Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information for

Photo-cleavable Analog of BAPTA Chelating Agent for the Fast and Efficient Release of Ca^{2+}

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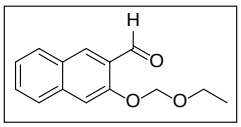
GENERAL INFORMATION

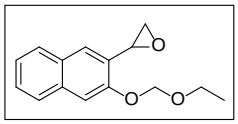
Column chromatography was performed using 40-63 μm silica gel. NMR spectra were recorded on a 400 MHz NMR spectrometer in $CDCl_3$, unless otherwise noticed. Chemical shifts were referenced to residual solvent proton or carbon signals. Melting points were determined using a Fisher-Johns melting point apparatus. High-resolution mass spectra were obtained using electron spray ionization and orbitrap mass analyzer. Solutions were prepared using HPLC grade water and acetonitrile. Photoreactions were conducted using a Rayonet photoreactor equipped with fifteen 4W 300 nm fluorescent lamps. The quantum yield of photoreaction was measured against the 4-nitroveratrole actinometer.[1] Fluorescence spectra were recorded with excitation and emission slit widths of 5.0 and 2.0 nm respectively.

MATERIALS

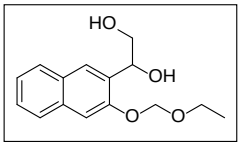
All reagents were obtained from commercial sources and were used without further purification unless otherwise noted. (3-(Ethoxymethoxy)naphthalen-2-yl)methanol **6** was prepared as reported previously.[2]



3-(Ethoxymethoxy)-2-naphthaldehyde (**7**). PCC (25.123 g, 97 mmol) was slowly added to a solution of **6** (15.1 g, 65 mmol), sodium acetate (7.95 g, 97 mmol), and molecular sieves Grade 564 8-12 mesh (2.5 g) in DCM (100 mL) at 0 °C. The reaction mixture was stirred at r.t. overnight and separated using short silica gel column (~ 15 cm, DCM) to produce 13.3 g (89%) of aldehyde 7 as colorless crystals. M.p. = 48 ^{0}C. IR: 2977; 1682; 1623; 1594; 1068; 742 cm^{-1}. ^{1}H NMR: 10.60 (1H, s); 8.39 (1H, s); 7.89 (1H, dd, *J* = 8.6 and 1.2 Hz); 7.76 (1H, dd, *J* = 8.8 and 1.2 Hz); 7.55-7.52 (2H, m); 7.39 (1H, dd, *J* = 8.2 and 8.3 Hz); 5.47 (2H, s); 3.83 (2H, q, *J* = 7.2 Hz); 1.27 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 190.2; 155.2; 137.4; 130.6; 129.8; 129.1; 128.2; 126.9; 125.8; 125.0; 110.1; 93.5; 64.9; 15.1. HRMS (ESI), *m/z*: calcd. for $C_{14}H_{14}O_3Na$ $[M+Na]^+$ 253.0841, found 253.0836.

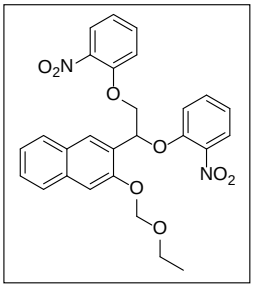


2-(3-(Ethoxymethoxy)naphthalen-2-yl)oxirane (**8**). NaH (4.52 g, 113 mmol) was added in small portions to a solution of trimethylsulfonium iodide (23 g, 113 mmol) in anhydrous DMSO (100 mL) and THF (65 mL) under Ar at 0 °C. Ice-bath was removed, and the reaction mixture was stirred for 30 minutes at r.t., cooled to 0 °C, and a solution of aldehyde **6** (13.0 g, 56.3 mmol) in THF (30 mL) was added dropwise (over 1 h). The reaction mixture was allowed to reach r.t., stirred for 8 h, and quenched with water. The product was extracted with ether, organic layer washed water, brine, and dried over Na_2SO_4. Crude epoxide **8** (13.6 g, 99%, of pink oil) was used in the next step without purification. IR: 2975; 2900; 1633; 1506; 1469; 1252; 1222; 1067; 991; 746 cm^{-1}. HRMS (ESI), *m/z*: calcd. for $C_{15}H_{16}O_3Na$ $[M+Na]^+$ 267.0997, found 267.0992.

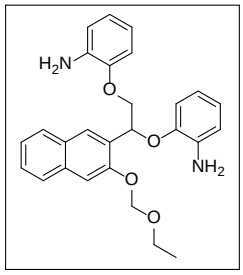


1-(3-(Ethoxymethoxy)naphthalen-2-yl)ethane-1,2-diol (**9**). Water (300 mL) was added under vigorous stirring to a solution of oxirane **8** (13 g, 53.3 mmol) in DMF (180 mL)and the resulting suspension was refluxed for 48 h. The reaction mixture was extracted with EtOAc, washed with water, brine, and dried over Na_2SO_4. The product was purified by column chromatography (EtOAc/Hexanes, 1:2) to give 8.38 g (60%) of diol **9** as yellowish powder. M.p. = 57 ºC. IR: 3394 (broad); 2975; 1633; 1503; 1052; 985; 740 cm^{-1}. ^{1}H NMR: 7.90 (1H, s); 7.76-7.72 (2H, m); 7.45-7.41 (2H, m); 7.37-7.33 (1H, m); 5.35 (2H, s); 5.24 (1H, dd, *J* = 7.8 and 4.0 Hz); 3.95-3.91 (1H, m); 3.76-3.68 (3H, m); 3.30 (1H, d, *J* = 4.8 Hz); 2.64 (1H, dd, *J* = 7.8 and 4.0 Hz); 1.23 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 152.4; 133.8; 130.1; 129.0; 127.7; 126.7; 126.4; 126.3; 124.3; 108.8; 93.1; 70.9; 66.8; 64.7; 15.1. HRMS (ESI), *m/z*: calcd. for $C_{15}H_{18}O_4Na$ $[M+Na]^+$ 285.1103, found 285.1098.

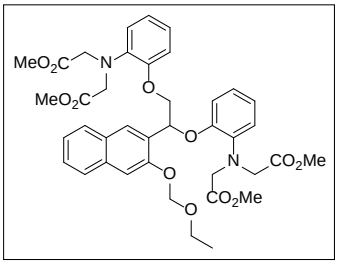
2-(1,2-bis(2-Nitrophenoxy)ethyl)-3-(ethoxymethoxy)naphthalene (**10**). NaH (1.52 g, 38 mmol) was added in small portions to a solution of diol **9** (5.0 g, 19 mmol) and 1-fluoro-2-nitrobenzene (5.4 g, 38 mmol) in anhydrous DMF (100 mL) and the reaction mixture was heated at 120 °C for 48 h. DMF was then evaporated in vacuum, the residue was dissolved in EtOAc, washed with water, brine, dried over Na_2SO_4. The crude product was purified by column chromatography (EtOAc/Hexanes, 1:9) to give 8.1 g (78%) of compound **10** as orange crystals. M.p. = 82 ºC. IR: 2975; 1603; 1520; 1348; 1240; 974; 740 cm^{-1}. ^1H NMR: 8.04 (1H, s); 7.82-7.75 (4H, m); 7.57-7.53 (2H, m); 7.47-7.44 (1H, m); 7.38-7.34 (2H, m); 7.23 (1H. dd, *J* = 8.6 and 0.8 Hz); 7.09-7.04 (2H, m); 6.99-6.95 (1H, m); 6.31 (1H, dd, *J* = 7.8 and 2.8 Hz); 5.51 (2H, dd, *J* = 10.0 and 6.8 Hz); 4.56 (1H, dd, *J* = 10.8 and 2.8 Hz); 4.47 (1H, dd, *J* = 10.8 and 2.8 Hz); 3.86-3.80 (2H, m); 1.29 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 152.1; 151.9; 151.1; 140.4; 140.3; 134.3; 134.1; 133.9; 129.0; 128.1; 127.4; 127.0; 126.8; 125.6; 125.5; 125.4; 124.6; 121.3; 120.8; 116.1; 109.3; 93.5; 75.5; 73.3; 65.0; 15.2. HRMS (ESI), *m/z*: calcd. for $C_{27}H_{24}N_2O_8Na$ $[M+Na]^+$ 527.1430, found 527.1425.



2,2'-((1-(3-(Ethoxymethoxy)naphthalen-2-yl)ethane-1,2-diyl)bis(oxy))dianiline (**11**). Glacial acetic acid (13.9 g, 232 mmol) was added to a stirred suspension of zinc dust (15.2 g, 232 mmol) and **10** (8.10 g, 16.1 mmol) in the THF - methanol mixture (1:10, 0.5 L), and the reaction mixture was stirred at r.t. overnight. The reaction was quenched by the addition of saturated $NaHCO_3$ solution (250 mL); solids were removed by filtration, and aqueous layer was extracted with EtOAc. Organic layer was washed with water, brine, and dried over Na_2SO_4. Solvent was removed in vacuum to give 7.0 g (98%) of **11** as yellow crystals. Compound was used without further purification. M.p. = 123 ºC. IR: 3475; 3417; 3340; 2912; 1614; 1504; 1207; 981; 735 cm^{-1}. ^1H NMR: 8.02 (1H, s); 7.79-7.75 (2H, m); 7.52 (1H, s); 7.47-7.43 (1H, m); 7.38-7.34 (1H, m); 6.87 (1H, d, *J* = 7.9 Hz); 6.84-6.78 (1H,m); 6.75-6.73 (4H, m); 6.60 (1H, d, *J* = 7.9 Hz); 6.51-5.46 (1H, m); 6.00 (1H, dd, *J* = 8.0 and 2.8 Hz); 5.47 (2H, dd, *J* = 10.4 and 6.8 Hz); 4.43-4.32 (2H, m); 3.93 (4H, s); 3.78 (2H, q, *J* = 7.2 Hz); 1.27 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 152.0; 146.3; 145.9; 137.3; 136.8; 134.1; 129.1; 127.9; 127.6; 127.0; 126.8; 126.6; 124.3; 122.0; 121.7; 118.2; 118.2; 115.3; 115.3; 114.6; 112.3; 109.0; 93.2; 75.7; 71.6; 64.8; 15.2. HRMS (ESI), *m/z*: calcd. for $C_{27}H_{29}N_2O_4$ $[M+H]^+$ 445.2127, found 445.2123.

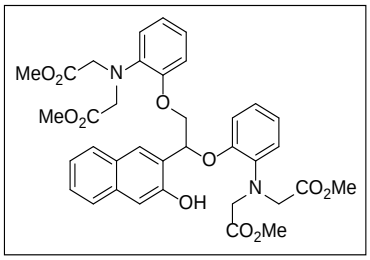


Tetramethyl 2,2',2'',2'''-((((1-(3-(ethoxymethoxy)naphthalen-2-yl)ethane-1,2-diyl)bis(oxy))-bis(2,1-phenylene))bis(azanetriyl))tetraacetate (**12**). Methyl bromoacetate (3.2 mL, 34 mmol) was added via syringe to a solution of aniline **11** (2.5 g, 5.6 mmol), 1,8-bis(dimethylamino)naphthalene (7.3 g, 34 mmol), NaI (450 mg, 3 mmol) in anhydrous CH_3CN (250 mL) under Ar and the reaction mixture was refluxed for 48 h. Toluene (200 mL) was added and precipitate of proton sponge was filtered of. The residue was washed with water, brine, and dried over Na_2SO_4. The product was purified by column chromatography (EtOAc/Hexanes, 1:6 to 1:2) to yield 3.1 g (75%) of tetraacetate as colorless crystals. M.p. = 46 ºC. IR: 2950; 1739; 1501; 1167; 984; 743 cm^{-1}. ^1H NMR: 8.05 (1H, s); 7.78 (1H, d, *J* = 8.0 Hz); 7.72 (1H, d, *J* = 8.4 Hz); 7.48 (1H, s); 7.43-7.39 (1H, m); 7.34-7.30 (1H, m); 6.87-6.86 (3H, m); 6.84-6.82 (2H, m); 6.73-6.71 (2H, m); 6.68-6.61 (1H, m); 6.22 (1H, t, *J* = 5.6 Hz); 5.47 (2H, dd, *J* = 11.2 and 7.2 Hz); 4.30 (4H, dd, *J* = 3.2 and 1.6 Hz); 4.24 (4H, dd, *J* = 3.2 and 1.6 Hz); 4.17 (1H, s); 4.12 (1H, s); 3.80 (2H, q, *J* = 7.2 Hz); 3.59 (6H, s); 3.44 (6H, s); 1.27 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 172.1; 171.6; 152.3; 150.4; 149.2; 139.8; 138.9; 134.0;

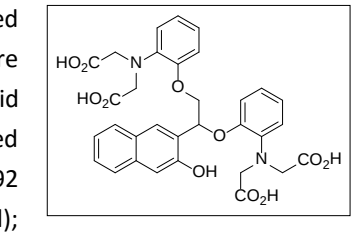


131.2; 128.0; 127.5; 126.8; 126.6; 124.1; 122.3; 122.0; 121.1; 121.0; 119.2; 114.0; 112.3; 108.7; 93.0; 73.1; 71.1; 64.6; 53.6; 52.9; 51.5; 51.3; 15.1 ppm. HRMS (ESI), *m/z*: calcd. for $C_{39}H_{44}N_2O_{12}Na$ $[M+Na]^+$ 755.2792, found 755.2794.

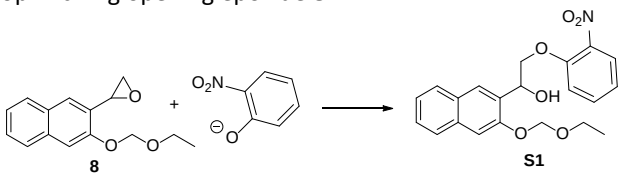
Tetramethyl 2,2',2'',2'''-((((1-(3-hydroxynaphthalen-2-yl)ethane-1,2-diyl)bis-(oxy))bis(2,1-phenyl-ene))bis(azanetriyl))tetraacetate (**13**). A solution of compound **12** (3.0 g, 4 mmol) in MeOH (50 mL) was refluxed overnight with 1.4 g of Amberlyst 15(H) resin. The reaction mixture was filtered through a plug of celite (~ 2 cm), washed with MeOH, and the filtrate was concentrated. The product was purified by column chromatography (EtOAc/Hexanes, 1:8) to produce 1.7 g (63%) of tetraacetate **13** as yellowish crystals. M.p. = 67 ºC. IR: 3381 (broad); 2951; 1732; 1501; 1194; 1168; 743 cm^{-1}. ^1H NMR: 7.79 (1H, s); 7.73 (1H, d, *J* = 8.4 Hz); 7.62 (1H, d, *J* = 8.4 Hz); 7.52 (1H, s); 7.40-7.36 (1H, m); 7.31-7.27 (1H, m); 7.20 (1H, s); 6.92-6.87 (5H, m); 6.82-6.75 (3H, m); 6.05 (1H, dd, *J* = 8.8 and 3.2 Hz); 4.65 (1H, m); 4.21 (1H, dd, *J* = 10.0 and 3.2 Hz); 4.16 (4H, s); 4.14 (4H, s); 3.56 (6H, s); 3.49 (6H, s). ^{13}C NMR: 172.4; 171.8; 152.7; 150.4; 148.8; 140.0; 139.0; 134.6; 128.7; 128.3; 127.6; 126.6; 126.1; 124.5; 123.6; 122.8; 122.7; 121.7; 121.4; 120.1; 119.6; 114.7; 112.9; 112.3; 77.5; 70.6; 53.6; 53.0; 51.7; 51.5. HRMS (ESI), *m/z*: calcd. for $C_{36}H_{39}N_2O_{11}$ $[M+H]^+$ 675.2554, found 675.2555.



2,2',2'',2'''-((((1-(3-hydroxynaphthalen-2-yl)ethane-1,2-diyl)bis(oxy))bis(2,10-phenylene))bis(azanetriyl))tetra-acetic acid (**NQMP-BAPTA**, **1**). 1 M aqueous potassium hydroxide (3 mL) was added to a solution of tetraacetate **13** (100 mg, 0.15 mmol) in MeOH - 1,4-dioxane mixture (1:1, 3 mL) and the reaction mixture was stirred at r.t. for 2 h. 1 M hydrochloric acid (20 mL) and brine (10 mL) were added to the reaction mixture, the resulted precipitate was separated, washed with water and dried under vacuum to give 92 mg (quant.) of tetra-acid **1** as colorless crystals. M.p. = 193 ºC. IR: 3042 (broad); 2922 (broad); 1716; 1497; 1229; 746 cm^{-1}. ^1H NMR (CD_3OD, 500 MHz): 7.76 (1H, s); 7.68 (1H, d, *J* = 8.4 Hz); 7.64 (1H, d, *J* = 8.0 Hz); 7.39-7.36 (1H, m); 7.26-7.22 (2H, m); 7.15 (1H, d, *J* = 8.0 Hz); 7.07-7.04 (1H, m); 6.81-6.77 (3H, m); 6.14 (1H, dd, *J* = 8.8 and 2.4 Hz); 4.45 (1H, m); 4.35 (1H, dd, *J* = 10.4 and 2.4 Hz); 4.10 (2H, d, J = 17.6 Hz); 3.95 (2H, d, *J* = 17.6 Hz); 3.92 (2H, d, *J* = 17.6 Hz); 3.75 (2H, d, *J* = 17.6 Hz) ppm. ^{13}C NMR (CD_3OD, 125 MHz): 176.0; 175.5; 153.9; 152.3; 150.5; 140.3; 139.9; 136.4; 129.8; 128.9; 128.0; 127.1; 126.1; 126.1; 125.1; 124.7; 122.7; 122.4; 119.2; 115.0; 113.4; 110.9; 74.8; 71.1; 57.3; 56.5. HRMS (ESI), *m/z*: calcd. for $C_{32}H_{30}N_2O_{11}Na$ $[M+Na]^+$ 641.1747, found 641.1743.



Scheme S1. Attempted nucleophilic ring opening epoxide **8**



1-(3-(ethoxymethoxy)naphthalen-2-yl)-2-(2-nitrophenoxy)ethan-1-ol (**S1**). A solution of epoxide **8** (500 mg, 2 mmol) and sodium 2-nitrophenolate (322 mg, 2 mmol) in anhydrous DMF (5 mL) was refluxed for 96 h. 1 M hydrochloric acid was added dropwise till the solution turned light yellow from red, product was extracted with EtOAc, washed with water, brine, and dried over Na_2SO_4. The product was purified by column chromatography (EtOAc/Hexanes, 1:6) to produce 411 mg (43%) of alcohol **S1** as orange oil. IR: 3587; 3386 (broad); 2903; 1603; 1522; 1355; 749 cm^{-1}. ^1H NMR: 7.88-7.85 (2H, m); 7.76 (1H, *J* = 8.4 Hz); 7.72 (1H, *J* = 8.0 Hz); 7.53 (1H, s); 7.46-7.43 (1H, m);

7.36-7.29 (2H, m); 7.00-6.96 (1H, m); 6.87 (1H, d, *J* = 8.4 Hz); 5.92 (1H, dd, *J* = 7.2 and 4.0 Hz); 5.50 (2H, dd, *J* = 10.8 and 6.8 Hz); 3.98 (2H, d, *J* = 6.8 Hz); 3.83 (2H, q, *J* = 7.2 Hz); 3.16 (1H, s); 1.30 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 151.6; 151.6; 140.0; 134.2; 134.1; 128.9; 127.8; 126.8; 126.7; 126.7; 126.0; 125.9; 125.7; 124.5; 120.8; 116.3; 109.1; 93.2; 79.4; 66.2; 64.8; 15.1. HRMS (ESI), *m/z*: calcd. for $C_{21}H_{21}NO_6Na$ $[M+Na]^+$ 406.1267, found 406.1264.

