

Acta Crystallographica Section E

Structure Reports

Online

ISSN 1600-5368

1-[2-(2-Bromophenyl)ethyl]-4-chloro-2-nitrobenzene

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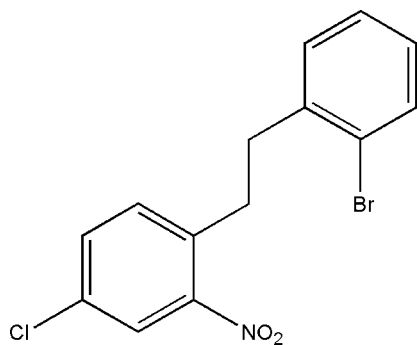
Received 18 November 2010; accepted 24 November 2010

Key indicators: single-crystal X-ray study; $T = 150$ K; mean $\sigma(\text{C}-\text{C}) = 0.006$ Å; R factor = 0.031; wR factor = 0.084; data-to-parameter ratio = 11.1.

In the title molecule, $\text{C}_{14}\text{H}_{11}\text{BrClNO}_2$, the dihedral angle between the mean planes of the bromo-substituted benzene and the chloro-substituted benzene rings is 1.8 (4)°. The nitro group is twisted by 15.8 (6)° from the mean plane of the benzene ring to which it is attached. The crystal packing is influenced by weak intermolecular $\text{C}-\text{H}\cdots\text{O}$ interactions and weak $\pi-\pi$ stacking interactions [centroid-centroid distances = 3.903 (2), 3.596 (2) and 3.903 (2) Å].

Related literature

For background and a related structure, see: Post & Horn (1977). For bond-length data, see: Allen *et al.* (1987).



Experimental

Crystal data

$\text{C}_{14}\text{H}_{11}\text{BrClNO}_2$
 $M_r = 340.60$
Orthorhombic, $Pna2_1$
 $a = 15.7756$ (4) Å
 $b = 7.3795$ (2) Å
 $c = 11.5236$ (3) Å
 $V = 1341.53$ (6) Å³
 $Z = 4$
Cu $K\alpha$ radiation
 $\mu = 5.99$ mm⁻¹
 $T = 150$ K
 $0.47 \times 0.35 \times 0.12$ mm

Data collection

Oxford Diffraction Xcalibur Ruby Gemini diffractometer
Absorption correction: multi-scan (*CrysAlis RED*; Oxford Diffraction, 2007)
 $T_{\min} = 0.655$, $T_{\max} = 1.000$
3043 measured reflections
1901 independent reflections
1839 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.021$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.031$
 $wR(F^2) = 0.084$
 $S = 1.08$
1901 reflections
172 parameters
1 restraint
H-atom parameters constrained
 $\Delta\rho_{\text{max}} = 0.51$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.36$ e Å⁻³
Absolute structure: Flack (1983),
472 Friedel pairs
Flack parameter: 0.04 (2)

Table 1

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{C3}-\text{H3A}\cdots\text{O2}^{\text{i}}$	0.95	2.62	3.479 (6)	150
$\text{C13}-\text{H13A}\cdots\text{O1}^{\text{ii}}$	0.95	2.60	3.421 (4)	145

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

Data collection: *CrysAlis PRO* (Oxford Diffraction, 2007); cell refinement: *CrysAlis PRO*; data reduction: *CrysAlis RED* (Oxford Diffraction, 2007); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); software used to prepare material for publication: *SHELXTL*.

MSS thanks R. L. Fine Chem. Bangalore, for the gift sample of the title compound and HSY thanks the University of Mysore for the sanction of sabbatical leave. RJB acknowledges the NSF MRI program (grant No. CHE-0619278) for funds to purchase an X-ray diffractometer.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: LH5167).

