



Belrobotics	
Leader in the automatic maintenance of large grounds	
1	<i>Multi-Zones Introduction and Typical Applications</i>
2	<i>Multi-Zones Settings : Parameters, Options,...</i>
3	<i>Multi-Zones Installation Guidelines</i>
4	<i>Two Concrete Installation Examples</i>

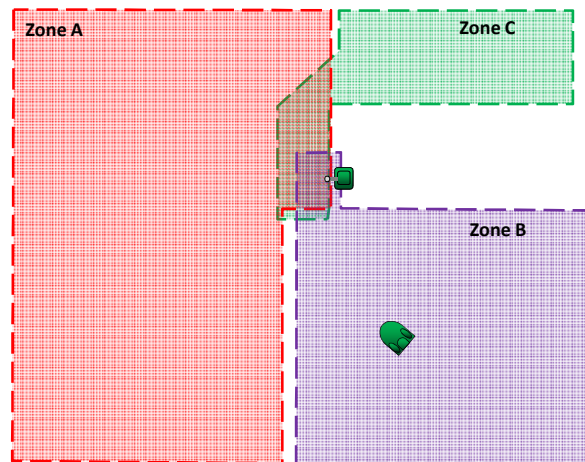
BELROBOTICS
THE GRASS MASTERS

Page 2

Multi-zones application

Adjacent football pitches

- Optimize mowing quality of several (2 or 3) zones
- Taking into account
 - individual size and grass growth rates
 - planned occupancy schedule
 - Unplanned occupancy schedule



Multi-zones application

Adjacent football pitches

Typical applications

Case 1 : Adjacent football pitches

✓ Work time optimisation

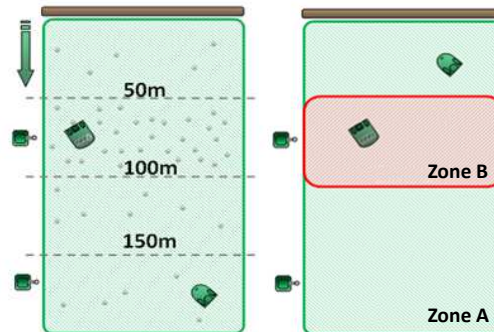
- ☐ The robot works according to occupancy schedule
- ☐ The robot takes less time to reach its docking station



Multi-zones application

Golf driving range

- One zone (the higher density zone) is totally included in the outer zone (the comprehensive driving range)
- **Main objective** : focus the Ballpicker in the higher density zone at peak times to optimize the Ballpicker efficiency
- **Constraint** : several robots in action: avoid collisions between Bigmow(s) and Ballpicker(s)



Multi-zones application

Multi-Zones Station

Multiple LED indicators



Wire Loop Cables

Pre-wired Power Supply
And Wire Loop Connectors
Inside the Station – Simplify installation



Multiple
Station boards



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2	Multi-Zones Settings : Parameters, Options,...

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Page 7

Multi-zones application

Settings

General settings

Option for MultiZones (MZ) mode

O16 Multizones : - (default)

By default, robots are in “Monozone mode”
=> **very minor changes** with previous program versions :
- New options 14&15, 5 resting periods (iso 4)

When set, robots are in “Multizones mode”
=> some options, installation parameters and rest periods must be set **for each enabled/active zone**

