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2,4-Dichloro-*N*-(2,6-dimethylphenyl)-benzenesulfonamide

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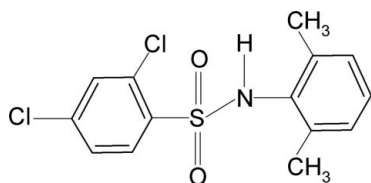
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 Key indicators: single-crystal X-ray study; $T = 293$ K; mean $\sigma(\text{C}-\text{C}) = 0.004$ Å; R factor = 0.038; wR factor = 0.107; data-to-parameter ratio = 16.7.

In the crystal of the title compound, $\text{C}_{14}\text{H}_{13}\text{Cl}_2\text{NO}_2\text{S}$, the N—H bond in the C—SO₂—NH—C segment orients itself away from the two *ortho*-methyl groups in the aniline benzene ring and towards the *ortho*-chloro group of the sulfonyl benzene ring. The molecule is bent at the S atom with a C—SO₂—NH—C torsion angle of -100.48 (18)°. The sulfonyl and aniline benzene rings are tilted relative to each other by 69.6 (1)°. Intermolecular N—H···O hydrogen bonds link the molecules into infinite chains.

Related literature

For the preparation of the title compound, see: Savitha & Gowda (2006). For the hydrogen-bonding preferences of sulfonamides, see: Adson & Grant (2001). For our studies on the effects of substituents on the structures and other aspects of *N*-(aryl)-amides, see: Arjunan *et al.* (2004); Gowda *et al.* (2001); of *N*-(aryl)-methanesulfonamides, see: Gowda *et al.* (2007); and of *N*-(aryl)-arylsulfonamides, see: Gelbrich *et al.* (2007); Perlovich *et al.* (2006); Gowda *et al.* (2003); Rodrigues *et al.* (2011).



Experimental

Crystal data

 $\text{C}_{14}\text{H}_{13}\text{Cl}_2\text{NO}_2\text{S}$
 $M_r = 330.21$

 Monoclinic, $P2_1/n$
 $a = 12.021$ (1) Å

 $b = 7.5458$ (7) Å
 $c = 16.837$ (1) Å
 $\beta = 92.324$ (7)°
 $V = 1526.0$ (2) Å³
 $Z = 4$

 Mo $K\alpha$ radiation
 $\mu = 0.56$ mm⁻¹
 $T = 293$ K
 $0.40 \times 0.36 \times 0.24$ mm

Data collection

 Oxford Diffraction Xcalibur diffractometer with a Sapphire CCD detector
 Absorption correction: multi-scan (*CrysAlis RED*; Oxford)

 Diffraction, 2009
 $T_{\min} = 0.807$, $T_{\max} = 0.877$
 6113 measured reflections
 3107 independent reflections
 2188 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.016$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.038$
 $wR(F^2) = 0.107$
 $S = 1.03$
 3107 reflections
 186 parameters
 1 restraint

 H atoms treated by a mixture of independent and constrained refinement
 $\Delta\rho_{\max} = 0.23$ e Å⁻³
 $\Delta\rho_{\min} = -0.30$ e Å⁻³
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—H1N···O2 ⁱ	0.83 (2)	2.14 (2)	2.891 (2)	152 (2)

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

Data collection: *CrysAlis CCD* (Oxford Diffraction, 2009); cell refinement: *CrysAlis RED* (Oxford Diffraction, 2009); data reduction: *CrysAlis RED*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *PLATON* (Spek, 2009); software used to prepare material for publication: *SHELXL97*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: BQ2306).

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supporting information

Acta Cryst. (2011). E67, o2691 [https://doi.org/10.1107/S1600536811037767]

2,4-Dichloro-*N*-(2,6-dimethylphenyl)benzenesulfonamide**Vinola Z. Rodrigues, Sabine Foro and B. Thimme Gowda****S1. Comment**

Several biologically important compounds contain the sulfonamide moiety. The hydrogen bonding preferences of sulfonamides have been investigated (Adsmund & Grant, 2001). As part of our studies on the substituent effects on the structures and other aspects of *N*-(aryl)-amides (Arjunan *et al.*, 2004; Gowda *et al.*, 2001), *N*-(aryl)-methanesulfonamides (Gowda *et al.*, 2007) and *N*-(aryl)-arylsulfonamides (Gowda *et al.*, 2003; Rodrigues *et al.*, 2011), in the present work, the crystal structure of 2,4-dichloro-*N*-(2,6-dimethylphenyl)-benzenesulfonamide (I) has been determined (Fig. 1).

