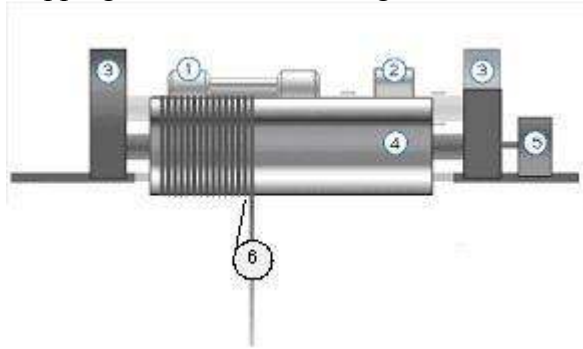## Electronic Programmable Limit Switches (EPLS)

The IMPULSE VG+ Series 3 software allows the programming of electronic limit switches to slow down and stop hoist motions at preset locations where historically a two or four position geared limit switch was used to accomplish this. The four positions can be defined as follows (imagine the hook traveling from highest point down to the lowest point):

Upper Limit Stop (UL2)
Upper Limit Slow Down (UL1)
Lower Limit Slow Down (LL1)
Lower Limit Stop (LL2)

A redundant secondary Upper Limit Switch (separate hardware) is required in case of failure of the primary upper limit stop. As illustrated in the hoist below, if the geared limit switch at UL2 failed to stop the hook, it would physically contact item # 6 which lifts a counter weight and in turn opens an electrical contact. This contact is wired into a multi-function digital input on the drive and can be integrated into the main line contactor. This could prevent a catastrophic load drop due to the hook running into the drum, causing the wire rope to break and ultimately dropping the load should the geared limit switch fail.

1. Motor/Encoder
2. Brake
3. Gear Reduction
4. Drum
5. Typical Geared Limit Switch
6. Weighted Limit Switch (Failsafe)

The Electronic Programmable Limit Switch function makes it possible to eliminate the geared limit switches (item #5 in Figure 1.). Geared limit switches are keeping track of the drum position, and have electrical contacts that open/close by adjustable cams to trip the switches at preset locations. These switches are in turn wired to the multi-function digital inputs of the drive or in series with raise / lower (forward / reverse) run commands. Since these geared limit switches are mechanical devices, they are subject to wear and vibration, which can cause loose screws on cams.

The weighted limit switch (item #6 in Figure 1) is independent of the geared limit switch, and cannot be eliminated. The weighted limit switch is also hard wired into the drive. This device should be used as a 'home' position for the "Height Measure Home" input. By default, "Home" is the upper most stop position; however it can be programmed as the lower most stop position if necessary for the application. This will provide an automatic home without having to go up on the crane to re-home or change the home position in the event that the wire rope is changed (ultimately changing the hook height position). This will also act as a fail safe to the EPLS

function in the event of a power failure or inadvertent movement to the hoist drum while the drive is powered down; it will shut down and 'home' at the same time. It is also acceptable to use a separate additional homing button in the control enclosure to avoid having to manually trip the weighted limit to achieve "home" position.

> **WARNING**
> The EPLS function should <u>NOT</u> take the place of the failsafe
> weighted limit switch

Setting Up Electronic Programmable Limit Switches using Weighted Limit for Home

UL1, UL2, LL1, and LL2 can be programmed (without the use of rotary limit switches). The Electronic Programmable Limit Switch (EPLS) function utilizes a stored height measurement (U1-50, U1-51), and therefore the Hook Height Measurement must be set-up correctly before using EPLS. When C3-12, C3-13, C3-14, or C3-15 has a setting other than zero(0), the ELPS function will be enabled.

Parameter	Name	Content	Range	Default Setting
C3-12	UL2 Revolutions	Motor revolutions from Home position to UL2	0-65535	0
C3-13	UL1 Revolutions	Motor revolutions from Home position to UL1	0-65535	0
C3-14	LL1 Revolutions	Motor revolutions from Home position to LL1	0-65535	0
C3-15	LL2 Revolutions	Motor revolutions from Home position to LL2	0-65535	0
C8-21	Height Measure	Total motor revolutions in lift	0-65535	10000
C8-24	Hook Height Home	0: Home = UL2 (Home by Upper Limit MFDI) 1: Home = LL2 (Home by Lower Limit MFDI) 2: Home = MFDI 67H, Home Top 3: Home = MFDI 67H, Home Bottom 4: Home = UL3, (Home by Weighted Limit)	0-4	0
C8-25	Hook Height Out	0: Home = OV; U1-50=0%; MFDO=0V 1: Home = 10V; U1-50=100%; MFDO=10V	0-1	0

1. Determine your preferred 'home' position, and set parameter C8-24 "Hook Height Home" accordingly. Set C8-24 = 2 (Home is TOP) as this will be electrically tied to the weighted limit switch as a means to home the system.

