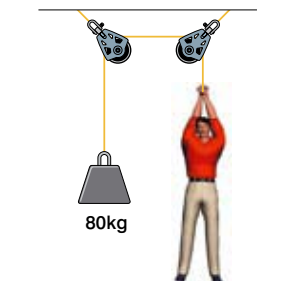


## Technical Reference — Choosing the right system.

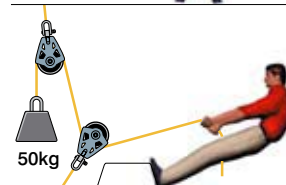
### Blocks and purchases:

#### How hard can you pull?

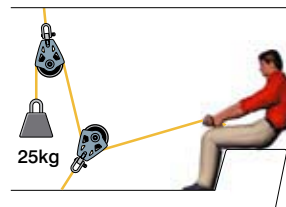


As a guide, the average person can:-  
Pull vertically down a force equivalent to his body weight (for a short period!)

When fully braced, pull intermittently sideways with one hand 25 kg, and with two hands, 50kg.



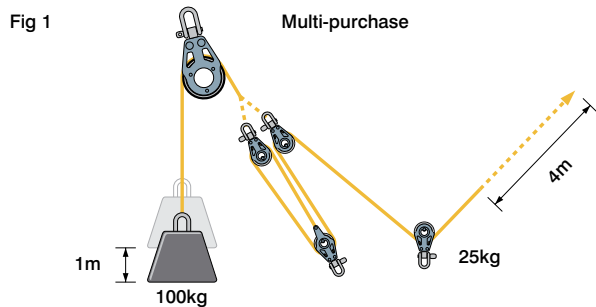
In a normal sailing environment, adjust control lines frequently loaded to 25 kg. Or exert 15kg single handed, or 25 kg double handed, on the handle of a winch.



To enable safe and accurate trimming of sails, this human force can be multiplied through a purchase, made up of block systems and/or winches. The purchase means that human power can comfortably achieve the higher forces required for most sailboat controls.

As an example, a 4:1 purchase requires 4 times as much rope to be pulled, but achieves 4 times as much force.

Lewmar manufacture a diverse range of blocks to suit all marine



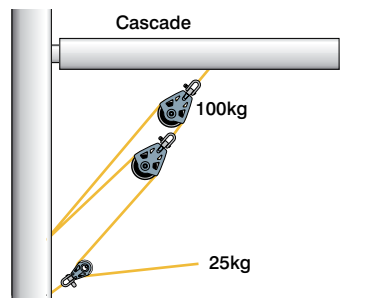
applications. This guide aims to help you to choose the best purchase system, and the appropriate Lewmar products, to suit your application.

#### Which purchase system?

Figs 1 and 2 show two different configurations for a 4:1 purchase system. The multi-purchase system is used where the full range of adjustment is required, for example a mainsheet traveller system.

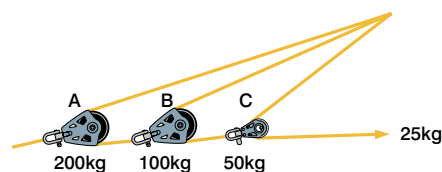
The cascade system can achieve a high purchase with fewer blocks, and diameter and type of line can be specified in line with the load on each part of the system, but it achieves a much smaller range of adjustment. A typical application is a vang system. Cascade systems also enable controls to be led conveniently to either side of the boat, for example with a backstay adjuster.

Fig 2



When specifying a cascade, it's important to ensure that each block in the system has sufficient travel to give the range required. Block B travels twice as far; and block C four times as far, as block A (fig 3). All blocks must be free to travel their full working length without danger of hooking or catching.

Fig 3



Frequently, a combination of cascade and multi-purchase achieves the best compromise between power and range. Fig 4 shows a variety of examples of combination systems, with typical applications, the genoa system showing a satellite purchase remote from the car.

