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Difluoromethyl Phenyl Sulfone, a Difluoromethylidene Equivalent: Use in the Synthesis of 1,1-Difluoro-1-Alkenes from Primary Alkyl Halides

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General:

Unless otherwise mentioned, all other chemicals were purchased from commercial sources. Potassium *t*-butoxide (95 %, Aldrich) was used as received. DMF was distilled over calcium hydride, and stored over activated molecular sieve. Difluoromethyl phenyl sulfone (**1**) was prepared using known procedures.[1-3] Some alkyl iodides were prepared from corresponding alkyl bromide (using NaI in acetone) or alcohols.[4] Silica gel column chromatography was used to isolate the products using 60-200 mesh silica gel (from J. T. Baker), mostly using hexane-ethyl acetate (9:1) as eluent. ^{1}H, ^{13}C and ^{19}F NMR spectra were recorded on 500 MHz or 360 MHz NMR spectrometer. ^{1}H NMR chemical shifts were determined relative to internal $(CH_3)_4Si$ (TMS) at δ 0.0 or to the signal of a residual protonated solvent: $CDCl_3$ δ 7.26. ^{13}C NMR chemical shifts were determined relative to internal TMS at δ 0.0 or to the ^{13}C signal of solvent: $CDCl_3$ δ 77.0. ^{19}F NMR chemical shifts were determined relative to internal $CFCl_3$ at δ 0.0. GC-MS data were recorded on a GC-MS spectrometer with a mass selective detector at 70 eV. High-resolution mass data of low boiling compounds were recorded on a GC chromatograph with micromass GCT (time of flight) mass spectrometer. Other high-resolution mass data were recorded on a high-resolution mass spectrometer in the EI mode.

Typical Procedure for Nucleophilic Substitution Reactions of Difluoromethyl Phenyl Sulfone with Alkyl Iodides. Under an argon atmosphere, into a Schlenk flask containing difluoromethyl phenyl sulfone (192 mg, 1 mmol) and *n*-heptyl iodide (904 mg, 4 mmol) in DMF (4 mL) at – 50 ^{o}C, was added dropwise via a syringe *t*-BuOK (224 mg, 2 mmol) in DMF (4 mL). The reaction mixture was stirred at – 50 ^{o}C for 1 h, and the completion of the reaction was monitored by ^{19}F NMR. The reaction was then quenched by adding 1N HCl aqueous solution (5 mL) at – 50 ^{o}C, followed by warming to room temperature. A saturated NaCl aqueous solution (10 mL) was added, and the mixture was extracted with Et_2O (15 mL x 3). The combined organic phase was dried over $MgSO_4$, filtered, and the solvent was removed in a rotary evaporator. The residue was further purified by silica gel column chromatography (hexane:ethyl acetate = 9:1) to give 1,1-difluorooctyl phenyl sulfone (**4a**) (230 mg, 79 % yield) as a colorless oily liquid. ^{1}H NMR (500 MHz, $CDCl_3$): δ 0.88 (t, J = 6.9 Hz, 3 H); 1.28 (m, 8 H); 1.64 (m, 2 H); 2.33

(m, 2H); 7.60 (t, *J* = 8.3 Hz, 2H); 7.73 (t, *J* = 7.3 Hz, 1H); 7.99 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 13.9; 20.7 (t, *J* = 3.4 Hz); 22.4; 28.7; 29.0; 29.1; 31.4; 124.6 (t, *J* = 286 Hz); 129.1; 130.6; 132.7; 135.1. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 104.2 (t, *J* = 19 Hz). GC-MS (EI, *m/z*): 291 (M^++1); 142; 77. HRMS (EI): *m/z* calcd for $C_{14}H_{21}F_2O_2S$ (M^++H) 291.1230, found 291.1222.