Photochemical studies

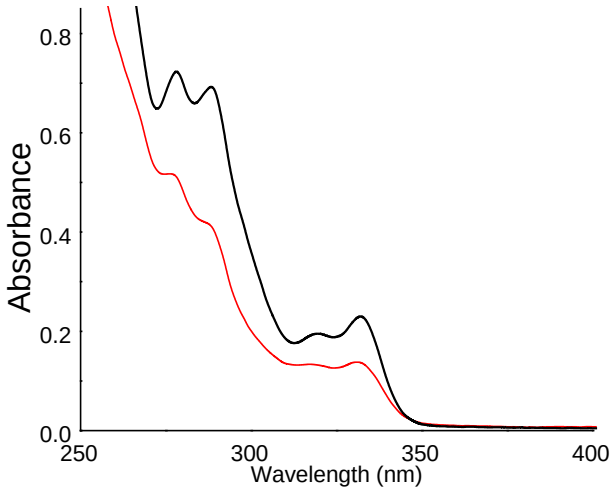
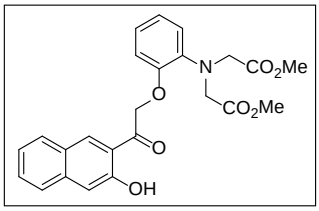


Figure S1. UV spectra of ca. 0.1 mM solutions of NQMP-BAPTA tetra-ester **13** (black line) and potassium salt of NQMP-BAPTA (**1**, red line) in HEPES buffer (pH= 7.4).

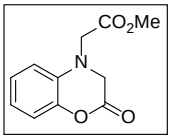
A solution of NQMP-BAPTA tetraacetate **13** (619 mg, 0.1 mmol) in 50% aqueous acetonitrile (1 L) was irradiated in a glass round-bottom flask under intensive stirring with 300 nm fluorescent lamps for 5 min. TLC of the reaction mixture showed complete consumption of the starting tetra-ester and the formation of four products. The HRMS-ESI analysis of the photolysate allowed to identify these products as diester **14**, phenol **15**, lactone **16,** and 3-hydroxy-2-naphthaldehyde **17** (Scheme 3). The products **14**, **16** and **17** were isolated by column chromatography (EtOAc/Hexanes, 1:8) and characterized by IR, ^{1}H NMR, ^{13}C NMR, and HRMS (ESI). Phenol **15** underwent rapid cyclization on silica gel to form lactone **16**.

Dimethyl 2,2'-((2-(2-(3-hydroxynaphthalen-2-yl)-2-oxoethoxy)phenyl)azanediyl)diacetate (**14**). Orange viscous oil, yield 23% (10 mg). IR: 3300 (broad); 2951; 1741; 1661; 1503; 1190; 1170; 746 cm^{-1}.

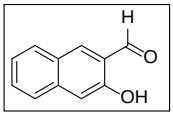


The compound **14** gives only one peak on HPLC and TLC, but two sets of ^{1}H NMR signals in the ratio of 1 : 10. We believe that it represents the presence of two rotamers, stabilized by intramolecular hydrogen bond. ^{1}H NMR (500 MHz): 11.17 (1H, s, major); 10.57 (0.1H, s, minor); 8.41 (1H, s, major); 8.40 (0.1H, s, minor); 7.90 (0.1H, d, *J* = 8.0 Hz, minor); 7.86-7.85 (0.1H, m, minor); 7.83 (1H, d, *J* = 8.5 Hz, major); 7.68 (1H, d, *J* = 8.5 Hz, major); 7.67-7.66 (0.1H, m, minor); 7.56-7.55 (0.1H, m, minor); 7.55-7.52 (1H, m, major); 7.45 (0.1H, *J* = 8.0 Hz, minor); 7.42 (0.1H, *J* = 8.0 Hz, minor); 7.36-7.32 (2H, m, major); 7.17 (0.1H, d, *J* = 8 Hz, minor); 7.05 (0.1H, s); 7.00-6.83 (4.0H, m, major); 6.88(0.1H, d, *J* = 8.0 Hz ,minor); 5.93(0.2H, s, minor); 5.60 (2H, s, major); 4.23 (4H, s, major); 4.18 (0.4H, s, minor); 3.73 (0.6H, s, minor); 3.70 (6H, s, major) ppm. ^{13}C NMR (125 MHz) 200.2; 171.7; 156.7; 149.9; 140.0; 138.3; 131.8; 130.0; 129.4; 126.9; 126.3; 124.3; 123.4; 122.9; 120.1; 119.0; 116.9; 112.6; 71.5; 53.6; 51.8. HRMS (ESI), *m/z*: calcd. for $C_{24}H_{24}NO_7$ $[M+H]^+$ 438.1553, found 438.1550.

Methyl 2-(2-oxo-2,3-dihydro-4H-benzo[b][1,4]oxazin-4-yl)acetate (**16**). Yellowish crystals, yield 72% (32 mg), m.p.= 84 ºC. IR: 3066; 2958; 1771; 1735; 1505; 1198; 742 cm^{-1}. ^{1}H NMR: 7.07-7.02 (2H, m); 6.90-6.85 (1H, m); 6.60 (1H, dd, *J* = 8.0 and 1.6 Hz); 4.10 (2H, s); 4.01 (2H, s); 3.76 (3H, s) ppm. ^{13}C NMR: 169.6; 164.2; 141.6; 133.2; 125.2; 120.5; 117.1; 112.4; 52.2; 50.9; 50.5. HRMS (EI), *m/z*: calcd. for $C_{11}H_{11}NO_4$ $[M]^{+\cdot}$ 221.0688, found 221.0682.

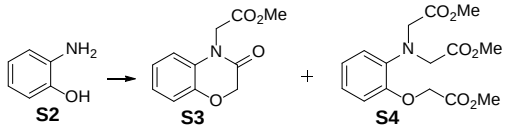


3-Hydroxy-2-naphthaldehyde 17. Yellow crystals, yield 64% (11 mg), M.P. = 94 ºC [lit. 95-96 ºC].[3] IR: 3289 (broad); 2918; 1659; 1503; 1456; 743 cm^{-1}. ^{1}H NMR: 10.33 (1H, s); 10.10 (1H, s); 8.17 (1H, s); 7.88 (1H, d, *J* = 8.4 Hz); 7.72 (1H, d, *J* = 8.4 Hz); 7.59-7.55 (1H, m); 7.40-7.36 (1H, m); 7.29 (1H, s). ^{13}C NMR: 196.7; 155.8; 138.2; 137.9; 130.3; 129.4; 127.4; 126.7; 124.4; 122.3; 111.9. HRMS (ESI), *m/z*: calcd. for $C_{11}H_7O_2$ $[M-H]^-$ 171.0446, found 171.0441.



Independent Syntheses of Photoproducts

Scheme S2. Preparation of lactam **S3** (an isomer of lactone **16**).

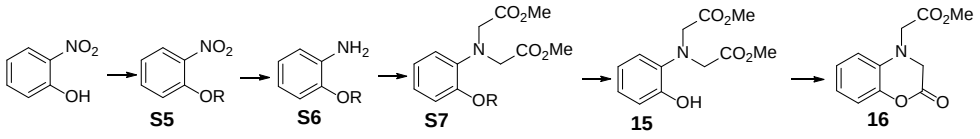


1,8-bis(Dimethylamino)naphthalene (980 mg, 4.58 mmol), methyl bromoacetate (1.051 g, 6.87 mmol) and NaI (7 mg, 46 µmol) were added to a solution of 2-aminophenol **S2** (250 mg, 2.29 mmol) in anhydrous CH_3CN (50 mL). The reaction mixture was heated at 70 ºC under Ar for 48 h, extracted with EtOAc, washed with water, brine, and dried over Na_2SO_4. Products were isolated by column chromatography (EtOAc/Hexanes, 1:8).

Methyl 3-oxo-2,3-dihydro-4H-benzo[b][1,4]oxazine-4-carboxylate (**S3**). Yield 53% (268 mg), yellow crystals, M.p. = 78 ºC. IR: 2953; 1747; 1684; 1502; 1392; 1211; 749 cm^{-1}. ^{1}H NMR: 7.04-7.01 (3H, m); 6.76 (1H, dd, *J* = 8.00 and 2.0 Hz); 4.68 (2H, s); 4.67 (2H, s); 3.79 (3H, s). ^{13}C NMR: 168.3; 164.9; 145.1; 128.6; 124.3; 122.9; 117.2; 114.3; 67.5; 52.7; 42.8 ppm. HRMS (EI), *m/z*: calcd. for $C_{11}H_{11}NO_4$ $[M]^{+\cdot}$ 221.0688, found 221.0683.

Dimethyl 2,2'-((2-(2-methoxy-2-oxoethoxy)phenyl)azanediyl)diacetate (**S4**). Yield 17% (127 mg), yellowish crystals, M.P. = 74 ºC [lit. 75 ºC][4]. ^{1}H NMR: 6.95-6.87 (3H, m); 6.80-6.78 (1H, m); 4.66 (2H, s); 4.20 (4H, s); 3.77 (3H, s); 3.71 (6H, s). ^{13}C NMR: 171.7; 169.4; 149.6; 139.4; 122.7; 122.6; 119.8; 114.7; 75.8; 66.1; 53.5; 52.1; 51.7.

Scheme S3. Independent Synthesis of lactone **16**.



R = $^{-}CH_2OCH_2CH_3$

1-(Ethoxymethoxy)-2-nitrobenzene (**S5**). Sodium hydride (346 mg, 8.64 mmol) was added to an ice-cold solution of 2-nitrophenol (1 g, 7.2 mmol) in anhydrous THF (100 mL). The reaction mixture was stirred at 0 °C for 30 minutes, then chloromethyl ethyl ether (1.79 g, 14.4 mmol) was added dropwise (over 30 min), and the solution was stirred at 0 °C for 2 h. The reaction was quenched by slow addition of cold water, the product was extracted with EtOAc, washed with water, brine, and dried over Na_2SO_4. The product was purified by column chromatography

(EtOAc/Hexanes, 1:6) to provide 1.4 g (99%) of **S5** as orange oil. IR: 2978; 1606; 1523; 1485; 1351; 1239; 962; 745 cm^{-1}. ^1H NMR: 7.80 (1H, dd, *J* = 8.0 and 1.6 Hz); 7.53-7.48 (1H, m); 7.35-7.33 (1H, m); 7.10-7.05 (1H, m); 5.34 (2H, s); 3.77 (2H, q, *J* = 7.2 Hz); 1.22 (3H, *J* = 7.2 Hz). ^{13}C NMR: 150.5; 133.8; 125.2; 121.4; 117.2; 94.0; 65.1; 15.0 ppm. HRMS (ESI), *m/z*: calcd. for $C_9H_{11}NO_4NNa$ $[M+Na]^+$ 220.0586, found 220.0580.

2-(Ethoxymethoxy)aniline (**S6**). Acetic acid (6.0 g, 101 mmol) was added dropwise to a stirred suspension of **S5** (1.4 g, 7 mmol) and zinc dust (6.6 g, 101 mmol) in THF - methanol mixture (1:10, 275 mL), the reaction mixture was stirred overnight at r.t, and quenched with saturated $NaHCO_3$ solution (50 mL). Solids we removed by filtration and filtrate was extracted with EtOAc. Organic layer was washed with water, brine, and dried over Na_2SO_4. The solvent was removed in vacuum to give 981 mg (84%) of aniline **S6** as orange oil. IR: 3460; 3369; 2975; 2985; 1614; 1502; 1204; 988; 739 cm^{-1}. ^1H NMR: 7.05 (1H, dd, *J* = 8.0 and 1.2 Hz); 6.87-6.83 (1H, m); 6.75-6.69 (1H, m); 5.25 (2H, s); 3.82 (2H, s); 3.75 (2H, q, *J* = 7.2 Hz); 1.25 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 144.9; 136.7; 122.3; 118.3; 115.3; 114.7; 93.7; 64.2; 15.0. HRMS (ESI), *m/z*: calcd. for $C_9H_{14}NO_2$ $[M+H]^+$ 168.1025, found 168.1019.

Dimethyl 2,2'-((2-(ethoxymethoxy)phenyl)azanediyl)diacetate S7. A solution of aniline **S6** (770 mg, 4.61 mmol), methyl bromoacetate (1.94 g, 12.7 mmol), anhydrous Na_2HPO_4 (1.80 g, 12.7 mmol), and NaI (347 mg, 2.3 mmol) in acetonitrile (35 mL) were stirred and refluxed under Ar for 18 h. The cooled reaction mixture was diluted with water until dissolution of inorganic salts. Then the mixture was extracted with toluene (4x50 mL). The combined organic extracts were dried with Na_2SO_4, filtered and evaporated. The product was purified by column chromatography (EtOAc/Hexanes. 1:8) to give 1.0 g (72%) of diacetate **S7** as a colorless oil. IR: 2952; 1739; 1502; 1167; 988; 746 cm^{-1}. ^1H NMR: 7.10-7.07 (1H, m); 6.90-6.88 (2H, m); 6.86-6.81 (1H, m); 5.18 (2H, s); 4.14 (4H, s); 3.74-3.69 (8H, m); 1.22 (3H, t, *J* = 7.2 Hz). ^{13}C NMR: 171.8; 149.0; 139.4; 122.3; 122.2; 119.1; 116.3; 93.7; 64.3; 53.8; 51.6; 15.0. HRMS (ESI), *m/z*: calcd. for $C_{15}H_{22}NO_6$ $[M+H]^+$ 312.1447, found 312.1444.

Dimethyl 2,2'-((2-hydroxyphenyl)azanediyl)diacetate 15. A solution of **S7** (1 g, 3.2 mmol) in MeOH (15 mL) with 1 g of Amberlyst 15(H) resin was refluxed overnight, filtered through a plug of celite (~ 2 cm), washed with MeOH, and the solvent removed in vacuum. The ^1H NMR and HRMS (ESI) spectra of the crude product indicate the presence of compounds **15** and **16** in the ratio 1:2. ^1H NMR: 7.88 (1H, s, **15**); 7.31 (1H, dd, *J* = 8.0 and 1.6Hz, **15**); 7.11-7.02 (5H, m, 1H of **15** and 4H of **16**); 6.94 (1H, dd, *J* = 8.0 and 1.6 Hz, **15**); 6.90-6.86 (2H, m, **16**); 6.83-6.79 (1H, m, **15**); 6.60 (2H, dd, *J* = 8.0 and 1.2 Hz, **16**); 4.11 (4H, s, **16**); 4.01 (4H, s, **16**); 3.89 (4H, s, **15**); 3.76 (6H, s, **16**); 3.72 (6H, s, **15**). HRMS (ESI) of **15**, *m/z*: calcd. for $C_{12}H_{16}NO_5$ $[M+H]^+$ 254.1028, found 254.1023. Phenol **15** could not be isolated in a pure form as it underwent rapid cyclization to lactone **15** on silica gel.

ANALYTICAL METHODS

HPLC analysis of photolysate of 13.

A solution tetraester **13** (100 μM) in 50% aqueous acetonitrile was irradiated in a quartz cuvette with 300 nm fluorescent lamps for 0, 90, 120, and 180 s. The composition of the photolysate after each period was analyzed by HPLC (eluent: MeOH (75%), CH_3CN (1%), water (24%)). After 90s of exposure, the formation of three products, namely **14**, **15**, and **16** are observed (Figure S2). Prolonged irradiation of the reaction mixture (>180 s) led to formation of a secondary photochemical product, which was found to be 3-hydroxy-2-naphthaldehyde **17**.

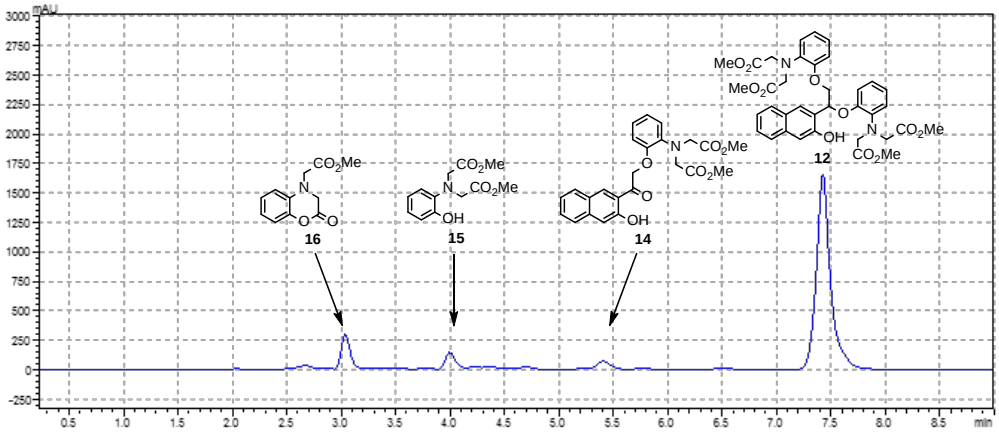


Figure S2. HPLC trace of the reaction mixture after 90 s of 300 nm irradiation of NQMP-BAPTA tetra-ester **13** in HEPES buffer at pH= 7.4.

Determination of Calcium Ca^{2+} Affinity of NQMP-BAPTA (**1**). A 2.16 µM solution of the NQMP-BAPTA (**1**) potassium salt in HEPES buffer (30 mM, pH= 7.20, [KCl] = 0.1 M) was titrated with 0.25 µM aqueous solution of $CaCl_2$ (in 5 µL aliquoutes) following the absorbance changes at 300 nm at 25.0±0.1 ^{o}C (Figure 1). Triplicate measurements were conducted at each Ca^{2+} concentration and the average absorption value was used for the analysis (Table S1). Titration was performed to achieve full saturation of the chelation.

Table S1. Observed absorbance at 300 nm at different concentrations of Ca^{2+}.

$[Ca^{2+}]$ (µM)	Absorbance @ 300 nm, a.u.
0.0000	0.061057
0.4175	0.059175
0.8350	0.057540
1.2525	0.055895
1.6700	0.054422
2.0875	0.053480
2.5050	0.052702
2.9225	0.052028
3.3400	0.051667
3.7575	0.051303
4.1750	0.051030
4.5925	0.050700
5.0100	0.050521
5.4275	0.050458
5.8450	0.050352
6.2625	0.050265
6.6800	0.050101
7.0975	0.049963
7.5150	0.049957
7.9325	0.049869
8.3500	0.049817
9.1850	0.049827
10.0200	0.049828
10.8550	0.049773
11.6900	0.049769

Determination of Calcium Photo-Release Efficiency was conducted using calcein indicator at pH 7.40. Calibration plot (Figure S4) has been constructed by measuring the 513 nm emission of 0.7 nM calcein solution in HEPES (30 mM)/KCl (100 mM) buffer in the presence of variable concentrations of Ca^{2+} (Figure S3, Table S2).

Table S2. Observed intensity of fluorescence at 513 nm at different concentrations of Ca^{2+}.

Concentration of Ca^{2+}, M x 10^3	Intensity @ 513 nm, a. u.
0.00	1.28 x 10^6
0.25	1.23 x 10^6
0.50	1.16 x 10^6
0.75	1.11 x 10^6
1.00	1.08 x 10^6
1.25	1.04 x 10^6
1.50	986627
1.75	927507
2.00	886686

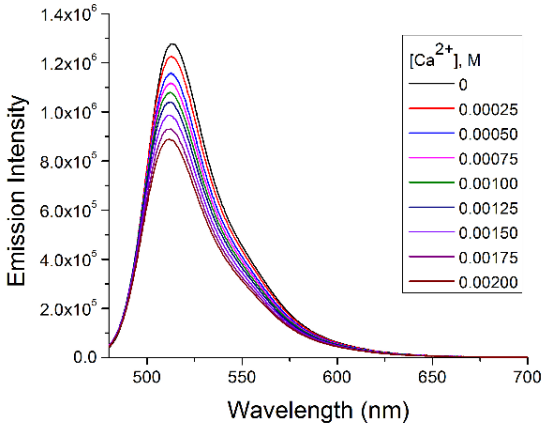


Figure S3. Emission spectra of calcein at different concentration of Ca^{2+}.

