

# Creating Computer Controls for the Motorized Polarization Controller in LHO's Arm Length Stabilization System

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SURF Midterm Talk

July 27, 2017



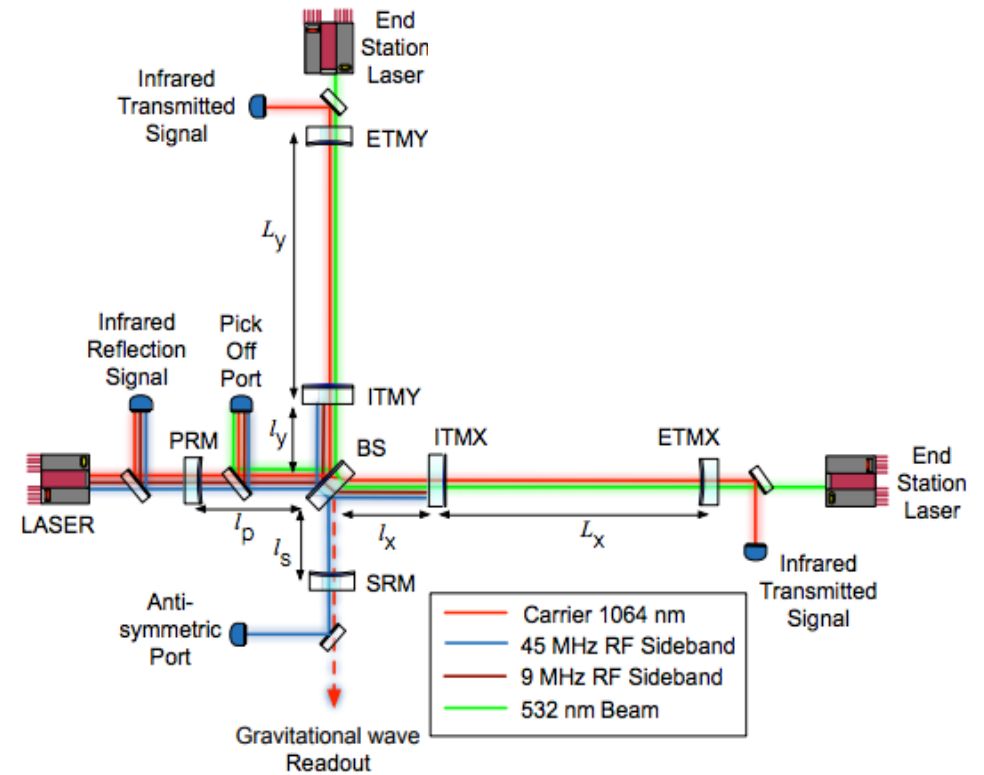
## Outline



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- I. Arm Length Stabilization
  - II. Motorized Polarization Controller
  - III. TwinCAT-EPICS-MEDM System
  - IV. Progress
  - V. Remaining Work