1,1-Difluorohexyl Phenyl Sulfone (4b): colorless liquid, yield: 80 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 0.90 (t, 3H); 1.37 (m, 4H); 1.62 (m, 2H); 2.30 (m, 2H); 7.60 (t, 2H); 7.78 (t, 1H); 8.00 (2, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 13.7; 20.4; 22.2; 29.1 (t, J = 20.4 Hz); 31.2; 124.7 (t, J = 286 Hz); 129.2; 130.7; 132.5; 135.2. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 104.6 (t, *J* = 19 Hz). GC-MS (EI, *m/z*): 262 (M^+); 142; 77. HRMS (EI): *m/z* calcd for $C_{12}H_{17}F_2O_2S$ (M^++H) 263.0917, found 263.0904.

1,1-Difluoropentyl Phenyl Sulfone (4c): colorless liquid, yield: 84 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 0.93 (t, *J* = 7.3 Hz); 1.42 (m, 2H); 1.62 (m, 2H); 2.32 (m, 2H); 7.60 (t, *J* = 7.3 Hz, 2H); 7.74 (t, *J* = 7.3 Hz, 1 H); 7.97 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 13.5; 22.3; 22.8 (t, *J* = 3.5 Hz); 28.9 (t, *J* = 20 Hz); 124.7 (t, *J* = 286 Hz); 129.2; 130.7; 132.7; 135.1. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 104.1 (t, *J* = 19 Hz). GC-MS (EI, *m/z*): 248 (M^+); 142; 77. HRMS (EI): *m/z* calcd for $C_{11}H_{15}F_2O_2S$ (M^++H) 249.0761, found 249.0749.

1,1-Difluorobutyl Phenyl Sulfone (4d): colorless liquid, yield: 73 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 0.98 (t, *J* = 7.2 Hz, 3H); 1.63 (m, 2H); 2.27 (m, 2H); 7.57 (t, *J* = 7.8 Hz); 7.71 (t, *J* = 7.6 Hz, 1H); 7.95 (d, *J* = 7.7 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 13.6; 14.4 (t, *J* = 3.6 Hz); 30.9 (t, *J* = 20 Hz); 124.5 (t, *J* = 286 Hz); 129.2; 130.5; 132.4; 135.1. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 104.1 (t, *J* = 20 Hz). GC-MS (EI, *m/z*): 234 (M^+); 142; 77. HRMS (EI): *m/z* calcd for $C_{10}H_{12}F_2O_2S$ (M^++H) 235.0604, found 235.0597.

1,1-Difluoropropyl Phenyl Sulfone (4e): colorless liquid, yield 62 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 1.15 (t, *J* = 7.2 Hz, 3H); 2.35 (m, 2H); 7.58 (t, *J* = 7.7 Hz, 2H); 7.72 (t, *J* = 7.6 Hz, 1H); 7.95 (t, *J* = 7.8 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 5.0 (t, *J* = 4.9 Hz); 23.0 (t, J = 20.8 Hz); 124.6 (t, *J* = 285.4 Hz); 129.2; 130.5; 132.4; 135.2. ^{19}F

NMR (338 MHz, $CDCl_3$): δ – 106.1 (t, *J* = 18 Hz). GC-MS (EI, *m/z*): 220 (M^+); 142; 77. HRMS (EI): *m/z* calcd for $C_9H_{10}F_2O_2S$ (M^+) 220.0342, found 220.0381.

1,1-Difluoroethyl Phenyl Sulfone (4f): colorless liquid, yield 42 %. ^1H NMR (500 MHz, $CDCl_3$): δ 2.01 (t, *J* = 19 Hz, 3H); 7.59 (t, J = 7.9 Hz, 2H); 7.74 (t, J = 7.6 Hz, 1H); 7.97 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 16.4 (t, *J* = 22 Hz); 124.0 (t, *J* = 283 Hz); 129.3; 130.7; 132.1; 135.3. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 97.5 (q, *J* = 19 Hz). GC-MS (EI, *m/z*): 206 (M^+); 142; 77. HRMS (EI): *m/z* calcd for $C_8H_8F_2O_2S$ (M^+) 206.0213, found 206.0212.