Fig 4.1  
48:1 cascade on Backstay



Fig 4.2  
8:1 combi on Jib system

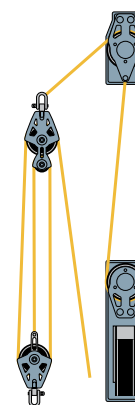
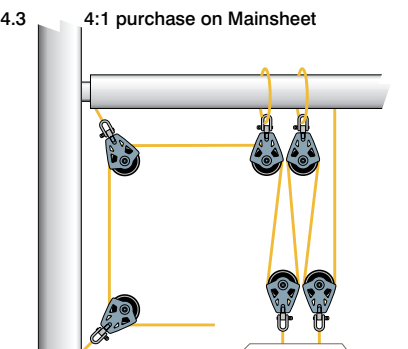
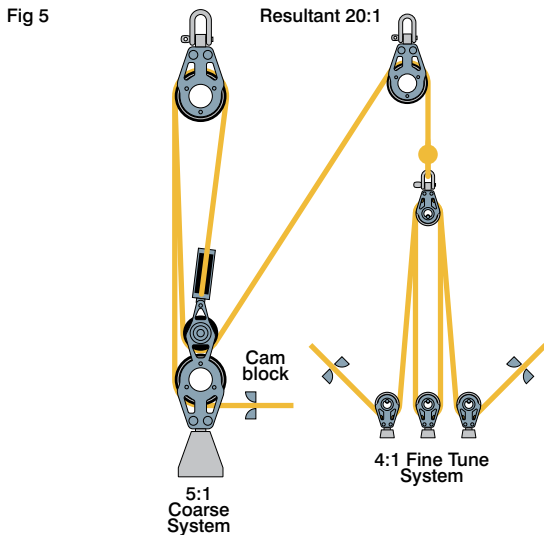


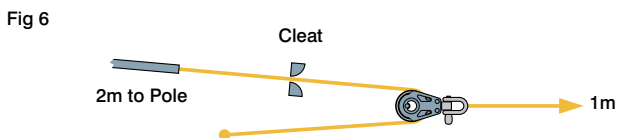
Fig 4.3  
4:1 purchase on Mainsheet



**Coarse/fine tune.** Racing mainsheet systems often comprise a coarse system; used for moving large amounts of unloaded mainsheet (for example at the windward or leeward mark), combined with a fine tune system, which is led to each side of the boat and used for playing the mainsail whilst beating. Fig 5 shows a typical configuration.



**Reverse purchase.** Occasionally, on a lightly loaded system, a reverse purchase system can achieve greater range or faster movement than the human input. Fig 6 shows an example of a 1:2 asymmetric pole launch system.



Pulling 1 metre on the control moves the pole out 2 metres. Note that the load on the control line is now twice that on the pole launch rope. For this reason in this system the cleat is located on the launch rope, not the control line.

**How much purchase power?**

If we know the approximate sailing (output) force required we can calculate the purchase required by dividing the output force by the input from control line or winch. To achieve 200kg tension on a system, for example, would require  $200\text{kg}/25\text{kg} = 8:1$  purchase.

The table (Fig 7) gives some typical examples of purchases used by Lewmar customers.

**Fig 7 — Typical purchase systems**

Boat size	4m/13ft	6m/20ft	8m/26ft	10m/33ft	12m/39ft	14m/45ft	16m/53ft
Mainsheet-Hand	3:1	4:1	4:1	5:1-10:1	8:1-24:1	-	-
Mainsheet-Winched	-	-	-	3:1	4:1	4:1	4:1
Vang-Cruising	4:1	4:1	4:1	6:1	8:1	10:1	10:1
Vang-Racing	5:1	6:1	8:1	12:1	24:1	36:1	48:1
Car tow-Cruising	-	-	2:1	2:1	2:1	3:1	3:1
Car tow-Racing	-	2:1	3:1	6:1	10:1	2:1 (winch)	2:1 (winch)

**Winched purchases.** To decide the purchase required in a system controlled by a winch, calculate the winch output by multiplying 15kg for a single handed, or 25kg for a double handed winch, by the winch model no. (44, 48, etc.) On Lewmar and most other brands, the winch number is also the highest power ratio the winch can provide when using a 250mm/10" winch handle. The following table suggests the pulling power that can be generated.

**Typical winch output loads**

Winch size	30	40	45	50	55
One handed input - 15 Kg on handle = Winch output load	450kg	600kg	660kg	720kg	-
Two handed input - 25 Kg on handle = Winch output load	-	-	1100kg	1200kg	1350kg