O16 mULTIZones: V

27,2 13:24

123F1

456F2▲

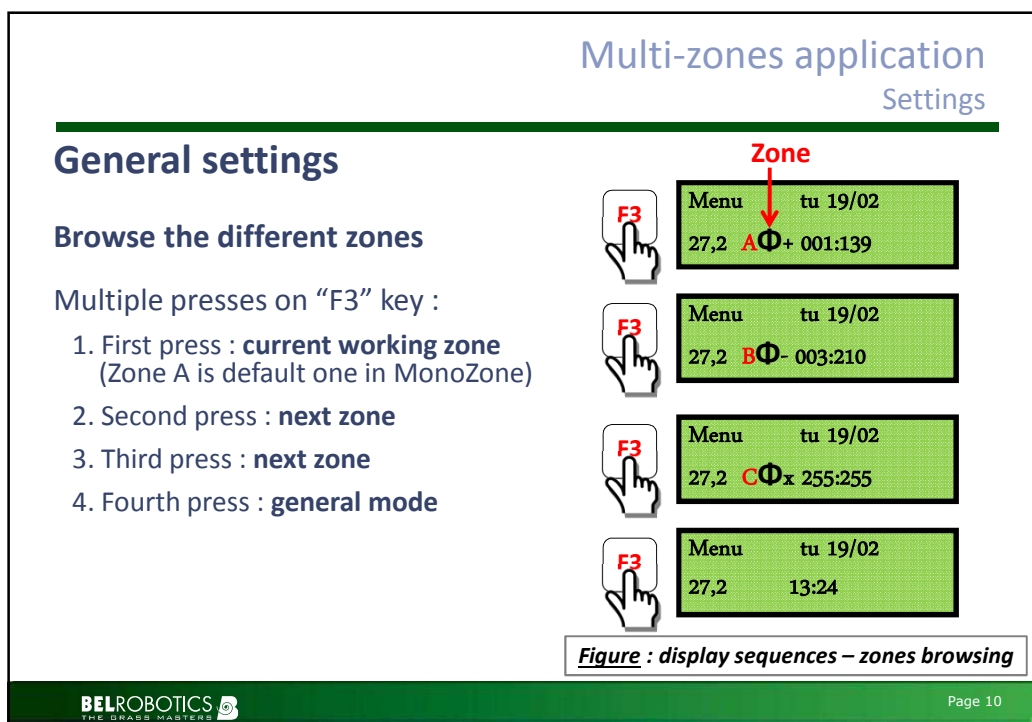
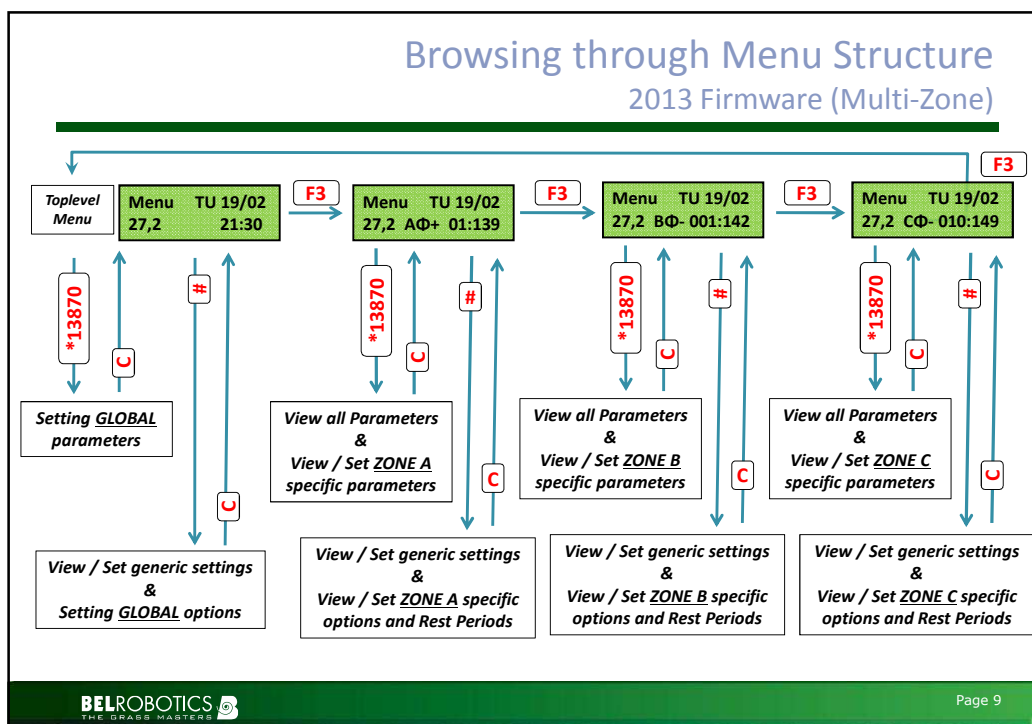
789F3▼

*0#C

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Page 8



Multi-zones application

Settings

General settings

Settings for a specific zone

1. Select the zone (via F3)

2. Set specific parameters, options and rest time periods

F3

Menu TU 19/02

27,2 AΦ+ 001:139

F3

Menu tu 19/02

27,2 BΦ- 003:210

*13870

*13870

27,2 BΦ- 003:210

#

P001:60

27,2 BΦ- 003:210

Figure : display sequences – going to user parameters of Zone B

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Page 11

Multi-zones application

Browsing through menu structure

Changes versus earlier software version:

– Multi-Zone aspects (see previous slides)

• Global versus Zone Specific Parameters (see Parameters details)

• Global versus Zone Specific Options (see Options details)

• Rest Periods are Zone Specific + 5 Periods (instead of 4)

– Settings Menu Order is changed :

OPTIONS

CLOCK

NEW CODE

LANGUAGES

CANCEL RESTS

REST PERIODS

Instead of

REST PERIODS

CLOCK

NEW CODE

LANGUAGES

OPTIONS

CANCEL RESTS

BELROBOTICS THE GRASS MASTERS

Page 12

Multi-zones application

Options settings

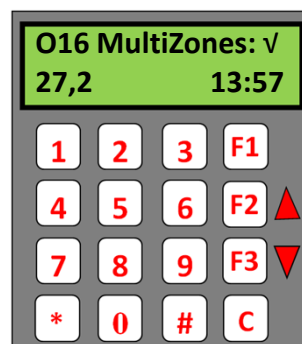
Default settings

OPTIONS	MEANING	Zone A	Zone B	Zone C
O00	Multiple robots	GLOBAL (-)		
O01	Back to station	GLOBAL (-)		
O02	Back & stay at station	GLOBAL (-)		
O03	Demonstration mode	GLOBAL (-)		
O04	Silent charge	GLOBAL (✓)		
O08	Phase inversion	GLOBAL (-)		
O09	Alternating HeadRot	GLOBAL (✓)		
O10	CCW station seek	(-)	(-)	(-)
O11	Charge on 2 sides	(✓)	(✓)	(✓)
O13	"U-shape" return	(✓)	(✓)	(✓)
O14	Not applicable			
O15	TimerOff	(-)	(-)	(-)
O16	Multizones	GLOBAL (-)		
O17	Enable zone	(✓)	(-)	(-)
O18	Kbd Lock	GLOBAL (-)		

Multi-zones application

Options settings – Option 016

- By default, the option 016 is not selected and robots are in **"Mono-Zone mode"**. Nothing changes.
- When option 016 is set, robots operate in **"Multi-Zones mode"**.
 - All parameters but P5 must be set individually for each zone.
 - Options 10, 11, 13 must be set individually for each zone
 - New options 15 and 17 must also be set individually for each zone



Multi-zones application

Options settings – Options 015 and 017

There are 5 different rest periods, each one available for each zone.