1,1-Difluoro-4-phenylbutyl Phenyl Sulfone (4g): colorless liquid, yield 71 %. ^1H NMR (360 MHz, $CDCl_3$): δ 2.01 (m, 2H); 2.39 (m, 2H); 2.74 (t, *J* = 7.5 Hz, 2 H); 7.21 (m, 3H); 7.32 (t, *J* = 7.3 Hz, 2H); 7.62 (t, *J* = 7.6 Hz, 2H); 7.76 (t, *J* = 7.7 Hz, 1H); 8.00 (d, *J* = 7.9 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 22.5 (t, *J* = 4 Hz); 28.6 (t, J = 20 Hz); 35.0; 124.5 (t, *J* = 286 Hz); 126.2; 128.3; 128.5; 129.2; 130.6; 132.3; 135.2; 140.5. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 103.9 (t, *J* = 19 Hz). MS (EI, *m/z*): 310 (M^+); 165; 149; 104. HRMS (EI): *m/z* calcd for $C_{16}H_{16}F_2O_2S$ (M^+) 310.0839, found 310.0829.

1,1-Difluoro-5-phenylpentyl Phenyl Sulfone (4h): colorless liquid, yield: 52 %. ^1H NMR (360 MHz, $CDCl_3$): δ 1.73 (m, 4H); 2.38 (m, 2H); 2.67 (t, *J* = 7.3 Hz, 2H); 7.19 (m, 3H); 7.30 (t, *J* = 7.3 Hz, 2H); 7.62 (t, *J* = 7.9 Hz, 2H); 7.76 (t, *J* = 7.8 Hz, 1H); 7.99 (d, *J* = 7.8 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 20.5 (t, *J* = 4 Hz); 29.0 (t, *J* = 20 Hz); 30.9; 35.4; 124.6 (t, J = 286 Hz); 125.9; 128.3; 128.4; 129.2; 130.7; 132.5; 135.2; 141.6. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 104.1 (t, *J* = 18 Hz). HRMS (EI): *m/z* calcd for $C_{17}H_{18}F_2O_2S$ (M^+) 324.0996, found 324.1007.

1,1-Difluoro-6-phenylhexyl Phenyl Sulfone (4i): colorless thick liquid, yield: 59 %. ^1H NMR (500 MHz, $CDCl_3$): δ 1.46 (m 2H); 1.69 (m, 4H); 2.36 (m, 2H); 2.65 (t, *J* = 7.6 Hz, 2H); 7.21 (m, 3H); 7.31 (t, *J* = 7.4 Hz, 2H); 7.62 (t, *J* = 7.4 Hz, 2H); 7.76 (t, *J* = 7.5 Hz, 1H); 8.01 (d, *J* = 7.3 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 20.6 (t, *J* = 4 Hz); 28.6; 29.1 (t, *J* = 18 Hz); 30.9; 35.5; 124.6 (t, *J* = 286 Hz); 125.7; 128.2; 128.3; 129.2; 130.6; 132.4; 135.2; 142.1. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 104.1 (t, *J* = 18 Hz). HRMS (EI): *m/z* calcd for $C_{18}H_{20}F_2O_2S$ (M^+) 338.1152, found 338.1147.

1,1-Difluoro-7-phenylheptyl Phenyl Sulfone (4j): colorless thick liquid, yield: 50 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 1.41 (m, 4H); 1.66 (m, 4H); 2.34 (m, 2H); 2.62 (t, *J* = 7.3 Hz, 2H); 7.20 (m, 3H); 7.29 (t, *J* = 7.3 Hz, 2H); 7.62 (t, *J* = 7.5 Hz, 2H); 7.76 (t, *J* = 7.3 Hz, 1H); 8.00 (d, *J* = 7.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 20.7 (t, *J* = 4 Hz); 28.8; 29.0; 29.1 (t, *J* = 20 Hz); 31.1; 35.8; 124.6 (t, *J* = 286 Hz); 125.6; 128.2; 128.3; 129.2; 130.7; 132.5; 135.2; 142.5. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 104.1 (t, *J* = 19 Hz). HRMS (EI): *m/z* calcd for $C_{19}H_{22}F_2O_2S$ (M^+) 352.1308, found 352.1298.

