Conventions: The terms “input” and “output” are used in reference to the Healthy circuitry.
Logic High is what is also thought of as a state of “1” or a 5 volt signal.
Logic Low is what is also thought of as a state of “0” or a grounded signal.
MPU refers to the main processor card installed in the system slot of the CompactPCI chassis.
IOC refers to the Compressor Controls designed IOC-555.

The purpose of this document is to describe the reset operation of the S5 I/O card. There are simplified schematics of the Healthy logic and FTA connections provided on pages 6 and 7 to help clarify the descriptions below.

MPU Healthy Signals:

/OPINION_A and /OPINION_B: These are input signals under software control that originate from the MPU cards. These signals can be thought of as the MPU’s “opinion” of PCI communications with the IOC. Each MPU controls this signal with bit 16 of the CNTRL register in the IOC’s PCI bridge chip, which controls the USERO signal. This bit powers up with a logic “1” value which corresponds to a “not healthy” vote. A value of 0 corresponds to a “healthy” vote. Any time the /OPINION signal from **both** MPU’s goes high, the FT_RELAY signal will be immediately disabled. Note that if the MPU is removed from the chassis, this bit can remain in the “healthy” state. In this case the watch dog will time out and set the corresponding MPU logic unhealthy.

/OPINION_A_ENABLE and /OPINION_B_ENABLE: These are input signals under software control that originate from the MPC555 and are used to allow the corresponding MPU /OPINION signal or force it “unhealthy”. These signals can be thought of as the IOC’s “opinion” of PCI communications with the MPU. These signals power up in a logic high state which forces the /OPINION signals to be unhealthy. A logic low value will enable the opinions. Any time the MPC555 sets **both** of these signals high, the FT_RELAY signal will be immediately disabled.

Watch Dog Timers: Two watch dog timers monitor the presence of the MPU cards. These timers are made up of eight latches connected in series that operate as countdown timers. The primary function of these timers is to detect when an MPU has failed and left its /OPINION signal in a “healthy” state. If the timers are not reset, their respective MPU’s /OPINION signal will be forced to an “unhealthy” state.

WD_CLOCK: This input signal is a 300Hz clock for the watch dog timer.

WD_A_RESET and WD_B_RESET: These are input signals under software control that originate from the MPU cards. The MPU must access a specific range of addresses in the IOC’s PCI bridge chip to generate these signals. Accessing this memory space will generate a high going pulse, which resets the watch dog timer. These signals must be sent at least every 26ms (8 counts at 300Hz) in order to keep the /OPINION signals in the healthy logic. Any time the watch dog from **both** MPU’s fail, the FT_RELAY signal will be immediately disabled.

FT_RELAY: This output signal drives a relay coil that is required, along with the FT_SWITCH signal, to complete the circuit that makes the IOC healthy. This signal originates from a flip/flop that is cleared by a combination of the /OPINION_ENABLE, /OPINION, and WD_RESET signals and clocked by the READ_EXT_OPINION signal.

MDA15: (MPU_A"die" & MPU_B"die"): These output signals are routed to the MPC555 to monitor the MPU's /OPINION signals. They are a logical AND combination of the MPU's /OPINION and /WD timer output. A high level indicates a valid "unhealthy" opinion from an MPU. These two signals are multiplexed onto one pin.

SELECT: This input signal under software control from the MPC555 is used to choose which of the multiplexed MPU "die" signals is directed to the MDA15 output pin. This signal powers up in the high state which selects the "A" MPU. When this signal is low the "B" MPU"die" signal is output on MDA15.

MDA31: This output signal is a direct feedback of the WD_CLOCK signal to the MPC555 to verify its operation.

IOC-555 Healthy Signals:

/S_RESET: This input signal comes from the MPC555 and powers up in a low state. When the MPC555 detects a cause to assert a soft reset it will drive this line low for 512 clock cycles. Causes for /S_RESET are: External soft reset, debug port soft reset, and BDM reset. Any time this signal goes low, the FT_SWITCH signal will be immediately disabled.

/H_RESET: This input signal comes from the MPC555 and powers up in a low state. When the MPC555 detects a cause to assert a hard reset it will drive this line low for 512 clock cycles. Causes for /H_RESET are: External hard reset, loss of lock, on-chip clock switch, illegal low-power mode, software watchdog, checkstop, and debug port hard reset. Any time this signal goes low, the FT_SWITCH signal will be immediately disabled.

