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CSAC GPSDO Operating Recommendations Rev. 1.1

ITEM 1: - Automatic CSAC Oscillator Calibration

Issue: The CSAC oscillator used on the CSAC GPSDO and other CSAC based products has an aging parameter specification of 0.3ppb per month. This oscillator aging is measured and compensated for on the CSAC GPSDO over a period of 24 hours during operation with GPS. The error may accrue if the unit is not operated for at least 24 hours with GPS, causing increasing cold-start lock times over time.

Solution: The CSAC GPSDO firmware automatically stores the frequency calibration data inside the CSAC NVRAM once every 24 hours. This is to maximize the lifetime of the CSAC as its internal NVRAM has only a limited number of allowable write cycles. When operating the unit for less than 24 hours, this parameter is not stored in the CSAC, and this calibration factor is lost upon power-down. This causes the CSAC to have larger and larger frequency offsets after power-on over months to years of life, which may cause longer and longer disciplining times after initial power-on. The first solution to this is simply to let the unit run for 24 to 48 hours with GPS lock once every 12 months. The second solution is to manually cause a write of the calibration parameter into the CSAC NVRAM using the:

CSAC:STEER:LATCH ONCE

command after the CSAC GPSDO indicates full lock. This command should not be issued more than once every 24 hours on average on a continuous basis to avoid exceeding the number of allowable lifetime writes into the internal NVRAM.

Storing the frequency calibration vector inside the CSAC NVRAM as shown above will enable the CSAC to generate 10MHz with very high frequency accuracy in case the GPS antenna is disconnected or damaged, the processor, or other parts on the CSAC GPSDO are damaged, and thus offers a higher default frequency accuracy after power-on even when operated without a GPS antenna.

Operating the unit for 48+ hours with GPS disciplining allows the software to measure the CSAC oscillator aging parameter, and to apply an automatic aging compensation value for this aging, to further reduce the operating frequency errors in the absence of GPS signals. It is thus recommended that the CSAC GPSDO is

operated 48 to 72 hours with a good GPS signal at least once per year to optimize the performance of the unit, and to fully compensate for accrued CSAC oscillator aging.

ITEM 2: BOM update for units produced in 2011 or earlier (ONLY APPLIES TO CSAC GPSDO BOARDS, PN: 100500x)

Issue: Units produced prior to August 2012 could have excessive phase noise and higher than usual frequency jitter and instability on the 10MHz output.

Solution: Units can be upgraded to address this issue by replacing resistor R61 with a 5.6K, 0402 resistor. Jackson Labs Tech., Inc. can do this upgrade to fielded units without charge.

ITEM 3: Premature CSAC failure for units manufactured in early 2014

Issue: Microsemi experienced a manufacturing defect in many CSAC units produced in early 2014 which can lead to loss-of-vacuum in the CSAC cavity, and failure to lock to the atomic cavity (CSAC? Status 8 – Failure).

Solution: The heater power (heat package) of the CSAC cavity can be monitored with the CSAC? or CSAC:HEAT? command, and will slowly increase in CSAC units that experience a slow vacuum failure mode.

Normal CSAC heater package power is between 4mW to 18mW at room temperature. Units operating at 24mW or higher are potentially slowly leaking their vacuum, and will fail to lock when the CSAC heater power reaches ~34mW. Units indicating >24mW heater power should be taken out of service as soon as practical.

ITEM 4: Microsemi FSB #: 098-50620-075, change of operating and storage temperature specification

Issue: Microsemi published the FSB in December 2014 changing the maximum operating and storage temperatures for the CSAC oscillator to +35C and +40C respectively.

Solution: Operating the CSAC at +35C is not practical for various reasons. Jackson Labs Tech., Inc. was able to verify that the FSB temperature changes are required to achieve the Microsemi-specified MTBF of 100,000 hours, which is 11.4 years, while the CSAC itself actually remains operational at much higher temperatures, albeit with a reduced MTBF expectation. JLT was able to establish with Microsemi that a much more realistic operating case temperature of +65C is allowable for 8 hours out of every 24 hour period, with an expected reduction of useful lifetime of up to 6 years when the unit is stored below +35C during the remaining 16 non-operating hours in every 24 hour period. Further analysis is in

progress to substantiate these expectations statistically.