**Some typical systems in use on current boats**

	Backstay	Mainsheet traveller	Mainsheet coarse tune	Extra purchase for mainsheet fine tune	Jib traveller	Vang	Cunningham
Racing dayboat (e.g. Etchells 22)	16:1 cascade	2:1	2:1	4:1 multi-purchase	Plunger	8:1 combination	4:1 cascade
Small cruiser (e.g. Hunter 32)	Fixed	2:1	4:1 multi-purchase	-	Plunger	4:1 multi-purchase	N/A
Small racing yacht (e.g. Mumm 30)	16:1 combination	8:1 multi-purchase	6:1 multi-purchase	4:1 multi-purchase	8:1 combination	20:1 combination	4:1 cascade
Medium cruiser (e.g. Oceanis 393)	Fixed	4:1	4:1	N/A	2:1 with plunger	5:1	N/A
Medium racing yacht (e.g. Farr 40)	Hydraulic	12:1 combination	2:1 Winched	N/A	12:1 combination	36:1 combination	6:1 combination
Large cruiser (e.g. HR 53)	Hydraulic	6:1	4:1 Winched	N/A	2:1 with plungers	8:1	4:1
Large racing yacht (e.g. Farr 52)	Hydraulic	2:1 Winched	2:1 Winched	N/A	2:1 Winched	Hydraulic	6:1 combination

## Technical Reference (cont)

### Which bearing?

Lewmar's Synchro Control Blocks fitted with ball bearing sheaves are designed for frequently adjusted applications which need free, fast running systems, such as sheets, or control lines which are controlled by hand and parked in cleats.

The Synchro Blocks use free spin bearings and are designed for applications which have high static loadings, but are adjusted less frequently, tending to be cleared for periods of time in the same position. Examples are mainsail halyard or runners controls.

Racing Blocks are fitted with Torlon roller bearing sheaves to combine the qualities of each of the above, and are the ultimate choice for any performance system.

### Which size/load block?

Every Lewmar block has a specified Safe Working Load, seen in the specification tables on the relevant page. From the force exerted by human or winch power, it is possible to calculate approximate load requirements of each block within a system, (see How hard can you pull) and match the forces and the products' Safe Working Load.

Deflection loads. The actual load exerted on a block also depends on line's angle of deflection around the sheave. A small deflection results in a lower load, maximum deflection (180°) gives maximum load. (Fig 8)

The table (Fig 9) enables a quick check of the block load as a percentage of the line load for the range of deflection angles.

**Genoa cars.** This principle has some interesting effects on genoa cars and genoa car tow loadings.

The sheet car on a high clewed no.3 jib deflects the sheet far more than that on a large overlapping genoa. The no.1 genoa may therefore create less load on the car than the no.3 which has a larger deflection angle.

Similarly, the force required to move the car forward is much higher when there is a large deflection than a small one. (Fig 10).

**Efficiency.** Always choose a sheave diameter at least 7x the line diameter. With smaller sheaves, energy is wasted in forcing the line to bend round the sheave, with a resulting loss in efficiency.

Ensure that blocks are fitted so they always align with the lines passing through them. Pay particular attention to multiple blocks, and those leading lines which go periodically slack.

All Lewmar products have been designed, tested, and developed to achieve best possible efficiency; however, no purchase system is 100% efficient. Therefore the force achieved at the working end of the purchase will be slightly less than the human load multiplied by the purchase. When calculating the purchase required to achieve a known load, we'd therefore recommend allowing a factor of 1.05 per block. Multiplied by the number of 180° turns in the rope make in a system to be certain of "fingertip control".

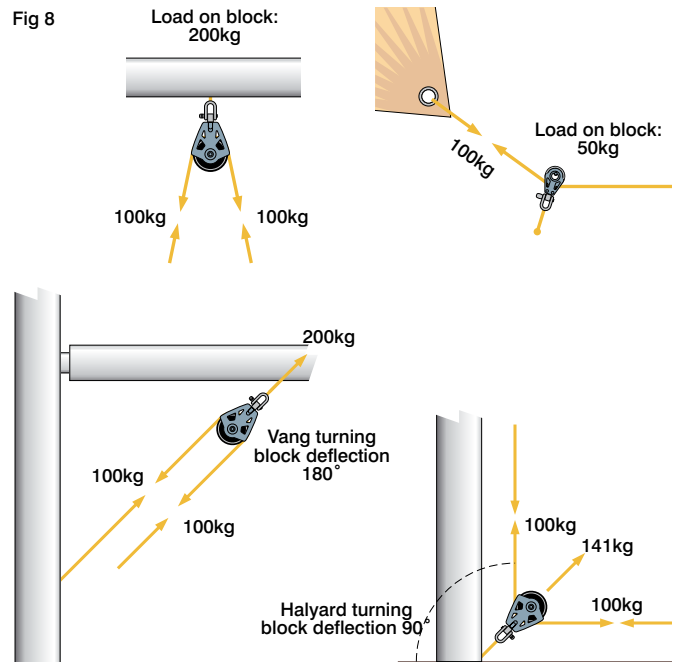
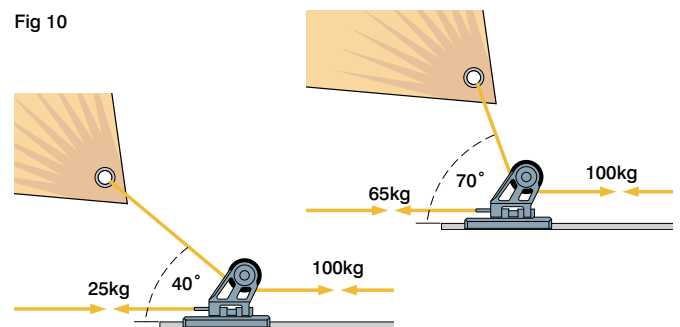