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supporting information

Acta Cryst. (2010). E66, o3358 [https://doi.org/10.1107/S1600536810049226]

1-[2-(2-Bromophenyl)ethyl]-4-chloro-2-nitrobenzene

Jerry P. Jasinski, Ray J. Butcher, M. S. Siddegowda, H. S. Yathirajan and A. R. Ramesha

S1. Comment

1-(4-Chloro-2-nitrophenethyl)-2-bromobenzene is an intermediate in the synthesis of 10,11-dihydro-5*H*-dibenzo[b,f]azepine derivatives. It has also been used successfully in the preparation of a number of biologically active compounds and drugs; *e.g.* the antidepressants imipramine, chloripramine are among the most commonly known. The crystal and molecular structure of the tricyclic antidepressant chlorimipramine hydrochloride is reported (Post & Horn, 1977). In view of the importance of the title compound as a pharmaceutical intermediate, this paper reports its crystal structure.

In the crystal structure of the title compound, $C_{14}H_{11}BrClNO_2$, the dihedral angle between the mean planes of 1-bromo benzene and 2-nitro, 4-chloro benzene rings is $1.8(4)^\circ$ (Fig. 1). The nitro group is twisted $15.8(6)^\circ$ from the mean plane of the 2-nitro, 4-chloro benzene ring. Bond angles and distances (Allen *et al.*, 1987) are in normal ranges. Crystal packing is influenced by weak C—H \cdots O intermolecular interactions (Table 2) and weak π – π stacking interactions (Fig. 2).

S2. Experimental

1-[2-(2-Bromo-phenylethyl)-4-chloro-2-nitrobenzene was obtained as a gift sample from RL Fine Chem, Bangalore. The compound was recrystallized from dichloromethane (m.p.: 361–363 K).

S3. Refinement

All of the H atoms were placed in their calculated positions and then refined using the riding model with Atom—H lengths of 0.95 \AA (CH) and 0.99 \AA (CH_2). Isotropic displacement parameters for these atoms were set to 1.18–1.21 (CH), or 1.18 (CH_2) times U_{eq} of the parent atom.

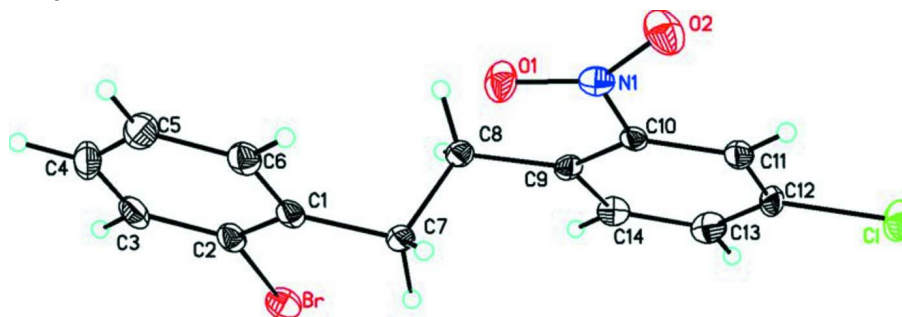


Figure 1

Molecular structure of the title compound showing the atom labeling scheme and 50% probability displacement ellipsoids.