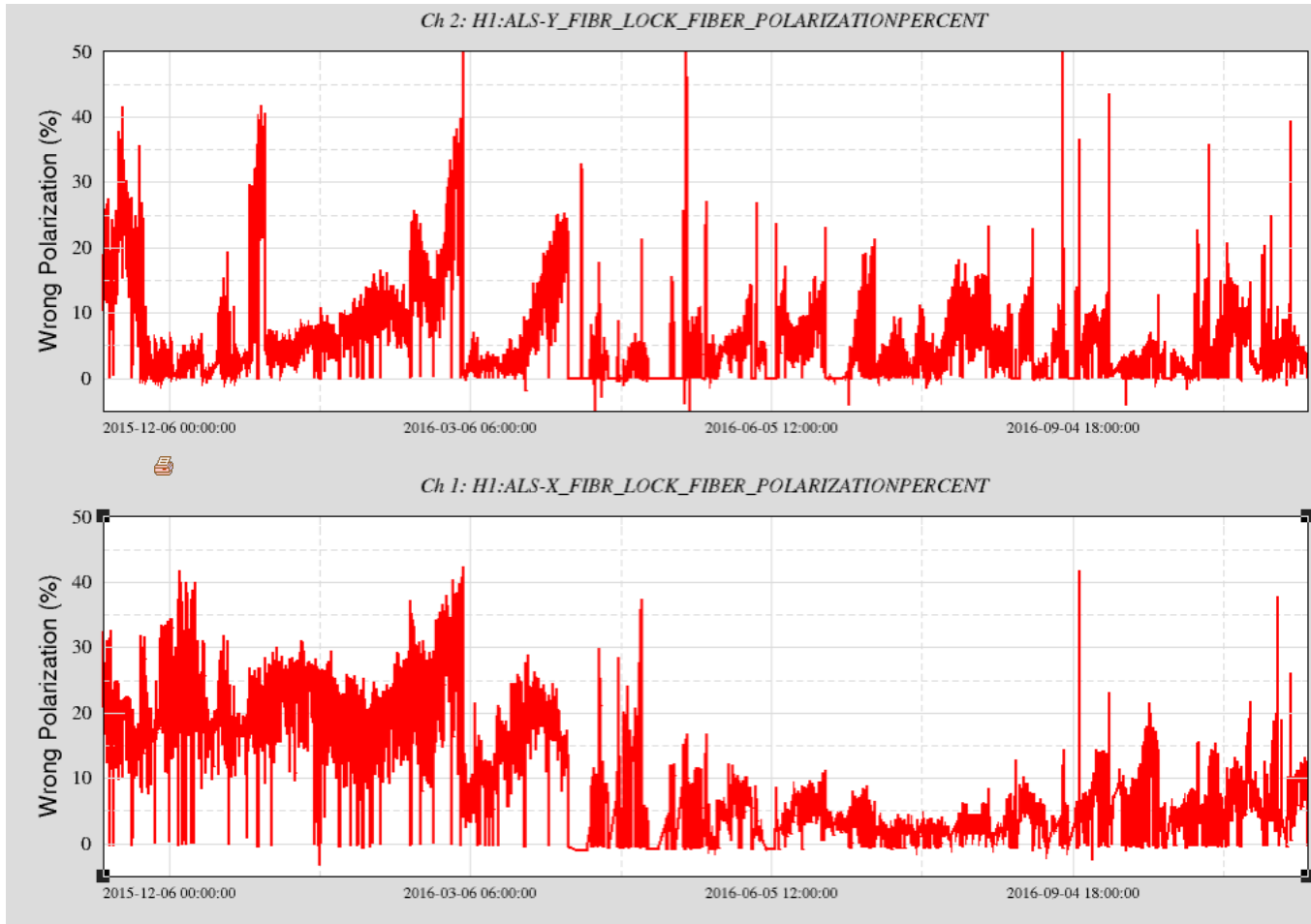
ALS locks each arm individually using lasers mounted behind the test mass

Part of this system includes a polarization controller located in corner station to correct for noise and polarization drift along the fiber optic cables



A. Staley et. al. Achieving Resonance in the Advanced LIGO Gravitational-Wave Interferometer. LIGO Document P1400105. 2014.