Fig 9

Change of Angle	Block Load as % of line load	Change of Angle	Block Load as % of line load
180°	200%	90°	141%
170°	199%	80°	129%
160°	197%	70°	115%
150°	193%	60°	100%
140°	187%	50°	84%
135°	184%	45°	76%
130°	181%	40°	68%
120°	173%	30°	52%
110°	164%	20°	35%
100°	153%	10°	17%
		0°	0%

Fig 10



Vertical genoa sheet angle	Tow load as % of sheet load
70°	65%
60°	50%
50°	35%
40°	25%

**Mainsheet traveller towing load**

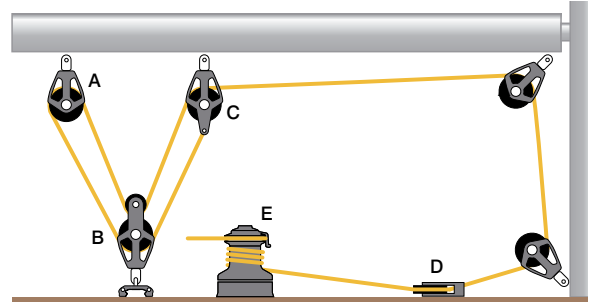
Guide % of mainsheet load	25%
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# Technical Reference — Mainsheet Systems

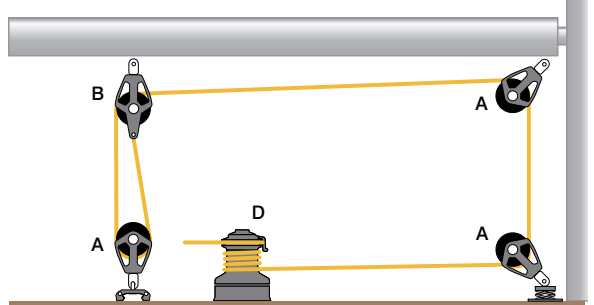
Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
<b>4:1 with dedicated Winch</b>	<b>A</b>	Single	-	-	29927201	29929001
	<b>B</b>	Fiddle	-	-	29927231	29929031
	<b>C</b>	Single Becket	-	-	29927204	29929004
	<b>D</b>	Footblock	-	-	29927261	29929061
	<b>E</b>	Winch	-	-	45st/46st	48st/50st
<b>Half German</b>	<b>A</b>	Single	-	-	-	29929001
	<b>B</b>	Single Becket	-	-	-	29929004
	<b>C</b>	Upstand	-	-	-	19831000
	<b>D</b>	Winch	-	-	-	48st/50st
<b>Double German</b>	<b>A</b>	Single	-	-	-	29929001
	<b>B</b>	Double	-	-	-	29929002
	<b>C</b>	Upstand	-	-	-	29393000
	<b>D</b>	Winch	-	-	-	48st/50st
<b>Maxi</b>	<b>A</b>	Single	-	-	-	29929001
	<b>B</b>	Car	-	-	-	29433682
	<b>C</b>	Footblock	-	-	-	29929061
	<b>D</b>	Winch	-	-	-	48st/50st
<b>4:1 Fiddle</b>	<b>A</b>	Fiddle	29905031	29926031	29927231	29929031
	<b>B</b>	Fiddle	29925037	29926037	29927237	29929039
<b>6:1 Tripple</b>	<b>A</b>	Triple	-	29906003	29907203	-
	<b>B</b>	Triple	-	29926010	29927210	-
<b>6:1/24:1</b>	<b>A</b>	Double	-	29926002	29927202	-
	<b>B</b>	Triple	-	29926010	29927210	-
	<b>C</b>	Single	-	29925001	29926001	-
	<b>D</b>	Fiddle	-	29925031	29926031	-
	<b>E</b>	Fiddle	-	29925039	29926039	-

