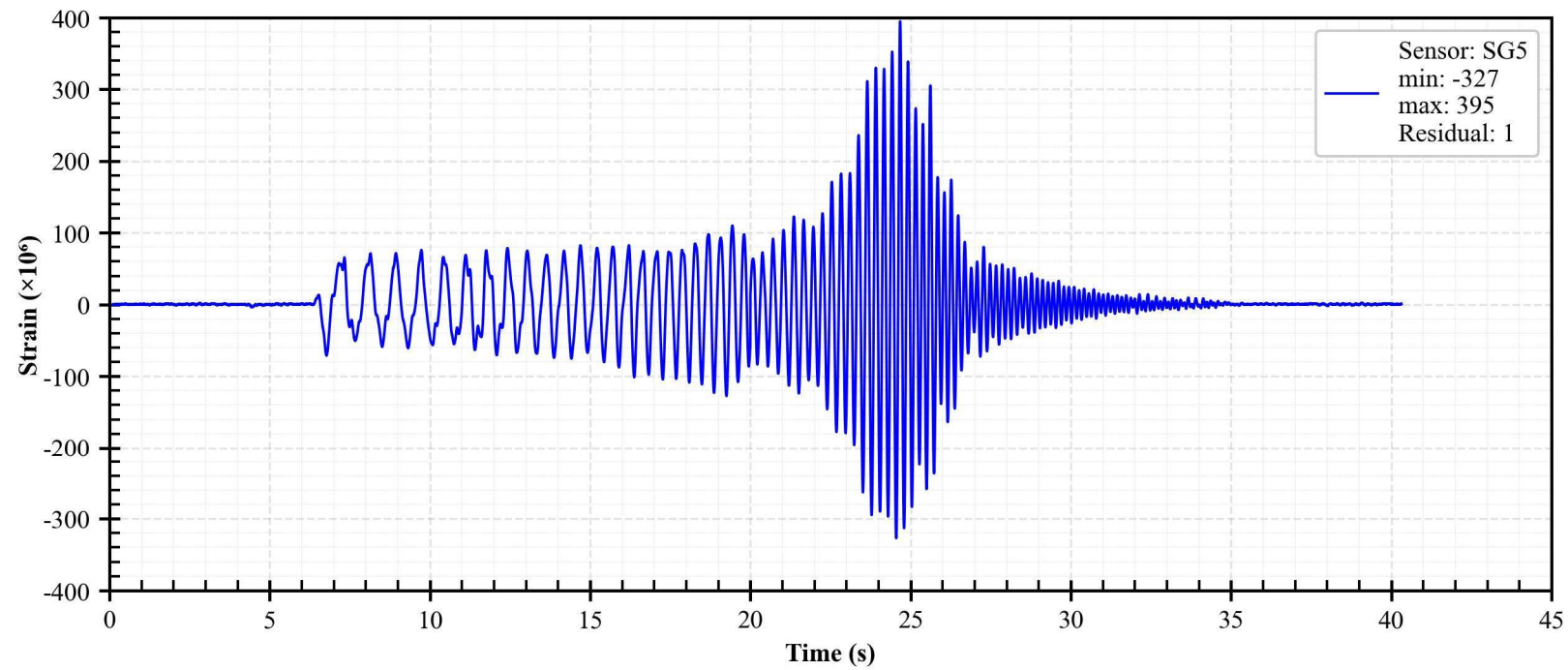


Figure 3.18.32 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 5

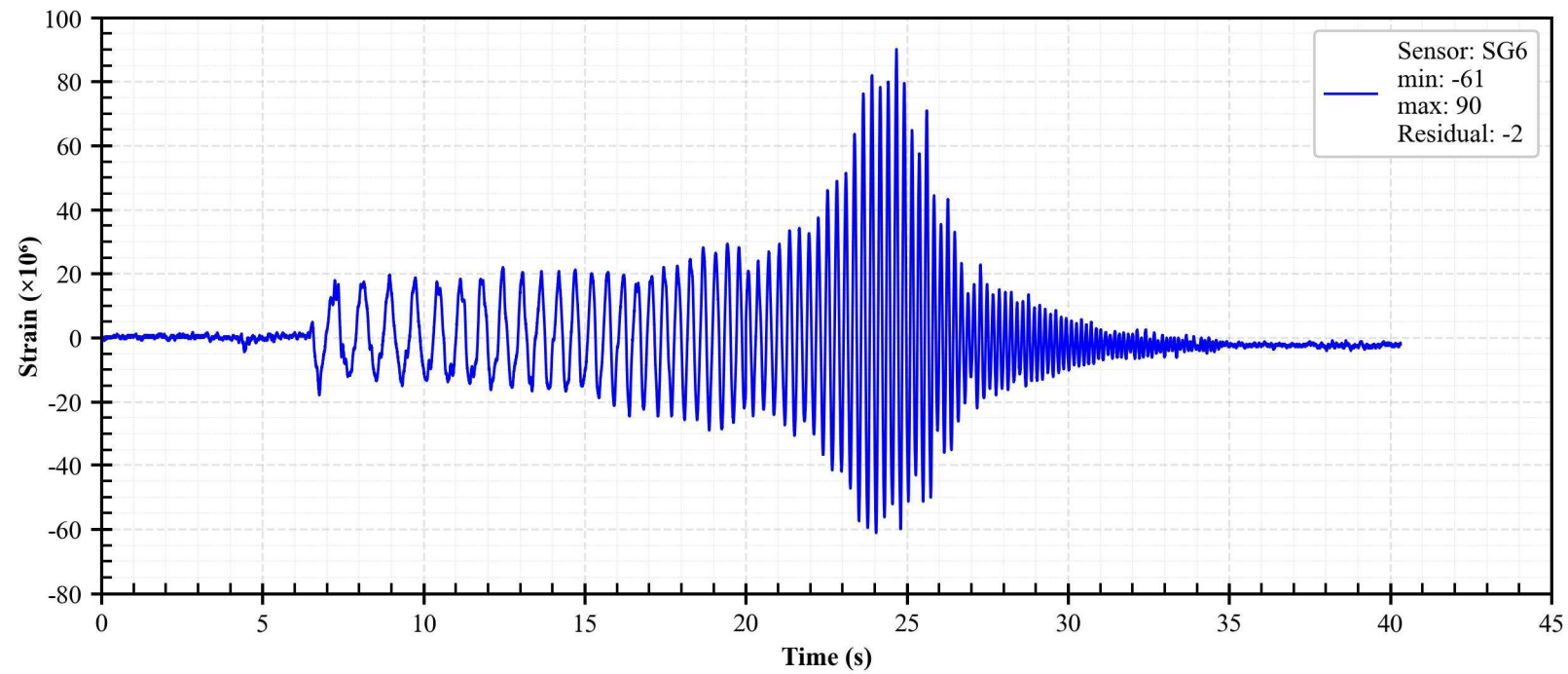


Figure 3.18.33 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 6

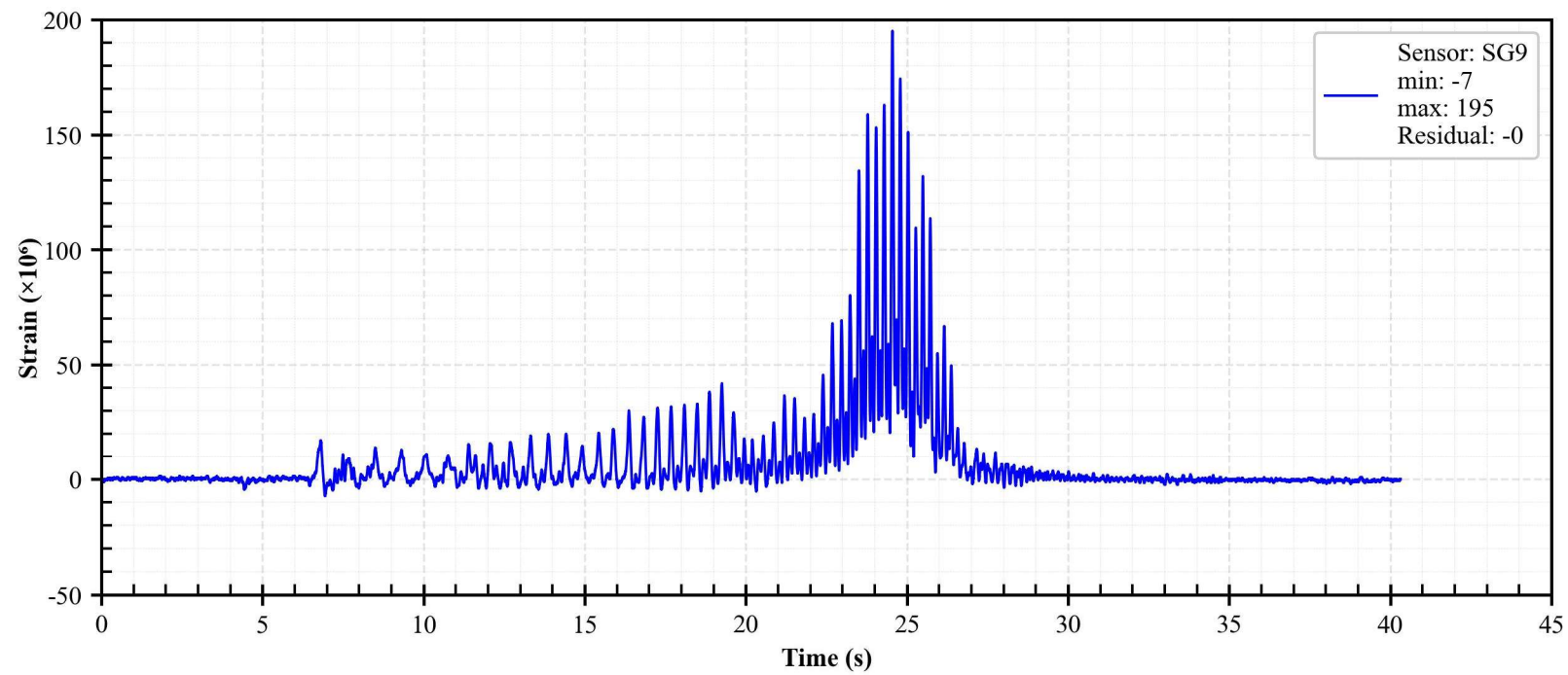


Figure 3.18.34 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 9

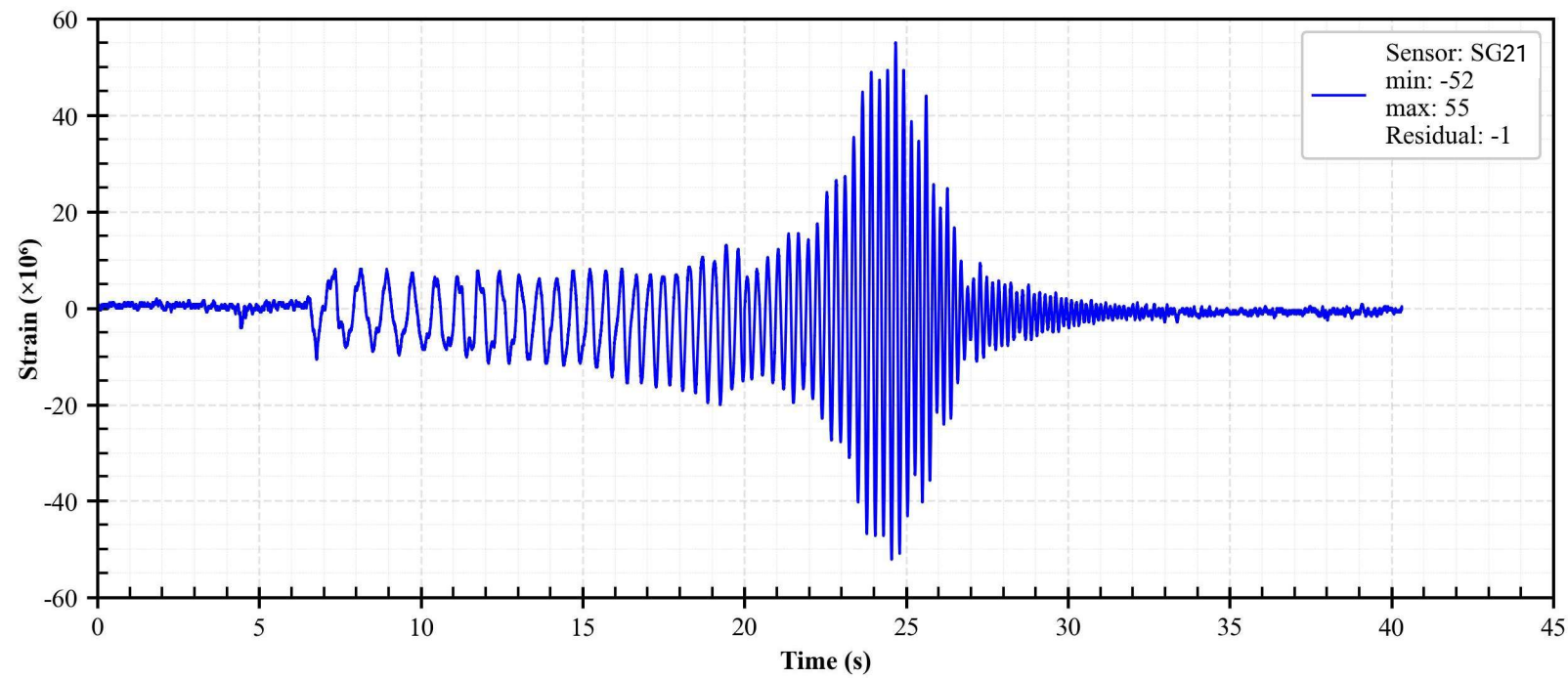


Figure 3.18.35 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 21 (PUFJ, column 1)

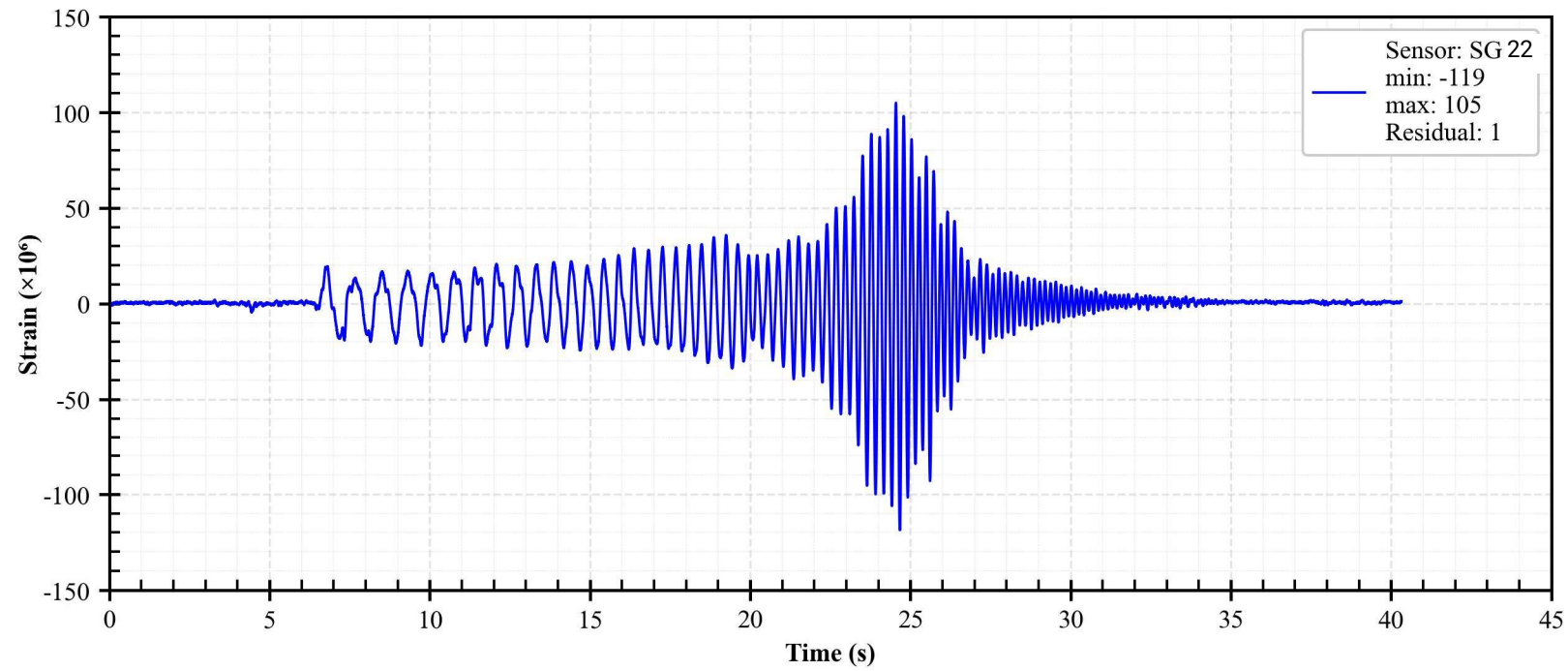


Figure 3.18.36 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 22 (PUFJ, column 2)

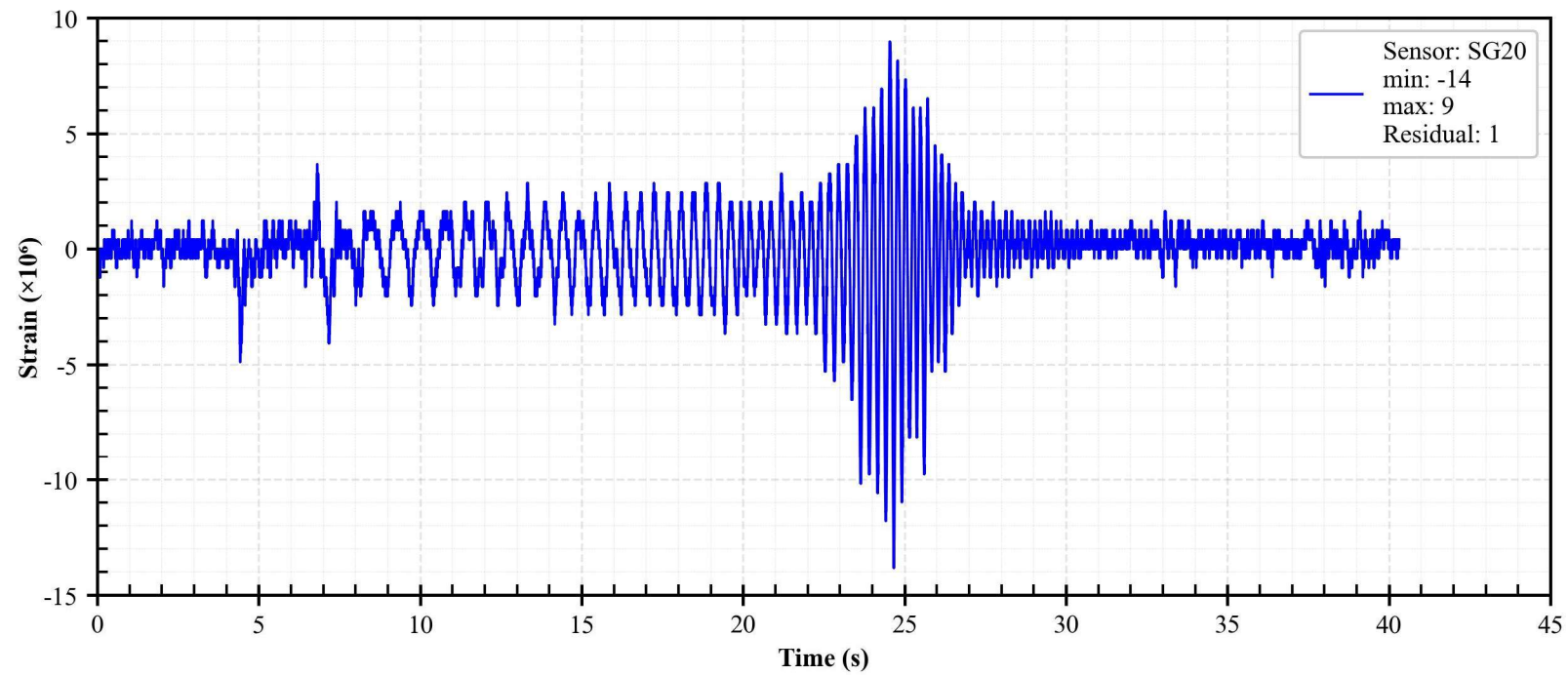


Figure 3.18.37 Characteristic results for phase B (earthquake EQ0,8g): strain gauge 20

3.19 Earthquake EQ1,1g

Accelerometers

Characteristic extracts from the time history of accelerations of different of different accelerometers are given below for earthquake EQ1,1g, without bottom fixing of the vertical living walls. The max acceleration at the slab level on the accelerometer acc4 is 1.66g. The max acceleration at the foundation level on the accelerometer acc10 is 1.33g.

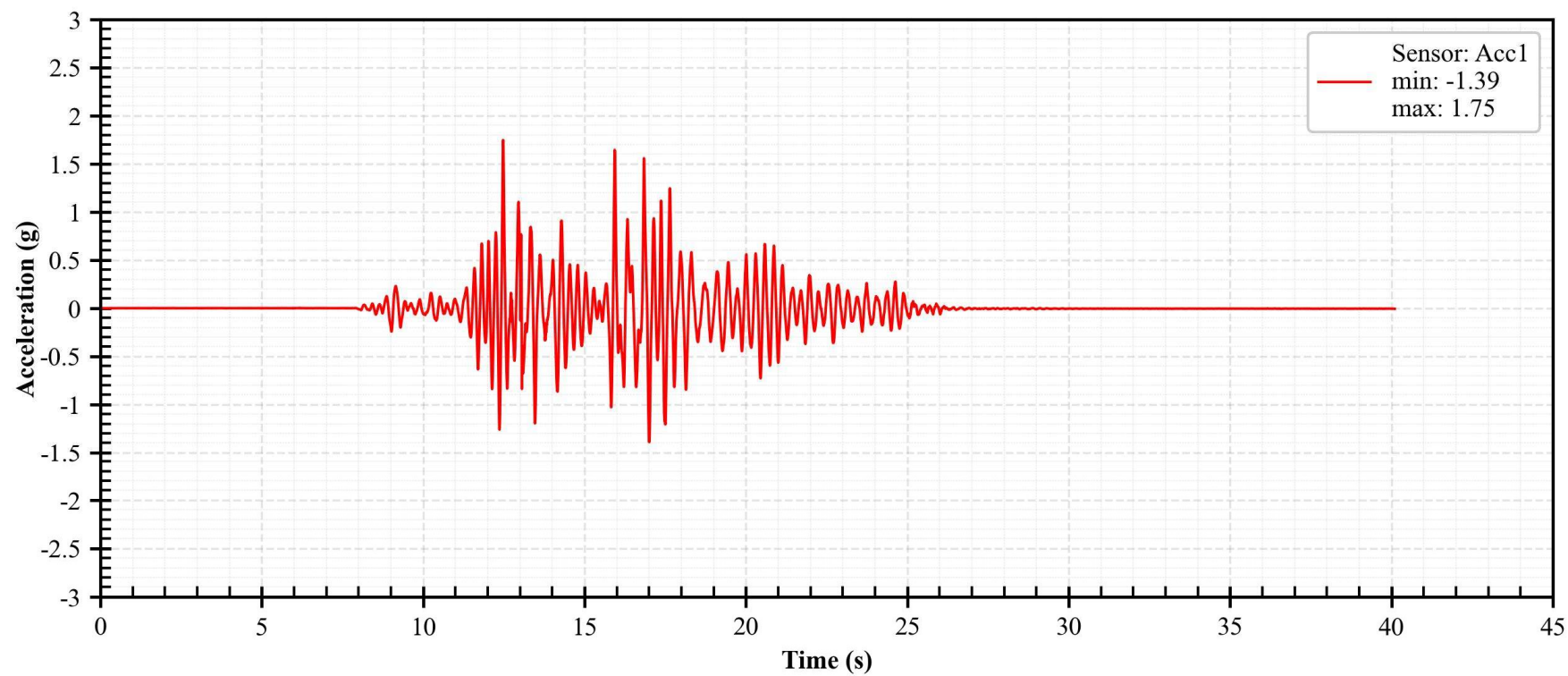


Figure 3.19.1 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 1

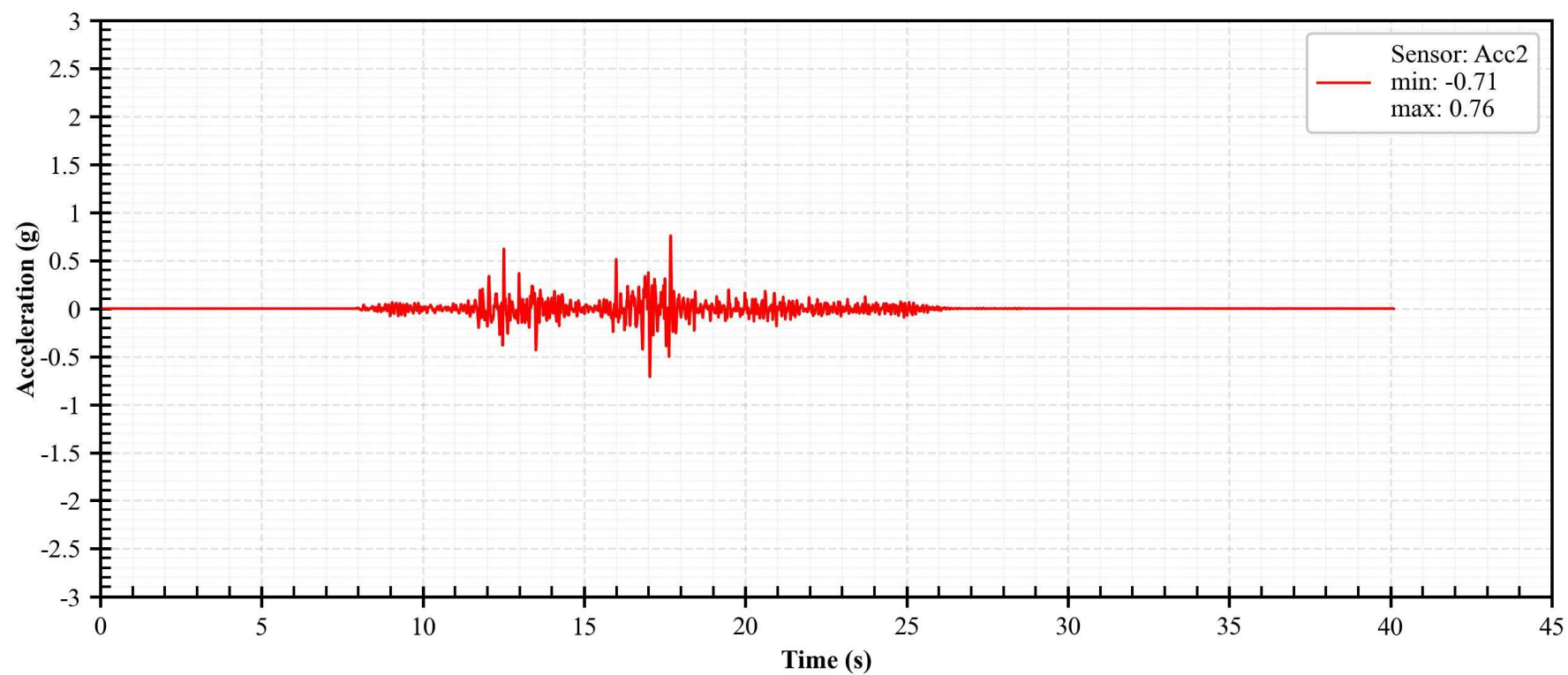


Figure 3.19.2 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 2

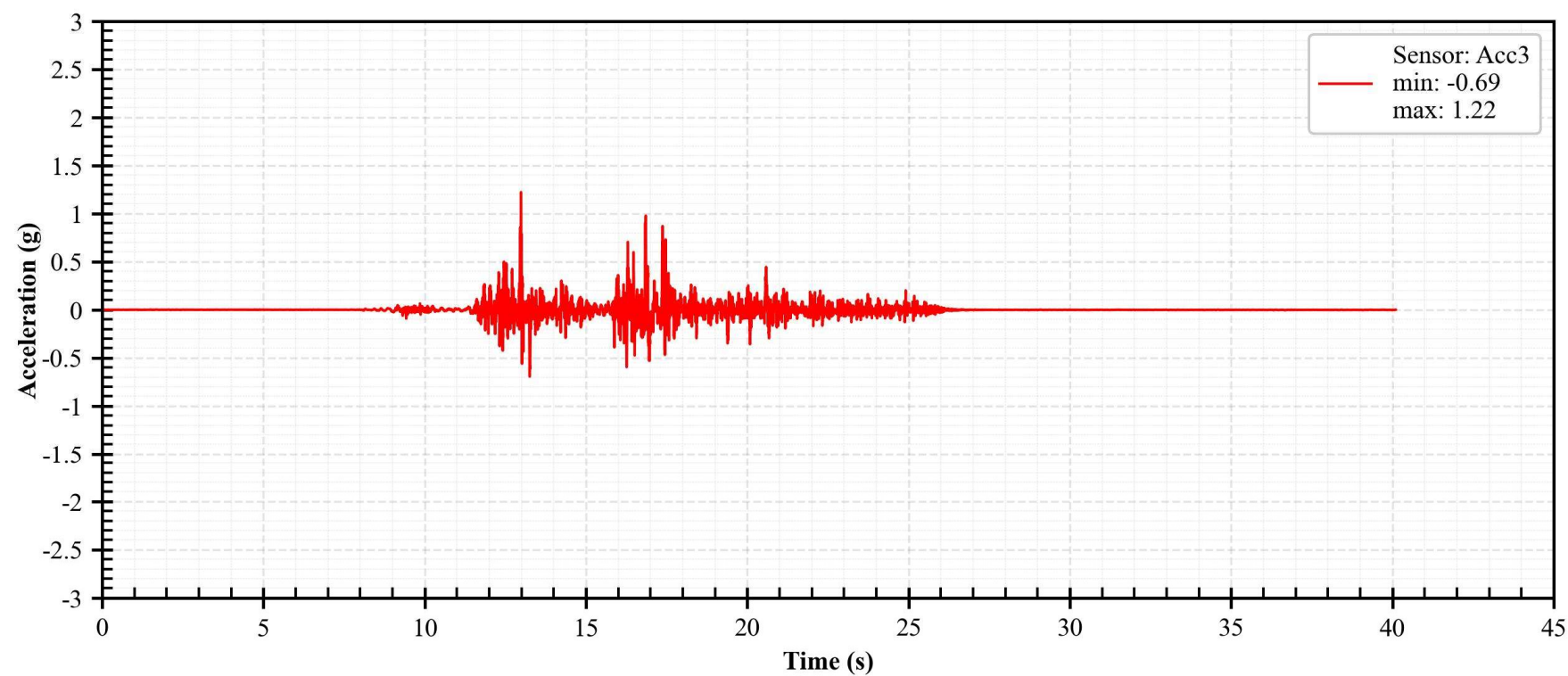


Figure 3.19.3 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 3

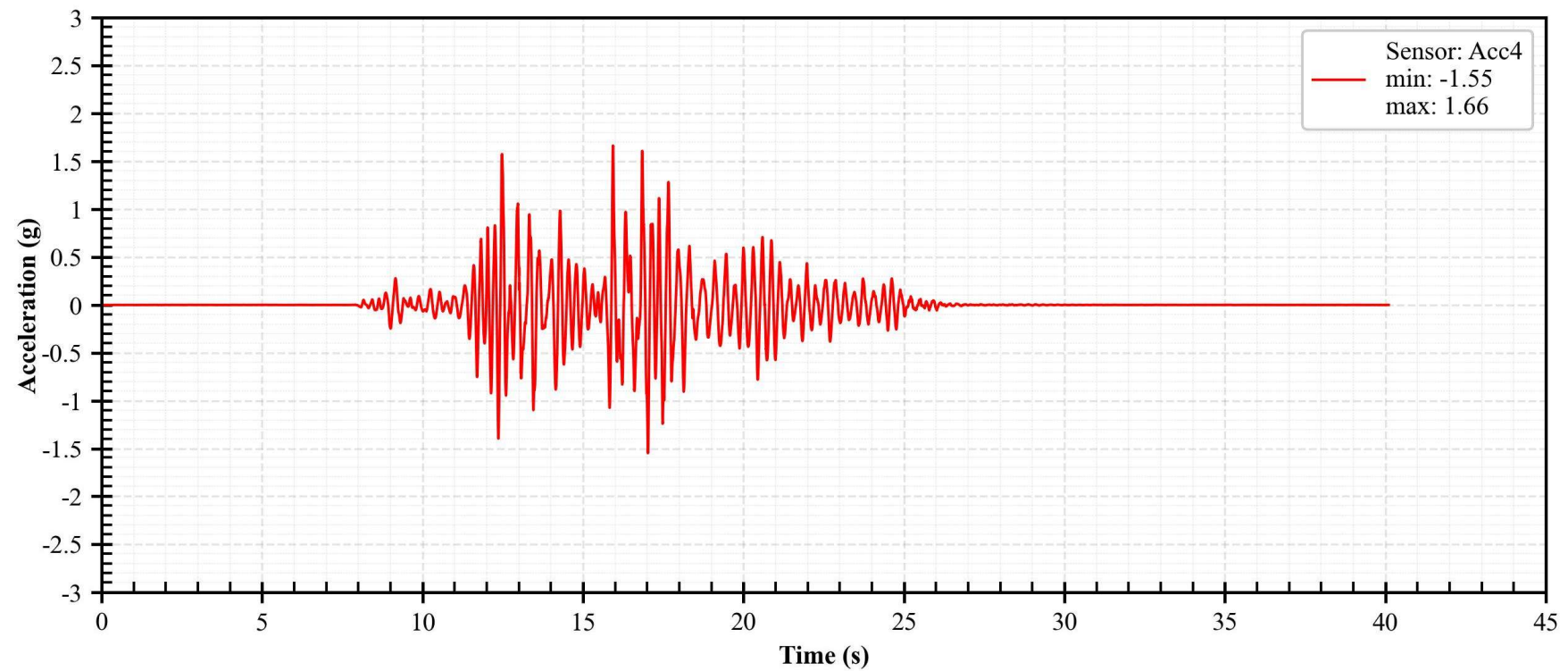


Figure 3.19.4 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 4

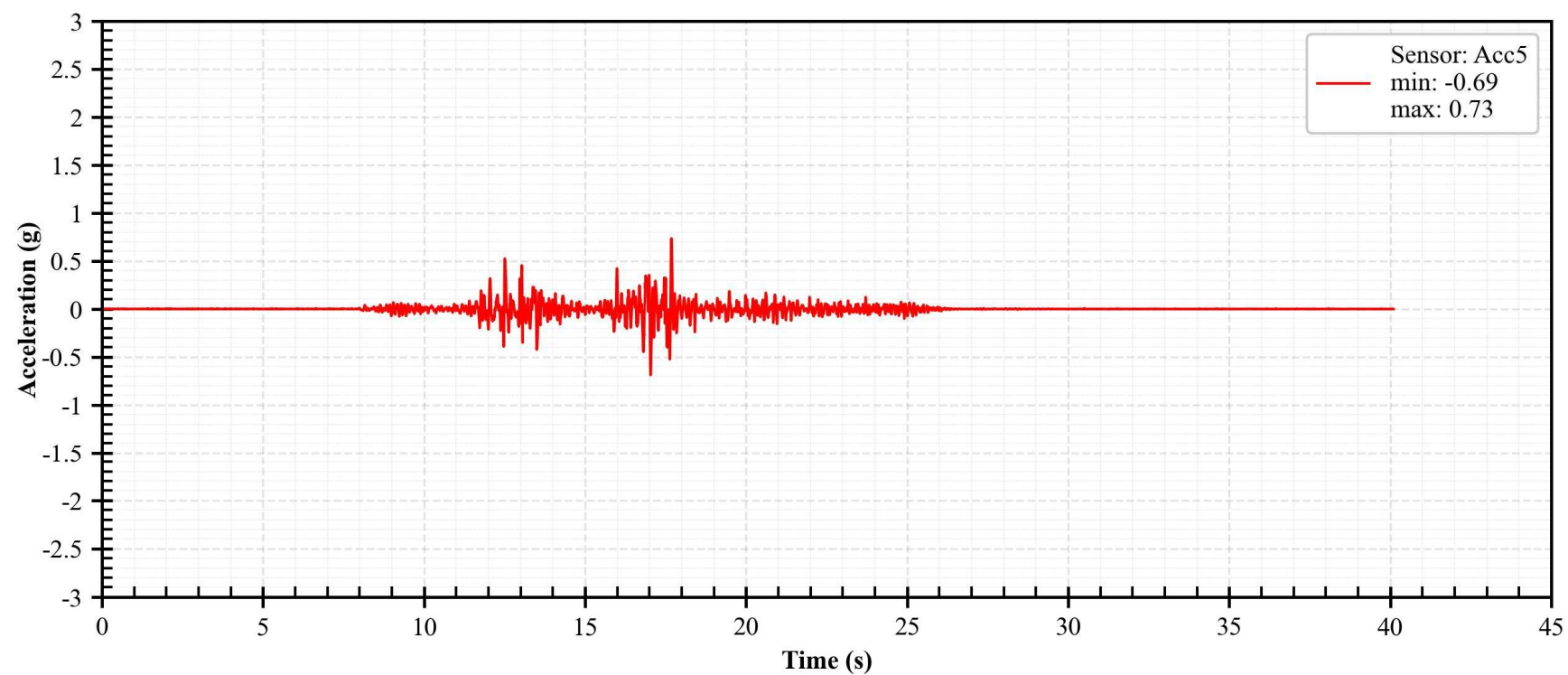


Figure 3.19.5 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 5

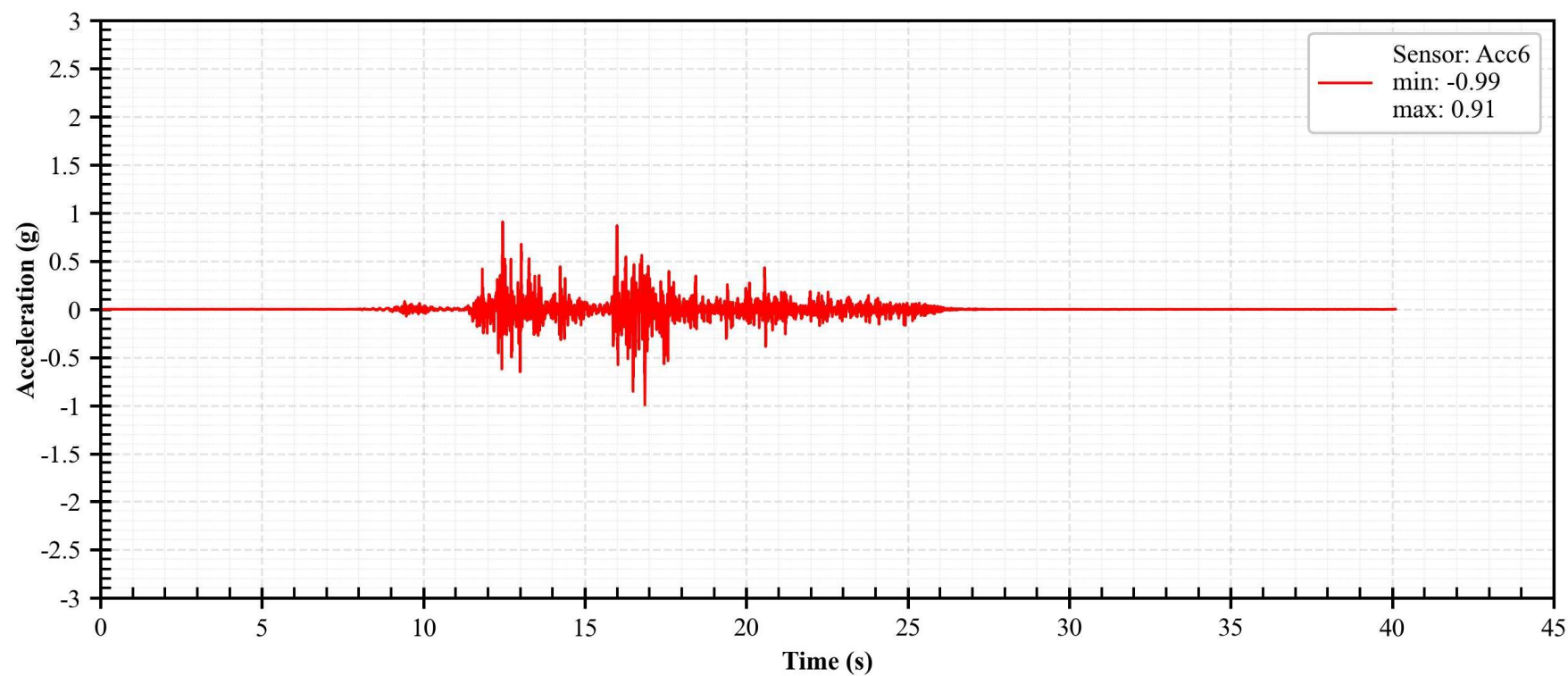


Figure 3.19.6 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 6

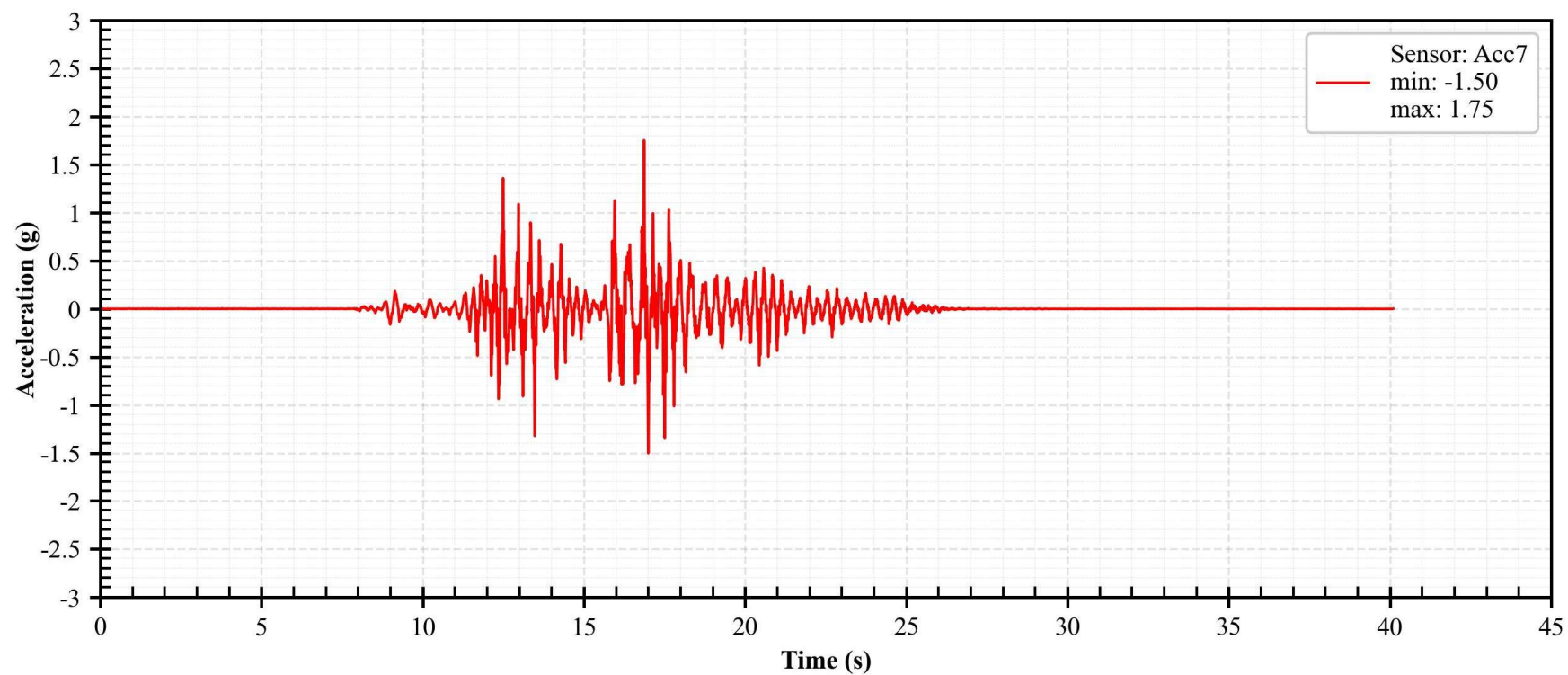


Figure 3.19.7 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 7

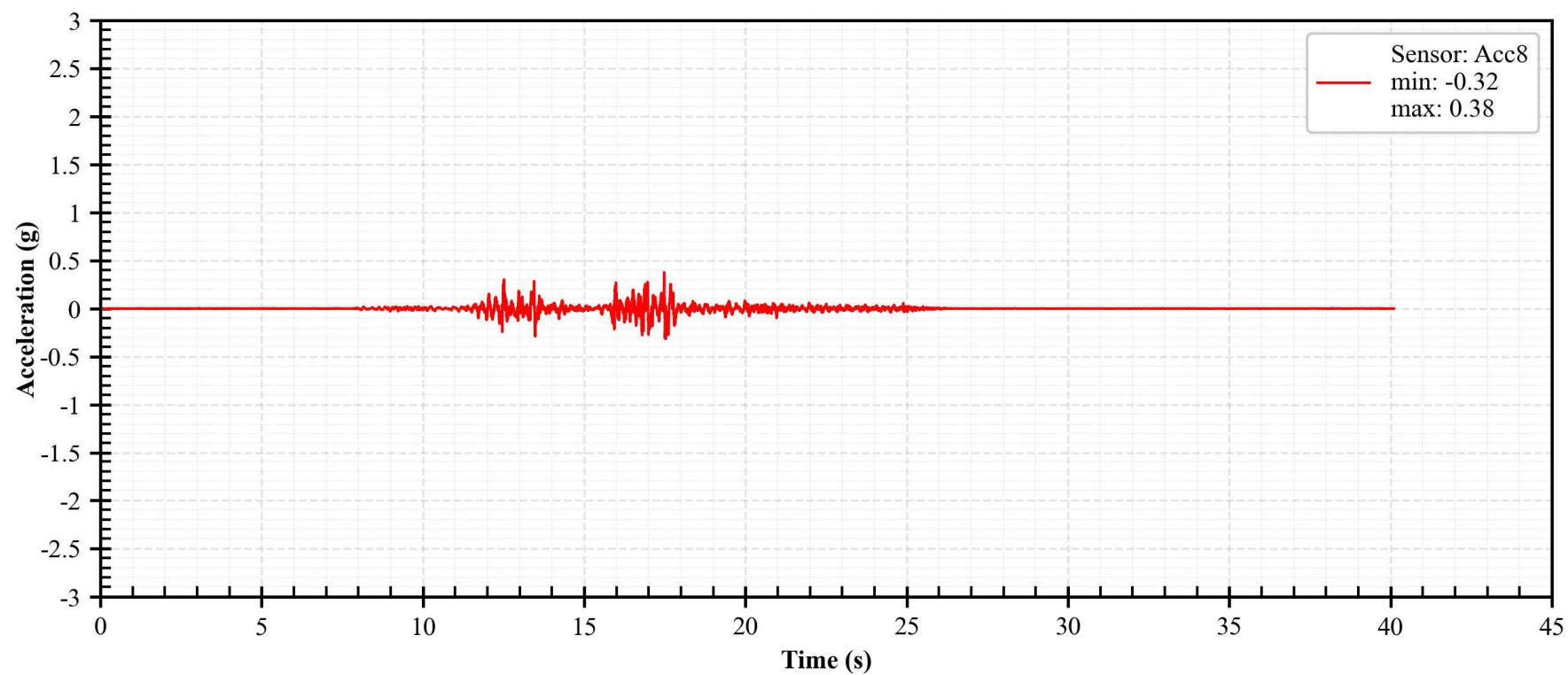


Figure 3.19.8 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 8

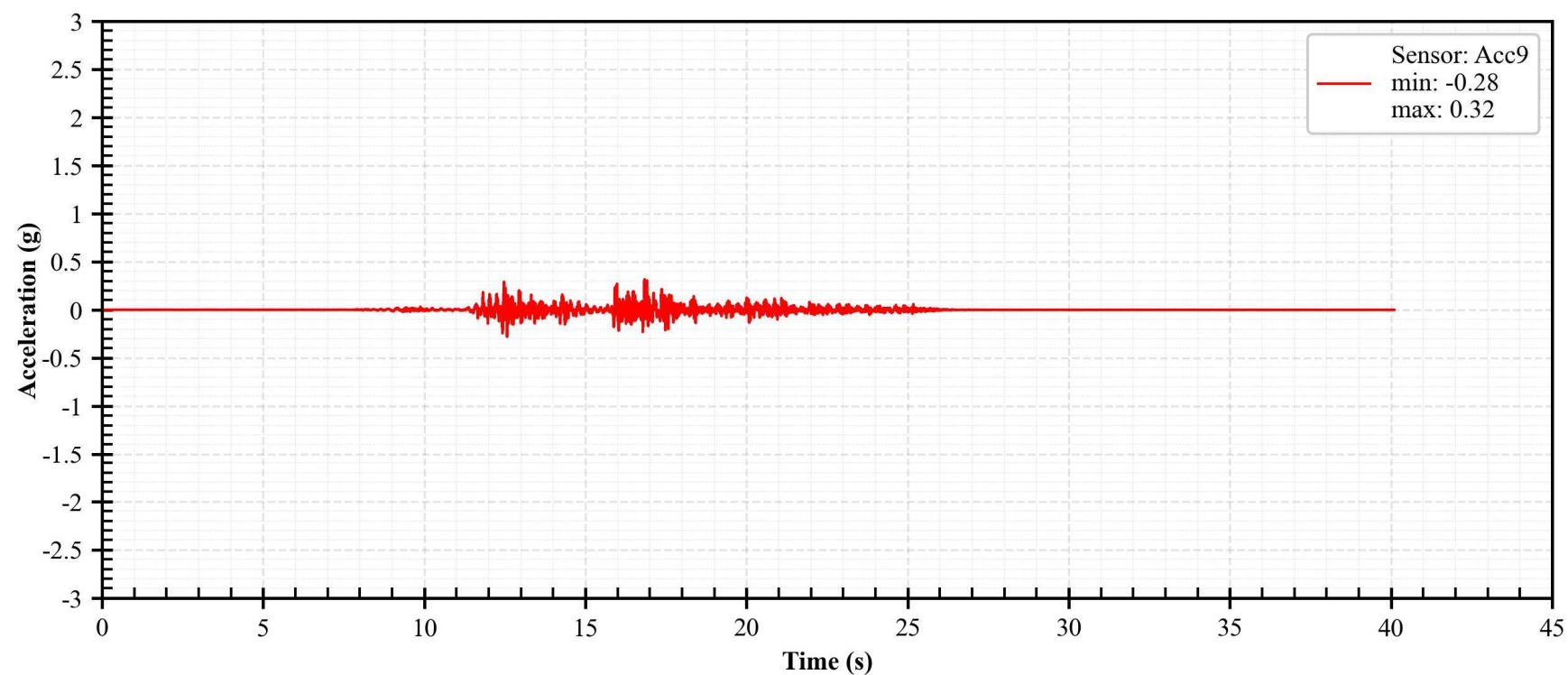


Figure 3.19.9 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 9

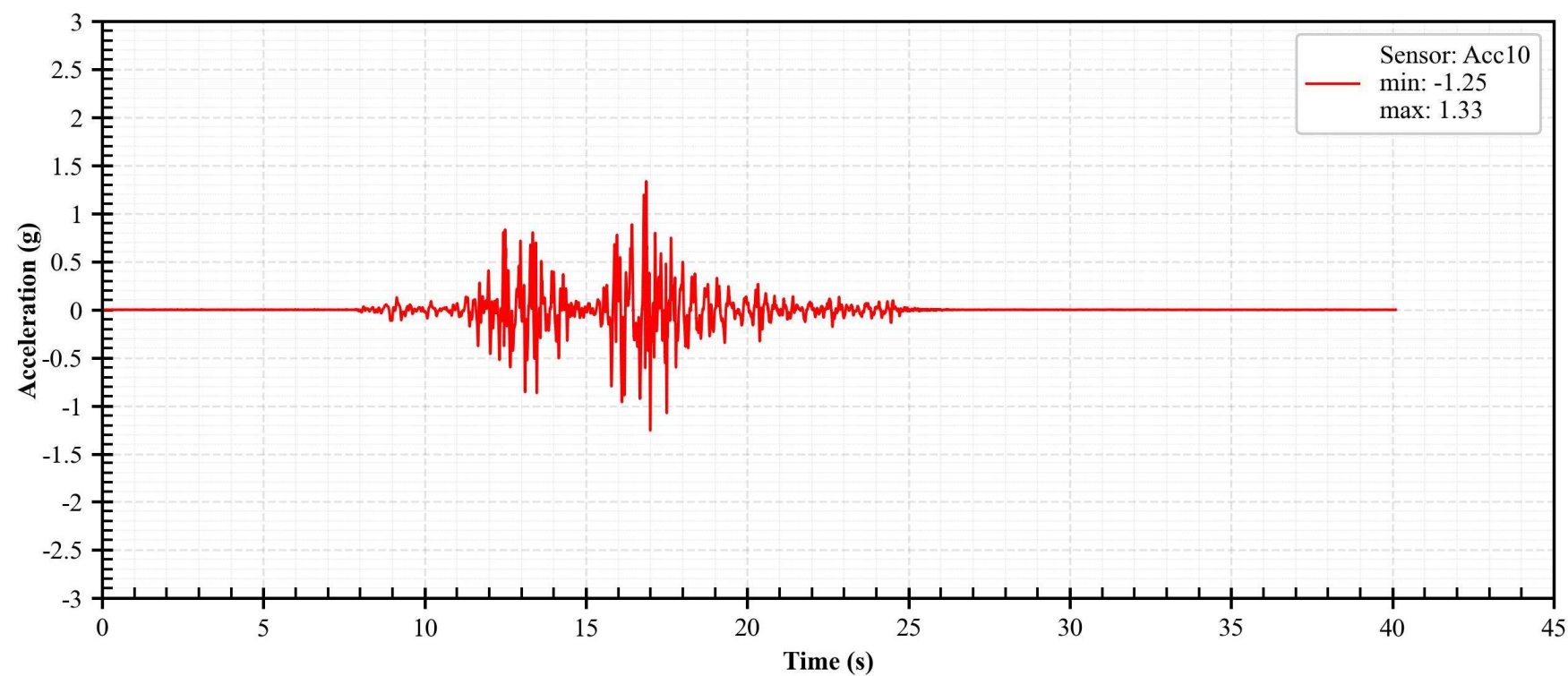


Figure 3.19.10 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 10

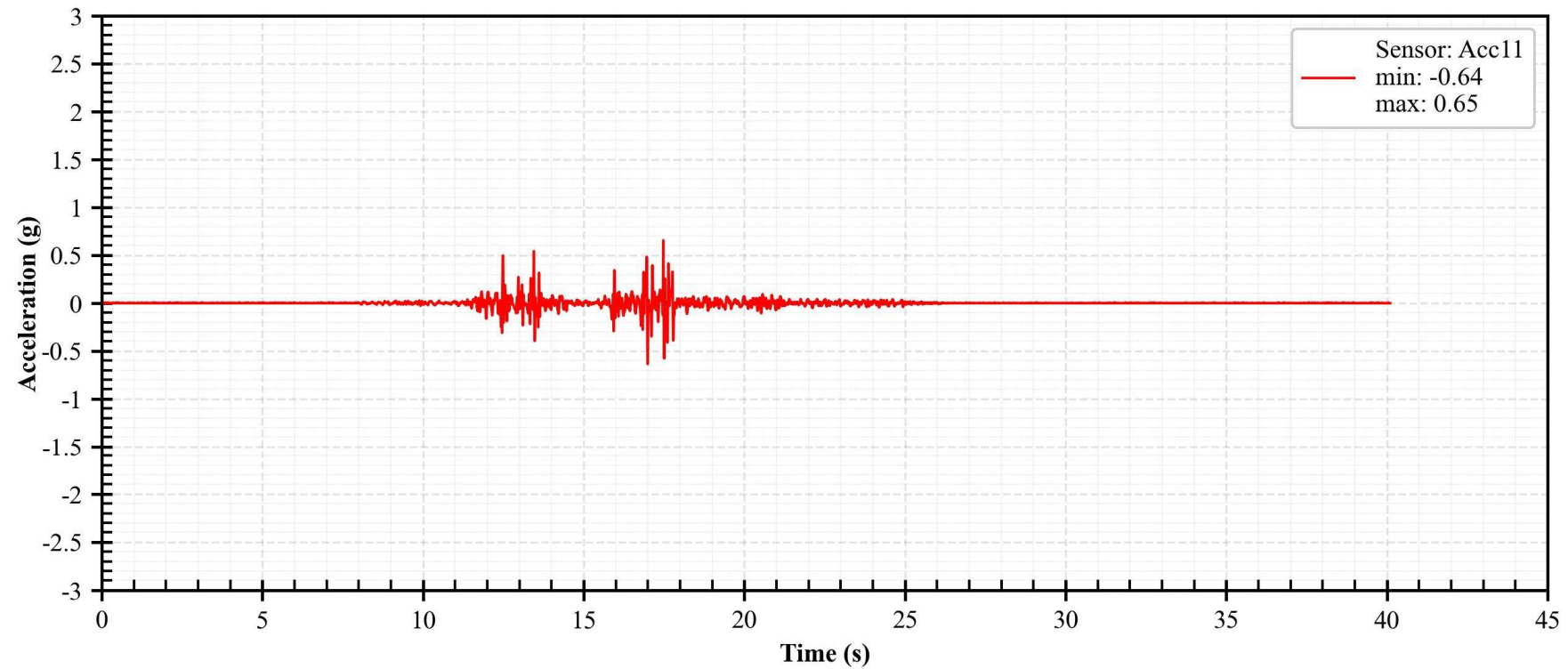


Figure 3.19.11 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 11

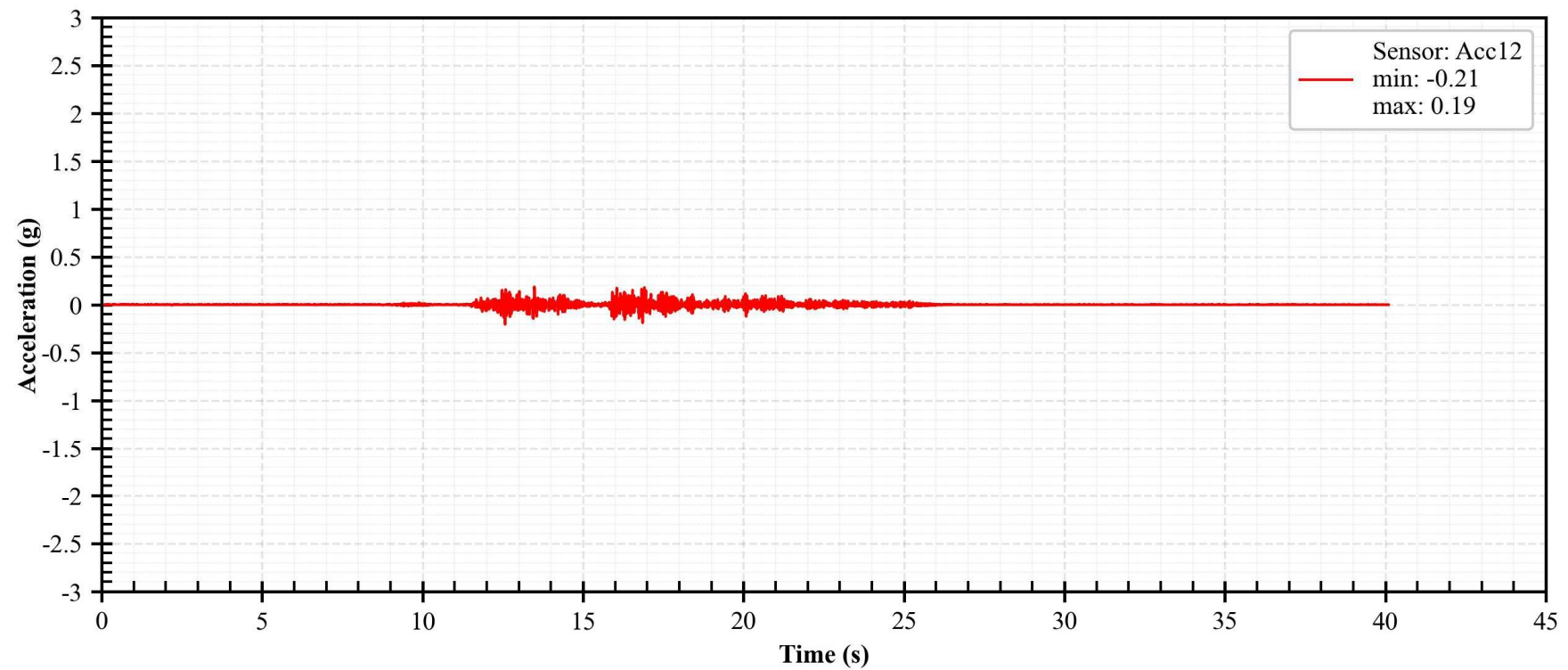


Figure 3.19.12 Characteristic results for phase B (earthquake EQ1,1g): Accelerometer 12

Draw wire sensors

Figures 3.19.13 – 3.19.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 32.92 mm while the minimum is -31.36 mm. The maximum movement detected by draw wire sensor W2 is 34.41 mm while the minimum is -31.04 mm. The maximum movement detected by draw wire sensor W3 is 24.51 mm while the minimum is -22.82 mm. The maximum movement detected by draw wire sensor W4 is 22.16 mm while the minimum is -22.16 mm. The maximum drift is $(14.08/1.225) = 11.49 \text{ ‰}$ and minimum drift is $(-13.92/1.225) = -11.36 \text{ ‰}$.

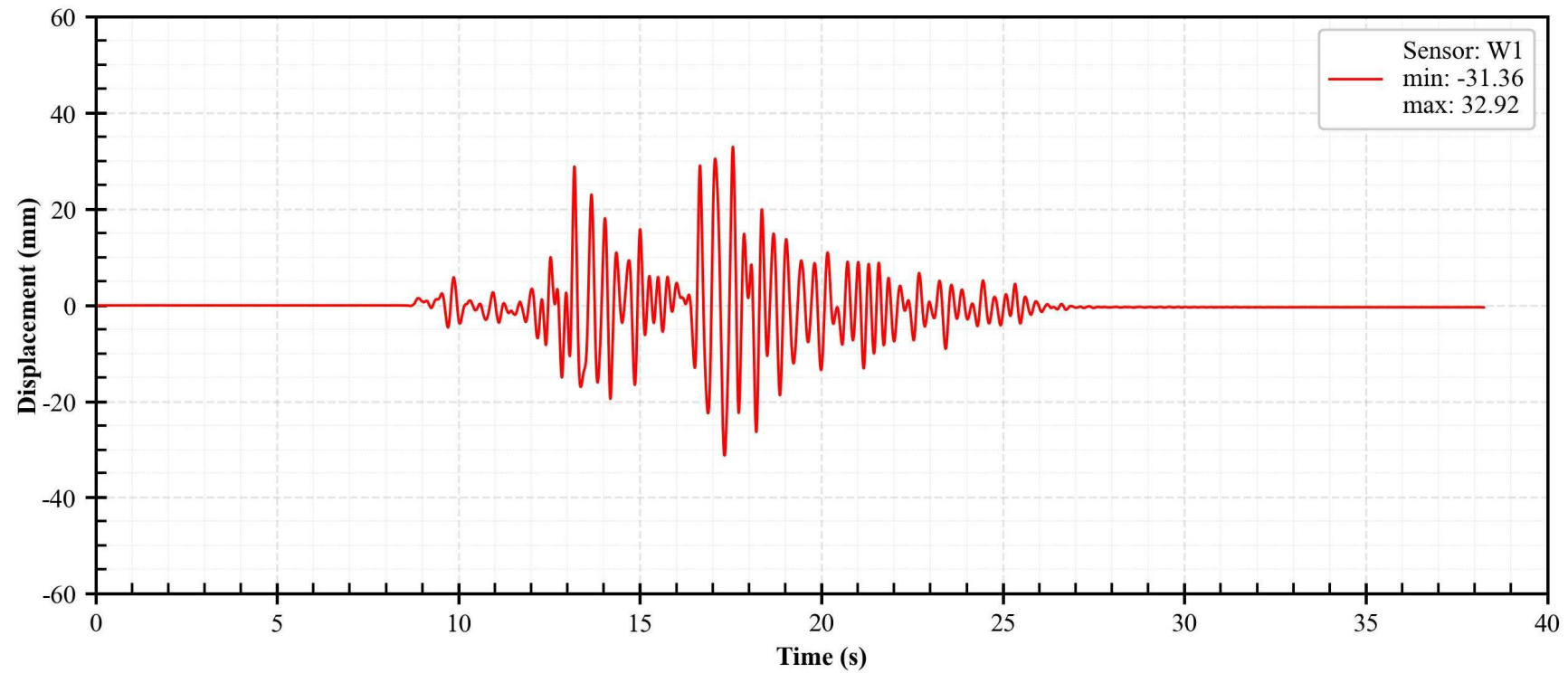


Figure 3.19.13 Characteristic results for phase B (earthquake EQ1,1g): Draw wire sensor 1

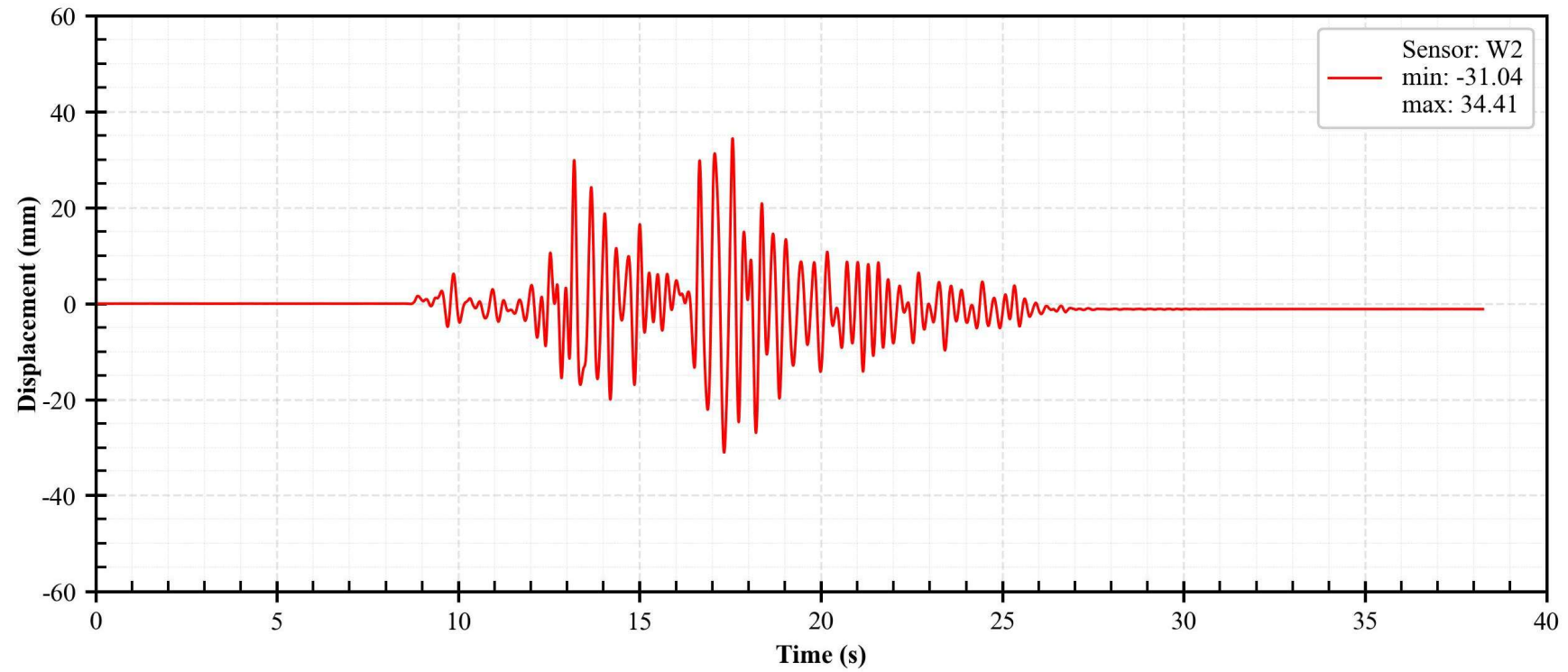


Figure 3.19.14 Characteristic results for phase B (earthquake EQ1,1g): Draw wire sensor 2

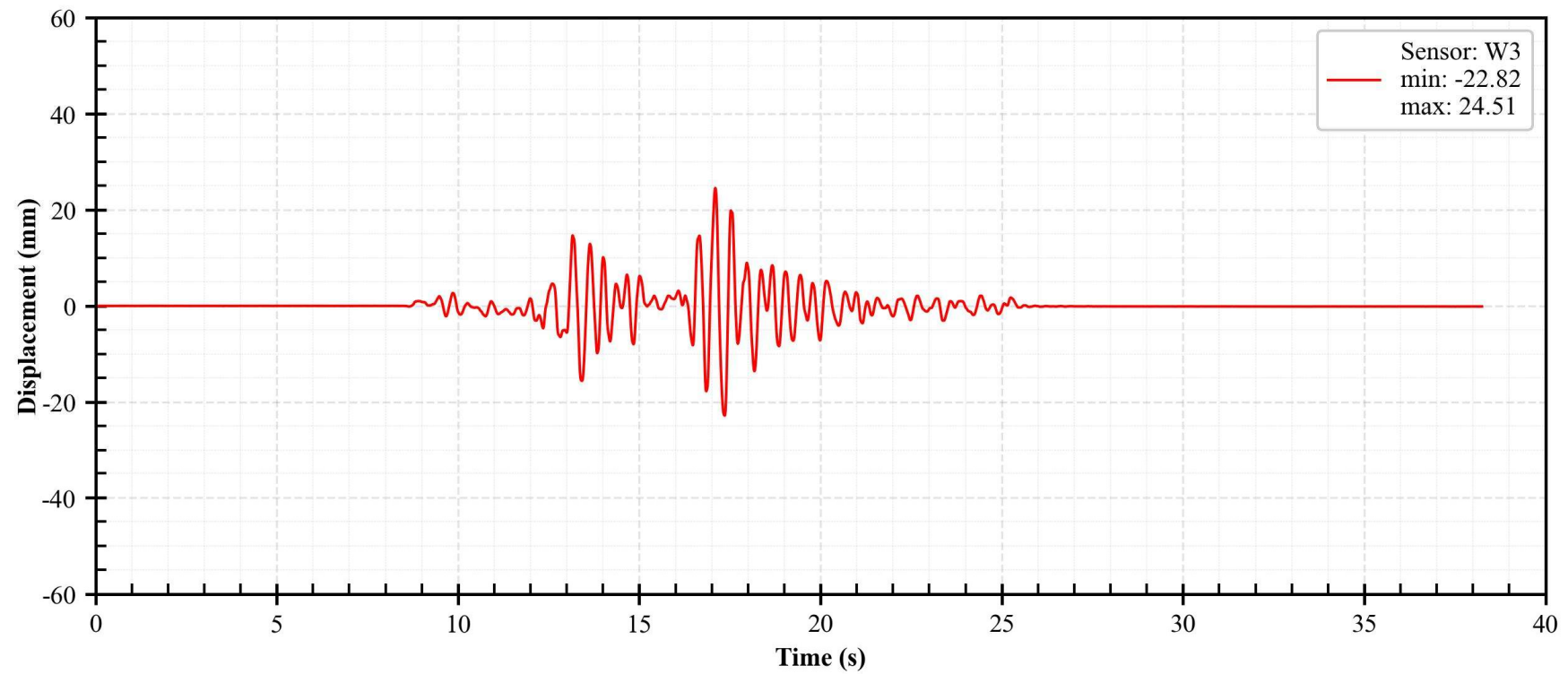


Figure 3.19.15 Characteristic results for phase B (earthquake EQ1,1g): Draw wire sensor 3

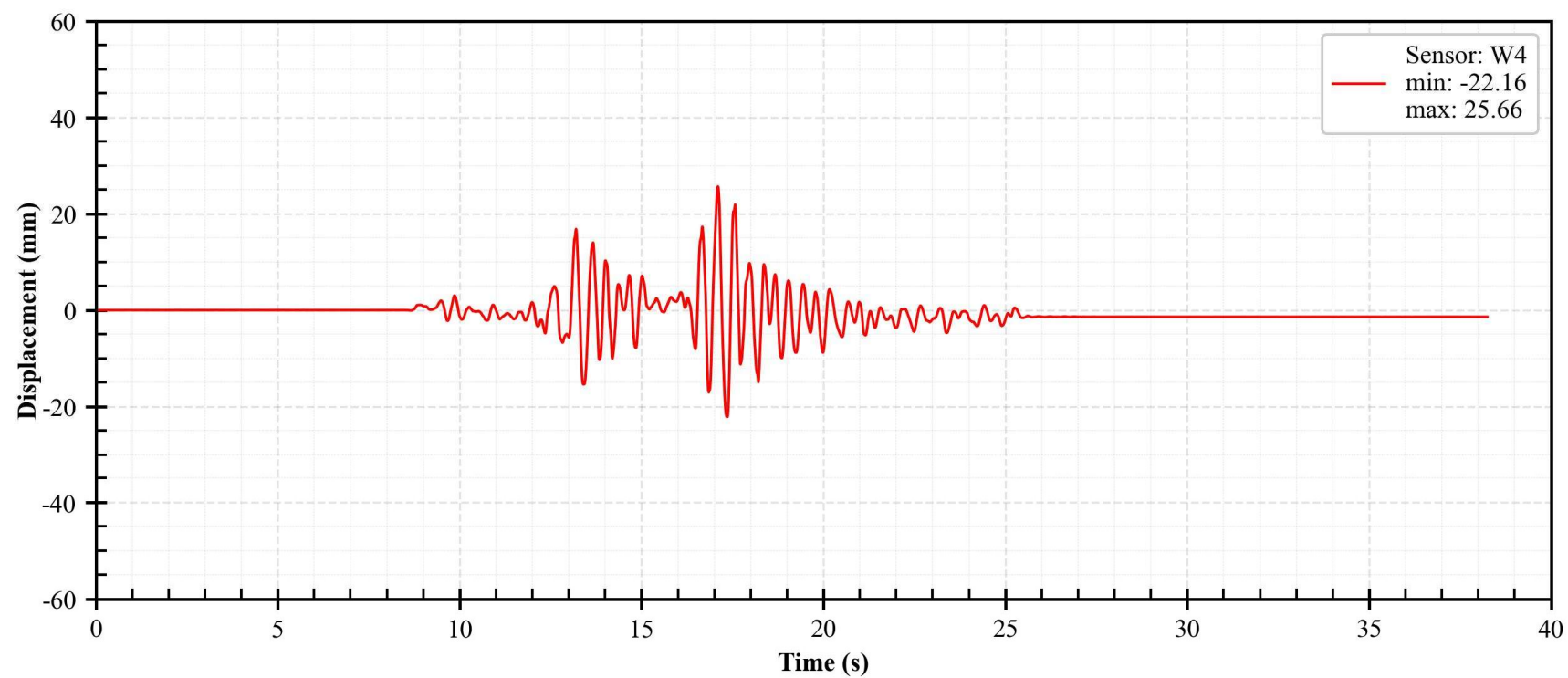


Figure 3.19.16 Characteristic results for phase B (earthquake EQ1,1g): Draw wire sensor 4

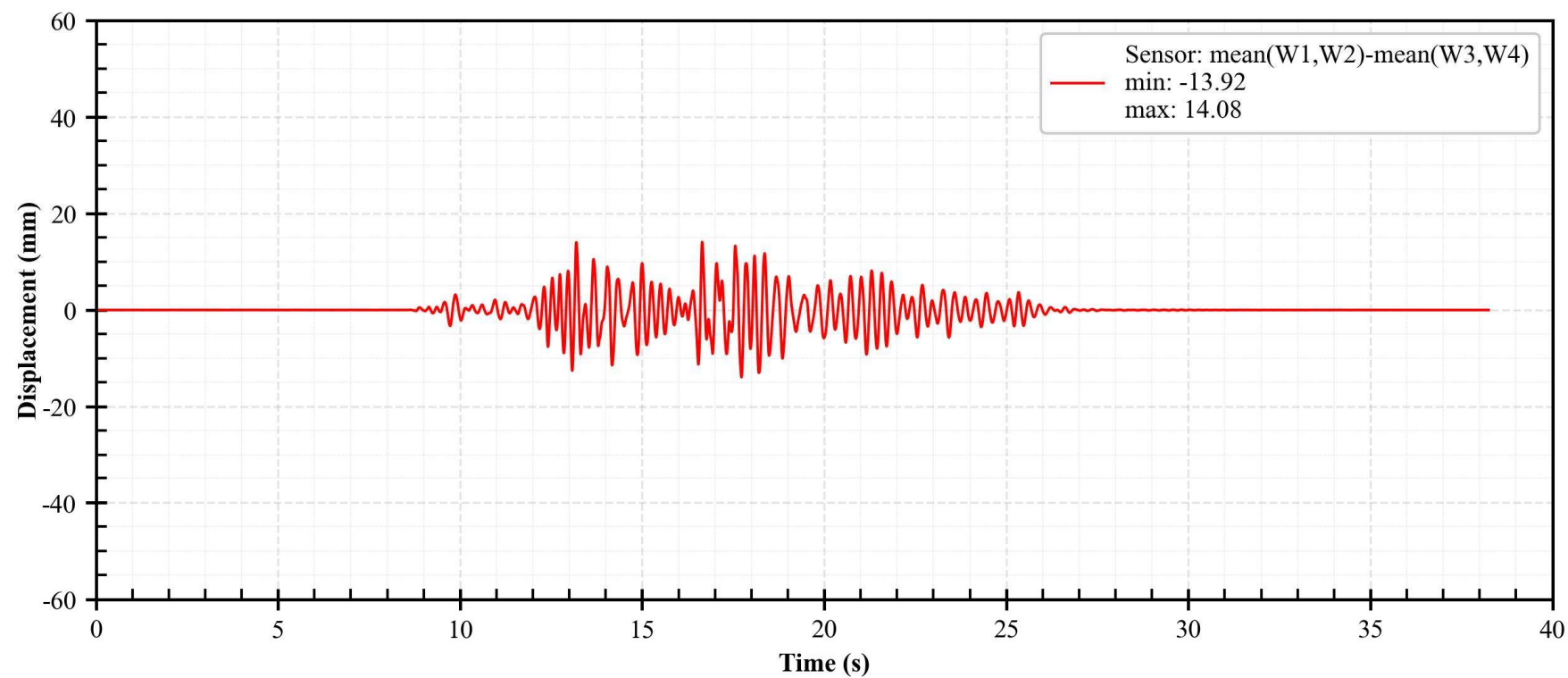


Figure 3.19.17 Characteristic results for phase B (earthquake EQ1,1g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.19.18, 3.19.19, 3.19.20, 3.19.21, 3.19.22, 3.19.23, 3.19.32, 3.19.33 are located on the longitudinal reinforcement, at the bottom of the column. More specifically, strain gauge SG1 has maximum strain 1218 μ strain and minimum strain -287 μ strain. The residual strain is 15 μ strain. Strain gauge SG2 has maximum strain 781 μ strain and minimum -43 μ strain. The residual strain is -6 μ strain. Strain gauge SG3 has 554 μ strain and -46 μ strain maximum and minimum strain respectively. The residual strain is 5 μ strain. Strain gauge SG4 has maximum 1217 μ strain and minimum -399 μ strain strain. The residual strain is -37 μ strain. Figure 3.19.32 and figure 3.19.33 show strain gauges SG5 and SG6, respectively. Strain gauge 5 has 2656 μ strain and -735 μ strain maximum and minimum strain respectively. Strain gauge SG5 presents -29 μ strain residual strain. Strain gauge SG6 has 23832 μ strain maximum strain, -48 μ strain minimum strain and 8637 μ strain residual. Finally in figure 3.19.22 we see strain gauge SG7 and in figure 3.19.23 strain gauge 8. Strain gauge SG7 has maximum strain 601 μ strain. Strain gauge SG7 has -45 μ strain minimum deformation. Strain gauge SG8 has maximum strain 1159 μ strain and minimum strain -292 deformation. The residual strain for strain gauge SG7 and SG8 - 12, 4 respectively.

Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. More specifically strain gauge 17 has 33 μ strain maximum strain. Strain gauge 17 has minimum deformation -35 μ strain and strain gauge 18 - 17 μ strain. Finally strain gauge 18 presents 8 μ strain residual. Strain gauge 17 doesn't present residual.

The strain gauges shown in the figures 3.19.24, 3.19.25, 3.19.26, 3.19.27, 3.19.28, 3.19.29 and 3.19.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG9 has 1906 μ strain maximum strain, -78 μ strain minimum strain and -22 residual. Strain gauge SG11 has 995 μ strain maximum strain and minimum -157 μ strain deformation. The residual strain is 20 μ strain for strain gauge SG11. Strain gauge SG12 has 700 μ strain maximum strain and -37 μ strain minimum strain. The residual strain is -19 μ strain for strain gauge SG12. Strain gauge SG13 has maximum strain 23 μ strain, minimum -18 μ strain and 1 μ strain residual. Strain gauge SG14 has maximum strain 1072 μ strain and minimum strain -126 μ strain. The residual value is 20 μ strain. Finally strain gauges SG15 has maximum strain 1501 μ strain and minimum strain -237 μ strain. Strain gauge SG16 has maximum strain 687 μ strain, minimum strain -48 μ strain and residual strain 22 μ strain.

Strain gauge SG21 has 60 μ strain maximum strain, -73 μ strain minimum strain and 0 μ strain residual. Strain gauge SG22 has maximum 563 μ strain and minimum -414 μ strain. Strain gauge SG22 presents 7 μ strain residual. Strain gauge 20 has maximum strain 28 μ strain and minimum -75 μ strain. The residual strain for strain gauge SG20 is 26 μ strain.

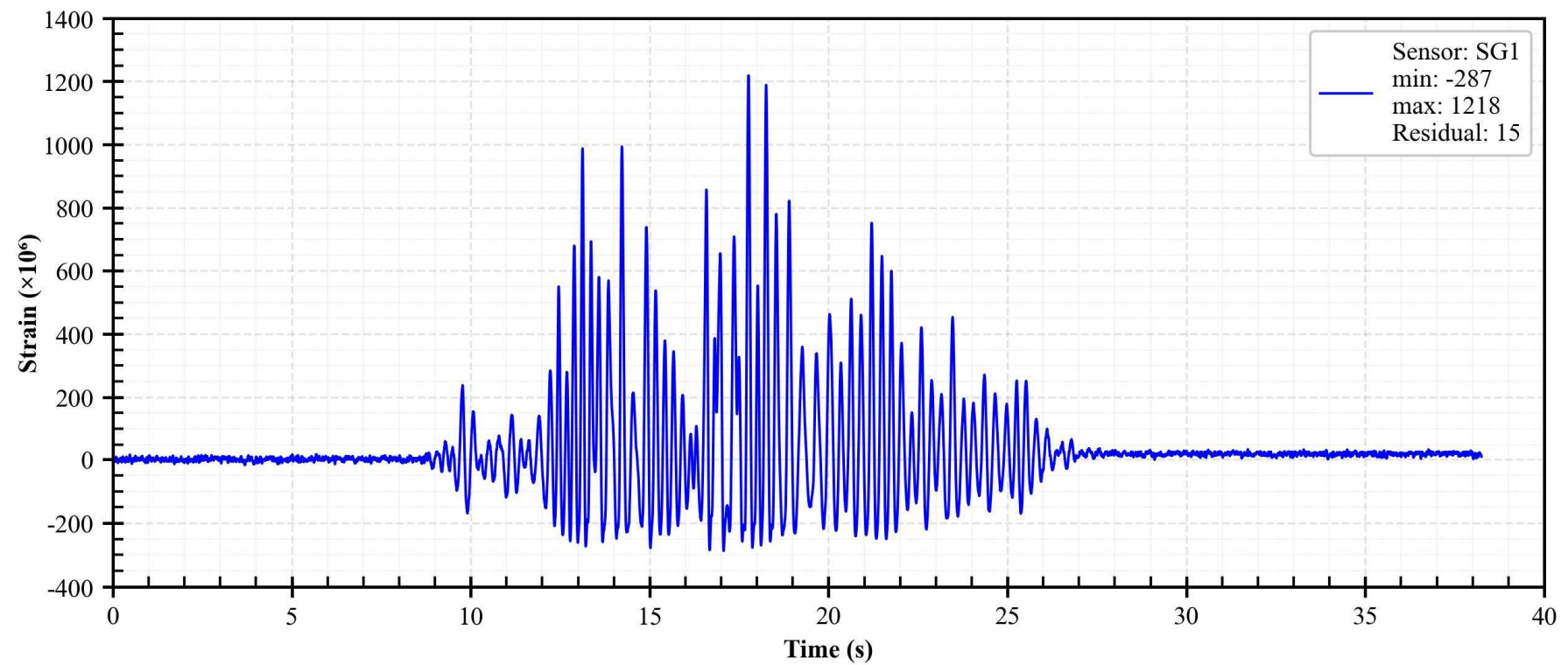


Figure 3.19.18 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 1

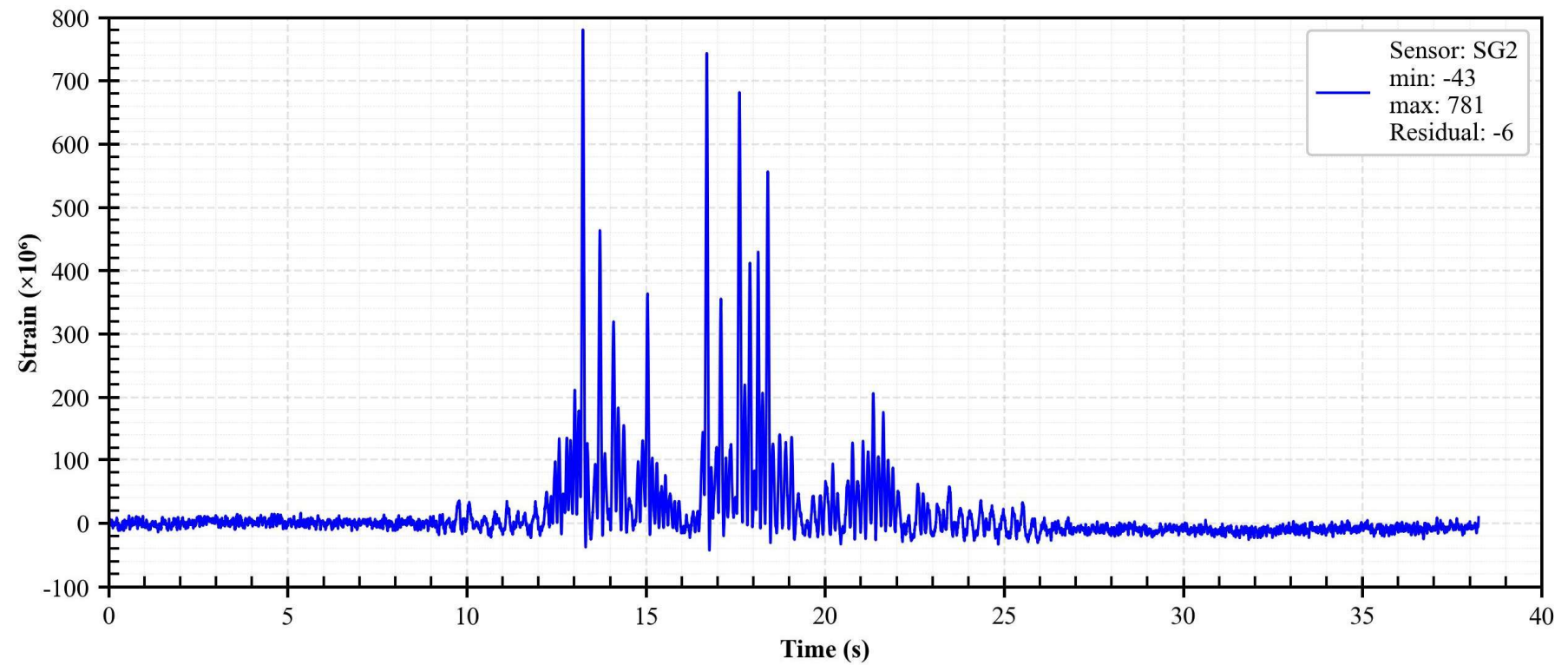


Figure 3.19.19 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 2

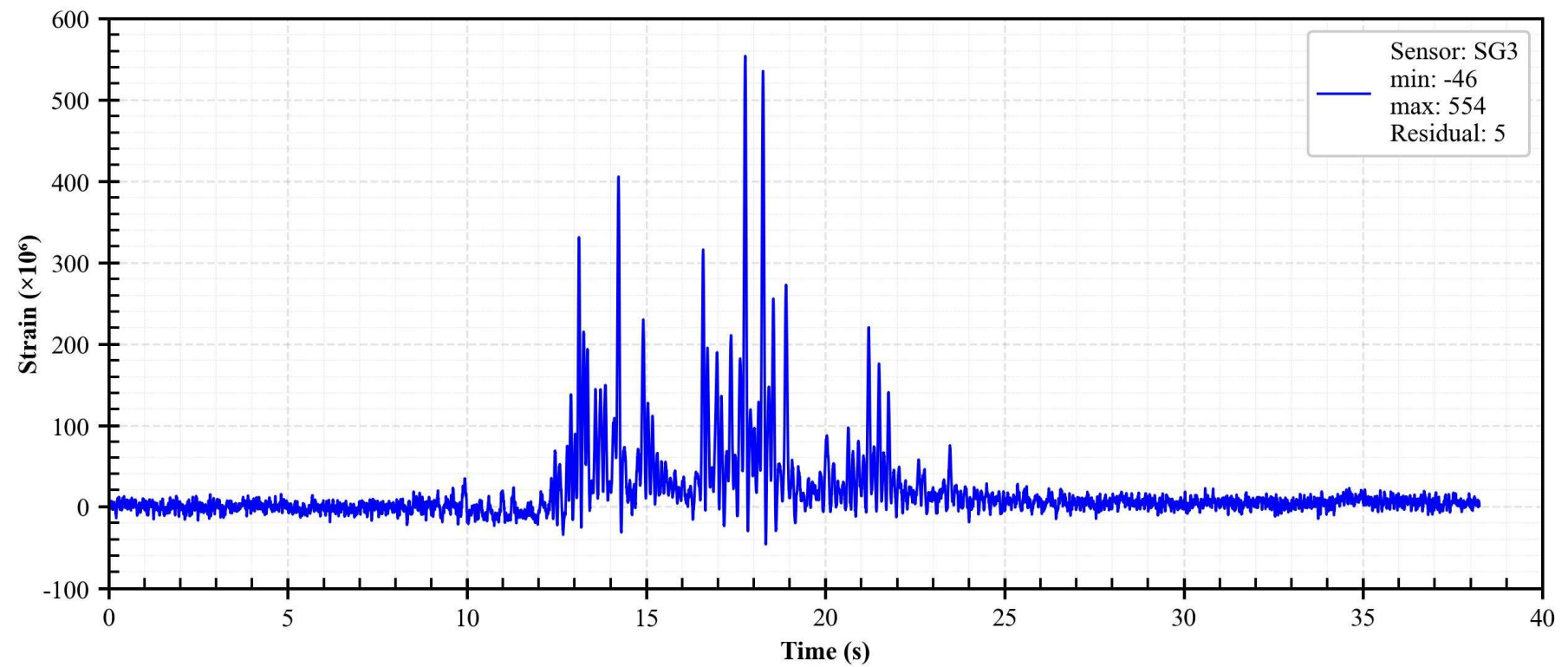


Figure 3.19.20 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 3

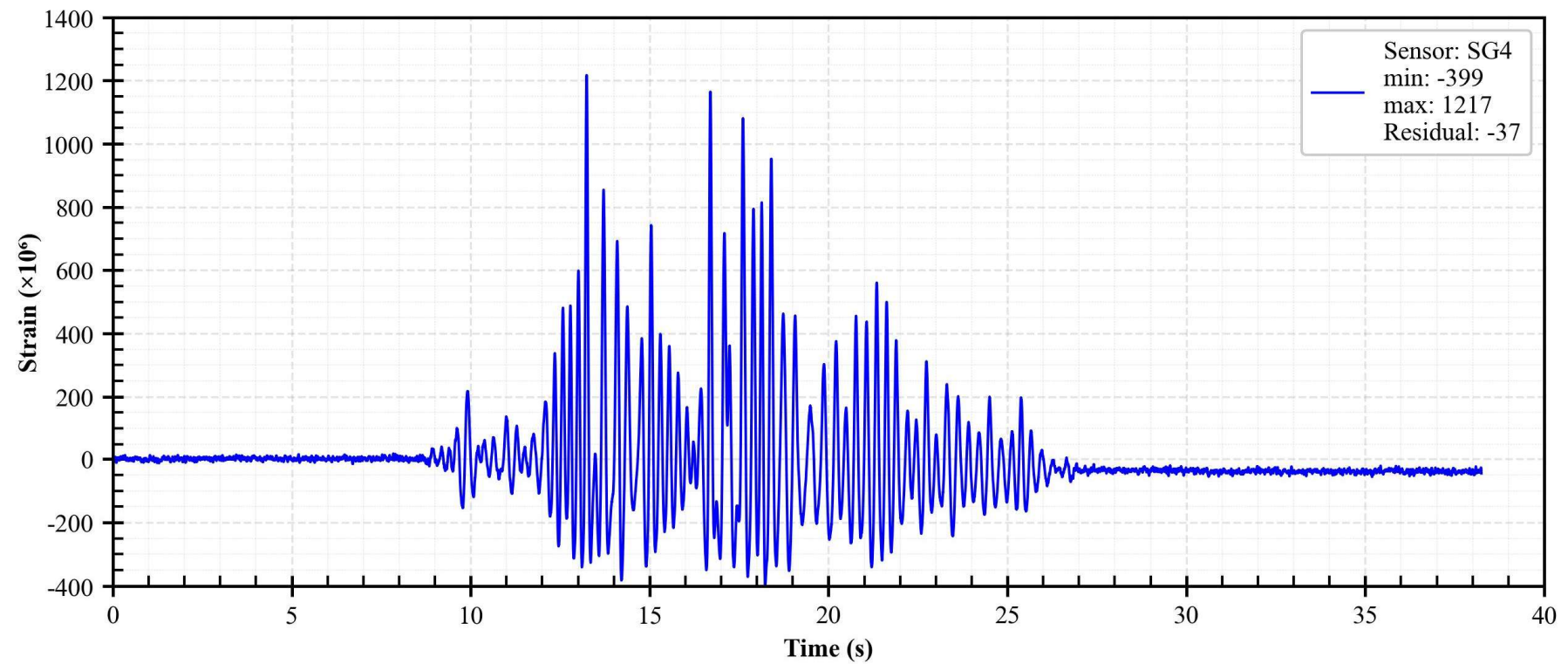


Figure 3.19.21 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 4

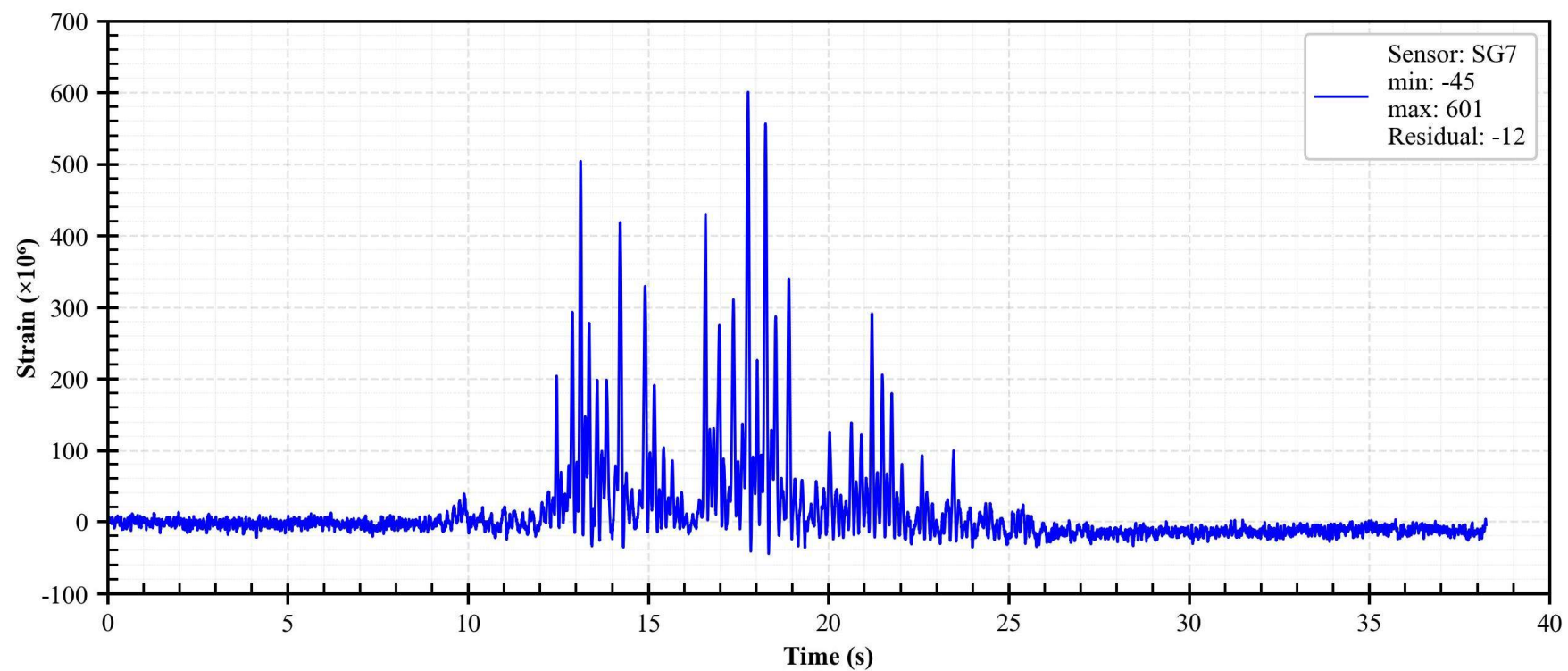


Figure 3.19.22 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 7

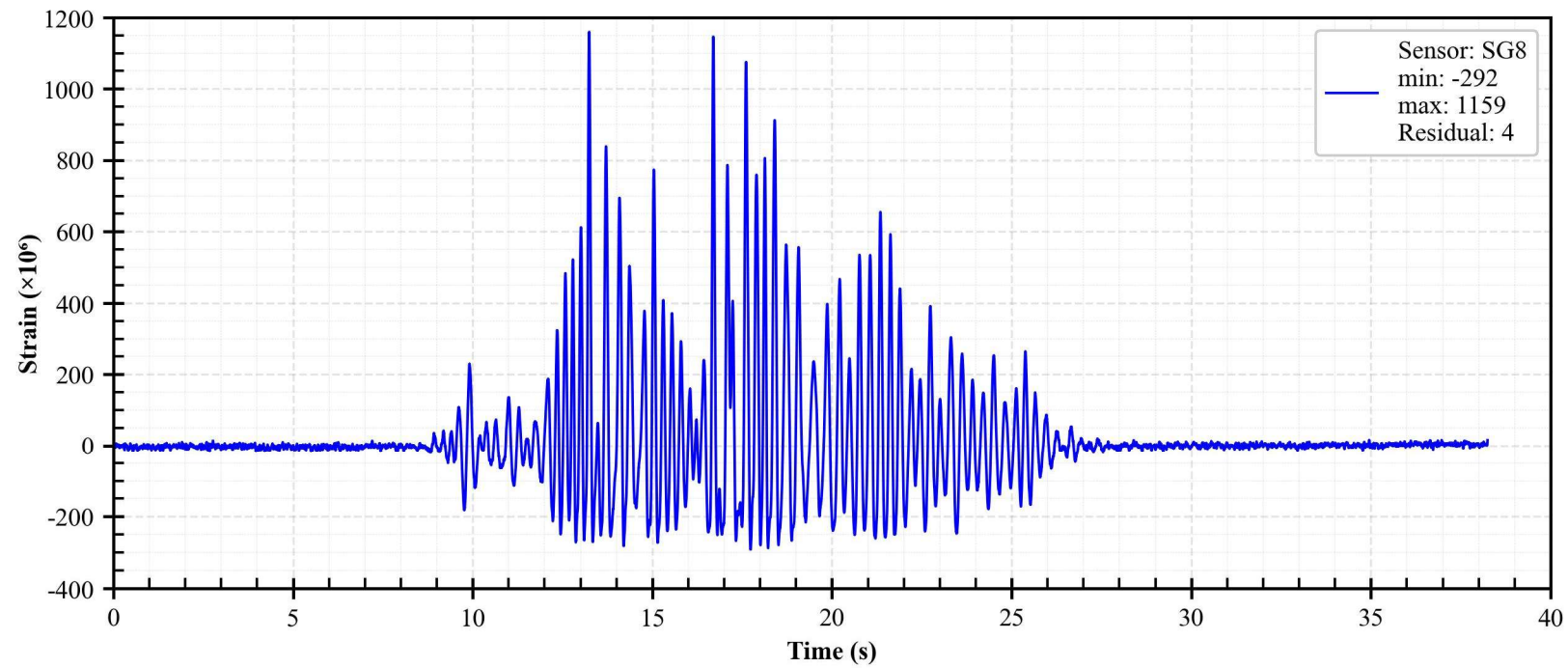


Figure 3.19.23 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 8

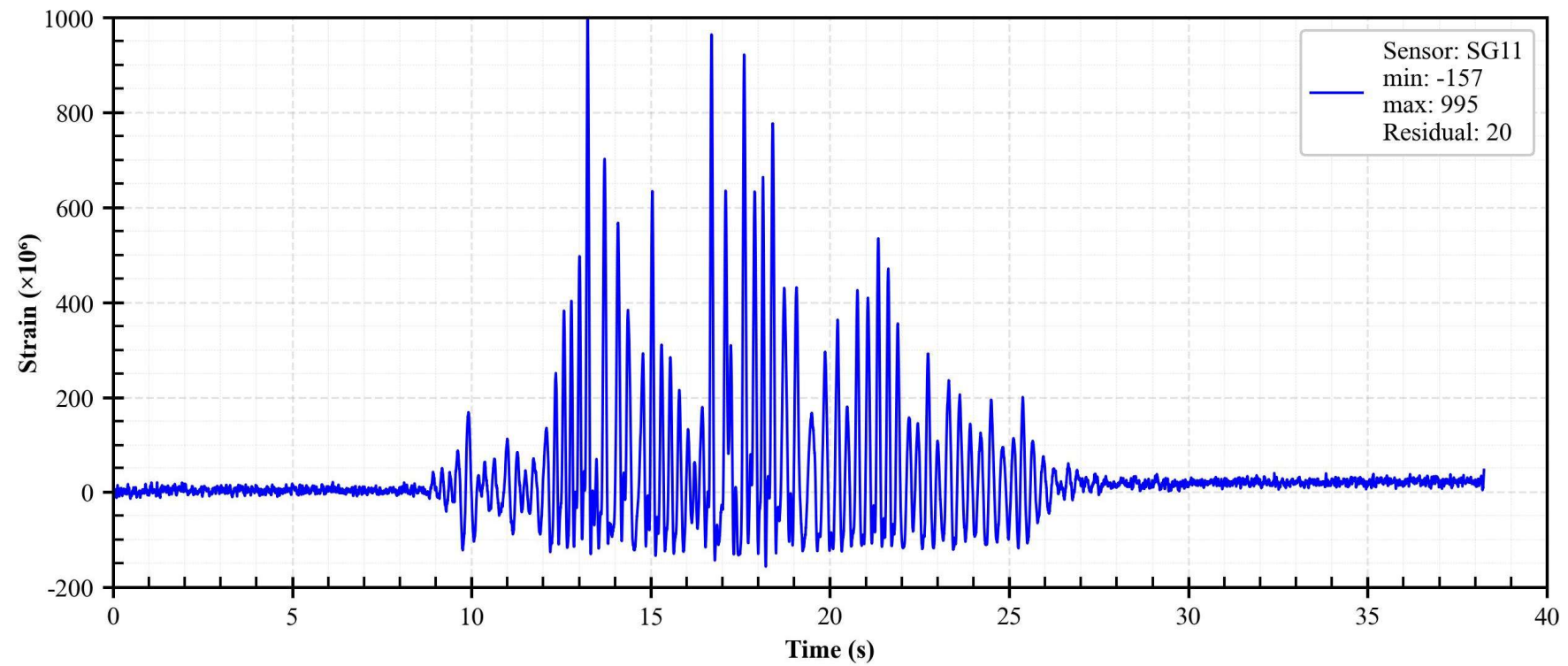


Figure 3.19.24 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 11

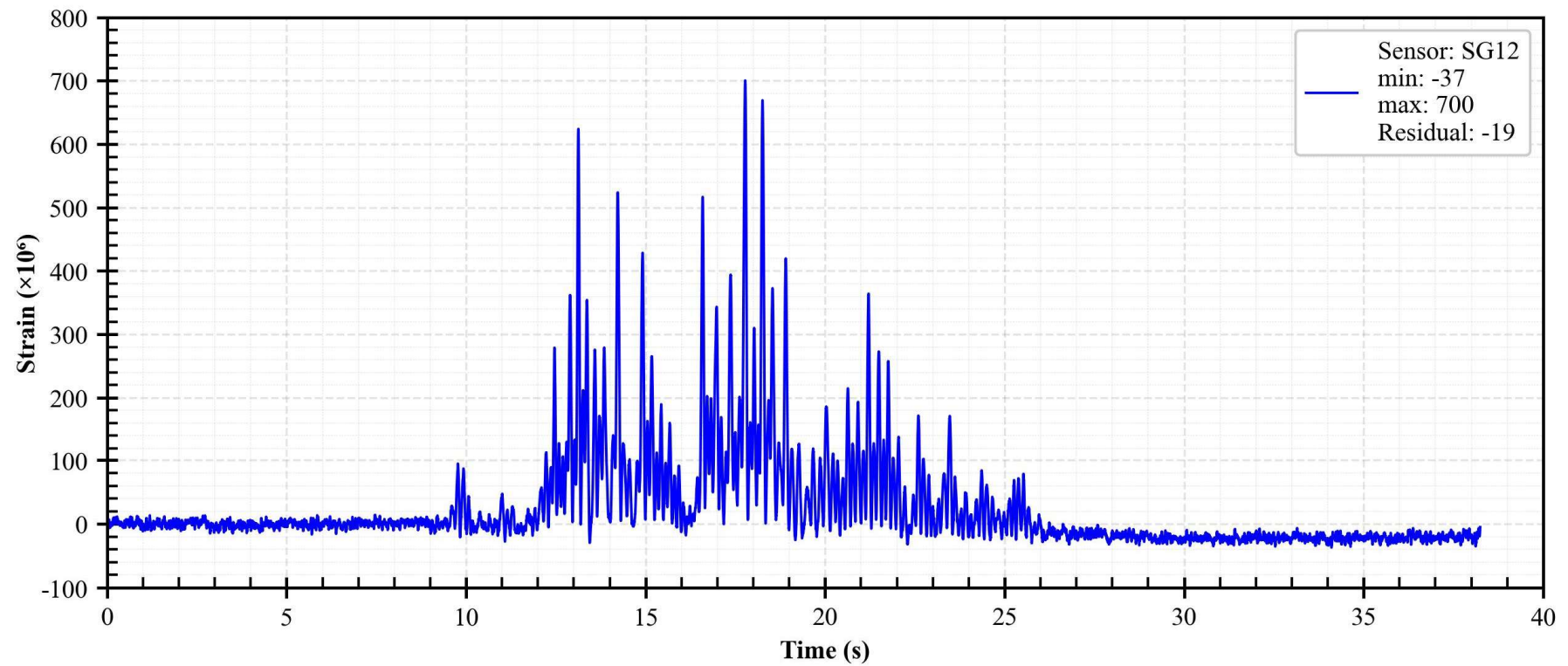


Figure 3.19.25 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 12

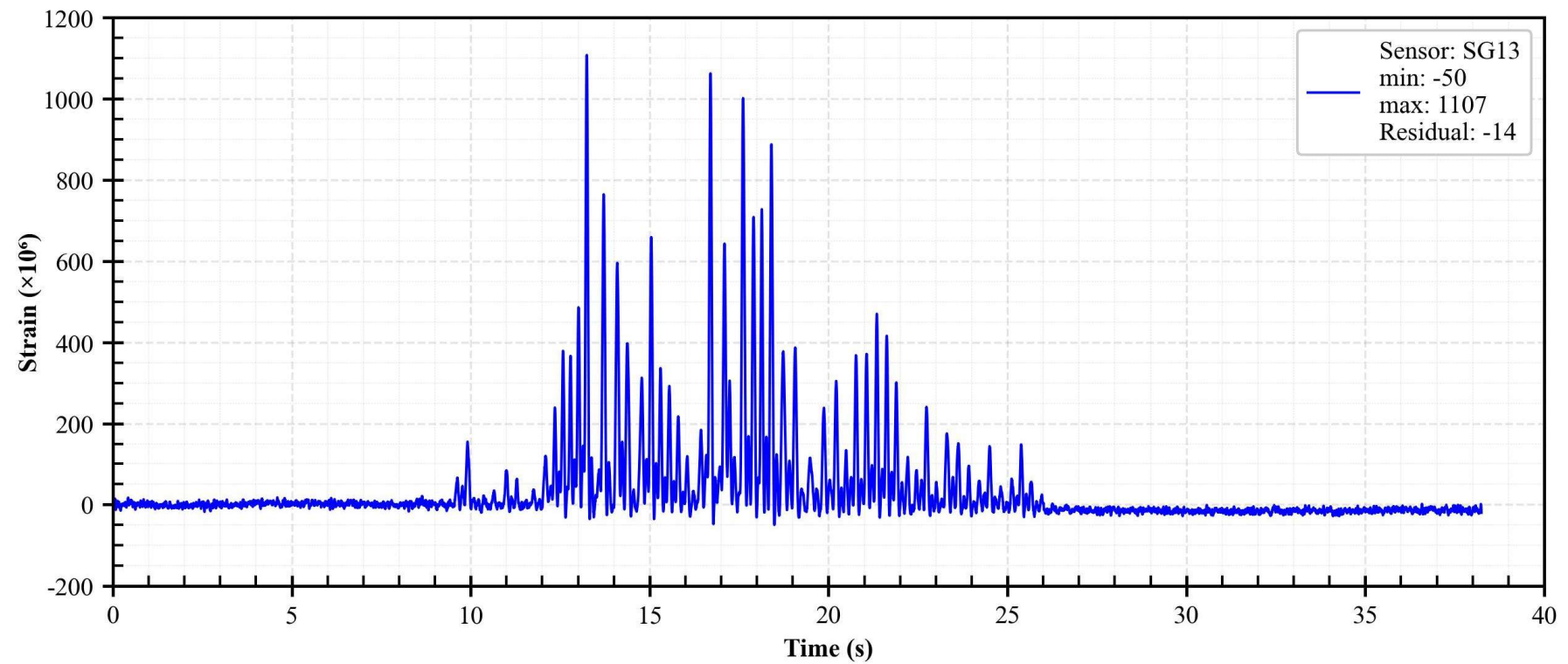


Figure 3.19.26 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 13

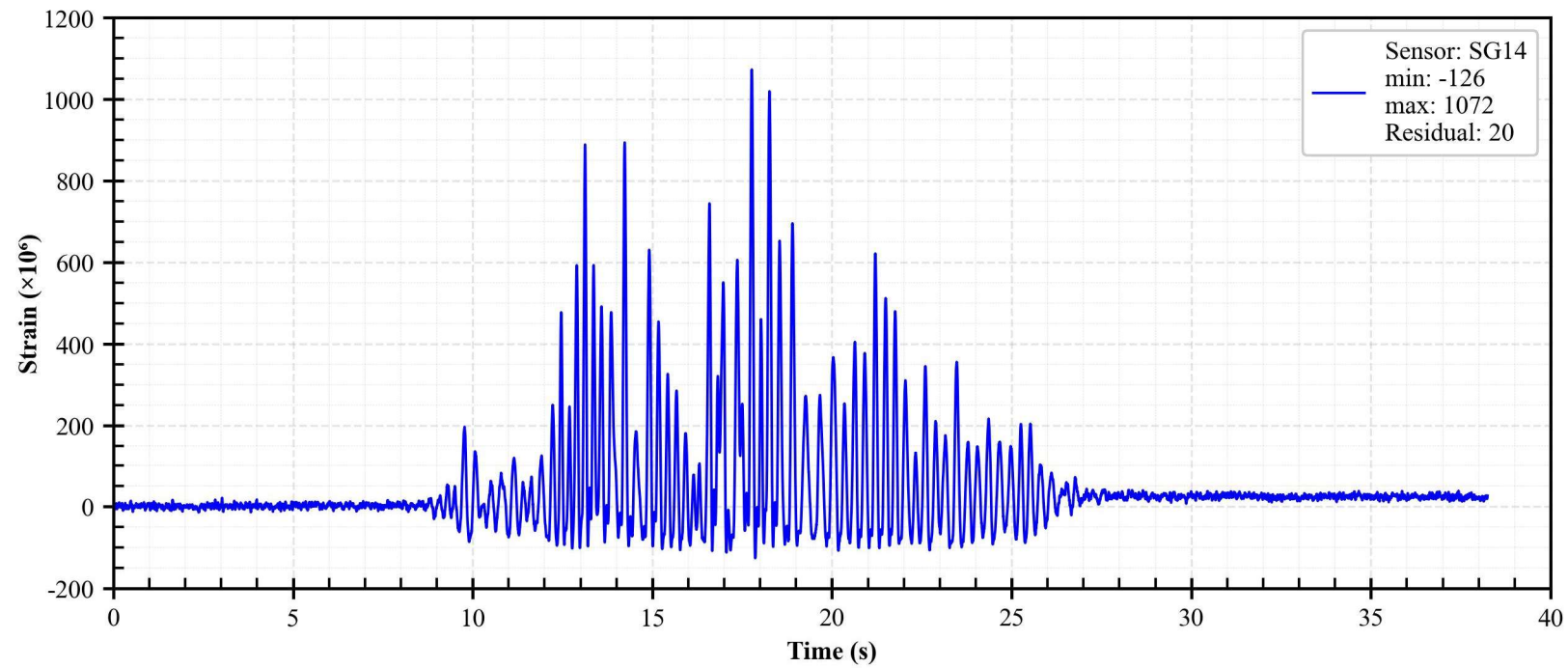


Figure 3.19.27 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 14

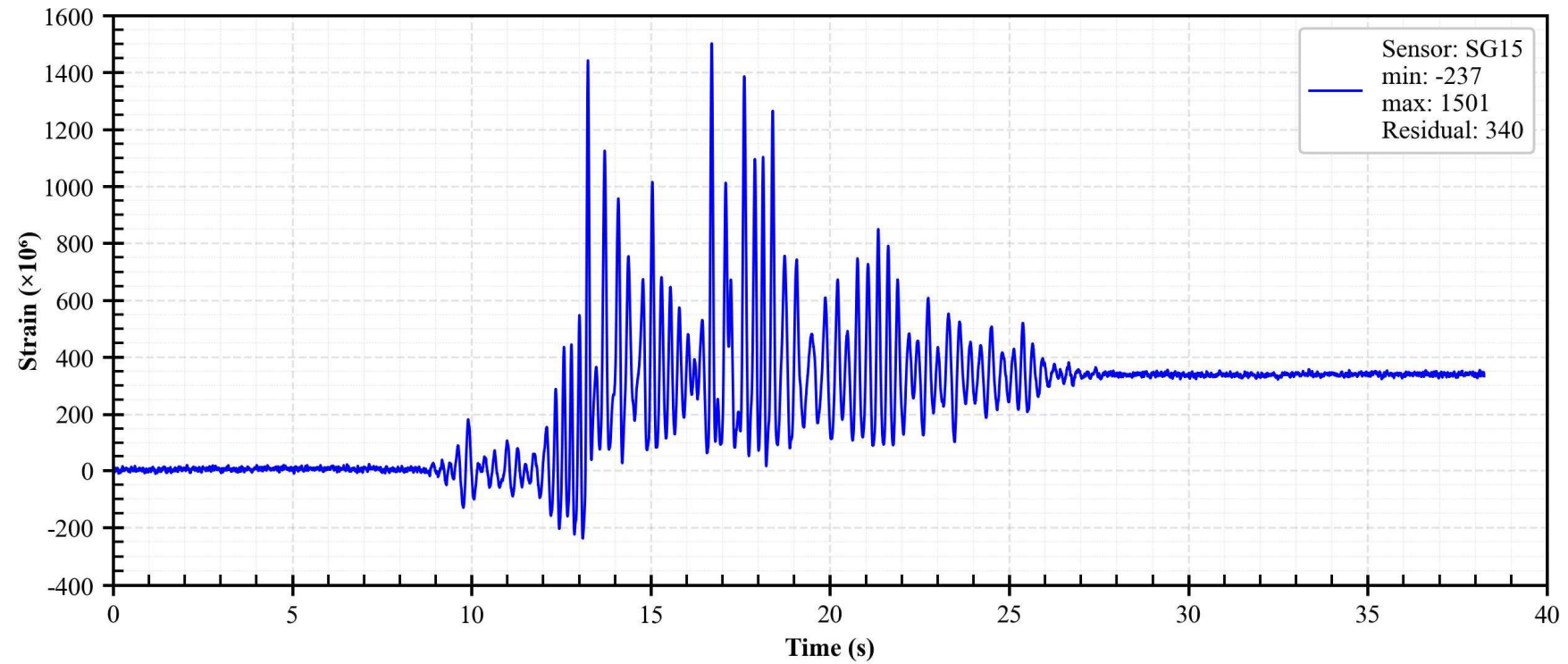


Figure 3.19.28 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 15

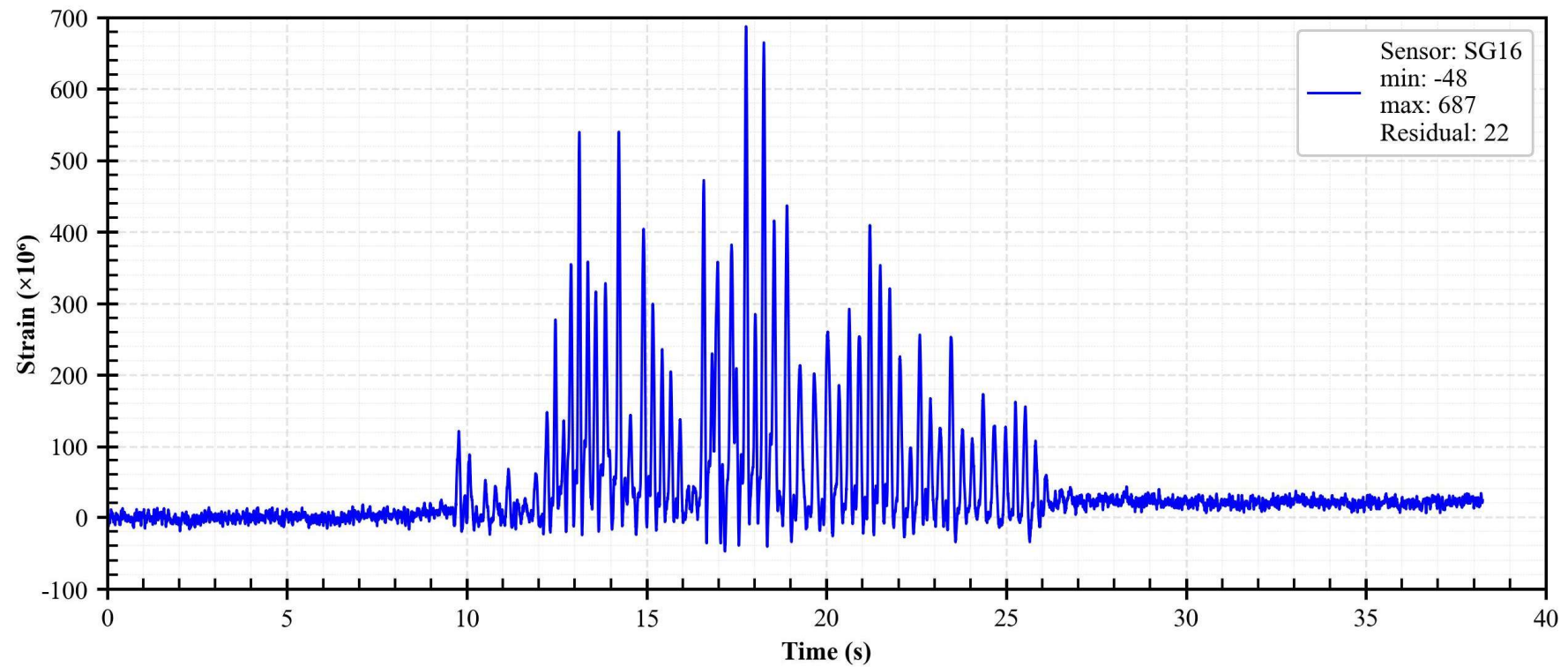


Figure 3.19.29 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 16

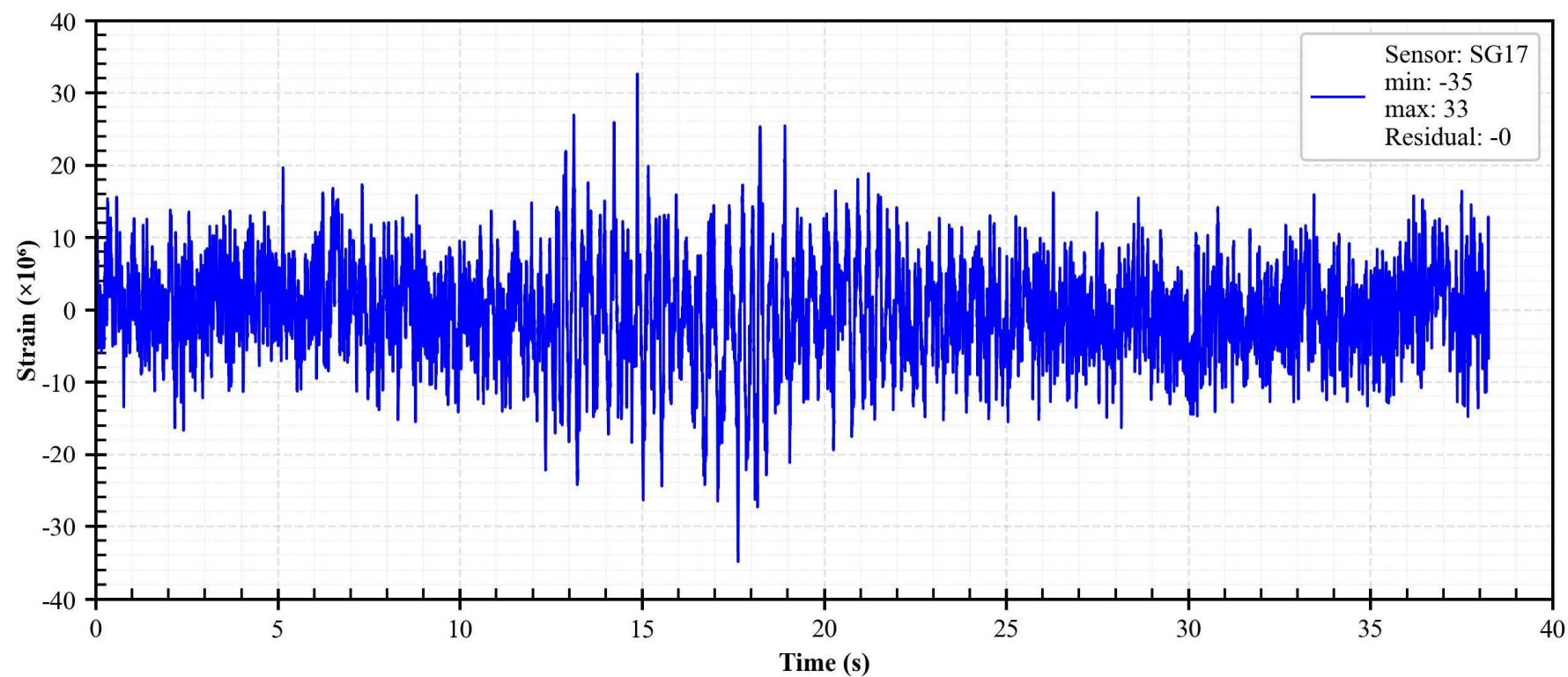


Figure 3.19.30 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 17

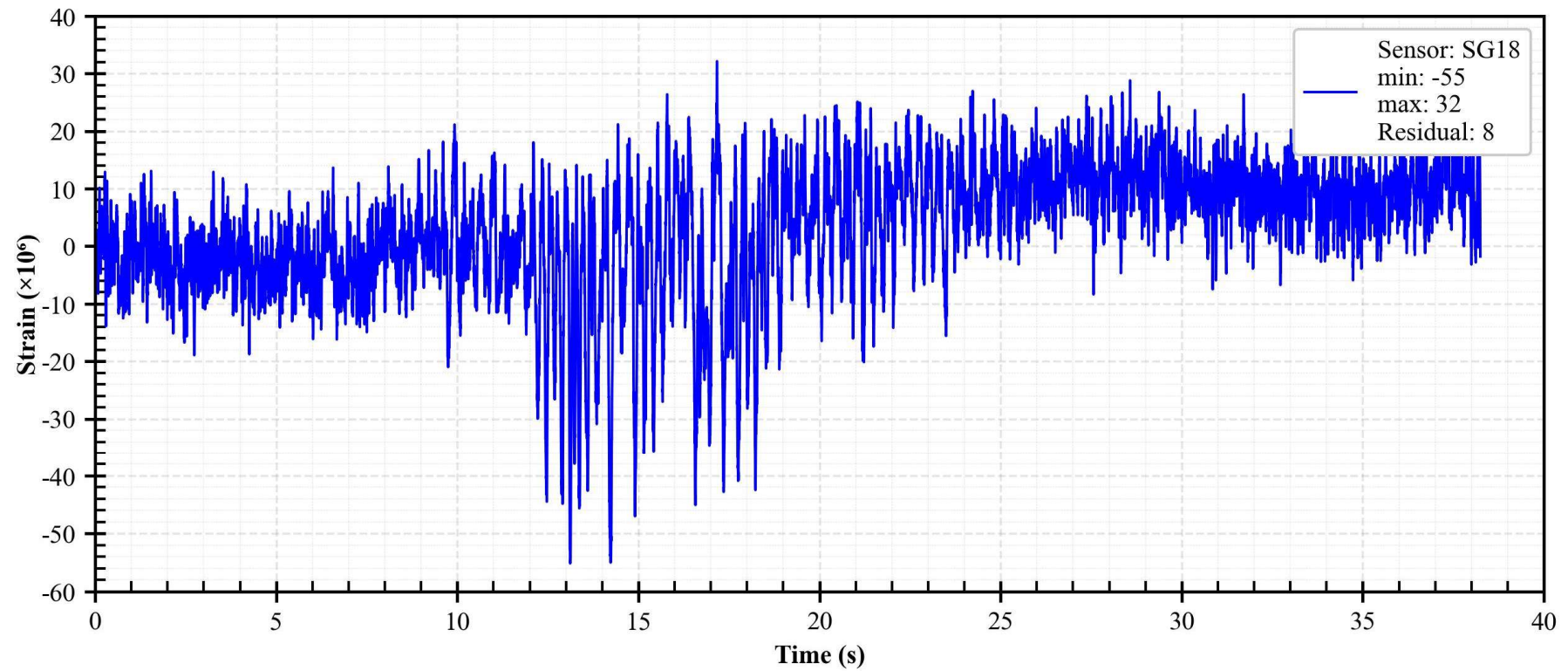


Figure 3.19.31 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 18

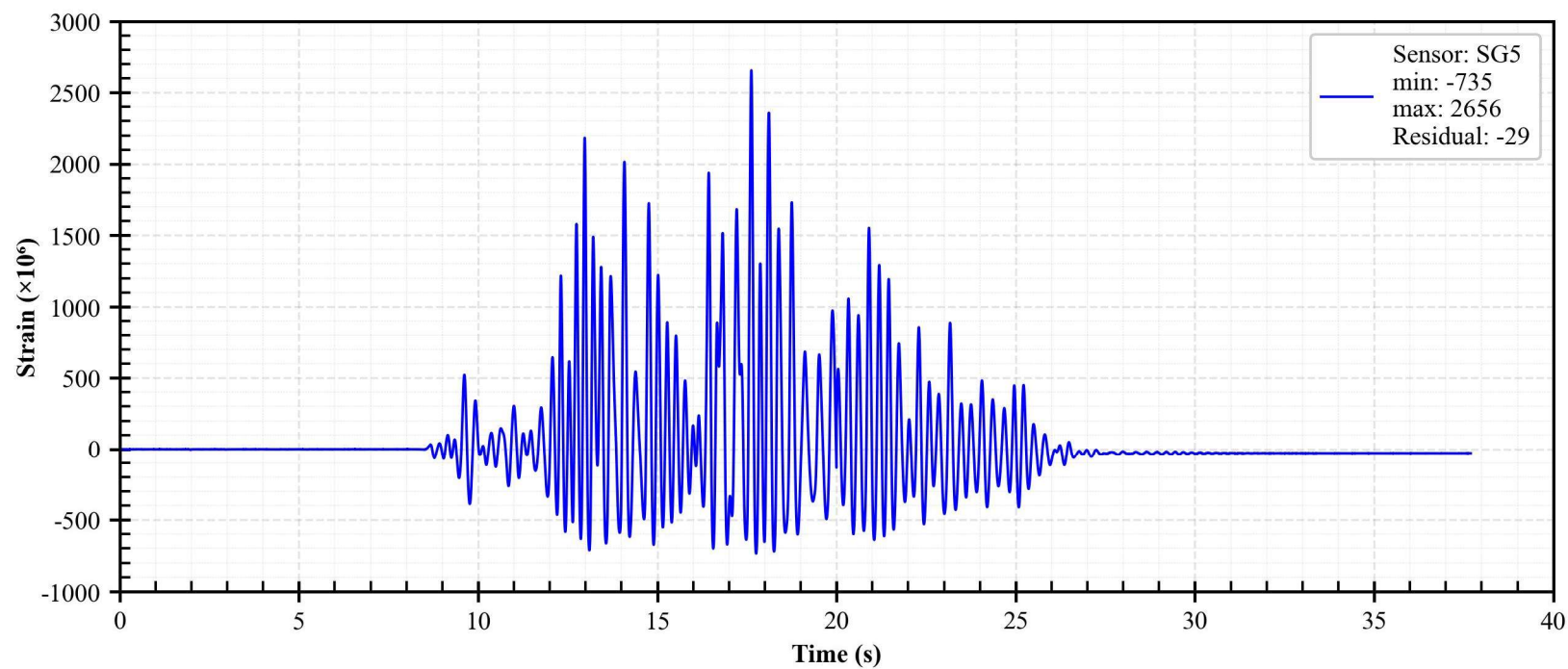


Figure 3.19.32 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 5

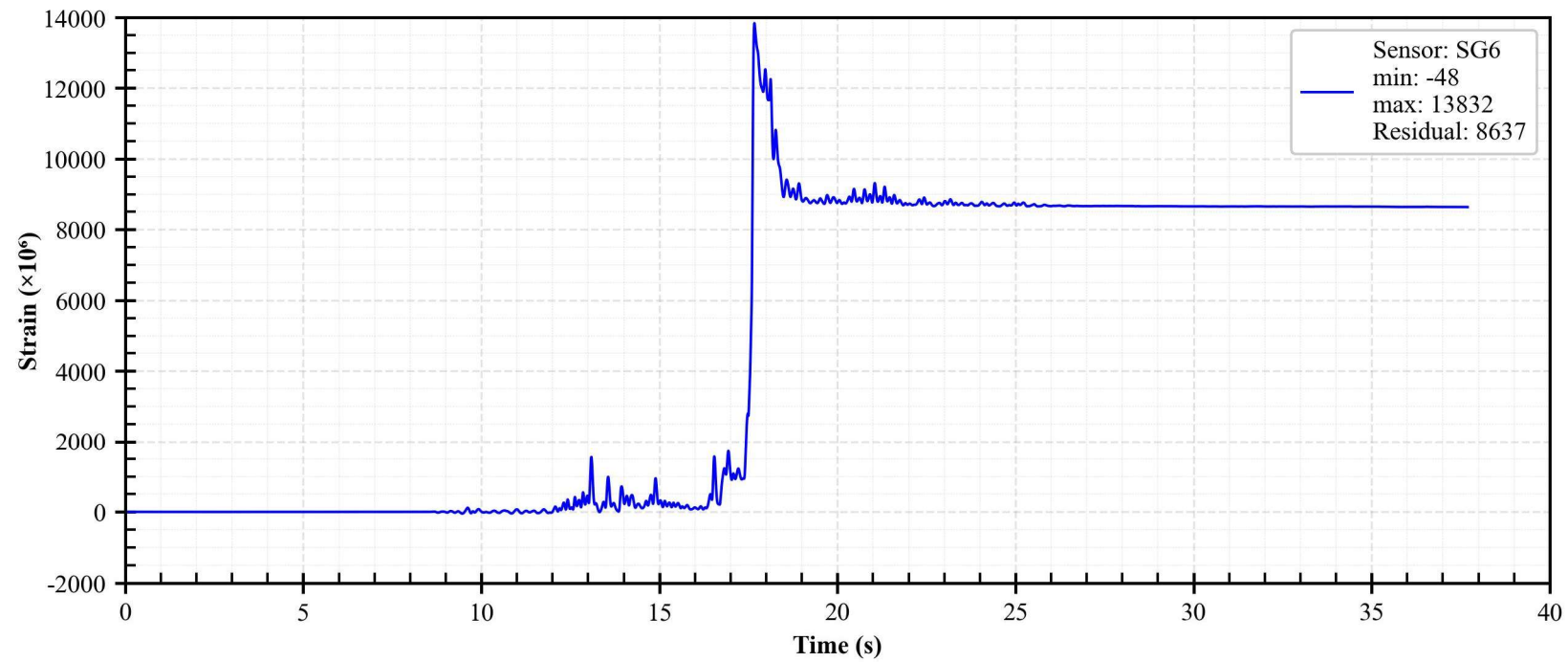


Figure 3.19.33 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 6

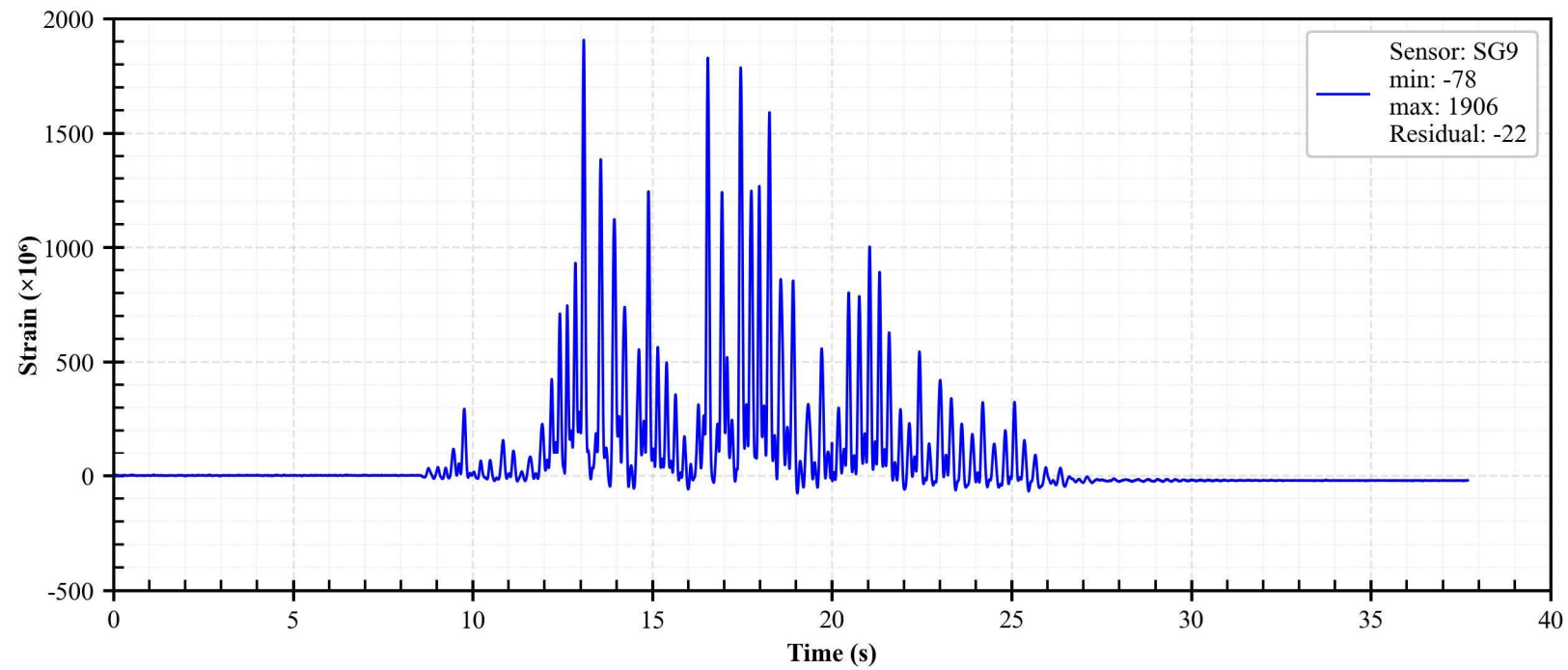


Figure 3.19.34 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 9

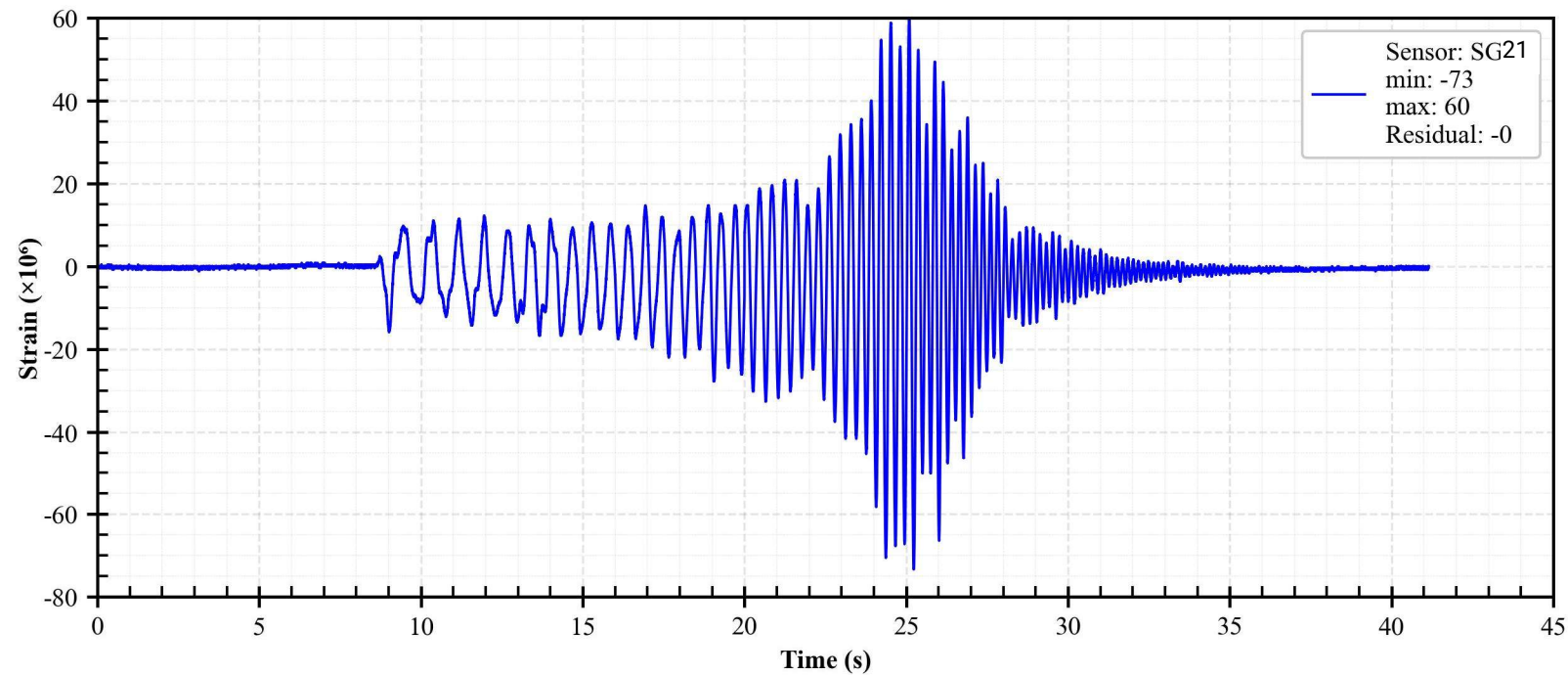


Figure 3.19.35 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 21 (PUFJ, column 1)

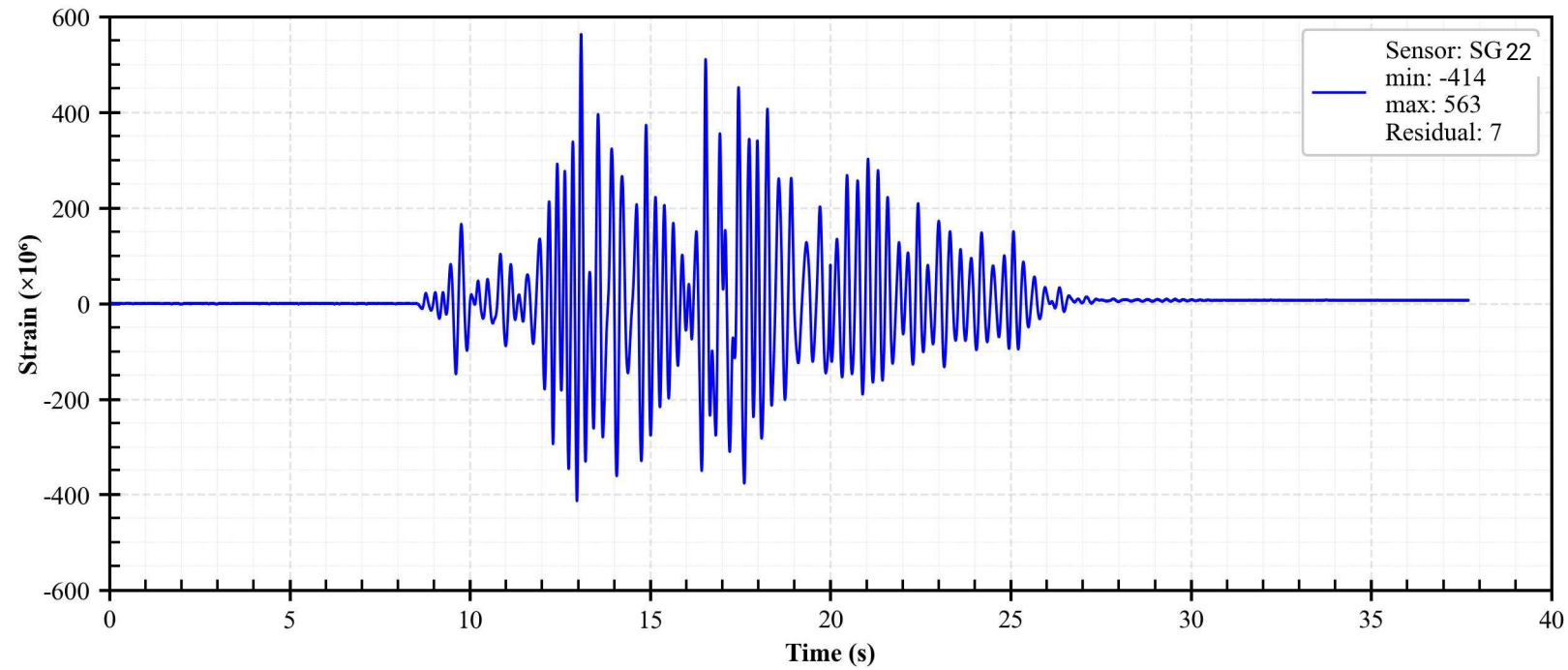


Figure 3.19.36 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 22 (PUFJ, column 2)

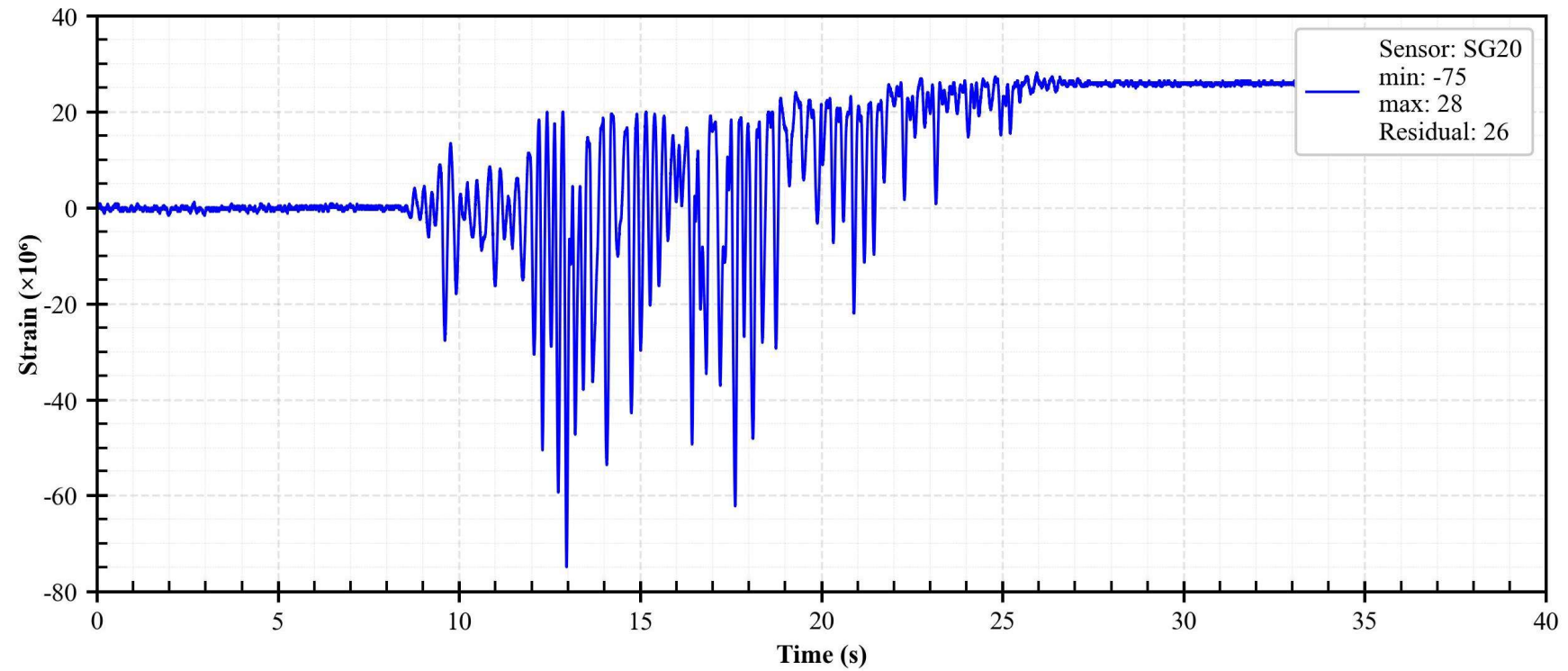


Figure 3.19.37 Characteristic results for phase B (earthquake EQ1,1g): strain gauge 20

3.20 White noise before EQ1,3g

Accelerometers

Characteristic extracts from the time history of accelerations of different of different accelerometers are given below for white noise before earthquake EQ1,3g. The max acceleration at the slab level on the accelerometer acc4 is 0.19g. The max acceleration at the foundation level on the accelerometer acc10 is 0.08g.