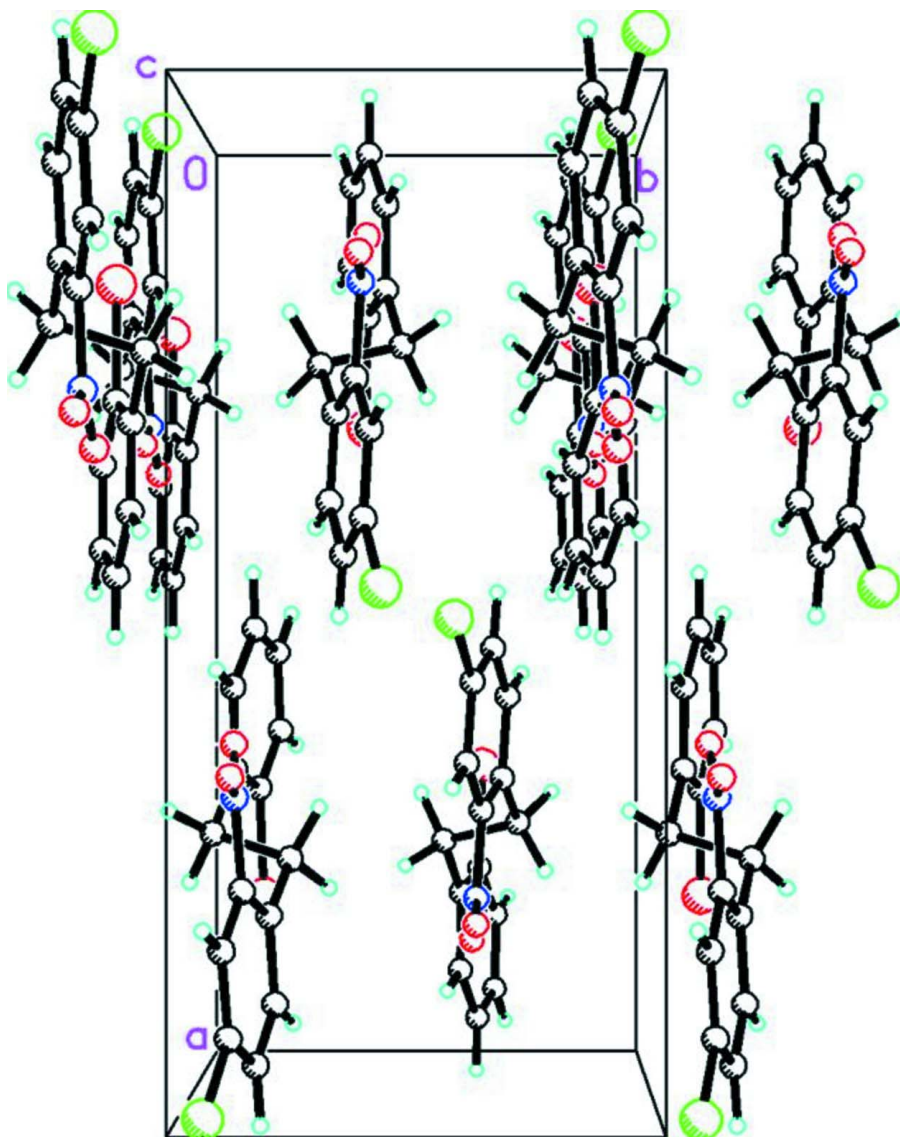


Figure 2

Packing diagram of the title compound viewed along the *c* axis.

1-[2-(2-Bromophenyl)ethyl]-4-chloro-2-nitrobenzene

Crystal data

$C_{14}H_{11}BrClNO_2$

$M_r = 340.60$

Orthorhombic, $Pna2_1$

Hall symbol: $P\ 2c\ -2n$

$a = 15.7756\ (4)\ \text{\AA}$

$b = 7.3795\ (2)\ \text{\AA}$

$c = 11.5236\ (3)\ \text{\AA}$

$V = 1341.53\ (6)\ \text{\AA}^3$

$Z = 4$

$F(000) = 680$

$D_x = 1.686\ \text{Mg m}^{-3}$

Cu $K\alpha$ radiation, $\lambda = 1.54184\ \text{\AA}$

Cell parameters from 2576 reflections

$\theta = 4.8\text{--}73.8^\circ$

$\mu = 5.99\ \text{mm}^{-1}$

$T = 150\ \text{K}$

Plate, pale yellow

$0.47 \times 0.35 \times 0.12\ \text{mm}$

Data collection

Oxford Diffraction Xcalibur Ruby Gemini diffractometer
 Radiation source: Enhance (Cu) X-ray Source
 Graphite monochromator
 Detector resolution: 10.5081 pixels mm⁻¹
 ω scans
 Absorption correction: multi-scan
 (*CrysAlis RED*; Oxford Diffraction, 2007)
 $T_{\min} = 0.655$, $T_{\max} = 1.000$