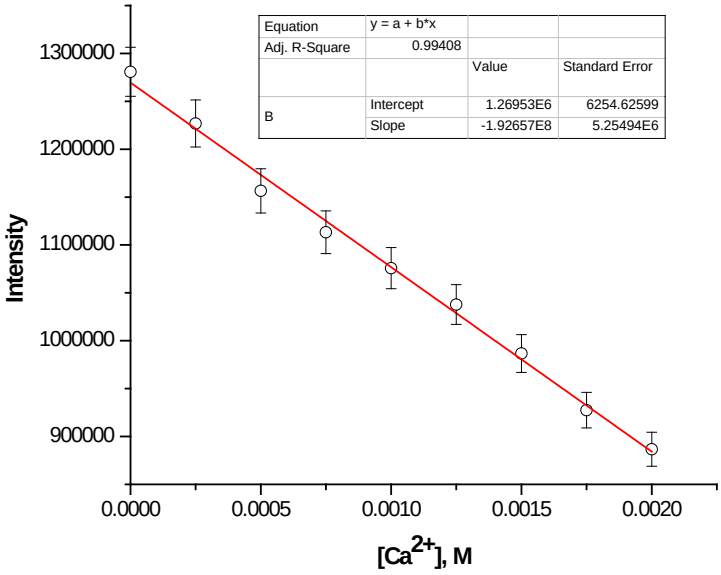


Figure S4. The intensity of 513 nm emission of 0.7 nM calcein solution in HEPES buffer versus [Ca^{2+}].

Determination of Ca^{2+} release. Glass vials contained solutions of **1** (1.135 mM) and Ca^{2+} (1.25 mM) in HEPES (30 mM)/KCl (100 mM) buffer at pH 7.40 were irradiated for 0, 0.5, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, and 8 min with 300 nm fluorescent lamps. Then 0.5 µL of calcein solution was added into each vial. Emission spectra were collected in 480-700 nm range at 25 ºC (Table S3, Figure S6). Intensity of emission at 513 nm was used for determination of concentration of calcium, which was released. The intensity of fluorescence of calcein were plotted to determine efficiency of Ca^{2+} release (Figure S6).

Table S3. Intensity of calcein fluorescence at 513 nm at different duration of irradiation at 300 nm.

Time of irradiation, min	Emission Intensity @ 513 nm
0	1.25 x 10^6
0.5	1.21 x 10^6
1	1.17 x 10^6
1.5	1.14 x 10^6
2	1.11 x 10^6
2.5	1.08 x 10^6
3	1.07 x 10^6
3.5	1.05 x 10^6
4	1.05 x 10^6
4.5	1.04 x 10^6
5	1.03 x 10^6
5.5	1.03 x 10^6
6	1.02 x 10^6
6.5	1.02 x 10^6
7	1.02 x 10^6
7.5	1.02 x1 0^6
8	1.02 x 10^6

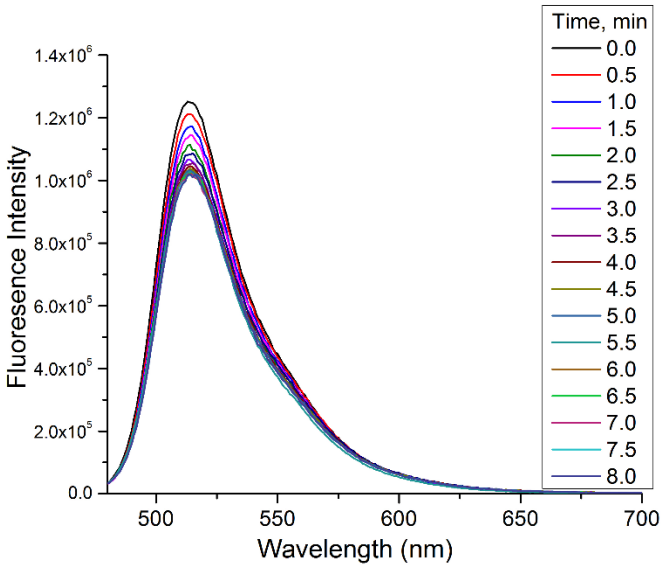
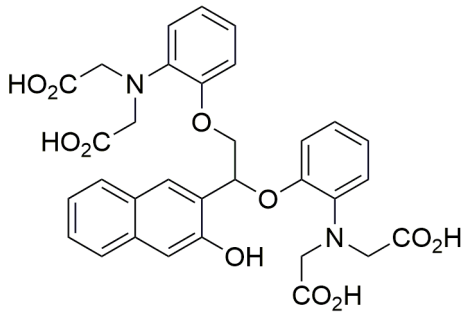


Figure S6. Emission spectra of calcein at different duration of exposure of NQMP-BAPTA:Ca^{2+} complex to 300 nm light.

REFERENCES

1. P. Kuzmič, L. Pavlíčková, J. Velek, and M. Souček, *Collect. Czech. Chem. Commun.* **1986**, *51*, 1665.
2. E. E. Nekongo, V. V. Popik, *J. Org. Chem.*, 2014, **79** (16), 7665.
3. F. Yang, Rauch, K. Kettelhoit, L. Ackermann, *Angew. Chem. Int. Ed.*, 2014, **53** (42), 11285.
4. E. Cielen, A. Stobiecka, A. Tahri, G. J. Hoornaert, F. C. De Schryver, J. Gallay, M. Vincent, N. Boens, *Perkin Trans. 2*, 2002 , **6**, 1197.



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4.128 4.084 3.967 3.956 3.923 3.912 3.773 3.729

4.475 4.450 4.426 4.375 4.369 4.349 4.343

6.157 6.151 6.134 6.129

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f1 (ppm)

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6.157 6.151 6.134 6.129

4.475 4.450 4.426 4.375 4.369 4.349 4.343 4.128 4.084 3.967 3.956 3.923 3.912 3.773 3.729

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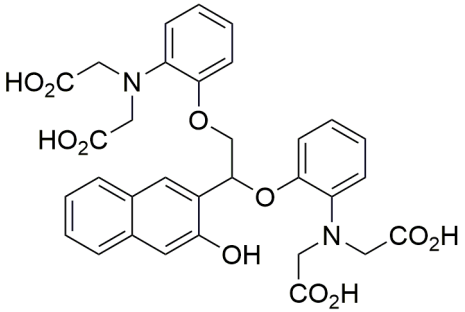
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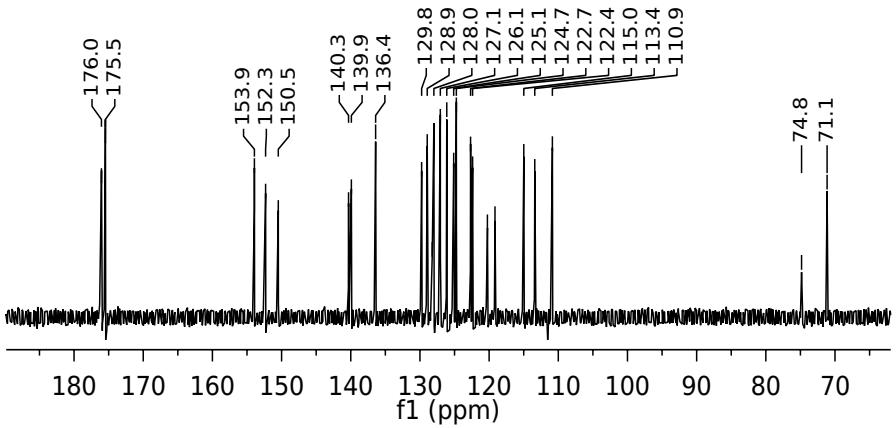
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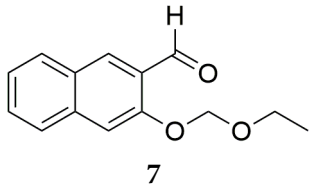
f1 (ppm)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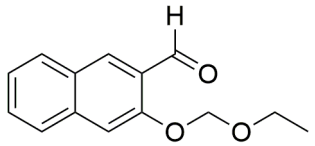
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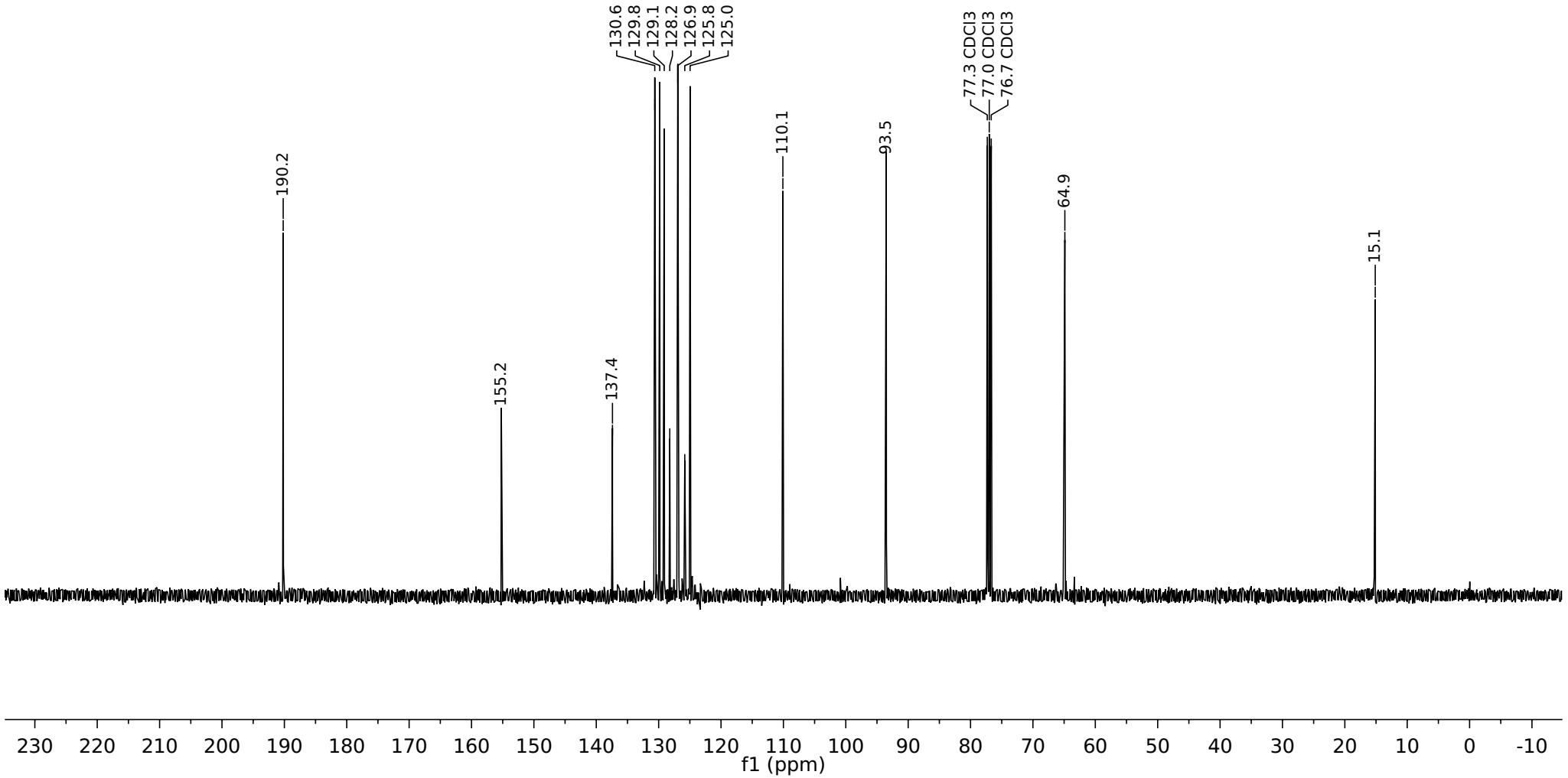
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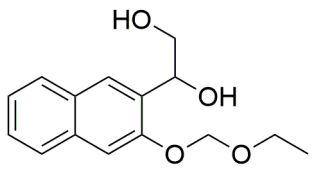
f1 (ppm)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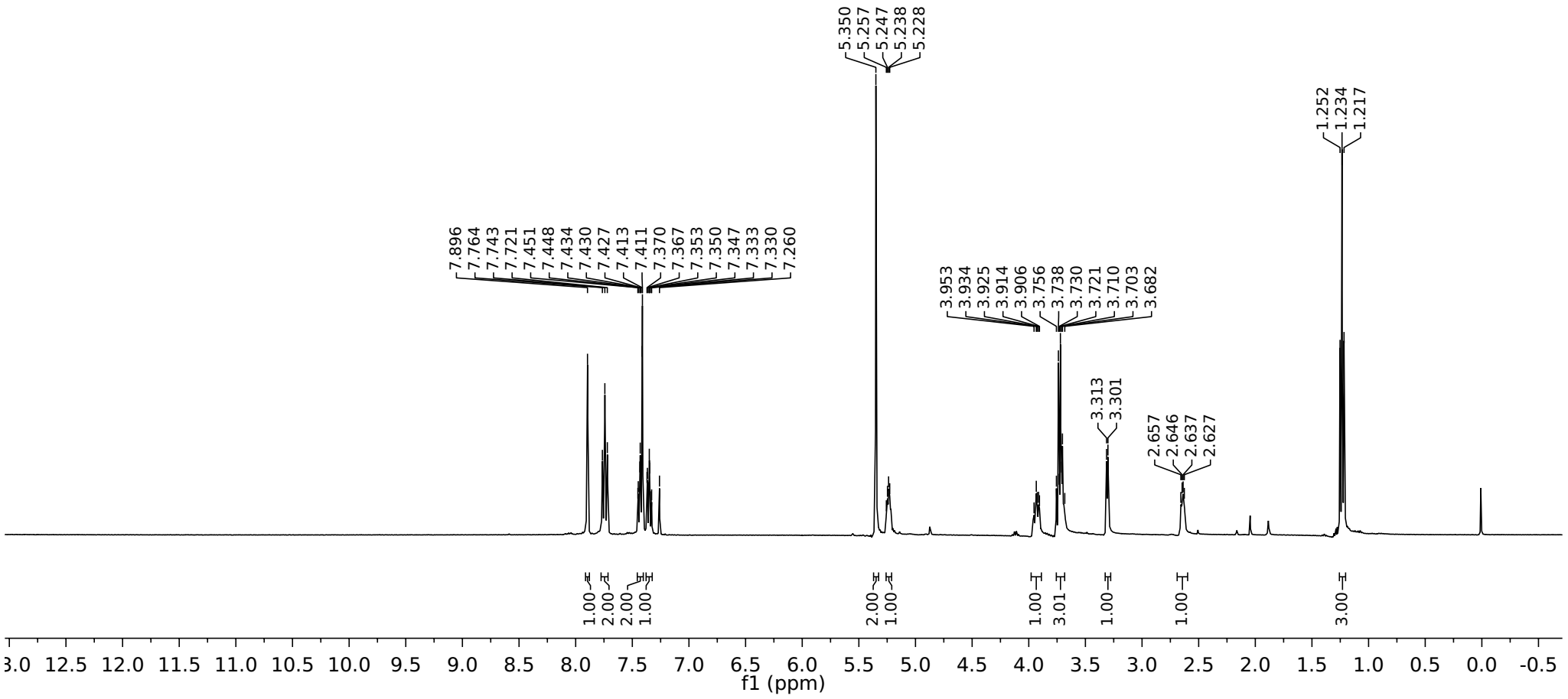
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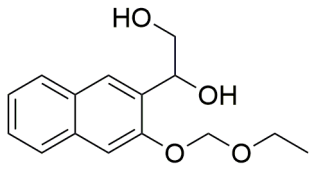
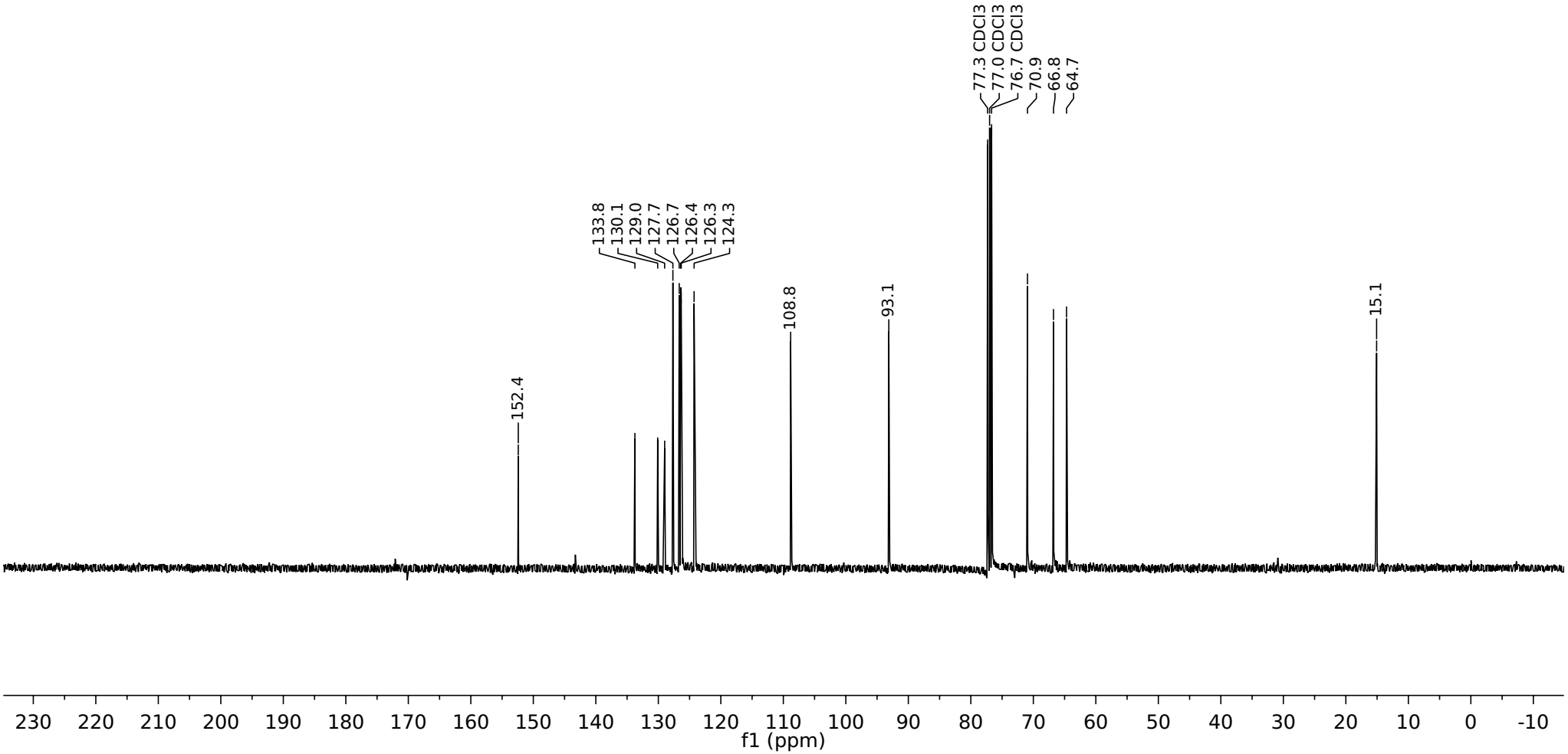
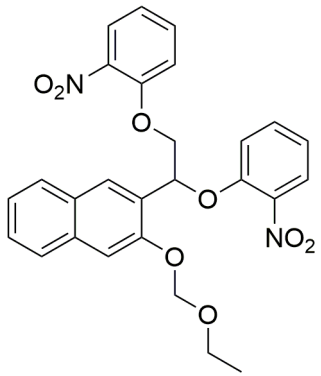
3.00
f1 (ppm)