/PO_RESET: This input signal is produced by the IOC's power control circuit. This signal is asserted low when power is first applied to the board and then goes high after approximately 4mS. Any time this signal goes low, the FT_SWITCH signal will be immediately disabled.

/I_AM_HEALTHY: This input signal is under software control and originates from the MPC555. It is intended to be the MPC555's opinion of the local operations of the IOC. This signal powers up in a high state, which is the "unhealthy" state and must be driven low to enable FT_SWITCH signal. Any time this signal goes high, the FT_SWITCH signal will be immediately disabled.

FT_SWITCH: This output signal drives a solid state switch that is required, along with the FT_RELAY signal, to complete the circuit that makes the IOC healthy. This signal originates from a flip/flop that is cleared by a logical combination of the /S_RESET, /H_RESET, /PO_RESET, and /I_AM_HEALTHY signals and clocked by the READ_EXT_OPINION signal.

READ_EXT_OPINION: This input signal is under software control and originates from the MPC555. It clocks the two flip/flops that drive the FT_RELAY and FT_SWITCH signals. This signal powers up in a logic high state. On a high to low transition of this signal, the FT_RELAY and FT_SWITCH signals will be enabled and the card will become healthy, as long as the "clears" for those signals are not asserted. The "clears" are combinations of the other input signals as described in this document.

DO_ENABLE: This signal is currently not used and is permanently tied high.

IN_CONTROL: This input signal is under software control and originates from the MPC555. Its only function is to turn on the CONTROL LED on the front panel of the IOC. This signal powers up in a high state, which is the

off state for the LED and must be driven low turn the LED on. It is logically "ANDed" with Healthy to insure that an unhealthy card cannot be accidentally made to look "In Control" to the user.

Theory of I/O card reset operation

When the 555 starts a reset cycle, at least one (and most likely all) of the /S_RESET, /H_RESET, /PO_RESET, or "I_AM_HEALTHY" signals will be in the "unhealthy" state. This asserts the clear to the flip/flop, which will disable the FT_SWITCH. If the MPC555 processor is operating correctly, all three reset signals will be negated after 512 clock cycles. Then, once the processor has determined that the rest of the I/O card is operating properly, it will set its "I_AM_HEALTHY" signal.

The MPU /OPINION and /OPINION_ENABLE signals will power up in the "unhealthy" state. Also, until the MPU starts executing code, the watch dog times will time out and be in the "unhealthy" state. The MPU cards then have to determine if the I/O card should be healthy. Each MPU card will communicate with the I/O card to make sure it is operating properly. If the MPU(s) is satisfied that the I/O card is operational it will set its /OPINION bit and start resetting the watch dog timers. If the I/O card is satisfied that the MPU is operational it will set its /OPINION_ENABLE bit. The /OPINION, /OPINION_ENABLE, and WD_RESET signals are all required to negate the clear on the FT_RELAY signal.

When the three resets and I_AM_HEALTHY signals are in their "healthy" states, the clear to the FT_SWITCH signal is negated. When the MPU /OPINION signals are in the "healthy" state and the watch dog timers are being reset, the clear to the FT_RELAY is negated. Once both of these clears are negated, a high to low transition on the READ_EXT_OPINION enables both signals and makes the IOC healthy. Although the FT_SWITCH and FT_RELAY signals can be enabled individually, both are required to make an I/O Card fully Healthy.

System operation:

The control logic is as follows:

If IOC_A is healthy then IOC_A is in control of the outputs, regardless of the state of IOC_B.
If IOC_A is not healthy and IOC_B is healthy then IOC_B is in control of the outputs.
If IOC_A and IOC_B are not healthy then system is faulted. All outputs are disconnected from the field.

The logic for deciding who is in control of the outputs will be implemented on the FTA using relays. Each I/O card can determine if it is in control of the outputs because the HEALTHY signal from the peer card will be returned to each I/O card. The MPU can determine which I/O card is in control by knowing which I/O card is A or B and then knowing the healthy status of each card. The 555 software will be in control of the LED on the front of the I/O card used to indicate which card is controlling the outputs.

Analog outputs: If both I/O cards are healthy then they both will have their local outputs enabled. IOC_A will be in control and the analog outputs of IOC_B will be routed through dummy loads. If IOC_A becomes unhealthy then IOC_B will be in control and the analog outputs from IOC_A will be routed through dummy loads.