# Polarization Drift



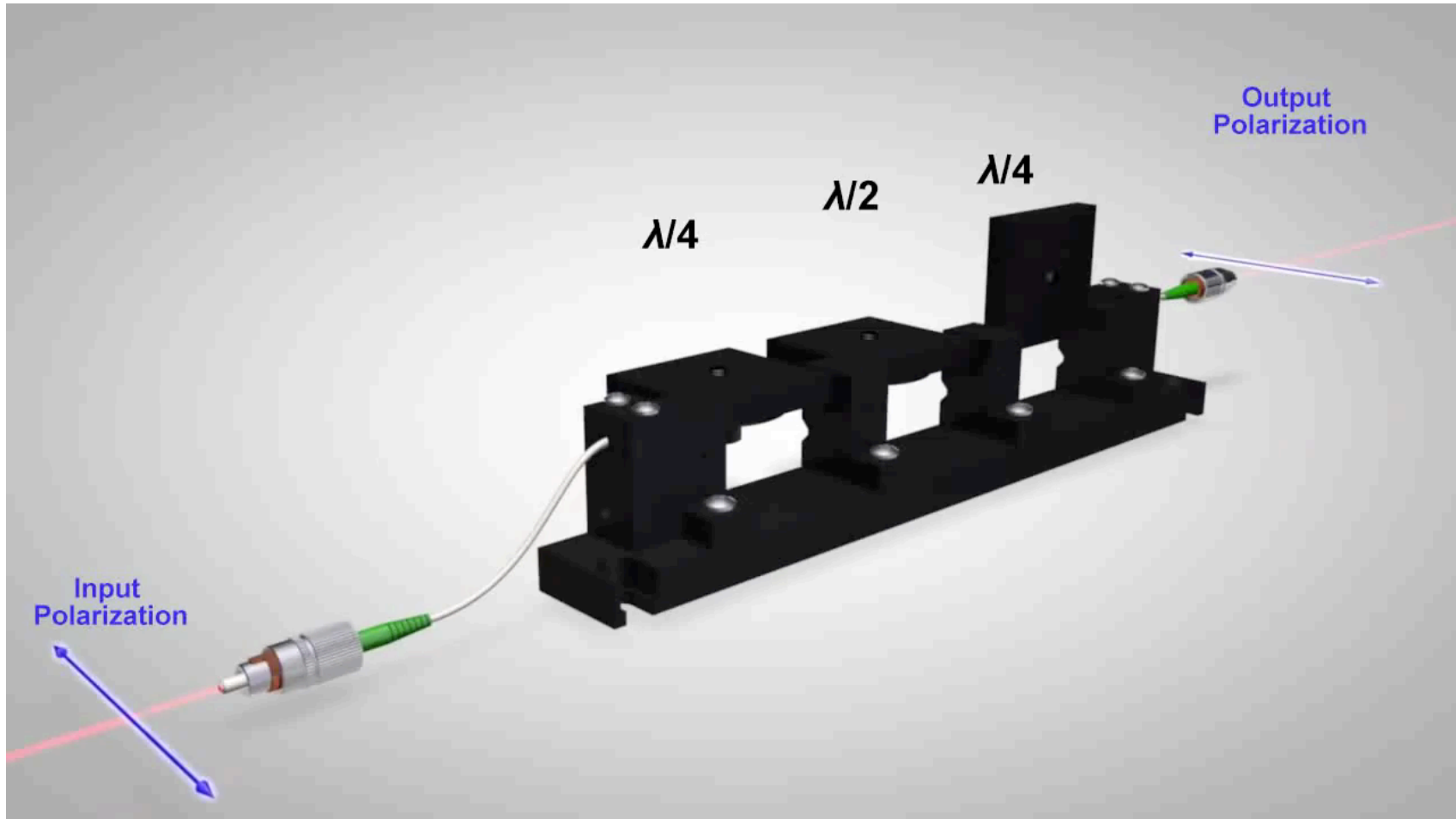
*Trend of Polarization in ALS Fiber Transmission.*  
Jeffrey Kissel,  
LHO Logbook,  
11/18/2016 4

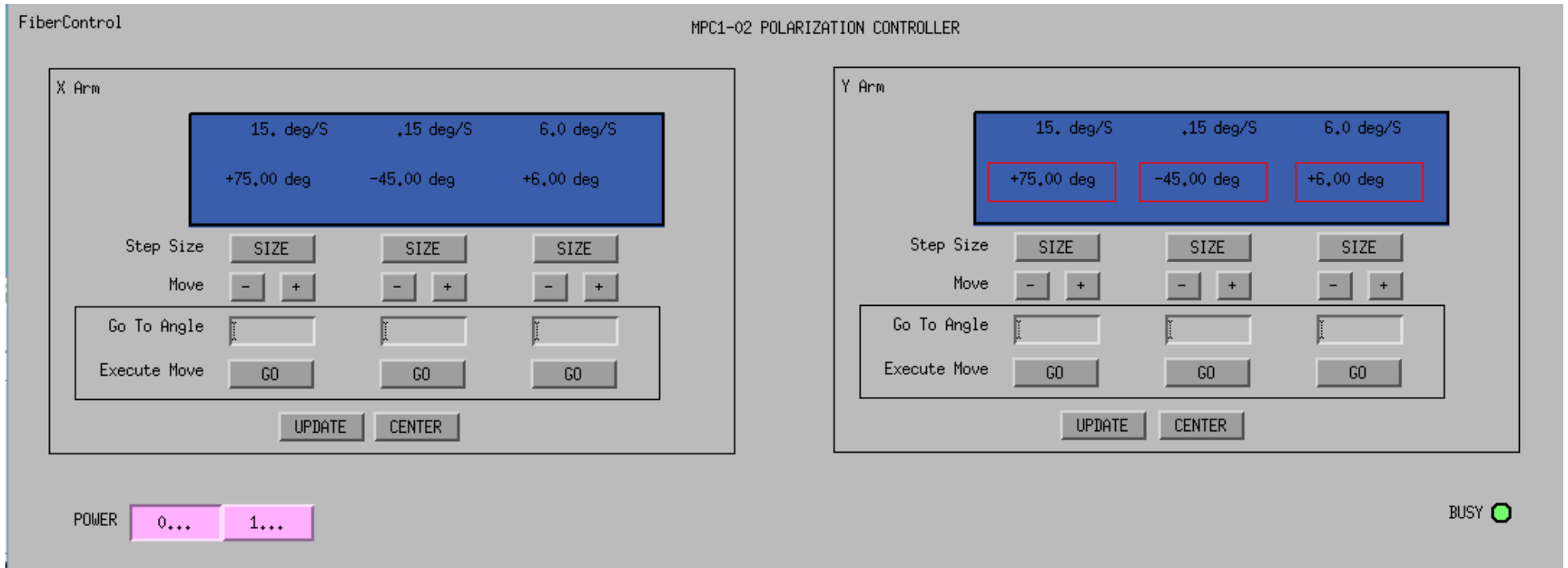
Dual channel to alter  
both X and Y arm