- Select the Zone (via F3) and set specific rest periods
- When Option 015 Timer Off is selected for one specific zone
 - The robot ignores programmed rest time periods for this zone.
 - Programmed rest time periods become effective again when Option 015 is unchecked.
 - Programmed rest periods remain in memory, even when not effective.
- When Option 017 Enable Zone is selected for one specific zone
 - The robot is allowed to operate in the displayed zone.
- When Option 017 Enable Zone is unchecked
 - The robot is not allowed to operate in the displayed zone.
 - Programmed parameters and options remain in memory, even when the zone is not enabled.

Parameters Overview

To access parameters, when MENU/ZONE is displayed, key in *13870

Parameters settings

		Default values			Min/Max
PAR.	MEANING	Zone A	Zone B	Zone C	
P0	Signal sensitivity	30	30	30	See following slides
P1	Length of peripheral wire (x10m)	BM 60 PM 35 GM 23	BM 60 PM 35 GM 23	BM 60 PM 35 GM 23	13/120
P2	Max. distance alongside wire when leaving station (x10m)	10	10	10	0/50
P3	Minimum track border Segment	0	0	0	0/3
P4	Minimum track border line (in Segment)	120	120	120	0/255
P5	Nominal speed when mowing	GLOBAL (BM 50 ; PM 40 ; GM 29)			BM: 15/60 PM: 15/50, GM: 15/40
P6	Min. distance alongside wire when leaving station (x10m)	1	1	1	0 / 50
P7	Phase sensitivity	30	30	30	8/30
P8	Wire Signal Channel	0	0	0	0/5
P9	Distance astride wire when leaving the station (in m)	3	3	3	2/100
P10	Work time ratio factor	1	1	1	1/10

Multi-zones application

Parameters – P10 “Work time ratio factor”

- ✓ Determines the time distribution of working hours of the robot amongst the different zones.
- ✓ Assess a “weight” for each zone (this is “P10”), that takes into account its area, its grass growth, and that will define the work ratio on this zone
- ✓ Sum up P10s of all zones and divide each individual weight by their sum

✓ *For example:*

- Weight for Zone A is 2, and is 1 for zones B and C
- The sum of weights is $2+1+1 = 4$
- P10 for Zone A is 2 and the work time ratio in Zone A is $2/4 = 50\%$
- P10 for Zone B is 1 and the work time ratio in Zone B is $1/4 = 25\%$
- P10 for Zone C is 1 and the work time ratio in Zone C is $1/4 = 25\%$

	MEANING	Z_A	Z_B	Z_C
O17	EnableZone	(v)	(v)	(v)
P10	Work time ratio factor	2	1	1

Multi-zones application

Parameters – P10 “Work time ratio factor”

- ✓ *Example (cont'd)*
- ✓ *When a Zone is disabled (the robot cannot access this zone for some period of time), the work planning of the robot is automatically reallocated between other active zones(s)*
- ✓ *Assume that Zone C is disabled:*

- Weight for Zone A is 2, and remains 1 for zones B and C
- Howevern, the sum of active zones is now $2+1+0 = 3$
- P10 for Zone A is 2 and the work time ratio in Zone A is $2/3 = 67\%$
- P10 for Zone B is 1 and the work time ratio in Zone B is $1/3 = 33\%$
- P10 for Zone C is 1 and the work time ratio in Zone C is $0/3 = 0\%$

	MEANING	Z_A	Z_B	Z_C
O17	EnableZone	(v)	(v)	(-)
P10	Work time ratio factor	2	1	1

Multi-zones application

Parameters – P10 “Work time ratio factor”

How to adjust P10 ?

- Draw a table with individual areas in ‘000 m2
→ A = 7,2 B = 5,2 C = 2,1
- Round these figures to nearest integer and set individual P10 accordingly
→ A = 7 B = 5 C = 2 and Sum P10s = 14

	MEANING	Z_A	Z_B	Z_C
O17	EnableZone	(v)	(v)	(v)
P10	Work time ratio factor	7	5	2

- If one P10 is higher than 10, divide all P10s by an integer value (2 in this instance):
→ Assume Zone A above is 12.100 m2
→ Then P10s for
 - P10 for Zone A is 12/2 = 6, P10 for Zone B is 5/2 = 3 and P10 for Zone C is 2/2 = 1

➤ Work time ratio Zone A = 7/14 = 50%
➤ Work time ratio Zone B = 5/14 = 36%
➤ Work time ratio Zone C = 2/14 = 14%

Page 19

Multi-zones application

Multi-zones and DTS

DTS 6.x is required to read Logs from robots 2013 onwards

Machine information

Resting Time | History | System parameters | Test

Machine information

Firmware version: C4-13022131
Serial Number: OCA4B963
Language: Français

Statistics

Mowing time: 1 min
Charging Time: 0 min
Nb of cycles: 0
L Wheel dist.: 10 m
R Wheel dist.: 10 m
Rest time: 0 min

Parameters

	Zone A	Zone B	Zone C
P 0: Signal Sensitivity	30	30	30
P 1: Peripheral Wire Length (x10m)	60	60	60
P 2: Max Distance Wire leaving station (x10m)	10	10	10
P 3: Minimum TrackBorder Segment	0	0	0
P 4: Minimum TrackBorder Line	120	120	120
P 5: Nominal Speed	50	50	50
P 6: Min Distance Wire leaving station (x10m)	1	1	1
P 7: Phase Sensitivity	30	30	30
P 8: Wire Signal Channel	0	0	0
P 9: Distance on wire leaving station (x1m)	3	3	3
P10: Work Time Ratio	1	1	1