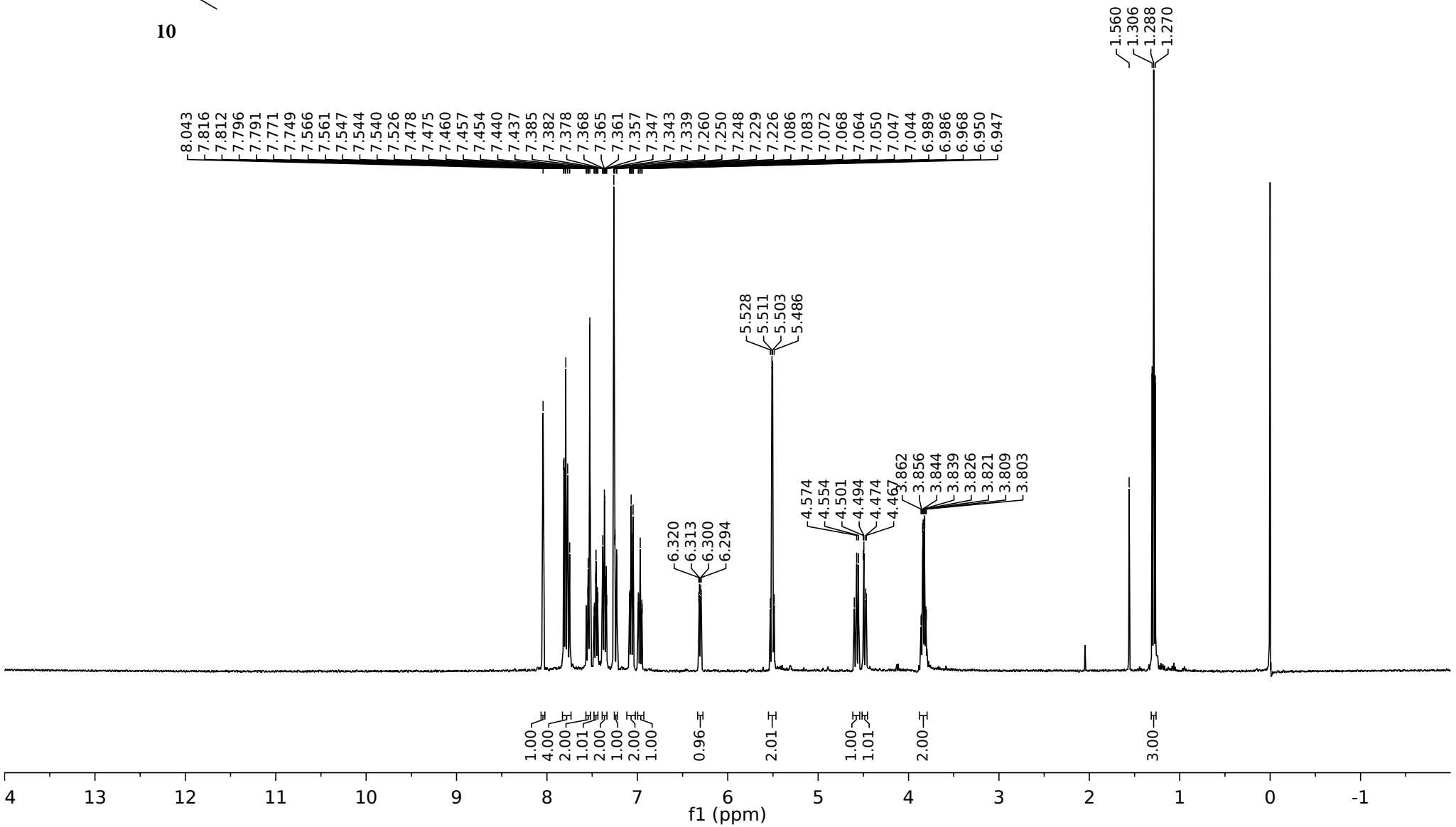

HO
OH
O
O

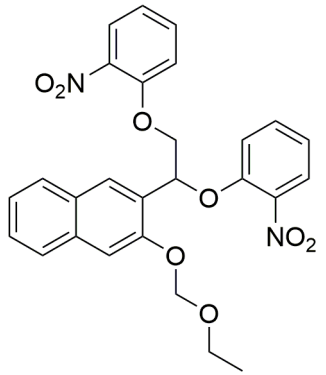
9


77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
70.9
66.8
64.7
133.8
130.1
129.0
127.7
126.7
126.4
126.3
124.3
108.8
93.1
15.1
152.4
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O2N
O
O
O
NO2
O
O

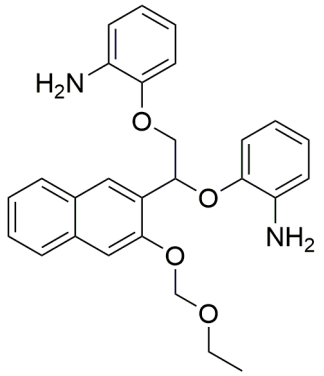
10


8.043
7.816
7.812
7.796
7.791
7.771
7.749
7.566
7.561
7.547
7.544
7.540
7.526
7.478
7.475
7.460
7.457
7.454
7.440
7.437
7.385
7.382
7.378
7.368
7.365
7.361
7.357
7.347
7.343
7.339
7.260
7.250
7.248
7.229
7.226
7.086
7.083
7.072
7.068
7.064
7.050
7.047
7.044
6.989
6.986
6.968
6.950
6.947
6.320
6.313
6.300
6.294
5.528
5.511
5.503
5.486
4.574
4.554
4.501
4.494
4.474
4.467
3.862
3.856
3.844
3.839
3.826
3.821
3.809
3.803
1.560
1.306
1.288
1.270
1.00
4.00
2.00
1.01
2.00
1.00
2.00
1.00
0.96
2.01
1.00
1.01
2.00
3.00
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)

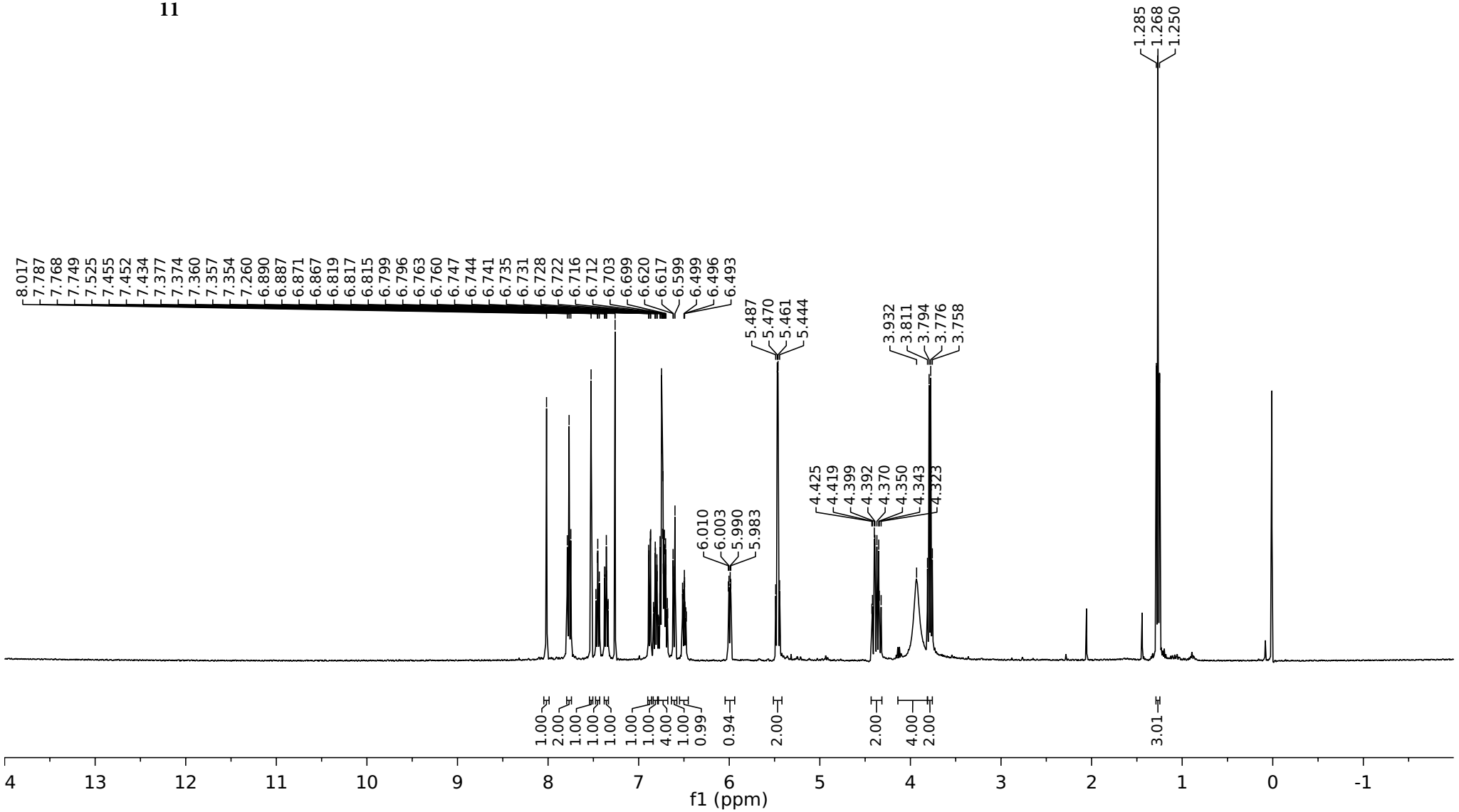

O2N
O
O
NO2
O
O
O

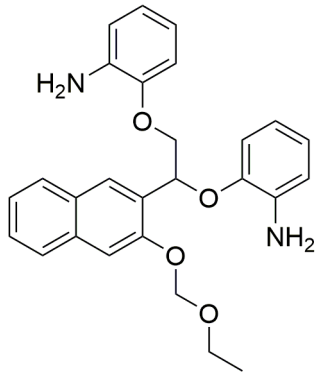
10

77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
75.5
73.3
134.3
134.1
133.9
129.0
128.1
127.4
127.0
126.8
125.6
125.5
125.4
124.6
121.3
120.8
152.1
151.9
151.1
140.4
140.3
134.1
133.9
127.4
125.6
125.5
121.3
120.8
116.1
109.3
93.5
65.0
15.2
135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120
f1 (ppm)
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


H2N
O
O
O
NH2
O
O

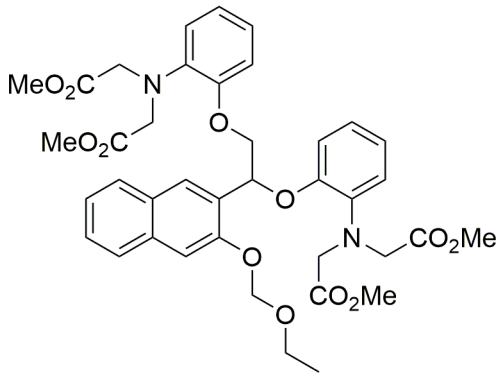
11


8.017
7.787
7.768
7.749
7.525
7.455
7.452
7.434
7.377
7.374
7.360
7.357
7.354
7.260
6.890
6.887
6.871
6.867
6.819
6.817
6.815
6.799
6.796
6.763
6.760
6.747
6.744
6.741
6.735
6.731
6.728
6.722
6.716
6.712
6.703
6.699
6.620
6.617
6.599
6.499
6.496
6.493
5.487
5.470
5.461
5.444
4.425
4.419
4.399
4.392
4.370
4.350
4.343
4.323
3.932
3.811
3.794
3.776
3.758
6.010
6.003
5.990
5.983
1.285
1.268
1.250
1.00
2.00
1.00
1.00
1.00
1.00
1.00
4.00
1.00
0.99
0.94
2.00
2.00
4.00
2.00
3.01
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)


H2N
O
O
O
NH2
O
O

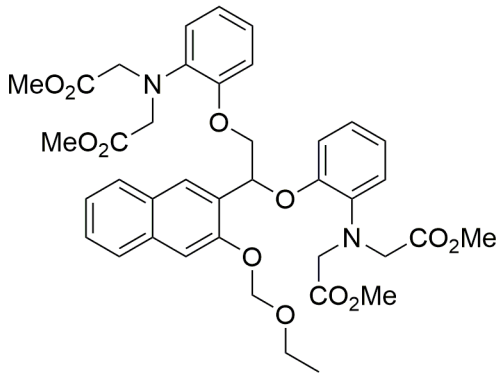
11

77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
75.7
71.6
137.3
136.8
134.1
129.1
127.9
127.6
127.0
126.8
126.6
124.3
122.0
121.7
118.2
118.2
115.3
115.3
114.6
112.3
109.0
152.0
146.3
145.9
93.2
64.8
15.2
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

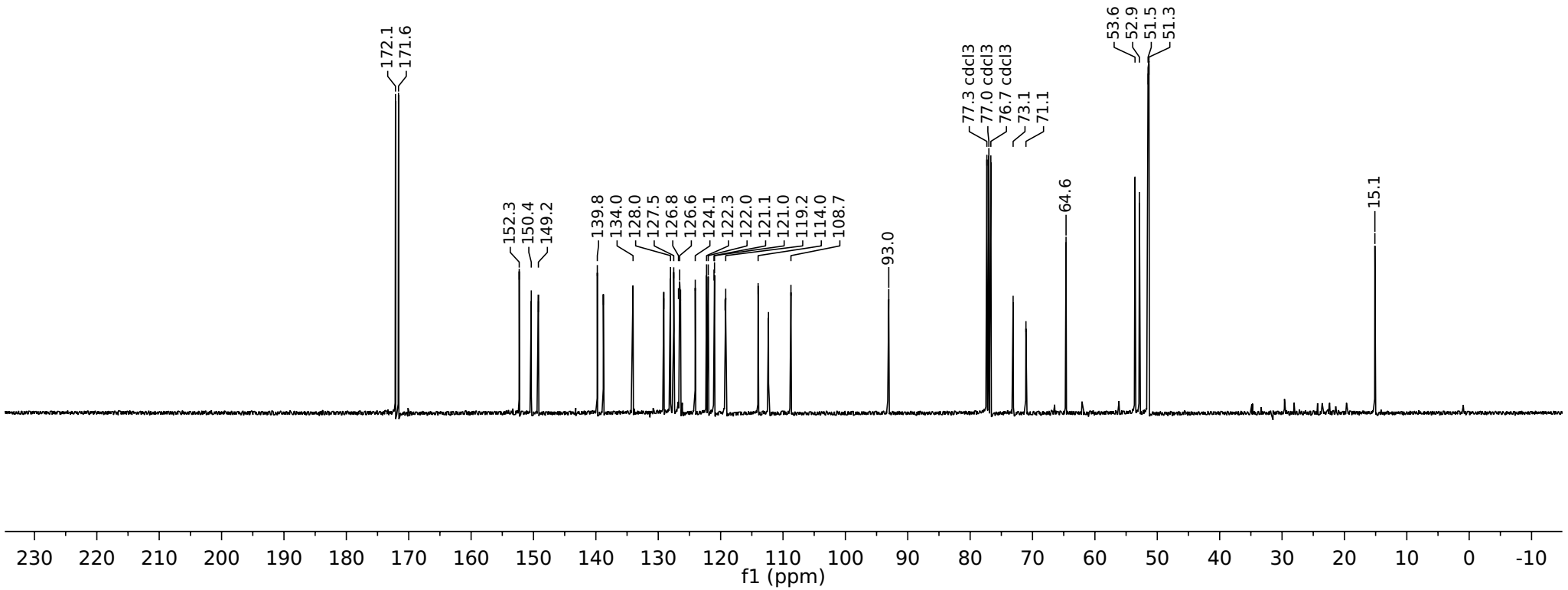

MeO2C
N
MeO2C
O
O
O
N
CO2Me
CO2Me
O
O

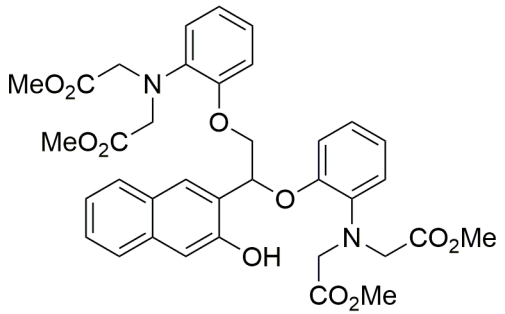
12

4.302
4.298
4.290
4.244
4.232
4.172
4.127
3.822
3.804
3.787
3.769
3.588
3.444
1.283
1.266
1.248
8.047
7.792
7.772
7.735
7.714
7.485
7.427
7.424
7.411
7.407
7.403
7.390
7.386
7.340
7.336
7.323
7.320
7.316
7.302
7.299
7.260
6.879
6.874
6.866
6.826
6.730
6.713
6.241
6.228
6.214
5.489
5.471
5.461
5.444
1.00
1.00
1.00
1.00
1.00
1.00
3.00
2.00
2.00
1.01
1.00
2.00
8.00
2.02
2.00
6.00
6.00
3.04
f1 (ppm)

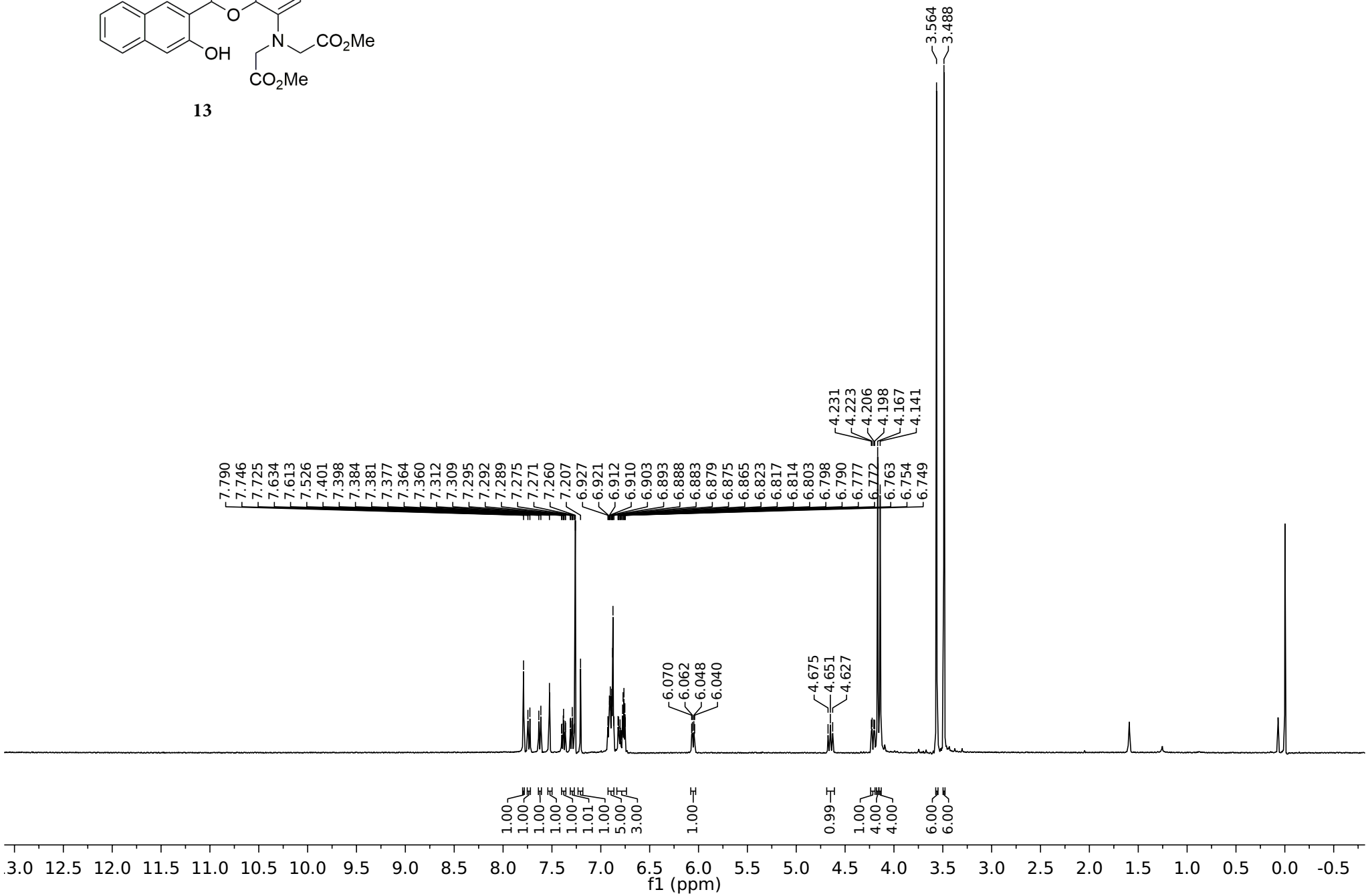

MeO2C
N
MeO2C
O
O
O
N
CO2Me
CO2Me
O
O

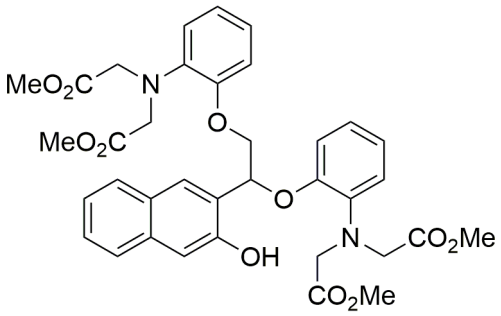
12


172.1
171.6
152.3
150.4
149.2
139.8
134.0
128.0
127.5
126.8
126.6
124.1
122.3
122.0
121.1
121.0
119.2
114.0
108.7
93.0
77.3 cdcl3
77.0 cdcl3
76.7 cdcl3
73.1
71.1
64.6
53.6
52.9
51.5
51.3
15.1
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