Changes the state-of-  
polarization using  
stress induced  
birefringence



# Motorized Polarization Controller





FiberControl MPC1-02 POLARIZATION CONTROLLER

X Arm

15. deg/S	.15 deg/S	6.0 deg/S
+75.00 deg	-45.00 deg	+6.00 deg

Step Size: [SIZE] [SIZE] [SIZE]

Move: [-] [+] [-] [+] [-] [+]

Go To Angle: [ ] [ ] [ ]

Execute Move: [GO] [GO] [GO]

[UPDATE] [CENTER]

Y Arm

15. deg/S	.15 deg/S	6.0 deg/S
+75.00 deg	-45.00 deg	+6.00 deg

Step Size: [SIZE] [SIZE] [SIZE]

Move: [-] [+] [-] [+] [-] [+]

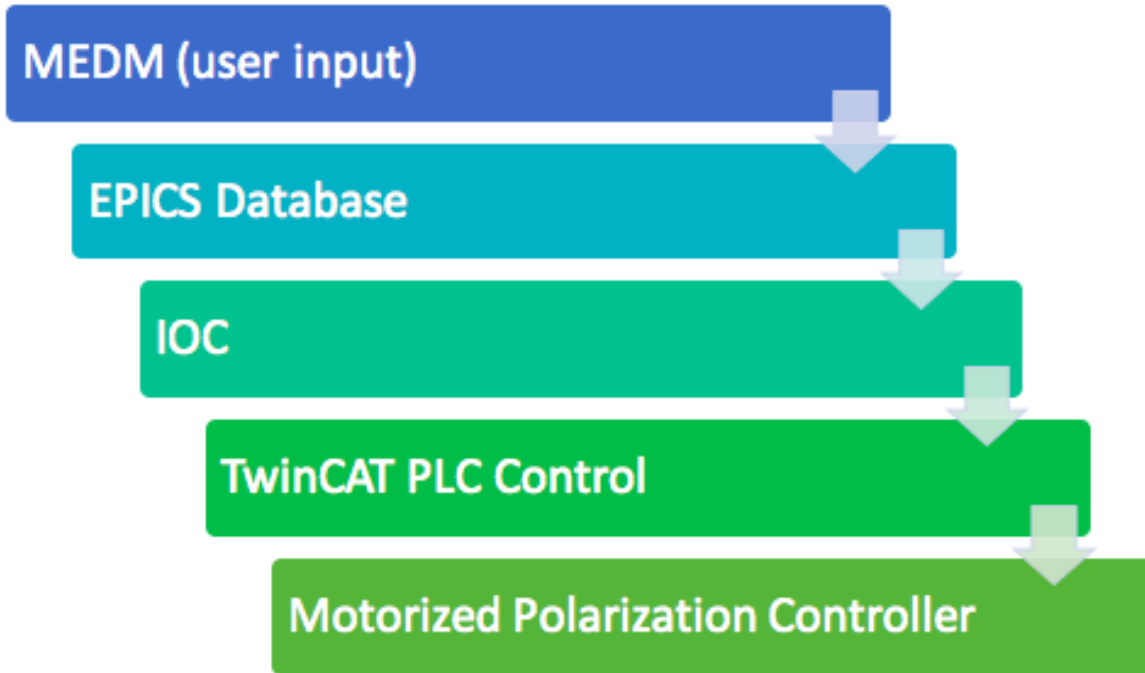
Go To Angle: [ ] [ ] [ ]

