

# 1-(2-Amino-5-chlorophenyl)-2,2,2-trifluoroethan-1-one

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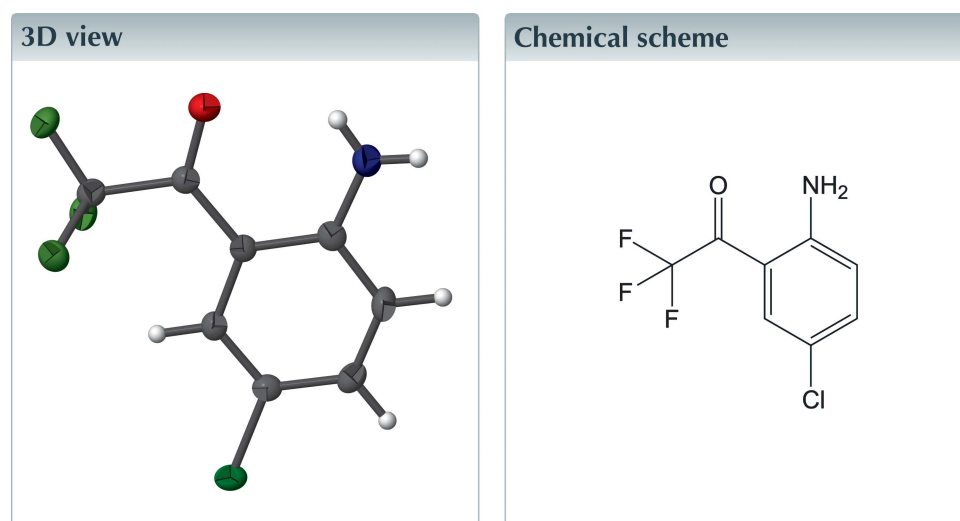
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Structural data: full structural data are available from [iucrdata.iucr.org](http://iucrdata.iucr.org)

In the title compound, C<sub>8</sub>H<sub>5</sub>ClF<sub>3</sub>NO, the F—C—C=O grouping shows a *syn* conformation [torsion angle = 1.1 (3)°] and an intramolecular N—H···O hydrogen bond generates an *S*(6) ring. In the crystal, N—H···F and N—H···O hydrogen bonds link the molecules into [010] chains.



## Structure description

Efavirenz is a potent HIV-1 reverse transcriptase inhibitor and an important anti-retroviral drug (Young *et al.*, 1995) for the treatment of AIDS (Vrouenraets, *et al.*, 2007). One of the intermediates for the preparation of efavirenz (Nicolaou *et al.*, 2009; Li & Ma, 2015) is the title compound (**1**) and we now describe its crystal structure. The title compound was synthesized by employing 2-amino-5-chlorobenzoic acid as starting material (Allendörfer *et al.*, 2012).

The F1—C8—C7=O1 grouping in (**1**) shows a *syn* conformation [torsion angle = 1.1 (3)°]. The average C—F bond distance is 1.338 Å and the C—Cl, C=O, and C—N bond lengths are 1.736 (3), 1.229 (3) and 1.344 (3) Å, respectively, which are all within their expected ranges. An intramolecular N—H···O hydrogen bond generates a *S*(6) ring; the same H atom also participates in a weak intermolecular N—H···F link (Table 1). In the crystal, N—H···F and N—H···O hydrogen bonds connect the molecules into [010] chains (Fig. 1).

## Synthesis and crystallization

To a solution of 2-amino-5-chlorobenzoic acid (0.86 g, 5.0 mmol) in toluene (25 ml), was added trimethylamine (1.52 g, 15 mmol) and acetic anhydride (1.53 g, 15 mmol). The reaction mixture was stirred at 110°C for 15 h. After the starting material had been

**Table 1**  
Hydrogen-bond geometry (Å, °).

<i>D</i> –H··· <i>A</i>	<i>D</i> –H	H··· <i>A</i>	<i>D</i> ··· <i>A</i>	<i>D</i> –H··· <i>A</i>
N1–H1A···O1	0.81 (3)	2.07 (3)	2.672 (3)	131 (3)
N1–H1A···F1 <sup>i</sup>	0.81 (3)	2.45 (3)	3.084 (3)	136 (3)
N1–H1B···O1 <sup>i</sup>	0.81 (4)	2.45 (3)	3.030 (3)	130 (3)

