Hypertherm®

Rapid Part™ technology technical overview

White paper

Introduction

Hypertherm's Built for Business Integrated Cutting Solutions for plasma provide numerous benefits to the user, including:

- Dramatic improvement in hole quality achieved without operator intervention using True Hole® technology
- Up to a 100% increase in productivity achieved without operator intervention using Rapid Part technology
- Optimal consumable life achieved without operator intervention
- Built-in Hypertherm process expertise that makes it easy to:
  - Train new operators to cut like a pro within minutes
  - Maintain more consistent performance – operator-to-operator, shift-to-shift and site-to-site – without operator intervention
- Remote Help™ makes it easy for OEMs to access the cutting system within seconds via the Internet to provide process support and/or troubleshoot

This document provides details on Rapid Part technology including what it is, what it does, and how it works.

Rapid Part technology overview

Watching a traditional plasma system cut reveals that a considerable percentage of the total cycle time is non-cutting time (time spent moving from one cut to the next cut – also known as cut-to-cut cycle time). Hypertherm has responded to industry demand for continuous process improvement with Rapid Part technology; a productivity system that delivers up to a 100% increase in productivity through cut-to-cut cycle time reductions achieved without operator intervention. Rapid Part technology means less cut-to-cut cycle time, maximizing the time the torch is cutting metal and minimizing operating cost.

A suite of Hypertherm products contribute to the delivery of Rapid Part technology, including:

- ProNest® nesting software
- EDGE® Pro or MicroEDGE Pro CNC
- ArcGlide® or Sensor™ THC
- HPRXD® plasma system

Unique aspects of the Rapid Part system include the following:

- Products produced and supported by Hypertherm, leveraging 40 years of experience in the plasma cutting industry
- Products designed and implemented to work together as a system, without operator intervention, leveraging several technology elements
- A system that not only delivers Rapid Part technology as a function of the job but also can incorporate True Hole and automatic arc voltage sampling in the same nest, where applicable
- Intelligent and automated calculation of optimum torch retract height
- Rapid Z-axis THC motion

Built for Business™
INTEGRATED CUTTING SOLUTIONS

Product	Deliverable	Benefit	Other system components required to execute	Contribution to cut-to-cut reduction (est. %)*
ProNest software	Apply optimized lead locations.	Minimizes the chance of torch collisions and the distance between the end of one cut and the pierce on the next part. Cycle time savings depend on part geometry and nest configuration.	None	15%
	Apply optimized avoidance paths, including partial or full torch raises.	Minimizes the chance of torch collisions and unnecessary torch Z-axis motion. Cycle time savings depend on part geometry and nest configuration.	None	
	Intelligent retract to the next pierce height, based on material and part properties.	Provides a cycle time savings of approximately one second per pierce.	ArcGlide or Sensor THC	
EDGE Pro or MicroEDGE Pro CNC	Decides when to skip IHS (Initial Height Sensing).	Minimizes unnecessary torch Z-axis motion. Cycle time savings depend on part geometry and nest configuration.	ArcGlide or Sensor THC	20%
	Sets the correct THC height settings.	Intelligently follows torch height instructions in the part program generated by ProNest. If no torch height commands are supplied, the CNC uses onboard factory cut charts to establish the torch height. Cycle time savings depend on part geometry and nest configuration.	None	
	Allows pre-flow during traverse to the next pierce.	Eliminates machine idle time while it waits for gas pre-flow, saving about 1.3 seconds per pierce.	HPRXD	
ArcGlide or Sensor THC	Rapid vertical (Z-axis) motion	Torch moves much closer to the plate at high speed providing cycle time savings.	None	60%
	Automatic measurement of the plate location and rapid-to-slow speed crossover calibration.	Automatic transition to slow speed and optimum pierce height, reducing IHS time by up to 3 seconds.	None	
HPRXD plasma system	Designed to fire the torch quickly using Rapid Ignition™ technology	Eliminates long purge cycles.	EDGE Pro or MicroEDGE Pro CNC	5%

*Contribution of a specific product to overall cut-to-cut cycle time reduction will vary by job

Table 1.1

Cut-to-cut cycle time overview

For a typical plasma cutting machine, cut-to-cut cycle time is the sum of all necessary movements between cuts and may be segmented into four primary components:

- Torch retract
- Table motion
- Initial height sensing (IHS)*
- Gas pre-flow*

*Some THCs combine these two steps.