1,1-Difluoro-4,4-diphenylbutyl Phenyl Sulfone (4k): colorless oily liquid, yield: 37 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.37 (m, 2H); 2.49 (m, 2H); 4.02 (t, *J* = 7.3 Hz, 1H); 7.23~7.36 (m, 10 H); 7.60 (t, *J* = 7.4 Hz, 2H); 7.74 (t, *J* = 7.5 Hz, 1H); 8.00 (d, *J* = 7.4 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 26.7; 28.2 (t, *J* = 20 Hz); 50.6; 124.5 (t, *J* = 286 Hz); 126.6; 127.6; 128.6; 129.2; 130.6; 132.3; 135.2; 143.3. ^{19}F NMR (470 MHz, $CDCl_3$): δ – 103.3 (t, *J* = 19 Hz). MS (EI, *m/z*): 386 (M^+). HRMS (EI): *m/z* calcd for $C_{22}H_{20}F_2O_2S$ (M^+) 386.1147, found 386.1148.

1,1-Difluoro-4-phenoxybutyl Phenyl Sulfone (4l): colorless oily liquid, yield: 71 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 2.17 (m, 2H); 2.61 (m, 2H); 4.04 (t, *J* = 5.9 Hz, 2H); 6.92 (d, *J* = 7.7 Hz, 2H); 7.00 (t, *J* = 7.3 Hz, 1H); 7.31 (t, *J* = 7.1 Hz, 2 H); 7.63 (t, *J* = 7.1 Hz, 2 H); 7.77 (t, *J* = 7.6 Hz, 1 H); 8.02 (d, *J* = 8.0 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 21.2 (t, *J* = 3.7 Hz); 26.4; 66.1; 114.4; 120.9; 124.5 (t, *J* = 286 Hz); 129.3; 129.4; 130.7; 132.3; 135.3; 158.5. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 104.0 (t, *J* = 18 Hz). MS (EI, *m/z*): 326 (M^+); 233; 185; 125. HRMS (EI): *m/z* calcd for $C_{16}H_{16}F_2O_3S$ (M^+) 326.0788, found 326.0789.

1,1-Difluoro-5-phenoxypentyl Phenyl Sulfone (4m): colorless liquid, yield: 60 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 1.90 (m, 4H); 2.44 (m, 2H); 3.99 (t, J = 5.8 Hz, 2H); 6.85~6.98 (m, 3H); 7.29 (t, *J* = 7.5 Hz, 2H); 7.62 (t, J = 7.6 Hz, 2H); 7.77 (t, J = 7.6 Hz, 1H); 7.99 (d, J = 7.6 Hz, 2H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 17.8 (t, J = 3.6 Hz); 28.6; 28.9 (t, J = 20 Hz); 66.8; 114.3; 120.6; 124.4 (t, J = 286 Hz); 129.2; 129.3; 130.6; 132.3; 135.2; 158.7. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 103.9 (t, *J* = 18 Hz). HRMS (EI): *m/z* calcd for $C_{17}H_{18}F_2O_3S$ (M^+) 340.0945, found 340.0951.