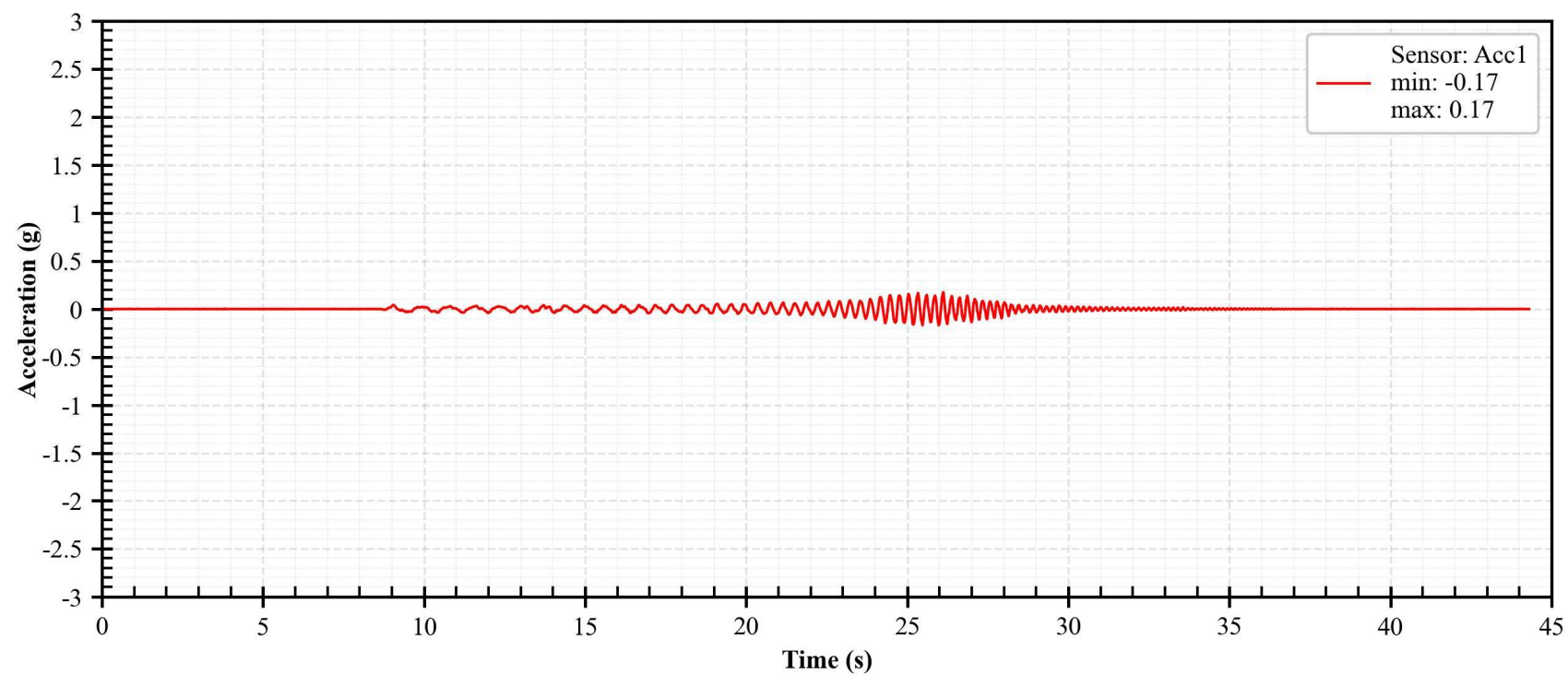


Figure 3.20.1 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 1

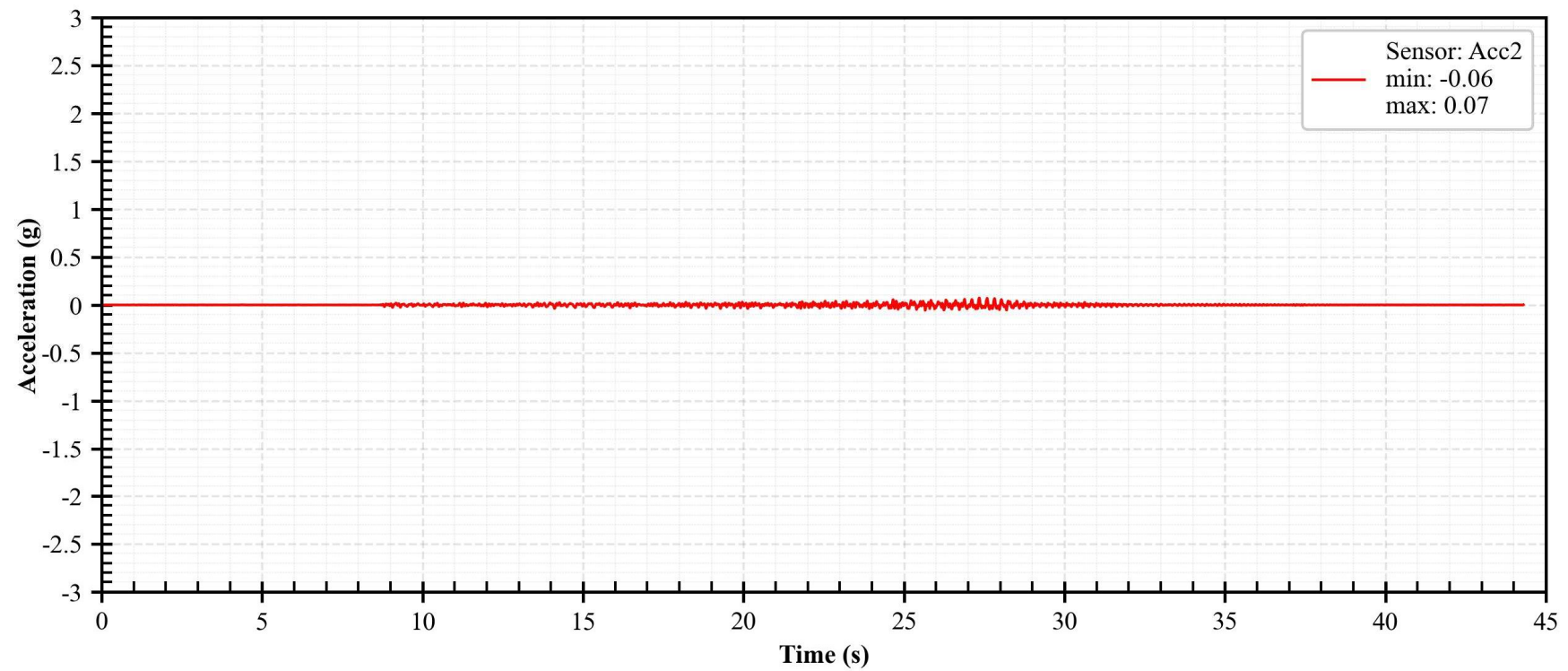


Figure 3.20.2 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 2

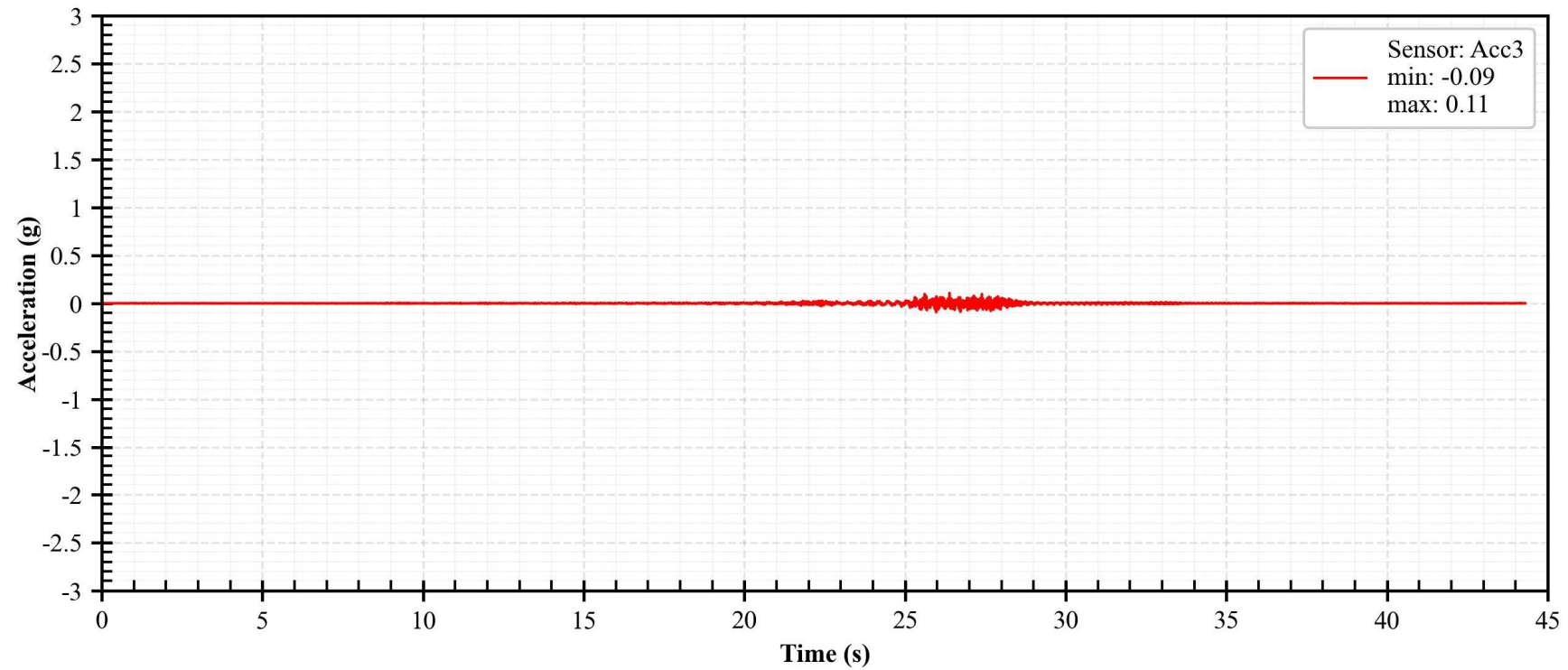


Figure 3.20.3 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 3

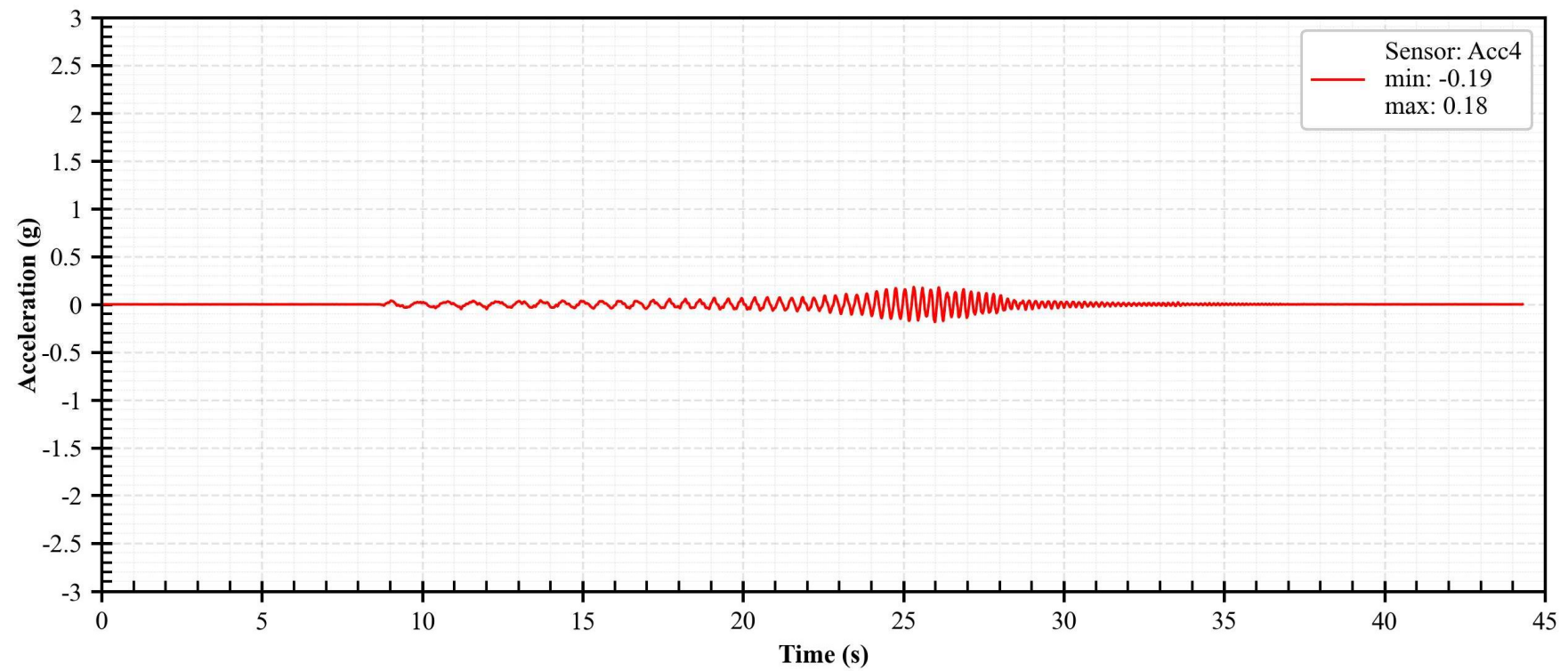


Figure 3.20.4 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 4

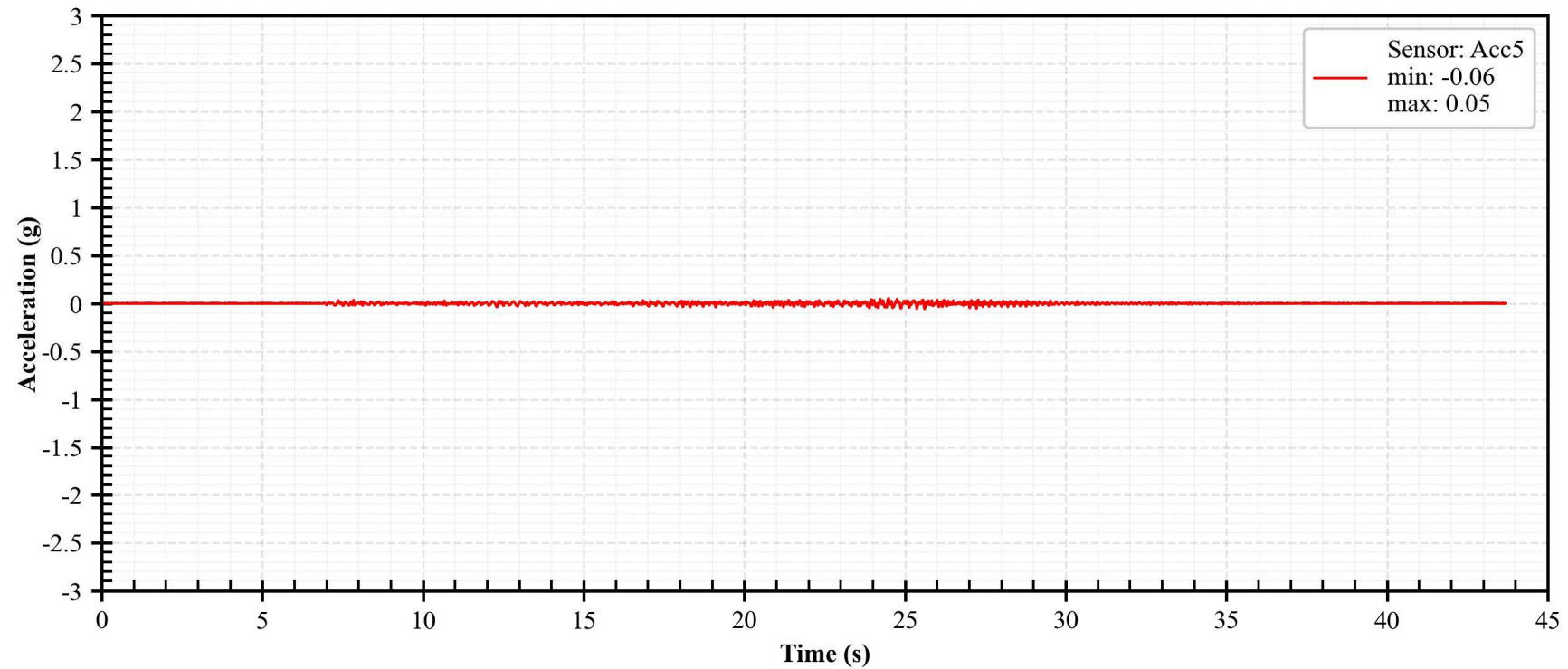


Figure 3.20.5 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 5

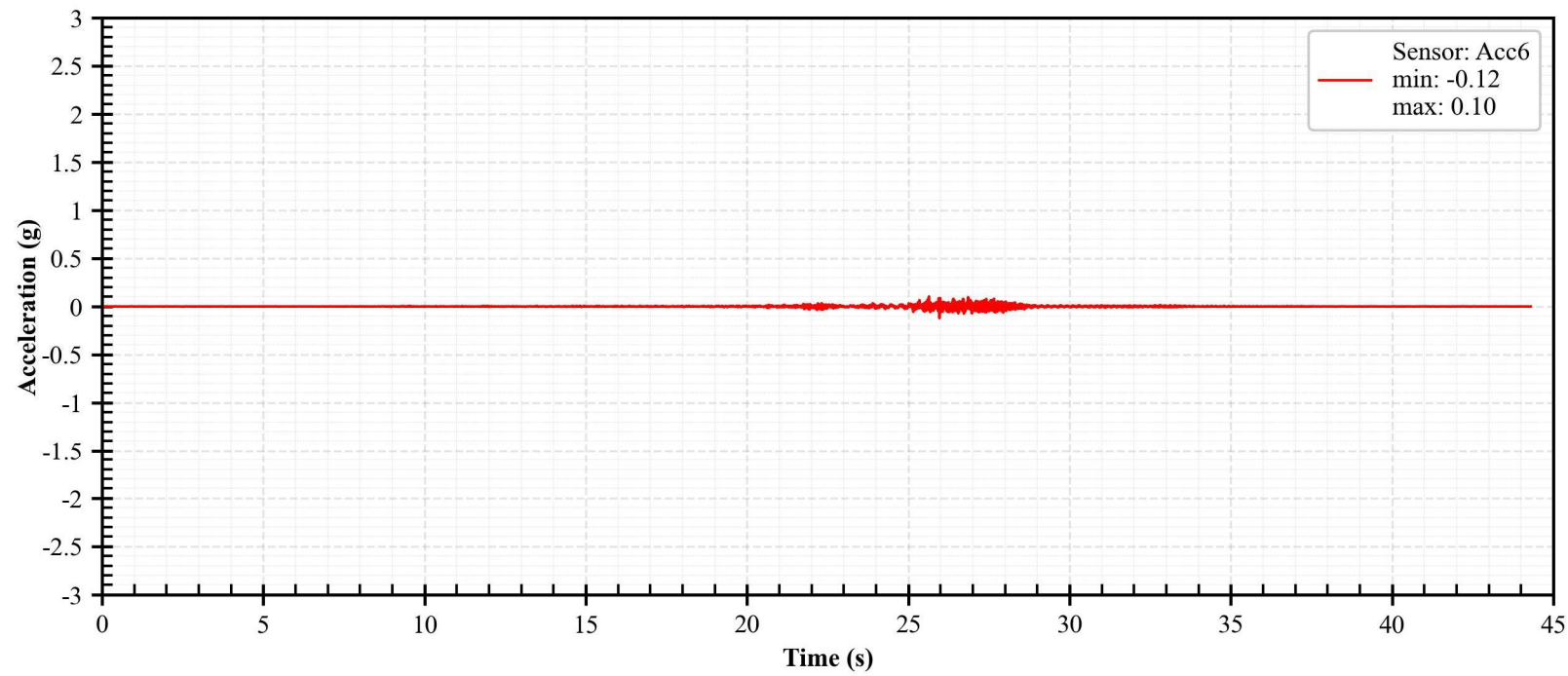


Figure 3.20.6 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 6

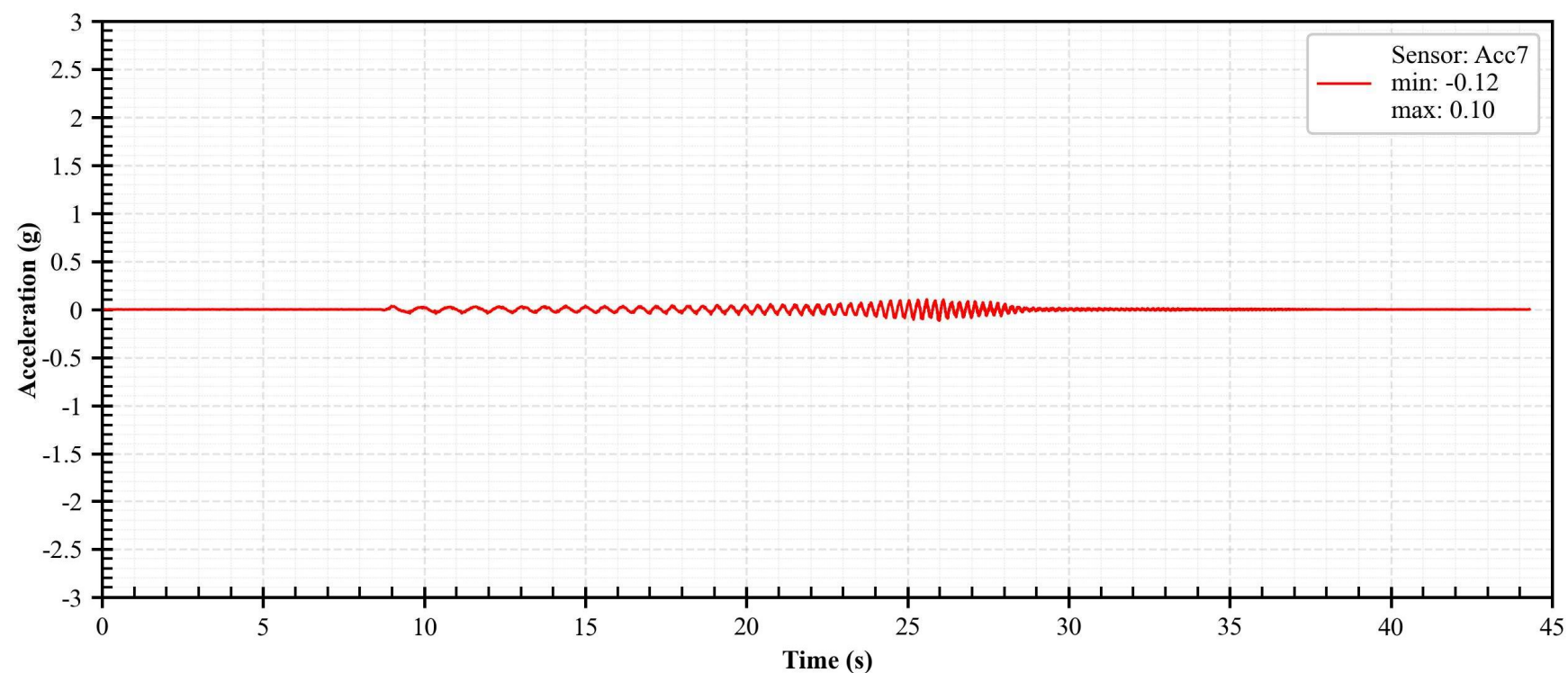


Figure 3.20.7 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 7

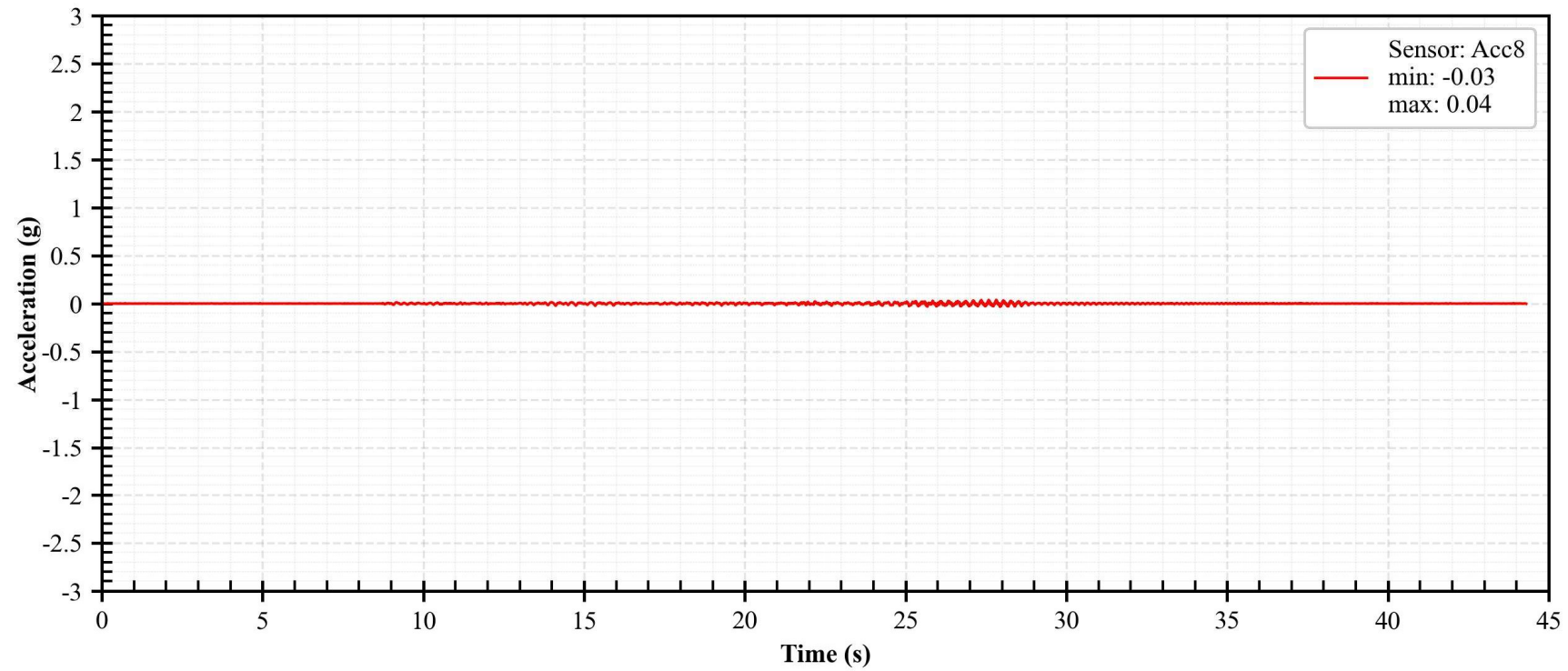


Figure 3.20.8 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 8

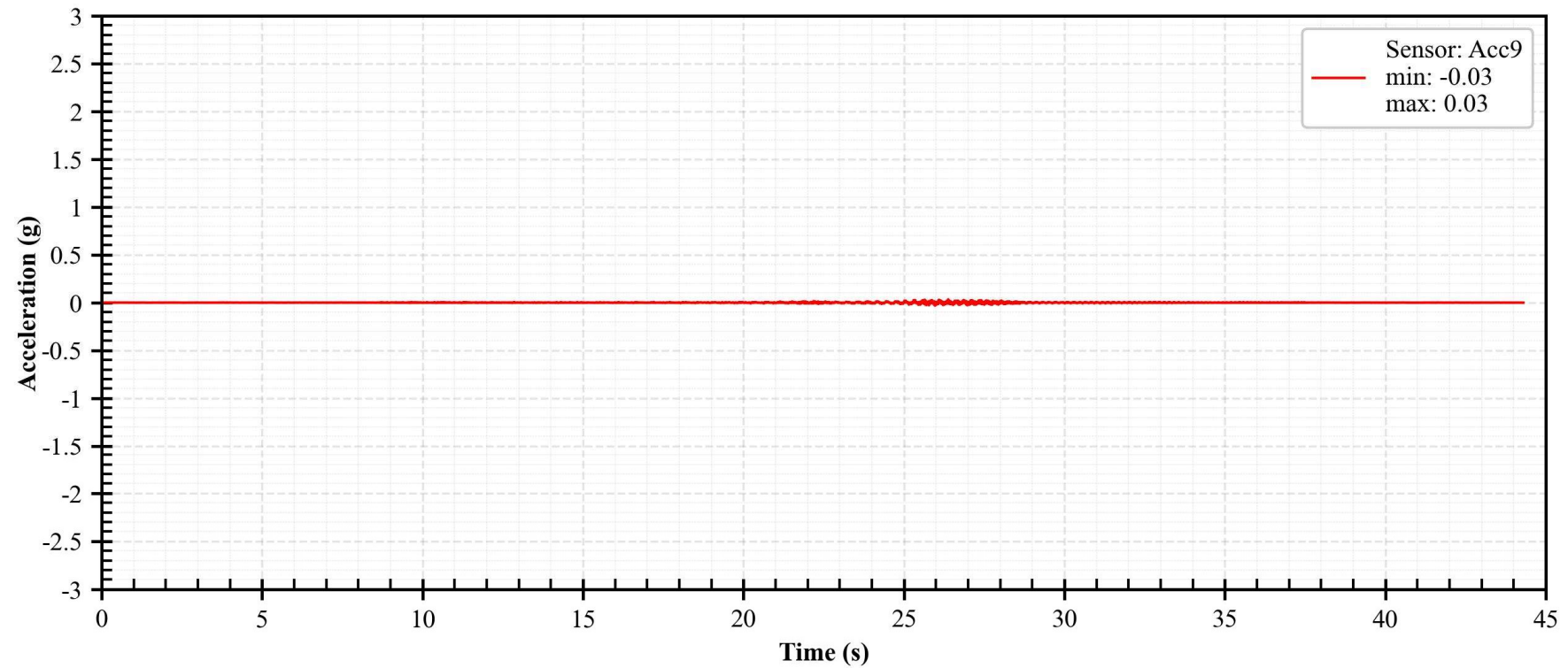


Figure 3.20.9 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 9

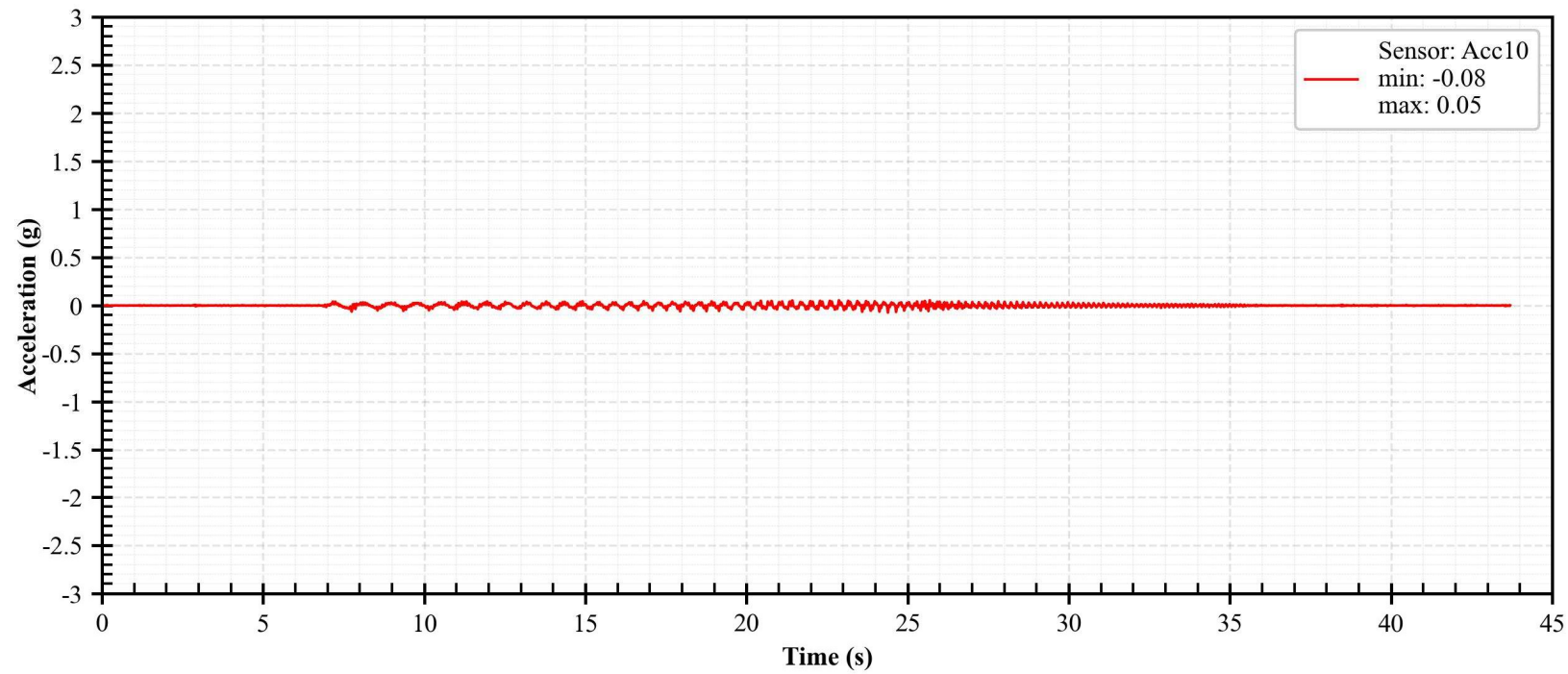


Figure 3.20.10 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 10

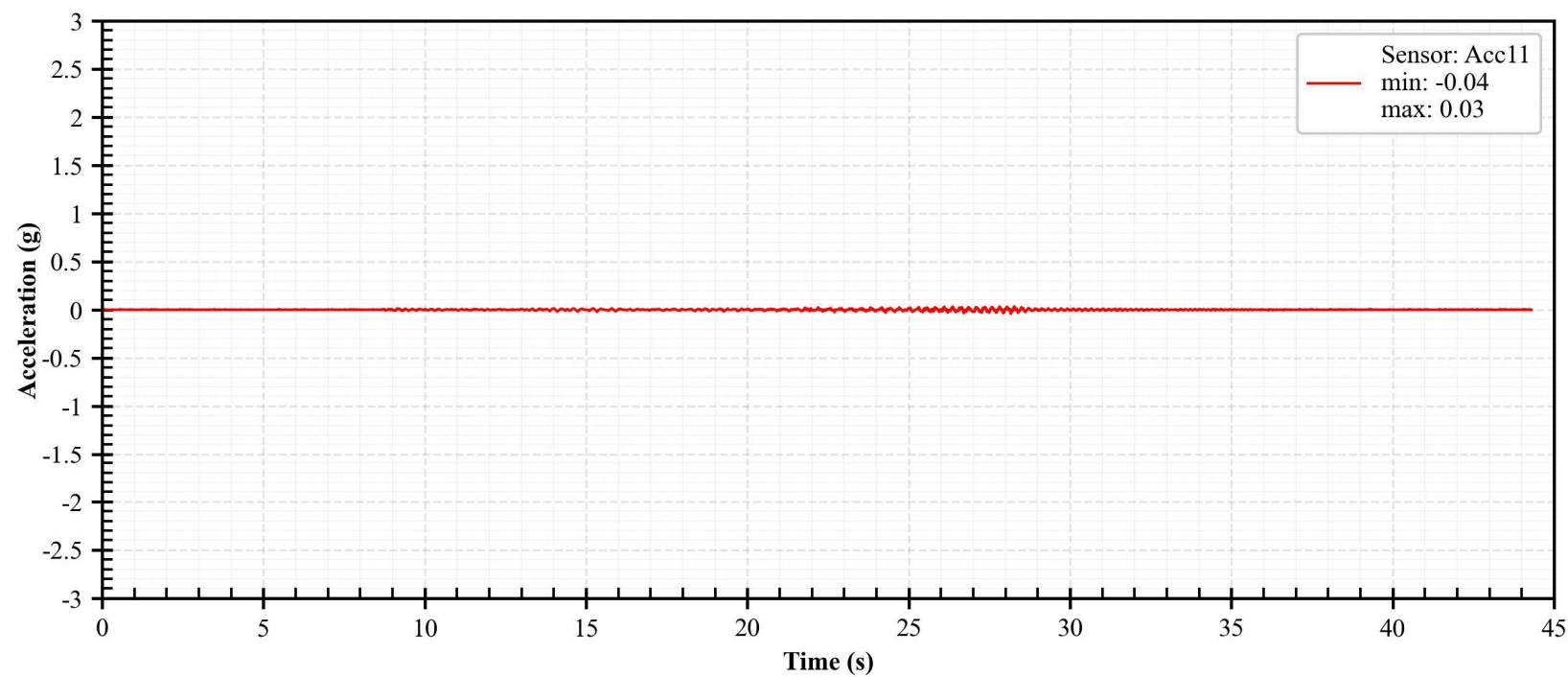


Figure 3.20.11 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 11

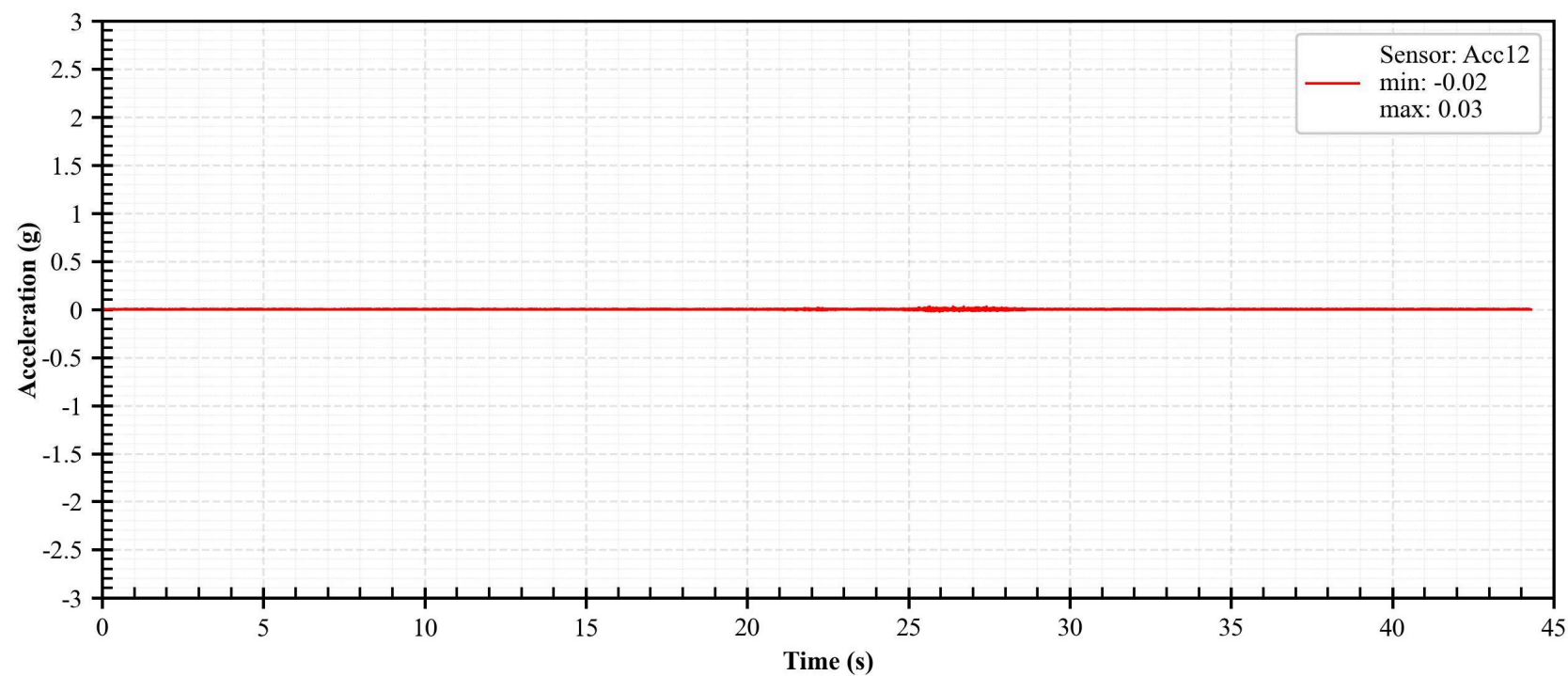


Figure 3.20.12 Characteristic results for phase B (white noise before EQ1,3g): Accelerometer 12

Draw wire sensors

Figures 3.20.13 – 3.20.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.28 mm while the minimum is -16.41 mm. The maximum movement detected by draw wire sensor W2 is 21.32 mm while the minimum is -16.59 mm. The maximum movement detected by draw wire sensor W3 is 21.13 mm while the minimum is -16.25 mm. The maximum movement detected by draw wire sensor W4 is 21.19 mm while the minimum is -16.32 mm. The maximum drift is $(2.35/1.225) = 1.92 \text{ ‰}$ and minimum drift is $(-2.44/1.225) = -1.99 \text{ ‰}$.

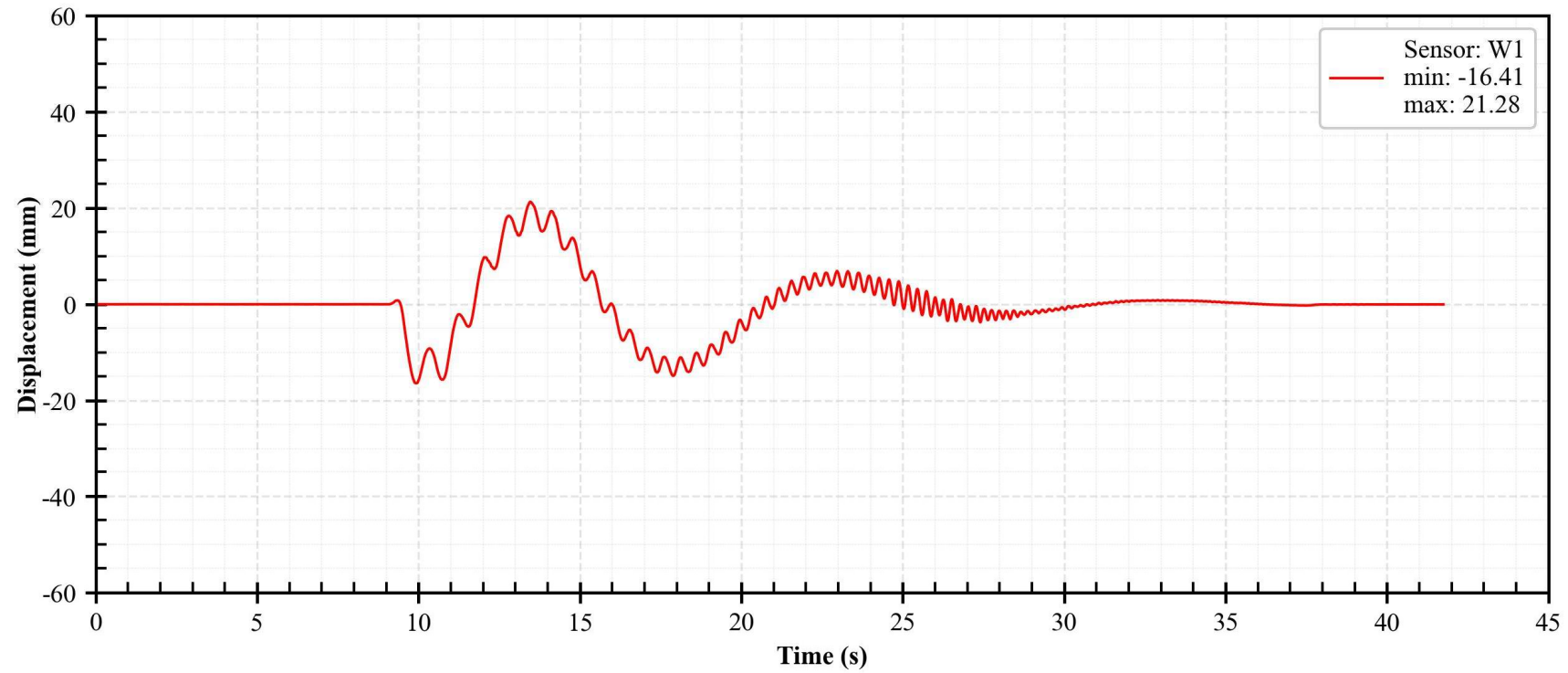


Figure 3.20.13 Characteristic results for phase B (white noise before EQ1,3g): Draw wire sensor 1

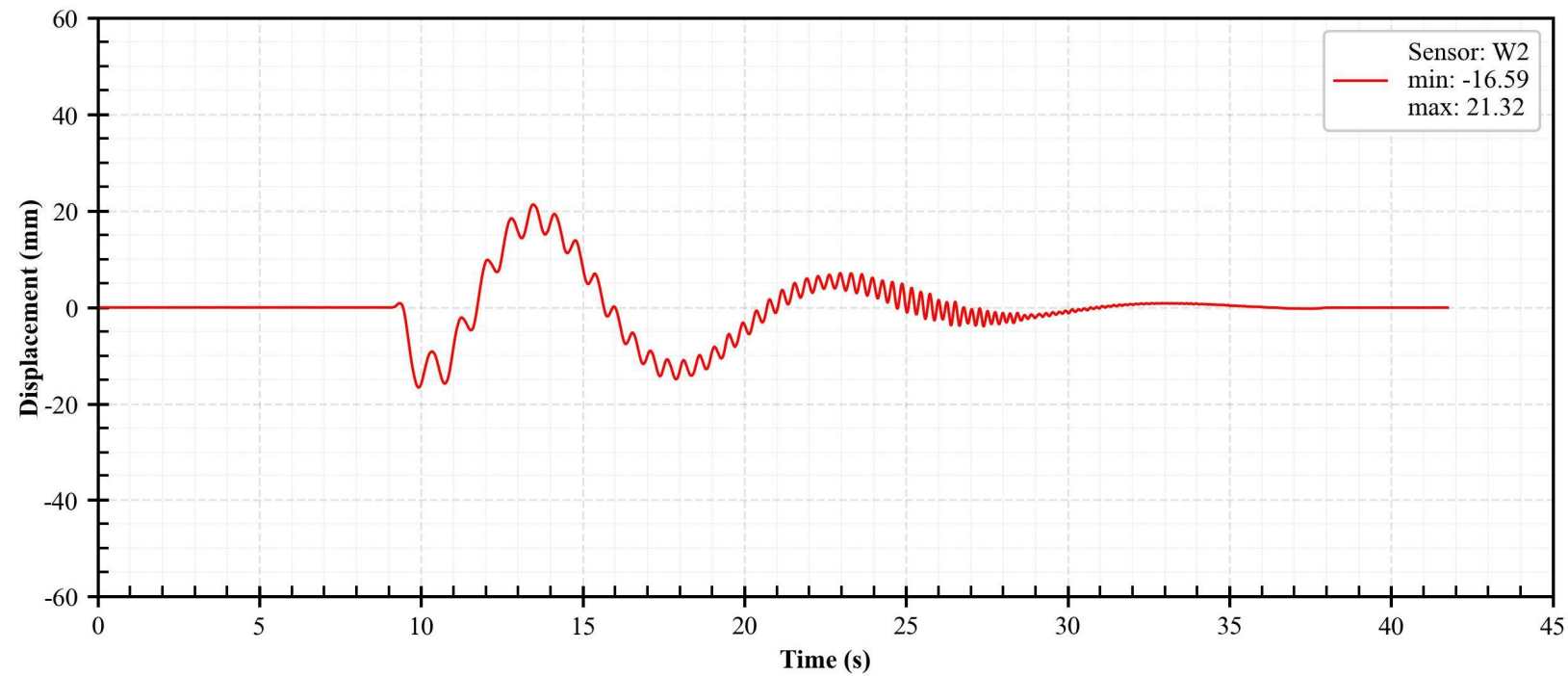


Figure 3.20.14 Characteristic results for phase B (white noise before EQ1,3g): Draw wire sensor 2

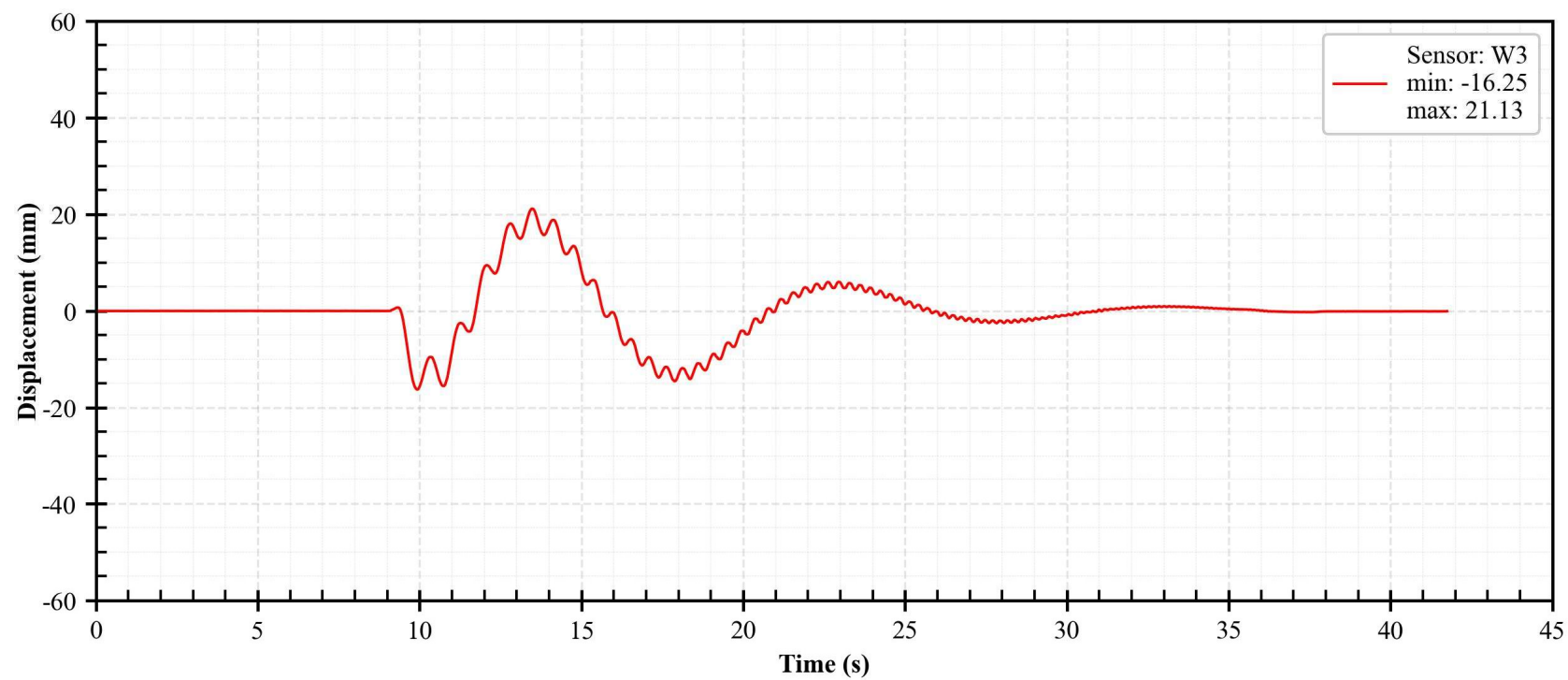


Figure 3.20.15 Characteristic results for phase B (white noise before EQ1,3g): Draw wire sensor 3

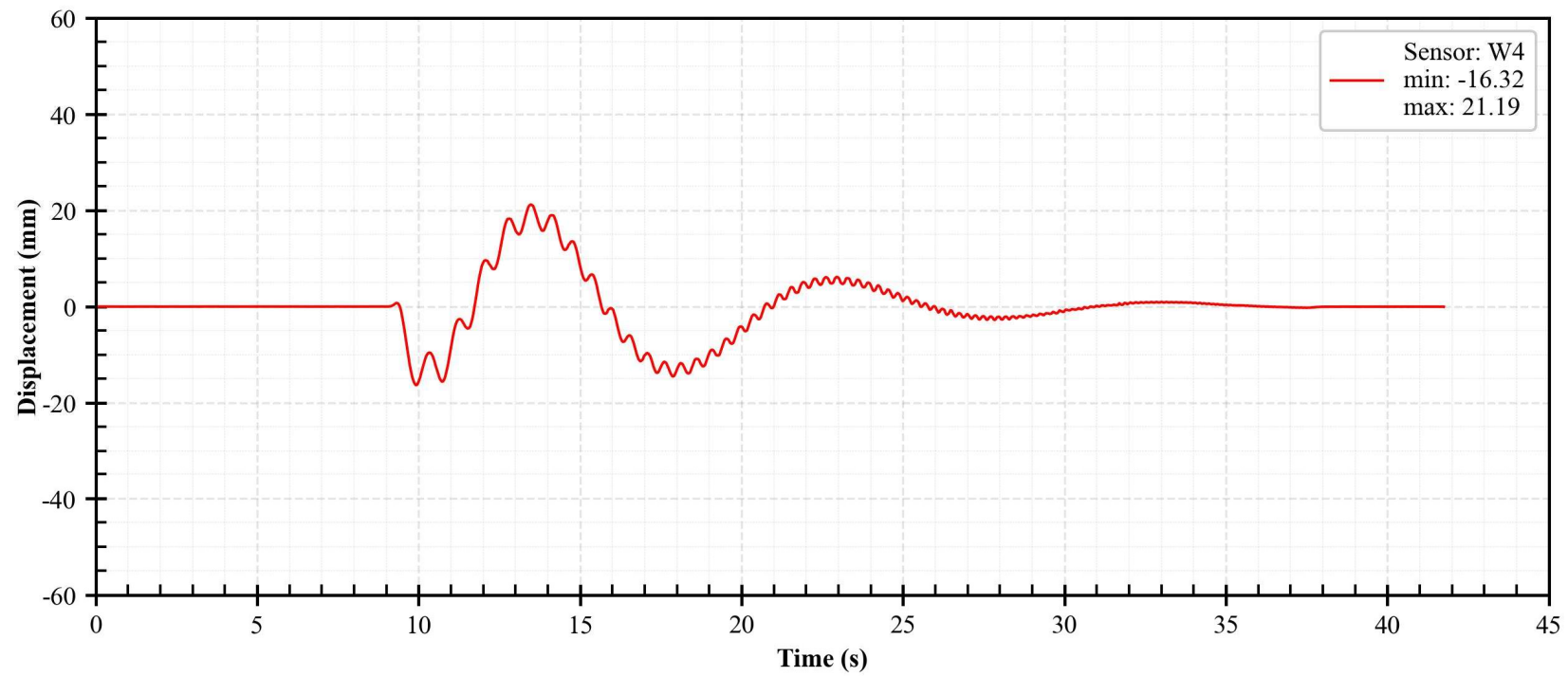


Figure 3.20.16 Characteristic results for phase B (white noise before EQ1,3g): Draw wire sensor 4

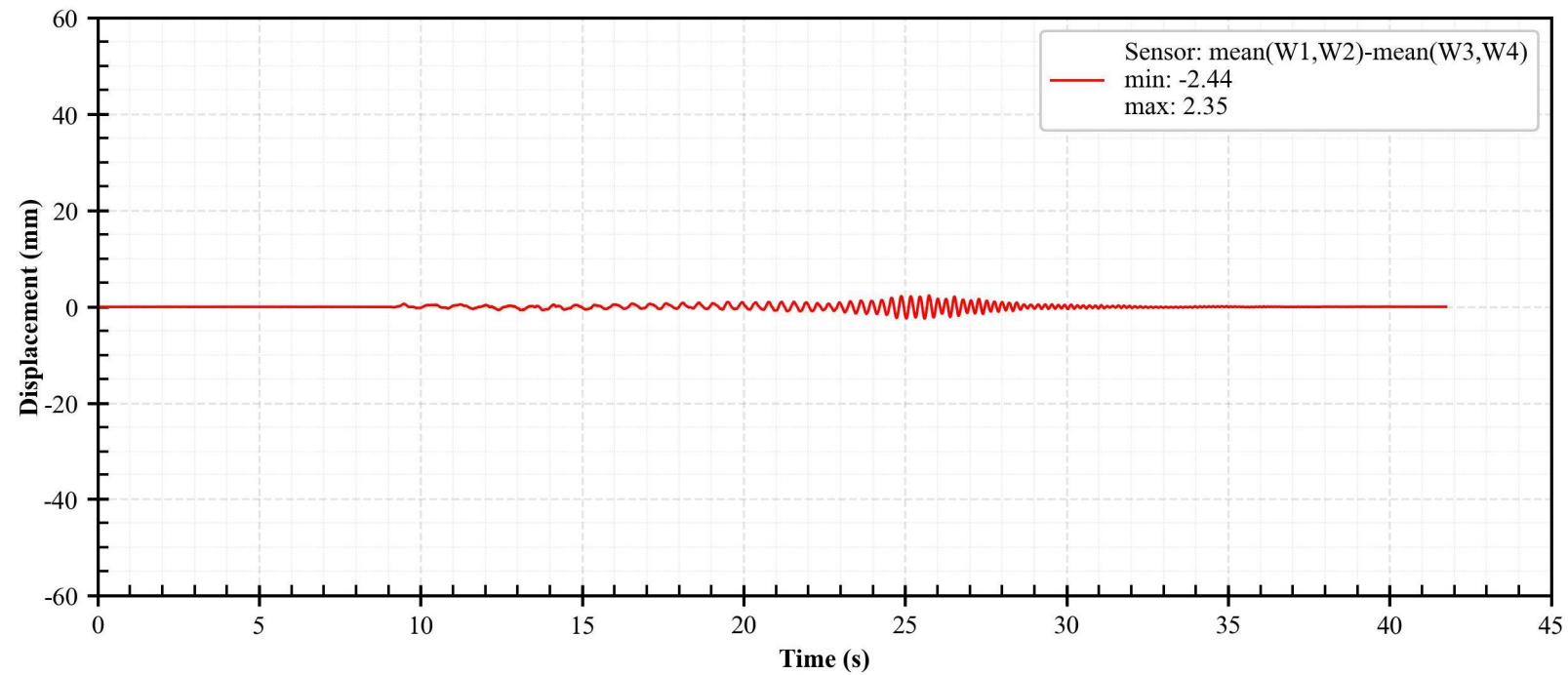


Figure 3.20.17 Characteristic results for phase B (white noise before EQ1,3g): $\text{mean}(W1,W2) - \text{mean}(W3,W4)$

Strain gauges

No notable changes are detected in the values of strain gauges.

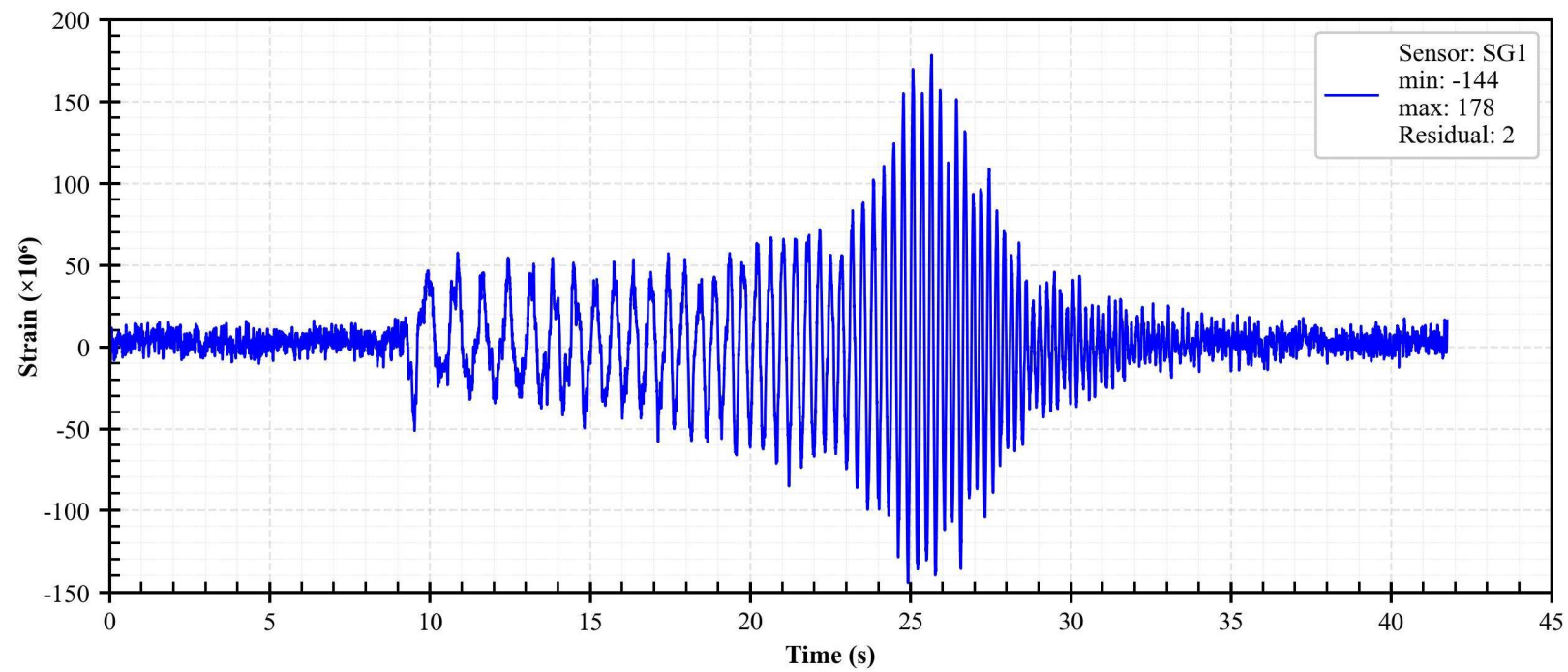


Figure 3.20.18 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 1

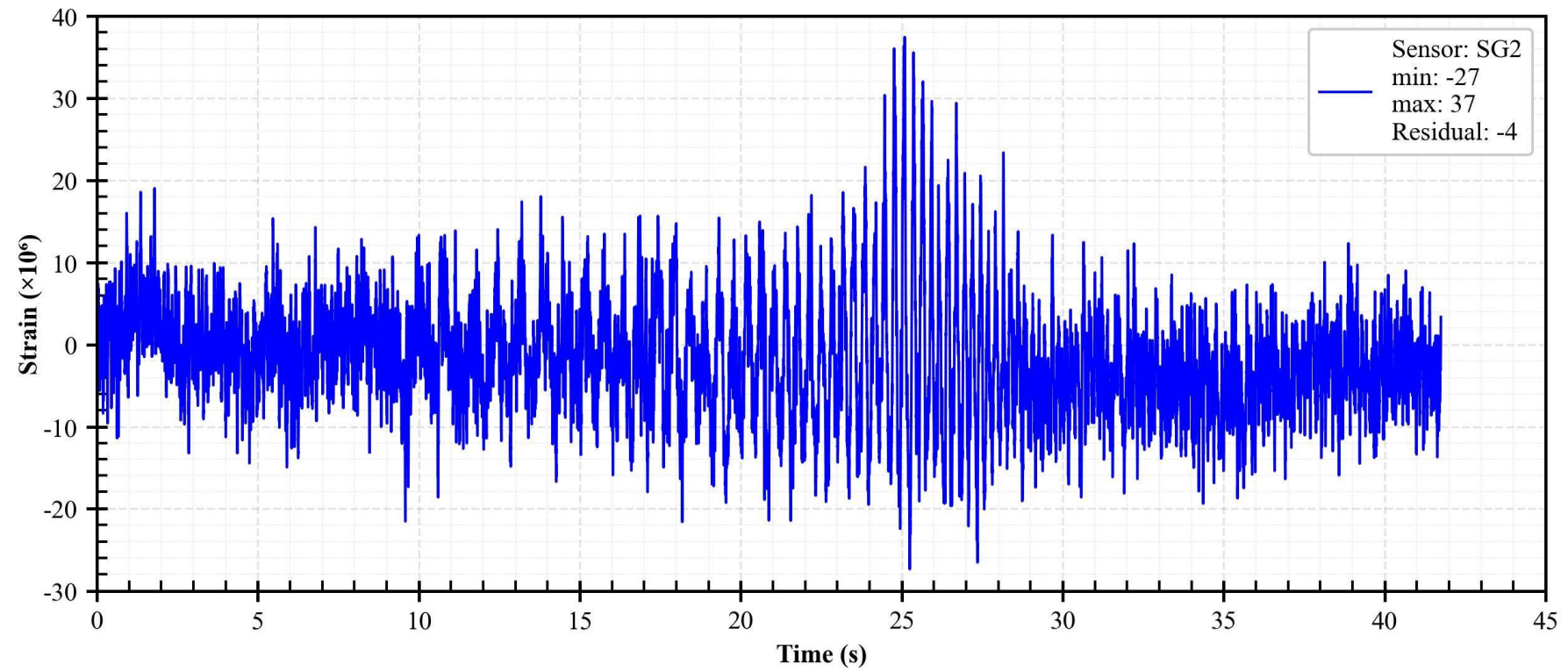


Figure 3.20.19 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 2

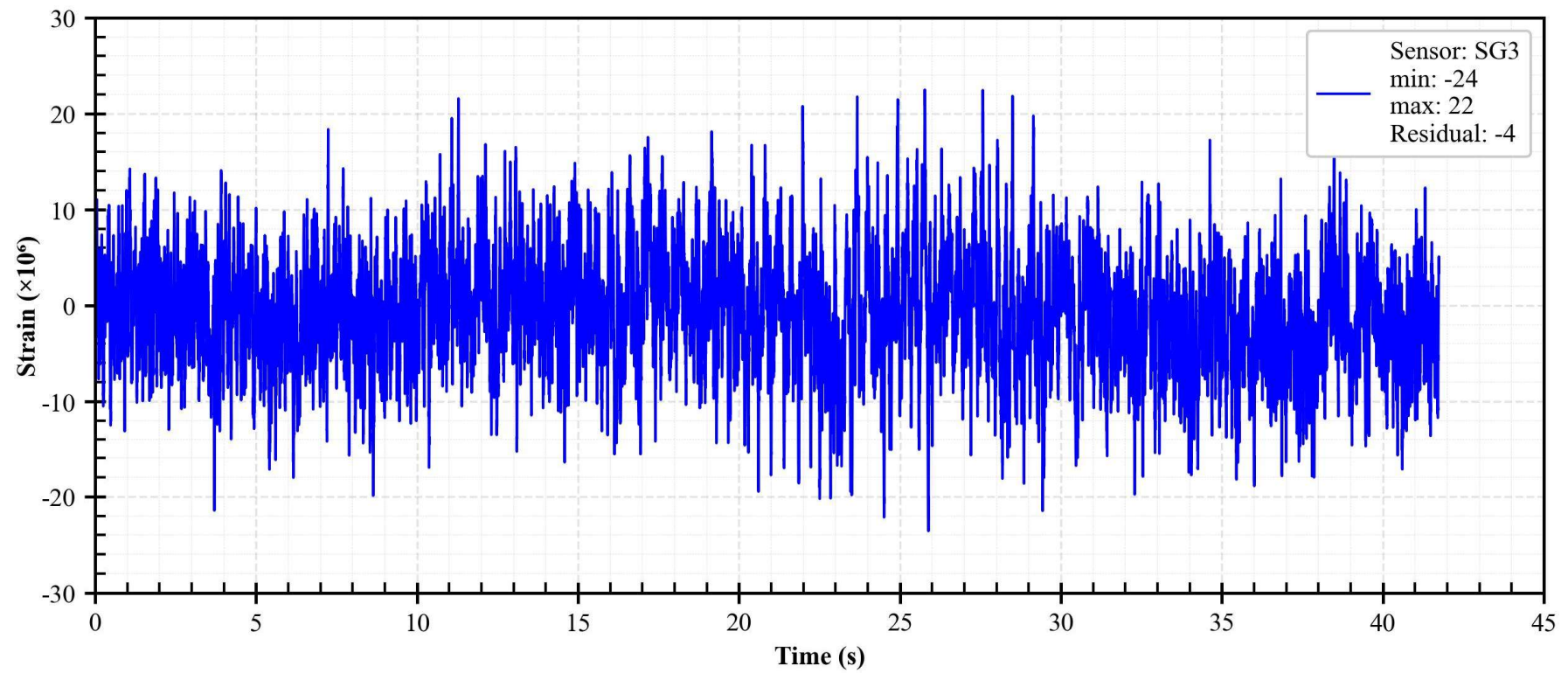


Figure 3.20.20 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 3

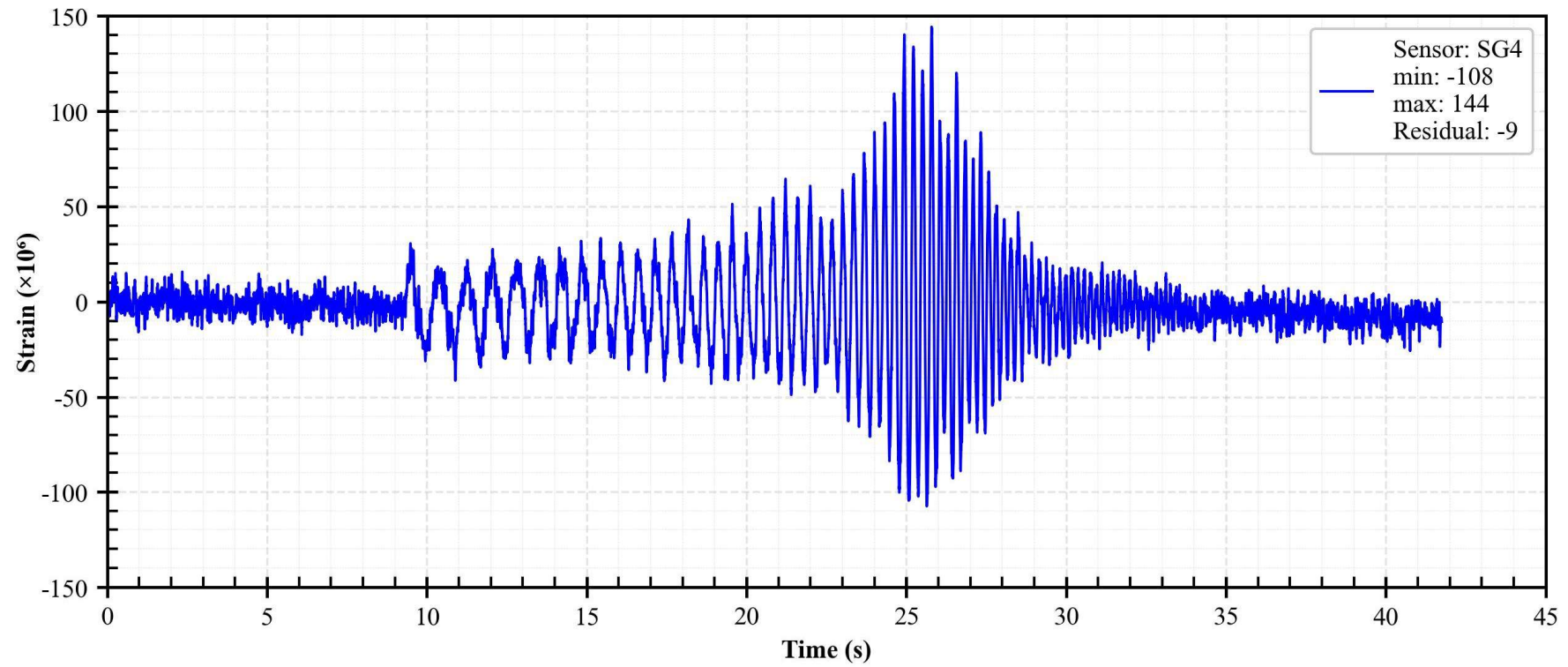


Figure 3.20.21 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 4

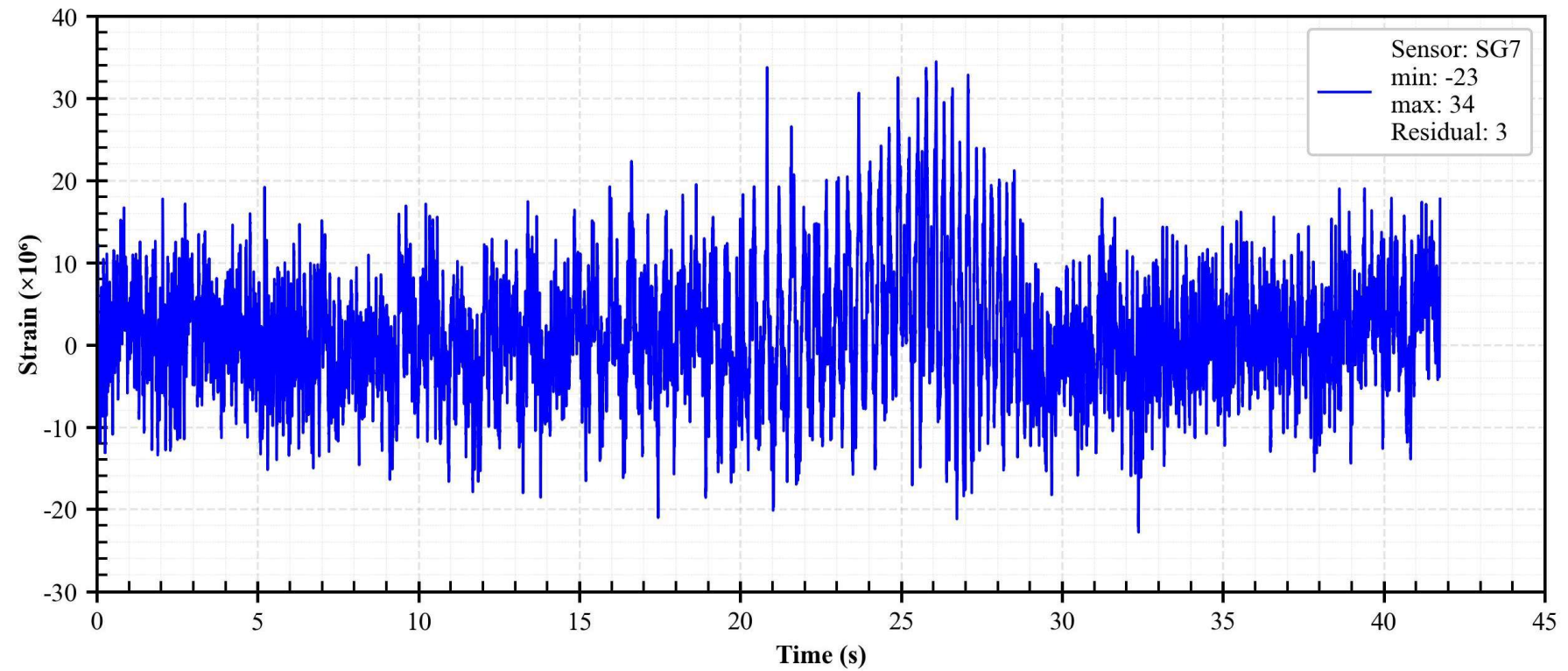


Figure 3.20.22 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 7

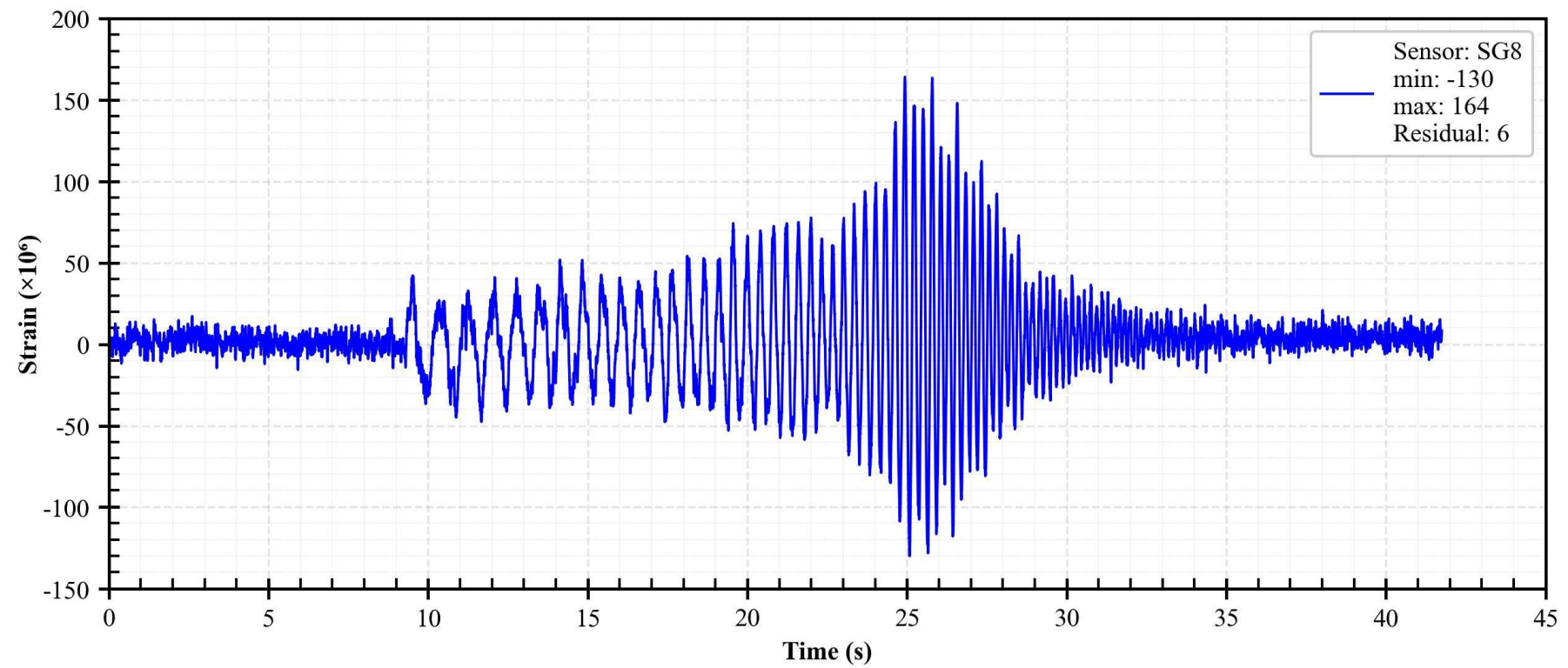


Figure 3.20.23 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 8

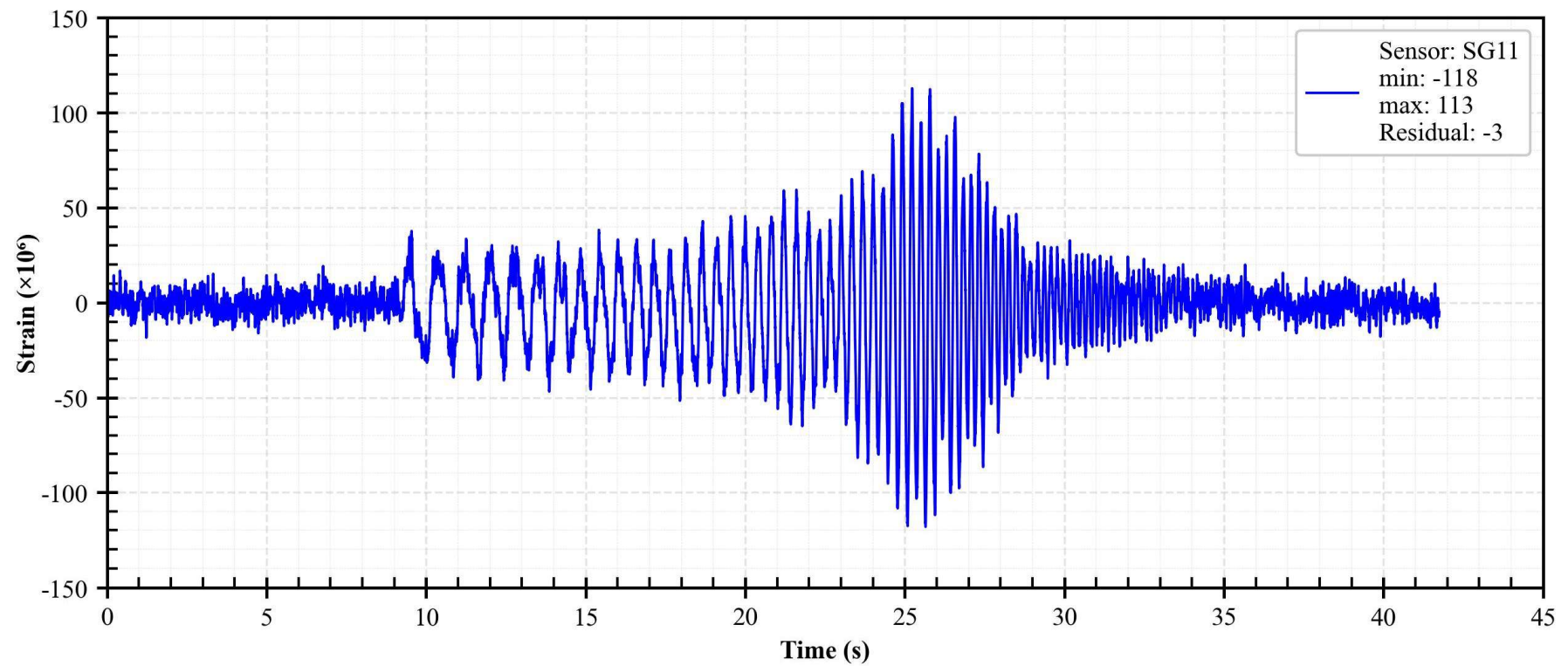


Figure 3.20.24 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 11

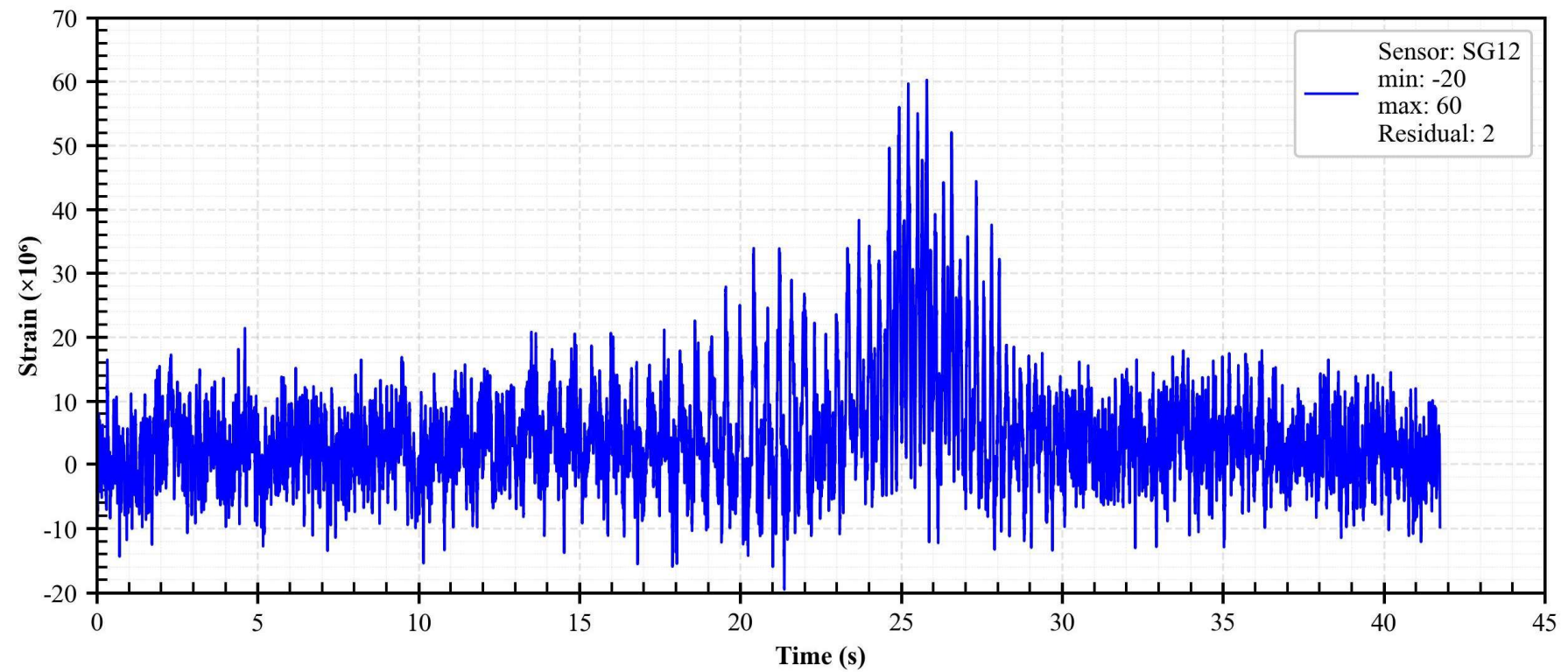


Figure 3.20.25 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 12

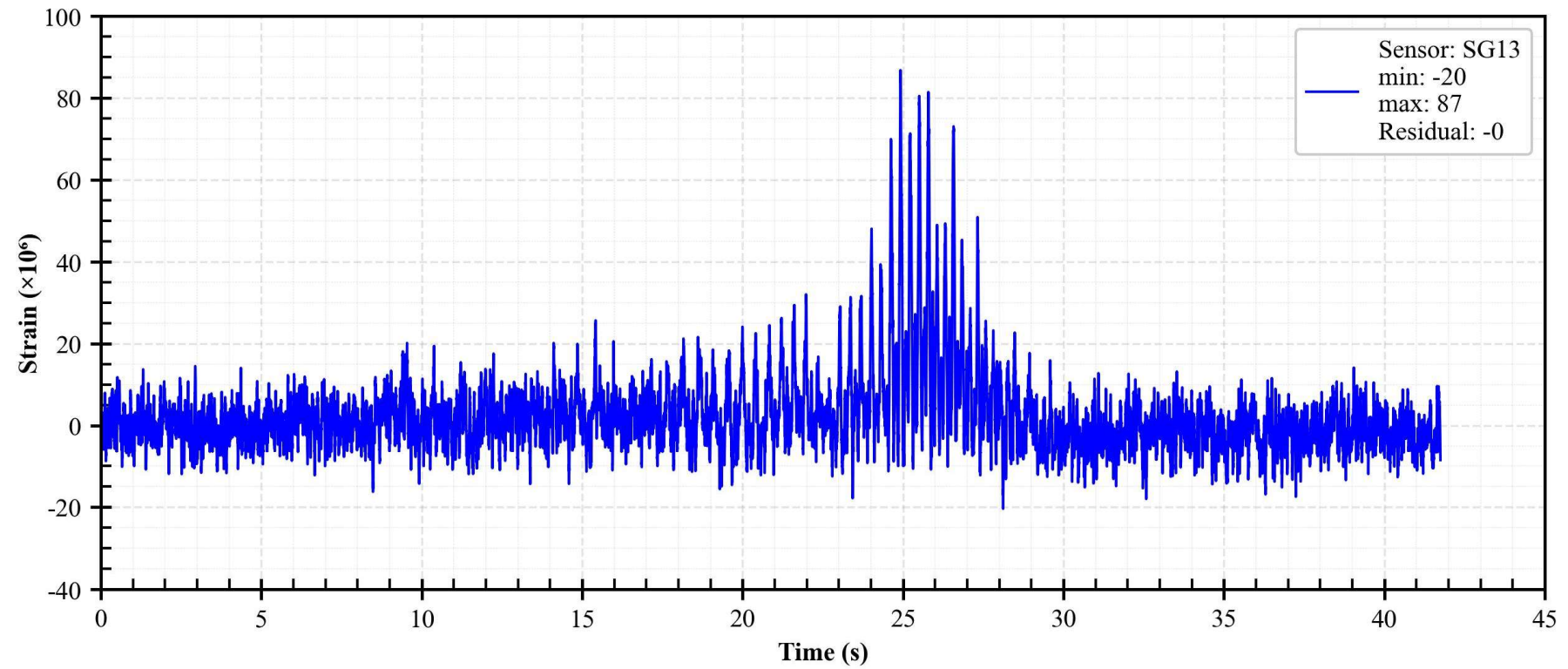


Figure 3.20.26 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 13

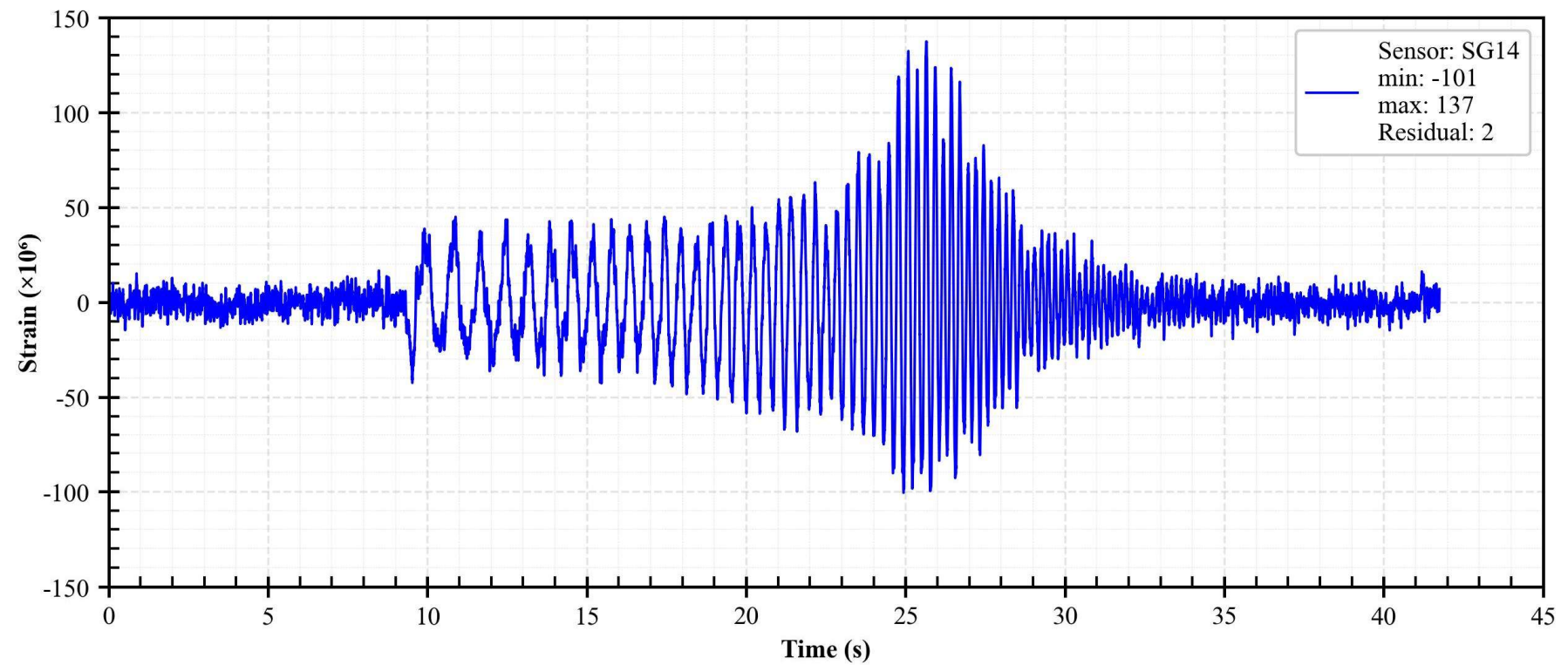


Figure 3.20.27 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 14

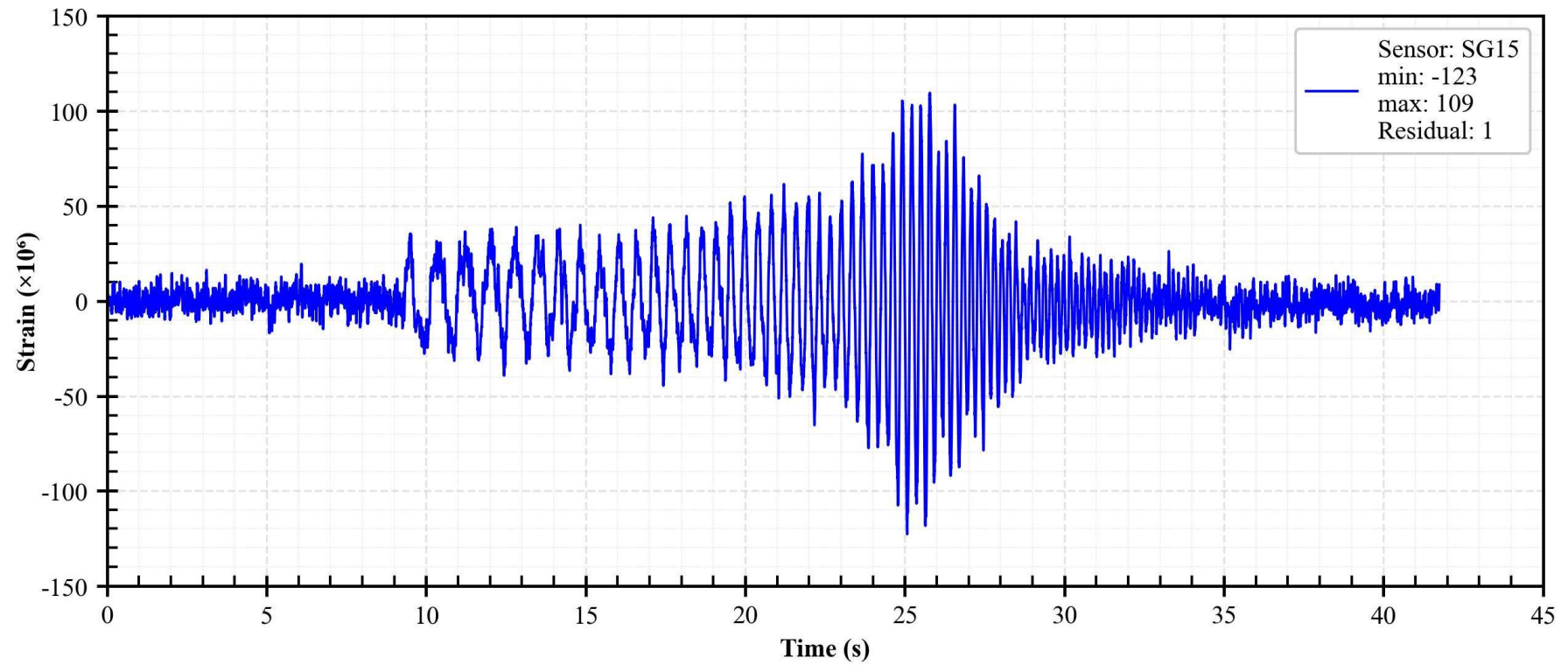


Figure 3.20.28 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 15

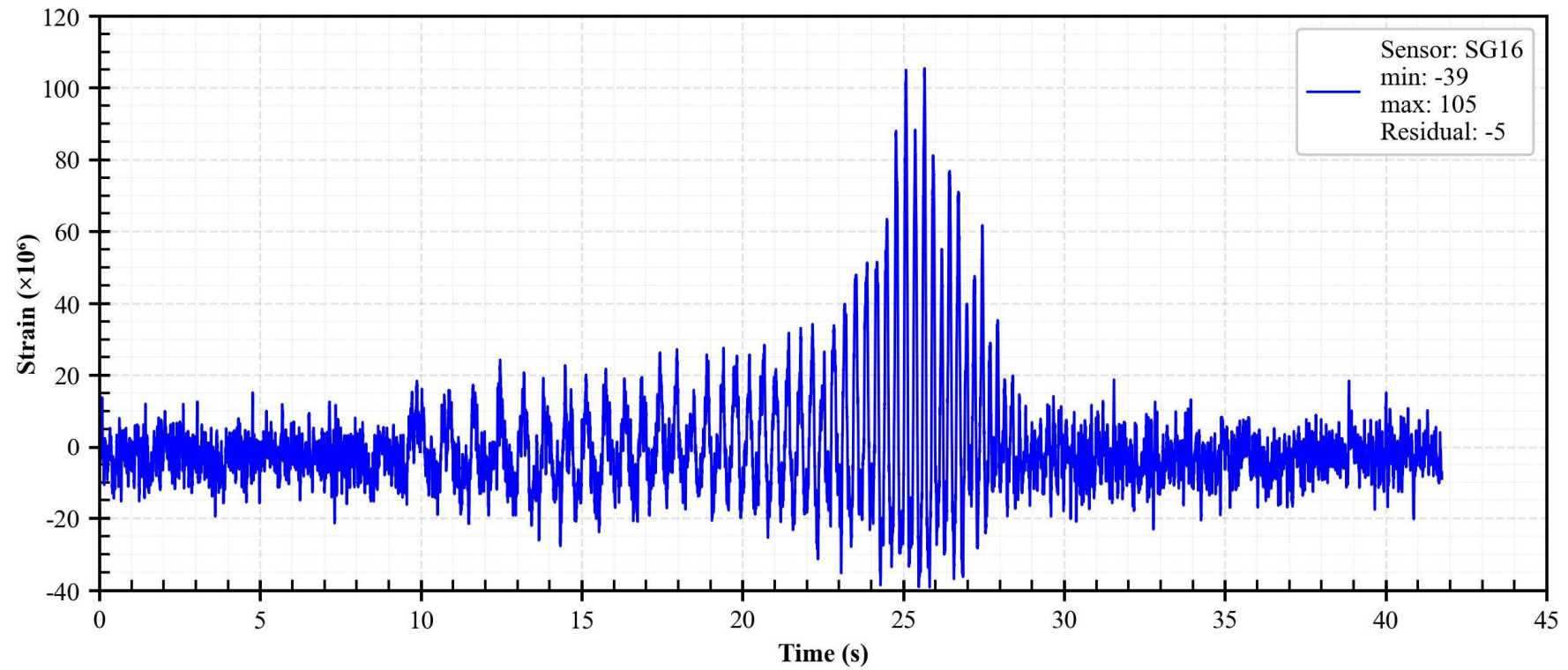


Figure 3.20.29 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 16

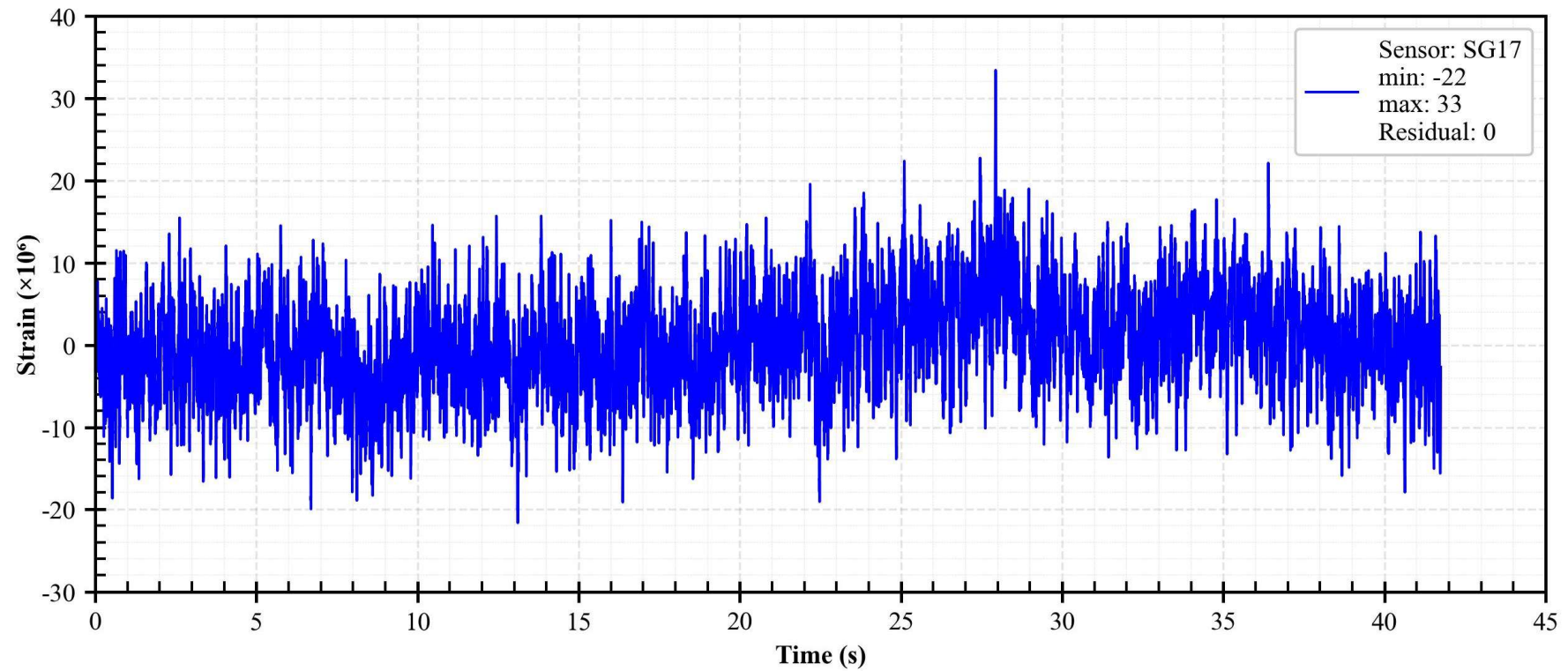


Figure 3.20.30 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 17

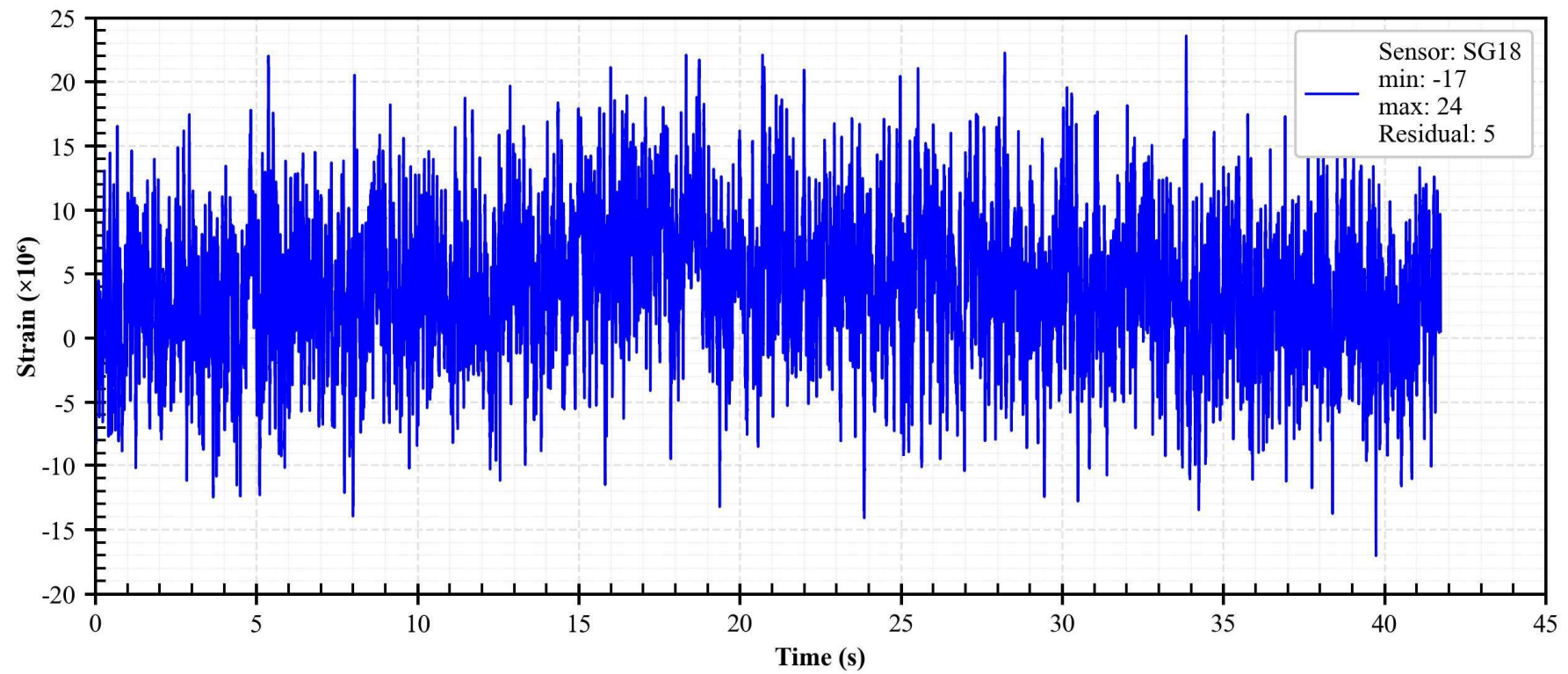


Figure 3.20.31 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 18

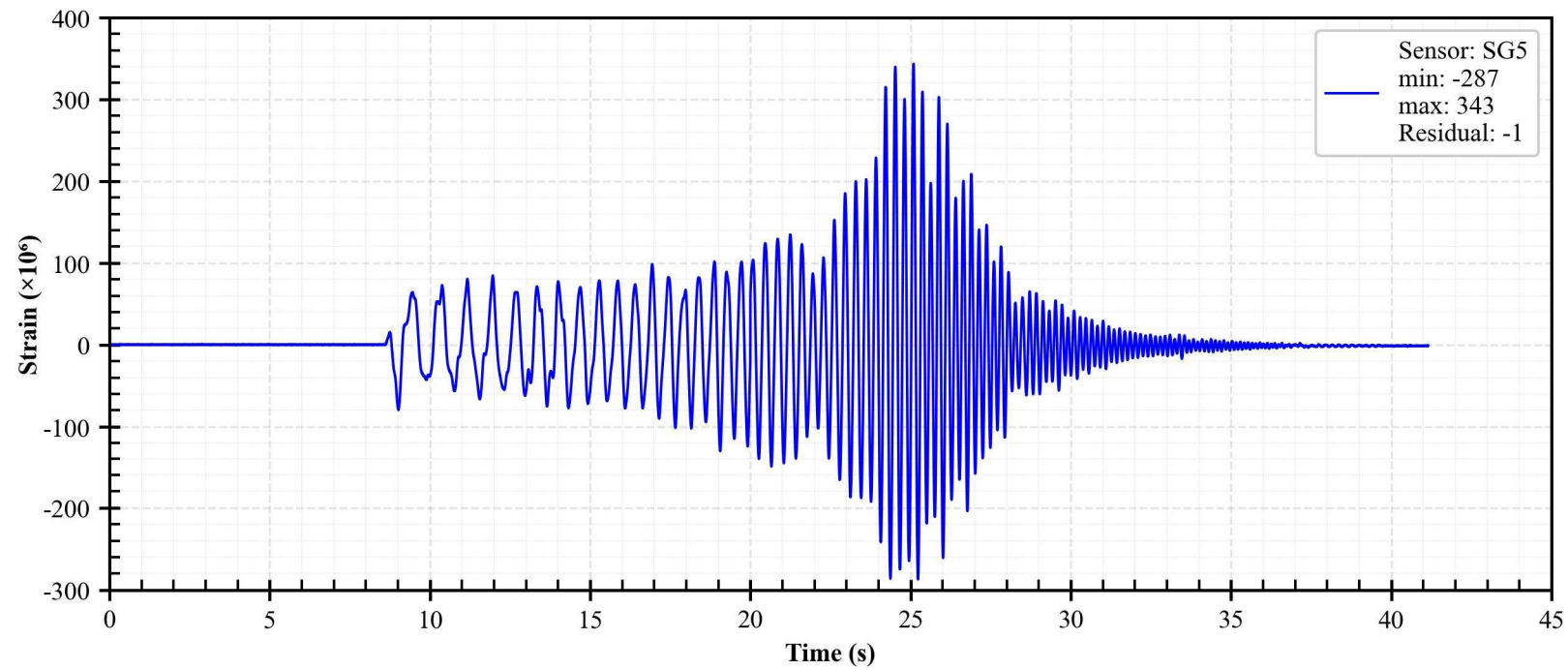


Figure 3.20.32 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 5

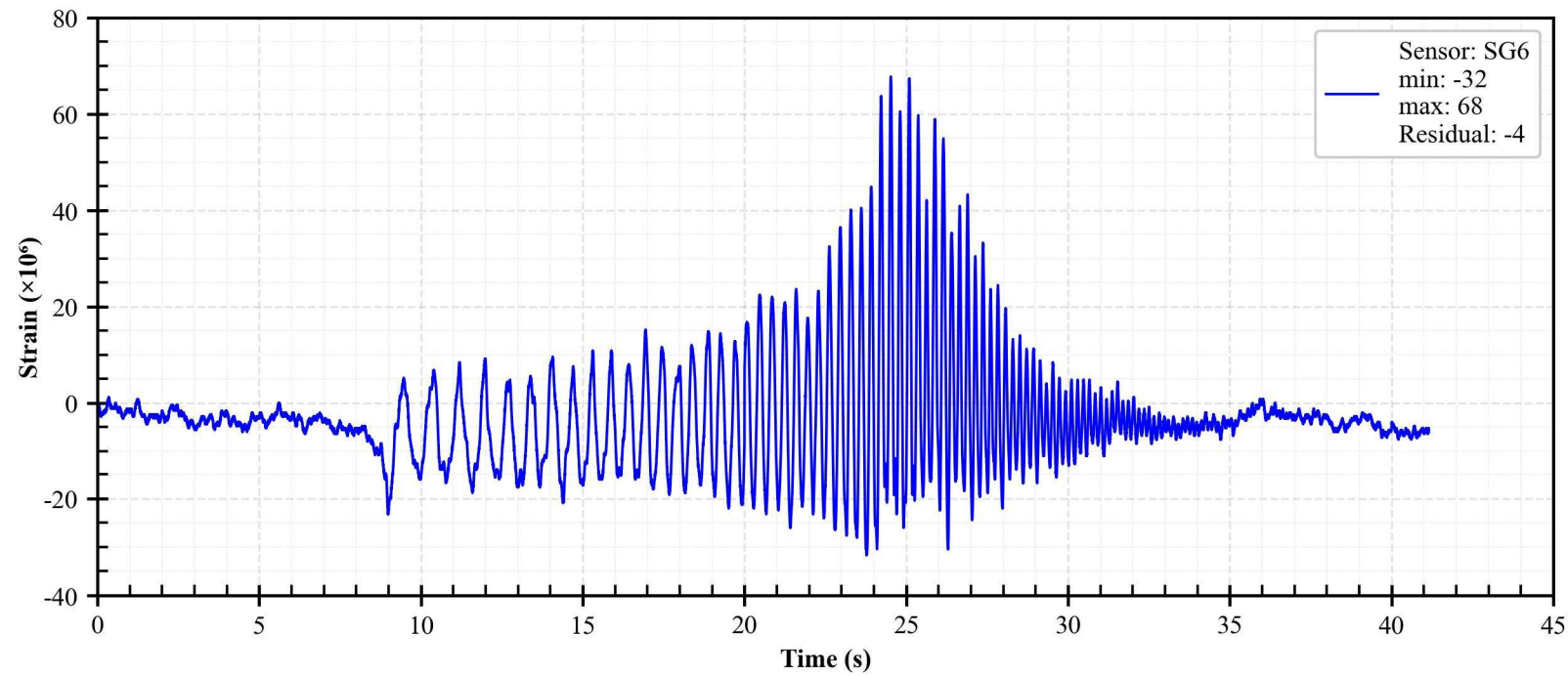


Figure 3.20.33 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 6

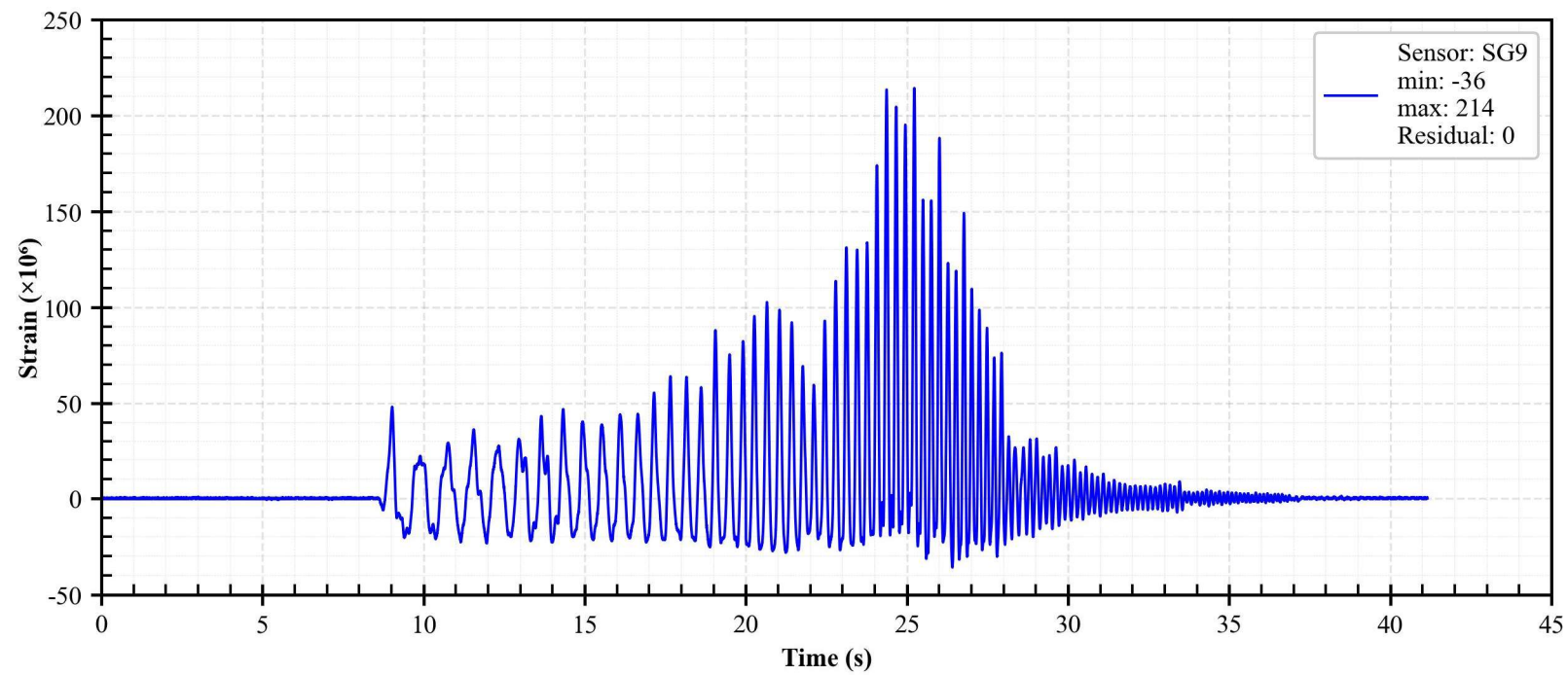


Figure 3.20.34 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 9

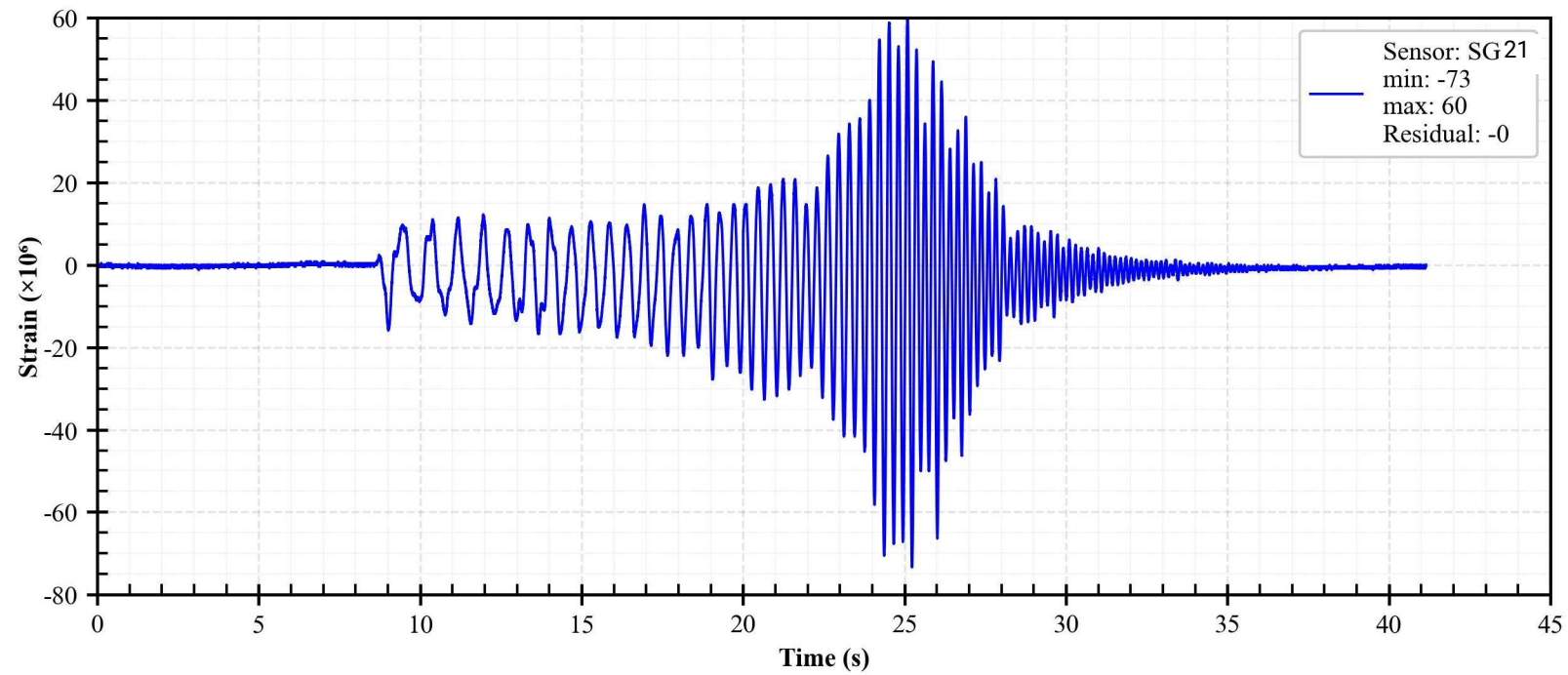


Figure 3.20.35 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 10

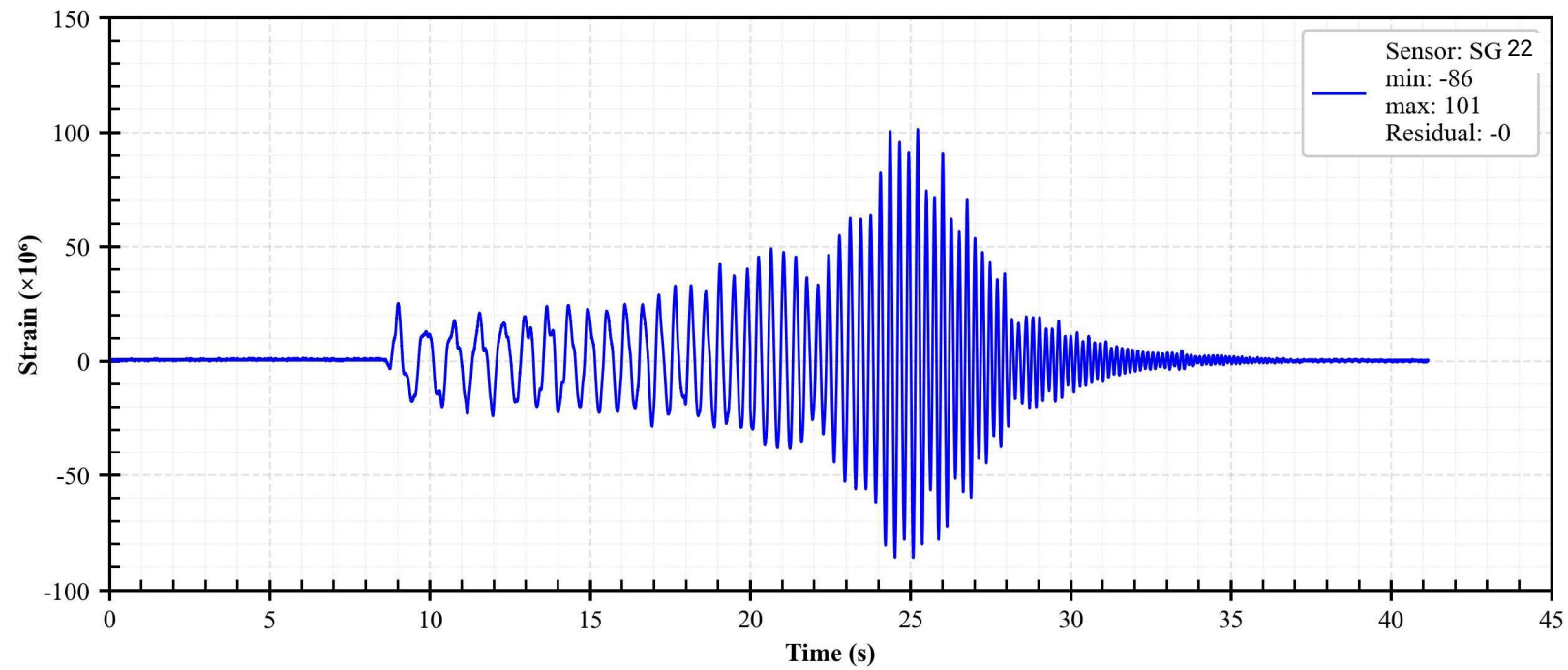


Figure 3.20.36 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 22 (PUFJ, column 2)

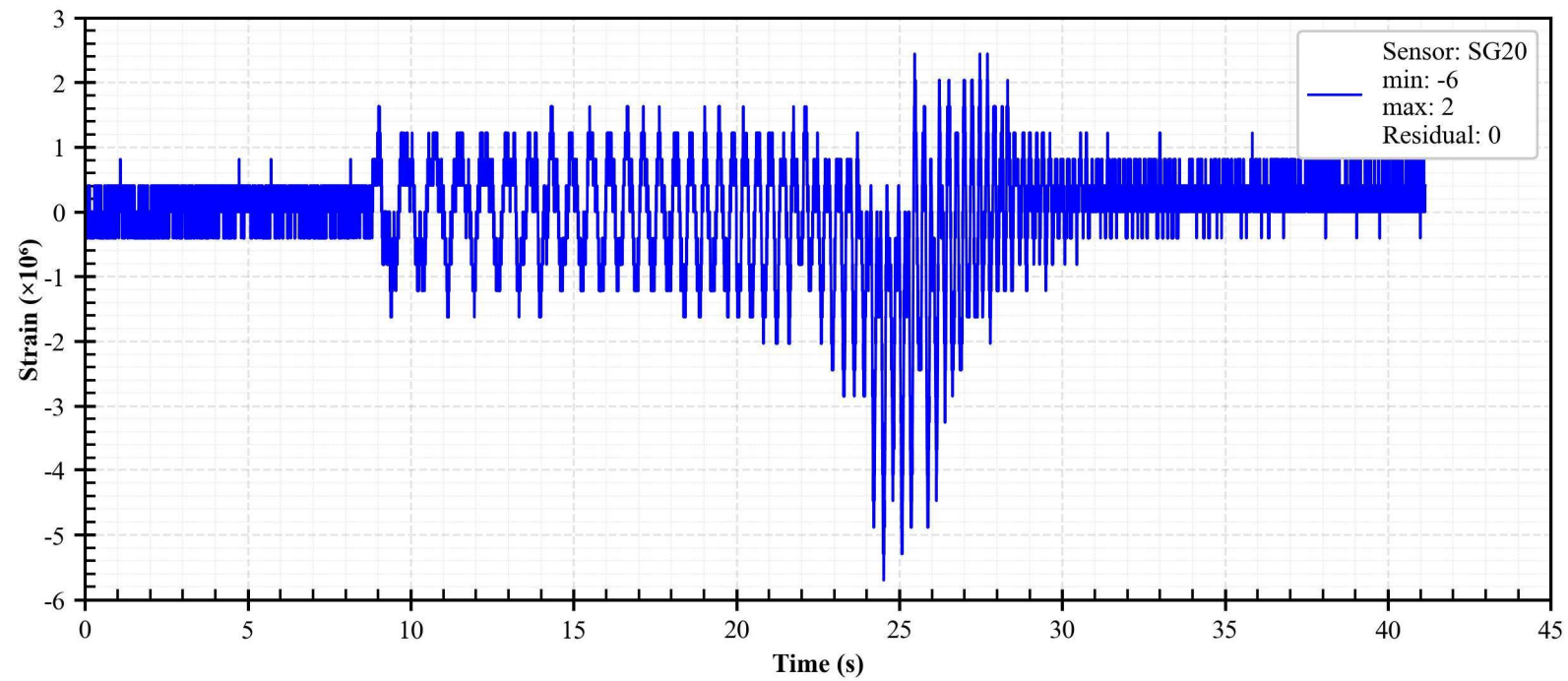


Figure 3.20.37 Characteristic results for phase B (white noise before EQ1,3g): strain gauge 20

3.21 Earthquake EQ1,3g

Draw wire sensors

Figures 3.21.1 – 3.21.5 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 41.66 mm while the minimum is -38.62 mm. The maximum movement detected by draw wire sensor W2 is 44.14 mm while the minimum is -36.64 mm. The maximum movement detected by draw wire sensor W3 is 29.26 mm while the minimum is -27.24 mm. The maximum movement detected by draw wire sensor W4 is 31.92 mm while the minimum is -24.75 mm. The maximum drift is $(19.76/1.225) = 16.13 \text{ ‰}$ and minimum drift is $(-20.18/1.225) = -16.47 \text{ ‰}$.

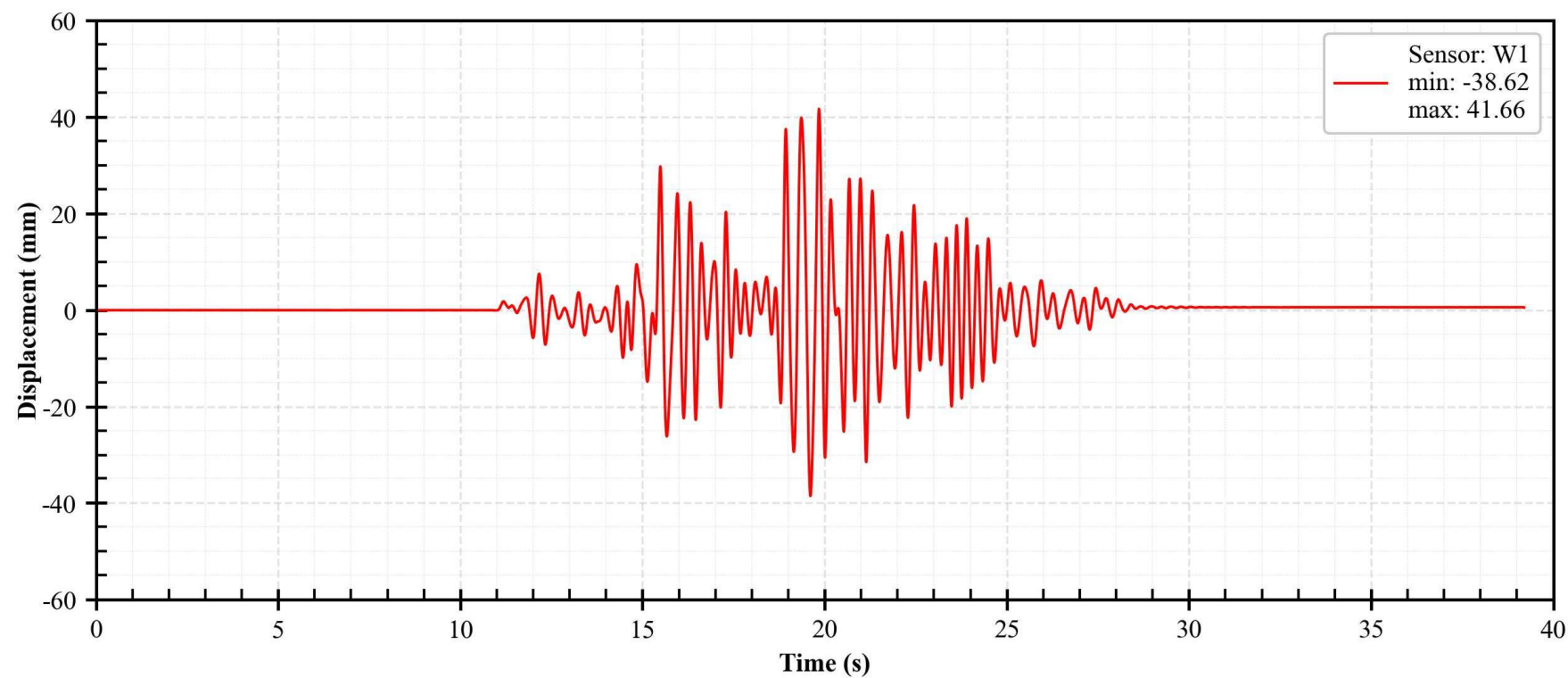


Figure 3.21.1 Characteristic results for phase B (earthquake EQ1,3g): Draw wire sensor 1

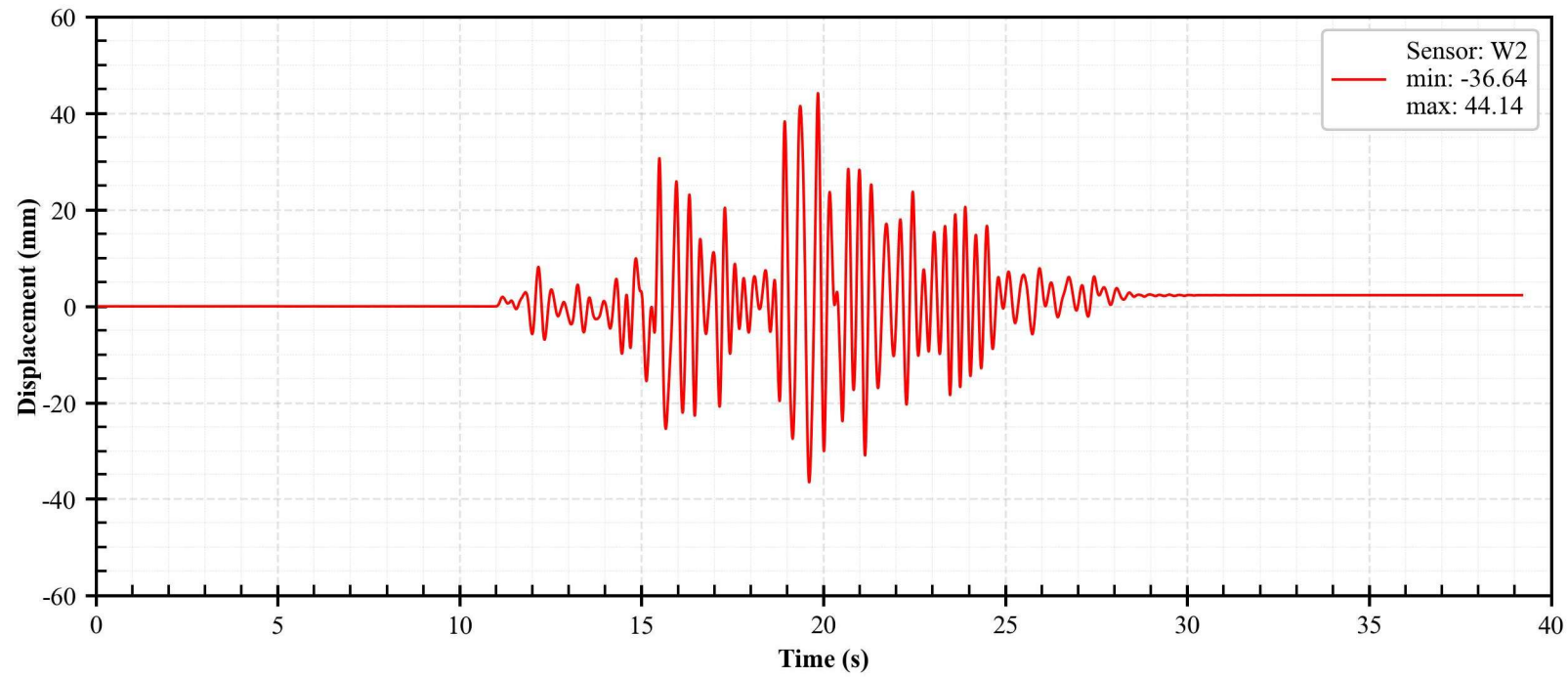


Figure 3.21.2 Characteristic results for phase B (earthquake EQ1,3g): Draw wire sensor 2

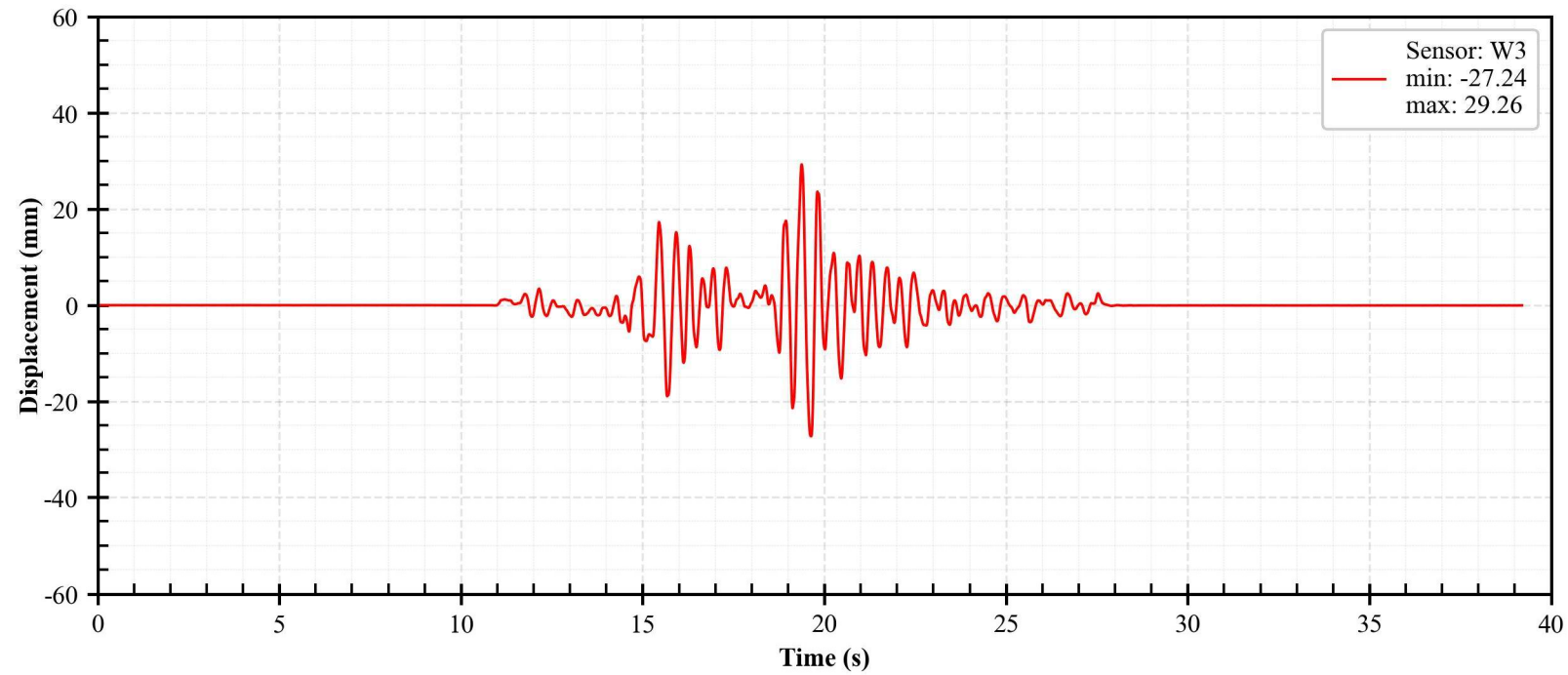


Figure 3.21.3 Characteristic results for phase B (earthquake EQ1,3g): Draw wire sensor 3

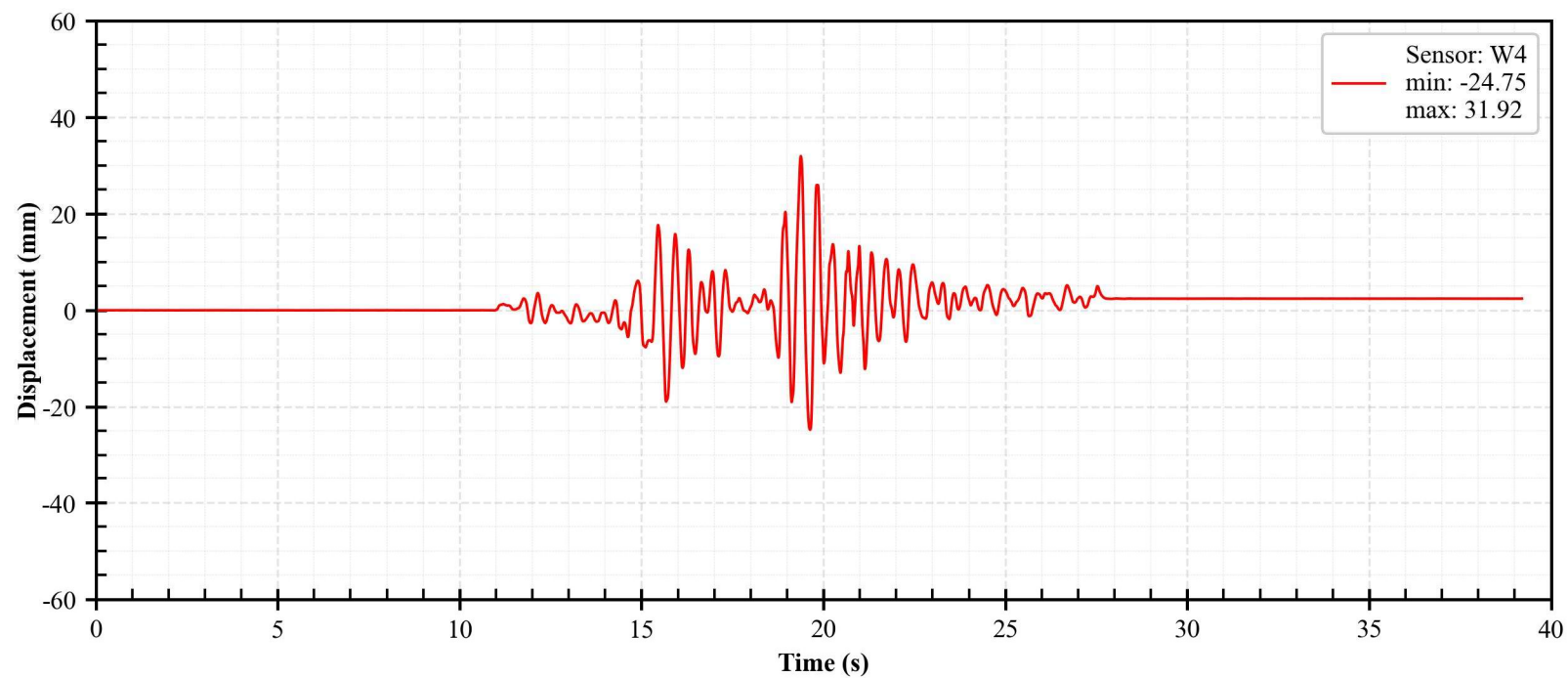


Figure 3.21.4 Characteristic results for phase B (earthquake EQ1,3g): Draw wire sensor 4

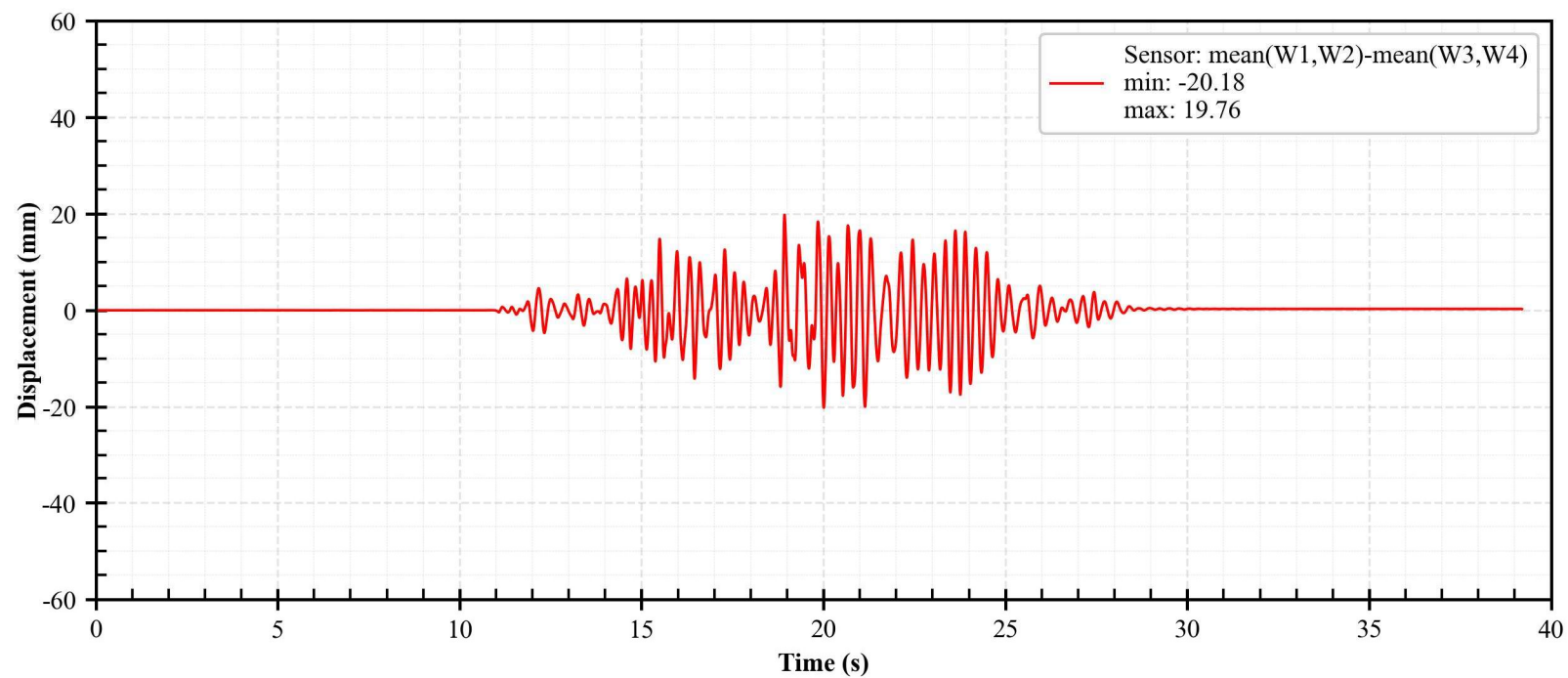


Figure 3.21.5 Characteristic results for phase B (earthquake EQ1,3g): mean (W1,W2) - mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.21.6, 3.21.7, 3.21.8, 3.21.9, 3.21.10, 3.21.11, 3.21.20, 3.21.21 are located on the longitudinal reinforcement, at the bottom of the column. More specifically, strain gauge SG1 has maximum strain 1280 μ strain and minimum strain -749 μ strain. The residual strain is -254 μ strain. Strain gauge SG2 has maximum strain 1242 μ strain and minimum -40 μ strain. The residual strain is 44 μ strain. Strain gauge SG3 has 1140 μ strain and -54 μ strain maximum and minimum strain respectively. The residual strain is 42 μ strain. Strain gauge SG4 has maximum 1399 μ strain and minimum -553 μ strain strain. The residual strain is -37 μ strain. Figure 3.21.20 and figure 3.21.21 show strain gauges SG5 and SG6, respectively. Strain gauge 5 has 2693 μ strain and -1539 μ strain maximum and minimum strain respectively. Strain gauge SG5 presents -534 μ strain residual strain. Strain gauge SG6 has 523 μ strain maximum strain, -11803 μ strain minimum strain and -8535 μ strain residual. Finally in figure 3.21.10 we see strain gauge SG7 and in figure 3.21.11 strain gauge 8. Strain gauge SG7 has maximum strain 2251 μ strain. Strain gauge SG7 has -742 μ strain minimum deformation. Strain gauge SG7 has maximum strain 1230 μ strain and minimum strain -33 deformation. The residual strain for strain gauge SG7 and SG8 66, -117 respectively.

Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. More specifically strain gauge 17 has 21 μ strain maximum strain. Strain gauge 17 has minimum deformation -33 μ strain and strain gauge 18 has maximum -33 μ strain. Finally strain gauge 17 presents -1 μ strain residual. Strain gauge 18 presents 3 μ strain residual.

The strain gauges shown in the figures 3.21.12, 3.21.13, 3.21.14, 3.21.15, 3.21.16, 3.21.17, and 3.21.22 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG9 has 2251 μ strain maximum strain, -742 μ strain minimum strain and -164 residual. Strain gauge SG11 has 1203 μ strain maximum strain and minimum -453 μ strain deformation. The residual strain is -153 μ strain for strain gauge SG11. Strain gauge SG12 has 1267 μ strain maximum strain and -38 μ strain minimum strain. The residual strain is 73 μ strain for strain gauge SG12. Strain gauge SG13 has maximum strain 1313 μ strain, minimum -334 μ strain and -42 μ strain residual. Strain gauge SG14 has maximum strain 1374 μ strain and minimum strain -300 μ strain. The residual value is -81 μ strain. Finally strain gauges SG15 has maximum strain 3230 μ strain and minimum strain -296 μ strain. Strain gauge residual is 1083 μ strain. Strain gauge SG16 has maximum strain 1317 μ strain, minimum strain -77 μ strain and residual strain 112 μ strain.

Strain gauge SG21 has 677 μ strain maximum strain, -444 μ strain minimum strain and -2 μ strain residual. Strain gauge SG22 has maximum 735 μ strain and minimum -218 μ strain. The residual strain for strain gauge SG22 is -10 μ strain. Strain gauge 20 has maximum strain 37 μ strain and minimum -73 μ strain. The residual strain for strain gauge SG20 is 33 μ strain.

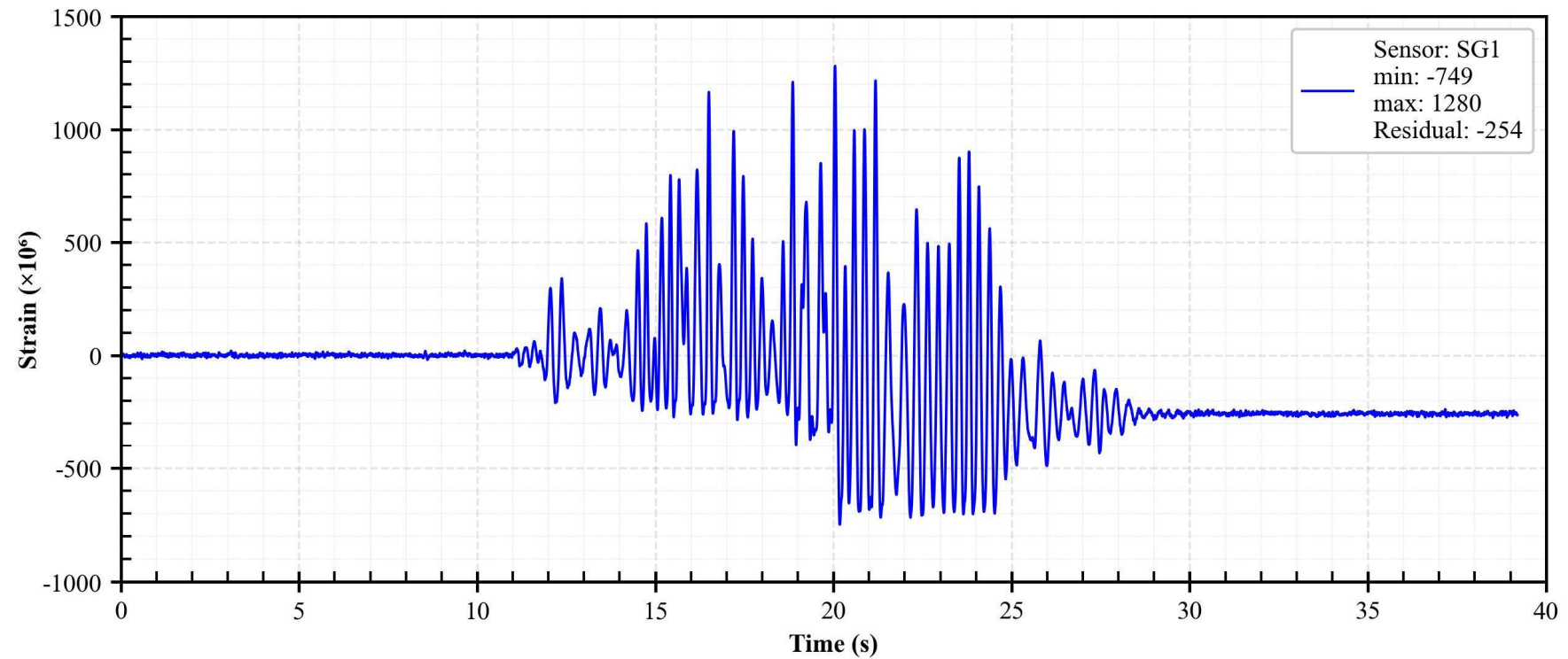


Figure 3.21.6 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 1

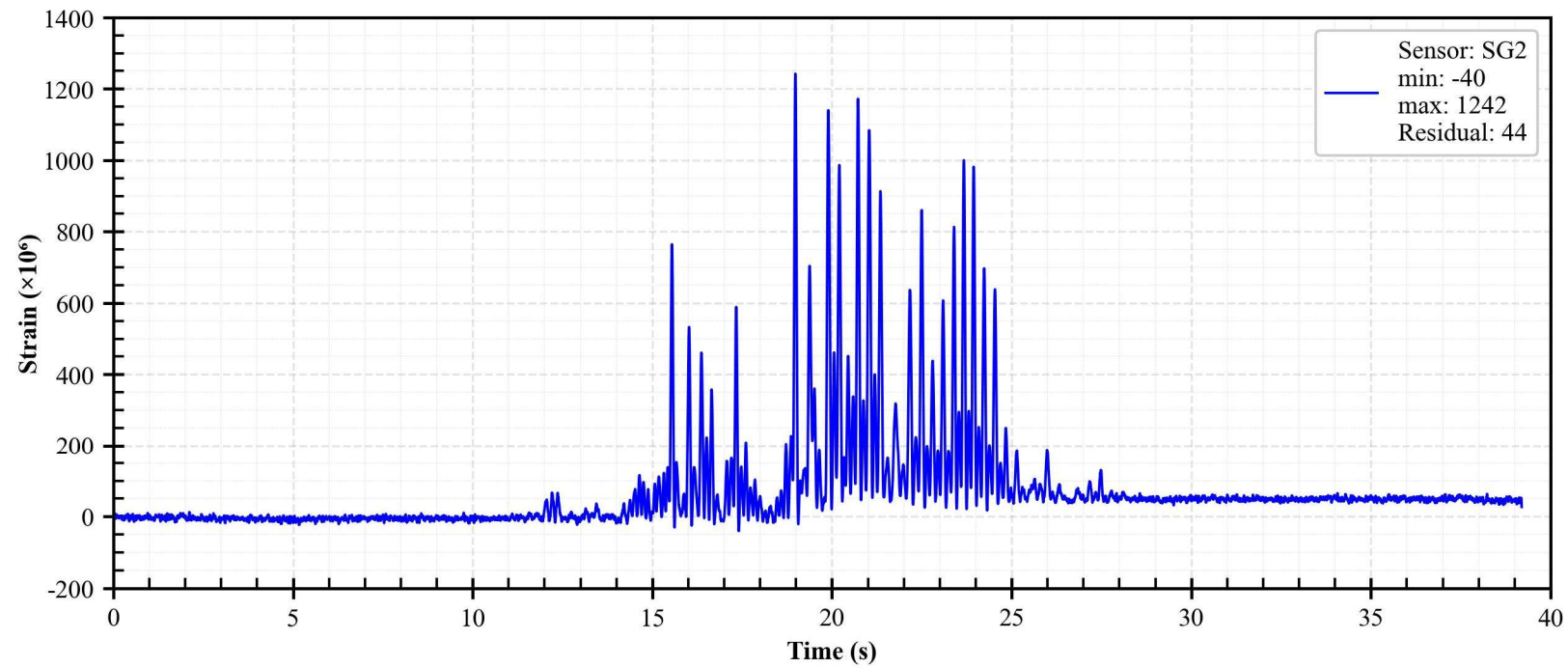


Figure 3.21.7 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 2

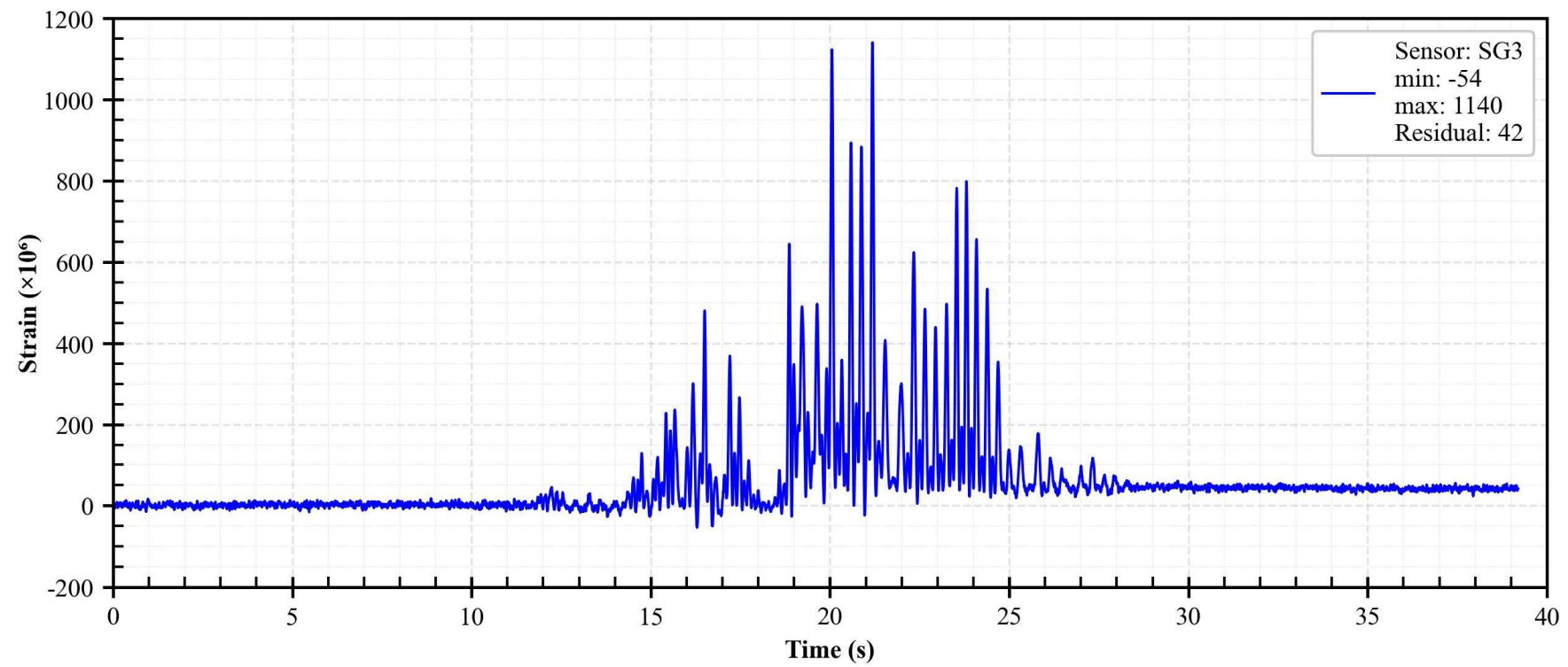


Figure 3.21.8 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 3

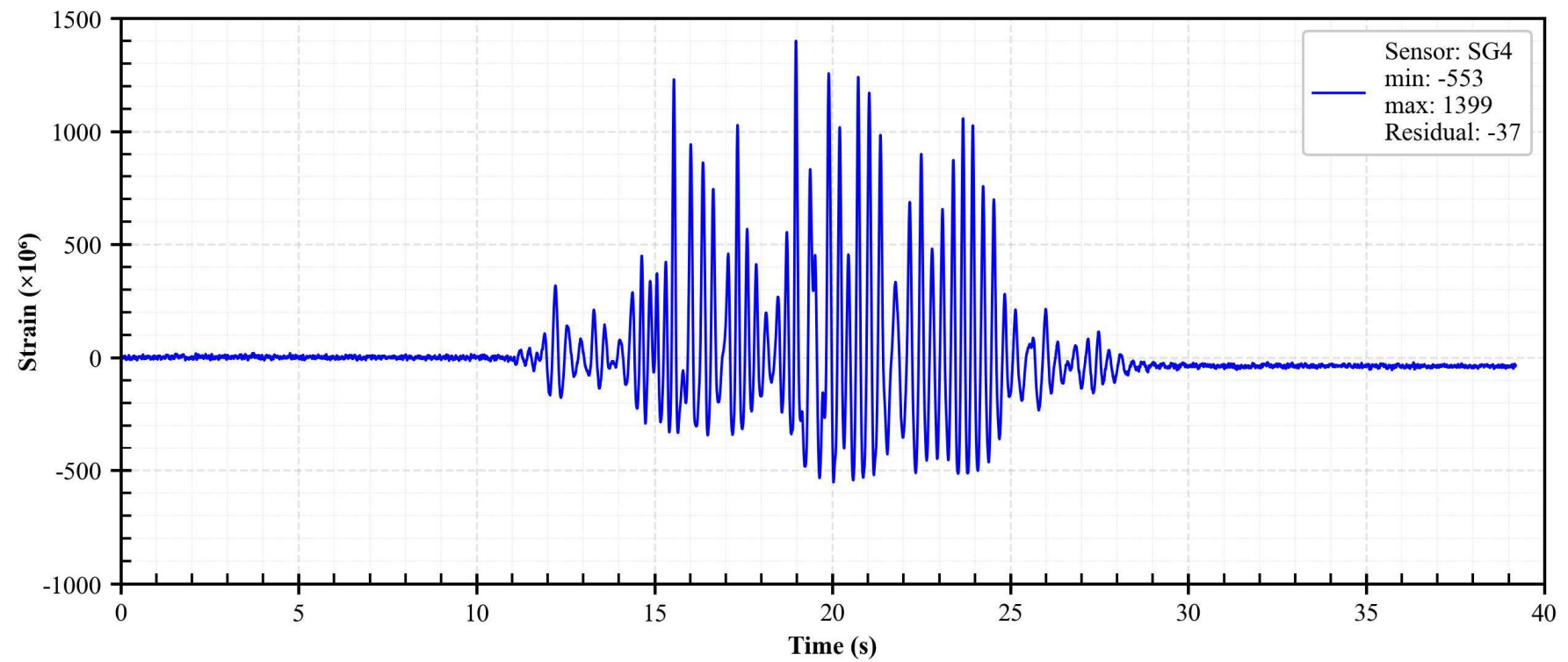


Figure 3.21.9 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 4

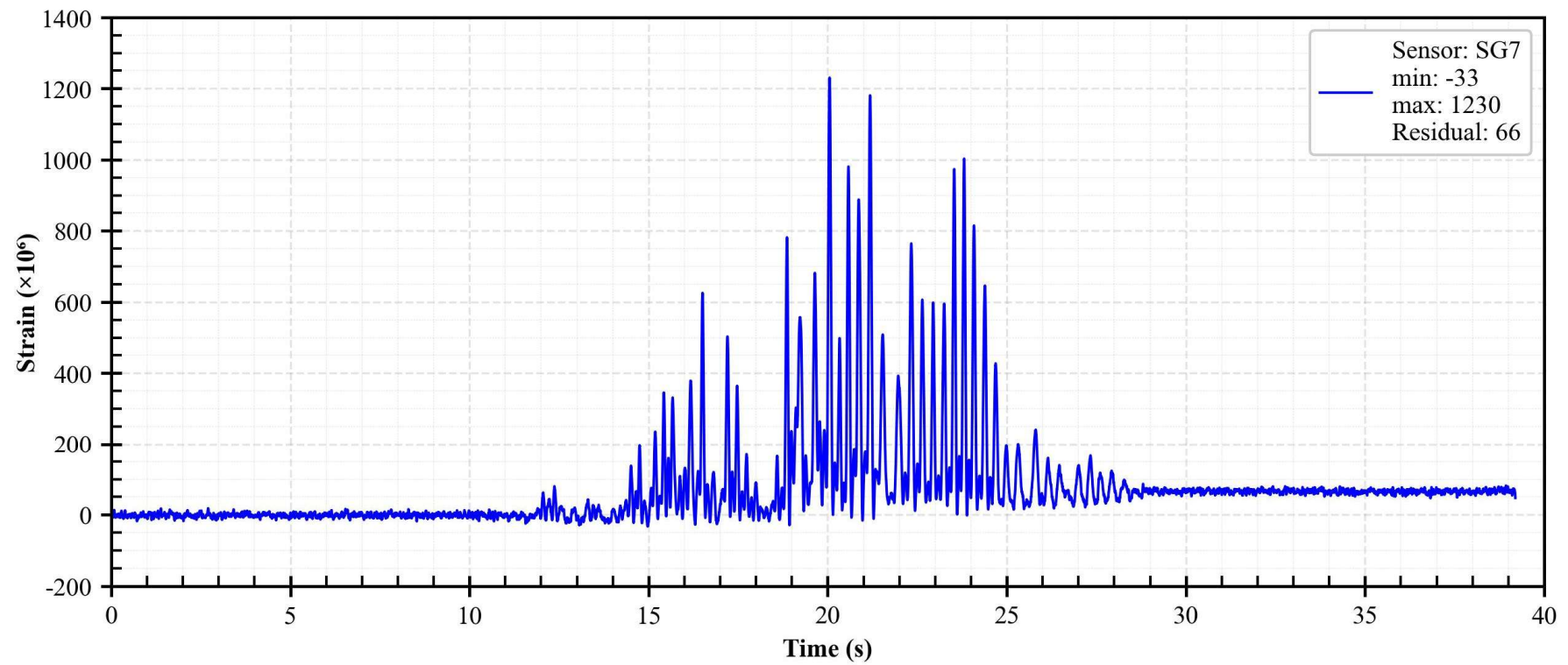


Figure 3.21.10 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 7

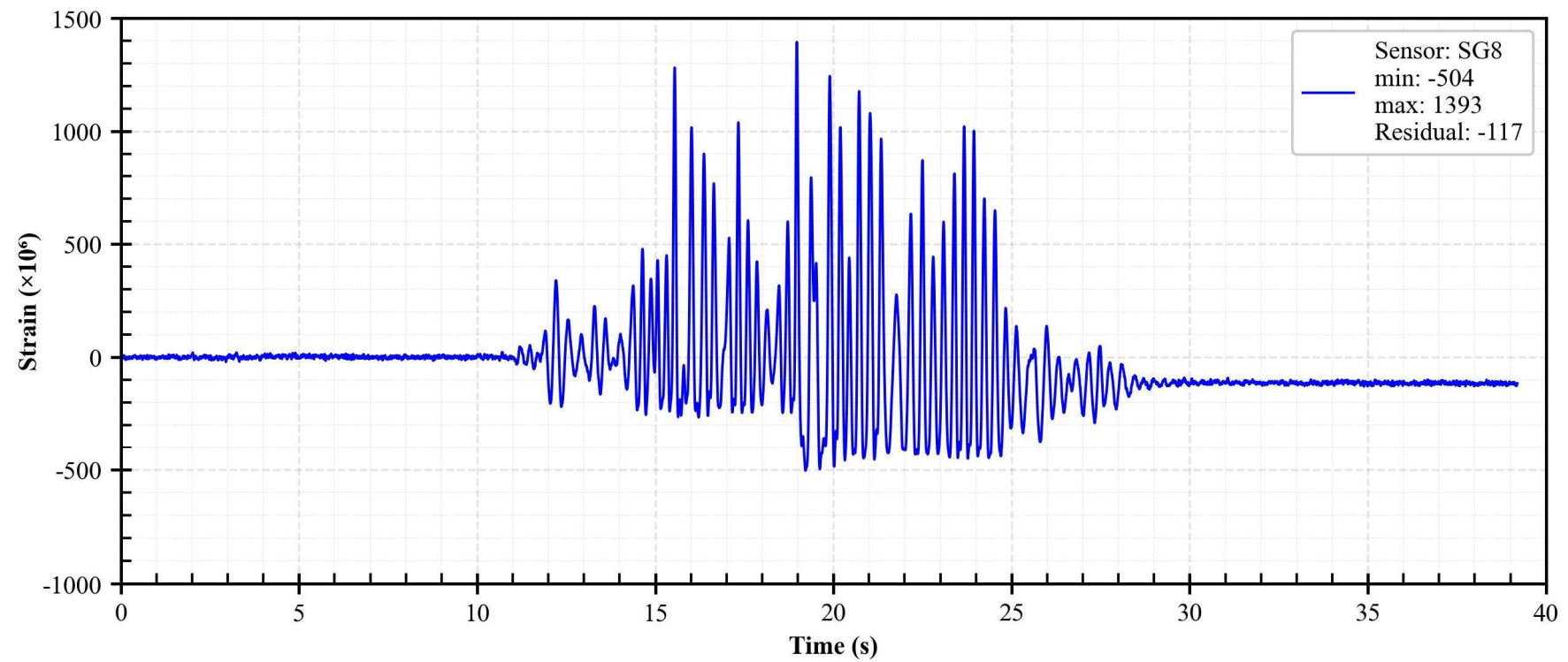


Figure 3.21.11 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 8

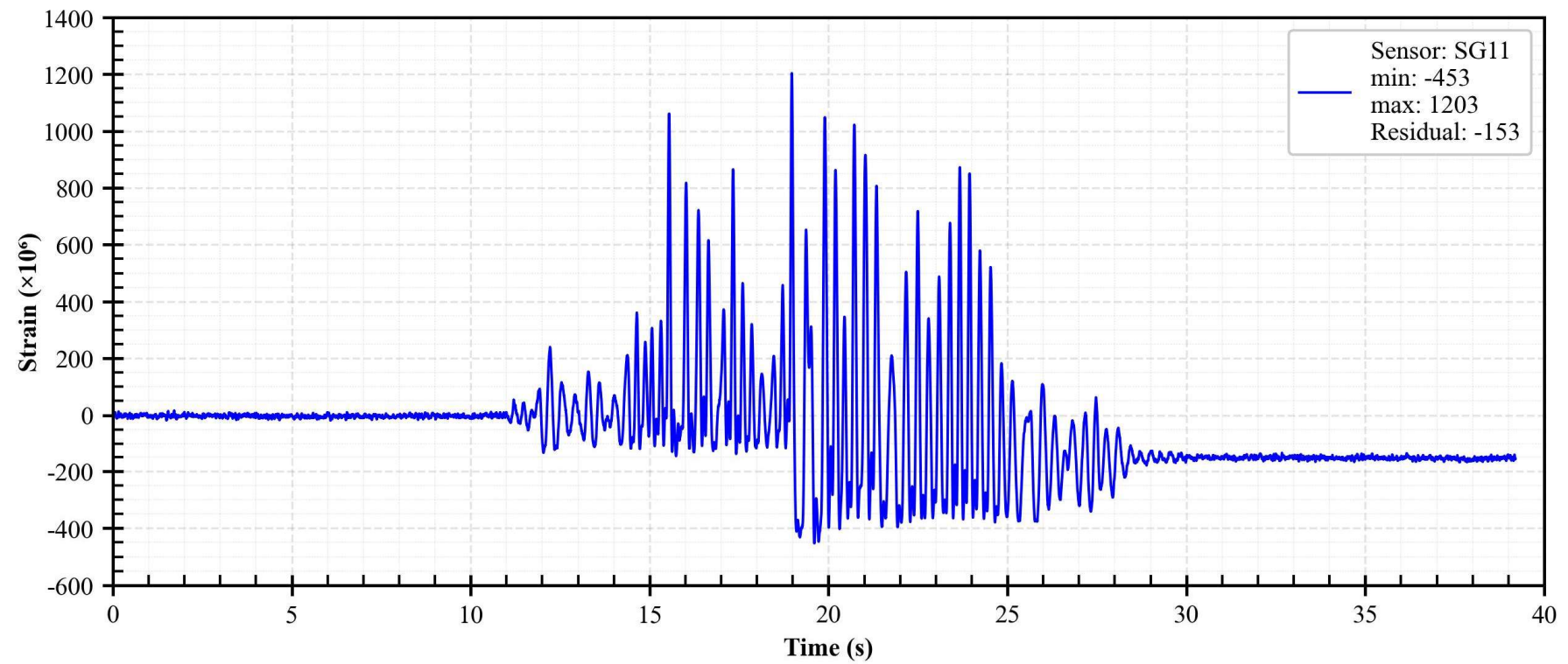


Figure 3.21.12 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 11

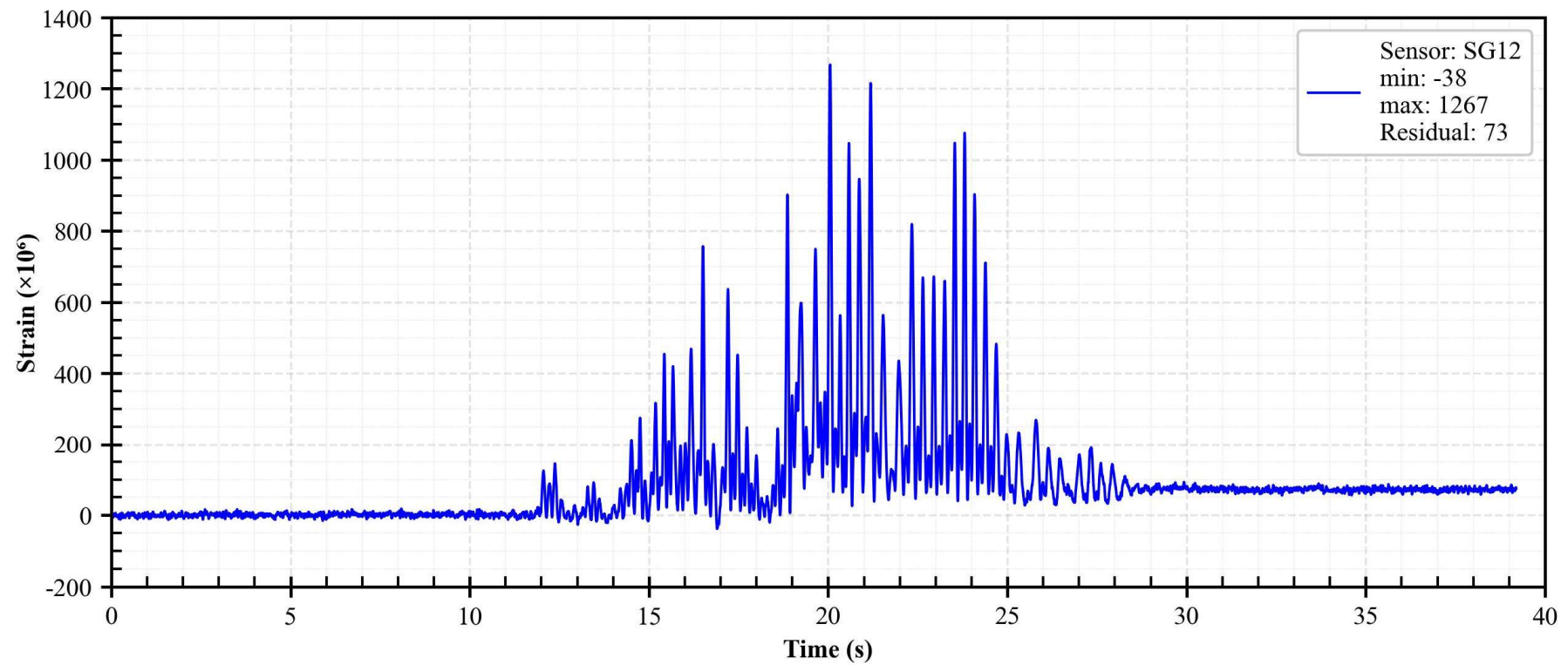


Figure 3.21.13 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 12

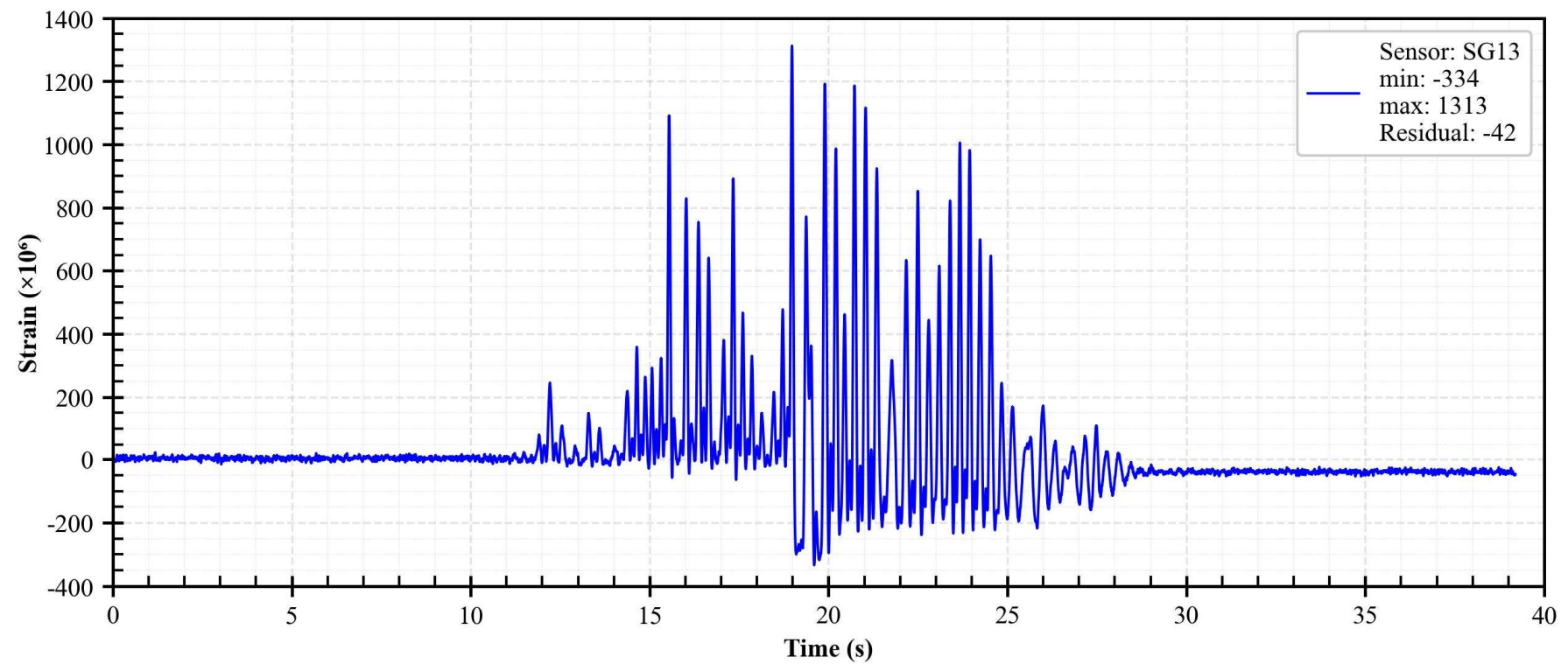


Figure 3.21.14 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 13

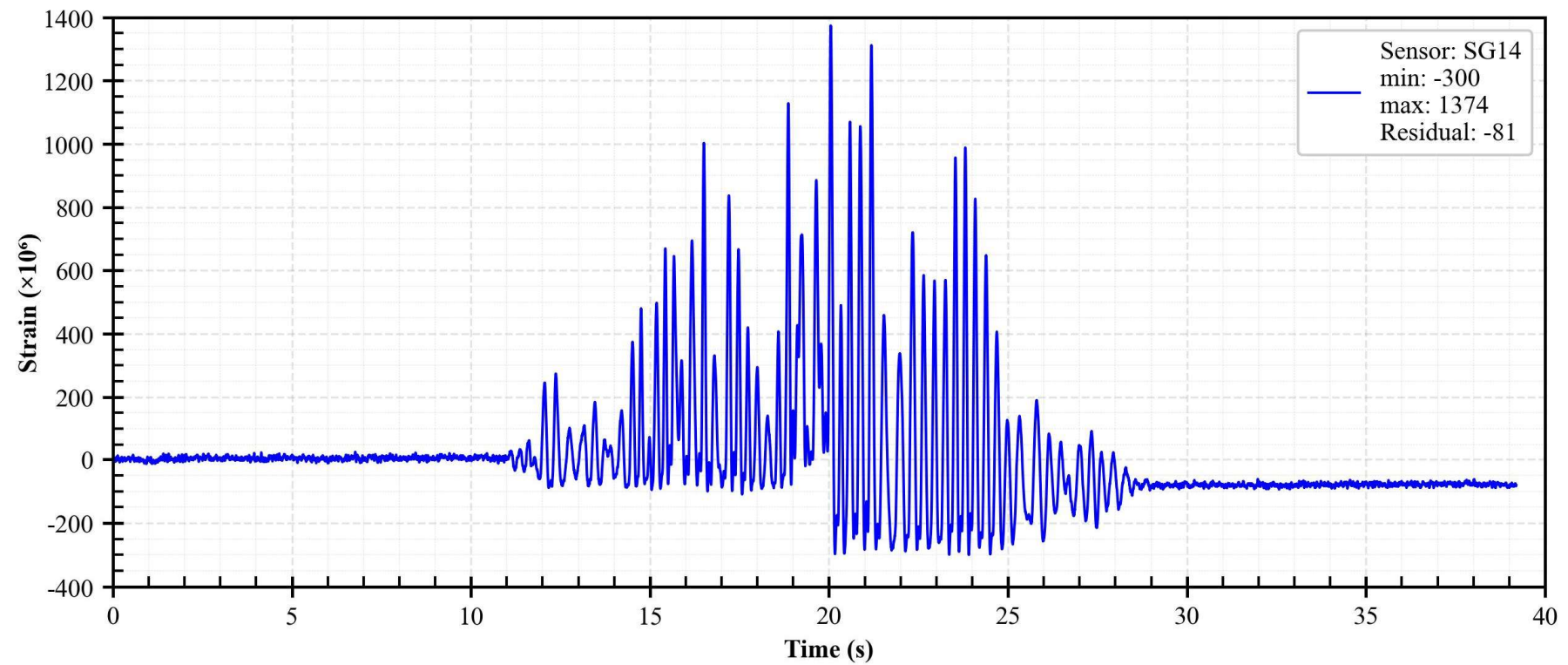


Figure 3.21.15 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 14

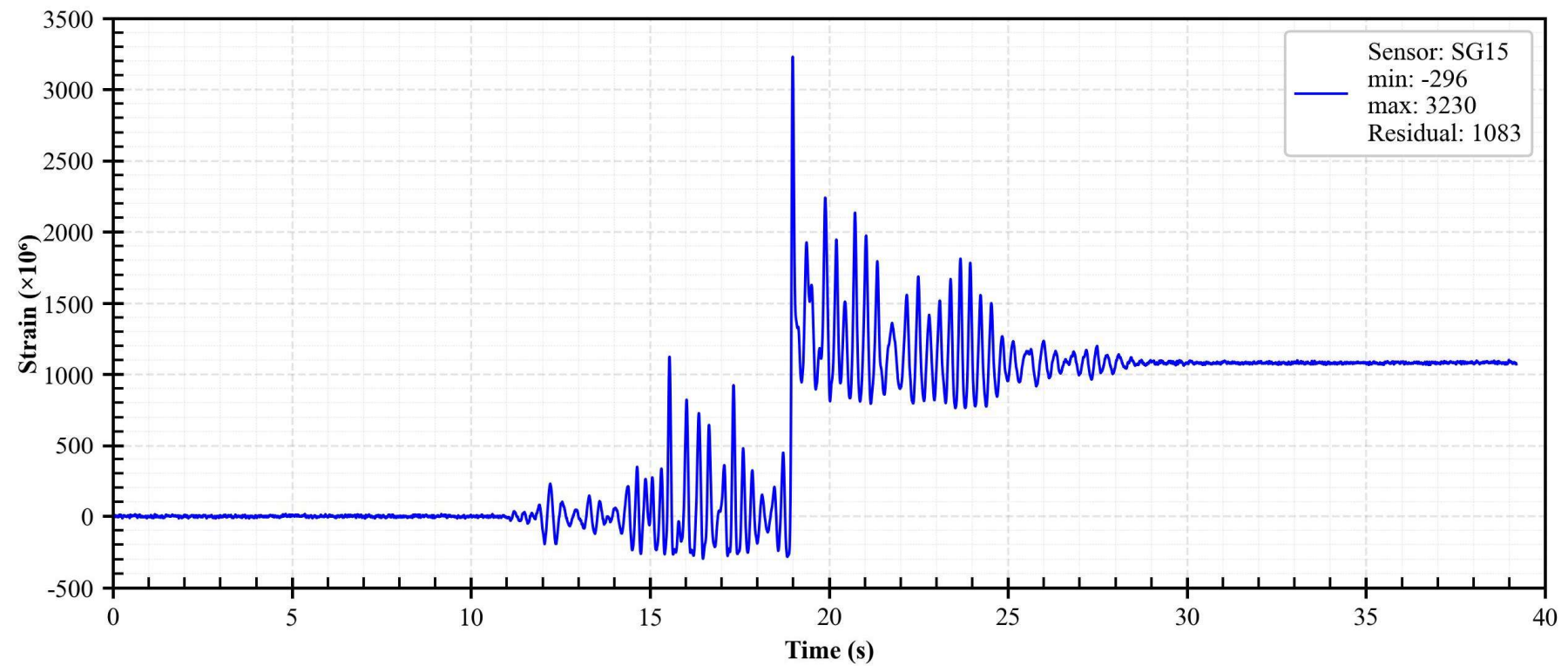


Figure 3.21.16 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 15

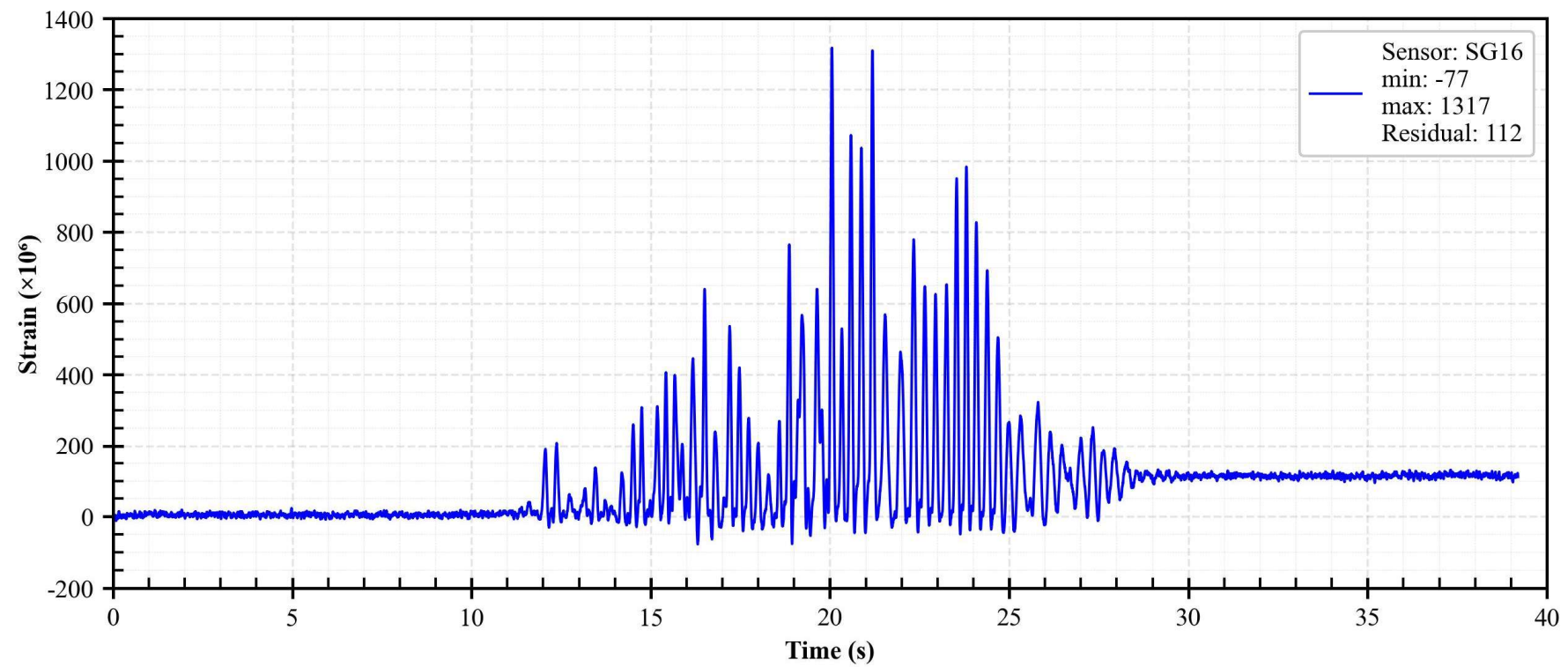


Figure 3.21.17 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 16

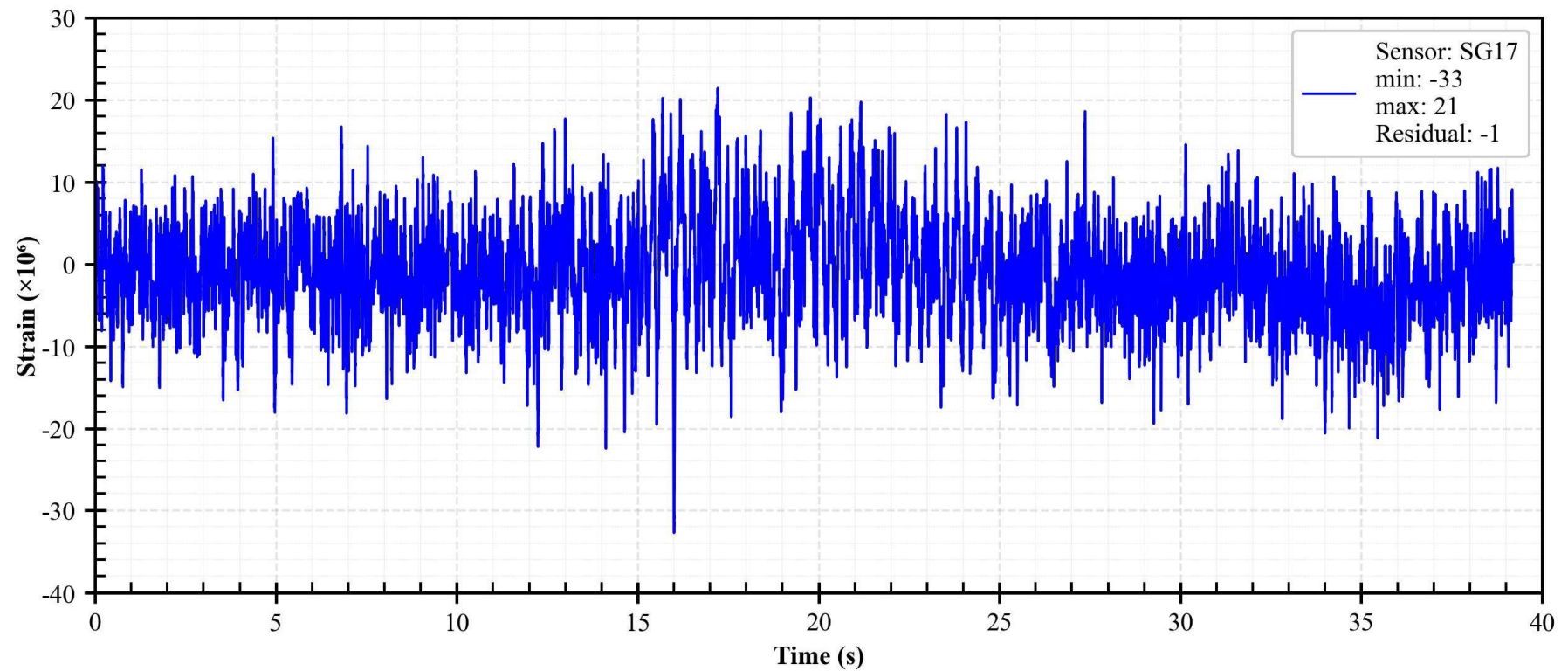


Figure 3.21.18 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 17

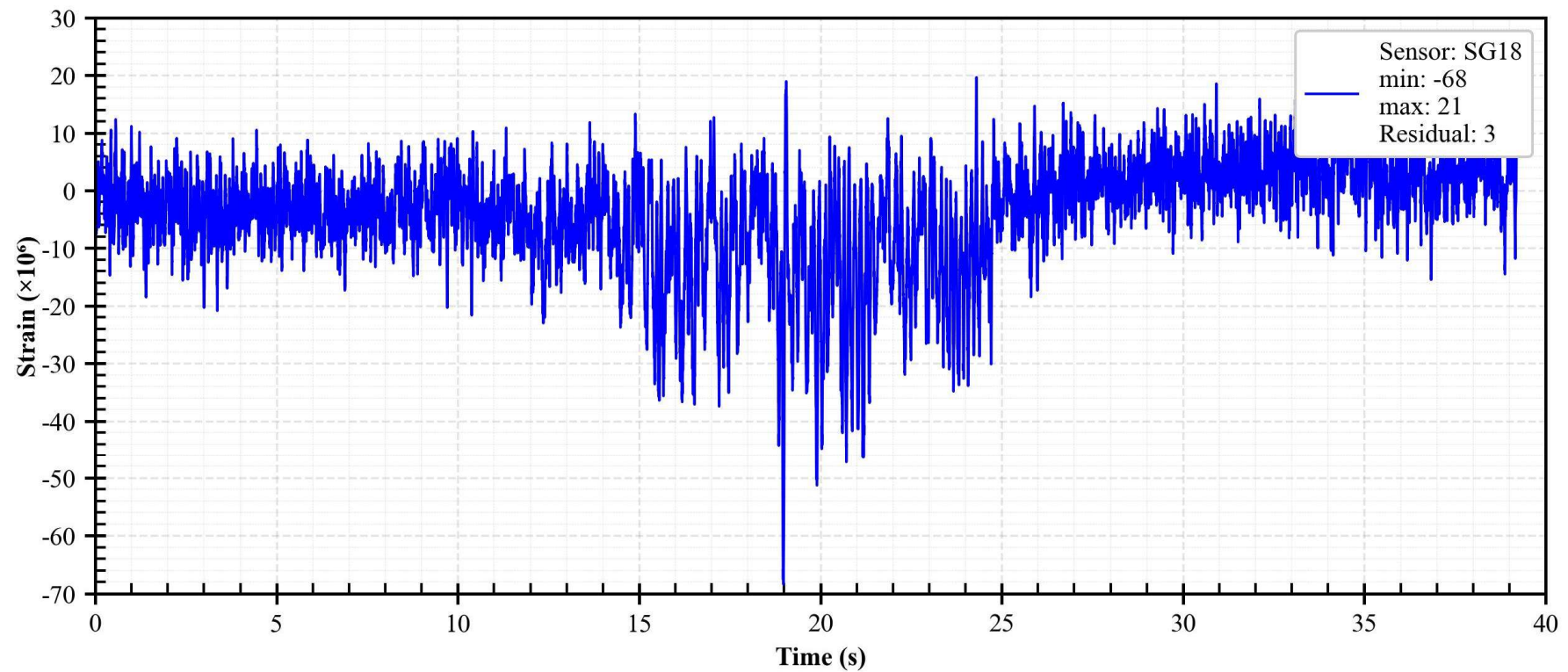


Figure 3.21.19 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 18

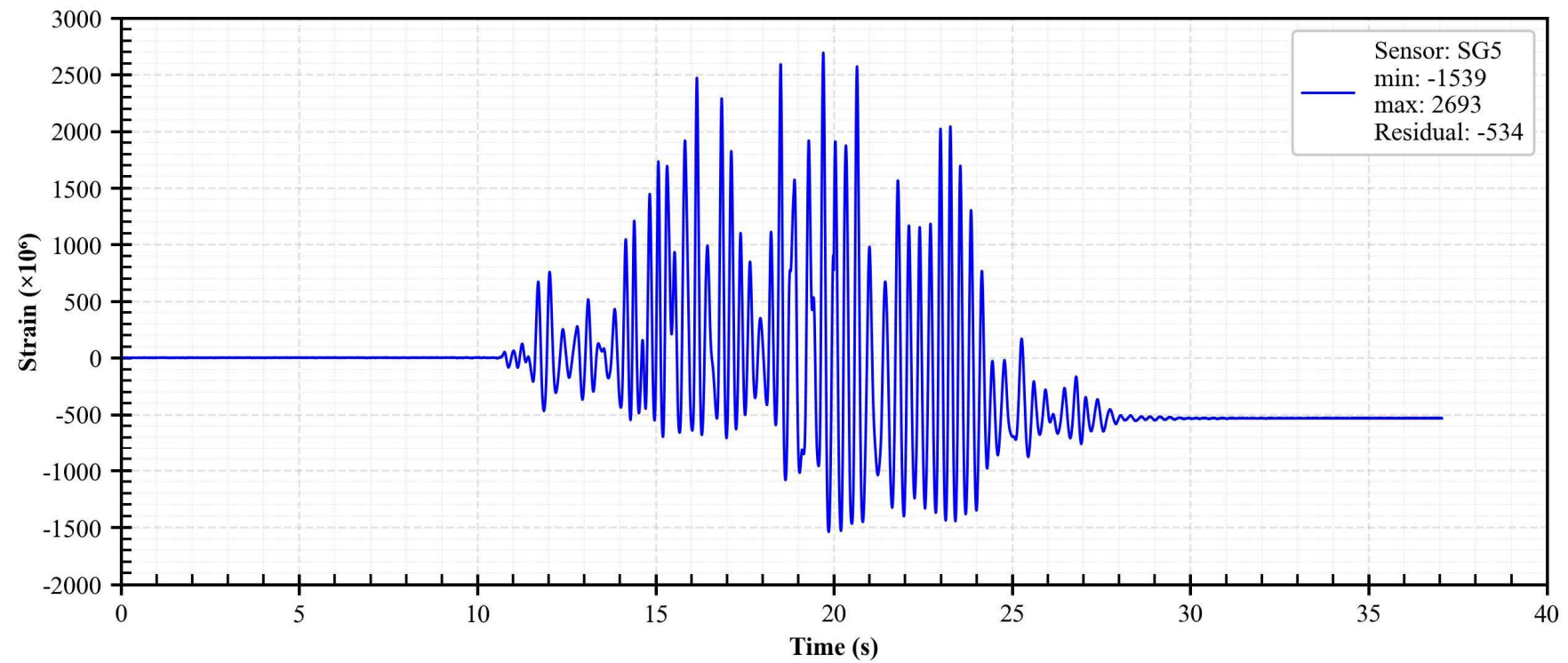


Figure 3.21.20 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 5

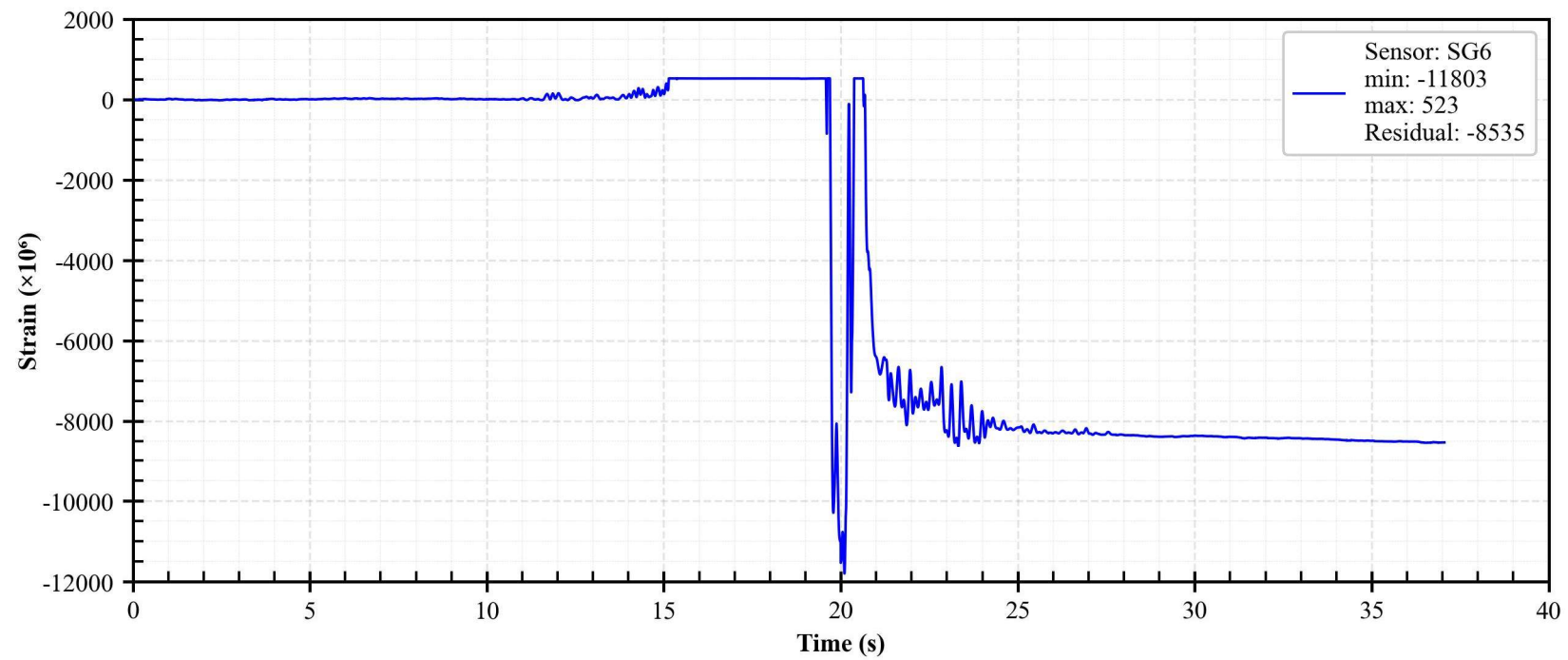


Figure 3.21.21 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 6

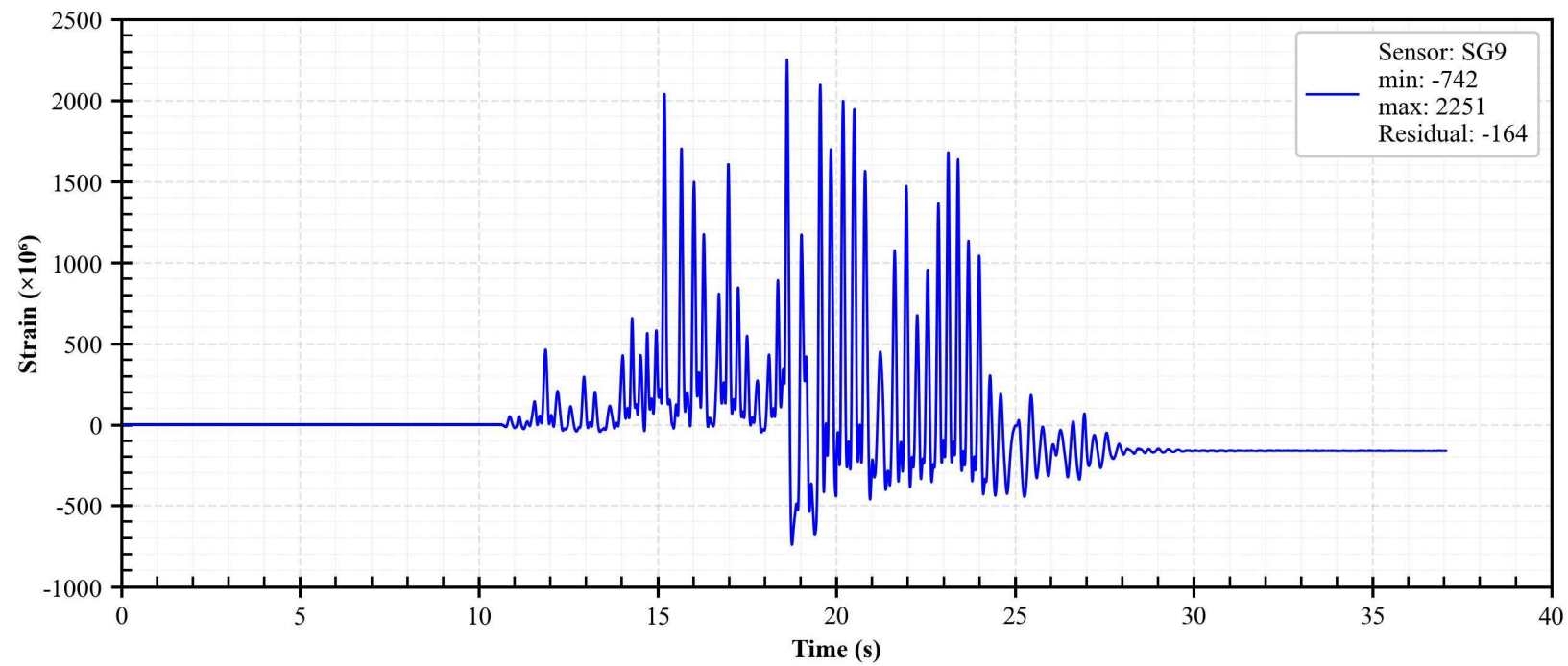


Figure 3.21.22 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 9

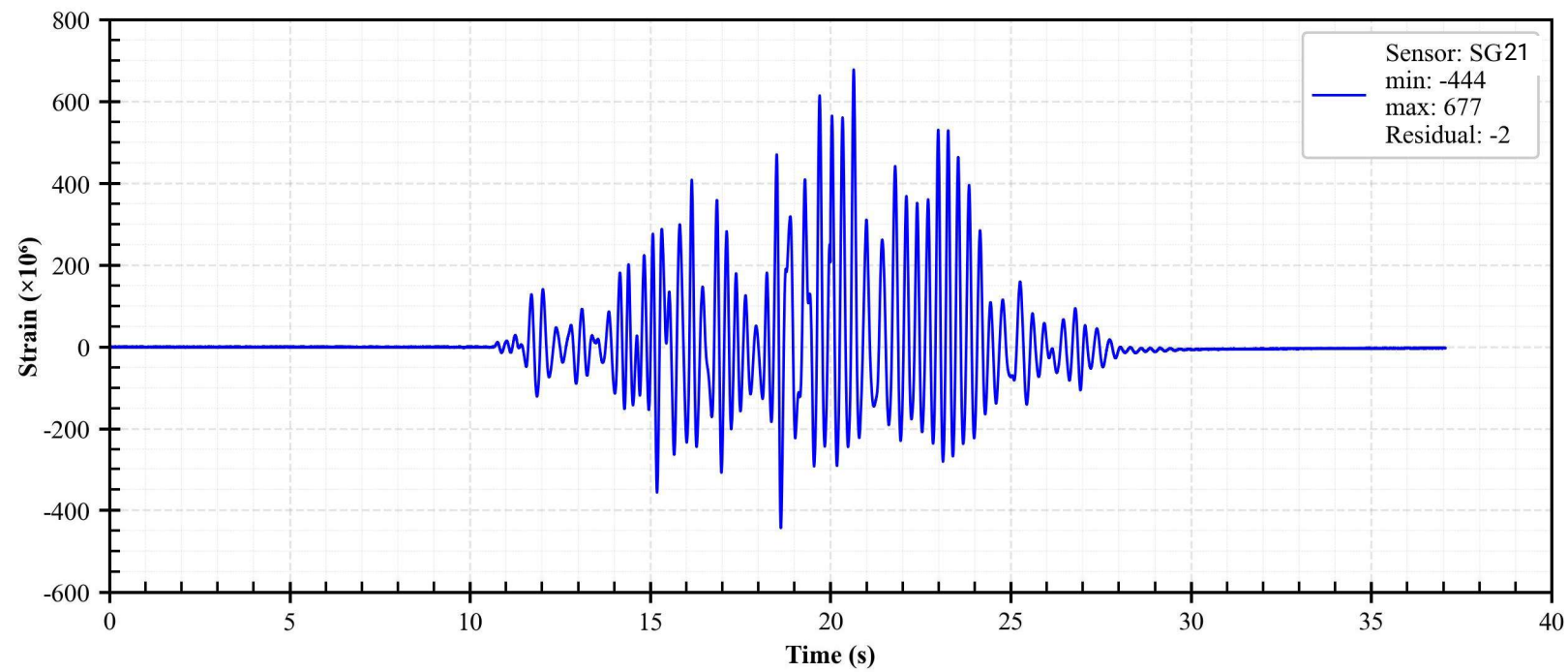


Figure 3.21.23 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 21 (PUFJ, column 1)