3043 measured reflections
 1901 independent reflections
 1839 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.021$
 $\theta_{\max} = 74.0^\circ$, $\theta_{\min} = 5.6^\circ$
 $h = -13 \rightarrow 19$
 $k = -8 \rightarrow 8$
 $l = -11 \rightarrow 13$

Refinement

Refinement on F^2
 Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.031$
 $wR(F^2) = 0.084$
 $S = 1.08$
 1901 reflections
 172 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-atom parameters constrained
 $w = 1/[\sigma^2(F_o^2) + (0.060P)^2 + 0.3149P]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} = 0.001$
 $\Delta\rho_{\max} = 0.51 \text{ e } \text{\AA}^{-3}$
 $\Delta\rho_{\min} = -0.36 \text{ e } \text{\AA}^{-3}$
 Absolute structure: Flack (1983), 472 Friedel pairs
 Absolute structure parameter: 0.04 (2)

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 (\AA^2)

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Br	0.18735 (2)	0.86647 (5)	-0.24466 (4)	0.03870 (15)
Cl	0.01563 (7)	0.92827 (15)	0.48765 (11)	0.0500 (3)
O1	0.36114 (15)	0.8900 (4)	0.2328 (3)	0.0367 (7)
O2	0.3344 (2)	0.8808 (4)	0.4162 (3)	0.0452 (7)
N1	0.31207 (17)	0.8805 (4)	0.3146 (4)	0.0272 (7)
C1	0.3270 (2)	0.9177 (5)	-0.0882 (4)	0.0258 (7)
C2	0.3041 (2)	0.8721 (5)	-0.2013 (4)	0.0283 (8)
C3	0.3634 (3)	0.8310 (5)	-0.2862 (4)	0.0366 (9)
H3A	0.3458	0.8004	-0.3626	0.044*
C4	0.4477 (3)	0.8353 (5)	-0.2583 (5)	0.0419 (11)
H4A	0.4890	0.8085	-0.3157	0.050*
C5	0.4730 (3)	0.8786 (5)	-0.1466 (4)	0.0379 (10)
H5A	0.5315	0.8804	-0.1275	0.046*
C6	0.4135 (2)	0.9190 (5)	-0.0635 (4)	0.0315 (8)