     C8-24   Hook Height Home   = 2 (Home is at the Top with MFDI = 67H)

Note: An OPE26 fault will occur when (C8-24 = 0 or 1) AND (C3-12 or C3-15 $\neq$ 0). When using Height measurement for EPLS function, UL2 or LL2 MFDI's cannot be used to home.

2. Set up one of the available multi-function digital inputs (MFDI) to 67H = 'hook height home' (MFDI terminals S3 – S8 are set via parameters H1-01 – H1-06).   This terminal should be closed when the Weighted Limit switch opens. This may require a relay as most weighted limit switches only provide normally closed contacts.

3. Set parameter C8-21 to the total number of motor revolutions available throughout the entire lift.
   a. Start by cautiously raising the hoist all the way to the weighted limit to the point where it changes states.   Ensure that this action results in the system being homed. (U1-50 will display 0% with the factory default setting of C8-25).
   b. Lower the hook all the way to lowest point of travel (Usually the floor).
   c. Transfer the number of motor revolutions from U1-51 to Parameter C8-21.
4. If using an analog output to monitor the hook height, determine whether the 'Hook Height Output' will count up or down when raising the hook, and set C8-25 'Hook Height Out' accordingly.
   C8-25   Hook Height Out   = 0 (At home position U1-50 = 0% and MFDO = 0V)
                                     = 1 (At home position U1-50 = 100% and MFDO = 10V)

Note: If C8-25 is set to '1' after the C3-12 ~ C3-15 parameters are programmed to non zero settings, may result in both Upper and Lower limits being tripped simultaneously and motion will not be possible until C3-12 ~ C3-15 are returned to 0.

5. Record the motor revolutions from 'home' to the desired hook positions (UL2, UL1, LL1, and LL2) and enter the number of revolutions (U1-51) for each position in parameters C3-12, C3-13, C3-14, and C3-15 respectively.
   a. From Weight Limit to Up Limit Stop Position – Transfer U1-51 value to C3-12
   b. From Weight Limit to Up Limit Slow Position – Transfer U1-51 value to C3-13
   c. From Weight Limit to Low Limit Slow Position – Transfer U1-51 value to C3-14
   d. From Weight Limit to Low Limit Stop Position – Transfer U1-51 value to C3-15
6. Use monitor parameters U1-50 and U1-51 to verify the set-up:
   U1-50   Hook Height   indicates the hook height as a percentage
   U1-51   Motor Revolution   indicates the motor revolutions from the home position

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WARNING!
Any modifications to the hoist may require that the EPLS parameters be verified / re-calibrated.
EPLS positions shall be verified at each change of shift.

Example: Setting up Electronic Programmable Limit Switch function with weighted limit for home