In (I), the N—H bond in the C—SO₂—NH—C segment orients itself away from the two *ortho*-methyl groups in the aniline benzene ring and orients itself towards the *ortho*-chloro group in the sulfonyl benzene ring. The molecule is bent at the S atom with C—SO₂—NH—C torsion angle of -100.48 (18)°, compared to the value of -71.38 (39)° observed in 2,4-dichloro-*N*-(2,4-dimethylphenyl)benzenesulfonamide (II) (Rodrigues *et al.*, 2011).

The sulfonyl and the aniline benzene rings are tilted relative to each other by 69.6 (1)°, compared to the value of 44.6 (1)° in (II).

The other bond parameters in (I) are similar to those observed in (II) and other aryl sulfonamides (Perlovich *et al.*, 2006; Gelbrich *et al.*, 2007).

The N—H···O intermolecular hydrogen bonds (Table 1) link the molecules into chains. Part of the crystal structure is shown in Fig. 2.

S2. Experimental

The solution of 1,3-dichlorobenzene (10 ml) in chloroform (40 ml) was treated dropwise with chlorosulfonic acid (25 ml) at 0 °C. After the initial evolution of hydrogen chloride subsided, the reaction mixture was brought to room temperature and poured into crushed ice in a beaker. The chloroform layer was separated, washed with cold water and allowed to evaporate slowly. The residual 2,4-dichlorobenzenesulfonylchloride was treated with 2,6-dimethylaniline in the stoichiometric ratio and boiled for ten minutes. The reaction mixture was then cooled to room temperature and added to ice cold water (100 ml). The resultant solid 2,4-dichloro-*N*-(2,6-dimethylphenyl)-benzenesulfonamide was filtered under suction and washed thoroughly with cold water. It was then recrystallized to constant melting point from dilute ethanol. The purity of the compound was checked and characterized by recording its infrared and NMR spectra (Savitha & Gowda, 2006).

Prism like light pink single crystals used in X-ray diffraction studies were grown in ethanolic solution by slow evaporation at room temperature.

S3. Refinement

The H atoms of the NH groups were located in a difference map and later restrained to N—H = 0.86 (2) Å. The other H atoms were positioned with idealized geometry using a riding model with the aromatic C—H = 0.93 Å and methyl C—H

= 0.96 Å. All H atoms were refined with isotropic displacement parameters. The $U_{\text{iso}}(\text{H})$ values were set at $1.2U_{\text{eq}}(\text{C- aromatic, N})$ and $1.5U_{\text{eq}}(\text{C- methyl})$.

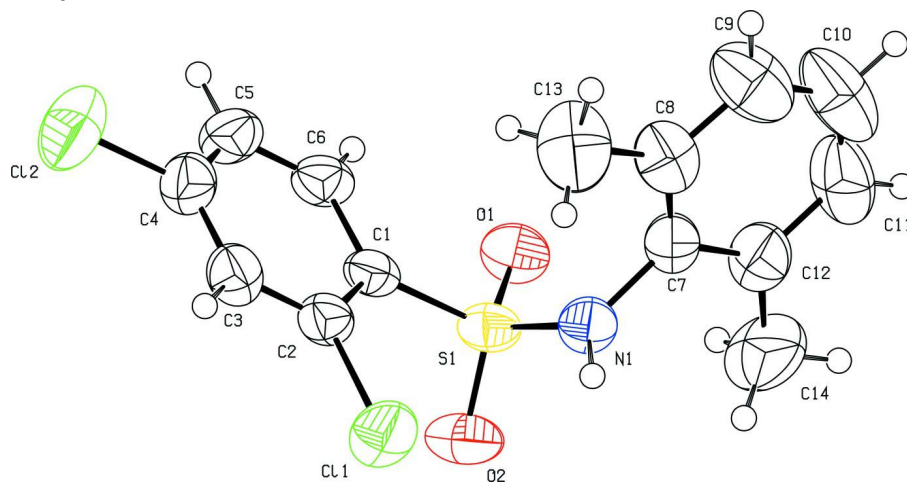


Figure 1

Molecular structure of the title compound, showing the atom labeling scheme and displacement ellipsoids are drawn at the 50% probability level.