Rapid Part technology reduces cut-to-cut cycle time by up to 80%. The table below (Table 1.2) provides an overview of how Rapid Part technology contributes to each element of cut-to-cut cycle time.

Fig.1

203 mm (8") flange

1. Torch retract	2. Table motion	3. Initial height sensing	4. Gas pre-flow
Rapid vertical (Z-axis) motion using the ArcGlide or Sensor THC intelligently retracts the torch to the next pierce height, based on material and part properties.	Optimized motion instructions programmed using ProNest with its optional Collision Avoidance module, which minimizes the chances of torch collision and the distance between the end of one cut and the pierce on the next part.	Rapid Z-axis motion using the ArcGlide or Sensor THC. Automatic fast-to-slow speed crossover calibration. IHS skipped intelligently, based on part geometry and nest configuration.	Completed simultaneously during initial height sensing and during machine motion if IHS is skipped.

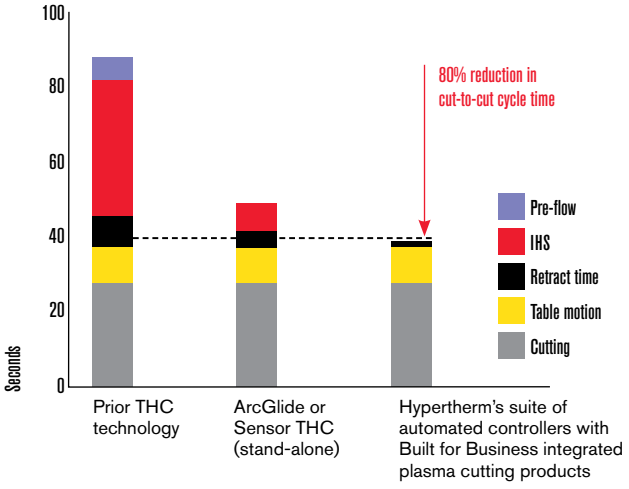
Table 1.2

With a typical plasma setup, when a cut is completed, the torch retracts from the plate by several inches. After moving to the next pierce location, the torch then performs an initial height sense and goes on to pre-flow the gases for piercing. When timed, this commonly adds up to 6-7 seconds for each cut-to-cut cycle, which can quickly accumulate to a significant amount of time in a day.

The chart (Fig. 2) shows a break-down of the processing time for a 203 mm (8 in.) flange part (Fig. 1). Note that with typical plasma setups using prior THC technology (such as Command THC), there is a substantial amount of time spent on pre-flow, IHS, and torch retract.

Fig. 2

Part processing time – 203 mm (8") flange



With Rapid Part and the ArcGlide or Sensor THC, cut-to-cut cycle time is significantly reduced. On all jobs, cut-to-cut cycle time is improved with Rapid Part, with the most significant productivity gains achieved on nests using thin plate with a high quantity of parts and/or pierces. The more pierces there are on a given plate, the greater the time savings will be.

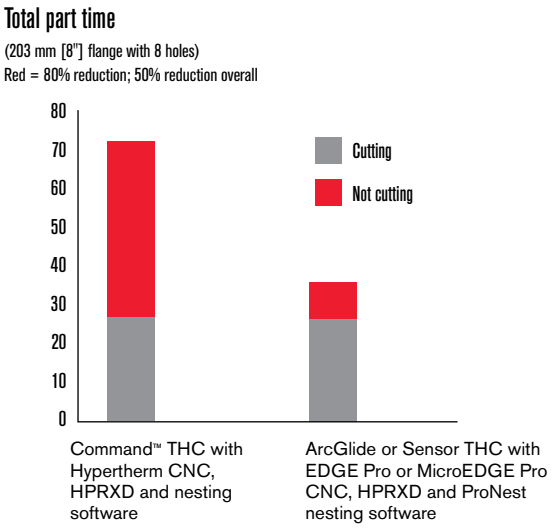


Fig. 3

As the charts (Fig. 3, Fig. 4) illustrate, when cutting the 203 mm (8 in.) flange with Rapid Part, cycle time is reduced by 80% and total production time is reduced by 50%. Note that the estimated number of parts that can be cut per day is significantly increased.