Only one MPU is required for an I/O card to become healthy. Both MPU's are required to force an I/O card unhealthy. This allows for one MPU to fail and still have duplex I/O card operation. In a simplex system there would be only one MPU.

Feedback signals from the FTA (see page 7 for a schematic diagram of all connections)

HEALTHY(1:4): These signals are used to monitor the HEALTHY output signal going to each FTA and are read by the MPC555 at Latch 1. When the IOC is healthy and everything is working correctly, these signals should be high at the processor's inputs.

HEALTHY_FB(1:4): These input signals originate on the FTA and are feedbacks of the HEALTHY signal. These signals are controlled by the healthy relay on the FTA and are used to verify its operation. The MPC555 can read these signals at Latch 1 or on the MDA port. Software has the option to use the MDA inputs as interrupts for the quickest response to a HEALTHY_FB failure. When the IOC is healthy and everything is working correctly, these signals should be low at the processor's inputs.

FT_PEER(1:4): These input signals originate on the FTA and are the HEALTHY_FB signal from the peer card in a duplex pair. The MPC555 can read these signals at Latch 1 or on the MDA port. Software has the option to use the MDA inputs as interrupts for the quickest response to a FT_PEER failure. When the peer IOC is healthy and everything is working correctly, these signals should be low at the processor's inputs.

A/B(1:4): These input signals originate on the FTA and are used to identify if an IOC is the "A" or "B" card in a duplex pair. The MPC555 can read these signals at Latch 1. For an IOC connected to a simplex FTA or the "A" connector on a duplex FTA, this signal will read low at the processor's inputs. For an IOC connected to the "B" connector on a duplex FTA, this signal will read high at the processor's inputs.

Following is a matrix of all the possible FTA signal states (at MPC555 inputs) and what can be determined from them.

A not B	HEALTHY	HEALTHY_FB	FT_PEER		Is the FTA cable connected	I am card A	I am card B	I/OA is healthy	I/OB is healthy	In control	Healthy A and Feedback disagree	Healthy B and Feedback disagree	
0	0	0	0		YES	YES		?	YES		YES		A: Fault Condition, B Heathly
0	0	0	1		YES	YES		?			YES		A: Fault Condition, B not Healthy
0	0	1	0		YES	YES		NO	YES	B			Valid: A not Healthy, B Healthy
0	0	1	1		YES	YES		NO		None			Valid: A not Healthy, B not Healthy
0	1	0	0		YES	YES		YES	YES	A			Valid: A Healthy, B Healthy
0	1	0	1		YES	YES		YES		A			Valid: A Healthy, B not Healthy
0	1	1	0		YES	YES		?	YES		YES		A: Fault Condition, B Heathly
0	1	1	1		YES	YES		?			YES		A: Fault Condition, B not Healthy
1	0	0	0		YES		YES	YES	?			YES	B: Fault Condition, A Healthy
1	0	0	1		YES		YES		?			YES	B: Fault Condition, A not healthy
1	0	1	0		YES		YES	YES	NO	A			Valid: A Healthy, B not Healthy
1	0	1	1		YES		YES		NO	None			Valid: A not Healthy, B not Healthy
1	1	0	0		YES		YES	YES	YES	A			Valid: A Healthy, B Healthy
1	1	0	1		YES		YES		YES	B			Valid: A not Healthy, B Healthy
1	1	1	0		YES		YES	YES	?			YES	B: Fault Condition, A Healthy
1	1	1	1		NO		?	?	?				Cable not connected

Rev.	Date	By	Aprv'd	Description
A		LB		
B	9/17/98	LB		Changed description of HEALTHY. Added HEALTHY_FB
C	9/23/98	LB		Minor changes per 9/21/98 review meeting
D	9/28/98	LB		Adding opinion WDT section
E	10/12/98	LB		Removed latches and FT_OUT, added WD_"I",
F	10/13/98	LB		Removed \DORESET
G	12/15/98	LB		Removed WD"I" text. Changed Read_EXT_Opinion to Read_Opinion Added 750"die" signals. Redefined "I_AM_Healthy" signal.
H	8/16/99	LB		Added logic level info to signal descriptions.
I	11/1/99	TS		Added signal descriptions and updated logic levels
J	04/22/04	TS		Updated for current hardware, added FTA signal matrix