H6A	0.4317	0.9486	0.0127	0.038*
C7	0.2645 (2)	0.9579 (4)	0.0073 (3)	0.0270 (7)
H7A	0.2126	1.0118	-0.0264	0.032*
H7B	0.2894	1.0468	0.0618	0.032*
C8	0.2413 (2)	0.7822 (4)	0.0736 (3)	0.0244 (6)
H8A	0.2090	0.7010	0.0215	0.029*
H8B	0.2941	0.7186	0.0963	0.029*
C9	0.18952 (19)	0.8201 (5)	0.1804 (3)	0.0226 (7)
C10	0.2198 (2)	0.8680 (4)	0.2905 (3)	0.0203 (6)
C11	0.1674 (2)	0.9012 (5)	0.3857 (3)	0.0268 (7)
H11A	0.1905	0.9317	0.4593	0.032*
C12	0.0819 (3)	0.8884 (5)	0.3697 (4)	0.0309 (8)
C13	0.0477 (2)	0.8412 (4)	0.2638 (6)	0.0353 (8)
H13A	-0.0120	0.8321	0.2543	0.042*
C14	0.1010 (2)	0.8078 (5)	0.1726 (3)	0.0285 (7)
H14A	0.0767	0.7745	0.1002	0.034*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Br	0.0430 (2)	0.0377 (2)	0.0354 (2)	-0.00382 (15)	-0.0082 (2)	0.0031 (2)
Cl	0.0498 (6)	0.0514 (5)	0.0486 (6)	0.0055 (5)	0.0305 (5)	0.0064 (5)
O1	0.0212 (10)	0.0559 (15)	0.0331 (18)	0.0000 (10)	0.0030 (11)	-0.0015 (12)
O2	0.0398 (14)	0.066 (2)	0.0297 (16)	-0.0066 (13)	-0.0109 (14)	0.0040 (14)
N1	0.0258 (16)	0.0237 (15)	0.032 (2)	-0.0007 (11)	-0.0051 (13)	0.0018 (13)
C1	0.0401 (17)	0.0139 (14)	0.0234 (18)	-0.0017 (12)	0.0040 (14)	-0.0001 (13)
C2	0.0379 (19)	0.0214 (17)	0.0256 (18)	-0.0019 (13)	0.0027 (14)	0.0008 (12)
C3	0.062 (3)	0.0214 (15)	0.0261 (18)	-0.0024 (16)	0.0109 (17)	0.0031 (14)
C4	0.050 (2)	0.0329 (17)	0.042 (3)	0.0008 (15)	0.024 (2)	0.0017 (19)
C5	0.036 (2)	0.0307 (19)	0.047 (3)	-0.0015 (14)	0.0067 (18)	0.0013 (17)
C6	0.0378 (18)	0.0233 (15)	0.033 (2)	-0.0034 (14)	0.0025 (15)	0.0012 (15)
C7	0.0364 (16)	0.0208 (14)	0.0238 (17)	0.0064 (13)	0.0037 (14)	-0.0006 (12)
C8	0.0289 (16)	0.0196 (14)	0.0247 (15)	0.0023 (12)	0.0003 (12)	-0.0021 (12)
C9	0.0267 (18)	0.0149 (14)	0.0262 (19)	0.0006 (11)	0.0007 (13)	-0.0024 (14)
C10	0.0262 (16)	0.0136 (14)	0.0210 (17)	-0.0002 (11)	0.0004 (12)	0.0021 (9)
C11	0.0349 (18)	0.0198 (15)	0.0257 (19)	0.0010 (13)	0.0029 (15)	0.0018 (14)
C12	0.0359 (19)	0.0255 (17)	0.0312 (19)	0.0023 (13)	0.0181 (16)	0.0054 (14)
C13	0.0232 (14)	0.0319 (17)	0.051 (2)	-0.0028 (12)	0.003 (2)	0.005 (2)
C14	0.0261 (16)	0.0273 (16)	0.0322 (19)	-0.0031 (13)	-0.0055 (14)	-0.0010 (15)

Geometric parameters (Å, °)

Br—C2	1.909 (4)	C7—C8	1.549 (4)
Cl—C12	1.739 (4)	C7—H7A	0.9900
O1—N1	1.222 (5)	C7—H7B	0.9900
O2—N1	1.222 (6)	C8—C9	1.503 (5)
N1—C10	1.485 (4)	C8—H8A	0.9900
C1—C2	1.393 (6)	C8—H8B	0.9900

