The notations of functors of $\mathcal{D}$-modules used in literature are pretty random. Below is a dictionary translating the various notations. The checked ones are the ones I use.

Dictionary

[HTT08]	[BGK+87]	[BD04]	Bernstein
$\int_f$	f_+ ✓	f_+	f_*
$\int_{f!}$	$f_!$ ✓	N/A	$f_!$
Lf^*	Lf°	f^* ✓	Lf^Δ
$f^\dagger$	$f^!$ ✓	N/A	$f^!$
$f^\star$	f^+ ✓	N/A	f^*

Warning. Note that, for a morphism $f : Y \to X$, the functor f^* defined and used in [BD04, 1.1, first page] equals $f^![\dim X - \dim Y]$ as defined below.

Let $f : Y \to X$ be a morphism of nonsingular algebraic varieties.

(1) There is the ordinary direct image functor f_+. For a complex $M \in D^b_h(\mathcal{D}_Y)$ we have $f_+M = \mathcal{D}_{X\leftarrow Y} \otimes^L M$. See [BGK+87, p241].
(2) There is the ordinary pull-back functor f^+. This is however defined by $f^!$ below via duality.
(3) There is the extraordinary direct image functor $f_!$. This is defined by f_+ above via duality.
(4) There is the extraordinary pull-back functor $f^!$. For $M \in D^b_h(\mathcal{D}_X)$, $f^!M = \mathcal{D}_{Y\to X} \otimes^L_{f^{-1}\mathcal{D}_X} f^{-1}M[\dim Y - \dim X]$. See [BGK+87, p234].
(5) $\boxed{f_! \dashv f^!}$ and $\boxed{f^+ \dashv f_+}$.
(6) If f is **proper**, then $\boxed{f_! = f_+}$. See [BGK+87, VII.9.12].
(7) If f is **smooth**, then $H^i f^! M = 0$ for all $i \neq \dim Y - \dim X$. See [BGK+87, p249, Proposition 4.8]
(8) If f is **smooth**, then

$$\boxed{f^![-2\dim Y + 2\dim X] = f^+}.$$

See [BGK+87, VII.9.14]
(9) If f is a **closed embedding** then f_+ and $f^!$ define an equivalence between the category of $\mathcal{D}_Y$-modules and $\mathcal{D}_X$-modules supported on Y. Moreover $\boxed{R\Gamma_{[Y]} = f_+f^!}$. See [BGK+87, p264, Proposition 7.13].
(10) **Base change formula.** Given a fiber diagram

$$\begin{array}{ccc} Y' & \xrightarrow{g'} & Y \\ {\scriptstyle f'}\downarrow & & \downarrow{\scriptstyle f} \\ X' & \xrightarrow{g} & X \end{array}$$

where all varieties in the diagram are nonsingular. Then for any $M \in D^b_h(\mathcal{D}_Y)$ we have

$$\boxed{g^! f_+ M = f'_+ g'^! M},$$

or

$$\boxed{f'_+ h'^* [\dim X' - \dim X] = g^* f_+ [\dim Y' - \dim Y]}.$$

This is proved in [BGK+87, VI.8.4] assuming that g is a *locally closed embedding.* A full proof is given in [HTT, Theorem 1.7.3] and [BD04, §A1].
(11) **Projection formula.** Given $M \in D^b_h(\mathcal{D}_X)$, and $N \in D^b_h(\mathcal{D}_Y)$, we then have

$$\boxed{f_+(N \otimes f^! M) = f_+ N \otimes M[\dim Y - \dim X]}$$

or

$$\boxed{f_+(N \otimes f^* M) = f_+ N \otimes M}.$$

See [BGK+87, VII.9.9], [HTT08, Corollary 1.7.5] or [BD04, (1.4)].
(12) Let $\mathcal{M}$ and $\mathcal{N}$ be two complexes of $\mathcal{D}$-modules. Define $\mathcal{M} \otimes^\sim \mathcal{N} = \mathcal{M} \otimes^L \mathcal{N}[-2\dim X]$.

(13) **Fourier transform.** Let E be a vector bundle on X with dual bundle $E^\vee$. Then for any complex $\mathcal{M}$ of $\mathcal{D}_E$-modules define $\mathrm{FT}_E(\mathcal{M}) = p_{E^\vee +}(p_E^* \mathcal{M} \otimes \mathrm{can}^* \exp)$, where
   (a) $\mathrm{can} : E \times_X E^\vee \to \mathbb{A}^1_X$ is the natural pairing between E and its dual,
   (b) exp is the integrable connection on $\mathbb{A}^1_X$ defined by $\nabla(e) = e$, e a basis so thus solution of exp is $\exp(-t)$, t being the coordinate on $\mathbb{A}^1$, and horizontal sections of exp are $C\exp(t)e$.

   Fourier transform takes $\mathcal{D}$-modules to $\mathcal{D}$-modules.

References

[BGK+87] — Borel, A., Grivel, P., Kaup, B., Haefliger, A., Malgrange, B., & Ehlers, F. (1987). Algebraic D-modules. Academic Press, Inc., Boston, MA.

[BD04] — Baldassarri, F., & D'Agnolo, A. (2004). On Dwork cohomology and algebraic D-modules. In Geometric aspects of Dwork theory. (pp. 245–253). Walter de Gruyter, Berlin.

[HTT08] — Hotta, R., Takeuchi, K., & Tanisaki, T. (2008). D-modules, perverse sheaves, and representation theory. Birkhäuser Boston, Inc., Boston, MA.