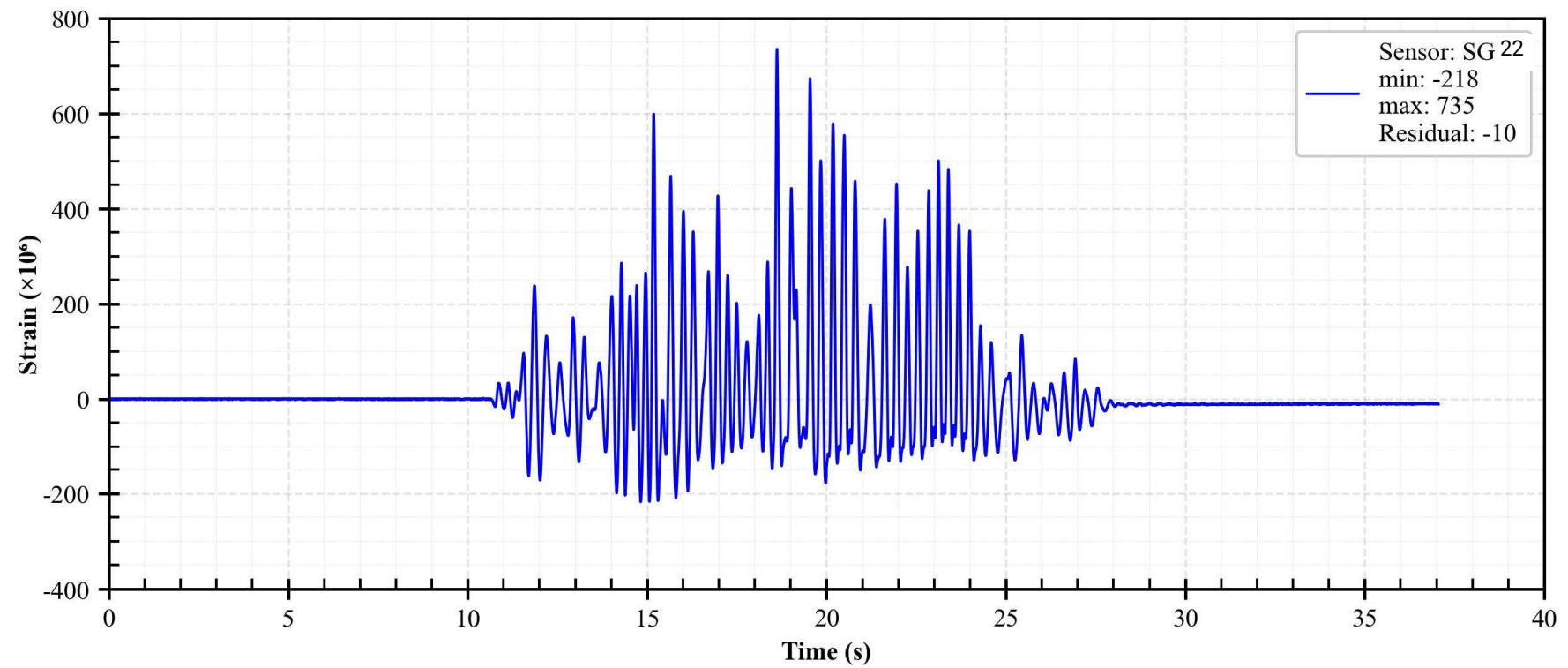


Figure 3.21.24 Characteristic results for phase B (earthquake EQ1,3g): strain gauge 22 (PUFJ, column 2)

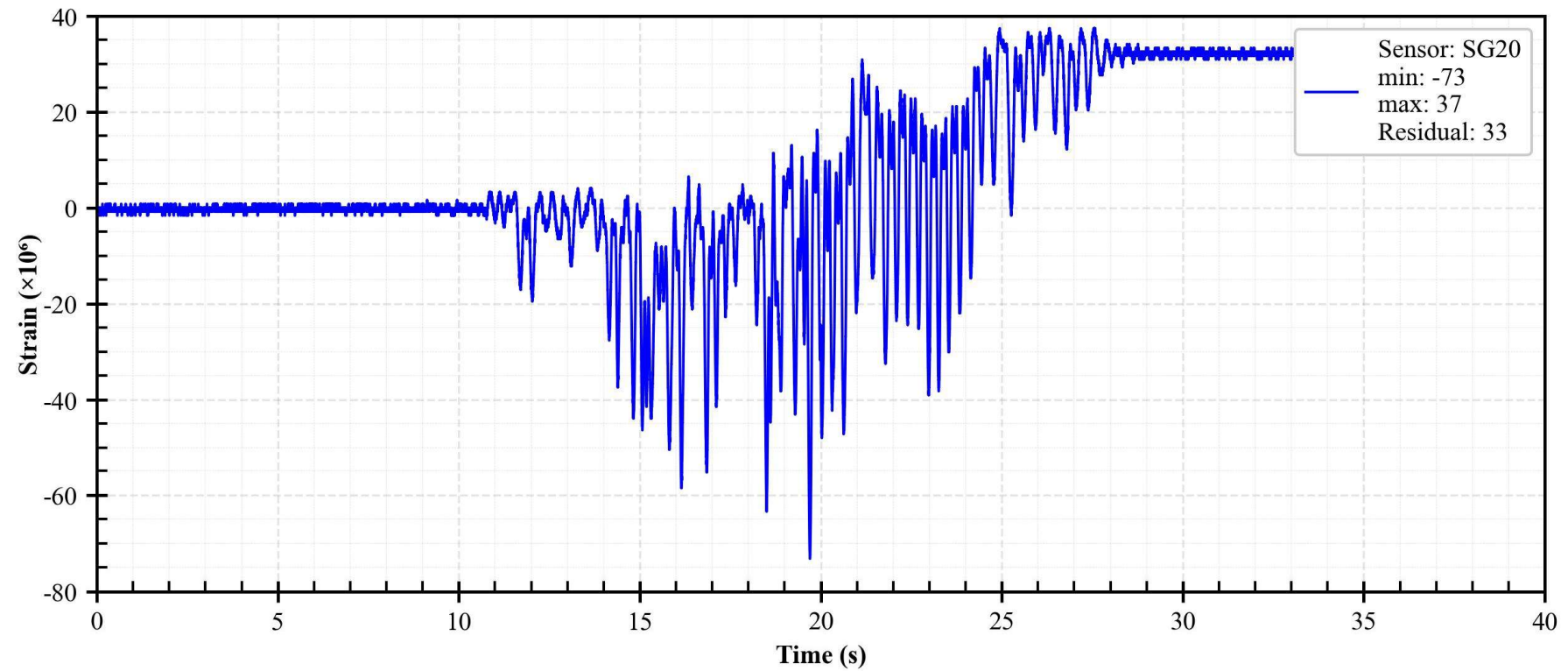


Figure 3.21.25 Characteristic results for phase B (earthquake EQ1,3g): strain gauge

3.22 White noise before EQ1,3g (2)

Draw wire sensors

Figures 3.22.1 – 3.22.5 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 21.57 mm while the minimum is -16.66 mm. The maximum movement detected by draw wire sensor W2 is 21.74 mm while the minimum is -16.86 mm. The maximum movement detected by draw wire sensor W3 is 20.97 mm while the minimum is -16.28 mm. The maximum movement detected by draw wire sensor W4 is 21.18 mm while the minimum is -16.42 mm. The maximum drift is $(3.56/1.225) = 2.91 \text{ ‰}$ and minimum drift is $(-3.94/1.225) = -3.22 \text{ ‰}$.

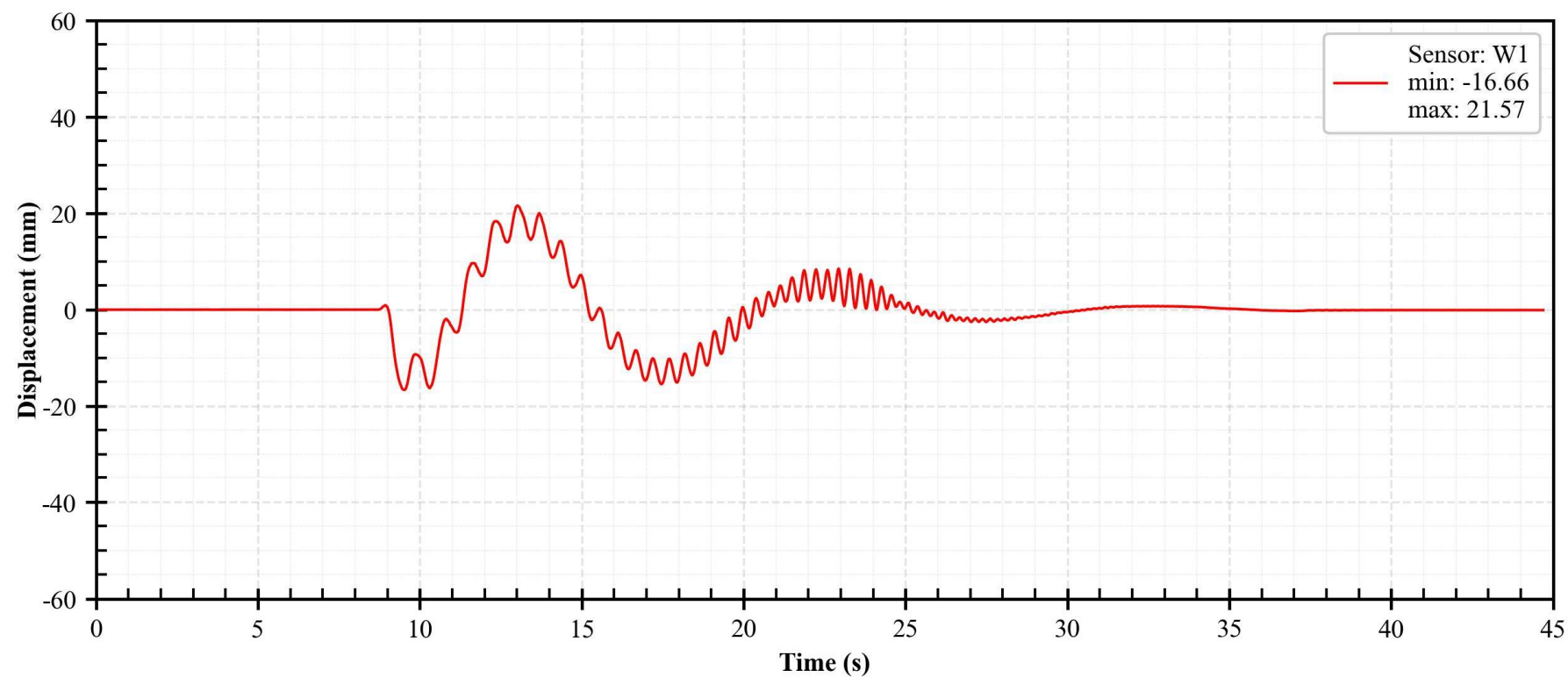


Figure 3.22.1 Characteristic results for phase B (white noise before EQ1,3g(2)): Draw wire sensor 1

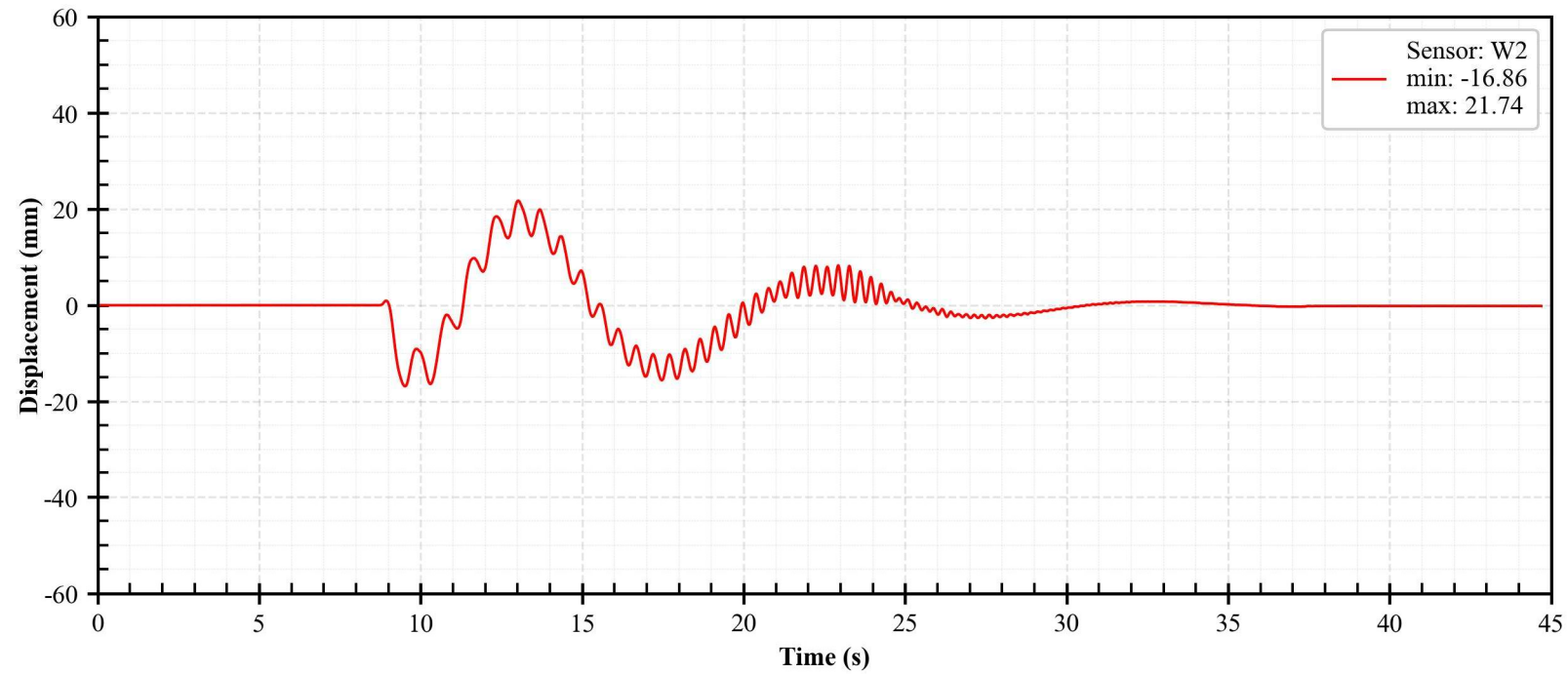


Figure 3.22.2 Characteristic results for phase B (white noise before EQ1,3g(2)): Draw wire sensor 2

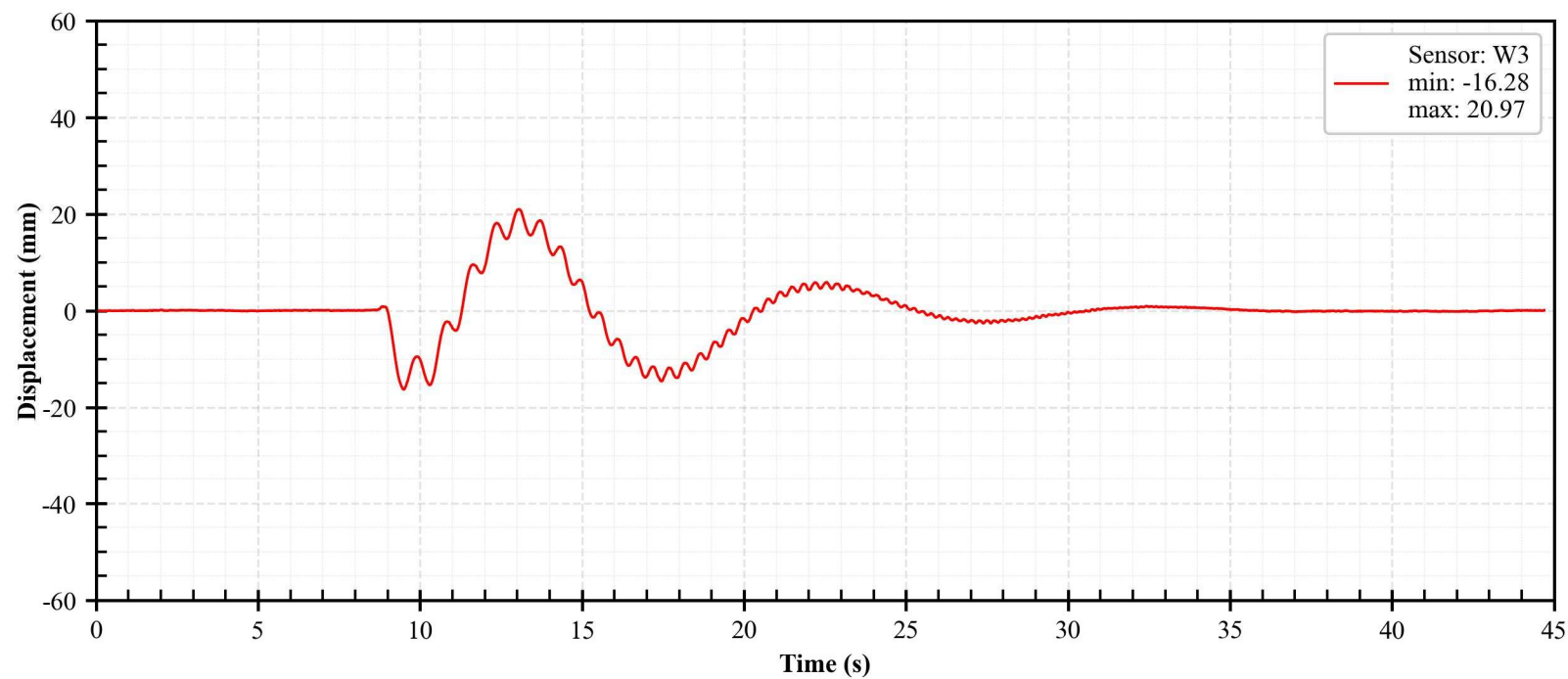


Figure 3.22.3 Characteristic results for phase B (white noise before EQ1,3g(2)): Draw wire sensor 3

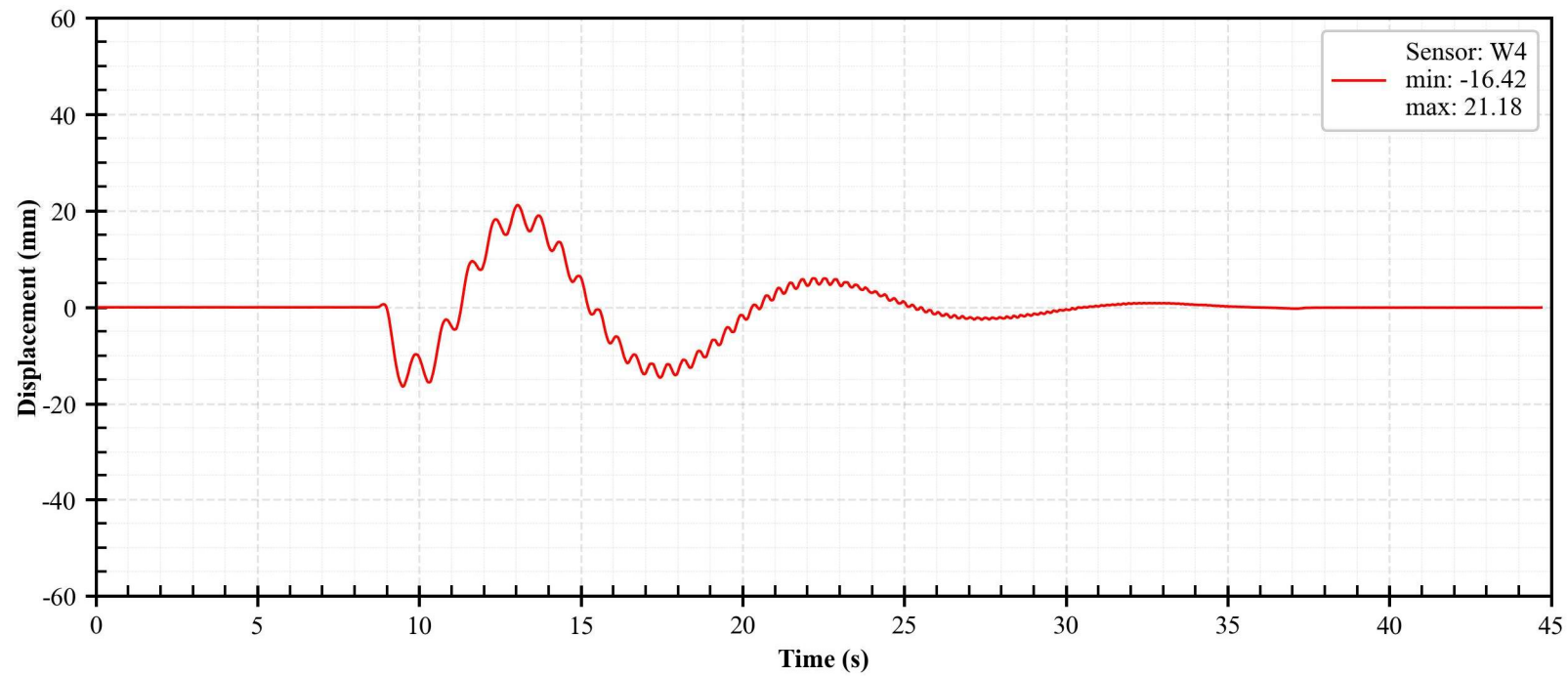


Figure 3.22.4 Characteristic results for phase B (white noise before EQ1,3g (2)): Draw wire sensor 4

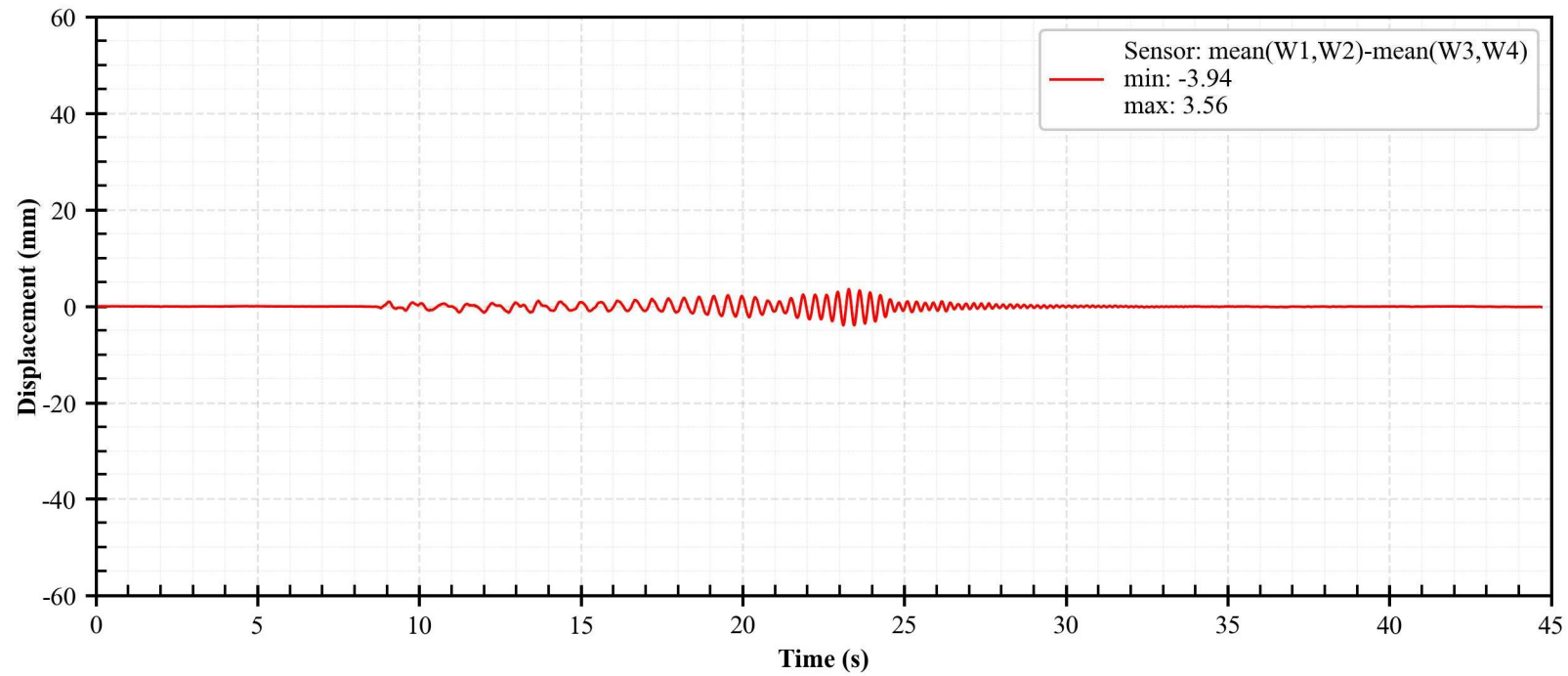


Figure 3.22.5 Characteristic results for phase B (white noise before EQ1,3g (2)): mean (W1,W2) - mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

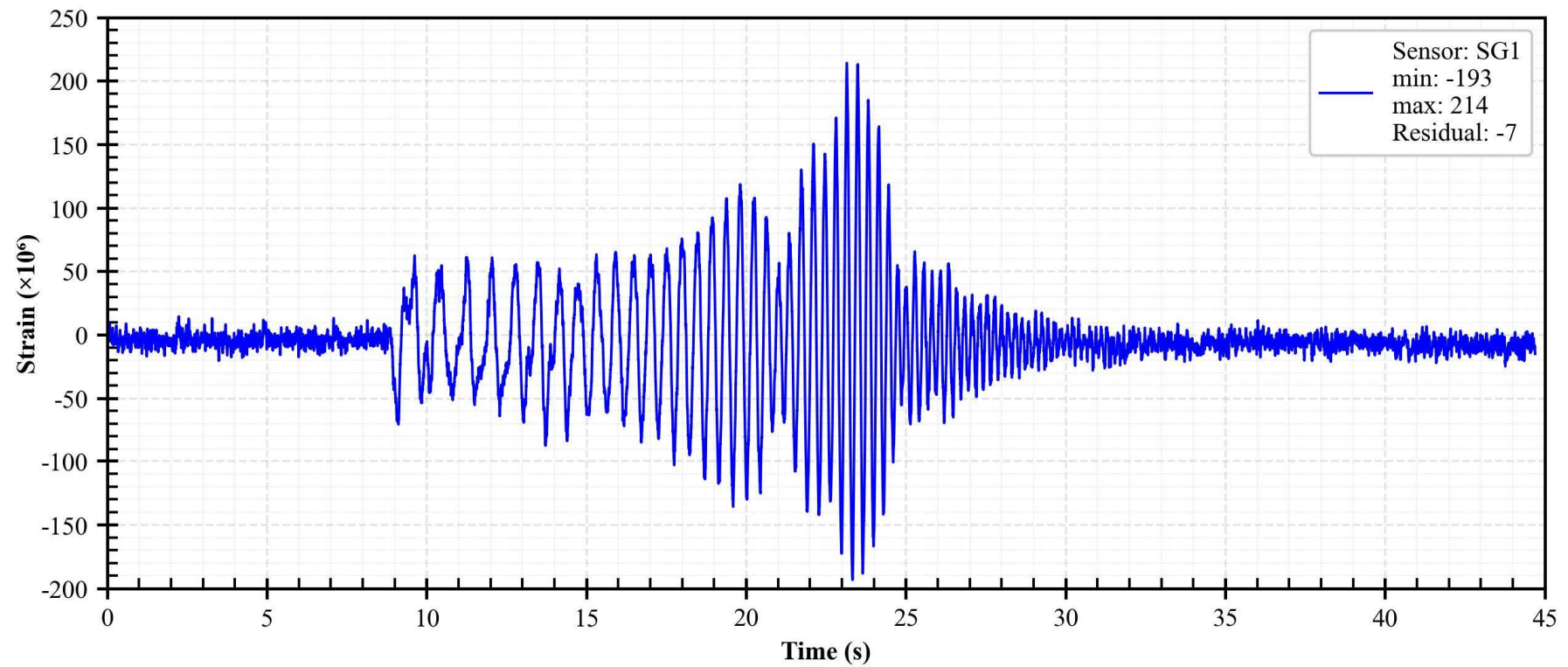


Figure 3.22.6 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 1

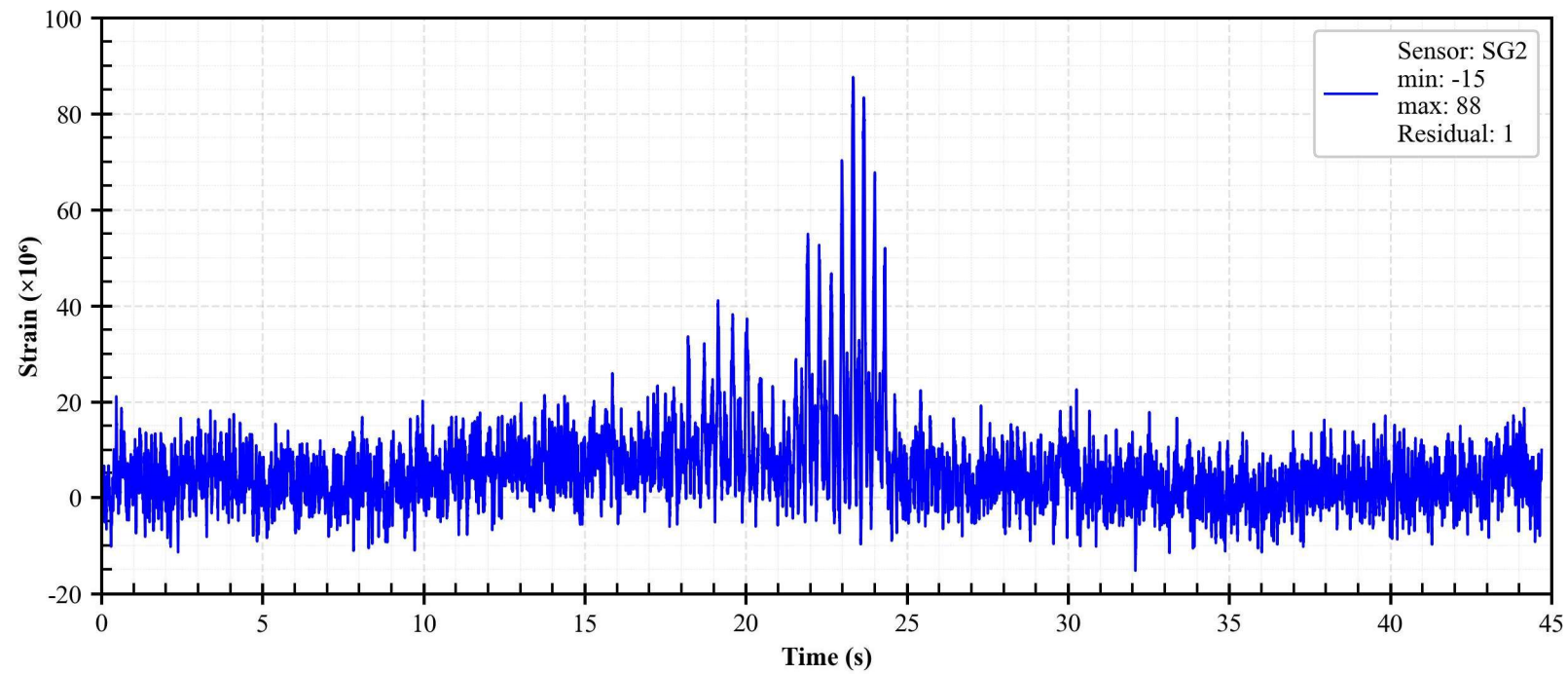


Figure 3.22.7 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 2

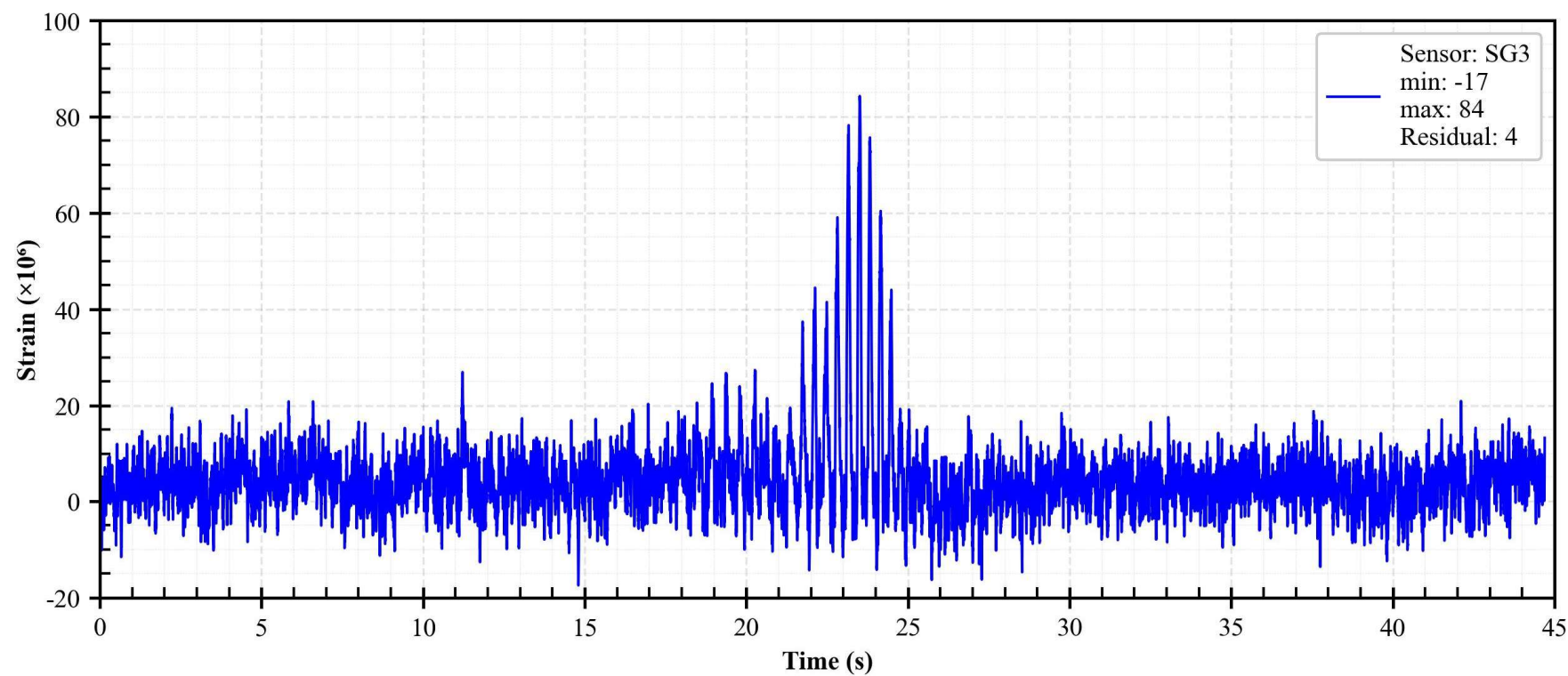


Figure 3.22.8 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 3

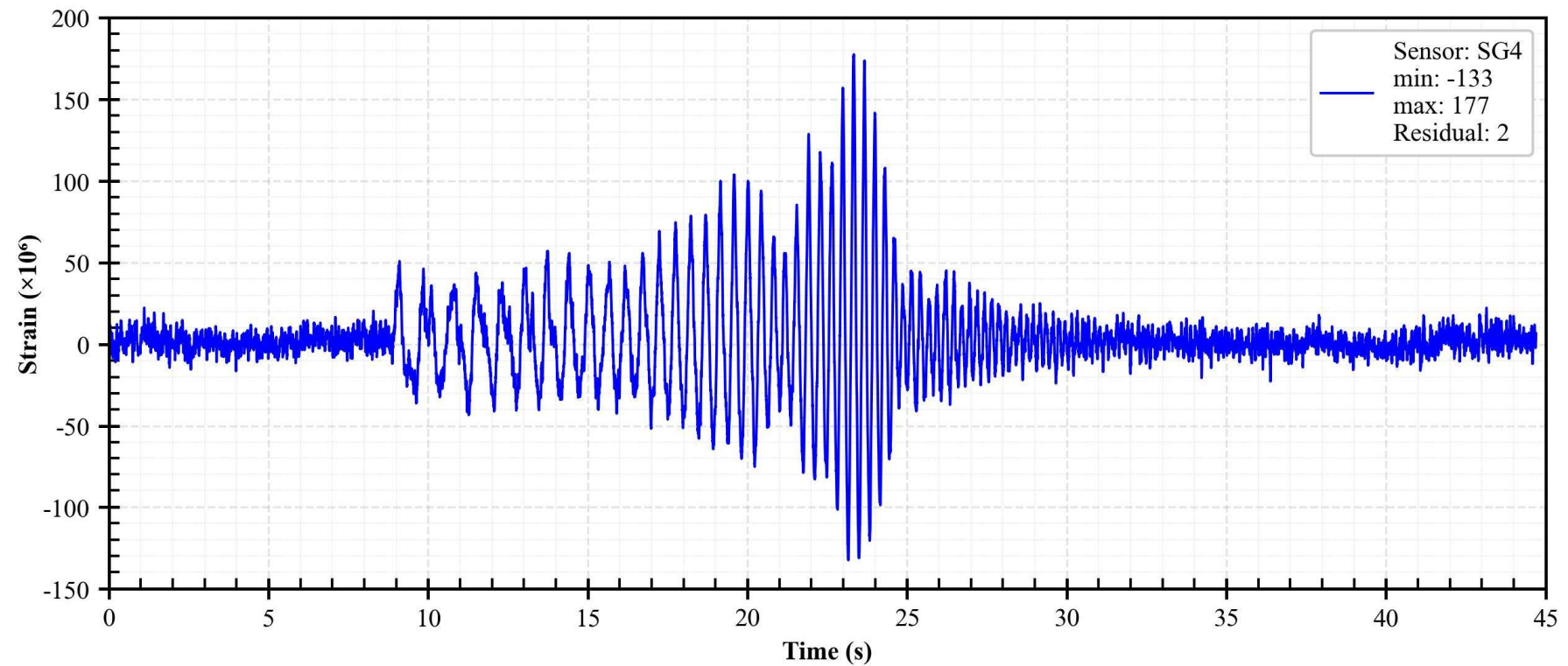


Figure 3.22.9 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 4

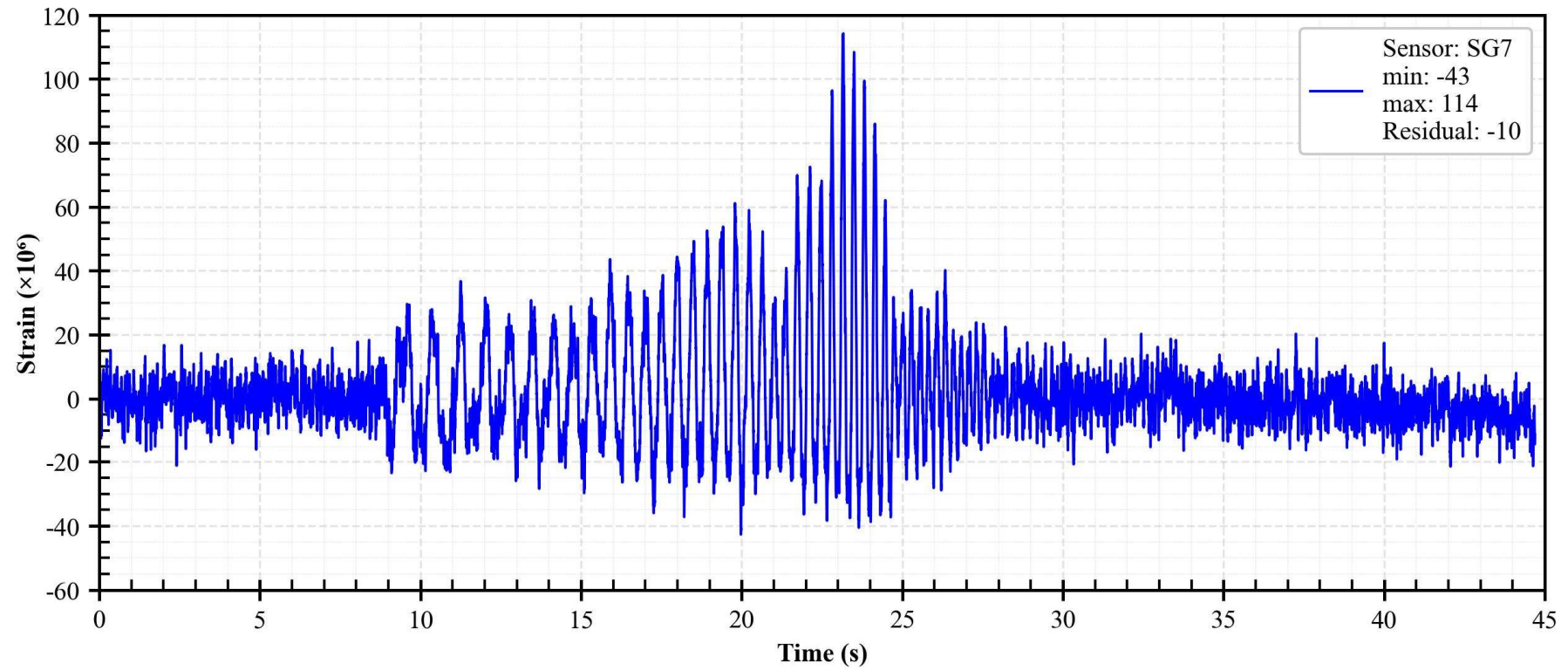


Figure 3.22.10 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 7

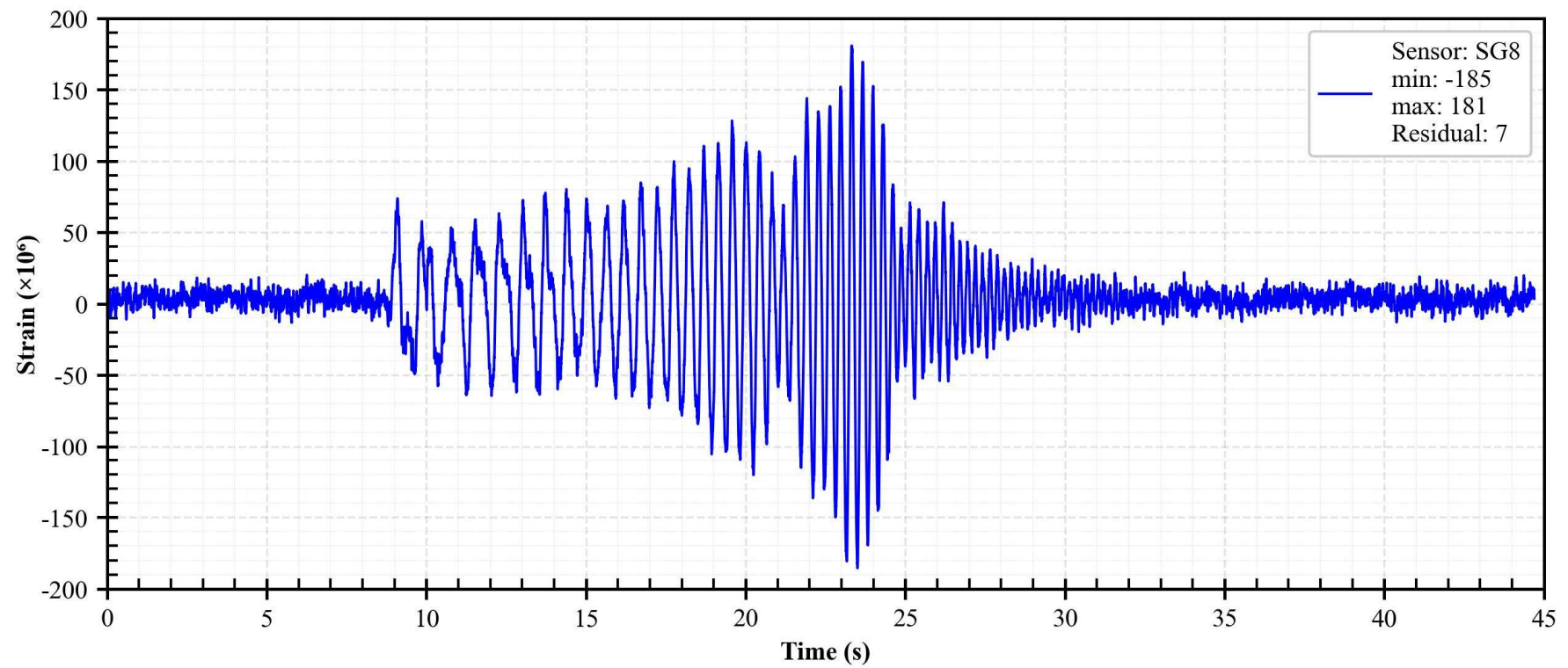


Figure 3.22.11 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 8

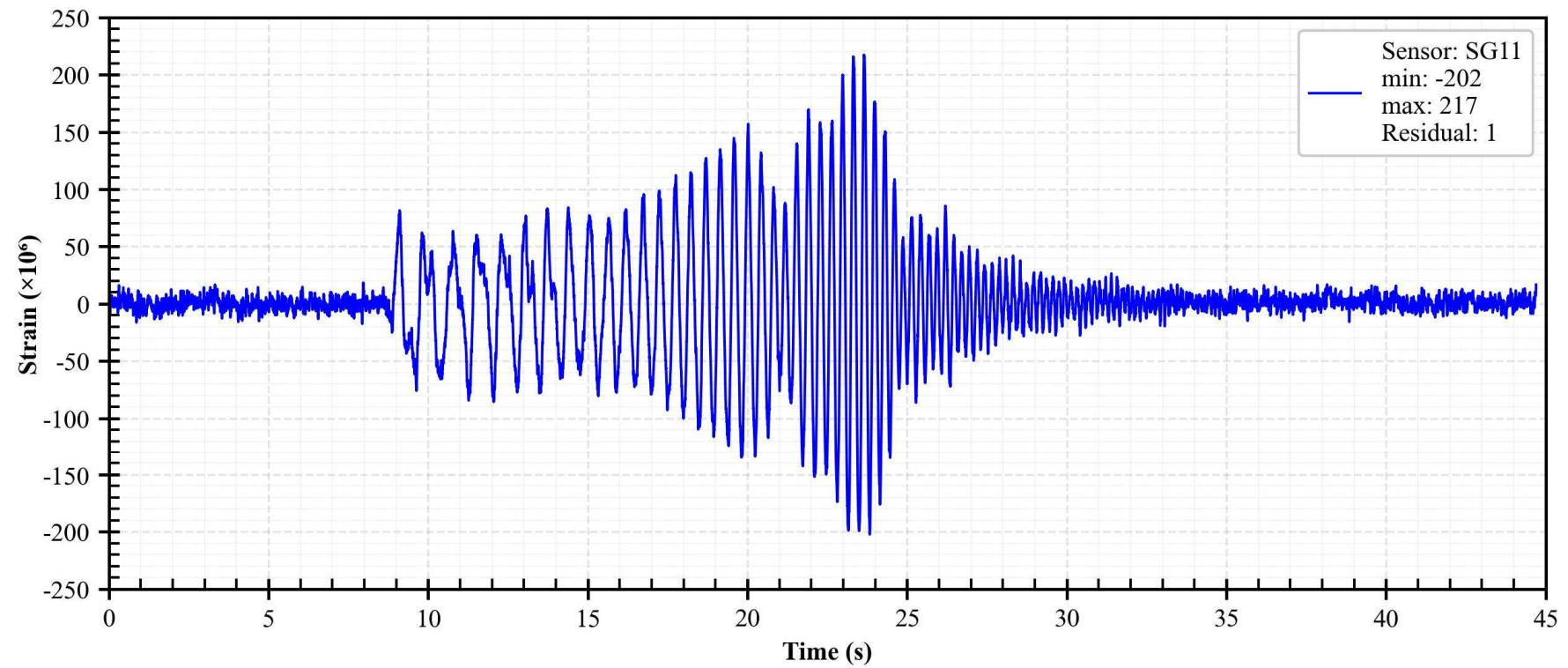


Figure 3.22.12 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 11

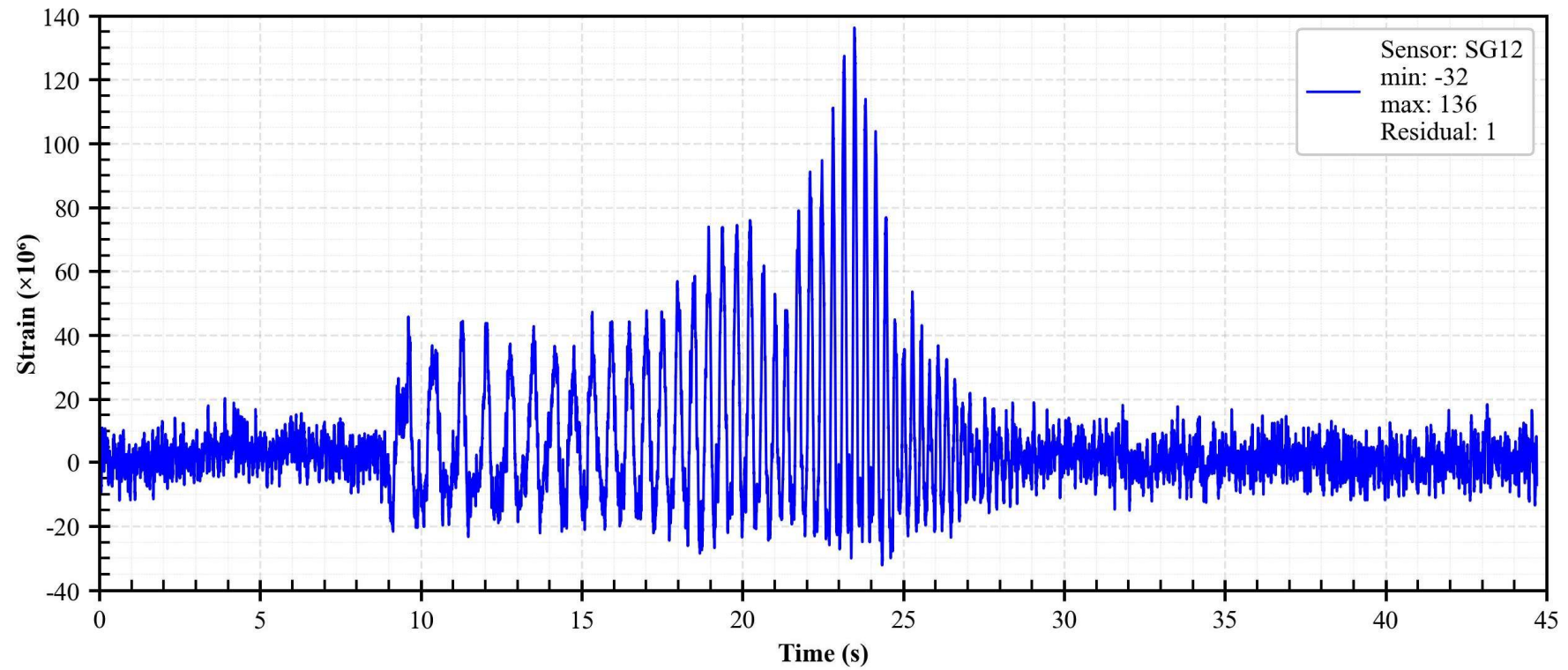


Figure 3.22.13 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 12

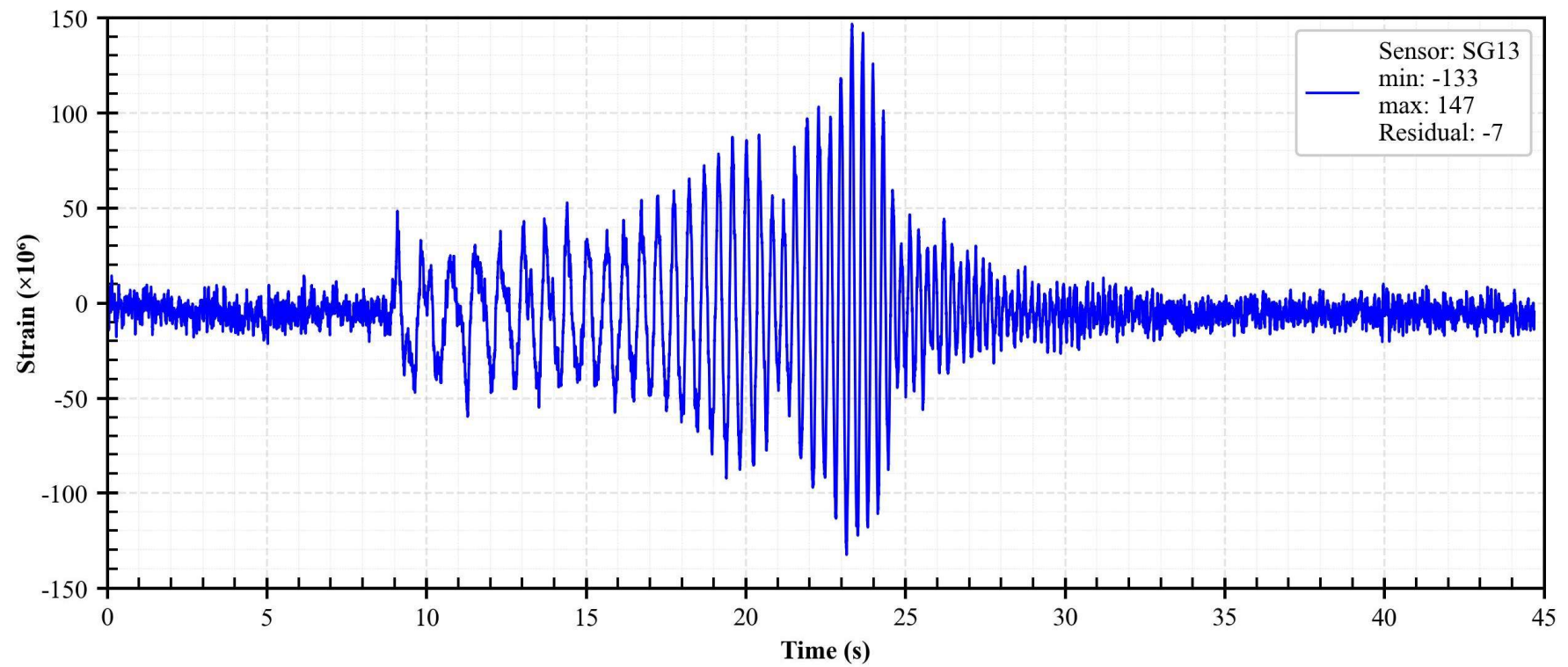


Figure 3.22.14 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 13

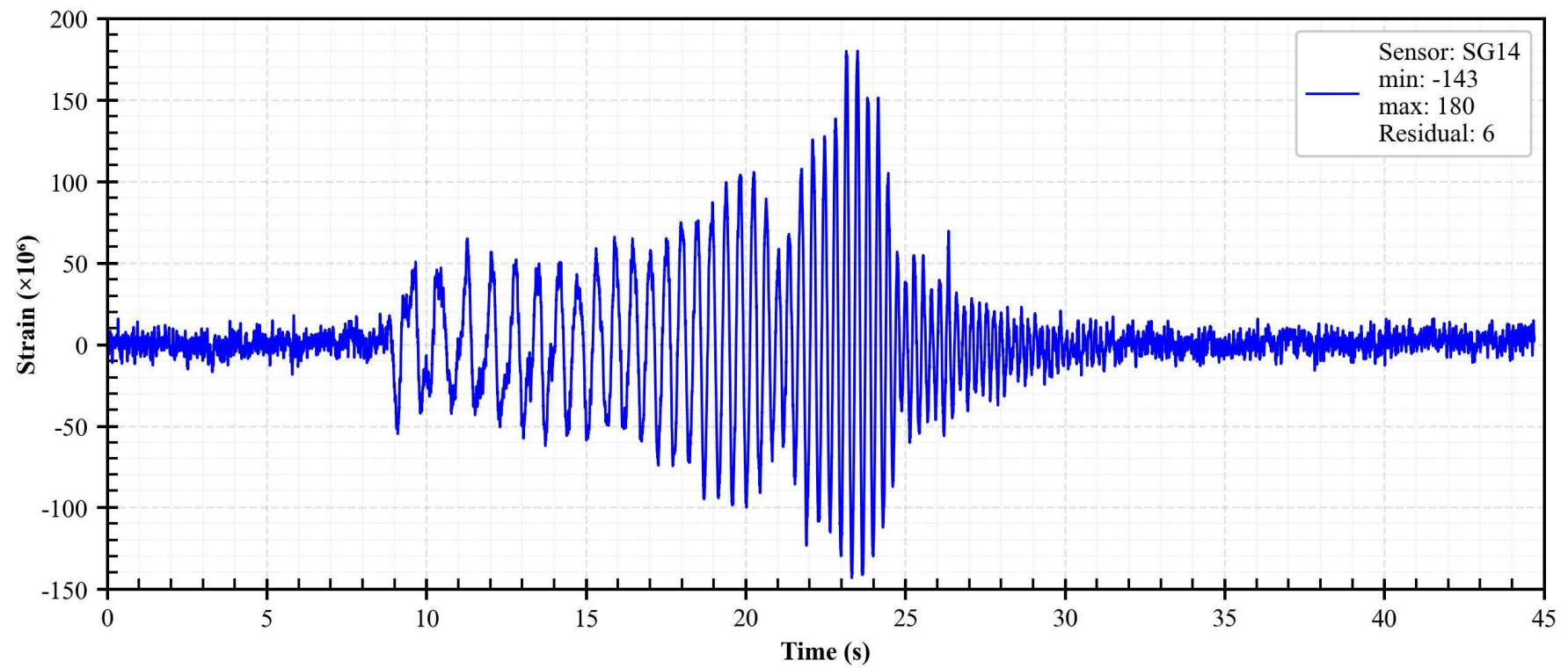


Figure 3.22.15 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 14

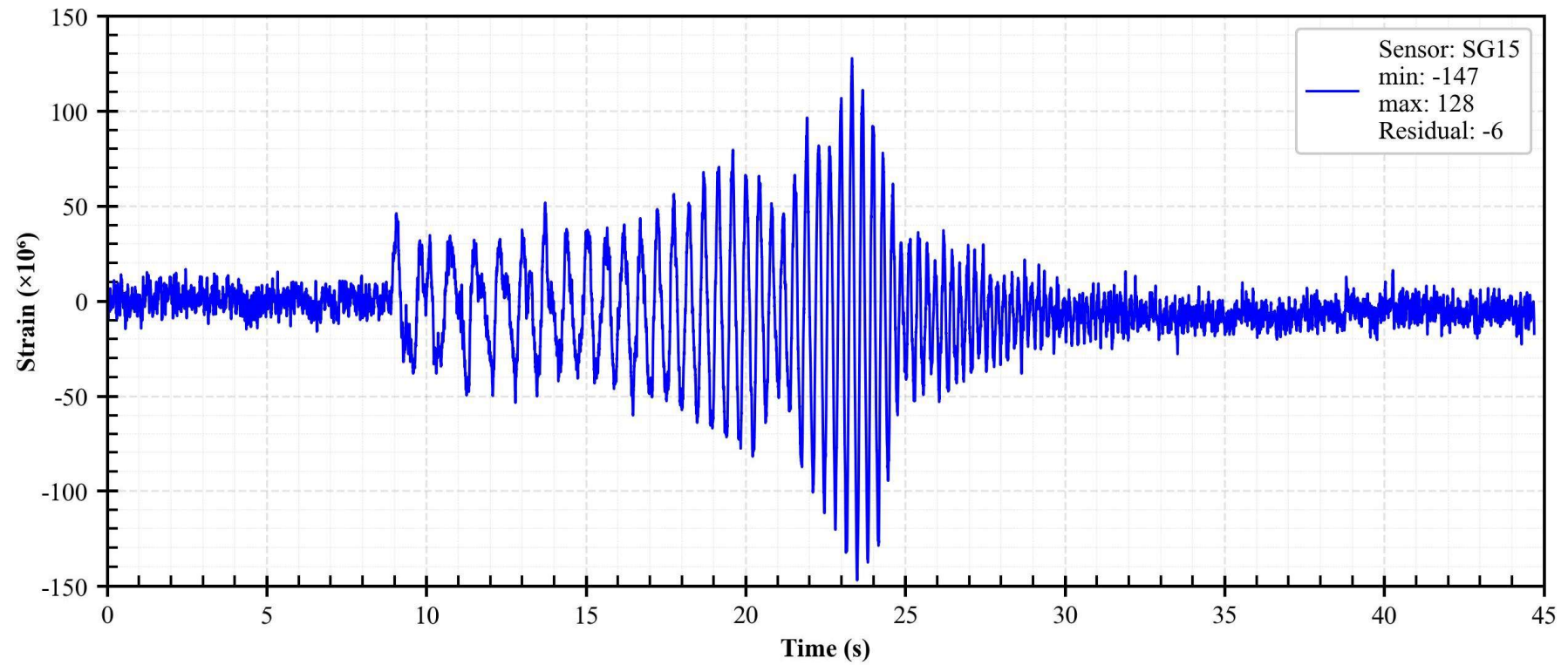


Figure 3.22.16 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 15

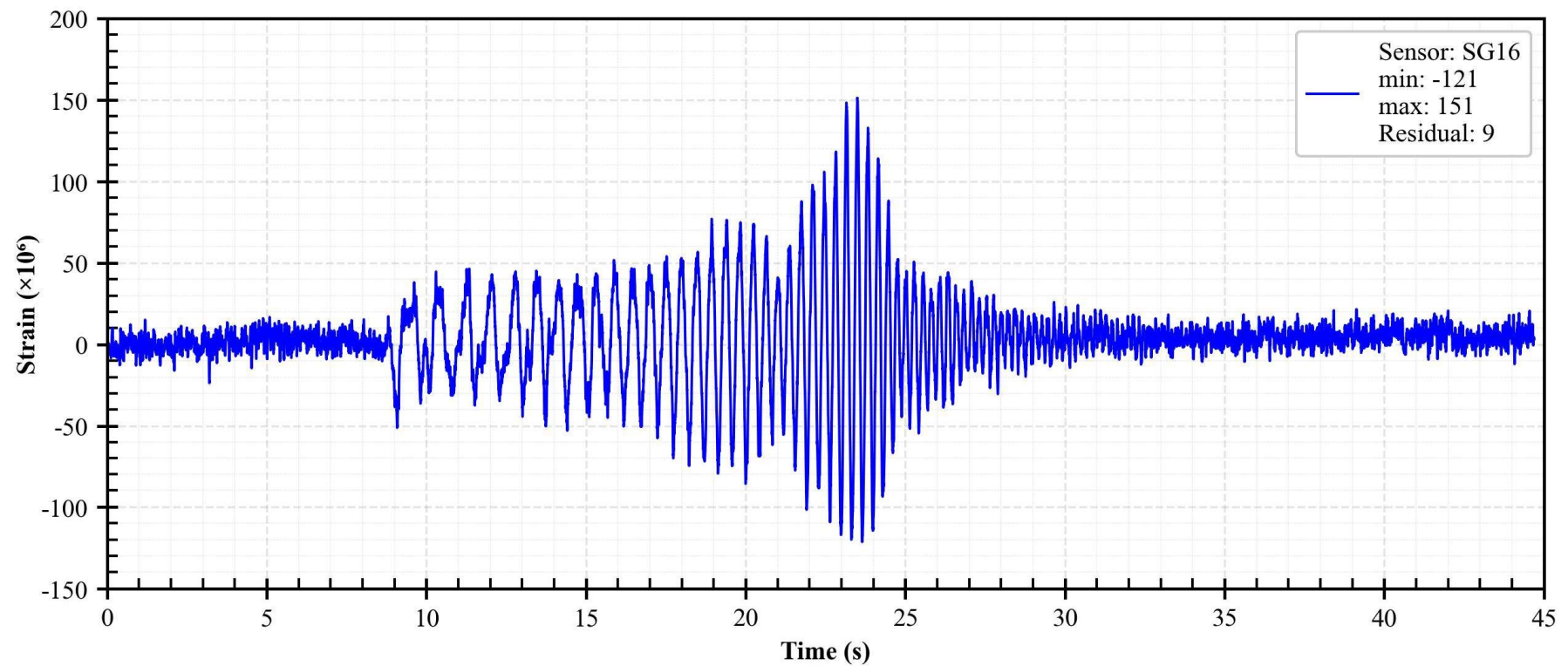


Figure 3.22.17 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 16

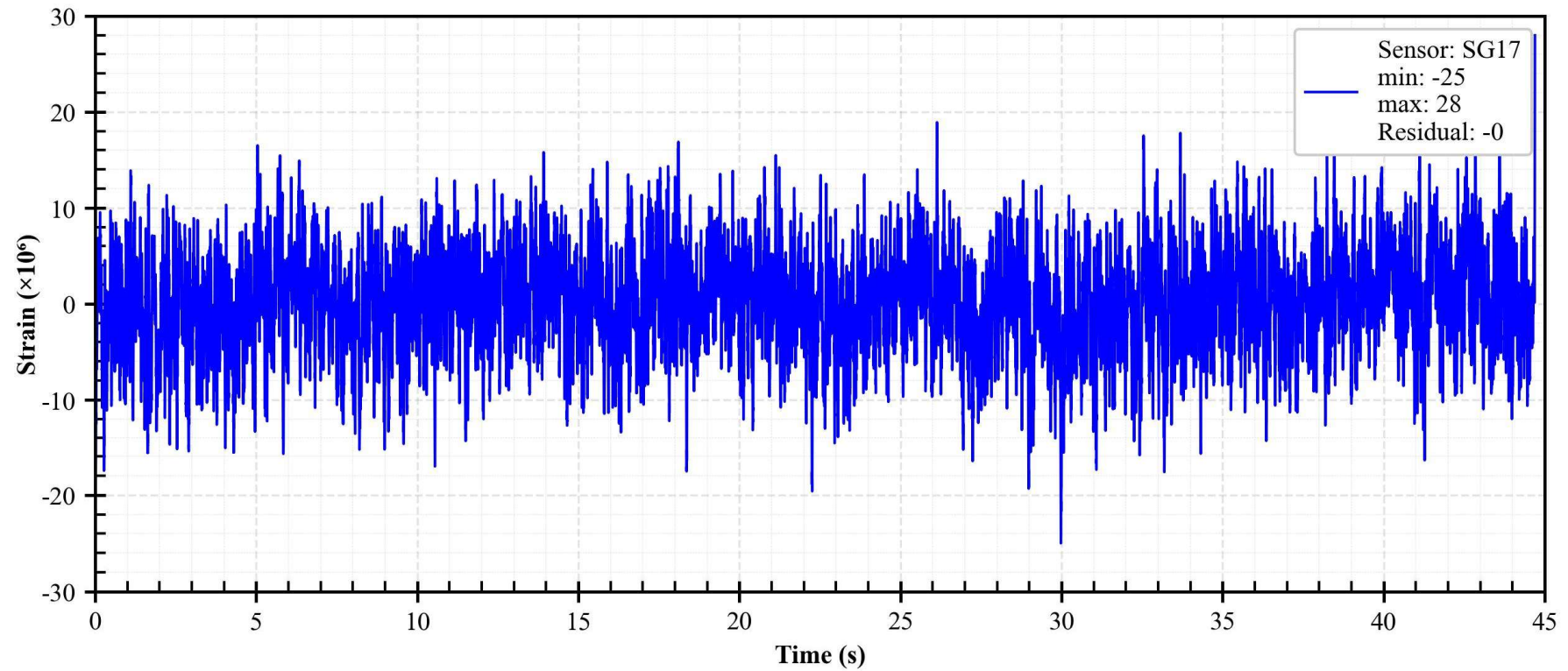


Figure 3.22.18 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 17

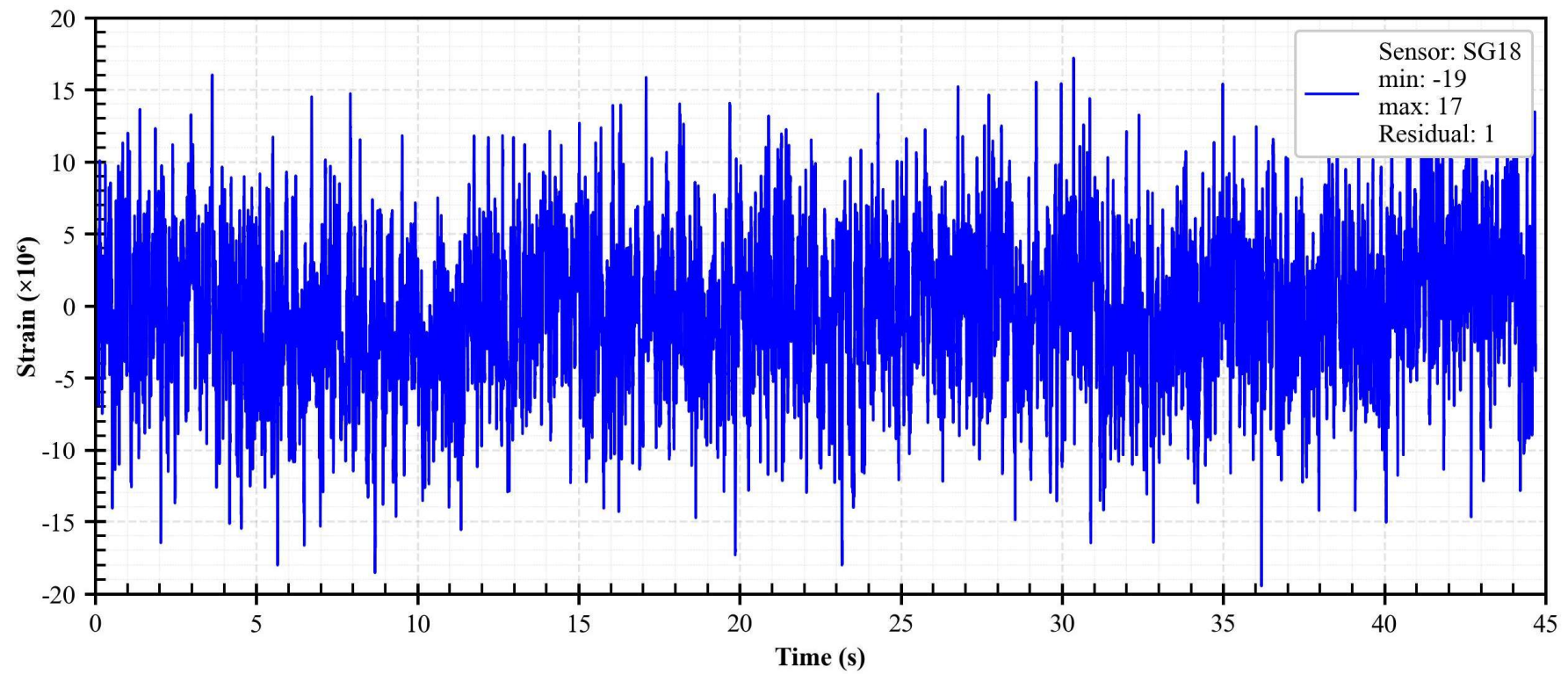


Figure 3.22.19 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 18

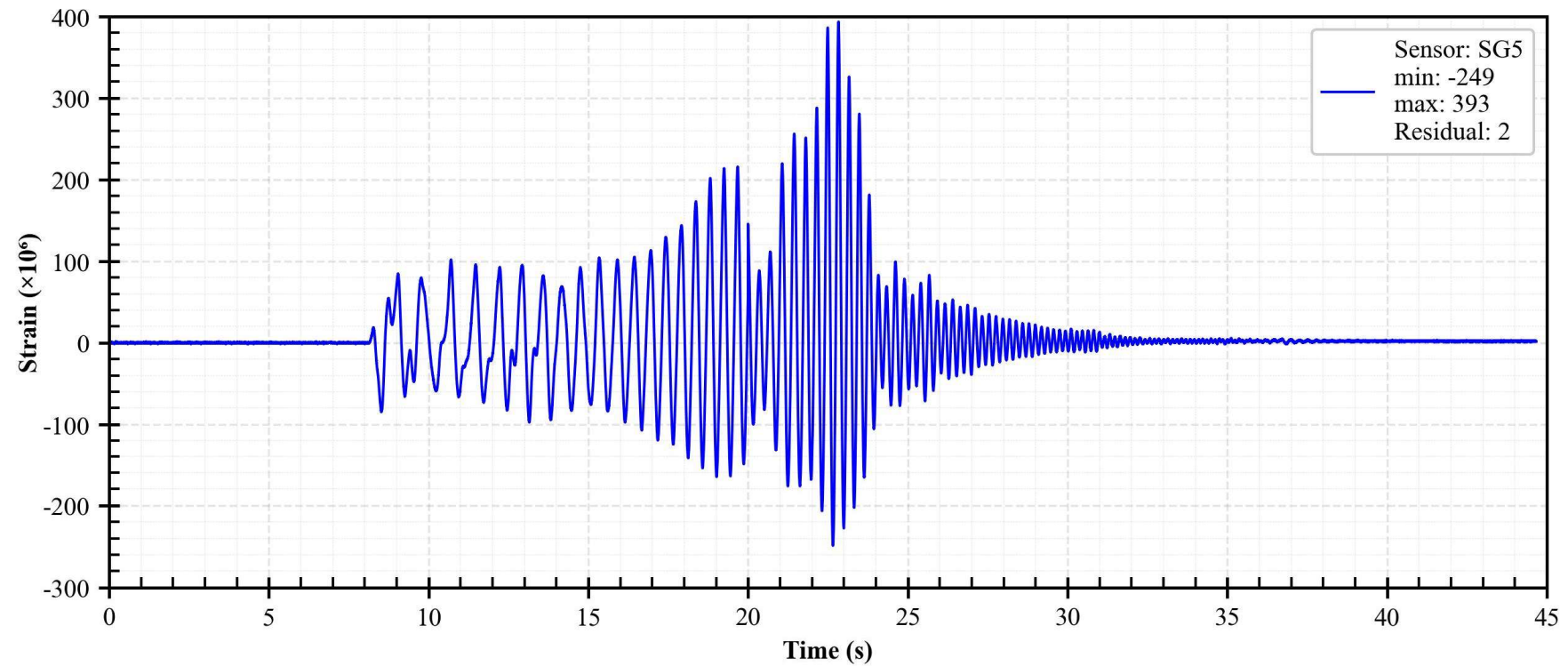


Figure 3.22.20 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 5

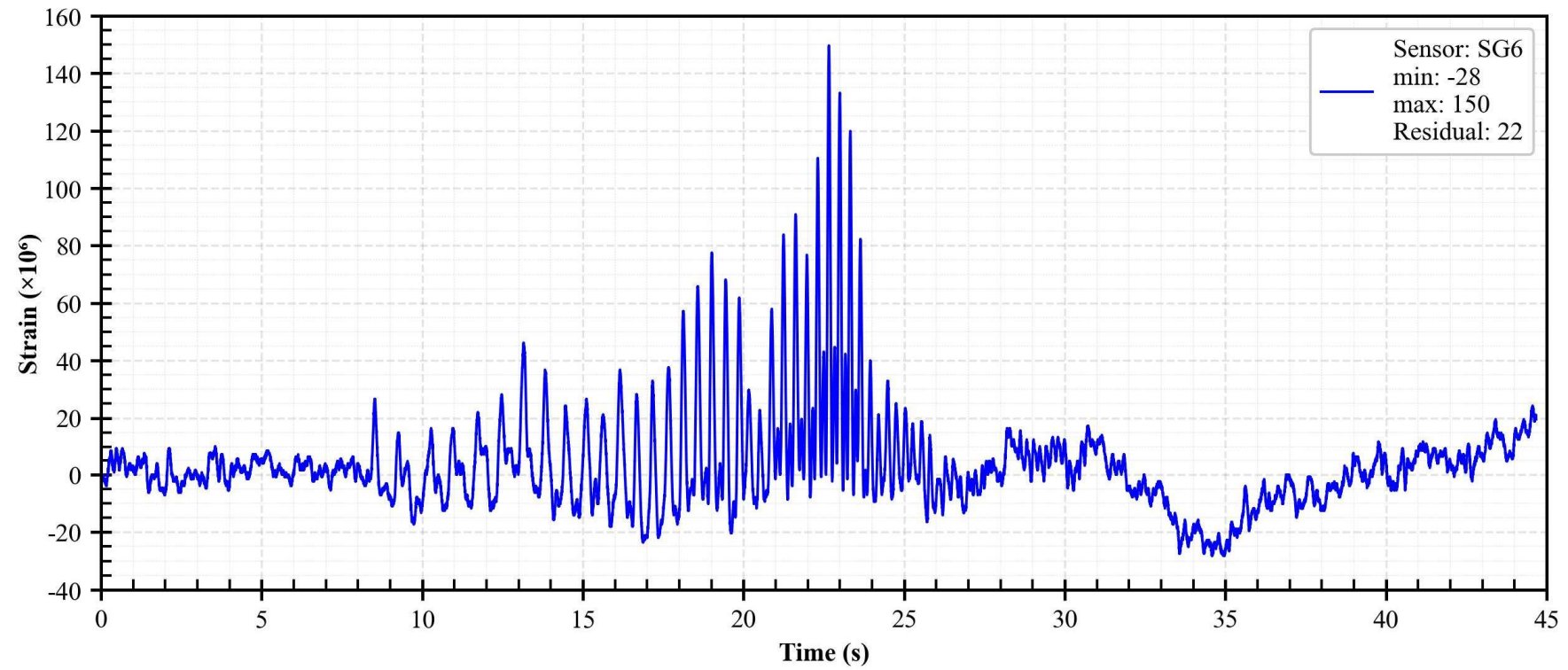


Figure 3.22.21 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 6

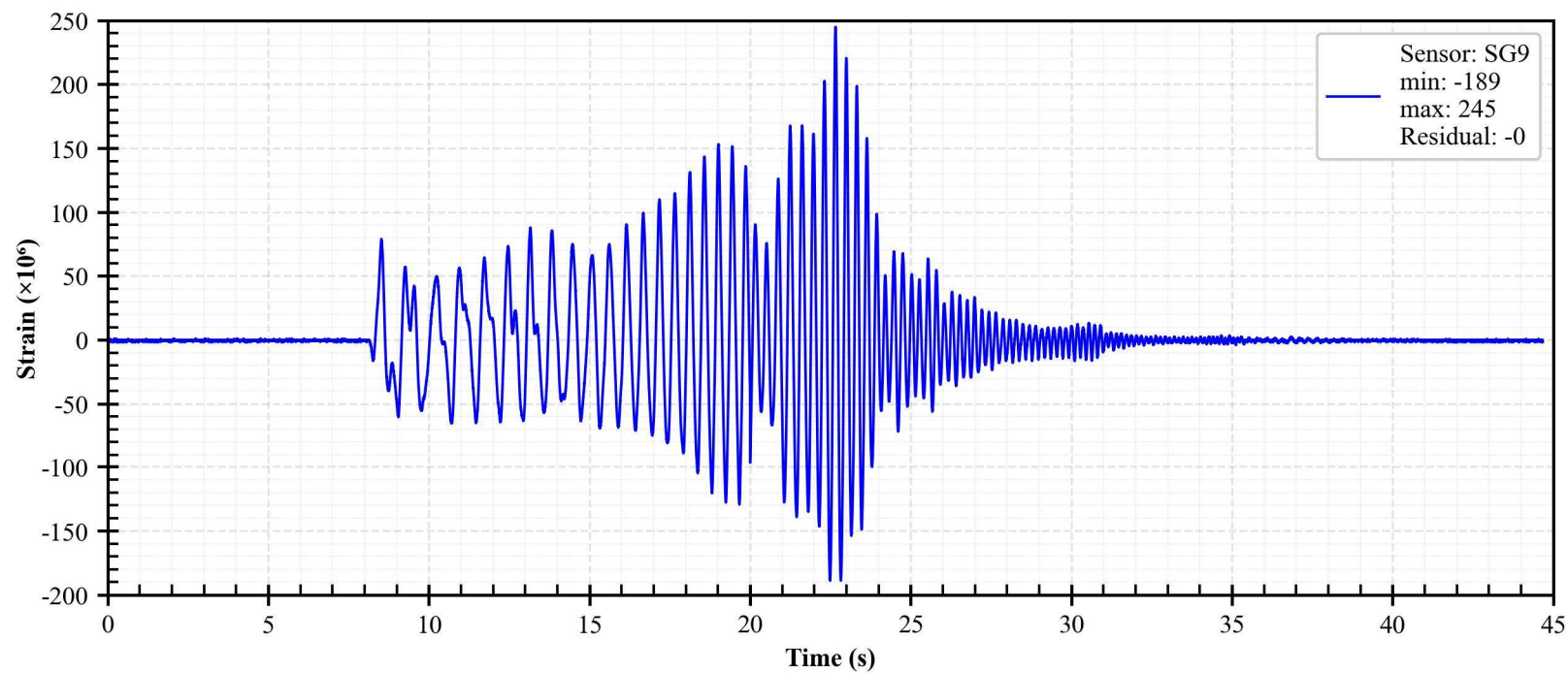


Figure 3.22.22 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 9

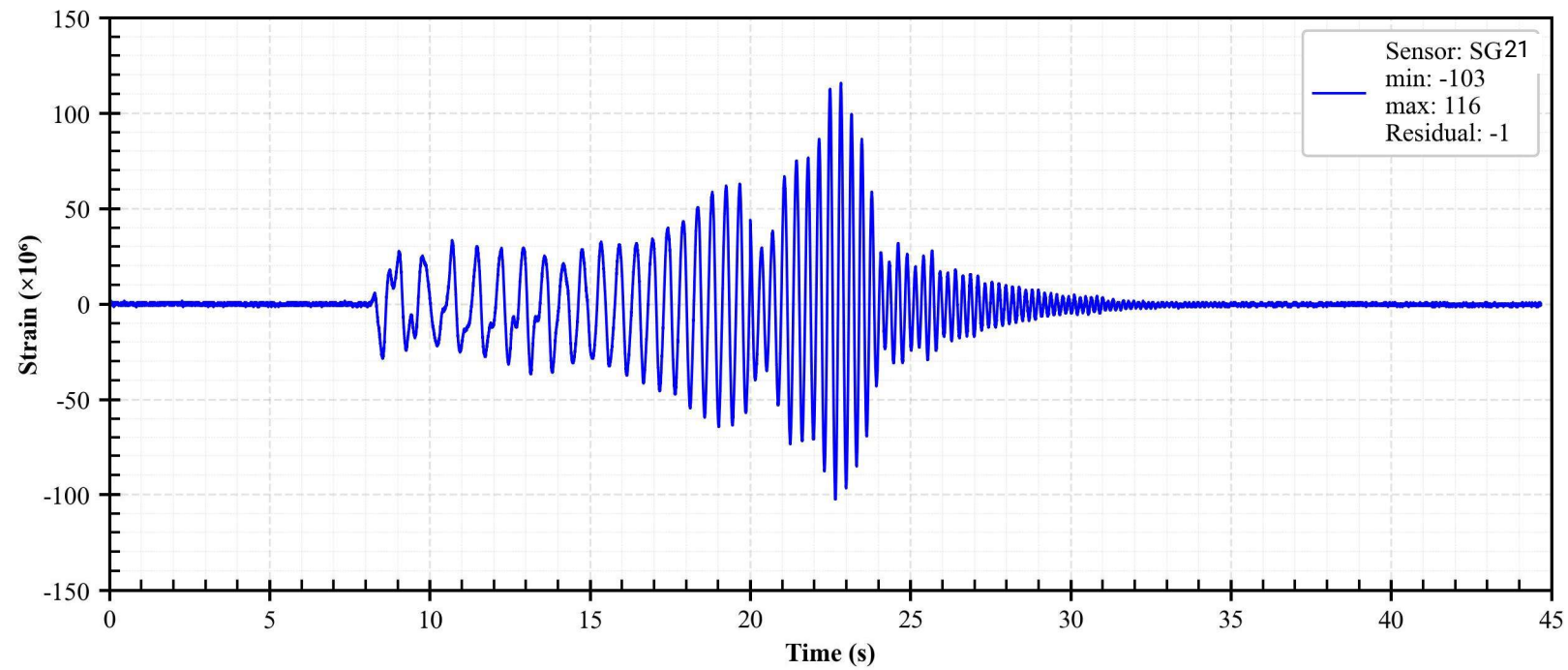


Figure 3.22.23 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 21 (PUFJ, column 1)

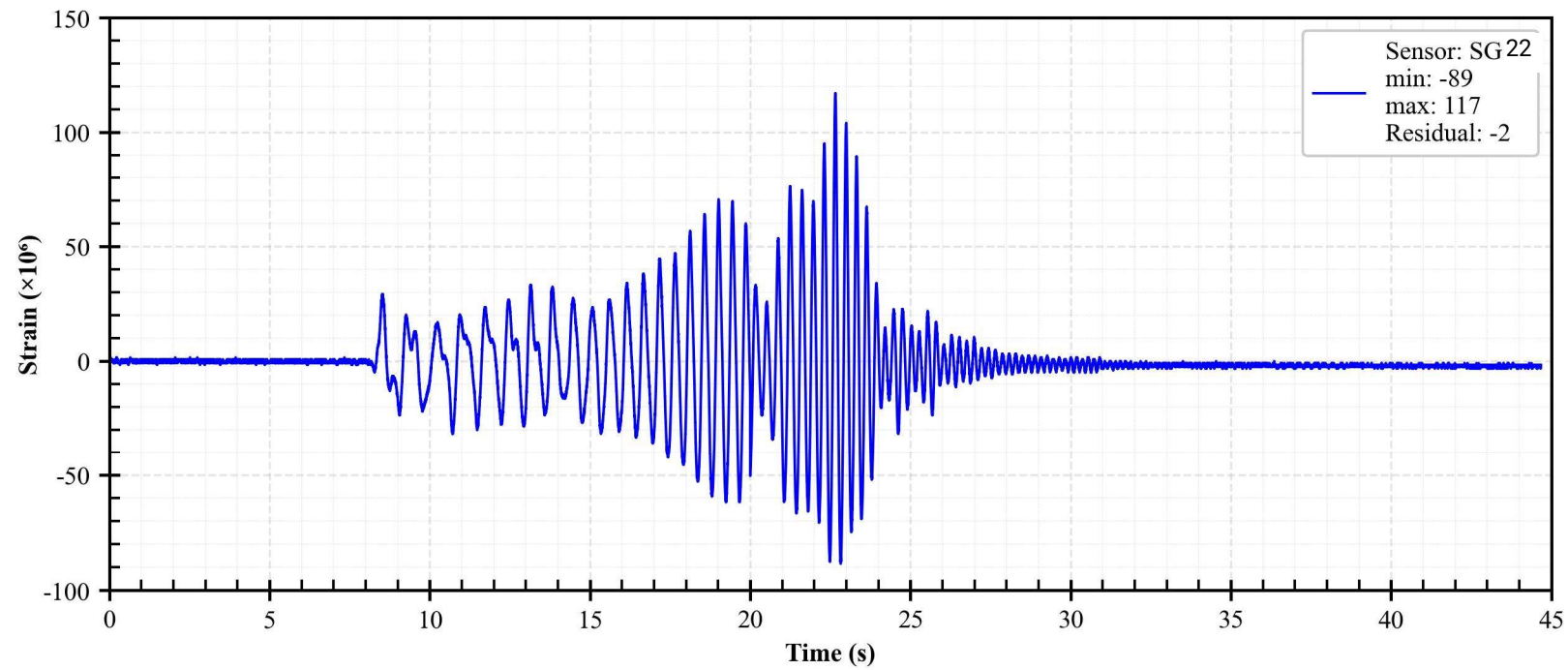


Figure 3.22.24 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 22 (PUFJ, column 2)

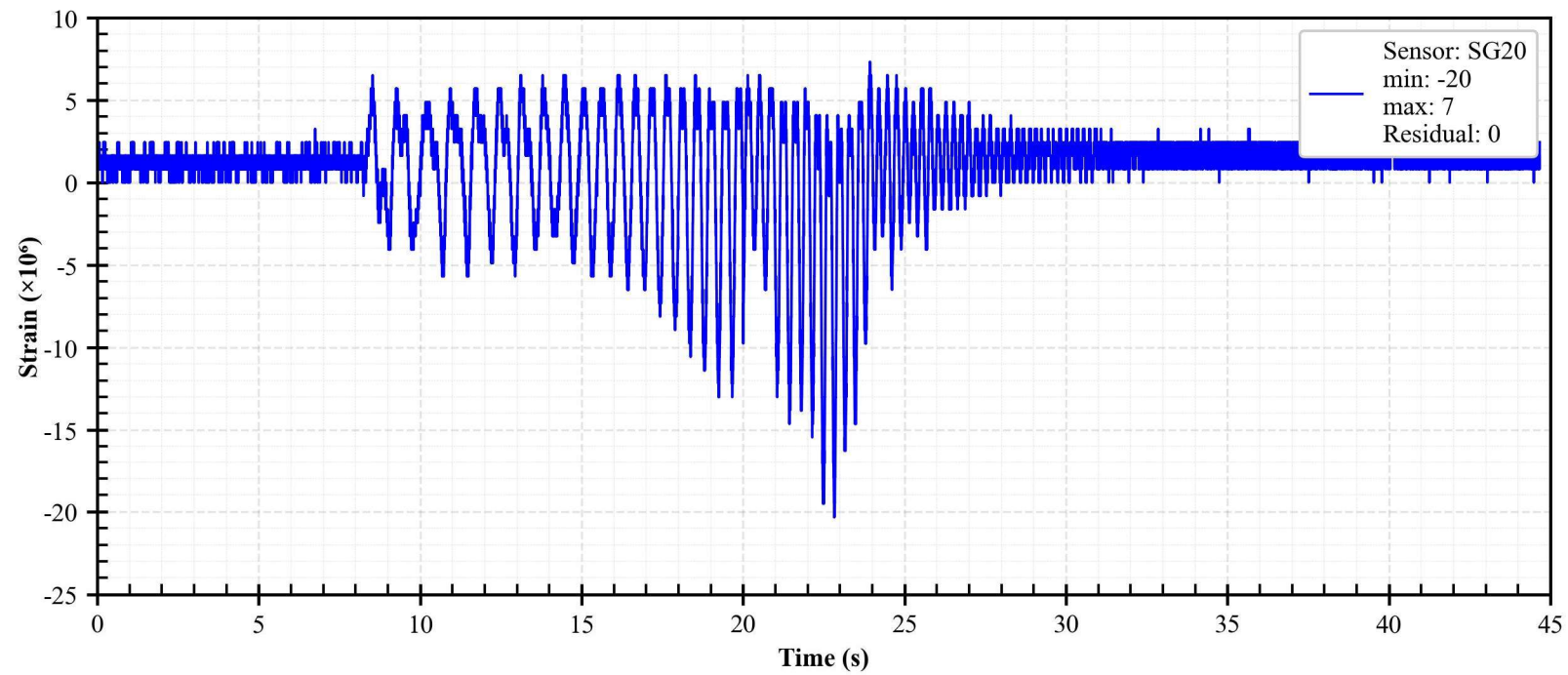


Figure 3.22.25 Characteristic results for phase B (white noise before EQ1,3g(2)): strain gauge 20

3.23 Earthquake EQ 1,3g (2)

Accelerometers

Characteristic extracts from the time history of accelerations of different of different accelerometers are given below for earthquake EQ1,3g (2), without bottom fixing of the vertical living walls. The max acceleration at the slab level on the accelerometer acc4 is 1.82g. The max acceleration at the foundation level on the accelerometer acc10 is 1.87g.

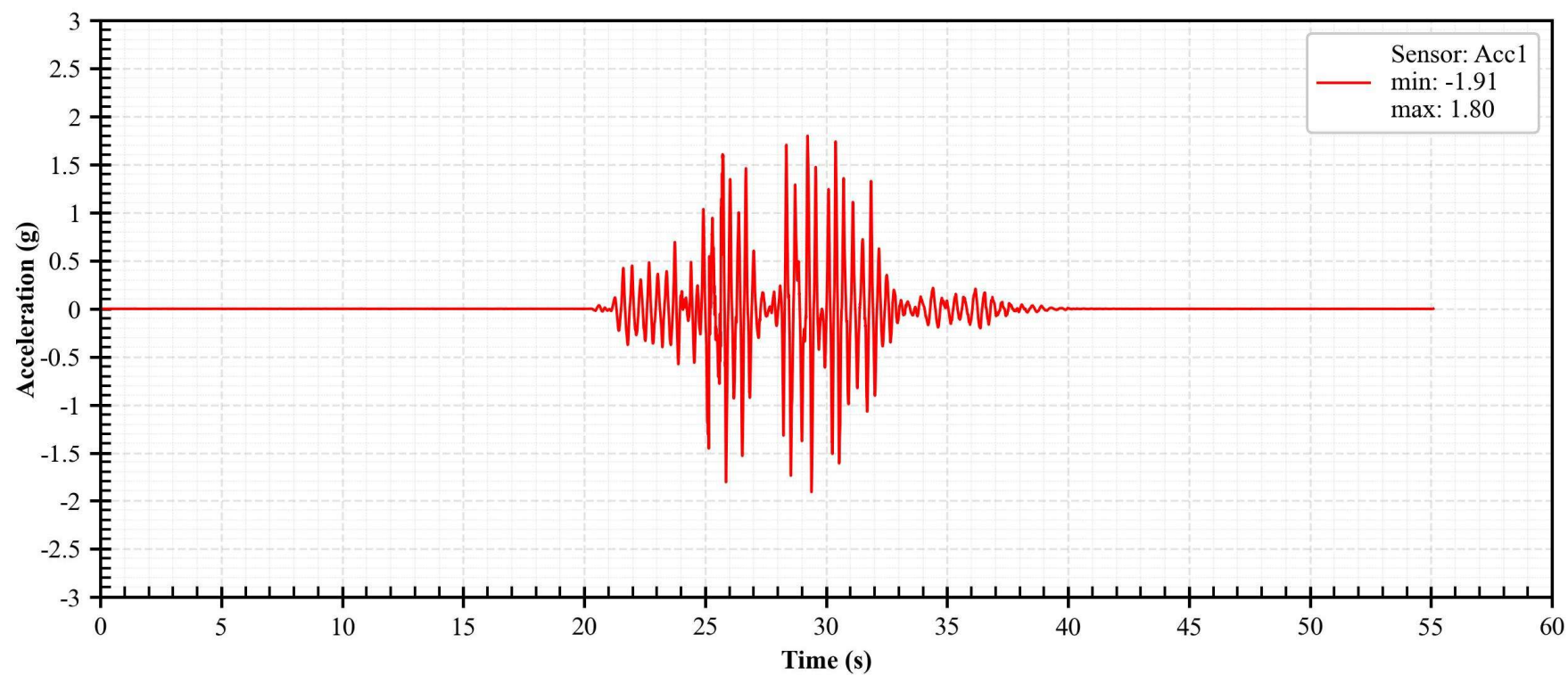


Figure 3.23.1 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 1

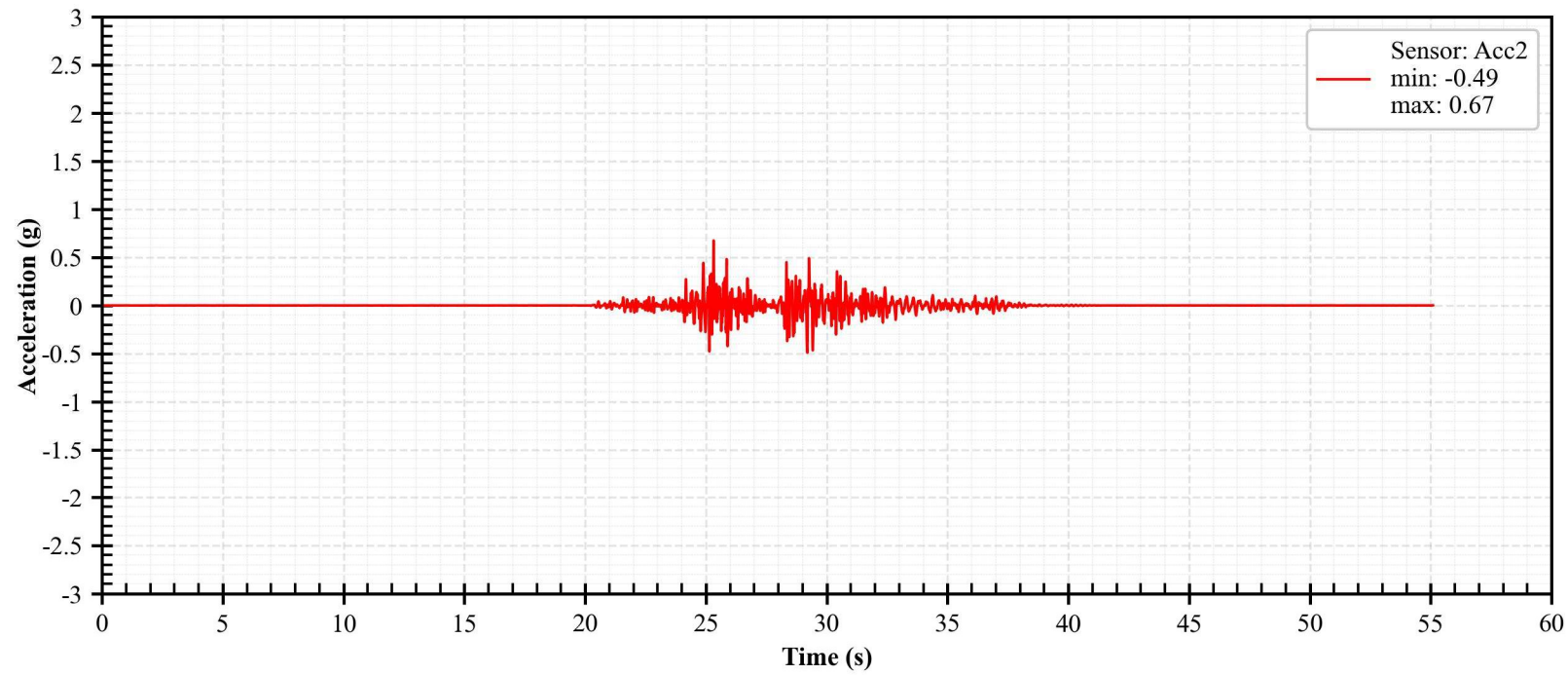


Figure 3.23.2 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 2

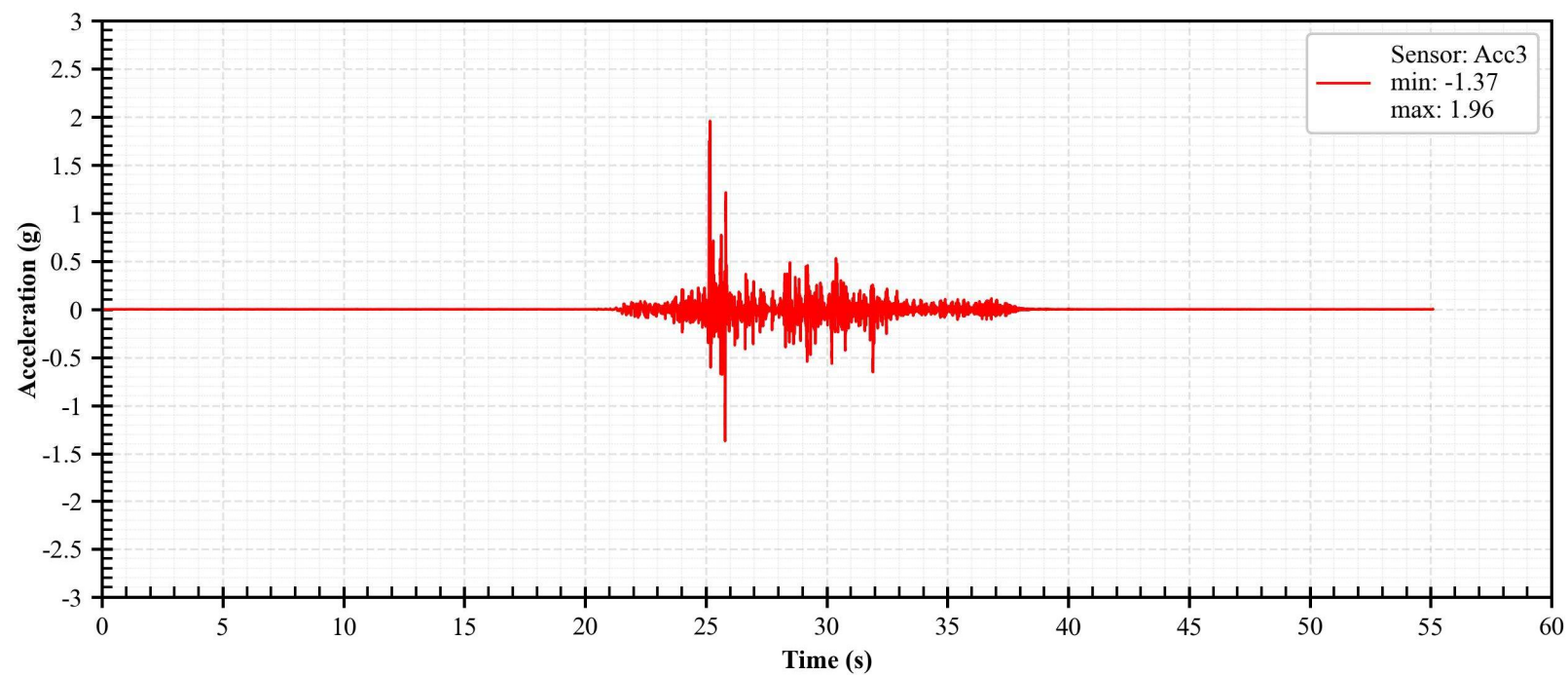


Figure 3.23.3 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 3

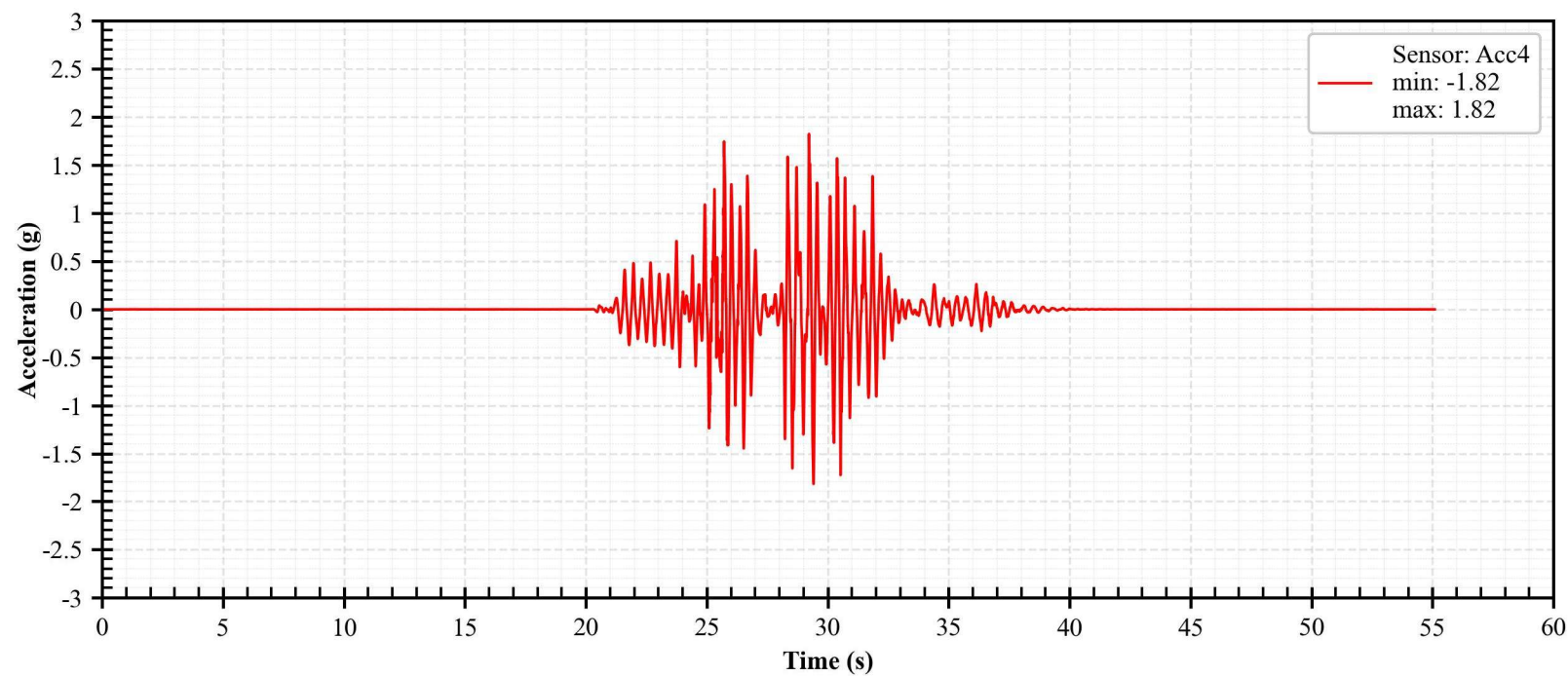


Figure 3.23.4 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 4

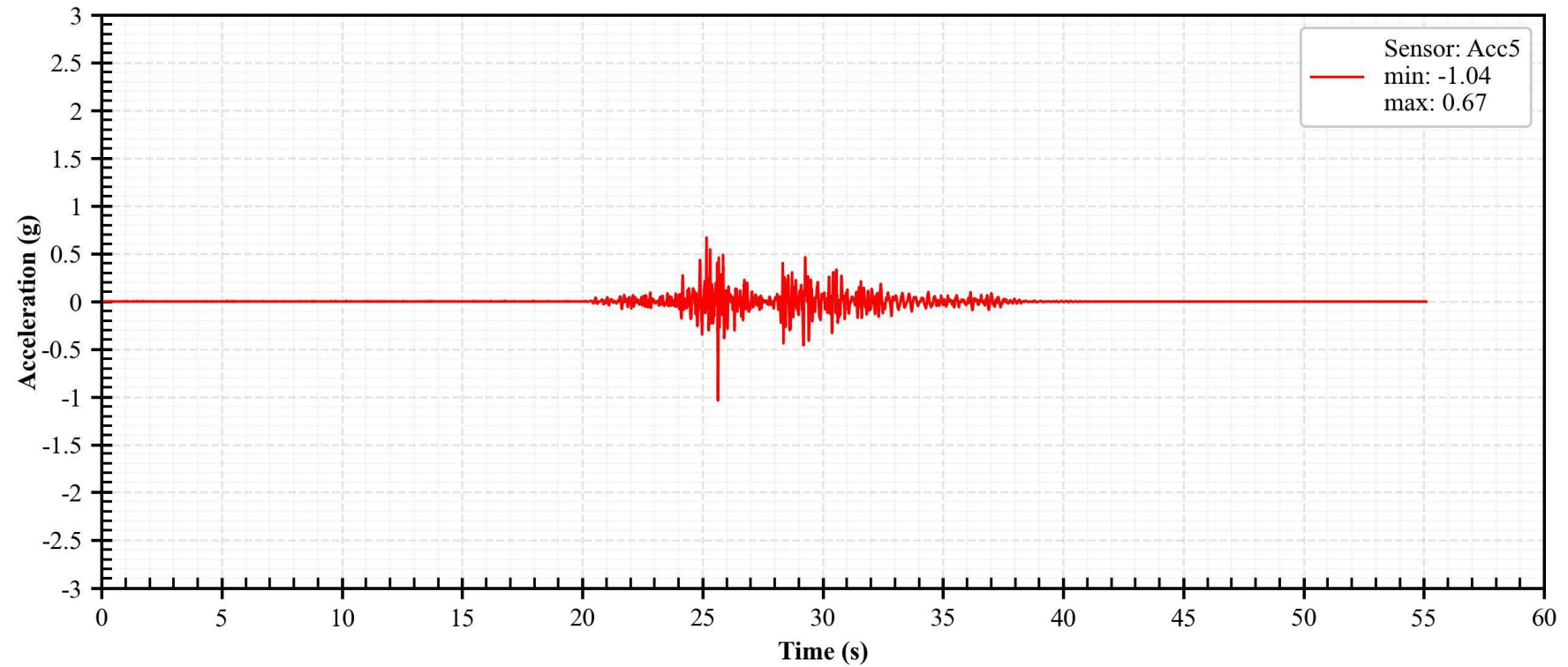


Figure 3.23.5 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 5

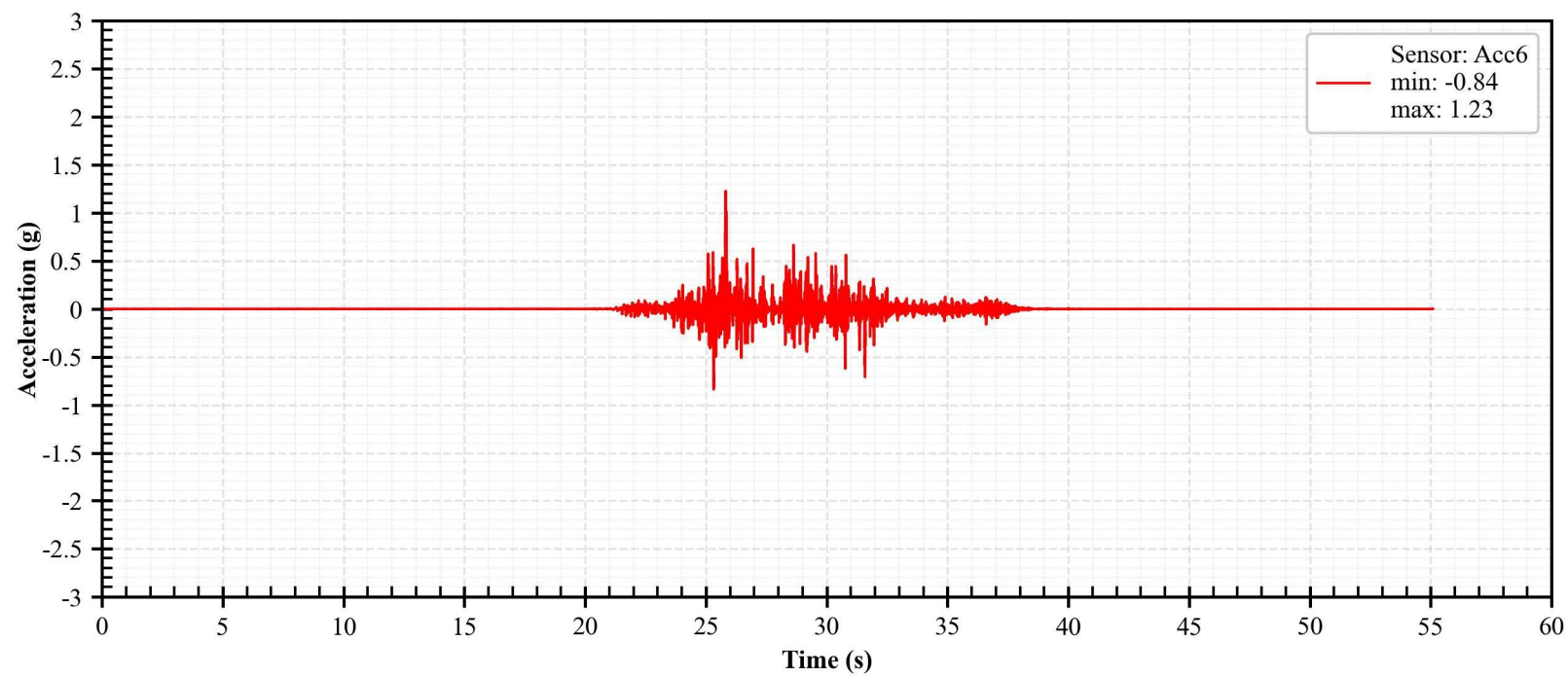


Figure 3.23.6 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 6

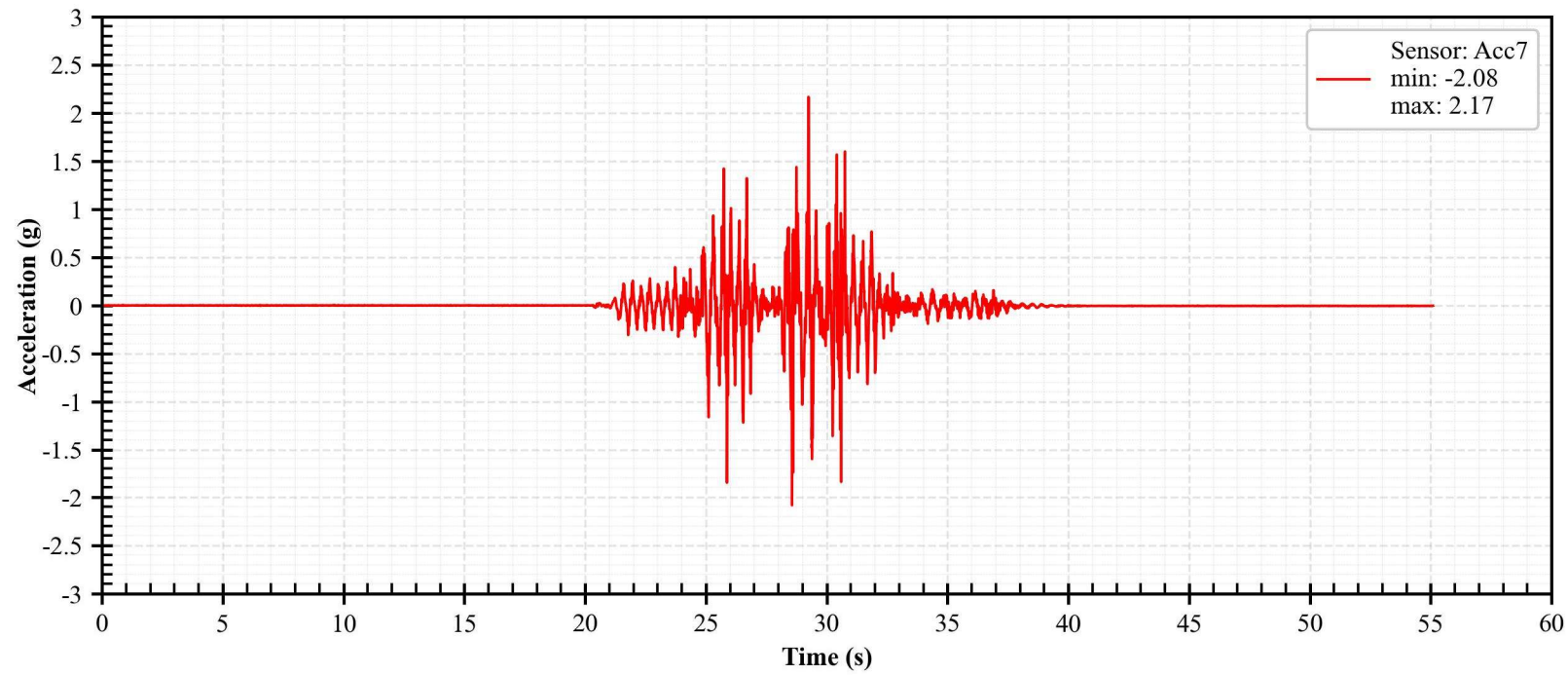


Figure 3.23.7 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 7

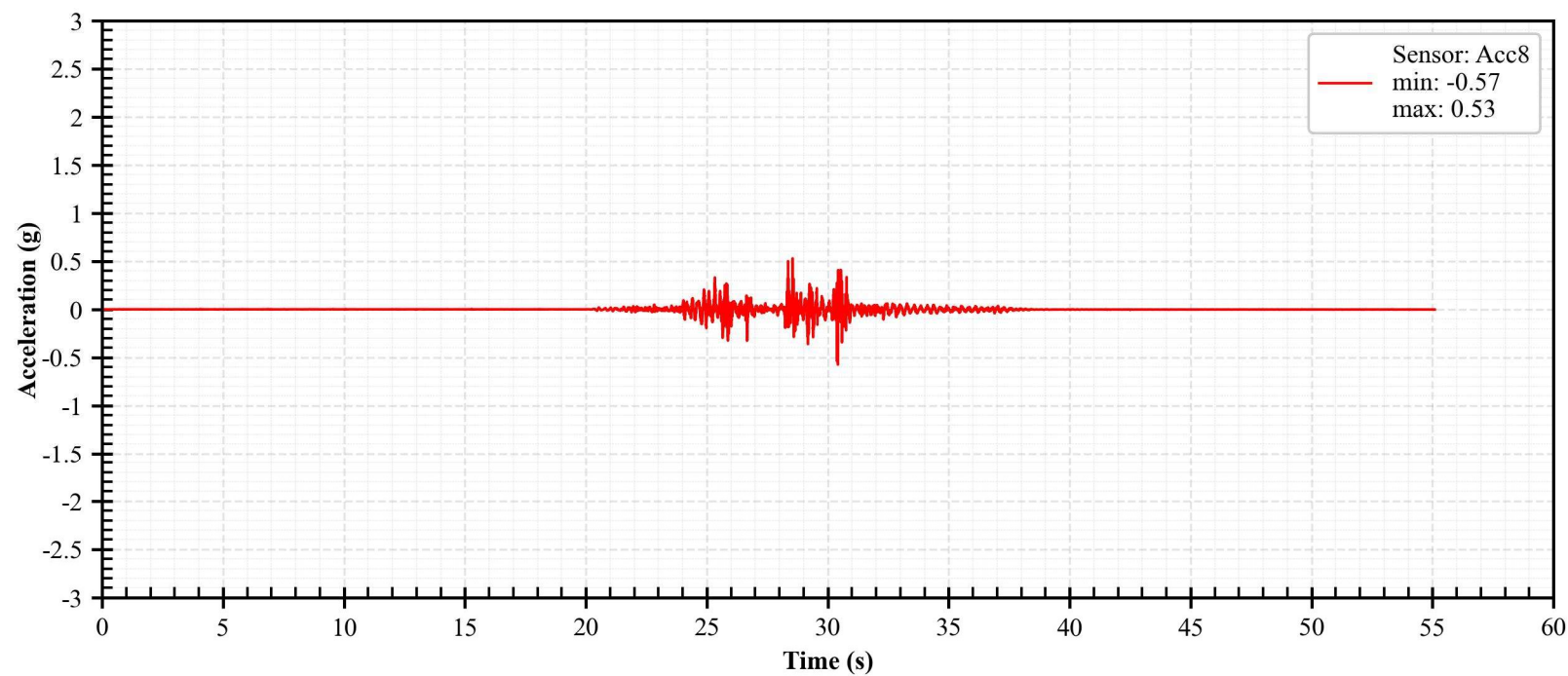


Figure 3.23.8 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 8

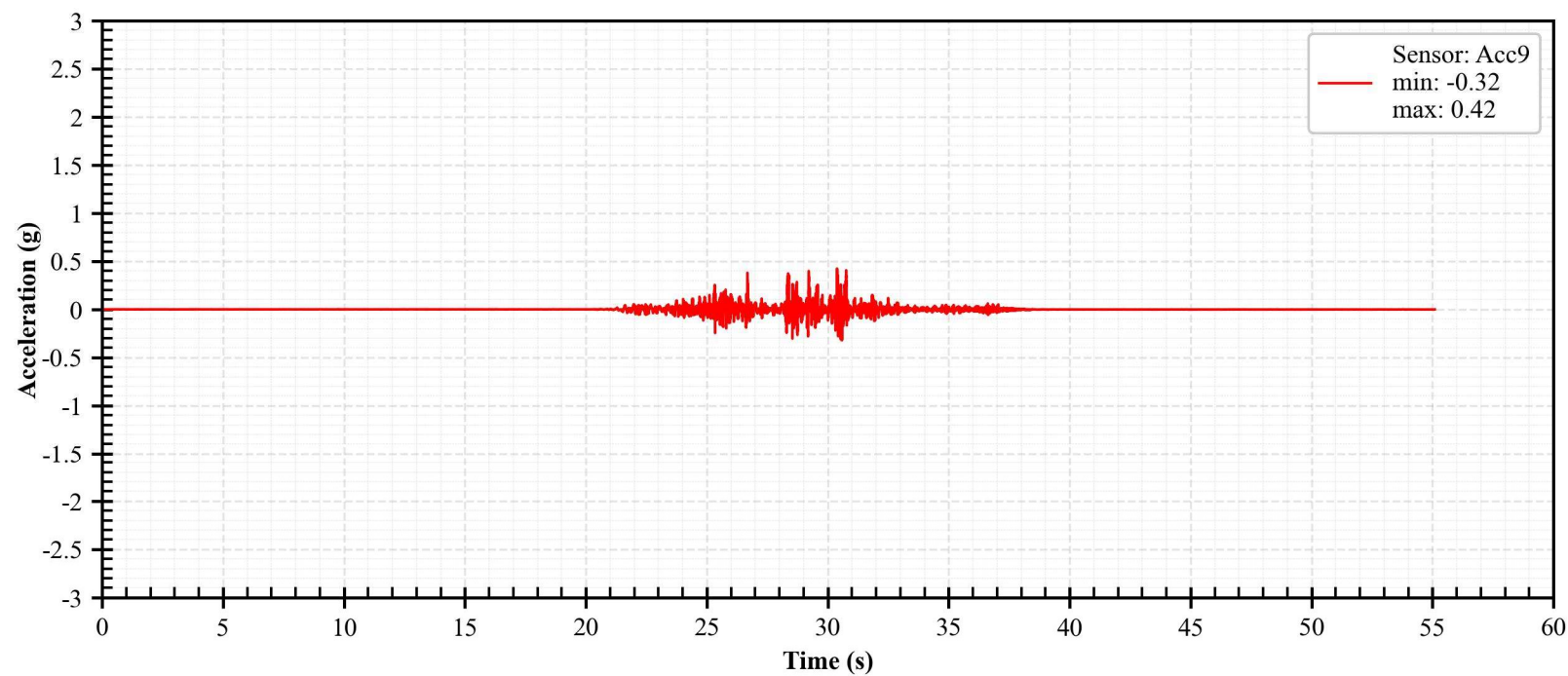


Figure 3.23.9 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 9

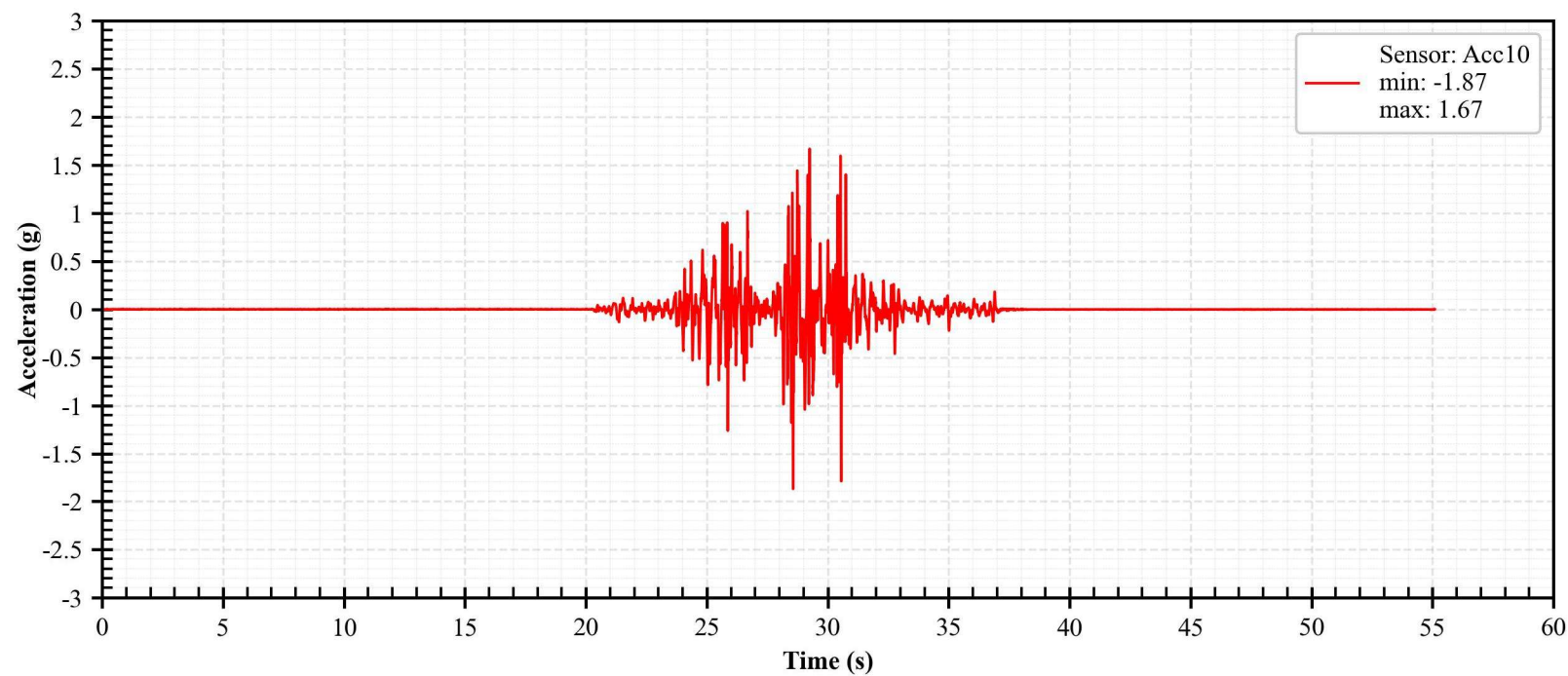


Figure 3.23.10 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 10

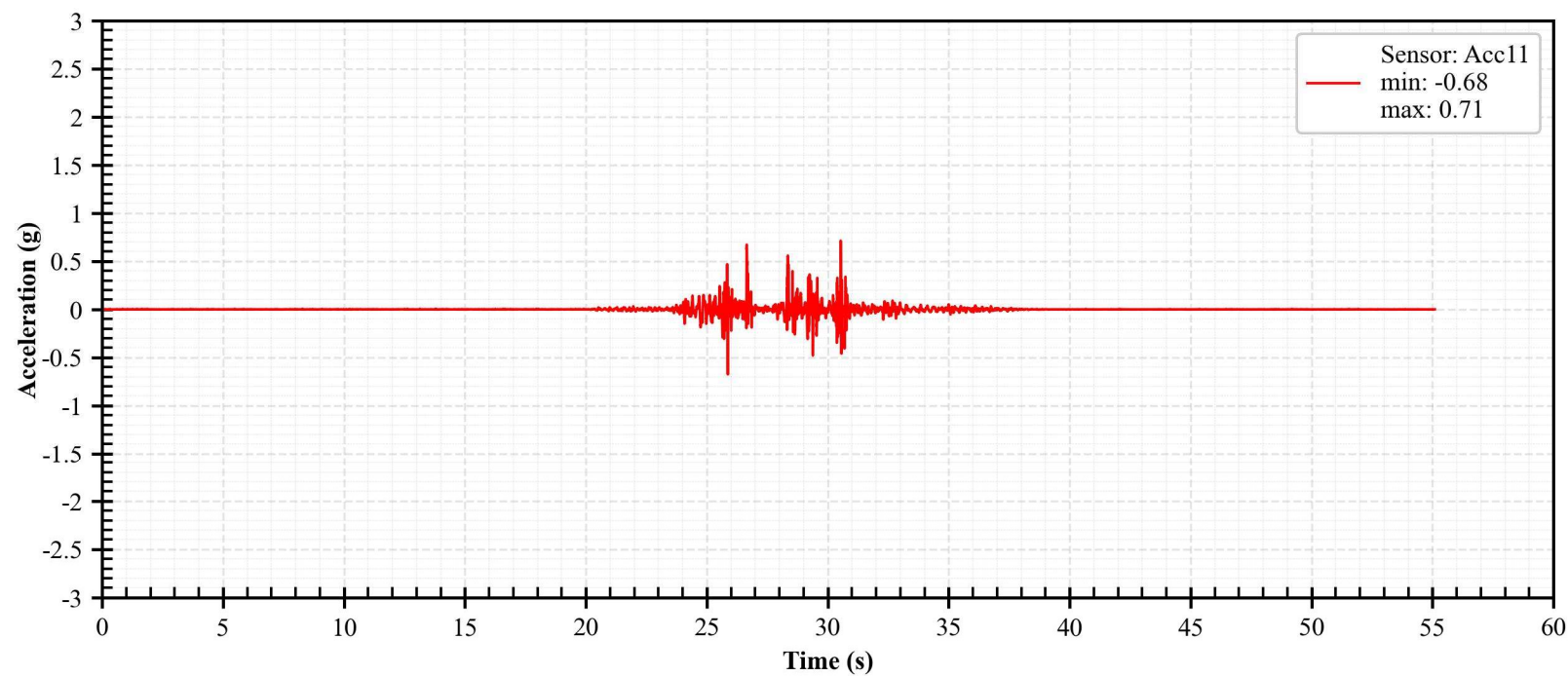


Figure 3.23.11 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 11

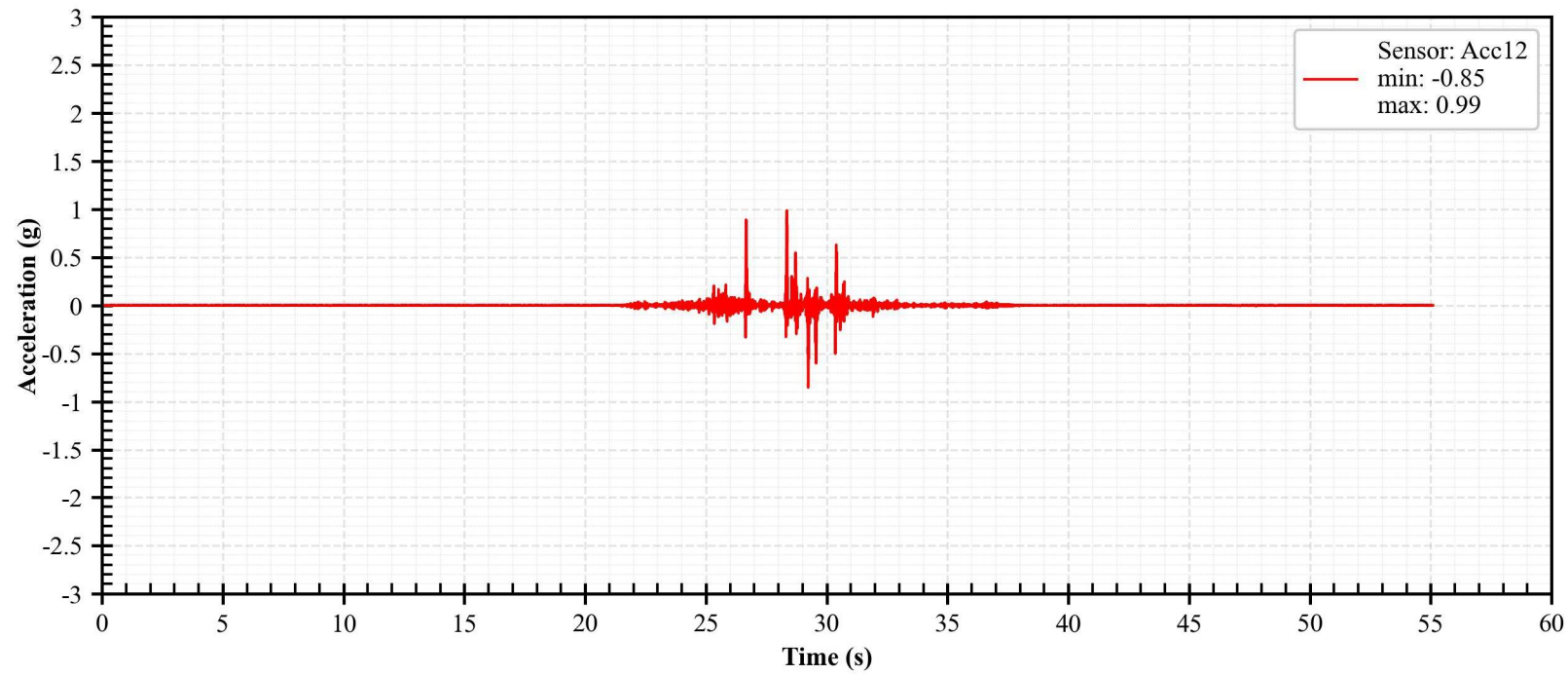


Figure 3.23.12 Characteristic results for phase B (earthquake EQ1,3g (2)): Accelerometer 12

Draw wire sensors

Figures 3.23.13 – 3.23.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 43.47 mm while the minimum is -46.53 mm. The maximum movement detected by draw wire sensor W2 is 42.95 mm while the minimum is -46.48 mm. The maximum movement detected by draw wire sensor W3 is 28.79 mm while the minimum is -28.11 mm. The maximum movement detected by draw wire sensor W4 is 27.79 mm while the minimum is -29.52 mm. The maximum drift is $(21.34/1.225) = 17.42 \text{ ‰}$ and minimum drift is $(-24.64/1.225) = -20.11 \text{ ‰}$.

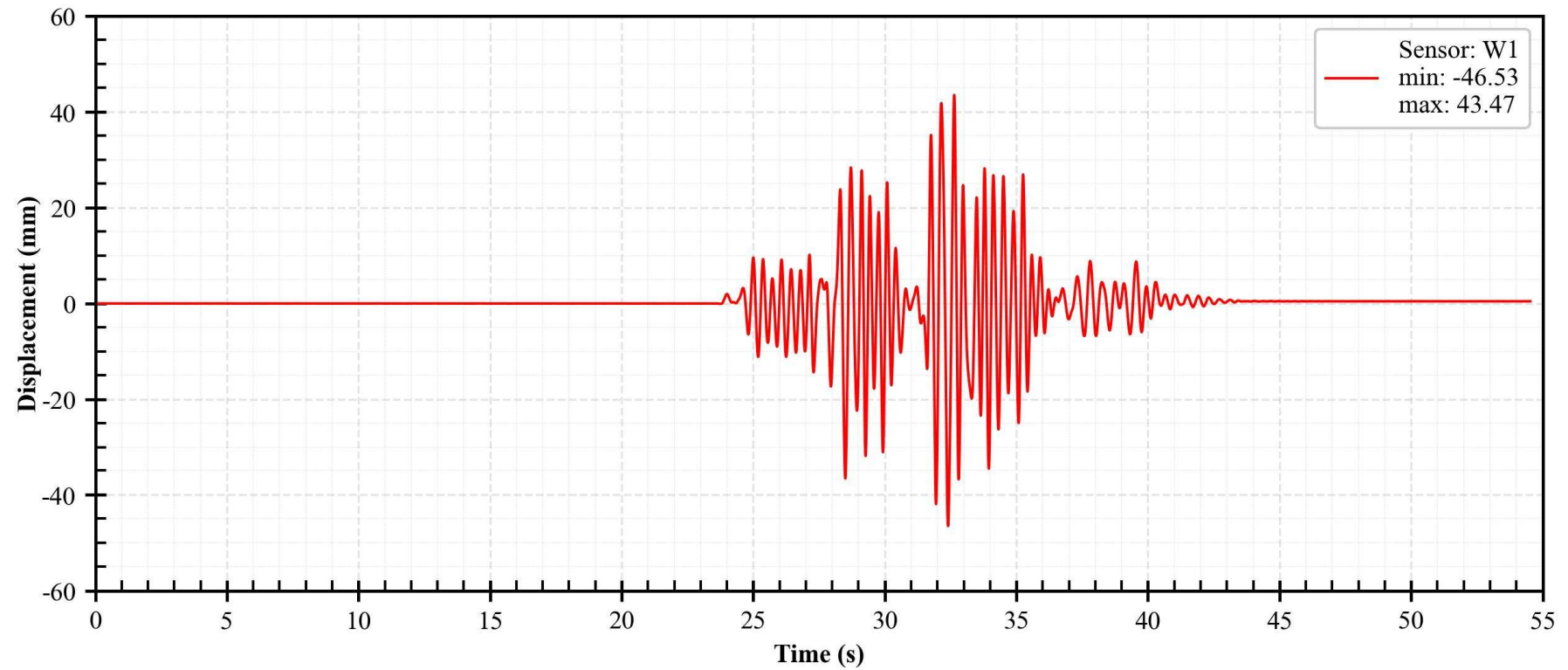


Figure 3.23.13 Characteristic results for phase B (earthquake EQ1,3g (2)): Draw wire sensor 1

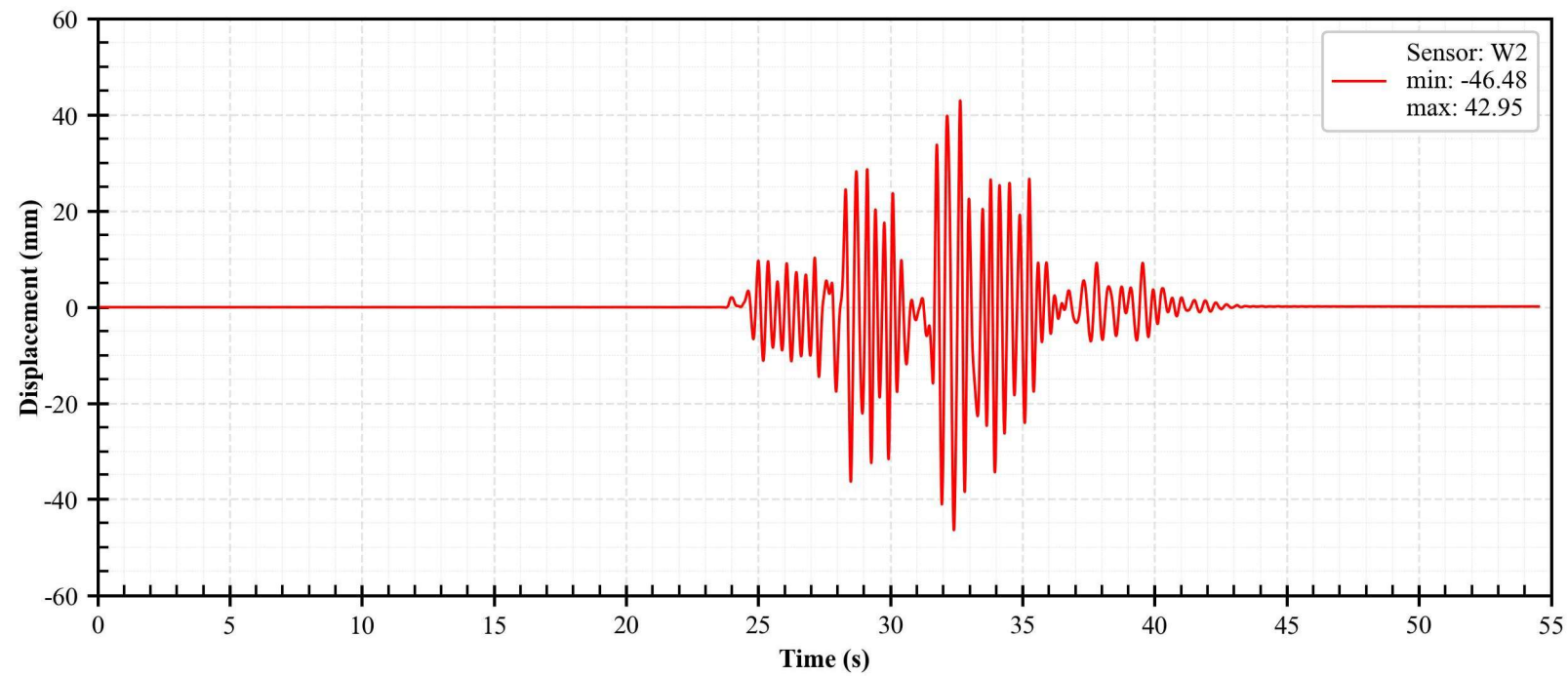


Figure 3.23.14 Characteristic results for phase B (earthquake EQ1,3g (2)): Draw wire sensor 2

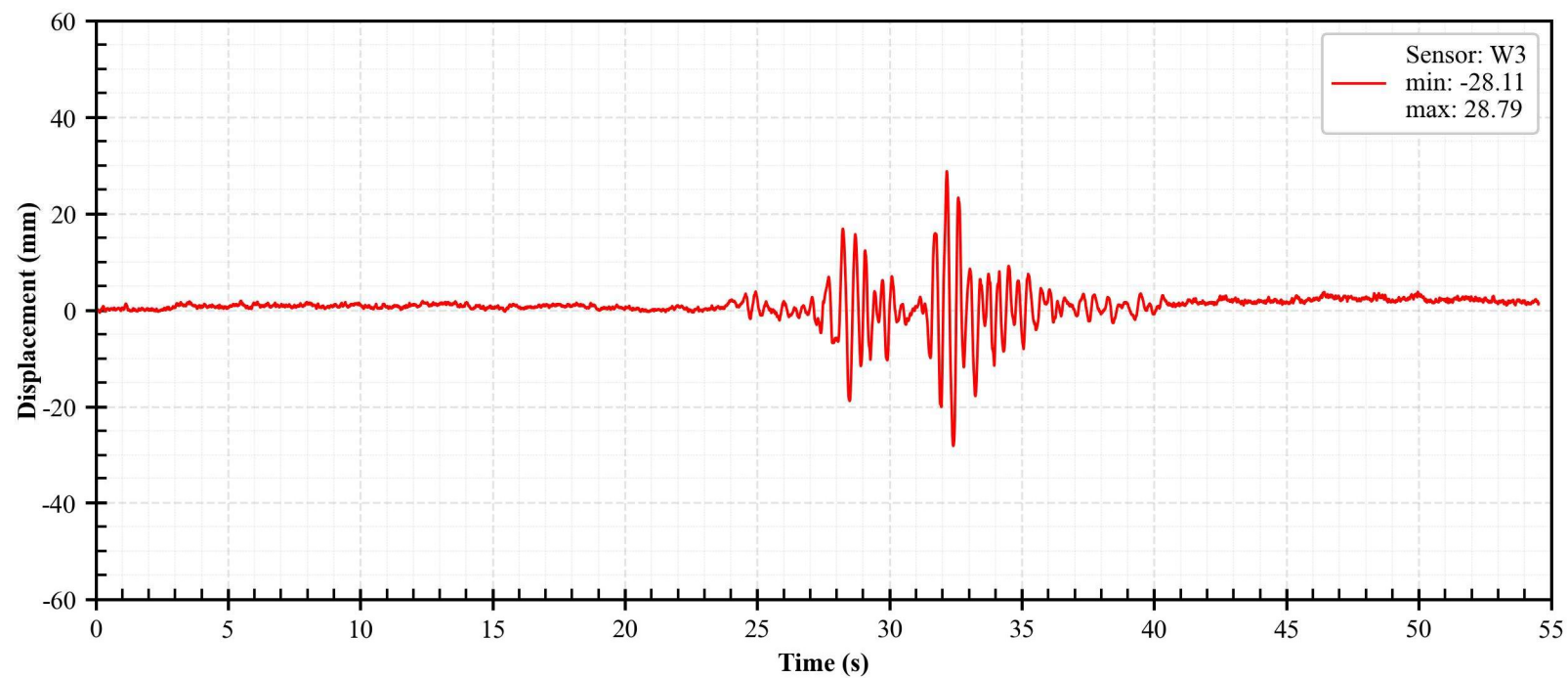


Figure 3.23.15 Characteristic results for phase B (earthquake EQ1,3g (2)): Draw wire sensor 3

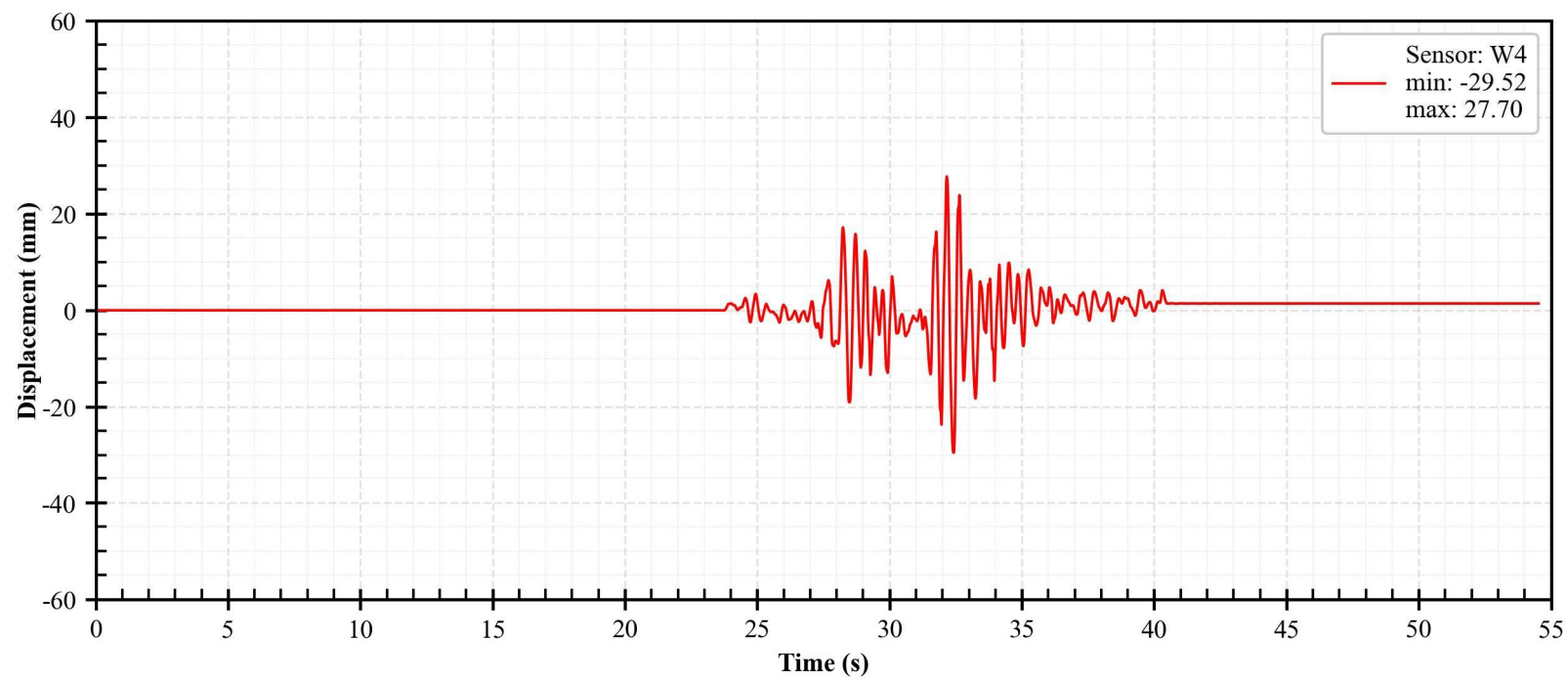


Figure 3.23.16 Characteristic results for phase B (earthquake EQ1,3g (2)): Draw wire sensor 4

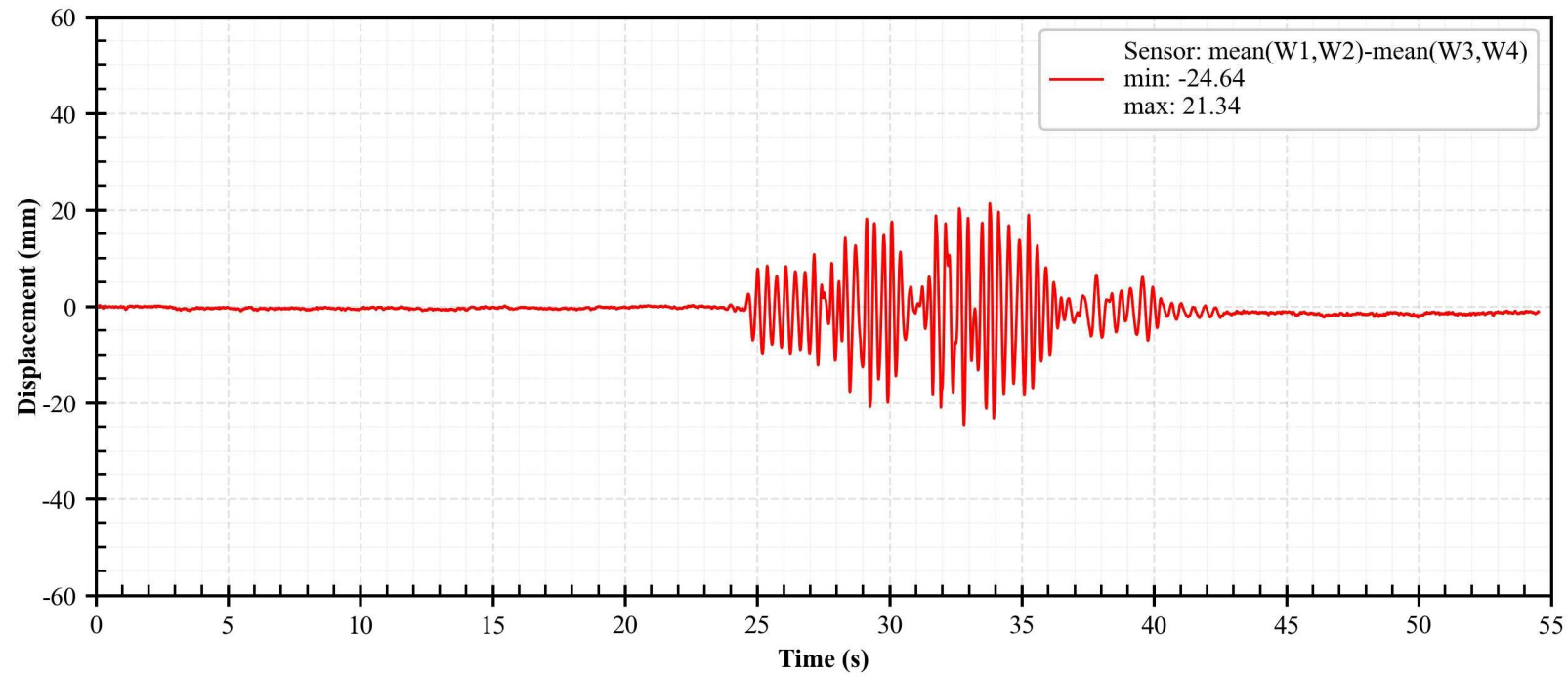


Figure 3.23.17 Characteristic results for phase B (earthquake EQ1,3g (2)): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.23.18, 3.23.19, 3.23.20, 3.23.21, 3.23.22, 3.23.23, 3.23.32, 3.23.33 are located on the longitudinal reinforcement, at the bottom of the column. More specifically, strain gauge SG1 has maximum strain 1466 μ strain and minimum strain -615 μ strain. The residual strain is -43 μ strain. Strain gauge SG2 has maximum strain 1334 μ strain and minimum -22 μ strain. The residual strain is -5 μ strain. Strain gauge SG3 has 1567 μ strain and -53 μ strain maximum and minimum strain respectively. The residual strain is 156 μ strain. Strain gauge SG4 has maximum 1592 μ strain and minimum -454 μ strain strain. The residual strain is 138 μ strain. Figure 3.23.32 and figure 3.23.33 show strain gauges SG5 and SG6, respectively. Strain gauge 5 has 3511 μ strain and -1222 μ strain maximum and minimum strain respectively. Strain gauge SG5 presents 58 μ strain residual strain. Strain gauge SG6 has 10919 μ strain maximum strain, -8657 μ strain minimum strain and -7139 μ strain residual. Finally in figure 3.23.22 we see strain gauge SG7 and in figure 3.1.23 strain gauge 8. Strain gauge SG7 has maximum strain 1430 μ strain. Strain gauge SG7 has -111 μ strain minimum deformation. Strain gauge SG8 has maximum strain 1458 μ strain and minimum strain -390 deformation. The residual strain for strain gauge SG7 and SG8 124, -17 respectively.

Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. More specifically strain gauge 17 has 38 μ strain maximum strain. Strain gauge 17 has minimum deformation -21 μ strain and strain gauge 18 -58 μ strain. Finally strain gauge 17 presents 6 μ strain residual. Strain gauge 18 presents -4 μ strain residual strain.

The strain gauges shown in the figures 3.23.24, 3.23.25, 3.23.26, 3.23.27, 3.23.28, 3.23.29 and 3.23.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG9 has 2673 μ strain maximum strain, -350 μ strain minimum strain and 4 residual. Strain gauge Strain gauge SG11 has 1341 μ strain maximum strain and minimum -292 μ strain deformation. The residual strain is 32 μ strain for strain gauge SG11. Strain gauge SG12 has 1290 μ strain maximum strain and -269 μ strain minimum strain. The residual strain is -72 μ strain for strain gauge SG12. Strain gauge SG13 has maximum strain 1331 μ strain, minimum -252 μ strain and -16 μ strain residual. Strain gauge SG14 has maximum strain 1398 μ strain and minimum strain -471 μ strain. The residual value is 12 μ strain. Finally strain gauges SG15 has maximum strain 1406 μ strain and minimum strain -361 μ strain. Strain gauge SG16 has maximum strain 1498 μ strain, minimum strain -306 μ strain and residual strain 19 μ strain.

SG21 has 868 μ strain maximum strain, -339 μ strain minimum strain and 22 μ strain residual. Strain gauge SG22 has maximum 670 μ strain and minimum -175 μ strain. Strain gauge 20 has maximum strain 11 μ strain and minimum -82 μ strain. The residual strain for strain gauge SG20 is -53 μ strain.

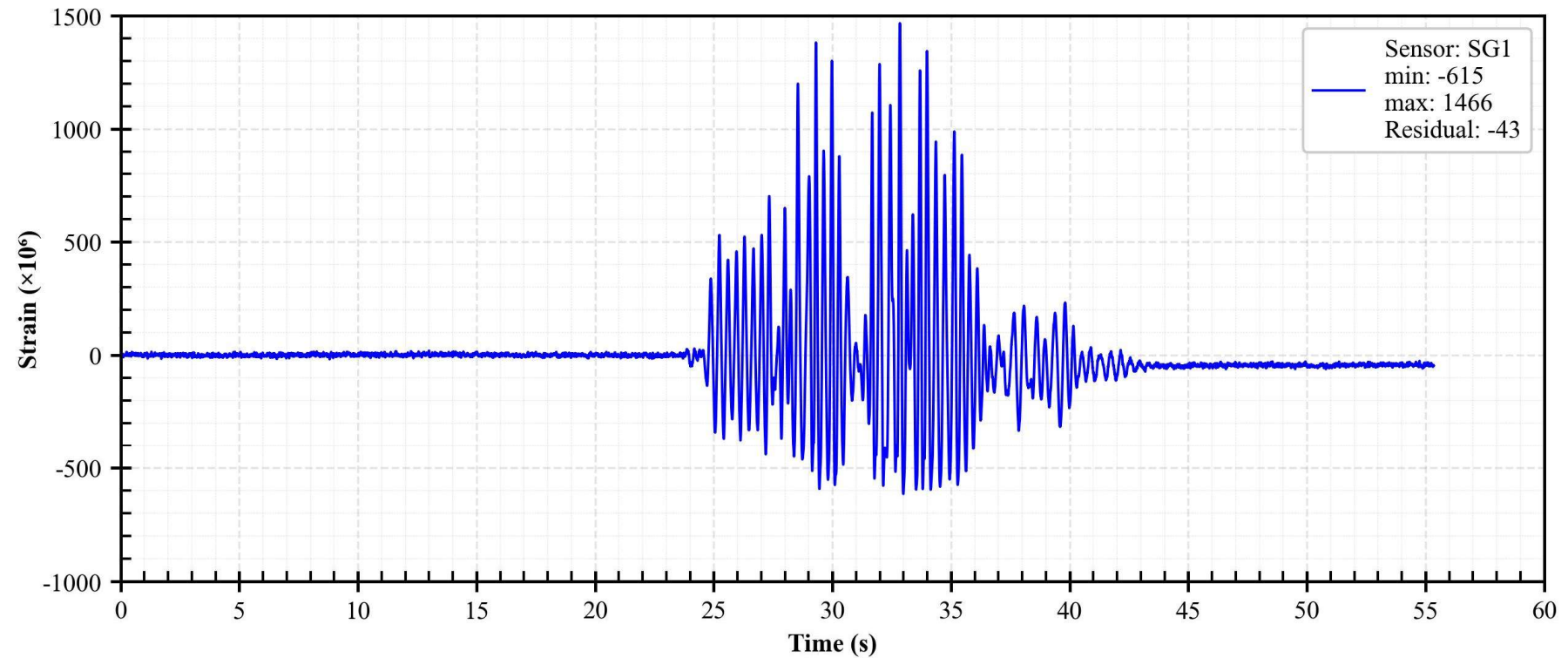


Figure 3.23.18 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 1

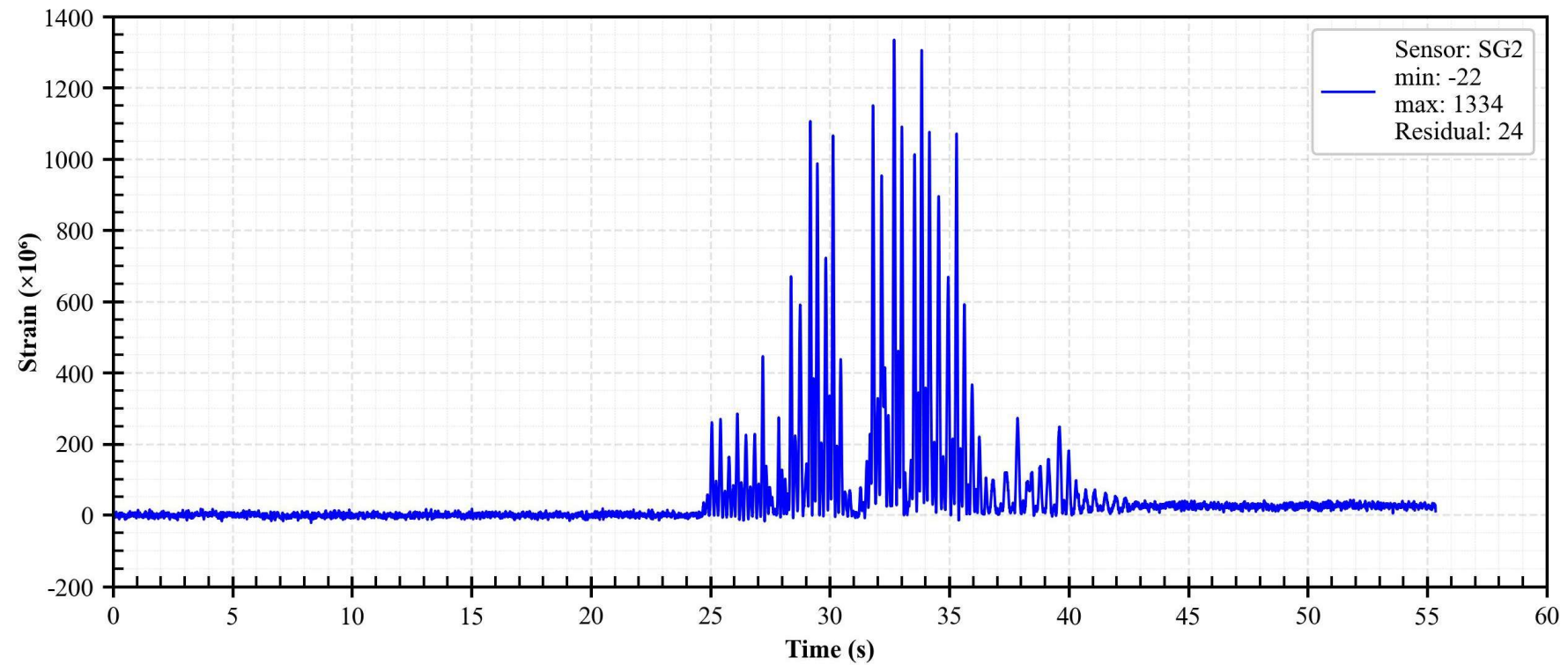


Figure 3.23.19 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 2

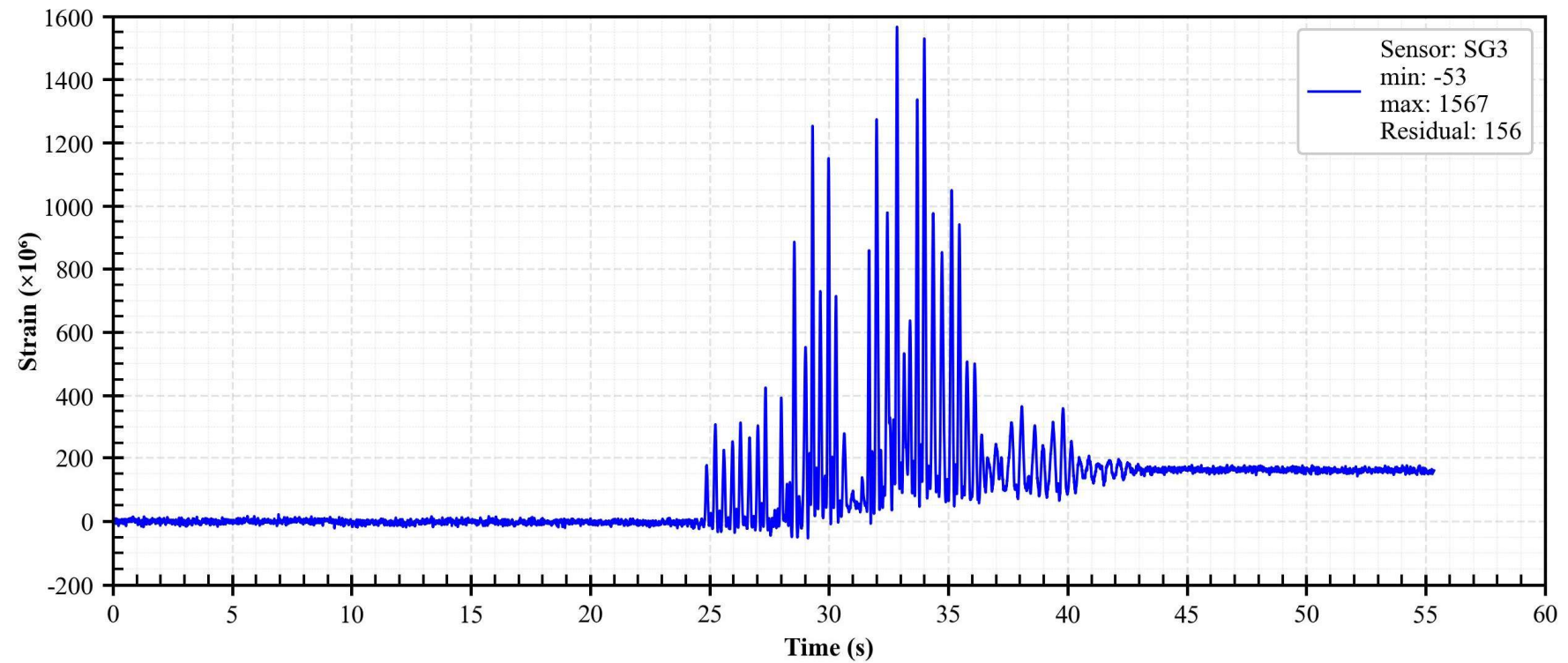


Figure 3.23.20 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 3

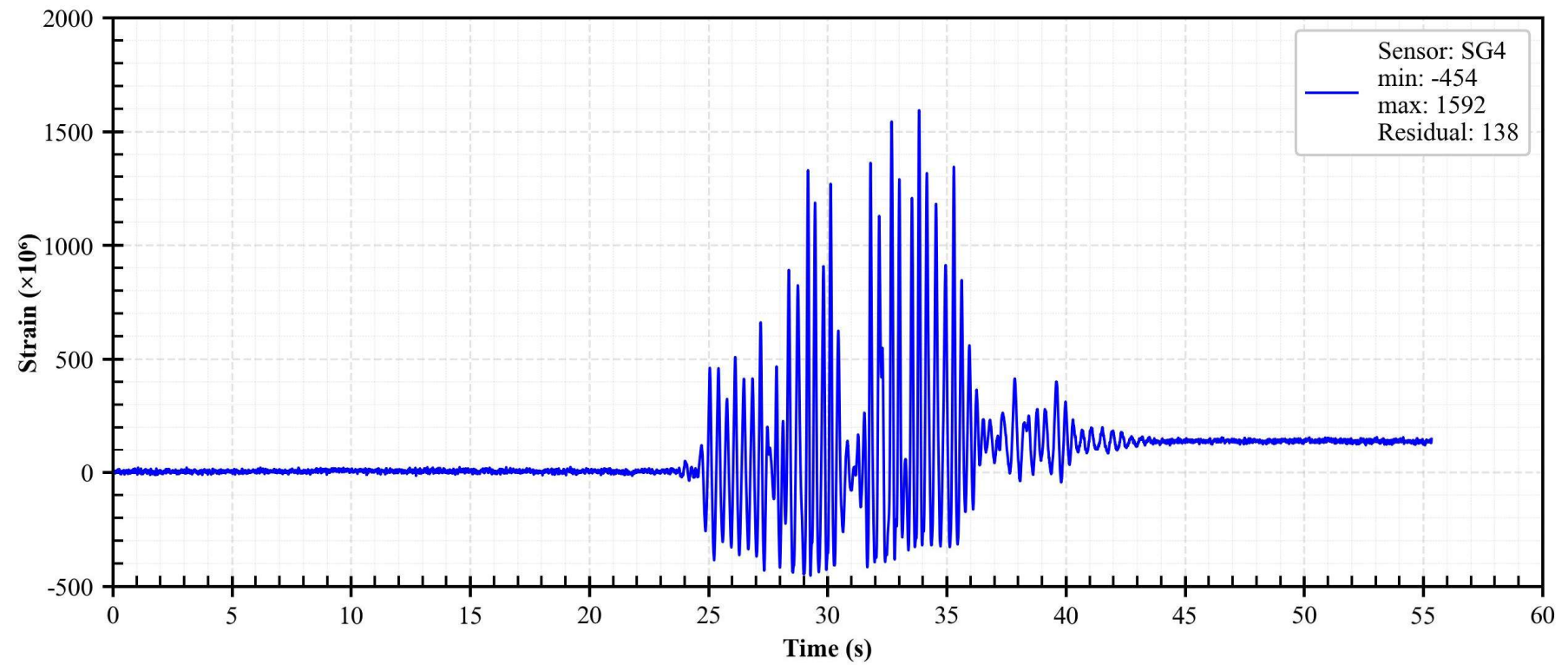


Figure 3.23.21 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 4

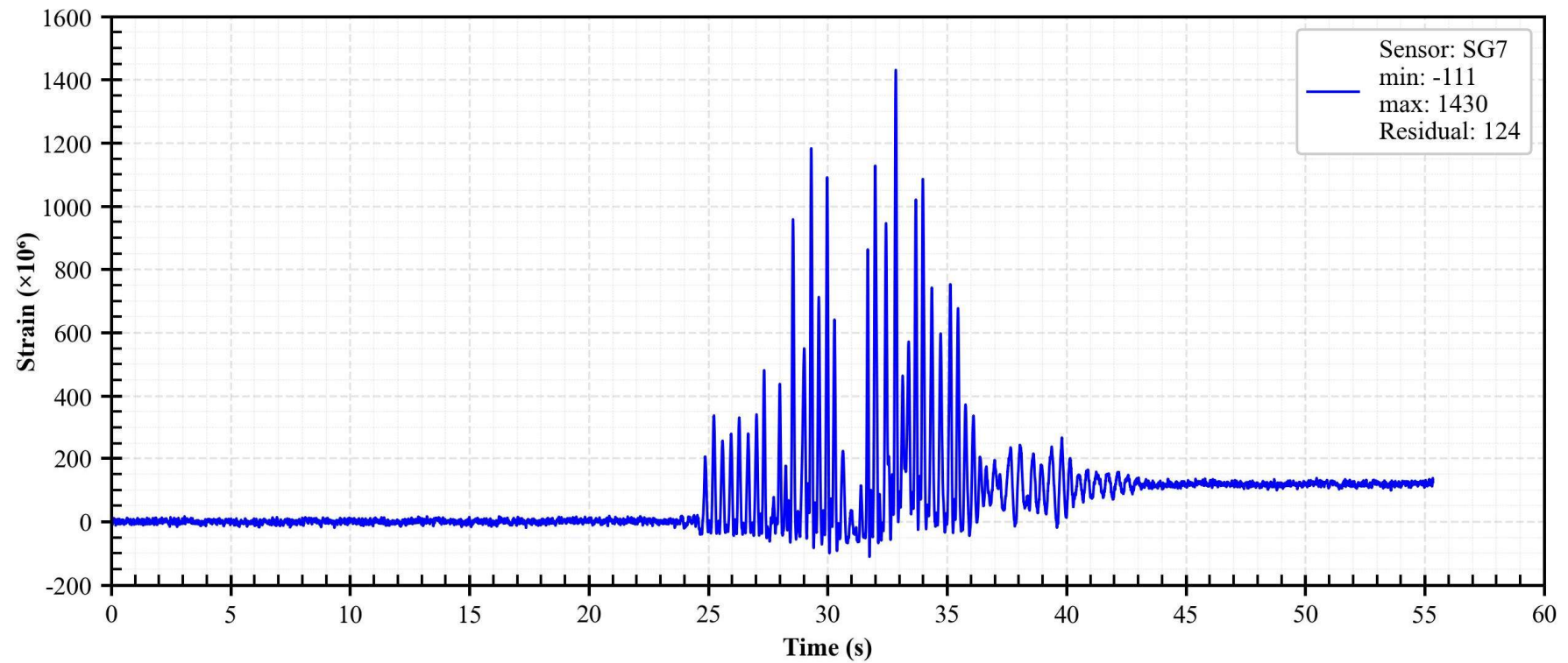


Figure 3.23.22 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 7

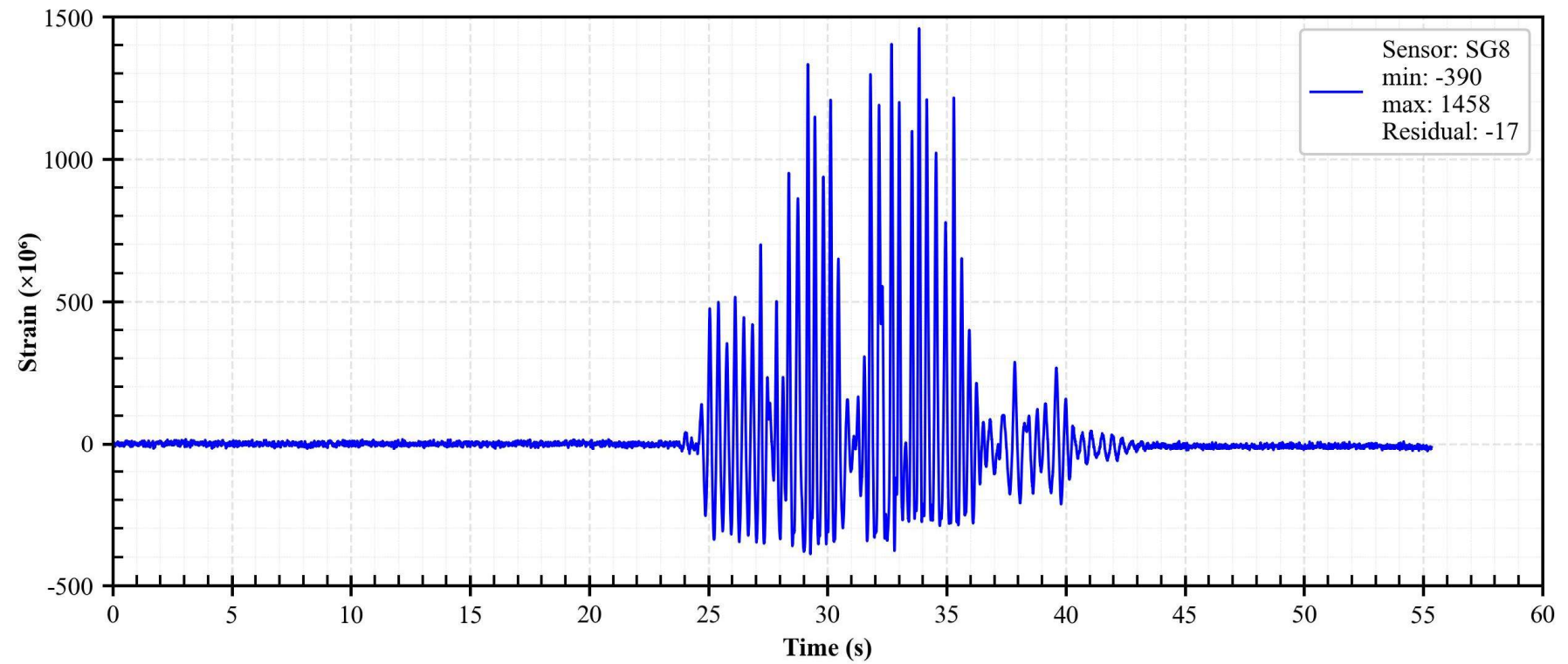


Figure 3.23.23 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 8

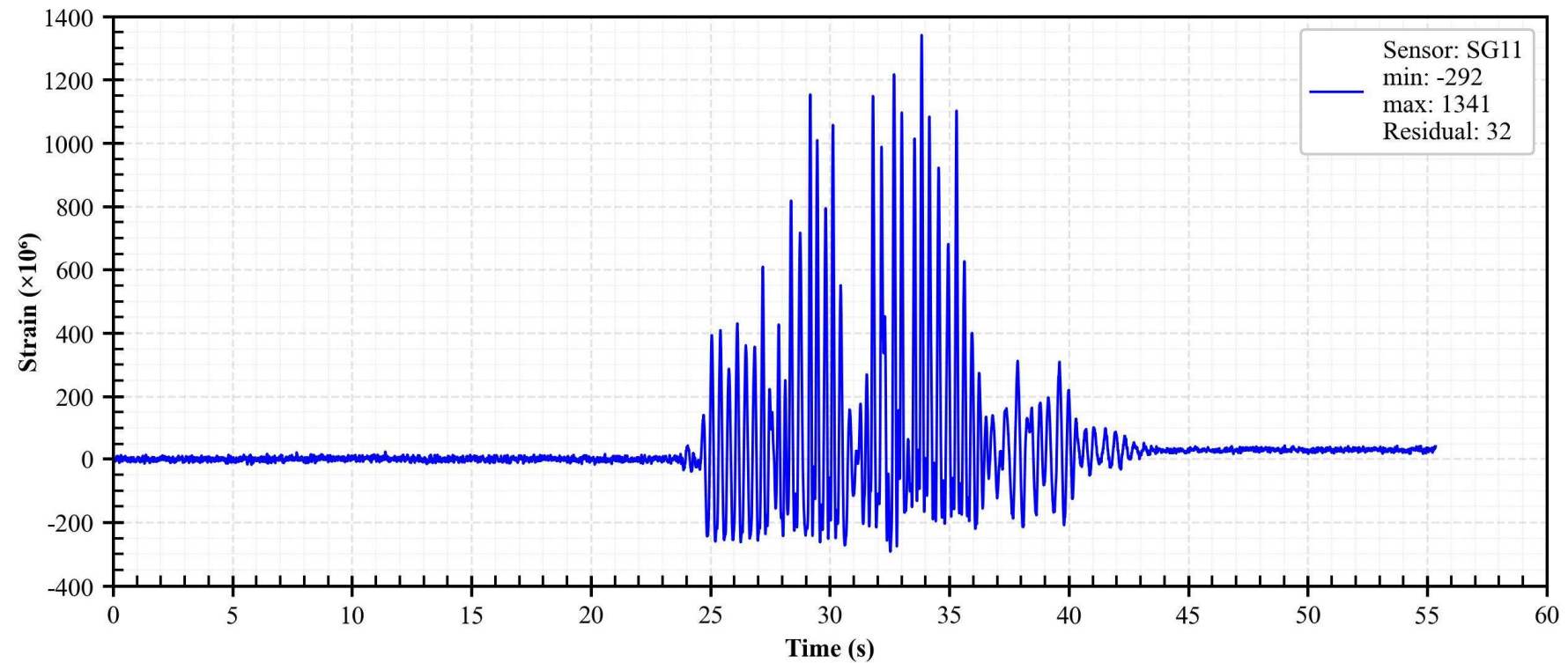


Figure 3.23.24 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 11

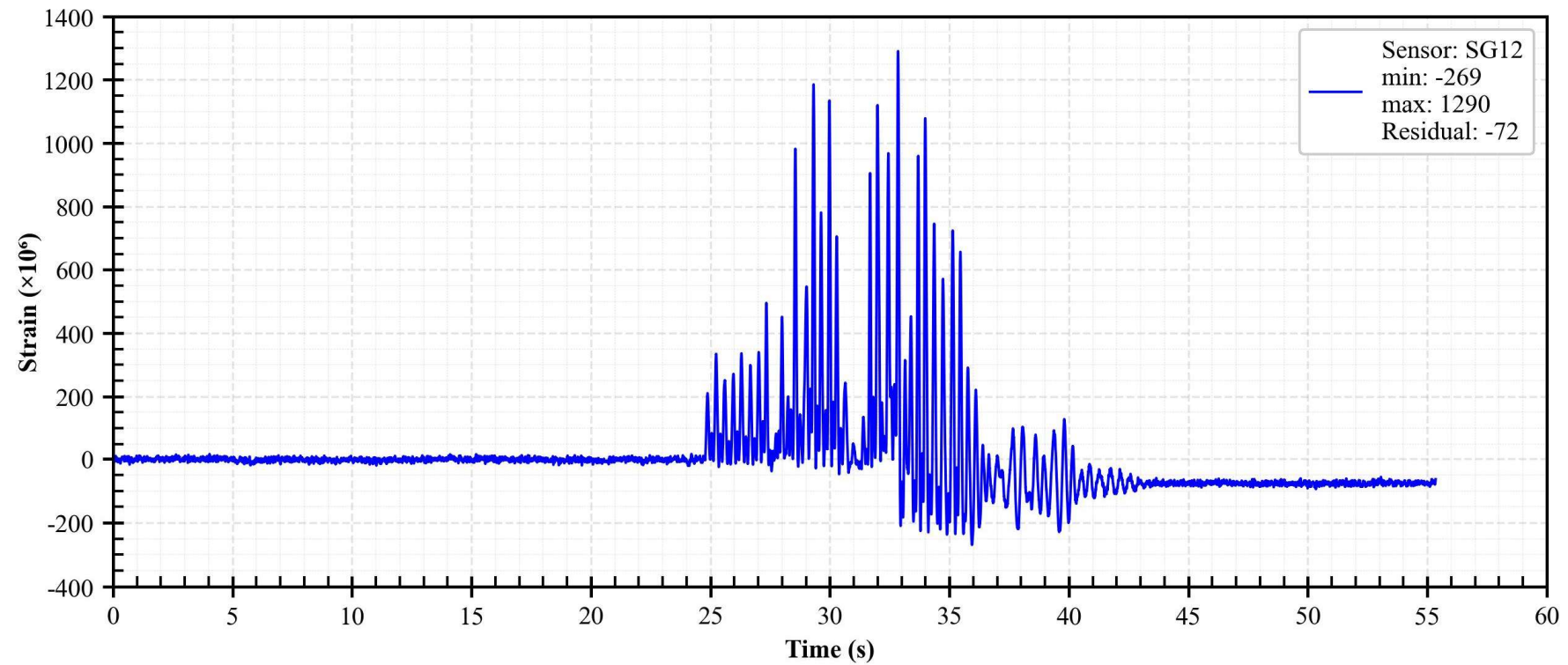


Figure 3.23.25 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 12

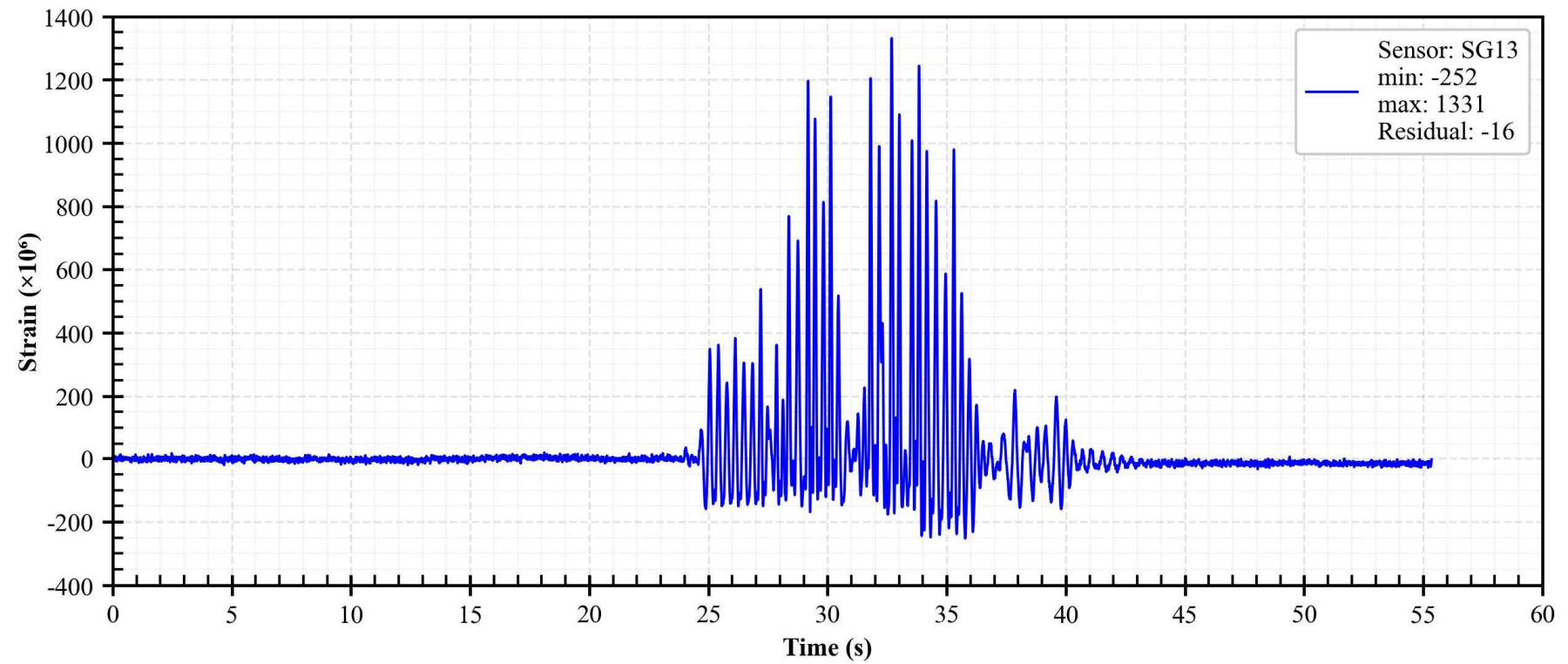


Figure 3.23.26 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 13

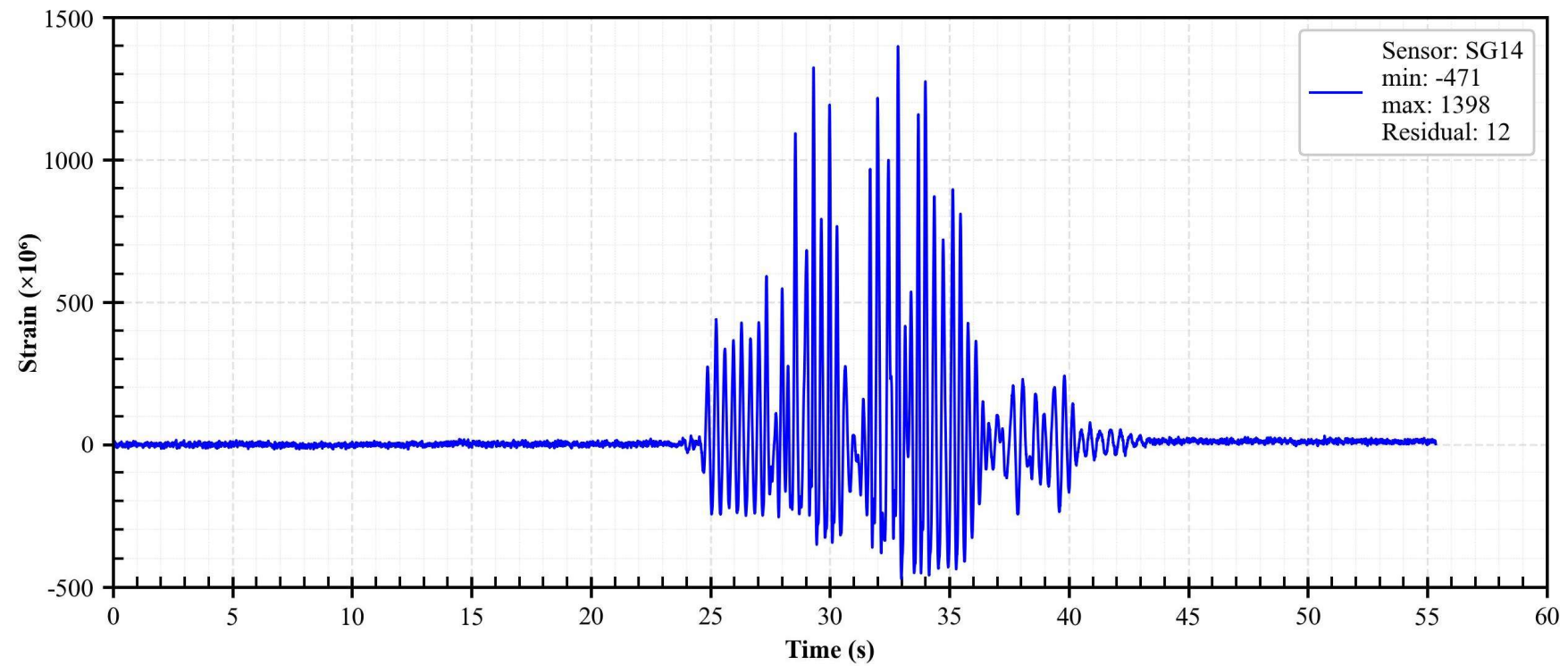


Figure 3.23.27 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 14

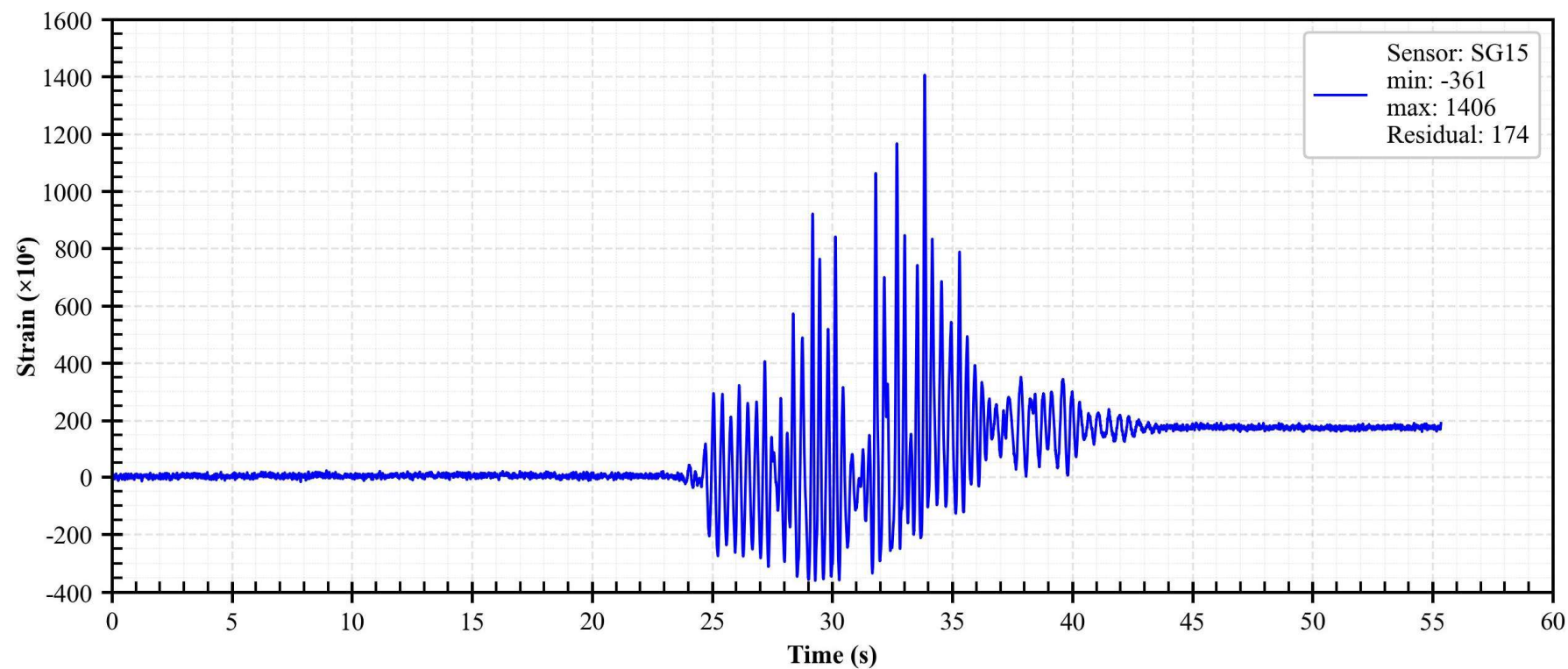


Figure 3.23.28 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 15

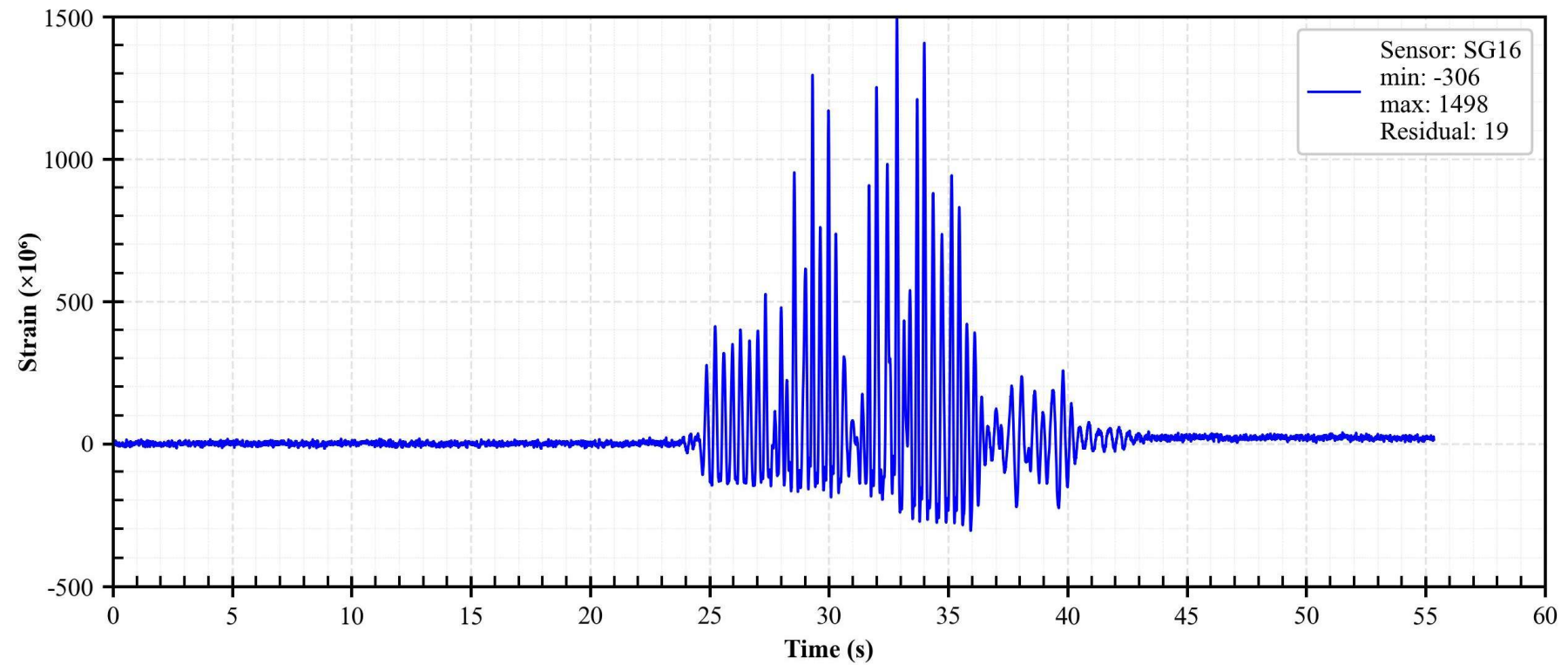


Figure 3.23.29 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 16

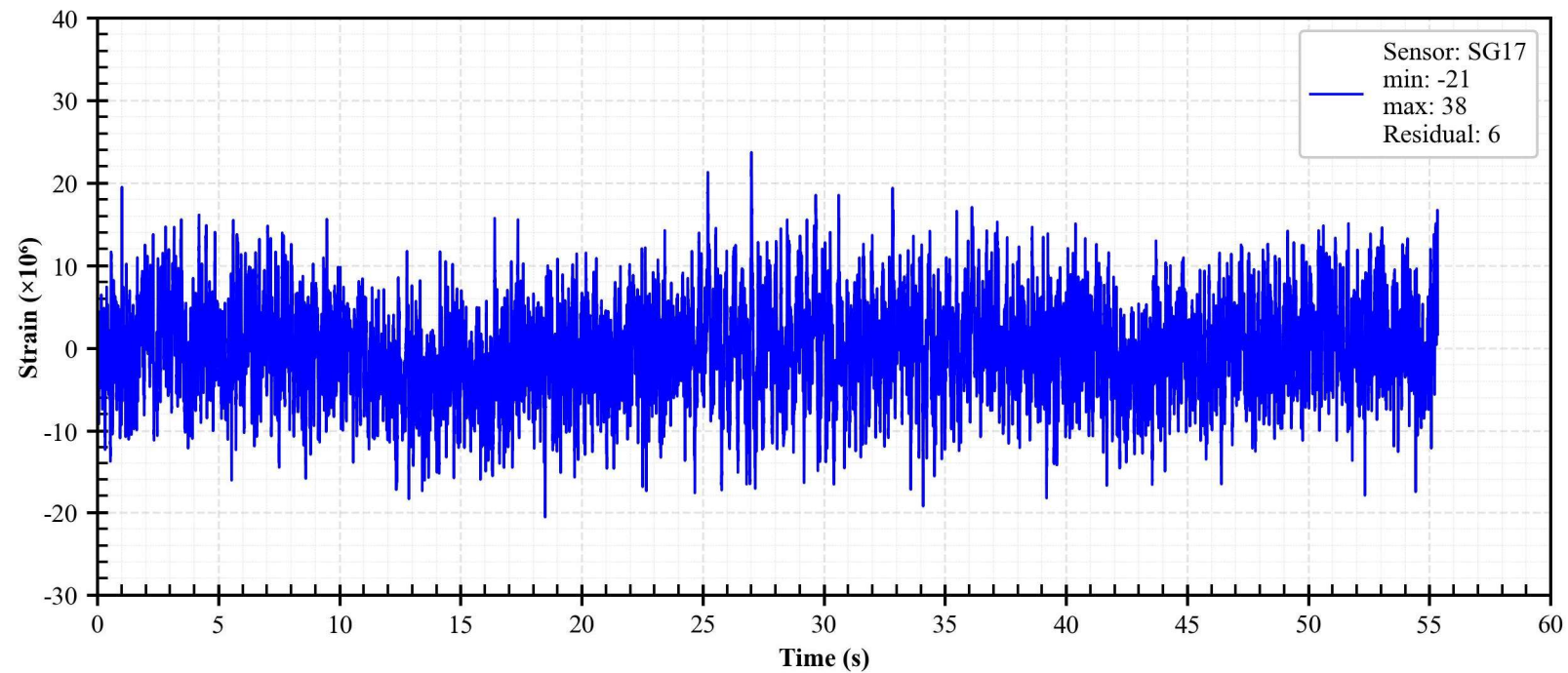


Figure 3.23.30 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 17

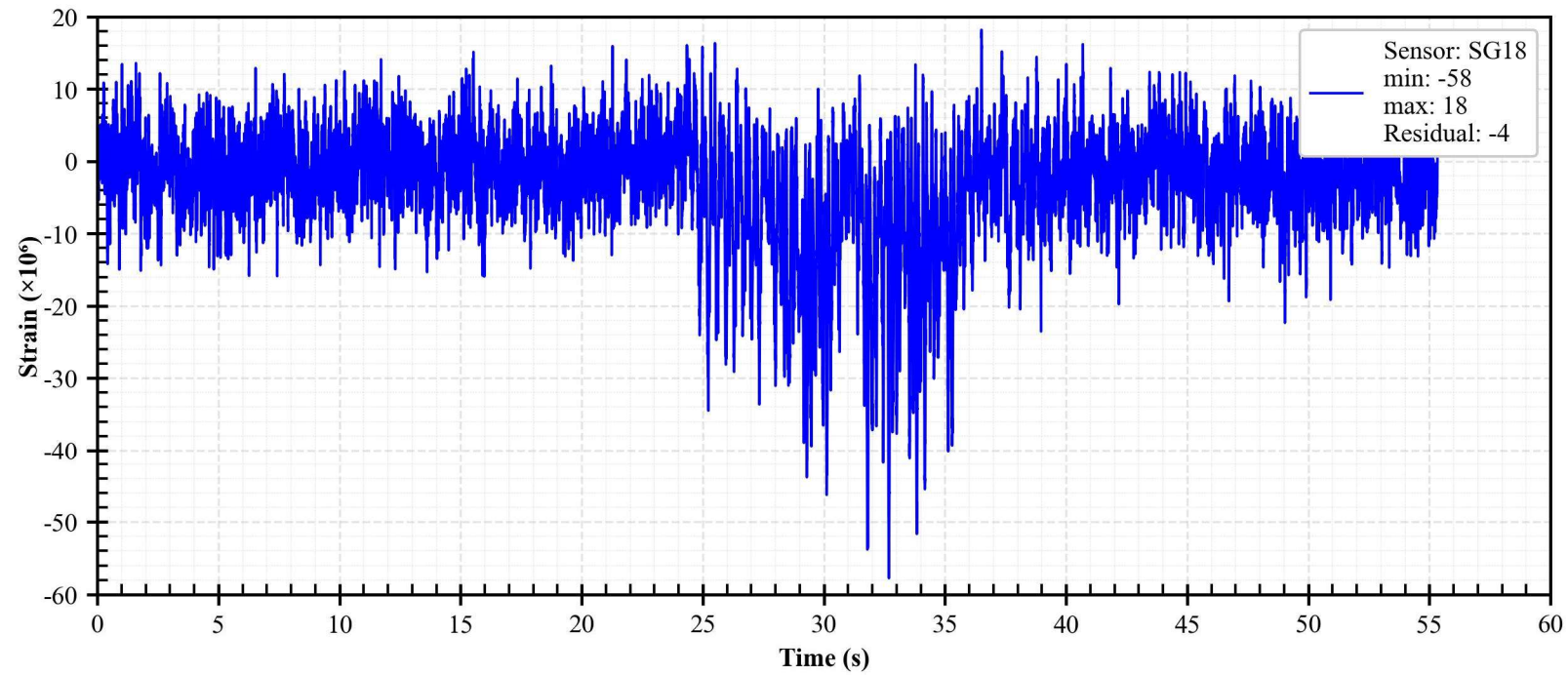


Figure 3.23.31 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 18

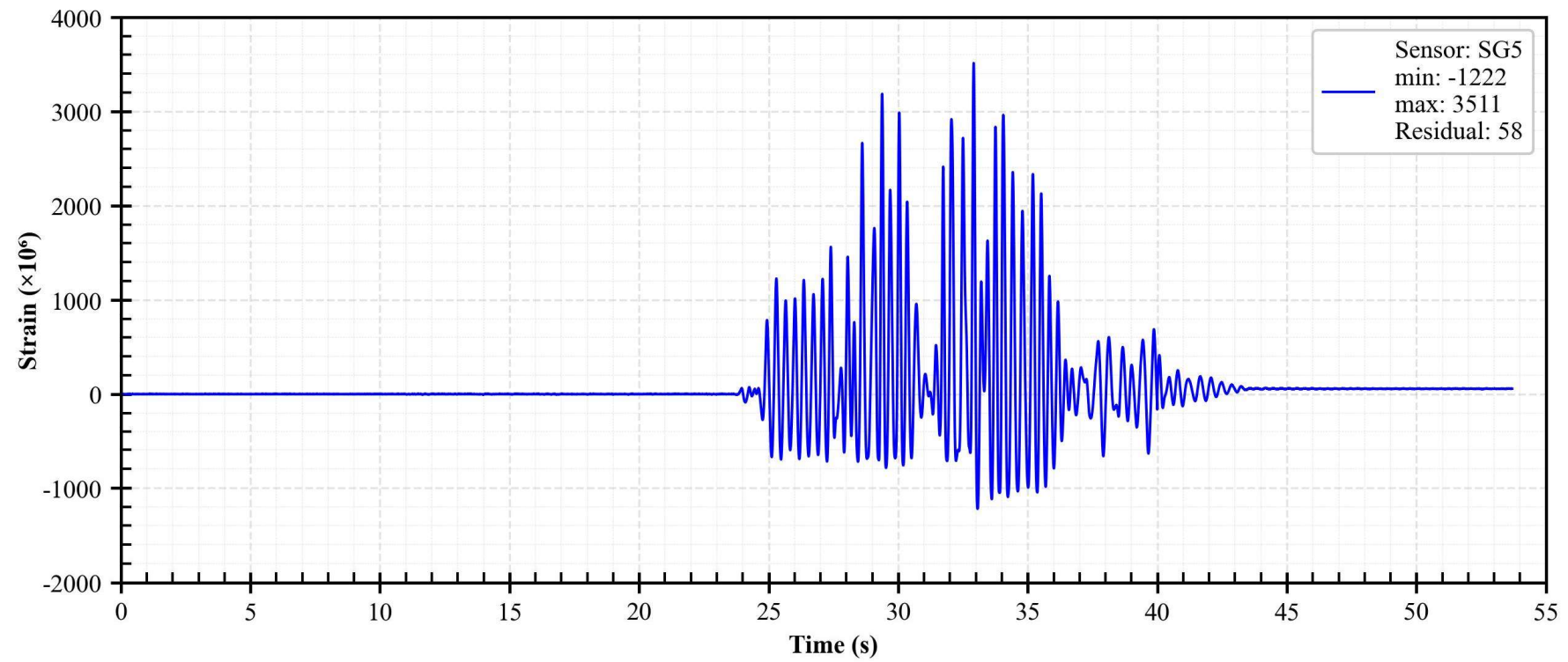


Figure 3.23.32 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 5

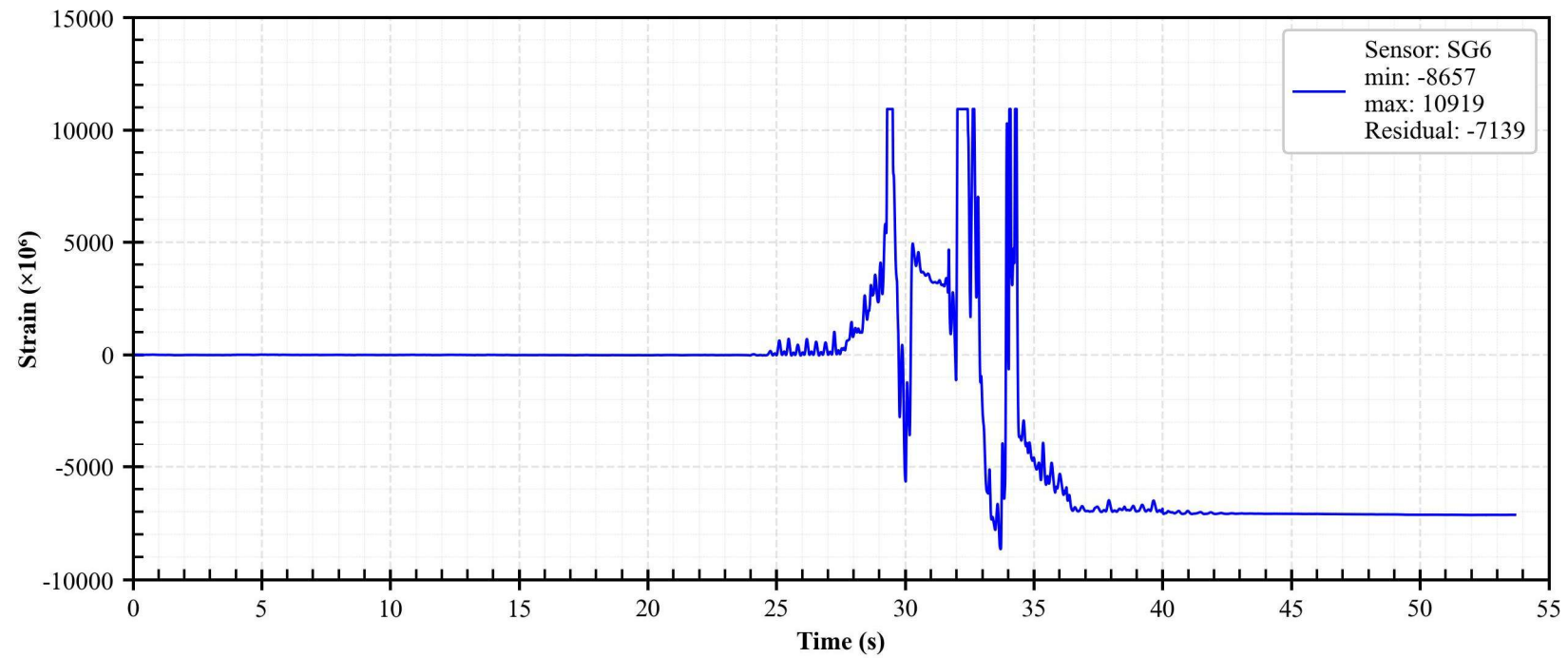


Figure 3.23.33 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 6

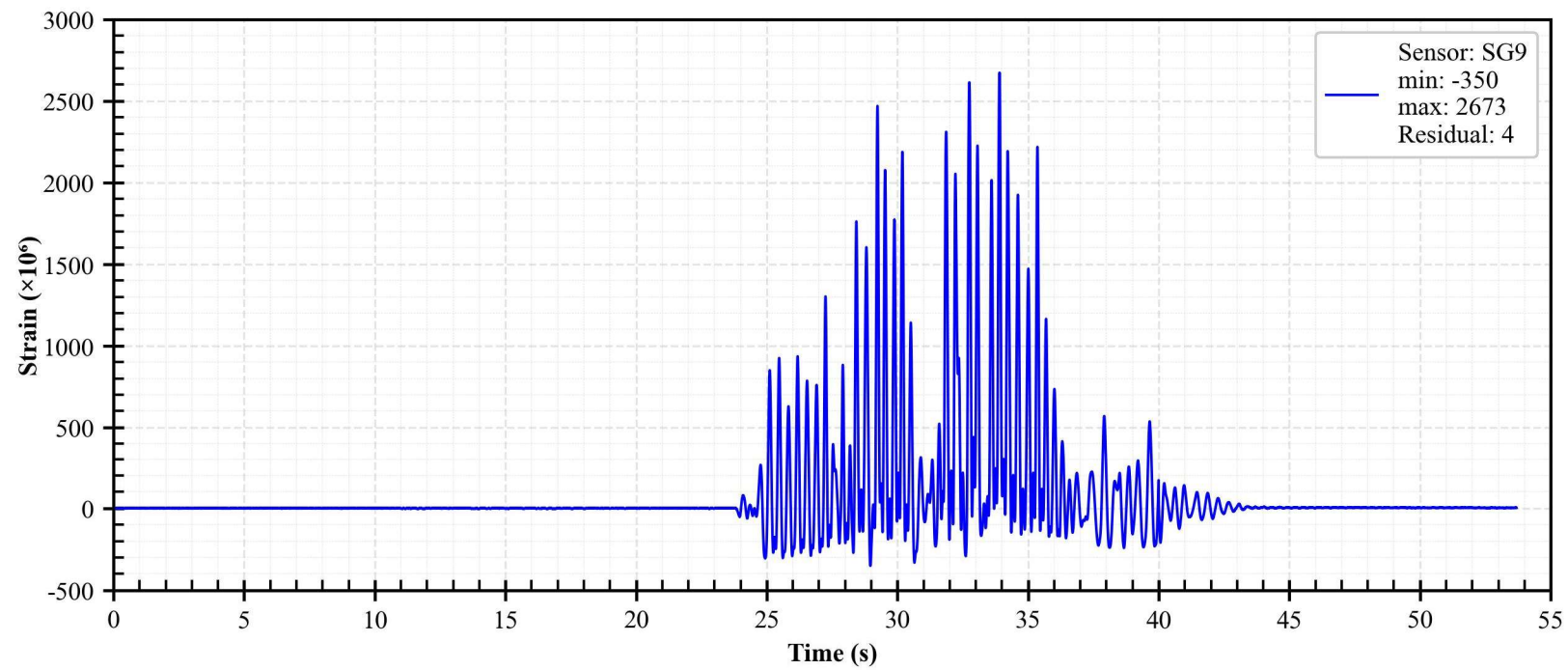


Figure 3.23.34 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 9

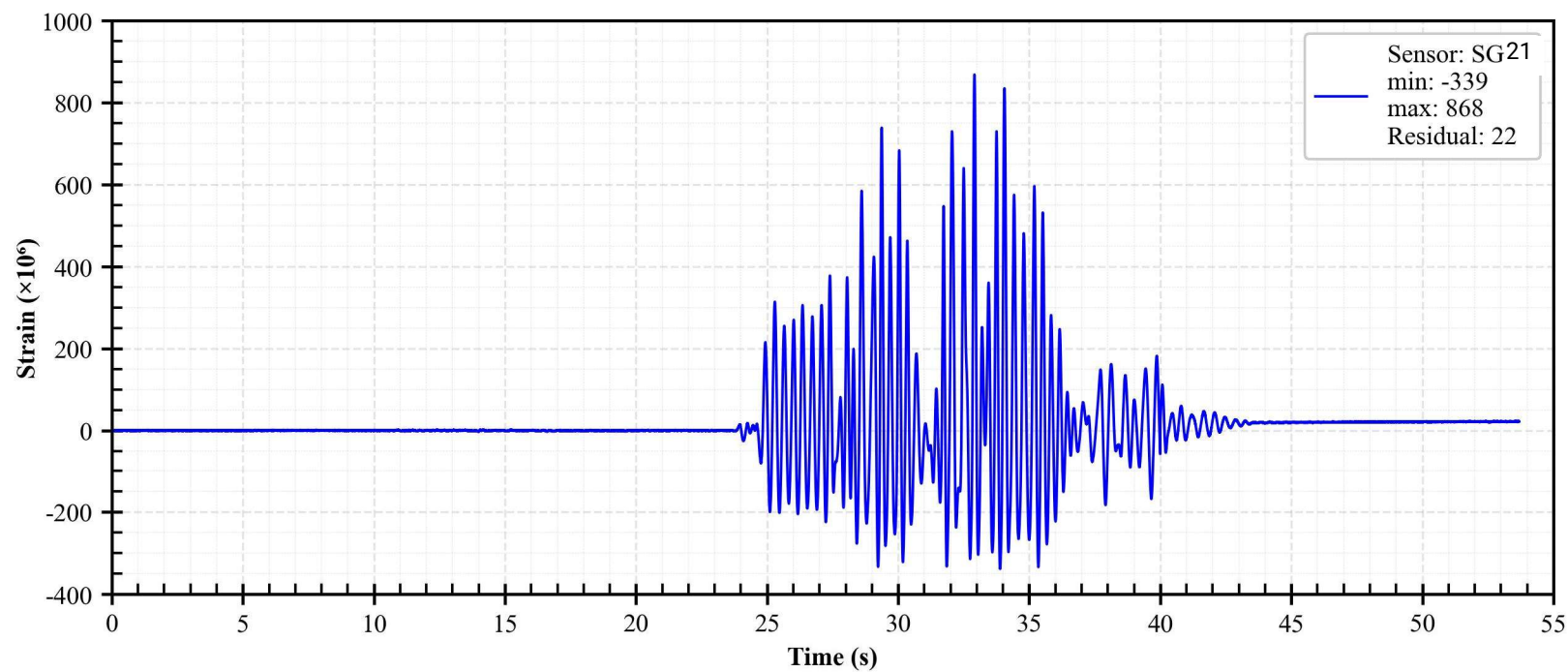


Figure 3.23.35 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 10

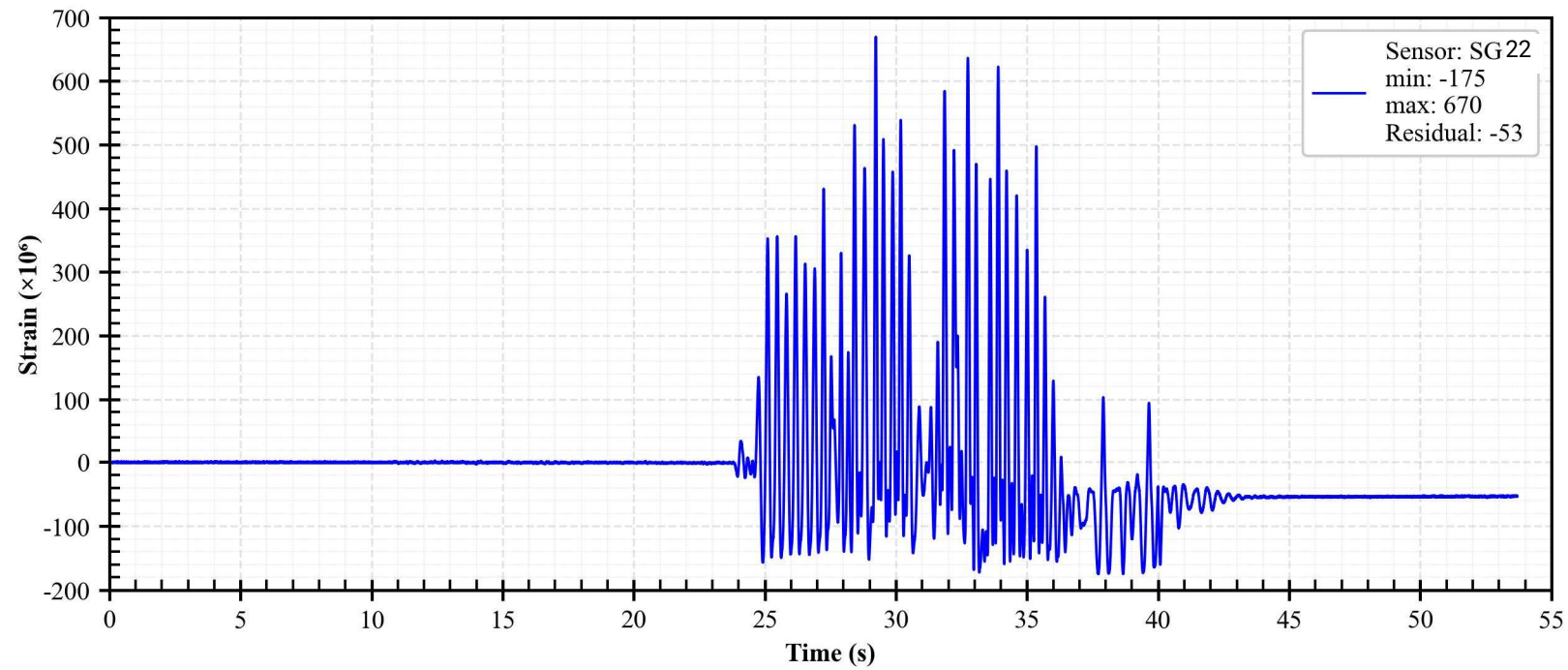


Figure 3.23.36 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 22 (PUFJ, column 2)

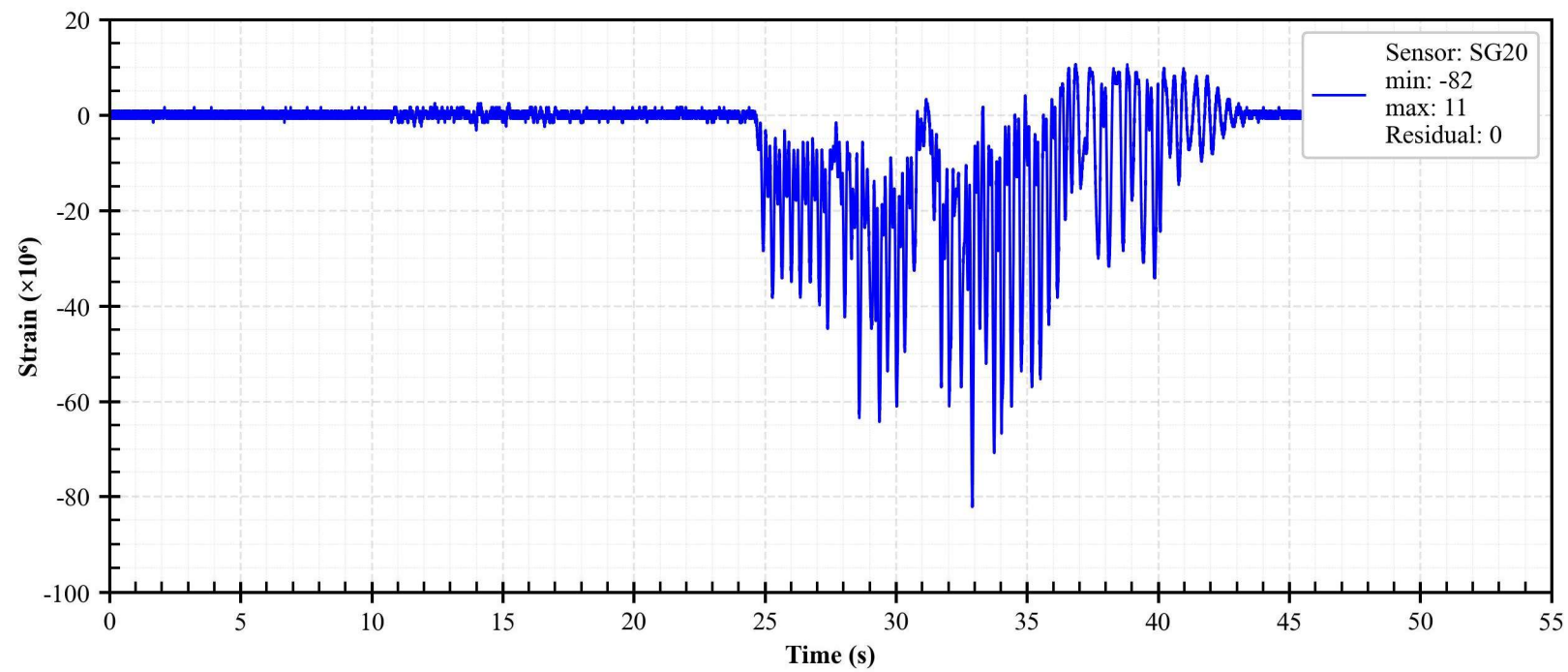


Figure 3.23.37 Characteristic results for phase B (earthquake EQ1,3g (2)): strain gauge 2

3.24 White noise before EQ1,4g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for white noise test before EQ1,4g. The max acceleration at the slab level on the accelerometer acc4 is 0.19g. The max acceleration at the foundation level on the accelerometer acc10 is 0.06g.

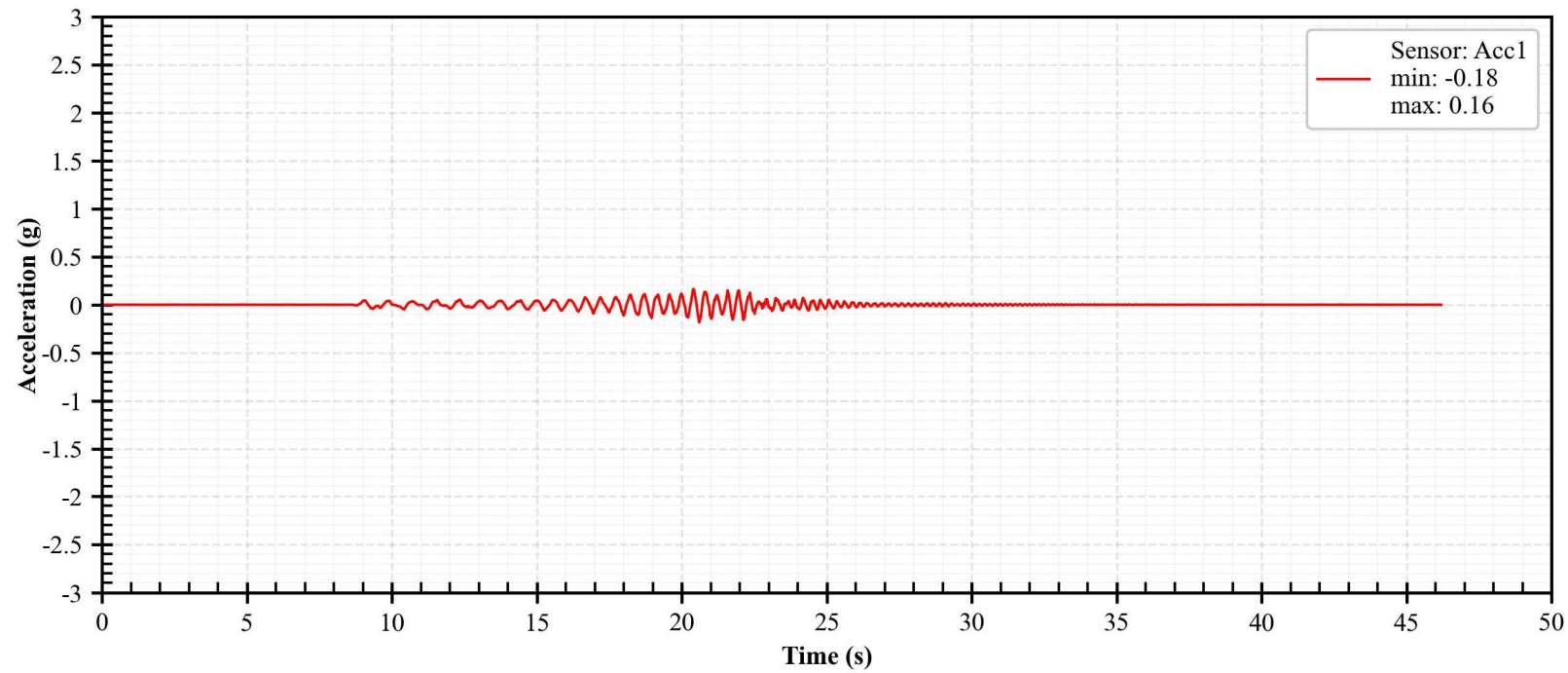


Figure 3.24.1 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 1

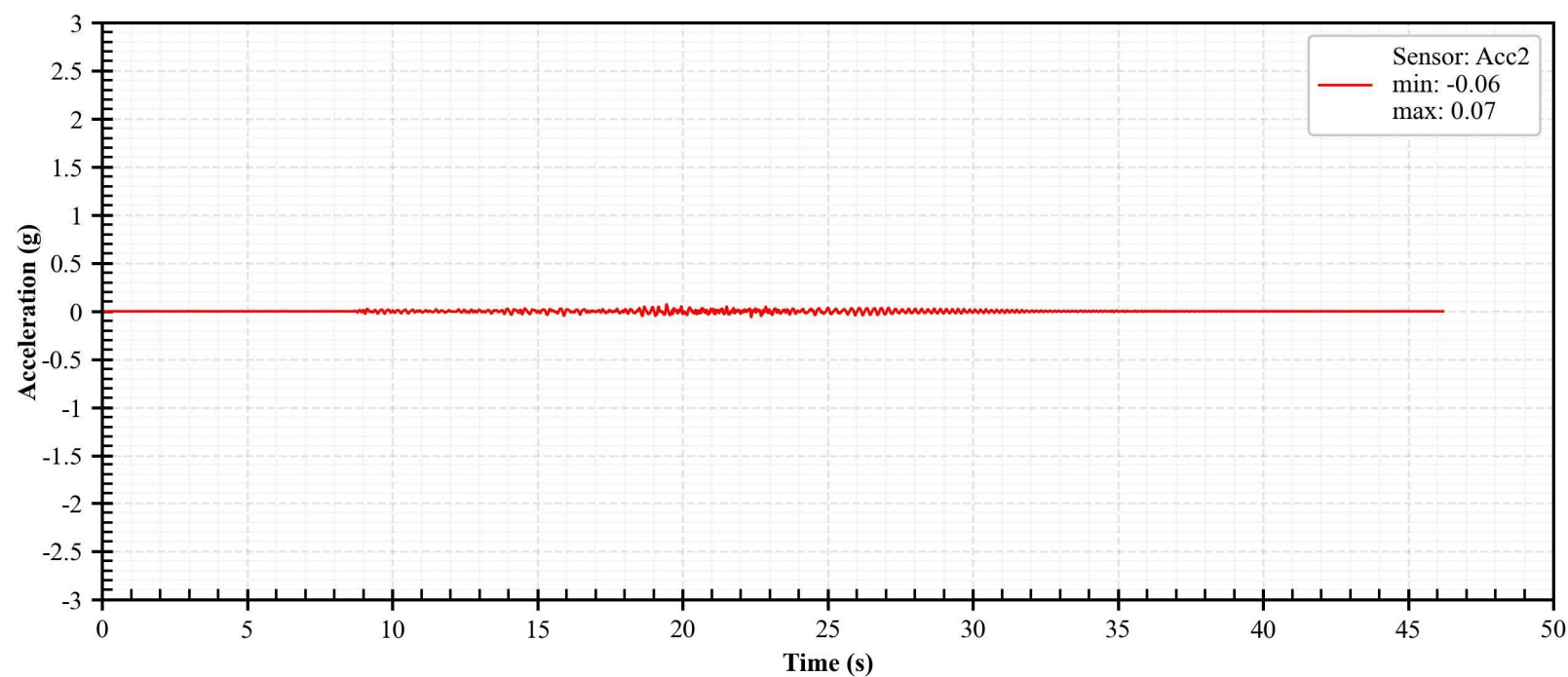


Figure 3.24.2 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 2

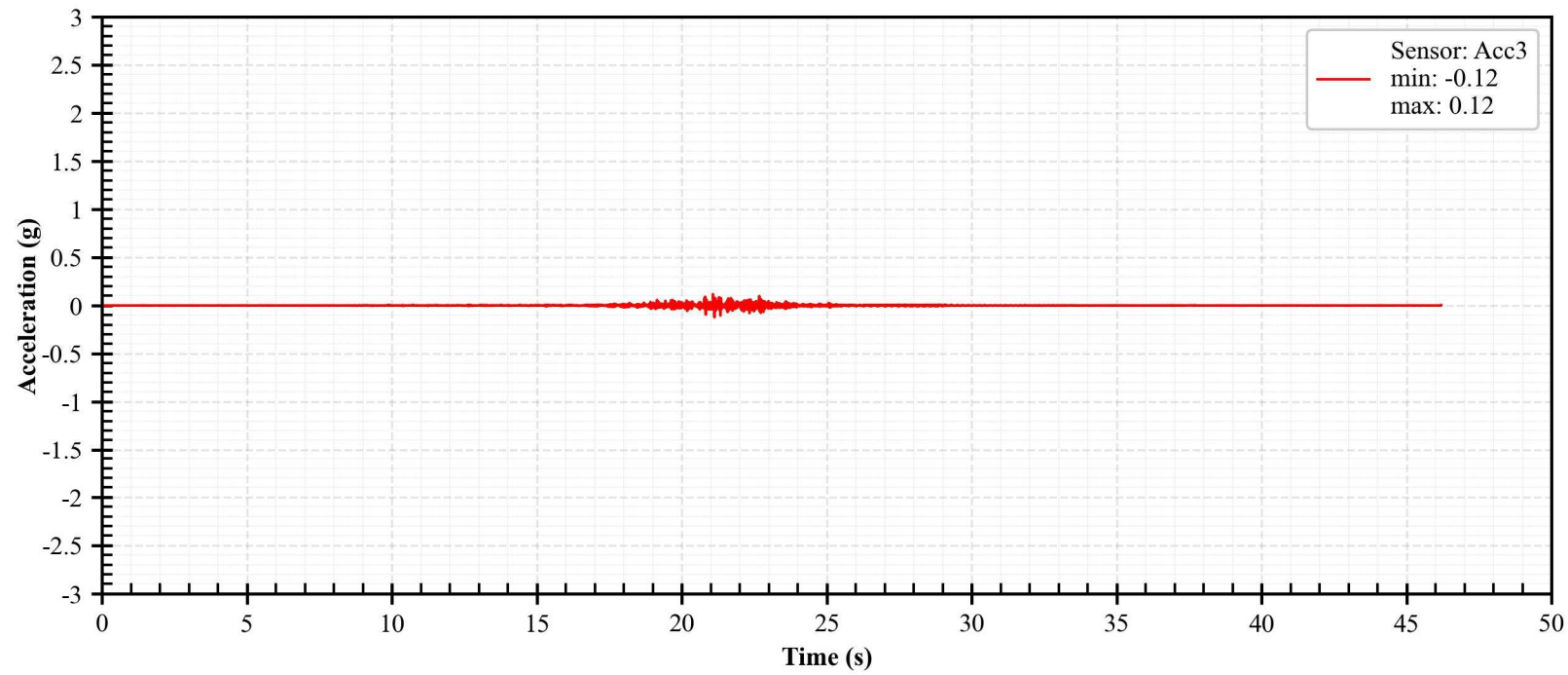


Figure 3.24.3 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 3

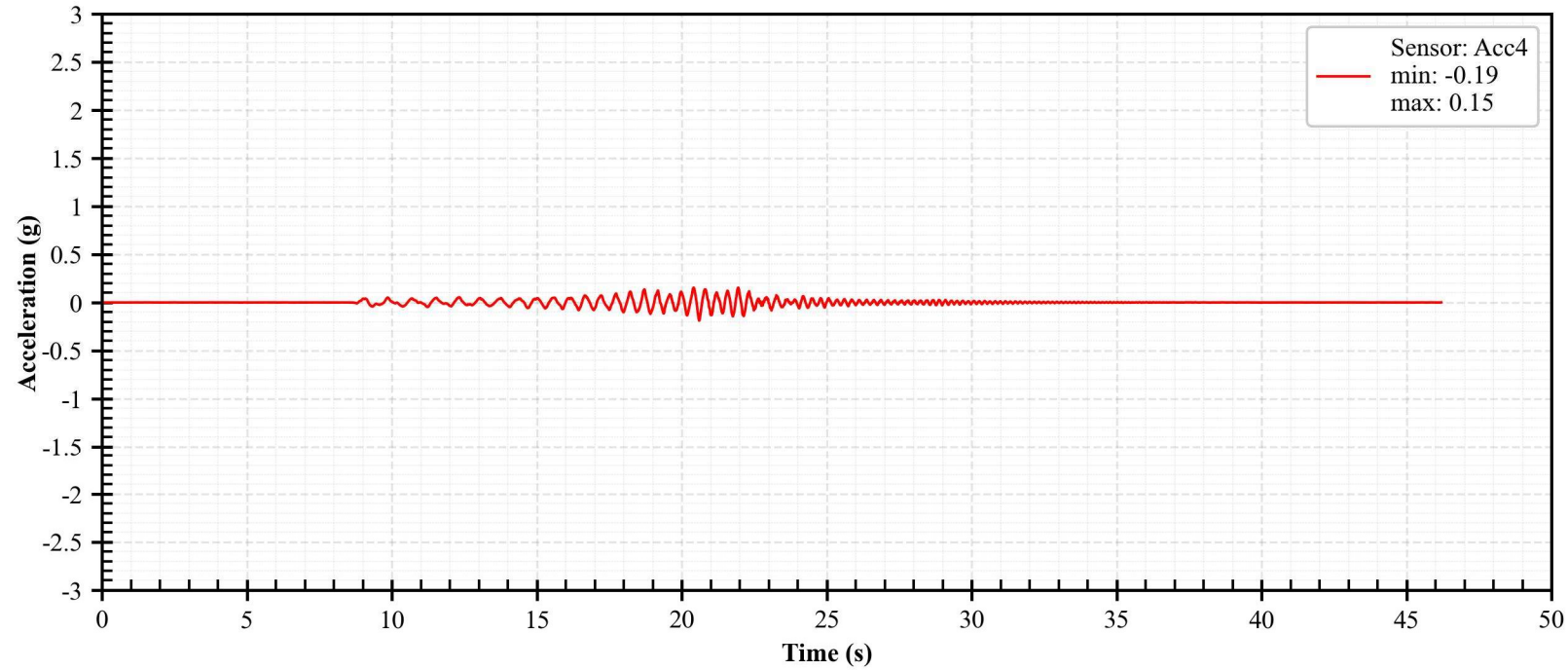


Figure 3.24.4 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 4

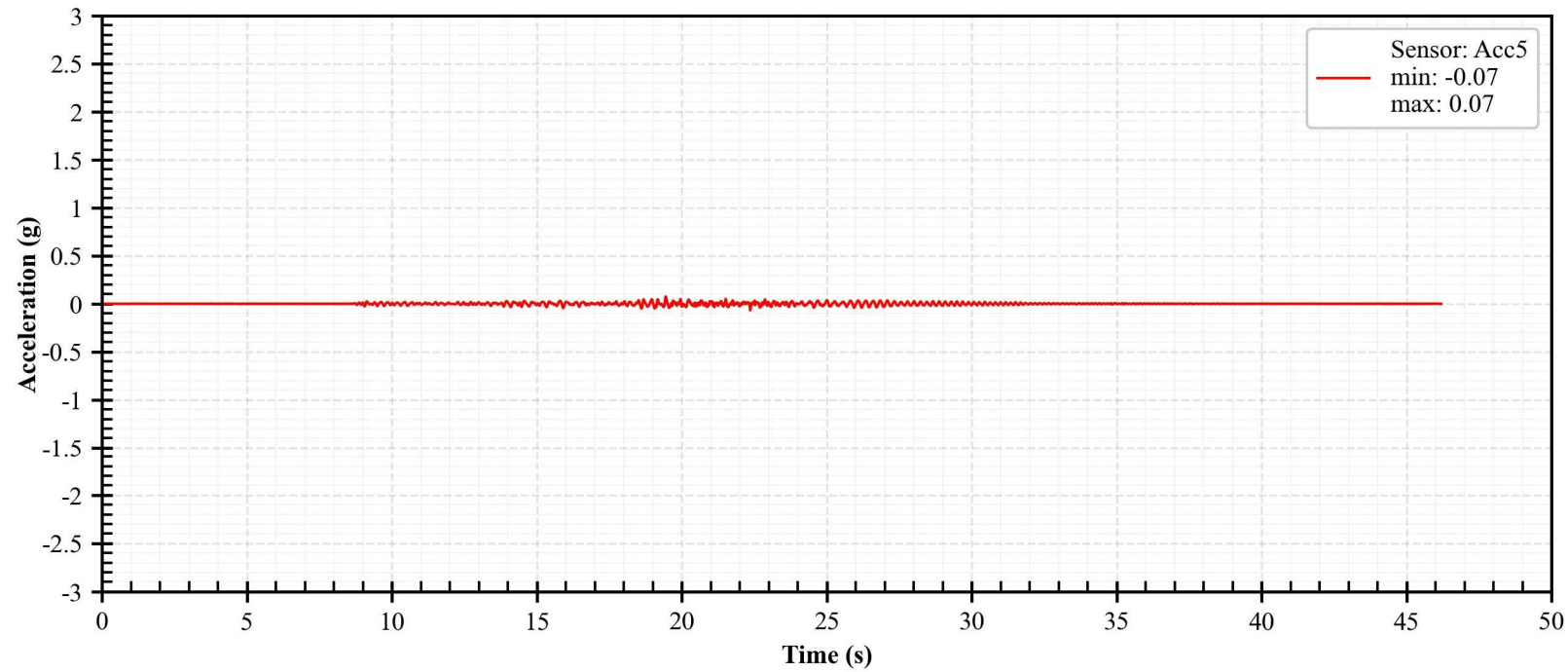


Figure 3.24.5 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 5

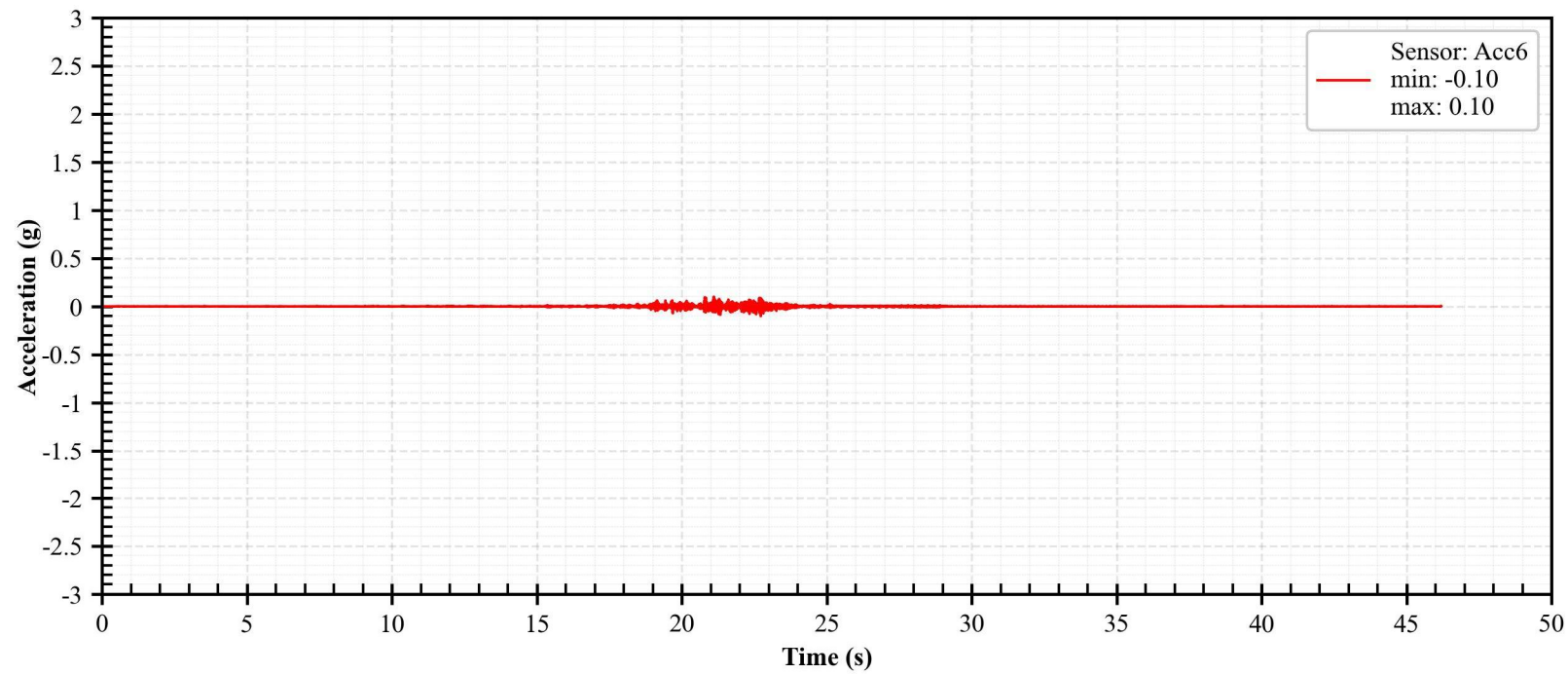


Figure 3.24.6 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 6

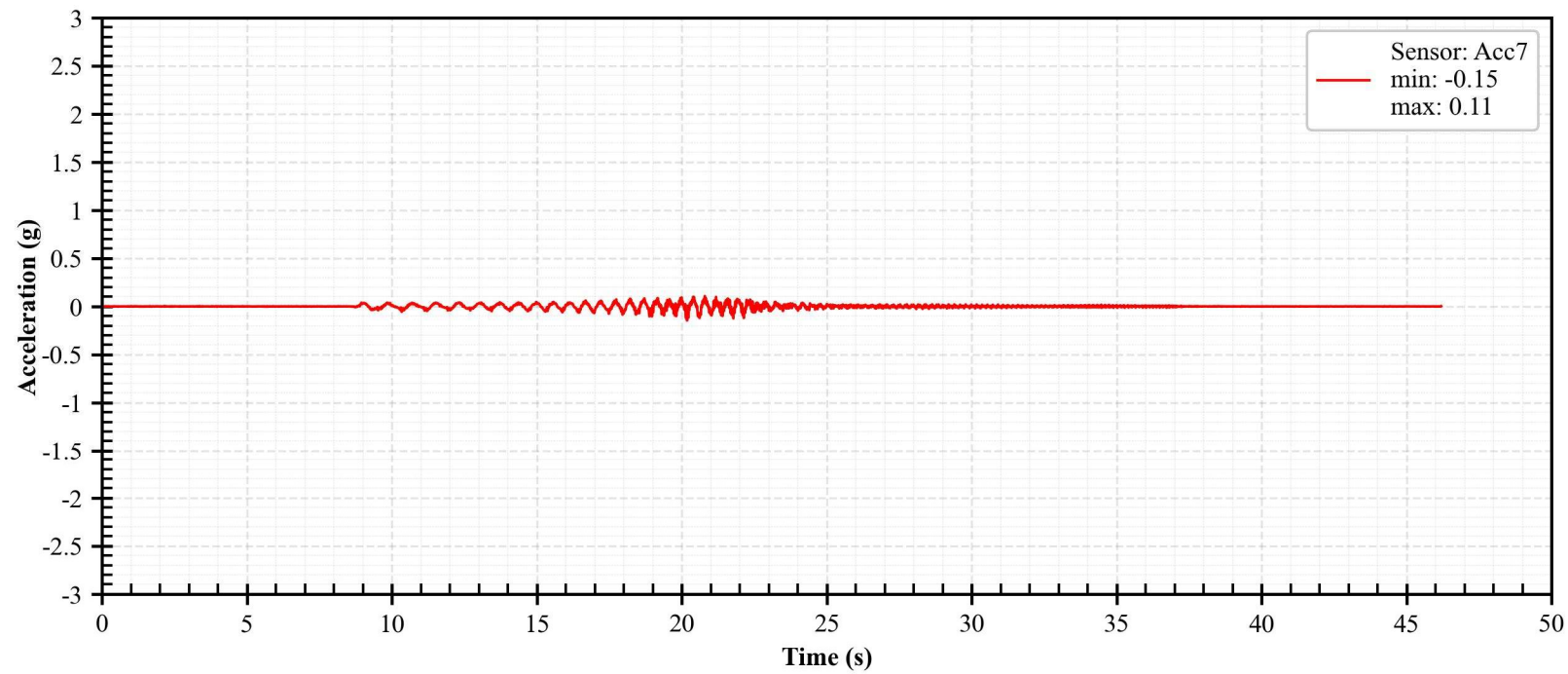


Figure 3.24.7 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 7

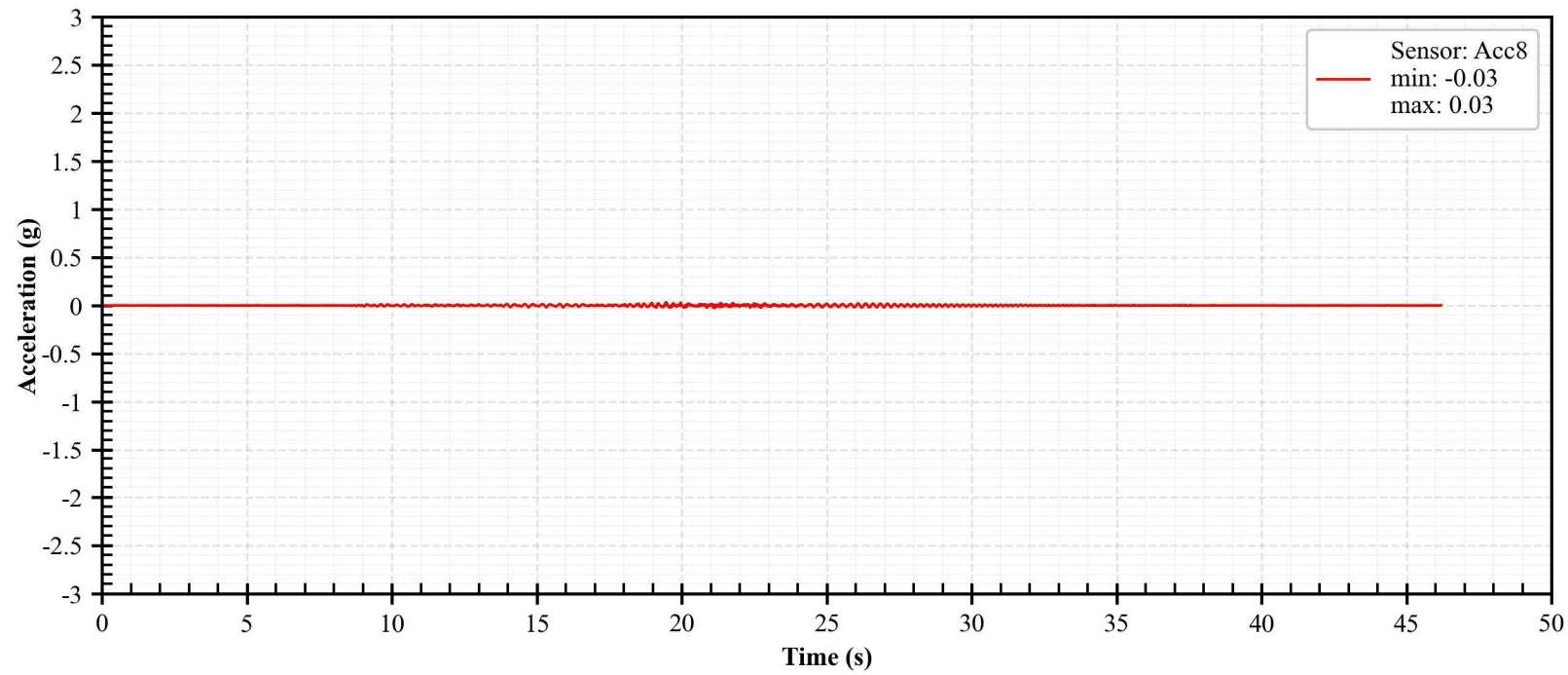


Figure 3.24.8 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 8

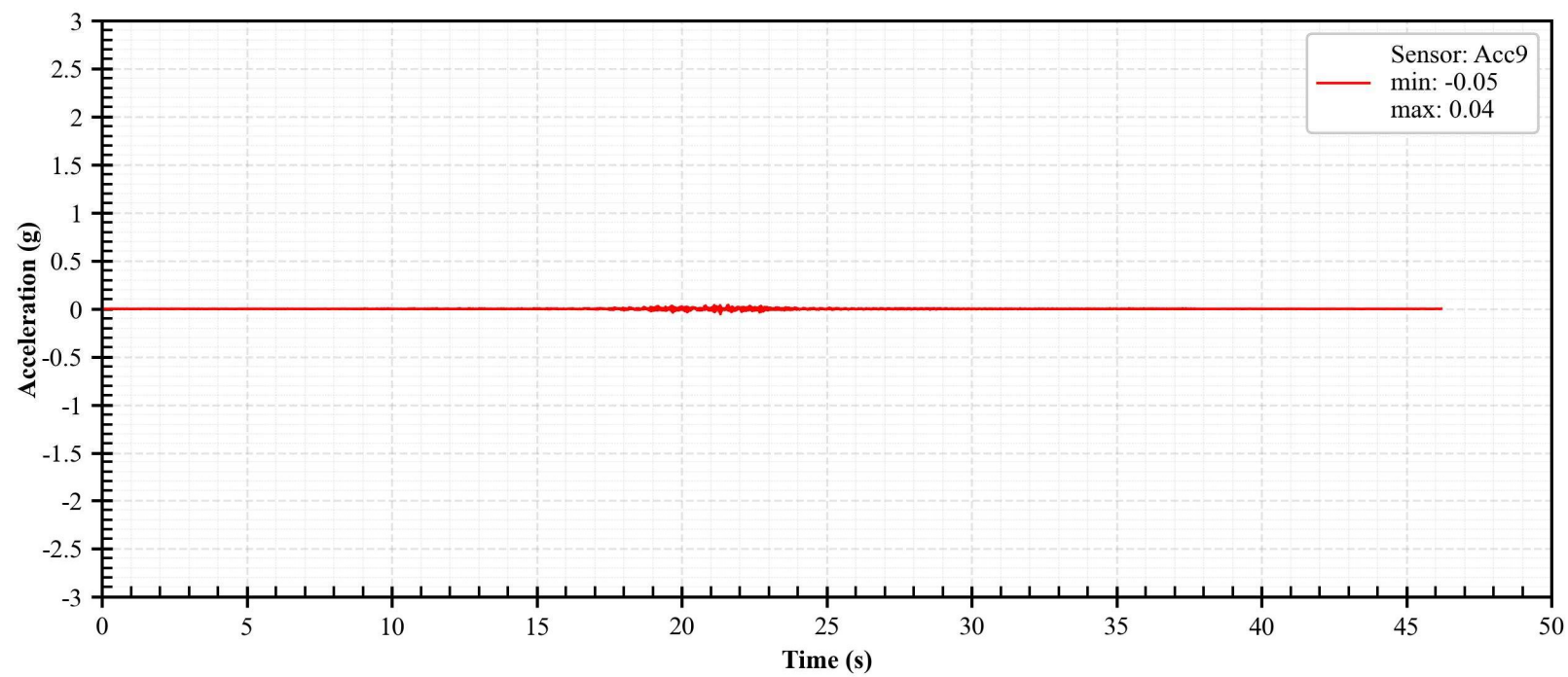


Figure 3.24.9 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 9

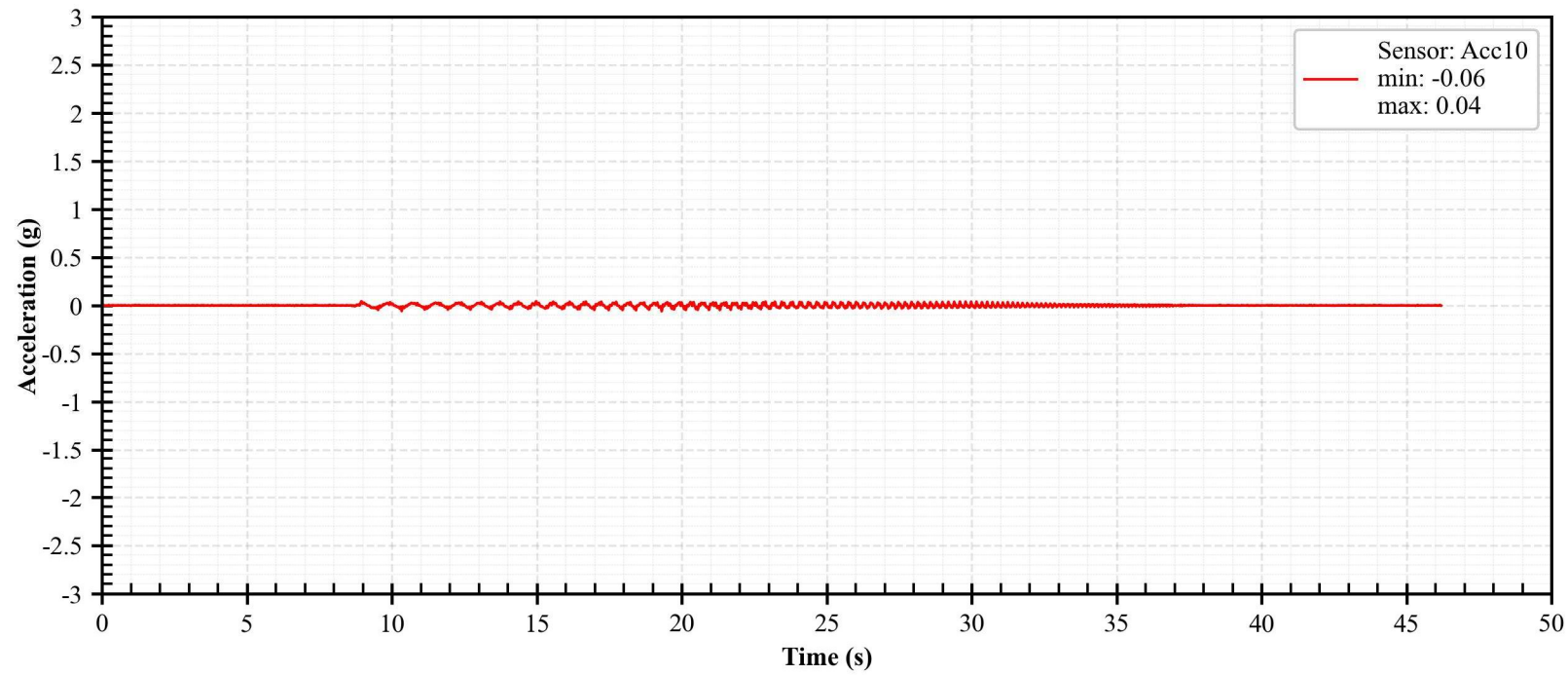


Figure 3.24.10 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 10

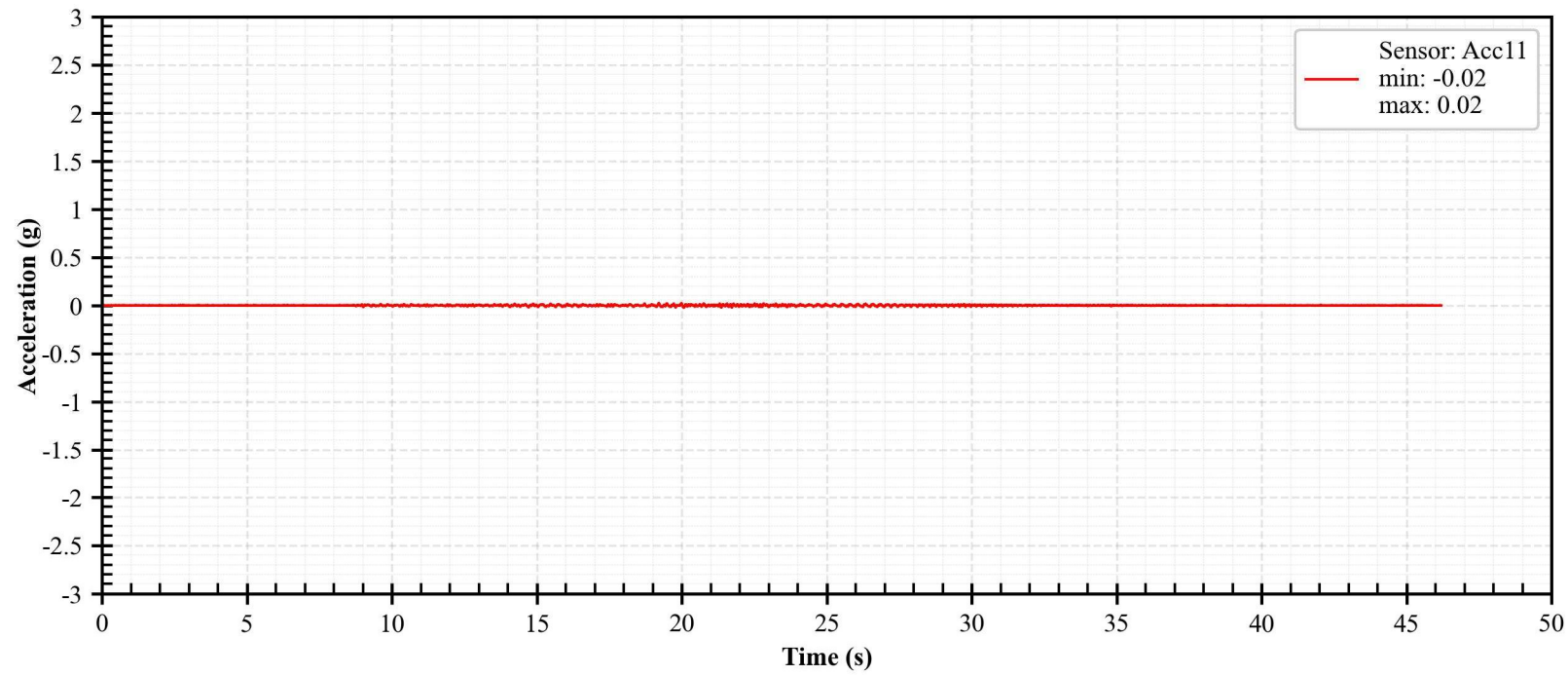


Figure 3.24.11 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 11

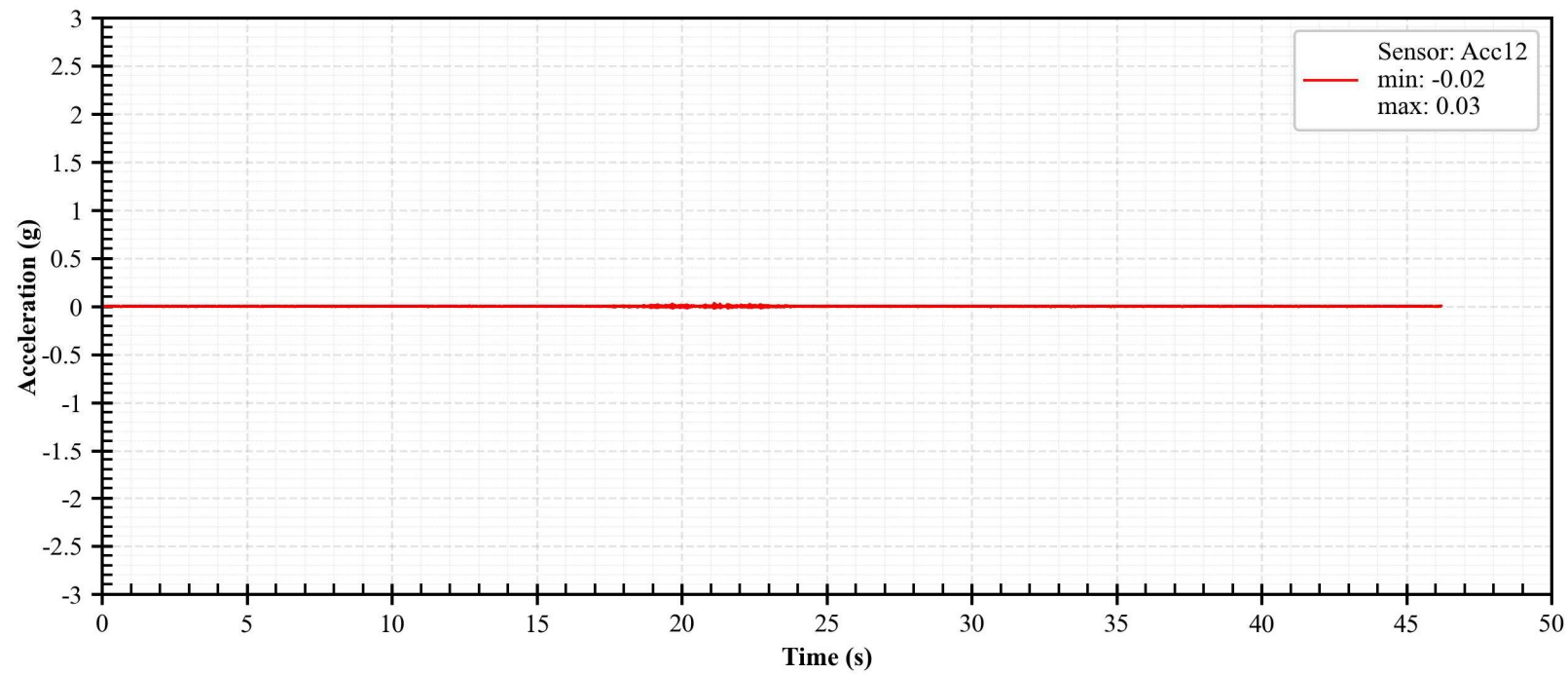


Figure 3.24.12 Characteristic results for phase B (white noise before EQ1,4g): Accelerometer 12

Draw wire sensors

Figures 3.24.13 – 3.24.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 23.38 mm while the minimum is -16.91 mm. The maximum movement detected by draw wire sensor W2 is 22.52 mm while the minimum is -16.85 mm. The maximum movement detected by draw wire sensor W3 is 21.91 mm while the minimum is -15.40 mm. The maximum movement detected by draw wire sensor W4 is 21.19 mm while the minimum is -16.32 mm. The maximum drift is $(4.66/1.225) = 3.80 \text{ ‰}$ and minimum drift is $(-6.56/1.225) = -5.36 \text{ ‰}$.

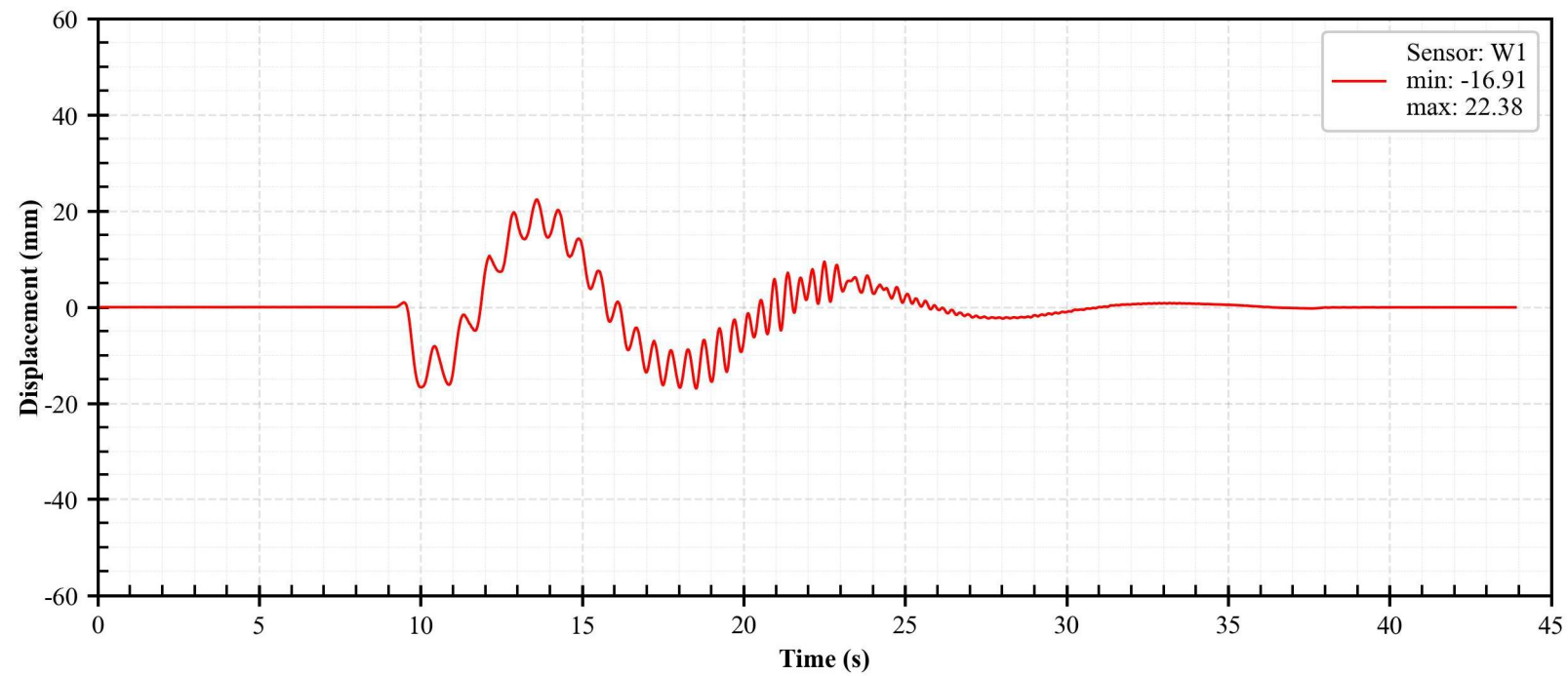


Figure 3.24.13 Characteristic results for phase B (white noise before EQ1,4g): Draw wire sensor 1

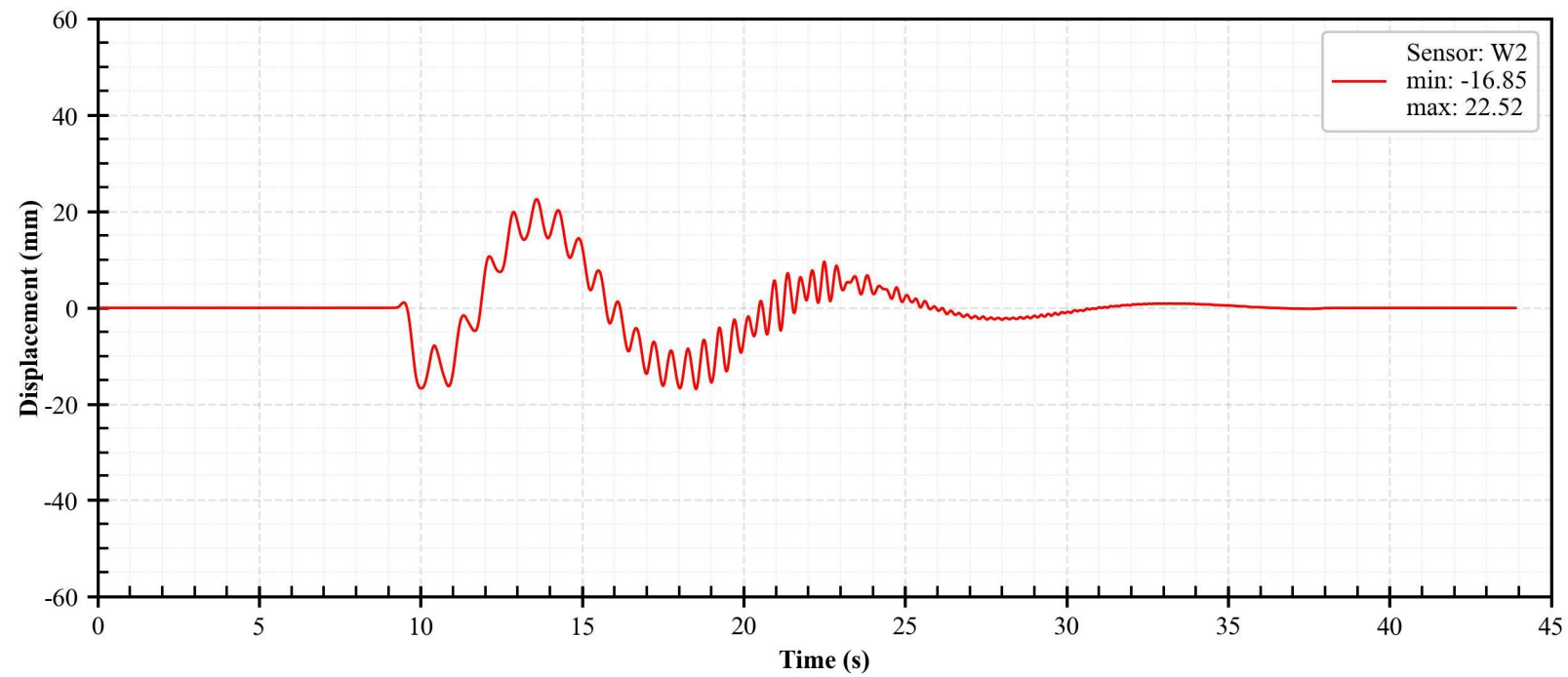


Figure 3.24.14 Characteristic results for phase B (white noise before EQ1,4g): Draw wire sensor 2

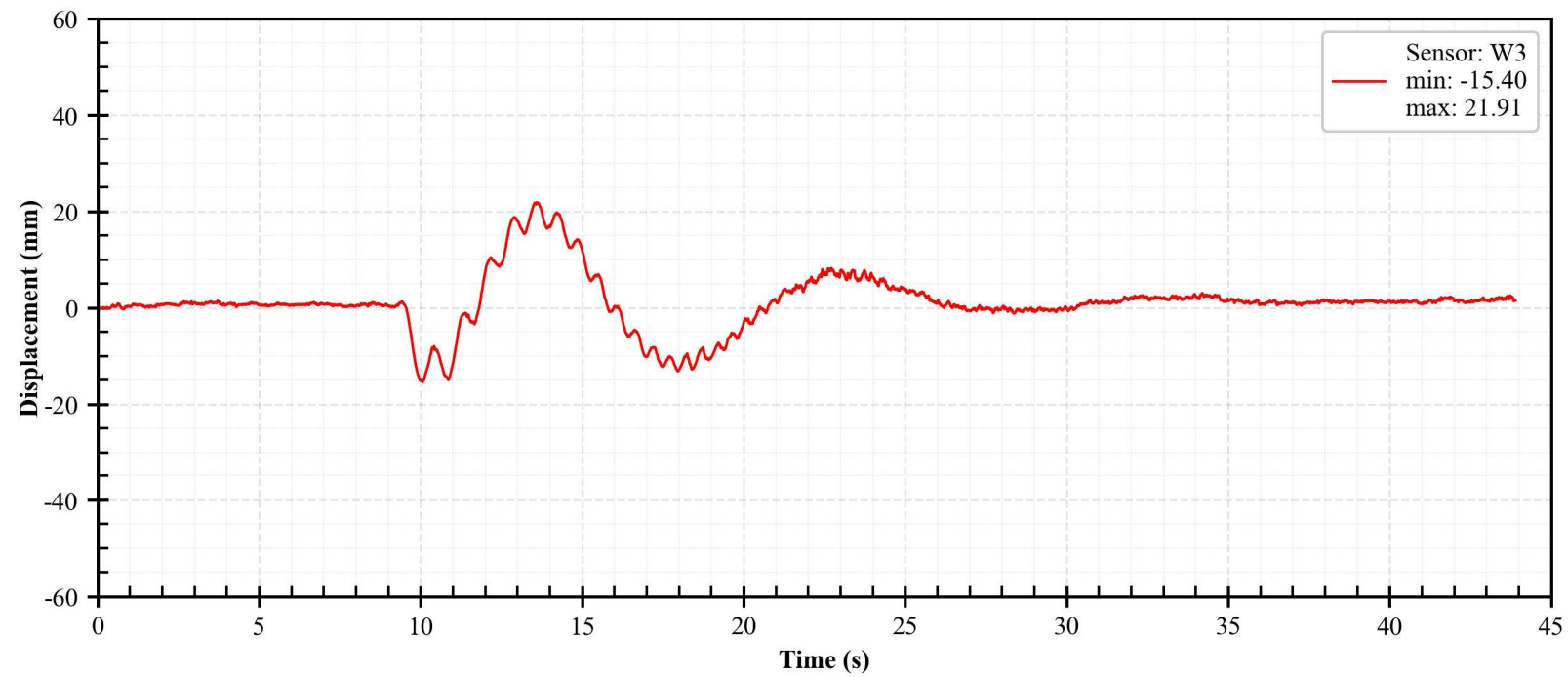


Figure 3.24.15 Characteristic results for phase B (white noise before EQ1,4g): Draw wire sensor 3

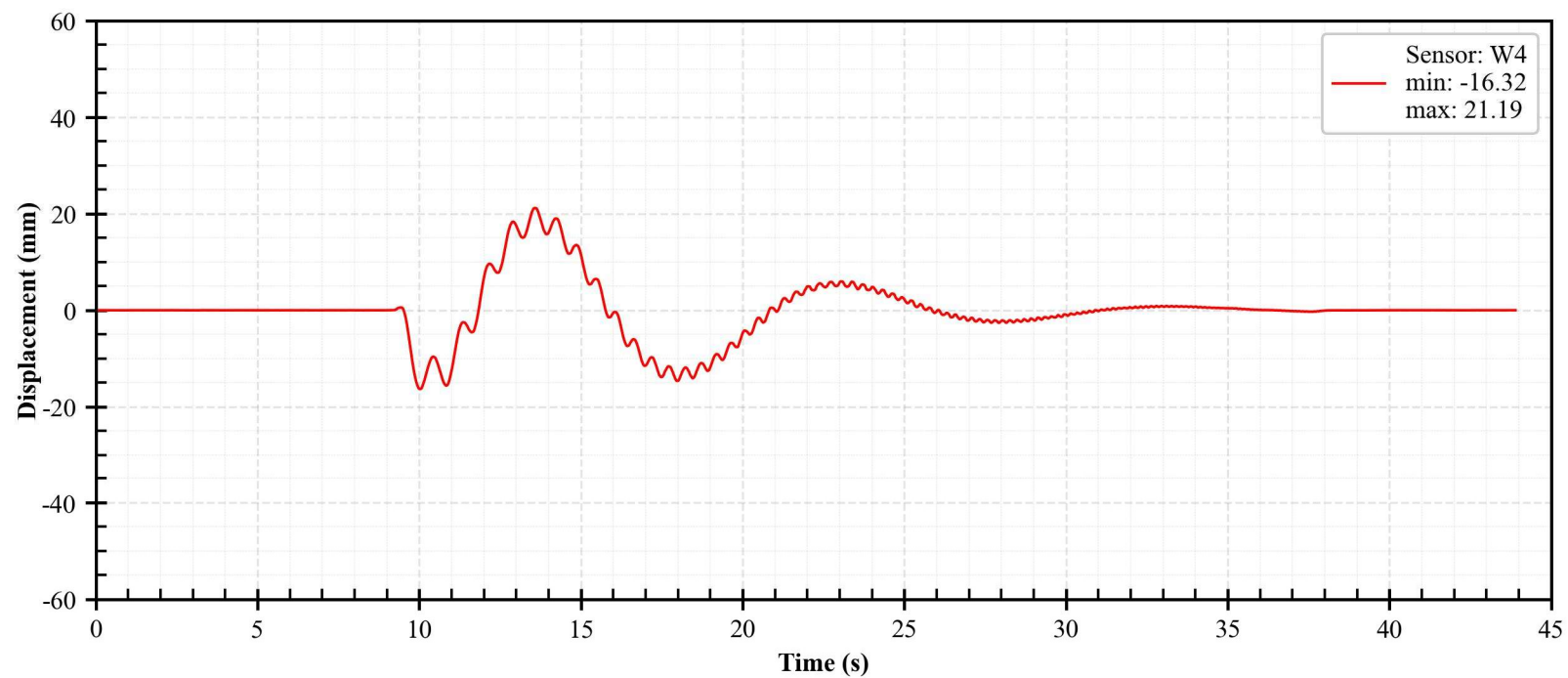


Figure 3.24.16 Characteristic results for phase B (white noise before EQ1,4g): Draw wire sensor 4

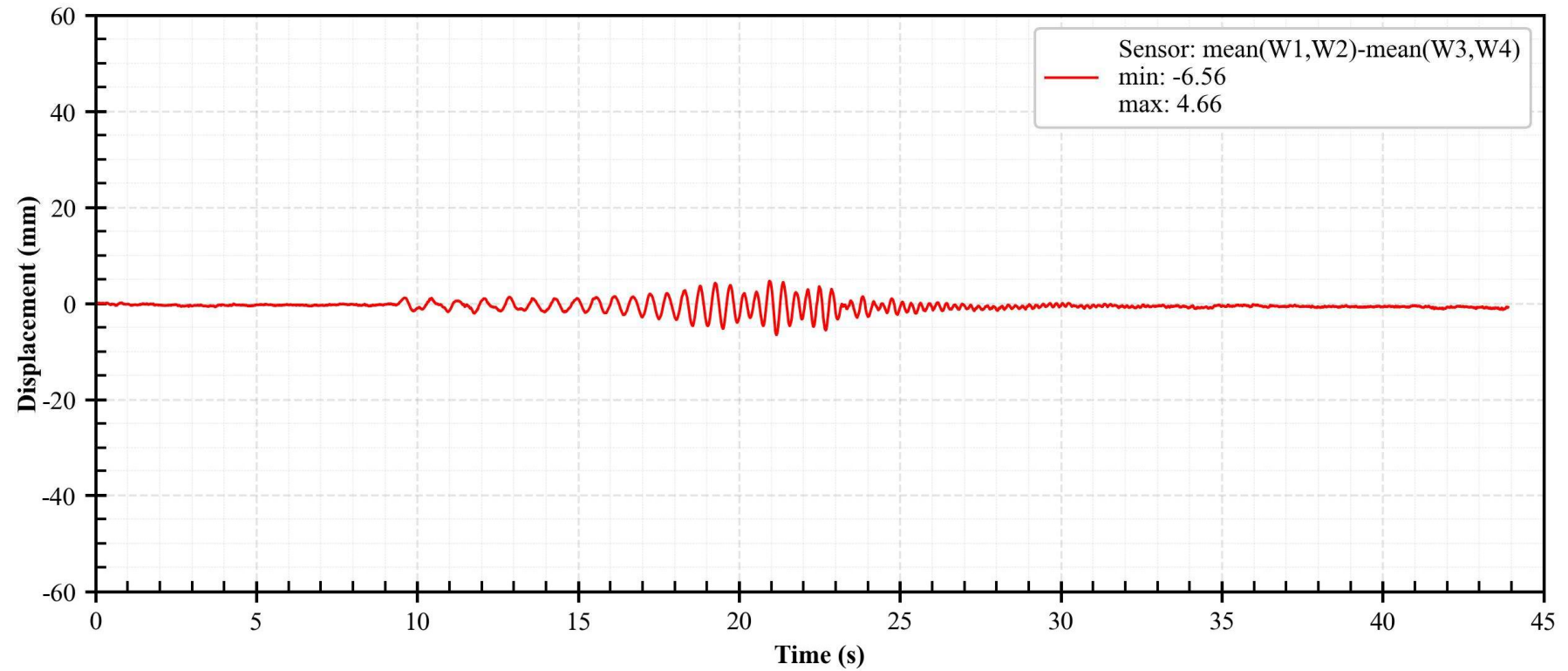


Figure 3.24.17 Characteristic results for phase B (white noise before EQ1,4g): mean (W1,W2) – mean (W3,W4)

Strain gauges

No notable changes are detected in the values of strain gauges.

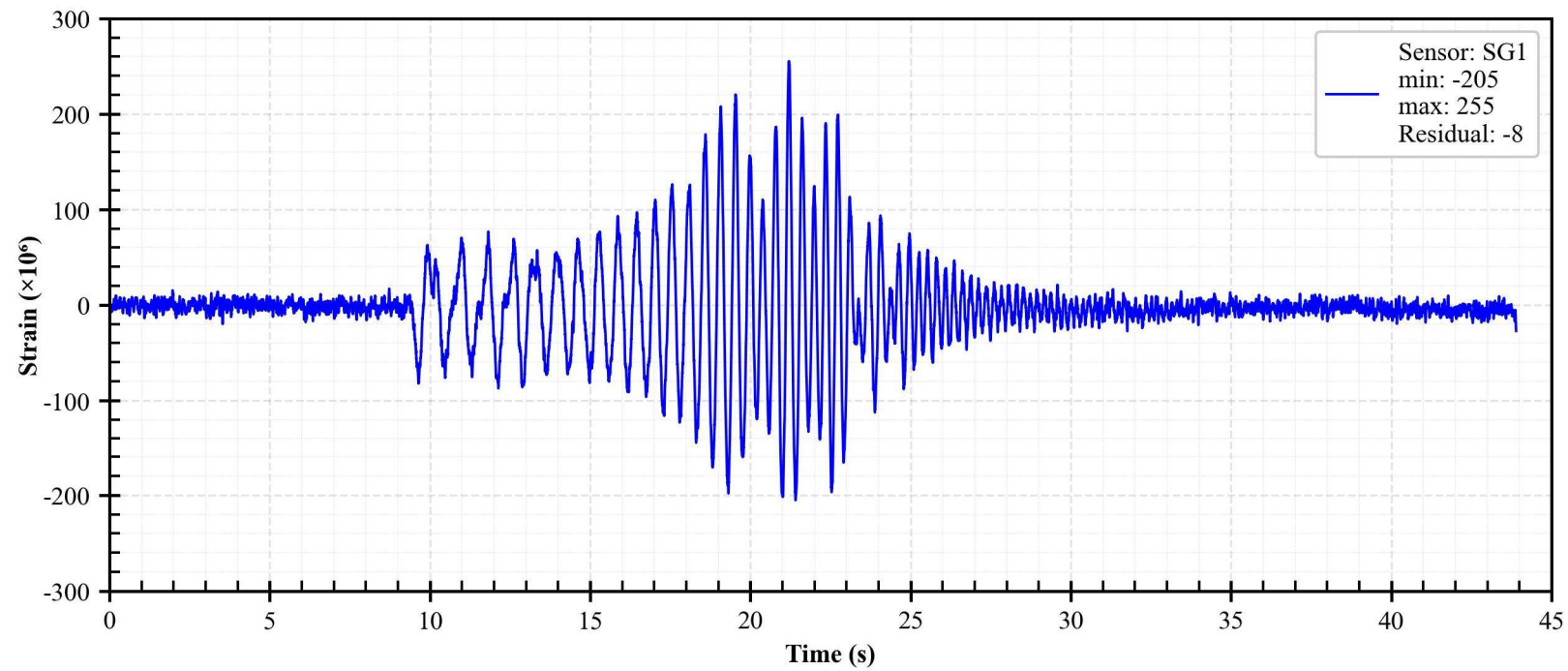


Figure 3.24.18 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 1

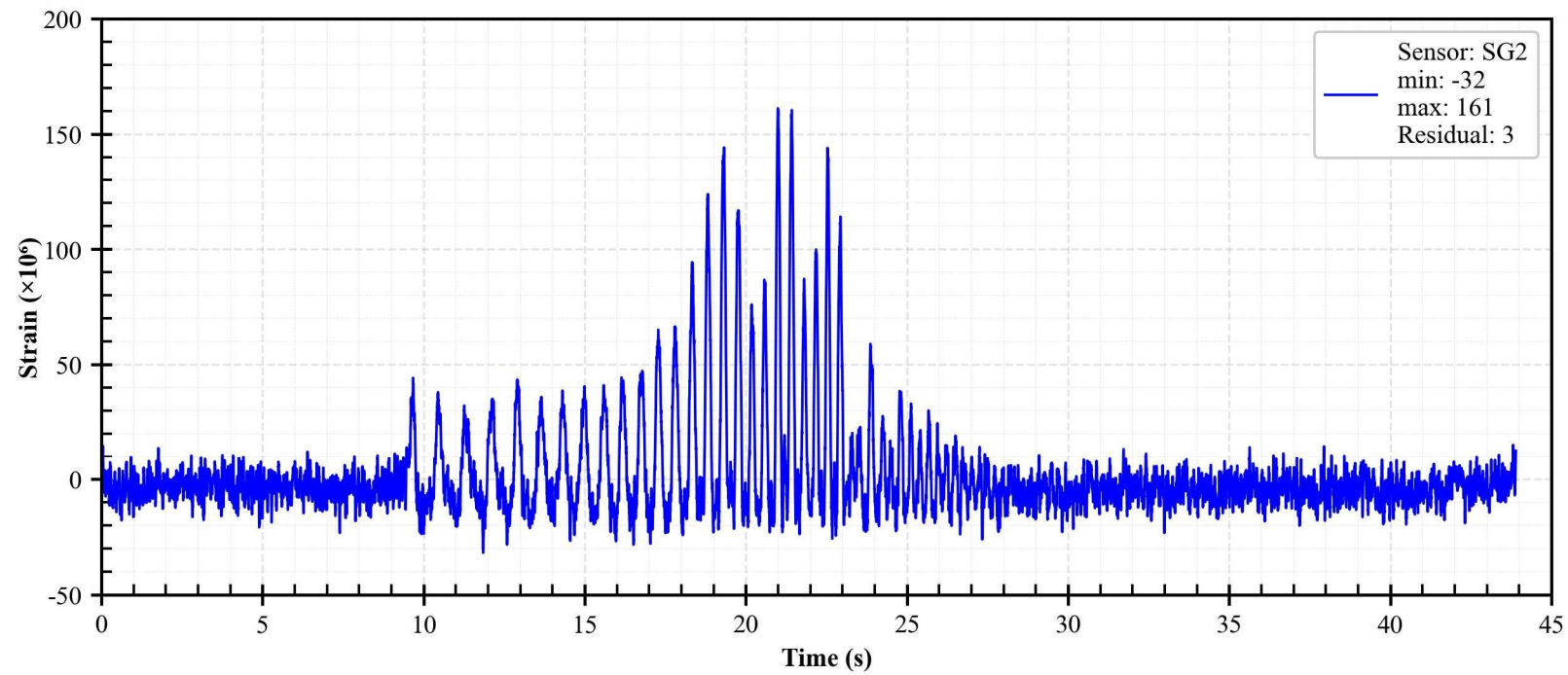


Figure 3.24.19 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 2

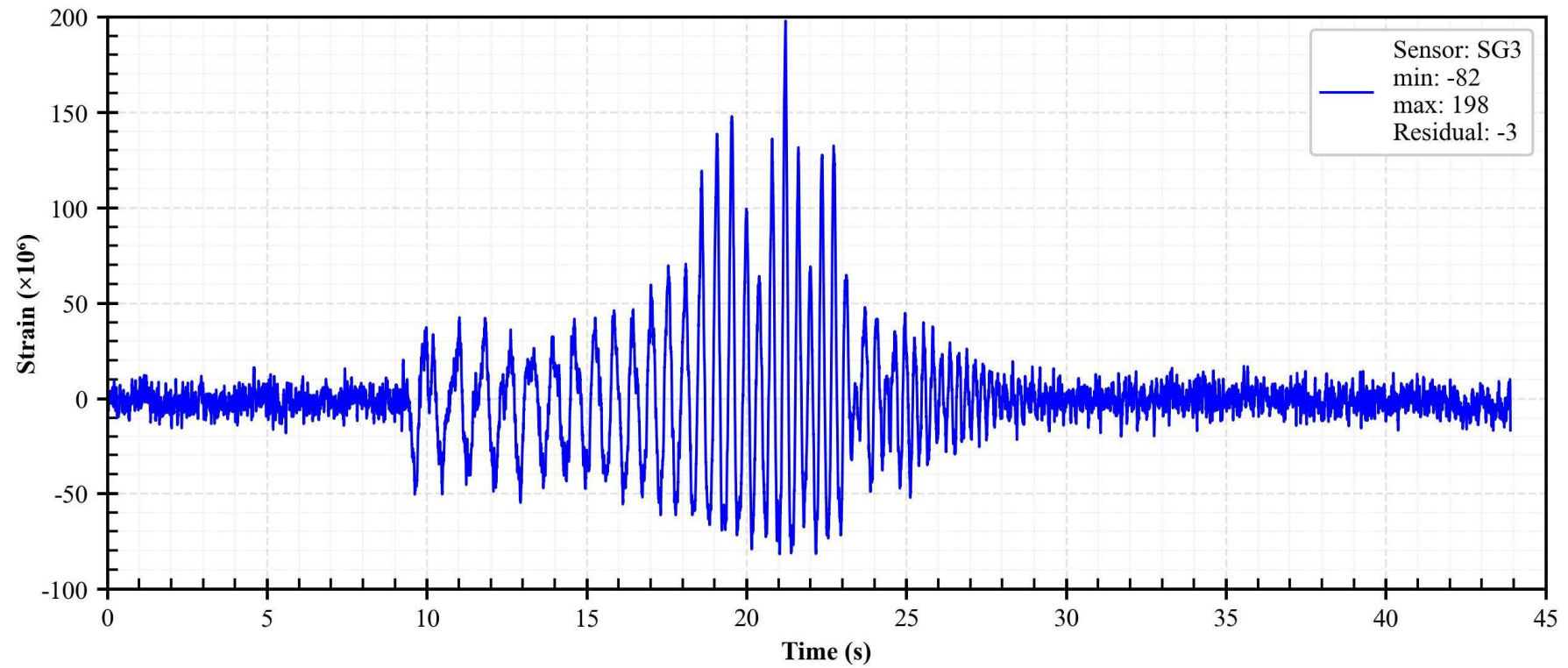


Figure 3.24.20 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 3

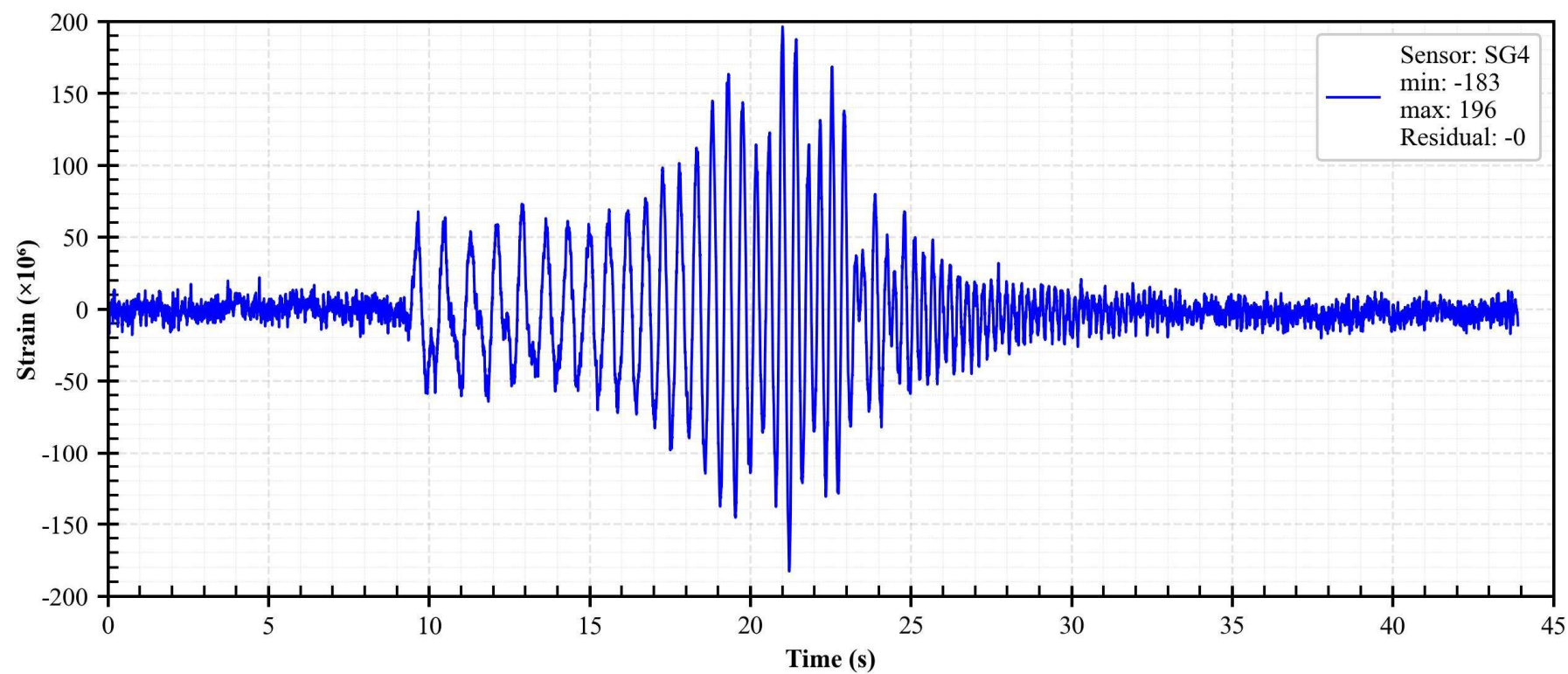


Figure 3.24.21 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 4

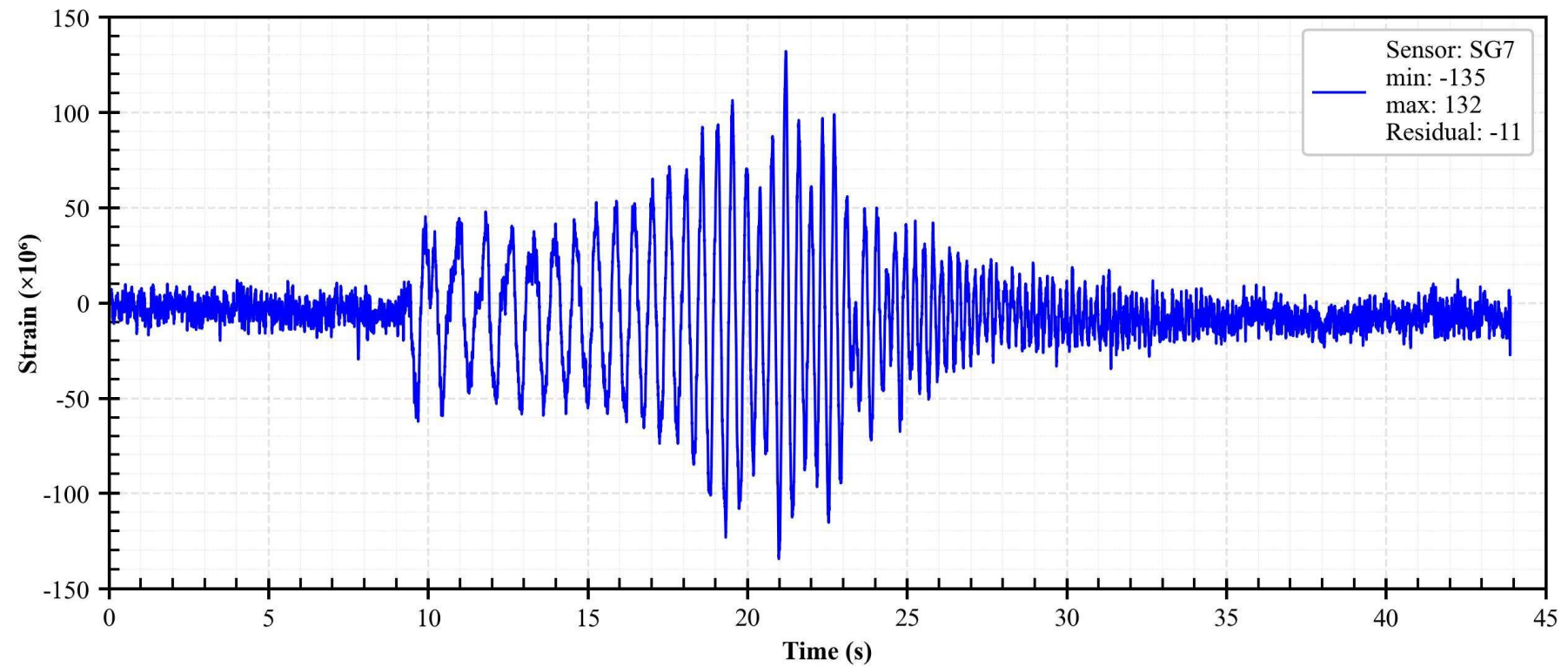


Figure 3.24.22 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 7

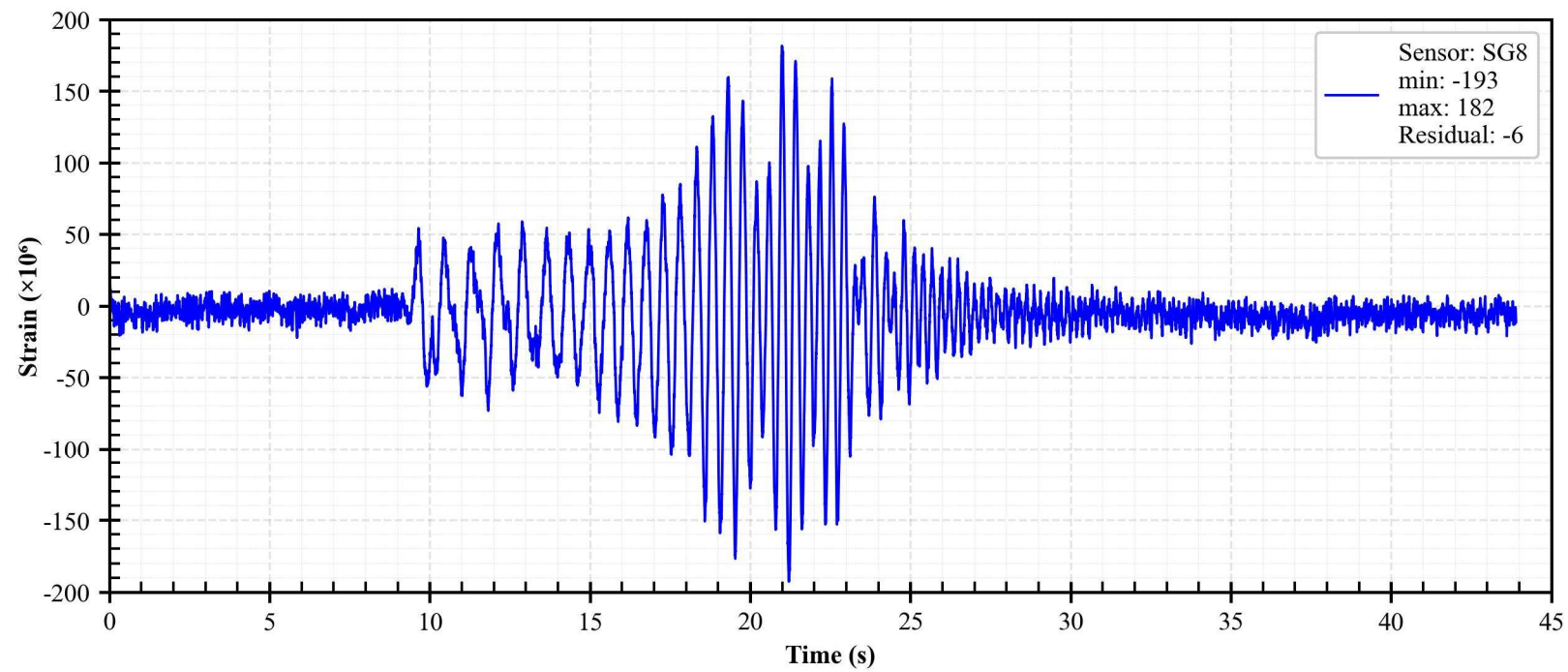


Figure 3.24.23 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 8

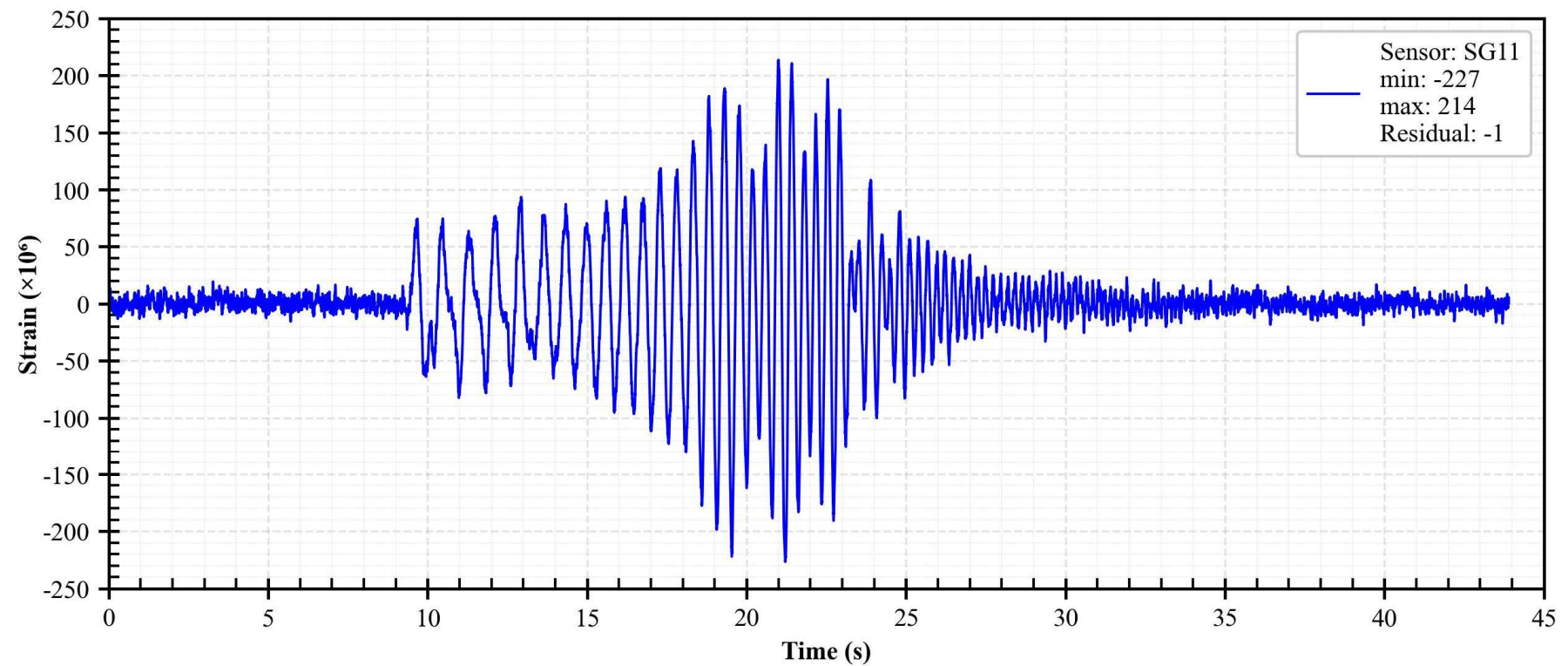


Figure 3.24.24 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 11

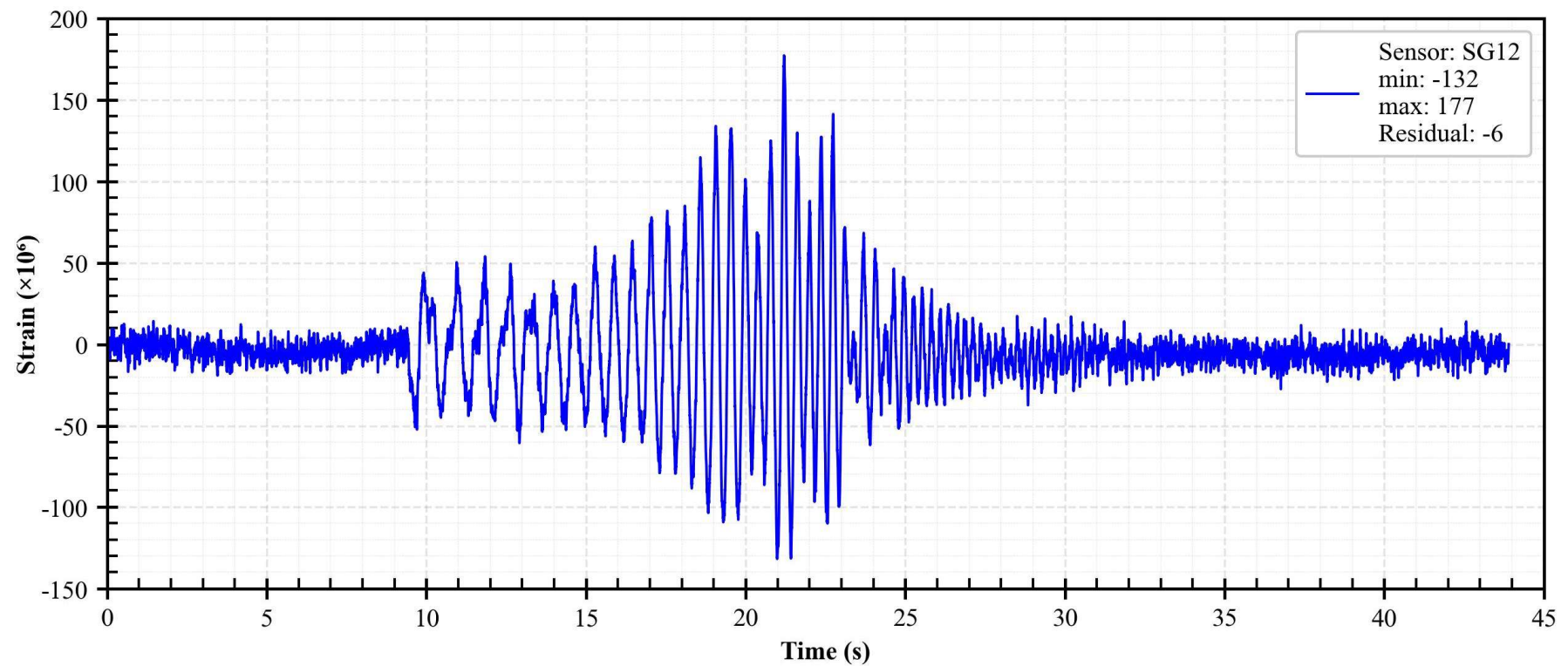


Figure 3.24.25 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 12

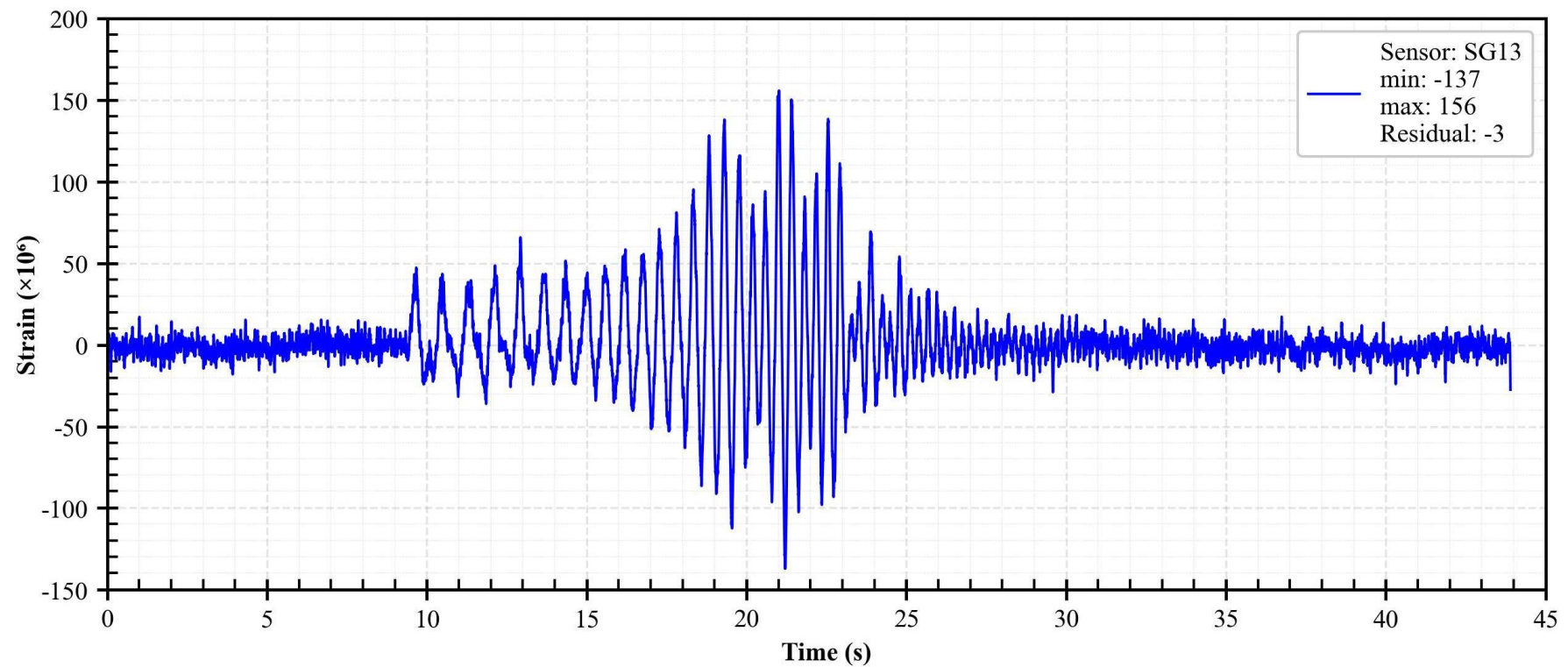


Figure 3.24.26 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 13

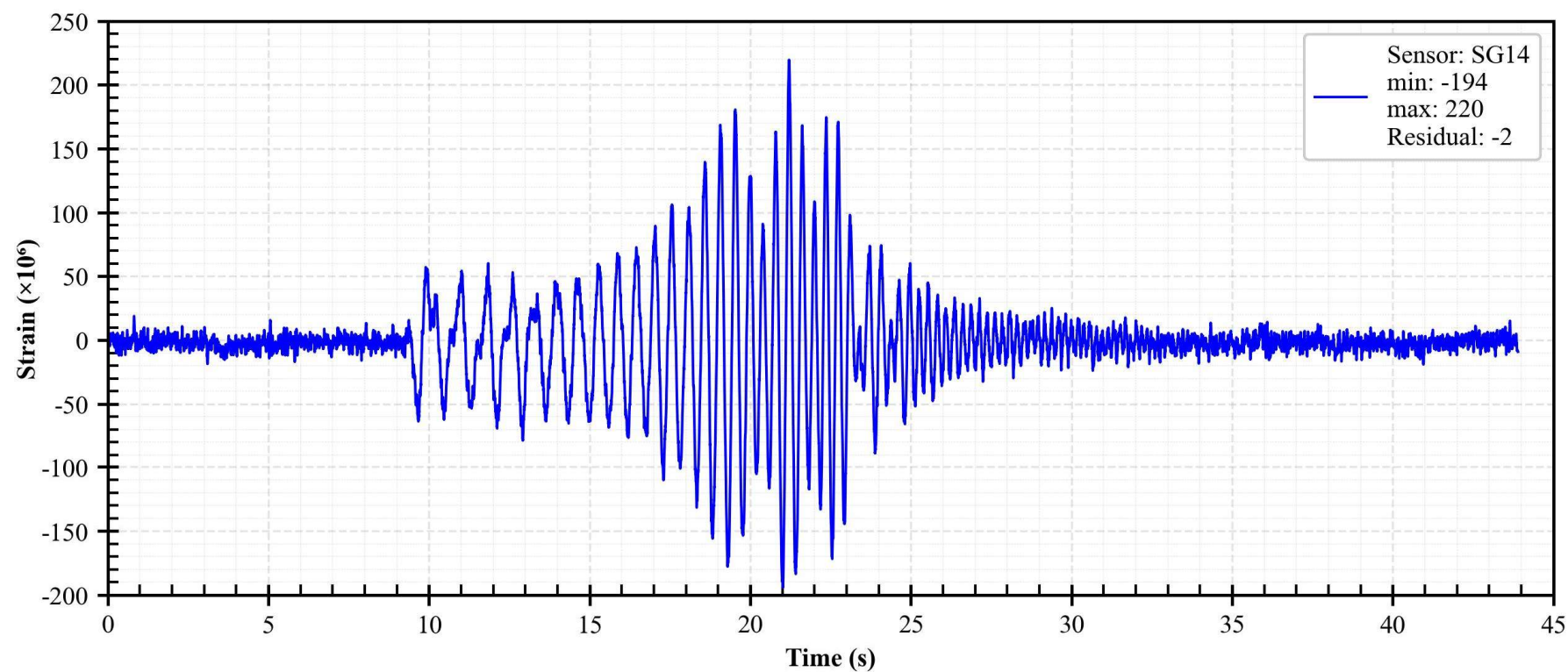


Figure 3.24.27 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 14

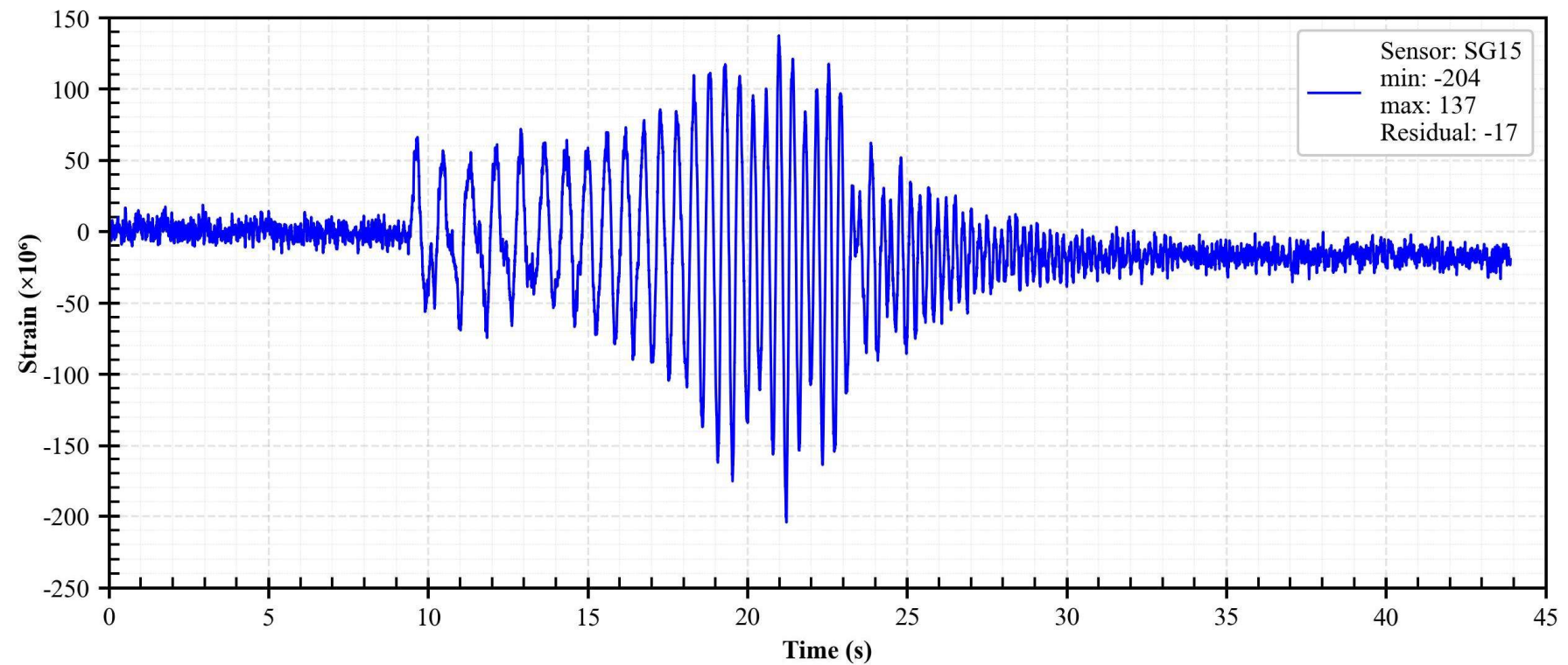


Figure 3.24.28 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 15

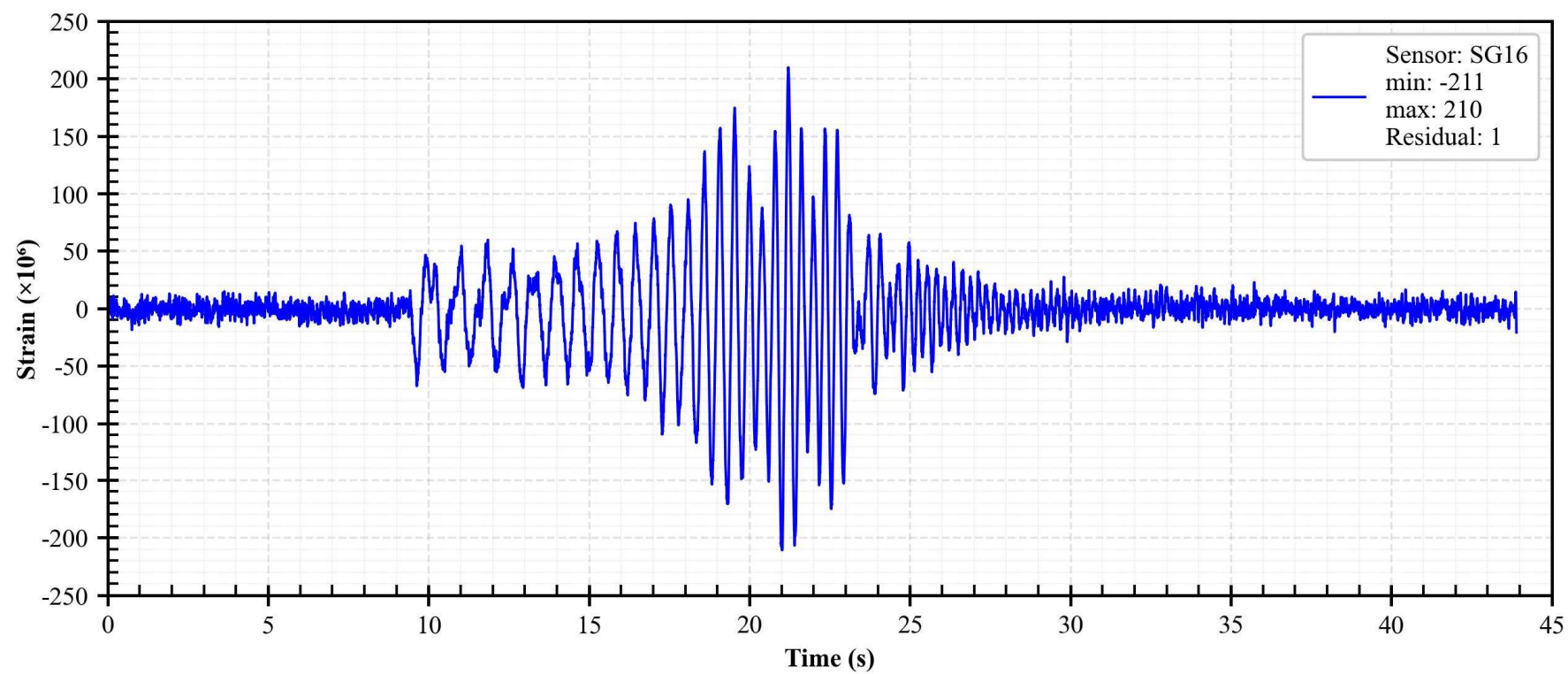


Figure 3.24.29 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 16

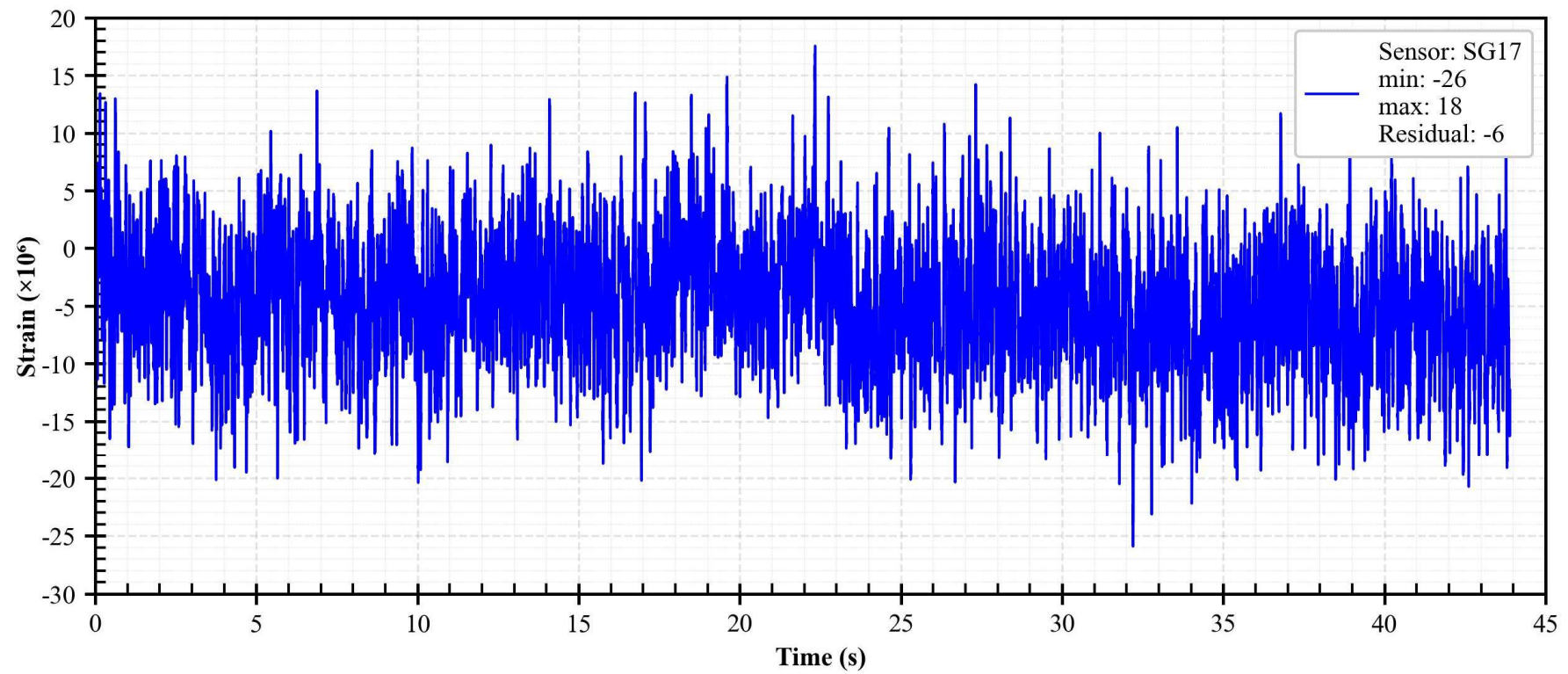


Figure 3.24.30 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 17

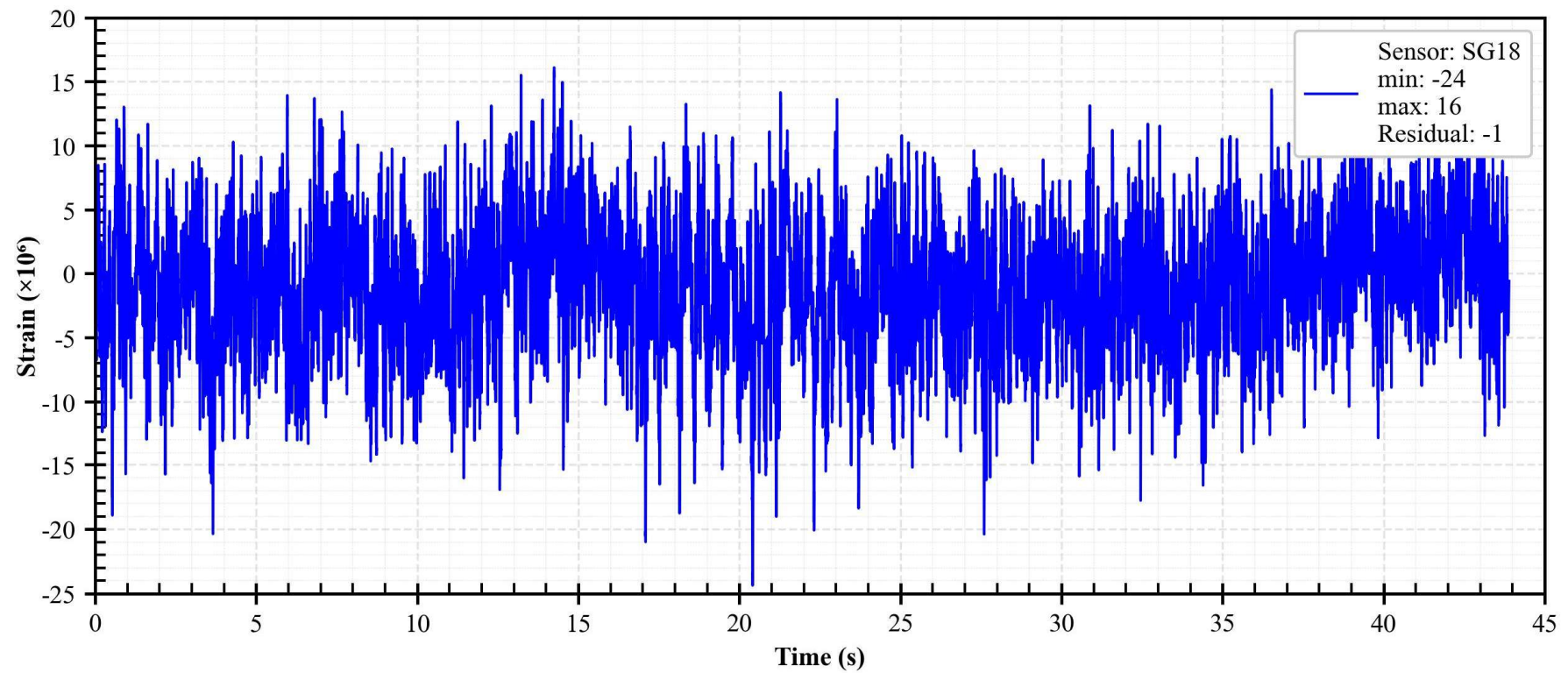


Figure 3.24.31 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 18

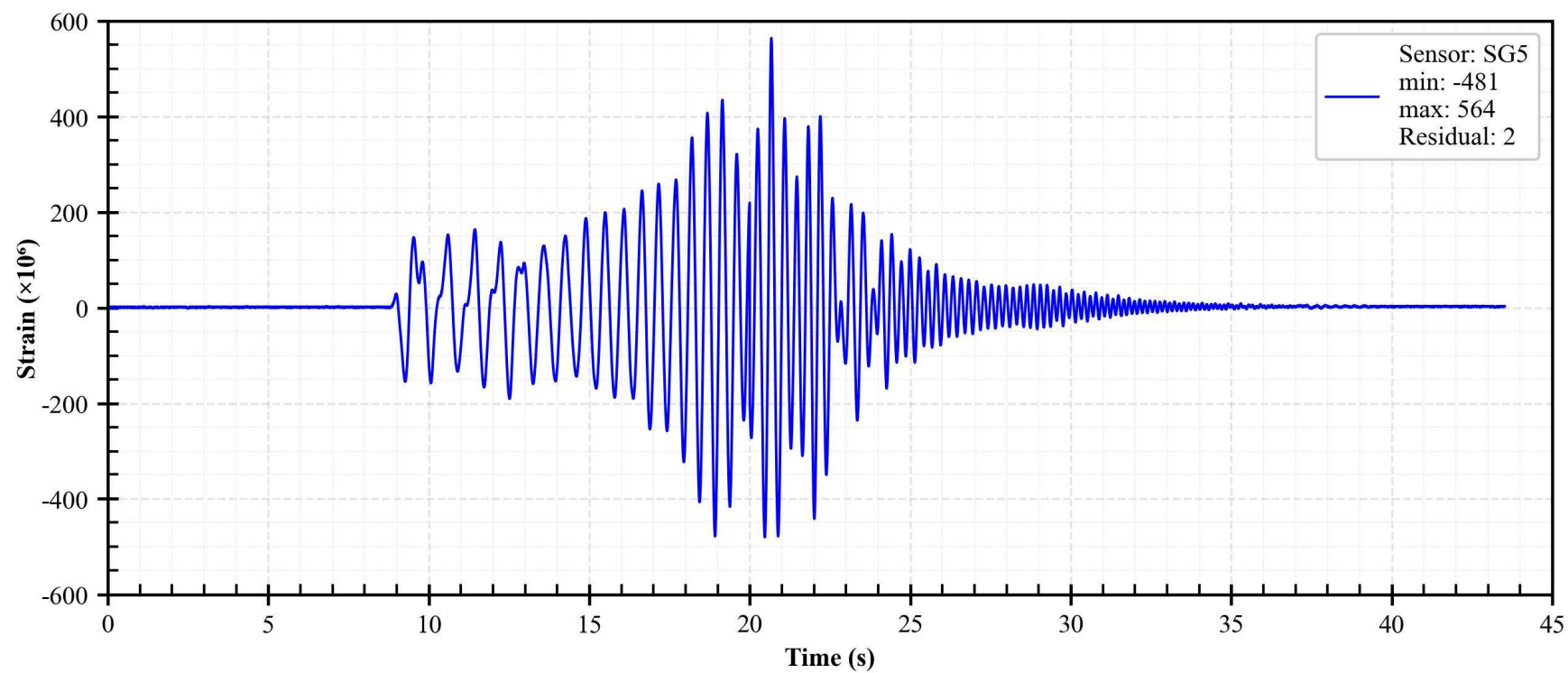


Figure 3.24.32 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 5

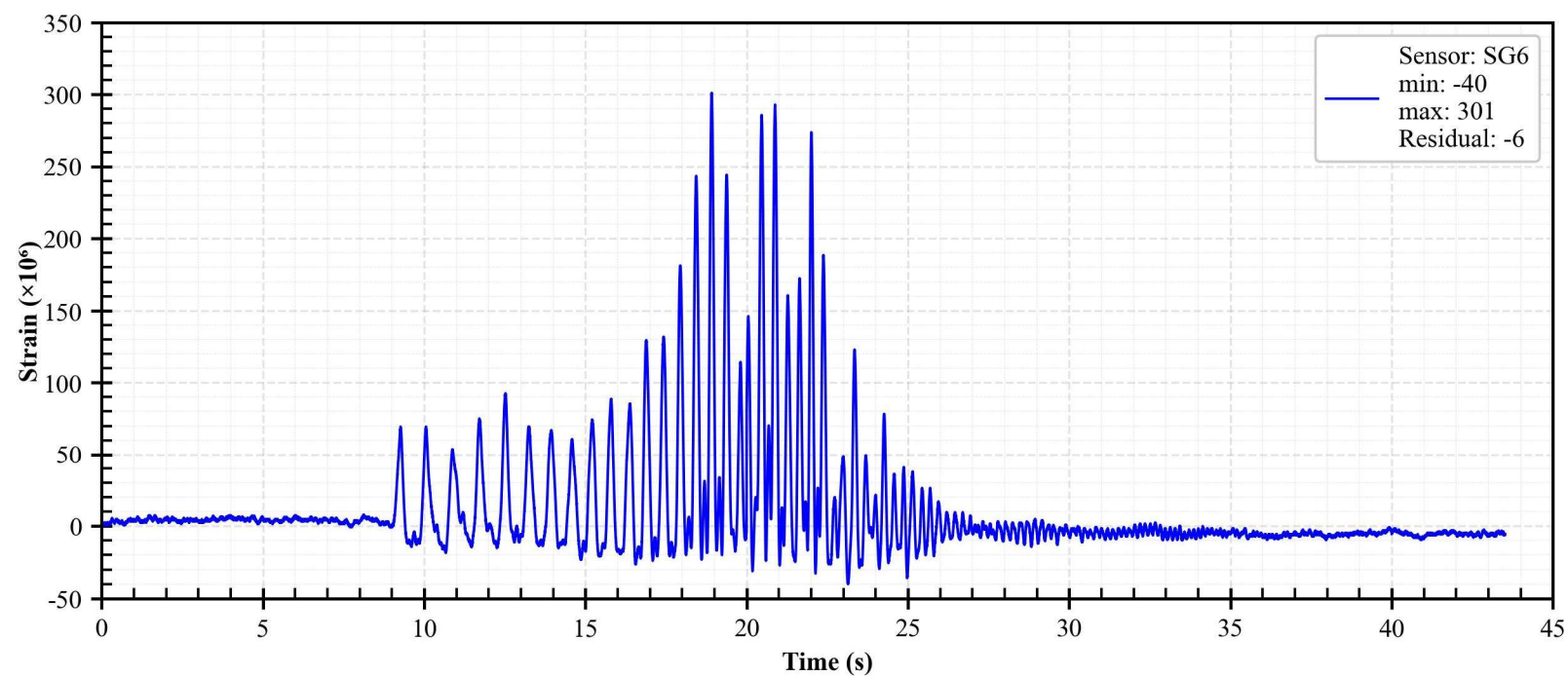


Figure 3.24.33 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 6

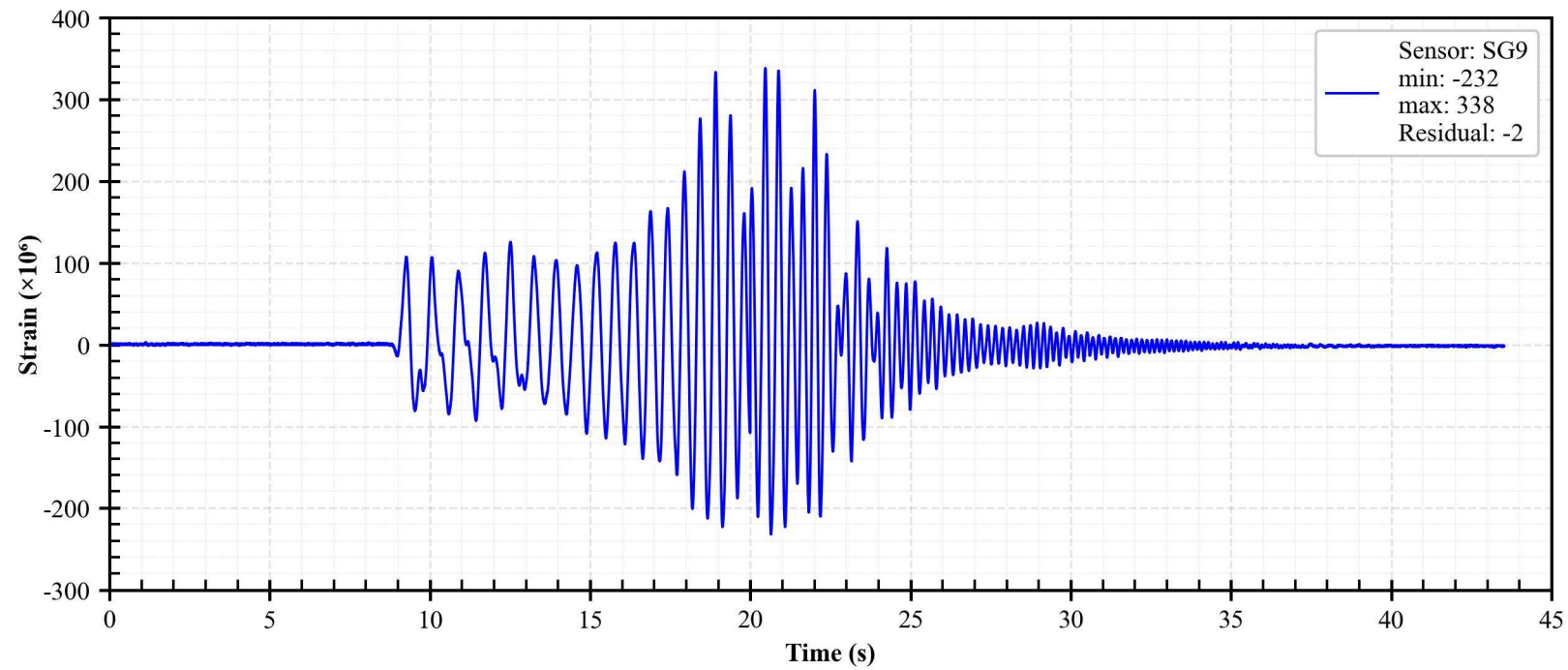


Figure 3.24.34 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 9

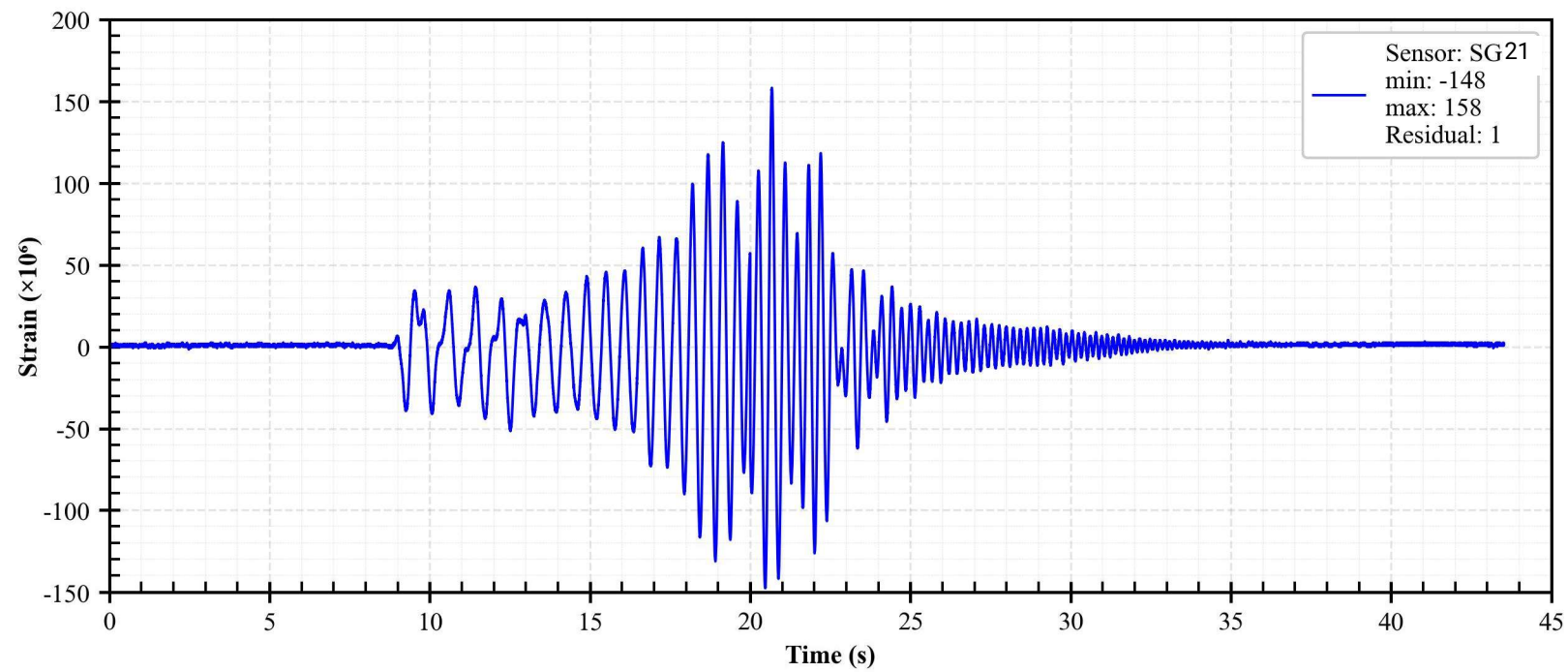


Figure 3.24.35 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 21 (PUFJ, column 2)