\*\* Last 2 digits declare the finish of the winch

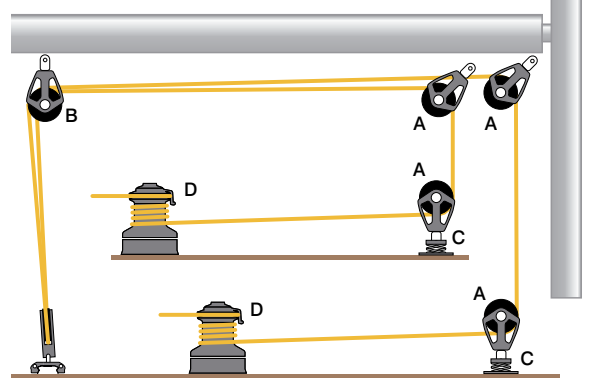
## 4:1 Dedicated Winch



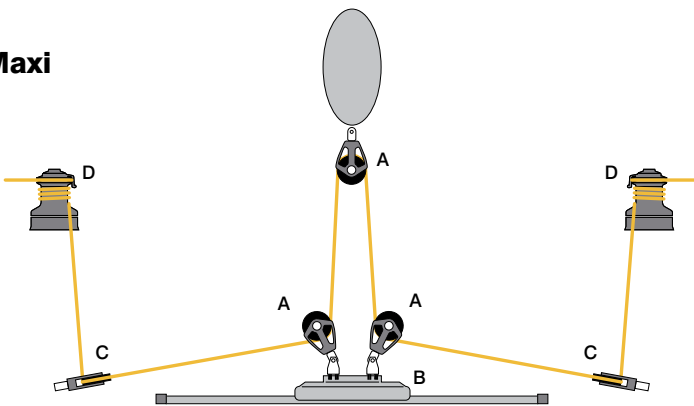
## Half German



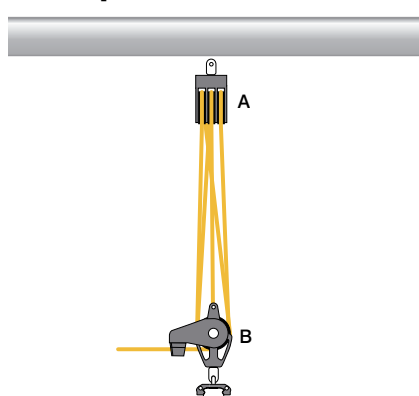
## Double German



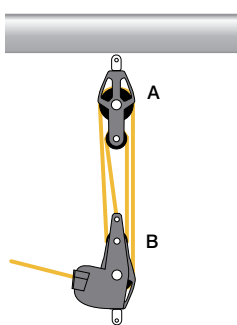
## Maxi



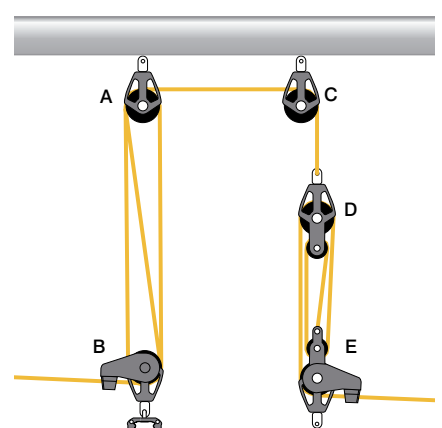
## 6:1 Triple



## 4:1 Fiddle



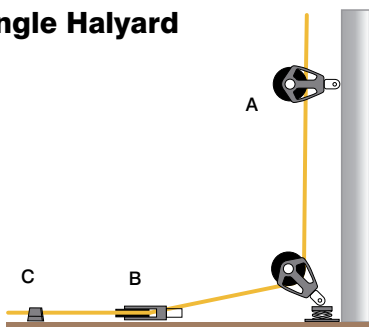
## 6:1/24:1



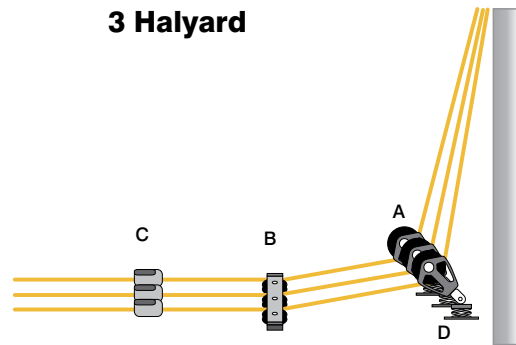
## Technical Reference — Halyards

Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
Single Halyard	A	Mastbase Block	29925021	-	-	-
	B	Footblock	29901460	-	-	-
	C	Cam	29104100	-	-	-
3 Halyard	A	Mastbase Block	-	29906021	29927221	-
	B	Organiser	-	29916090	29916060	-
	C	Clutch	-	29101410	29101412	-
	D	Upstand	-	19811000	19821000	-