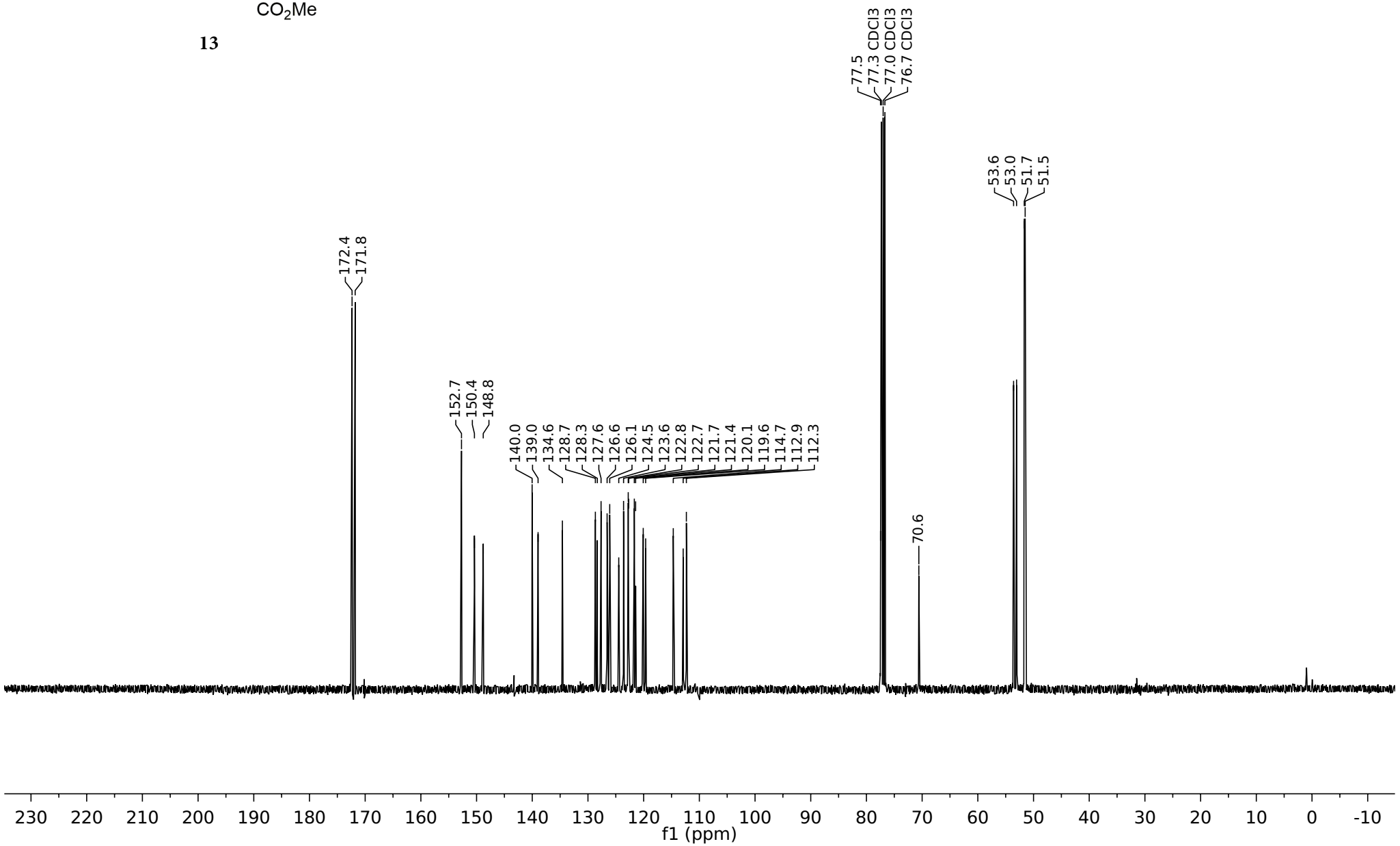

MeO2C
N
MeO2C
O
O
OH
N
CO2Me
CO2Me

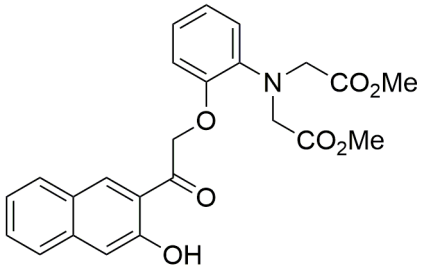
13


3.564
3.488
4.231
4.223
4.206
4.198
4.167
4.141
7.790
7.746
7.725
7.634
7.613
7.526
7.401
7.398
7.384
7.381
7.377
7.364
7.360
7.312
7.309
7.295
7.292
7.289
7.275
7.271
7.260
7.207
6.927
6.921
6.912
6.910
6.903
6.893
6.888
6.883
6.879
6.875
6.865
6.823
6.817
6.814
6.803
6.798
6.790
6.777
6.772
6.763
6.754
6.749
6.070
6.062
6.048
6.040
4.675
4.651
4.627
1.00
1.00
1.00
1.00
1.00
1.01
1.00
5.00
3.00
1.00
0.99
1.00
4.00
4.00
6.00
6.00
f1 (ppm)

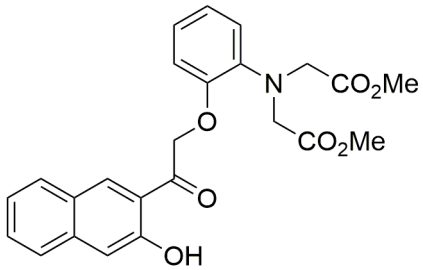

MeO2C
N
MeO2C
O
O
OH
N
CO2Me
CO2Me

13


77.5
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
53.6
53.0
51.7
51.5
172.4
171.8
152.7
150.4
148.8
140.0
139.0
134.6
128.7
128.3
127.6
126.6
126.1
124.5
123.6
122.8
122.7
121.7
121.4
120.1
119.6
114.7
112.9
112.3
70.6
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

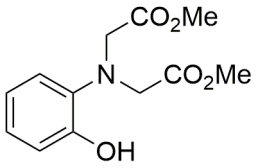


14

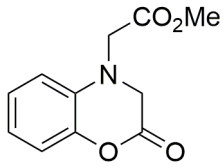

N
CO2Me
CO2Me
O
O
OH

14

77.3 cdcl3
77.0 cdcl3
76.7 cdcl3
71.5
53.60
51.80
71.52
200.22
171.70
156.72
149.95
140.03
138.26
131.83
130.00
129.42
126.88
126.34
124.27
123.36
122.86
120.08
118.96
116.90
112.61
f1 (ppm)
200.2
171.7
156.7
149.9
140.0
138.3
131.8
130.0
129.4
126.9
126.3
124.3
123.4
122.9
120.1
119.0
116.9
112.6
53.6
51.8
f1 (ppm)

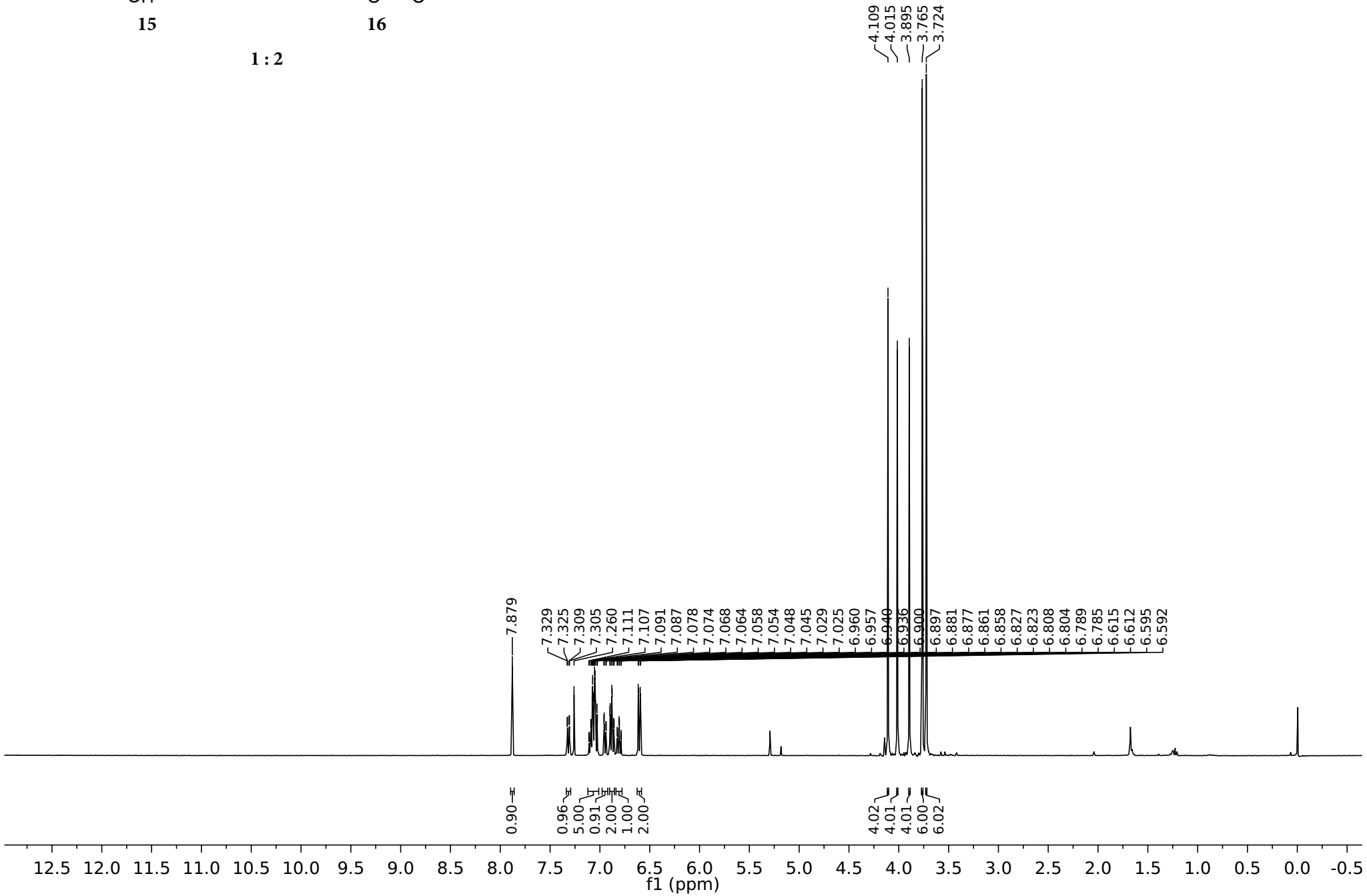

CO2Me
N
CO2Me
OH

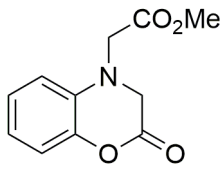
15


CO2Me
N
O
O

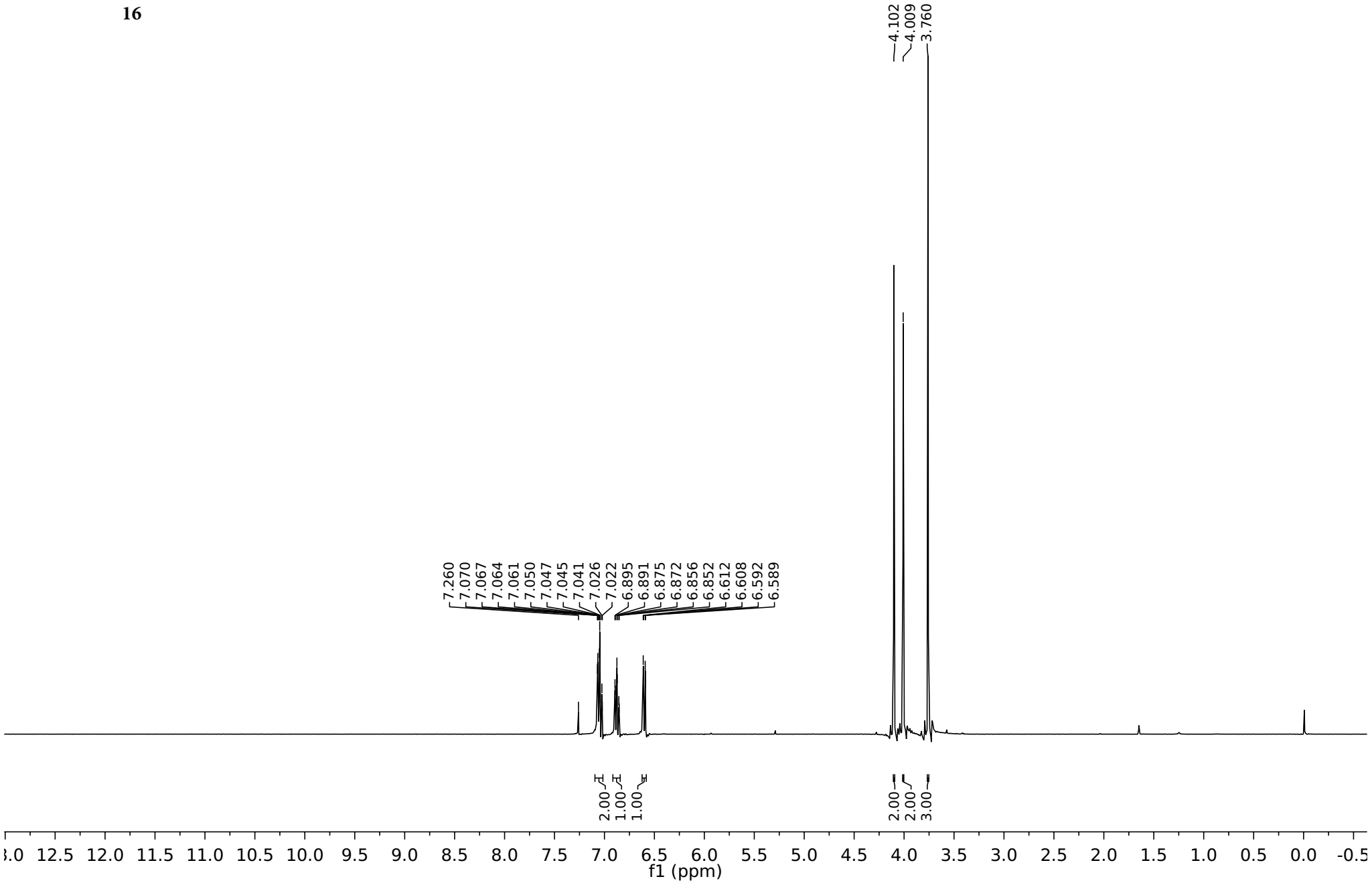
16

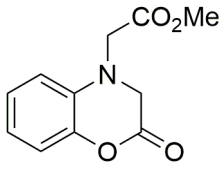
1 : 2


4.109
4.015
3.895
3.765
3.724
7.879
7.329
7.325
7.309
7.305
7.260
7.111
7.107
7.091
7.087
7.078
7.074
7.068
7.064
7.058
7.054
7.048
7.045
7.029
7.025
6.960
6.957
6.940
6.936
6.900
6.897
6.881
6.877
6.861
6.858
6.827
6.823
6.808
6.804
6.789
6.785
6.615
6.612
6.595
6.592
0.90
0.96
5.00
0.91
2.00
1.00
2.00
4.02
4.01
4.01
6.00
6.02
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

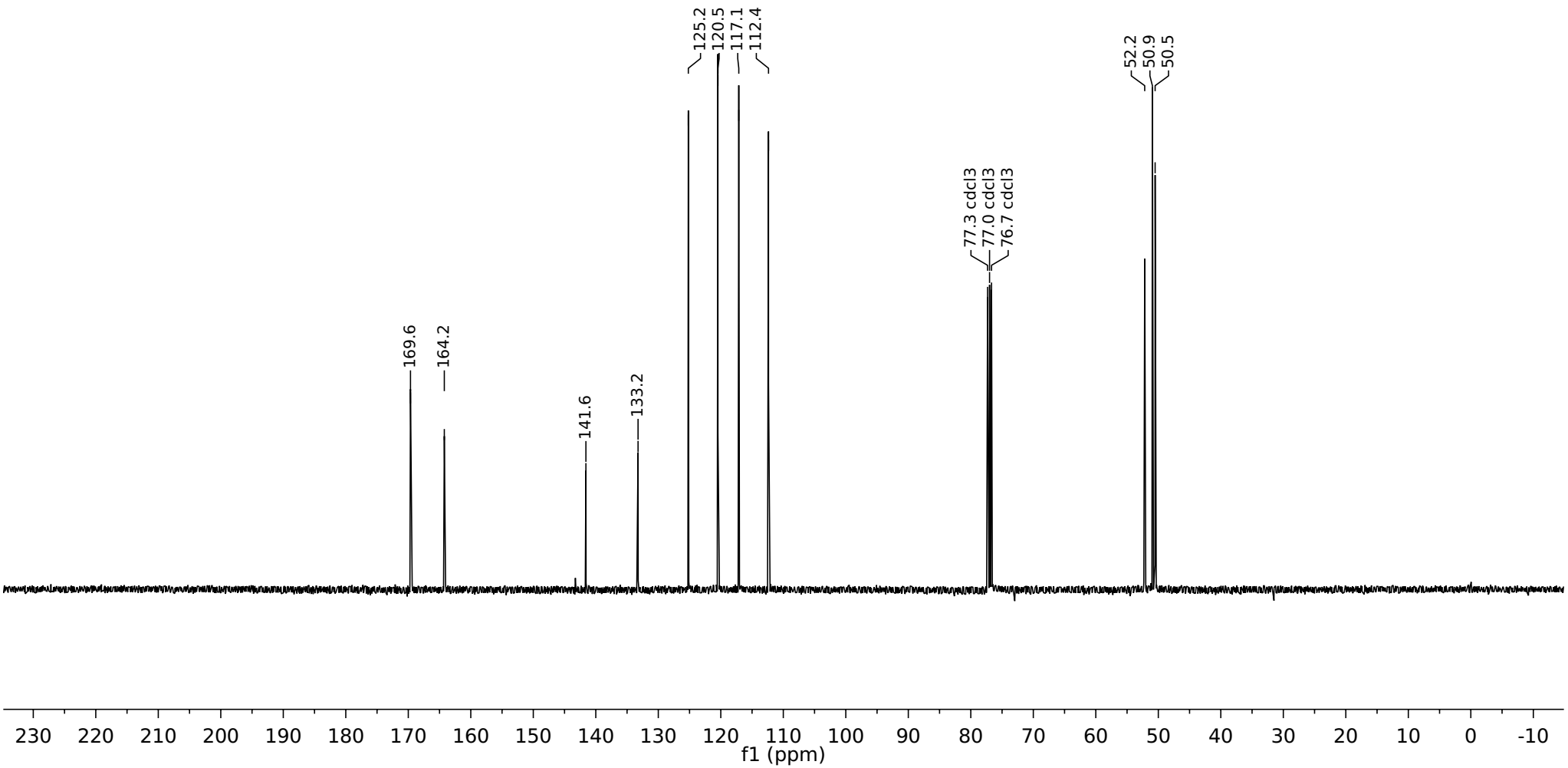

CO2Me
N
O
O

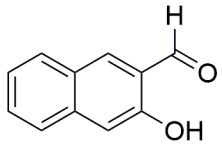
16


4.102
4.009
3.760
7.260
7.070
7.067
7.064
7.061
7.050
7.047
7.045
7.041
7.026
7.022
6.895
6.891
6.875
6.872
6.856
6.852
6.612
6.608
6.592
6.589
2.00
1.00
1.00
2.00
2.00
3.00
f1 (ppm)