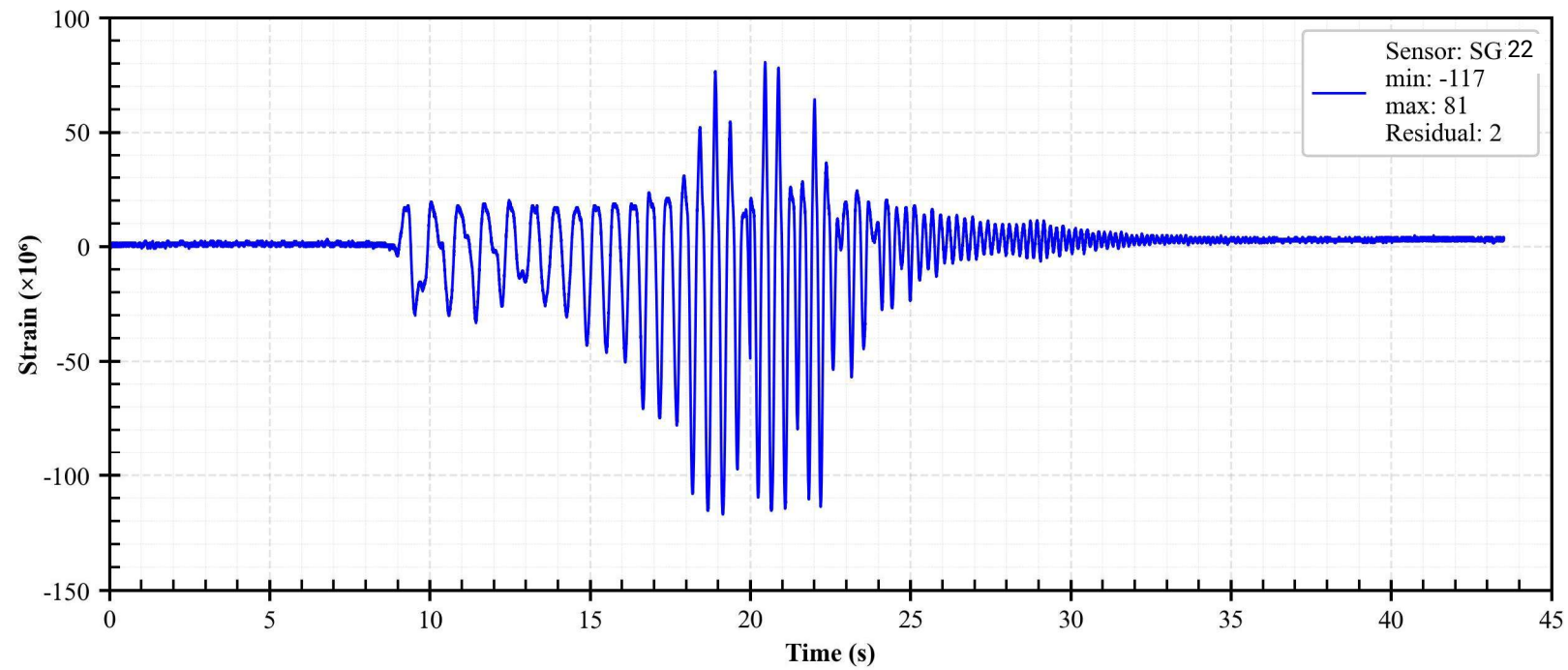


Figure 3.24.36 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 22 (PUFJ, column 2)

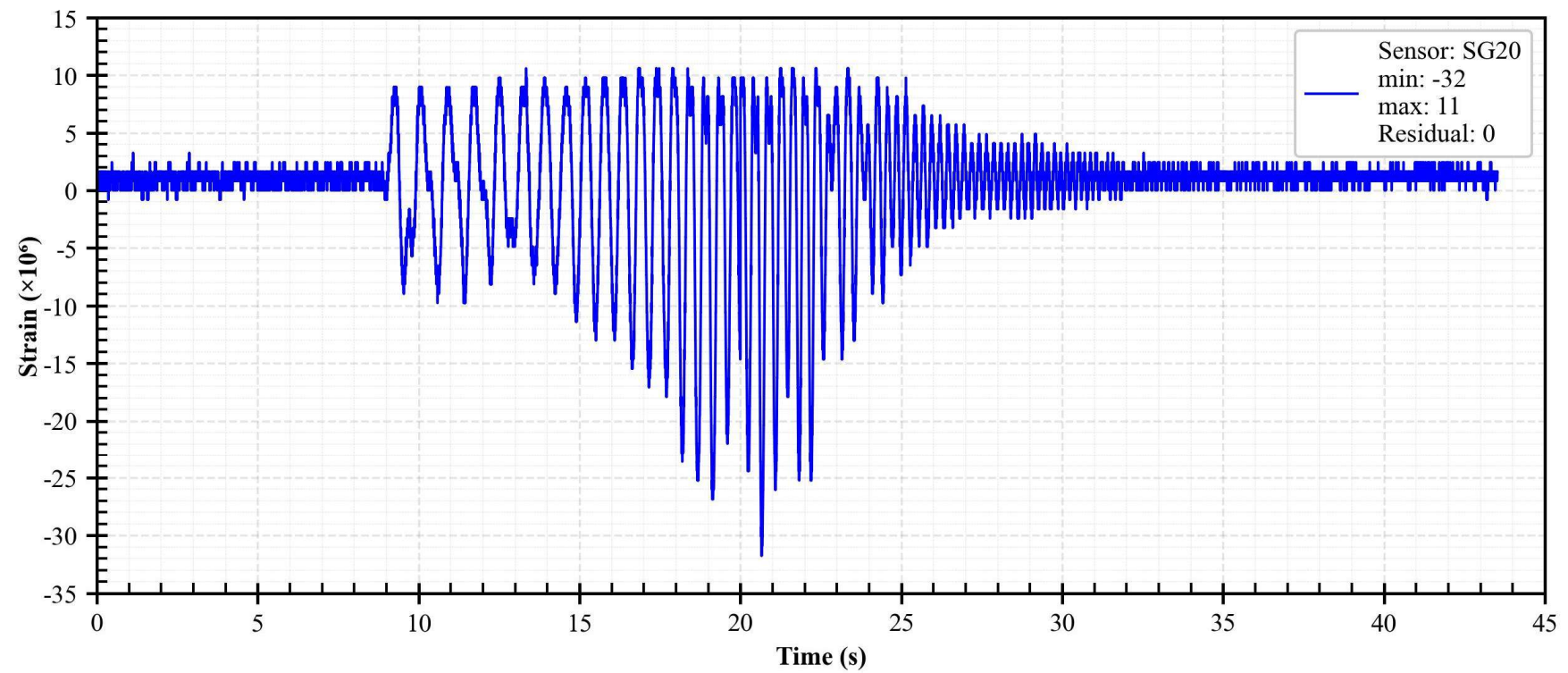


Figure 3.24.37 Characteristic results for phase B (white noise before EQ1,4g): strain gauge 20

3.25 Earthquake EQ1,4g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below for earthquake EQ1,4g. The max acceleration at the slab level on the accelerometer acc4 is 1.86g. The max acceleration at the foundation level on the accelerometer acc10 is 2.56g.

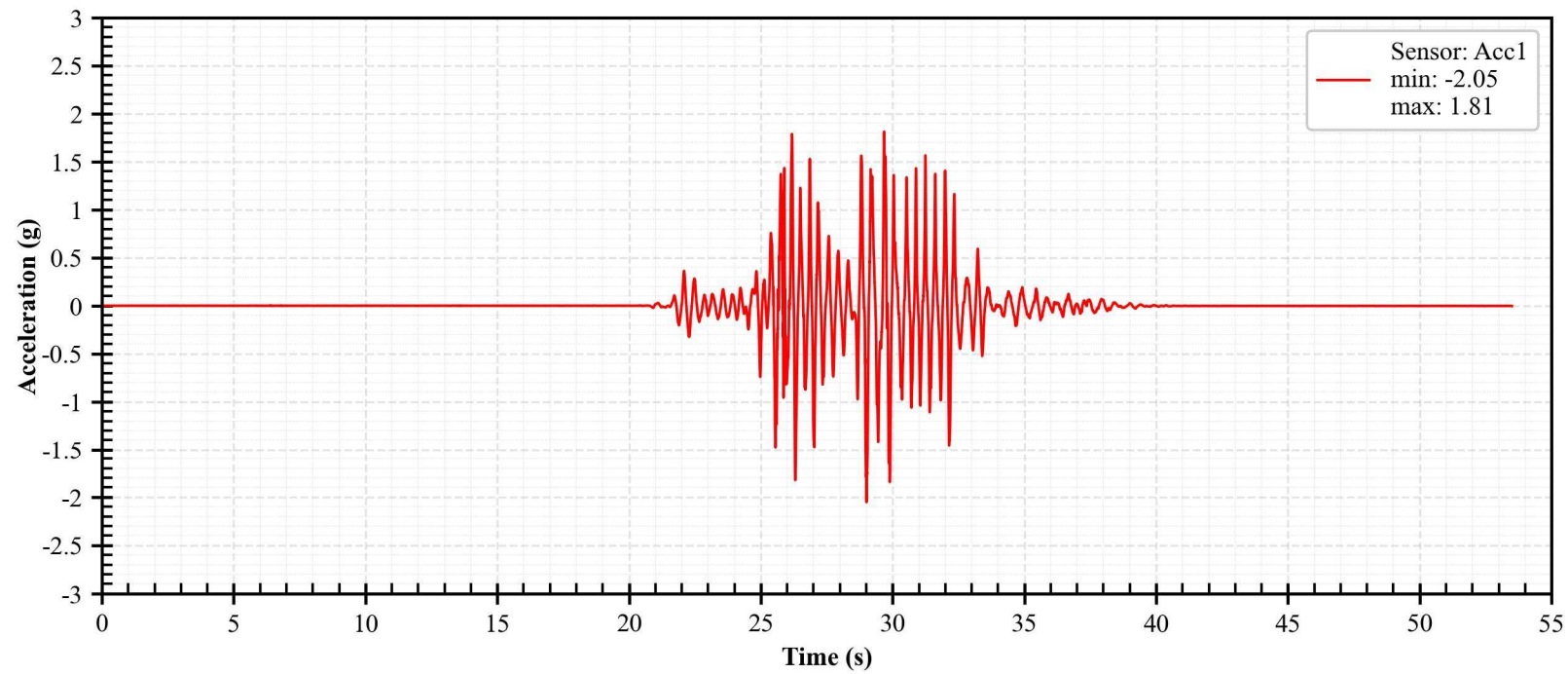


Figure 3.25.1 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 1

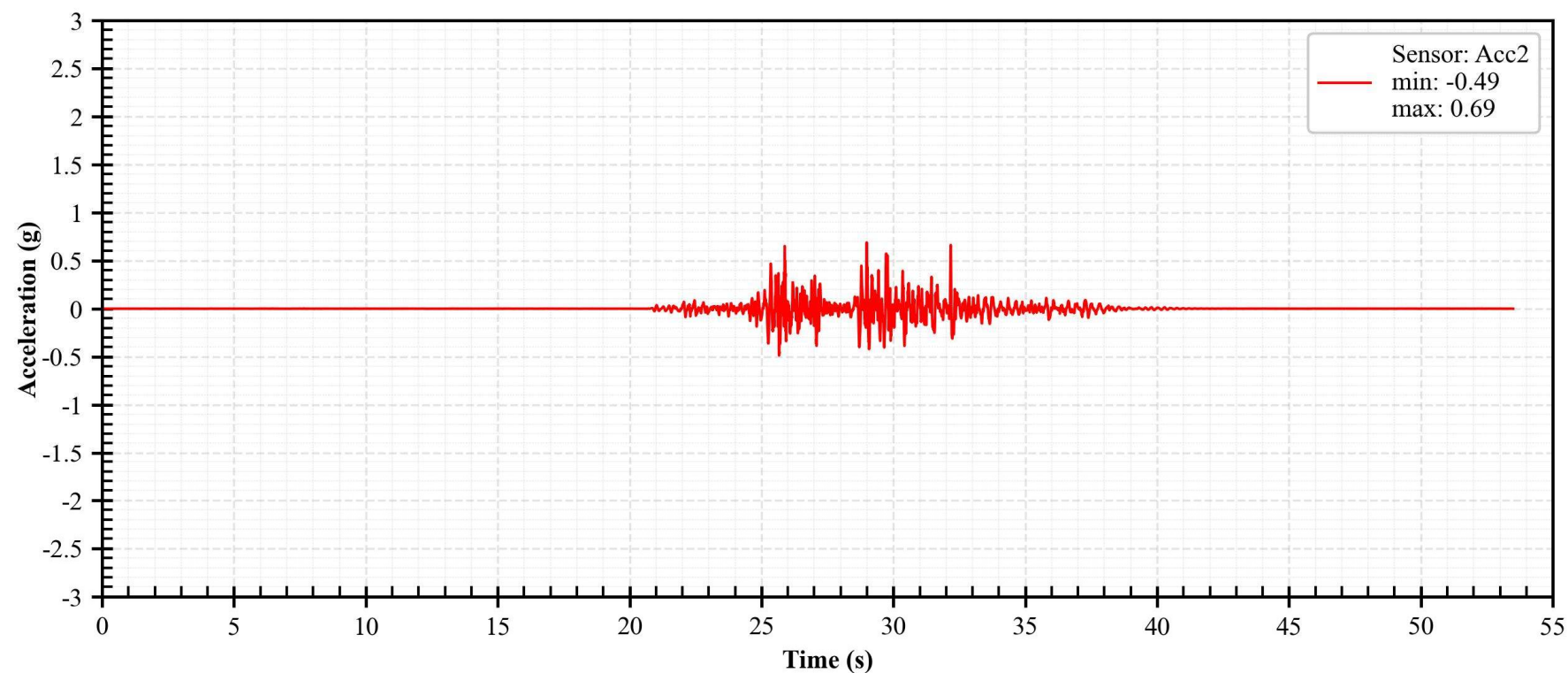


Figure 3.25.2 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 2

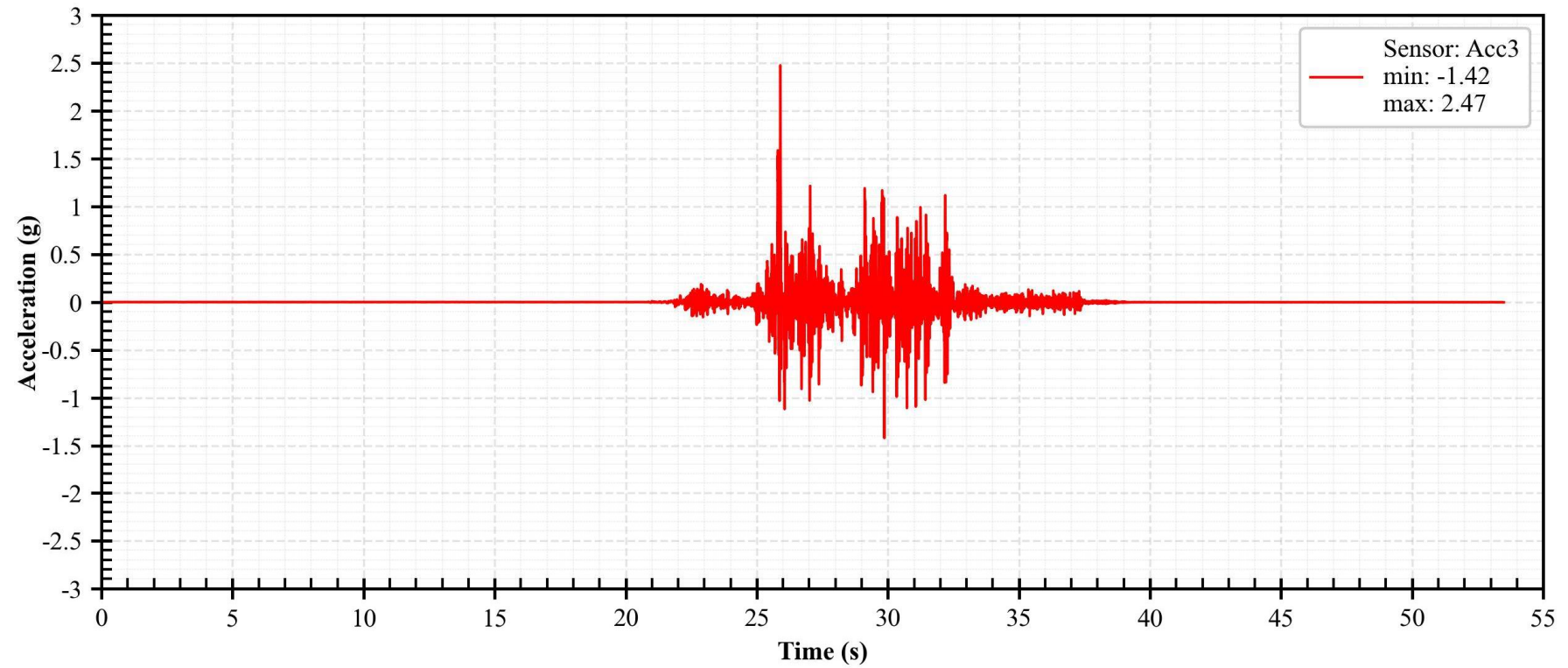


Figure 3.25.3 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 3

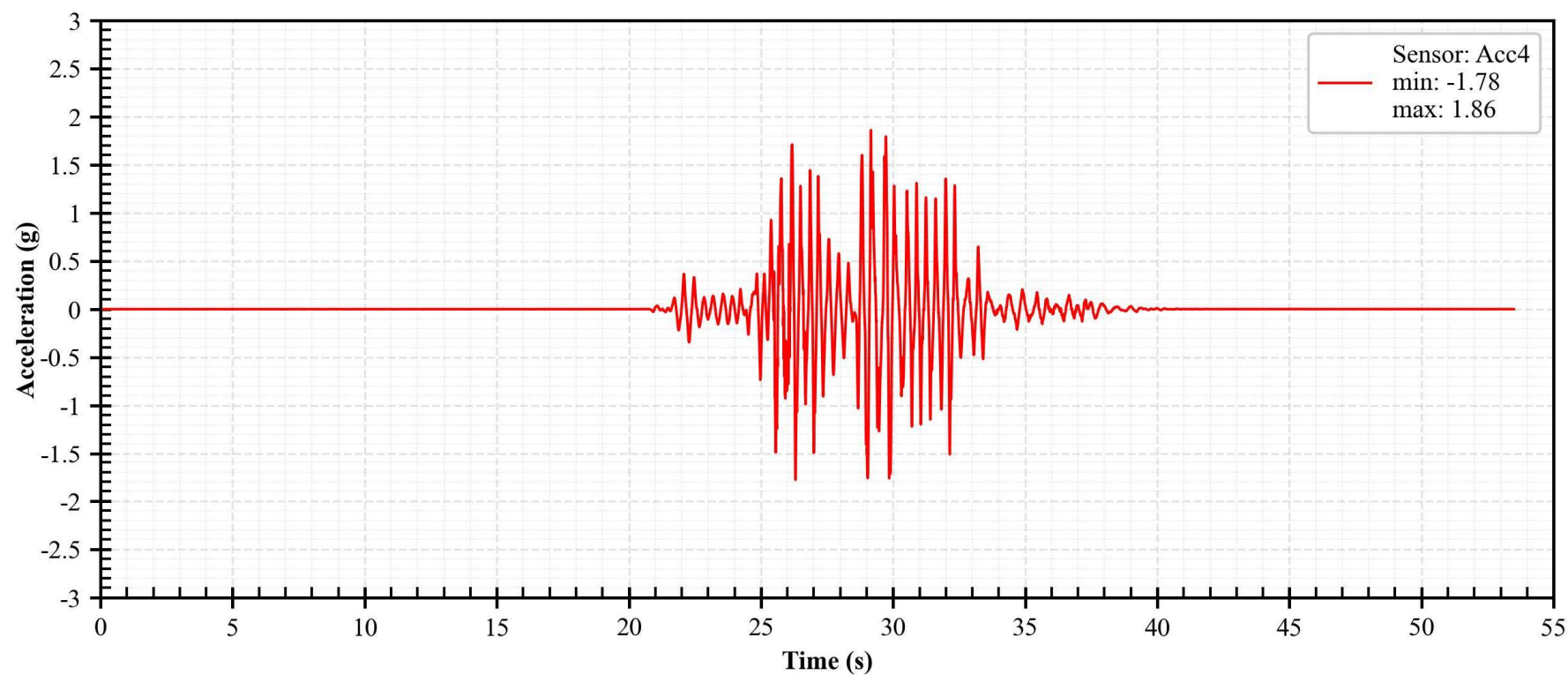


Figure 3.25.4 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 4

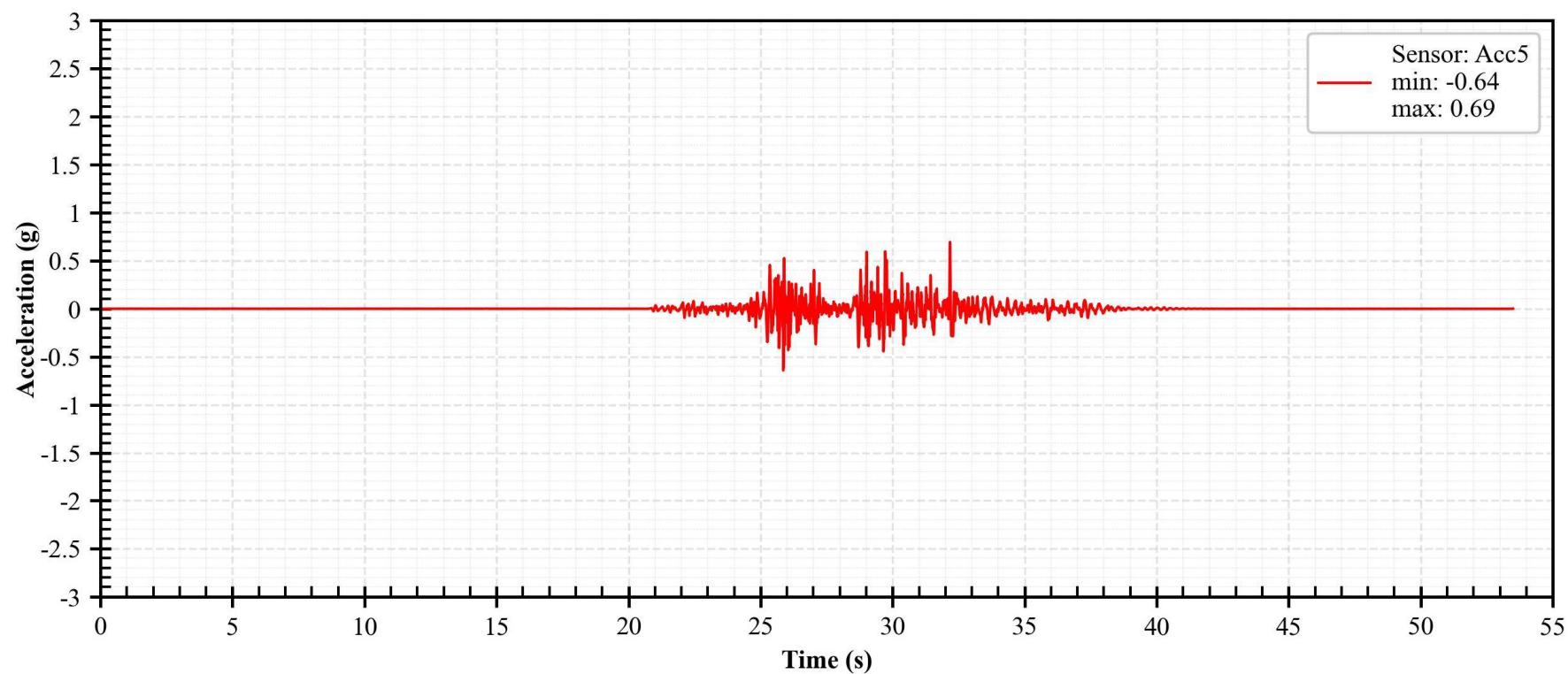


Figure 3.25.5 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 5

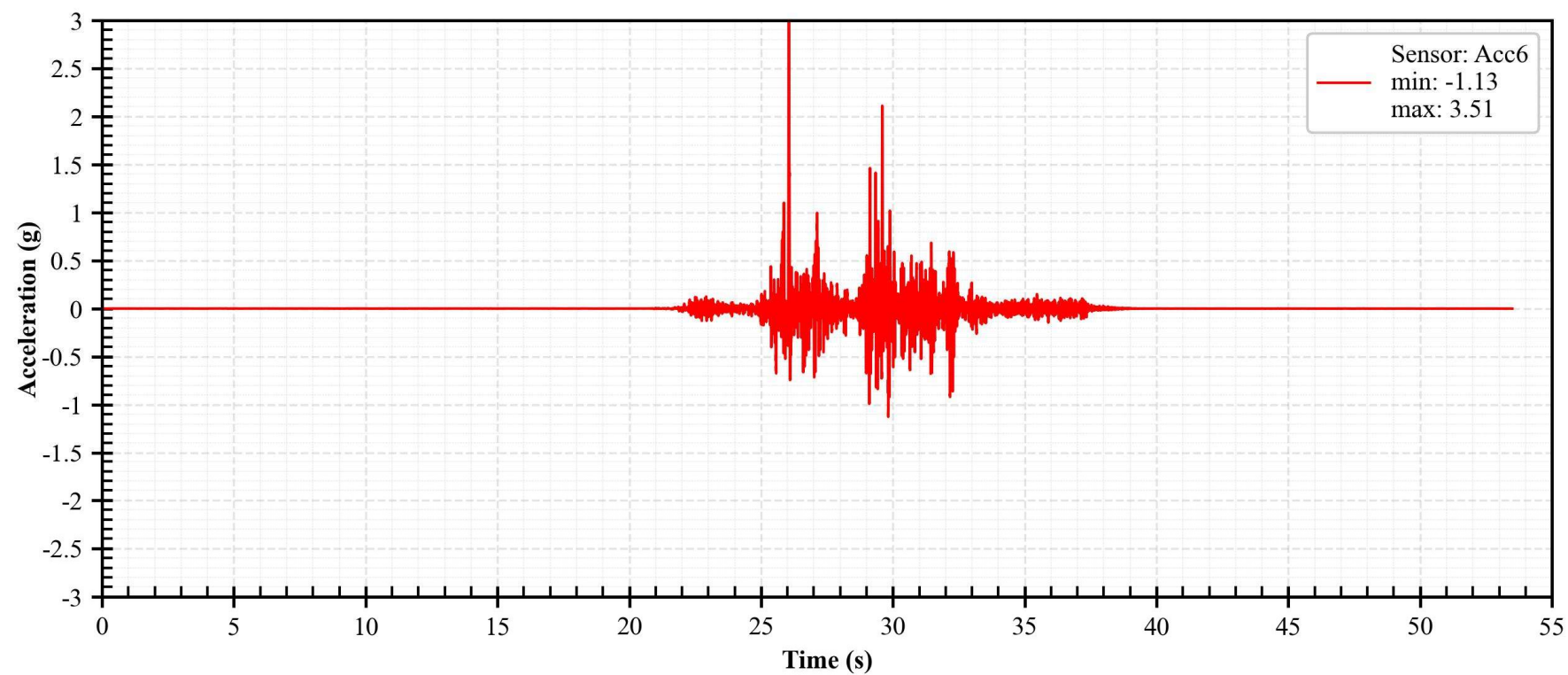


Figure 3.25.6 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 6

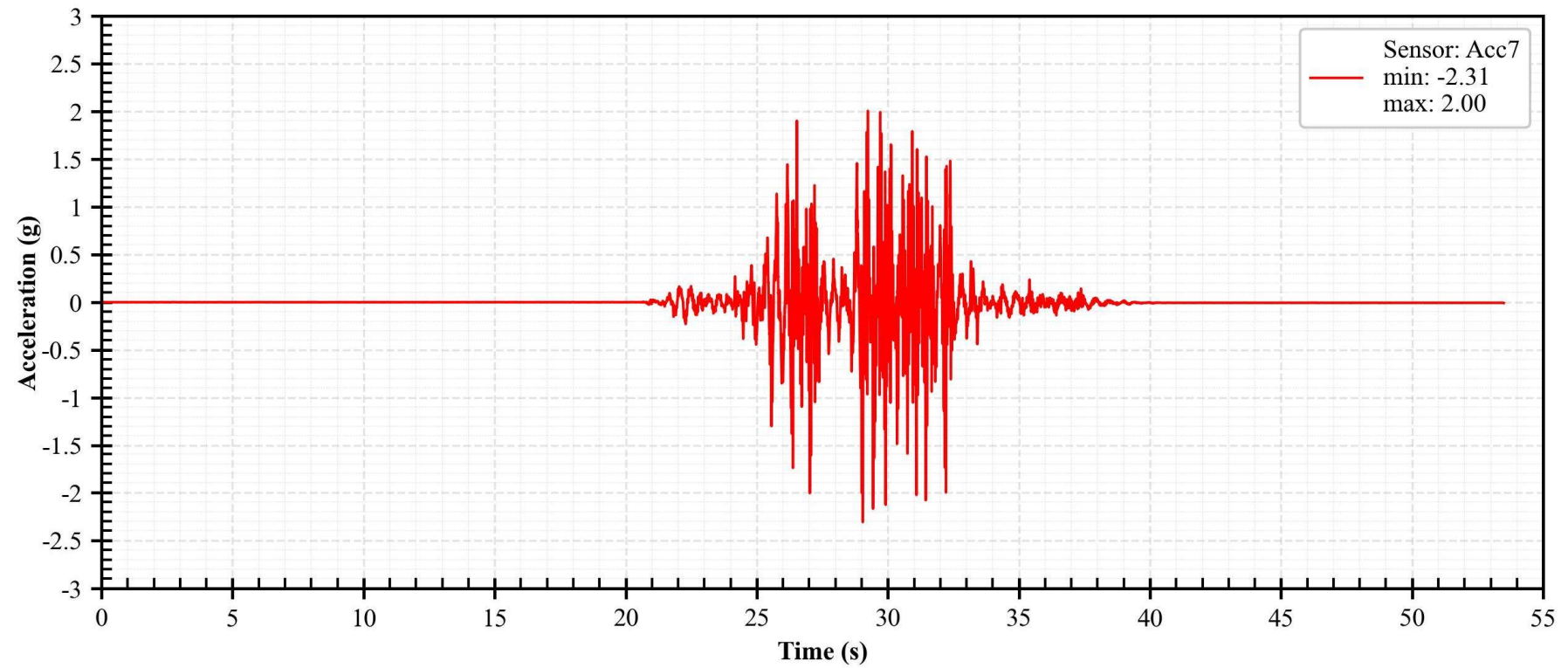


Figure 3.25.7 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 7

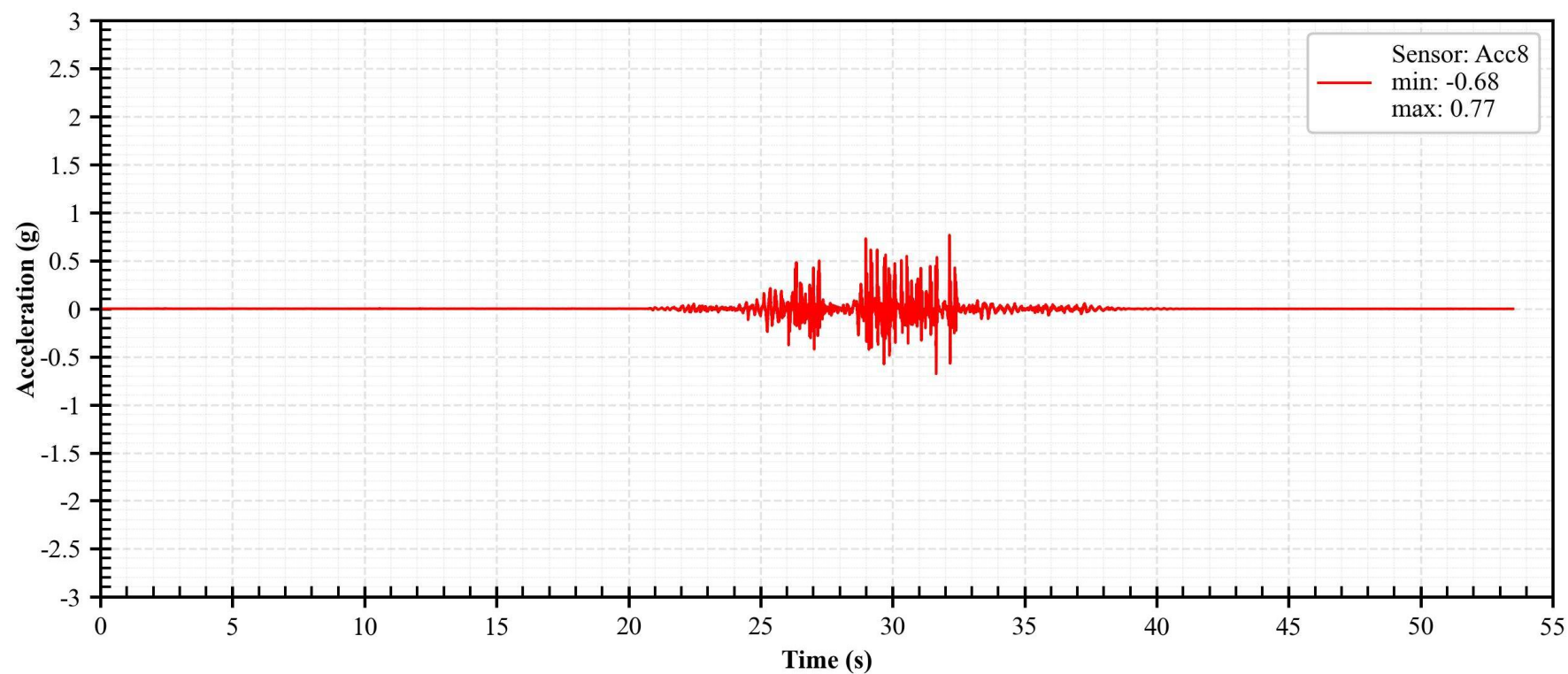


Figure 3.25.8 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 8

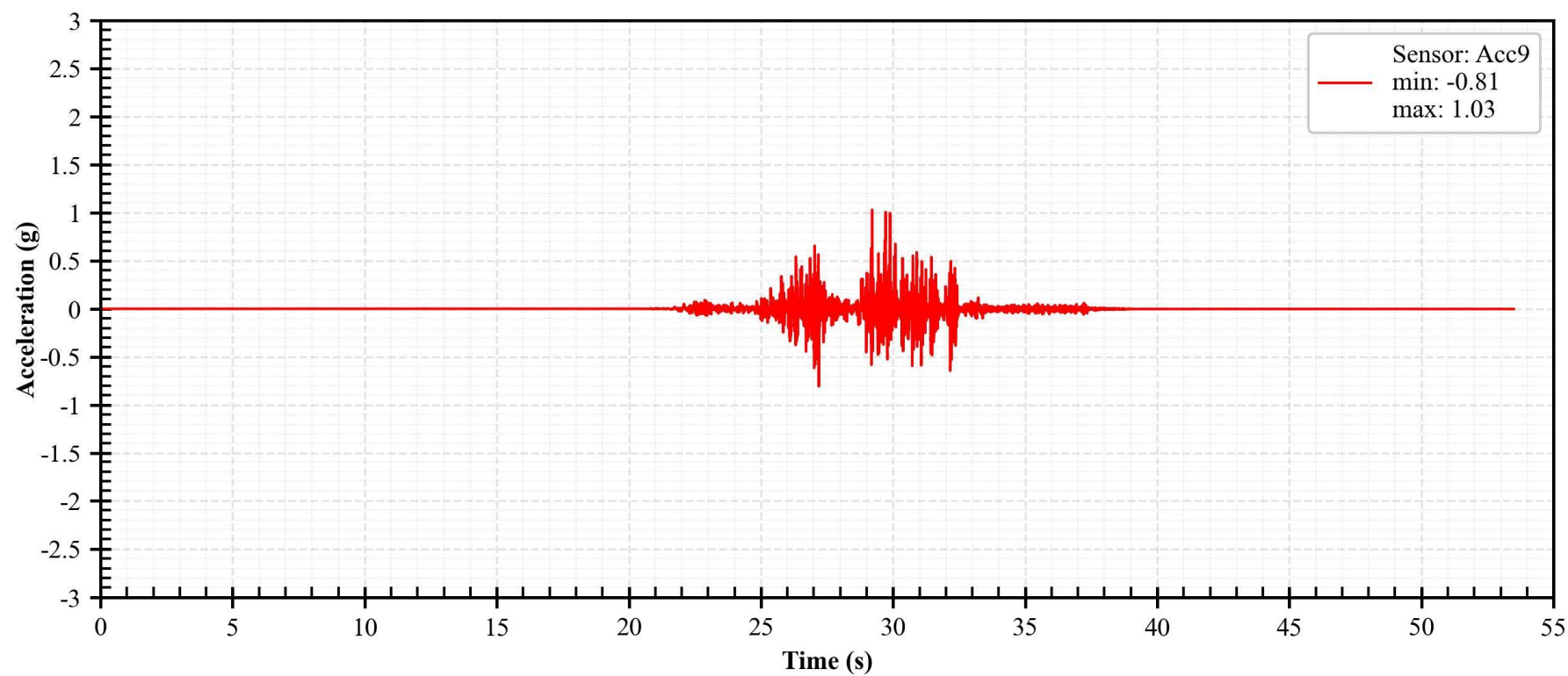


Figure 3.25.9 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 9

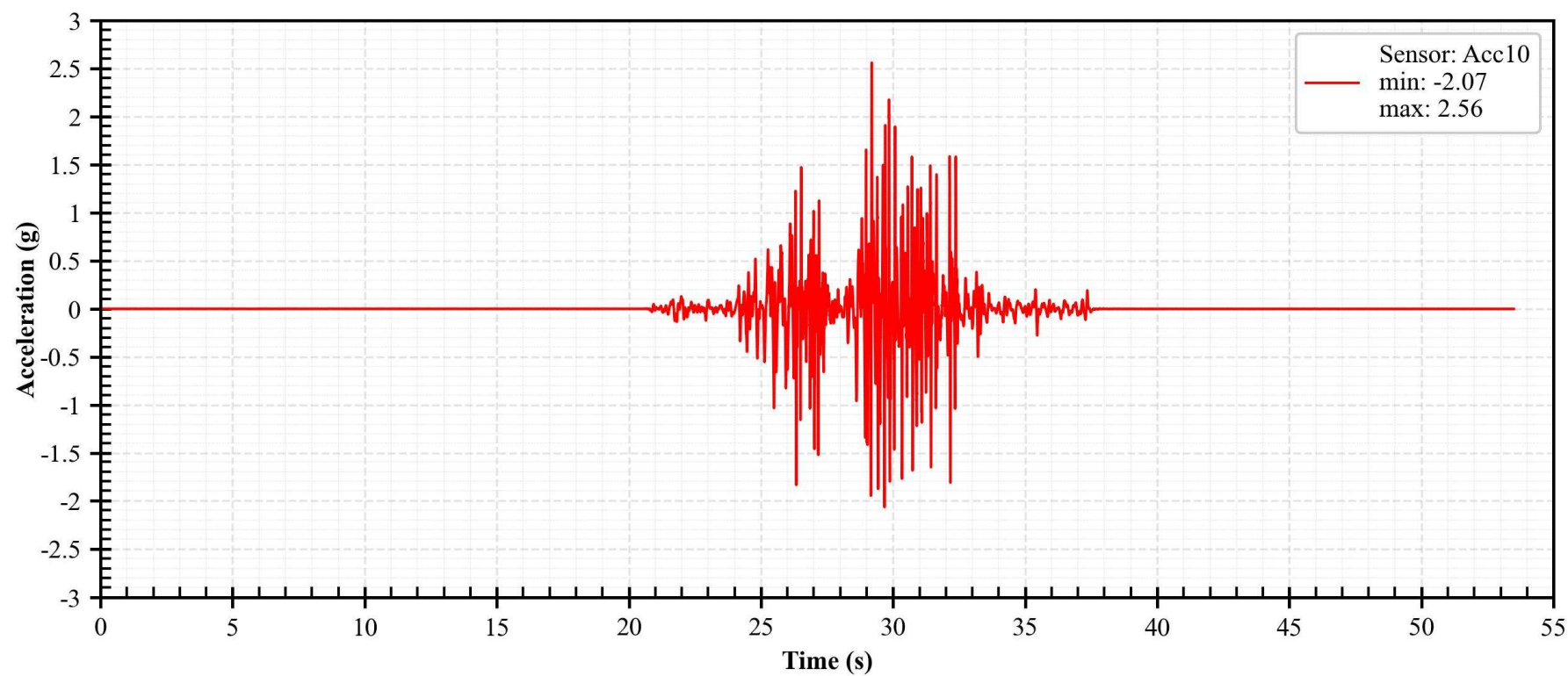


Figure 3.25.10 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 10

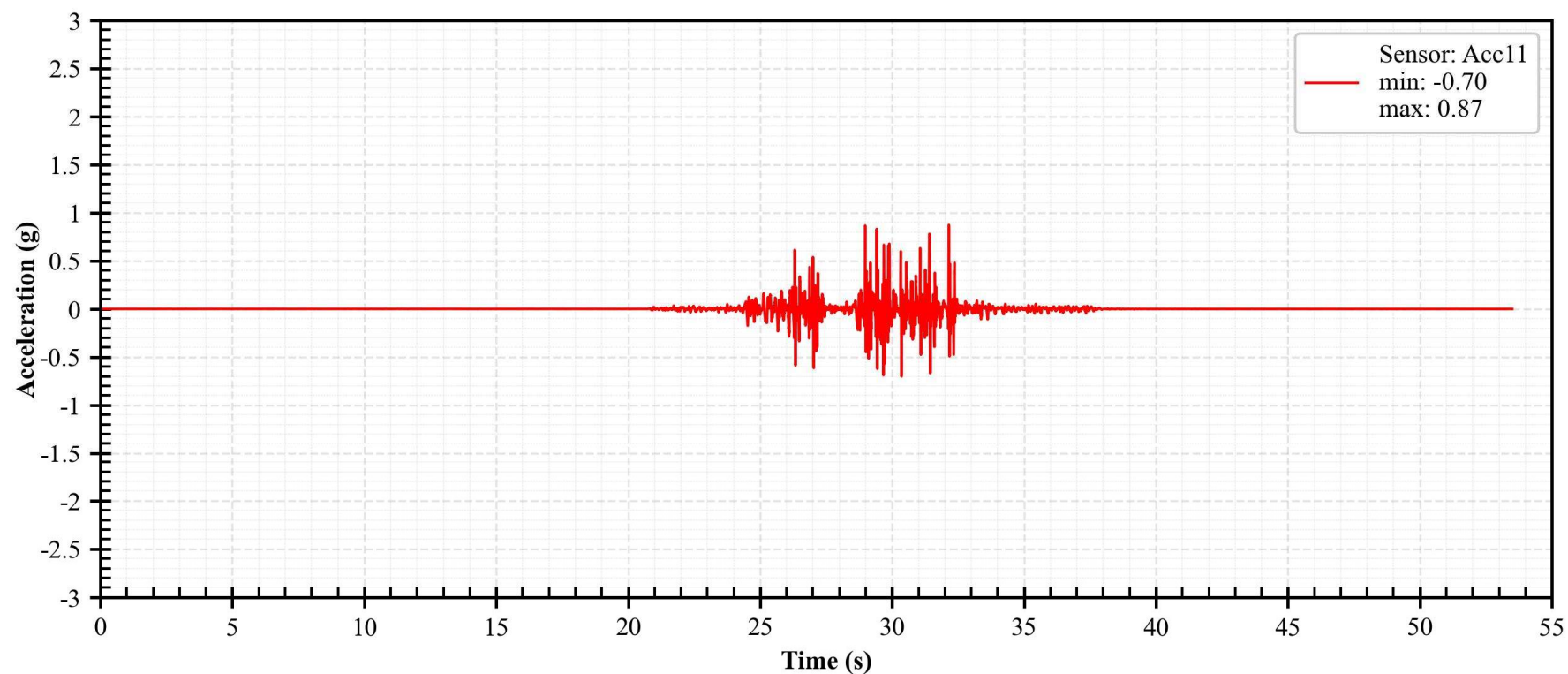


Figure 3.25.11 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 11

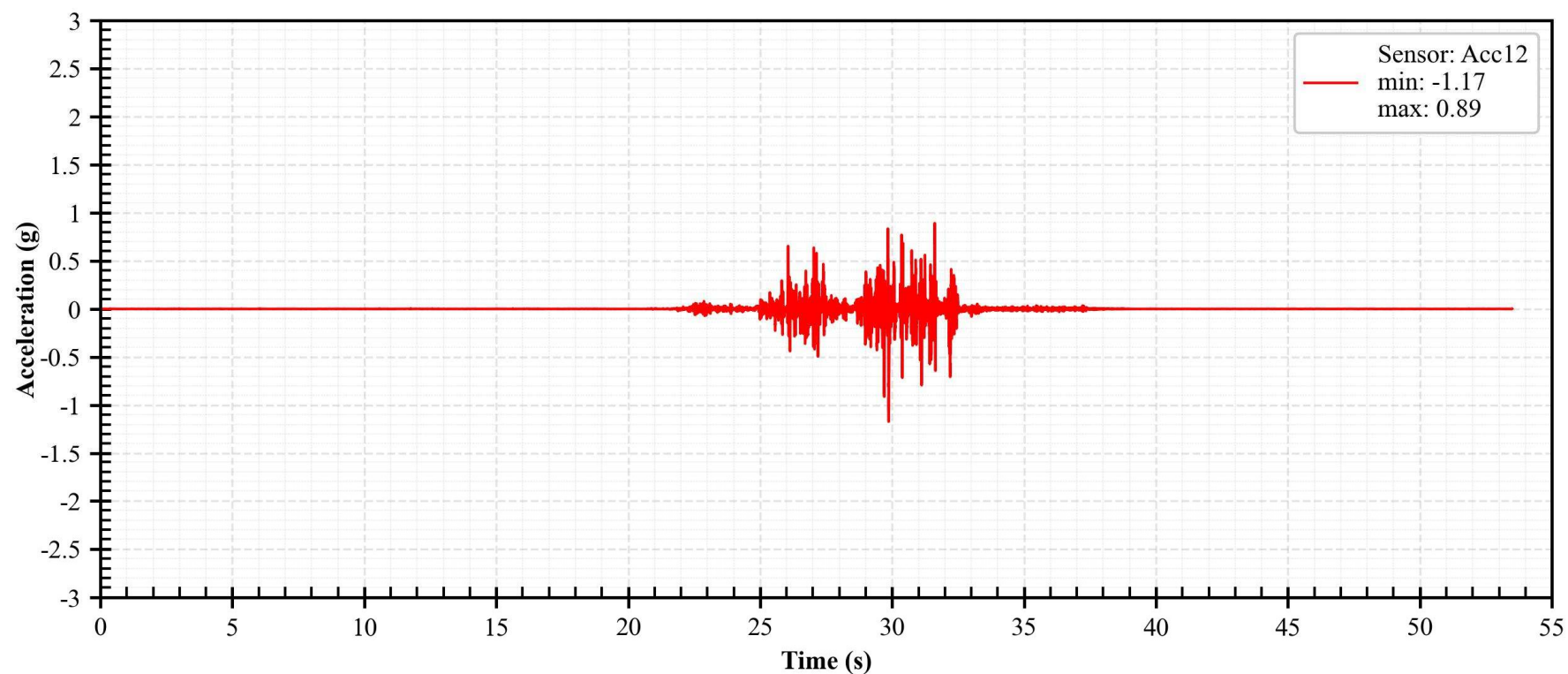


Figure 3.25.12 Characteristic results for phase B (earthquake EQ1,4g): Accelerometer 12

Draw wire sensors

Figures 3.25.13 – 3.25.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 55.95 mm while the minimum is -58.84 mm. The maximum movement detected by draw wire sensor W2 is 55.35 mm while the minimum is -59.73 mm. The maximum movement detected by draw wire sensor W3 is 34.28 mm while the minimum is -33.79 mm. The maximum movement detected by draw wire sensor W4 is 34.58 mm while the minimum is -37.61 mm. The maximum drift is $(26.56/1.225) = 21.68 \text{ ‰}$ and minimum drift is $(-32.10/1.225) = -26.20 \text{ ‰}$.

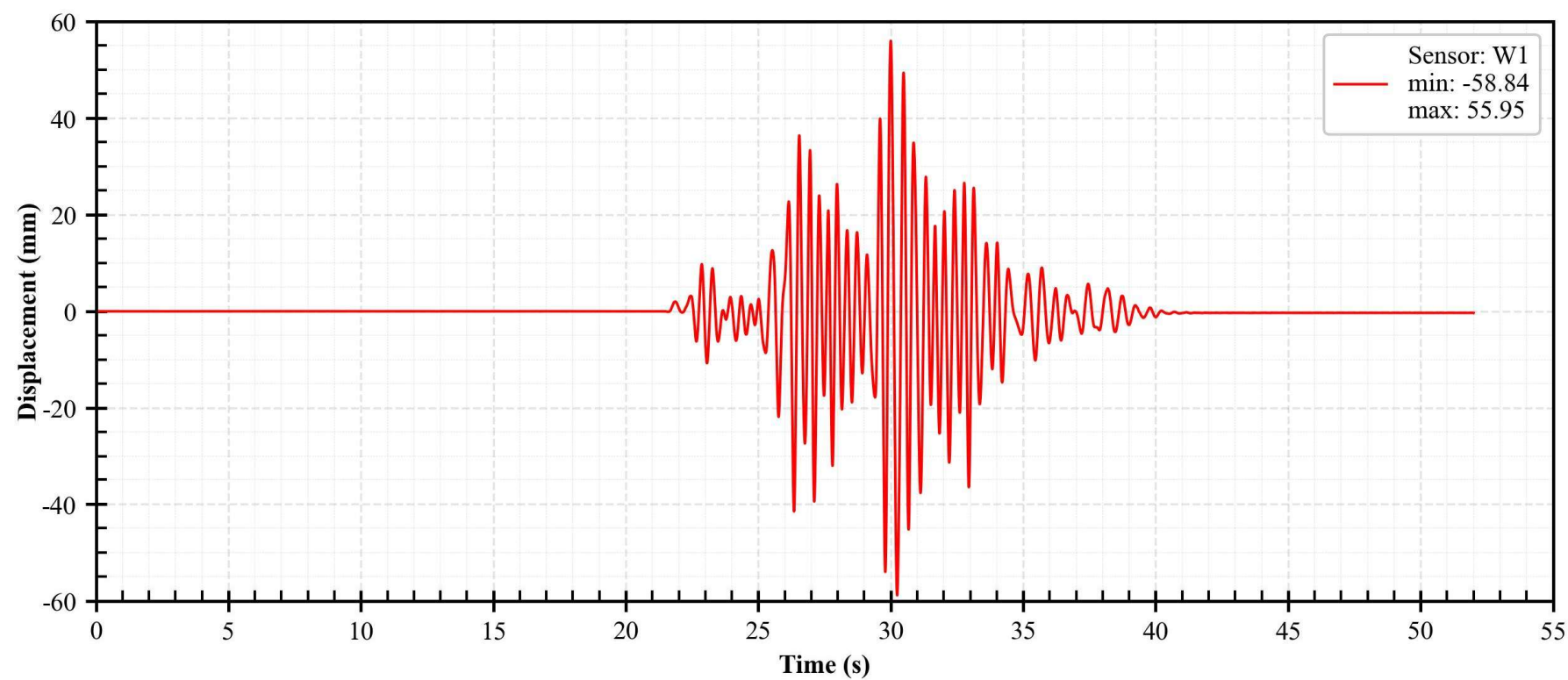


Figure 3.25.13 Characteristic results for phase B (earthquake EQ1,4g): Draw wire sensor 1

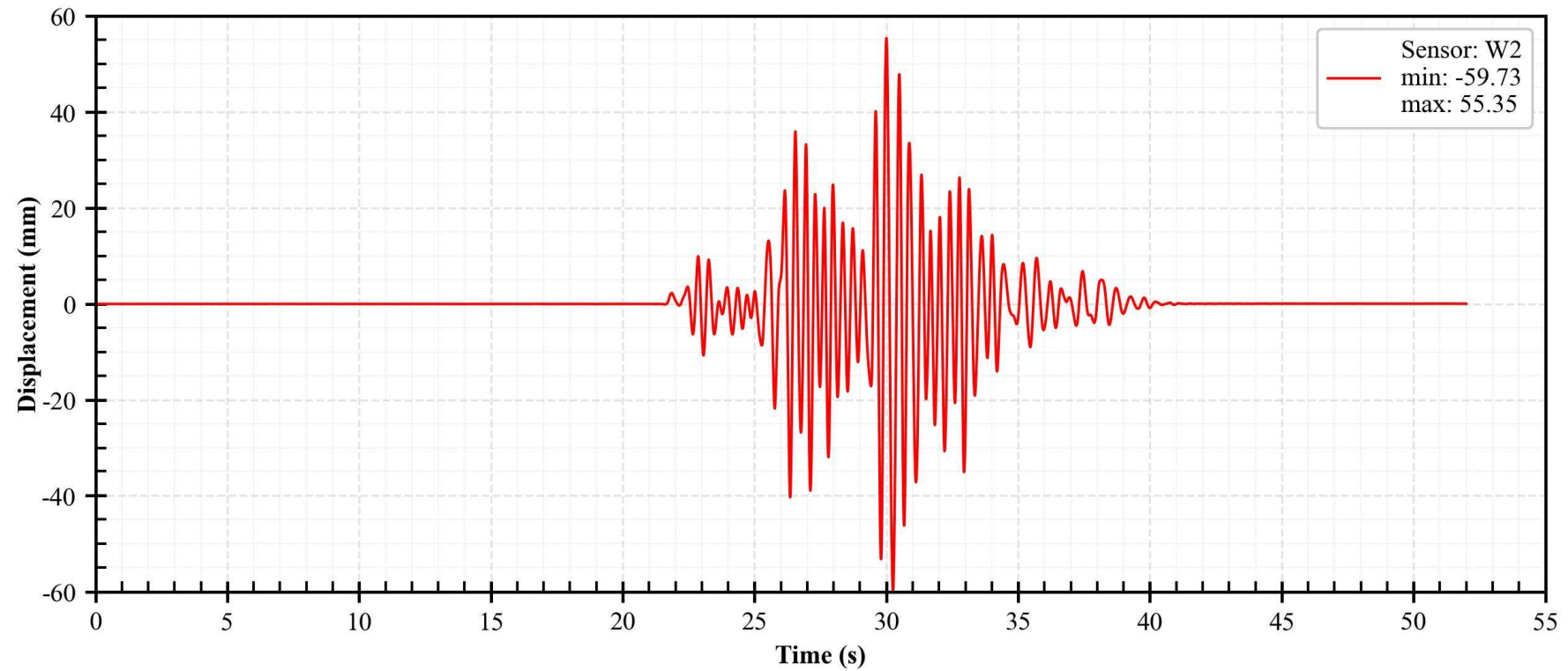


Figure 3.25.14 Characteristic results for phase B (earthquake EQ1,4g): Draw wire sensor 2

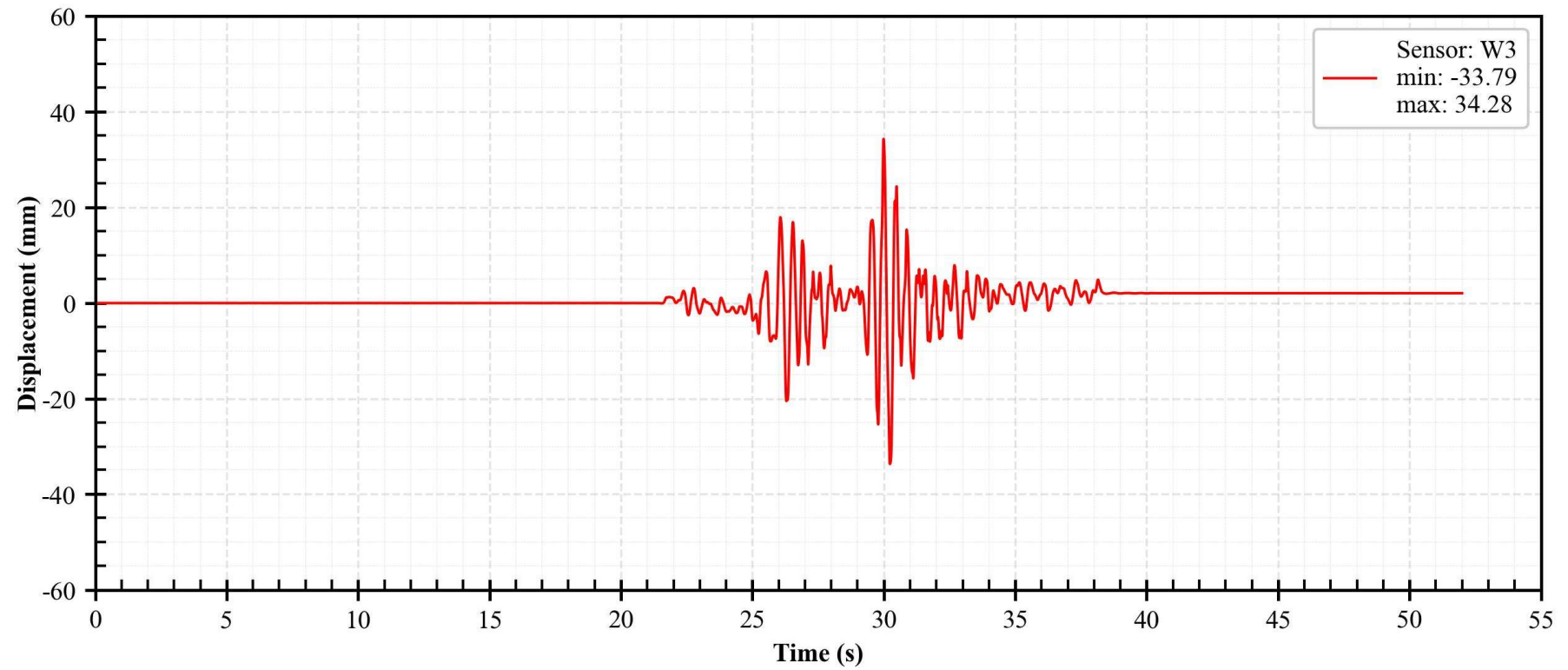


Figure 3.25.15 Characteristic results for phase B (earthquake EQ1,4g): Draw wire sensor 3

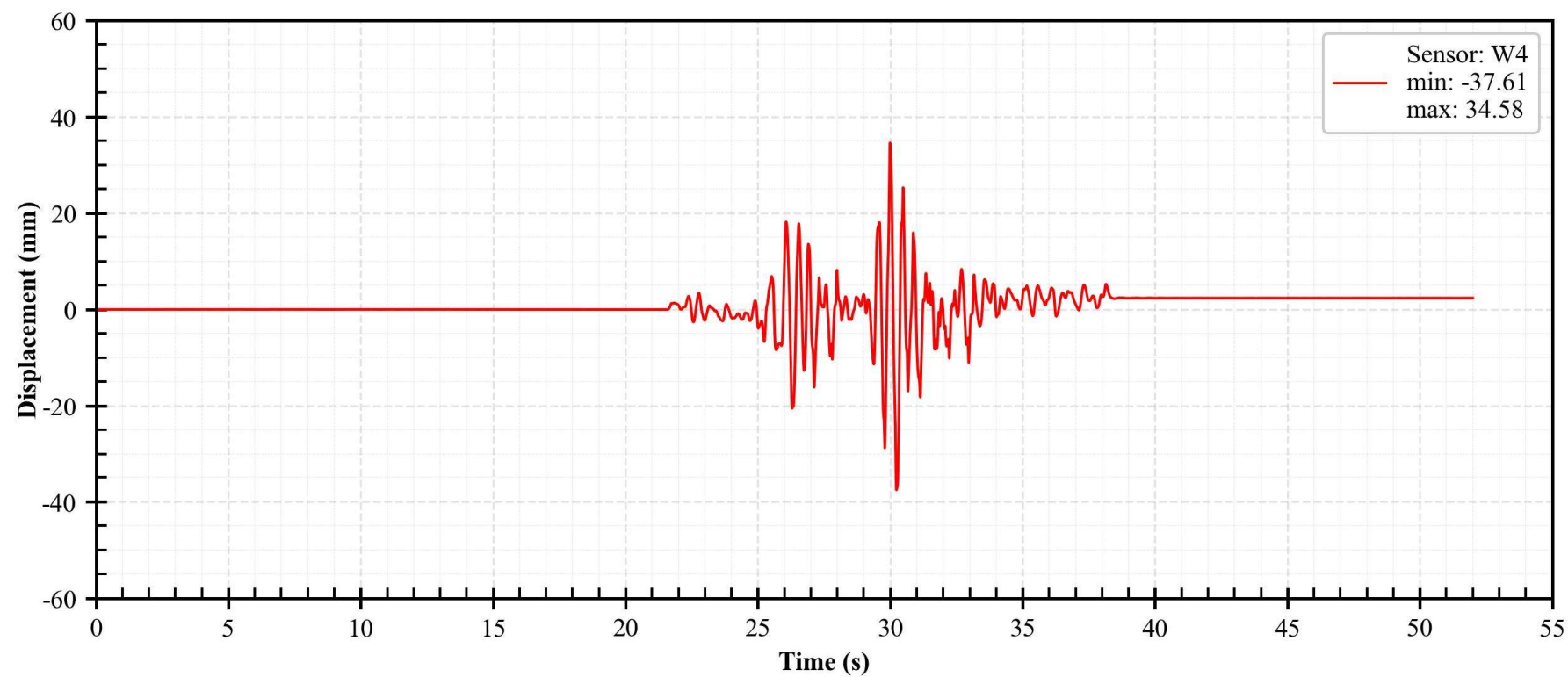


Figure 3.25.16 Characteristic results for phase B (earthquake EQ1,4g): Draw wire sensor 4

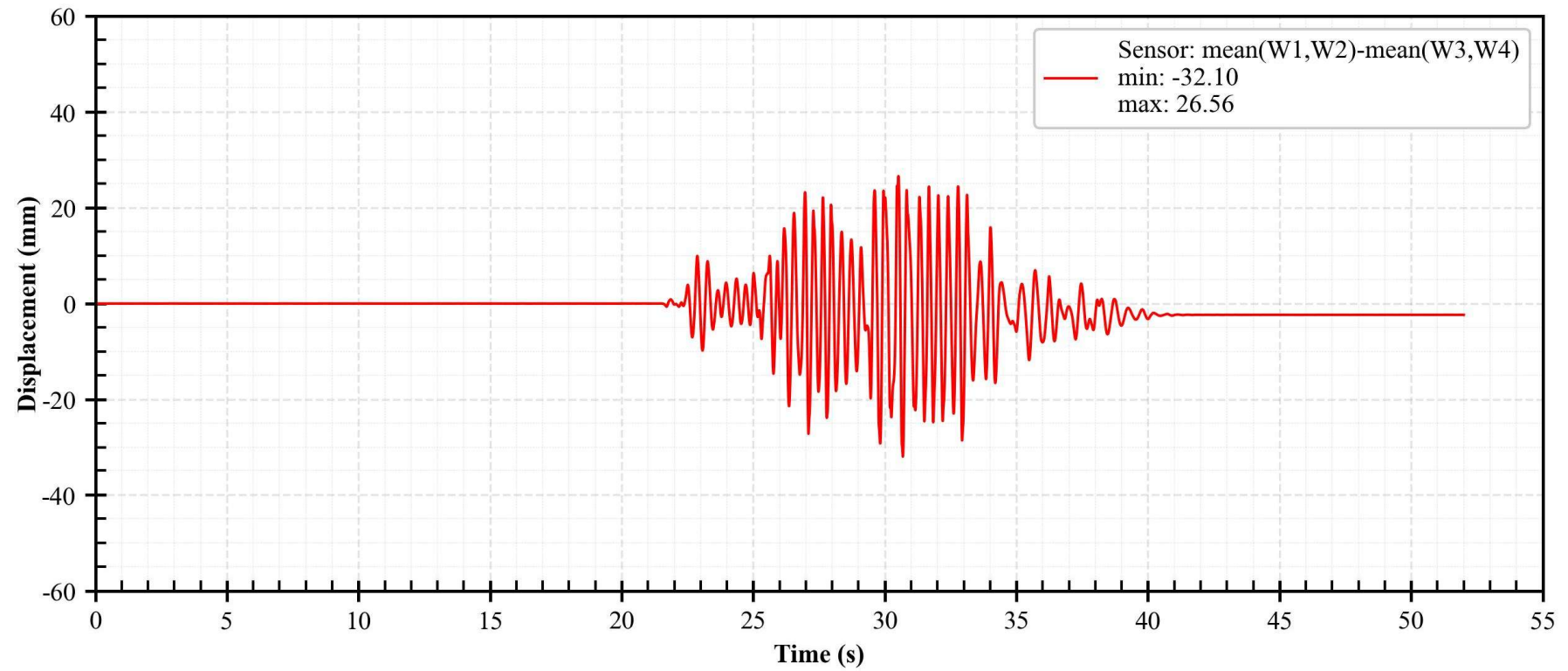


Figure 3.25.17 Characteristic results for phase B (earthquake EQ1,4g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.25.18, 3.25.19, 3.25.20, 3.25.21, 3.25.22, 3.25.23, 3.25.32, 3.25.33 are located on the longitudinal reinforcement, at the bottom of the column. More specifically, strain gauge SG1 has maximum strain 1739 μ strain and minimum strain -640 μ strain. The residual strain is 436 μ strain. Strain gauge SG2 has maximum strain 1336 μ strain and minimum -142 μ strain. The residual strain is 2 μ strain. Strain gauge SG3 has 1532 μ strain and -373 μ strain maximum and minimum strain respectively. The residual strain is 14 μ strain. Strain gauge SG4 has maximum 1908 μ strain and minimum -408 μ strain strain. The residual strain is 279 μ strain. Figure 3.25.32 and figure 3.25.33 show strain gauges SG5 and SG6, respectively. Strain gauge 5 has 3887 μ strain and -1302 μ strain maximum and minimum strain respectively. Strain gauge SG5 presents 195 μ strain residual strain. Strain gauge SG6 has 11843 μ strain maximum strain, -7802 μ strain minimum strain and -4448 μ strain residual. Finally in figure 3.25.22 we see strain gauge SG7 and in figure 3.25.23 strain gauge 8. Strain gauge SG7 has maximum strain 1260 μ strain. Strain gauge SG7 has -500 μ strain minimum deformation. Strain gauge SG8 has maximum strain 1454 μ strain and minimum strain -430 deformation. The residual strain for strain gauge SG7 and SG8 -240, 31 respectively.

Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. More specifically strain gauge 17 has 20 μ strain maximum strain. Strain gauge 18 has 28 μ strain maximum strain. Strain gauge 17 has minimum deformation -17 μ strain and strain gauge 18, -62 μ strain. Finally strain gauge 17 presents 6 μ strain residual. Strain gauge 18 presents 1 μ strain residual strain.

The strain gauges shown in the figures 3.25.24, 3.25.25, 3.25.26, 3.25.27, 3.25.28, 3.25.29 and 3.25.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG9 has 3042 μ strain maximum strain, -483 μ strain minimum strain and -98 residual. Strain gauge SG11 has 1275 μ strain maximum strain and minimum -463 μ strain deformation. The residual strain is -53 μ strain for strain gauge SG11. Strain gauge SG12 has 1330 μ strain maximum strain and -445 μ strain minimum strain. The residual strain is 0 μ strain for strain gauge SG12. Strain gauge SG13 has maximum strain 1229 μ strain, minimum -294 μ strain and -50 μ strain residual. Strain gauge SG14 has maximum strain 1299 μ strain and minimum strain -767 μ strain. The residual value is -14 μ strain. Finally strain gauges SG15 has maximum strain 1279 μ strain and minimum strain -283 μ strain. Strain gauge SG16 has maximum strain 2605 μ strain, minimum strain -500 μ strain and residual strain 1415 μ strain.

Strain gauges SG21,22 are located on the PUFJ along in-plane direction on the top of connection between column 1 and partial brick infill as well as between column 2 and the partial brick infill respectively. SG21 has 1173 μ strain maximum strain, -485 μ strain minimum strain and 36 μ strain residual. Strain gauge SG22 has maximum 803 μ strain and minimum -126 μ strain. Strain gauge SG22 presents 49 μ strain residual.

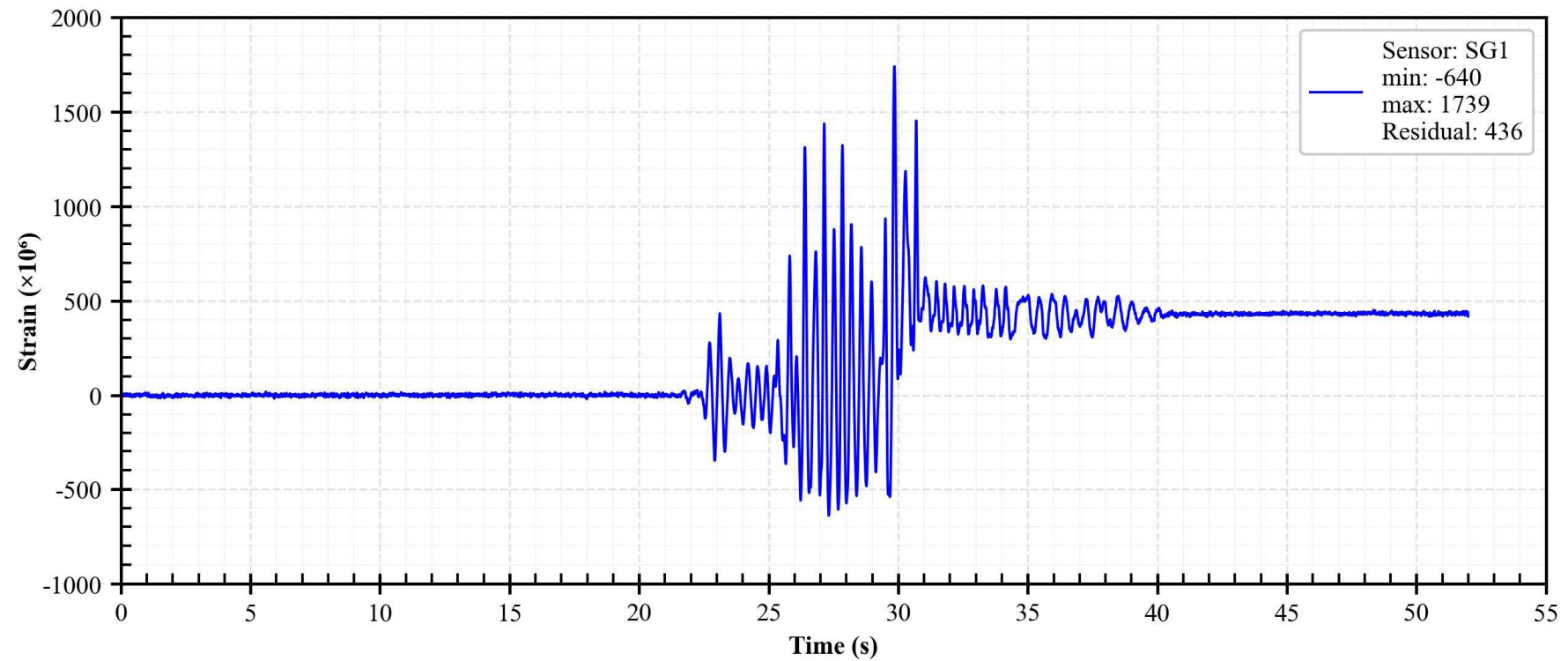


Figure 3.25.18 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 1

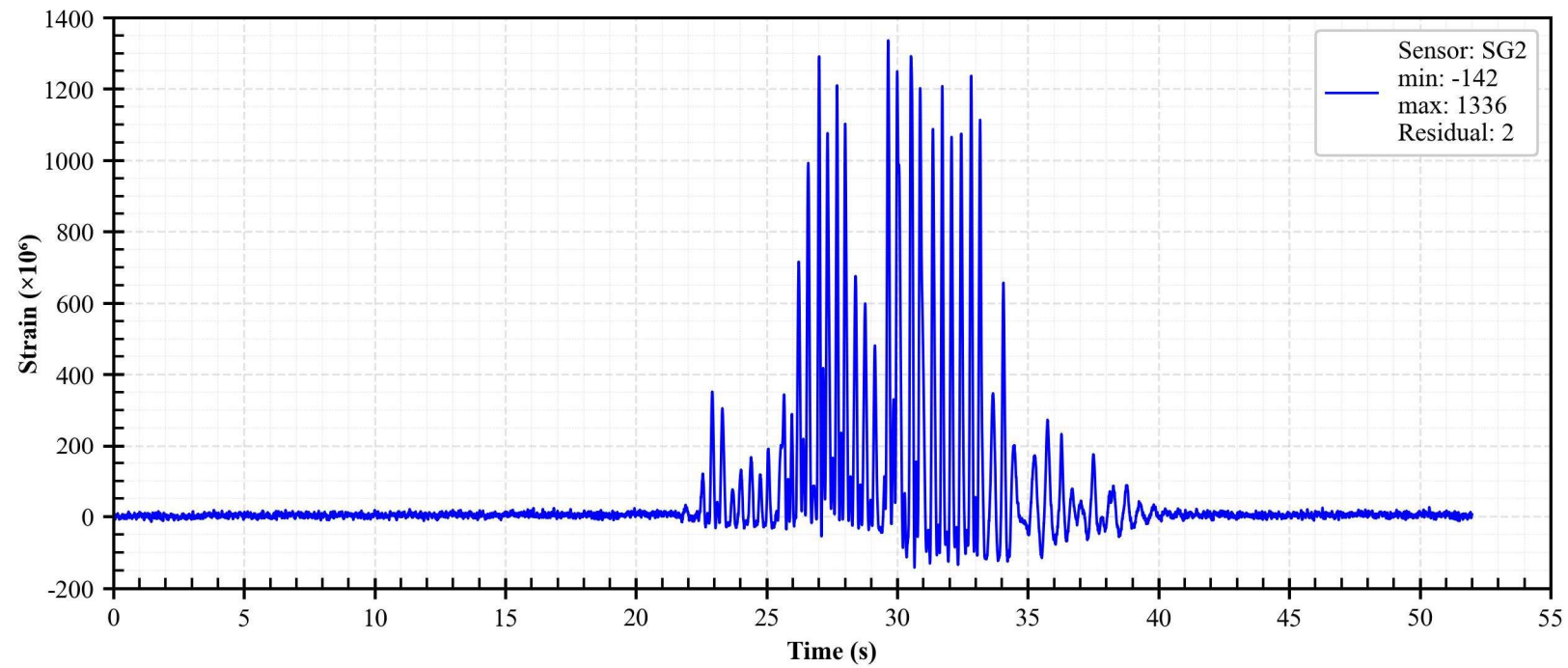


Figure 3.25.19 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 2

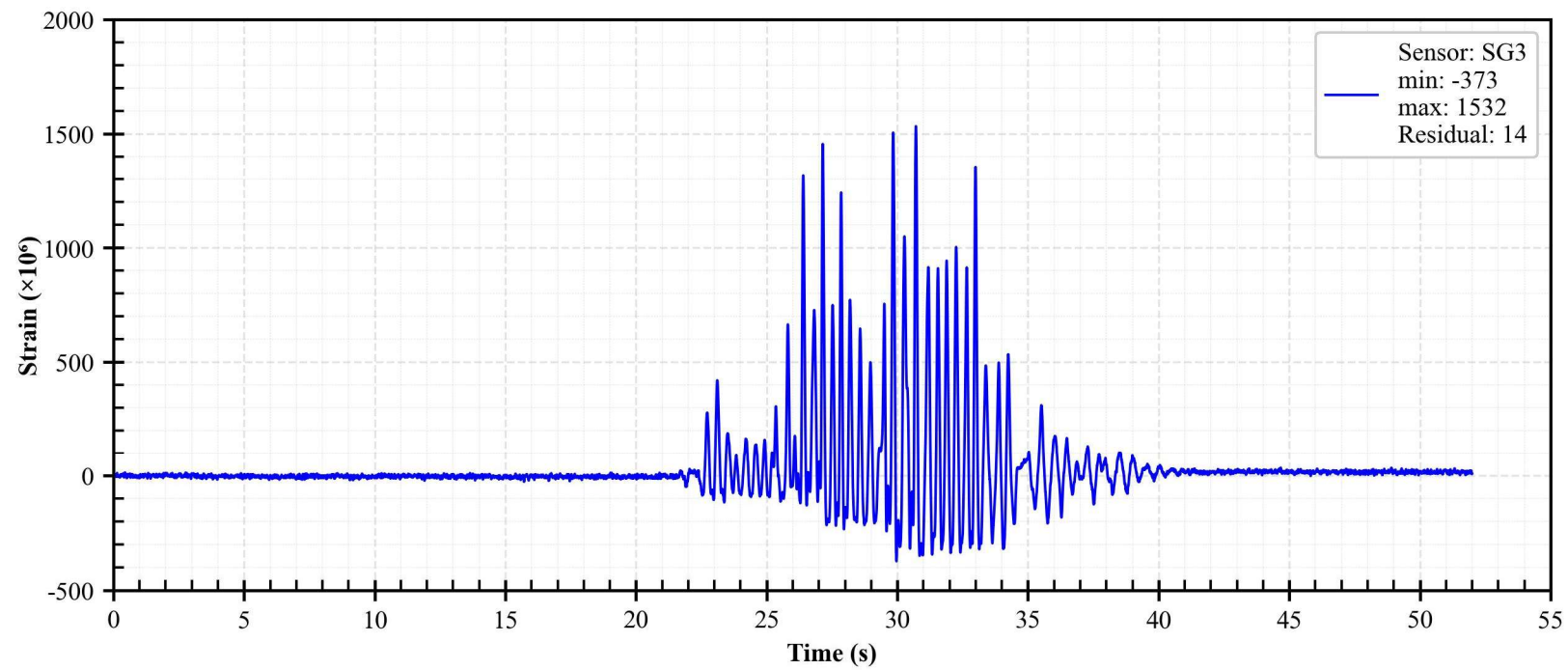


Figure 3.25.20 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 3

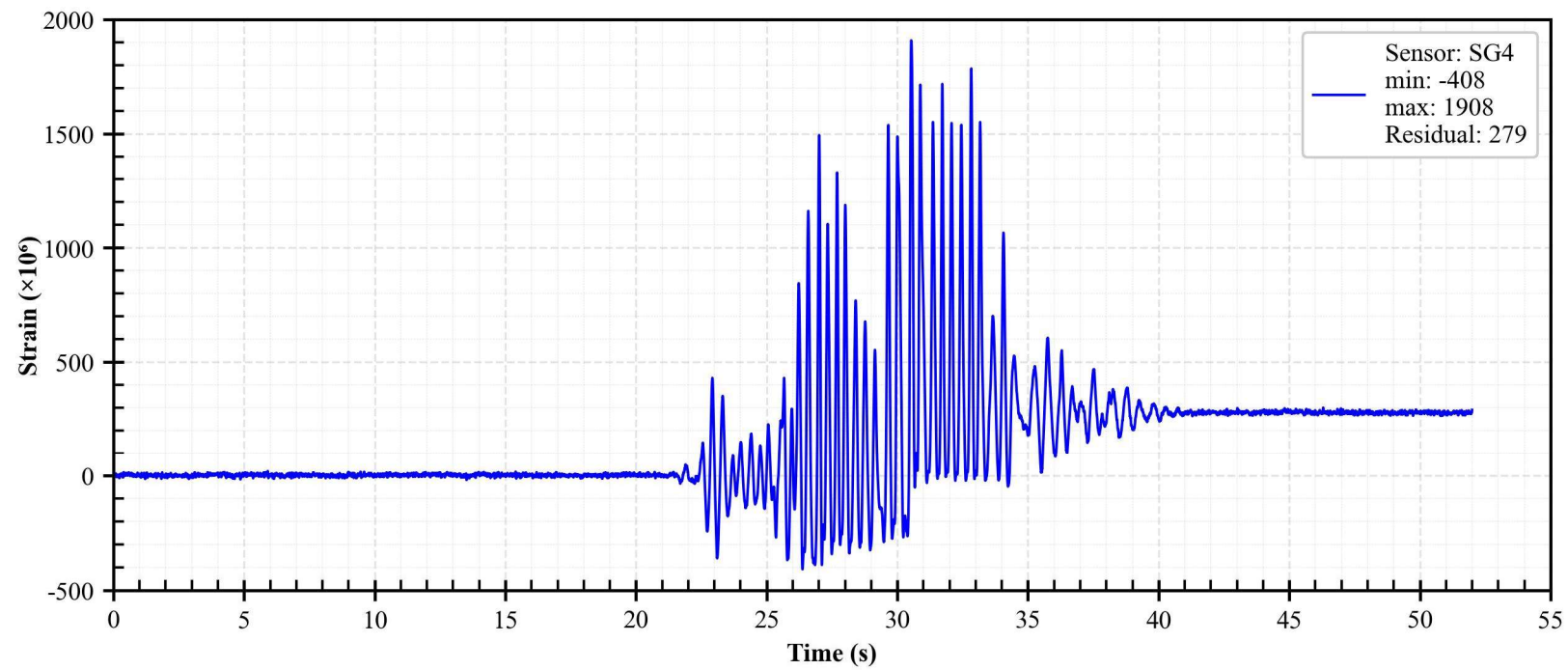


Figure 3.25.21 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 4

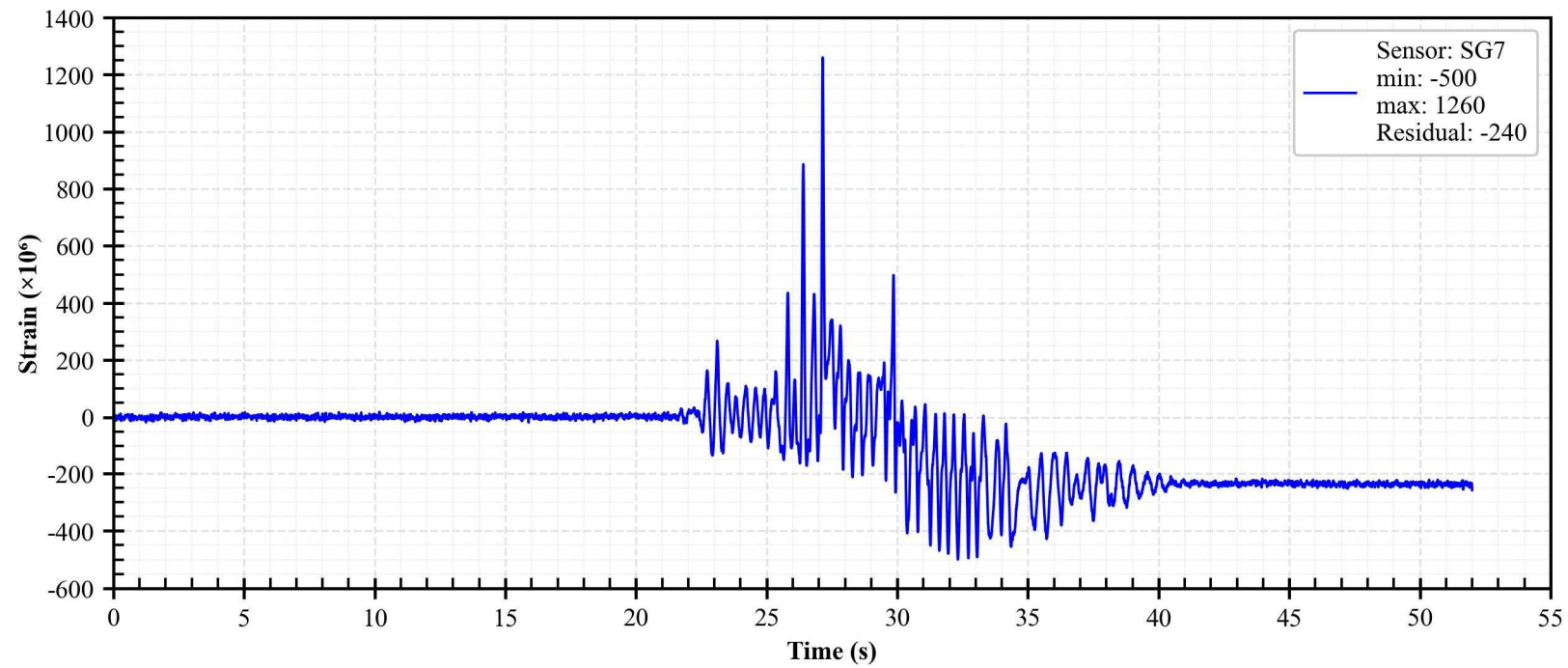


Figure 3.25.22 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 7

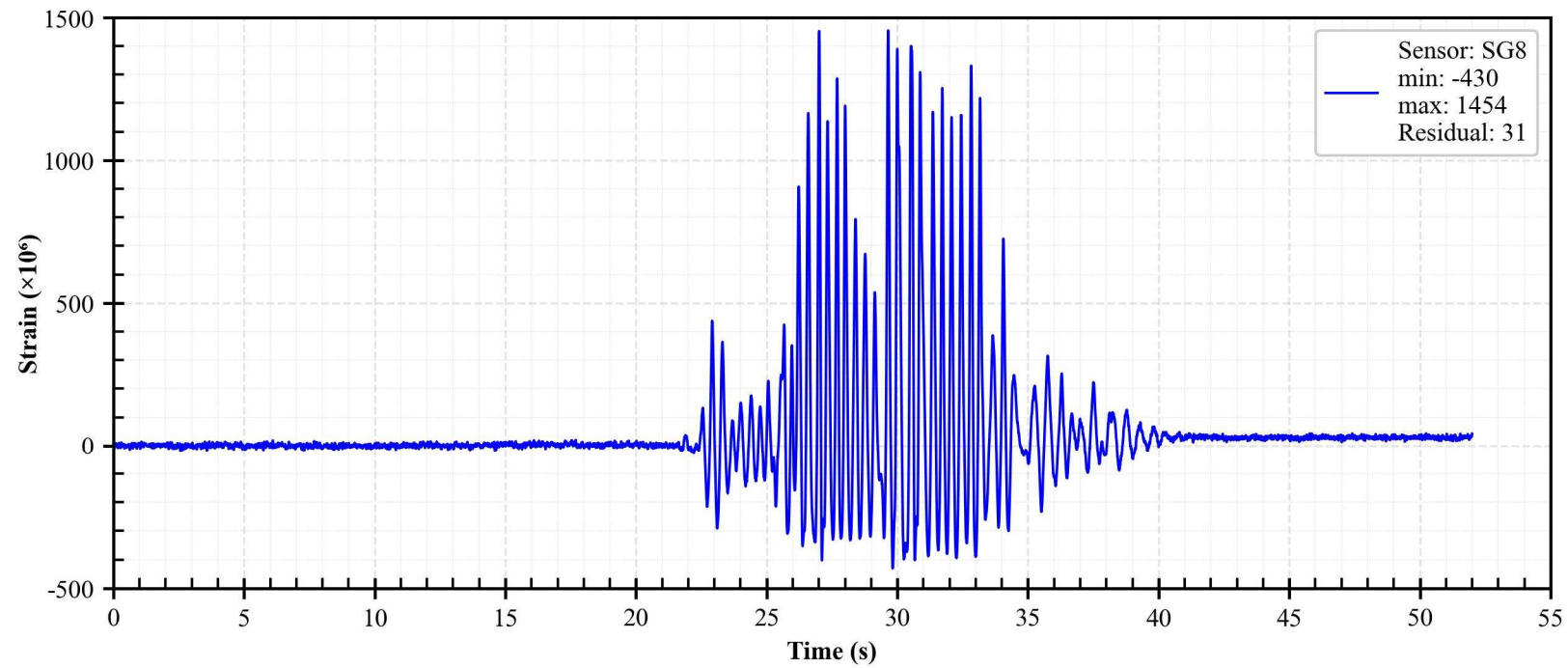


Figure 3.25.23 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 8

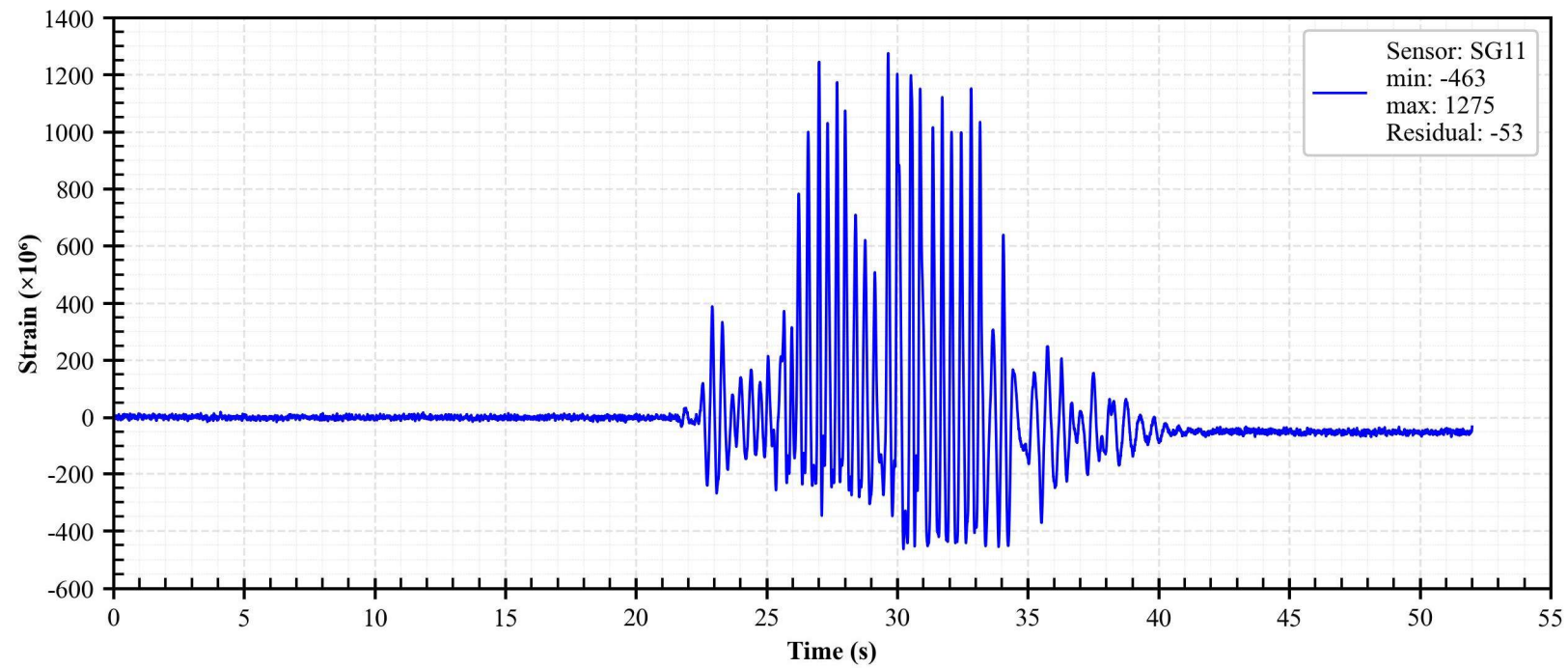


Figure 3.25.24 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 11

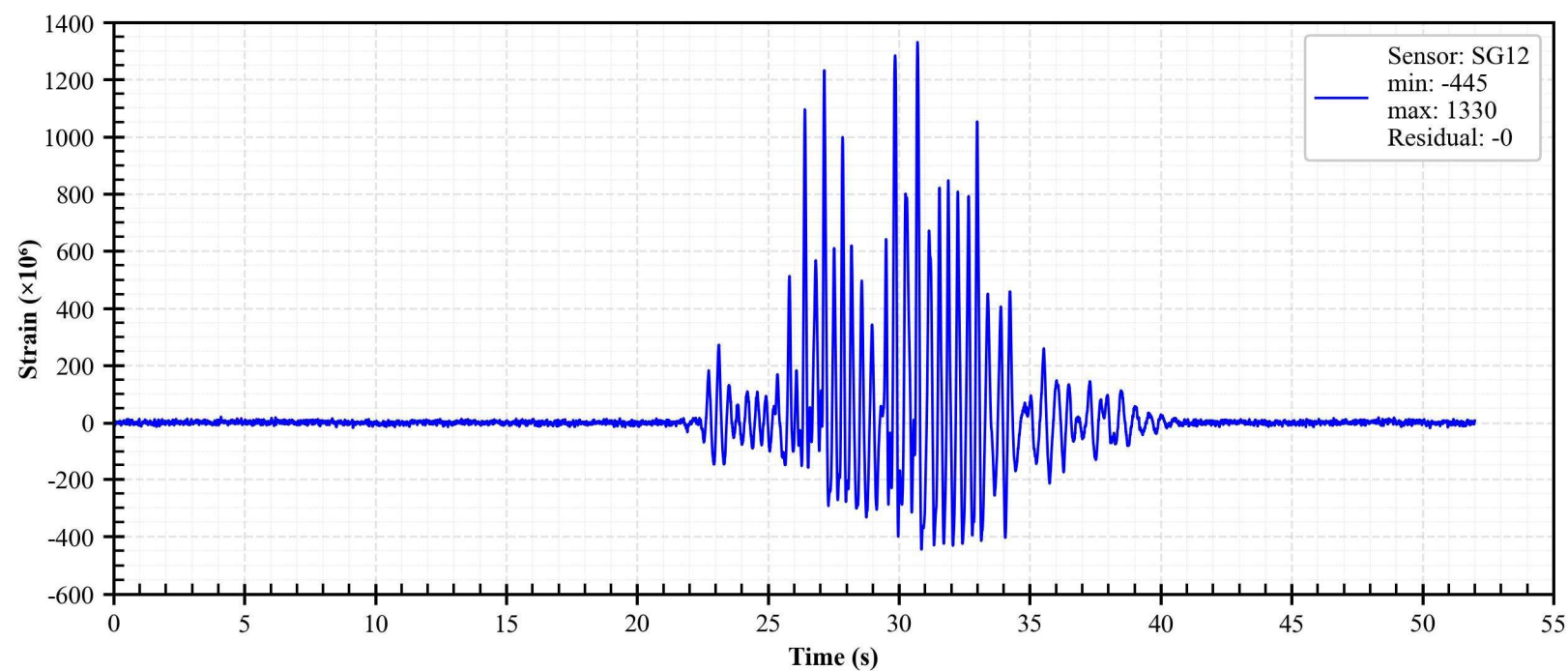


Figure 3.25.25 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 12

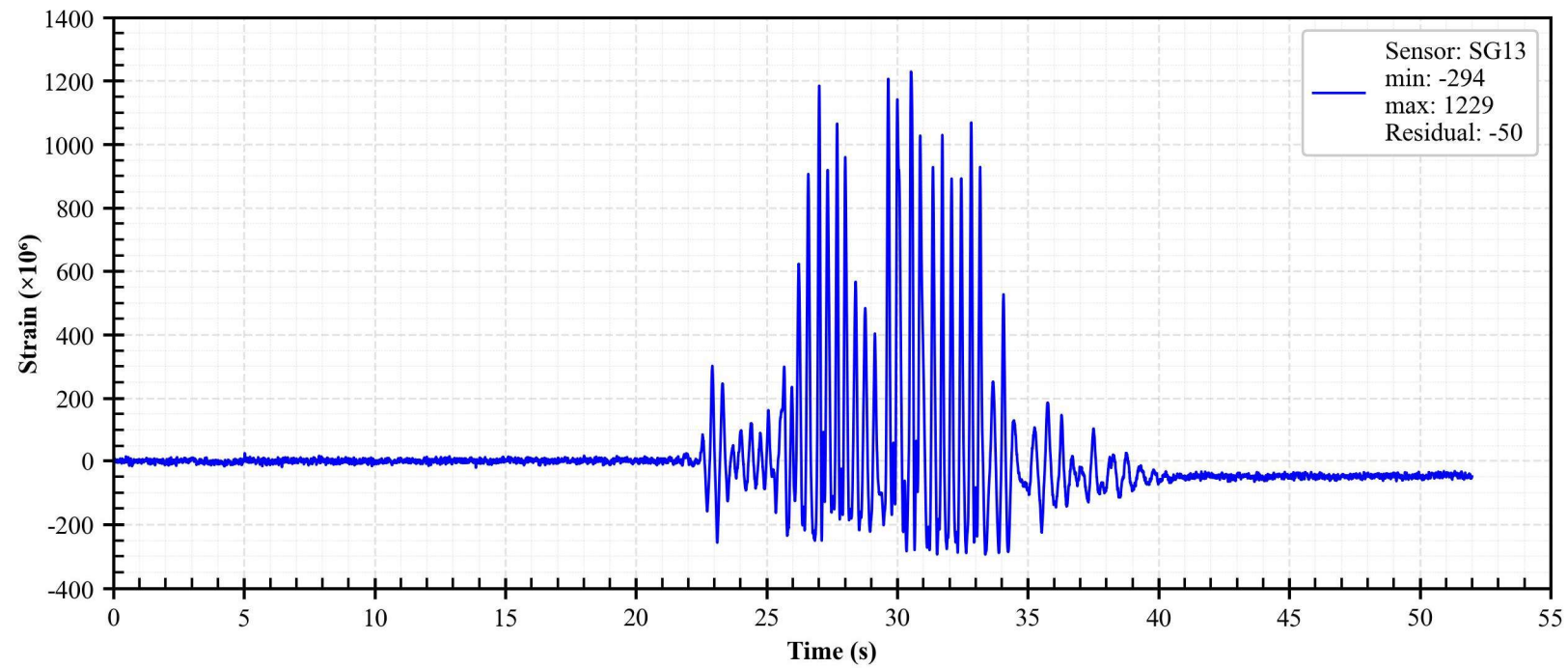


Figure 3.25.26 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 13

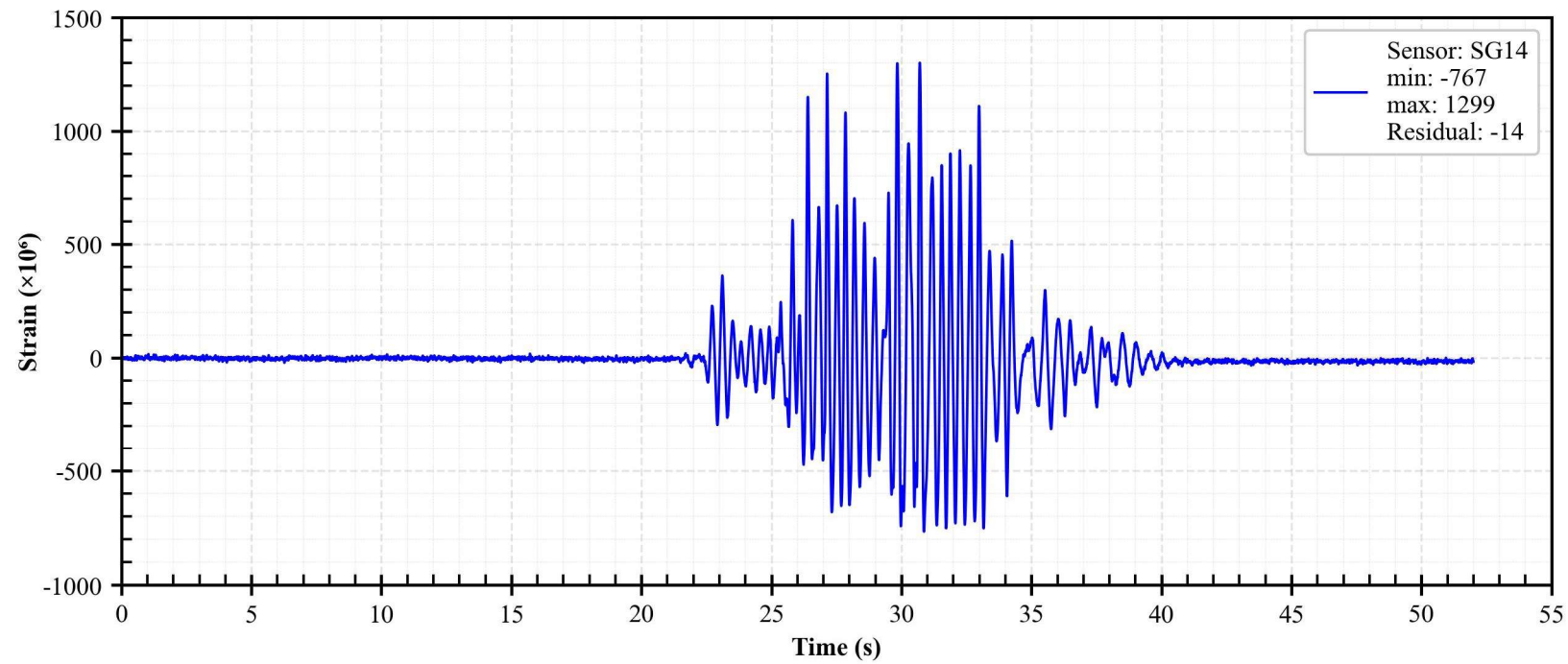


Figure 3.25.27 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 14

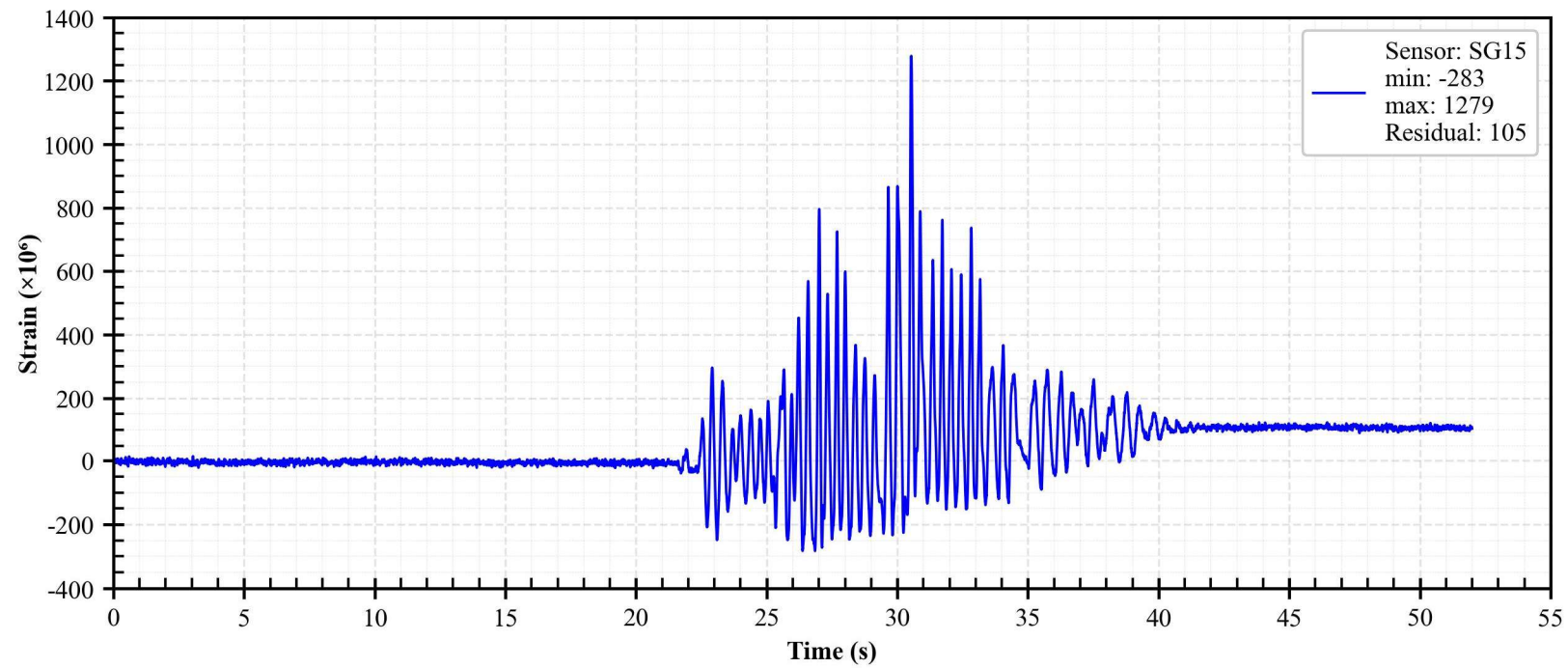


Figure 3.25.28 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 15

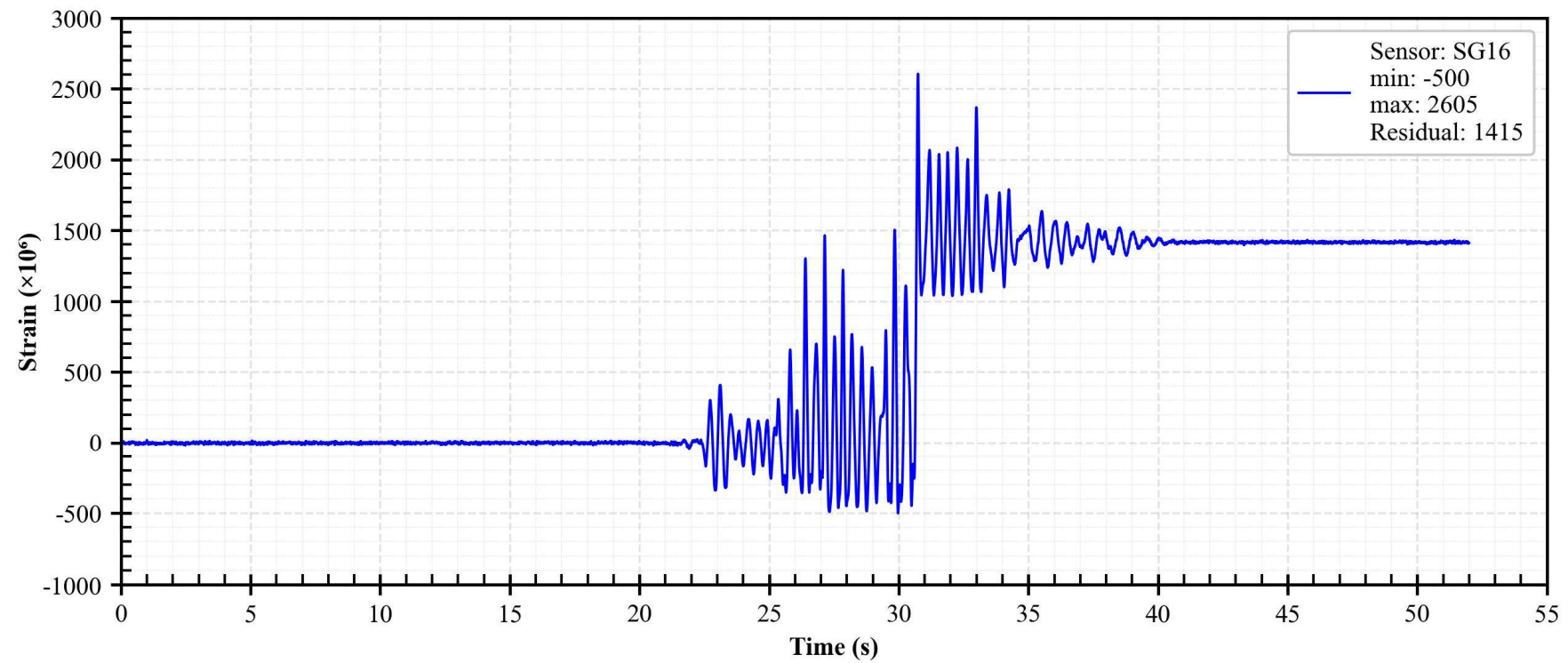


Figure 3.25.29 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 16

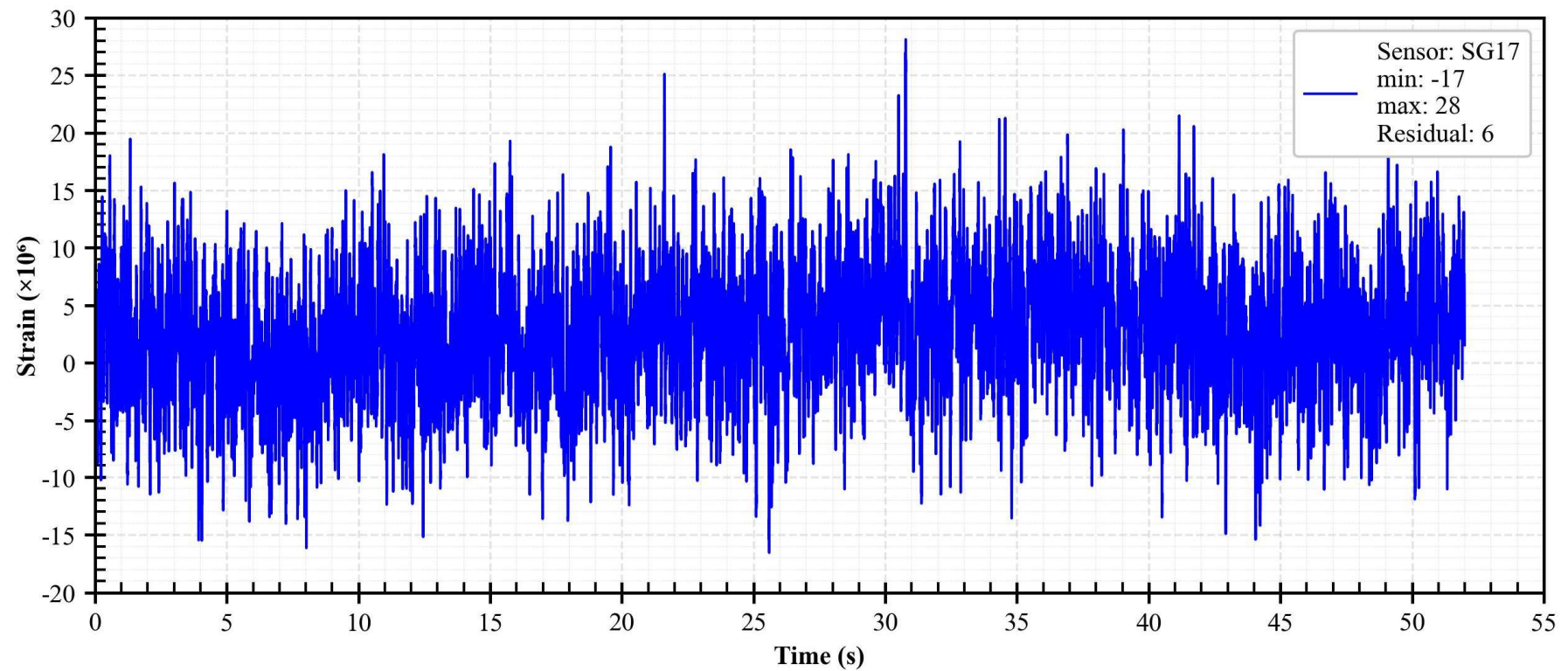


Figure 3.25.30 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 17

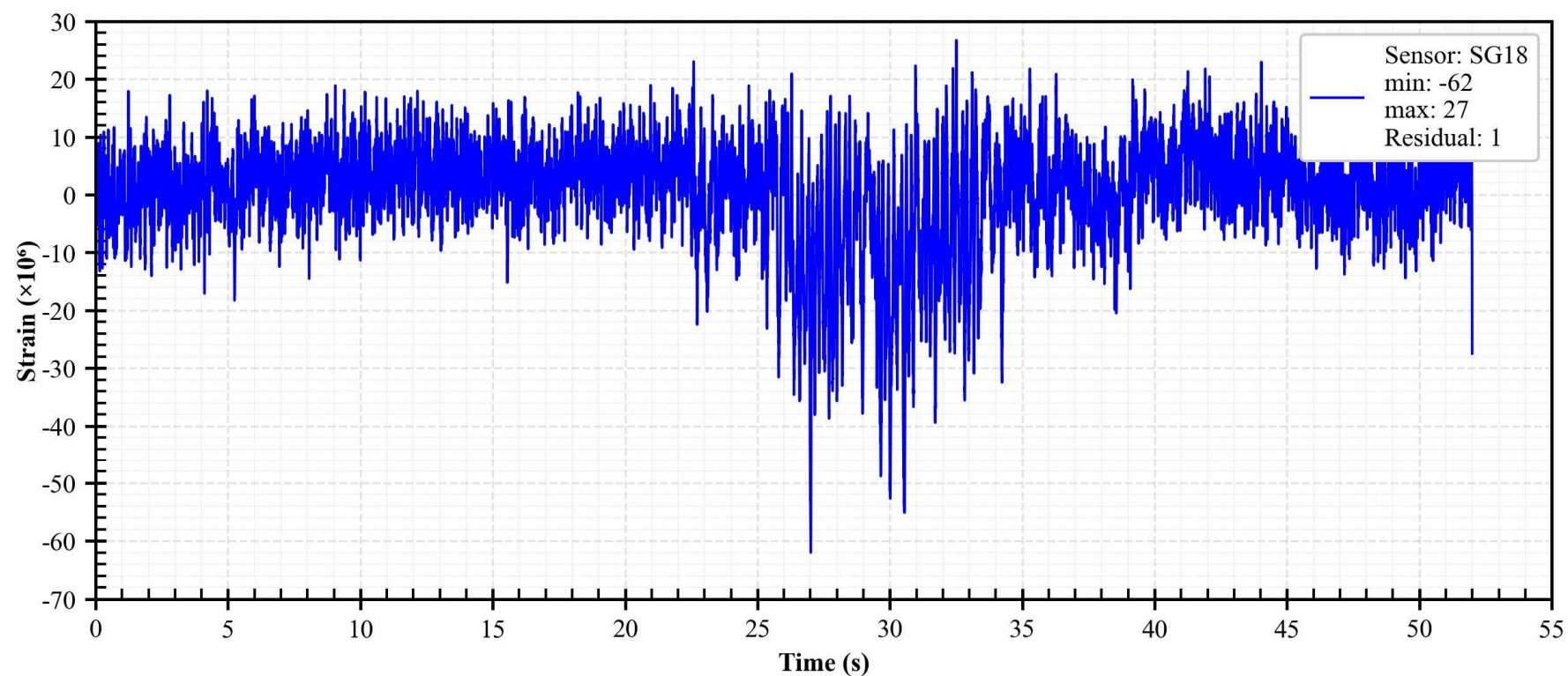


Figure 3.25.31 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 18

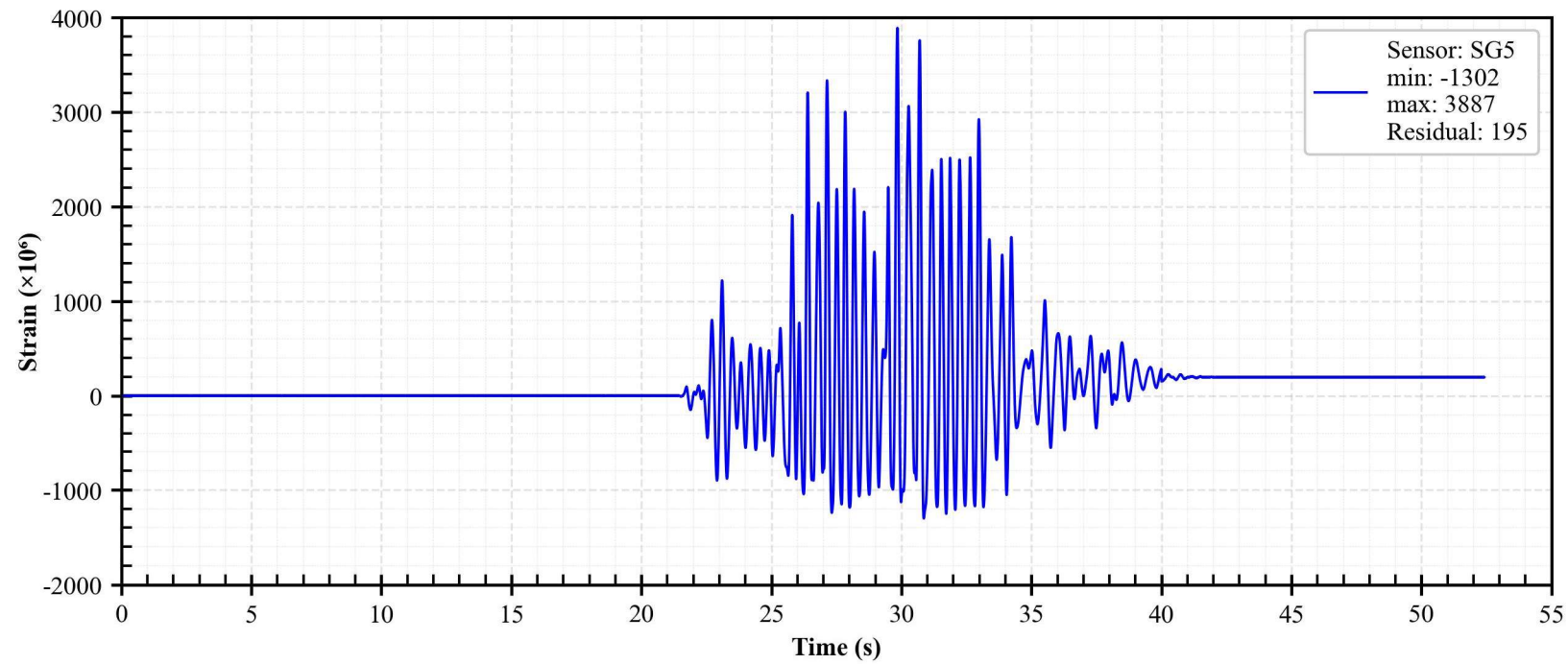


Figure 3.25.32 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 5

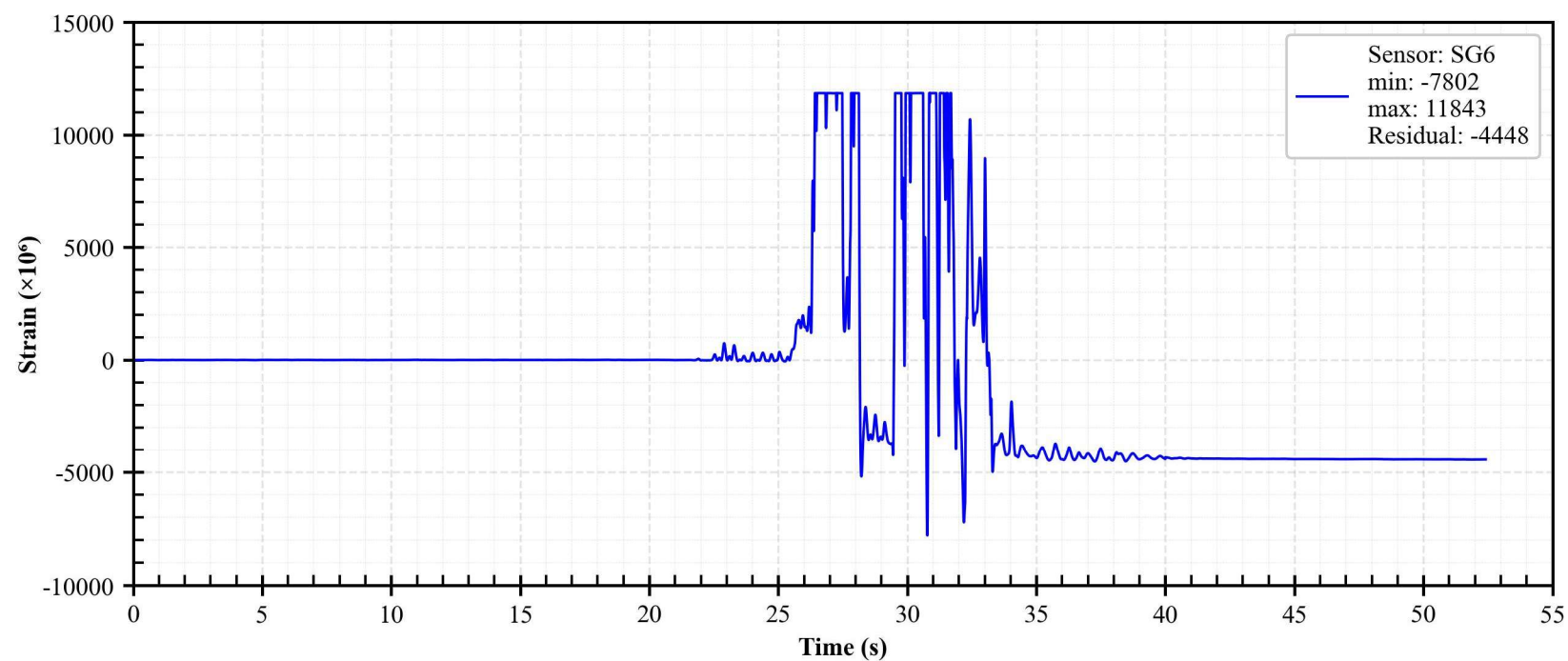


Figure 3.25.33 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 6

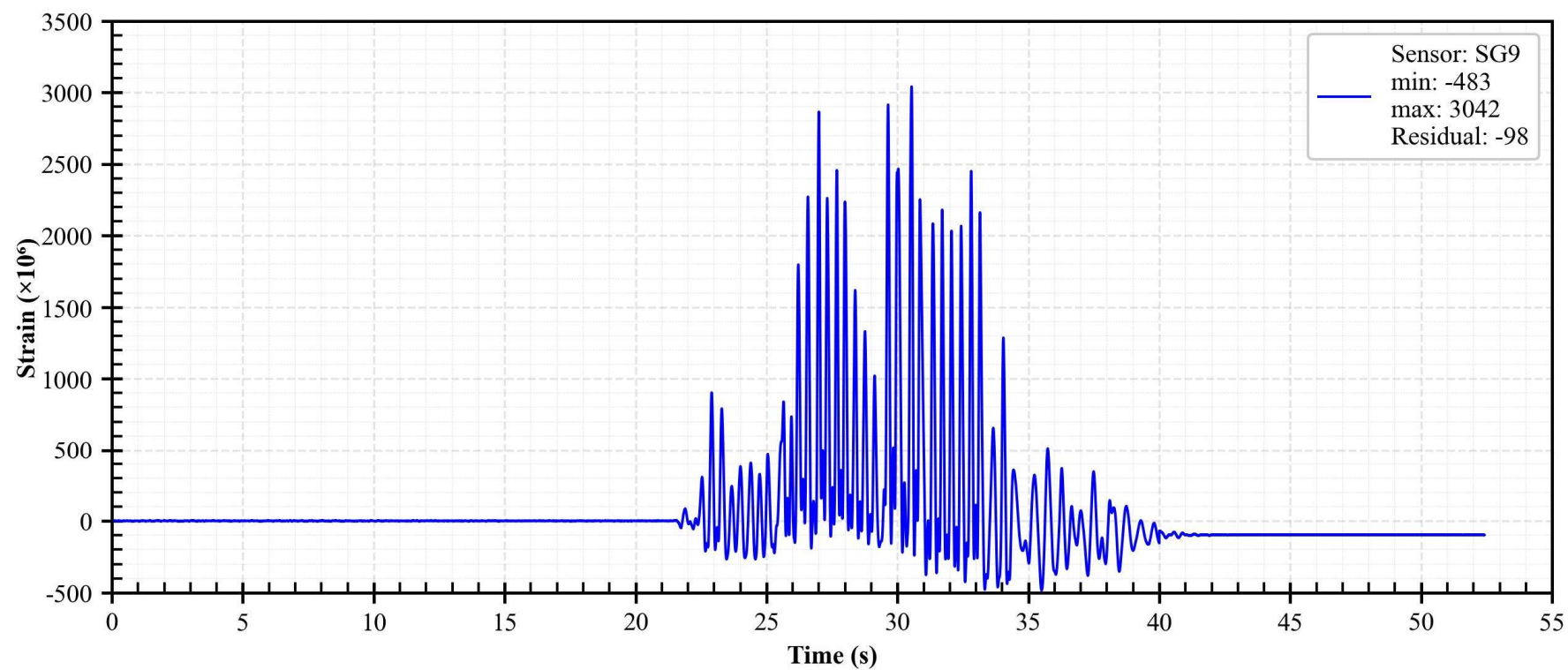
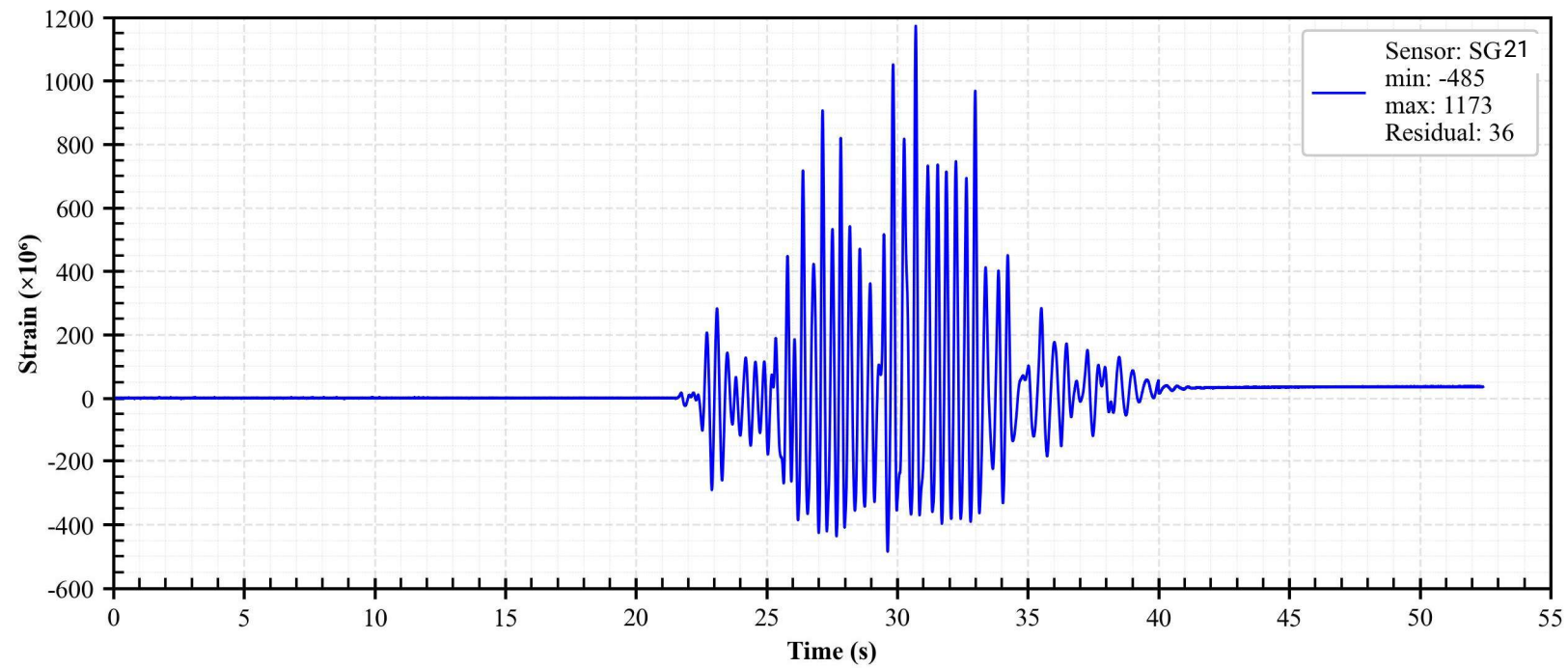


Figure 3.25.34 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 9



22

Figure 3.25.35 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 21 (PUFJ, column 1)



22

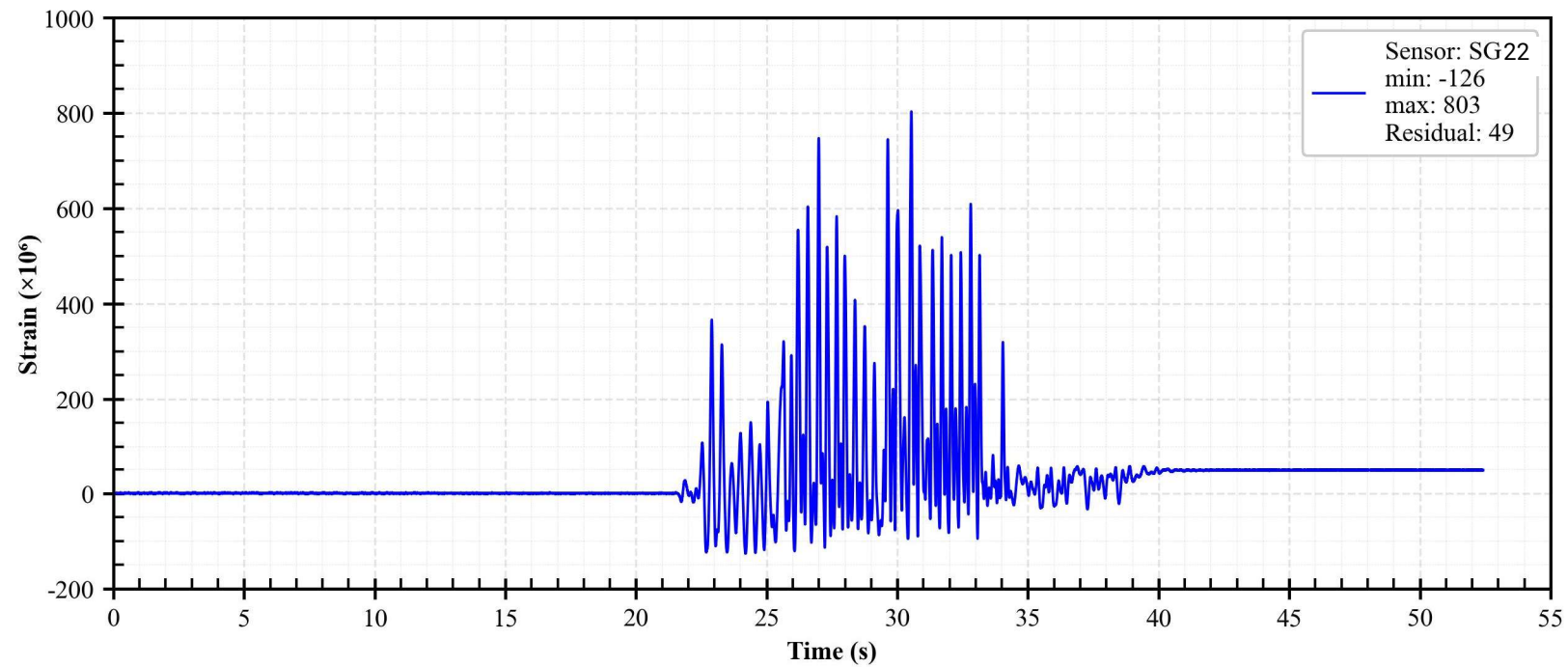


Figure 3.25.36 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 22 (PUFJ, column 2)

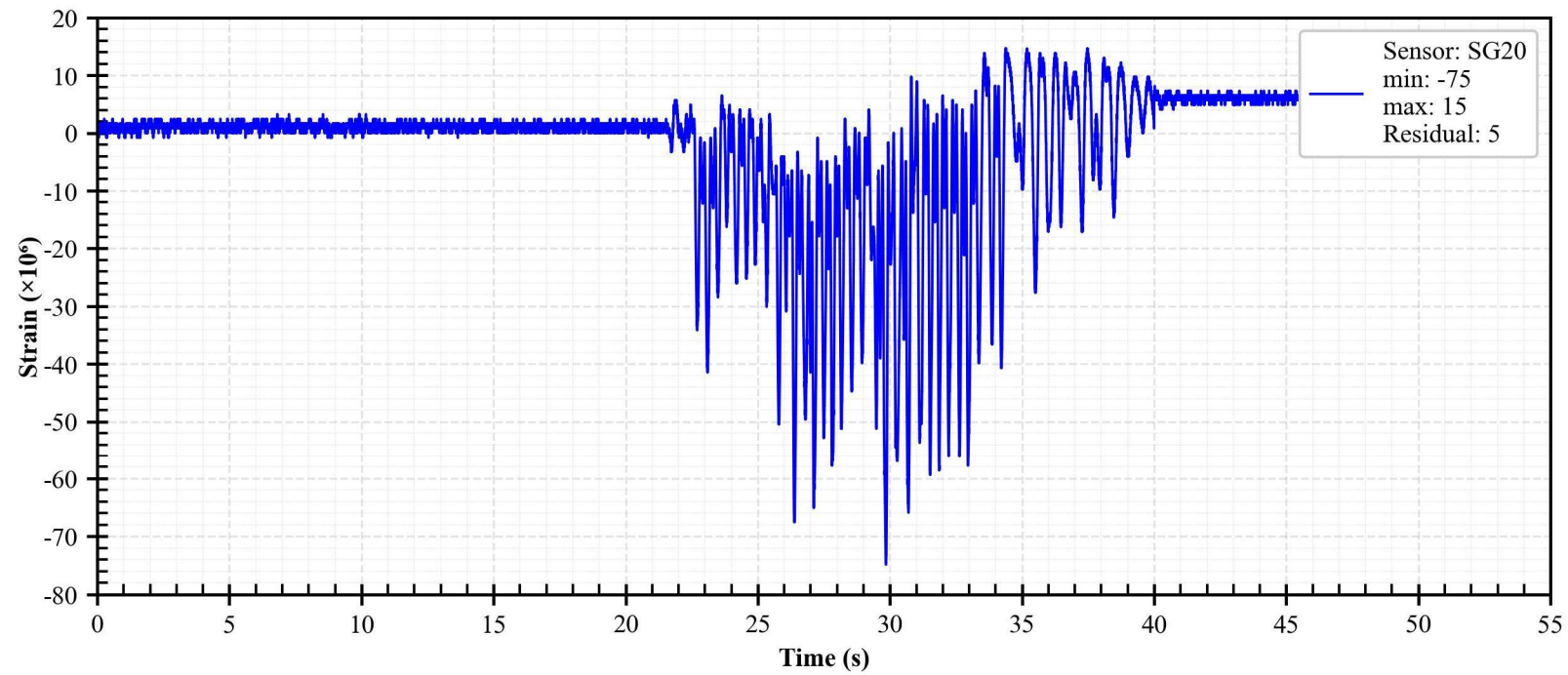


Figure 3.25.37 Characteristic results for phase B (earthquake EQ1,4g): strain gauge 20

3.26 White noise before 0,2g

Accelerometers

Characteristic extracts from the time history of accelerations of different of different accelerometers are given below for white noise test before EQ0,2g. The max acceleration at the slab level on the accelerometer acc4 is 0.20g. The max acceleration at the foundation level on the accelerometer acc10 is 0.05g.