Execute Move: [GO] [GO] [GO]

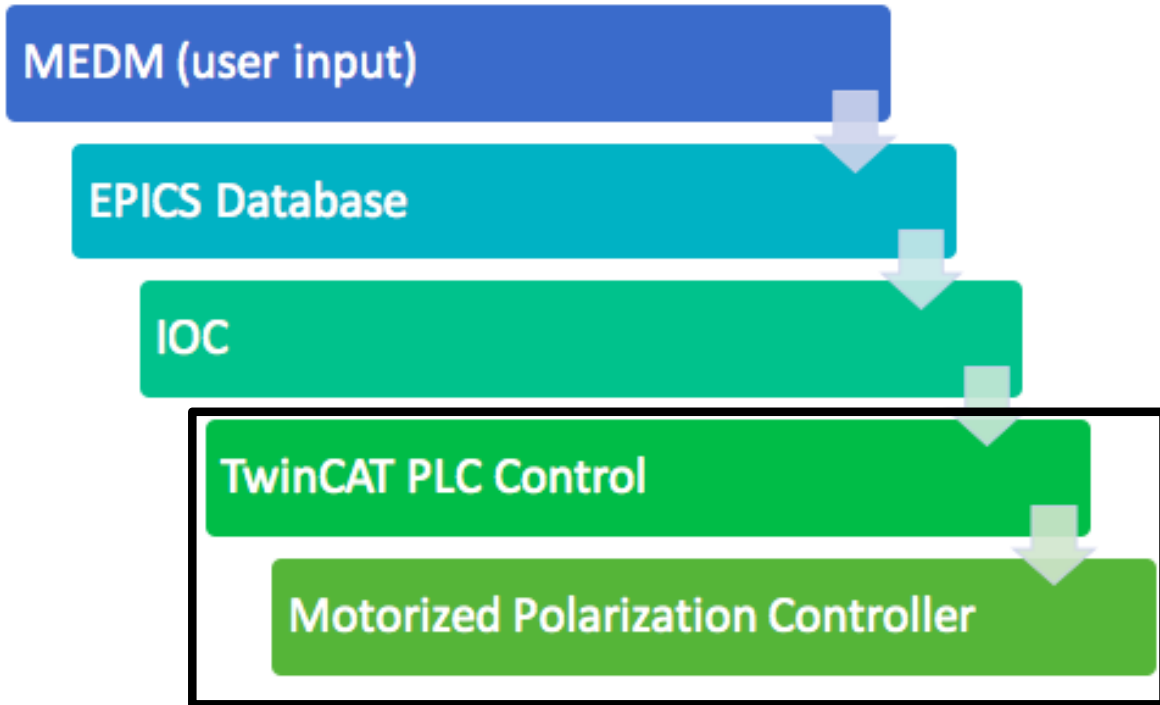
[UPDATE] [CENTER]

POWER: [0...] [1...]

BUSY: ●









- POUs
- BACKGROUND (PRG)
- MAIN (PRG)