Global Options

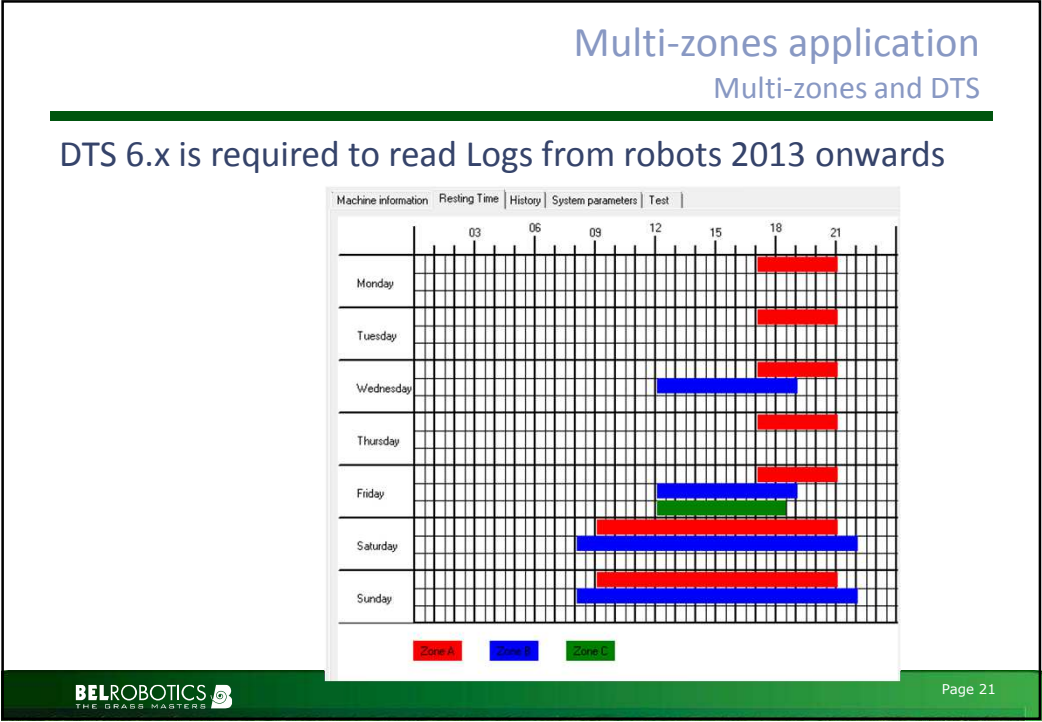
0000: Multiple Robots	-	-	-
0004: Silent Charge	-	-	-
0008: Phase Inversion	-	-	-
0009: Inversion Heads Direction	V	-	-
0016: Multizones	V	-	-

Zone Depending Options

Zone :	A	B	C
0010: CounterClockWise Station See	-	-	-
0011: Charge on 2 Sides	V	V	V
0013: U-Shape Return	V	V	V
0014: Astride/Wire	-	-	-
0015: TimeOff	-	-	-
0017: Enable Zone	V	-	V

Zone B Disabled (grayed zone)

Page 20



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3	Multi-Zones Installation Guidelines

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Page 22

Installing multi-zones configurations

General constraints and best practices

Constraints

- ❑ All previous installation rules do apply to each separate zone !
- ❑ Between 200 m and 1.200 m peripheral wire per zone.

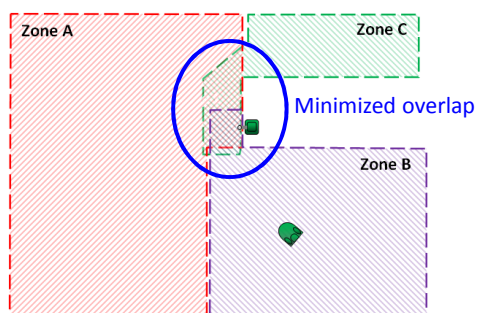
Best practices

- ✓ All previous best practices do apply in each separate zone !
- ✓ **Minimize the overlapping area** (the area common to all zones) while respecting docking station installation rules
- ✓ Peripheral wires **of adjacent zones must be spaced 300 mm**, except in the immediate vicinity of the docking station (see general installation rules : straight line critical distance upstream/downstream)
- ✓ Peripheral wires coming out of the ground to the electronic boards **must be twisted together by zone and kept as short as possible**

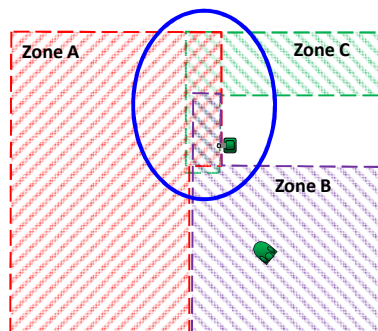
Installing multi-zones configurations

Constraints and best practices : overlap zone

In this area, the robot is always working.



Large overlap should be avoided

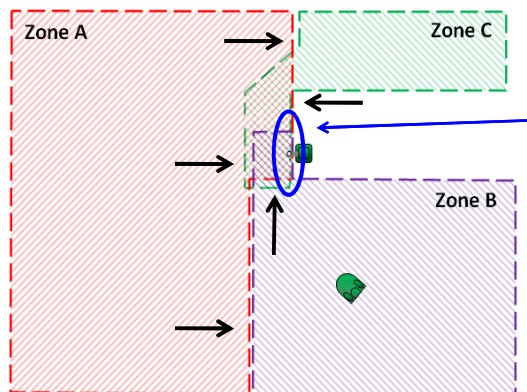


The robot wastes time as it operates in the overlap zone in every cycle!