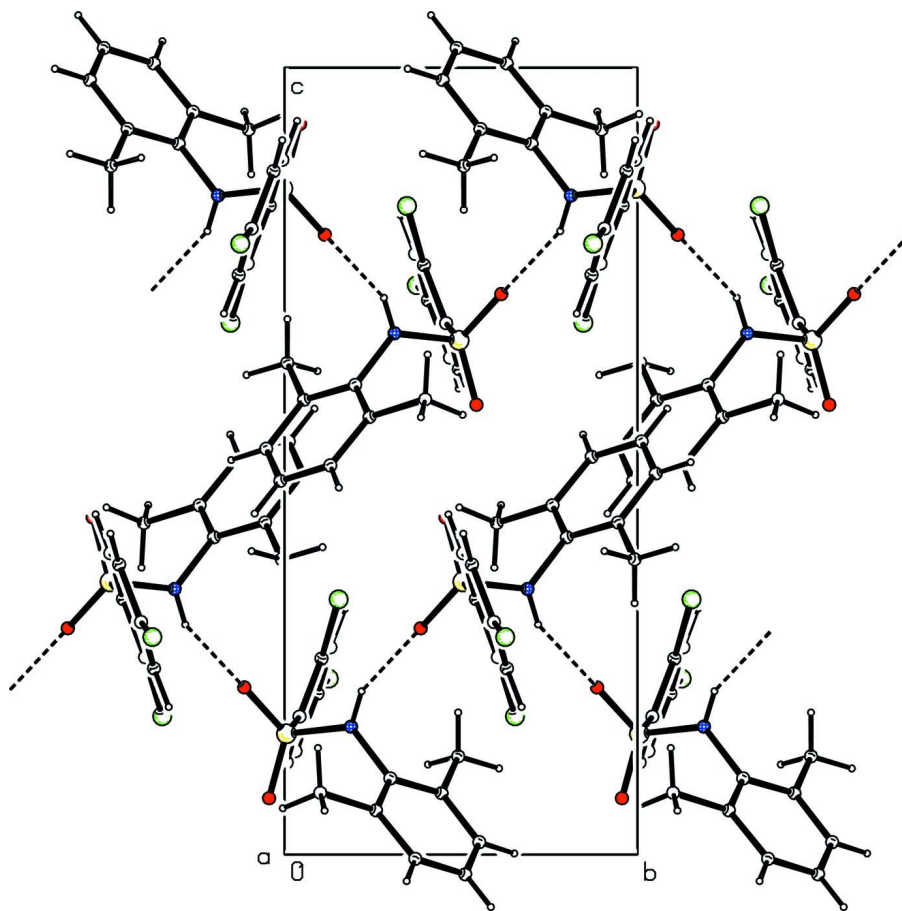


Figure 2

Molecular packing of (I) with hydrogen bonding shown as dashed lines.

2,4-Dichloro-*N*-(2,6-dimethylphenyl)benzenesulfonamide

Crystal data

$C_{14}H_{13}Cl_2NO_2S$
 $M_r = 330.21$
 Monoclinic, $P2_1/n$
 Hall symbol: -P 2yn
 $a = 12.021$ (1) Å
 $b = 7.5458$ (7) Å
 $c = 16.837$ (1) Å
 $\beta = 92.324$ (7)°
 $V = 1526.0$ (2) Å³
 $Z = 4$

$F(000) = 680$
 $D_x = 1.437$ Mg m⁻³
 Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
 Cell parameters from 2095 reflections
 $\theta = 2.9$ – 27.9 °
 $\mu = 0.56$ mm⁻¹
 $T = 293$ K
 Prism, light pink
 $0.40 \times 0.36 \times 0.24$ mm

Data collection

Oxford Diffraction Xcalibur
 diffractometer with a Sapphire CCD detector
 Radiation source: fine-focus sealed tube
 Graphite monochromator
 Rotation method data acquisition using ω scans
 Absorption correction: multi-scan
 (*CrysAlis RED*; Oxford Diffraction, 2009)
 $T_{\min} = 0.807$, $T_{\max} = 0.877$