(It is also important to note that different cutting machines inherently exhibit differences in the time taken to complete some of the above-mentioned elements, based on different drive motion capabilities, etc.)

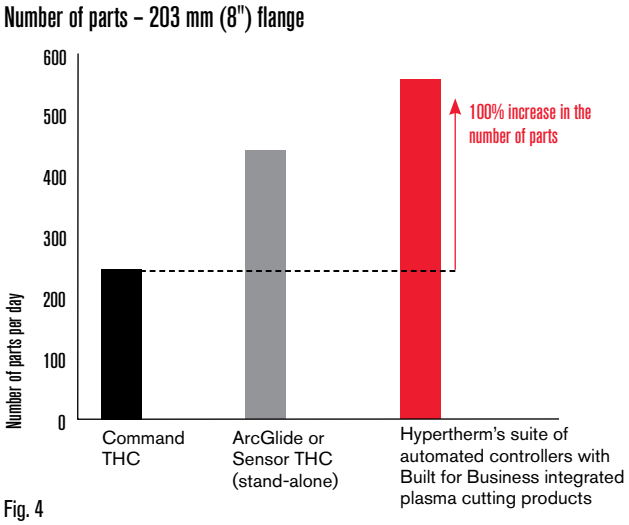


Fig. 4

System technical overview

The following provides details of how each system component operates to deliver its Rapid Part contribution:

ProNest nesting software

Use of ProNest nesting software, with its optional Collision Avoidance module, for programming the job contributes to optimized table motion and torch retract instructions, delivered automatically, without operator intervention:

Optimized table motion instructions

- Part sequencing
  - Optimizes the interior profile (holes and slots) cut sequence and nest cut sequence so that the occurrence of a potential torch crash is minimized.
- Lead placements
  - Repositions the interior leads on parts so that the distance between the end of one cut and the pierce on the next part is optimized (actual benefit depends on the part size and number of the internal features).
  - Repositions the exterior leads on parts to reduce the need for full torch retracts, plus the distance between the end of one cut and the pierce on the next part is minimized. (Additional productivity gains may result from minimized torch collisions that can lead to torch damage and production downtime.)
  - A combination of re-routing traverse motions and full or partial raises of the cutting head to avoid areas on the nest where potential torch damage and production downtime can occur due to tip-ups or plate warping.

Example:

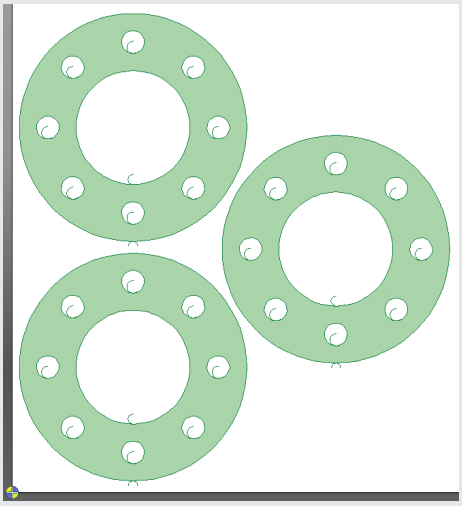


Fig. 5

With Collision Avoidance disabled, when parts are added to the nest (shown in Fig. 5 above):

- Lead locations are set to the standard 6 o'clock position. This means the torch head may cross directly over previously cut holes in its path. This method would require a full head raise to avoid collisions from tip ups.
- External lead locations are not positioned for the shortest traverse time.
- Internal cut sequence is always set to a standard sequence (the same for all parts). This approach may not be optimal. For example, the sequence for a given part may not finish in a location that is close to the next part.