Installing multi-zones configurations

Constraints and best practices: wire layout

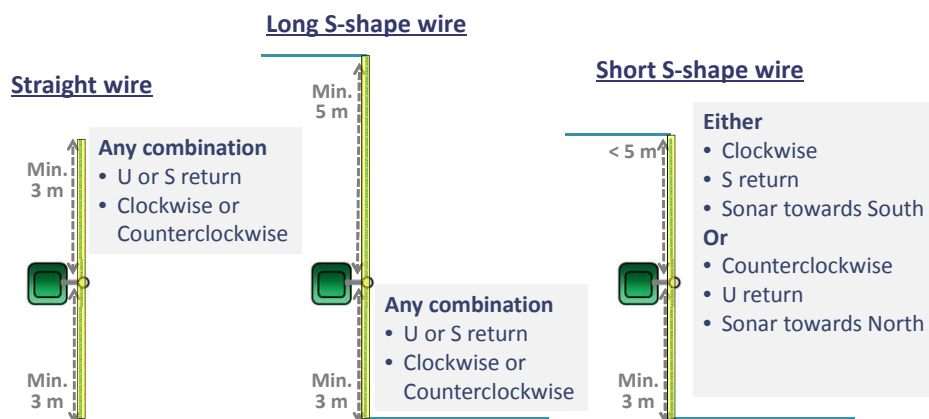
The black arrows below refer to wires on adjacent zones, that must be spaced at least 300 mm



In the immediate vicinity of the docking station (upstream and downstream – see next slide), the wires of different zones must be on top of each other!

Installation rules: positioning the docking station

Critical distances upstream and downstream of the docking station



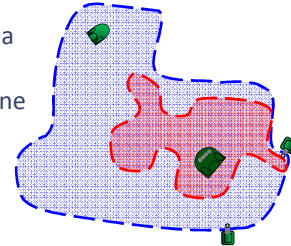
Multi-Zones : On the critical Upstream/Downstream section to/from the docking station, the wires of different zones must be on top of each other!

Multi-zones application

Golf driving ranges: constraints and best practices

Constraints

- ☐ Avoid collisions between robots operating on same area when going or leaving the stations
- ☐ Optimize Ballpicker efficiency: focus on high density zone at peak times



Best practices

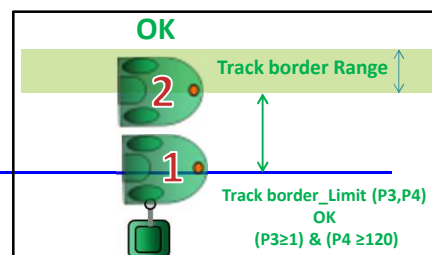
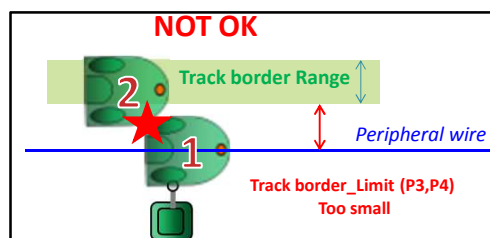
- ☐ Use one of the two recommended Multi-Robot configurations (see next slides)
- ☐ Increase the efficiency of the Ballpicker through setting mutually exclusive resting periods (and not through using P10 working time ratio parameter)

Multi-zones application

Golf driving ranges: constraints and best practices

Multi-Robot : General Rules (always use)

- Adjust the Ballpicker docking station, with **jumper on JBP** : Sonar Signal will be adapted so this station is only recognized by the Ballpicker.
- Activate Option 0 (Multiple Robots) on all robots.
- Correct Setting of Track Border (P3/P4)
 - P3/P4 large enough to avoid collision when one robot is charging and the other robot is on its way to its station : ($P3 \geq 1$) and ($P4 \geq 120$)



Multi-zones application

Golf driving ranges: constraints and best practices

Multi-Robot : Configuration 1 (on top of general rules)

To avoid collisions between the two robots :

- ✓ Get robots going into the same direction to their station (CC or CCW).
- ✓ Use S-Shape to keep this same direction at anytime.



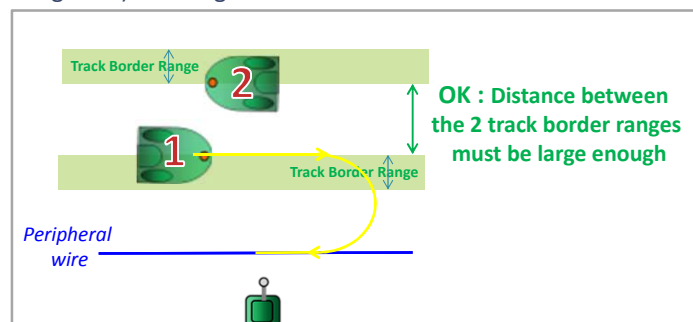
Multi-zones application

Golf driving ranges: constraints and best practices

Multi-Robot : configuration 2 (on top of general rules)

If it's mandatory to use U-Shape return or opposite return directions:

- ✓ Use a distance between the 2 track border ranges larger than 1 robot width (~1 Segment) allowing the 2 robots to cross each other.