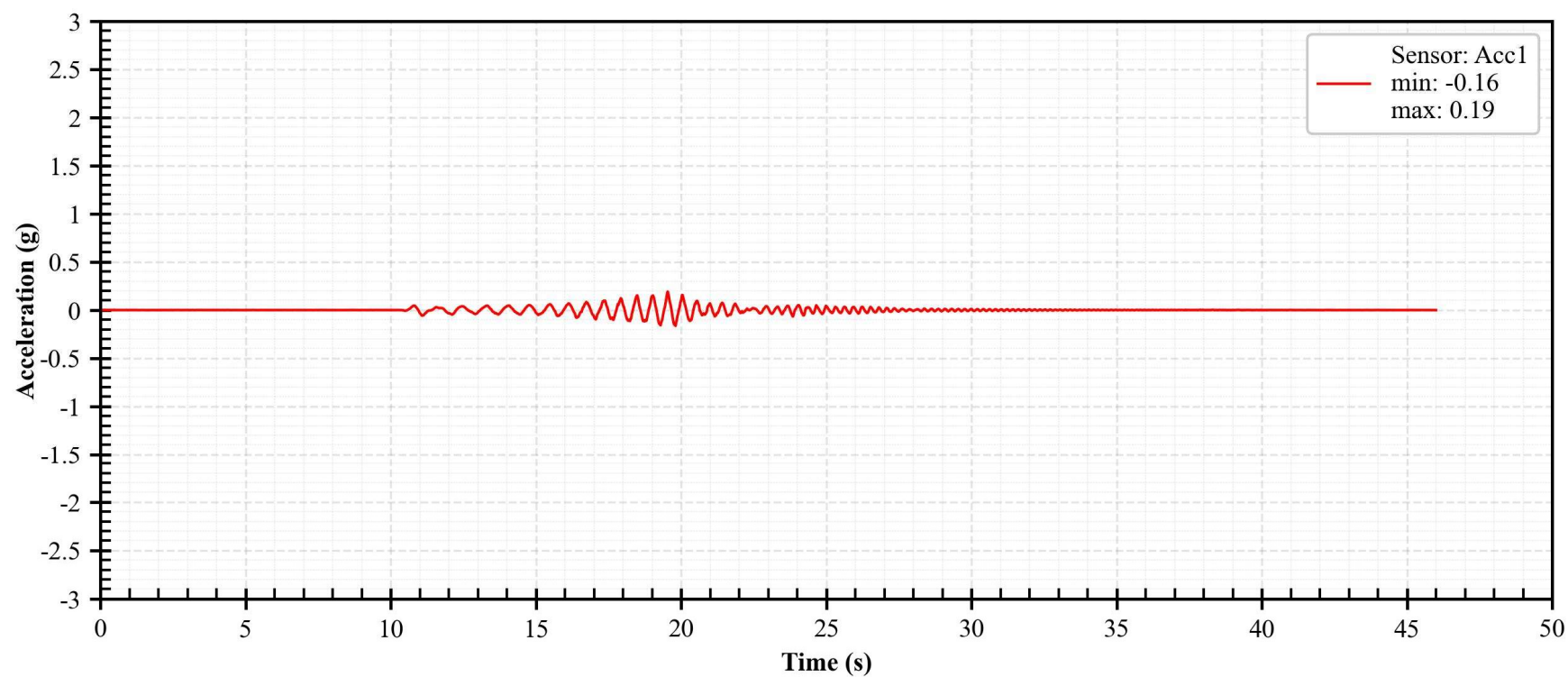


Figure3.26.1 Characteristic results for phase B (white noise before 0,2g): Accelerometer 1

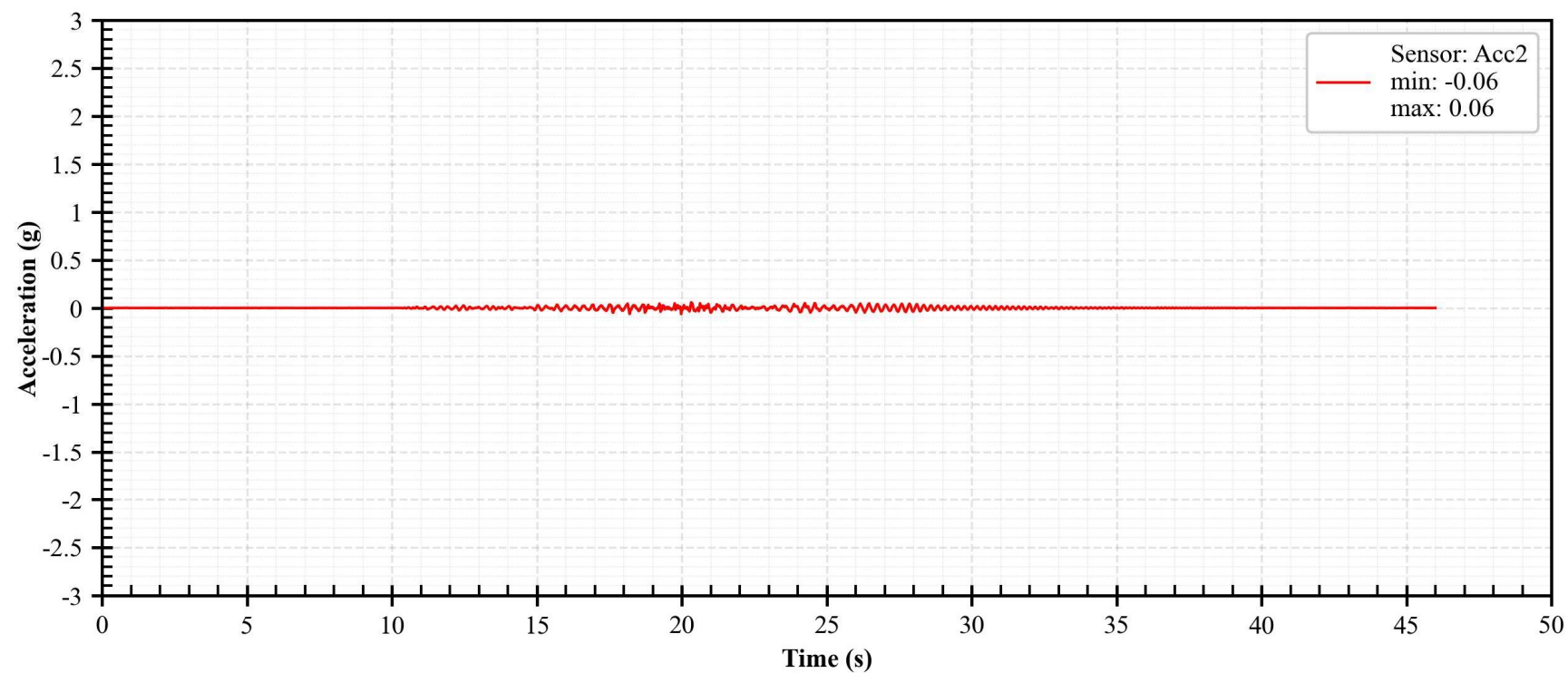


Figure 3.26.2 Characteristic results for phase B (white noise before 0,2g): Accelerometer 2

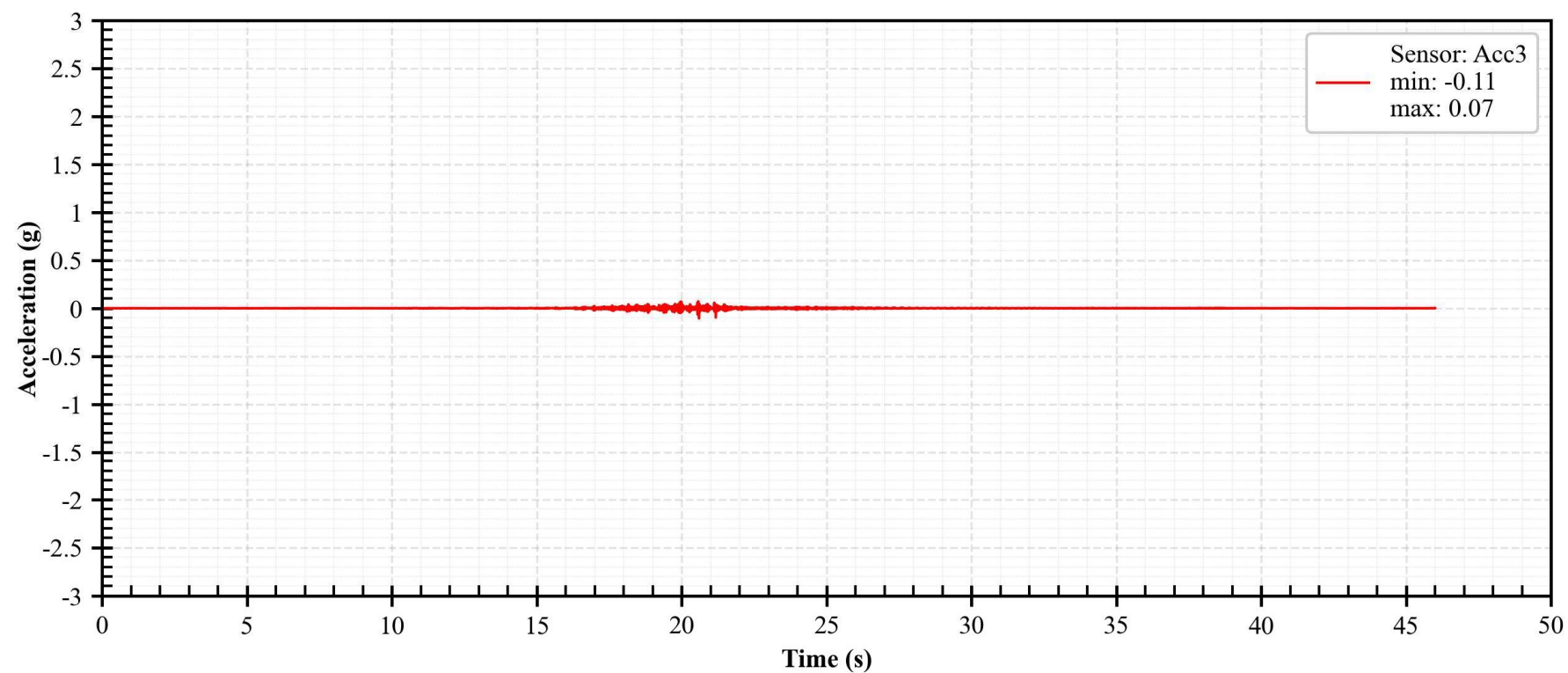


Figure 3.26.3 Characteristic results for phase B (white noise before 0,2g): Accelerometer 3

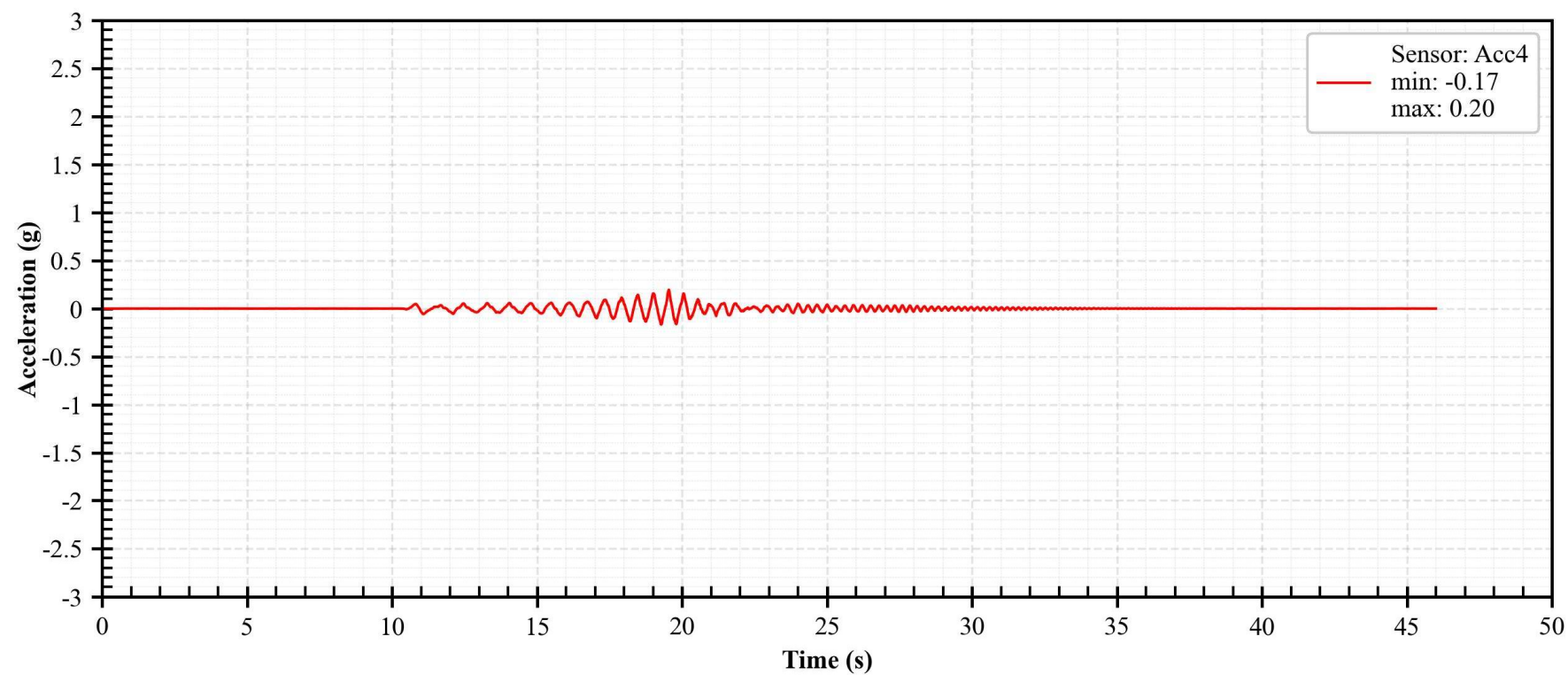


Figure 3.26.4 Characteristic results for phase B (white noise before 0,2g): Accelerometer 4

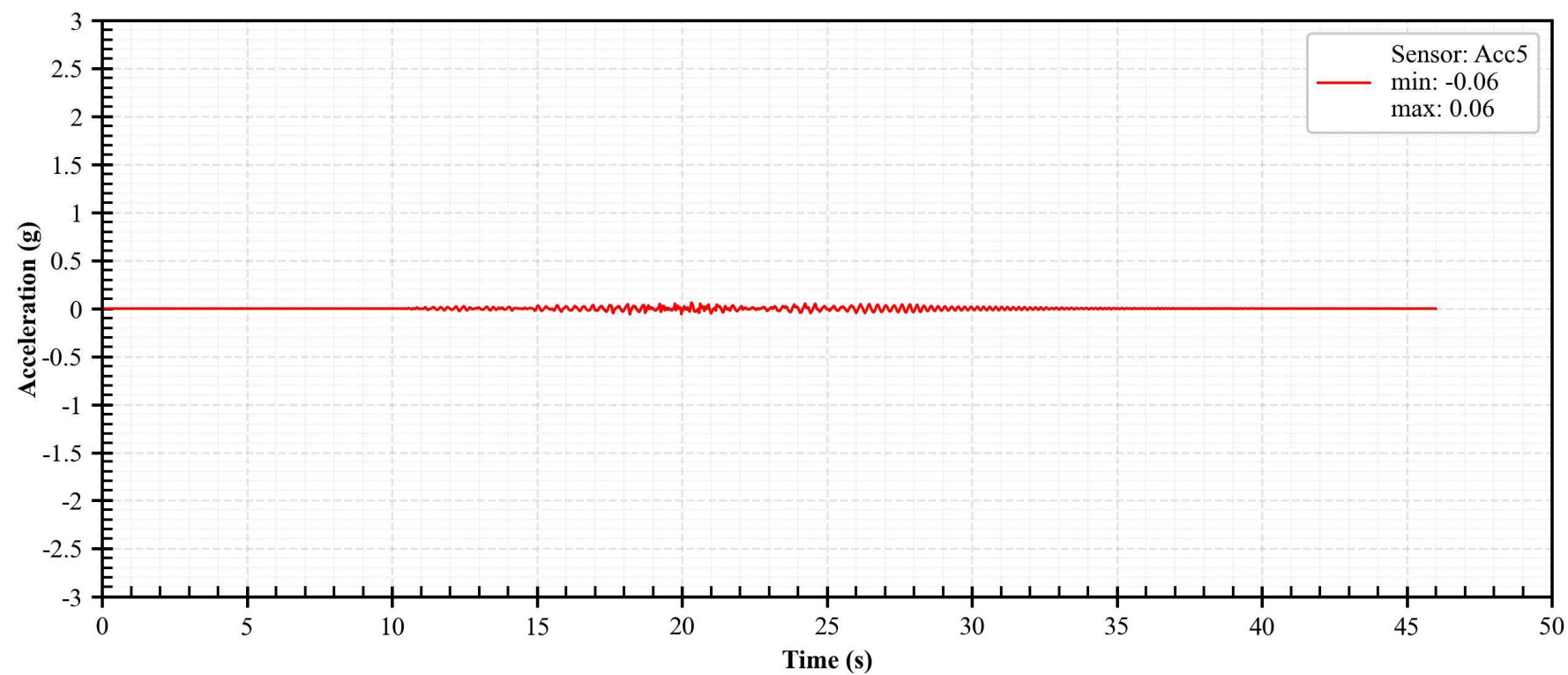


Figure 3.26.5 Characteristic results for phase B (white noise before 0,2g): Accelerometer 5

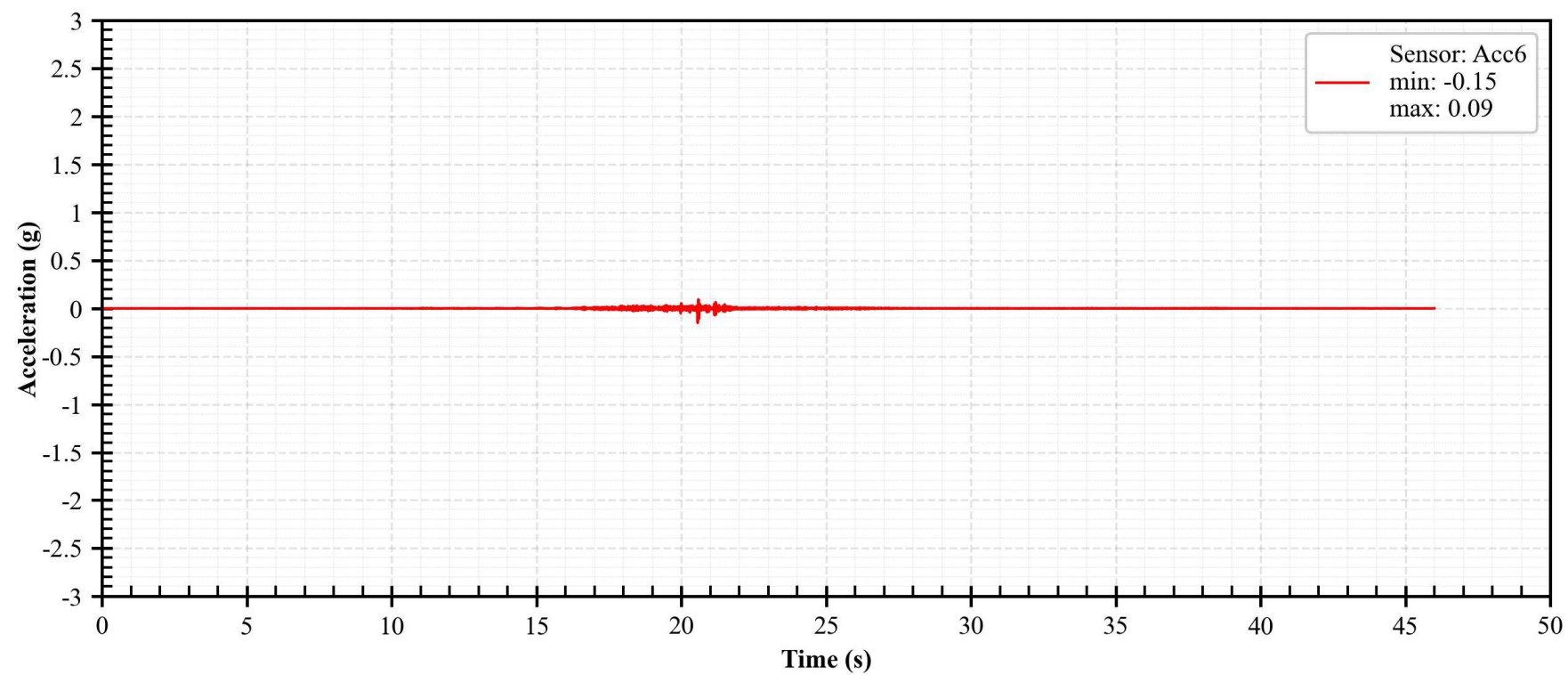


Figure 3.26.6 Characteristic results for phase B (white noise before 0,2g): Accelerometer 6

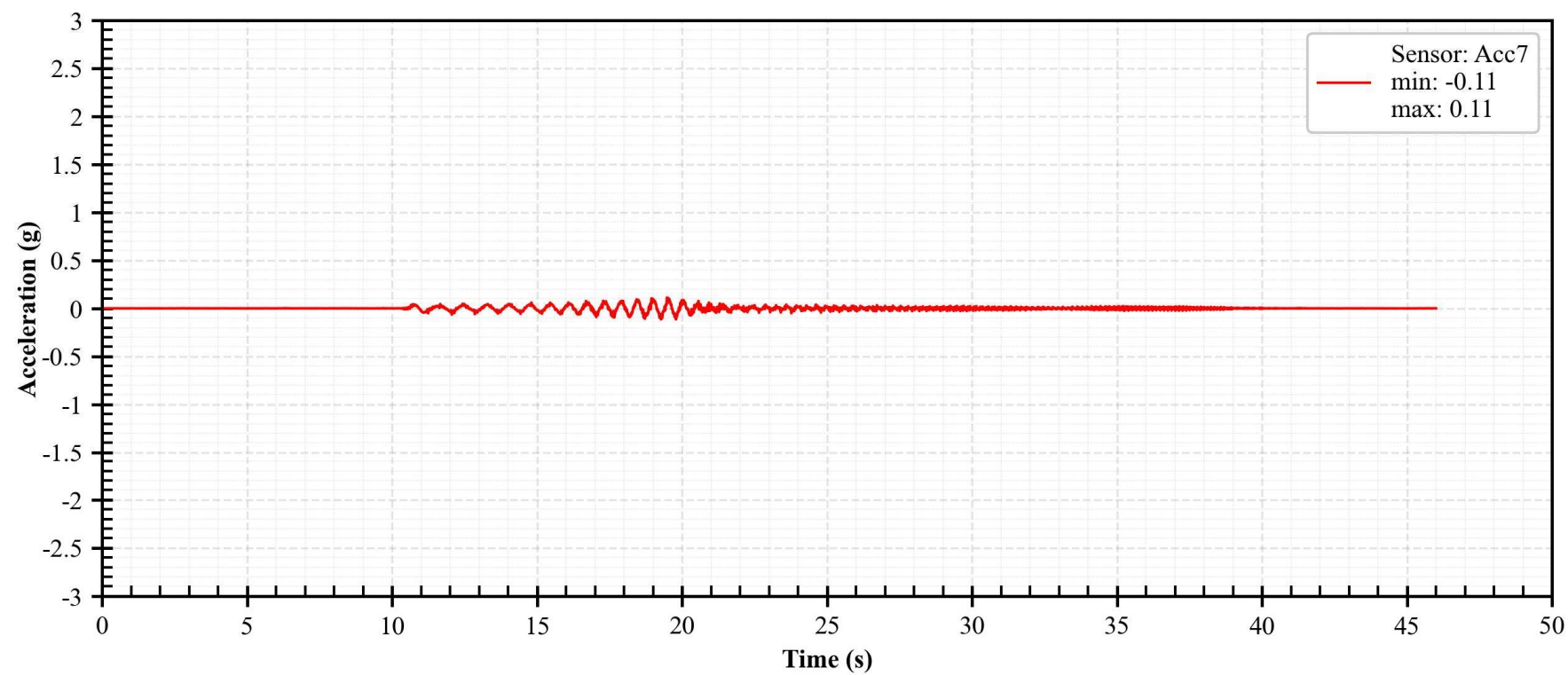


Figure 3.26.7 Characteristic results for phase B (white noise before 0,2g): Accelerometer 7

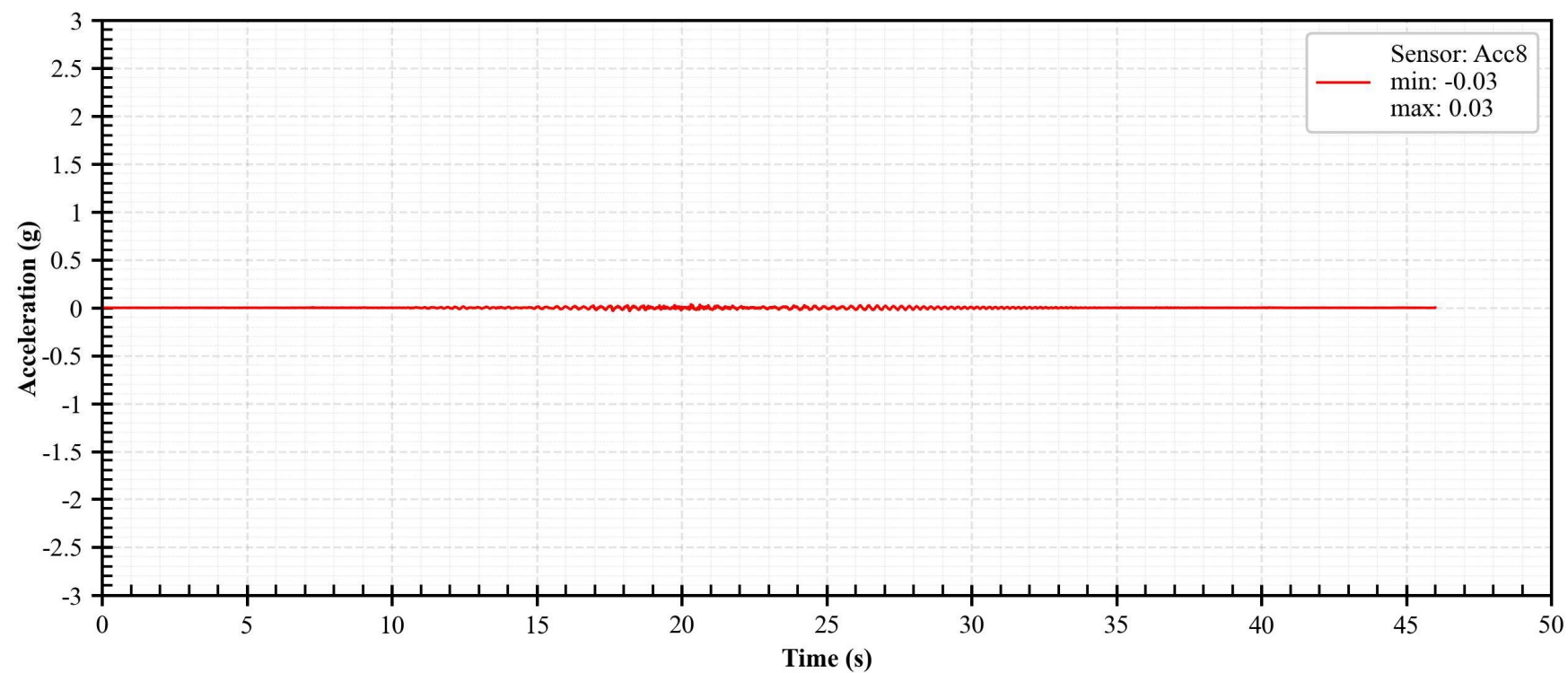


Figure 3.26.8 Characteristic results for phase B (white noise before 0,2g): Accelerometer 8

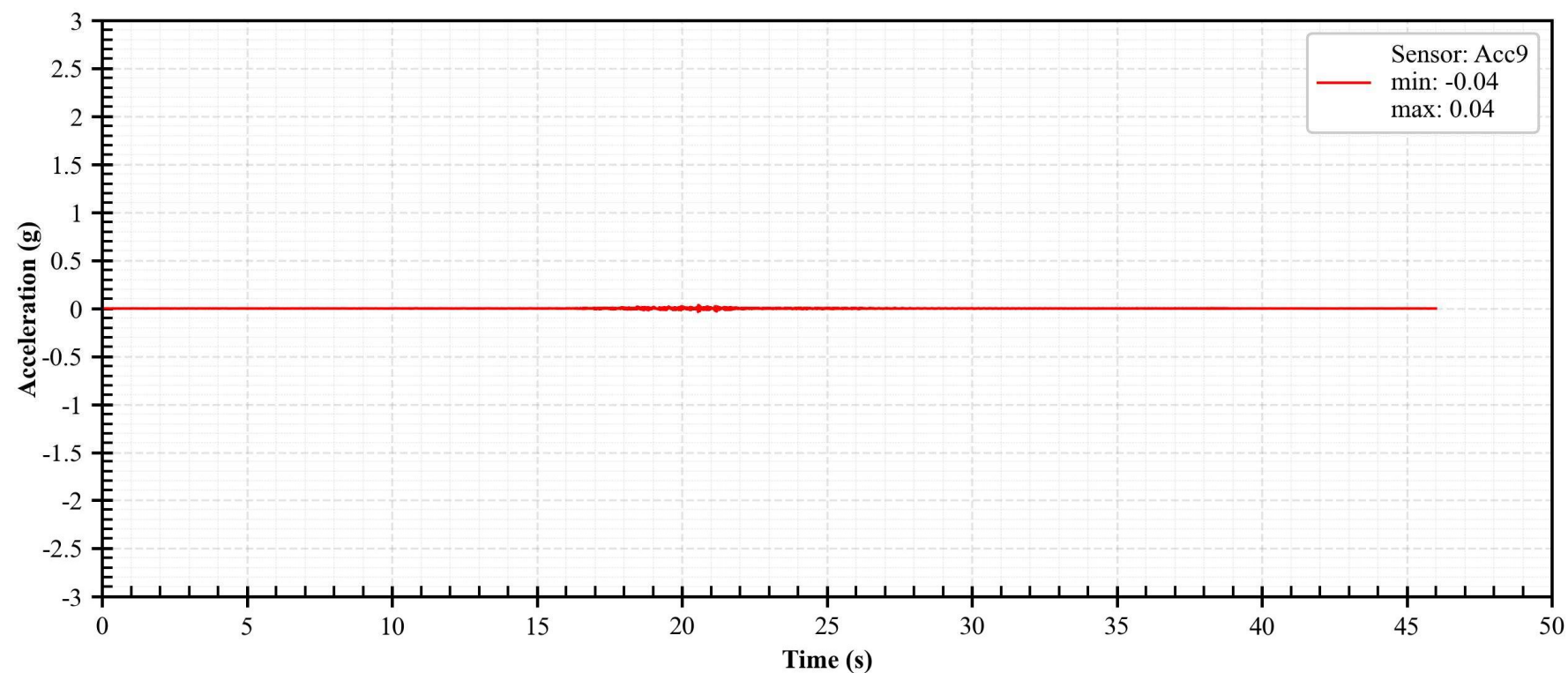


Figure 3.26.9 Characteristic results for phase B (white noise before 0,2g): Accelerometer 9

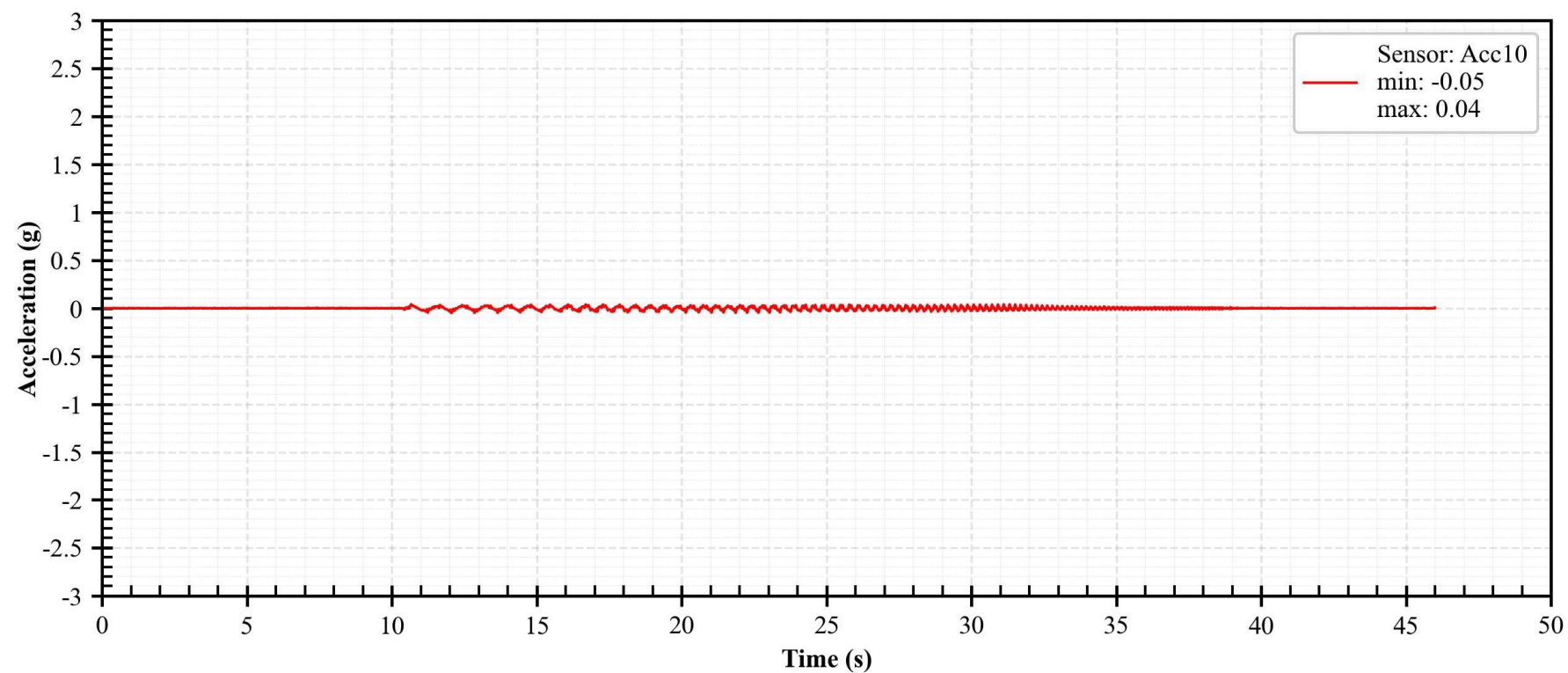


Figure 3.26.10 Characteristic results for phase B (white noise before 0,2g): Accelerometer 10

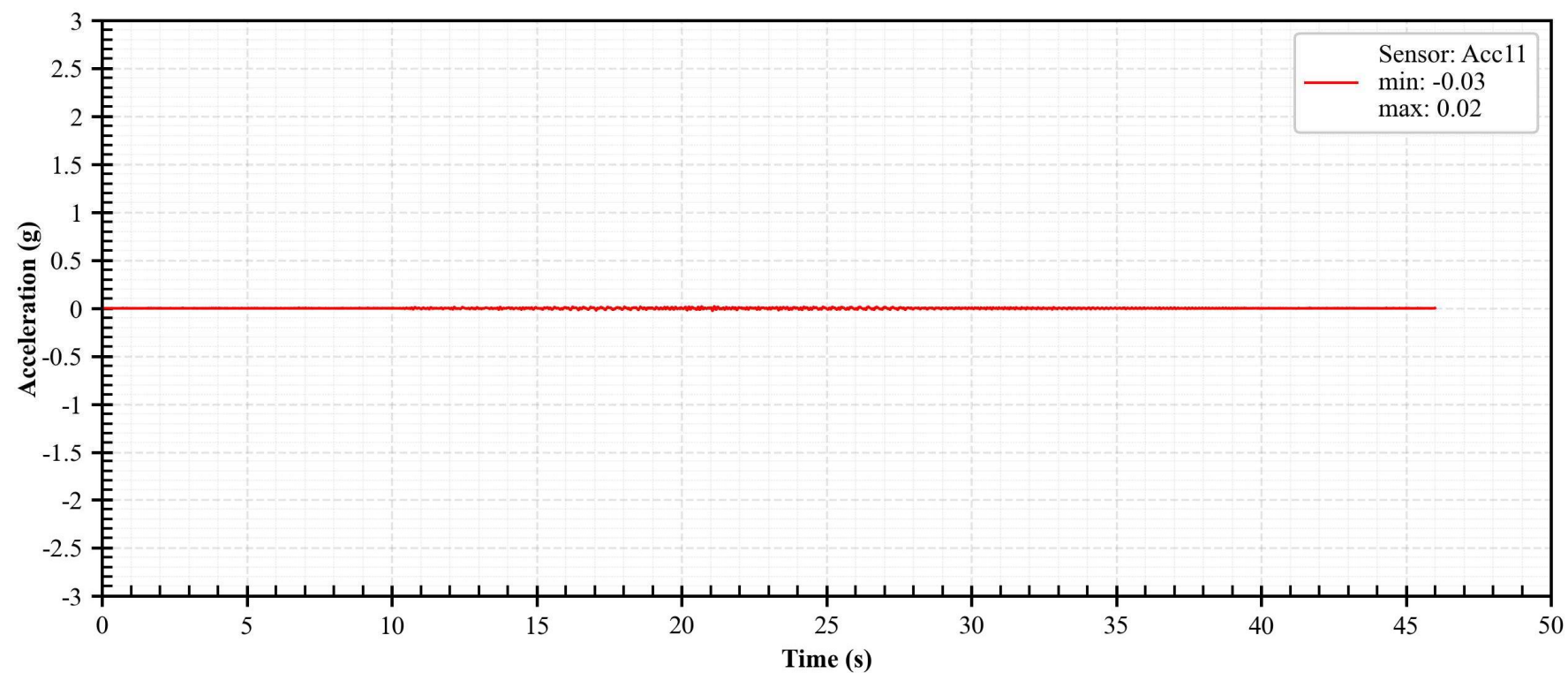


Figure 3.26.11 Characteristic results for phase B (white noise before 0,2g): Accelerometer 11

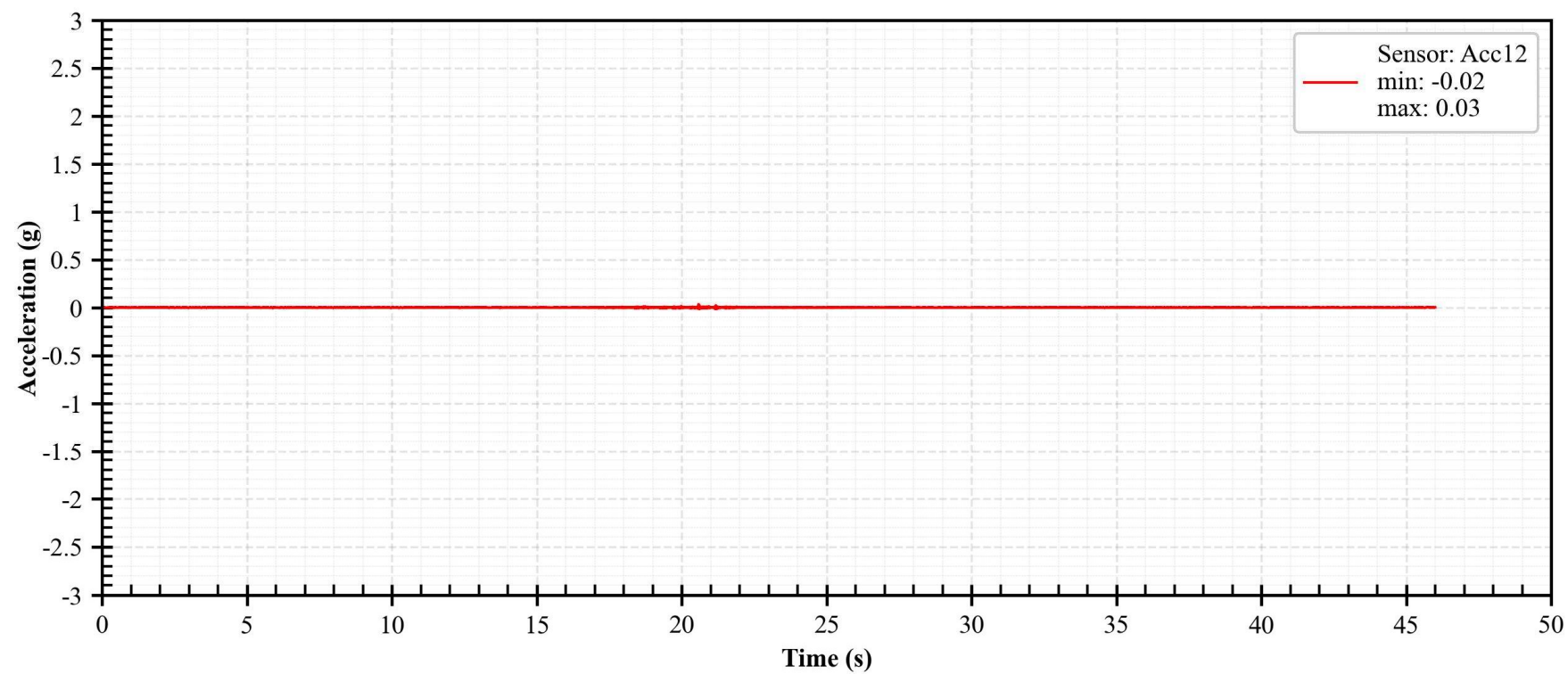


Figure 3.26.12 Characteristic results for phase B (white noise before 0,2g): Accelerometer 12

Draw wire sensors

Figures 3.26.13 – 3.26.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 23.43 mm while the minimum is -21.52 mm. The maximum movement detected by draw wire sensor W2 is 23.74 mm while the minimum is -21.20 mm. The maximum movement detected by draw wire sensor W3 is 21.07 mm while the minimum is -16.46 mm. The maximum movement detected by draw wire sensor W4 is 21.11 mm while the minimum is -16.43 mm. The maximum drift is $(9.52/1.225) = 7.77 \text{ ‰}$ and minimum drift is $(-8.25/1.225) = -6.74 \text{ ‰}$.

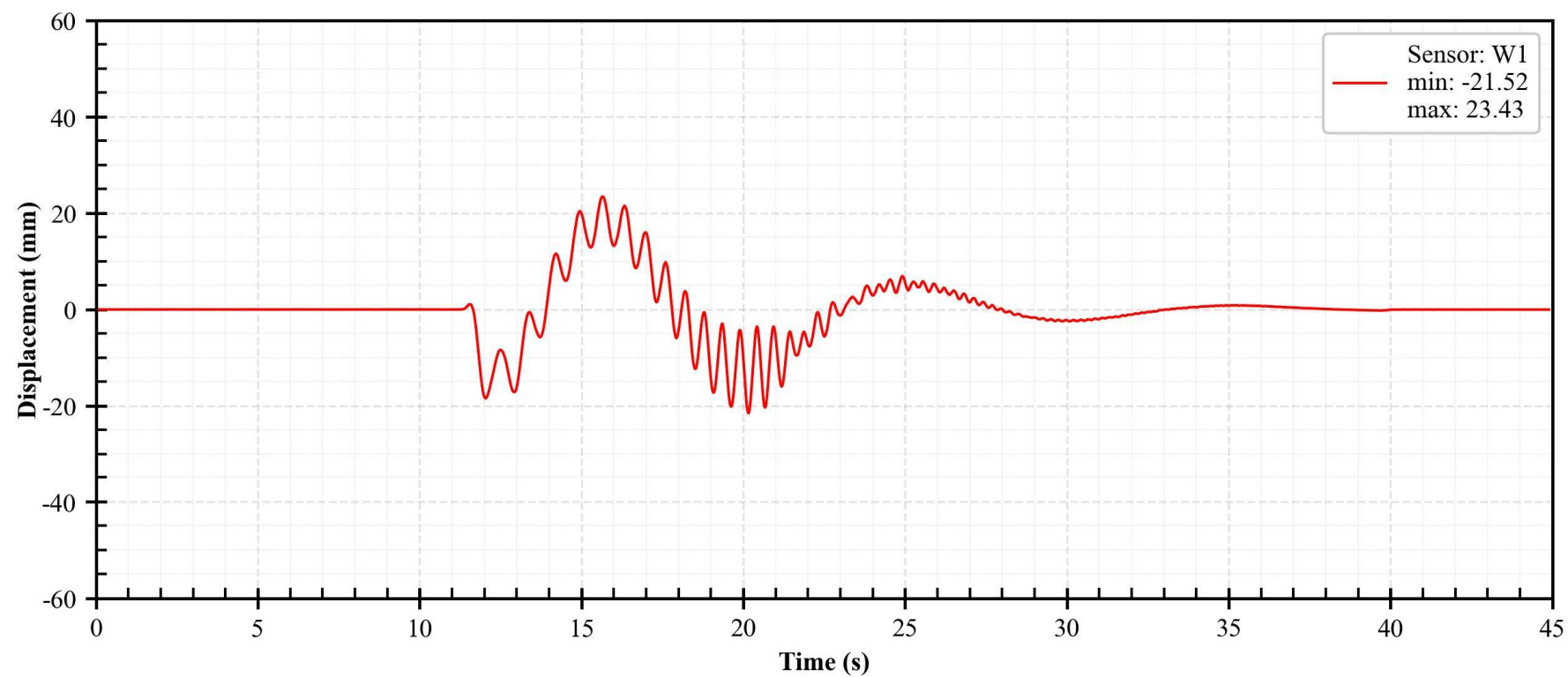


Figure 3.26.13 Characteristic results for phase B (white noise before 0,2g): Draw wire sensor 1

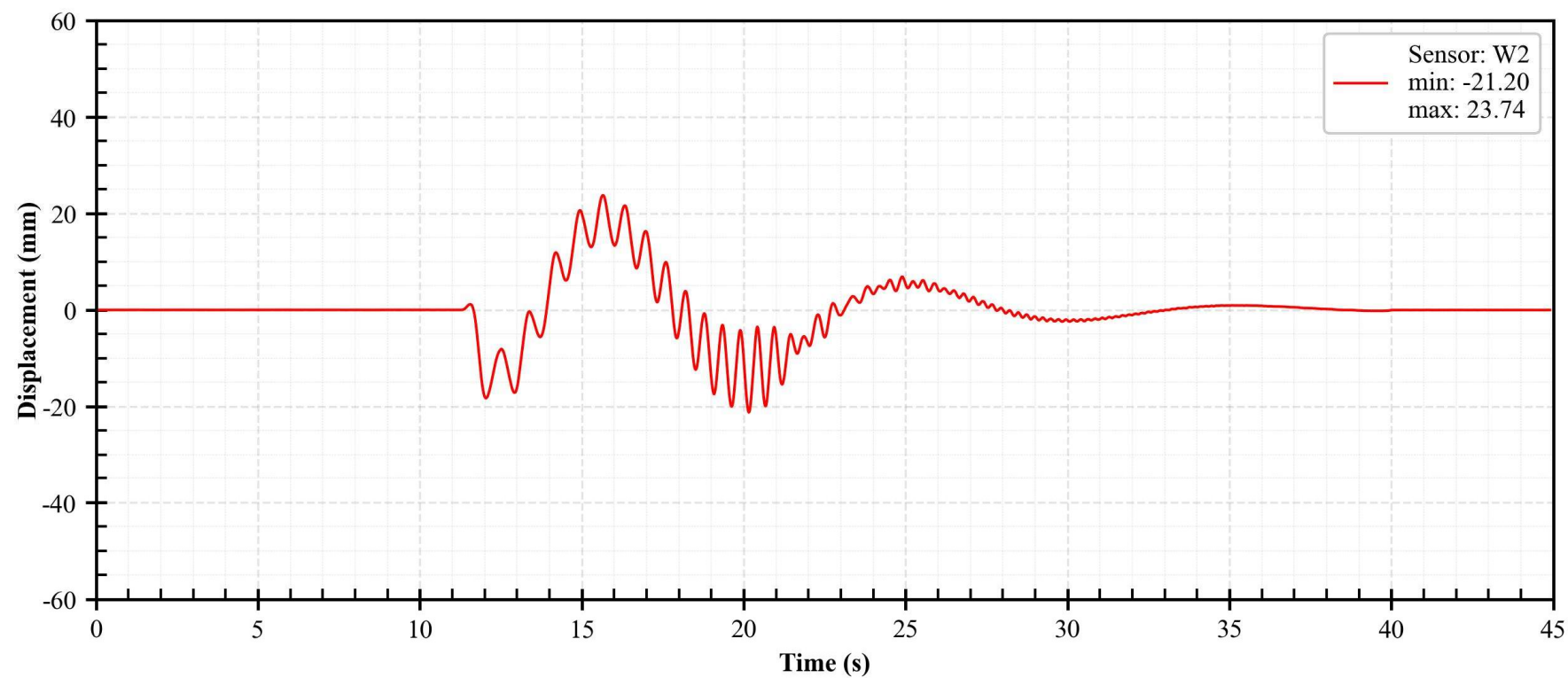


Figure 3.26.14 Characteristic results for phase B (white noise before 0,2g): Draw wire sensor 2

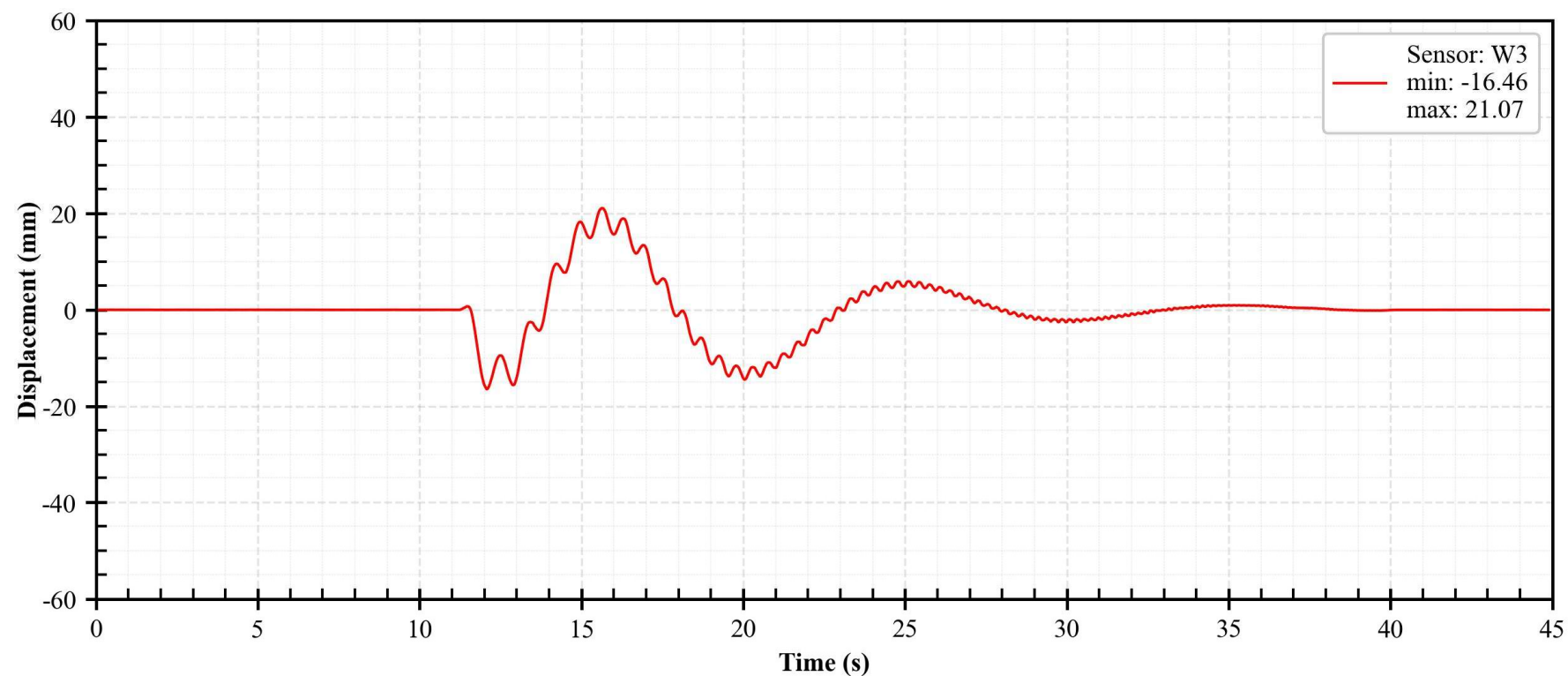


Figure 3.26.15 Characteristic results for phase B (white noise before 0,2g): Draw wire sensor 3

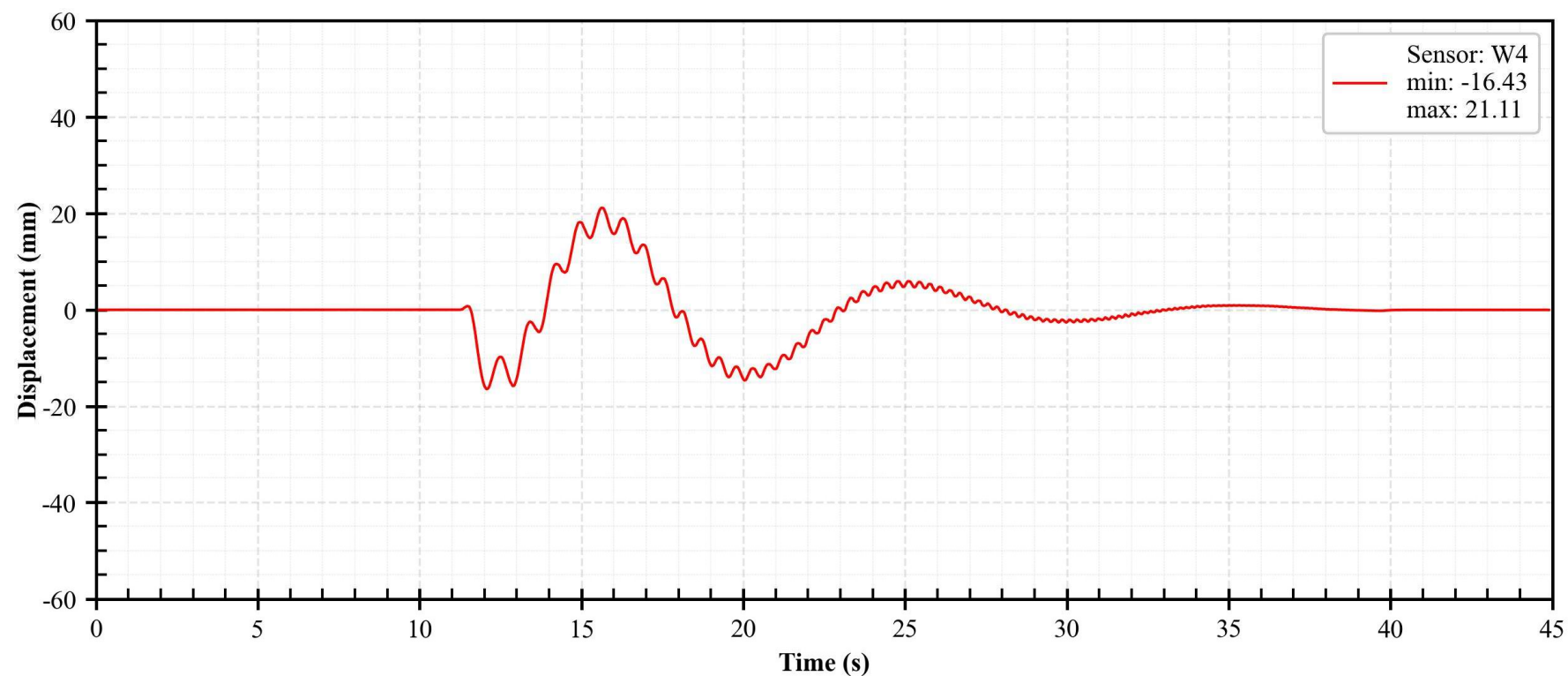


Figure 3.26.16 Characteristic results for phase B (white noise before 0,2g): Draw wire sensor 4

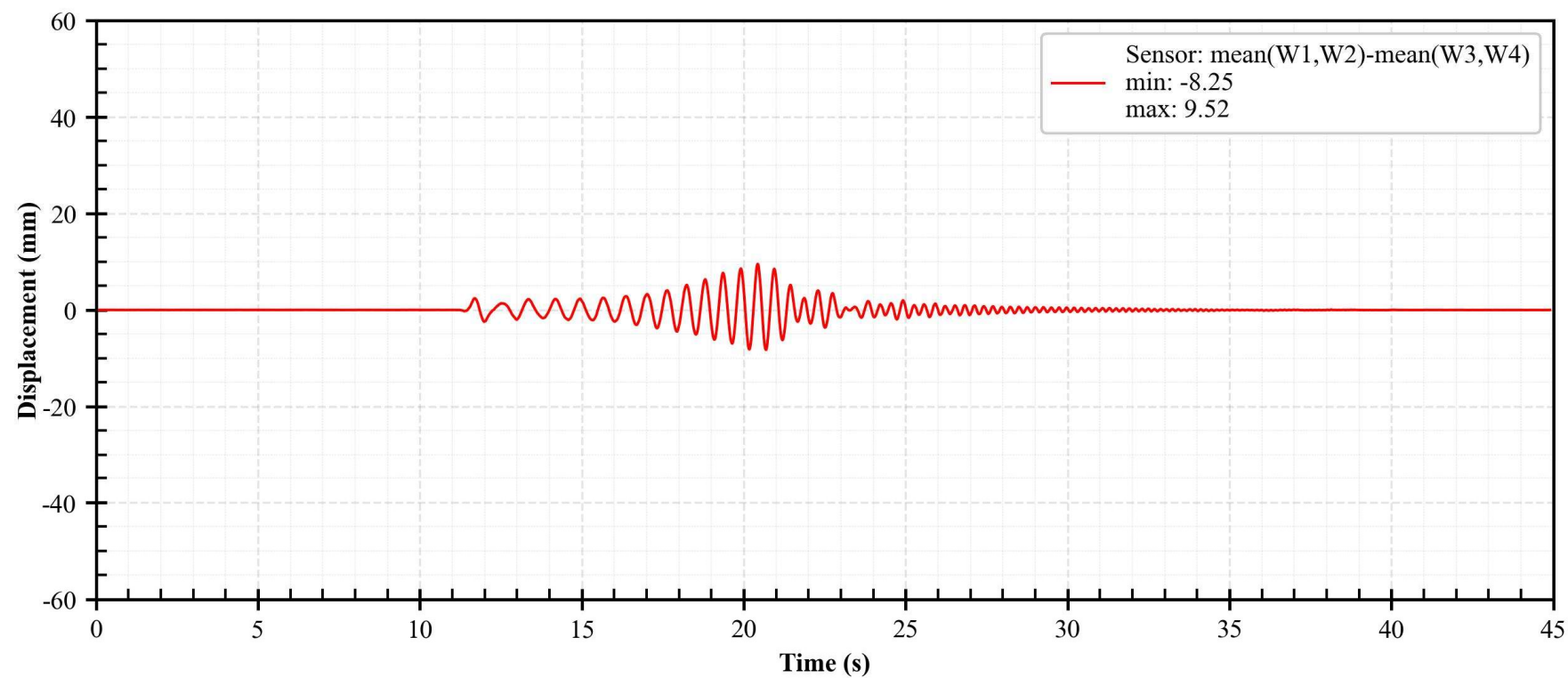


Figure 3.26.17 Characteristic results for phase B (white noise before 0,2g): $\text{mean}(W1,W2) - \text{mean}(W3,W4)$

Strain gauges

No notable changes are detected in the values of strain gauges.

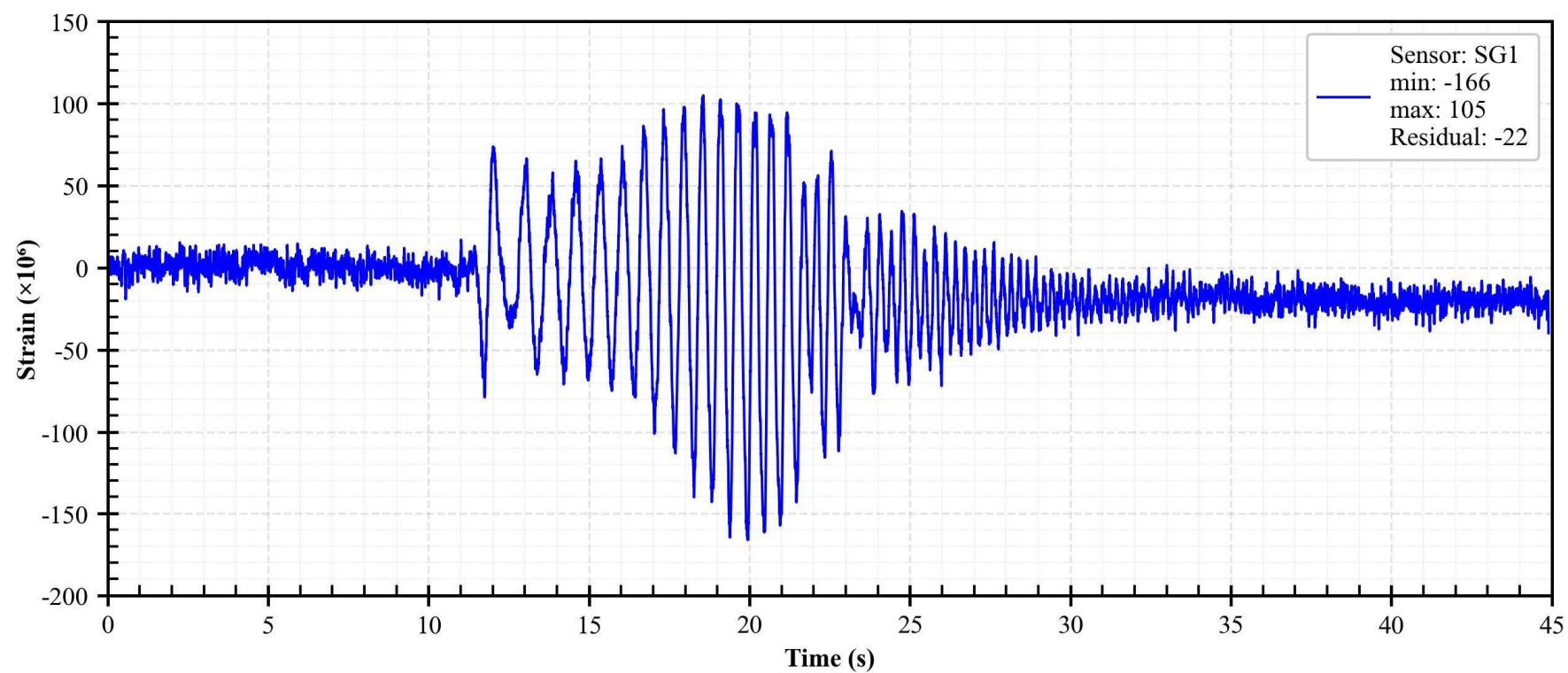


Figure 3.26.18 Characteristic results for phase B (white noise before 0,2g): strain gauge 1

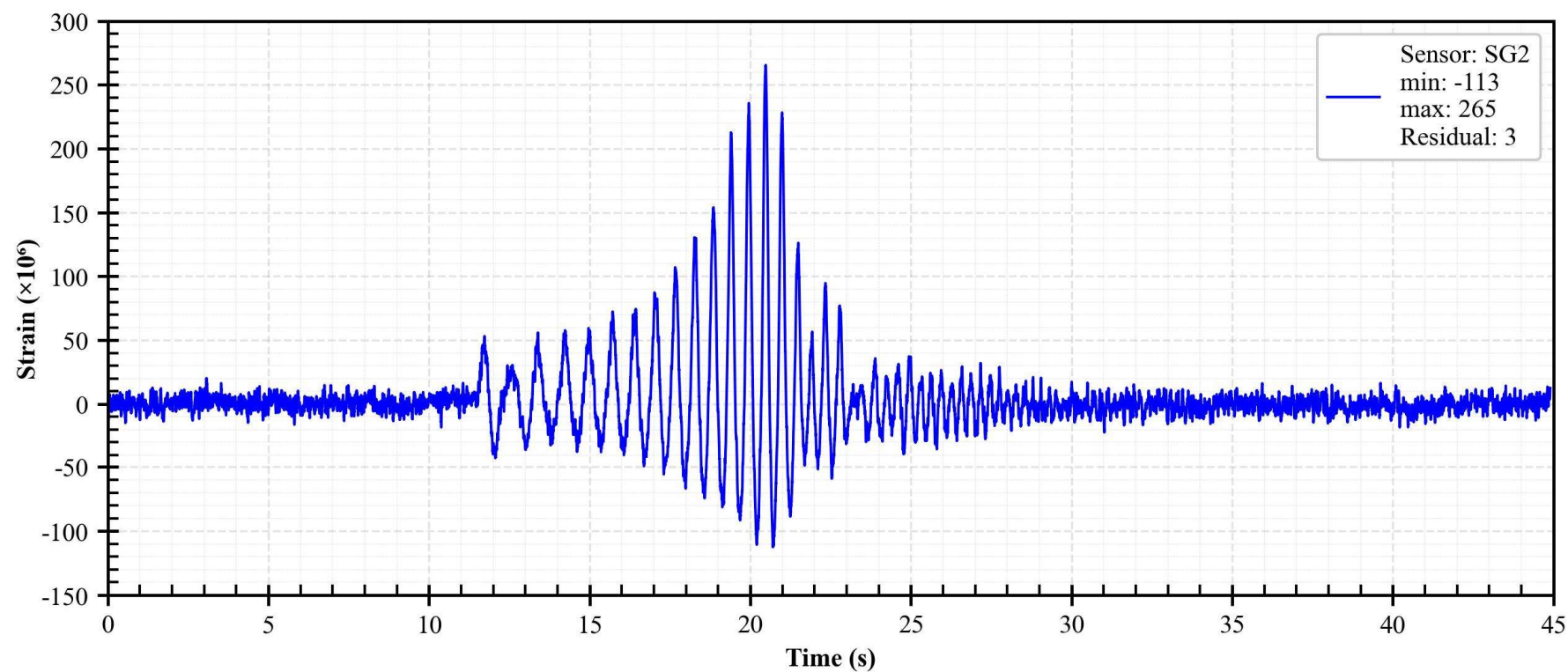


Figure 3.26.19 Characteristic results for phase B (white noise before 0,2g): strain gauge 2

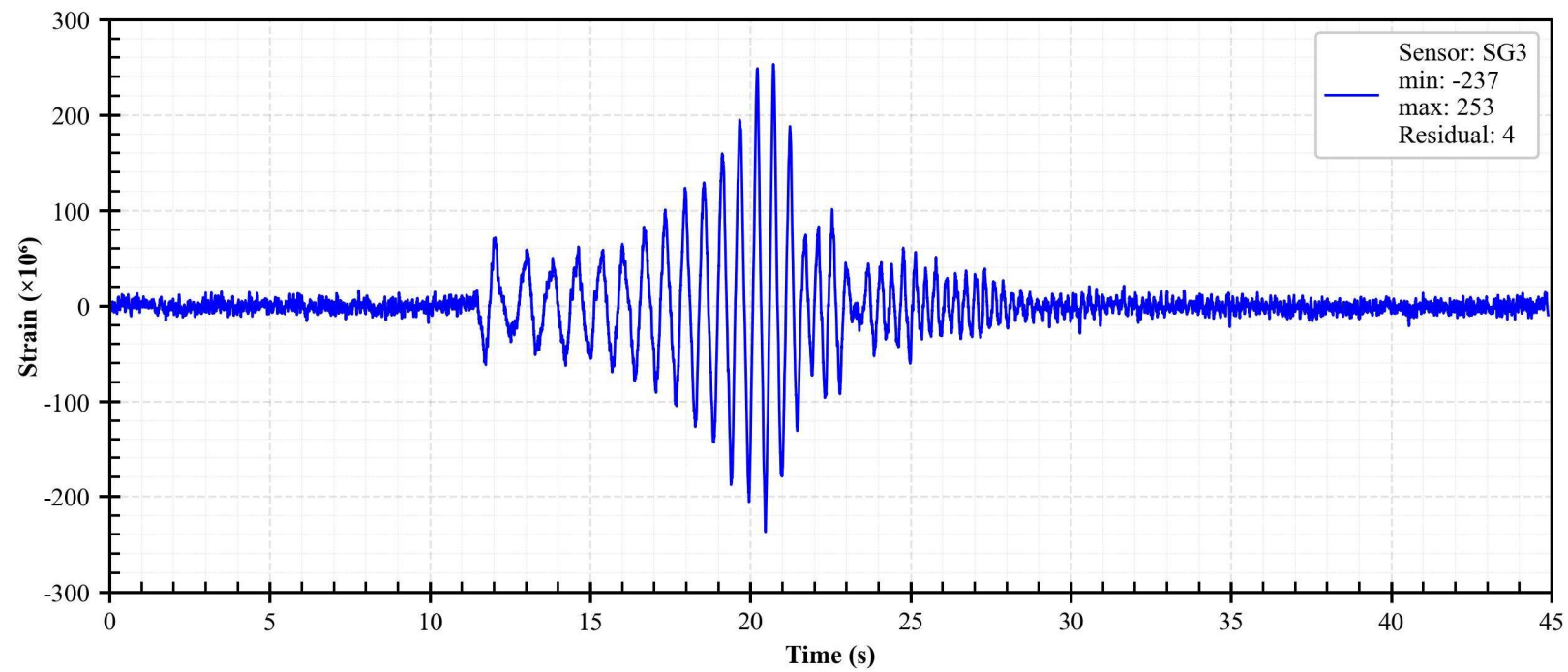


Figure 3.26.20 Characteristic results for phase B (white noise before 0,2g): strain gauge 3

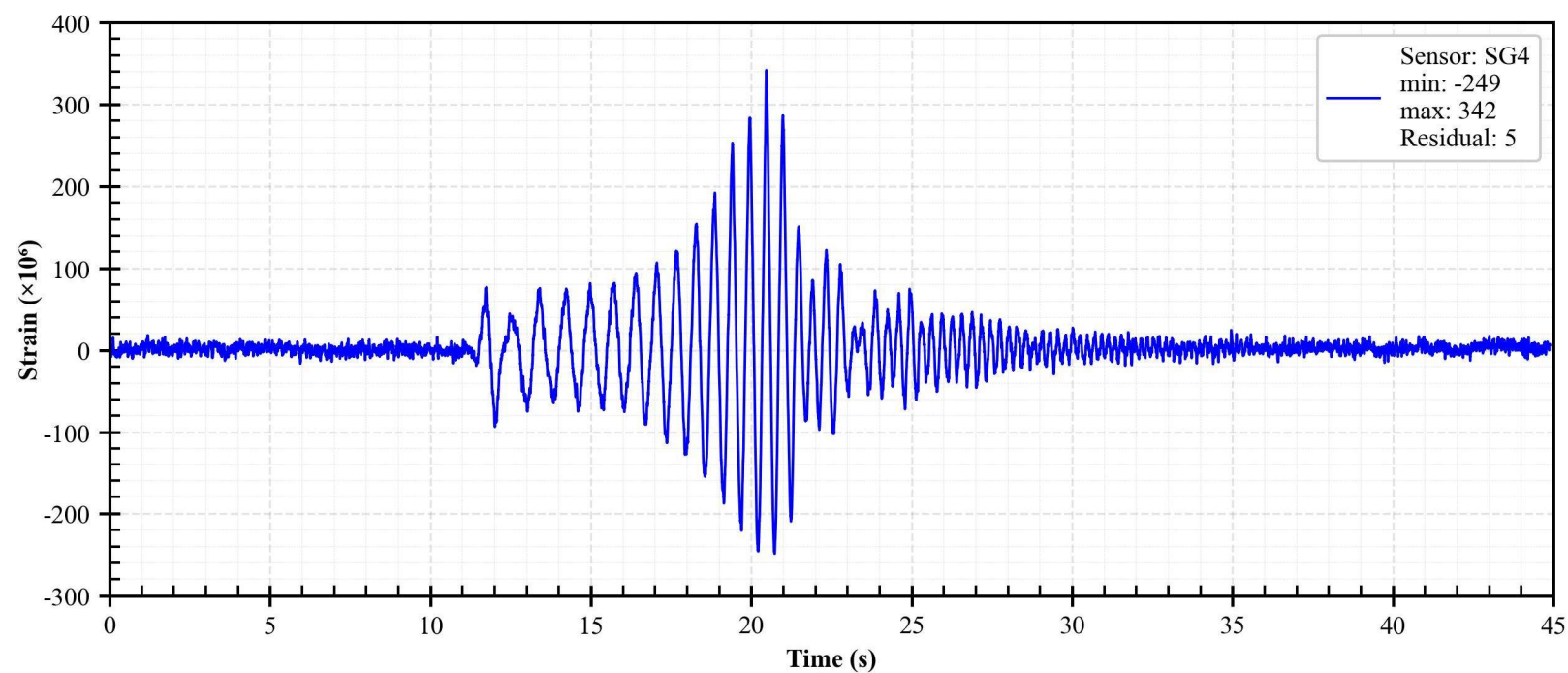


Figure 3.26.21 Characteristic results for phase B (white noise before 0,2g): strain gauge 4

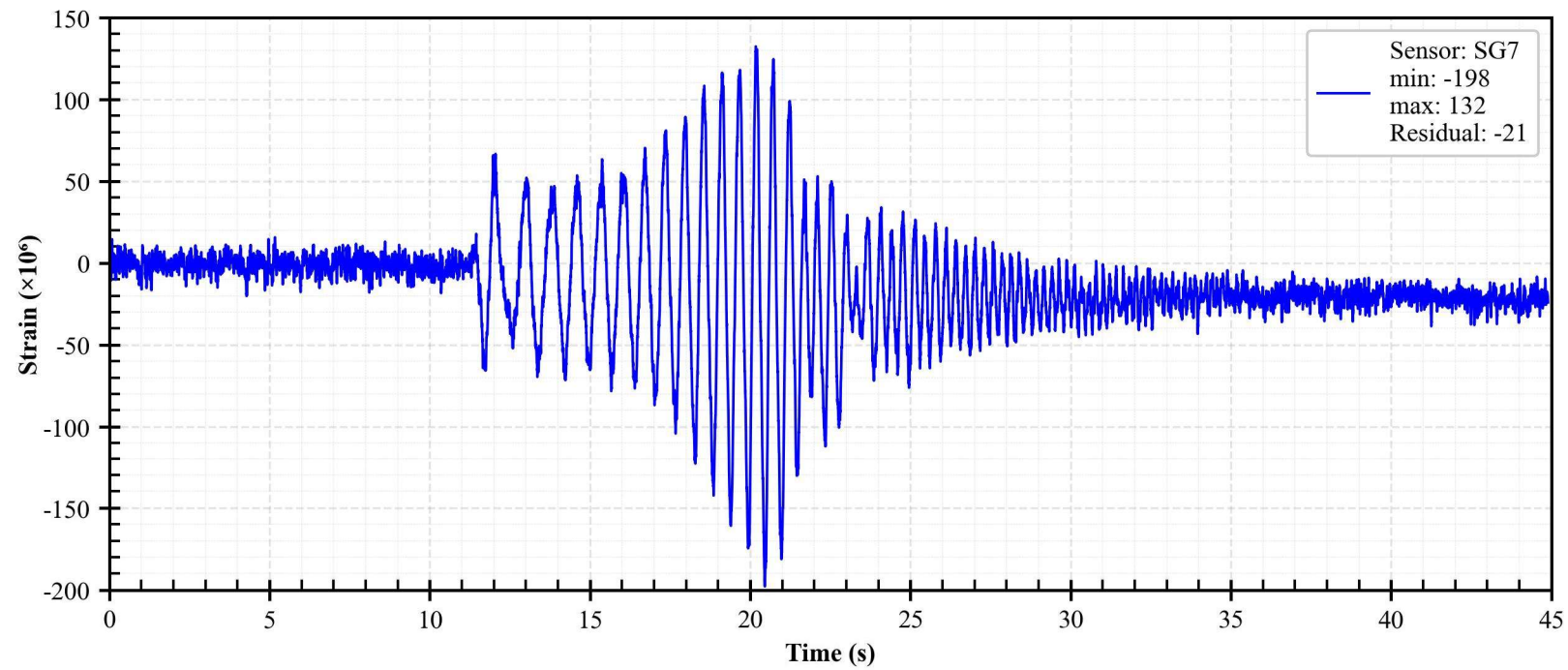


Figure 3.26.22 Characteristic results for phase B (white noise before 0,2g): strain gauge 7

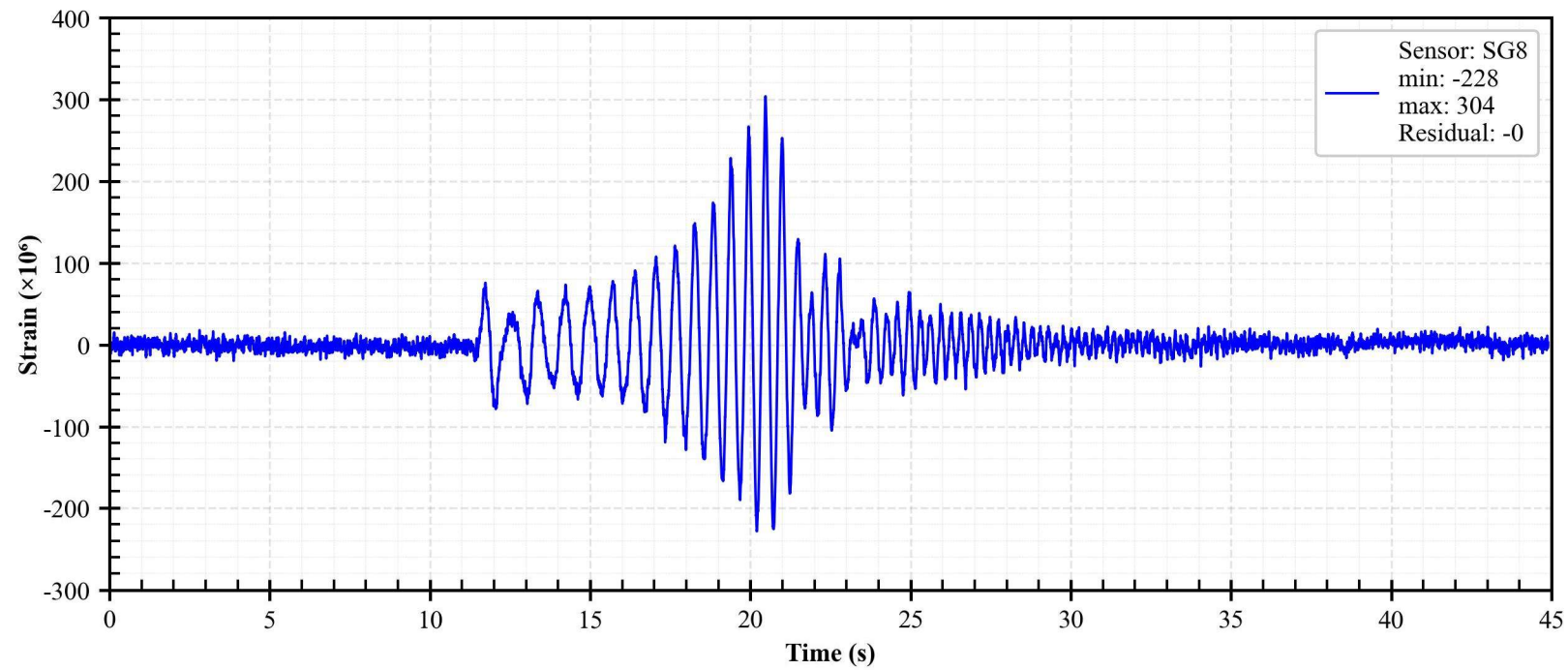


Figure 3.26.23 Characteristic results for phase B (white noise before 0,2g): strain gauge 8

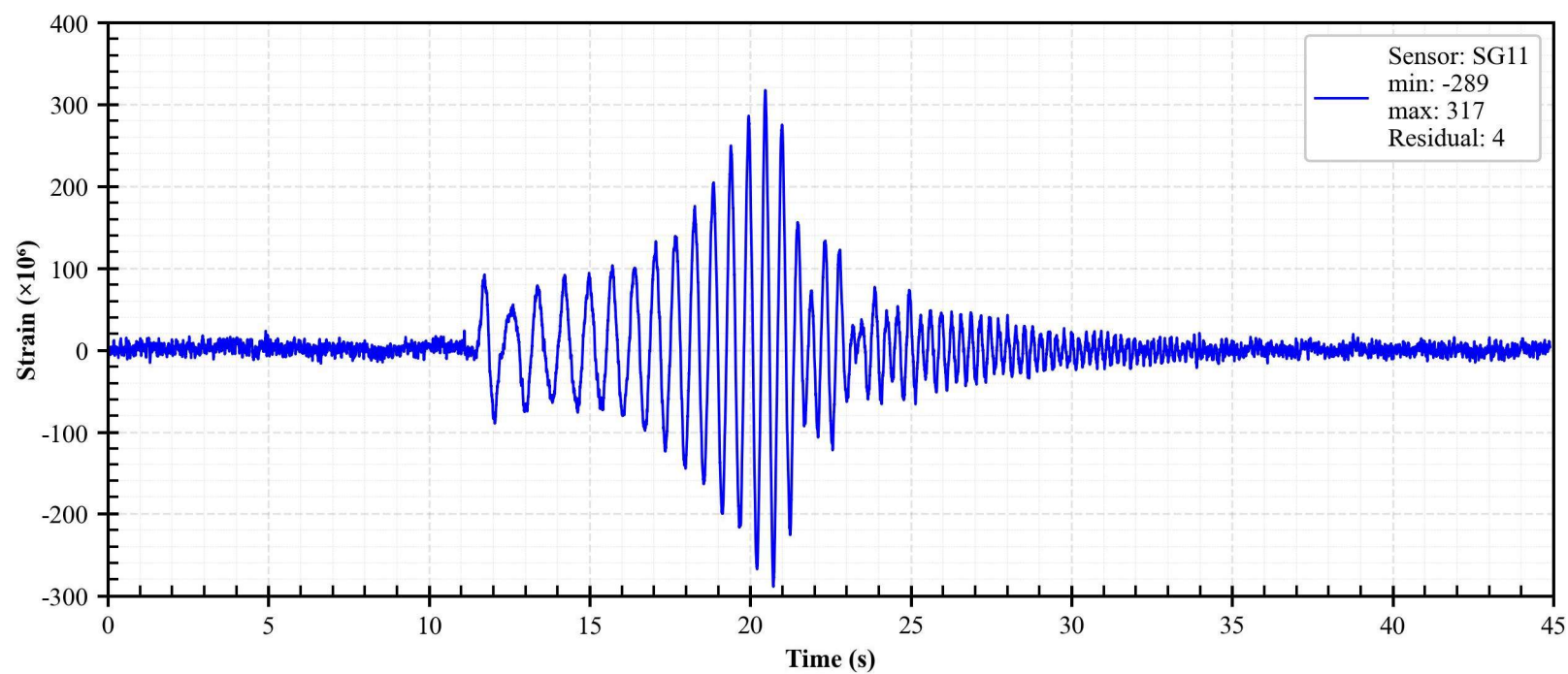


Figure 3.26.24 Characteristic results for phase B (white noise before 0,2g): strain gauge 11

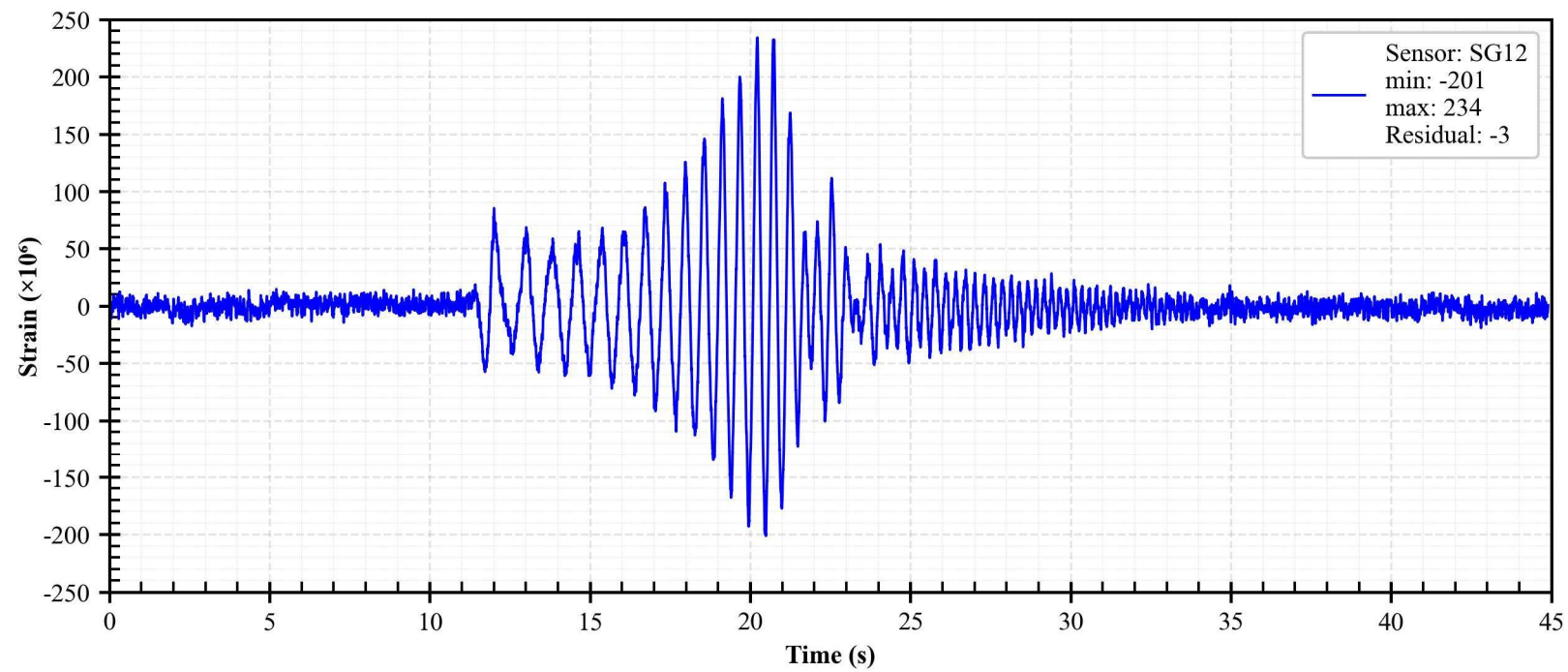


Figure 3.26.25 Characteristic results for phase B (white noise before 0,2g): strain gauge 12

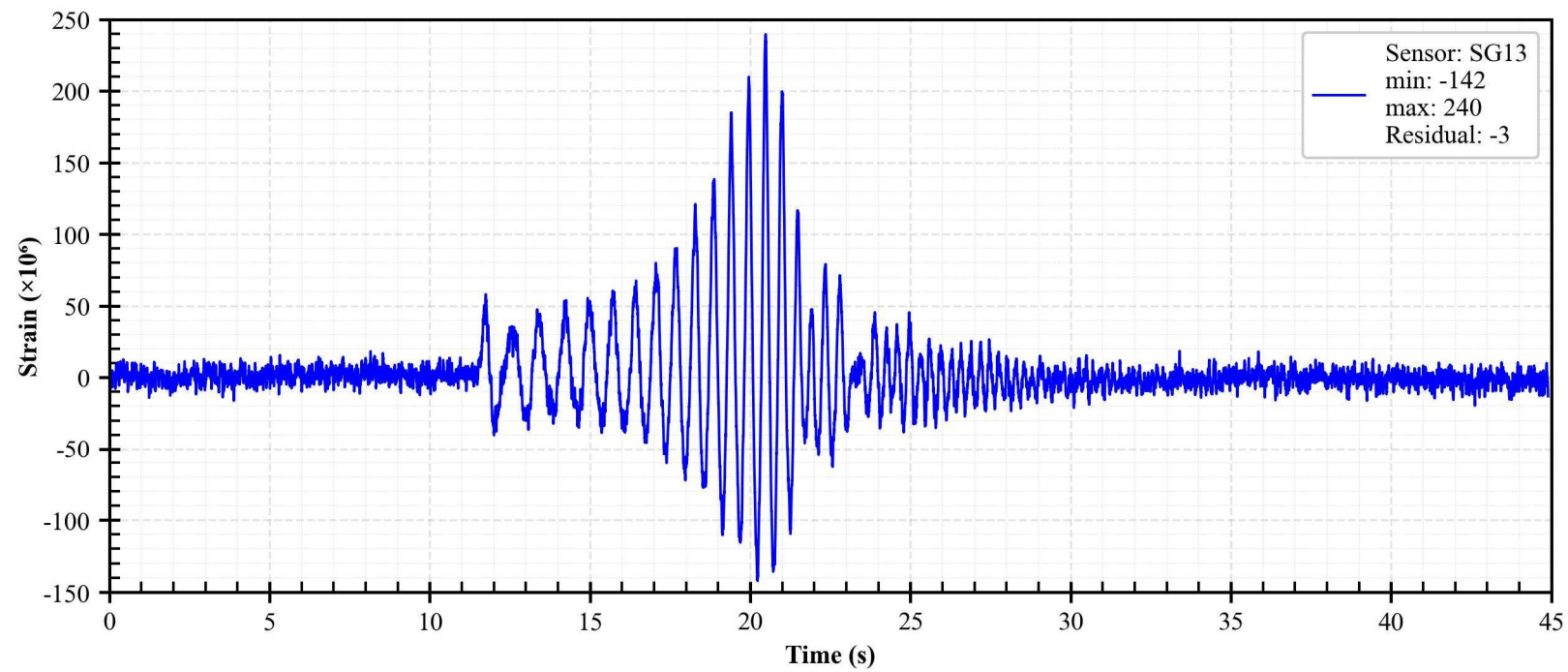


Figure 3.26.26 Characteristic results for phase B (white noise before 0,2g): strain gauge 13

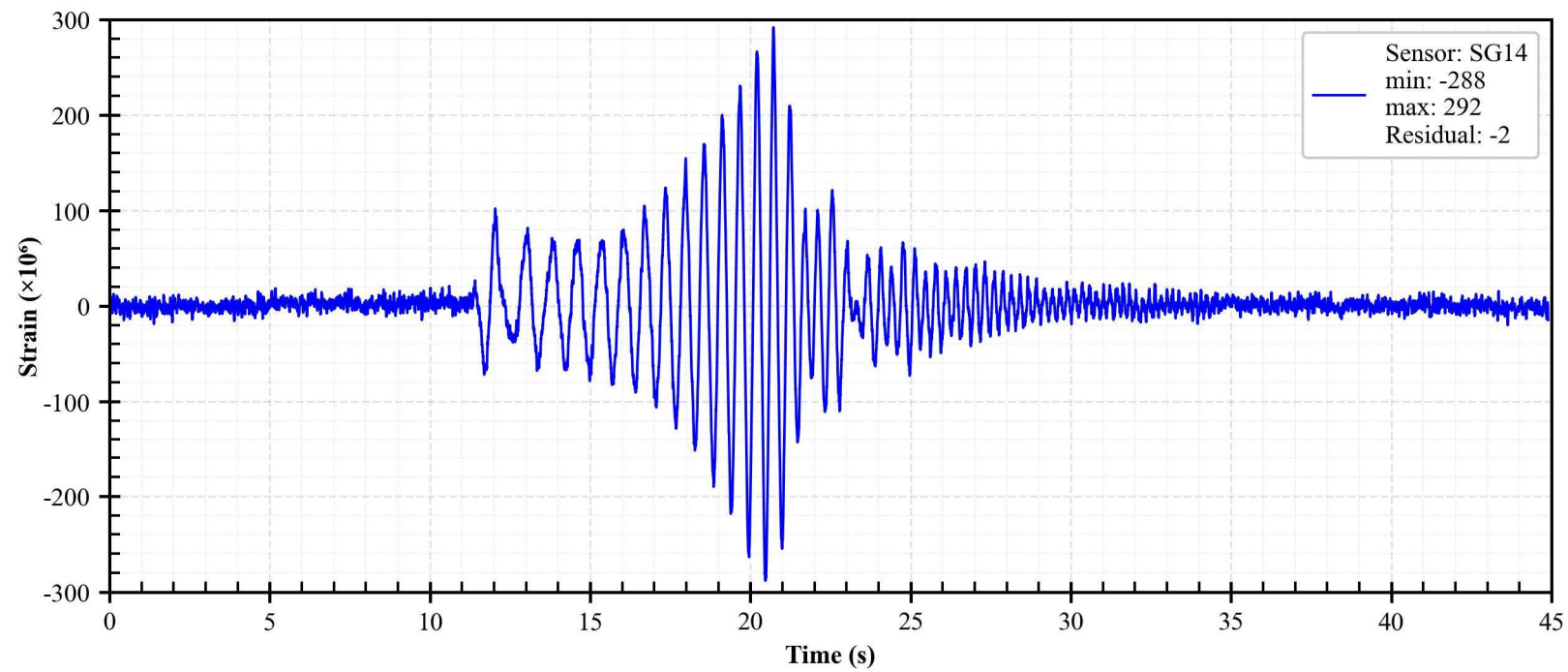


Figure 3.26.27 Characteristic results for phase B (white noise before 0,2g): strain gauge 14

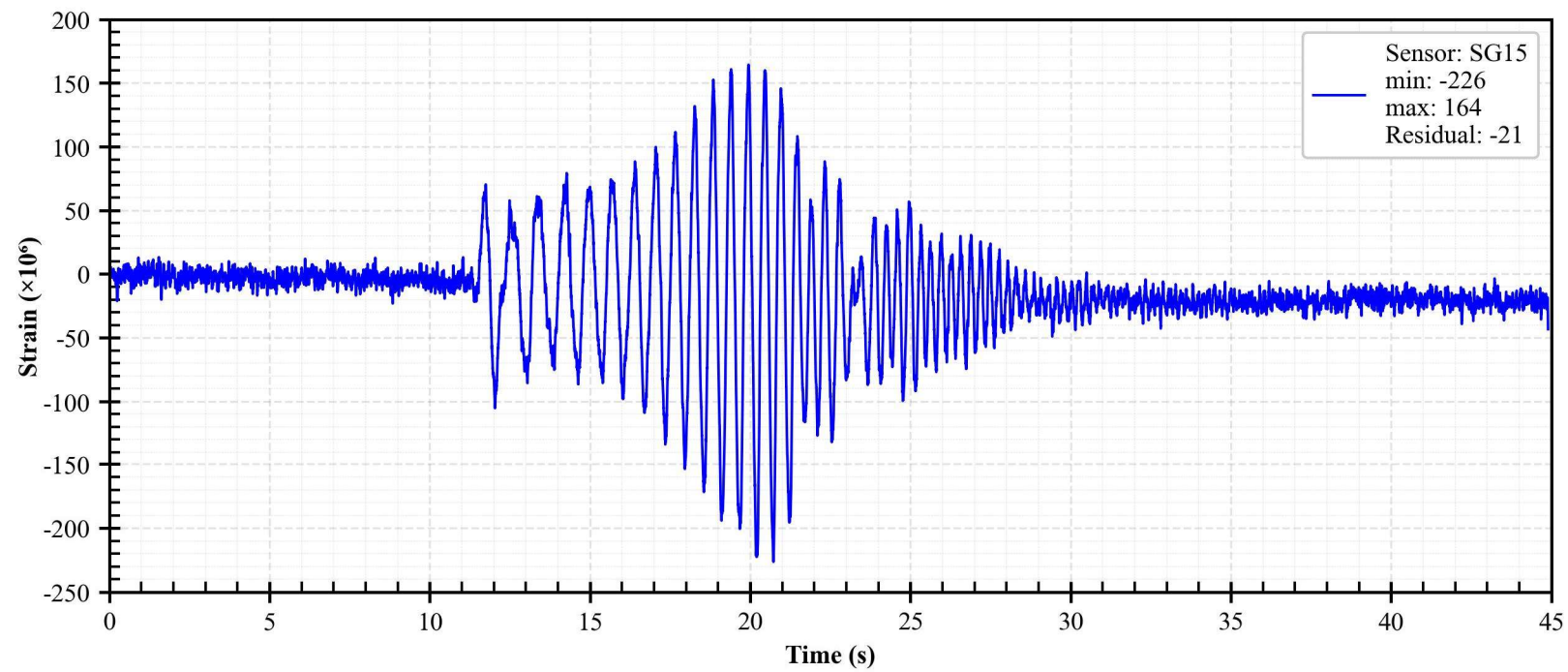


Figure 3.26.28 Characteristic results for phase B (white noise before 0,2g): strain gauge 15

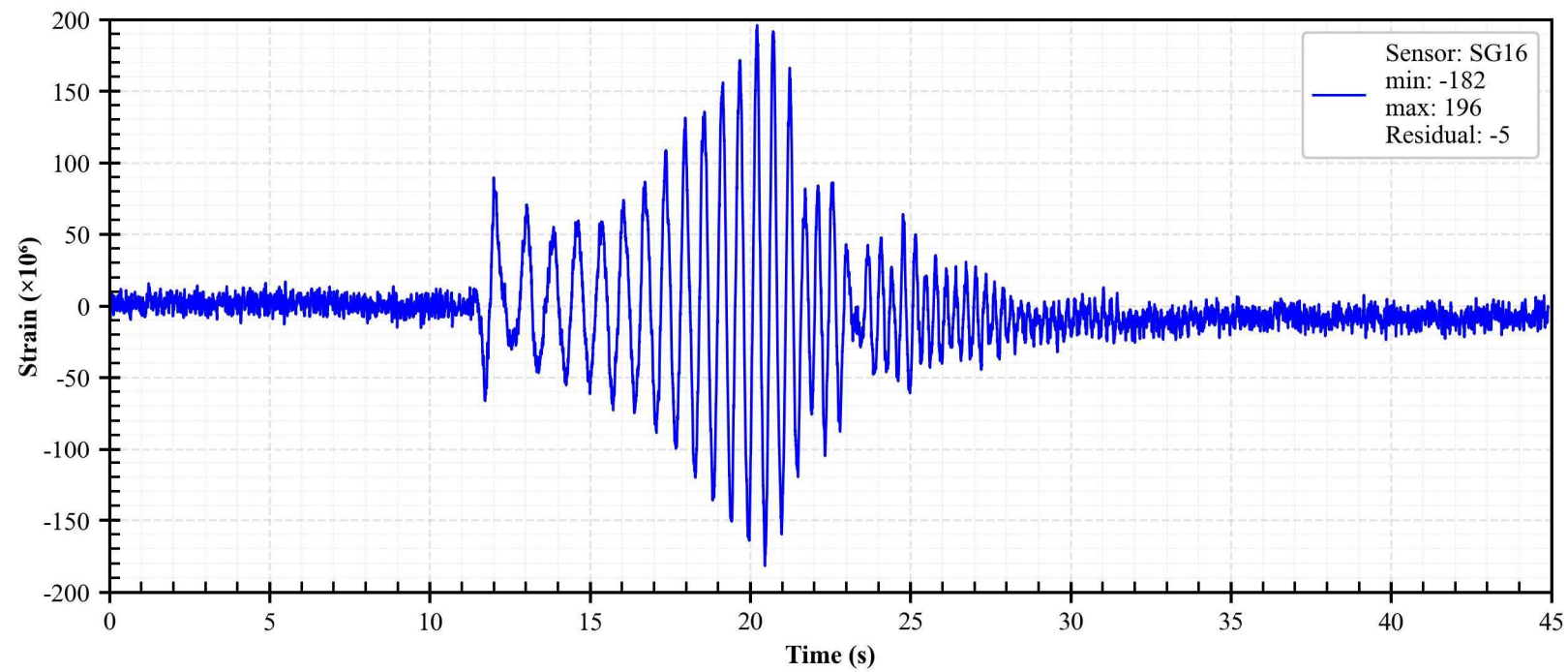


Figure 3.26.29 Characteristic results for phase B (white noise before 0,2g): strain gauge 16

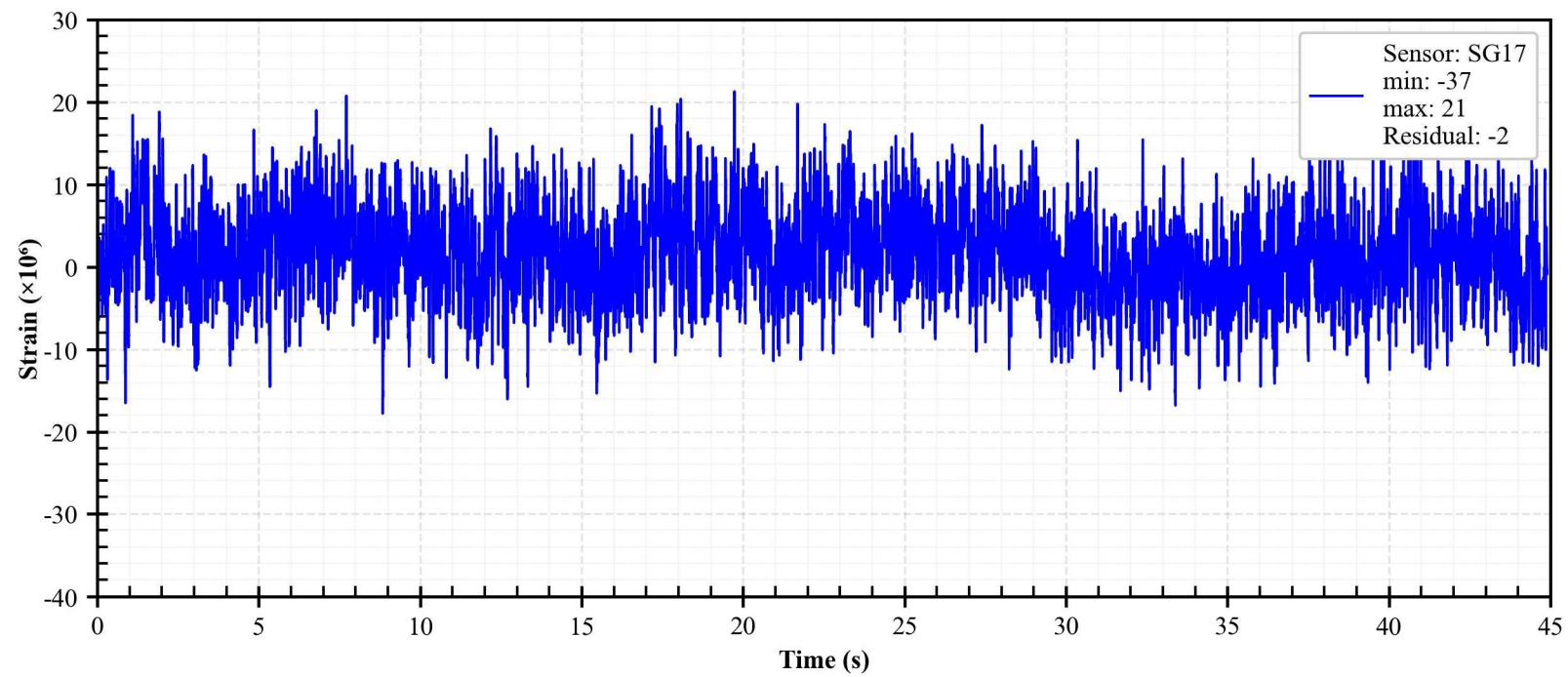


Figure 3.26.30 Characteristic results for phase B (white noise before 0,2g): strain gauge 17

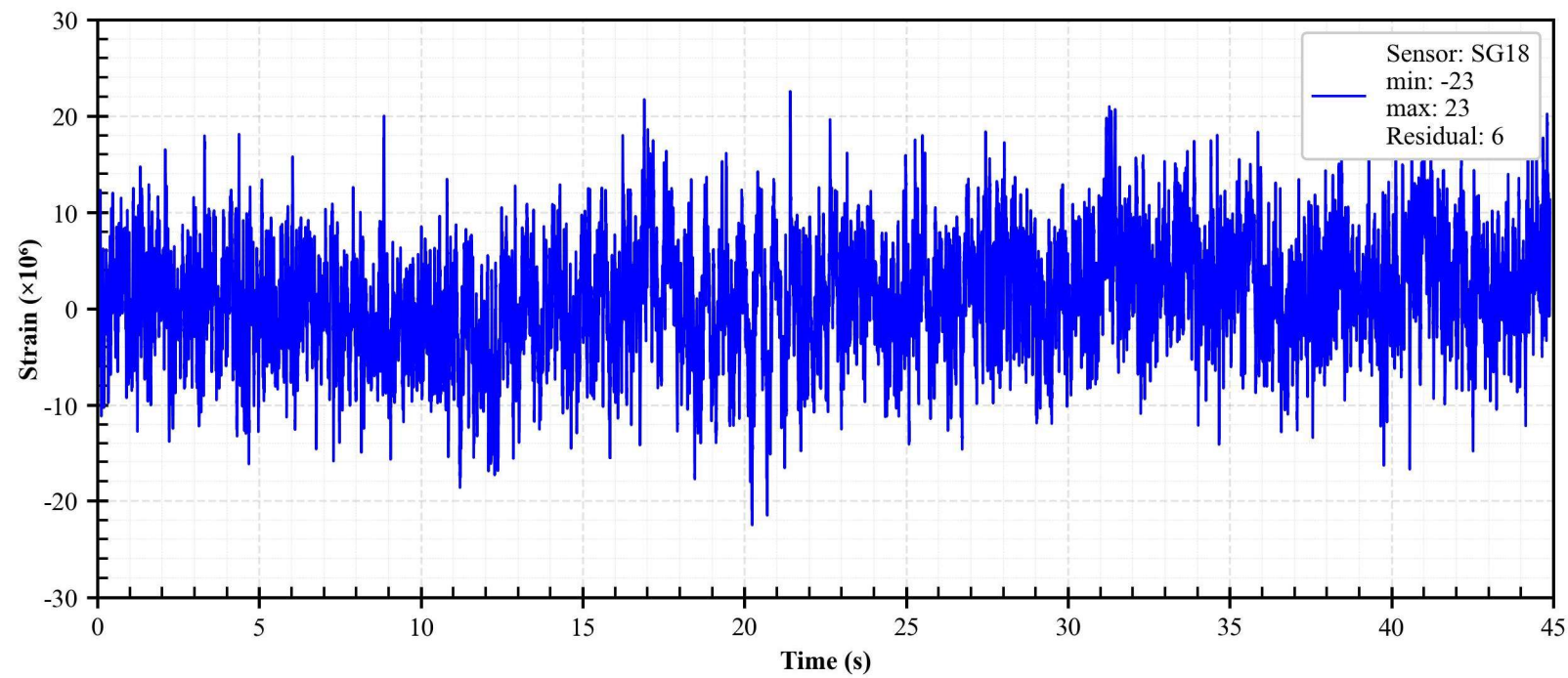


Figure 3.26.31 Characteristic results for phase B (white noise before 0,2g): strain gauge 18

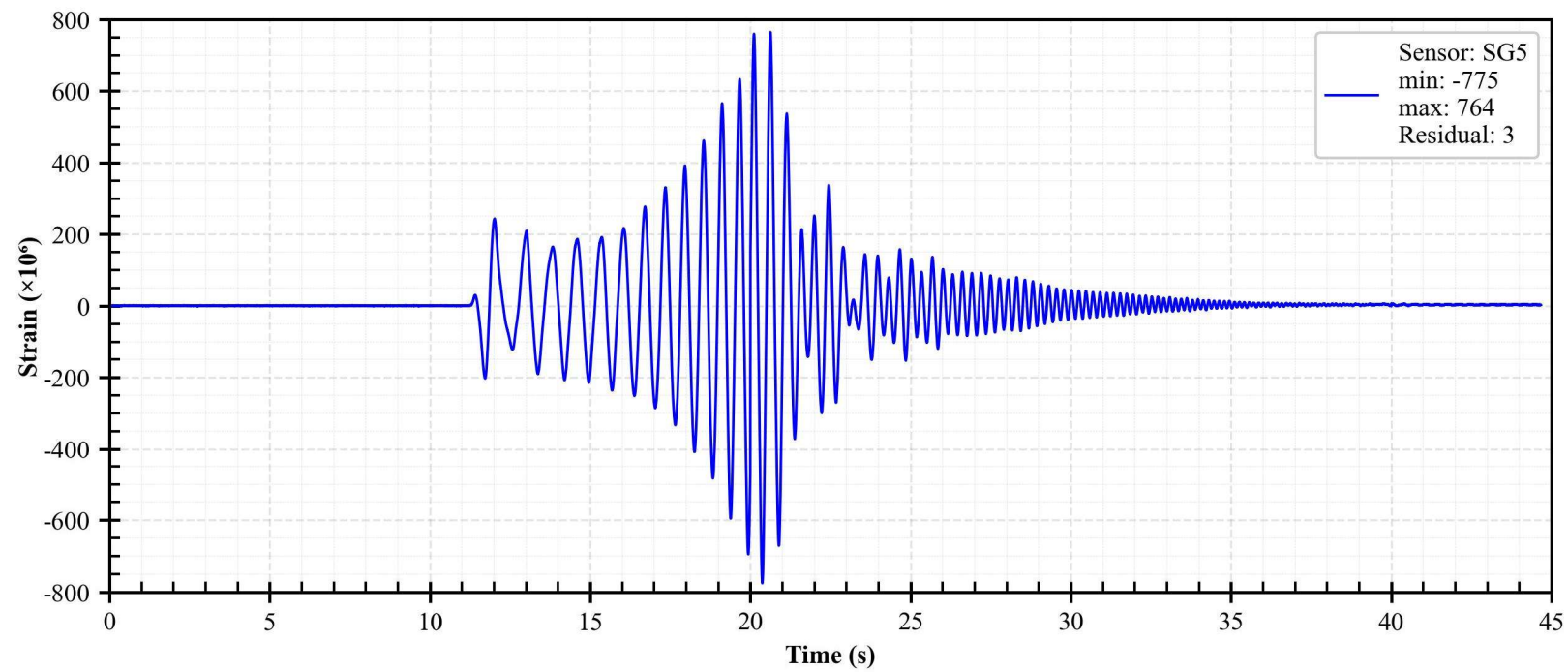


Figure 3.26.32 Characteristic results for phase B (white noise before 0,2g): strain gauge 5

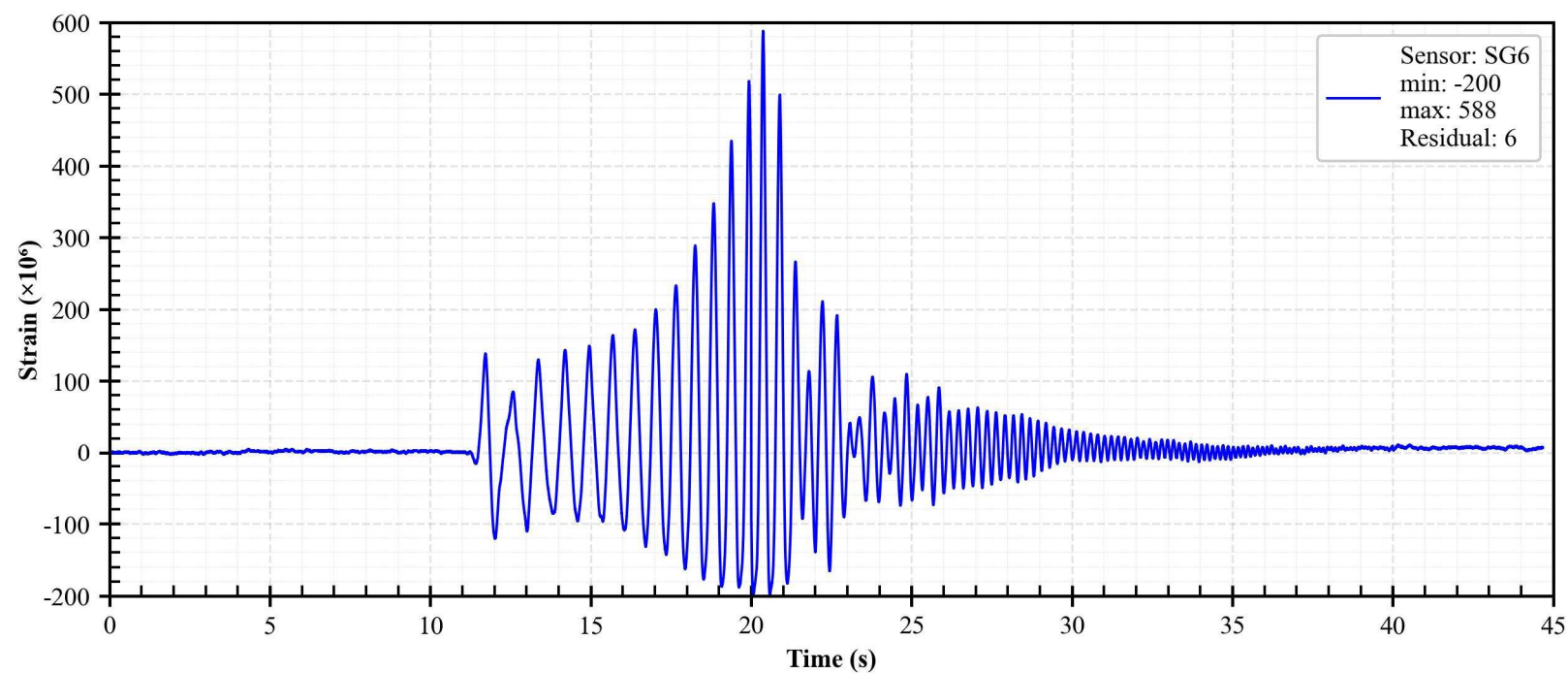


Figure 3.26.33 Characteristic results for phase B (white noise before 0,2g): strain gauge 6

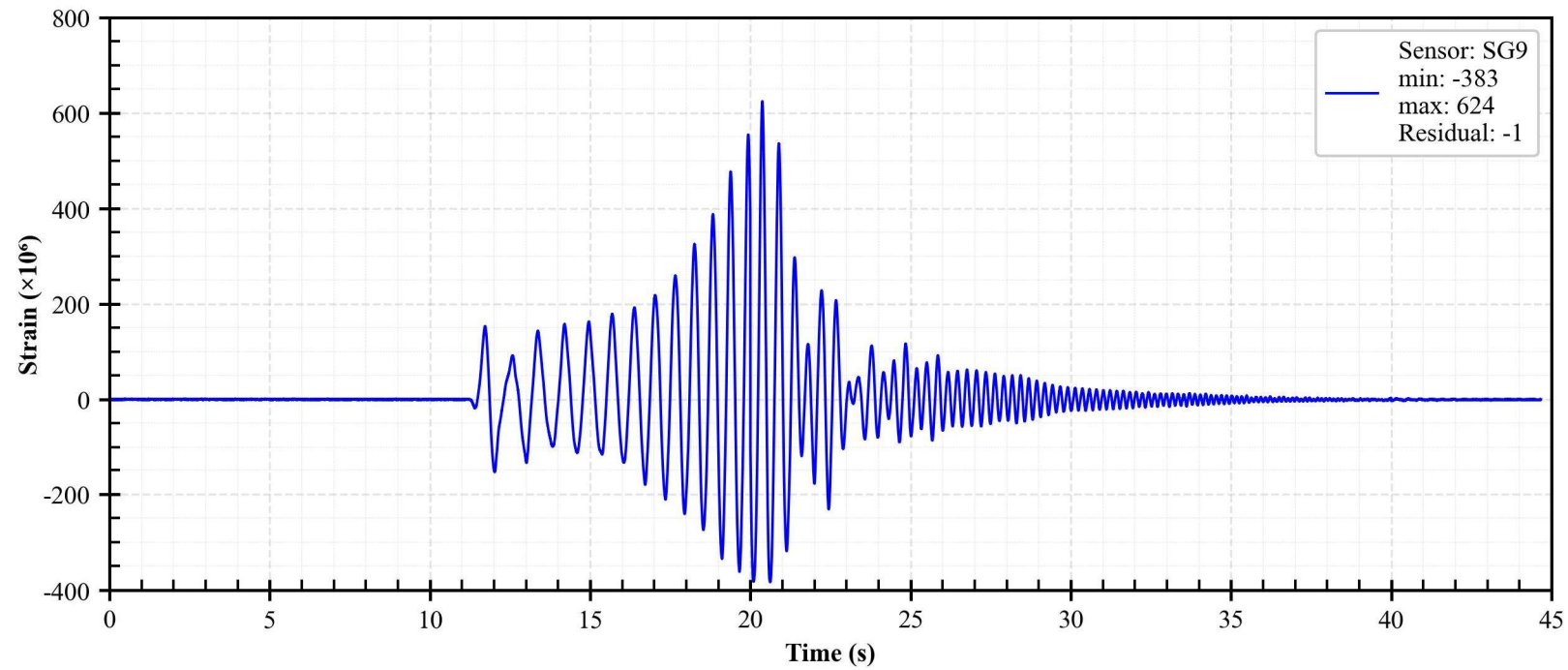


Figure 3.26.34 Characteristic results for phase B (white noise before 0,2g): strain gauge 9

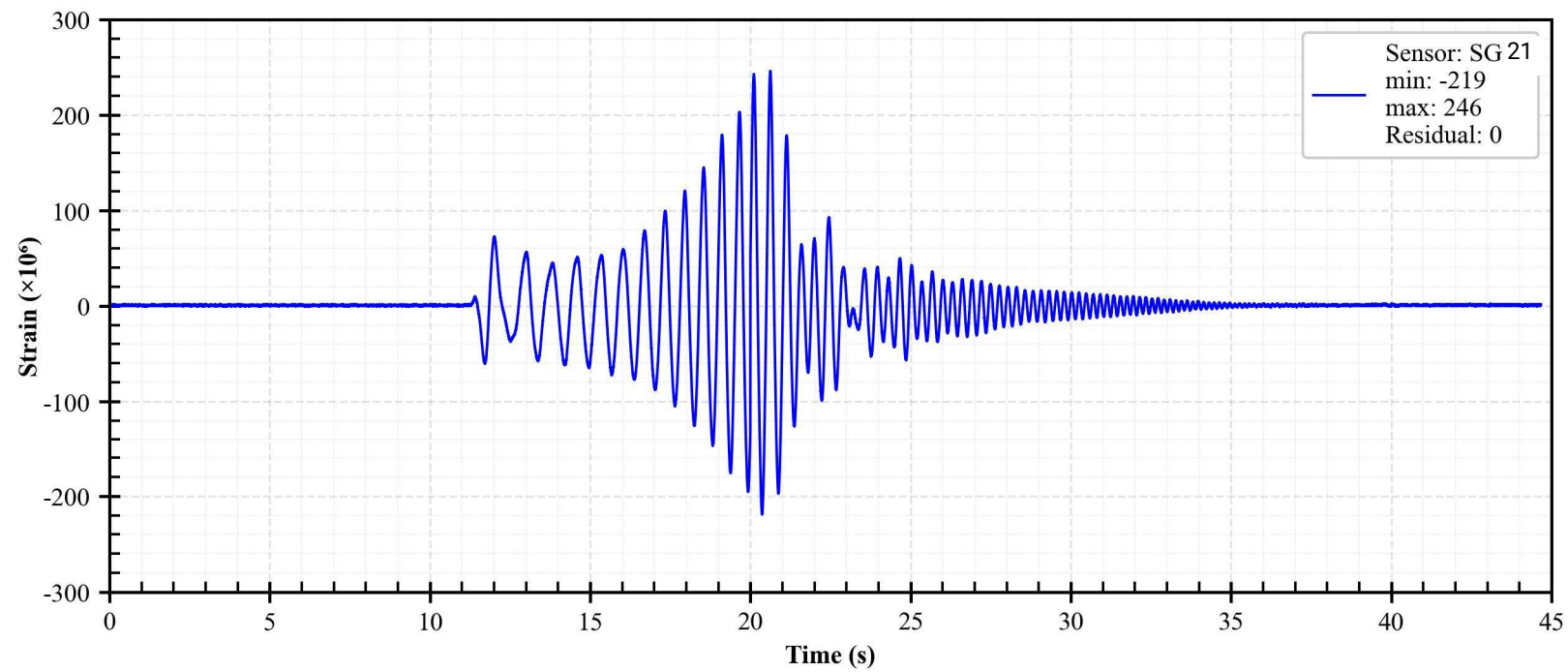


Figure 3.26.35 Characteristic results for phase B (white noise before 0,2g): strain gauge 21 (PUFJ, column 2)

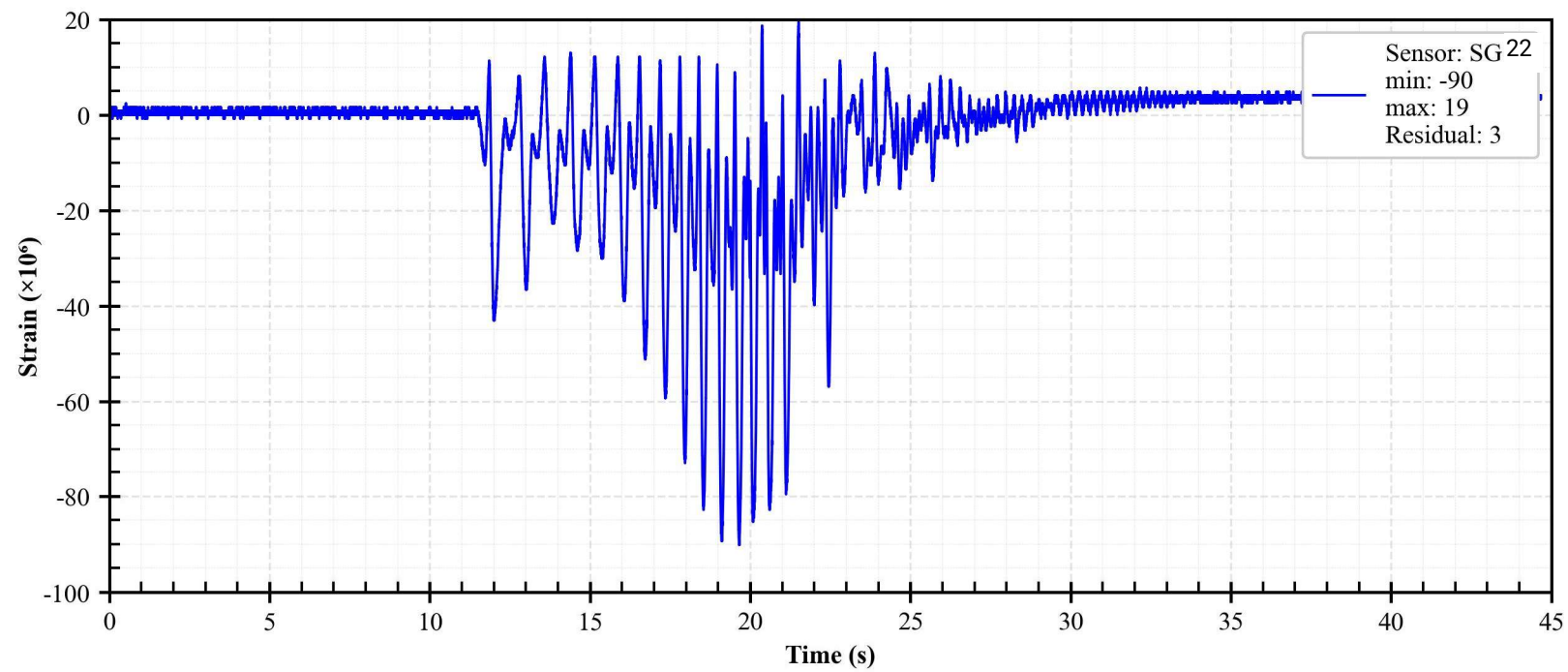


Figure 3.26.36 Characteristic results for phase B (white noise before 0,2g): strain gauge 22 (PUFJ, column 2)

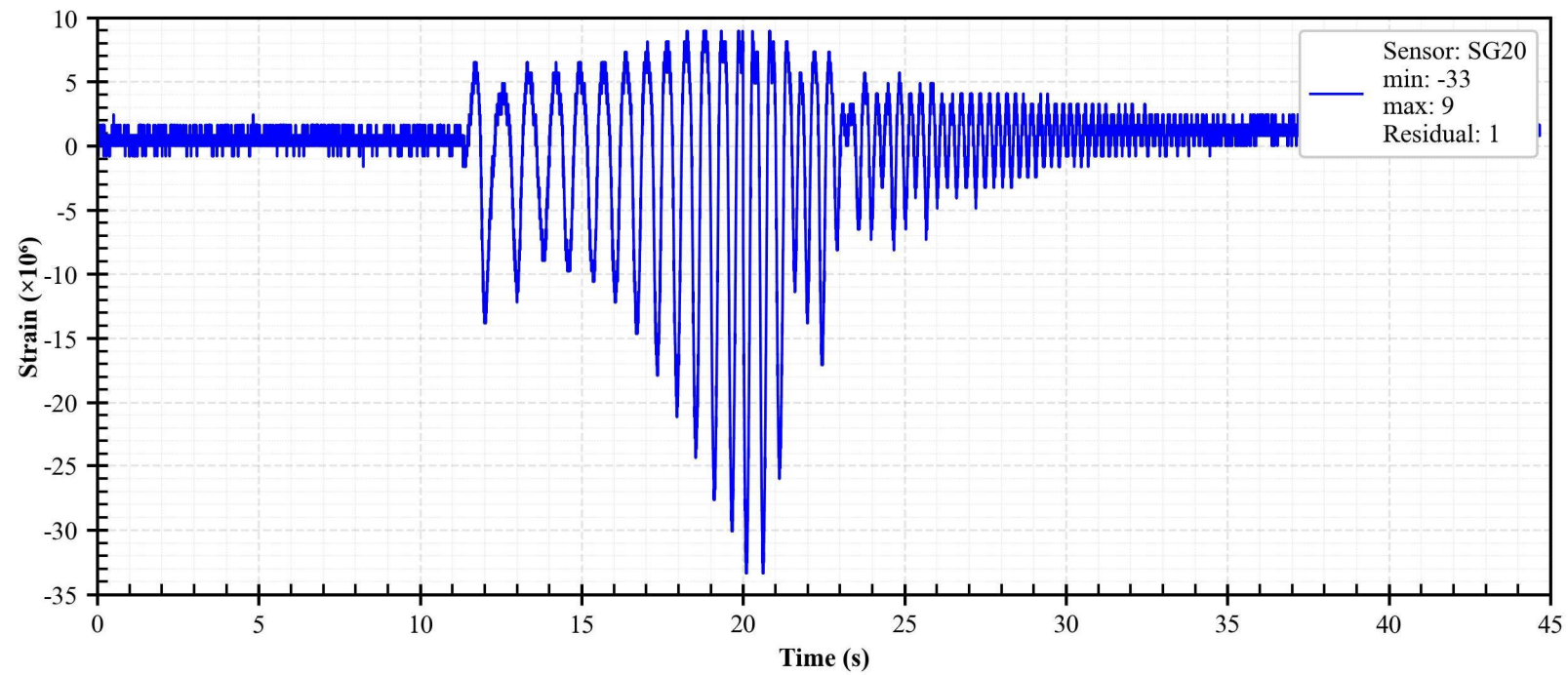


Figure 3.26.37 Characteristic results for phase B (white noise before 0,2g): strain gauge 20

3.27 Earthquake EQ0,2g

Accelerometers

Characteristic extracts from the time history of accelerations of different accelerometers are given below earthquake EQ0,2g. The max acceleration at the slab level on the accelerometer acc4 is 0.37g. The max acceleration at the foundation level on the accelerometer acc10 is 0.19g.

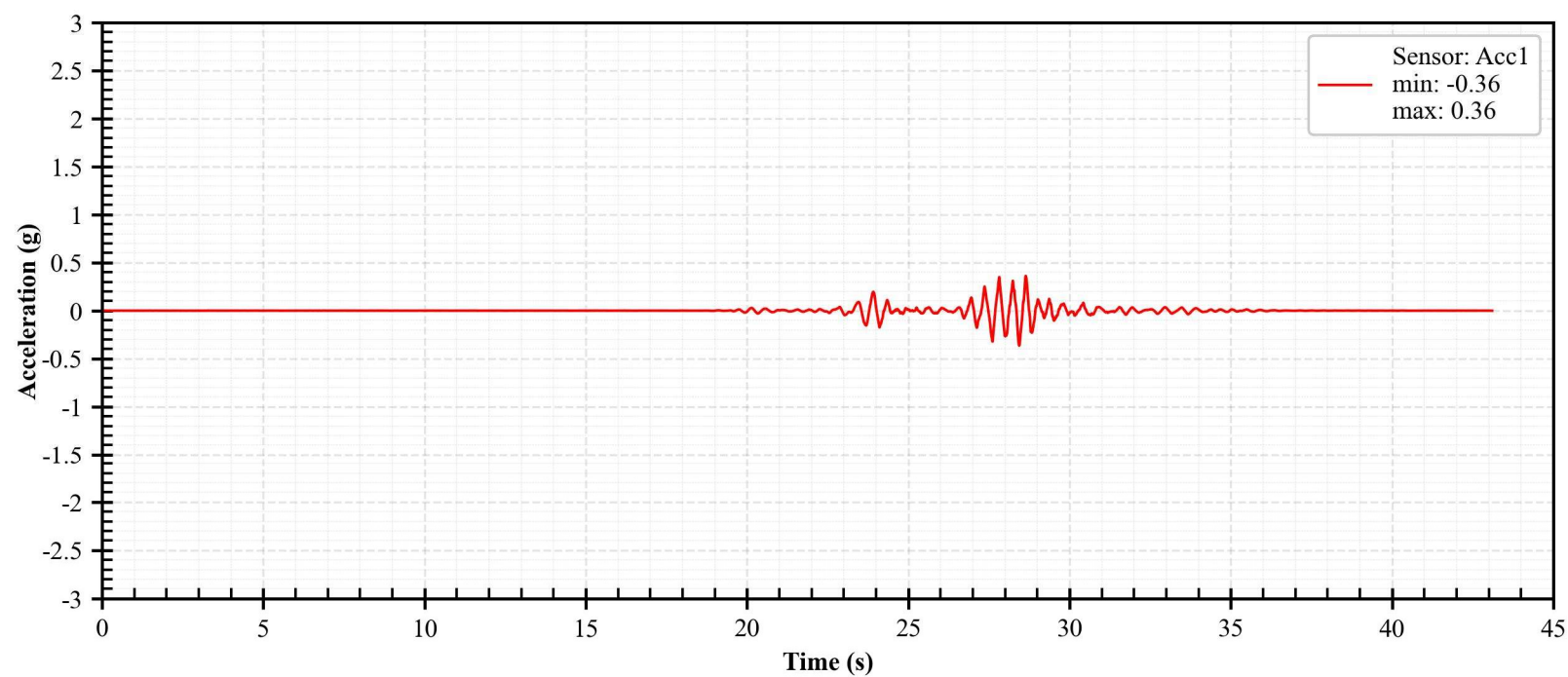


Figure 3.27.1 Characteristic results for phase B (earthquake 0,2g): Accelerometer 1

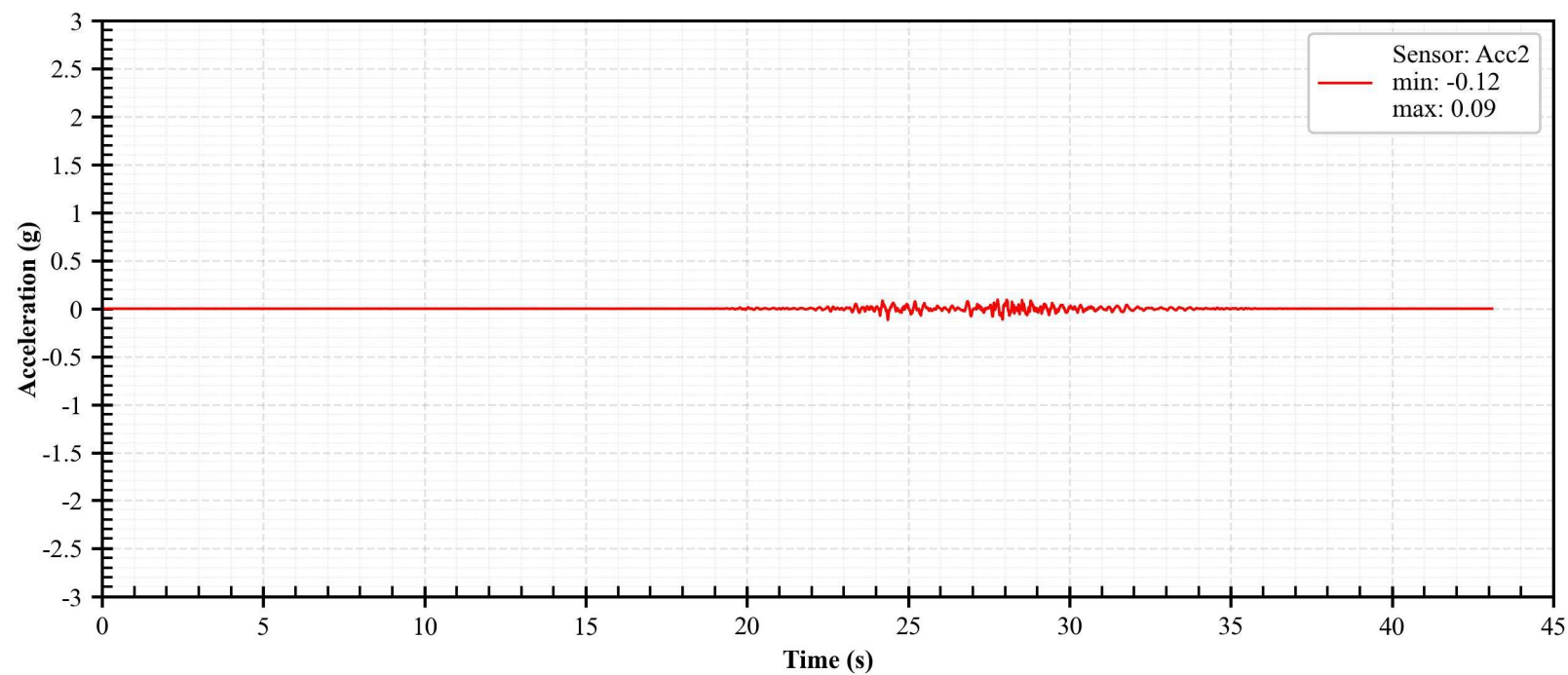


Figure 3.27.2 Characteristic results for phase B (earthquake 0,2g): Accelerometer 2

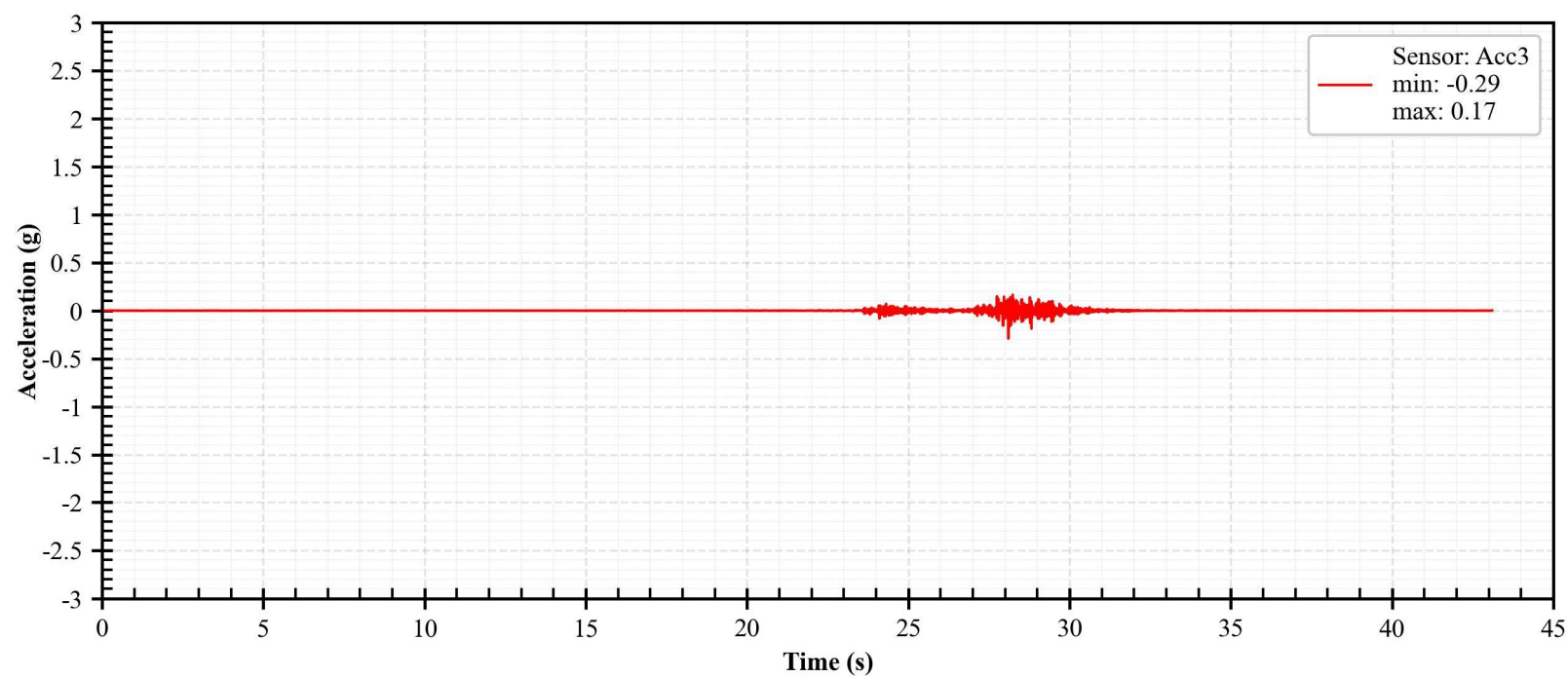


Figure 3.27.3 Characteristic results for phase B (earthquake 0,2g): Accelerometer 3

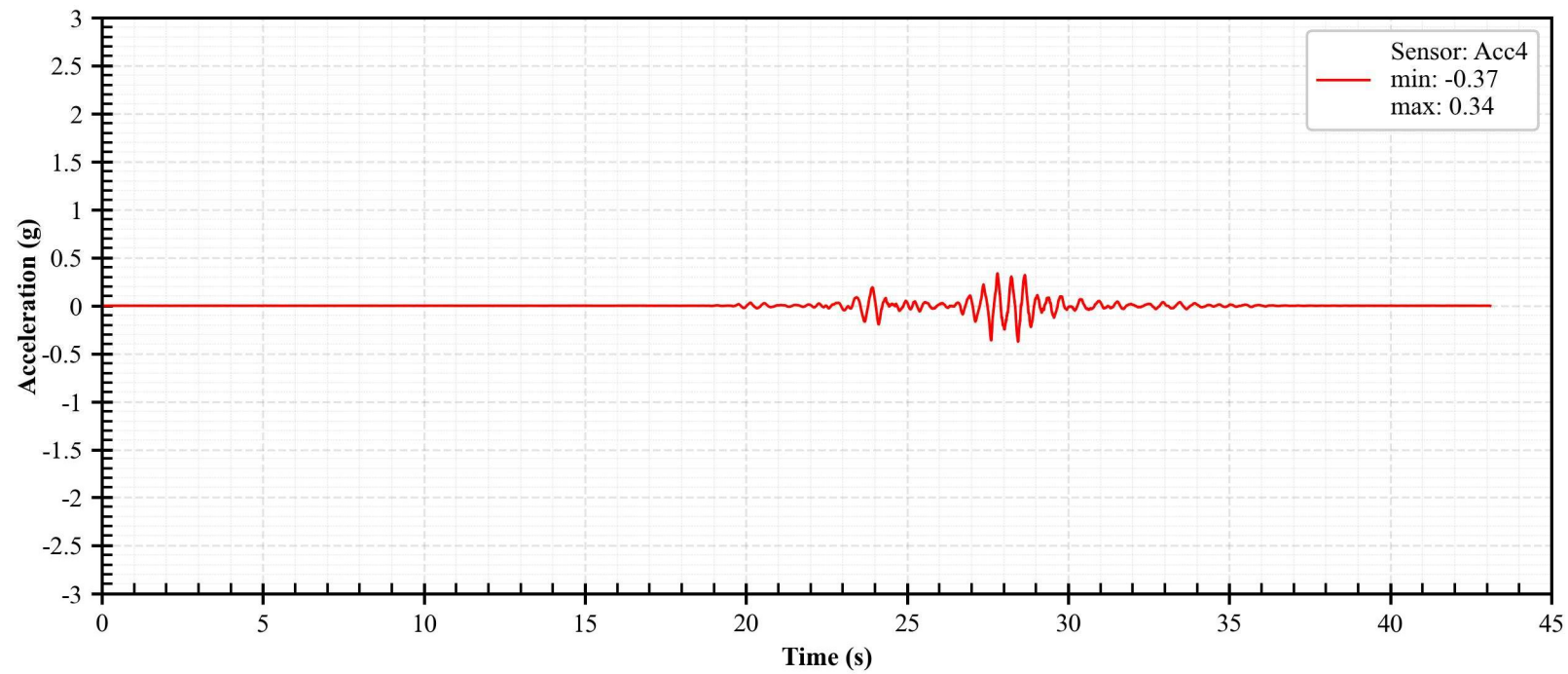


Figure 3.27.4 Characteristic results for phase B (earthquake 0,2g): Accelerometer 4

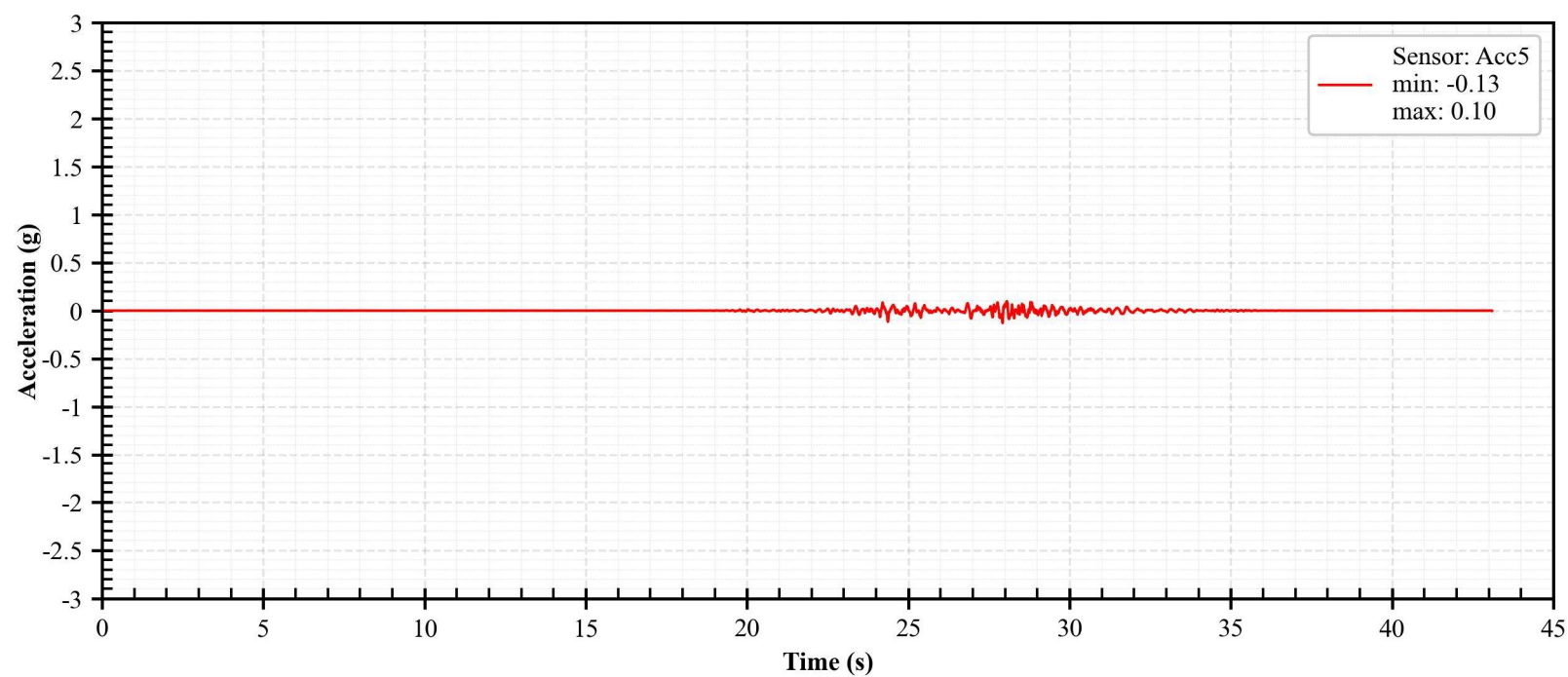


Figure 3.27.5 Characteristic results for phase B (earthquake 0,2g): Accelerometer 5

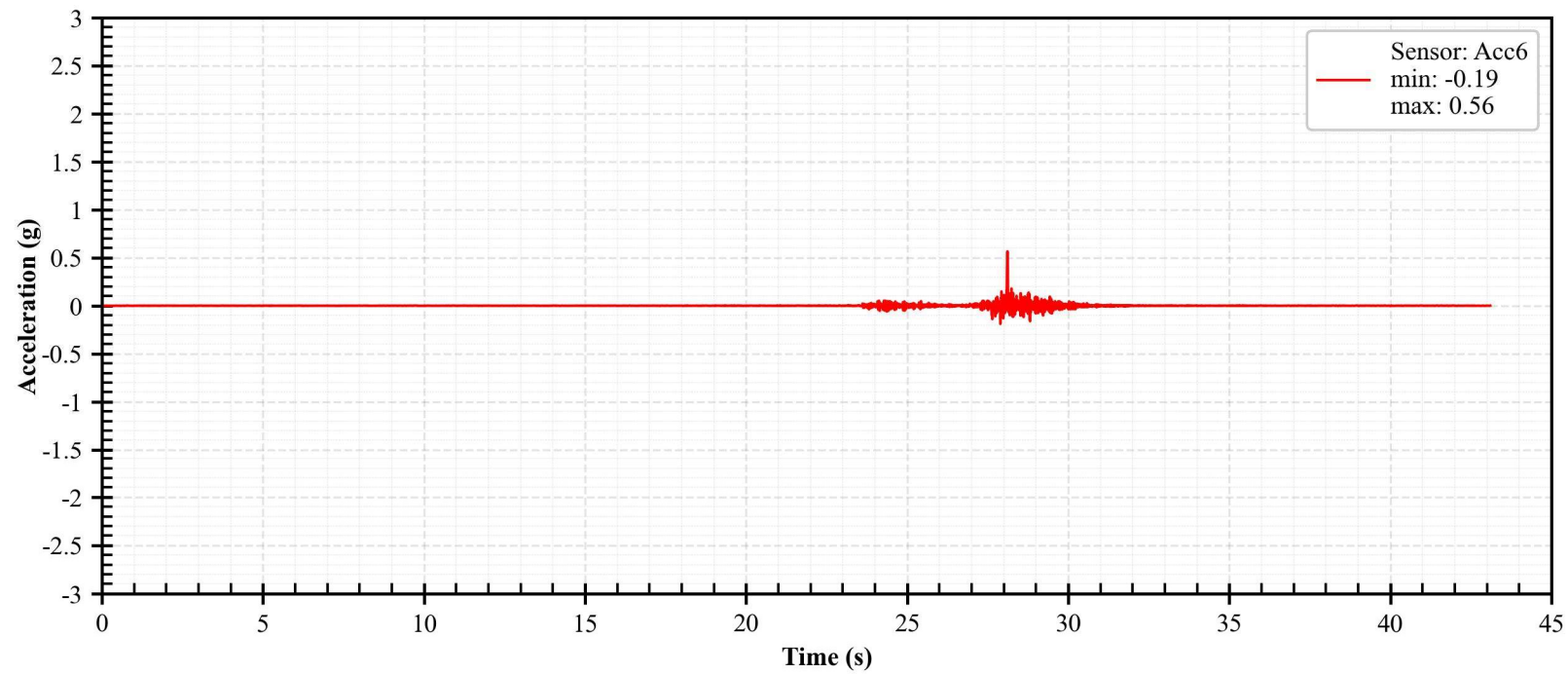


Figure 3.27.6 Characteristic results for phase B (earthquake 0,2g): Accelerometer 6

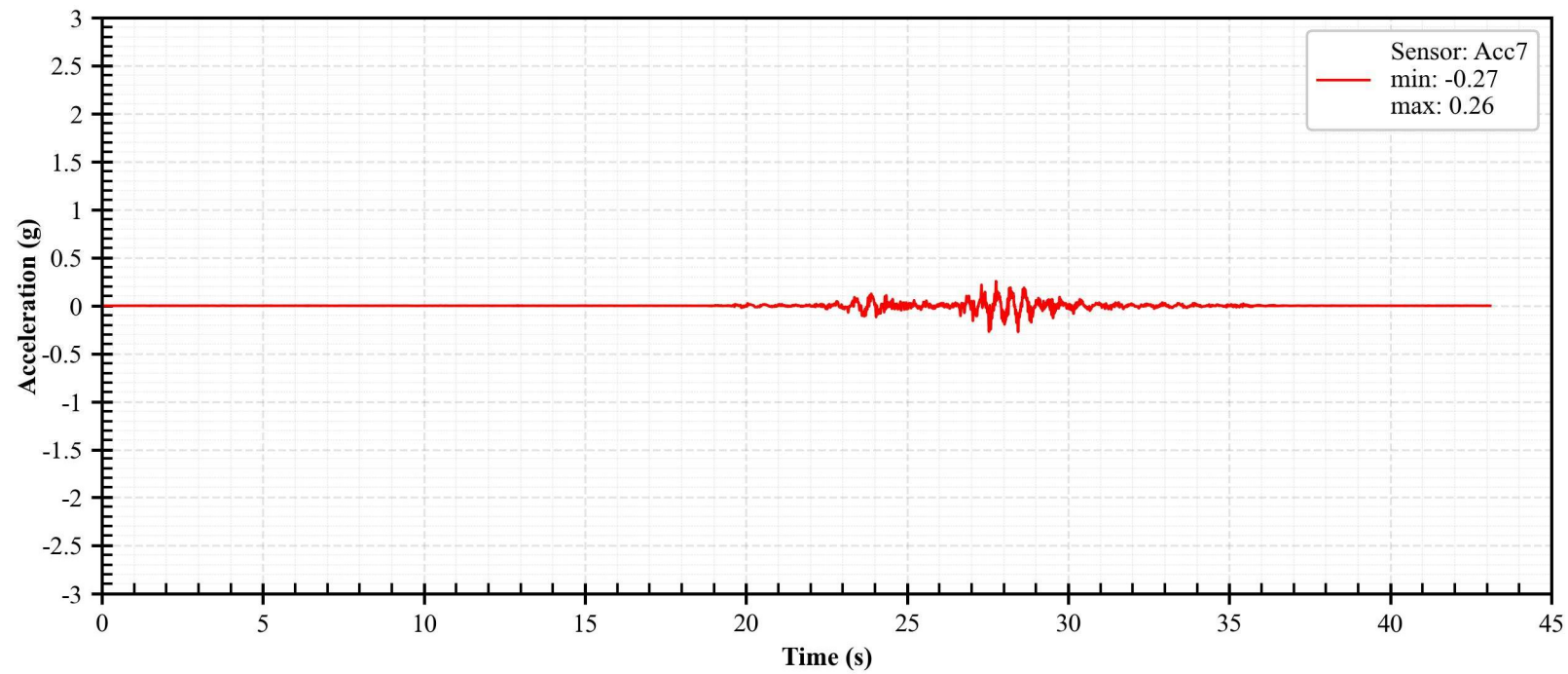


Figure 3.27.7 Characteristic results for phase B (earthquake 0,2g): Accelerometer 7

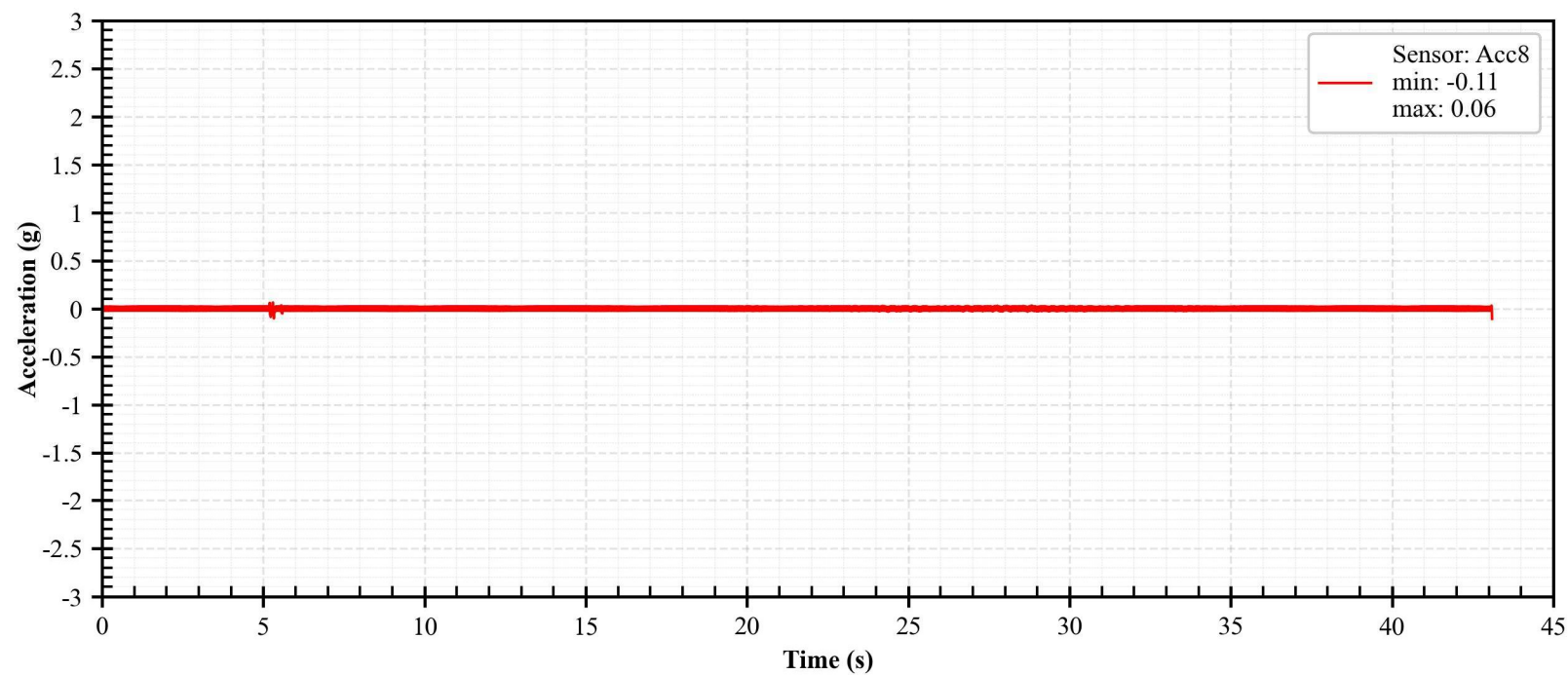


Figure 3.27.8 Characteristic results for phase B (earthquake 0,2g): Accelerometer 8

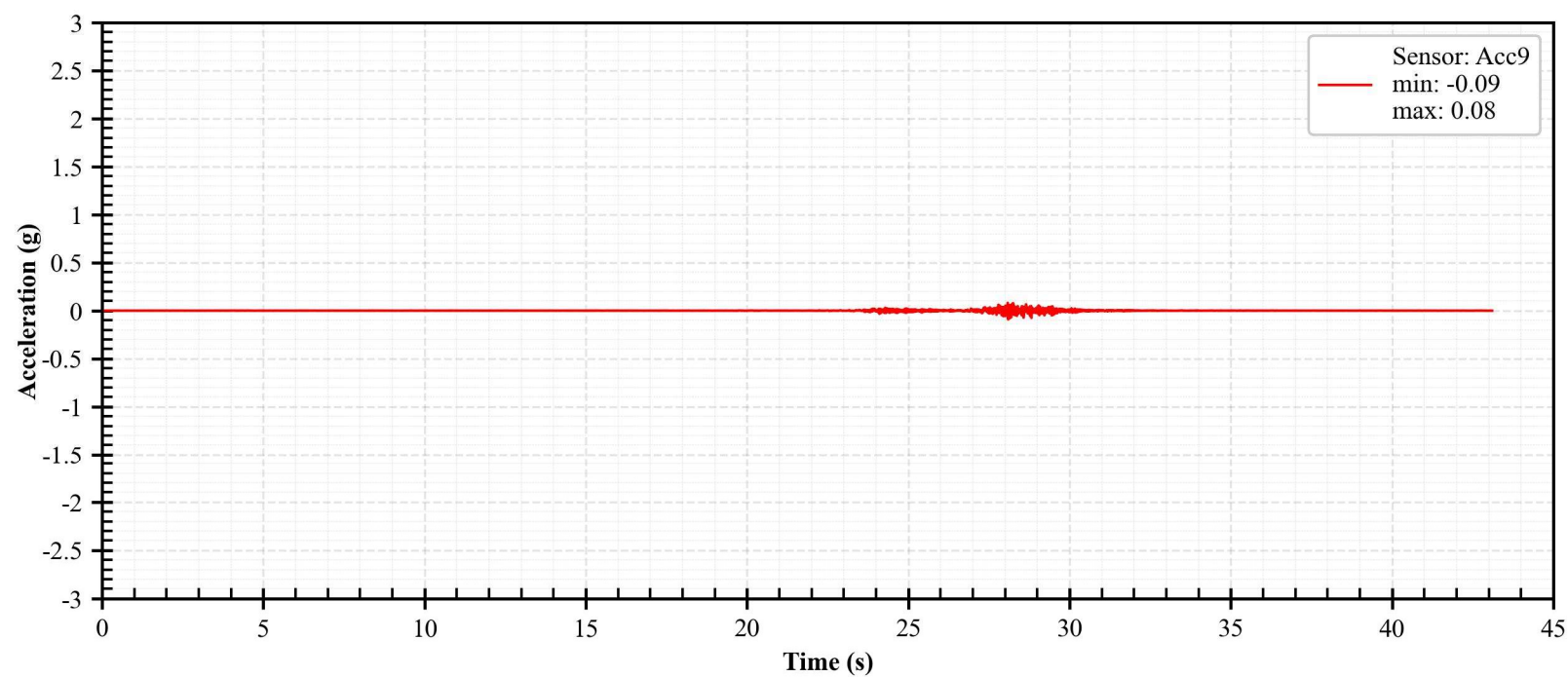


Figure 3.27.9 Characteristic results for phase B (earthquake 0,2g): Accelerometer 9

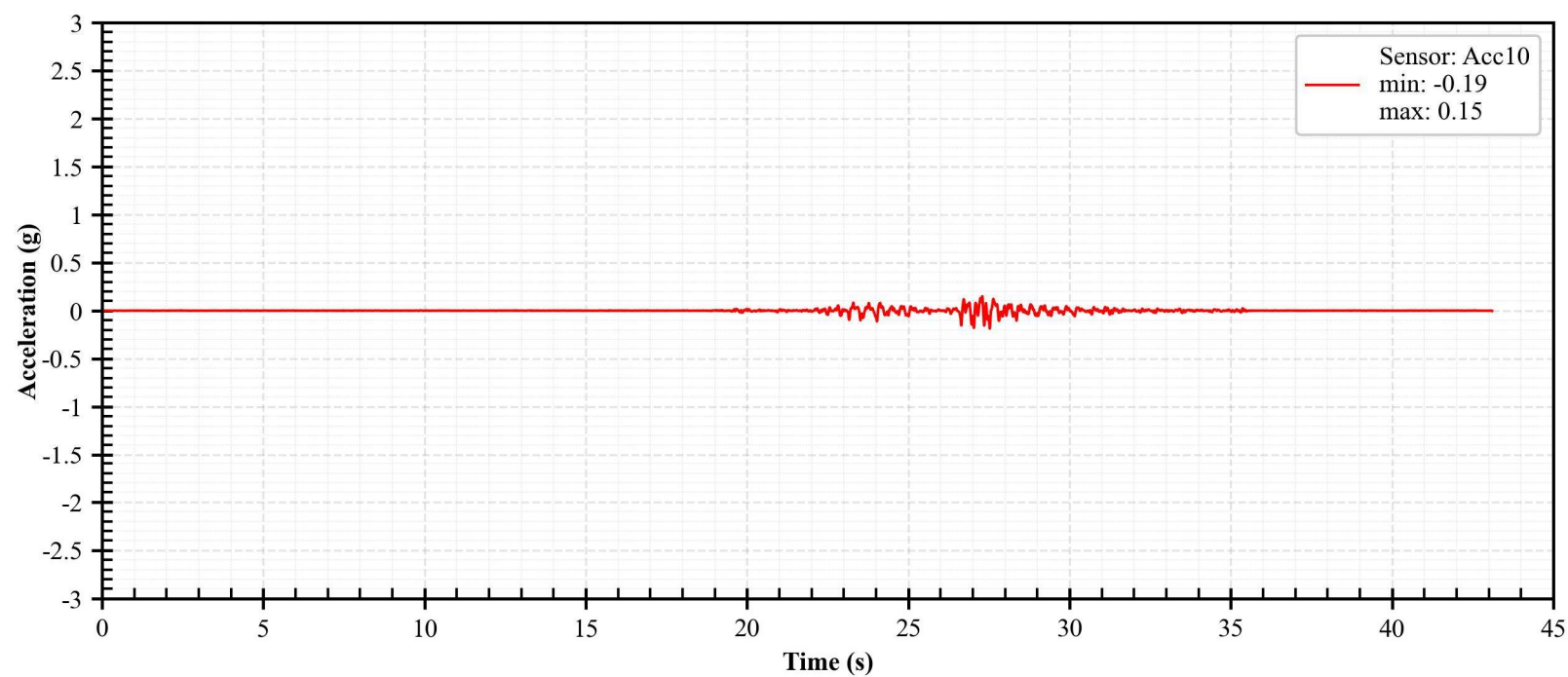


Figure 3.27.10 Characteristic results for phase B (earthquake 0,2g): Accelerometer 10

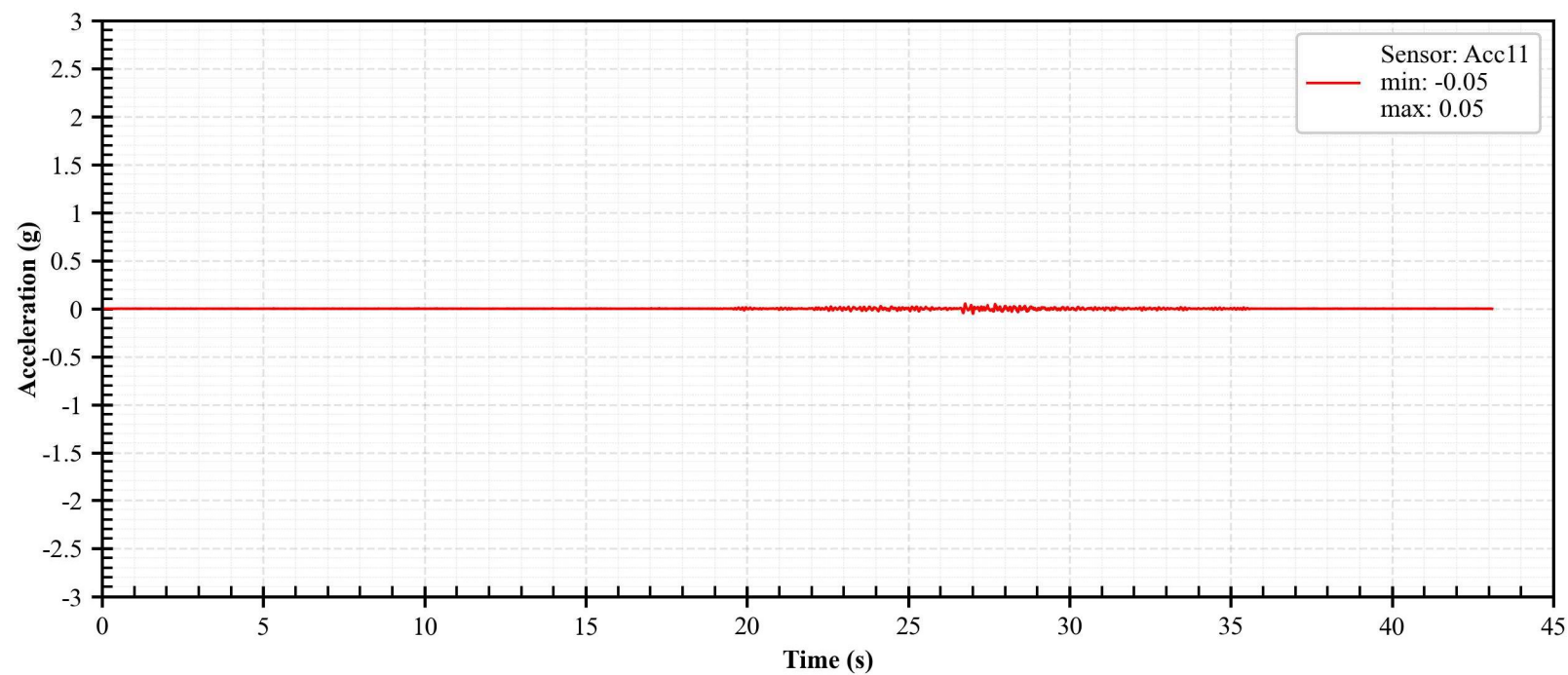


Figure 3.27.11 Characteristic results for phase B (earthquake 0,2g): Accelerometer 11

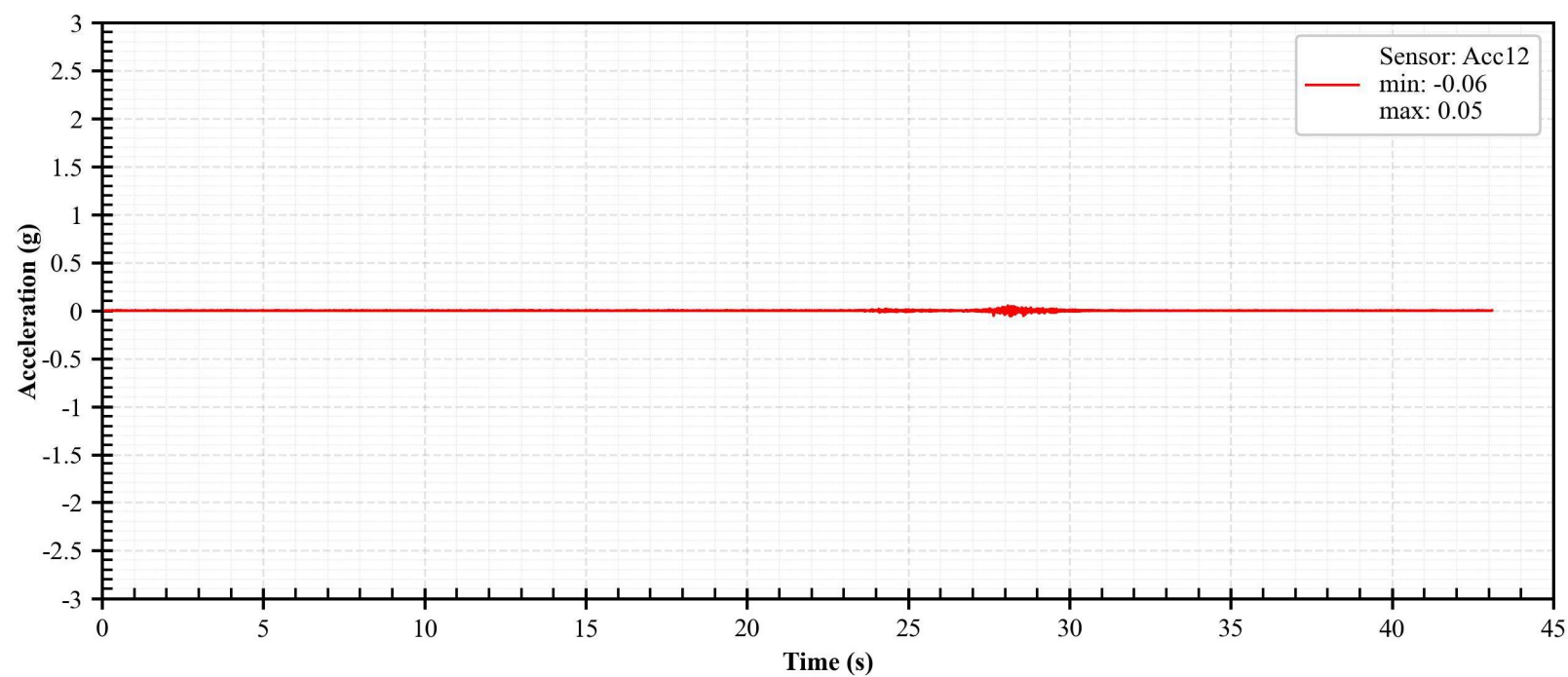


Figure 3.27.12 Characteristic results for phase B (earthquake 0,2g): Accelerometer 12

Draw wire sensors

Figures 3.27.13 – 3.27.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 24.44 mm while the minimum is -11.22 mm. The maximum movement detected by draw wire sensor W2 is 12.09 mm while the minimum is -10.94 mm. The maximum movement detected by draw wire sensor W3 is 4.34 mm while the minimum is -4.05 mm. The maximum movement detected by draw wire sensor W4 is 4.54 mm while the minimum is -4.21 mm. The maximum drift is $(12.50/1.225) = 10.20 \text{ ‰}$ and minimum drift is $(-12.01/1.225) = -9.80 \text{ ‰}$.