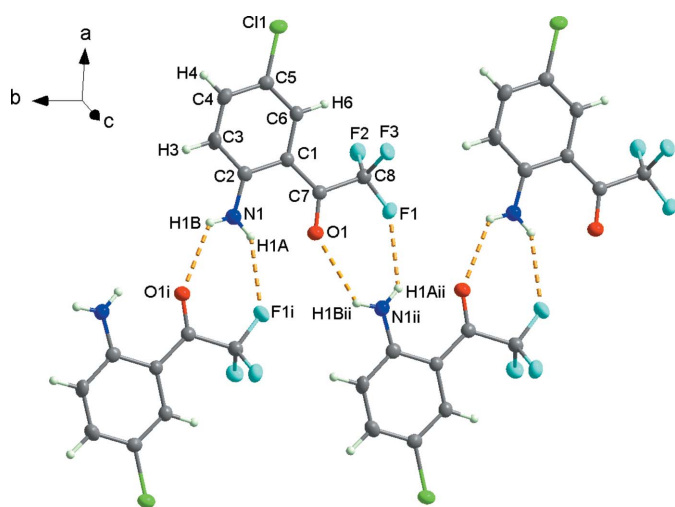
Symmetry code: (i)  $-x, y + \frac{1}{2}, -z + \frac{3}{2}$ .

consumed completely, the solvent was removed under reduced pressure. The resulting mixture was dissolved in water and extracted by ethyl acetate. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent removed under reduced pressure. The 6-chloro-2-methyl-4*H*-benzo[*d*][1,3]oxazin-4-one product was used in the next step without further purification.

Under an argon atmosphere, 6-chloro-2-methyl-4*H*-benzo[*d*][1,3]oxazin-4-one (0.60 g, 3.0 mmol) was dissolved in dry DMSO. To the solution, (trifluoromethyl)trimethylsilane (TMS-CF<sub>3</sub>; 0.87 g, 6.0 mmol) and tetra-*n*-butylammonium fluoride (TBAF; 0.37 ml) were added and the mixture was stirred at room temperature for 15 h. Then the reaction mixture was quenched with HCl (2 *M*) and further stirred for 1 h. The mixture was extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic layer was washed with brine and dried over Na<sub>2</sub>SO<sub>4</sub>. The solvent was removed under reduced pressure. The title compound was isolated by column chromatography and recrystallized from a solvent mixture of CH<sub>3</sub>OH and CH<sub>2</sub>Cl<sub>2</sub> (*v*:*v* = 1:1).

## Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2.



**Figure 1**  
The molecular structure and hydrogen-bonding interactions of the title compound. Symmetry codes: (i)  $-x, \frac{1}{2} + y, \frac{3}{2} - z$ ; (ii)  $-x, -\frac{1}{2} + y, \frac{3}{2} - z$ .

**Table 2**  
Experimental details.

Crystal data	
Chemical formula	C <sub>8</sub> H <sub>5</sub> ClF <sub>3</sub> NO
<i>M<sub>r</sub></i>	223.58
Crystal system, space group	Monoclinic, <i>P</i> 2 <sub>1</sub> / <i>c</i>
Temperature (K)	120
<i>a</i> , <i>b</i> , <i>c</i> (Å)	12.7307 (16), 9.0363 (12), 7.4742 (9)
$\beta$ (°)	100.924 (4)
<i>V</i> (Å <sup>3</sup> )	844.24 (19)
<i>Z</i>	4
Radiation type	Mo <i>K</i> $\alpha$
$\mu$ (mm <sup>-1</sup> )	0.46
Crystal size (mm)	0.20 × 0.10 × 0.02
Data collection	
Diffractometer	Bruker APEXII CCD
Absorption correction	Multi-scan ( <i>SADABS</i> ; Bruker, 2005)
<i>T<sub>min</sub></i> , <i>T<sub>max</sub></i>	0.304, 0.746
No. of measured, independent and observed [ <i>I</i> > 2 $\sigma$ ( <i>I</i> )] reflections	8037, 1934, 1374
<i>R<sub>int</sub></i>	0.091
( <i>sin</i> $\theta$ / $\lambda$ ) <sub>max</sub> (Å <sup>-1</sup> )	0.650
Refinement	
<i>R</i> [ <i>F</i> <sup>2</sup> > 2 $\sigma$ ( <i>F</i> <sup>2</sup> )], <i>wR</i> ( <i>F</i> <sup>2</sup> ), <i>S</i>	0.043, 0.113, 1.06
No. of reflections	1934
No. of parameters	135
H-atom treatment	H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{\max}$ , $\Delta\rho_{\min}$ (e Å <sup>-3</sup> )	0.37, -0.32

Computer programs: *APEX2* and *SAINT* (Bruker, 2005), *SHELXS97* and *SHELXTL* (Sheldrick, 2008), *SHELXL* (Sheldrick, 2015) and *DIAMOND* (Brandenburg, 1999).