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4	Two Concrete Installation Examples

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Page 31

Multi-zones application

Comprehensive example - football pitches

Zone C / CH2
S ~ 3750m²
L ~ 400m
Goalkeepers training

Zone A / CH0
S ~ 8000m²
L ~ 400m
Competition

Zone B / CH1
S ~ 3500m²
L ~ 290m
Training

25m

BASIC SETTINGS

✓ Multizone - 3 zones

-> **O16** set

-> **O17** set for each zone

✓ Wire lengths defined individually

-> **P1A=40 ; P1B=30 ; P1C=40**

✓ No obstacles or narrow path on the way back to the docking station

✓ Identical trackborder for all 3 zones

-> **P3, P4** kept at default value everywhere

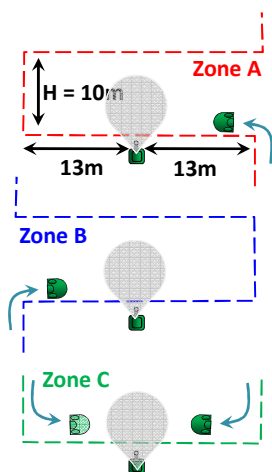
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THE GRASS MASTERS

Page 32

Multi-zones application

Comprehensive example - football pitches



STATION RELATED SETTINGS

- To minimise the overlap area, 'H' must be as short as possible.
- Pay attention to peripheral wire on opposite side of the station !
 - ✓ Take a value of **H = 10m**
 - ✓ Leave the sonar range at default value (direct range ~ 7m)
 - ✓ Come back in **CW** in zone A ; **CCW** in zone B ; **2 sides** in zone C
- To go back to work faster after charge in **Zone A and B** :
 - ✓ Use **U-shape return** (default)
- To be sure to go back to work on the pitches in Zone A and B :
 - ✓ **P6A=2 ; P6B=2**

Multi-zones application

Comprehensive example - football pitches



MULTIZONE RELATED SETTINGS

- ✓ Signal channel must be set for each zone
-> **P8A=0** (default) ; **P8B=1** ; **P8C=2**
- ✓ Use the method based on areas to estimate the work time ratio factor for each zone :
-> **ZA=8 ; ZB=3,5 ; ZC=3,7** (x1000m²)
-> method gives **P10A=8 ; P10B=4 ; P10C=4**

Multi-zones application

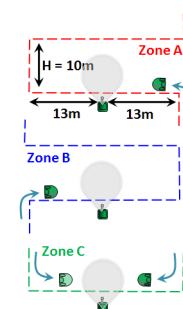
Comprehensive example - football pitches

Options configuration summary

OPTIONS	MEANING	Zone A	Zone B	Zone C
O10	CCW station seek	(-)	(✓)	(-)
O11	Charge on 2 sides	(-)	(-)	(✓)
O13	"U-shape" return	(✓)	(✓)	(✓)
O14	AstrideWire	(-)	(-)	(-)
O16	Multizones	GLOBAL (✓)		
O17	Enable zone	(✓)	(✓)	(✓)

Rest Periods

Must be defined according to occupancy schedule
(trainings and competitions)

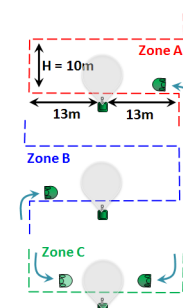


Multi-zones application

Comprehensive example - football pitches

Parameters configuration summary

PAR.	MEANING	Zone A	Zone B	Zone C
P0	Signal sensitivity	30	30	30
P1	Length of peripheral wire	40	30	40
P2	Max. distance alongside wire when leaving station	10	10	10
P3	Minimum trackborder Segment	0	0	0
P4	Minimum trackborder line (in Segment)	120	120	120
P5	Nominal speed when mowing	GLOBAL (BM 50)		
P6	Min. distance alongside wire when leaving station	2	2	1
P7	Phase sensitivity	30	30	30
P8	Wire Signal channel	0	1	2
P9	Distance astride wire when leaving the station	3	3	3
P10	Work time ratio factor	8	4	4



Multi-zones application

Comprehensive example - football pitches

Managing unexpected/unscheduled events

Situation 1 :

- The robot is working on Z_A.
- There is a training session on Z_B, and the trainer would like to use Z_A to have two working teams.
- The Zone C is free.



Solution :

- Disable Z_A (*Keyboard Options / SMS ZoneDisable A*).
- Send the robot back to its station (*Keyboard F1 / implicit in SMS Disable*).
- After the charge end, if Z_B is still busy (cf rest time schedule), the robot will work on one of the free zones available, Z_C only in this case.
- Enable back Z_A after the training (*Keyboard Options / SMS ZoneEnable A*).

Multi-zones application

Comprehensive example - football pitches

Managing unexpected/unscheduled events

Situation 2 :

- All competition matches of weekend are cancelled, so that Z_A will be free
- We could delete the rest period of Z_A for weekend but we would have to change settings afterwards
- There is a better way



Solution :

- TimerOff for Z_A on Saturday morning (*Keyboard Options / SMS TimerOff A*).
- TimerOn for Z_A on Sunday evening (*Keyboard Options / SMS TimerOn A*).

Multi-zones application

Comprehensive example - football pitches

Managing unexpected/unscheduled events

Situation 3 :

There is a tournament all this weekend, so that all the three zones are used by players.