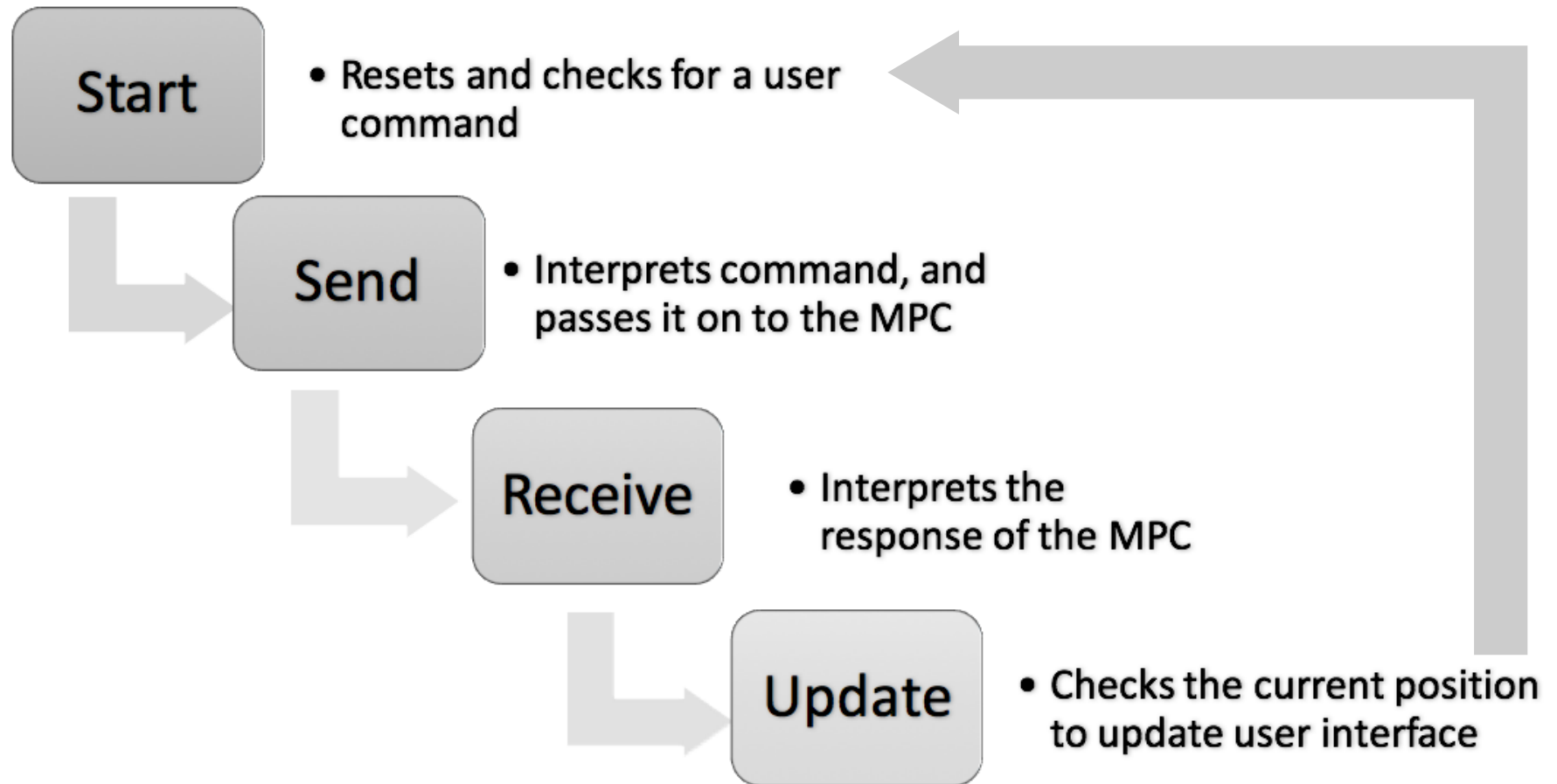
```
0001 SEND_FB
0002 RECEIVE_FB
0003 COMMAND = 'X1?SR$N'
0004 RESPONSE = '$N +15.00 $R$N'
0005 STATE = 16#0001
0006
0007
0008
0009
0010
0011
0012
0013
0014
```

```
0001 CASE STATE OF
0002 0:
0003     SEND_FB(
0004         SendString := COMMAND,
0005         TXbuffer := TX_BUFFER
0006     );
0007
0008     IF SEND_FB.Busy = FALSE THEN
0009         STATE := 1;
0010     END_IF
0011
0012 1:
0013     IF RX_BUFFER.Count > 0 THEN
0014         RECEIVE_FB(
0015             ReceivedString := RESPONSE,
0016             (* Prefix := 'X1?', *)
0017             Suffix := '$0D$0A',
0018             (* Timeout := T#1S, *)
0019             RXbuffer := RX_BUFFER
0020         );
0021     END_IF
0022 END CASE
```

```
STATE = 16#0001
STATE = 16#0001
COMMAND = 'X1?SR$N'

SEND_FB.Busy = FALSE
STATE = 16#0001

RX_BUFFER.Count = 16#0000
RESPONSE = '$N +15.00 $R$N'
```