6113 measured reflections
 3107 independent reflections
 2188 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.016$
 $\theta_{\max} = 26.4$ °, $\theta_{\min} = 3.0$ °
 $h = -15 \rightarrow 12$
 $k = -4 \rightarrow 9$
 $l = -15 \rightarrow 21$

Refinement

Refinement on F^2
 Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.038$
 $wR(F^2) = 0.107$
 $S = 1.03$
 3107 reflections
 186 parameters
 1 restraint
 Primary atom site location: structure-invariant
 direct methods

Secondary atom site location: difference Fourier
 map
 Hydrogen site location: inferred from
 neighbouring sites
 H atoms treated by a mixture of independent
 and constrained refinement
 $w = 1/[\sigma^2(F_o^2) + (0.058P)^2 + 0.1526P]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} < 0.001$
 $\Delta\rho_{\max} = 0.23$ e Å⁻³
 $\Delta\rho_{\min} = -0.30$ e Å⁻³

Special details

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

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
C1	-0.00339 (18)	0.0423 (3)	0.17532 (11)	0.0447 (5)

C2	-0.03633 (18)	0.1047 (3)	0.24905 (11)	0.0488 (5)
C3	-0.14639 (19)	0.1301 (3)	0.26339 (13)	0.0567 (6)
H3	-0.1675	0.1718	0.3125	0.068*
C4	-0.2252 (2)	0.0933 (3)	0.20448 (15)	0.0610 (6)
C5	-0.1960 (2)	0.0313 (3)	0.13147 (15)	0.0631 (6)
H5	-0.2505	0.0066	0.0922	0.076*
C6	-0.0852 (2)	0.0062 (3)	0.11709 (12)	0.0529 (5)
H6	-0.0649	-0.0355	0.0678	0.063*
C7	0.23032 (18)	0.2999 (3)	0.09672 (11)	0.0518 (5)
C8	0.1656 (2)	0.4451 (3)	0.07794 (15)	0.0658 (7)
C9	0.1977 (3)	0.5519 (4)	0.01570 (19)	0.0947 (10)
H9	0.1554	0.6509	0.0014	0.114*
C10	0.2916 (4)	0.5121 (5)	-0.02503 (19)	0.1055 (13)
H10	0.3120	0.5846	-0.0667	0.127*
C11	0.3539 (3)	0.3704 (5)	-0.00542 (17)	0.0915 (10)
H11	0.4170	0.3462	-0.0337	0.110*
C12	0.3262 (2)	0.2592 (4)	0.05622 (13)	0.0692 (7)
C13	0.0657 (3)	0.4921 (4)	0.1248 (2)	0.0961 (10)
H13A	0.0863	0.4924	0.1805	0.115*
H13B	0.0079	0.4063	0.1146	0.115*
H13C	0.0392	0.6075	0.1093	0.115*
C14	0.3972 (3)	0.1014 (6)	0.0786 (2)	0.1130 (13)
H14A	0.3617	-0.0047	0.0588	0.136*
H14B	0.4065	0.0947	0.1354	0.136*
H14C	0.4687	0.1135	0.0558	0.136*
N1	0.20289 (15)	0.1885 (3)	0.16252 (9)	0.0543 (5)
H1N	0.2250 (19)	0.219 (3)	0.2076 (10)	0.065*
O1	0.13715 (14)	-0.0438 (2)	0.07160 (8)	0.0590 (4)
O2	0.18112 (15)	-0.1142 (2)	0.21241 (9)	0.0718 (5)
Cl1	0.06147 (5)	0.15315 (10)	0.32422 (3)	0.0749 (2)
Cl2	-0.36486 (6)	0.12532 (12)	0.22362 (6)	0.0975 (3)
S1	0.13772 (5)	0.00526 (7)	0.15342 (3)	0.04943 (17)