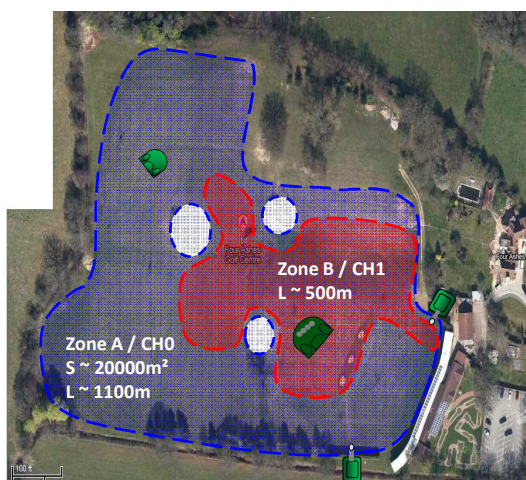


Solution :

- Send the robot to **rest** at the docking station (*Keyboard F2 / SMS BackHome*).
- After the tournament, restart the robot (*Keyboard ON / SMS Restart*).

Multi-zones application

Comprehensive example – golf driving range

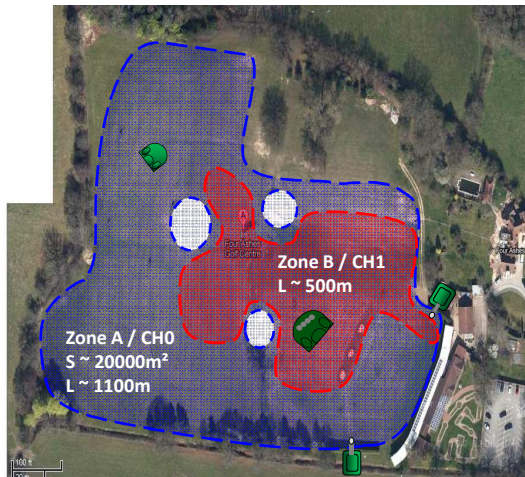


GENERAL DESCRIPTION

- Zone A must be mowed all the time.
- Zone B contains more than 80% of the total played golf balls.
- There are 3 bunkers that need to be installed as islands/pseudo-islands in Zone A.
- Station 1 : BallPicker
 - Battery Charge
 - Balls Discharge
 - Mono-zone station (1 card only : CH1)
- Station 2 : BigMow
 - Battery Charge
 - Mono-zone station (1 card only : CH0)

Multi-zones application

Comprehensive example – golf driving range

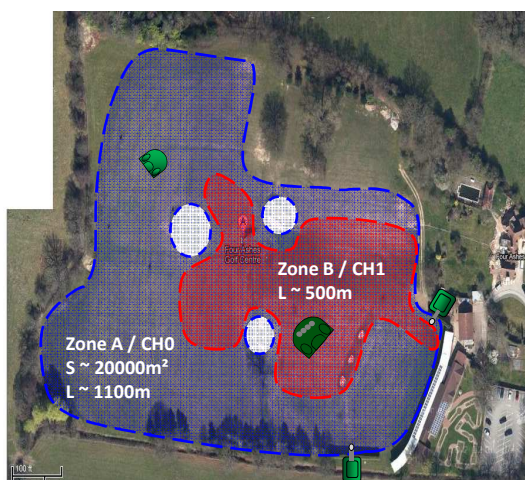


BIGMOW SETTINGS

- ✓ Since Bigmow must mow all the time the whole Zone A, it is working in MonoZone mode.
- ✓ Wire length must be adjusted :
-> **P1=110**
- ✓ Configure Bigmow for multi-robots settings (see previous slide) : **P3, P4, O10, O11, O13**

Multi-zones application

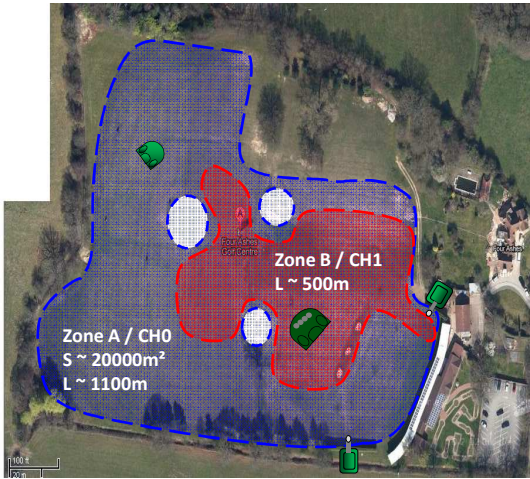
Comprehensive example – golf driving range



BALLPICKER BASIC SETTINGS

- ✓ The BallPicker must spend some time in Zone A, and (much) more time in Zone B.
-> Multizone, for two different zones
-> **O16** set
-> **O17** set for Zone A and Zone B
- ✓ Adjustment of wire length for each zone
-> **P1A=110 ; P1B=50**
- ✓ Configure Ballpicker for multi-robots settings (see previous slide) : **P3, P4, O10, O11, O13**

Multi-zones application
Comprehensive example – golf driving range



BALLPICKER MULTIZONE RELATED SETTINGS

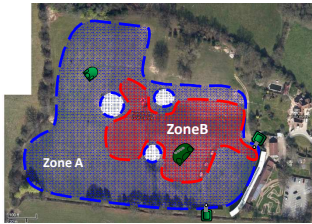
- ✓ Signal channel must be set for each zone
-> **P8A=0** (default) ; **P8B=1**
- ✓ Ballpicker must stay in ZoneB when players are practicing (to pick maximum of balls) and go working in ZoneA at other moments
 - ☐ Set mutually exclusive resting periods
 - Work in ZoneB only when players are there
 - Work in ZoneA overnight

Multi-zones application
Comprehensive example – golf driving range

Bigmow configuration summary

OPTIONS	MEANING	Zone A
O00	Multiple Robot	(v)
O16	Multizones	(-)