Single Halyard



3 Halyard



## Technical Reference — Genoa System

Plunger Car

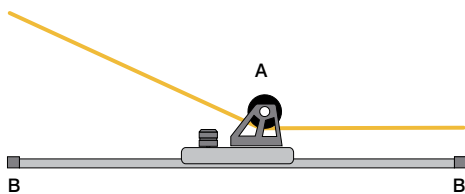
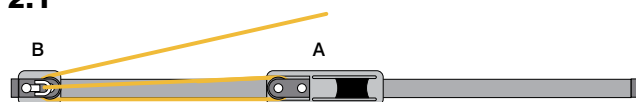
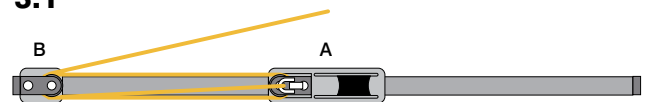


Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
Plunger Car	A	Car	29040600	29441700	29442412	29443700
	B	Endstop	29179040	29171040	29172040	29443040
2:1	A	Car	29040100	29441311	-	29443311
	B	Endstop	29170030	29471035	-	29473135
3:1	A	Car	-	29441345	29442345	-
	B	Endstop	-	29471032	29472035	-
8:1	A	Car	-	-	29442321	29443311
	B	Endstop	-	-	29472035	29473035
	C	Pad Eye	-	-	29904040	29904040
	D	Cleat	-	-	29104110	29104110
	E	Fairlead	-	-	29104114	29104114
	F	Single Becket	-	-	29925004	29926004
	G	Single Fiddle	-	-	29925031	29926031

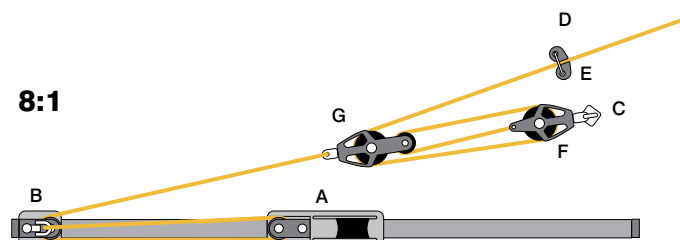
2:1



3:1



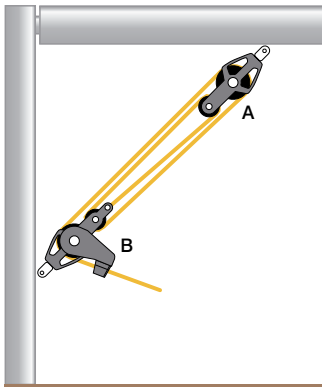
8:1



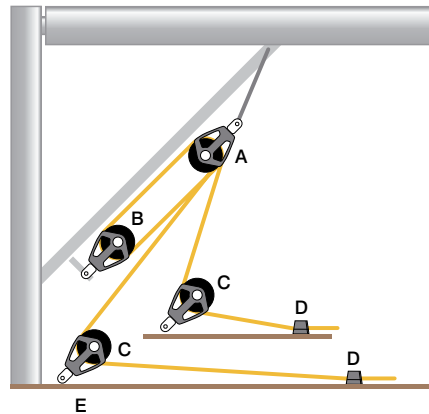
## Technical Reference — Boom Vang

Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
4:1 Fiddle	A	Fiddle	-	29906031	-	-
	B	Fiddle & Cam	-	29906039	-	-
6:1 Double Ended	A	Tripple	-	-	-	29929003
	B	Double	-	-	-	29929002
Ended	C	Single	-	-	-	29909001
Cascade	C	Cam Cleat	-	-	-	29104110
	D	Eye Strap	-	-	-	29104113