# Does it work?



Global_Variables	MAIN (PRG-ST)
0001 <input type="checkbox"/> TX_BUFFER	0004 COMMAND = 'X1=5.00\$R\$N'
0002 <input type="checkbox"/> RX_BUFFER	0005 RESPONSE = 'X1=5.00\$R\$N'
0003 FIBER_POLARIZER_XARM_1 = '5.00'	0006 UPDATE_COMMAND = 'X1? \$R\$N'
0004 FIBER_POLARIZER_XARM_2 = ''	0007 UPDATE_RESPONSE = ' + 4.95 \$R\$N'
0005 FIBER_POLARIZER_XARM_3 = ''	0008 FIBER_POLARIZER_SEND_XARM_1 = FALSE
0006 FIBER_POLARIZER_YARM_1 = ''	0009 FIBER_POLARIZER_SEND_XARM_2 = FALSE
0007 FIBER_POLARIZER_YARM_2 = ''	0010 FIBER_POLARIZER_SEND_XARM_3 = FALSE
0008 FIBER_POLARIZER_YARM_3 = ''	0011 FIBER_POLARIZER_SEND_YARM_1 = FALSE
0009 FIBER_POLARIZER_UPDATE_XARM_1 = 0	0012 FIBER_POLARIZER_SEND_YARM_2 = FALSE
0010 FIBER_POLARIZER_UPDATE_XARM_2 = 0	0013 FIBER_POLARIZER_SEND_YARM_3 = FALSE
0011 FIBER_POLARIZER_UPDATE_XARM_3 = 0	0014 <input type="checkbox"/> FIBER_POL_UPDATE_OUTPUT
0012 FIBER_POLARIZER_UPDATE_YARM_1 = 0	0015
0013 FIBER_POLARIZER_UPDATE_YARM_2 = 0	0016
0014 FIBER_POLARIZER_UPDATE_YARM_3 = 0	
0015 <input type="checkbox"/> SystemInfo (%MB32768)	
0016 <input type="checkbox"/> SystemTaskInfoArr (%MB32832)	
0017	



# Does it work?



Global_Variables	MAIN (PRG-ST)
0001 TX_BUFFER	0004 COMMAND = 'X1=5.00\$R\$N'
0002 PY_BUFFER	0005 RESPONSE = 'X1=5.00\$R\$N'
0003 <b>FIBER_POLARIZER_XARM_1 = '5.00'</b>	0006 UPDATE_COMMAND = 'X1? \$R\$N'
0004 FIBER_POLARIZER_XARM_2 = ''	0007 UPDATE_RESPONSE = ' + 4.95 \$R\$N'
0005 FIBER_POLARIZER_XARM_3 = ''	0008 FIBER_POLARIZER_SEND_XARM_1 = FALSE
0006 FIBER_POLARIZER_YARM_1 = ''	0009 FIBER_POLARIZER_SEND_XARM_2 = FALSE
0007 FIBER_POLARIZER_YARM_2 = ''	0010 FIBER_POLARIZER_SEND_XARM_3 = FALSE
0008 FIBER_POLARIZER_YARM_3 = ''	0011 FIBER_POLARIZER_SEND_YARM_1 = FALSE
0009 FIBER_POLARIZER_UPDATE_XARM_1 = 0	0012 FIBER_POLARIZER_SEND_YARM_2 = FALSE
0010 FIBER_POLARIZER_UPDATE_XARM_2 = 0	0013 FIBER_POLARIZER_SEND_YARM_3 = FALSE
0011 FIBER_POLARIZER_UPDATE_XARM_3 = 0	0014 FIBER_POL_UPDATE_OUTPUT
0012 FIBER_POLARIZER_UPDATE_YARM_1 = 0	0015
0013 FIBER_POLARIZER_UPDATE_YARM_2 = 0	0016
0014 FIBER_POLARIZER_UPDATE_YARM_3 = 0	
0015 SystemInfo (%MB32768)	
0016 SystemTaskInfoArr (%MB32832)	
0017	

# Does it work?

Global_Variables	MAIN (PRG-ST)
0001 TX_BUFFER	0004 COMMAND = 'X1=5.00\$R\$N'
0002 PY_BUFFER	0005 RESPONSE = 'X1=5.00\$R\$N'
0003 FIBER_POLARIZER_XARM_1 = '5.00'	0006 UPDATE_COMMAND = 'X1? \$R\$N'
0004 FIBER_POLARIZER_XARM_2 = ''	0007 UPDATE_RESPONSE = ' + 4.95 \$R\$N'
0005 FIBER_POLARIZER_XARM_3 = ''	0008 FIBER_POLARIZER_SEND_XARM_1 = FALSE
0006 FIBER_POLARIZER_YARM_1 = ''	0009 FIBER_POLARIZER_SEND_XARM_2 = FALSE
0007 FIBER_POLARIZER_YARM_2 = ''	0010 FIBER_POLARIZER_SEND_XARM_3 = FALSE
0008 FIBER_POLARIZER_YARM_3 = ''	0011 FIBER_POLARIZER_SEND_YARM_1 = FALSE
0009 FIBER_POLARIZER_UPDATE_XARM_1 = 0	0012 FIBER_POLARIZER_SEND_YARM_2 = FALSE
0010 FIBER_POLARIZER_UPDATE_XARM_2 = 0	0013 FIBER_POLARIZER_SEND_YARM_3 = FALSE
0011 FIBER_POLARIZER_UPDATE_XARM_3 = 0	0014 FIBER_POL_UPDATE_OUTPUT
0012 FIBER_POLARIZER_UPDATE_YARM_1 = 0	0015
0013 FIBER_POLARIZER_UPDATE_YARM_2 = 0	0016
0014 FIBER_POLARIZER_UPDATE_YARM_3 = 0	
0015 SystemInfo (%MB32768)	
0016 SystemTaskInfoArr (%MB32832)	
0017	