PAR.	MEANING	Zone A
P1	Length of peripheral wire	110
P3	Minimum trackborder Segment	1
P4	Minimum trackborder line (in Segment)	120
P8	Signal frequency channel	0

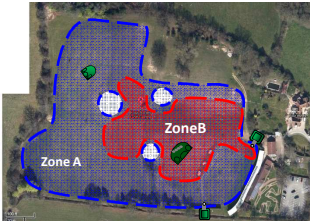


Standard docking station
(MonoZone on CH0)

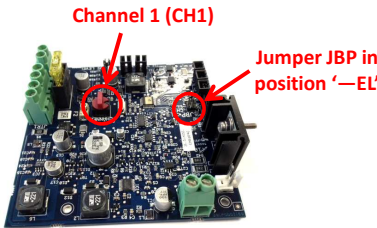
Multi-zones application
Comprehensive example – golf driving range

BallPicker configuration summary

OPTIONS	MEANING	Zone A	Zone B	Zone C
O00	Multiple Robots	GLOBAL (√)		
O16	Multizones	GLOBAL (√)		
O17	Enable zone	(√)	(√)	(-)



PAR.	MEANING	Zone A	Zone B
P1	Length of peripheral wire	110	50
P3	Minimum trackborder Segment	1	1
P4	Minimum trackborder line (in Segment)	120	120
P8	Wire Signal Channel	0	1
P10	Work time ratio factor	1	1



Multi-zones application
Golf driving range : Ballpicker Settings

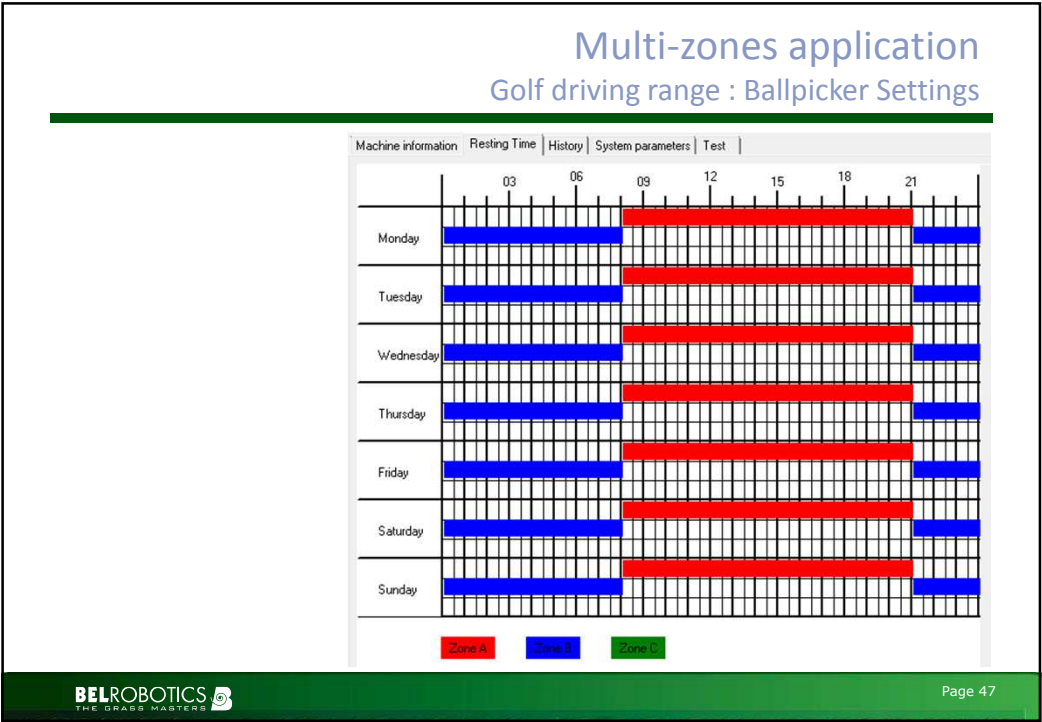
Parameters				
		Zone A	Zone B	Zone C
P 0 :	Signal Sensitivity	30	30	30
P 1 :	Peripheral Wire Length (x10m)	110	50	60
P 2 :	Max Distance Wire leaving station (x10m)	10	10	10
P 3 :	Minimum TrackBorder Segment	1	1	0
P 4 :	Minimum TrackBorder Line	120	120	120
P 5 :	Nominal Speed	50	50	50
P 6 :	Min Distance Wire leaving station (x10m)	1	1	1
P 7 :	Phase Sensitivity	30	30	30
P 8 :	Wire Signal Channel	0	1	0
P 9 :	Distance on wire leaving station (x1m)	3	3	3
P10 :	Work Time Ratio	1	1	1

Global Options			
O000:	Multiple Robots	√	
O004:	Silent Charge	-	
O008:	Phase Inversion	-	
O009:	Inversion Heads Direction	√	
O016:	Multizones	√	

Zone Depending Options			
Zone :	A	B	C
O010:	CounterClockWise Station Set	√	√
O011:	Charge on 2 Sides	-	√
O013:	U-Shape Return	-	√
O014:	AstrideWire	-	-
O015:	TimeOff	-	-
O017:	Enable Zone	√	√

Multiple Robots Configuration : avoid collisions using configuration 1 (S-Shape, Same Direction)

Multi-Zones Aspects (2 zones A and B). P10 is irrelevant: operation is defined by mutually exclusive rest periods (see next slide)



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THE GRASS MASTERS

Page 48