C1—C6	1.393 (5)	C9—C10	1.401 (5)
C1—C7	1.507 (5)	C9—C14	1.403 (4)
C2—C3	1.388 (6)	C10—C11	1.395 (5)
C3—C4	1.368 (6)	C11—C12	1.365 (6)
C3—H3A	0.9500	C11—H11A	0.9500
C4—C5	1.385 (8)	C12—C13	1.379 (8)
C4—H4A	0.9500	C13—C14	1.368 (6)
C5—C6	1.374 (6)	C13—H13A	0.9500
C5—H5A	0.9500	C14—H14A	0.9500
C6—H6A	0.9500		
O1—N1—O2	123.8 (3)	H7A—C7—H7B	108.1
O1—N1—C10	118.7 (3)	C9—C8—C7	112.1 (3)
O2—N1—C10	117.5 (3)	C9—C8—H8A	109.2
C2—C1—C6	116.6 (4)	C7—C8—H8A	109.2
C2—C1—C7	124.1 (3)	C9—C8—H8B	109.2
C6—C1—C7	119.3 (3)	C7—C8—H8B	109.2
C3—C2—C1	122.5 (4)	H8A—C8—H8B	107.9
C3—C2—Br	117.5 (4)	C10—C9—C14	114.4 (3)
C1—C2—Br	120.0 (3)	C10—C9—C8	127.1 (3)
C4—C3—C2	119.0 (4)	C14—C9—C8	118.5 (3)
C4—C3—H3A	120.5	C11—C10—C9	123.7 (3)
C2—C3—H3A	120.5	C11—C10—N1	115.0 (3)
C3—C4—C5	120.3 (4)	C9—C10—N1	121.3 (3)
C3—C4—H4A	119.9	C12—C11—C10	117.9 (4)
C5—C4—H4A	119.9	C12—C11—H11A	121.1
C6—C5—C4	120.1 (4)	C10—C11—H11A	121.1
C6—C5—H5A	120.0	C11—C12—C13	121.5 (4)
C4—C5—H5A	120.0	C11—C12—Cl	118.5 (4)
C5—C6—C1	121.6 (4)	C13—C12—Cl	120.0 (3)
C5—C6—H6A	119.2	C14—C13—C12	119.0 (3)
C1—C6—H6A	119.2	C14—C13—H13A	120.5
C1—C7—C8	110.5 (3)	C12—C13—H13A	120.5
C1—C7—H7A	109.6	C13—C14—C9	123.5 (4)
C8—C7—H7A	109.6	C13—C14—H14A	118.3
C1—C7—H7B	109.6	C9—C14—H14A	118.3
C8—C7—H7B	109.6		
C6—C1—C2—C3	-0.4 (5)	C8—C9—C10—C11	180.0 (3)
C7—C1—C2—C3	-178.2 (3)	C14—C9—C10—N1	177.8 (3)
C6—C1—C2—Br	-179.9 (2)	C8—C9—C10—N1	-2.2 (5)
C7—C1—C2—Br	2.4 (5)	O1—N1—C10—C11	-165.3 (3)
C1—C2—C3—C4	0.0 (6)	O2—N1—C10—C11	14.7 (5)
Br—C2—C3—C4	179.4 (3)	O1—N1—C10—C9	16.7 (5)
C2—C3—C4—C5	0.5 (6)	O2—N1—C10—C9	-163.3 (3)
C3—C4—C5—C6	-0.6 (6)	C9—C10—C11—C12	-0.9 (5)
C4—C5—C6—C1	0.1 (6)	N1—C10—C11—C12	-178.8 (3)
C2—C1—C6—C5	0.4 (5)	C10—C11—C12—C13	1.1 (6)

C7—C1—C6—C5	178.3 (3)	C10—C11—C12—C1	179.7 (3)
C2—C1—C7—C8	90.2 (4)	C11—C12—C13—C14	-0.4 (6)
C6—C1—C7—C8	-87.5 (4)	C1—C12—C13—C14	-179.0 (3)
C1—C7—C8—C9	171.4 (3)	C12—C13—C14—C9	-0.5 (6)
C7—C8—C9—C10	-84.5 (4)	C10—C9—C14—C13	0.7 (5)
C7—C8—C9—C14	95.5 (4)	C8—C9—C14—C13	-179.3 (3)
C14—C9—C10—C11	0.0 (5)		

Hydrogen-bond geometry (Å, °)

<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>
C3—H3 <i>A</i> \cdots O2 ⁱ	0.95	2.62	3.479 (6)	150
C13—H13 <i>A</i> \cdots O1 ⁱⁱ	0.95	2.60	3.421 (4)	145

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