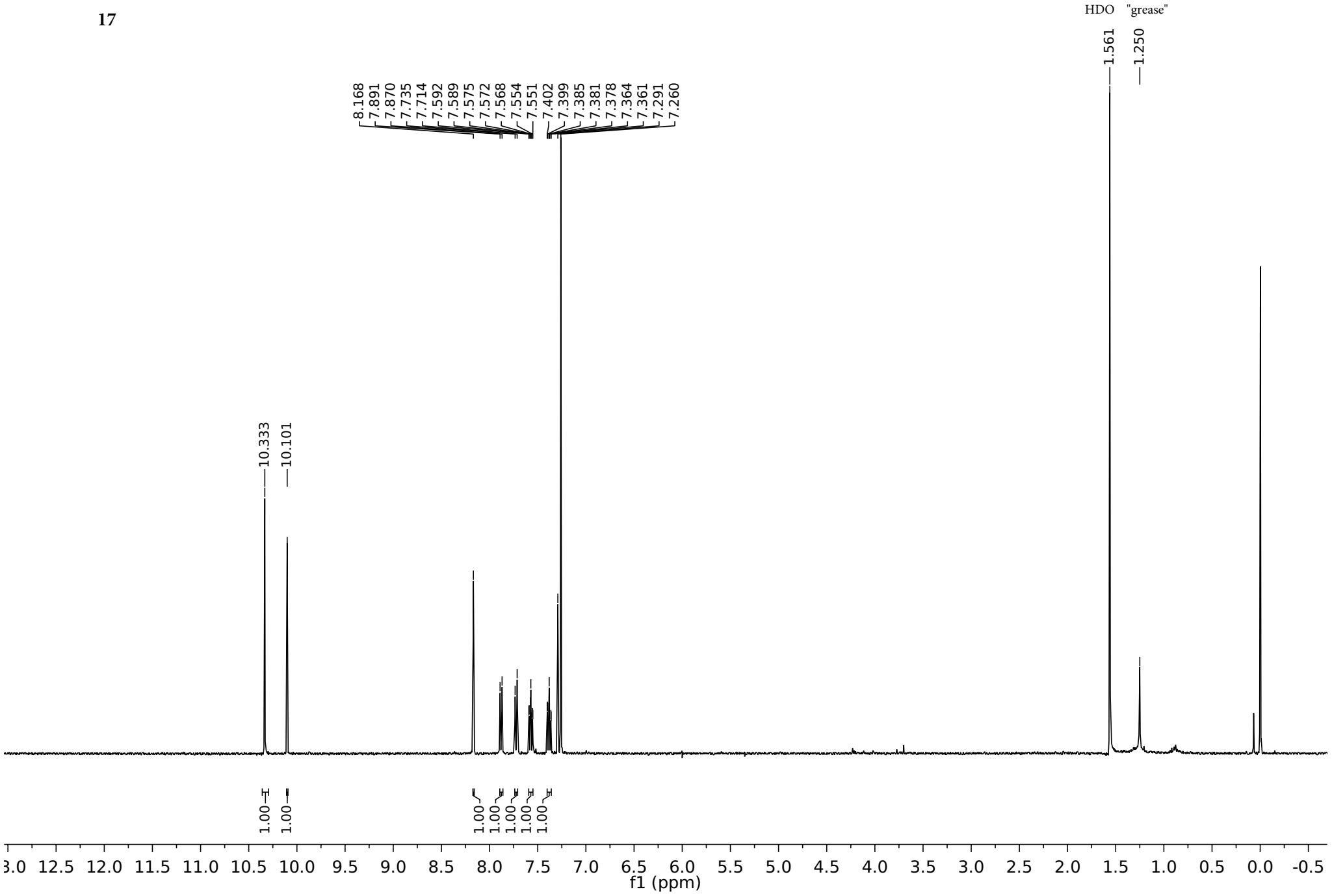

CO2Me
N
O
O

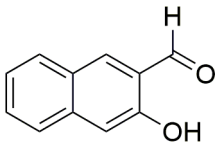
16


169.6
164.2
141.6
133.2
125.2
120.5
117.1
112.4
77.3 cdcl3
77.0 cdcl3
76.7 cdcl3
52.2
50.9
50.5
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

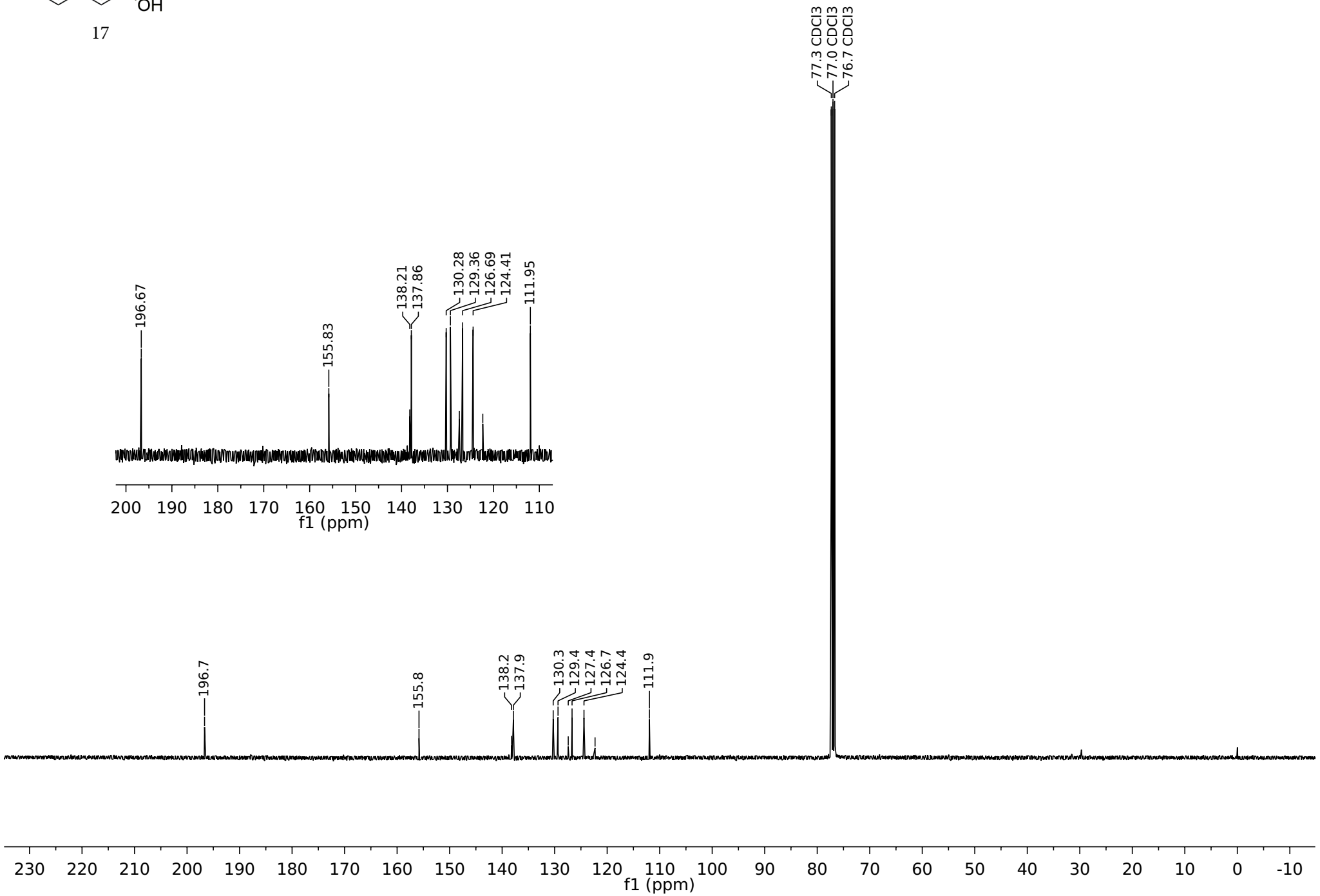

H
O
OH

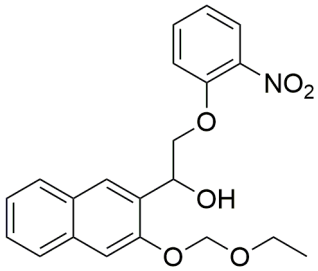
17


HDO
"grease"
1.561
1.250
8.168
7.891
7.870
7.735
7.714
7.592
7.589
7.575
7.572
7.568
7.554
7.551
7.402
7.399
7.385
7.381
7.378
7.364
7.361
7.291
7.260
10.333
10.101
1.00
1.00
1.00
1.00
1.00
1.00
1.00
f1 (ppm)

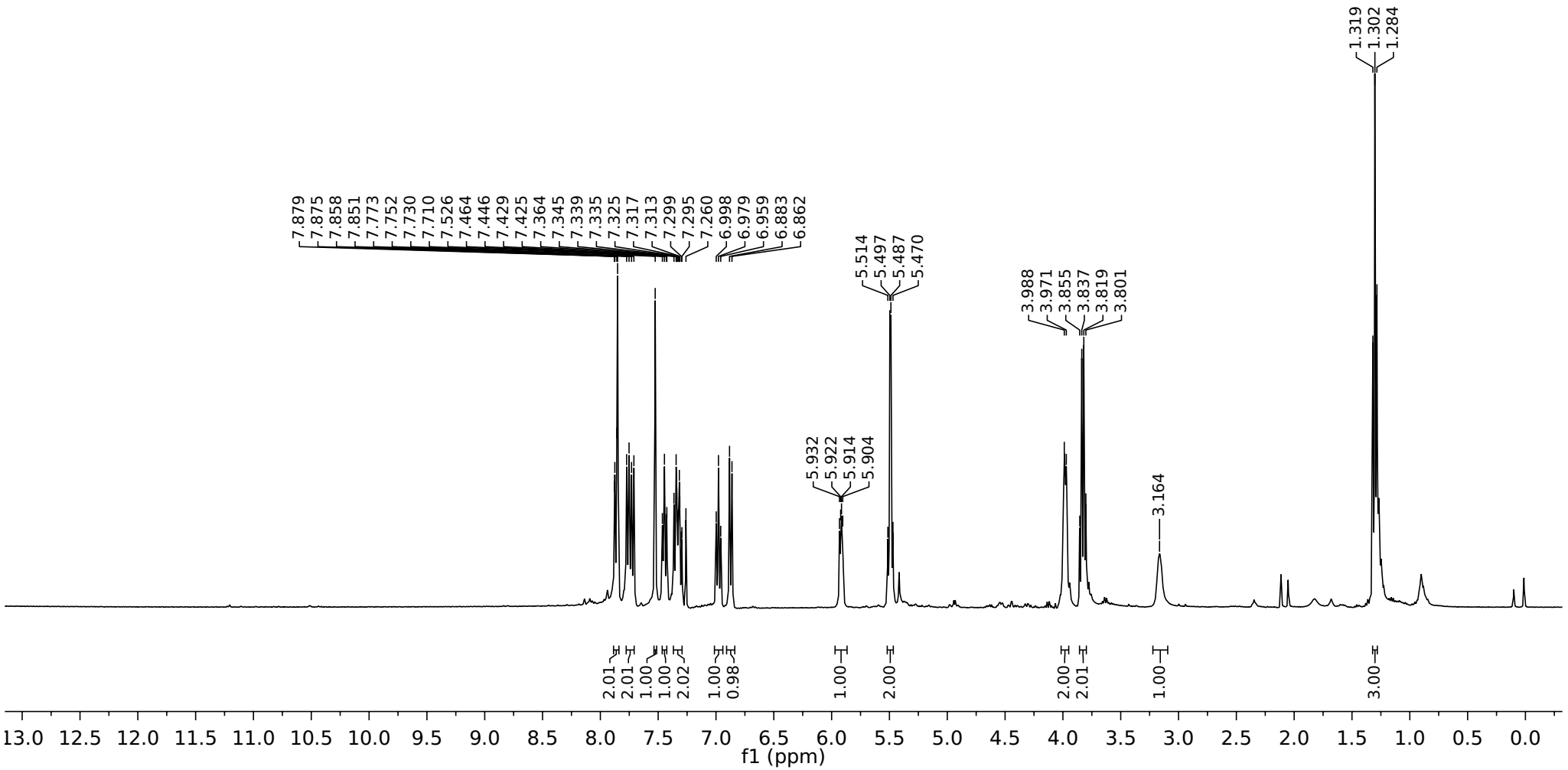

H
O
OH

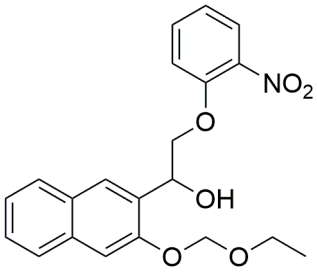
17


77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
196.67
155.83
138.21
137.86
130.28
129.36
126.69
124.41
111.95
200 190 180 170 160 150 140 130 120 110
f1 (ppm)
196.7
155.8
138.2
137.9
130.3
129.4
127.4
126.7
124.4
111.9
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

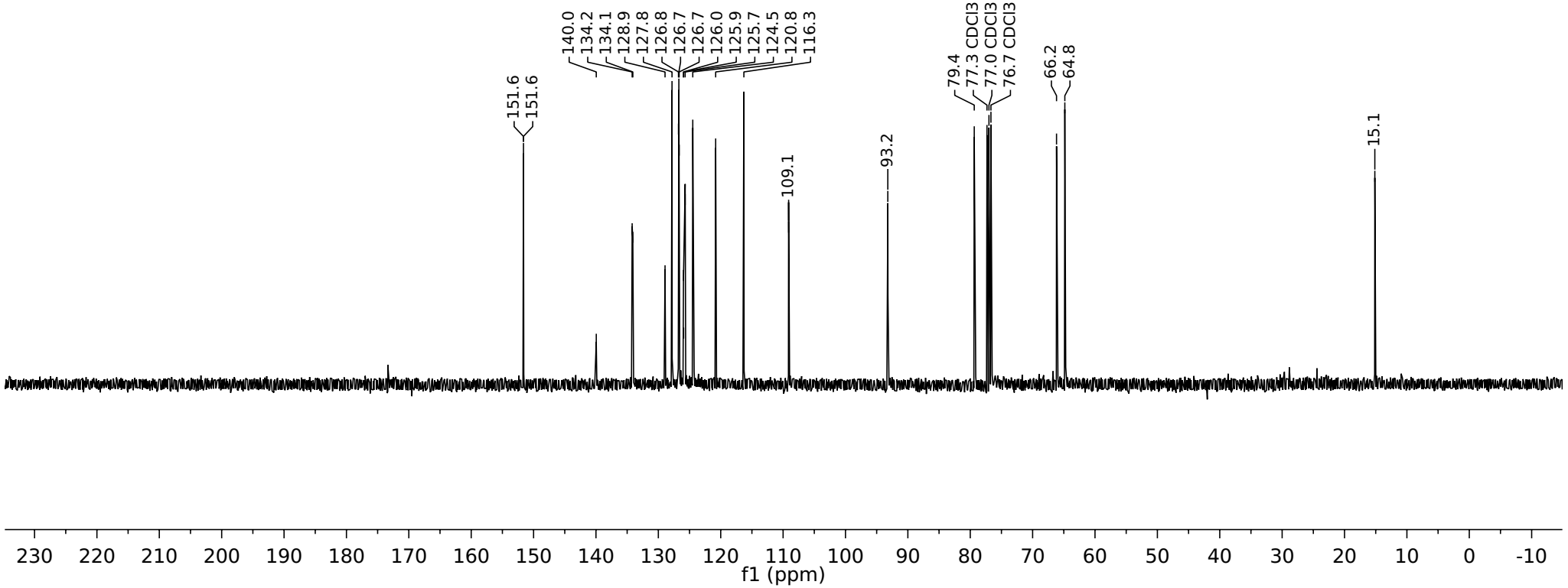

NO2
O
OH
O
O

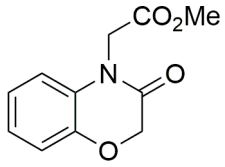
S1


7.879
7.875
7.858
7.851
7.773
7.752
7.730
7.710
7.526
7.464
7.446
7.429
7.425
7.364
7.345
7.339
7.335
7.325
7.317
7.313
7.299
7.295
7.260
6.998
6.979
6.959
6.883
6.862
5.932
5.922
5.914
5.904
5.514
5.497
5.487
5.470
3.988
3.971
3.855
3.837
3.819
3.801
3.164
1.319
1.302
1.284
2.01
2.01
1.00
1.00
2.02
1.00
0.98
1.00
2.00
2.00
2.01
1.00
3.00
13.0 12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

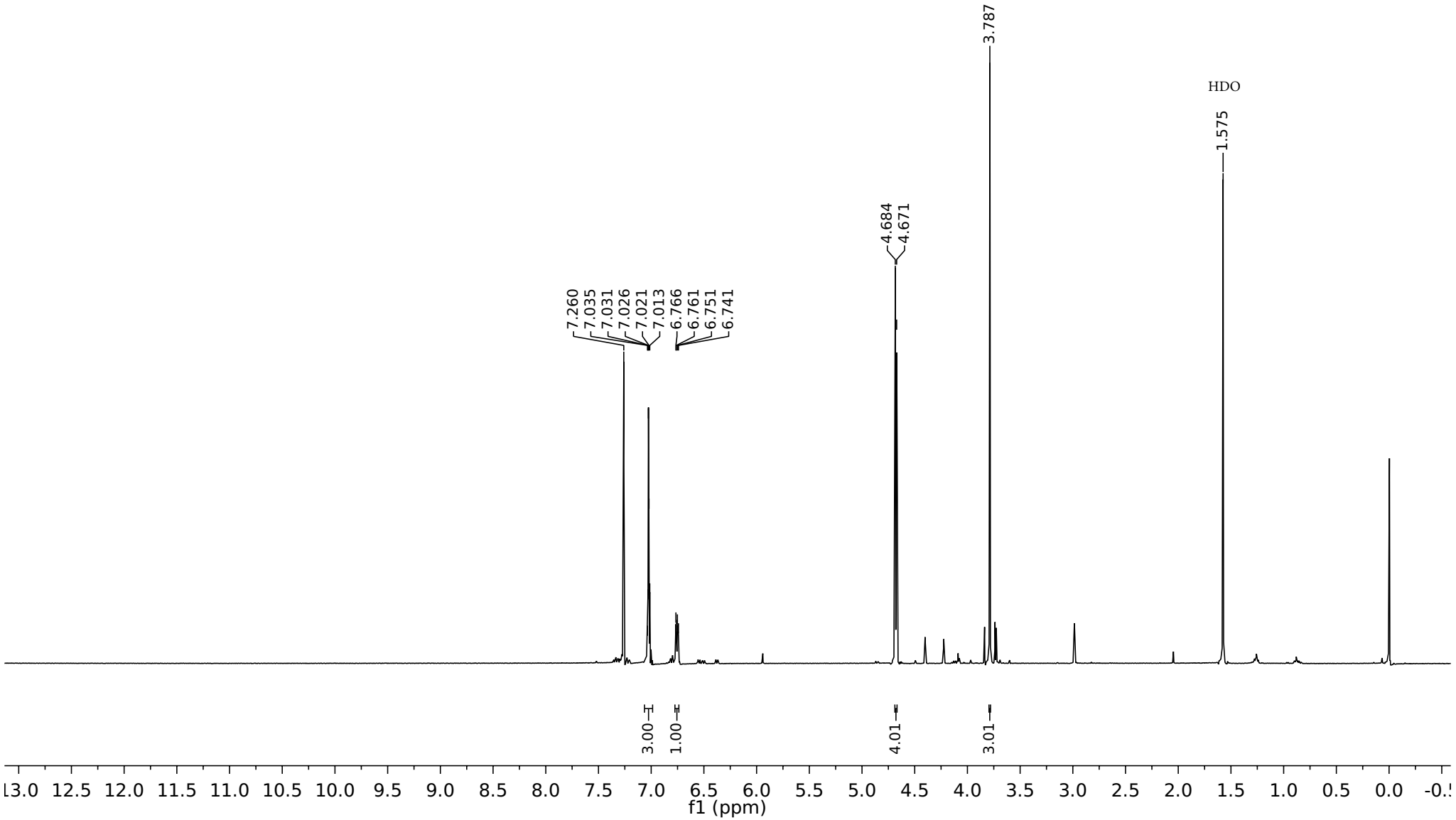

NO2
O
OH
O
O

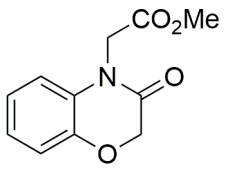
S1


151.6
151.6
140.0
134.2
134.1
128.9
127.8
126.8
126.7
126.7
126.0
125.9
125.7
124.5
120.8
116.3
109.1
93.2
79.4
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
66.2
64.8
15.1
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