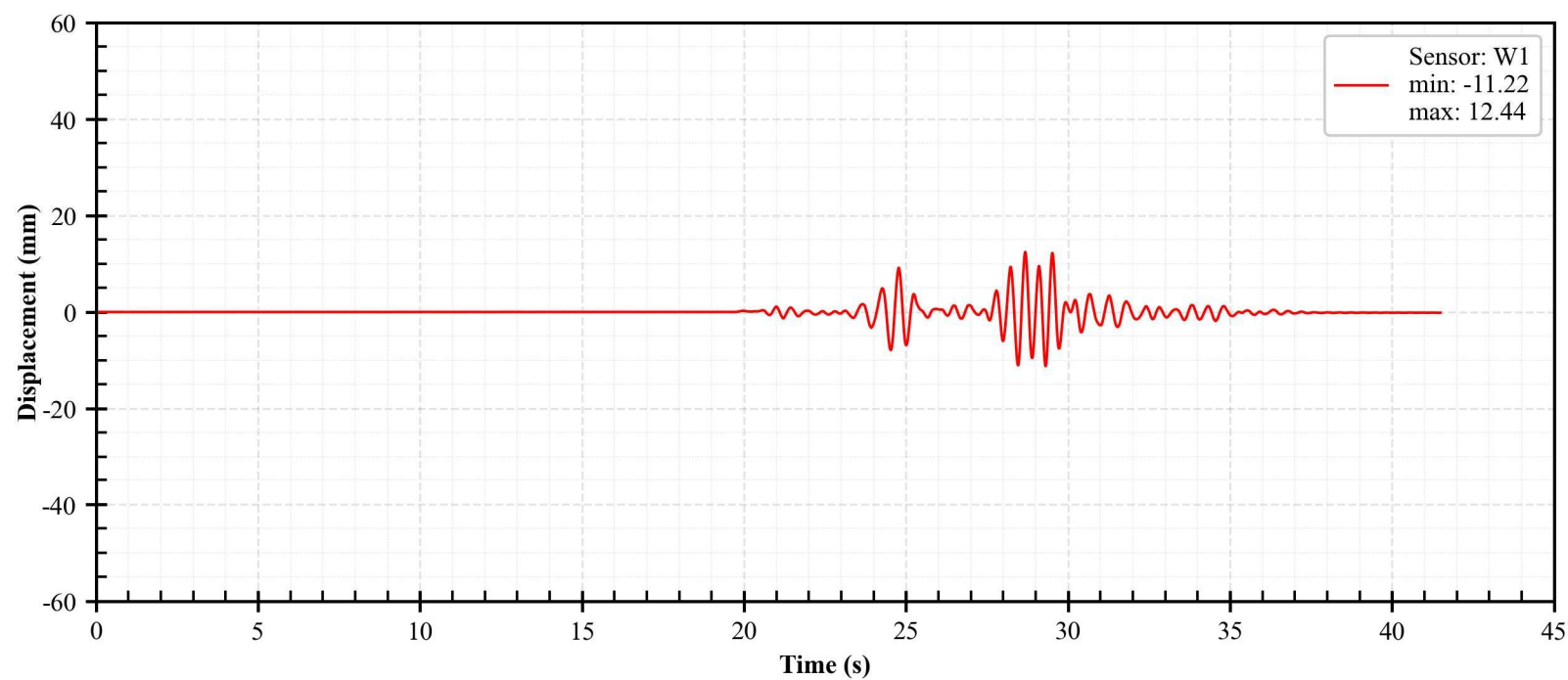


Figure 3.27.13 Characteristic results for phase B (earthquake 0,2g): Draw wire sensor 1

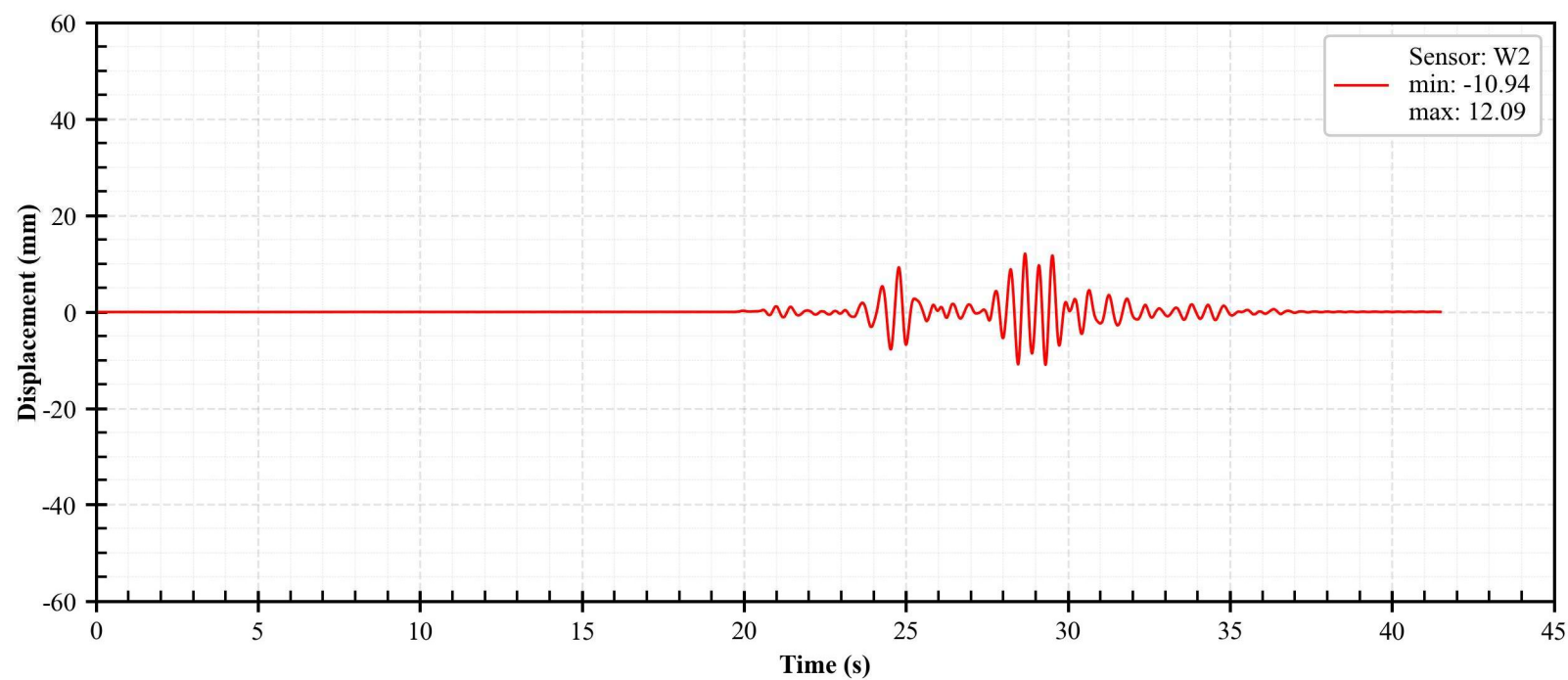


Figure 3.27.14 Characteristic results for phase B (earthquake 0,2g): Draw wire sensor 2

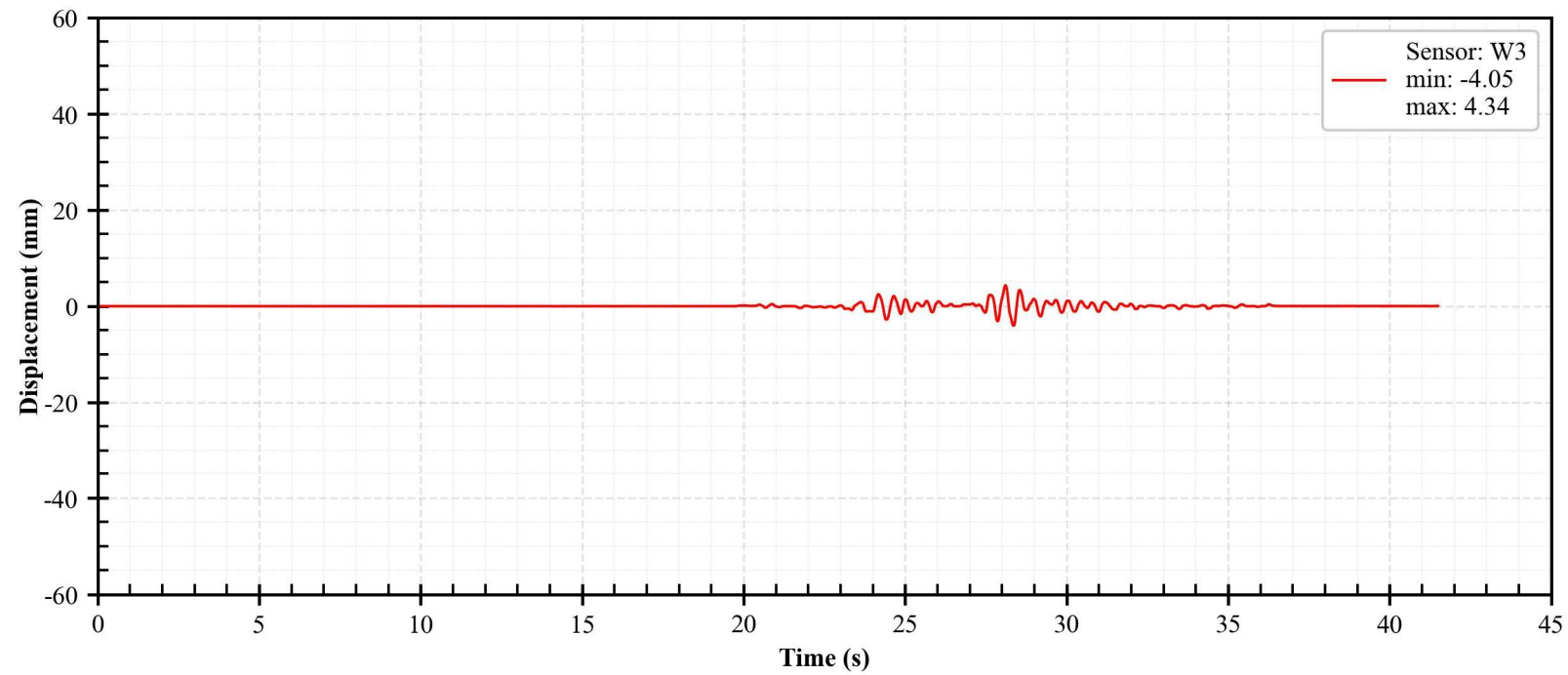


Figure 3.27.15 Characteristic results for phase B (earthquake 0,2g): Draw wire sensor 3

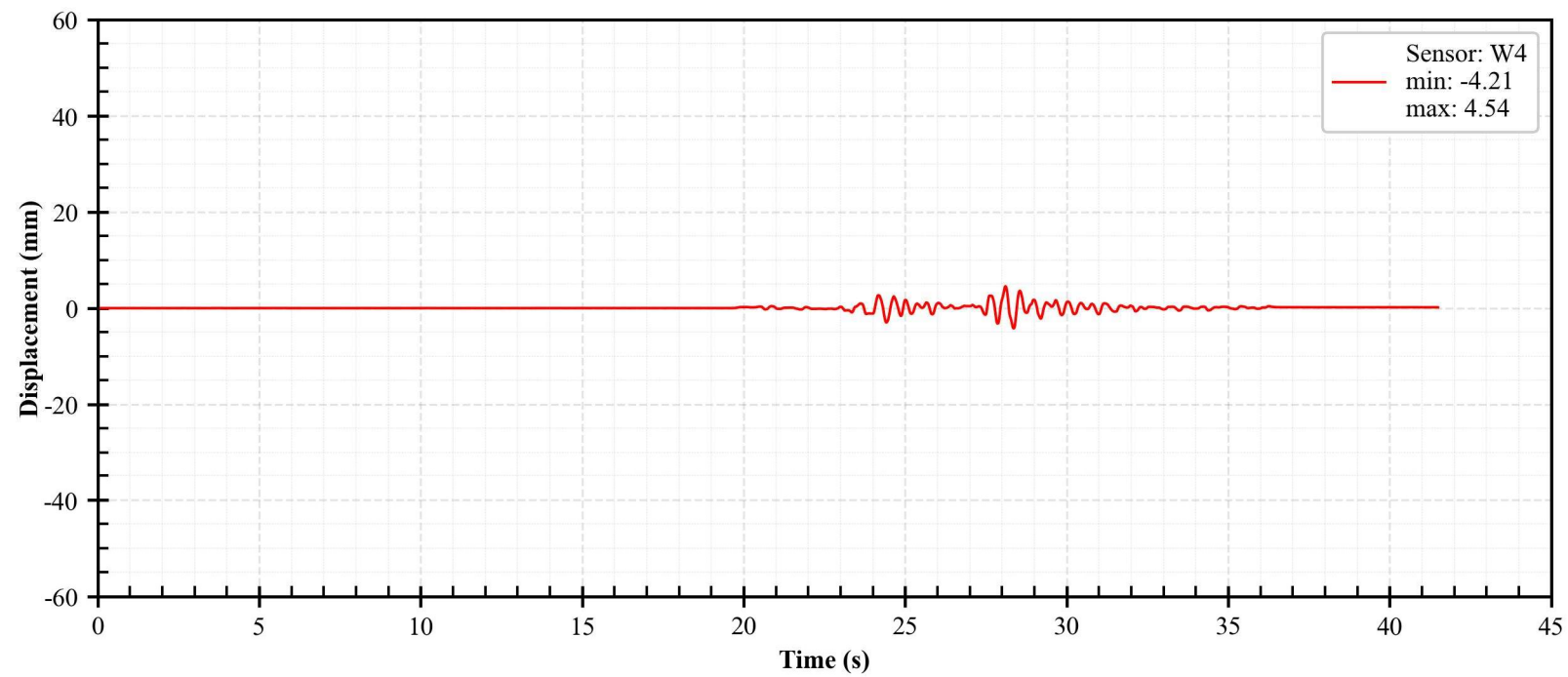


Figure 3.27.16 Characteristic results for phase B (earthquake 0,2g): Draw wire sensor 4

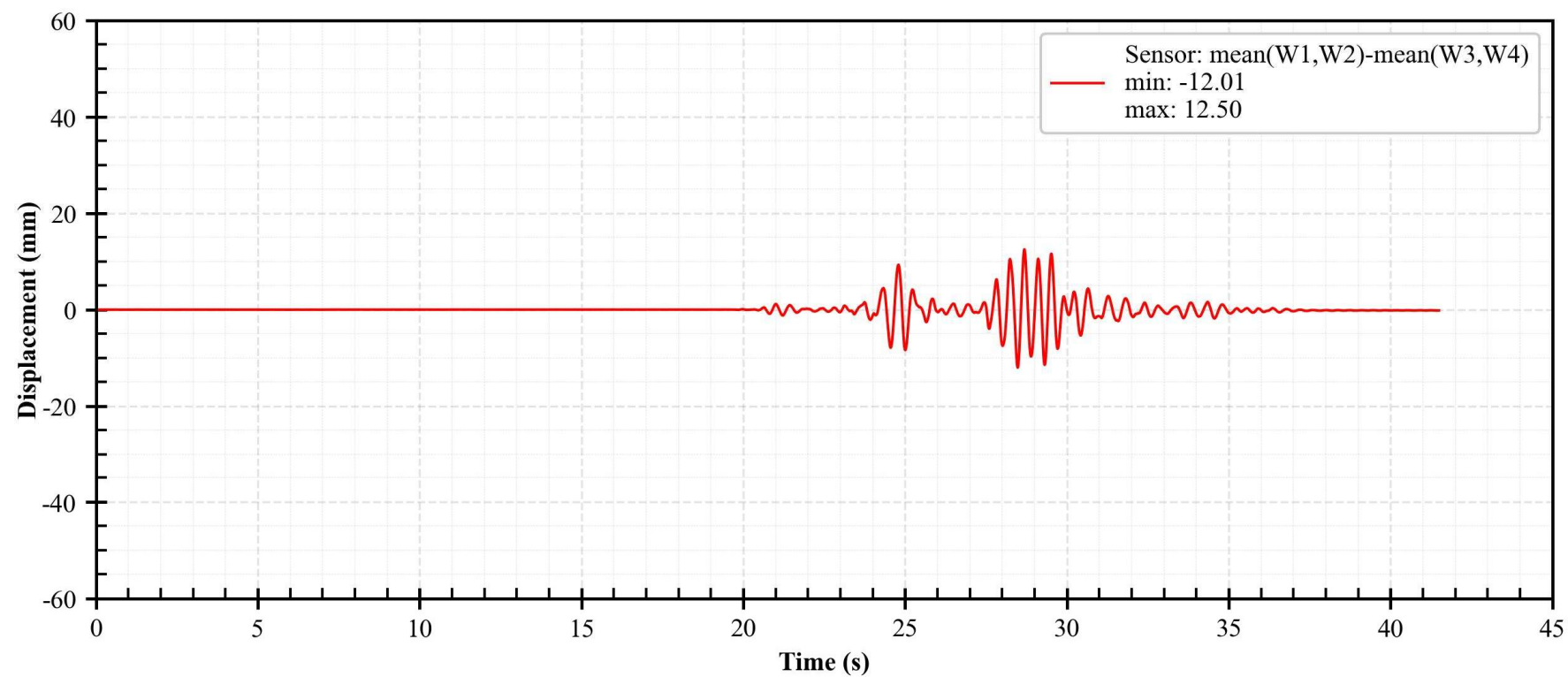


Figure 3.27.17 Characteristic results for phase B (earthquake 0,2g): mean (W1,W2) – mean (W3,W4)

Strain gauges

Strain gauges detect strain on the surface of the steel reinforcement. The strain gauges shown in the figures 3.27.18, 3.27.19, 3.27.20, 3.27.21, 3.27.22, 3.27.23, 3.27.32, 3.27.33 are located on the longitudinal reinforcement, at the bottom of the column. Strain gauge SG17 is located on the centre of partial masonry 1 along direction x. Strain gauge SG18 is located on the centre of partial masonry 1 along direction z. The strain gauges shown in the figures 3.27.24, 3.27.25, 3.27.26, 3.27.27, 3.27.28, 3.27.29 and 3.27.34 are located in the longitudinal reinforcement, on the upper side. More specifically, strain gauge SG5 has maximum strain 1074 μ strain and minimum strain -926 μ strain. The residual strain is -14 μ strain.

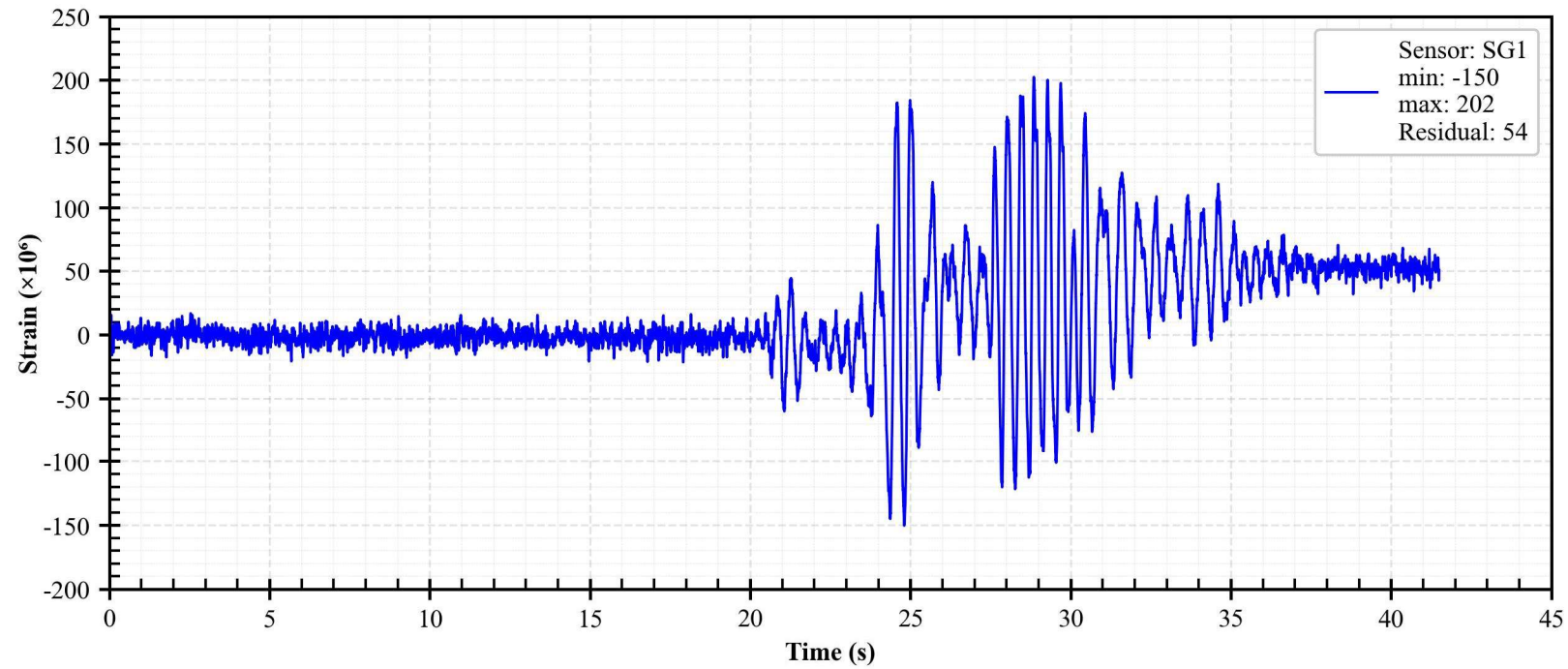


Figure 3.27.18 Characteristic results for phase B (earthquake 0,2g): strain gauge 1

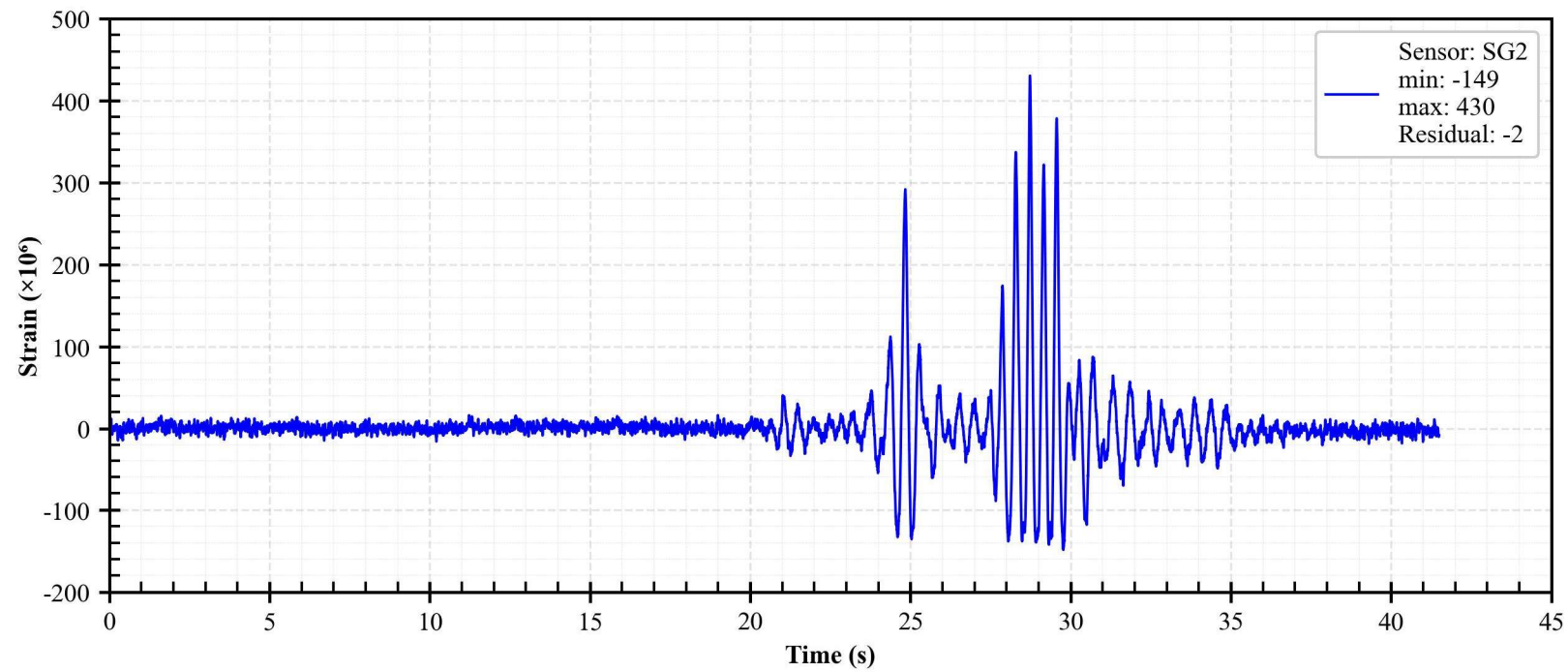


Figure 3.27.19 Characteristic results for phase B (earthquake 0,2g): strain gauge 2

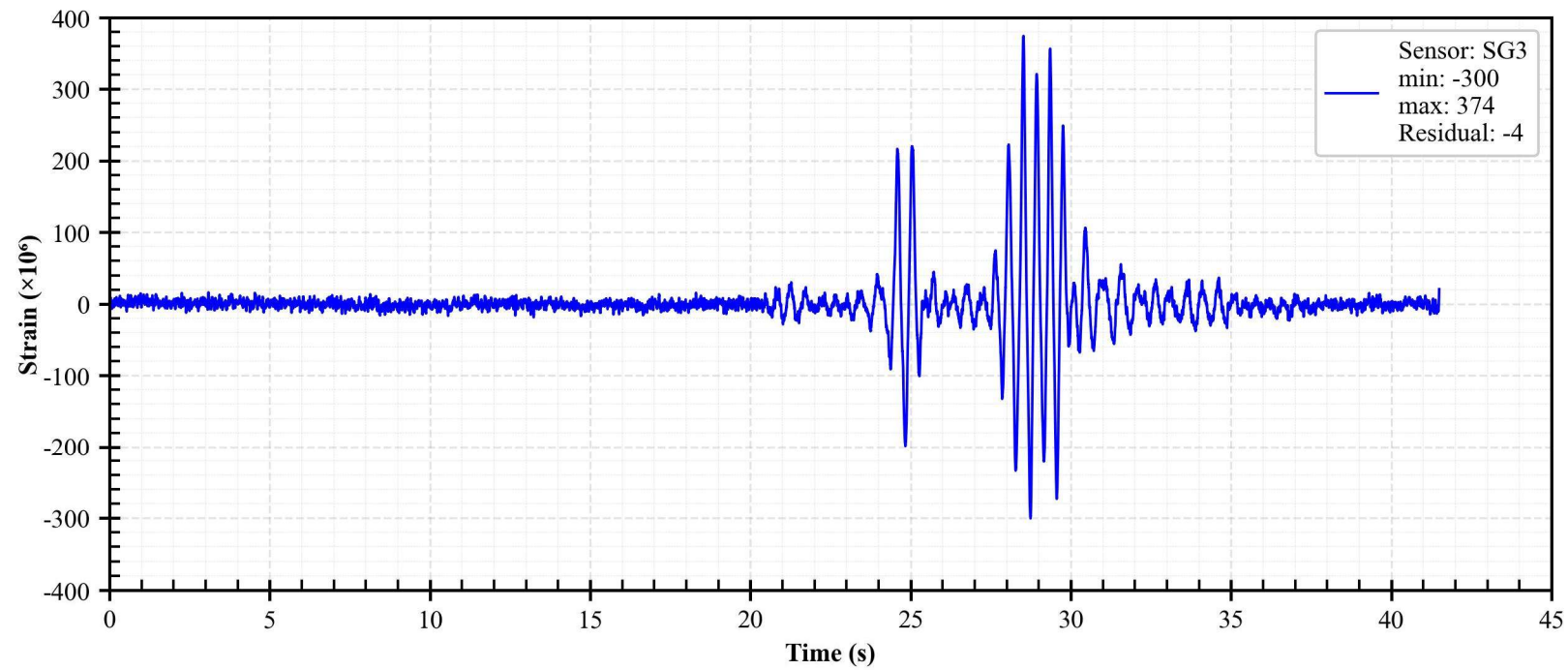


Figure 3.27.20 Characteristic results for phase B (earthquake 0,2g): strain gauge 3

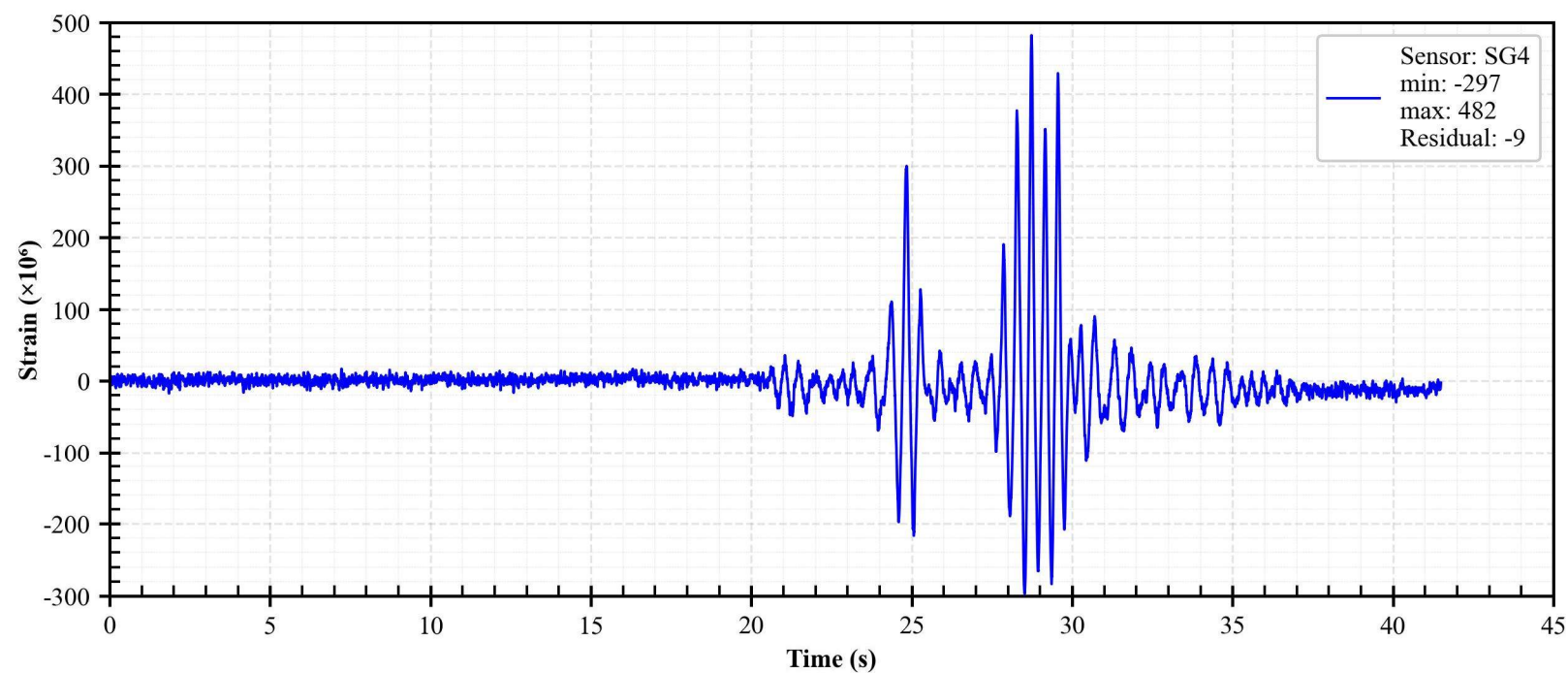


Figure 3.27.21 Characteristic results for phase B (earthquake 0,2g): strain gauge 4

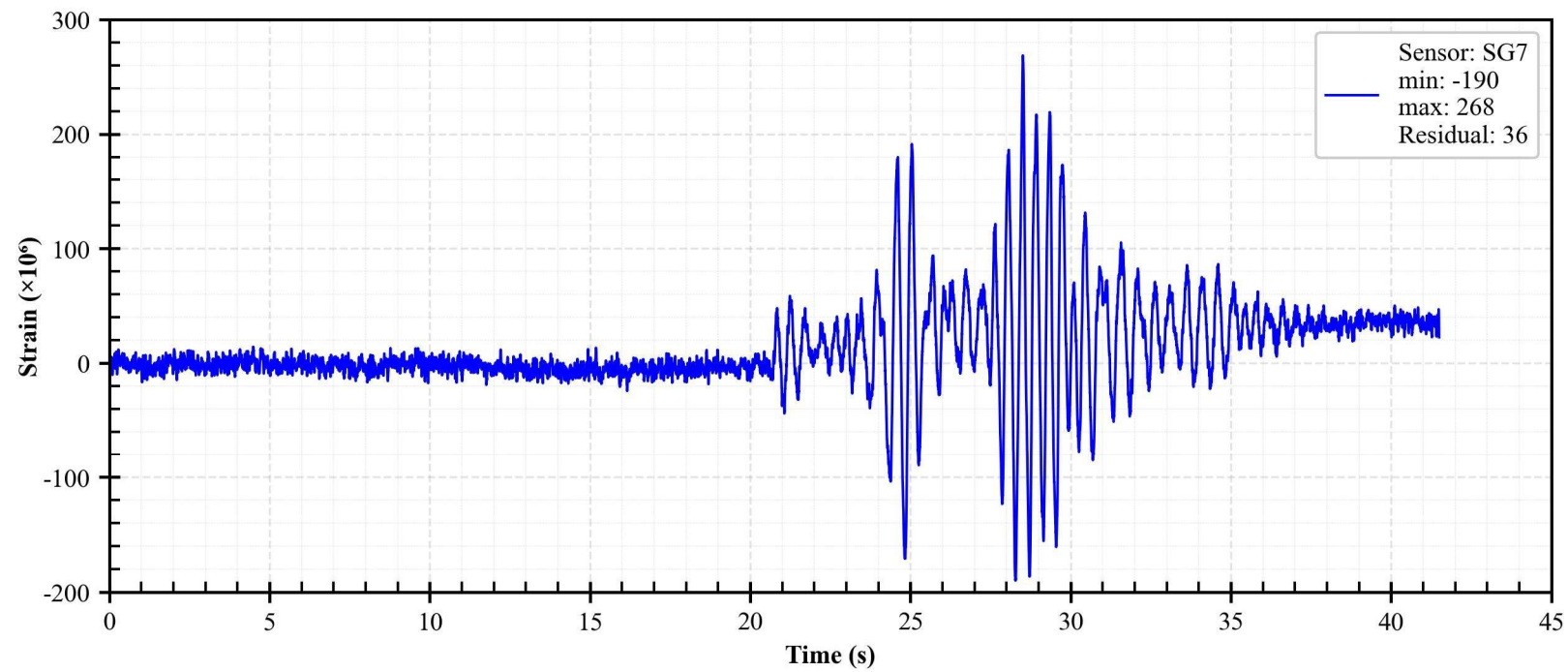


Figure 3.37.22 Characteristic results for phase B (earthquake 0,2g): strain gauge 7

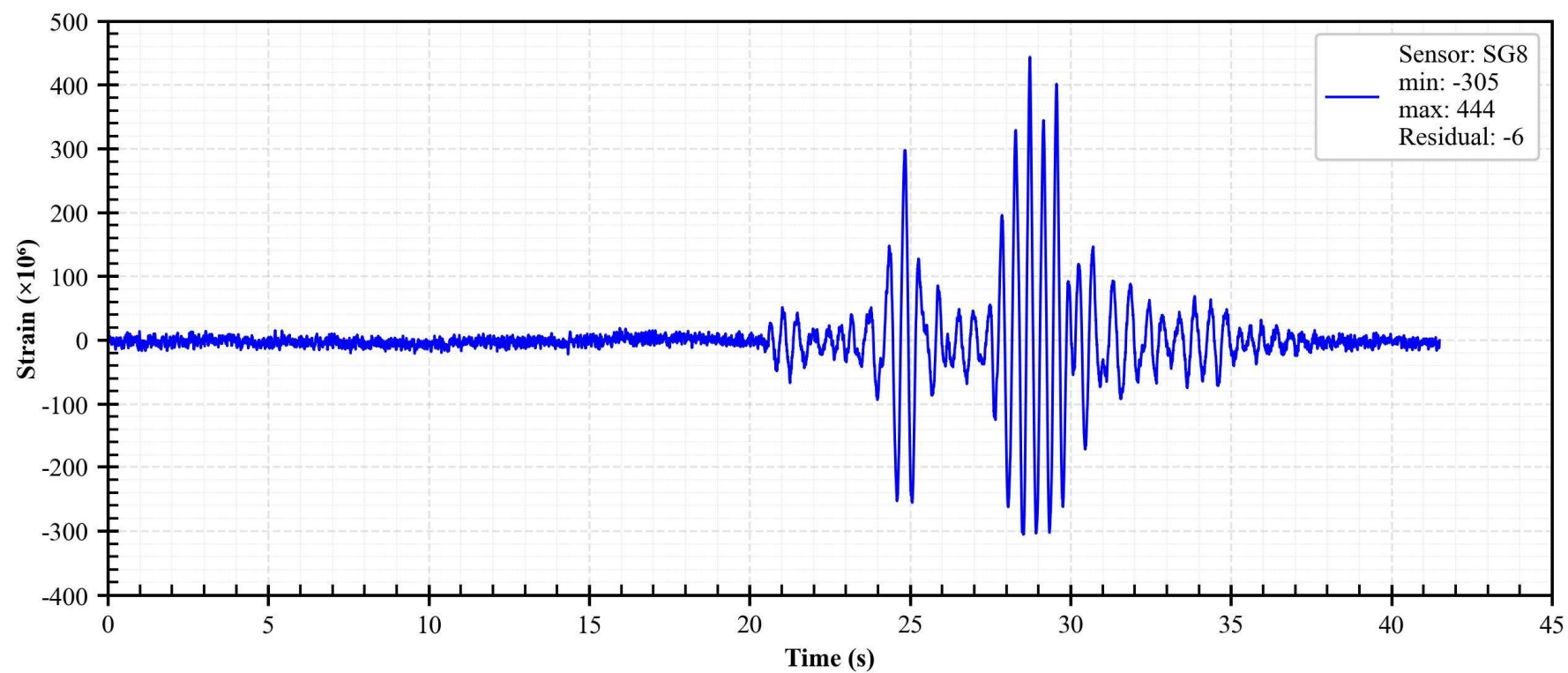


Figure 3.37.23 Characteristic results for phase B (earthquake 0,2g): strain gauge 8

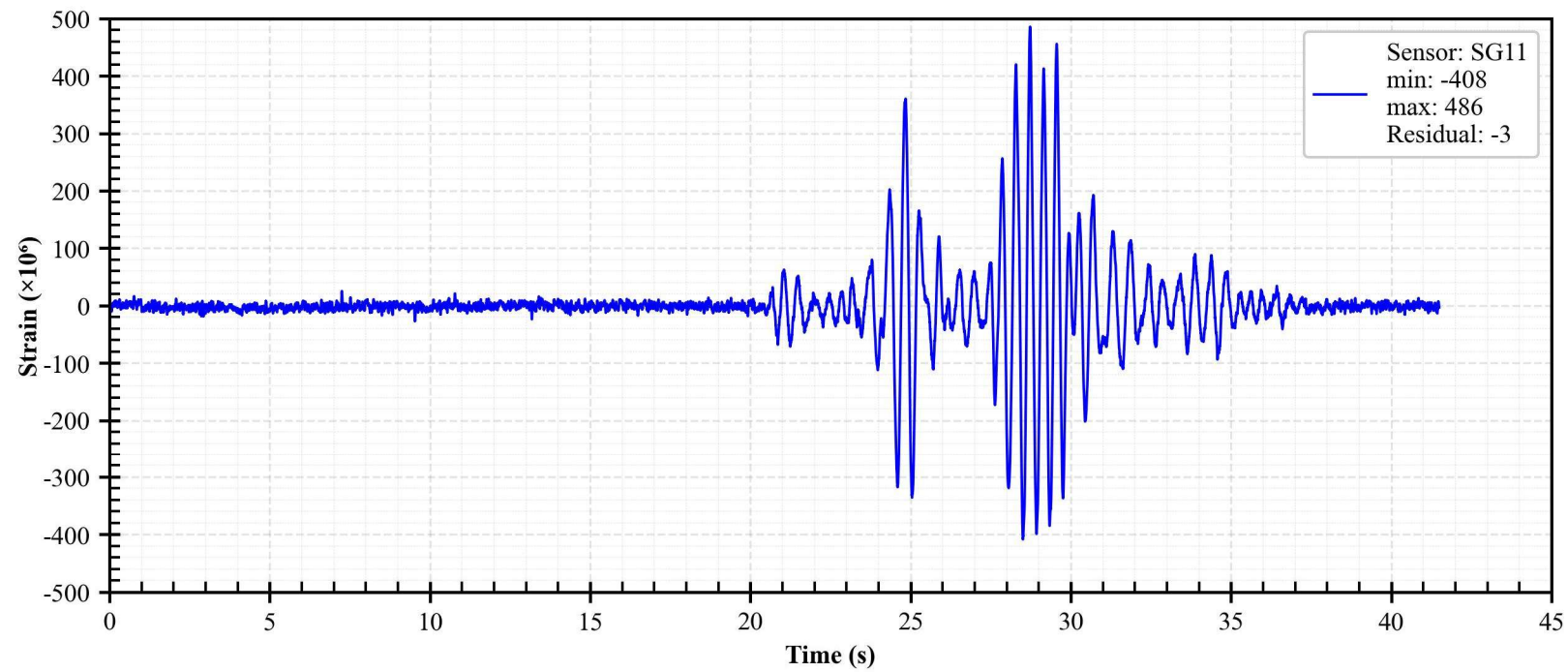


Figure 3.27.24 Characteristic results for phase B (earthquake 0,2g): strain gauge 11

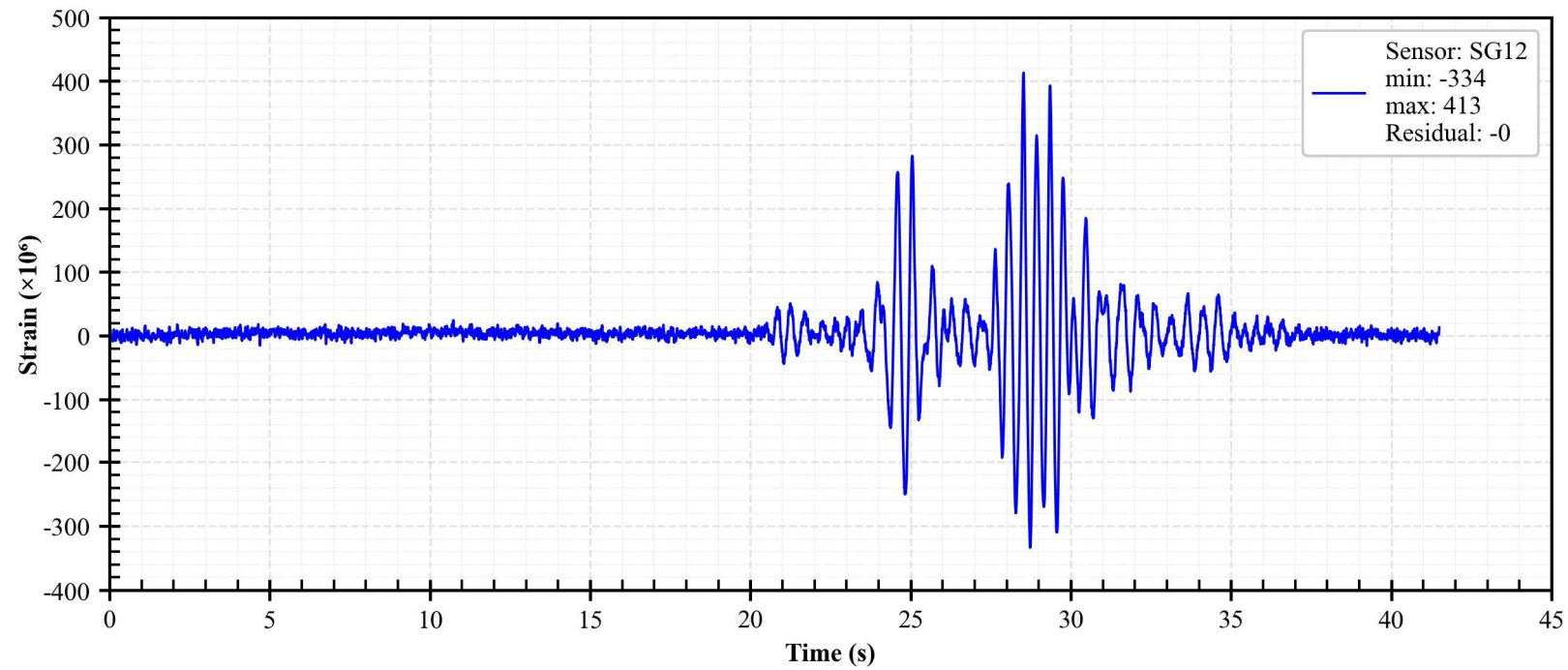


Figure 3.27.25 Characteristic results for phase B (earthquake 0,2g): strain gauge 12

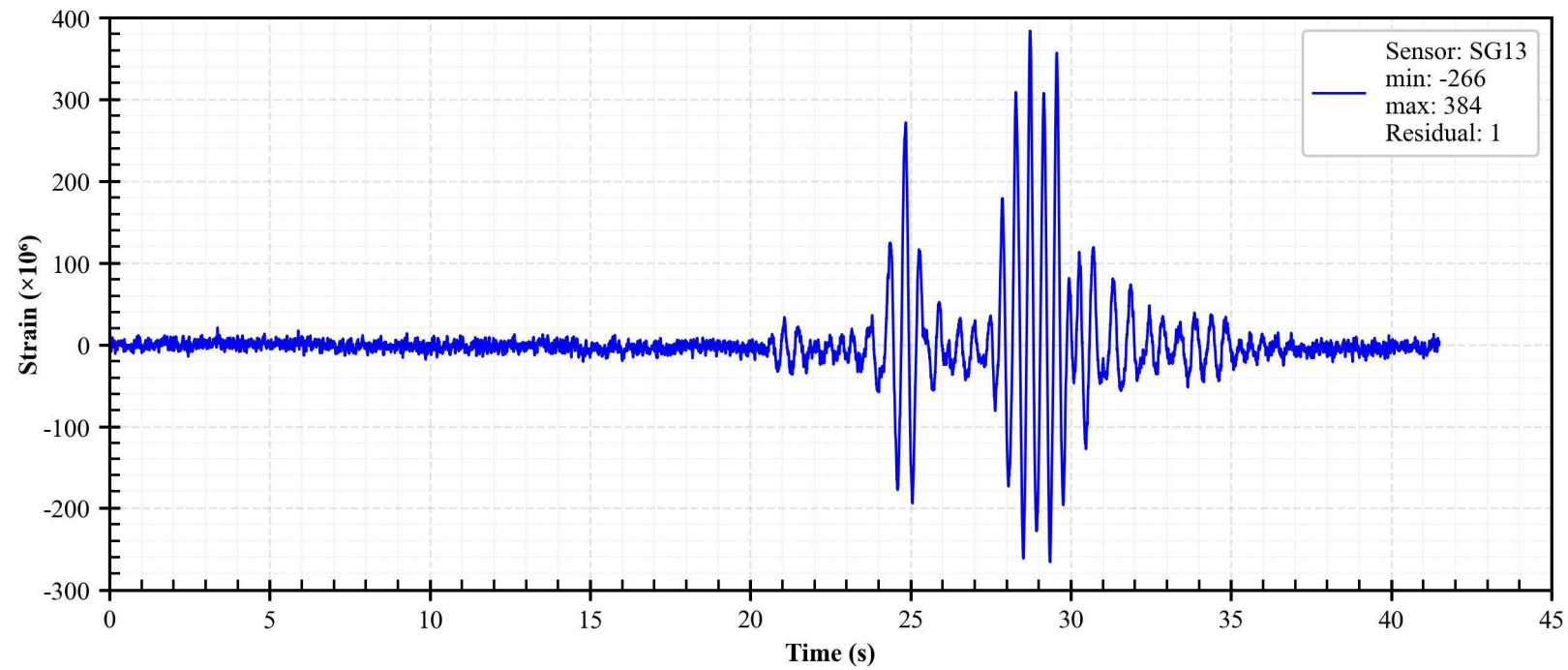


Figure 3.27.26 Characteristic results for phase B (earthquake 0,2g): strain gauge 13

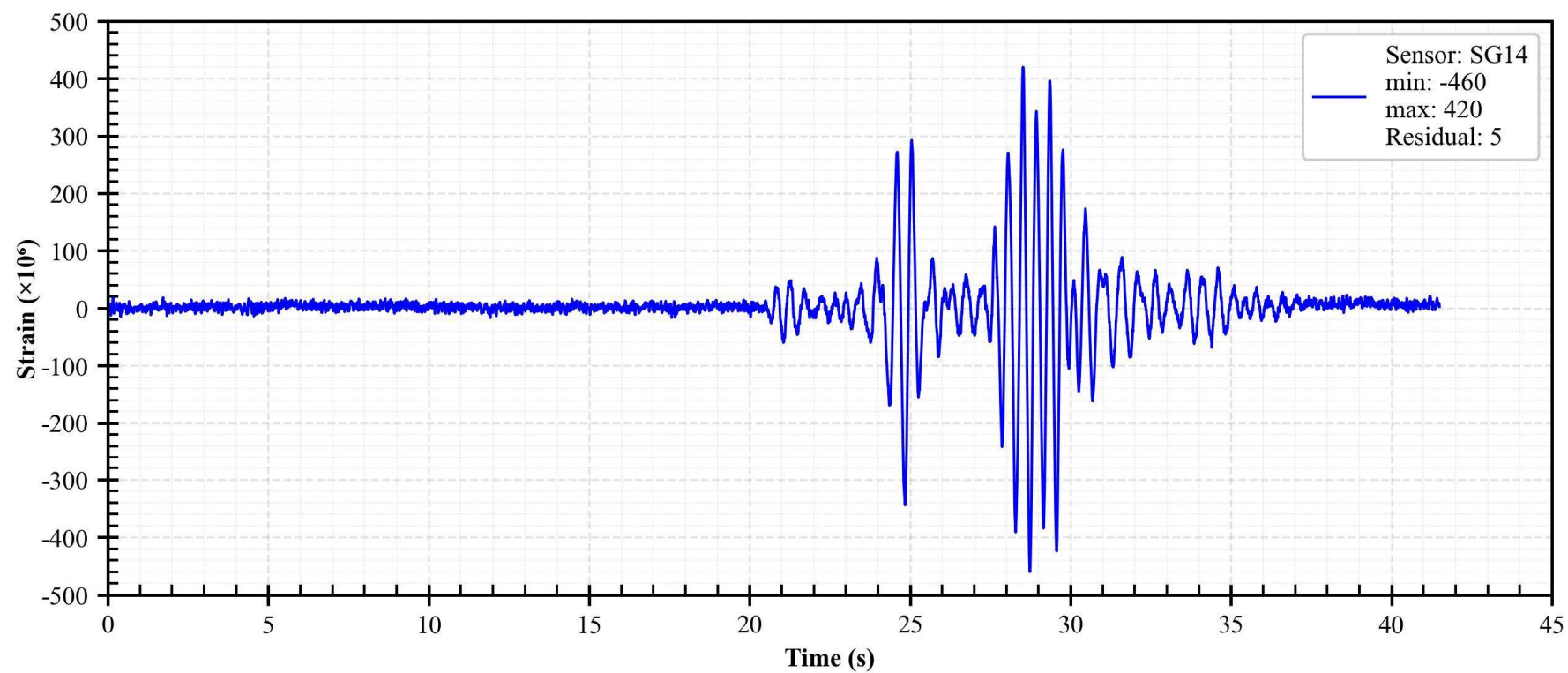


Figure 3.27.27 Characteristic results for phase B (earthquake 0,2g): strain gauge 14

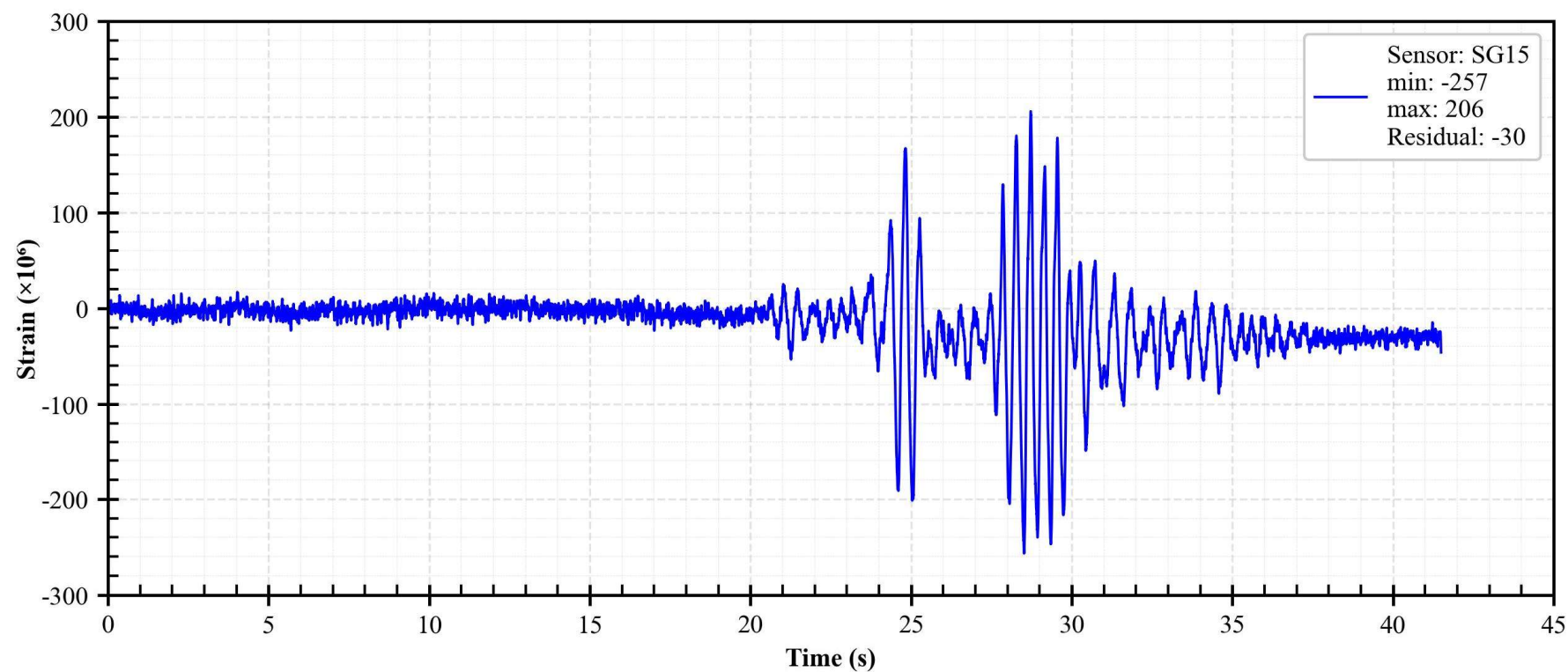


Figure 3.27.28 Characteristic results for phase B (earthquake 0,2g): strain gauge 15

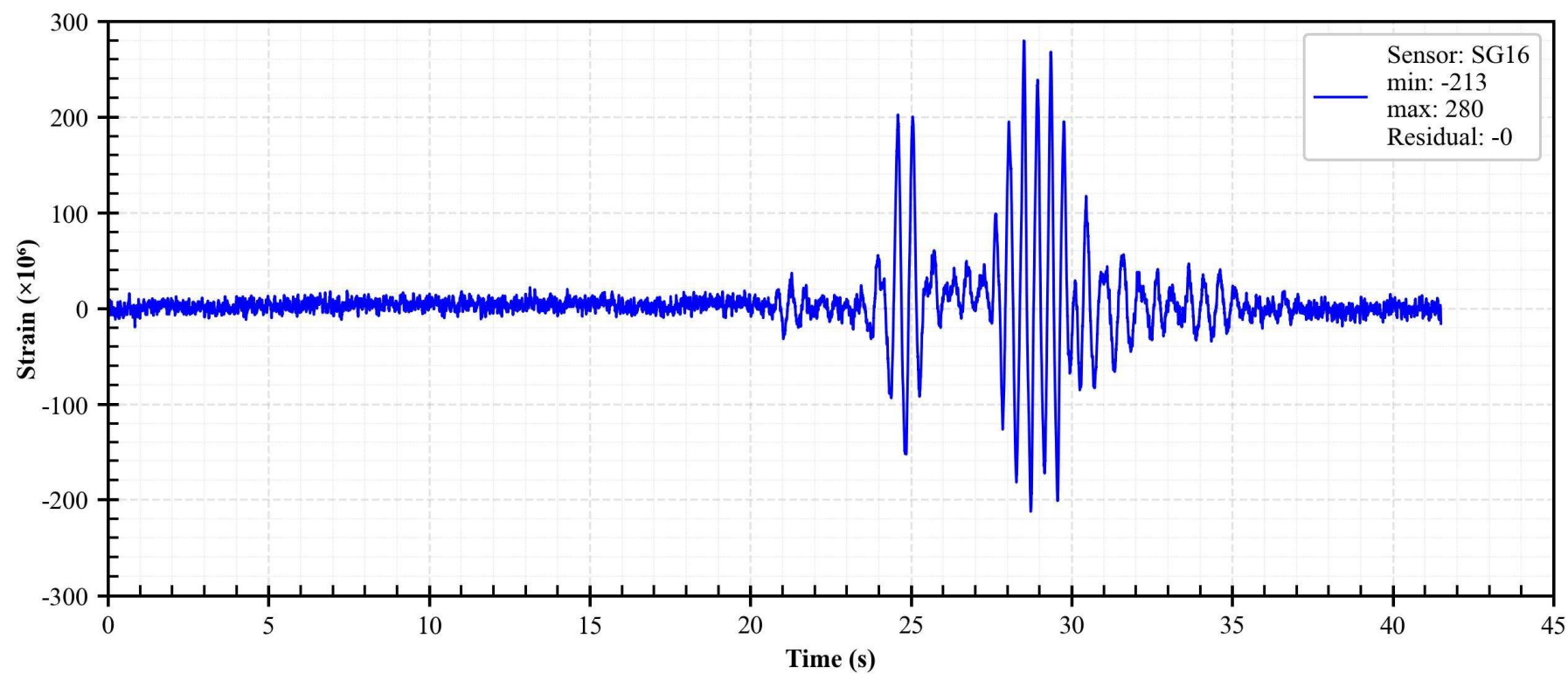


Figure 3.27.29 Characteristic results for phase B (earthquake 0,2g): strain gauge 16

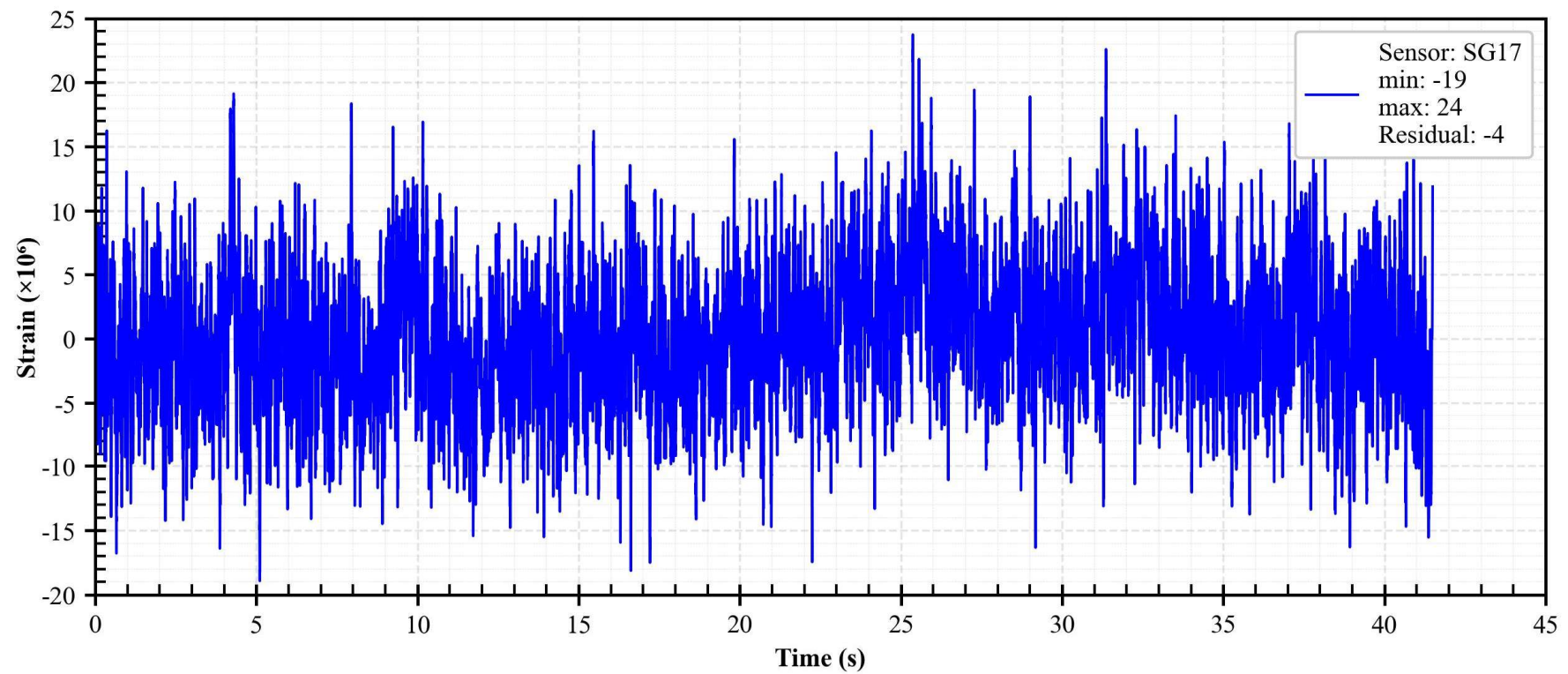


Figure 3.27.30 Characteristic results for phase B (earthquake 0,2g): strain gauge 17

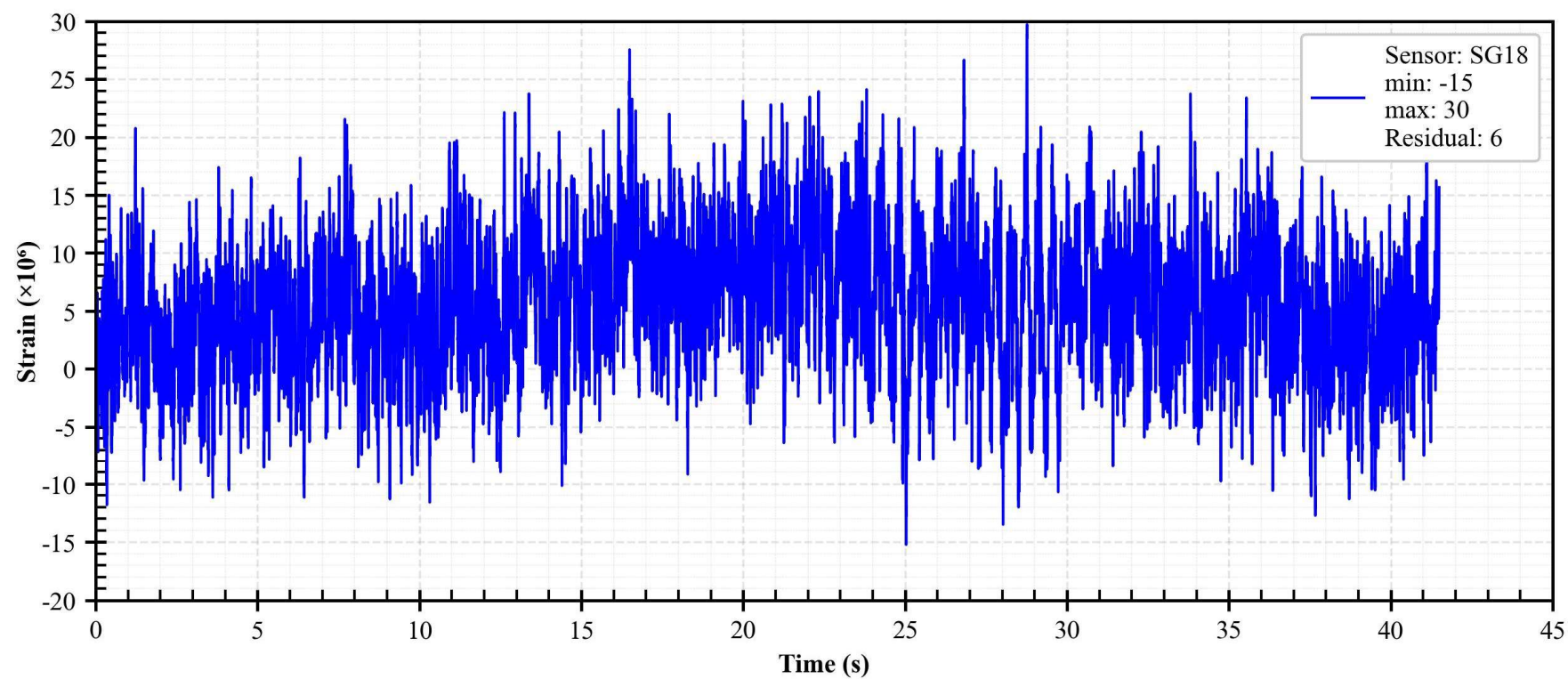


Figure 3.27.31 Characteristic results for phase B (earthquake 0,2g): strain gauge 18

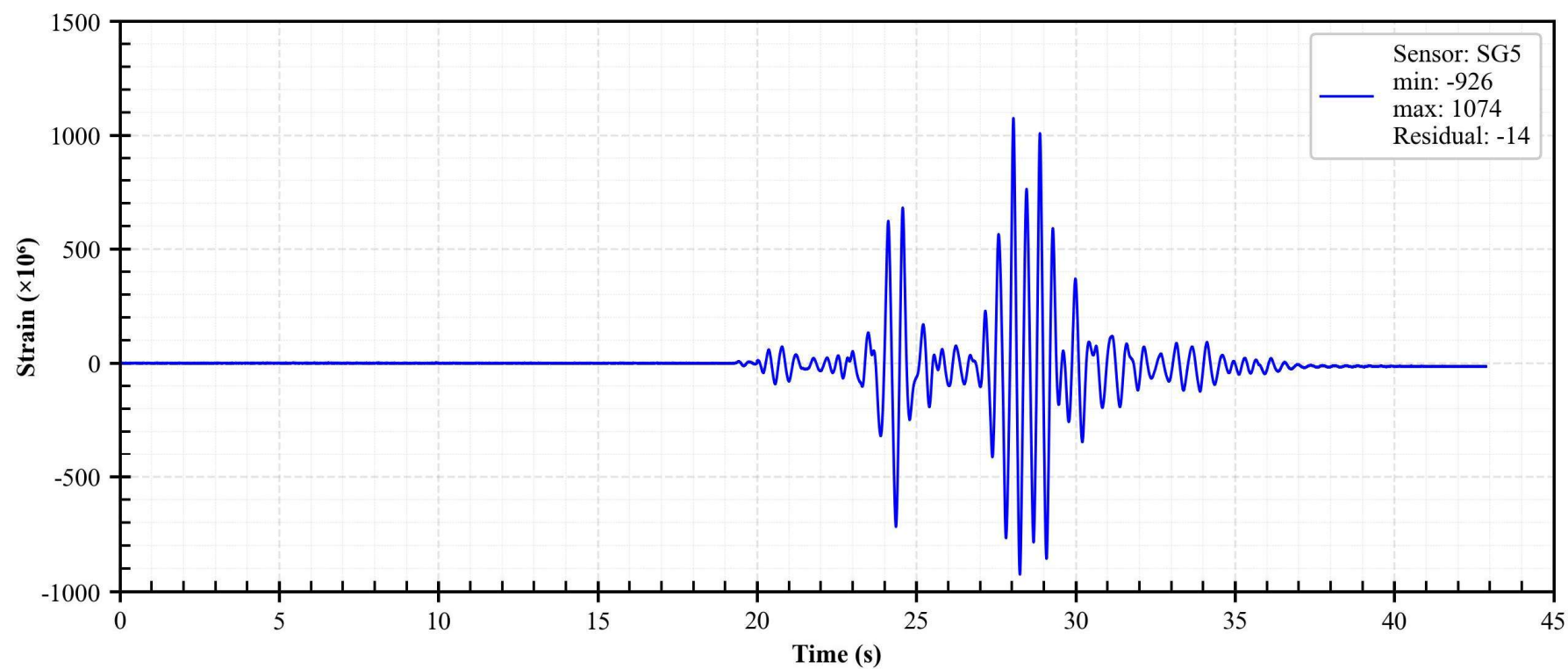


Figure 3.27.32 Characteristic results for phase B (earthquake 0,2g): strain gauge 5

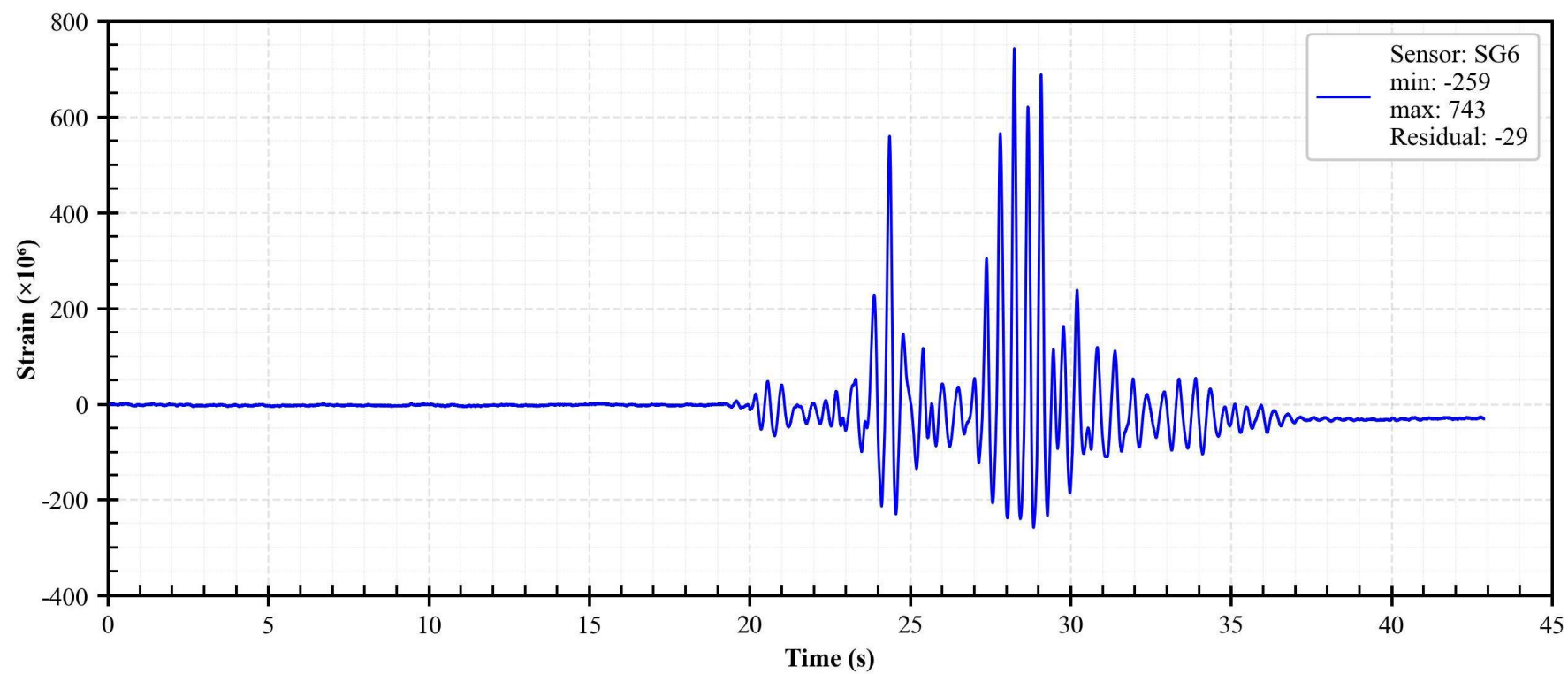


Figure 3.27.33 Characteristic results for phase B (earthquake 0,2g): strain gauge 6

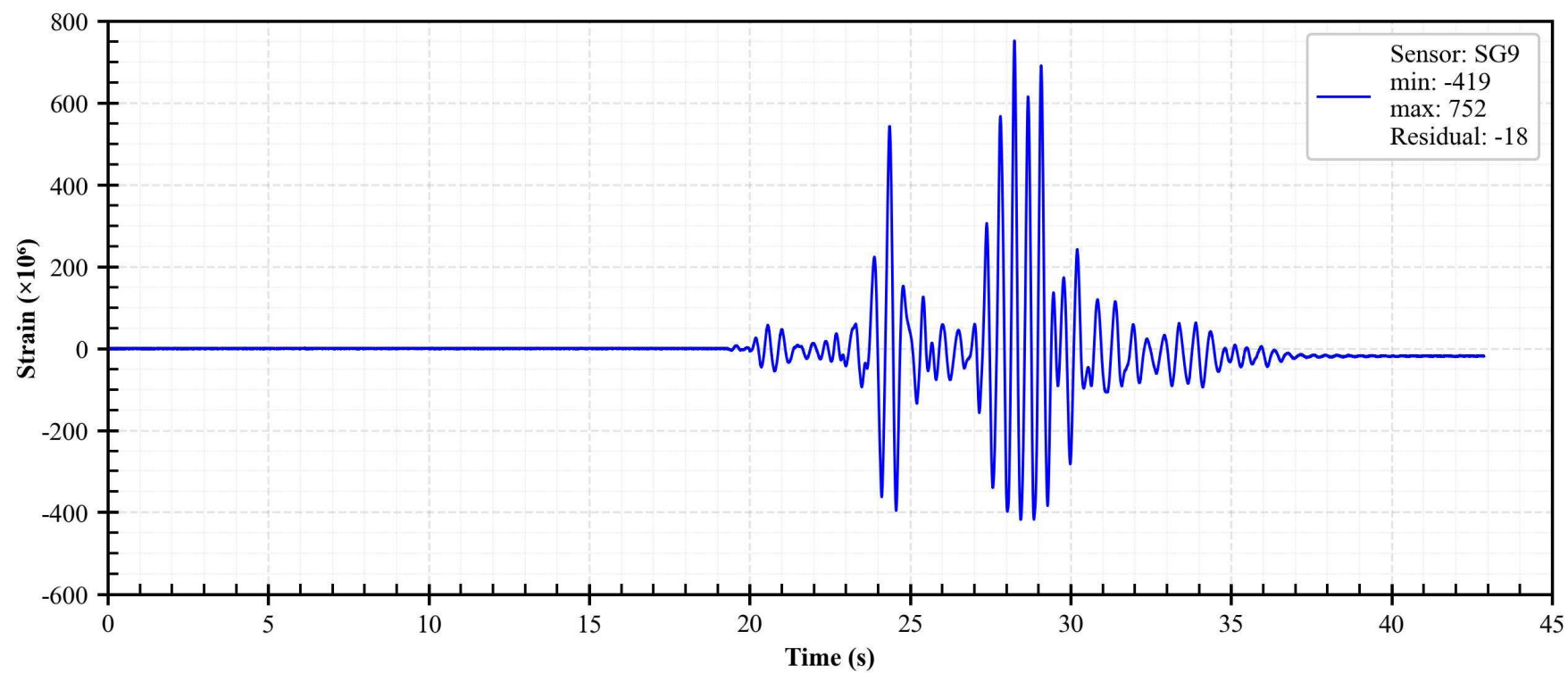


Figure 3.27.34 Characteristic results for phase B (earthquake 0,2g): strain gauge 9

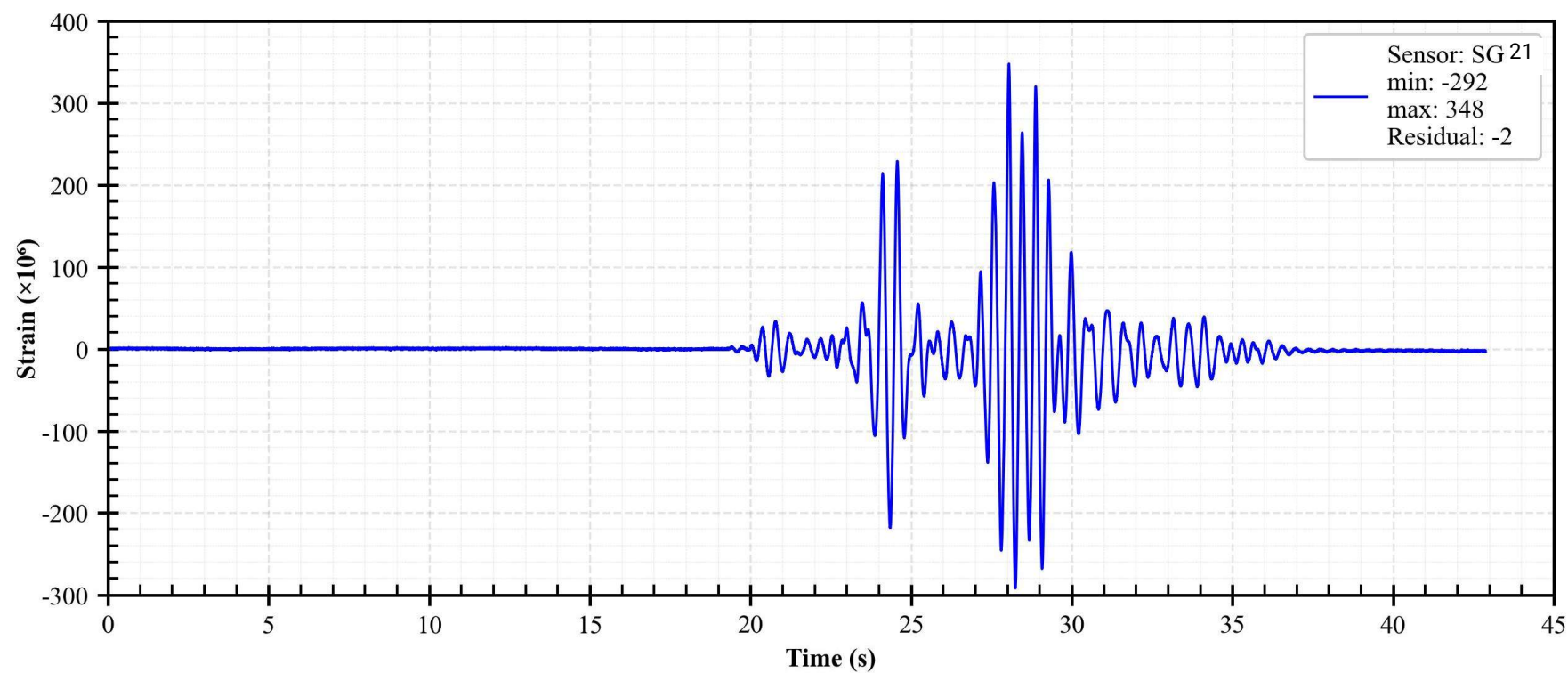


Figure 3.27.35 Characteristic results for phase B (earthquake 0,2g): strain gauge 21 (PUFJ, column 1)

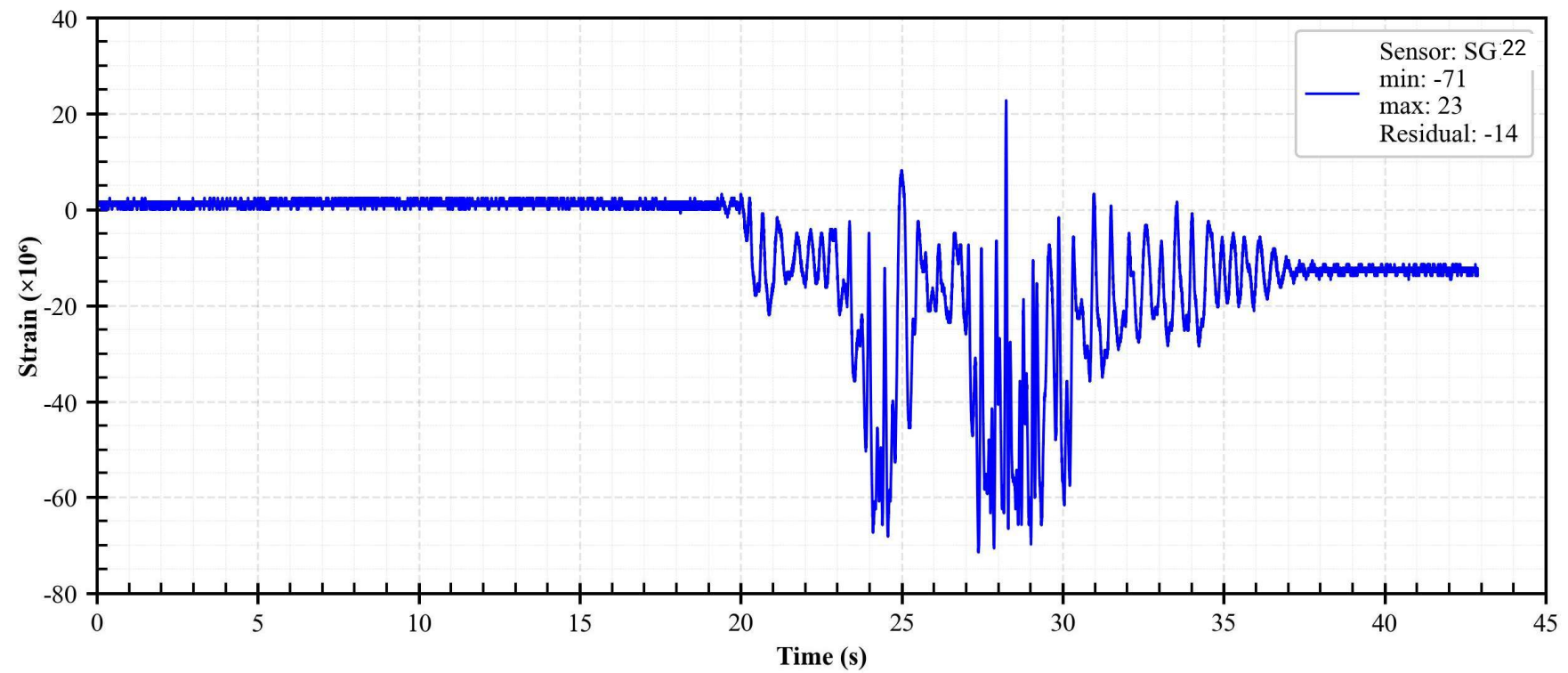


Figure 3.27.36 Characteristic results for phase B (earthquake 0,2g): strain gauge 22 (PUFJ, column 2)

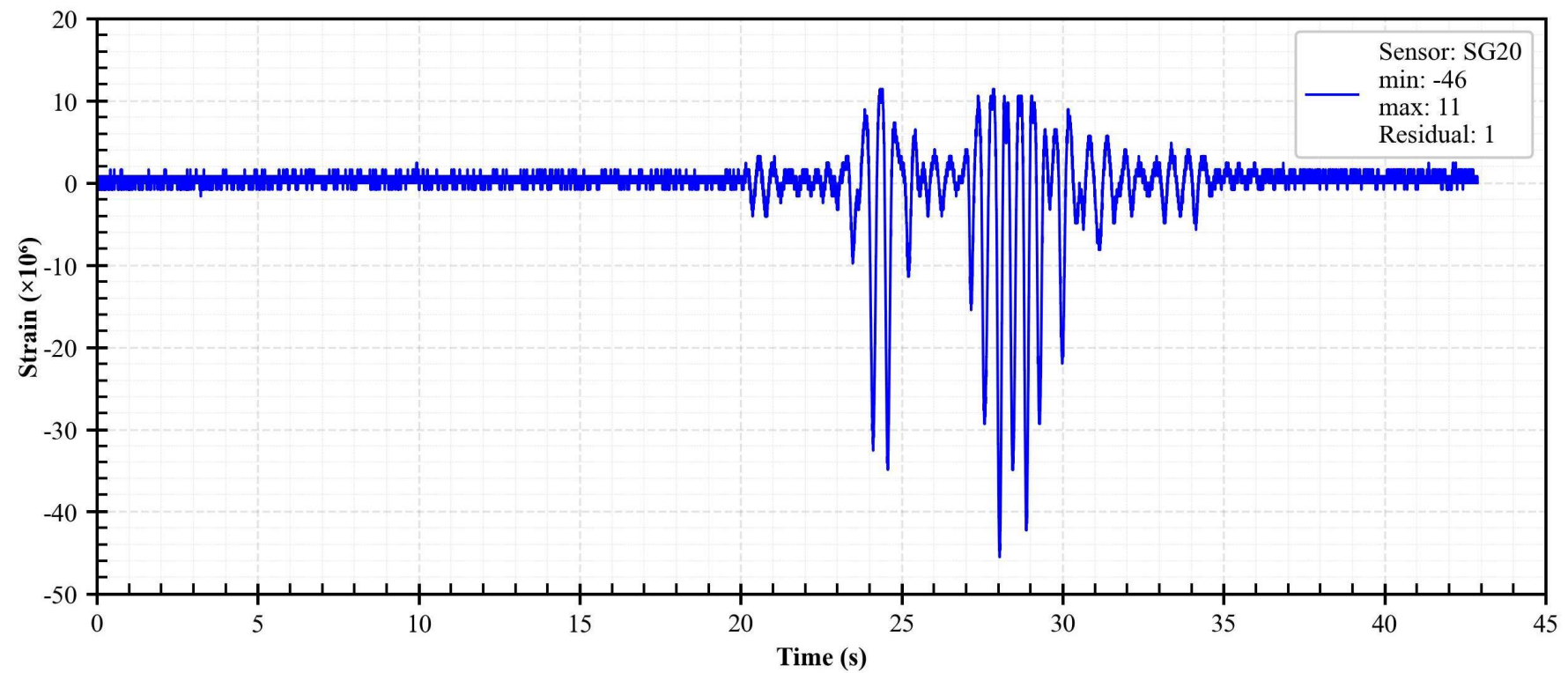


Figure 3.27.37 Characteristic results for phase B (earthquake 0,2g): strain gauge 20

3.28 White noise after EQ0,2g

Accelerometers

Characteristic extracts from the time history of accelerations of different of different accelerometers are given below for white noise test after EQ0,2g, without bottom fixing of the vertical living walls. The max acceleration at the slab level on the accelerometer acc4 is 0.21g. The max acceleration at the foundation level on the accelerometer acc10 is 0.05g.

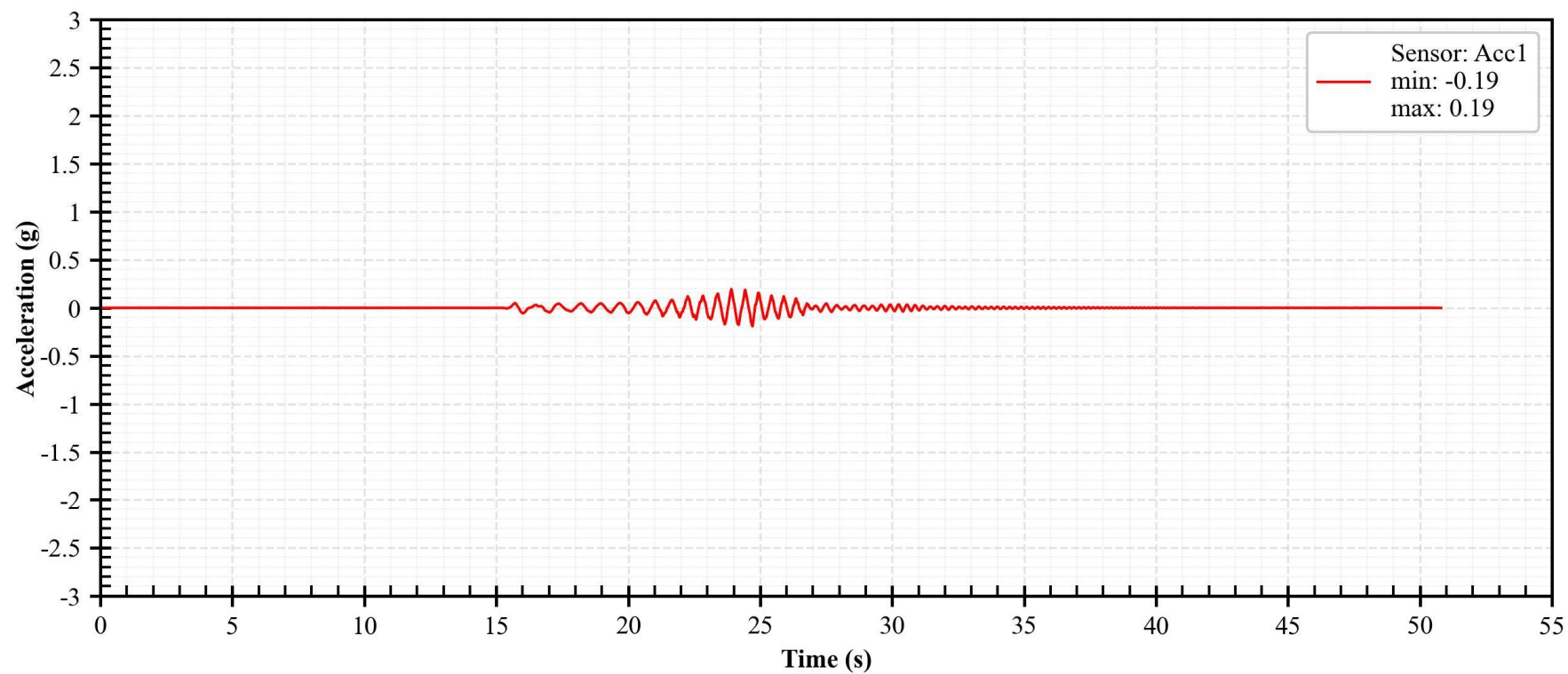


Figure 3.28.1 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 1

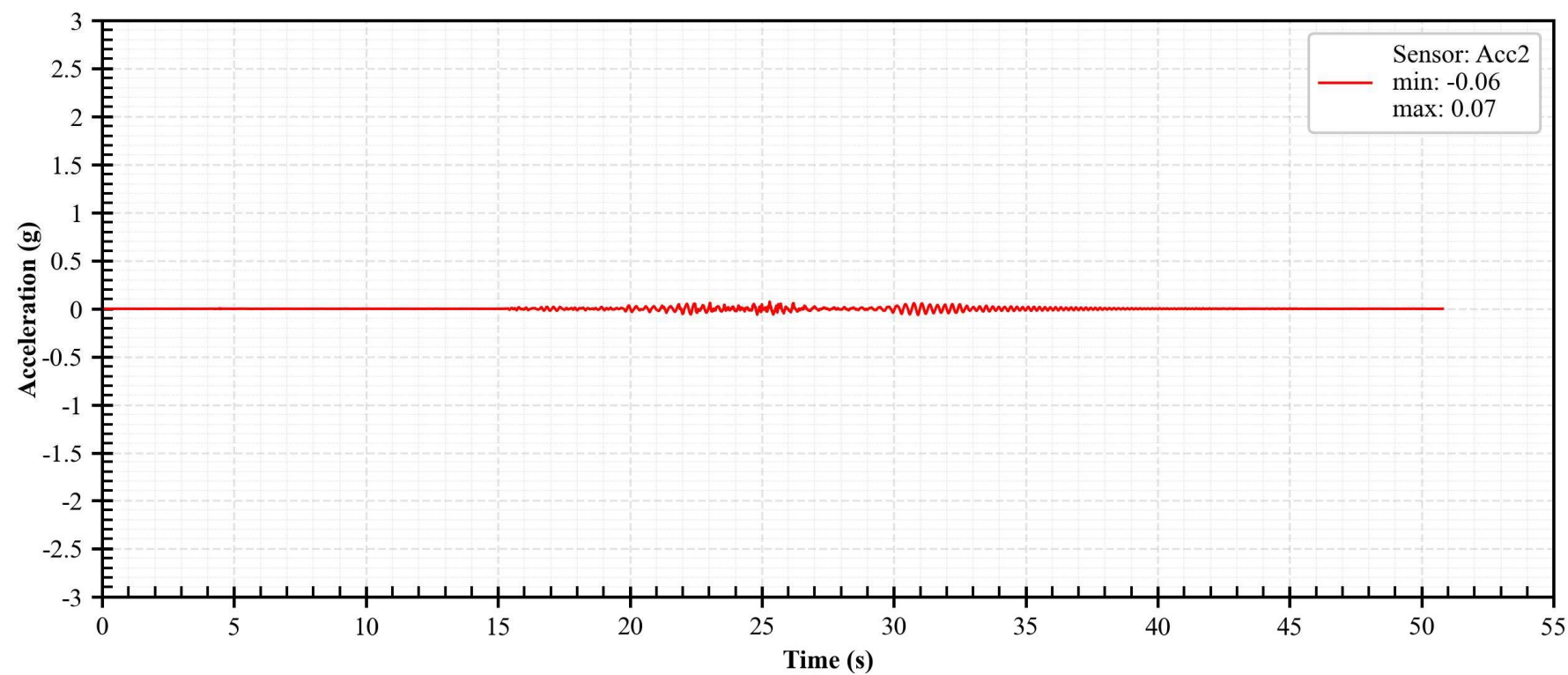


Figure 3.28.2 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 2

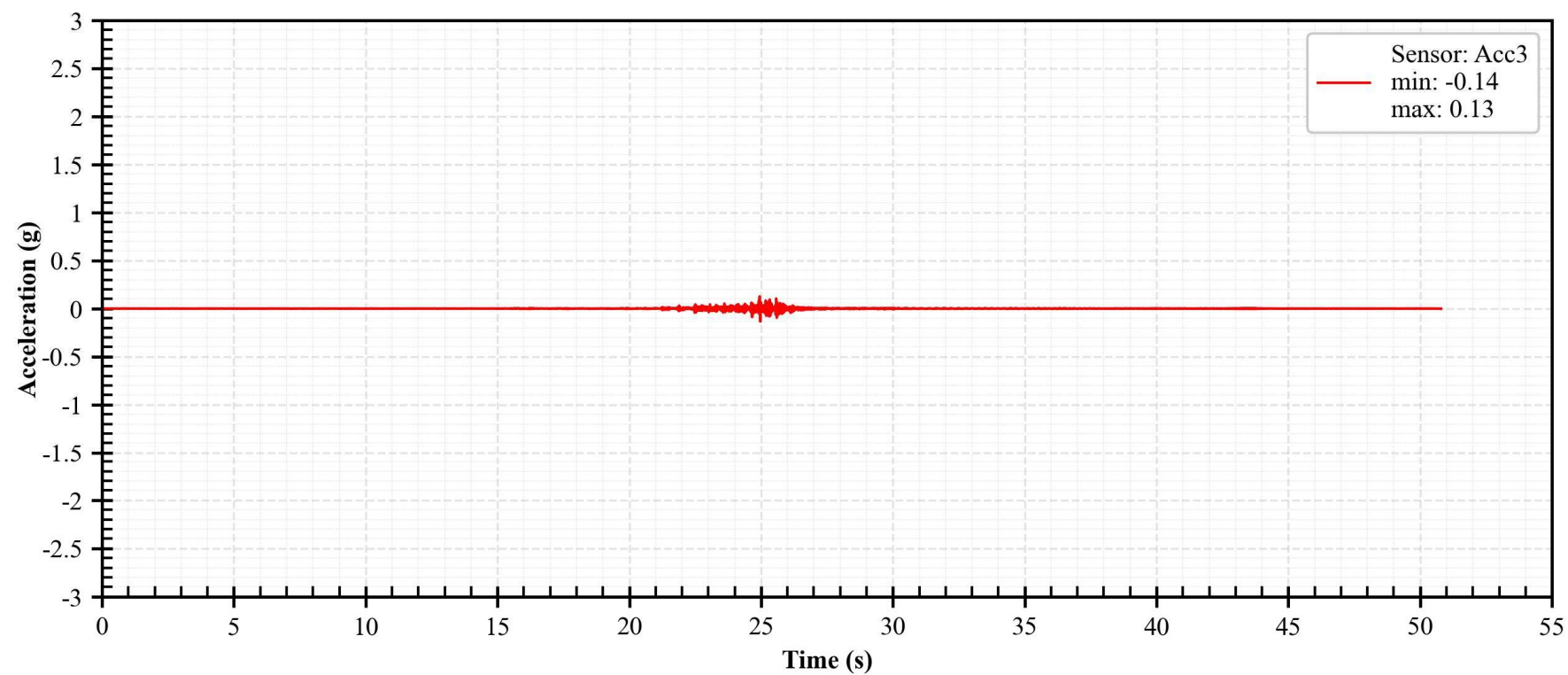


Figure 3.28.3 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 3

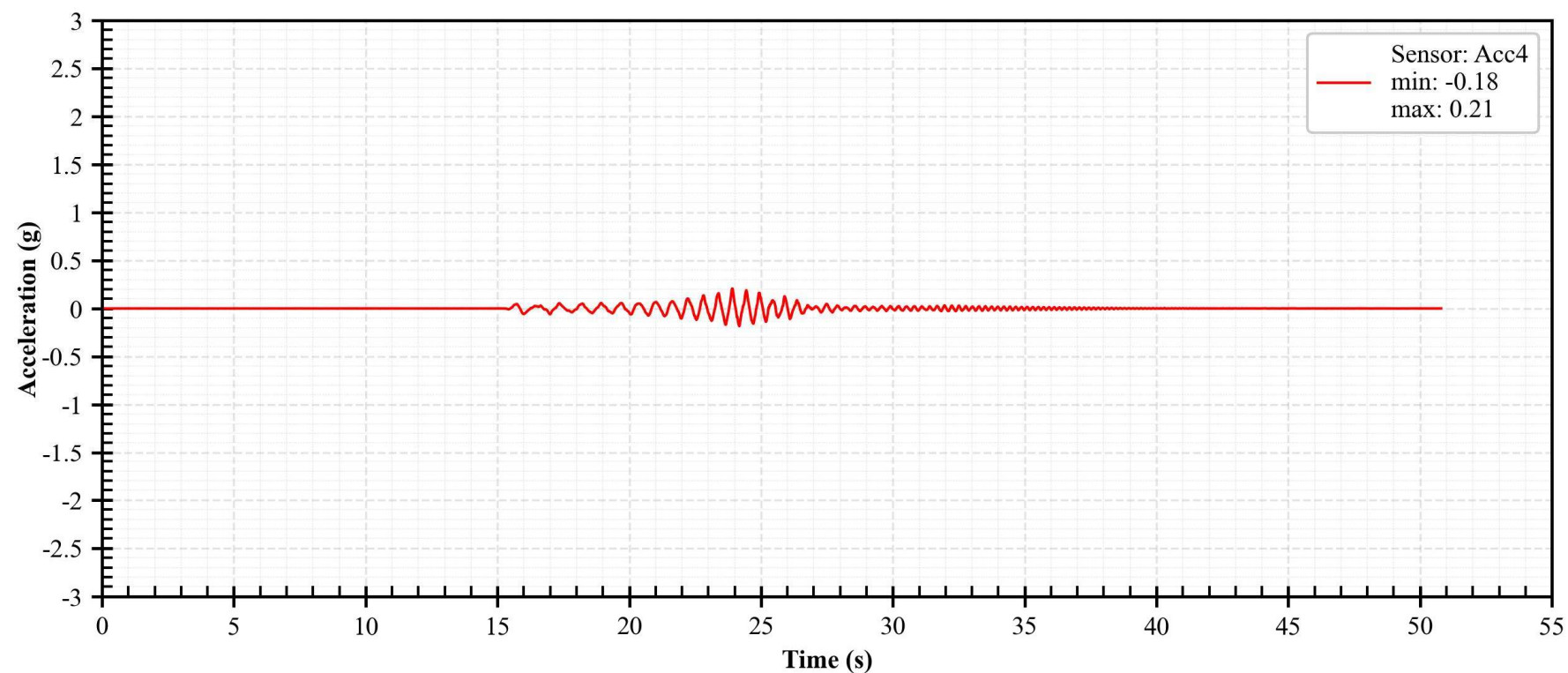


Figure 3.28.4 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 4

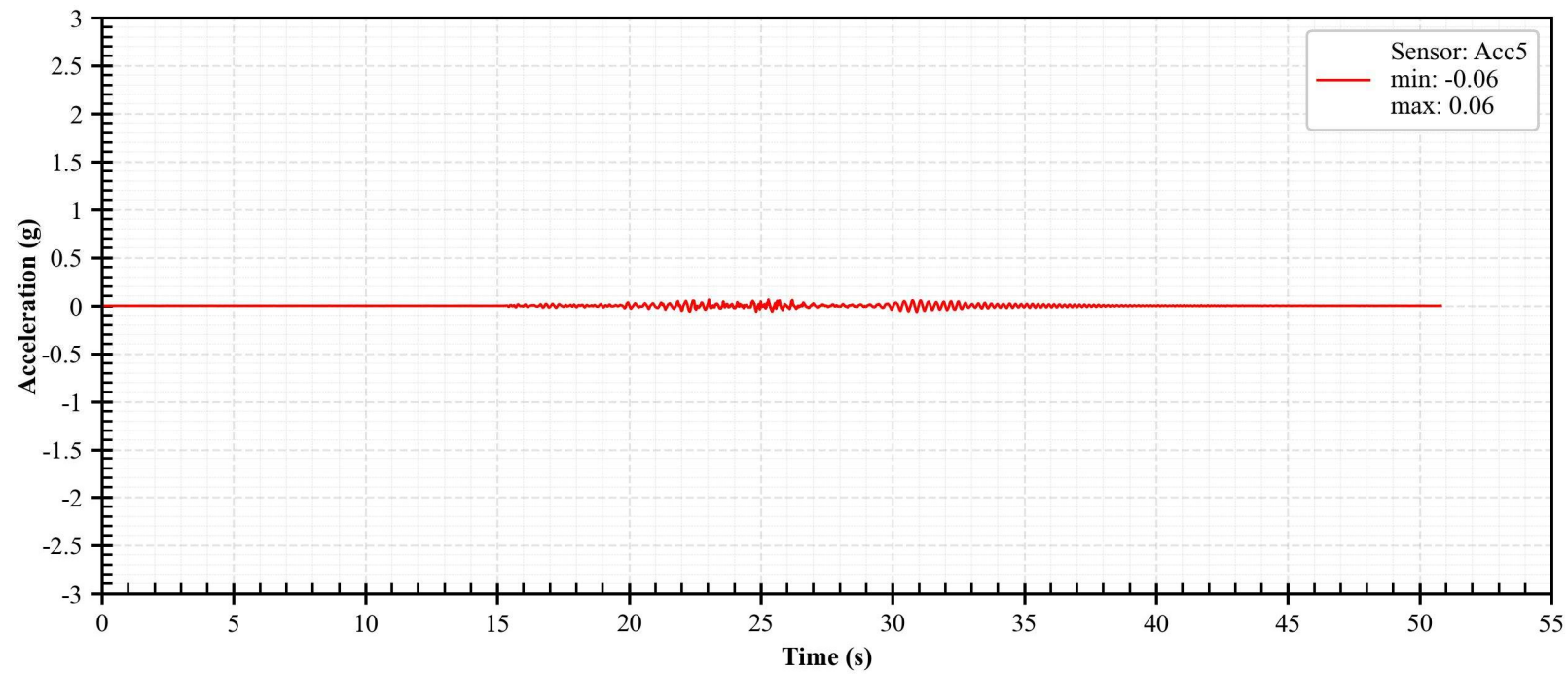


Figure 3.28.5 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 5

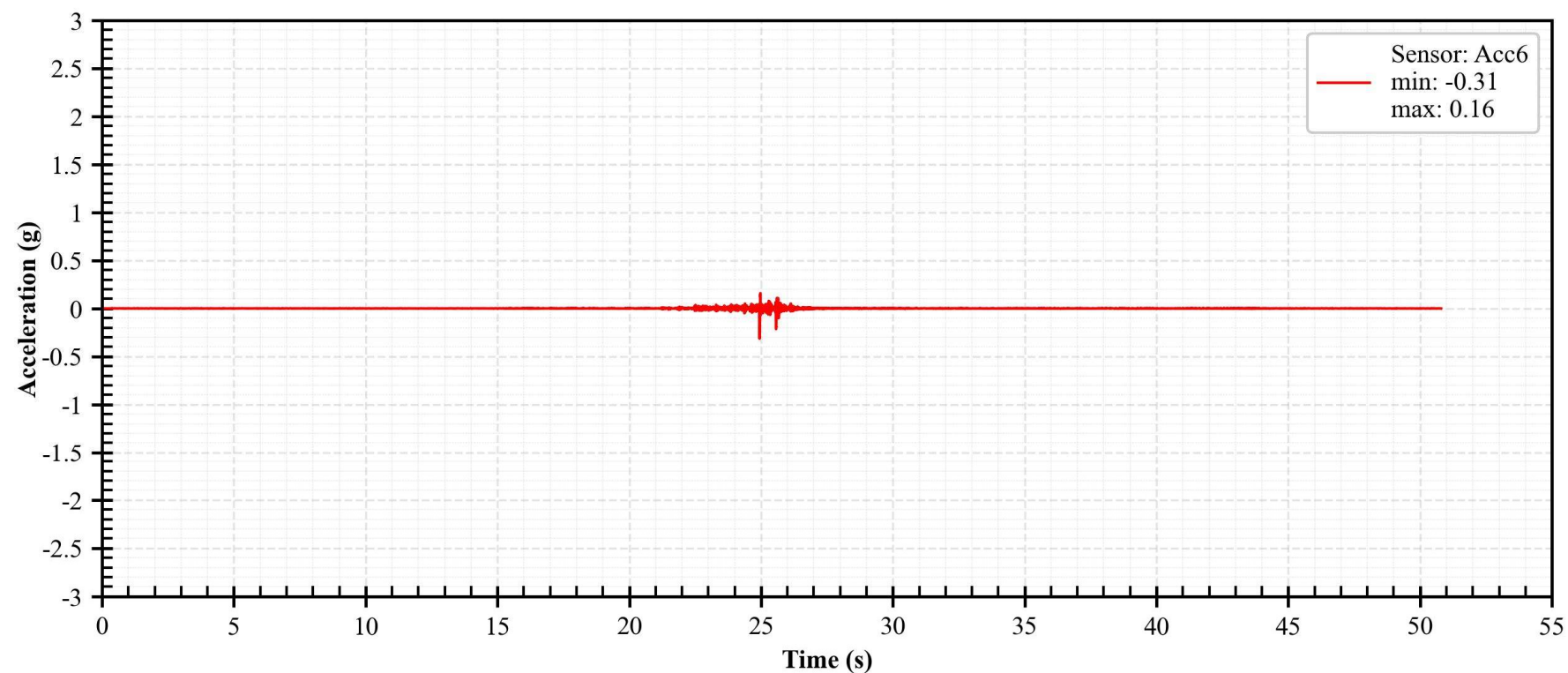


Figure 3.28.6 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 6

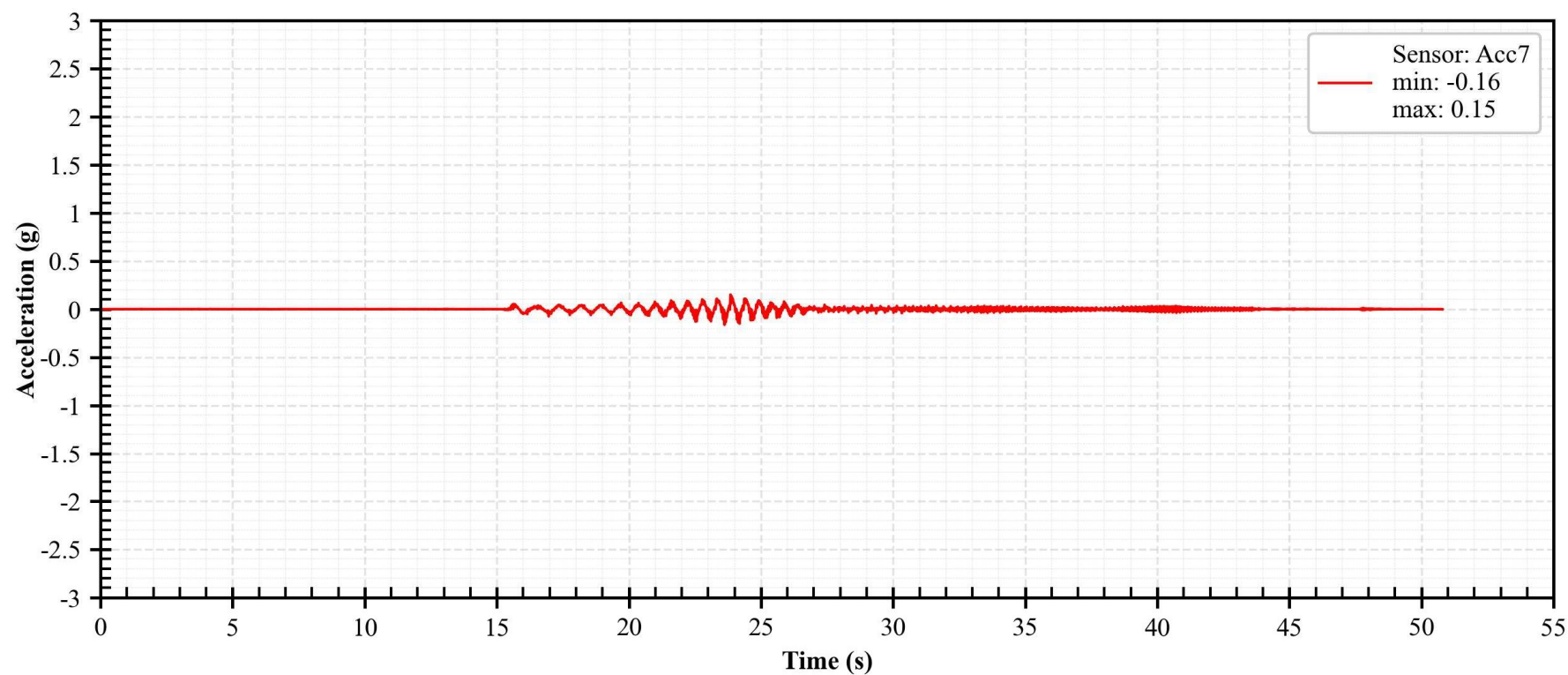


Figure 3.28.7 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 7

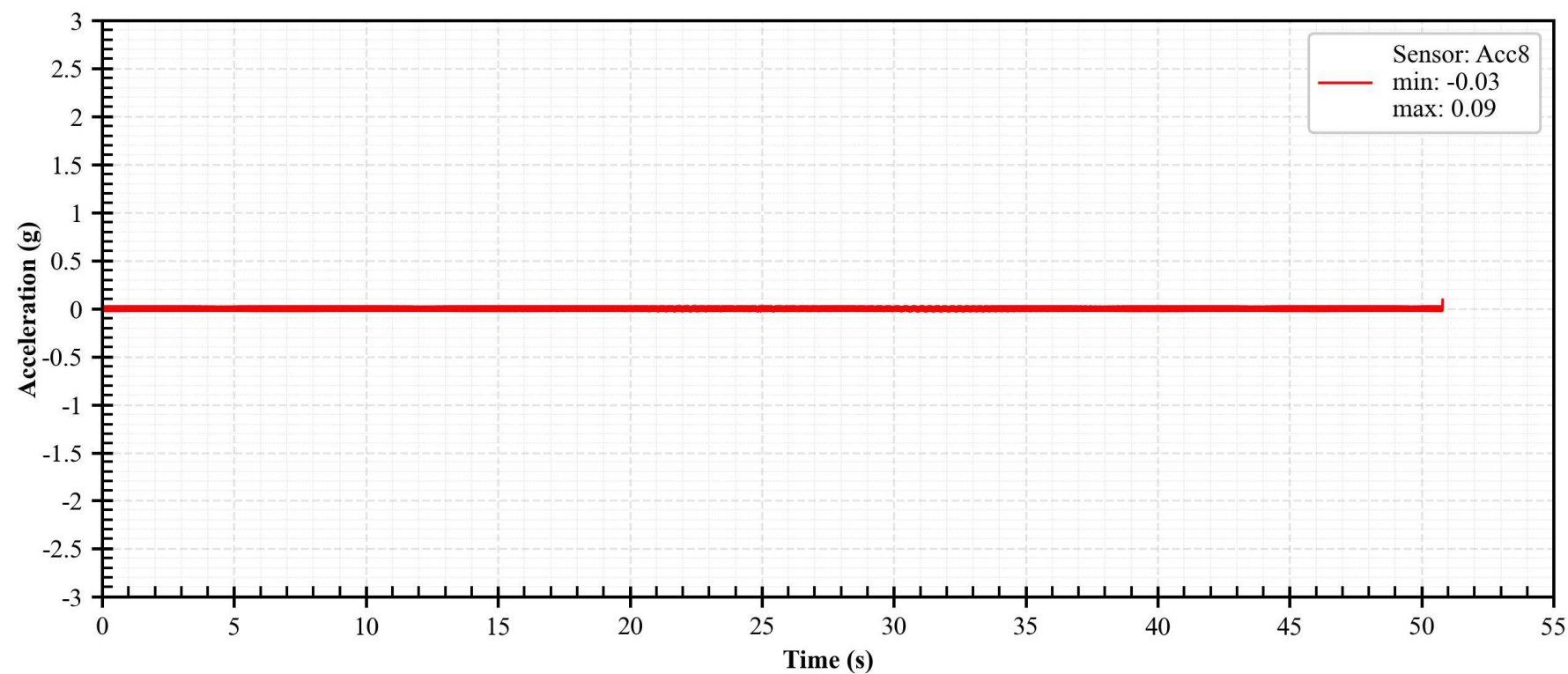


Figure 3.28.8 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 8

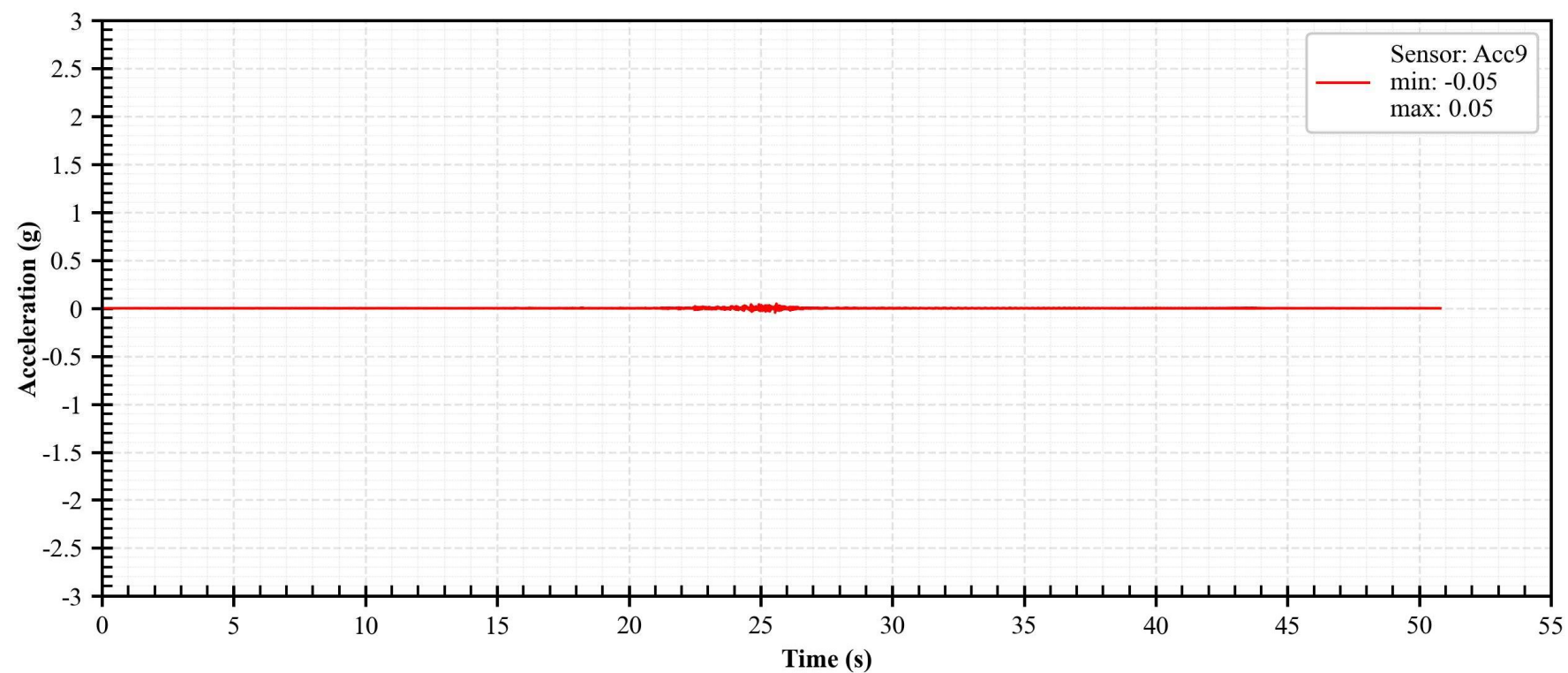


Figure 3.28.9 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 9

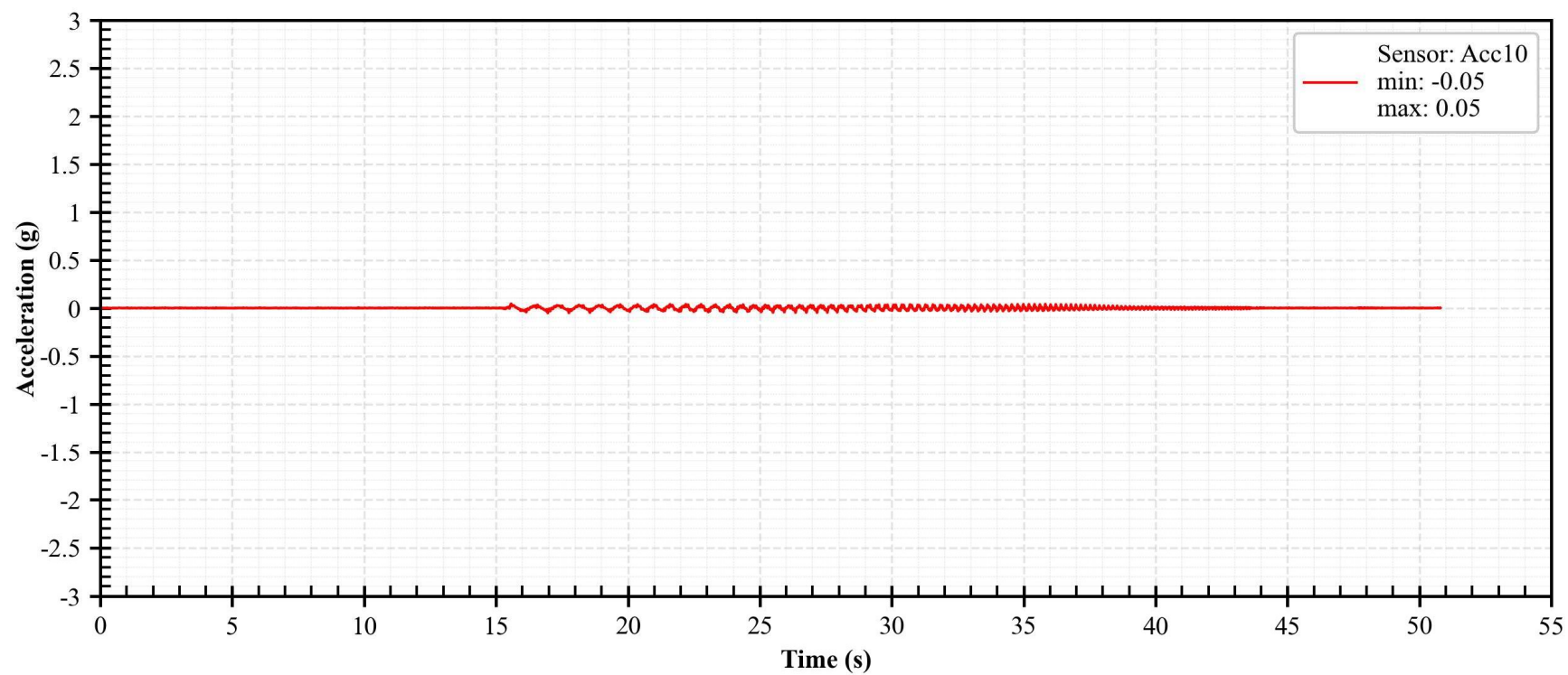


Figure 3.28.10 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 10

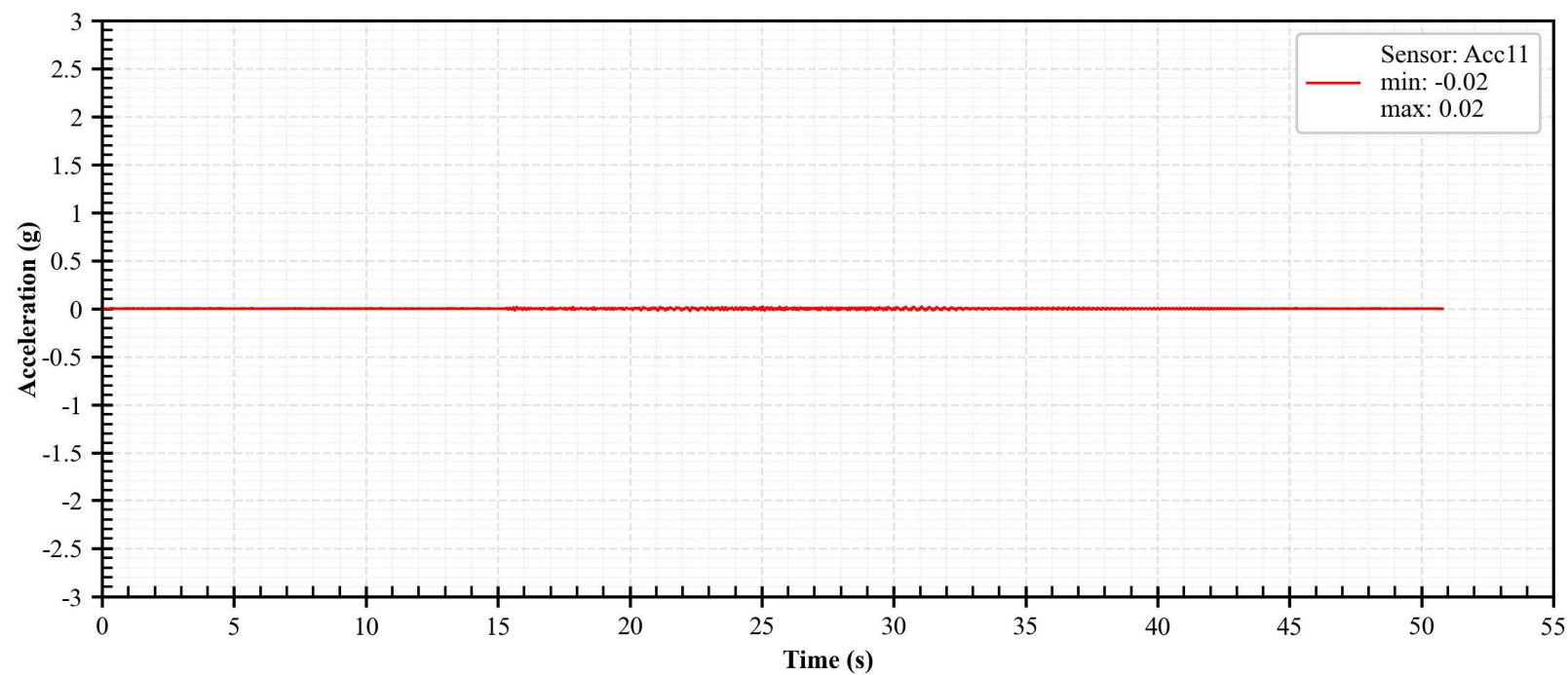


Figure 3.28.11 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 11

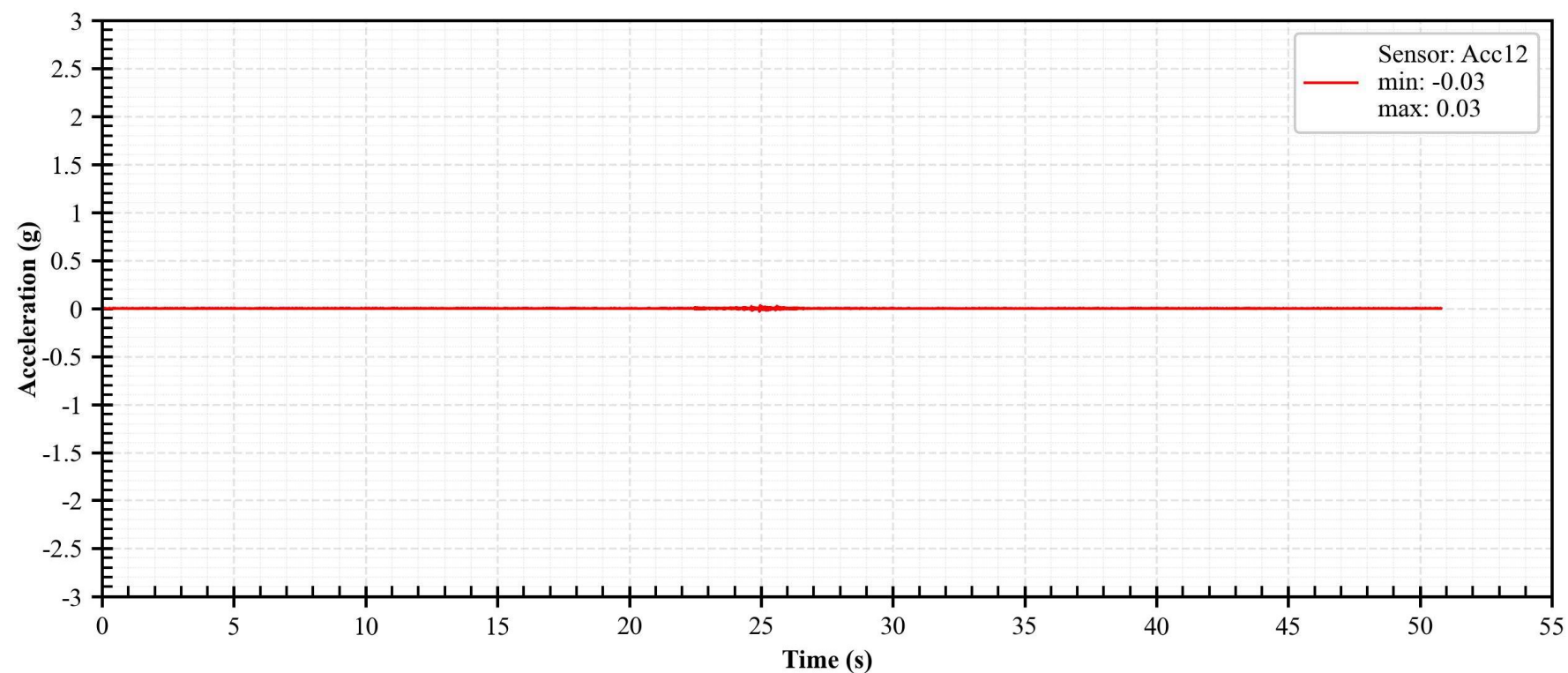


Figure 3.28.12 Characteristic results for phase B (white noise after EQ0,2g): Accelerometer 12

Draw wire sensors

Figures 3.27.13 – 3.27.16 show draw wire sensors W1, W2, W3, W4, accordingly. More specifically, draw wire sensor W1 is located on the slab, on the left side and draw wire sensor W2 is located on the slab, on the right side. Draw wire sensor W3, is located on the foundation, on the left side and draw wire sensor W4 is located on the foundation, on the right side. The maximum movement detected by draw wire sensor W1 is 23.55 mm while the minimum is -22.26 mm. The maximum movement detected by draw wire sensor W2 is 23.48 mm while the minimum is -22.02 mm. The maximum movement detected by draw wire sensor W3 is 21 mm while the minimum is -16.44 mm. The maximum movement detected by draw wire sensor W4 is 21.07 mm while the minimum is -16.48 mm. The maximum drift is $(9.64/1.225) = 7.87 \text{ ‰}$ and minimum drift is $(-8.71/1.225) = -7.11 \text{ ‰}$.



Draw wire sensors

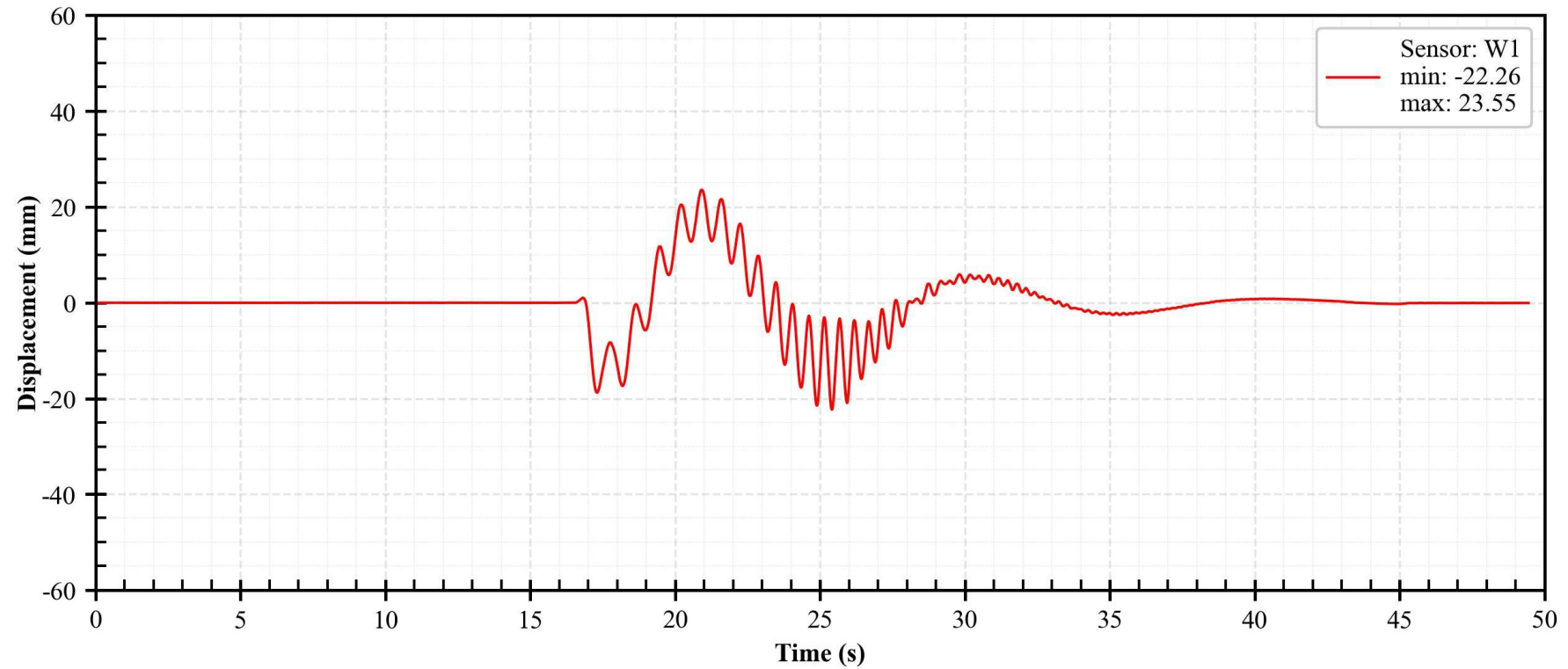


Figure 3.28.13 Characteristic results for phase B (white noise after EQ0,2g): Draw wire sensor 1

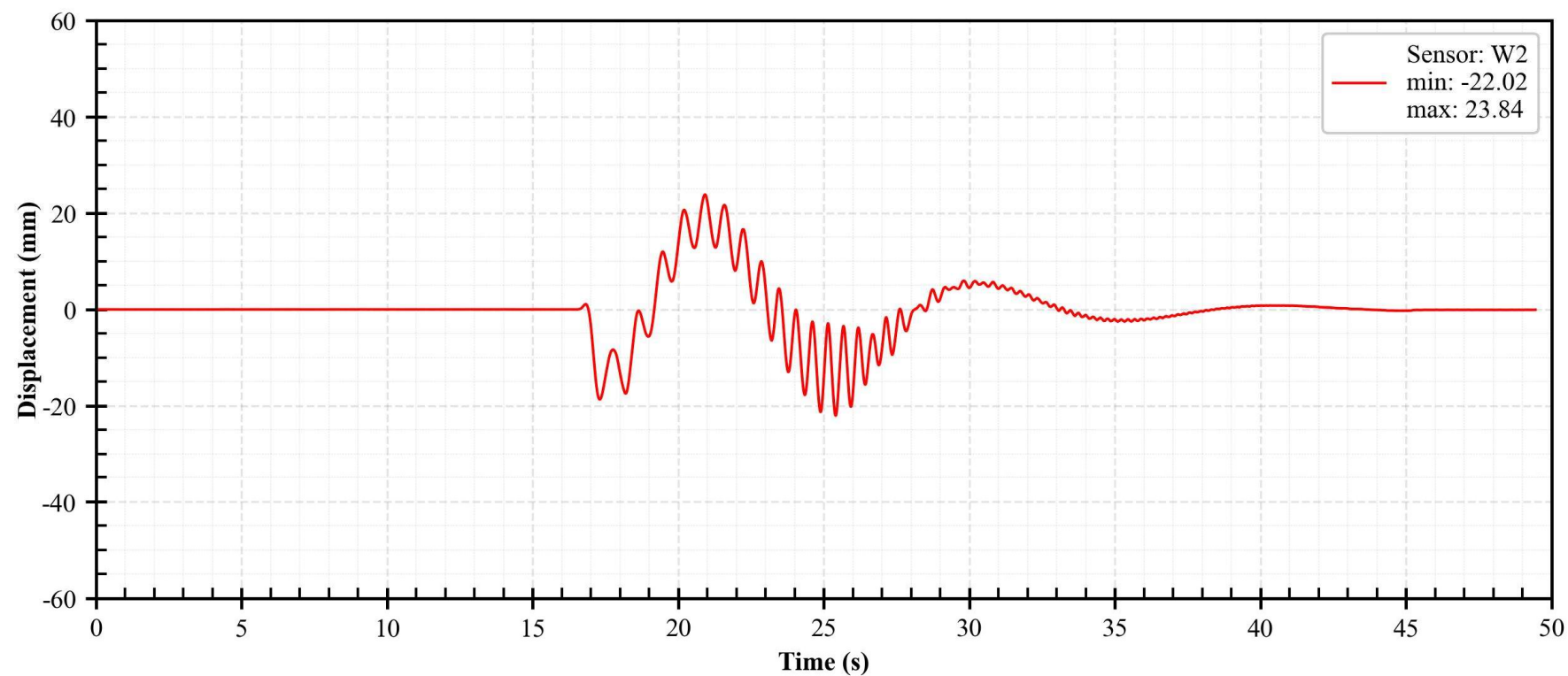


Figure 3.28.14 Characteristic results for phase B (white noise after EQ0,2g): Draw wire sensor 2

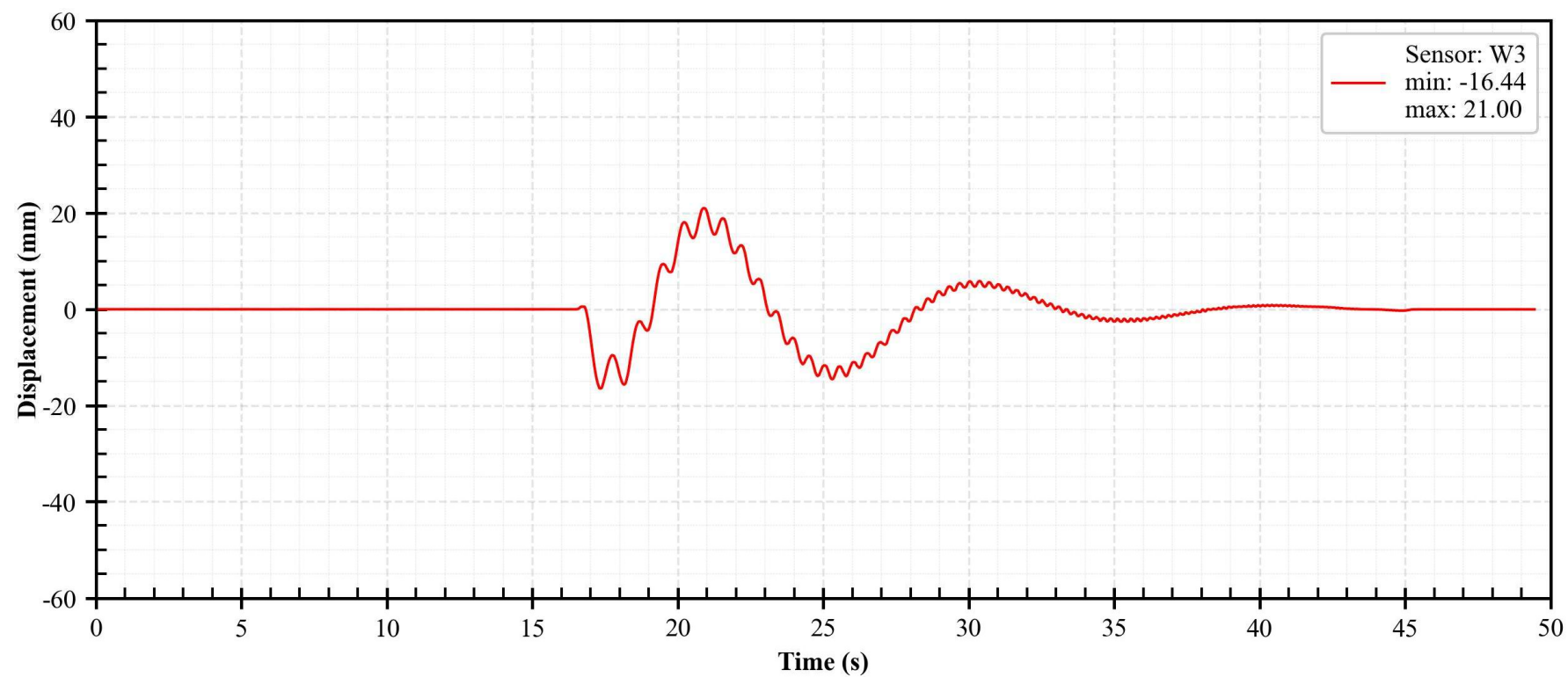


Figure 3.28.15 Characteristic results for phase B (white noise after EQ0,2g): Draw wire sensor 3

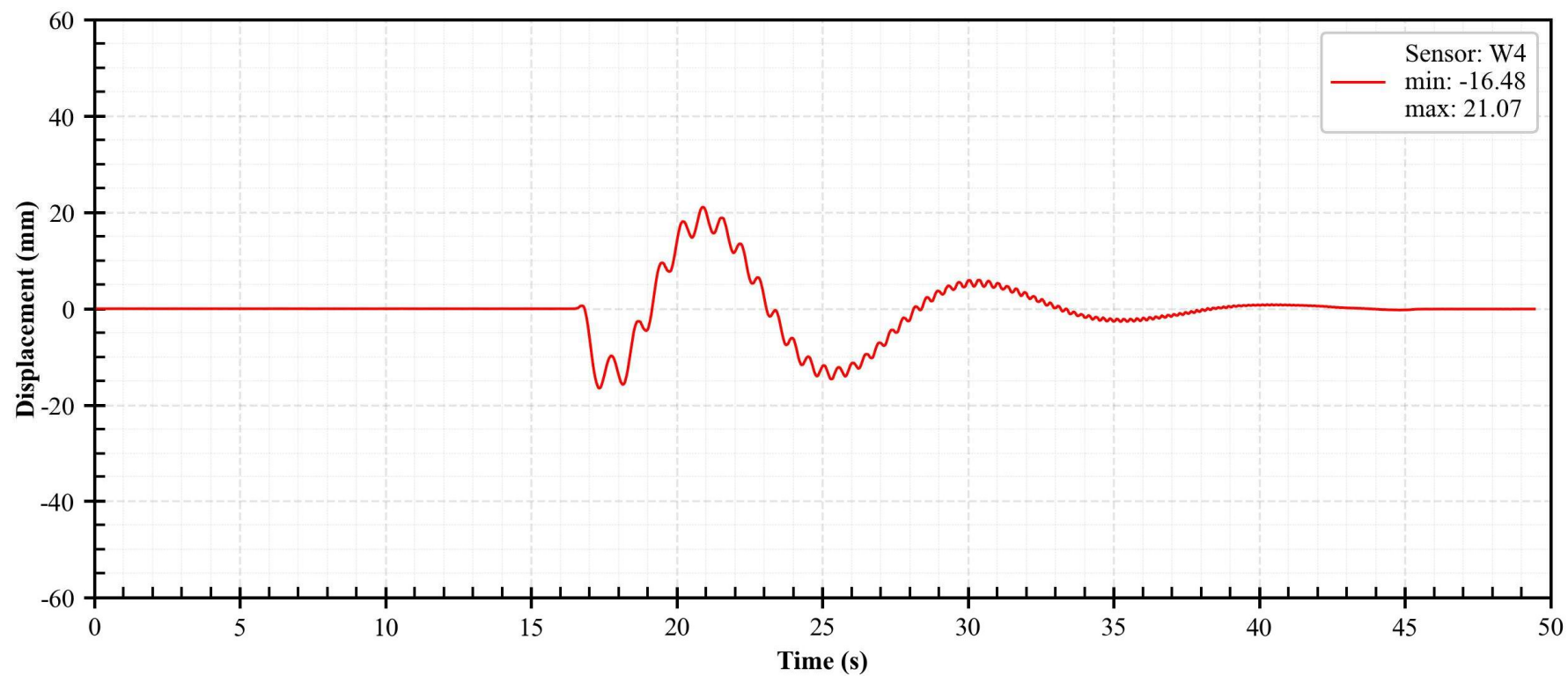


Figure 3.28.16 Characteristic results for phase B (white noise after EQ0,2g): Draw wire sensor 4

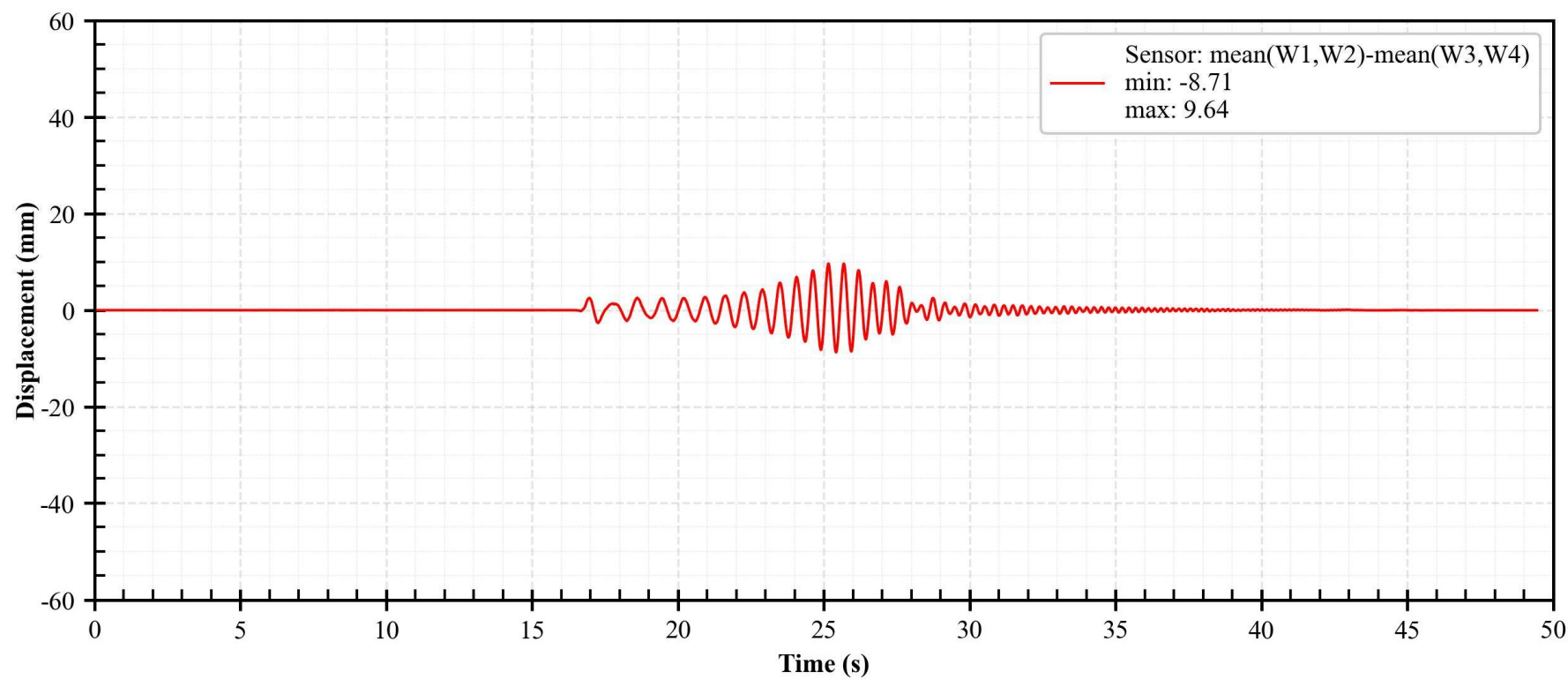


Figure 3.28.17 Characteristic results for phase B (white noise after EQ0,2g): $\text{mean}(W1, W2) - \text{mean}(W3, W4)$

Strain gauges

No notable changes are detected in the values of strain gauges.