In the following example, the total motor revolutions in the lift are 1880.
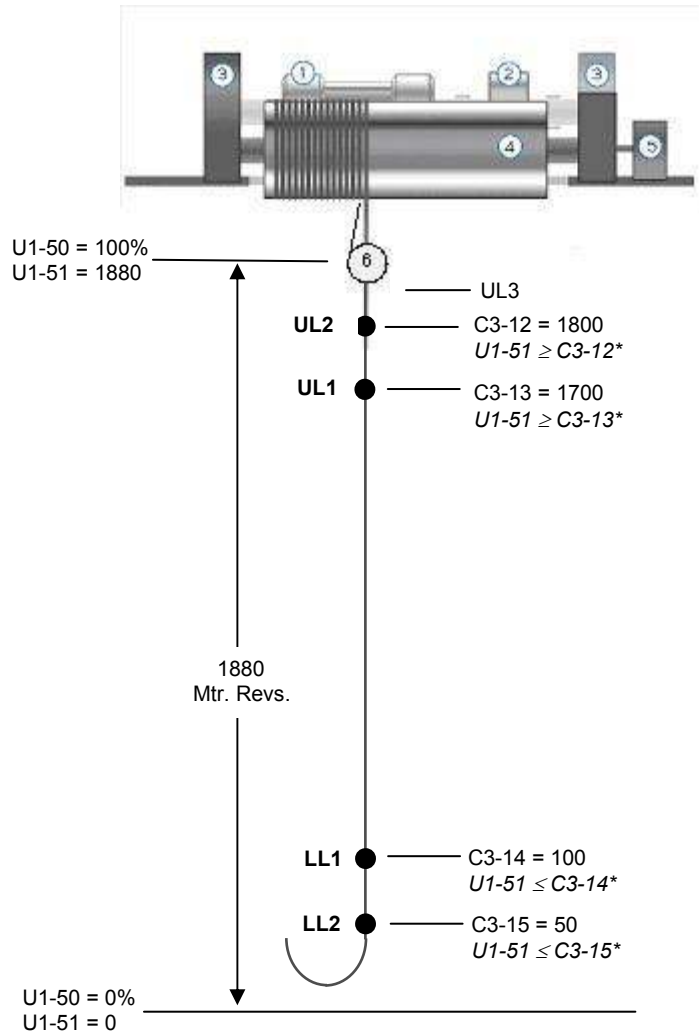
C8-21 Height Measure = 1880 revs

The Home position is the Weight Limit Switch (UL3 position).

C8-24 Hook Height Home = 2

The Hook Height Out is at 100% at the Home position (UL3), and counts down as you lower the hook.

C8-25 Hook Height Out = 1

U1-50 = 100%
U1-51 = 1880

UL3

UL2 — C3-12 = 1800
$U1\text{-}51 \geq C3\text{-}12*$

UL1 — C3-13 = 1700
$U1\text{-}51 \geq C3\text{-}13*$

1880 Mtr. Revs.

LL1 — C3-14 = 100
$U1\text{-}51 \leq C3\text{-}14*$

LL2 — C3-15 = 50
$U1\text{-}51 \leq C3\text{-}15*$

U1-50 = 0%
U1-51 = 0

* Motor revolutions do not count negative

<u>Bypassing of Limits:</u>
Bypassing the Upper or Lower Limits can be done to allow the following without the use of jumpers or re-programming of the drive parameters:

- To allow the testing of the weighted upper limit switch (UL3), or re-homing the Height Measurement function.
- To allow changing of the wire ropes (spooling all of the rope off of the hoist drum).

It is recommended to use a momentary key-switch to operate the bypass.

WARNING
The momentary key-switch to operate this bypass function should only be accessible to maintenance personnel, not the crane operator. These 'end of travel' limits should never be left in a bypassed state during normal operation.

When a MFDI is set to 73H 'LL2 / UL2 Bypass', and the input is ON, the following are bypassed:

- H1-0X – 7H *'Upper Lmt 2 N.O.'* and BH *'Upper Lmt 2 N.C.'* ⎫ *Mechanical Geared Limit*
- H1-0X – 9H *'Lower Lmt 2 N.O.'* and DH *'Lower Lmt 2 N.C.'* ⎬ *Switch Inputs*
- UL2 detected by Electronic Limit Switch (C3-12)
- LL2 detected by Electronic Limit Switch (C3-15)

When a MFDI is set to 74H 'LL / UL Bypass', and the input is ON, the following are bypassed:

- H1-0X – 7H *'Upper Lmt 2 N.O.'* and BH *'Upper Lmt 2 N.C.'* ⎫
- H1-0X – 6H *'Upper Lmt 1 N.O.'* and AH *'Upper Lmt 1 N.C.'* ⎬ *Mechanical Geared Limit*
- H1-0X – 8H *'Lower Lmt 1 N.O.'* and CH *'Lower Lmt 1 N.C.'* ⎬ *Switch Inputs*
- H1-0X – 9H *'Lower Lmt 2 N.O.'* and DH *'Lower Lmt 2 N.C.'* ⎭
- UL2 detected by Electronic Limit Switch (C3-12)
- UL1 detected by Electronic Limit Switch (C3-13)
- LL1detected by Electronic Limit Switch (C3-14)
- LL2 detected by Electronic Limit Switch (C3-15)

WARNING
This bypass function will disable all limit checks other than the Weighted Upper Limit (UL3). The slowdown limits will be bypassed which could result in undesired travel if stopping from full speed. It is recommended that 73H 'LL2 / UL2 Bypass' be used for most applications.