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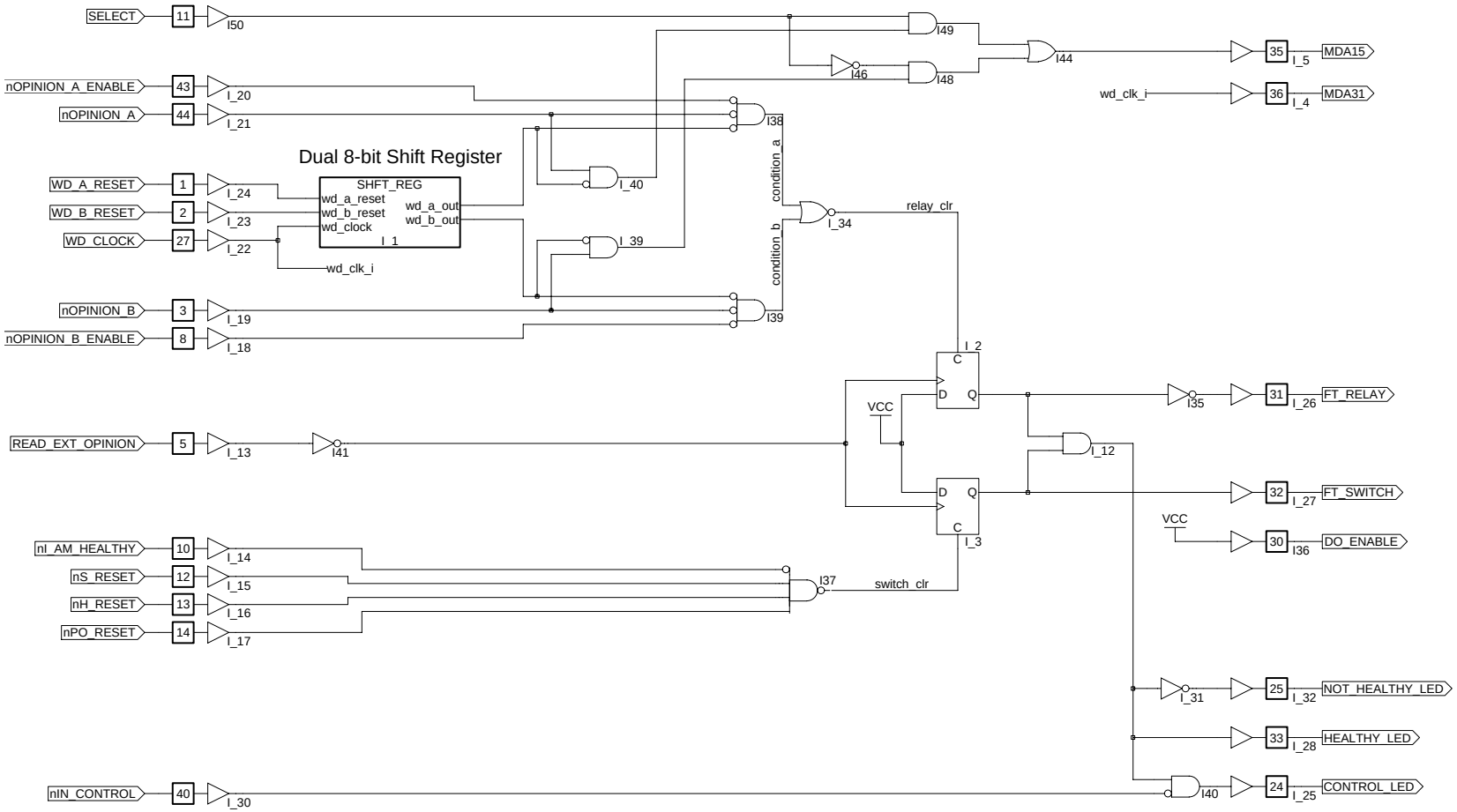
DATE: 04/22/04	**CCC PRODUCT:** S5 I/O card	**PRODUCT DESIGN LEADER:**
SHEET: 6 of 7		**CCC DOCUMENT:** D:\Users\Tom Stoll\My Documents\Work\WORD\IORESETj.doc
REV: J	**ENGINEER:** Luke Brown	

HEALTHY LOGIC SCHEMATIC



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DATE: 04/22/04	**CCC PRODUCT:** S5 I/O card	**PRODUCT DESIGN LEADER:**
SHEET: 7 of 7		**CCC DOCUMENT:** D:\Users\Tom Stoll\My Documents\Work\WORD\IORESETj.doc
REV: J	**ENGINEER:** Luke Brown