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0554 (12)	0.0439 (11)	0.0343 (9)	-0.0036 (9)	-0.0050 (8)	0.0050 (8)
C2	0.0552 (13)	0.0541 (12)	0.0367 (10)	-0.0081 (10)	-0.0030 (9)	0.0006 (9)
C3	0.0597 (14)	0.0589 (14)	0.0518 (12)	-0.0064 (11)	0.0080 (11)	0.0003 (11)
C4	0.0523 (14)	0.0563 (14)	0.0741 (16)	-0.0061 (11)	-0.0007 (12)	0.0086 (12)
C5	0.0608 (15)	0.0642 (15)	0.0626 (14)	-0.0112 (12)	-0.0193 (12)	0.0043 (12)
C6	0.0662 (15)	0.0524 (12)	0.0390 (10)	-0.0064 (11)	-0.0102 (10)	-0.0001 (10)
C7	0.0554 (13)	0.0648 (14)	0.0352 (10)	-0.0136 (12)	0.0025 (9)	-0.0116 (10)
C8	0.0829 (18)	0.0504 (13)	0.0647 (15)	-0.0088 (13)	0.0105 (13)	-0.0117 (12)
C9	0.144 (3)	0.0562 (16)	0.084 (2)	-0.0063 (18)	0.012 (2)	0.0024 (15)
C10	0.169 (4)	0.084 (2)	0.0656 (18)	-0.034 (2)	0.040 (2)	-0.0043 (17)
C11	0.104 (2)	0.112 (3)	0.0610 (17)	-0.028 (2)	0.0366 (17)	-0.0190 (18)
C12	0.0623 (15)	0.0968 (19)	0.0492 (13)	-0.0059 (15)	0.0105 (11)	-0.0123 (13)

C13	0.094 (2)	0.0641 (17)	0.132 (3)	0.0111 (16)	0.031 (2)	-0.0061 (18)
C14	0.0634 (18)	0.177 (4)	0.100 (2)	0.035 (2)	0.0149 (17)	0.007 (2)
N1	0.0569 (11)	0.0752 (13)	0.0304 (8)	-0.0107 (10)	-0.0024 (7)	-0.0089 (8)
O1	0.0749 (11)	0.0631 (9)	0.0388 (8)	0.0026 (8)	0.0006 (7)	-0.0118 (7)
O2	0.0827 (12)	0.0793 (11)	0.0525 (9)	0.0227 (10)	-0.0090 (8)	0.0118 (8)
Cl1	0.0654 (4)	0.1225 (6)	0.0366 (3)	-0.0108 (4)	-0.0019 (2)	-0.0188 (3)
Cl2	0.0536 (4)	0.1048 (6)	0.1342 (7)	-0.0020 (4)	0.0035 (4)	-0.0047 (5)
S1	0.0586 (3)	0.0562 (3)	0.0330 (3)	0.0065 (3)	-0.0041 (2)	-0.0020 (2)

Geometric parameters (Å, °)

C1—C6	1.387 (3)	C9—C10	1.378 (5)
C1—C2	1.400 (3)	C9—H9	0.9300
C1—S1	1.773 (2)	C10—C11	1.339 (5)
C2—C3	1.368 (3)	C10—H10	0.9300
C2—Cl1	1.731 (2)	C11—C12	1.386 (4)
C3—C4	1.372 (3)	C11—H11	0.9300
C3—H3	0.9300	C12—C14	1.504 (4)
C4—C5	1.374 (3)	C13—H13A	0.9600
C4—Cl2	1.739 (2)	C13—H13B	0.9600
C5—C6	1.377 (3)	C13—H13C	0.9600
C5—H5	0.9300	C14—H14A	0.9600
C6—H6	0.9300	C14—H14B	0.9600
C7—C8	1.373 (3)	C14—H14C	0.9600
C7—C12	1.396 (3)	N1—S1	1.593 (2)
C7—N1	1.440 (3)	N1—H1N	0.825 (15)
C8—C9	1.389 (4)	O1—S1	1.4262 (14)
C8—C13	1.506 (4)	O2—S1	1.4247 (16)
C6—C1—C2	118.4 (2)	C9—C10—H10	119.6
C6—C1—S1	118.59 (16)	C10—C11—C12	121.3 (3)
C2—C1—S1	123.03 (16)	C10—C11—H11	119.4
C3—C2—C1	120.9 (2)	C12—C11—H11	119.4
C3—C2—Cl1	118.32 (16)	C11—C12—C7	117.4 (3)
C1—C2—Cl1	120.75 (17)	C11—C12—C14	121.0 (3)
C2—C3—C4	119.3 (2)	C7—C12—C14	121.5 (2)
C2—C3—H3	120.4	C8—C13—H13A	109.5
C4—C3—H3	120.4	C8—C13—H13B	109.5
C3—C4—C5	121.4 (2)	H13A—C13—H13B	109.5
C3—C4—Cl2	118.8 (2)	C8—C13—H13C	109.5
C5—C4—Cl2	119.78 (19)	H13A—C13—H13C	109.5
C4—C5—C6	119.2 (2)	H13B—C13—H13C	109.5
C4—C5—H5	120.4	C12—C14—H14A	109.5
C6—C5—H5	120.4	C12—C14—H14B	109.5
C5—C6—C1	120.8 (2)	H14A—C14—H14B	109.5
C5—C6—H6	119.6	C12—C14—H14C	109.5
C1—C6—H6	119.6	H14A—C14—H14C	109.5
C8—C7—C12	122.3 (2)	H14B—C14—H14C	109.5