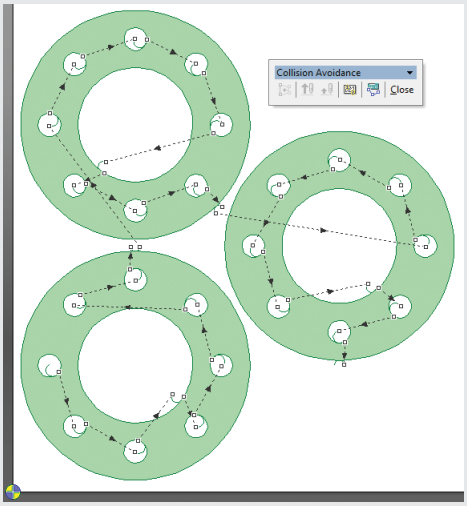


Fig. 6

With Collision Avoidance enabled (shown in Fig. 6 above):

- Lead locations are now positioned to always be moving away from the previously cut holes. The head is no longer in danger of collisions from tip-ups. This allows for a safe head down motion throughout the cut.
- External leads are now positioned closer to the next part in order to minimize traverse time.
- Internal cut sequence is optimized for the start and end points that best support collision avoidance and minimal traverse time, relative to the exterior lead location.

IHS skipped intelligently

- ProNest's built-in Hypertherm process expertise contributes to intelligent torch retract to the next pierce height, based on material and part properties.
  - ProNest includes factory tested torch height parameters in the NC file. Torch retract time is minimized by only partially retracting to the next pierce (transfer) height instead of performing a full retract. This saves approximately one second per pierce, when implemented.

mm	4	Hypertherm Cut with confidence	Hypertherm Patented True Hole® Technology										
Part Attributes			Part Program Support (PPS)										
			V600 (Height Control Setup)										
Material	Thickness	Class	Transfer Height Factor	Edge Transfer Height Factor	Pierce Height Factor	Edge Pierce Height Factor	Pierce Delay Time	Edge Pierce Time	Cut Height	Cut Height Delay	Edge Cut Height Delay	Kerf Redetect	Arc Voltage
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120
MS	4.00	80Amp O2/Air	200		200		0.20	0.10	2.00				120

Fig. 7

Parameters that contribute to torch retract decisions are based on Collision Avoidance settings established within ProNest's machine configuration. During machine operation, if ProNest determines retract to the next pierce height is safe to apply, then parameters inserted by ProNest into the NC file are referenced by the CNC to acquire the appropriate pierce height value, based on material type and thickness. The image above (Fig. 7) is an excerpt of a process parameter table. Notice the V600 height control setup columns containing transfer height, pierce height, cut height, and arc-voltage parameters.

ArcGlide or Sensor THC

The ArcGlide or Sensor THC work seamlessly with ProNest, the EDGE Pro or MicroEDGE Pro CNC , and HPRXD plasma system to perform the following:

- Executes the optimized motion routines defined by ProNest and processed by the EDGE Pro CNC to deliver:
  - Rapid Z-axis motion
  - Automatic rapid-to-slow speed crossover calibration
  - IHS skipped intelligently, based on part geometry and nest configuration

The items below describe how the THC's automated functionality operates.

Rapid Z-axis motion

- During torch retract, motion (stroke) speed of the ArcGlide THC reaches 15.240 mm/min (600 ipm) and the Sensor THC reaches 25.400 mm/min (1000 ipm). This rapid motion speed results in a retract time reduction of more than 0.5 second per full retract.

Automatic rapid-to-slow speed crossover calibration

- Typically, a torch height control moves down very rapidly towards the plate until it reaches a certain distance, when its speed slows dramatically. Many torch height controls use a fixed distance to the cutting table, not the actual plate location to establish the distance from the plate where the speed slows. This distance is set by the cutting machine installer. While operators have control over this setting, few actually optimize it for each plate thickness, as forgetting to change it for thick plates can damage the torch. As a result, for thick plates, the torch may slow down 12.5 mm (.5 in.) above the plate but when a thin plate is loaded on the table, this distance at which the torch speed slows may be up to 63 mm (2.5 in.) above the plate, drastically increasing the cut-to-cut cycle time.

  The ArcGlide or Sensor THC automatically calibrates this rapid-to-slow speed crossover during the initial height sense (IHS) on the plate by sensing the plate's actual location, making sure that it does not slow down until 12.5 mm (0.5 in.) above the plate, no matter the plate thickness. This can save as much as 1 second during IHS.