## Acknowledgements

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## full crystallographic data

*IUCrData* (2019). 4, x191025 [https://doi.org/10.1107/S2414314619010253]

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*Crystal data*

$C_8H_5ClF_3NO$

$M_r = 223.58$

Monoclinic,  $P2_1/c$

$a = 12.7307$  (16) Å

$b = 9.0363$  (12) Å

$c = 7.4742$  (9) Å

$\beta = 100.924$  (4)°

$V = 844.24$  (19) Å<sup>3</sup>

$Z = 4$

$F(000) = 448$

$D_x = 1.759$  Mg m<sup>-3</sup>

Mo  $K\alpha$  radiation,  $\lambda = 0.71073$  Å

Cell parameters from 2386 reflections

$\theta = 2.8$ – $27.3$ °

$\mu = 0.46$  mm<sup>-1</sup>

$T = 120$  K

Block, yellow

$0.20 \times 0.10 \times 0.02$  mm

*Data collection*

Bruker APEXII CCD  
diffractometer

$\varphi$  and  $\omega$  scans

Absorption correction: multi-scan  
(SADABS; Bruker, 2005)

$T_{\min} = 0.304$ ,  $T_{\max} = 0.746$

8037 measured reflections

1934 independent reflections

1374 reflections with  $I > 2\sigma(I)$

$R_{\text{int}} = 0.091$

$\theta_{\max} = 27.5$ °,  $\theta_{\min} = 3.3$ °

$h = -16 \rightarrow 15$

$k = -11 \rightarrow 11$

$l = -9 \rightarrow 9$

*Refinement*

Refinement on  $F^2$

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.043$

$wR(F^2) = 0.113$

$S = 1.06$

1934 reflections

135 parameters

0 restraints

Primary atom site location: structure-invariant  
direct methods

Hydrogen site location: mixed

H atoms treated by a mixture of independent  
and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.0262P)^2 + 0.5023P]$

where  $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{\max} < 0.001$

$\Delta\rho_{\max} = 0.37$  e Å<sup>-3</sup>

$\Delta\rho_{\min} = -0.32$  e Å<sup>-3</sup>

*Special details*

**Geometry.** All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

**Refinement.** All H atoms were positioned geometrically and refined using a riding model.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters ( $\text{\AA}^2$ )

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Cl1	0.52355 (5)	0.71433 (7)	0.54712 (9)	0.0274 (2)
F2	0.19882 (12)	0.37800 (16)	0.46110 (19)	0.0281 (4)
F3	0.26469 (12)	0.36210 (16)	0.7480 (2)	0.0283 (4)
F1	0.09924 (13)	0.31042 (16)	0.6487 (2)	0.0293 (4)
O1	0.05780 (14)	0.5844 (2)	0.6915 (2)	0.0257 (4)
N1	0.0944 (2)	0.8744 (3)	0.6703 (3)	0.0273 (5)
C2	0.1916 (2)	0.8337 (3)	0.6426 (3)	0.0202 (5)
C7	0.1467 (2)	0.5662 (3)	0.6533 (3)	0.0197 (5)
C6	0.3249 (2)	0.6482 (3)	0.5988 (3)	0.0198 (5)
H6	0.345180	0.547756	0.589568	0.024*
C1	0.2214 (2)	0.6819 (3)	0.6294 (3)	0.0183 (5)
C4	0.3678 (2)	0.9071 (3)	0.5960 (3)	0.0242 (6)
H4	0.417990	0.983013	0.586013	0.029*
C8	0.1775 (2)	0.4030 (3)	0.6273 (3)	0.0226 (6)
C5	0.3962 (2)	0.7580 (3)	0.5822 (3)	0.0206 (5)
C3	0.2680 (2)	0.9429 (3)	0.6238 (3)	0.0249 (6)
H3	0.249430	1.044290	0.630777	0.030*
H1A	0.051 (2)	0.814 (3)	0.689 (4)	0.022 (8)*
H1B	0.084 (3)	0.961 (4)	0.684 (4)	0.045 (10)*

Atomic displacement parameters ( $\text{\AA}^2$ )

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
Cl1	0.0210 (4)	0.0319 (4)	0.0306 (4)	−0.0025 (3)	0.0077 (3)	−0.0007 (3)
F2	0.0373 (10)	0.0229 (8)	0.0252 (8)	−0.0002 (7)	0.0089 (7)	−0.0039 (6)
F3	0.0246 (8)	0.0256 (8)	0.0320 (8)	0.0029 (6)	−0.0012 (7)	0.0063 (7)
F1	0.0278 (9)	0.0211 (8)	0.0395 (9)	−0.0051 (6)	0.0076 (7)	0.0037 (7)
O1	0.0215 (10)	0.0261 (10)	0.0300 (10)	−0.0009 (8)	0.0064 (8)	0.0000 (8)
N1	0.0274 (14)	0.0222 (14)	0.0338 (13)	0.0007 (11)	0.0096 (11)	−0.0012 (11)
C2	0.0233 (14)	0.0234 (12)	0.0135 (11)	0.0016 (11)	0.0027 (10)	0.0002 (10)
C7	0.0202 (13)	0.0218 (13)	0.0163 (11)	0.0003 (10)	0.0018 (10)	0.0006 (10)
C6	0.0237 (14)	0.0194 (13)	0.0157 (11)	0.0007 (10)	0.0027 (10)	0.0005 (10)
C1	0.0202 (13)	0.0198 (12)	0.0145 (11)	0.0000 (10)	0.0021 (10)	−0.0006 (9)
C4	0.0288 (15)	0.0229 (13)	0.0212 (13)	−0.0059 (11)	0.0053 (11)	0.0013 (10)
C8	0.0228 (14)	0.0228 (13)	0.0221 (12)	−0.0017 (11)	0.0041 (11)	0.0010 (10)
C5	0.0211 (13)	0.0258 (13)	0.0151 (12)	−0.0007 (11)	0.0039 (10)	−0.0003 (10)
C3	0.0341 (16)	0.0168 (13)	0.0251 (13)	0.0001 (11)	0.0086 (12)	−0.0004 (10)