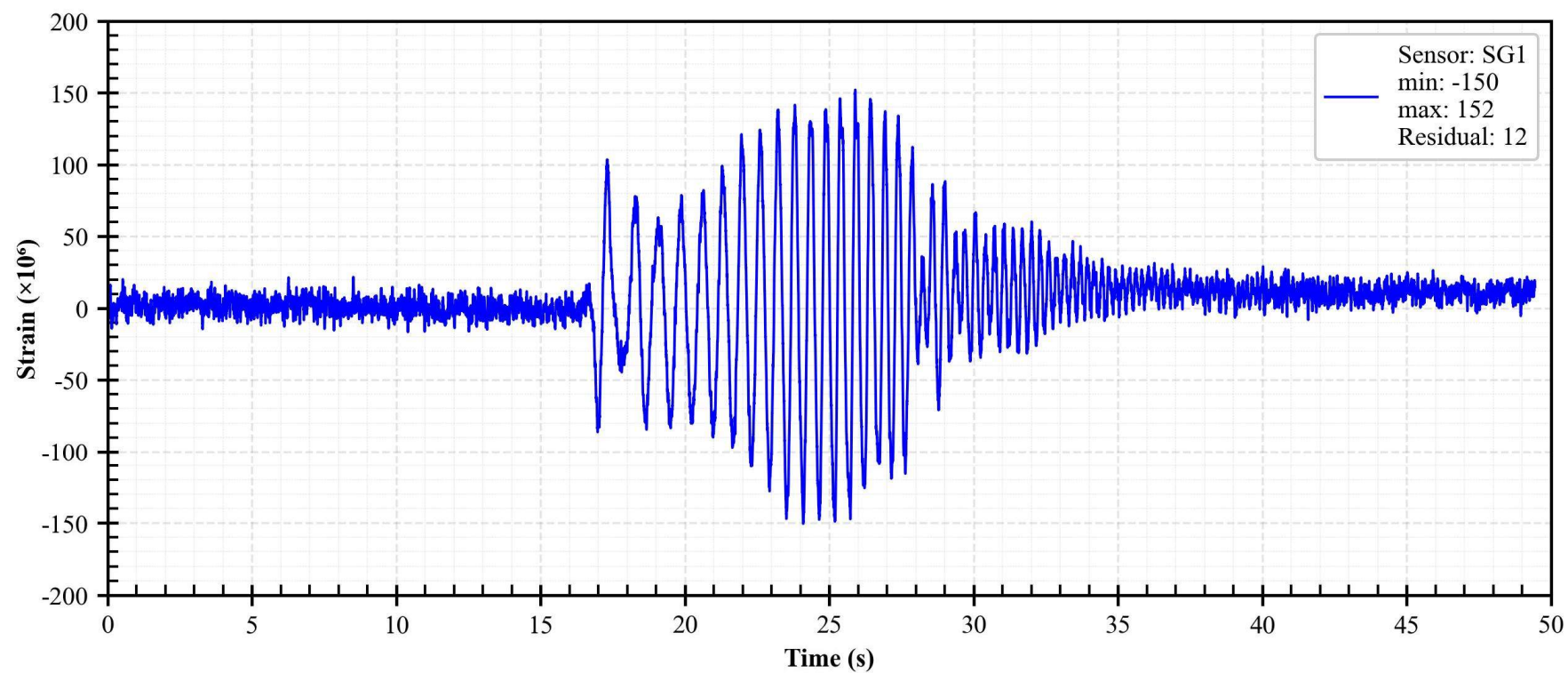


Figure 3.28.18 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 1

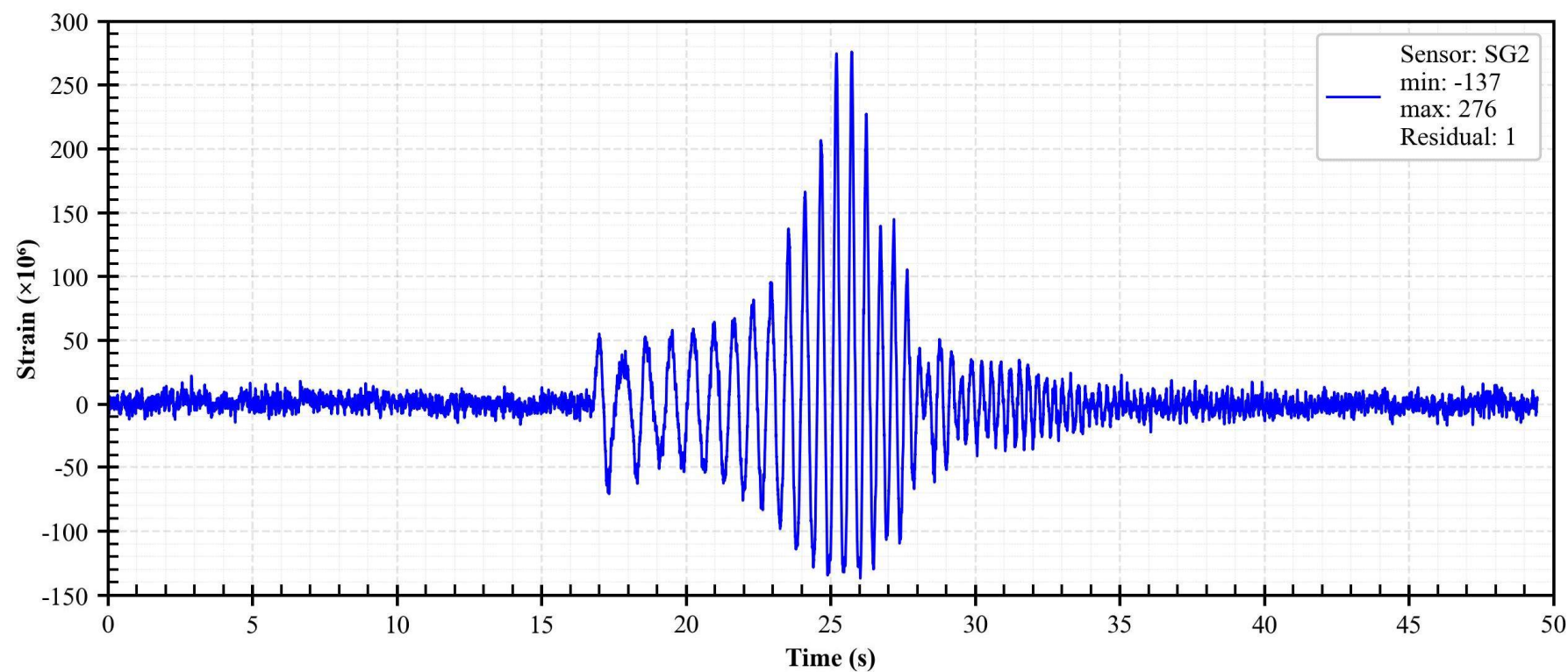


Figure 3.28.19 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 2

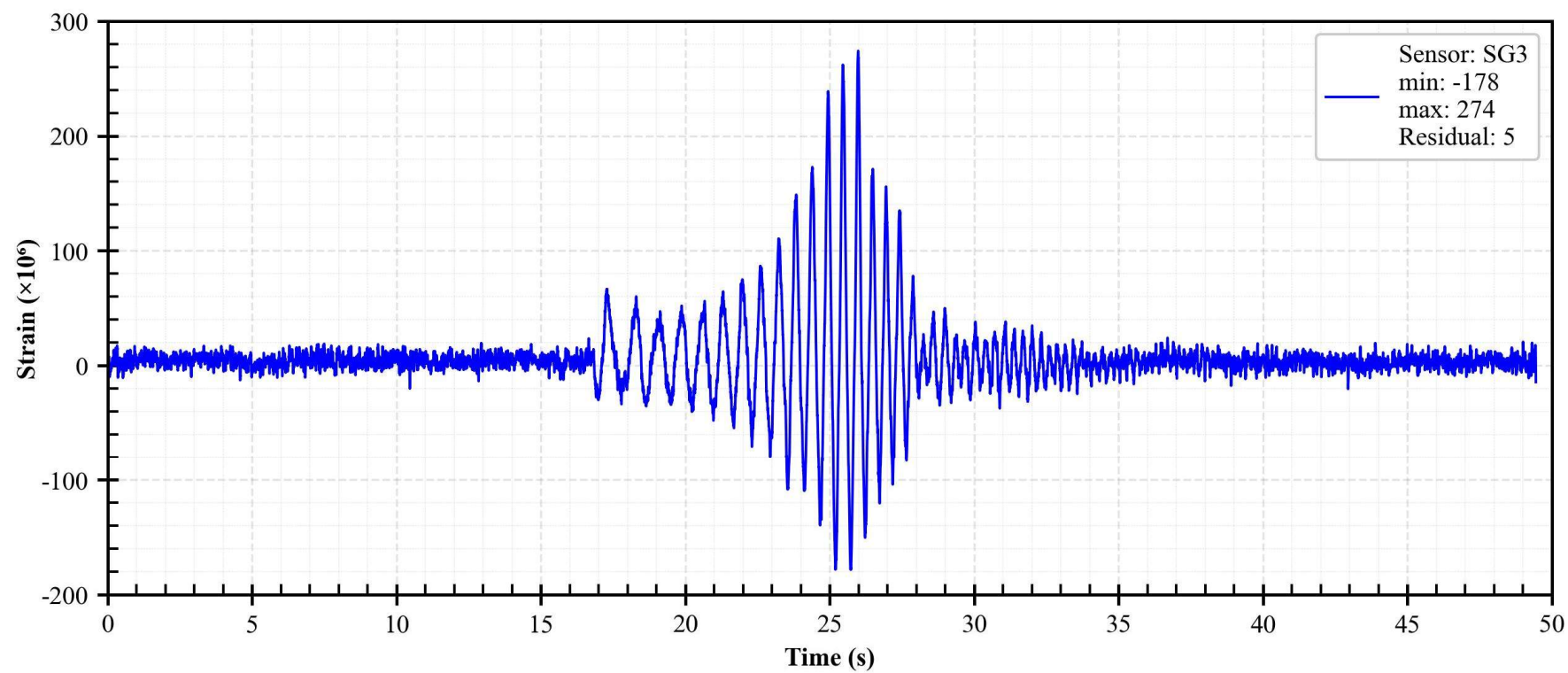


Figure 3.28.20 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 3

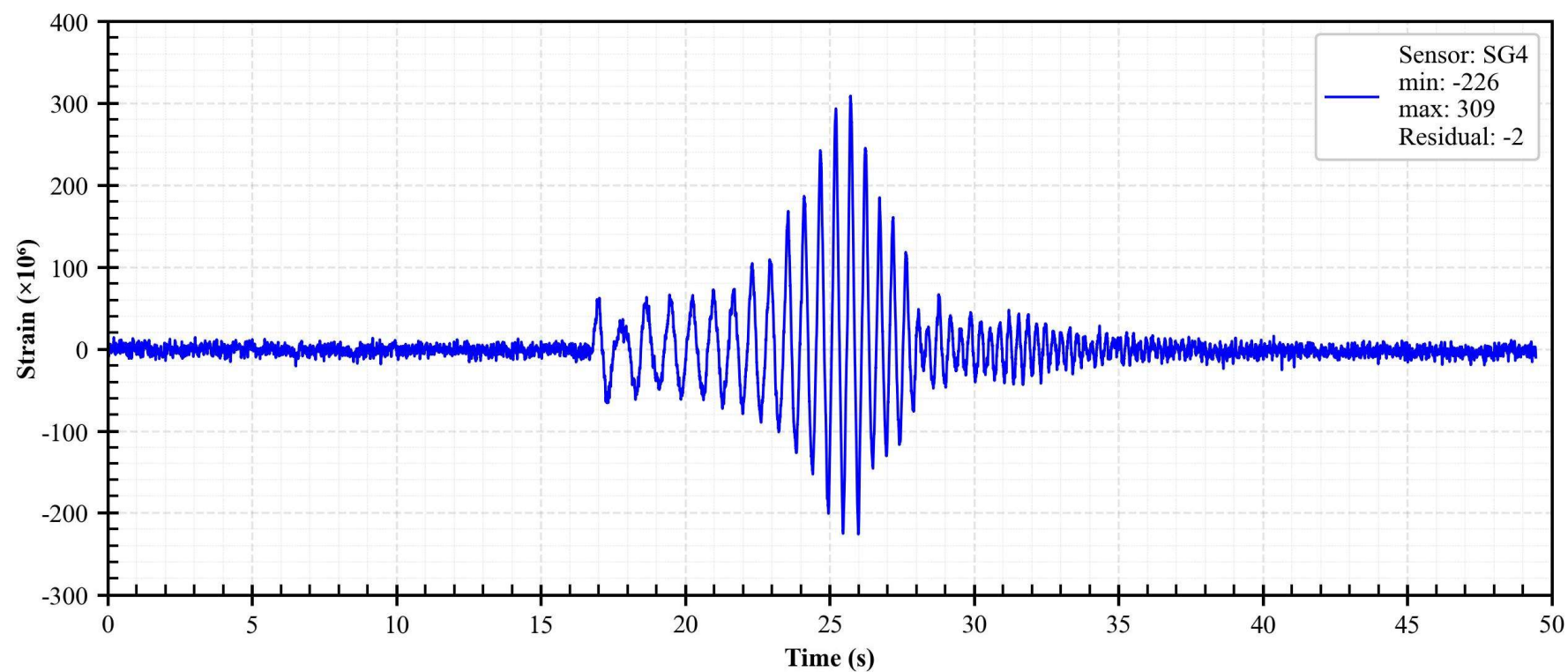


Figure 3.28.21 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 4

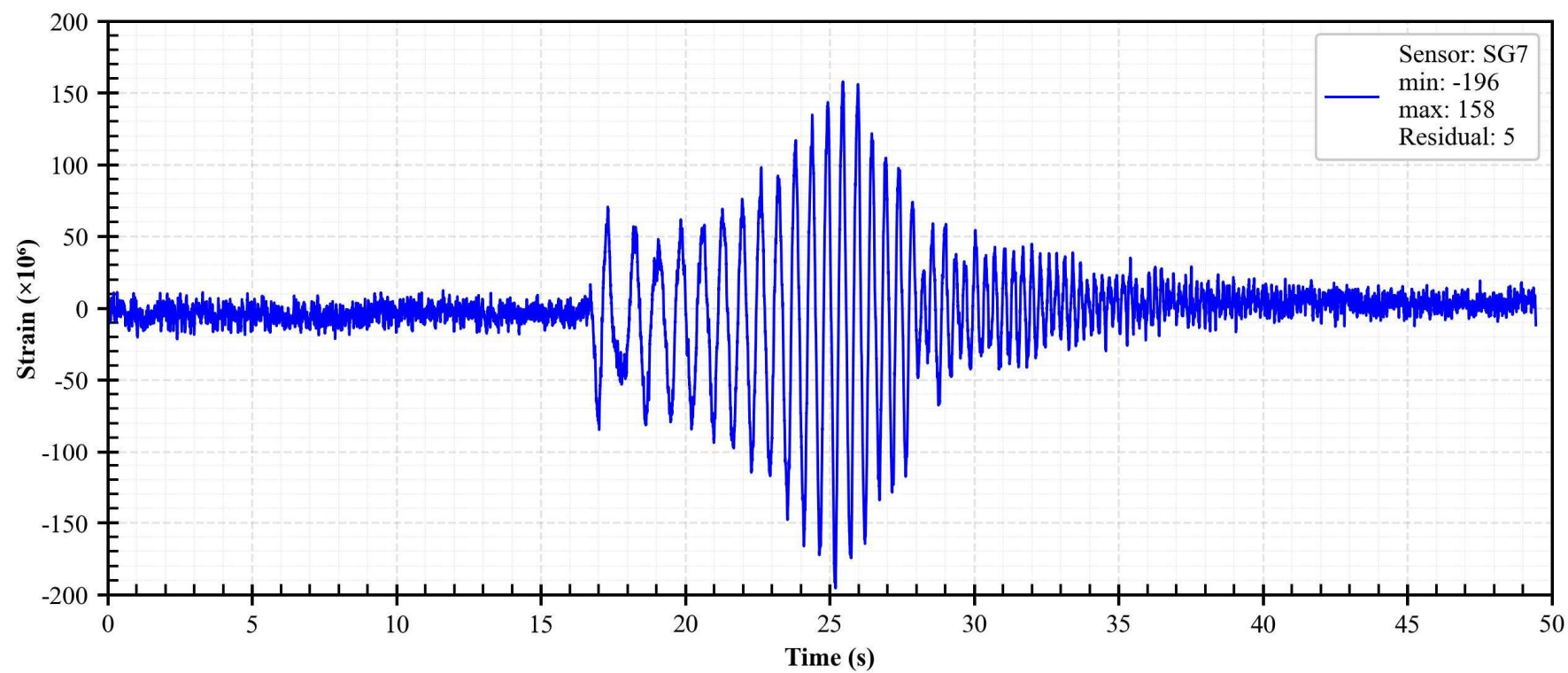


Figure 3.28.22 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 7

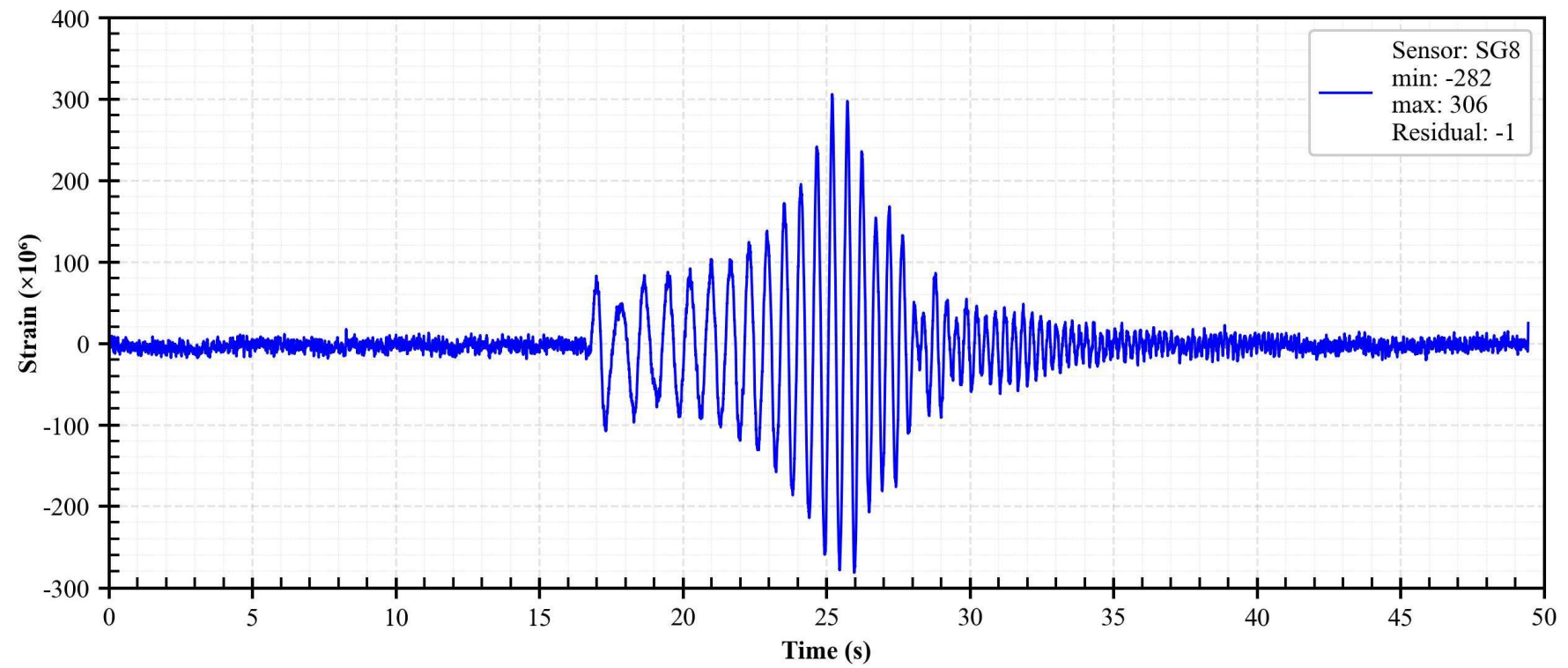


Figure 3.28.23 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 8

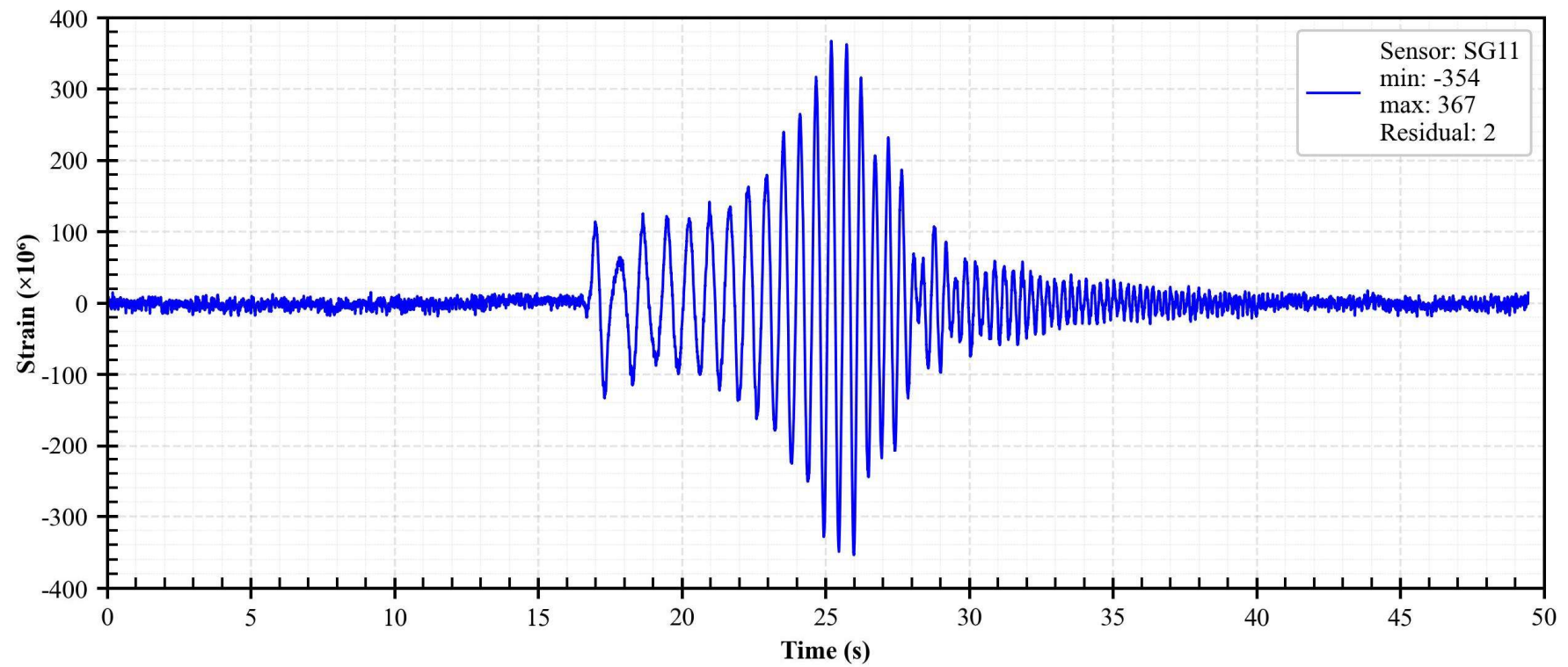


Figure 3.28.24 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 11

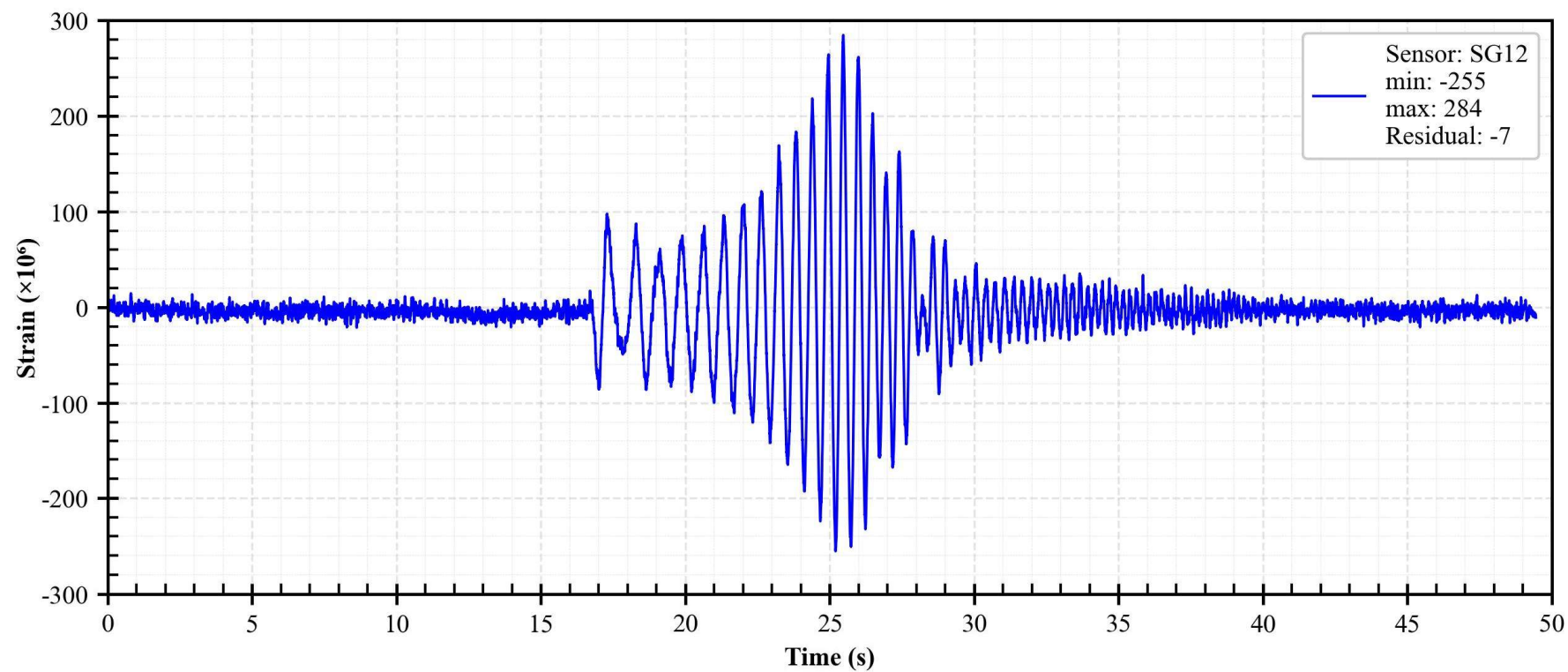


Figure 3.28.25 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 12

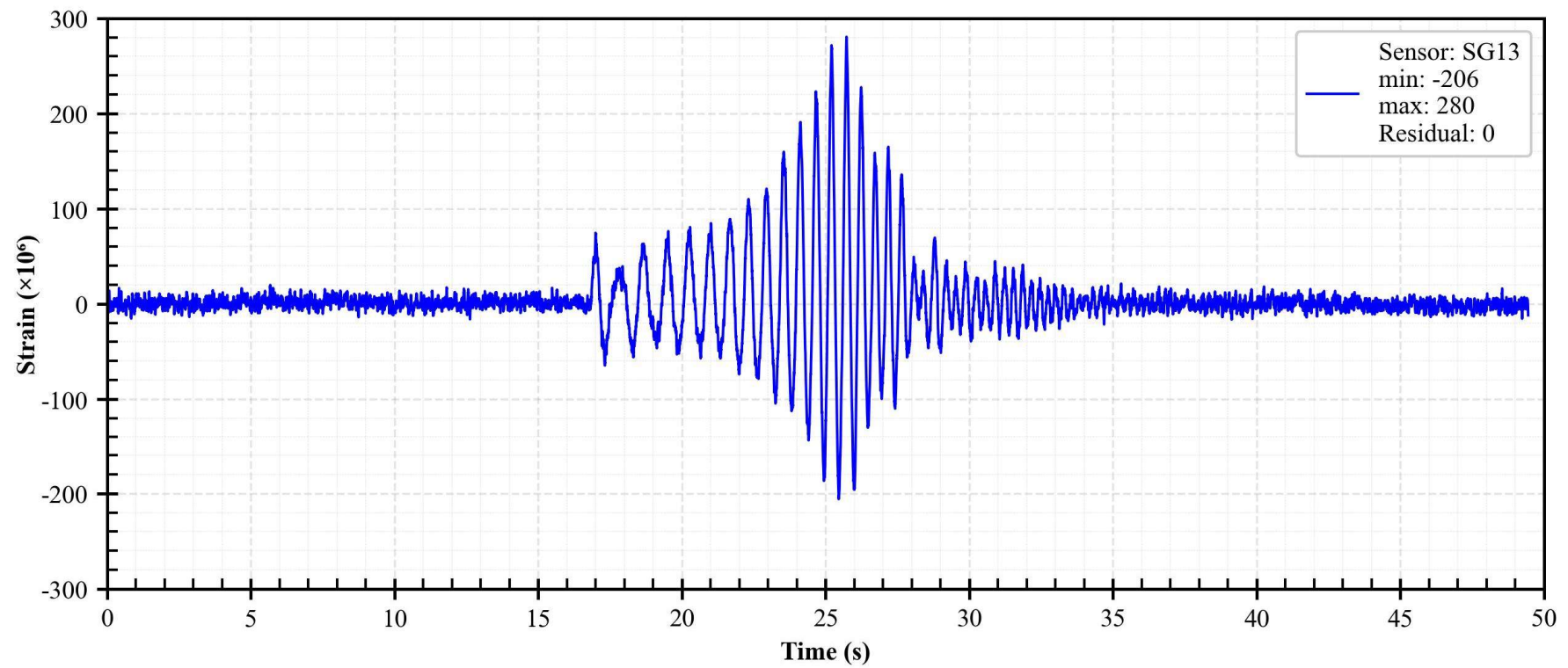


Figure 3.28.26 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 13

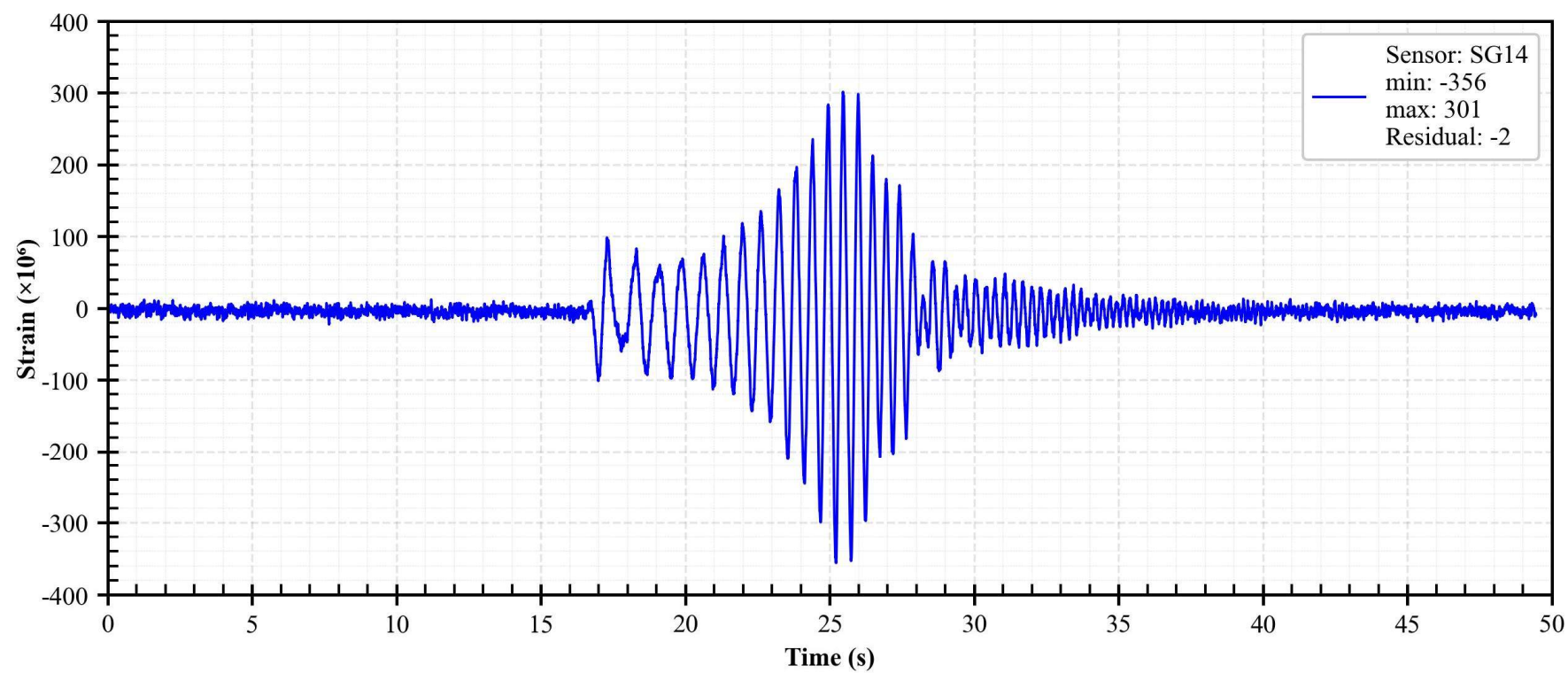


Figure 3.28.27 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 14

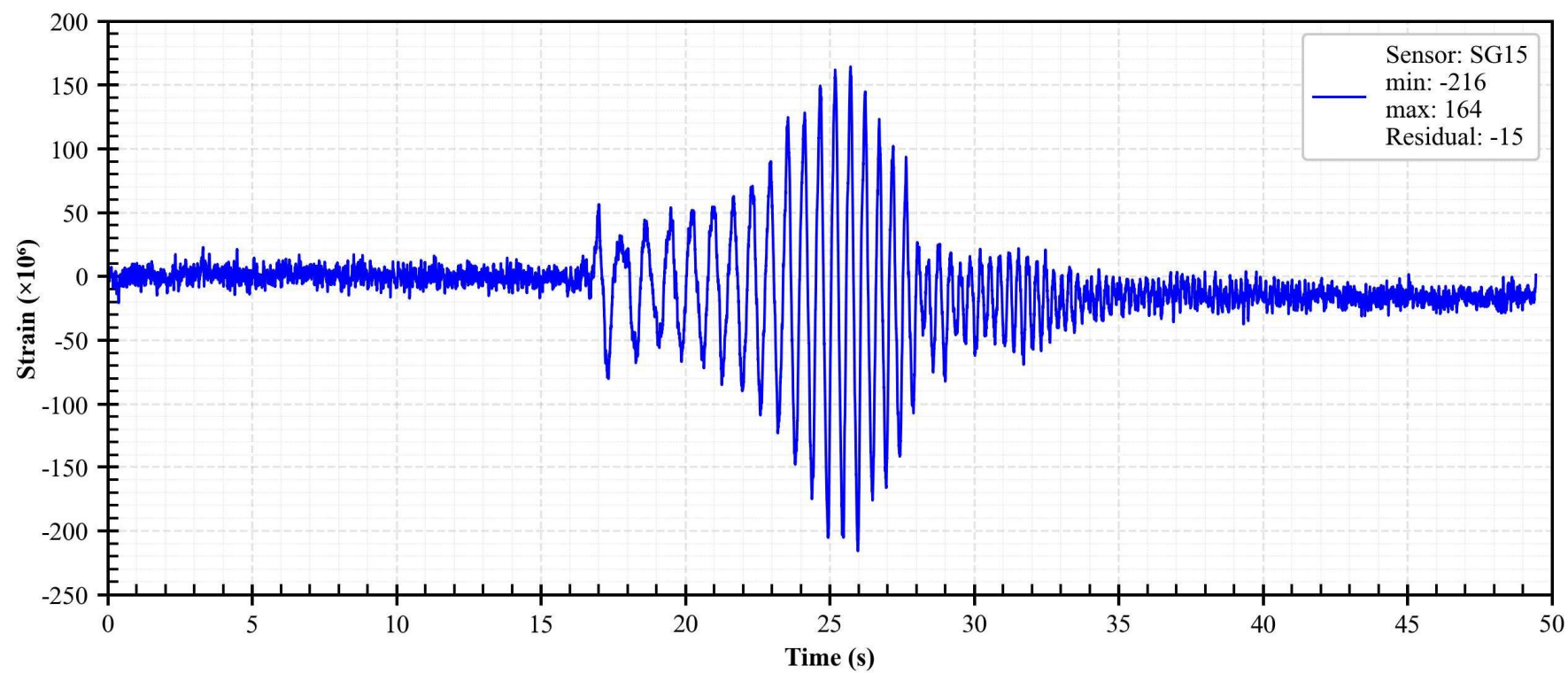


Figure 3.28.28 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 15

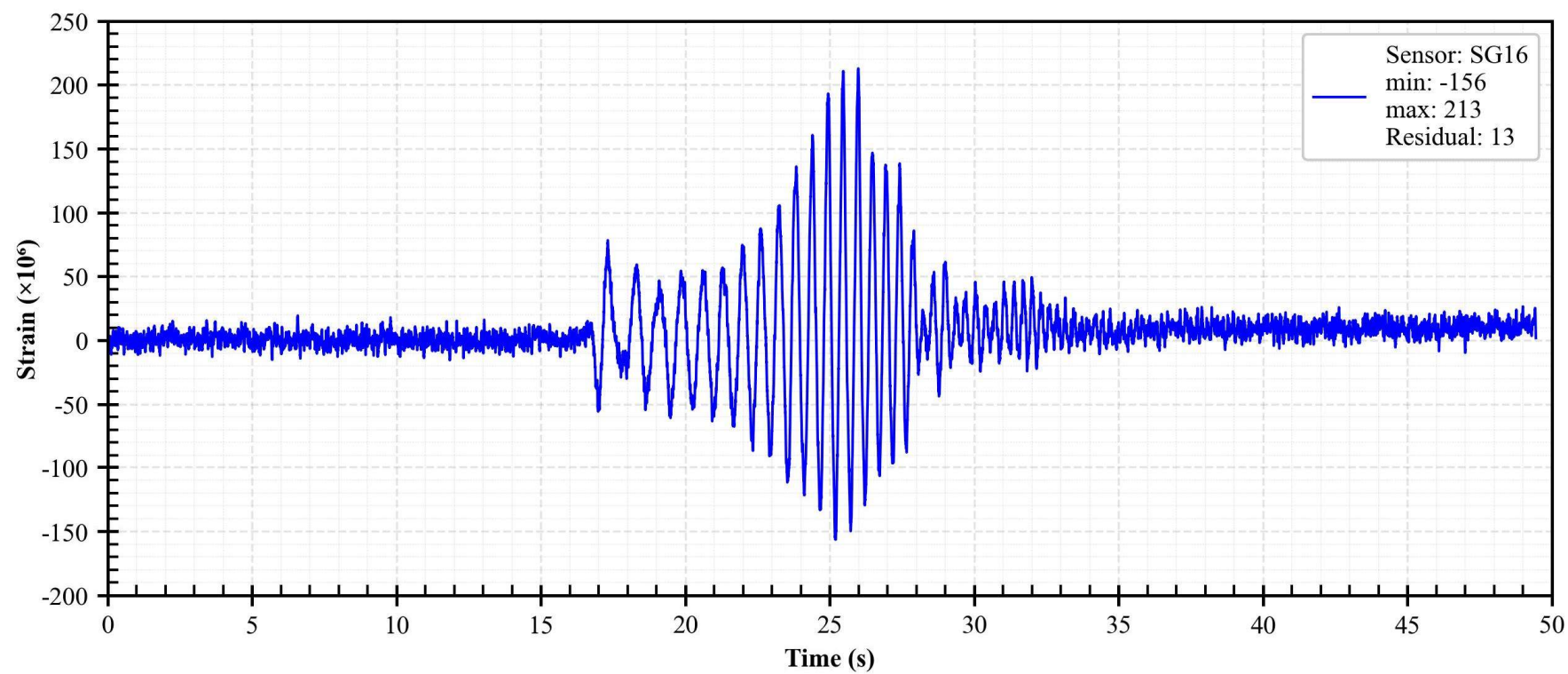


Figure 3.28.29 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 16

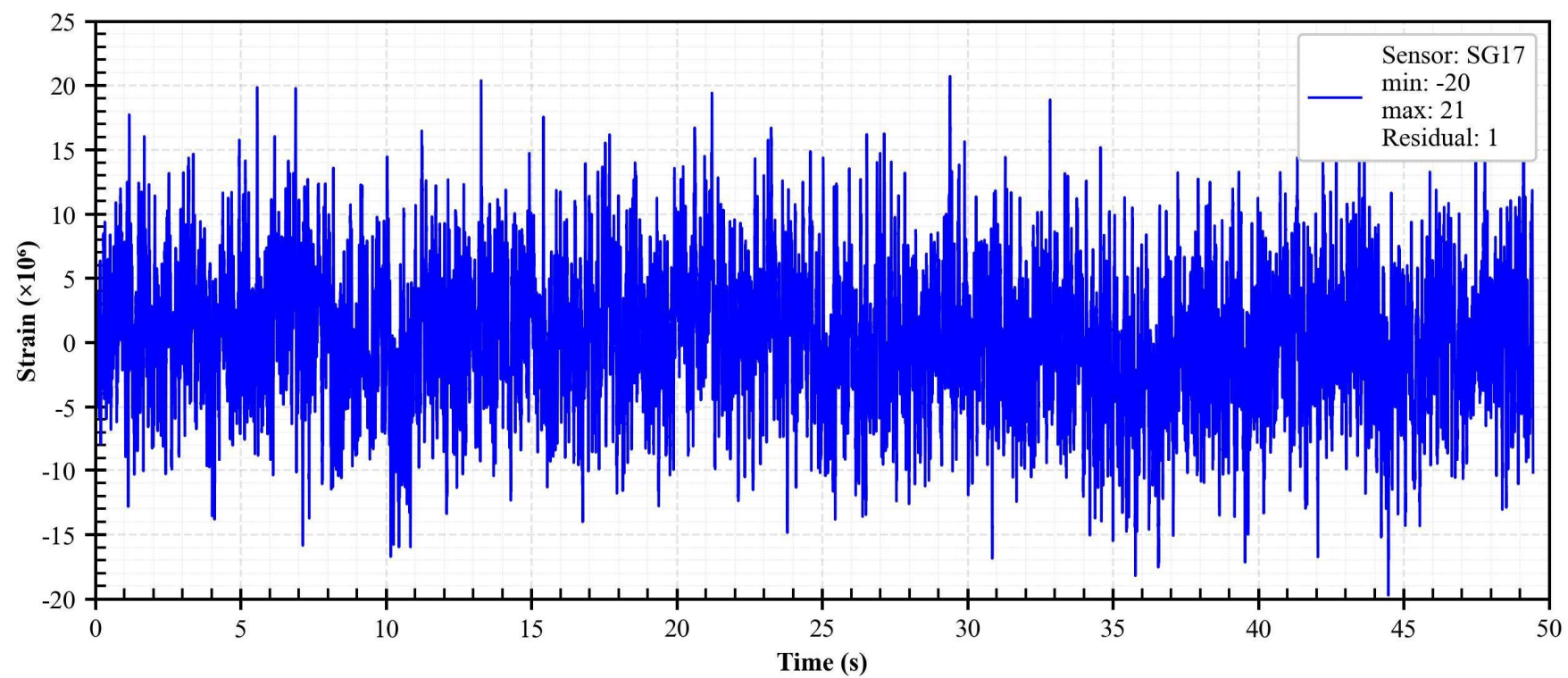


Figure 3.28.30 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 17

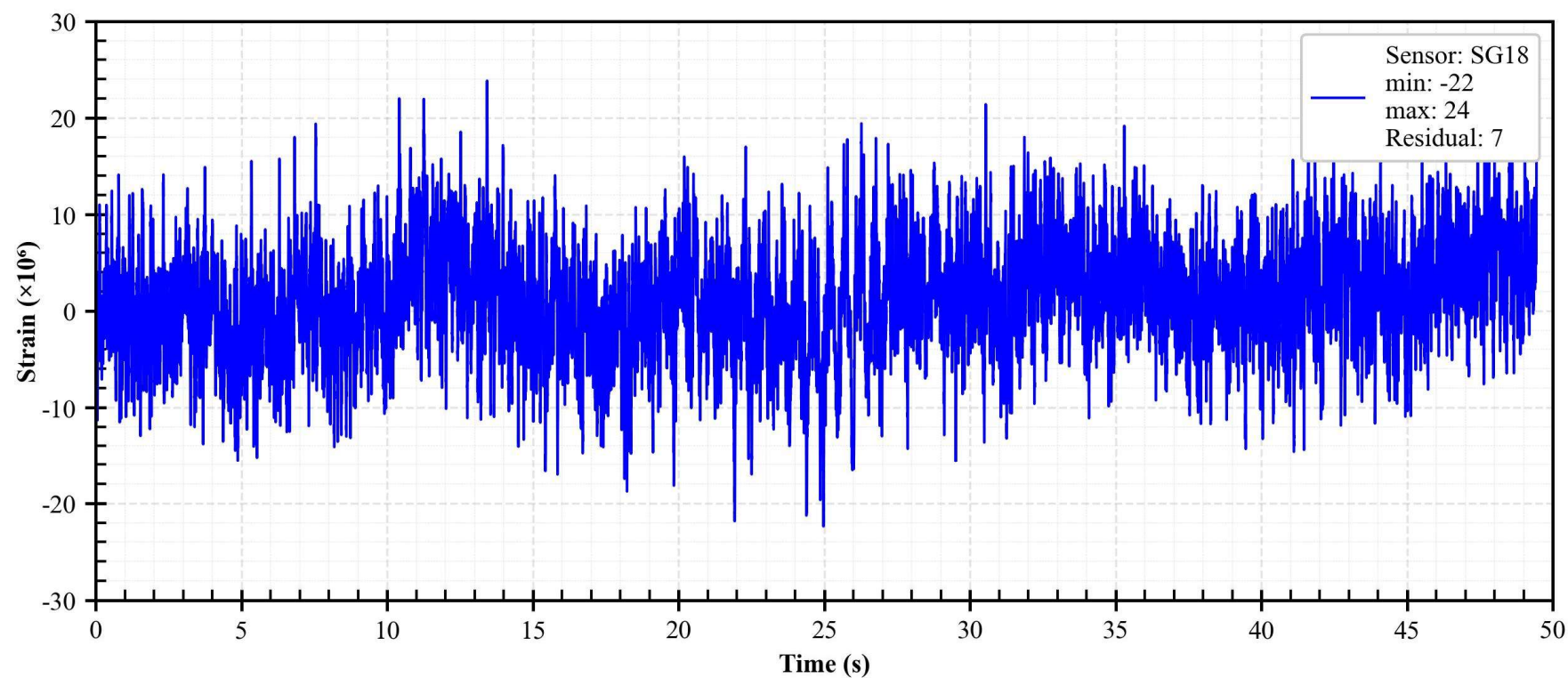


Figure 3.28.31 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 18

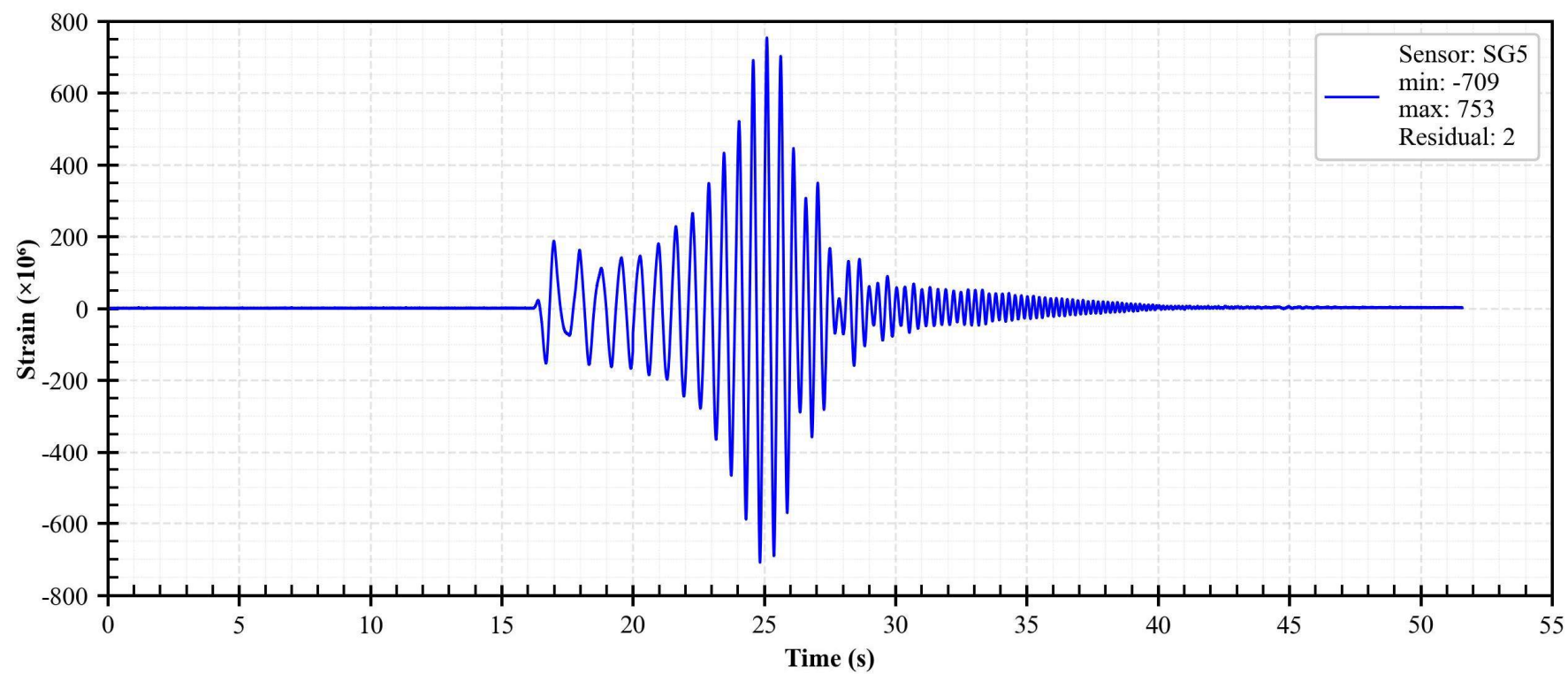


Figure 3.28.32 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 5

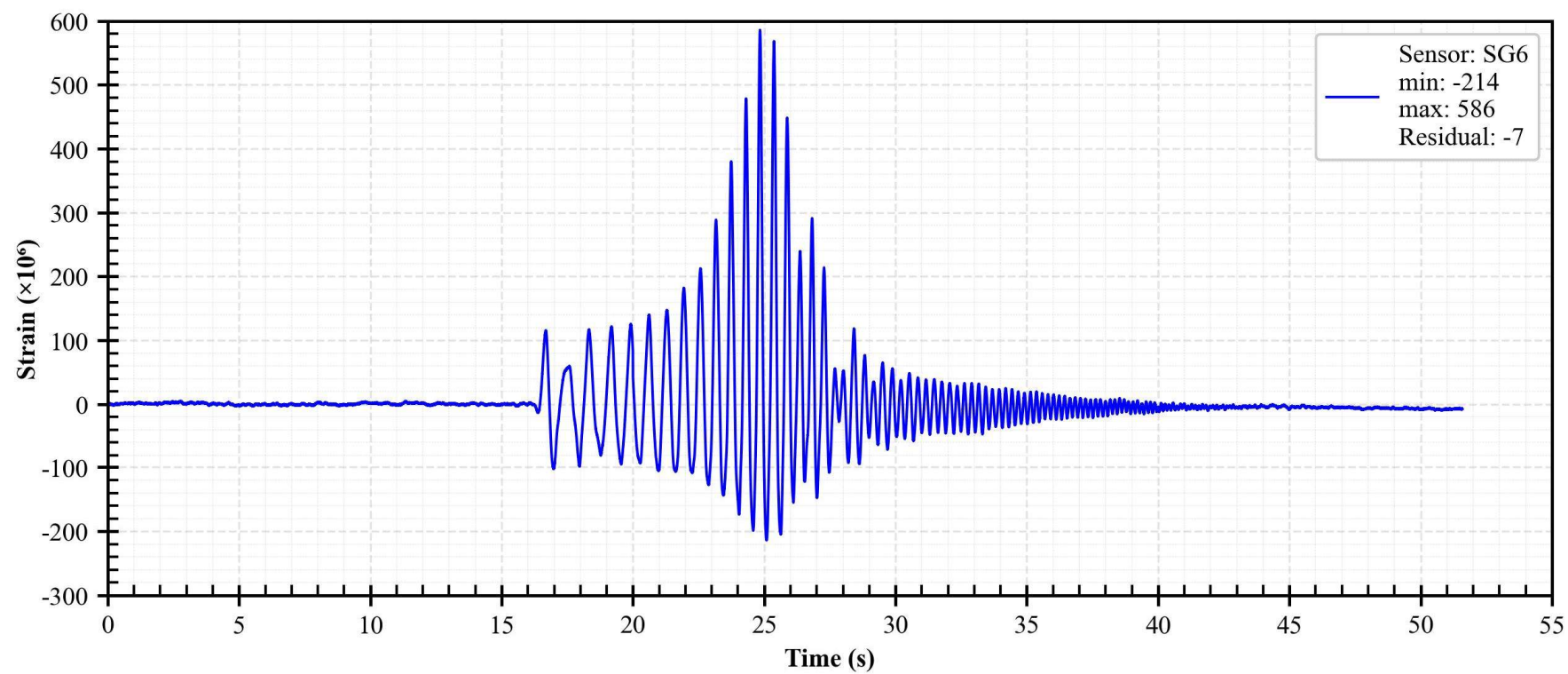


Figure 3.28.33 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 6

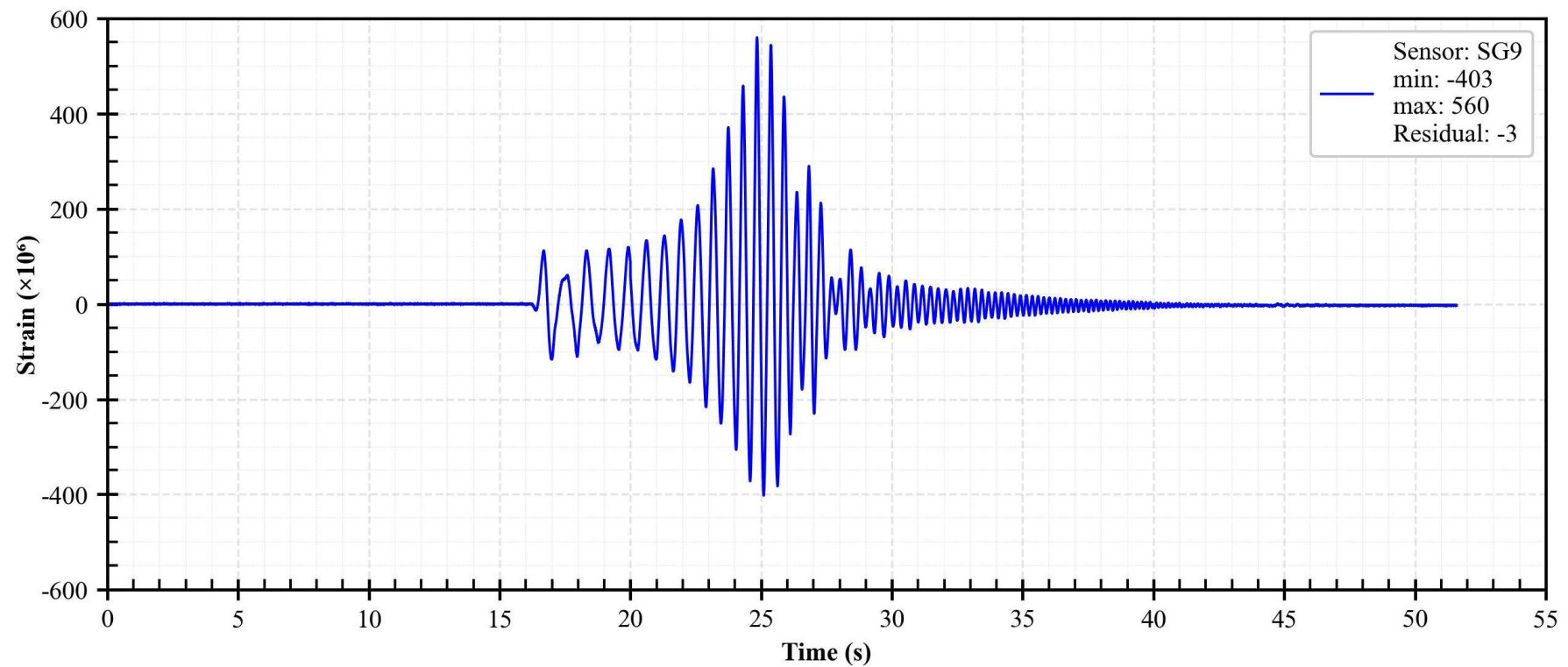


Figure 3.28.34 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 9

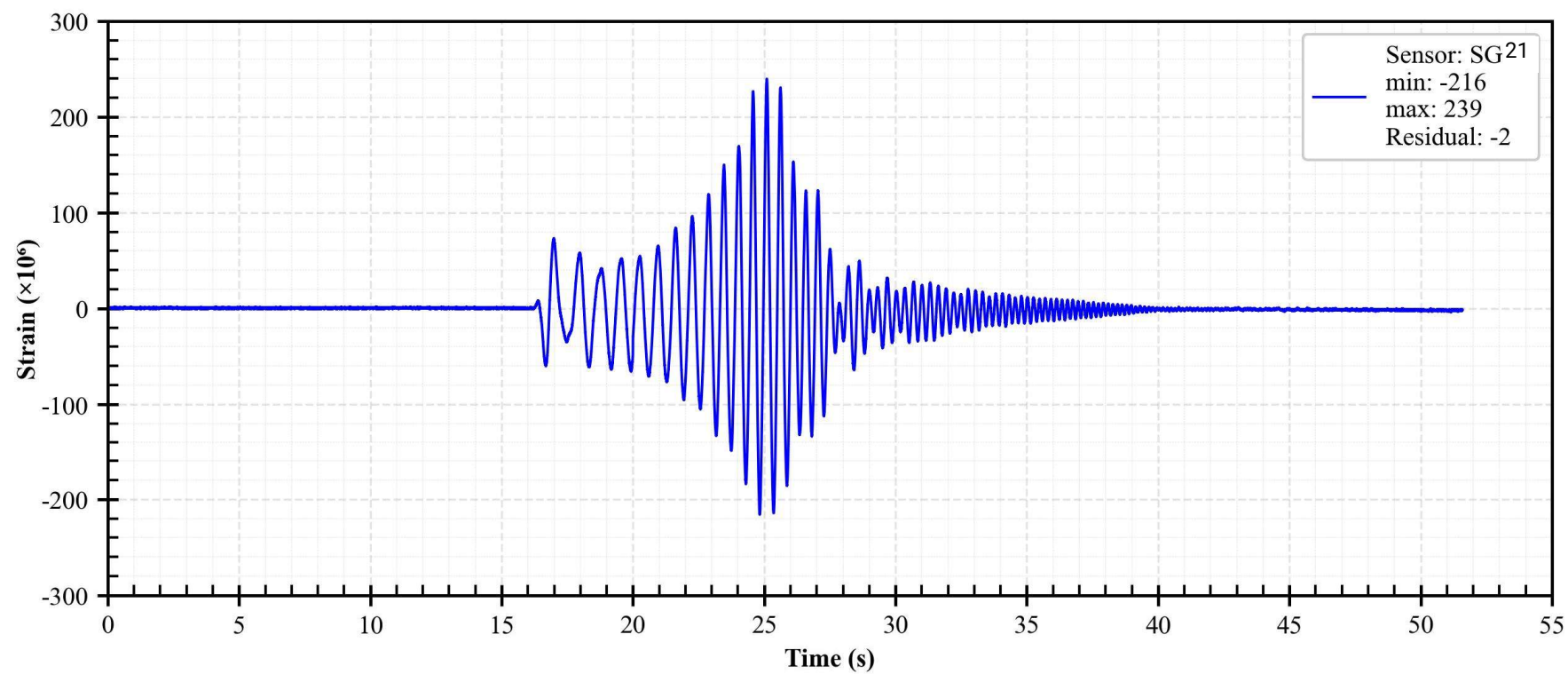


Figure 3.28.35 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 21 (PUFJ, column 1)

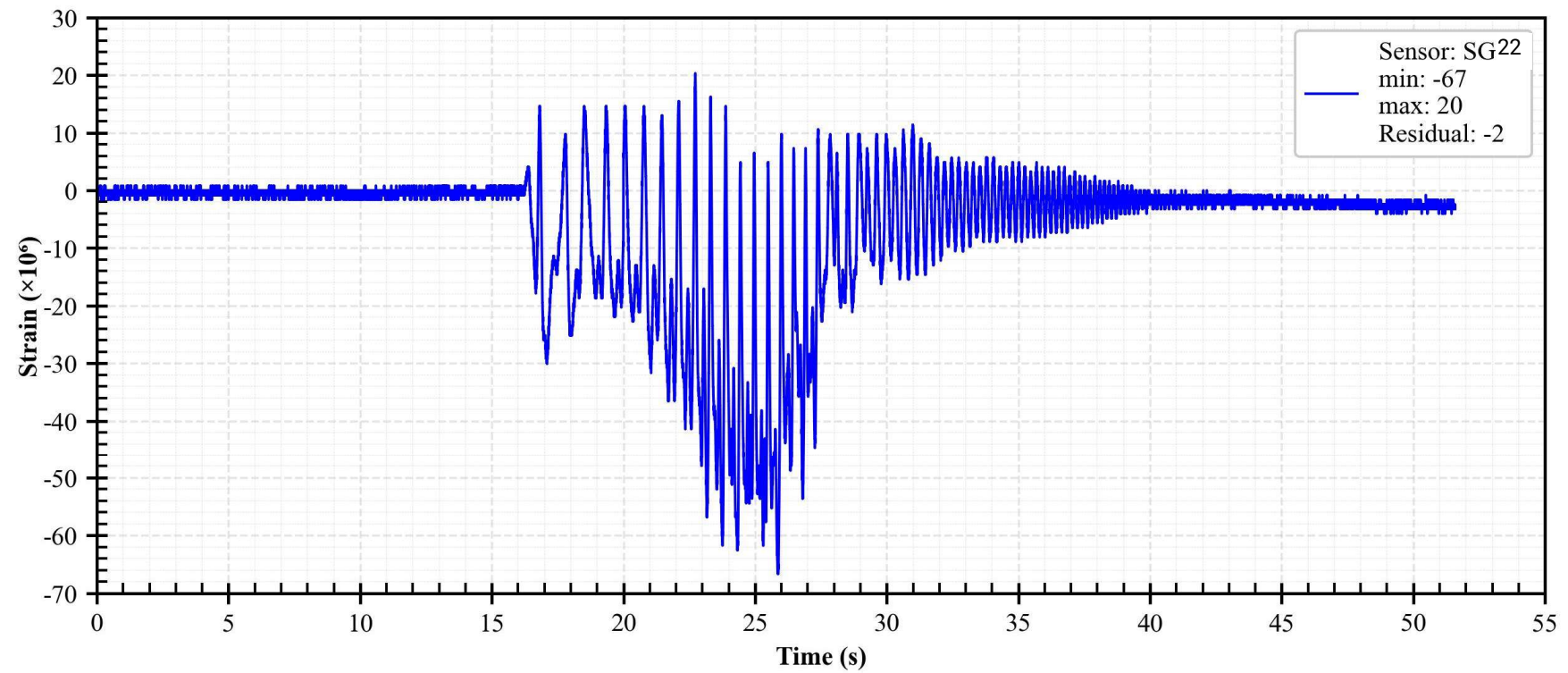


Figure 3.28.36 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 22 (PUFJ, column 2)

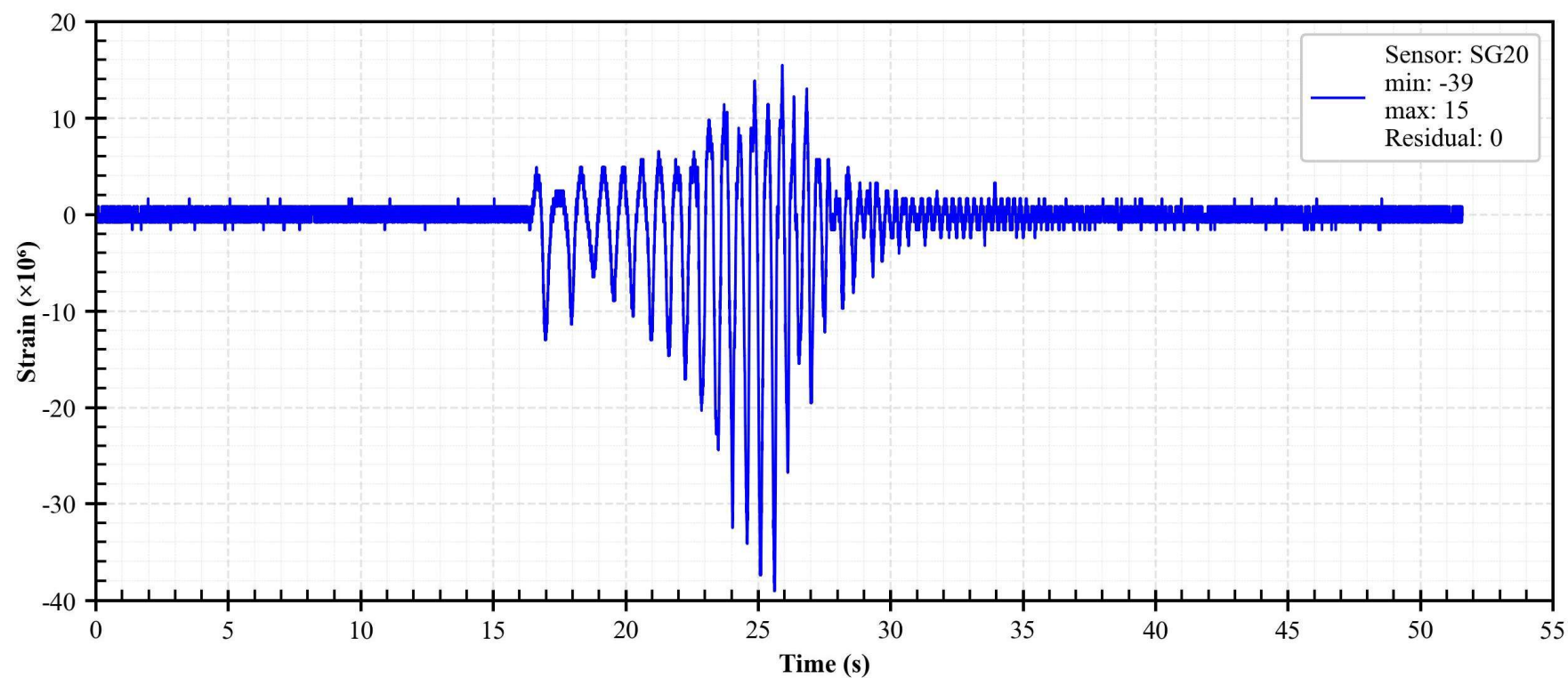
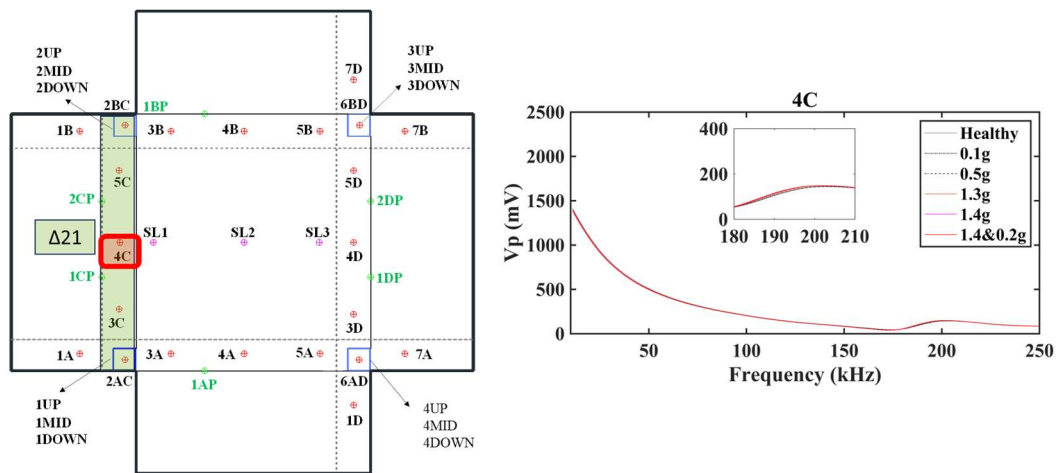


Figure 3.28.37 Characteristic results for phase B (white noise after EQ0,2g): strain gauge 20

4 RECORDED PZT MEASUREMENTS AND CHARACTERISTIC PHOTOS OF THE RENOVATED 3D VF STRUCTURE

4.1 Recorded results of THE renovated 3D VF structure, PZT measurements

The voltage signal measurements of the PZT sensors across a range of frequencies, 10–250 kHz, with a resolution of 1 kHz following the loading sequence, are illustrated in the above figures. These figures highlight the frequency response of the PZT sensors for the healthy condition and six loading sequences that were examined. Some notable observations can be drawn from the displayed voltage signal responses for all PZTs, smart aggregates and externally bonded on concrete or on walls. The EMI response of each PZT sensor in the healthy (initial) condition of the specimen was captured and used as a baseline frequency response. For real-time condition and damage assessment in the tested strengthened VF RC, the EMI response of the installed PZT patches was captured after the end of each loading sequence. The next figures present the design and code names of the PZTs, along with representative results from the frequency response.



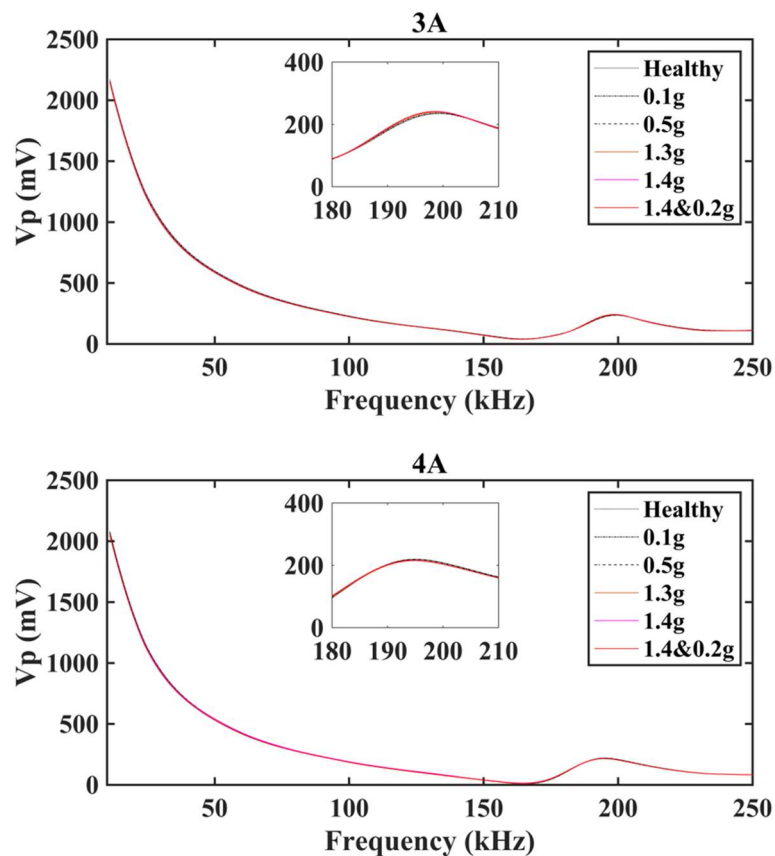


Figure 4.1.3 Voltage frequency response of the PZT sensors 4A and 3A

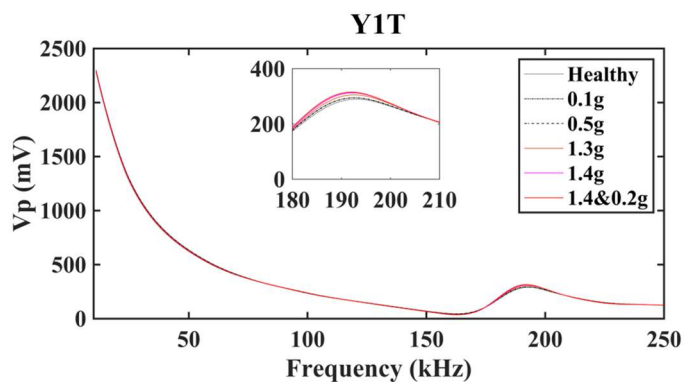


Figure 4.1.4 Location and voltage frequency response of the PZT sensor Y1T

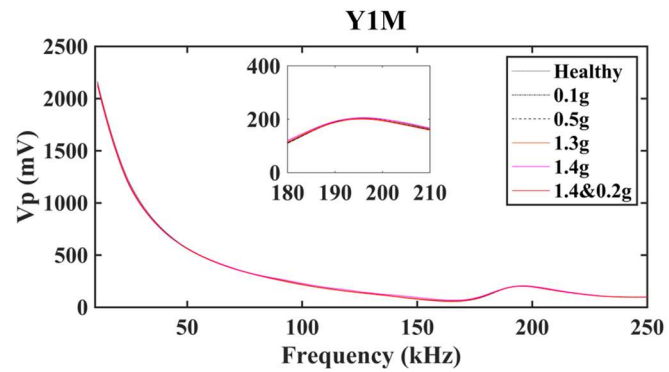


Figure 4.1.5 Location and voltage frequency response of the PZT sensor Y1M

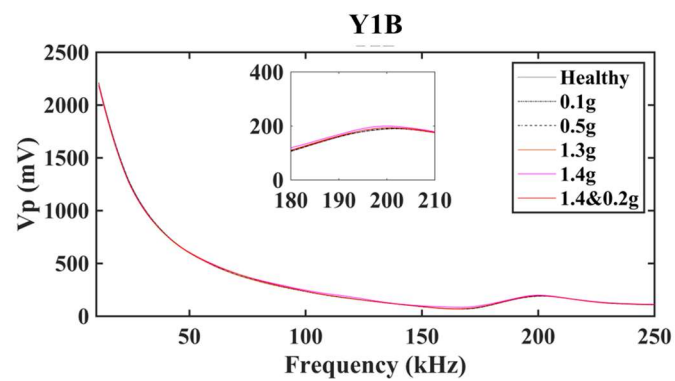
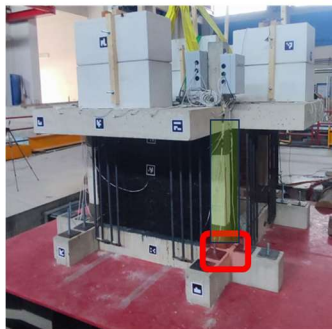


Figure 4.1.6 Location and voltage frequency response of the PZT sensor Y1B

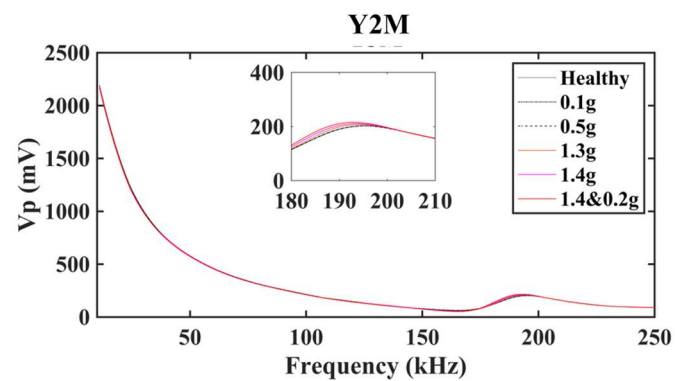


Figure 4.1.7 Location and voltage frequency response of the PZT sensor Y2M

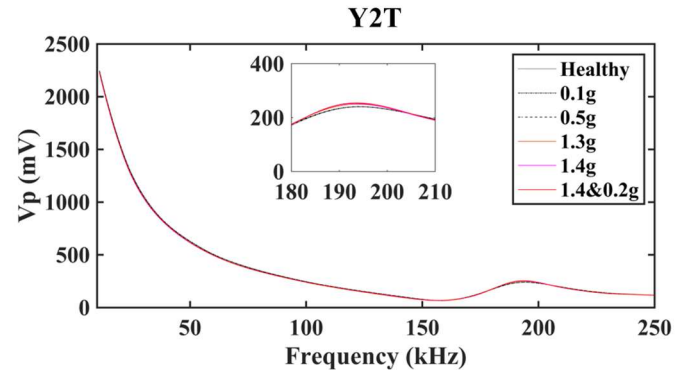


Figure 4.1.8 Location and voltage frequency response of the PZT sensor Y2T

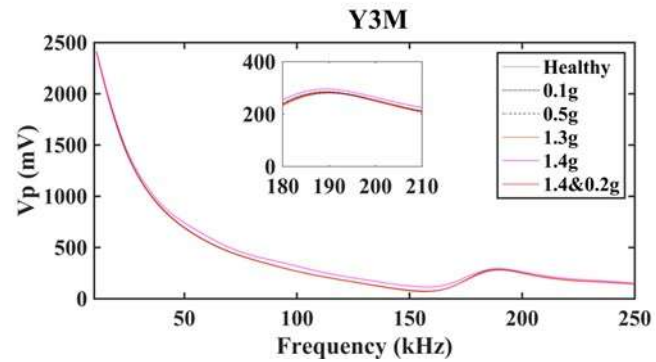


Figure 4.1.9 Location and voltage frequency response of the PZT sensor Y3M

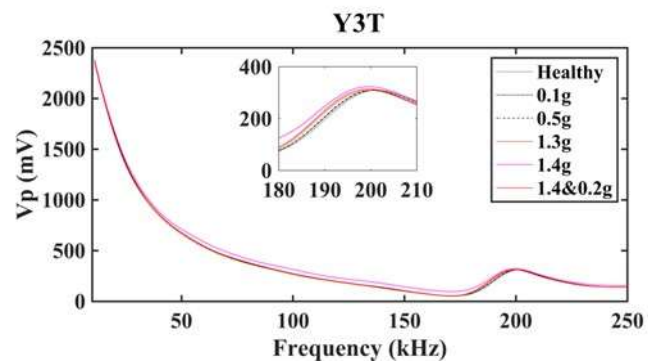
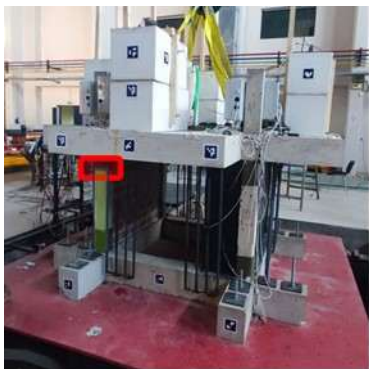


Figure 4.1.10 Location and voltage frequency response of the PZT sensor Y3T

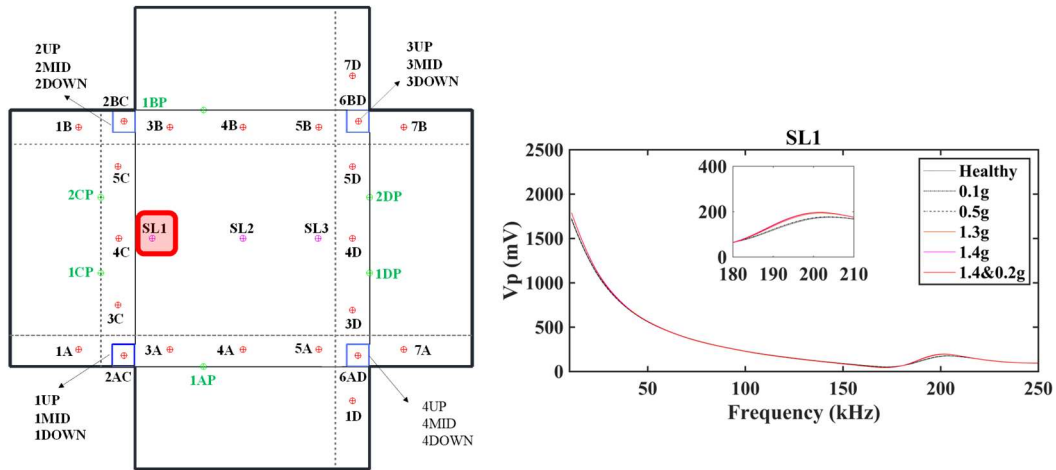


Figure 4.1.11 Location and voltage frequency response of the PZT sensor SL1

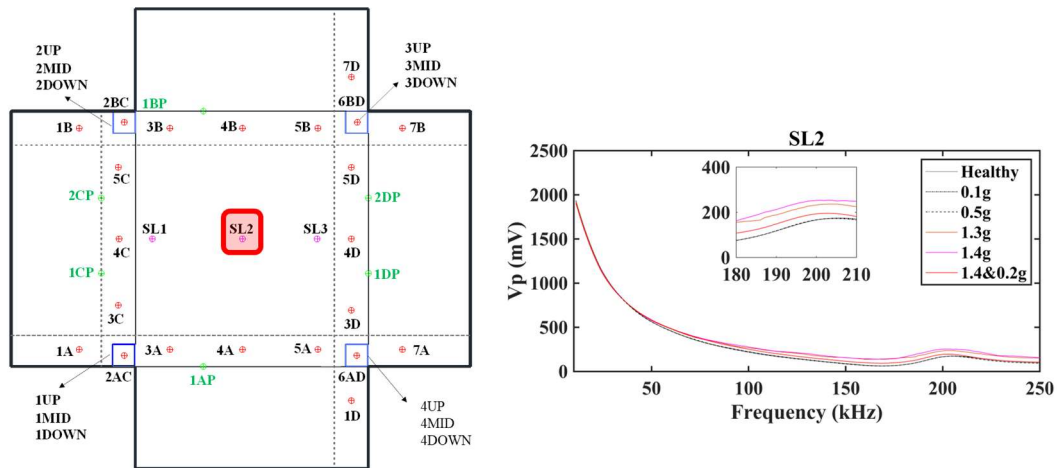


Figure 4.1.12 Location and voltage frequency response of the PZT sensor SL2

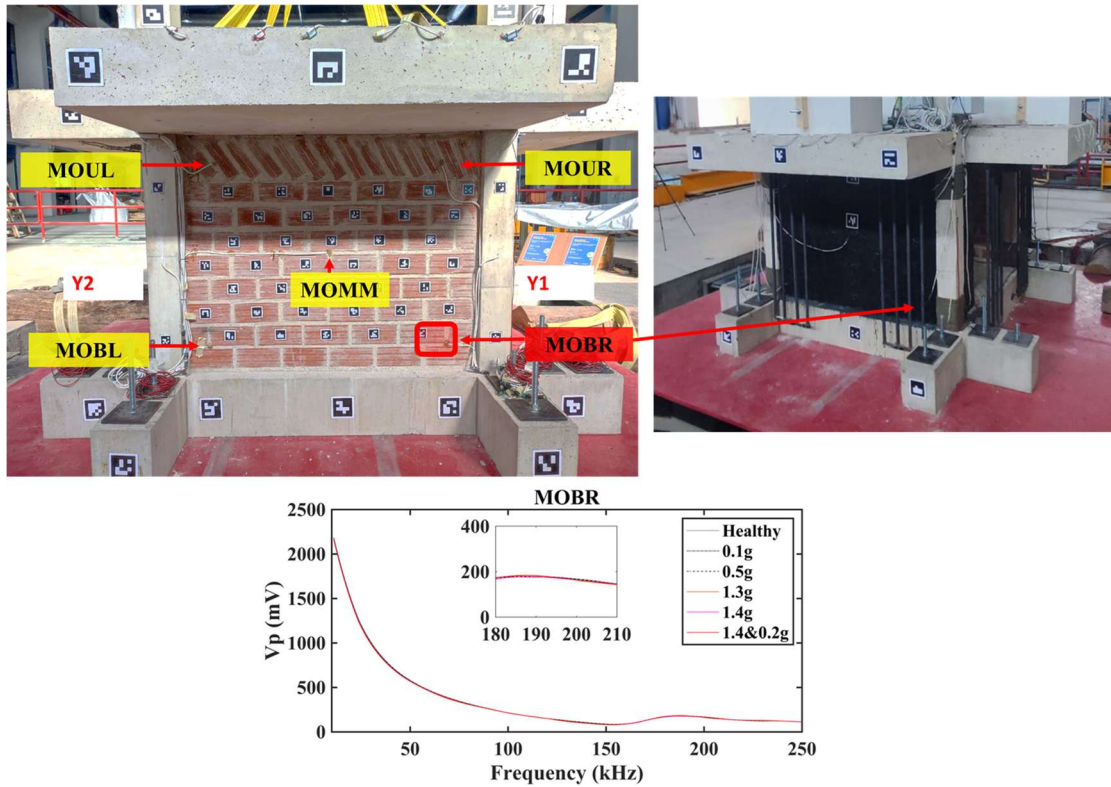


Figure 4.1.13 Location and voltage frequency response of the PZT sensor MOBR

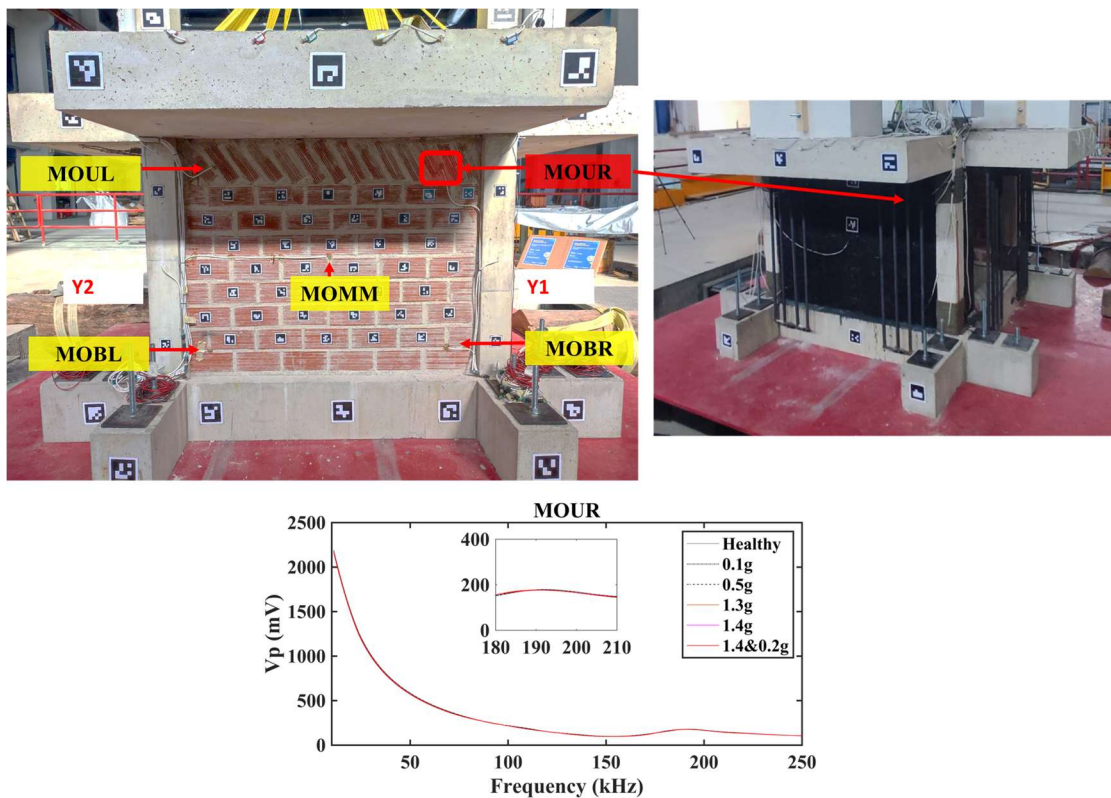


Figure 4.1.14 Location and voltage frequency response of the PZT sensor MOUR

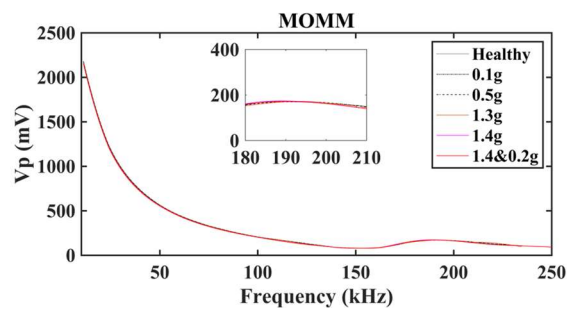
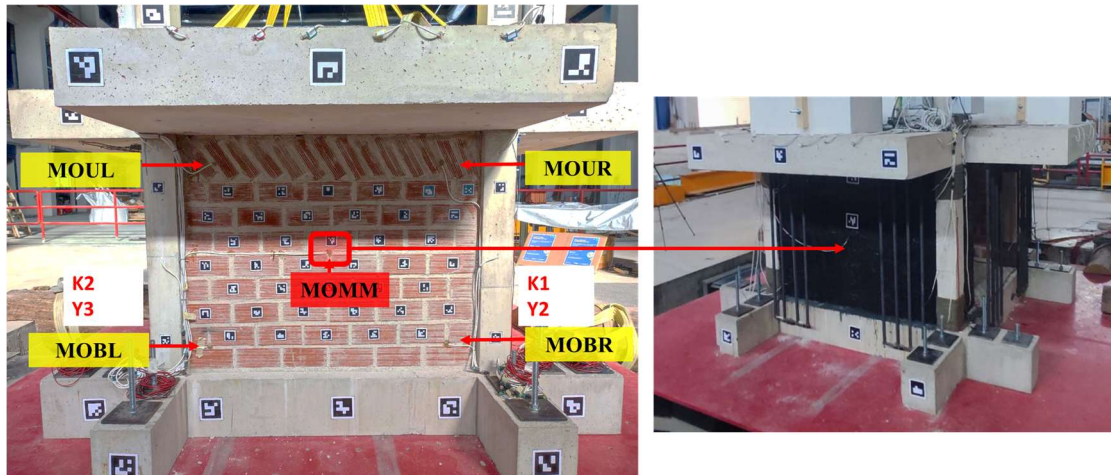


Figure 4.1.15 Location and voltage frequency response of the PZT sensor MOMM

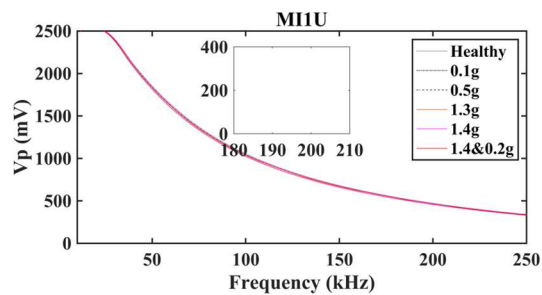
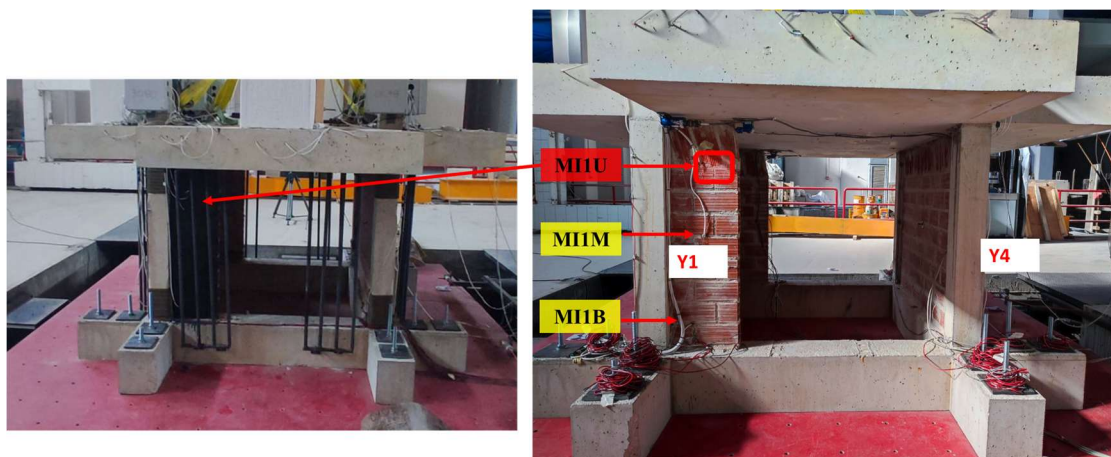


Figure 4.1.16 Location and voltage frequency response of the PZT sensor MI1U

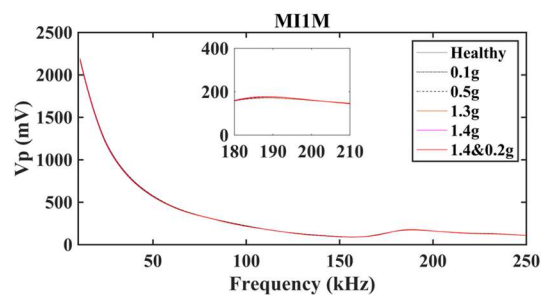
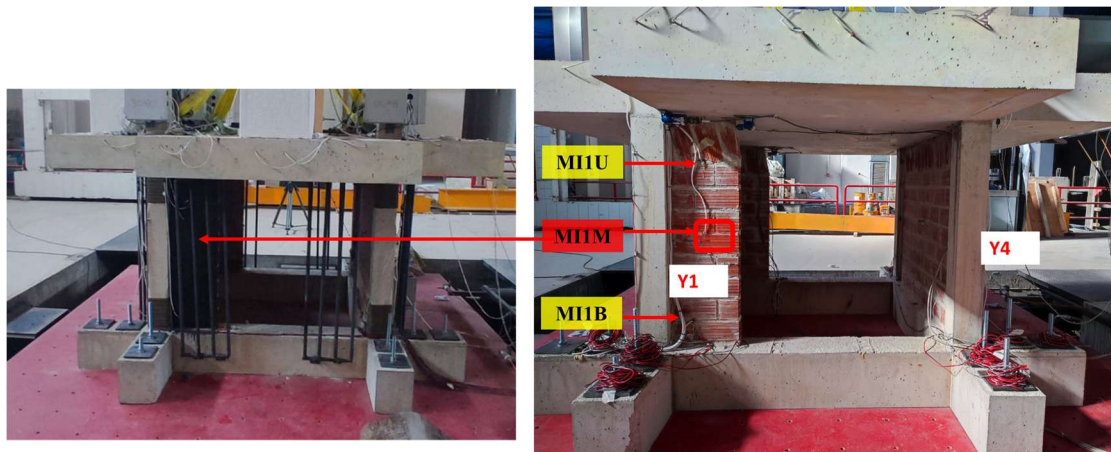


Figure 4.1.17 Location and voltage frequency response of the PZT sensor MI1M

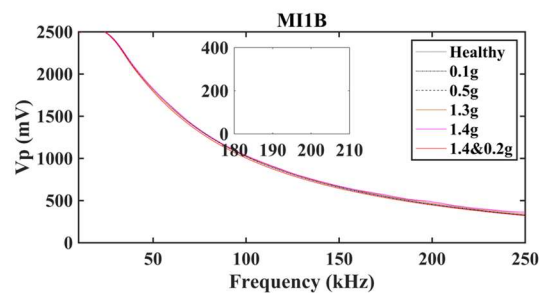
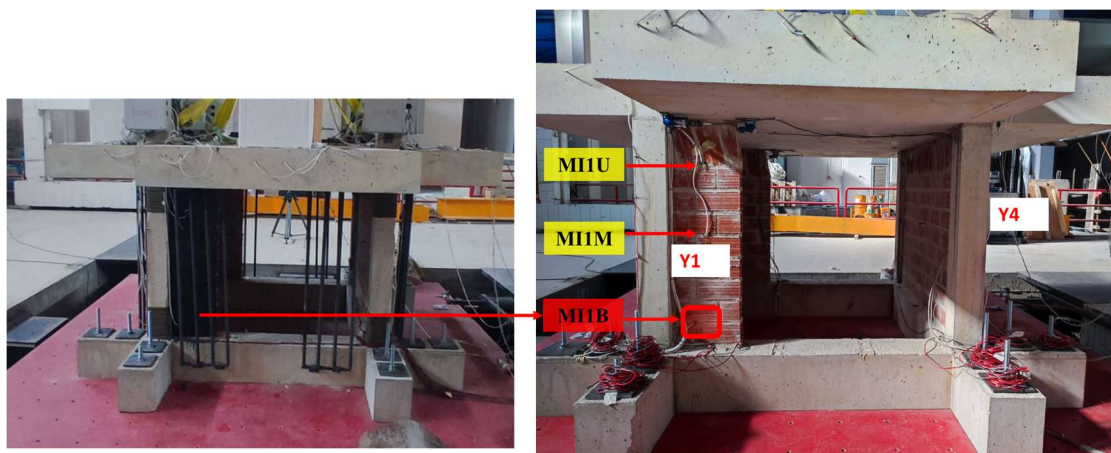


Figure 4.1.18 Location and voltage frequency response of the PZT sensor MI1B

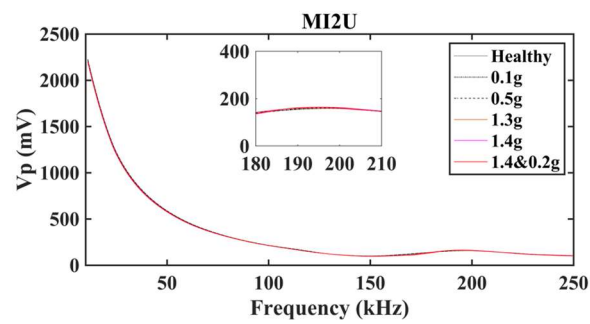
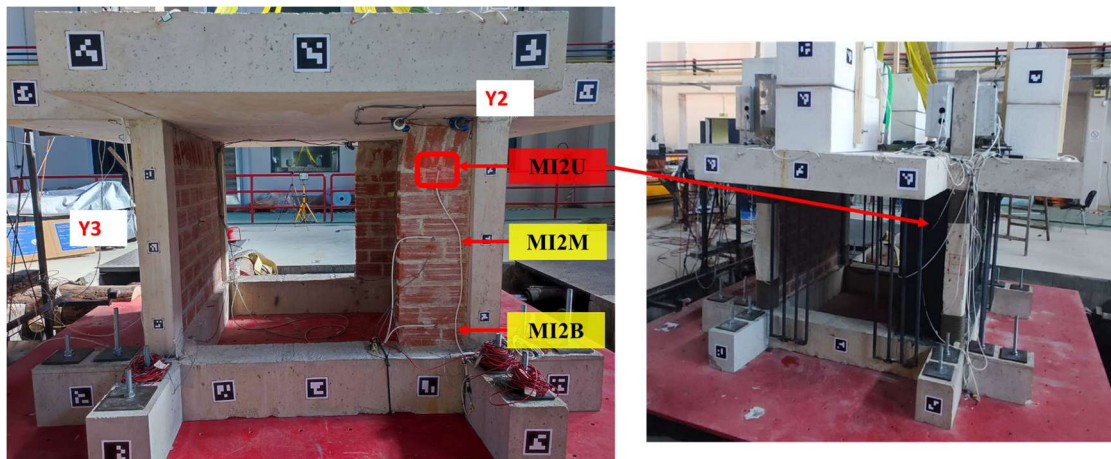


Figure 4.1.19 Location and voltage frequency response of the PZT sensor MI2U

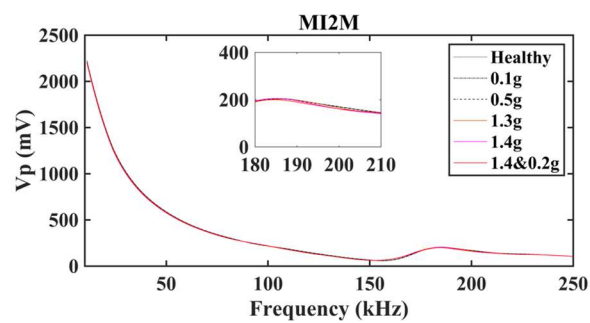
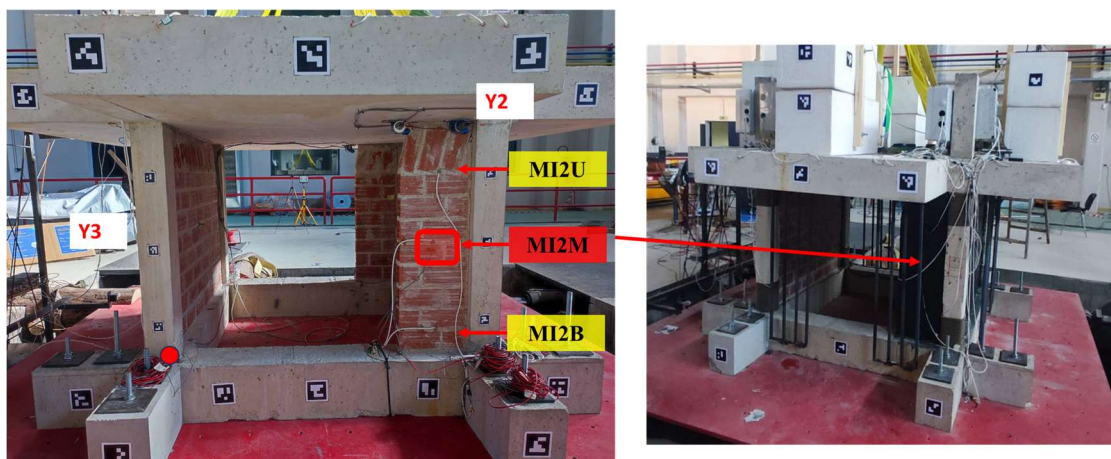


Figure 4.1.20 Location and voltage frequency response of the PZT sensor MI2M

4.2 Expanding the smart PZT monitoring system for the renovated 3D VF structure

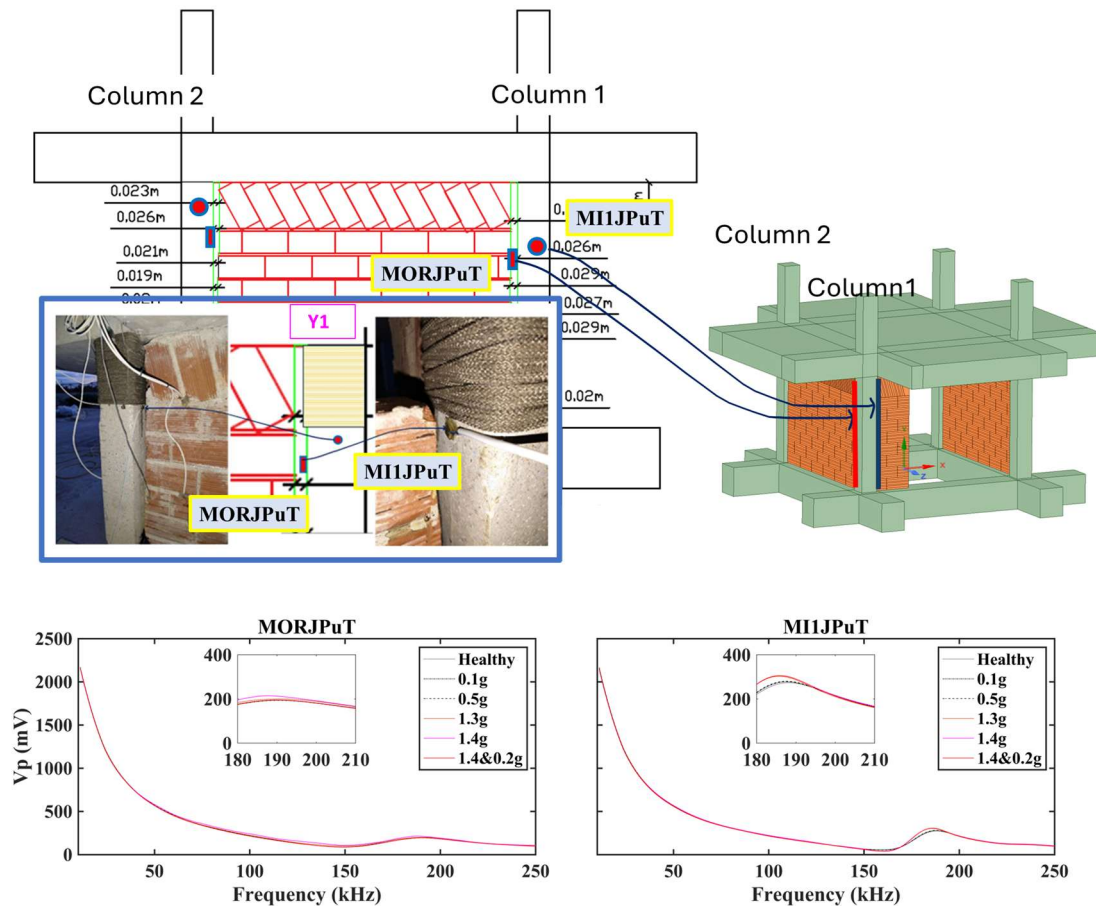


Figure 4.2.1 Location and voltage frequency response of the PZT sensors MORJPuT and MI1JPuT (at the surface of RC column 1, MORJPuT at infill wall and MI1JPuT at partial infill wall)

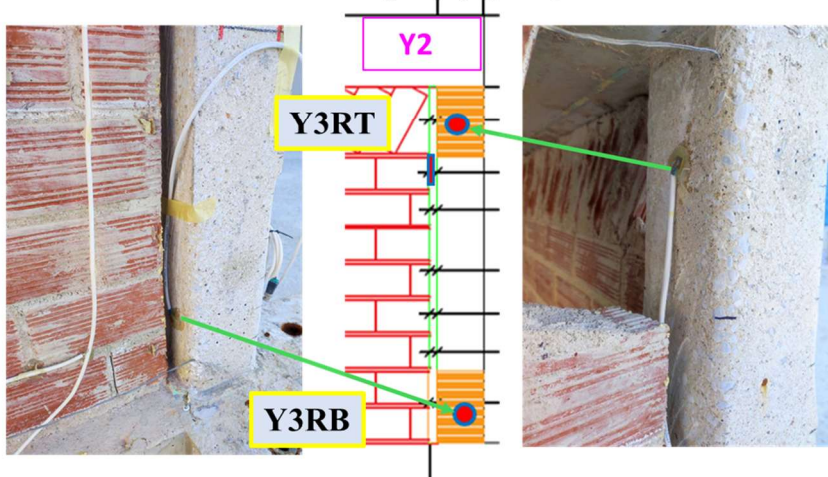
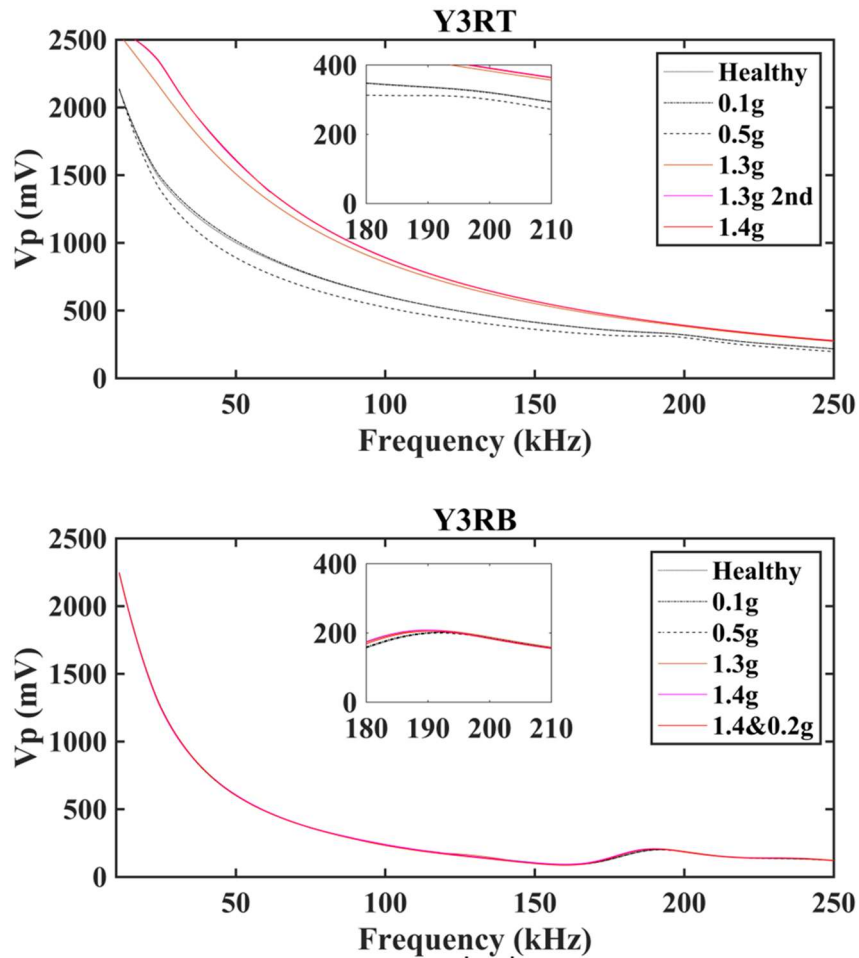


Figure 4.2.2 Location and voltage frequency response of the PZT sensors Y3RT and Y3RB

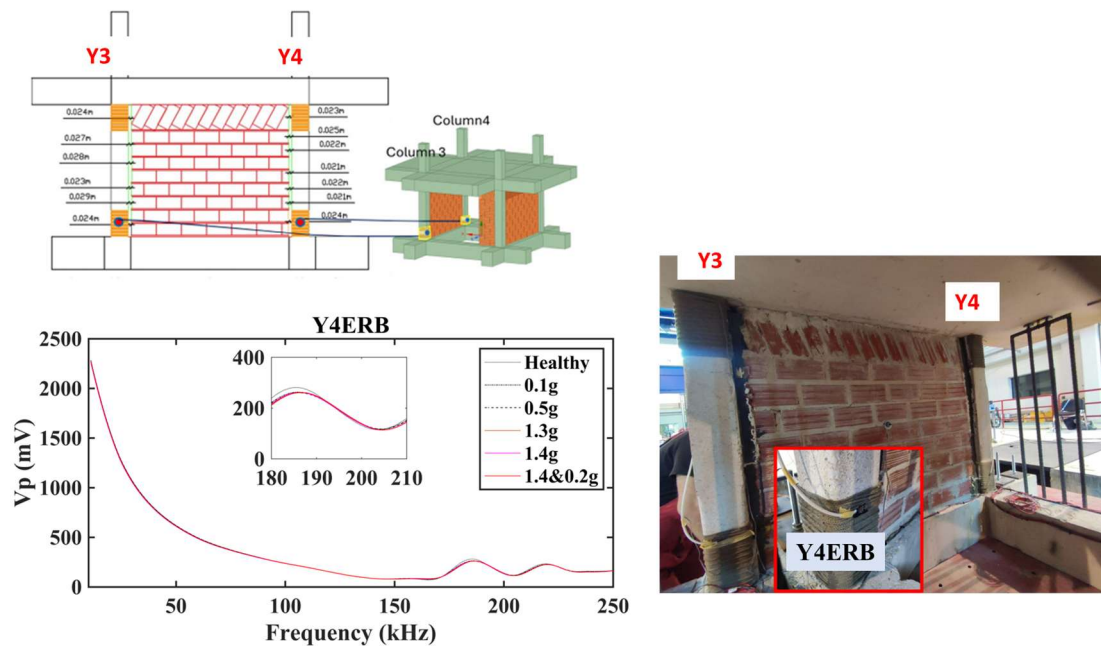


Figure 4.2.3 Location and voltage frequency response of the PZT sensor Y4ERB

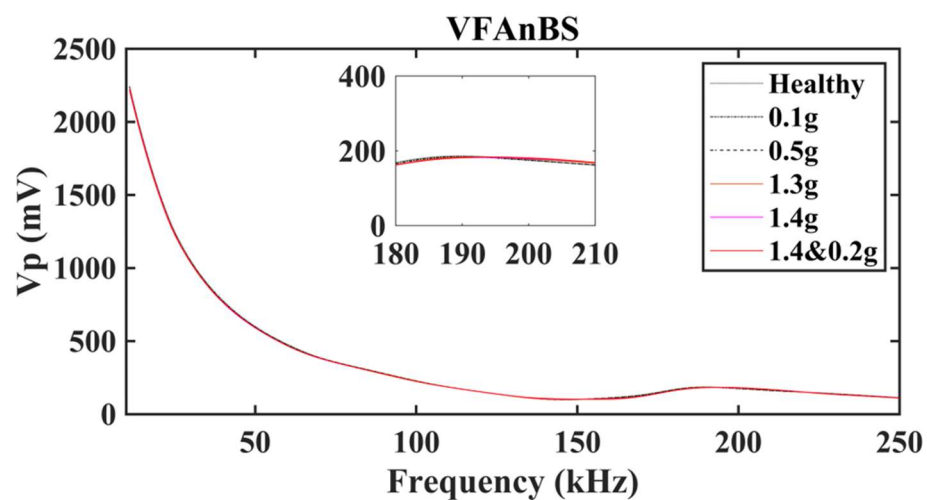


Figure 4.2.4 Location and voltage frequency response of the PZT sensor VFAnBS

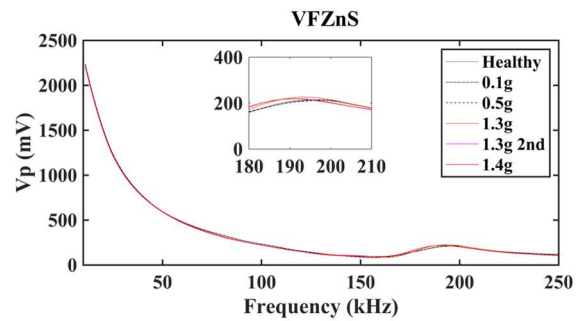


Figure 4.2.5 Location and voltage frequency response of the PZT sensor VFZnS

The results from the PZTs demonstrate the ability of the PZT-enabled SHM system to detect changes in the health condition at different locations after each loading sequence.

4.3 Recorded measurements of strain gauges SG23, SG24 glued on the rope at position of PZT sensor Y4ERB AND Y3ERB

The maximum recorded strain on the basalt ropes of columns 3 and 4 are close to zero, that is 58 ustrain or 44 ustrain respectively.

Earthquake 0,5g

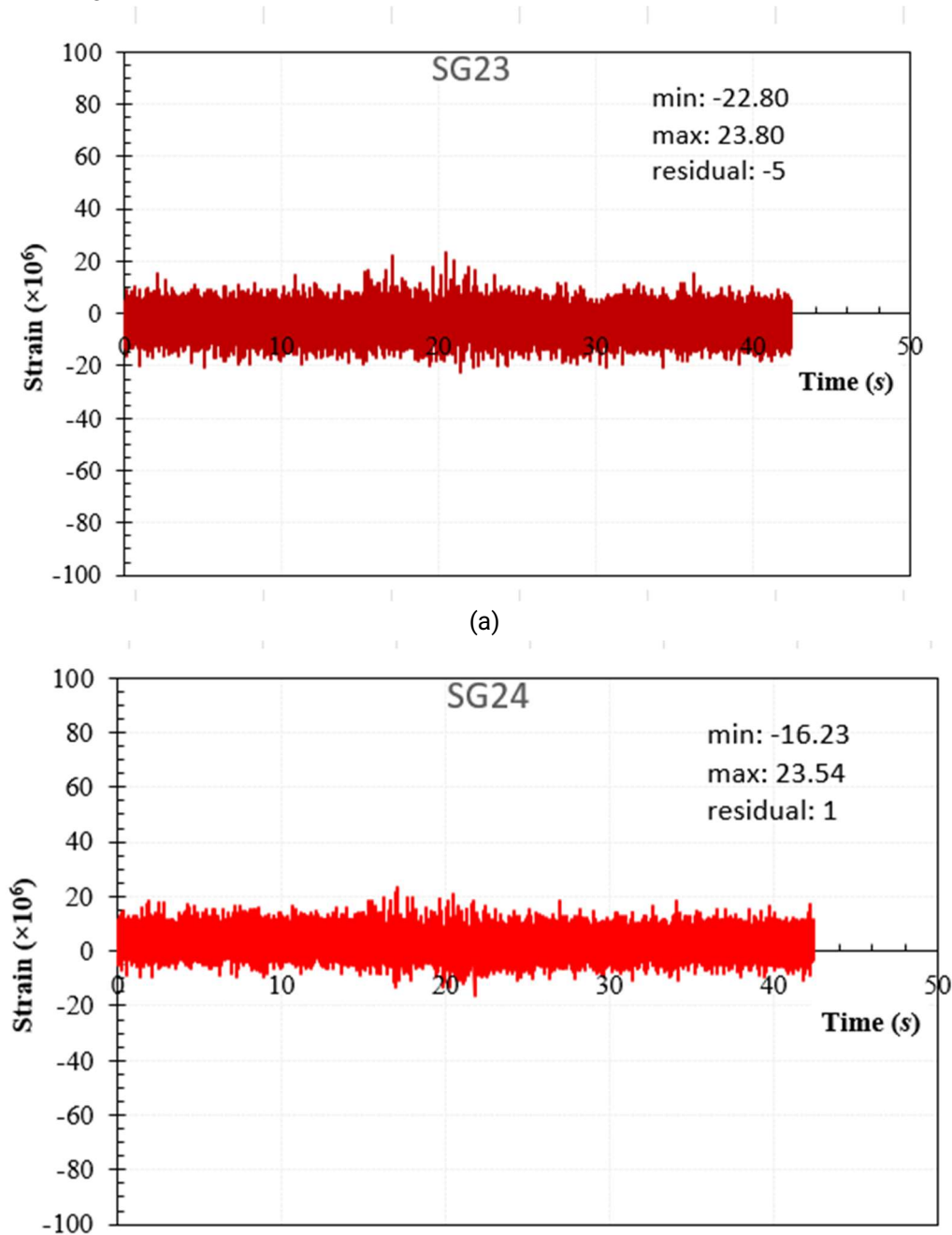


Figure 4.3.1 Characteristic results for phase B (earthquake 0,5g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 0,55g

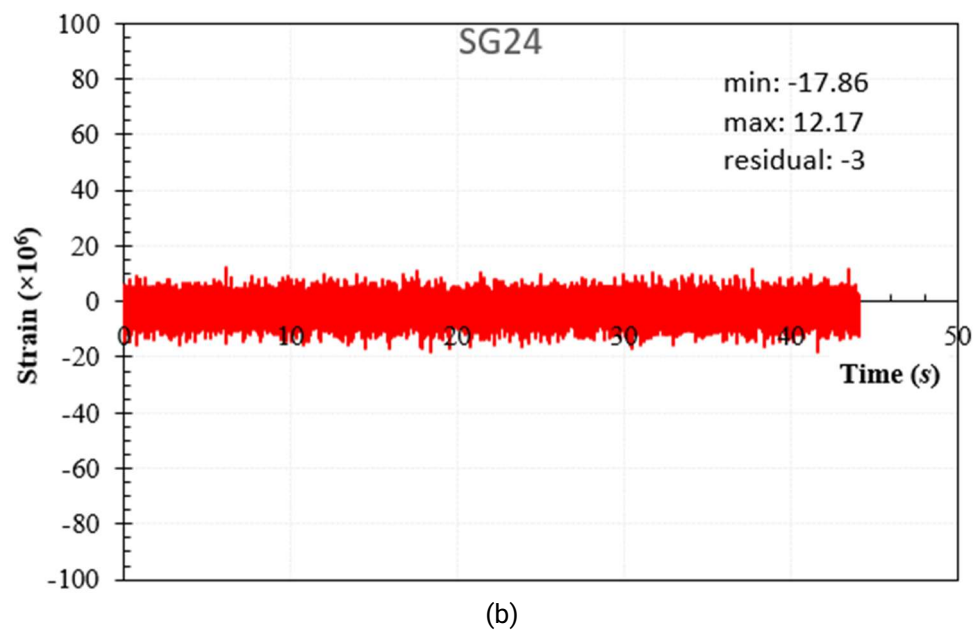
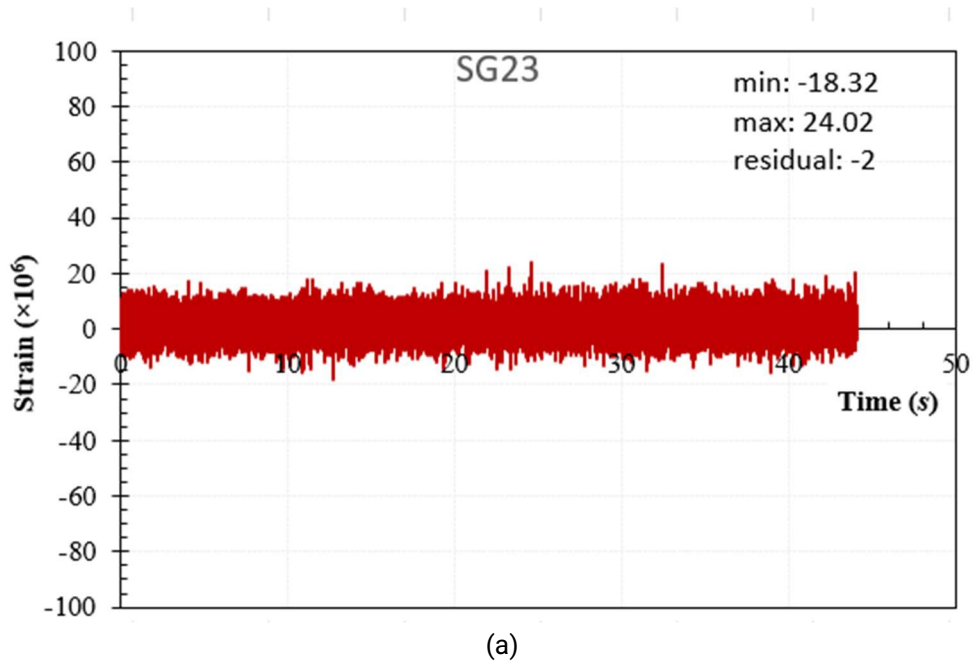
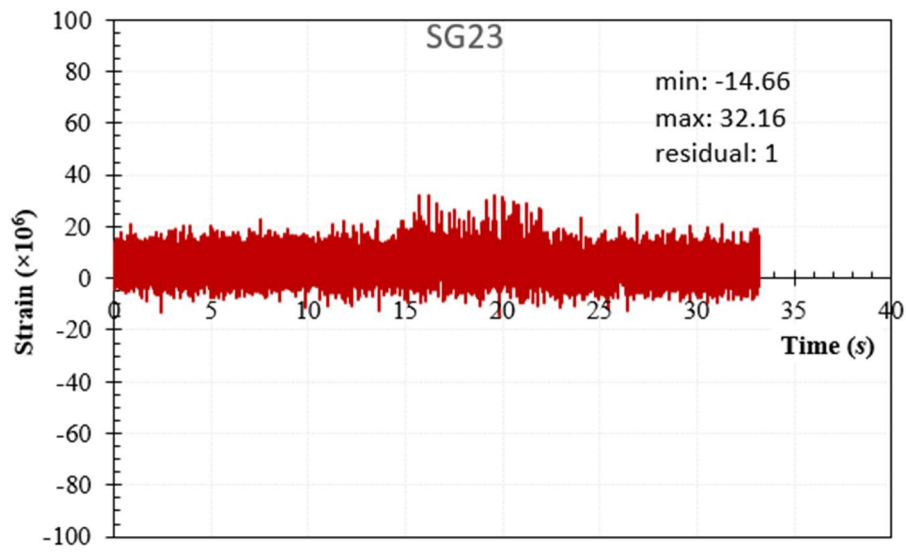
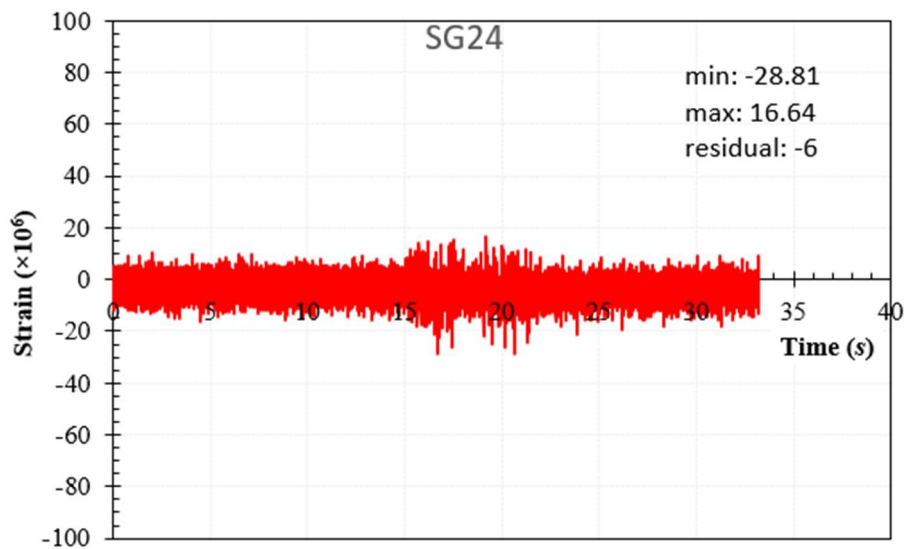


Figure 4.3.2 Characteristic results for phase B (white noise before 0,55g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 0,55g



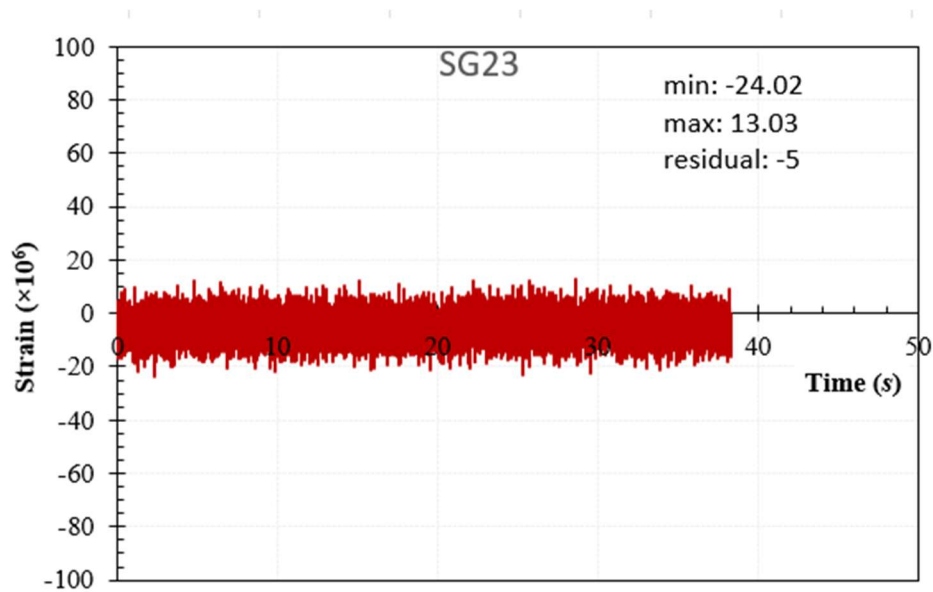
(a)



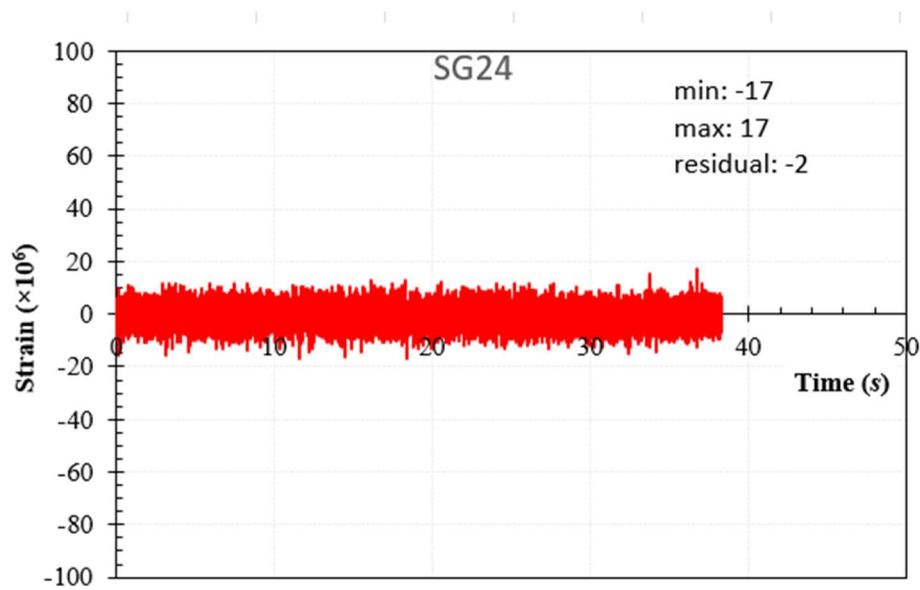
(b)

Figure 4.3.3 Characteristic results for phase B (earthquake 0,55g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 0,74g



(a)



(b)

Figure 4.3.4 Characteristic results for phase B (white noise before 0,74g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 0,74g

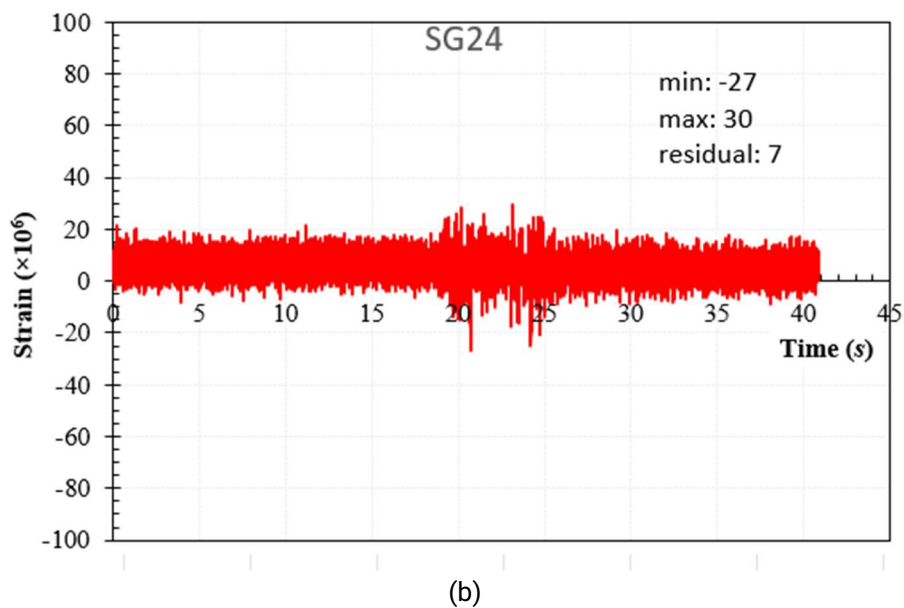
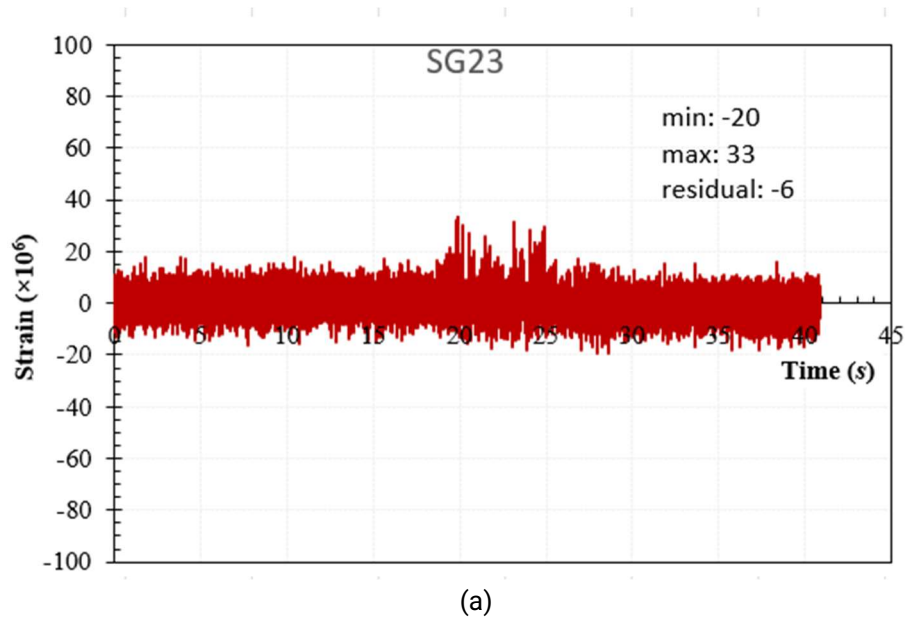
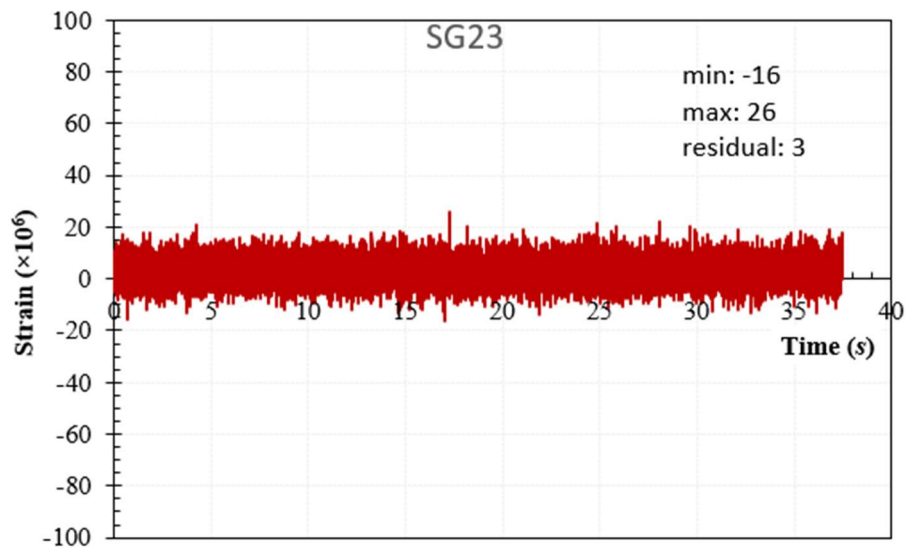
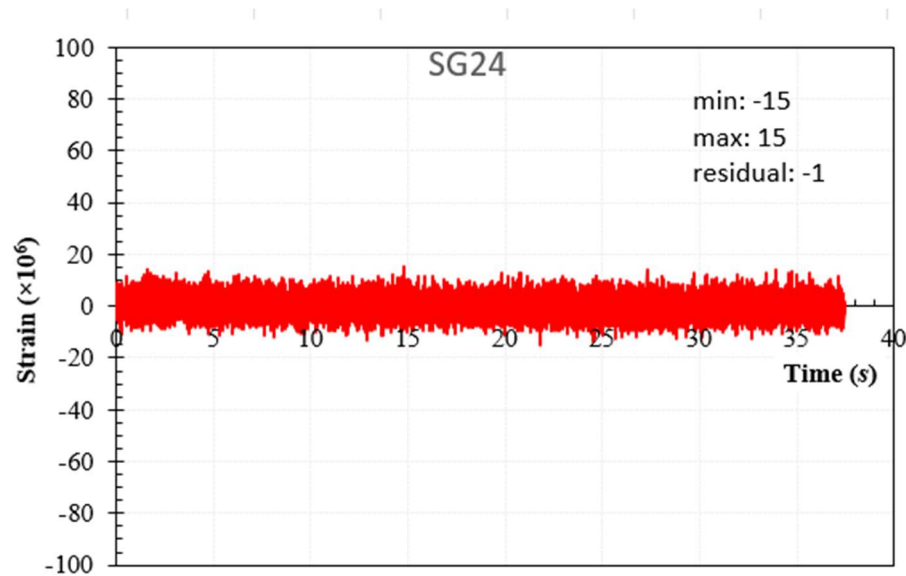


Figure 4.3.5 Characteristic results for phase B (earthquake 0,74g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 0,8g



(a)



(b)

Figure 4.3.6 Characteristic results for phase B (white noise before 0,8g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 0,8g

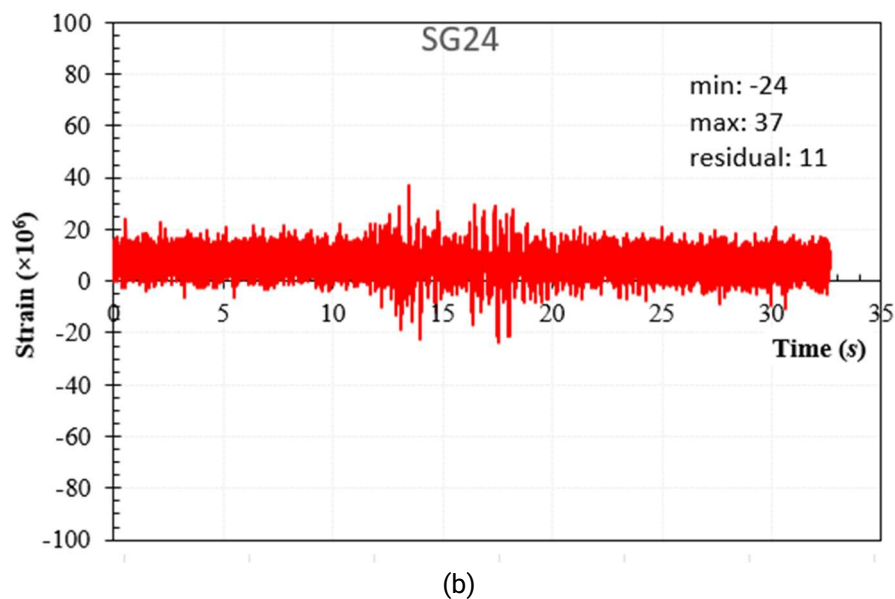
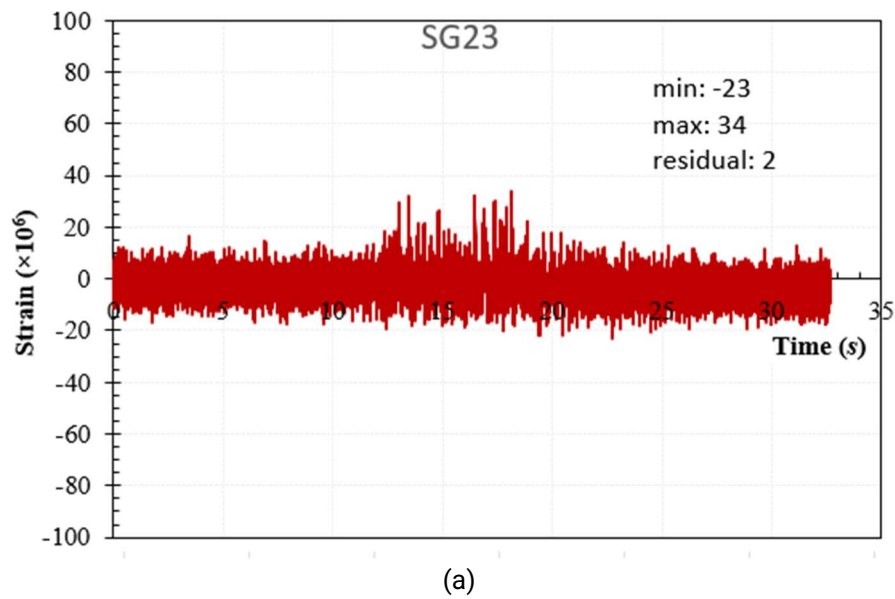
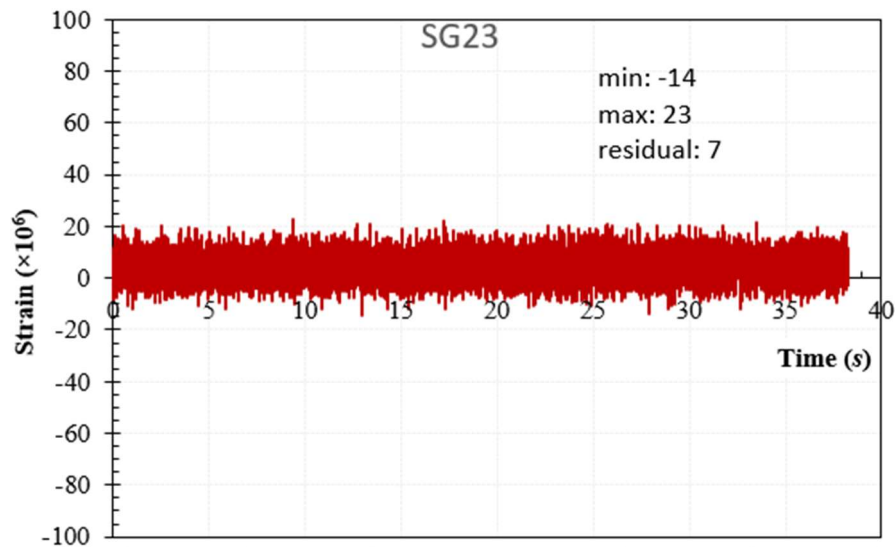
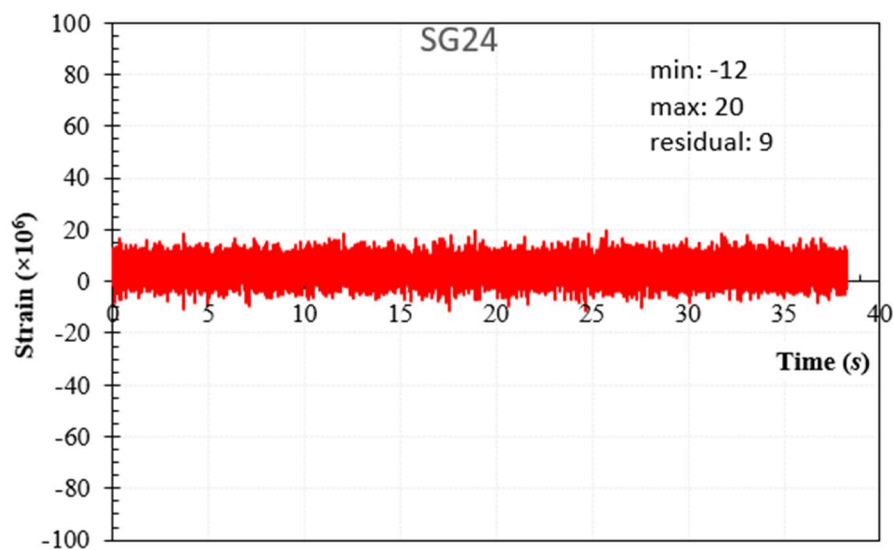


Figure 4.3.7 Characteristic results for phase B (earthquake 0,8g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 1,1g



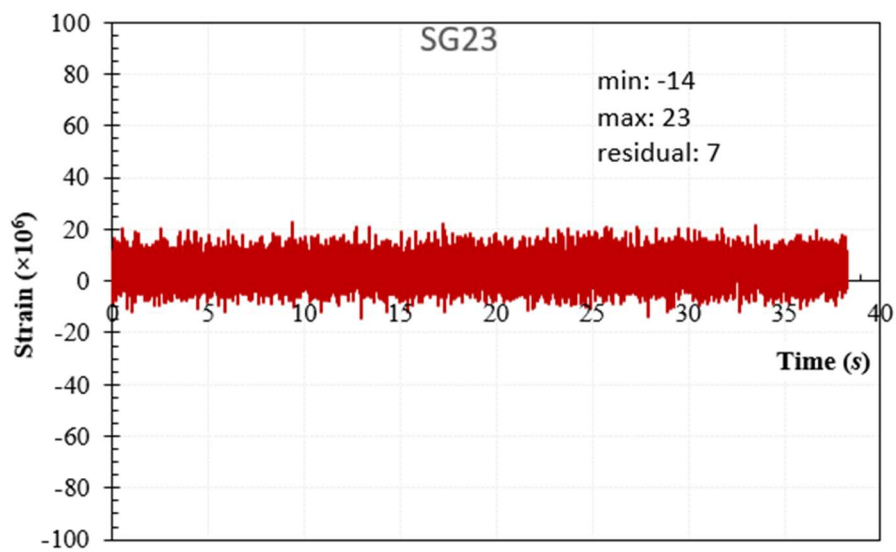
(a)



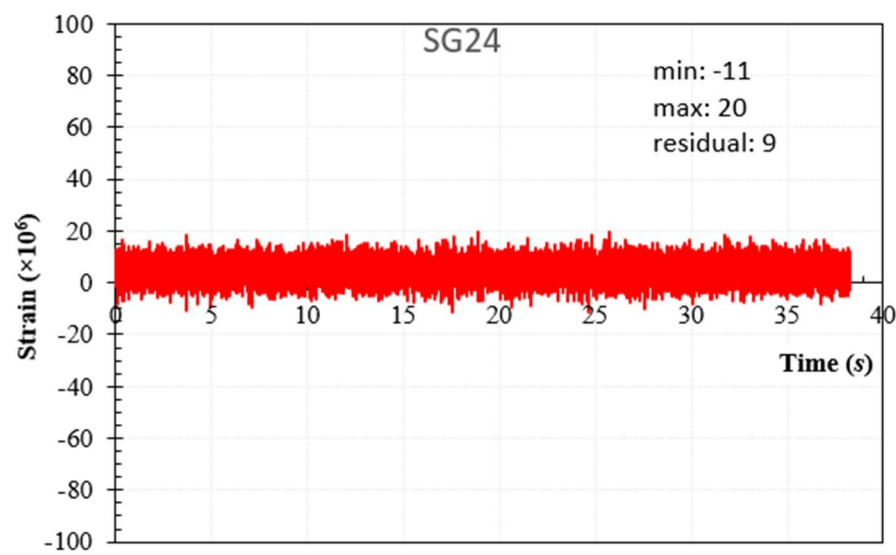
(b)

Figure 4.3.8 Characteristic results for phase B (white noise before 1,1g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 1,1g



(a)



(b)

Figure 4.3.9 Characteristic results for phase B (earthquake 1,1g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 1,3g

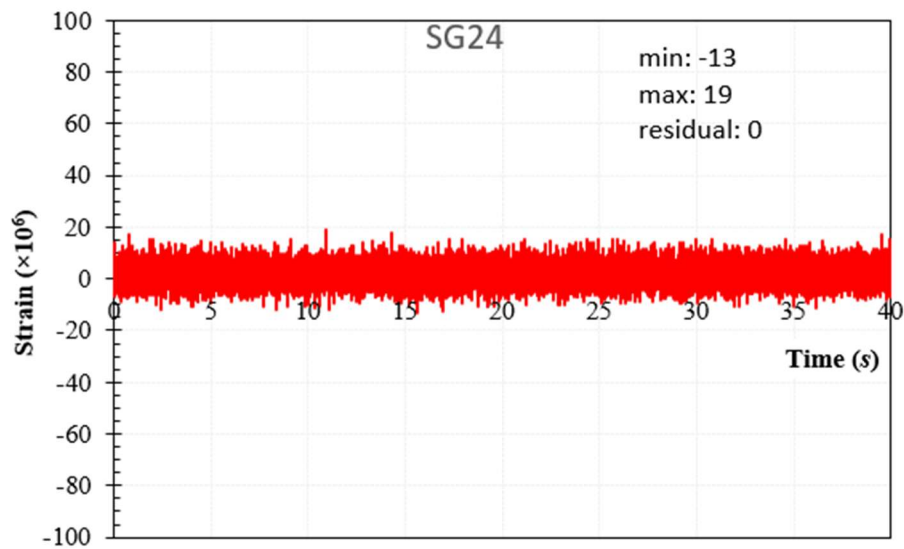
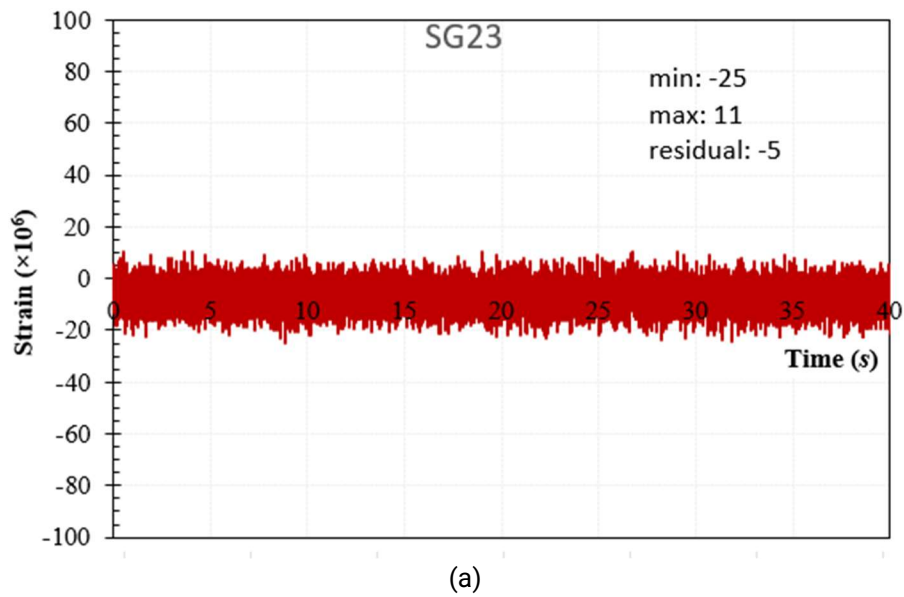
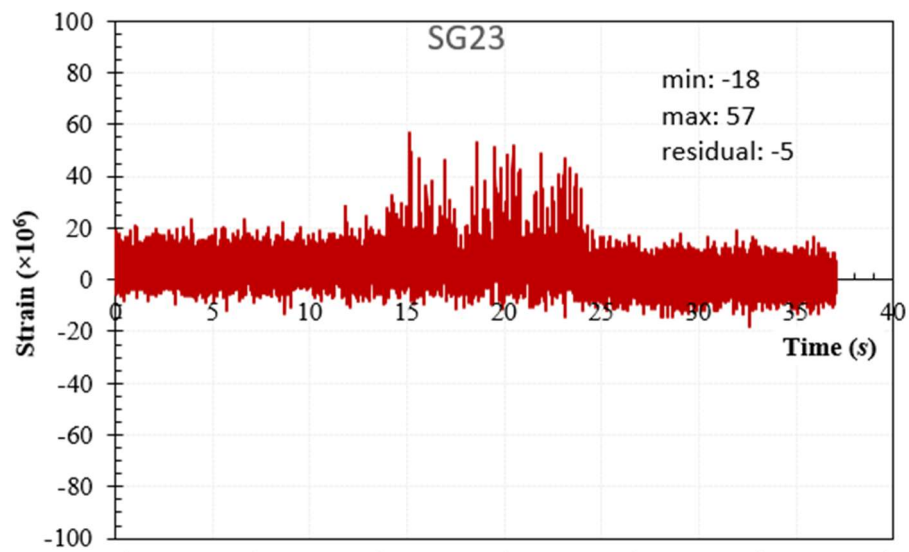
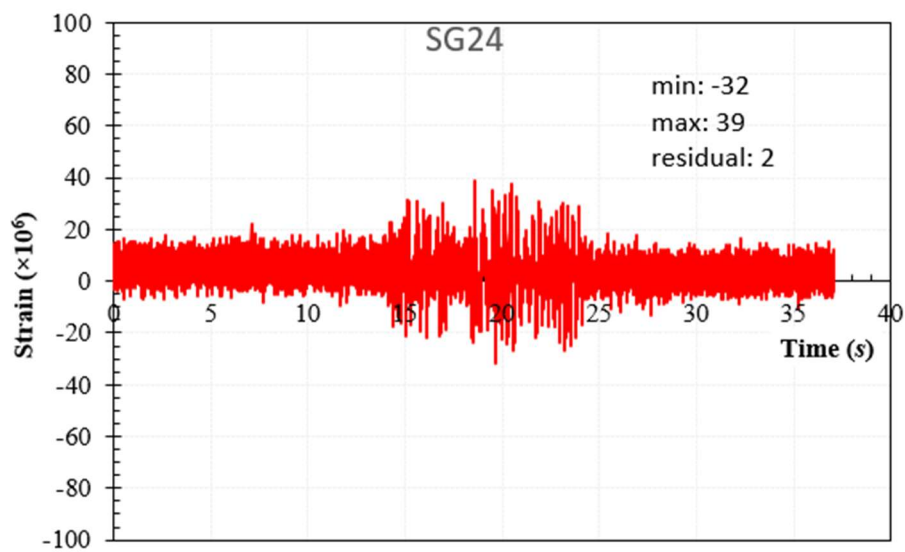


Figure 4.3.10 Characteristic results for phase B (white noise before 1,3g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 1,3g



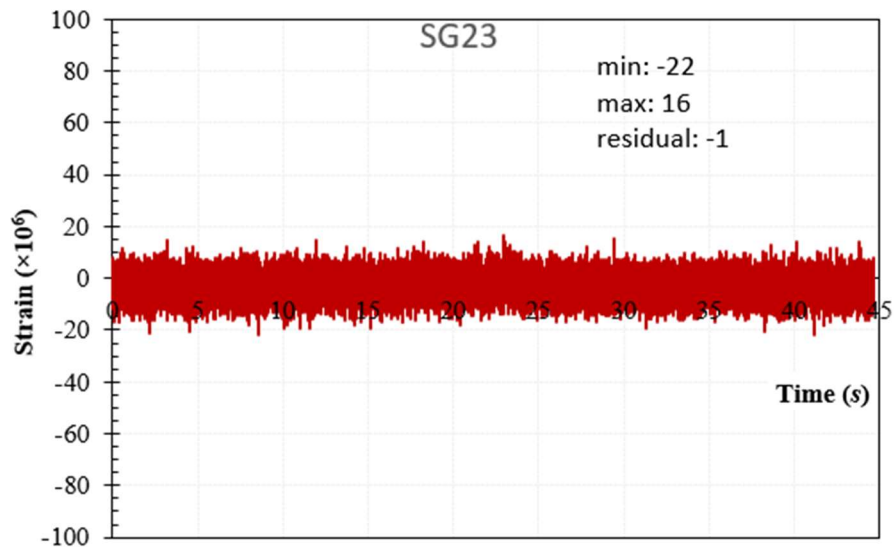
(a)



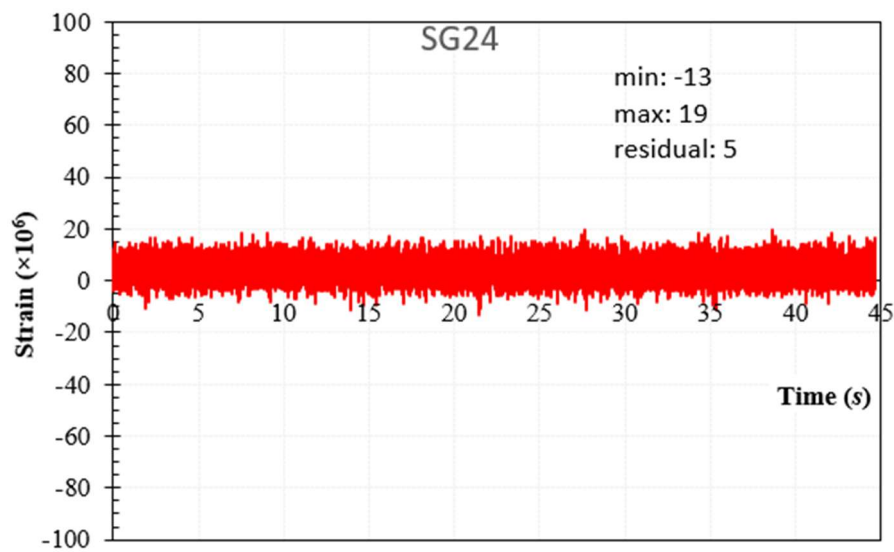
(b)

Figure 4.3.11 Characteristic results for phase B (earthquake 1,3g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 1,3g(2)



(a)



(b)

Figure 4.3.12 Characteristic results for phase B (white noise before 1,3g(2)): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 1,3g(2)

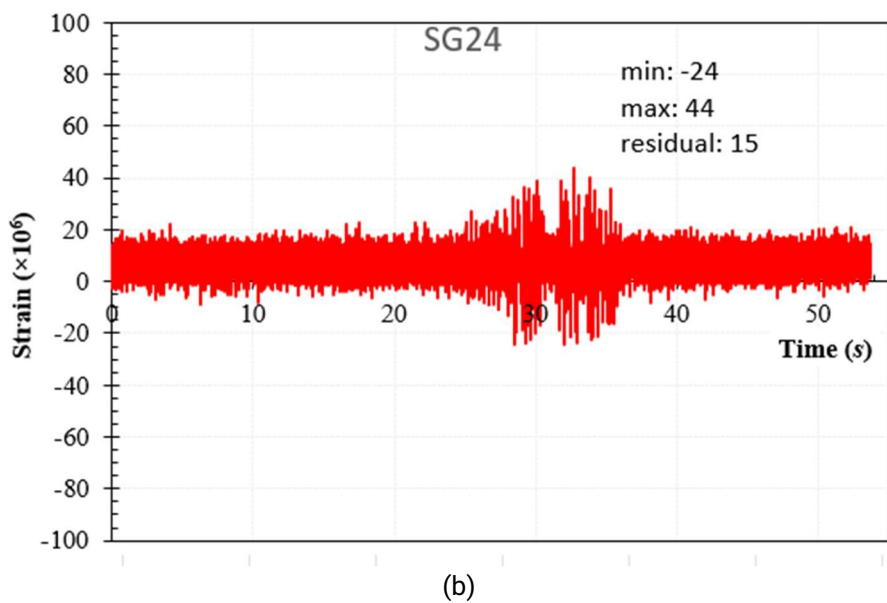
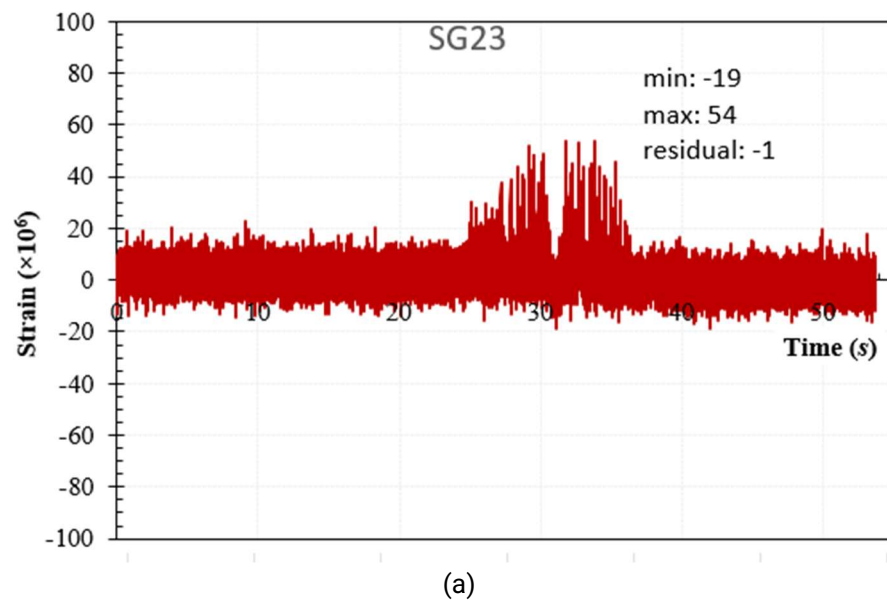


Figure 4.3.13 Characteristic results for phase B (earthquake 1,3g(2)): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 1,4g

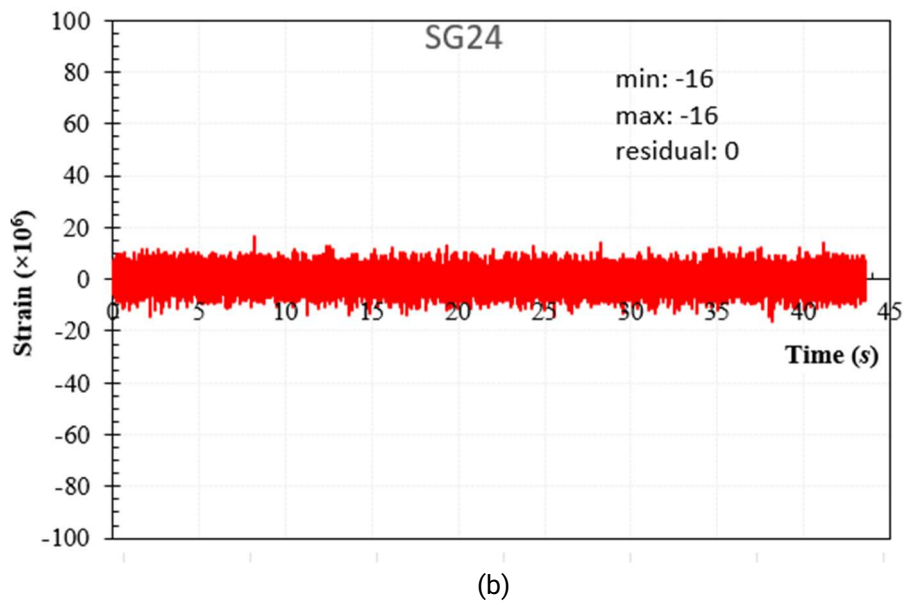
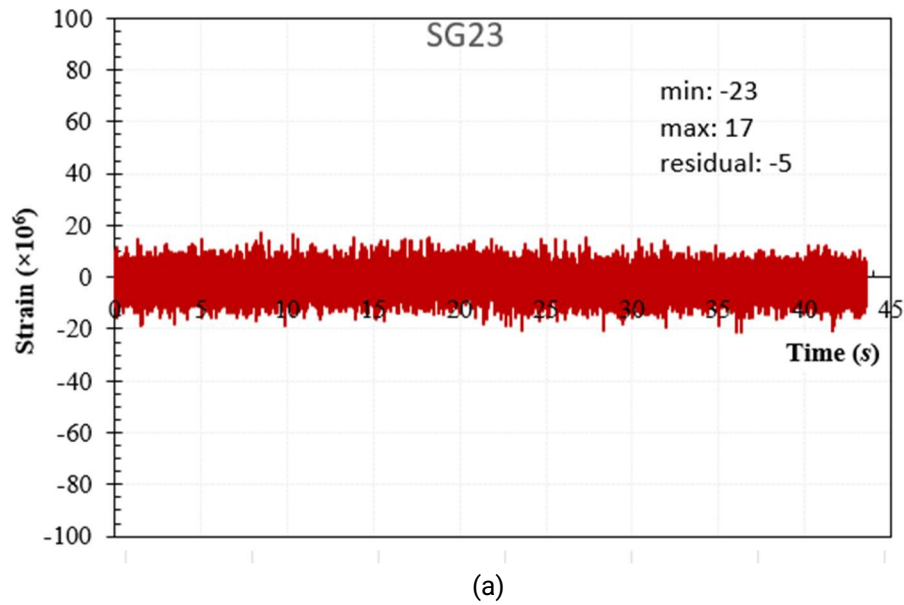
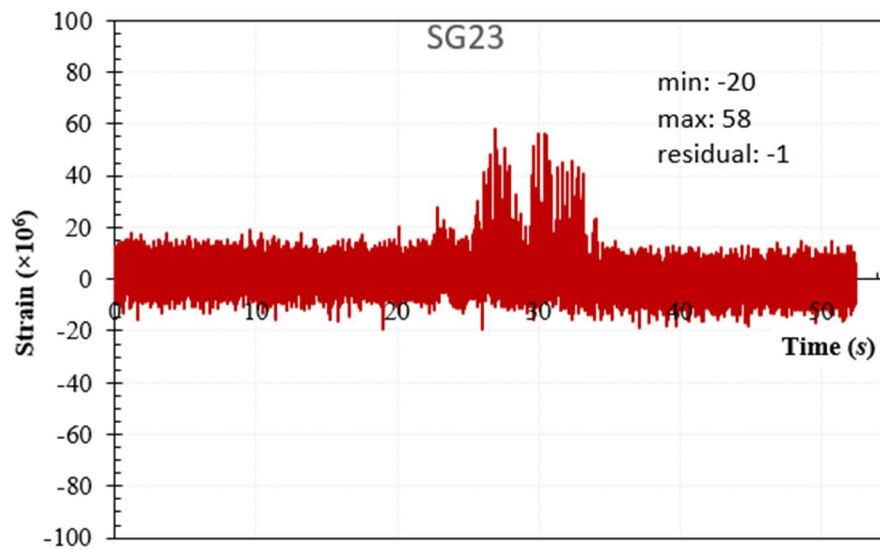
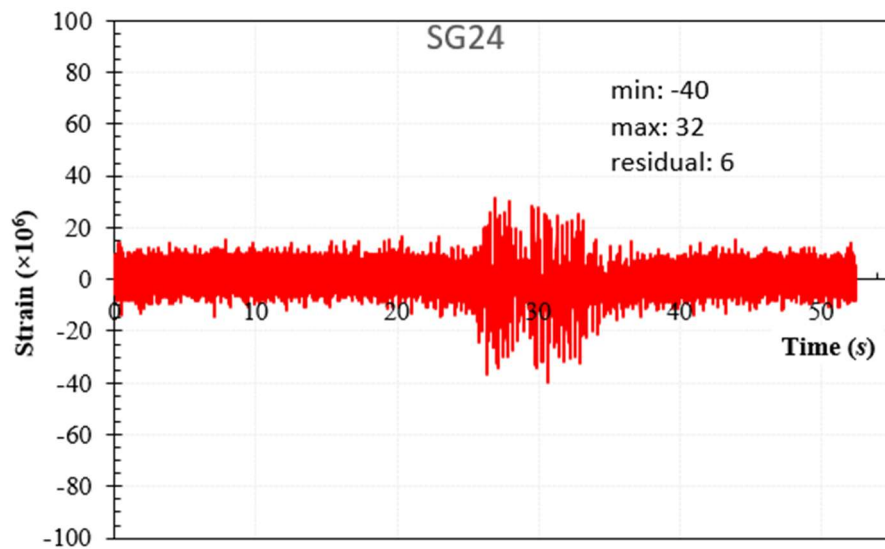


Figure 4.3.14 Characteristic results for phase B (white noise before 1,4g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 1,4g



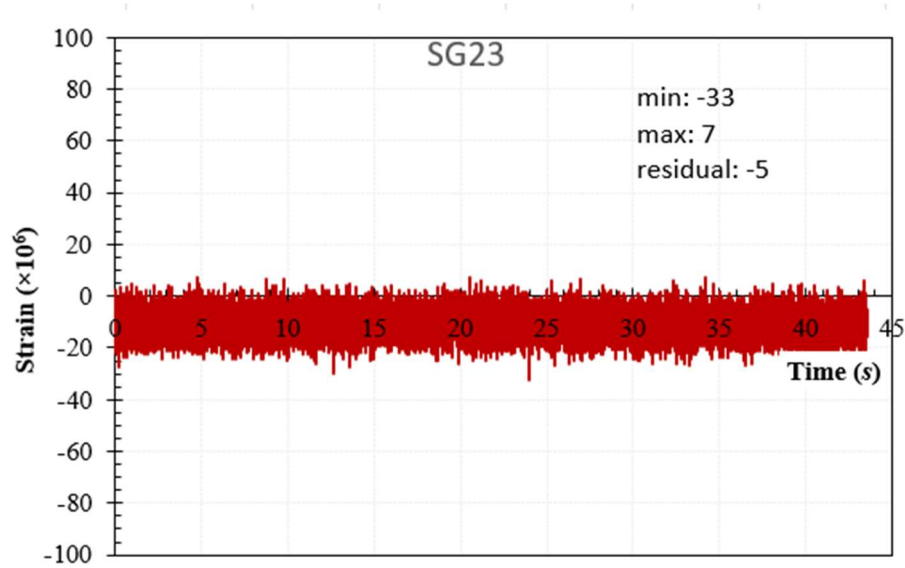
(a)



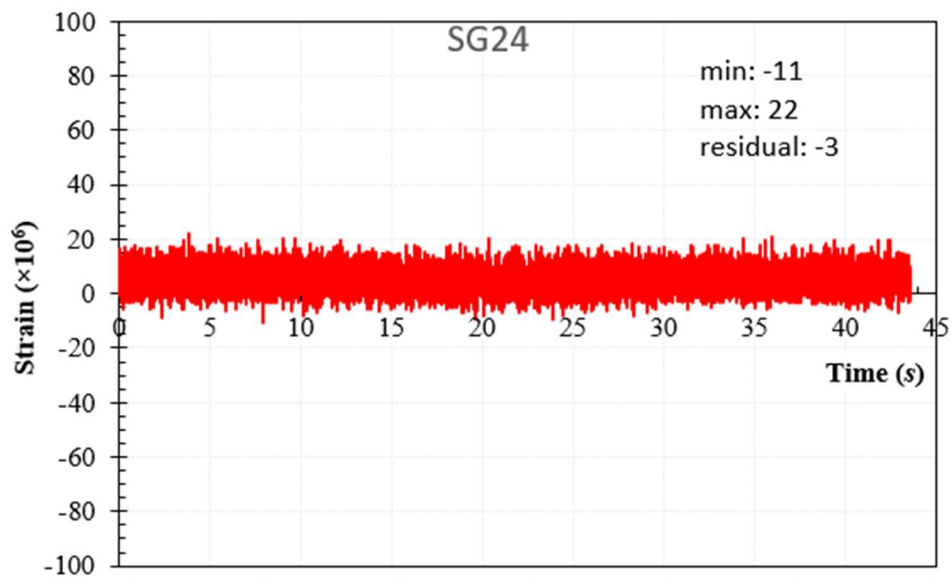
(b)

Figure 4.3.15 Characteristic results for phase B (earthquake 1,4g): (a) strain gauge SG23, (b) strain gauge SG24

White noise before 0,2g



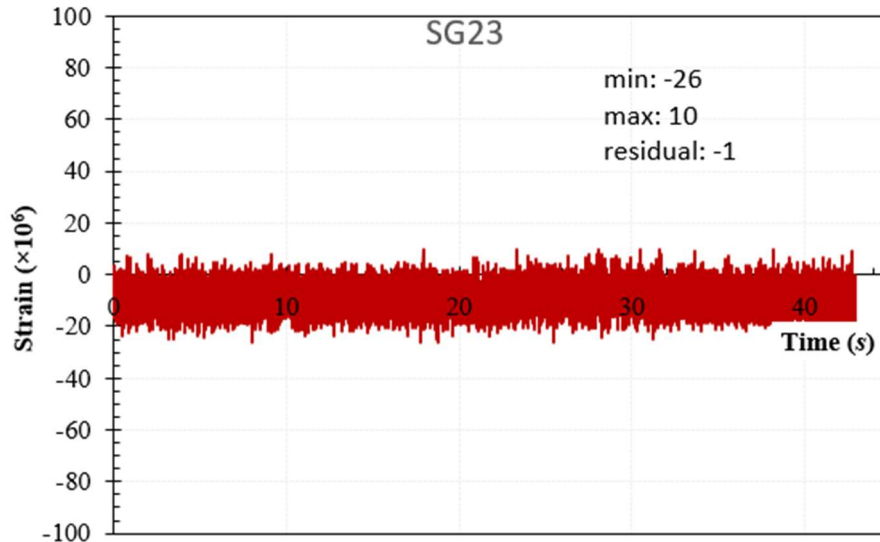
(a)



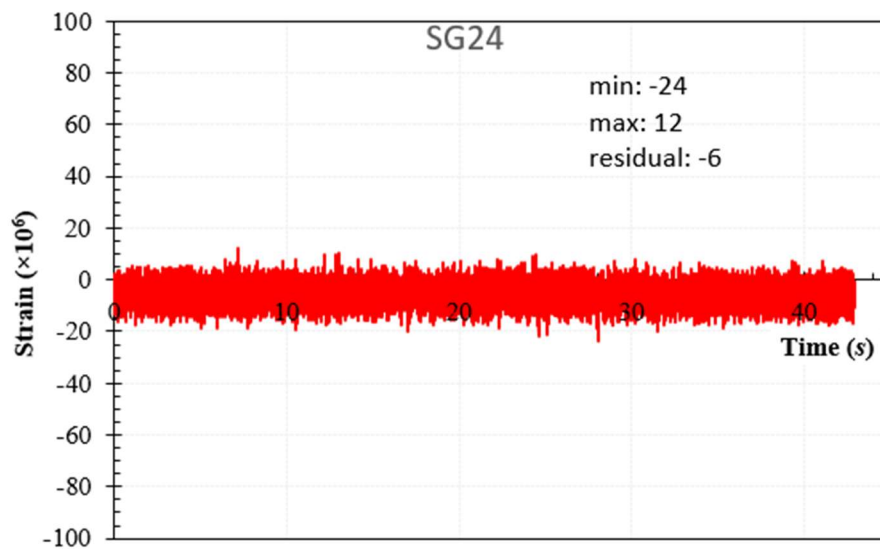
(b)

Figure 4.3.16 Characteristic results for phase B (white noise before 0,2g): (a) strain gauge SG23, (b) strain gauge SG24

Earthquake 0,2g



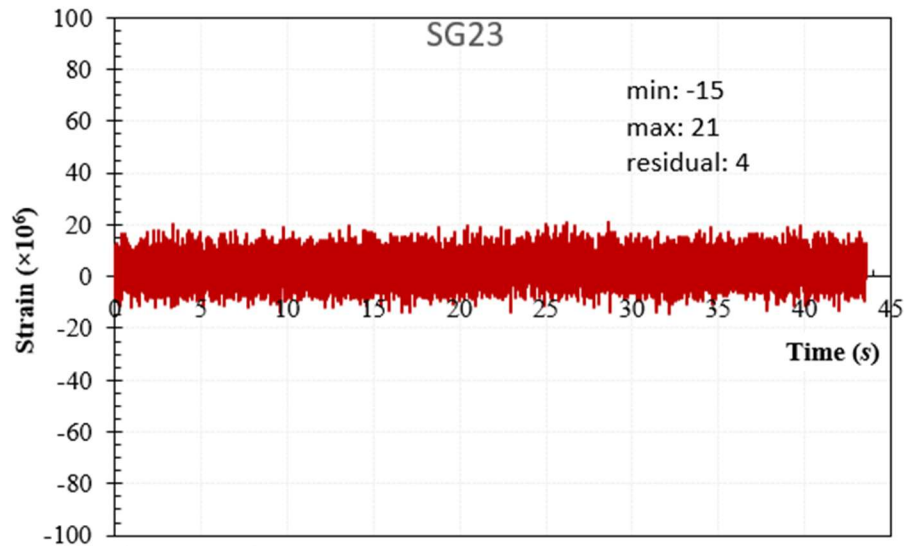
(a)



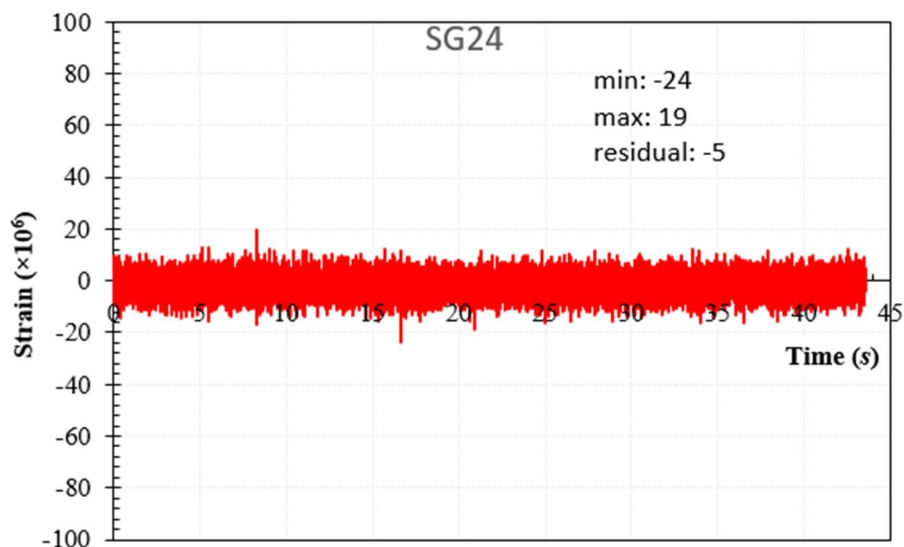
(b)

Figure 4.3.17 Characteristic results for phase B (earthquake 0,2g): (a) strain gauge SG23, (b) strain gauge SG24

White noise after 0,2g



(a)



(b)

Figure 4.3.18 Characteristic results for phase B (white noise after 0,2g): (a) strain gauge SG23, (b) strain gauge SG24

4.4 Characteristic photos of the damages of the renovated 3D VF structure

After all seismic tests the partial brick infill 1- 4 suffered crushing of the bottom brick (figure (a)) and local fracture of the FRPU jacket at the boundary between the crushed brick and the bottom foundation beam. The same is valid for partial brick infill 2 – 3 (figure c). PUFJ between concrete columns and brick infills maintained their integrity without fracture or debonding. FRPU jackets maintained their bonding on the PUFJs, on the concrete and on the bricks. No failure of brick infills 1 – 2 and 4 – 3 (out of plane) was observed.

The columns entered yielding strain of their longitudinal steel reinforcements at the bottom and at the top critical regions (columns 1, 2, 4). Basalt ropes seem to maintain the integrity of concrete core in these regions through external confinement.

The vertical forest VF renovations, that is the 8 vertical living walls (LW) and the 5 planters with the trees (P) presented a remarkably resilient performance up to very severe seismic excitations. All different cases of vertical Living Wall attachment on the concrete elements with basalt ropes and PU pads as well as of Planters anchoring with basalt ropes or steel rod on the top slab, sustained high displacement drifts and top slab accelerations respectively. Despite, steel rod or basalt rope loosening (in some cases) at very high accelerations of the structure, no planter or living wall collapse was observed. In some cases the basalt rope anchors of the planters were cut and were easily replaced. It is important to mention that LW4-3L, LW1-2L and LW1-2R showed better performance than LW4-3R at very high displacement drifts. Similar high performance showed LW1-4L and LW2-3R.

Damage with crushing of bottom brick at both partial infill walls occurred at very high displacement drift levels (2,62%), characteristic for rc structures at ULS, and for EQ1,4g. Therefore, the second phase of the seismic testing of the VF renovated structure is completed successfully, after the execution of 28 dynamic tests. The innovative renovations avoided partial or global collapse of the structure while at the end of all tests the structure showed extremely low stiffness around zero displacement drift. However, it reveals a recovery potential with negligible residual drift.

The PZTs reveal remarkable sensitivity to the damage accumulation inside concrete core or at the brick – mortar joints, feeling also the rocking behavior of planters. PZT recordings coincide with photographic validation and observations and demonstrate the ability of the PZT-enabled SHM system to detect changes in the health condition at different locations after each loading sequence.



(a)



(b)



(c)



(d)

Figure 4.4.1 Observed damage after all excitations: interior of partial wall infill 1-4 along the direction of movement of seismic table at the bottom (a), and at the top (b), interior of partial wall infill 2-3 along the direction of movement of seismic table at the bottom (c), and at the top (d)



(a)



(b)



(c)

Figure 4.4.2: Living wall 3 - 2 LW3-2L and LW3-2R anchoring details under the top slab with PU pads (a), planters and wooden sticks (simulating small trees) (b), (c)

5 RECORDED RESULTS OF SHEAR TESTS ON FRPU REPAIRED TRIPLETS OF BRICKS

The present study investigates the shear strength parameters of the mortar–brick interface, including average shear strength, characteristic shear strength, failure mode and ultimate shear capacity of a masonry triplet specimen constructed with three standard hollow clay bricks bonded with two binder mortar joints of lime-cement. These parameters are obtained by subjecting the specimen to a monotonic shear load, followed by an incremental application until failure. The brick triplet test contributes to the determination of the shear strength (f_v) of the bed joint of the infill, i.e the bond of the interface between the brick and the binder mortar. For this test, at least five specimens were constructed with one-sided PS jacket applied on the brick triplet as well as specimens with PS jacket with embedded glass grid (as applied on the renovated 3d rc structure).

The configuration includes two lime-cement mortar joints constructed to a uniform thickness of 10 mm, following EN 1052-3 guidelines. The nominal dimensions of the specimens are 290 mm (length) x 60 mm (width) x 190 mm (height).

The experimental loading setup of the triplet of hollow bricks is illustrated in Figure 5.1, 5.2. The shear strength is equal to the ratio of the reaction of the support equal to force $P/2$ divided by the area of the joint. Based on the roller supports the lateral force is zero.

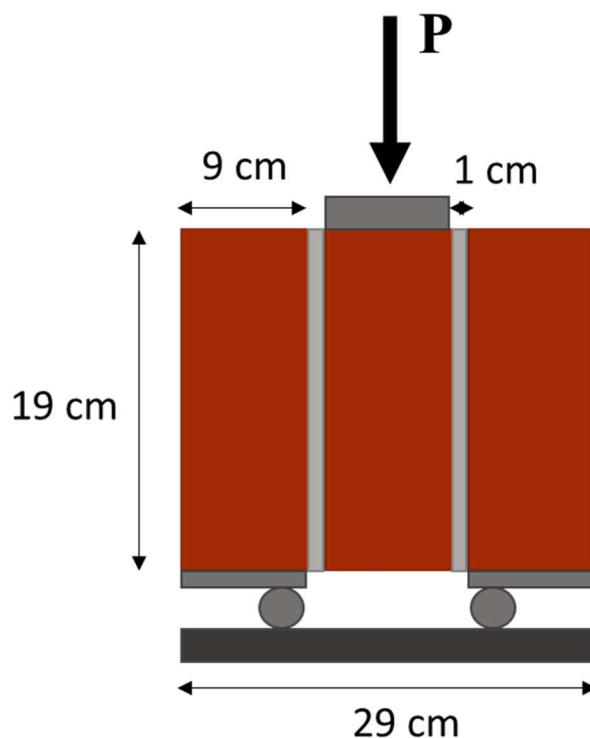


Figure 5.1: Triplet of clay bricks for the direct shear test with an intermediate connecting lime-cement mortar joint of 10 mm.

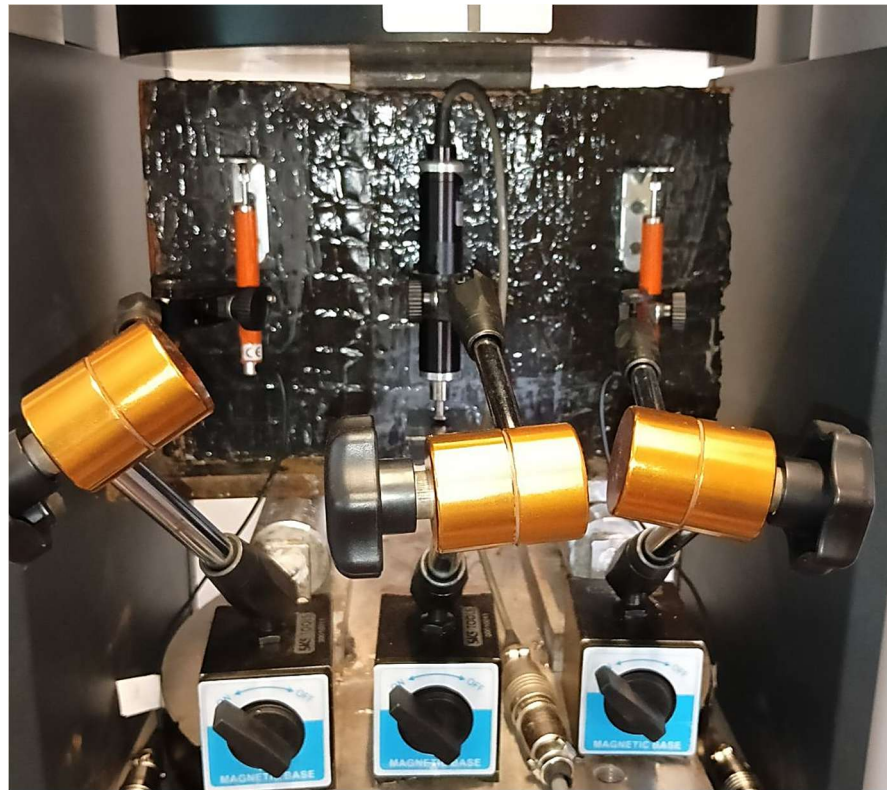


Figure 5.2: Experimental direct shear test setup of clay bricks triplet.

The experimental results of the direct shear test of triplet clay bricks are summarized in Table 5.1. The first column indicates the specimen code, where tr is the initials of the word "triplet". The second column gathers the maximum shear sliding load. The third column cites the area of the joint surface A , while the fourth column calculates the shear strength of each specimen resulting from the ratio of $P/2$ to the area of the triplet joint. The sixth column calculates the value of the average initial shear strength (f_{vo}). The seventh column shows the value of the characteristic initial shear strength (f_{vok}) of the triplet specimen multiplied by the correction factor 0.8. The last column shows the failure mode of each triplet specimen.

Specimens strengthened with both PS and glass textile demonstrated a noteworthy increase of approximately 171% in shear strength, from 0.25 MPa to 0.66 MPa. Specimens with PS jacket revealed 114% increase in shear strength, compared to the reference plain clay brick triplets with mortar bed joint, from 0.25 MPa to 0.52 MPa. This improvement is attributed to the added benefits of crack-bridging capabilities conferred by the PS layer and even more so with the glass textile layer.

Table 5.1: Experimental results of the direct shear test of clay bricks triplet.

Triplet Code	Load	Area	Shear strength	Average initial shear strength	Characteristic initial shear strength	Failure Mode	One-sided jacket
	$F_{\max}$ (N)	A_i (mm ²)	$f_{\text{voi}} = F_{\max} / 2A_i$ (MPa)	f_{vo} (MPa)	$f_{\text{vok}} = 0.8 f_{\text{voi}}$ (MPa)		
tr_1	5280	11400	0.23	0.25	0.20	A2	-
tr_2	5290		0.23			A2	
tr_3	5900		0.26			A2	
tr_4	6680		0.29			A2	
T_PS_1	11090	11400	0.49	0.52	0.42	A2	PS
T_PS_2	8920		0.39			A2	
T_PS_3	18520* temporary load loss		0.81			C/A2	
T_PS_4	10590		0.46			A2	
T_PS_5	7780* temporary load loss		0.34			A2	
T_PS_G_1	14770* temporary load loss	11400	0.65	0.66	0.53	A2/A2	PS-Glass Textile
T_PS_G_2	10940		0.48			A2/A2	
T_PS_G_3	16060 temporary load loss		0.70			C/A2/A2	
T_PS_G_4	11850 temporary load loss		0.52			A2/A2	
T_PS_G_5	15800 temporary load loss		0.69			A2/A2	
T_PS_G_6	21360		0.94			C-A2	

Shear failure modes of clay brick triplets

Four different failure modes A1, A2, B, C and D may be identified, as illustrated in Figure 5.3 (according to the EN 1052-3 specifications without lateral compression for the shear tests). Specifically, the failure of the strengthened specimen occurs only in the binder mortar, due to the weakness of the interface between the two materials (crack in one side of the mortar-brick interface A1, in both sides of the mortar-brick interface A2, within the mortar joint and not in the brick interface B, within the brick unit only, along the joint length C, and inclined shear crack crossing both bricks and the joint D. For each specimen, its failure mode is listed in detail, which is type A2 in one or in both joints and/or type C, as shown in Table 5.1.

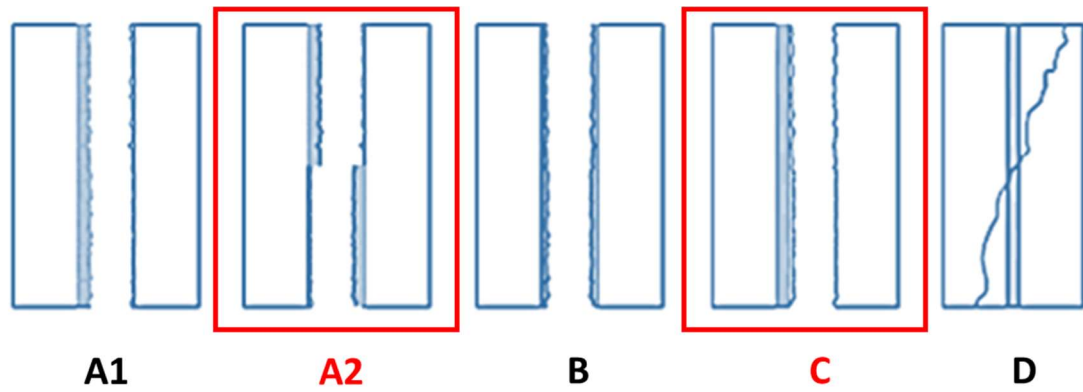


Figure 5.3: Types of failure modes of the strengthened brick triplets with PS and PS- glass textile subjected to shear test. Shear failure at the brick/mortar interface (A1, A2), within the joint mortar only (B), within one brick unit only (C), inclined crack crossing both bricks and the joint (D).



(a)



(b)



(c)



(d)

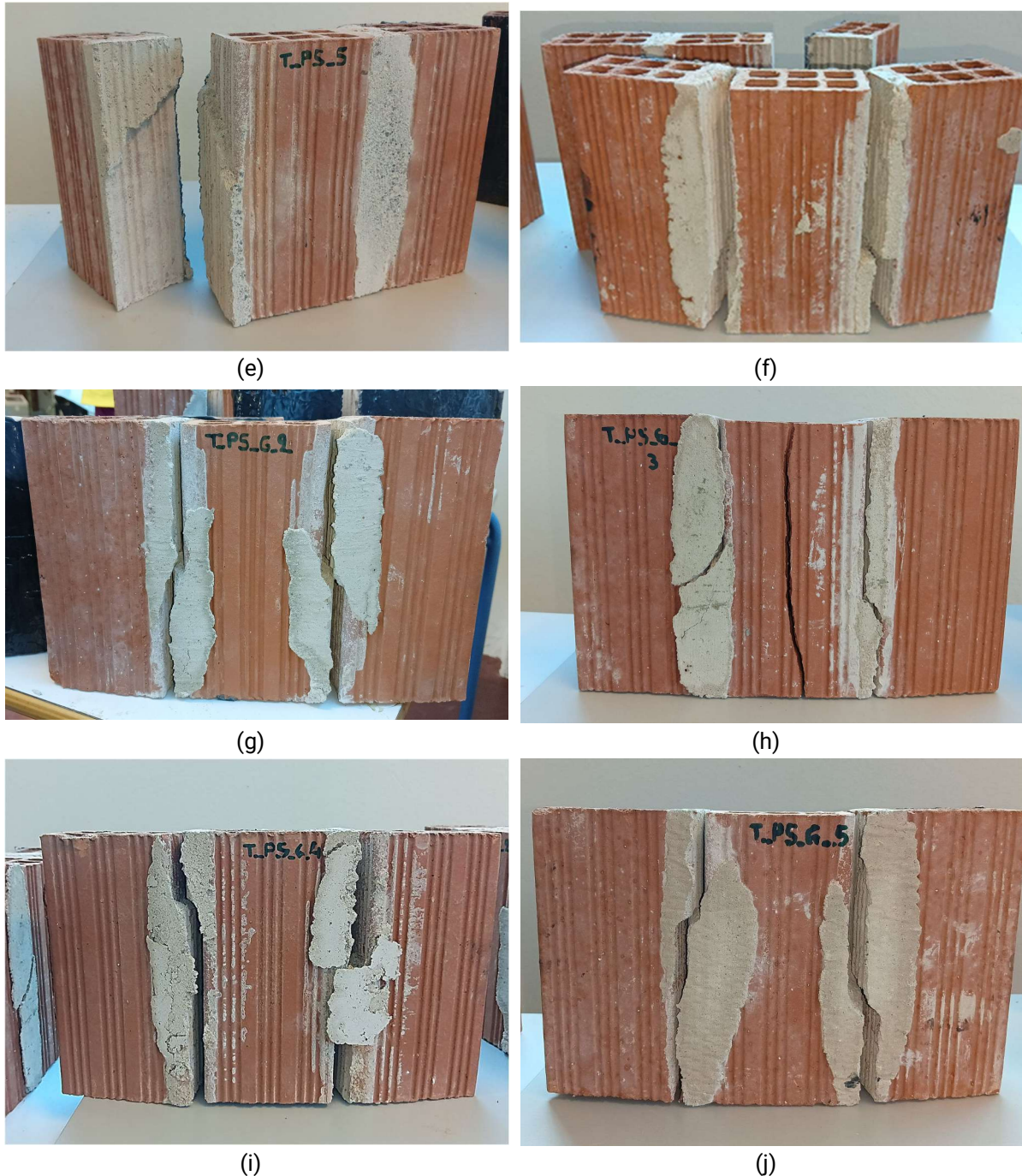


Figure 5.4: Failure modes of brick triplets subjected to shear testing. Shear failure only in the binder mortar (A2) of one joint between two interfaces (a,b,d,e), or in both joints after damage redistribution (f-j). Two specimens showed earlier brick cracking of type C (c,h)

All specimens with PS jacket failed primarily in the binder mortar at one of the joints per type A2, except for one that showed earlier brick crack of type C and then type A2 at one joint. as shown in Figure 5.4a-e (see also earlier tests on novel bricks by Thomoglou et al. 2024). Specimens TPS3 and TPS5 showed some load recovery. Specimens with FRPU jacket (PS impregnated and bonded glass grid) showed advanced damage redistribution potential with initial joint cracking on one side and then second cracking in the remaining joint. Load recovery was characteristic.

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