Typical Procedures for the Preparation of 1,1-Difluoro-1-alkenes (6) from Alkyl-substitued Difluoromethyl Sulfones (4): Under an argon atmosphere, into a Schlenk flask containing 1,1-difluoro-4-phenylbutyl phenyl sulfone **(4g)** (100 mg, 0.32 mmol) in THF (4 mL) at – 20 ^{o}C, was added dropwise via a syringe *t*-BuOK (224 mg, 2 mmol) in DMF (4 mL). The reaction mixture was stirred at – 20 ^{o}C ~ rt for 1 h, and the completion of the reaction was monitored by ^{19}F NMR [δ – 89.6 (d, *J* = 46.6 Hz, 1F); – 91.6 (dd, *J* = 46.6 Hz, 24.8 Hz, 1F)]. The reaction was then quenched by adding aqueous NaCl solution (10 mL), followed by extraction with Et_2O (15 mL x 3). The combined organic phase was dried over anhydrous Na_2SO_4, filtered, and the solvent was removed. The crude product was purified by a flash chromatography to give 1,1-difluoro-4-phenyl-1-butene (**6a**) (46 mg, 85 % yield) as a colorless liquid. The characterization data is consistent with those reported earlier.[5]

1,1-Difluoro-5-phenyl-1-pentene (6b): colorless liquid, yield: 71 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 1.70 (p, *J* = 7.6 Hz, 2H); 2.01 (qt, *J* = 7.5 Hz, 1.7 Hz, 2H); 2.62 (t, *J* = 7.6 Hz, 2H); 4.15 (dtd, *J* = 25 Hz, 7.9 Hz, 2.7 Hz, 1H); 7.16~7.31 (m, 5H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 21.8; 31.1; 35.1; 77.7 (t, *J* = 21 Hz); 125.8; 128.3; 128.4; 142.0; 156.2 (t, *J* = 286 Hz). ^{19}F NMR (338 MHz, $CDCl_3$): δ – 89.7 (d, J = 46.6 Hz, 1F); – 92.0 (dd, J = 46.6 Hz, 25.1 Hz, 1F). HRMS (EI): *m/z* calcd for $C_{11}H_{12}F_2$ (M^+) 182.0907, found 182.0909.

1,1-Difluoro-6-phenyl-1-hexene (6c): colorless liquid, yield: 82 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 1.43 (m, 2H); 1.66 (m, 2H); 2.03 (m, 2H); 2.63 (t, *J* = 7.4 Hz, 2H); 4.14 (dtd, *J* = 25.5 Hz; 7.8 Hz, 2.5 Hz, 1H); 7.18~7.34 (m, 5H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 22.0; 29.0; 30.7; 35.5; 77.8 (t, J = 21 Hz); 125.7; 128.3; 128.4; 142.4; 156.3 (t, J = 286 Hz). ^{19}F NMR (338 MHz, $CDCl_3$): δ – 90.0(d, J = 50 Hz, 1F); – 92.5 (dd, J = 50 Hz, 25 Hz, 1F). HRMS (EI): *m/z* calcd for $C_{12}H_{14}F_2$ (M^+) 196.1063, found 196.1061.

1,1-Difluoro-7-phenyl-1-heptene (6d): colorless liquid, yield: 80 %. ^{1}H NMR (360 MHz, $CDCl_3$): δ 1.40 (m, 4H); 1.64 (m, 2H); 1.99 (m, 2H); 2.62 (t, *J* = 7.4 Hz, 2H); 4.13 (dtd, *J* = 25 Hz, 7.9 Hz, 3.0 Hz, 1H); 7.17~7.33 (m, 5H). ^{13}C NMR (90 MHz, $CDCl_3$): δ 22.1; 28.5; 29.3; 31.2; 35.9; 77.9 (t, *J* = 21 Hz); 125.6; 128.3; 128.4; 142.6; 156.3 (t, *J* =