C8—C7—N1	119.84 (19)	C7—N1—S1	124.04 (13)
C12—C7—N1	117.8 (2)	C7—N1—H1N	118.1 (17)
C7—C8—C9	117.7 (3)	S1—N1—H1N	117.8 (17)
C7—C8—C13	121.6 (2)	O2—S1—O1	119.76 (10)
C9—C8—C13	120.7 (3)	O2—S1—N1	108.50 (10)
C10—C9—C8	120.5 (3)	O1—S1—N1	107.53 (9)
C10—C9—H9	119.7	O2—S1—C1	106.34 (10)
C8—C9—H9	119.7	O1—S1—C1	105.95 (10)
C11—C10—C9	120.8 (3)	N1—S1—C1	108.30 (10)
C11—C10—H10	119.6		
C6—C1—C2—C3	-0.3 (3)	C8—C9—C10—C11	-0.2 (5)
S1—C1—C2—C3	-179.53 (17)	C9—C10—C11—C12	0.1 (5)
C6—C1—C2—C11	-179.77 (16)	C10—C11—C12—C7	0.4 (4)
S1—C1—C2—C11	1.0 (3)	C10—C11—C12—C14	-179.3 (3)
C1—C2—C3—C4	0.1 (3)	C8—C7—C12—C11	-0.8 (4)
C11—C2—C3—C4	179.67 (17)	N1—C7—C12—C11	-178.0 (2)
C2—C3—C4—C5	0.1 (4)	C8—C7—C12—C14	178.9 (3)
C2—C3—C4—C12	179.73 (17)	N1—C7—C12—C14	1.7 (3)
C3—C4—C5—C6	-0.2 (4)	C8—C7—N1—S1	99.6 (2)
C12—C4—C5—C6	-179.87 (17)	C12—C7—N1—S1	-83.2 (2)
C4—C5—C6—C1	0.1 (3)	C7—N1—S1—O2	144.48 (18)
C2—C1—C6—C5	0.1 (3)	C7—N1—S1—O1	13.6 (2)
S1—C1—C6—C5	179.42 (17)	C7—N1—S1—C1	-100.48 (18)
C12—C7—C8—C9	0.7 (4)	C6—C1—S1—O2	-123.30 (17)
N1—C7—C8—C9	177.8 (2)	C2—C1—S1—O2	56.0 (2)
C12—C7—C8—C13	-176.9 (3)	C6—C1—S1—O1	5.14 (19)
N1—C7—C8—C13	0.2 (4)	C2—C1—S1—O1	-175.59 (17)
C7—C8—C9—C10	-0.2 (5)	C6—C1—S1—N1	120.25 (17)
C13—C8—C9—C10	177.4 (3)	C2—C1—S1—N1	-60.47 (19)

Hydrogen-bond geometry (\AA , $^\circ$)

<i>D</i> —H \cdots <i>A</i>	<i>D</i> —H	H \cdots <i>A</i>	<i>D</i> \cdots <i>A</i>	<i>D</i> —H \cdots <i>A</i>
N1—H1N \cdots O2 ⁱ	0.83 (2)	2.14 (2)	2.891 (2)	152 (2)

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