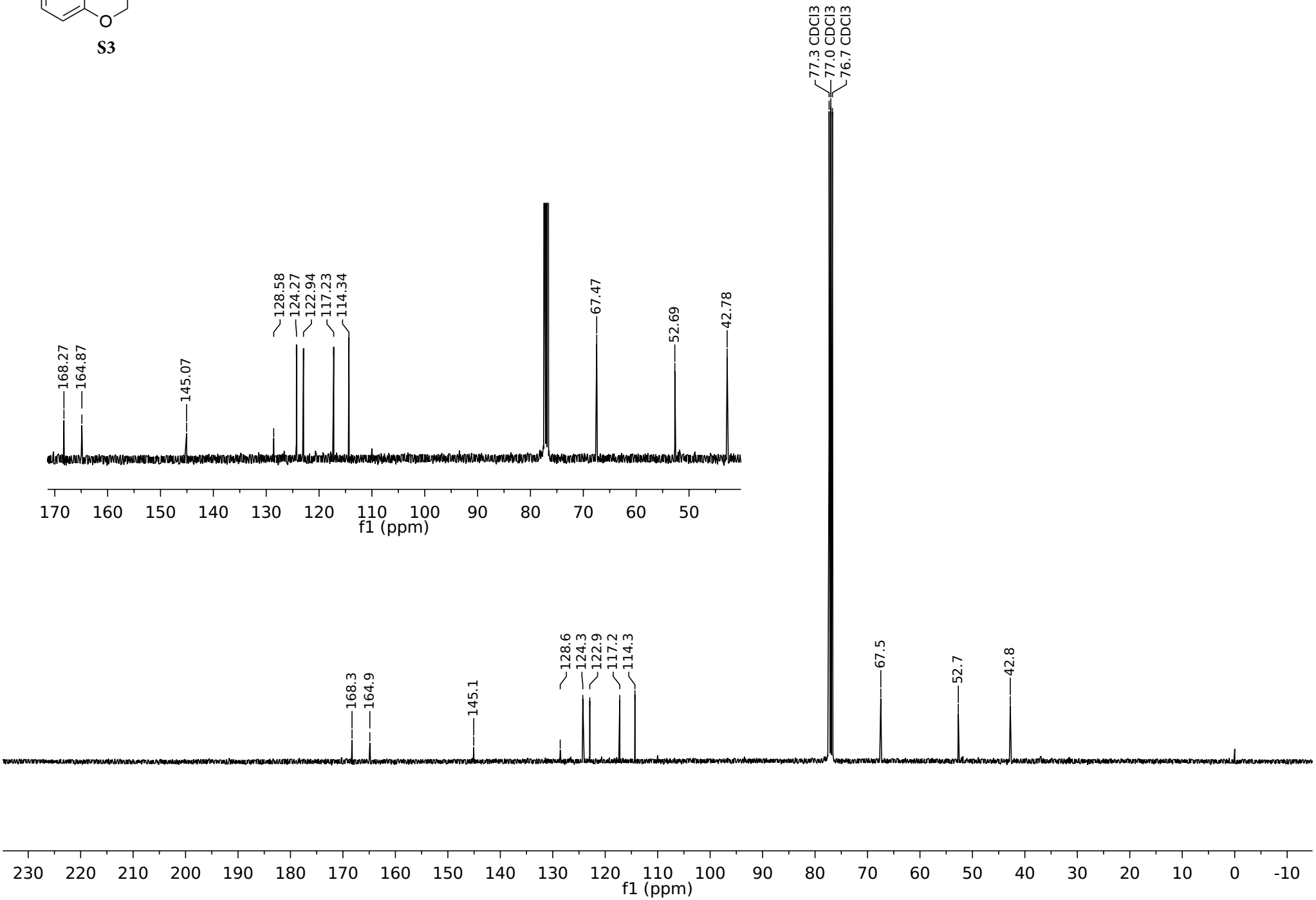

CO2Me
N
O
O

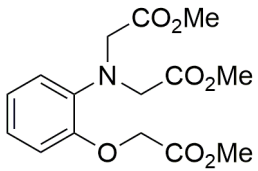
S3


7.260
7.035
7.031
7.026
7.021
7.013
6.766
6.761
6.751
6.741
4.684
4.671
3.787
HDO
1.575
3.00
1.00
4.01
3.01
f1 (ppm)

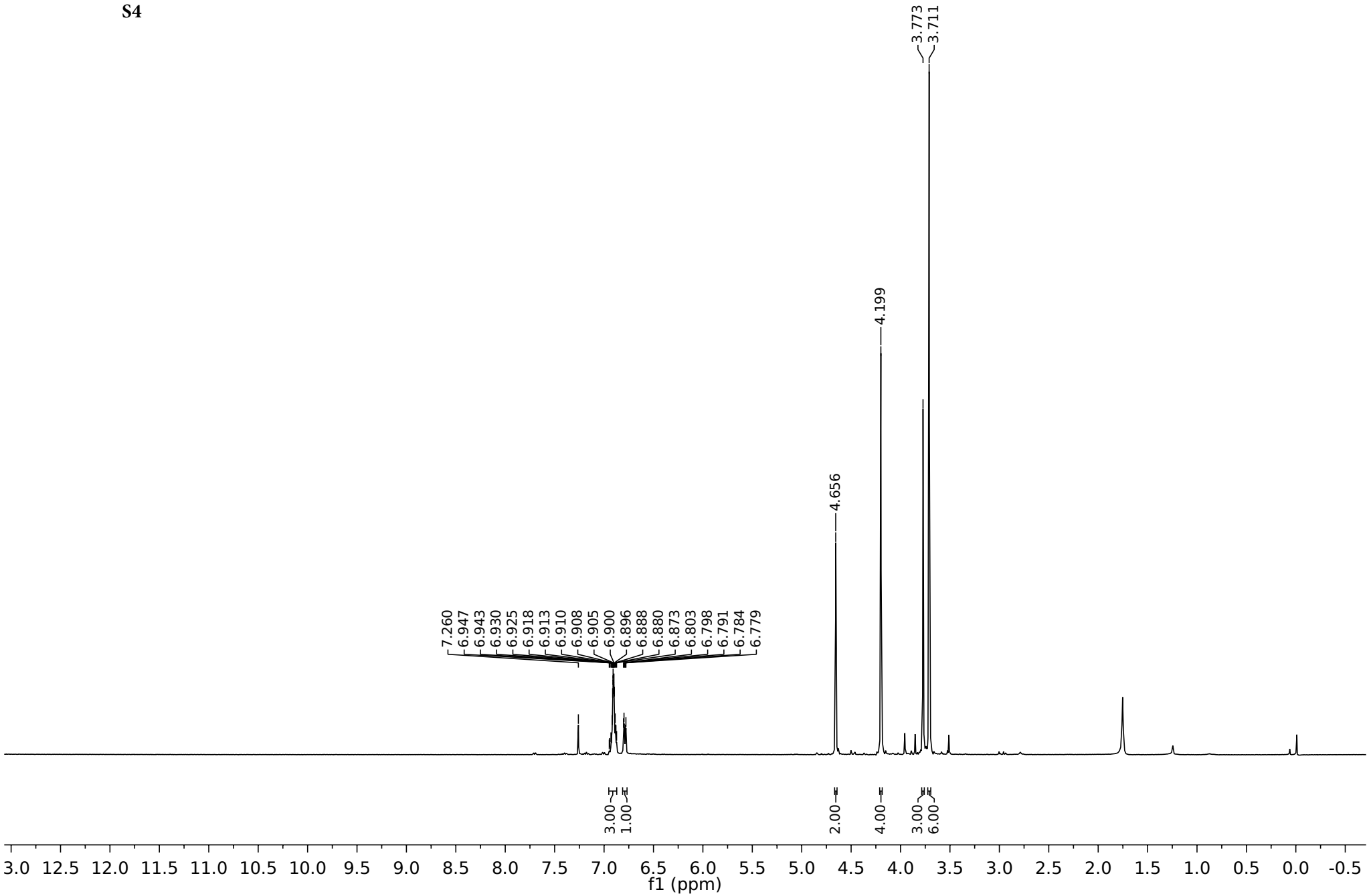

CO2Me
N
O
O

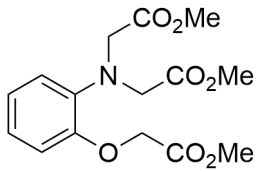
S3


77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
168.27
164.87
145.07
128.58
124.27
122.94
117.23
114.34
67.47
52.69
42.78
168.3
164.9
145.1
128.6
124.3
122.9
117.2
114.3
67.5
52.7
42.8
f1 (ppm)
f1 (ppm)

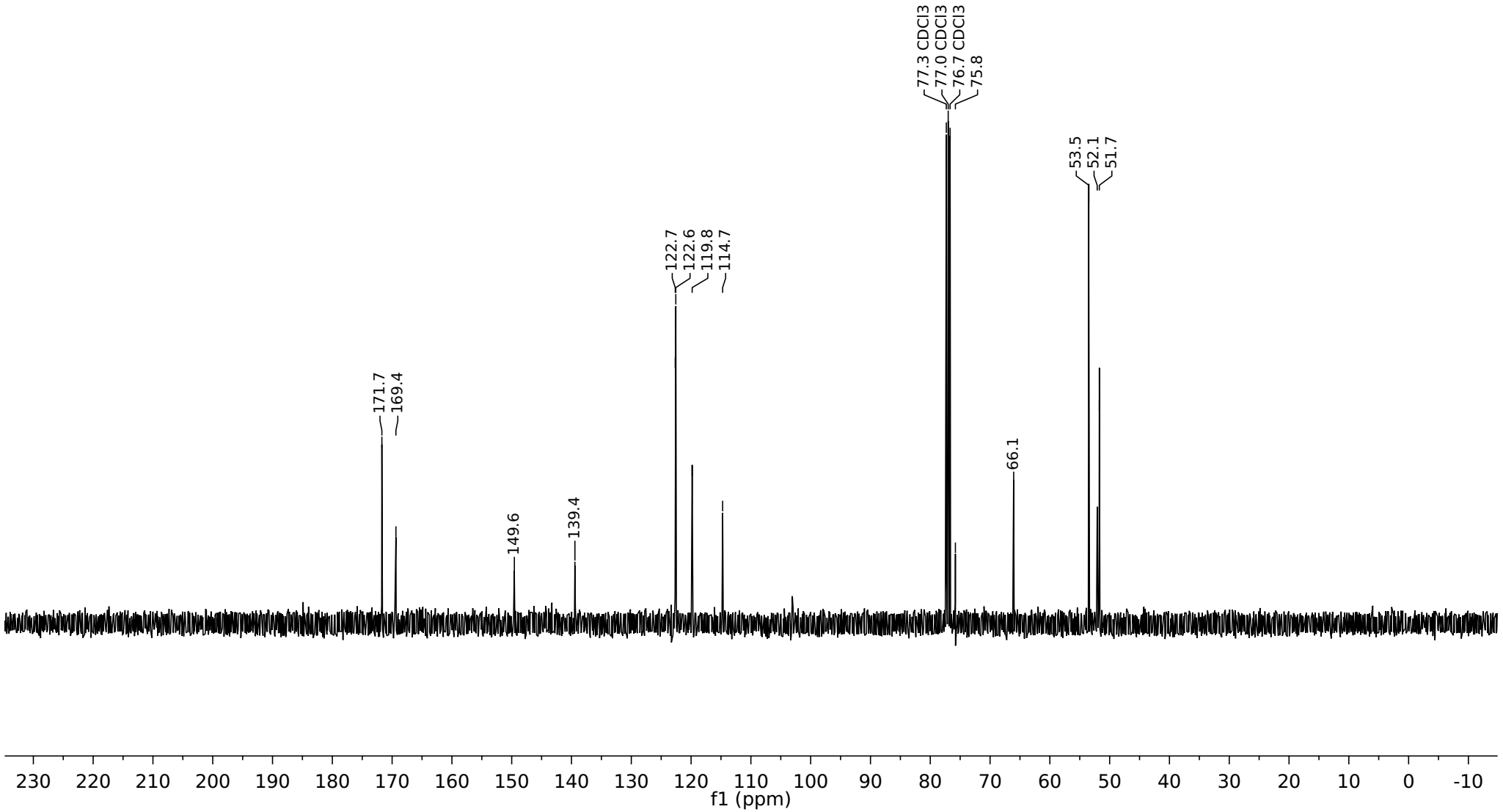

CO2Me
N
CO2Me
O
CO2Me

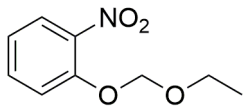
S4


3.773
3.711
4.199
4.656
7.260
6.947
6.943
6.930
6.925
6.918
6.913
6.910
6.908
6.905
6.900
6.896
6.888
6.880
6.873
6.803
6.798
6.791
6.784
6.779
3.00
1.00
2.00
4.00
3.00
6.00
f1 (ppm)

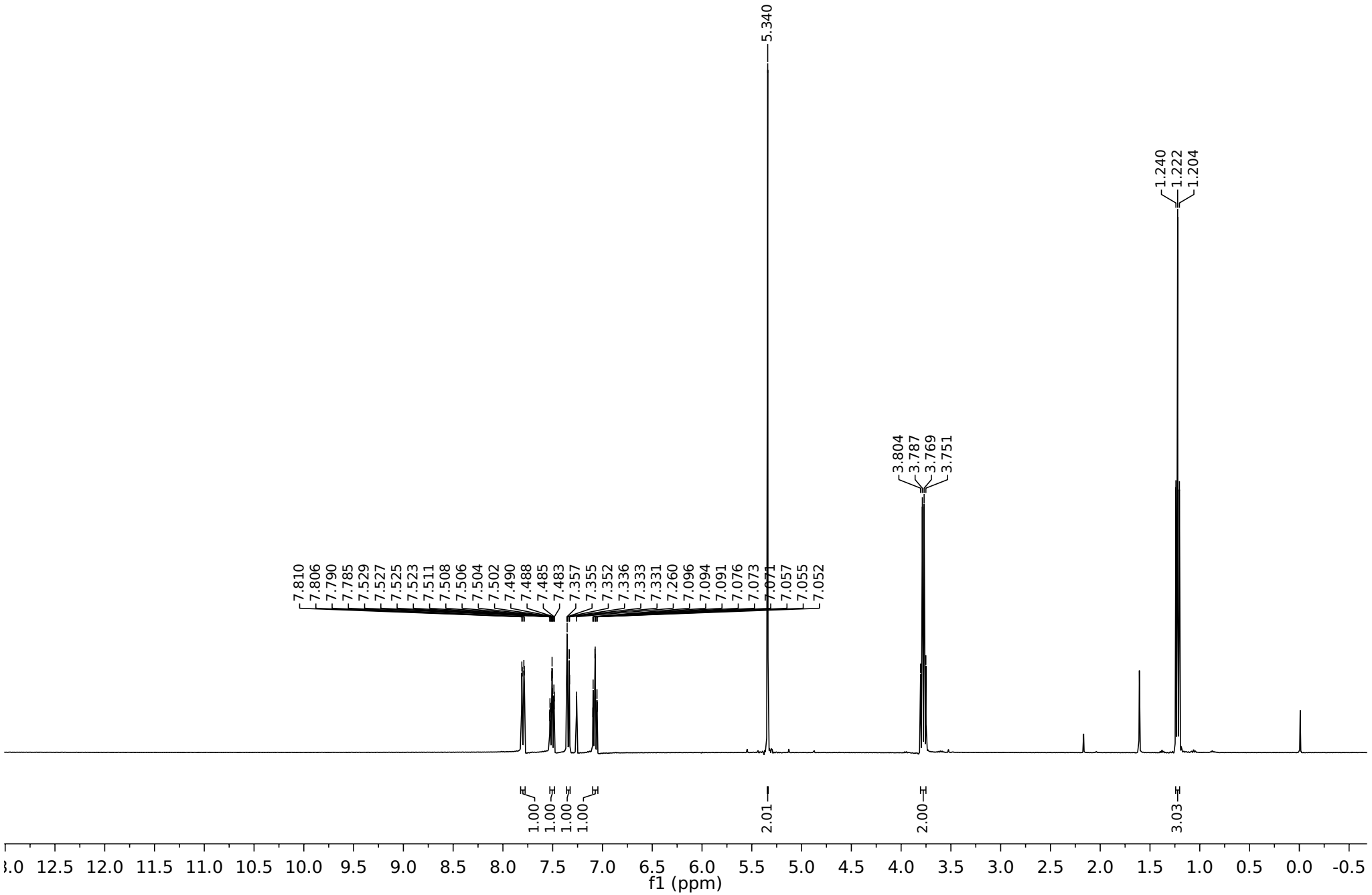

CO2Me
N
CO2Me
O
CO2Me

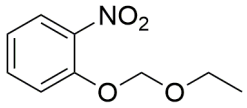
S4


77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
75.8
53.5
52.1
51.7
122.7
122.6
119.8
114.7
171.7
169.4
149.6
139.4
66.1
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