Geometric parameters ( $\text{\AA}$ ,  $^\circ$ )

Cl1—C5	1.736 (3)	C7—C1	1.447 (3)
F2—C8	1.340 (3)	C7—C8	1.548 (3)
F3—C8	1.343 (3)	C6—C5	1.366 (4)
F1—C8	1.334 (3)	C6—C1	1.413 (3)
O1—C7	1.229 (3)	C6—H6	0.9500

N1—C2	1.344 (3)	C4—C3	1.364 (4)
N1—H1A	0.81 (3)	C4—C5	1.404 (4)
N1—H1B	0.81 (4)	C4—H4	0.9500
C2—C3	1.411 (4)	C3—H3	0.9500
C2—C1	1.432 (3)		
C2—N1—H1A	121 (2)	C3—C4—C5	119.9 (2)
C2—N1—H1B	117 (2)	C3—C4—H4	120.0
H1A—N1—H1B	121 (3)	C5—C4—H4	120.0
N1—C2—C3	119.7 (2)	F1—C8—F2	107.0 (2)
N1—C2—C1	122.4 (2)	F1—C8—F3	106.72 (19)
C3—C2—C1	117.9 (2)	F2—C8—F3	106.9 (2)
O1—C7—C1	126.0 (2)	F1—C8—C7	111.7 (2)
O1—C7—C8	115.0 (2)	F2—C8—C7	112.2 (2)
C1—C7—C8	119.0 (2)	F3—C8—C7	112.0 (2)
C5—C6—C1	121.0 (2)	C6—C5—C4	120.3 (2)
C5—C6—H6	119.5	C6—C5—Cl1	120.3 (2)
C1—C6—H6	119.5	C4—C5—Cl1	119.3 (2)
C6—C1—C2	119.0 (2)	C4—C3—C2	121.9 (2)
C6—C1—C7	121.3 (2)	C4—C3—H3	119.1
C2—C1—C7	119.7 (2)	C2—C3—H3	119.1
C5—C6—C1—C2	0.1 (3)	O1—C7—C8—F2	121.2 (2)
C5—C6—C1—C7	-177.9 (2)	C1—C7—C8—F2	-58.0 (3)
N1—C2—C1—C6	179.5 (2)	O1—C7—C8—F3	-118.6 (2)
C3—C2—C1—C6	0.1 (3)	C1—C7—C8—F3	62.2 (3)
N1—C2—C1—C7	-2.4 (4)	C1—C6—C5—C4	0.2 (4)
C3—C2—C1—C7	178.1 (2)	C1—C6—C5—Cl1	179.28 (18)
O1—C7—C1—C6	175.3 (2)	C3—C4—C5—C6	-0.8 (4)
C8—C7—C1—C6	-5.6 (3)	C3—C4—C5—Cl1	-179.91 (19)
O1—C7—C1—C2	-2.7 (4)	C5—C4—C3—C2	1.1 (4)
C8—C7—C1—C2	176.4 (2)	N1—C2—C3—C4	179.8 (2)
O1—C7—C8—F1	1.1 (3)	C1—C2—C3—C4	-0.7 (4)
C1—C7—C8—F1	-178.2 (2)		

## Hydrogen-bond geometry (Å, °)

<i>D</i> —H... <i>A</i>	<i>D</i> —H	H... <i>A</i>	<i>D</i> ... <i>A</i>	<i>D</i> —H... <i>A</i>
N1—H1A...O1	0.81 (3)	2.07 (3)	2.672 (3)	131 (3)
N1—H1A...F1 <sup>i</sup>	0.81 (3)	2.45 (3)	3.084 (3)	136 (3)
N1—H1B...O1 <sup>i</sup>	0.81 (4)	2.45 (3)	3.030 (3)	130 (3)

Symmetry code: (i)  $-x, y+1/2, -z+3/2$ .