286 Hz). ^{19}F NMR (338 MHz, $CDCl_3$): δ – 90.1(d, J = 50 Hz, 1F); – 92.5 (dd, J = 50 Hz, 25 Hz, 1F).

1,1-Difluoro-4,4-diphenyl-1-butene (6e): colorless liquid, yield: 84 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.76 (m, J = 7.7 Hz, 2H); 3.98 (t, J = 7.9 Hz, 1H); 4.10 (dtd, J = 25.4 Hz, 7.4 Hz, 2.6 Hz, 1H); 7.20~7.36 (m, 10 H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 28.5; 51.2; 76.6 (t, *J* = 20 Hz); 126.5; 127.8; 128.5; 143.7; 156.3 (t, *J* = 286 Hz). ^{19}F NMR (338 MHz, $CDCl_3$): δ – 88.8(d, J = 46 Hz, 1F); – 90.7 (dd, J = 46 Hz, 24 Hz, 1F). MS (EI, *m/z*): 244 [M^+]. HRMS (EI): *m/z* calcd for $C_{16}H_{14}F_2$ (M^+) 244.1052, found 244.1053.

1,1-Difluoro-5-(4'-methoxy)phenyl-1-pentene (6f): colorless liquid, yield: 55 %.^{1}H NMR (360 MHz, $CDCl_3$): δ 1.67 (m, 2H); 1.99 (m, 2H); 2.57 (t, *J* = 7.4 Hz, 2H); 3.79 (s, 3H); 4.15 (dtd, *J* = 25 Hz, 7.8 Hz, 3.0 Hz, 1H); 6.83 (d, *J* = 8.6 Hz, 2H); 7.09 (d, *J* = 8.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 14.1; 21.7; 34.2; 55.2; 77.7 (t, *J* = 21 Hz); 113.8; 129.3; 133.9; 156.3 (t, *J* = 286 Hz); 157.8. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 90.0(d, *J* = 50 Hz, 1F); – 92.3 (dd, *J* = 50 Hz, 26 Hz, 1F). HRMS (EI): *m/z* calcd for $C_{12}H_{14}F_2O$ (M^+) 212.1013, found 212.1001.

1,1-Difluoro-4-phenoxy-1-butene (6g): colorless liquid, yield: 88 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 2.48 (m, 2H); 3.98 (t, *J* = 6.2 Hz, 2H); 4.35 (dtd, *J* = 25.4 Hz, 7.9 Hz, 2.4 Hz, 1H); 6.91 (d, *J* = 8.0 Hz, 2H); 6.97 (t, *J* = 7.5 Hz, 1H); 7.30 (t, *J* = 8.0 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 22.8; 66.7; 74.7 (t, *J* = 22 Hz); 114.5; 120.9; 129.5; 156.8 (t, *J* = 287 Hz); 158.7. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 88.1 (d, *J* = 46 Hz, 1F); – 90.5 (dd, *J* = 46 Hz, 26 Hz, 1F). MS (EI, *m/z*): 184 [M^+]. HRMS (EI): *m/z* calcd for $C_{10}H_{10}F_2O$ (M^+) 184.0700, found 184.0702.

1,1-Difluoro-5-phenoxy-1-pentene (6h): colorless liquid, yield: 87 %. ^{1}H NMR (500 MHz, $CDCl_3$): δ 1.87 (m, 2H); 2.21 (m, 2H); 3.97 (t, *J* = 7.2 Hz, 2H); 4.21 (dtd, *J* = 25.4 Hz, 7.9 Hz, 2.4 Hz, 1H); 6.93 (m, 3H); 7.29 (t, *J* = 7.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$): δ 19.0; 29.0 (t, *J* = 2.5 Hz); 66.6; 74.4 (t, *J* = 22 Hz); 114.5; 120.7; 129.4; 156.4 (t, *J* = 287 Hz); 159.0. ^{19}F NMR (338 MHz, $CDCl_3$): δ – 89.2 (d, *J* = 46 Hz, 1F); – 91.7 (dd, *J* = 46 Hz, 26 Hz, 1F). HRMS (EI): *m/z* calcd for $C_{11}H_{12}F_2O$ (M^+) 198.0856, found 198.0853.

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