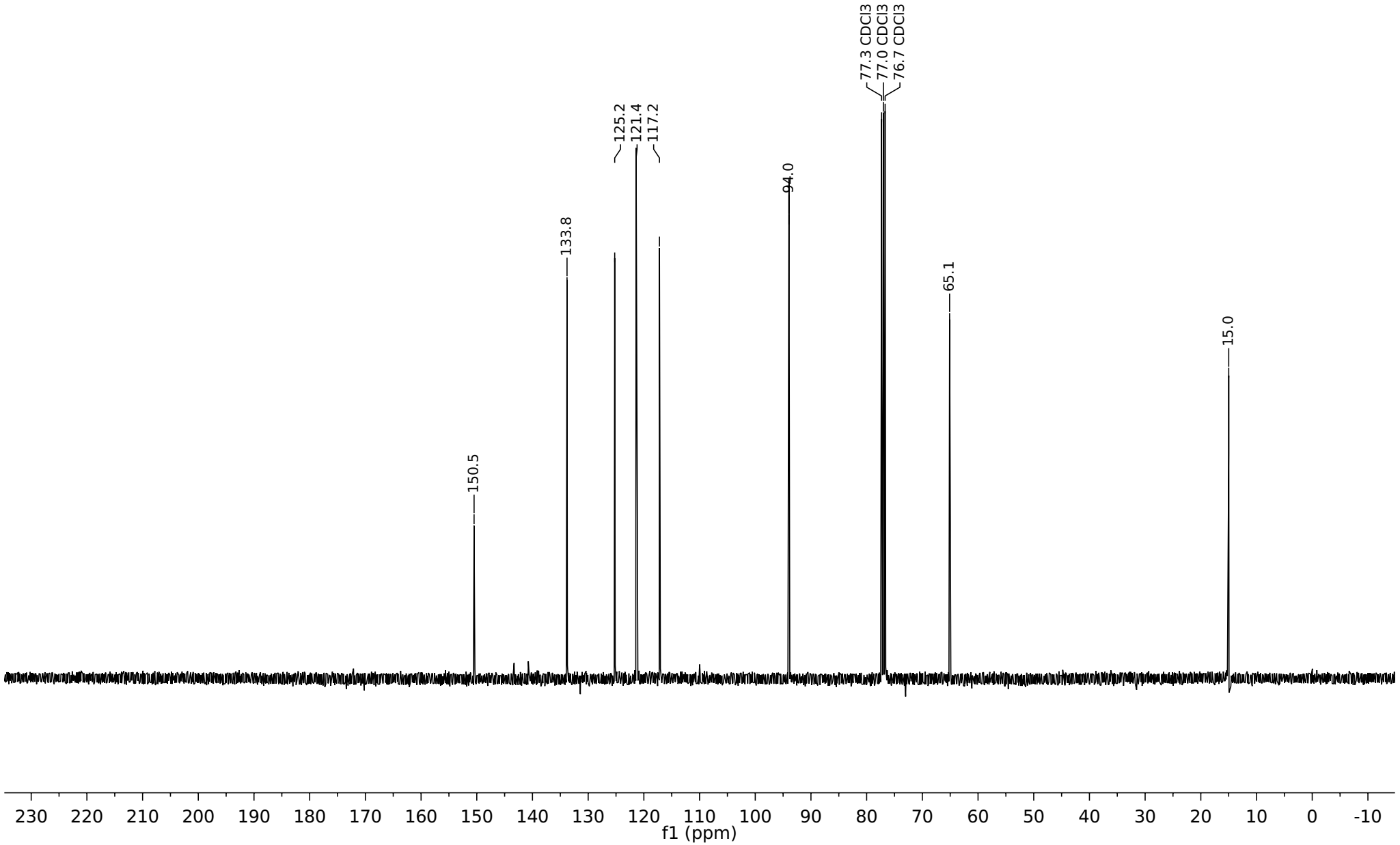

NO2
O
O

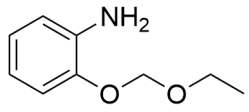
S5


5.340
1.240
1.222
1.204
3.804
3.787
3.769
3.751
7.810
7.806
7.790
7.785
7.529
7.527
7.525
7.523
7.511
7.508
7.506
7.504
7.502
7.490
7.488
7.485
7.483
7.357
7.355
7.352
7.336
7.333
7.331
7.260
7.096
7.094
7.091
7.076
7.073
7.071
7.057
7.055
7.052
1.00
1.00
1.00
1.00
2.01
2.00
3.03
f1 (ppm)

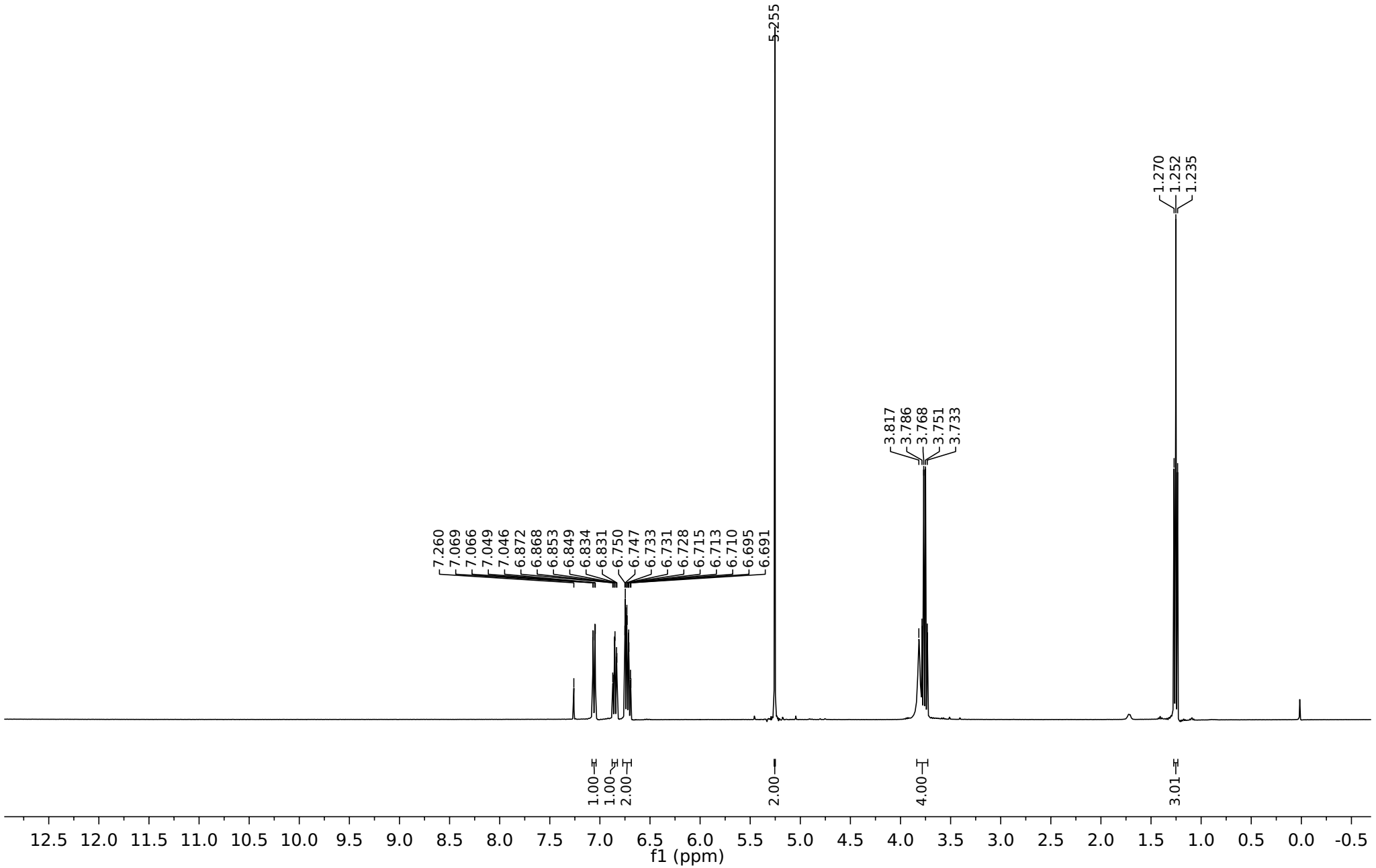

NO2
O
O

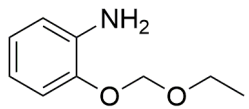
S5


150.5
133.8
125.2
121.4
117.2
94.0
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
65.1
15.0
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

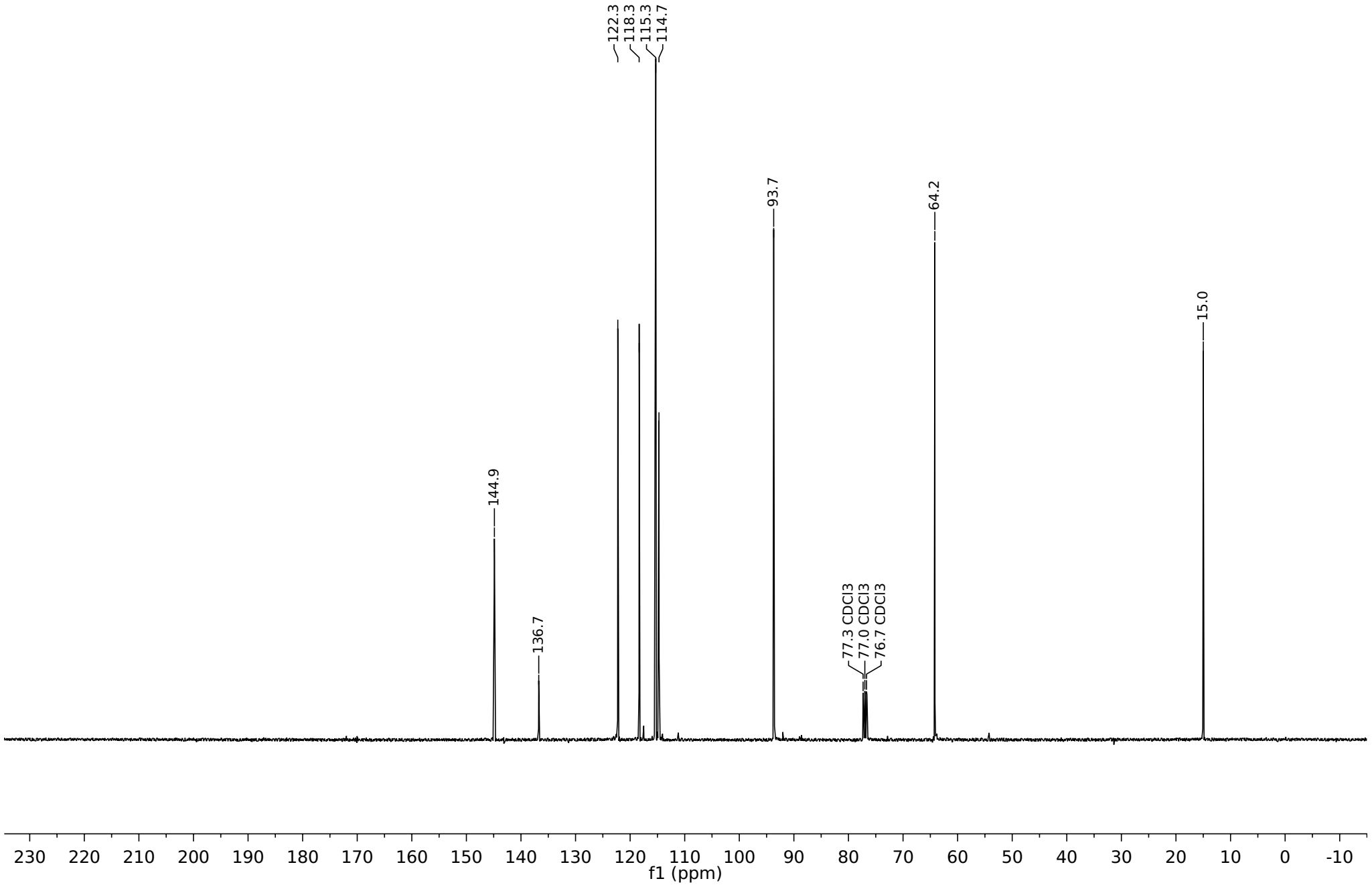

NH2
O
O

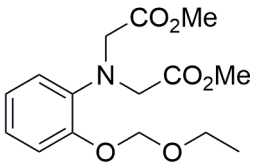
S6


5.255
1.270
1.252
1.235
3.817
3.786
3.768
3.751
3.733
7.260
7.069
7.066
7.049
7.046
6.872
6.868
6.853
6.849
6.834
6.831
6.750
6.747
6.733
6.731
6.728
6.715
6.713
6.710
6.695
6.691
1.00
1.00
2.00
2.00
4.00
3.01
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

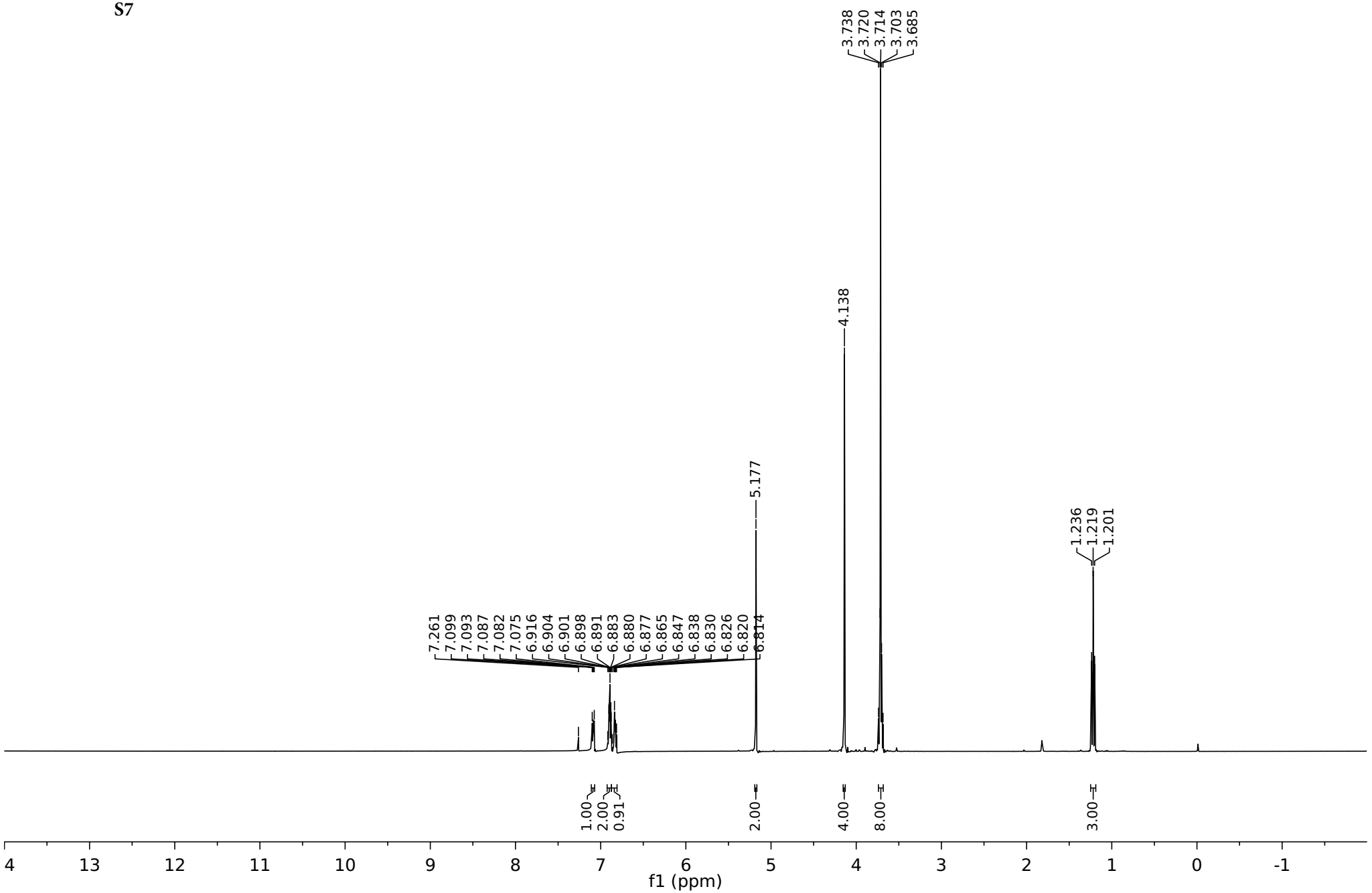

NH2
O
O

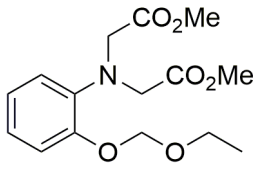
S6


122.3
118.3
115.3
114.7
93.7
64.2
15.0
144.9
136.7
77.3 CDCl3
77.0 CDCl3
76.7 CDCl3
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

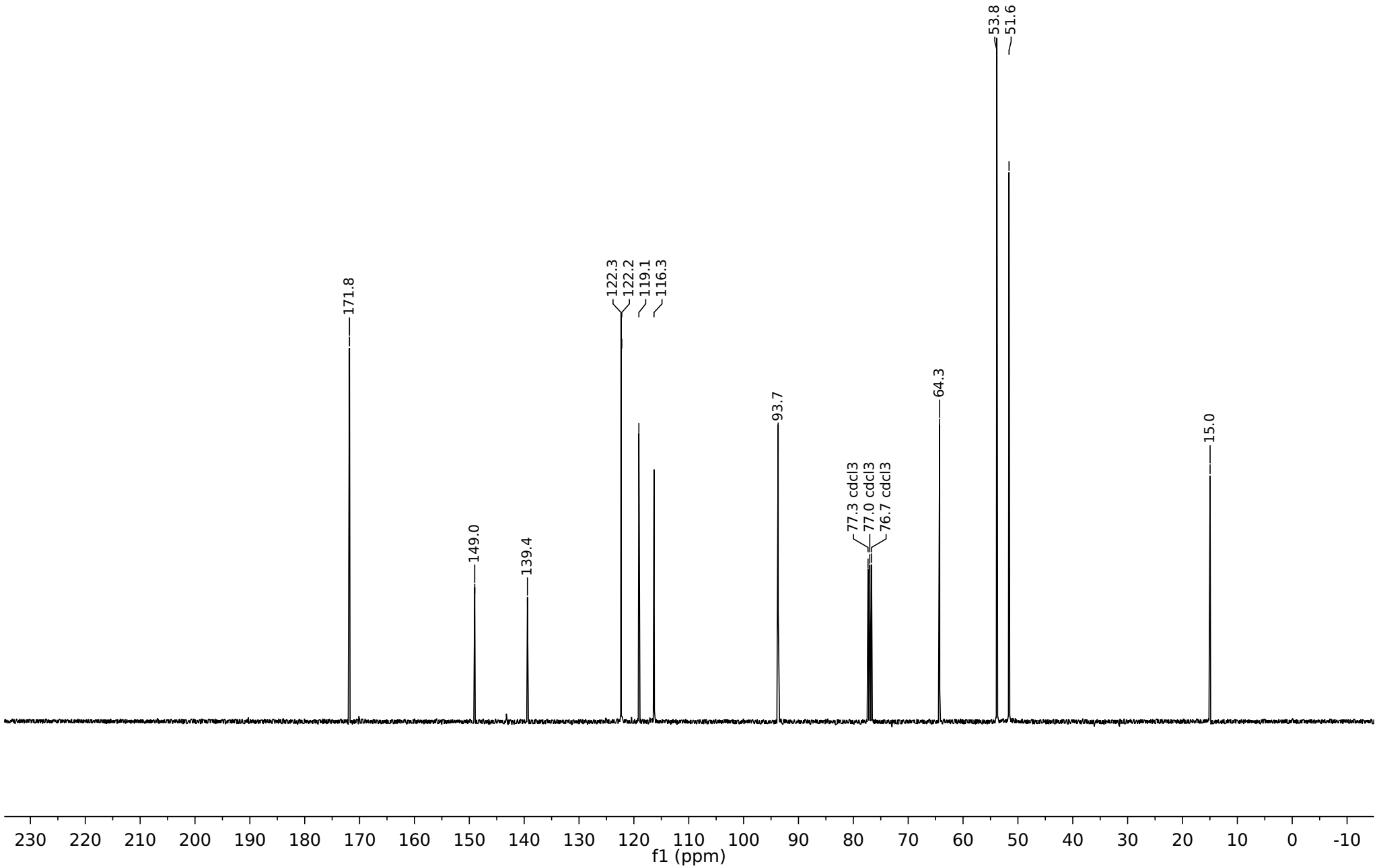

CO2Me
N
CO2Me
O
O

S7


3.738
3.720
3.714
3.703
3.685
4.138
5.177
1.236
1.219
1.201
7.261
7.099
7.093
7.087
7.082
7.075
6.916
6.904
6.901
6.898
6.891
6.883
6.880
6.877
6.865
6.847
6.838
6.830
6.826
6.820
6.814
1.00
2.00
0.91
2.00
4.00
8.00
3.00
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)


CO2Me
N
CO2Me
O
O

S7


171.8
149.0
139.4
122.3
122.2
119.1
116.3
93.7
77.3 cdcl3
77.0 cdcl3
76.7 cdcl3
64.3
53.8
51.6
15.0
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)