**4:1 Fiddle**

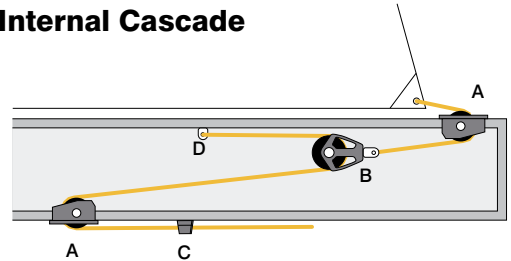


**6:1 Double Ended**

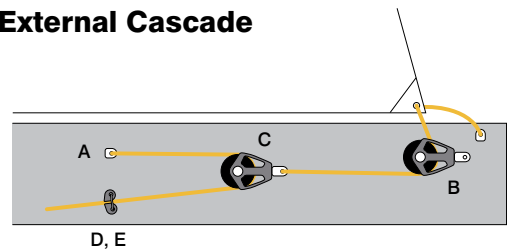


## Technical Reference — Outhaul

**2:1 Internal Cascade**



**4:1 External Cascade**



**4:1 Internal Cascade**

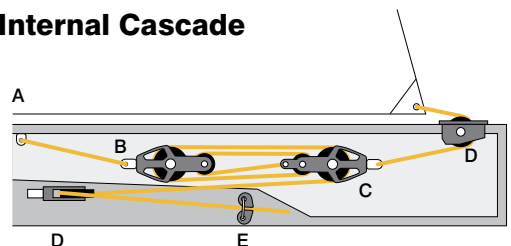
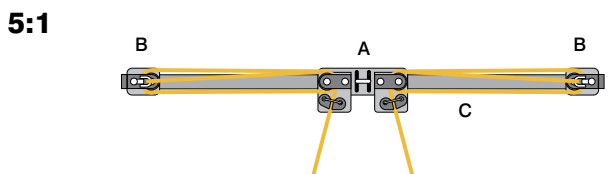
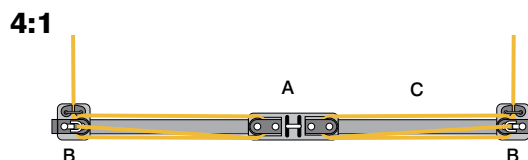
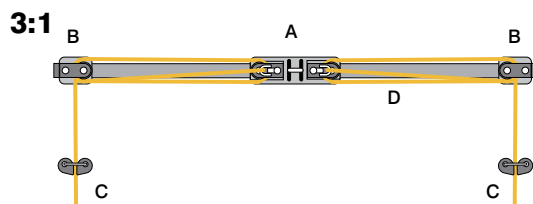
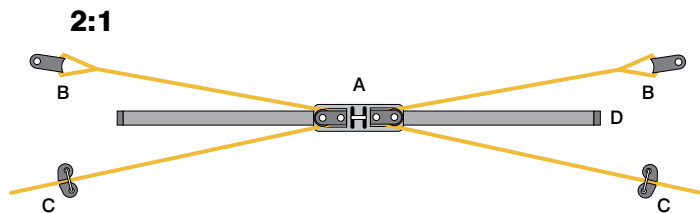


Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
2:1 Internal Cascade	A	Through Deck	29901361	-	-	-
	B	Single	29901421	-	-	-
	C	Cam Cleat	29104100	-	-	-
	D	Eye Strap	29104103	-	-	-
4:1 Internal Cascade	A	Eye Strap	-	29104113	-	-
	B	Footblock	-	29901460	-	-
	C	Single	-	29105001	-	-
	D	Cam Cleat	-	29104110	-	-
	E	Feeder Loop	-	29104116	-	-
4:1 External Cascade	A	Eye Strap	-	-	29104113	-
	B	Fiddle	-	-	29927231	-
	C	Fiddle & Becket	-	-	29927234	-
	D	Through Deck	-	-	29901361	-
	E	Cam Cleat	-	-	29104110	-

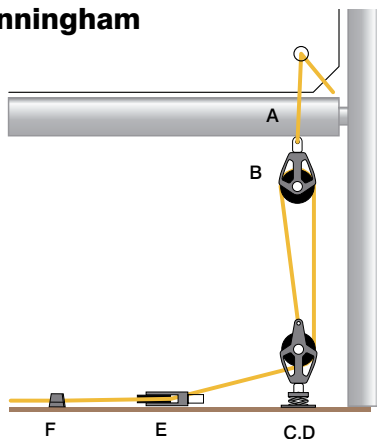
## Technical Reference — Traveller Systems

Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
2:1	A	Car	29330107	29431311	-	29433602
	B	Dead Eye	29171010	29171010	-	29473135
	C	Cleat	29904100	29904100	-	29101412
	D	Track	291614**	291614**	-	291636**
	E	Winch	-	-	-	40ST
3:1	A	Car	-	29431315	-	-
	B	Endstop	-	29471032	-	-
	C	Cleat	-	29471015	-	-
	D	Track	-	291614**	-	-
4:1	A	Car	-	29431312	29432312	-
	B	Endstop	-	29471836	29472836	-
	C	Track	-	291614**	291624**	-
5:1	A	Car	-	29431916	29432816	-
	B	Endstop	-	29471032	29473032	-
	C	Track	-	291614**	291624**	-

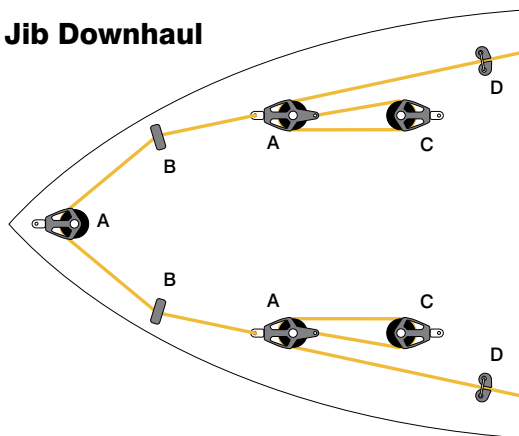


## Technical Reference — Cunningham

### 4:1 Cunningham



### 6:1 Jib Downhaul



### 8:1 Cunningham

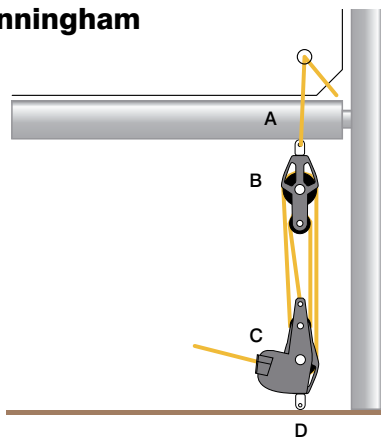
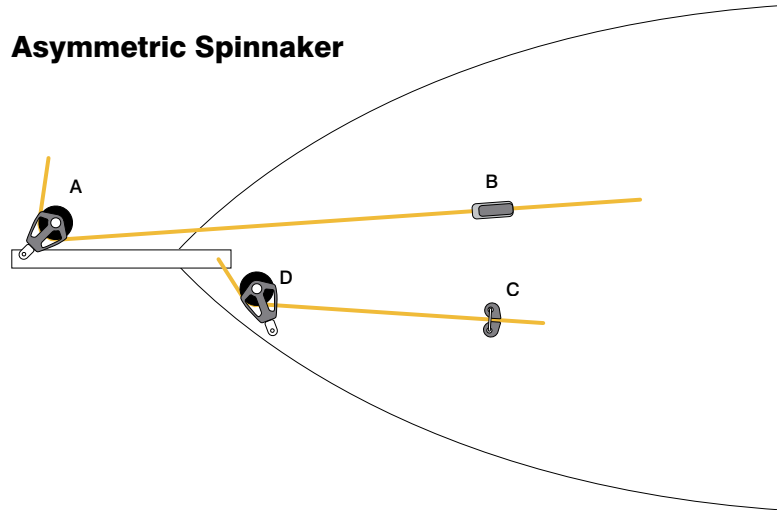


Diagram Title	Ref	Description	Size 0	Size 1	Size 2
4:1 Cascaded	A	Eye Strap	29014113	29014113	-
	B	Single	29925001	29906001	-
	C	Single Becket	29925004	29926004	-
	D	Upstand	29904046	19811000	-
	E	Footblock	29901460	29926061	-
	F	Cam Cleat	29104100	29104100	-
8:1 Cascaded	A	Eye Strap	-	29014113	29014113
	B	Fidle	-	29926031	29927231
	C	Fiddle/Becket/Cam	-	29926039	29927239
8:1 Jib Downhaul J24	A	Single	29906001	-	-
	B	Bulls Eye	29904117	-	-
	C	Footblock	29901460	-	-
	D	Cam Cleat	29104100	-	-

## Technical Reference — Asymmetric Spinnaker

Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
Asymmetric Spinnaker	A	Single	-	-	29927201	-
	B	Jammer	-	-	29101112	-
	C	Footblock	-	-	29927264	-
	D	Cam	-	-	29104110	-



## Technical Reference — Various

Diagram Title	Ref	Description	Size 0	Size 1	Size 2	Size 3
6:1 Right Angle	A	Triple	-	29926003	-	-
	B	Triple/Cam/Becket	-	29906010	-	-

### 6:1 Right Angle Backstay