  As a safety measure, the ArcGlide and Sensor THC's automatic crossover height calibration resets if the THC has not been cutting for thirty seconds or more, or if the torch has been manually jogged in the raise or lower position. Essentially, if the system determines there might be a risk of collision, the ArcGlide or Sensor THC will approach the plate slowly on the first pierce.

IHS skipped intelligently

During IHS, the THC moves slowly when it finds the plate for the first pierce. Each subsequent IHS is much quicker using this initial calibration, allowing for minimized cut-to-cut cycle time without the risk of torch collision. The THC will perform an IHS on the first few pierces while it obtains the initial samples for the arc voltage setting of the THC. IHS is very rapid, but skipping IHS altogether is even faster. Gas pre-flow for the torch is accomplished during the torch rapid movement and the torch retracts only when it believes there may be a risk of collision, otherwise it retracts just to the pierce height of the next pierce. This capability is enabled using ProNest's Collision Avoidance feature, discussed above. After the first part is cut, in order to make sure the torch clears the part, it retracts fully, but still skips IHS for the next part.

EDGE Pro or MicroEDGE Pro CNC

The EDGE Pro or MicroEDGE Pro CNC receive and process the NC file for the job created by ProNest. The CNC also communicates with the ArcGlide and Sensor THC and HPRXD plasma system to help ensure successful job completion. Specifically, the EDGE Pro or MicroEDGE Pro CNC offer the following contributions to Rapid Part technology:

- Execute the optimized motion routines defined by ProNest nesting and process optimization software.
- Using Hypertherm's proprietary Hypernet® technology, the CNC automatically communicates the optimal torch height control settings to the THC without need for operator input.
- Instruct the ArcGlide or Sensor THC to retract to the next pierce height, when called for by the part program.
- Instruct the HPRXD plasma system to pre-flow gases during table motion, ensuring the plasma system is ready to fire immediately after moving into position.

HyPerformance HPRXD plasma system

The HPRXD allows the plasma system to support faster gas pre-flow cycles, an element of reduced cut-to-cut cycle time discussed in the THC section.

- Designed to fire quickly contributing to reduced purge cycles.

ProNest	EDGE Pro / MicroEDGE	ArcGlide/Sensor THC	HyPerformance Plasma HPRXD	
●				Intelligent lead location
●				Intelligent motion path
●		●		Intelligent retract height
	●	●	●	Skip IHS
	●		●	Pre-flow during traverse
		●		Rapid Z-axis motion
		●		Intelligent plate location measurement and rapid-to-slow speed crossover calibration
	●		●	Designed to fire the torch quickly
15%	20%	60%	5%	Estimated contribution to Rapid Part technology

Table 1.3

System component variations

Use of Hypertherm's ProNest nesting software, EDGE Pro or MicroEDGE Pro CNC, ArcGlide or Sensor THC, and HPRXD plasma system, working together, provide the full benefits of cut-to-cut cycle time reduction. However, as detailed in Table 1.1, a significant percentage of overall cycle time benefit may be achieved without use of all system components used to deliver Rapid Part technology.

For certain users, employing a partial system to achieve a majority percentage of cycle time benefits may be a logical decision. For example, a user has an established relationship with a machine OEM who does not incorporate a full Hypertherm integrated solution to their machine and instead produces their own nesting software or CNC.

Depending on configuration, the machine could still deliver excellent productivity gains.

Conversely, users owning machines incorporating prior Hypertherm technology, such as a Command THC or a version of ProNest that does not support True Hole, may be in an excellent position to retrofit their machine with the latest Hypertherm components that deliver the full Rapid Part experience at an easily justifiable return on investment.

Refer to Table 1.1 for details of what's gained and lost when using different component configurations, or use the simplified overview Table 1.3, above.

See Rapid Part in action at www.hypertherm.com/rapidpart

One of Hypertherm's long-standing core values is a focus on minimizing our impact on the environment. Doing so is critical to our, and our customers' success. We are always striving to become better environmental stewards; it is a process we care deeply about.

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Greener Cuts™

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Cut with confidence®