# Does it work?

Global_Variables	MAIN (PRG-ST)
0001 TX_BUFFER	0004 COMMAND = 'X1=5.00\$R\$N'
0002 PY_BUFFER	0005 RESPONSE = 'X1=5.00\$R\$N'
0003 FIBER_POLARIZER_XARM_1 = '5.00'	0006 UPDATE_COMMAND = 'X12\$R\$N'
0004 FIBER_POLARIZER_XARM_2 = ''	0007 UPDATE_RESPONSE = ' + 4.95 \$R\$N'
0005 FIBER_POLARIZER_XARM_3 = ''	0008 FIBER_POLARIZER_SEND_XARM_1 = FALSE
0006 FIBER_POLARIZER_YARM_1 = ''	0009 FIBER_POLARIZER_SEND_XARM_2 = FALSE
0007 FIBER_POLARIZER_YARM_2 = ''	0010 FIBER_POLARIZER_SEND_XARM_3 = FALSE
0008 FIBER_POLARIZER_YARM_3 = ''	0011 FIBER_POLARIZER_SEND_YARM_1 = FALSE
0009 FIBER_POLARIZER_UPDATE_XARM_1 = 0	0012 FIBER_POLARIZER_SEND_YARM_2 = FALSE
0010 FIBER_POLARIZER_UPDATE_XARM_2 = 0	0013 FIBER_POLARIZER_SEND_YARM_3 = FALSE
0011 FIBER_POLARIZER_UPDATE_XARM_3 = 0	0014 FIBER_POL_UPDATE_OUTPUT
0012 FIBER_POLARIZER_UPDATE_YARM_1 = 0	0015
0013 FIBER_POLARIZER_UPDATE_YARM_2 = 0	0016
0014 FIBER_POLARIZER_UPDATE_YARM_3 = 0	
0015 SystemInfo (%MB32768)	
0016 SystemTaskInfoArr (%MB32832)	
0017	

# Does it work?

```

Global_Variables
0001  ⊕---TX_BUFFER
0002  ⊕---RX_BUFFER
0003      FIBER_POLARIZER_XARM_1 = '5.00'
0004      FIBER_POLARIZER_XARM_2 = '10.00'
0005      FIBER_POLARIZER_XARM_3 = '15.00'
0006      FIBER_POLARIZER_YARM_1 = '20.00'
0007      FIBER_POLARIZER_YARM_2 = '25.00'
0008      FIBER_POLARIZER_YARM_3 = '30.00'
-----
0009      FIBER_POLARIZER_UPDATE_XARM_1 = 4.95
0010      FIBER_POLARIZER_UPDATE_XARM_2 = 9.9
0011      FIBER_POLARIZER_UPDATE_XARM_3 = 15
0012      FIBER_POLARIZER_UPDATE_YARM_1 = 19.95
0013      FIBER_POLARIZER_UPDATE_YARM_2 = 24.9
0014      FIBER_POLARIZER_UPDATE_YARM_3 = 30
0015  ⊕---SystemInfo (%MB32768)
0016  ⊕---SystemTaskInfoArr (%MB32832)
0017
0018
  
```



# Does it work?



# Does it work?





## Future Goals



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Error and error classification

Add more robust controls- rescan function, power on/off, scrolling mechanism, centering

MEDM/EPICS- user interface

Upgrade to TwinCAT 3



## Conclusion



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Basic communication and controls established

Still a long way to go before it's ready to be used

Opens up the potential not only for digital controls, but also automation of polarization correction



